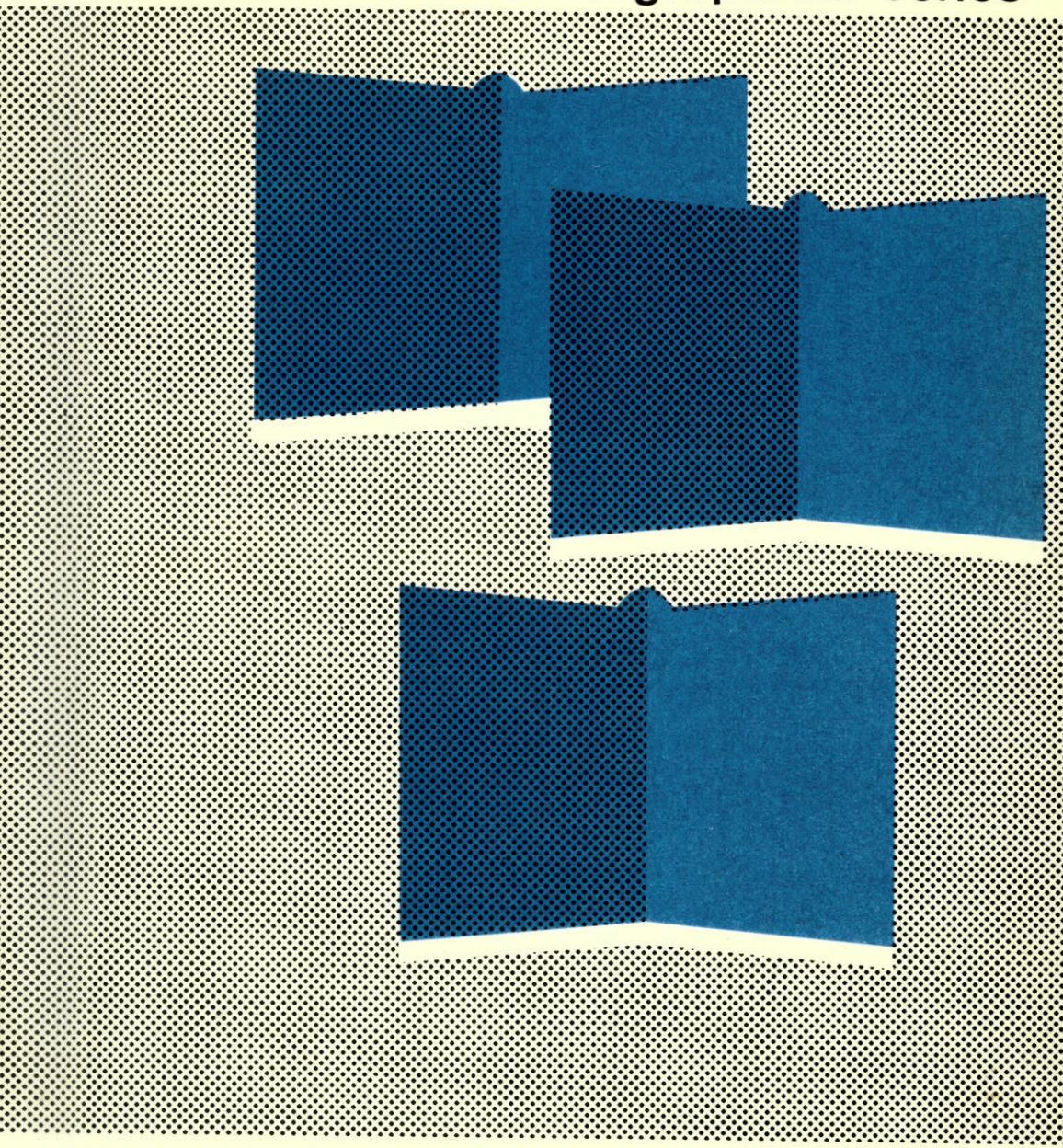
bibliographical series



No. 9

# RADIOISOTOPES AND IONIZING RADIATIONS IN ENTOMOLOGY

INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA 1963

BIBLIOGRAPHICAL SERIES

No. 9

The following States are Members of the International Atomic Energy Agency:

AFGHANISTAN
ALBANIA
ARGENTINA
AUSTRALIA
AUSTRIA
BELGIUM
BRAZIL
BULGARIA
BURMA
BYELORUSSIAN SOVIET SOCIALIST REPUBLIC
CAMBODIA
CANADA
CEYLON
CHILE
CHINA
COLOMBIA
CONGO (LÉOPOLDVILLE)
CUBA
CZECHOSLOVAK SOCIALIST REPUBLIC
DENMARK
DOMINICAN REPUBLIC
ECUADOR
EL SALVADOR
ETHIOPIA
FINLAND
FRANCE
FEDERAL REPUBLIC OF GERMANY
GHANA
GREECE
GUATEMALA
HAITI
HOLY SEE
HONDURAS
HUNGARY
ICELAND
INDIA
INDONESIA
IRAN
IRAQ
ISRAEL
ITALY
JAPAN
REPUBLIC OF KOREA
LEBANON
LIBERIA
LUXEMBOURG
MALI
MEXICO
MONACO
MOROCCO
NETHERLANDS
NEW ZEALAND
NICARAGUA
NORWAY
PAKISTAN
PARAGUAY
PERU
PHILIPPINES
POLAND
PORTUGAL
ROMANIA
SAUDI ARABIA
SENEGAL
SOUTH AFRICA
SPAIN
SUDAN
SWEDEN
SWITZERLAND
THAILAND
TUNISIA
TURKEY
UKRAINIAN SOVIET SOCIALIST REPUBLIC
UNION OF SOVIET SOCIALIST REPUBLICS
UNITED ARAB REPUBLIC
UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND
UNITED STATES OF AMERICA
URUGUAY
VENEZUELA
VIET-NAM
YUGOSLAVIA

The Agency's Statute was approved on 26 October 1956 at an international conference held at United Nations headquarters, New York, and the Agency came into being when the Statute entered into force on 29 July 1957. The first session of the General Conference was held in Vienna, Austria, the permanent seat of the Agency, in October, 1957.

The main objective of the Agency is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

© IAEA, 1963

Permission to reproduce or translate the information contained in this publication may be obtained by writing to the International Atomic Energy Agency, Kärntner Ring 11, Vienna I.

Printed by the IAEA in Austria
March 1963

BIBLIOGRAPHICAL SERIES
No. 9

# RADIOISOTOPES AND IONIZING RADIATIONS IN ENTOMOLOGY

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA 1963

BIBLIOGRAPHICAL SERIES, No. 9: RADIOISOTOPES AND IONIZING RADIATIONS IN ENTOMOLOGY, IAEA, VIENNA, 1963
STI/PUB/21/9

# FOREWORD
# AVANT-PROPOS
# ПРЕДИСЛОВИЕ
# PREFACIO

This bibliography on Radioisotopes and Ionizing Radiations in Entomology is the ninth in the "Bibliographical Series" published by the International Atomic Energy Agency. Source material was obtained from the open world literature for the years 1950 to 1960, inclusive. The aim, scope and details of coverage are discussed more fully in the Introduction. No claim to completeness is made although every effort has been made to include all pertinent references that could be traced. The bibliography reflects the enormous impetus given to research into various aspects of entomology by the availability of radioisotopes and ionizing radiations. It should be of interest to the specialist in need of a survey of relevant publications in related disciplines, and to workers requiring collected references covering particular aspects of the field. The Agency intends to continue bibliographical work in entomology.

A special effort has been made to present the references in such a way that they will be of the fullest use to readers in developing countries where certain publications may not be easily available. References have therefore been supplied with abstracts. To increase the usefulness of this bibliography a detailed subject index is included, in addition to the usual author index.

The bibliography was compiled by Mrs. M. Binggeli of the Agency's Division of Scientific and Technical Information.

Readers are invited to address their suggestions and other correspondence regarding the "Bibliographical Series" to: The Director, Division of Scientific and Technical Information, International Atomic Energy Agency, Vienna I., Kärntnerring 11, Austria.

La présente bibliographie, consacrée aux radioisotopes et aux rayonnements ionisants en entomologie, est la neuvième de la collection "Bibliographies" publiée par l'Agence internationale de l'énergie atomique. Les ouvrages cités ont été choisis dans la documentation publiée dans le monde entier entre 1950 et 1960. Le but, la portée et le détail de cette bibliographie sont indiqués d'une manière plus complète dans l'introduction. Sans prétendre a une étude exhaustive, on n'a ménagé aucun effort pour citer tous les ouvrages pertinents qu'on a pu retrouver. Cette bibliographie reflète l'essor considérable de la recherche dans divers domaines de l'entomologie depuis qu'on utilise les radioisotopes et les rayonnements ionisants. Elle devrait intéresser les spécialistes qui désirent posséder une liste de publications en la matière et les chercheurs qui ont besoin de rassembler des références sur certains aspects particuliers de la recherche entomologique. L'Agence a l'intention de continuer ce travail bibliographique en entomologie.

On s'est efforcé surtout de présenter les listes d'ouvrages de telle manière que les lecteurs des pays en voie de développement, qui peuvent avoir des difficultés à se procurer certaines publications, puissent en tirer le meilleur profit. On a donc fait suivre chaque titre d'un bref résumé. Pour qu'il soit encore plus facile de consulter cette bibliographie, on a complété l'index par auteur habituel par un index détaillé par sujet.

Cette bibliographie a été établie par Mme M. Binggeli, de la Division de la documentation scientifique et technique de l'Agence.

Les lecteurs sont prié d'adresser leurs suggestions et toute la correspondance concernant la collection "Bibliographies" au Directeur de la Division de la documentation scientifique et technique, Agence internationale de l'énergie atomique, Vienna I, Kärntnerring 11, Autriche.

Библиография по вопросам использования радиоактивных изотопов и ионизирующих излучений в энтомологии является девятой в "Библиографической серии", издаваемой Международным агентством по атомной энергии. Материал, вошедший в нее, был взят из открытой литературы, опубликованной в разных странах за период с 1950 - 1960 гг. Предмет, объем и характерные особенности библиографии подробно изложены во Введении. Библиография не претендует на полноту охвата, хотя было сделано все возможное, чтобы отыскать и включить в нее все относящиеся к данной теме материалы. В библиографии отразились огромные успехи в исследовании различных областей энтомологии, стимулированном использованием радиоактивных изотопов и ионизирующих излучений. Библиография представит интерес как для специалистов, работающих в смежных с данной областях, так и для ученых, нуждающихся в подборке работ, посвященных специфическим проблемам, охватываемым настоящей библиографией. Агентство намерено продолжать библиографическую работу по энтомологии.

Особое внимание было уделено форме представления библиографических данных, с тем чтобы ученые развивающихся стран, где некоторые издания могут оказаться труднодоступными, могли извлечь наибольшую пользу из каждой приведенной ссылки. Поэтому всюду, где было возможно, библиографические данные сопровождаются аннотациями. Для увеличения ценности данной библиографии, кроме обычного авторского указателя, в нее включен также подробный предметный указатель.

Библиография составлена сотрудницей Отдела научно-технической информации Агентства г-жой М. Бинггели.

Читателей просят направлять предложения и замечания, относящиеся к "Библиографической серии", по адресу: Австрия, Вена I, Кернтнерринг 11, Директору Отдела научно-технической информации Международного агентства по атомной энергии.

Esta bibliografía sobre el empleo de radioisótopos y radiaciones ionizantes en entomología es la novena que edita el Organismo Internacional de Energía Atómica en su "Colección de Bibliografías". En ella se recopilan las obras de carácter no confidencial publicadas entre 1950 y 1960 inclusive. En la Introducción se describen detenidamente los fines, el alcance y los detalles de las obras recopiladas. Claro está que la bibliografía no resulta completa, aunque se ha hecho todo lo posible por recoger todas las referencias que se han podido encontrar. Pese a ello, queda perfectamente reflejado el enorme inpulso adquirido por las investigaciones sobre diversos aspectos de la entomología gracias al empleo de radioisótopos y de radiaciones ionizantes. La recopilación será de interés para los especialistas que necesiten un análisis de las publicaciones importantes sobre disciplinas afines a las suyas, y para los investigadores que precisan disponer de datos bibliográficos acerca de un aspecto particular de esta esfera. El Organismo tiene la intención de continuar sus trabajos bibliográficos sobre entomología.

Se ha tratado especialmente de confeccionar y presentar la bibliografía de forma que resulte del máximo provecho para los lectores de los países en vías de desarrollo, que quizá tropiecen con dificultades para procurarse ciertas publicaciones. Por eso, con cada obra citada se da un breve resumen de su contenido. Para facilitar el empleo de esta recopilación, además del índice de autores hay un índice detallado de materias.

La bibliografía ha sido preparada por la Sra. M. Binggeli, de la División de Información Científica y Técnica del Organismo.

Se ruega a los lectores que envíen sus observaciones y toda la correspondencia relativa a la "Colección de Bibliografías" al Director de la División de Información Científica y Técnica, Organismo Internacional de Energía Atómica, Kärntnerring 11, Viena I (Austria).

# CONTENTS


INTRODUCTION ..... 13

PART I: RADIOISOTOPES ..... 17

I INSECTS ..... 19

A Ecology ..... 19
1 Survey Articles ..... 19
2 Behaviour ..... 22
a Feeding ..... 22
b Transmission of Food ..... 27
c General Behaviour ..... 30
3 Population Dynamics (Dispersal, Flight Range, etc.) ..... 32
4 Parasites and Predators ..... 45
B Insect Physiology and Metabolism ..... 47
1 Carbohydrates ..... 47
2 Proteins and Amino Acids ..... 52
3 Nucleic Acids ..... 62
4 Sterols ..... 66
5 Elements ..... 68
6 Virus Diseases ..... 82
7 Miscellaneous ..... 82
C Insect Labelling ..... 85
D Developmental and Genetic Effects Incurred through Labelling ..... 95
E Insects as Disease Vectors in ..... 101
1 Man ..... 101
2 Animal ..... 102
3 Plant ..... 103

II INSECTICIDES ..... 105

A Survey Articles ..... 105
B Fumigants ..... 106
C Halogenated Hydrocarbons ..... 108
D Organophosphates ..... 123
E Pyrethrins and related Compounds ..... 156
F Nicotine, Carbamates and other Compounds ..... 159
G Repellents ..... 165
H Insecticide Metabolism in ..... 166
1 Insects ..... 166
2 Mammals ..... 174
3 Plants ..... 178
I Insecticide Residues in ..... 183
1 Mammals ..... 183
2 Plants ..... 184
3 Soil ..... 187

III TECHNIQUES ..... 189

A Autoradiography ..... 189
B Dosimetry ..... 190
C Isotope Dilution ..... 190
D Labelled Pool Technique ..... 191
E Paper Chromatography ..... 192
F Miscellaneous ..... 192

IV BIBLIOGRAPHIES AND GENERAL SURVEYS ..... 194

A Bibliographies ..... 194
B Surveys ..... 195

PART II: IONIZING RADIATIONS ..... 197

I RESEARCH ..... 199

A Radiosensitivity ..... 199
1 Radiosensitivity to different Types of Radiation ..... 199
2 Radiosensitivity of one or more Stages of Development ..... 209
3 Radiosensitivity of different Species or Strains ..... 216
4 Radiosensitivity at the Cellular Level ..... 220
B Genetic Effects ..... 226
1 General ..... 226
2 Induced Mutations ..... 232
3 Induced Sterility ..... 262
C Effects on Development ..... 267
1 Survey Articles ..... 267
2 Fecundity ..... 268
3 Germ Cells (including oögenesis and spermatogenesis) ..... 273
4 Lethal Effects ..... 293
5 Longevity and Recovery Phenomena ..... 300
6 Physiological and Biochemical Effects ..... 306
7 Tumour Formation ..... 315
D Combination or Comparison of Several Treatments (other Radiations, Heat, Chemicals, etc.) .... 317
E Radiation Effects on Insect Populations ..... 334

II APPLICATIONS ..... 340

A Sterile Male Technique ..... 340
1 Screwworm Fly ..... 340
2 Fruit Flies ..... 344
3 Tsetse Fly ..... 345
4 Various ..... 346
B Stored Products Infestation and its Detection ..... 346
1 Commodities ..... 346
2 Sources for Disinfestation ..... 351
3 Economics ..... 353
4 Detection ..... 354
C Sericulture ..... 356
D Miscellaneous Applications ..... 357
1 Timber Protection ..... 357
2 Various ..... 358

ADDENDUM ..... 359

NEMATODES ..... 361

A Radioisotope Studies ..... 361
B Ionizing Radiation Studies ..... 361

APPENDIX ..... 365

Table Ia Dispersal of Radioisotope-marked Forest Insects ..... 367

Table Ib Dispersal of Radioactive-marked Orchard Insects ..... 368

Table Ic Dispersal and Flight Range of Radioactive-marked Mosquitoes ..... 369

Table Id Dispersal and Flight Range of Radioactive-marked Flies ..... 370

Table II Radiation Sterilization of Medically-important Insects ..... 371

Table III Mortality of Irradiated Insects of Medical Interest ..... 372

Table IV References for the Synthesis of some Radio-labelled Organic Insecticides and Related Compounds ..... 373

Table V Radiotracer Studies on the Metabolism of Organophosphate Insecticides by Plants ..... 374

AUTHOR INDEX ..... 381

SUBJECT INDEX ..... 393

# INTRODUCTION

## GENERAL

A bibliographical survey on radioisotopes and radiation in entomology was initially undertaken to provide documentation for an internal study in the Division of Isotopes of the International Atomic Energy Agency. The decision to publish a fully annotated bibliography was taken subsequently, when it became clear that it would meet a real need. The present volume represents a reference work covering the 11-year period from 1950-1960. Relatively little was published before 1950 and this can easily be traced by following the references to earlier work given in some of the review articles cited. The exciting possibilities opened up by the general availability of radioisotopes for research in the field of entomology are reflected in the ever-increasing number of research reports and publications. The present bibliography will be followed up by further surveys, each dealing with a more specialized aspect, to bring the information up to date. It is intended to aid those who are interested in documentation, not only in their own particular and rapidly developing fields, but also in those border-line areas where it is often difficult to get an overall picture of research trends and achievements. Yet such an orientation may have important bearings on the specialist's own problem.

## SOURCES

The bibliography was compiled from the open literature. A routine documentation search was conducted by scanning the following secondary sources:

(a) Abstracting journals, including
Biological Abstracts (BA),
Chemical Abstracts (CA),
Bullétin Signalétique (BS),
Review of Applied Entomology, series A and B (RAE-A, -B),
Berichte der gesamten Biologie, Teil A (BgB-A),
Nuclear Science Abstracts (NSA),
Excerpta Medica (EM),
Referativnyj Žurnal (in as far as subject indexes were available); and

(b) Reference listings such as those in
Bibliography of Agriculture (B. Ag.), and
Agricultural Index (A. I.),
which were followed up.

Among the many surveys, books and reports consulted are:

"Annual Review of Entomology". (Steinhaus, E. A., Smith, R. F., eds.) 1 - 6 Palo Alto, Calif., Annual Reviews, Inc. (1956/61);

"Advances in Pest Control Research", (Metcalf, R. L., ed.) 1 - 3, New York, (1957/59);

Radiation Biology 1 - 3;

Bibliography of Scientific Publications of South and Southeast Asia, UNESCO Science Cooperation Offices for S & S.E. Asia, INSDOC, N.P.L., New Delhi (1959) (1960) (1961);

Annual Report of the Research Committee on the Applications of Artificial Radioisotopes in Japan, 1 - 3, Jap. Soc. for the Promotion of Science (1951/53);

Selected abstracs of Atomic Energy Project Unclassified Report Literature in the Field of Radiation Chemistry and Bibliography of Published Literature, AERE C/R 1575 (1 - 6), (1958);

Bibliographies of papers published by United Kingdom Sources on Radiobiological and Allied Subjects;

Archiv für Geflügelzucht und Kleintierkunde: "Titel der im landwirtschaftlichen Zentralblatt 1960 referierten Arbeiten auf dem Gebiet der Kleintierzucht" (with reference to work on bees and silkworms);

Congress and Conference Proceedings (see source references in bibliography) (including the Proc. UN Int. Conf. PUAE, 1955/58).

Books and bibliographies (as listed in the bibliography)

Nevertheless, an essential part of the work consisted in consulting and, where necessary, abstracting original papers, reviews and reports and in following up the references cited there.

ORGANIZATION

The references within any one section have been arranged alphabetically by first author.

Whenever abstracts have not been compiled directly their source has been indicated. The length of an abstract is not a criterion for the importance of the article concerned; thus, a good review article may be be dealt with very briefly. A comparative inaccessibility of the source may justify a more detailed abstract.

Some papers which, as far as could be ascertained, have only appeared as abstracts without subsequent publication in full have nevertheless been when their contents would appear of sufficient cited partially or in toto interest.

Some research reports of special interest have been cited and abstracted individually; when publications under the same or similar titles have appeared, reference to corresponding preceding research reports has been limited to a brief comment at the end of the particular abstract.

The bibliography has been broadly divided into two main parts: I dealing with radioisotopes, as applied in research on insects and insecticides, and II dealing with ionizing radiations in research and their possible applications. Occasionally the assigning of categories proved difficult because of a certain overlap; therefore, cross-references are freely cited throughout.

A section (III) on techniques has been included in part I on radioisotopes. Sample papers have been chosen to represent work on autoradiography, dosimetry, isotope dilution techniques, the labelled-pool technique, paper chromatography and others.

For orientation purposes, an attempt was made to head sub-sections by some introductory or survey article(s). General bibliographies and reviews are grouped together in Section IV.

Some difficulties arose in separating research on ionizing radiation effects from applications since present-day research is frequently at a pre-application stage; it may then be taken to mean here "research with a definite application

in view". This is true of the "sterile-male" technique applied to insects other than the screwworm fly as much as of radiation measures envisaged for controlling stored-products infestation.

Particular difficulties were experienced in selecting papers from the vast amount of fundamental work which has appeared on radiation effects in the field of Drosophila genetics (see I. H. Herskowitz "Bibliography on the Genetics of Drosophila", Bloomington, Indiana Univ. Press (1958) 296p.). It would have been neither possible nor justifiable to include more than a slight sampling; however, it would have been equally untenable to ignore this field. Bushland (see author index) stressed that "...anyone planning work on insect sterilization should read the publications by

Catcheside, D. G., Advances in Genetics 2: 271 (1958),
Lea, D., Actions of radiations on living cells. (Macmillan, New York, 1957),
Muller, H. J., Cold Spring Harbor Symposia Quant. Biol. 9:290 (1941),
Hollaender, A., Radiation Biology, Vol. 1, Part 2 "High Energy Radiation" (McGraw-Hill, New York, 1955)
Bacq, Z. M. and Alexander, P., Radiobiol. Symp., Liège 1954 (Butterworths Scientific Publ., London, 1955) ...".

A number of papers on genetics (Drosophila, Habrobracon, Mormoniella, mosquito and silkworm) have therefore been included. The importance of genetics research emerges clearly in connection with the sterile-male technique, and the significance of, for example, developing strains allowing sex differentiation according to egg colour for the silkworm industry, and strains with modified feeding behaviour.

Special attention needs to be paid to genetic and developmental effects incurred through radioisotope labelling, and a separate section (I:D) has been devoted to this aspect in the present bibliography.

Addendum - A special section on nematodes of agricultural interest has been included.

Appendix - An appendix has been included, consisting of tabulated summarizing data with supporting references, taken from recent review articles.

Author index - The usual alphabetical author index has been included. Authors' institutions may easily be traced by referring to the article in question, or to the abstracting journal were indicated.

Subject index - A comprehensive subject index was compiled. Alongside each entry the radioisotope or radiation used is indicated, when feasible.

ACKNOWLEDGEMENTS

Additional very useful references were also obtained through direct correspondence with scientists, among them

Professor Astaurov, Severtzov Institute of Animal Morphology, Academy of Sciences of the USSR, Bol'šaja Kalougeskaja
Dr. M. Legay, Maitre de Conferences, Faculté des sciences de Lyon, Laboratoire de zoologie expérimentale, 16, Quai, Claude-Bernard;
Dr. Shigematsu, The Sericultural Experiment Station, Ministry of Agriculture and Forestry, Suginami-ku, Tokyo, Japan;

} on silkworm

| | |
|---|---|
| Professor Tazima, National Institute of Genetics, Siznikaken - Mishima, Japan; | on silkworm |
| Dr. C.C. Hassett, United States Army Chemical Research and Development Labs.; | on dispersal and radiation studies of insects |
| Dr. D.F. Heath, Medical Research Council, Toxicology Research Unit, MRC Laboratories, Woodmansterne Road, Carshalton, Surrey, United Kingdom; | on insecticides |
| Dr. T. L. Hopkings, Assistant Professor of Entomology, Kansas, USA | |
| Professor Dr. K. Gösswald and Privatdozent Dr. W. Kloft, Institut für angewandte Zoologie der Universität Würzburg, Würzburg, Röntgenring 10. Federal Republic of Germany | on social insects |

The compiler of this bibliography is greatly indebted to Mr. Claude H. Schmidt of the Division of Research and Isotopes for active collaboration and advice.

Very useful references and reprints have also been received from a variety of other sources, too numerous to acknowledge individually. These have all been greatly appreciated and of considerable assistance.

# PART I

# RADIOISOTOPES

# I INSECTS

## I-A Ecology

### I-A-1 SURVEY ARTICLES

1 Ankersmit, G.W. HET MERKEN VAN INSEKTEN MET RADIOACTIEVE ISOTOPEN EN ENKELE TOEPASSINGSMOGELIJKHEDEN (Labelling of insects by radioisotopes and its possible applications). Landbouwk. Tijdschr., Groningen 70, extra no. (1958) 350-6, disc. 356-7. (In Dutch).

A review article (20 references). Methods for labelling insects, and the doses to be applied are discussed. Dispersal and behaviour of insects, population density, and plant-insect and insect-insect relations are amongst the problems which may be studied by these techniques.

* Asperen 1958 - [804]

2 Auerbach, S.I. THE SOIL ECOSYSTEM AND RADIOACTIVE WASTE DISPOSAL TO THE GROUND. Ecology 39 (1958) 522-9.

Weighed samples of tree hole substrate containing dense and complex arthropod populations were exposed to various doses of $\gamma$-radiation from a $Co^{60}$ source. Irradiated samples were then maintained in the laboratory at 30-d intervals up to 90 d; a series of these samples was processed through Berlese funnels to obtain the surviving arthropods. It appears from the data on Collembola and Acarina that related species can differ in their sensitivity to radiation. Evidence of predator-prey differential radiosensitivity was also obtained for 2 mite species, Rhizoglyphus sp. (a herbivorous, saprophagous mite) and a predator (Neoparasitidae). It was noticed as an increase in number amongst individuals of the irradiated population above control levels at around 300 r.

* Dahm 1953 - [805]

* Dahm 1957 - [806]

3 Day, M.F. APPLICATION OF ISOTOPIC TRACERS IN ENTOMOLOGICAL RESEARCH. A REVIEW. p.145-60 in "Proceedings of the Conference on Applications of Isotopes in Scientific Research. University of Melbourne August 1950". 1951.

The author comments on the (then!) less than 30 papers which had appeared in the field during the 20-year period of 1930 to 1950. They deal with problems in pharmacology, biosynthesis, genetics, biochemistry, physiology and ecology. The isotopes mentioned are $C^{14}$, $Na^{24}$, $P^{32}$, $S^{35}$, $Mn^{56}$, $Co^{59}$, $As^{74}$ and $As^{76}$, $Br^{82}$, $Sr^{89}$, $Zr^{95}$, $I^{131}$, and $Ba^{140}$.

4 Dick, W.E. RADIOACTIVE MATERIALS IN THE FIGHT AGAINST PESTS. p.74-100 in "Atomic Energy in Agriculture", Chapter 4. London, Butterworths Scientific Publications. 1957.

Radioisotope tagging and its use in insect studies (habits, physiology, insecticide action and resistance phenomena), and applications of radiation for killing or the production of sterile males are reviewed. (Work is cited by author and year but no bibliography is included).

5 Dugal, L.-P. L'EMPLOI DES ISOTOPES EN BIOLOGIE. Ann. Soc. Ent. Quebec 2 (1956) 21-31.

Après avoir touché aux principes nécessaires pour l'application des radioisotopes, l'auteur donne plusieurs examples où les radioisotopes ont été employés avec succès:le marquage d'insectes pour étudier leurs zones de dispersion, le marquage de pucerons et d'autres insectes vecteurs de maladie des plantes par transmission de virus, bactéries, etc.

* Haller 1956 - [410]

6 Hinton, H.E. RADIOACTIVE TRACERS IN ENTOMOLOGICAL RESEARCH. Sci. Progr. 42 (1954) 292-305.

A very useful review, dealing with insect physiology, insecticide metabolism and distribution,and insect tagging in dispersal and field studies. More than 100 relevant references are cited.

7 Jenkins, D.W. RADIOISOTOPES IN ENTOMOLOGY. p.195-229 in "Atomic Energy and Agriculture", Publication No.49. Comar, C.L., ed. Washington, D.C., American Association for the Advancement of Science. 1957.

Review. The use of radioisotopes is discussed in studies of insect dispersal, abundance and size of insect populations, the transmission of disease, insect physiology, and the mode of action of insecticides. The biosynthesis by insects of complex radioactive chemicals from simpler tagged compounds, and the dispersal by aeroplanes of labelled insecticides are also covered. The absorption and transmission through plants of radioactive systemic insecticides, and the synthesis by plants grown in an atmosphere of $C^{14}O_2$ of various botanical insecticides, e.g. pyrethrum and nicotine, are discussed. The section on radiation effects on insects considers mutations, growth, physiology, metamorphosis, reproduction, longevity, behaviour, etc. Five tables are included. The comprehensive bibliography contains 178 references.

8 Lindquist, A.W. RADIOACTIVE MATERIALS IN ENTOMOLOGICAL RESEARCH. J. econ. Ent. 45 (1952) 264-70.

The possible applications of radioisotopes are reviewed, together with the nature of the problems involved, the results obtained in connection with recent research, and suggestions on how to initiate studies on the biology and control of insect pests. The need for close collaboration with other disciplines is stressed.

9 Lindquist, A.W. STUDIES OF INSECTS AND INSECTICIDES WITH RADIOACTIVE MATERIALS. p.527-35 in "Proceedings of the Inter-American Symposium on the Peaceful Application of Nuclear Energy. Brookhaven National Lab., 13-17 May 1957". TID-7554, Department of Agriculture. Beltville, Md. 1957.

Review article. Entomology is among the scientific disciplines employing radioactive materials in studies on the biology, physiology, toxicology, biosynthesis, disease transmission, and effects of radiation on reproduction, habits, longevity, and control of insects. Flight habits, dispersal distances, migrations, longevity, and population numbers have been studied with specimens tagged with radioactive materials. Results are reviewed from studies on the effects of radiation on insects and studies with radioactive insecticides. Applications in the control of insect pests are discussed. (NSA 13: 8537, 1959)

10 Lindquist, A.W. ENTOMOLOGICAL USES OF RADIOISOTOPES. p.688-710 in "Radiation Biology and Medicine". Claus, W.D., ed. Reading, Mass., Addison-Wesley Publishing Co. 1958, 944p.

Review article. Application of radioisotopes to studying the biology (dispersal, flight range, etc.) of a particular pest is described, with citations from the literature. The use of radiation effects (lethal) to various insects and the practical feasibility of such measures are discussed. Further possible applications of the sterile-male technique are considered. Tracers may be used to evaluate the effectiveness of control measures, and in insect-physiology studies, in which a labelled chemical is traced during its absorption, metabolism, and excretion. A similar technique is used for tracing the course of a systemic insecticide in animal and plant tissues. Insecticide residue hazards may also be evaluated. (57 references)

11 Russel, S.R., Middleton, L.J. USE OF RADIOACTIVE ISOTOPES IN THE STUDY OF CERTAIN AGRICULTURAL PROBLEMS. p.75-86 in "Progress in Nuclear Energy. Series 6: Biological Sciences". Bugher, J.C., Coursaget, J., Loutit, J.F., eds. London, Pergamon Press, Ltd. 1956, 205p.

Various types of applications are reviewed such as in insect migration studies. The investigations described range from studies on the dispersal of populations of mosquitoes, locusts, blackflies, grasshoppers and pine weevils to that of the movement of individual cutworms and wireworms in the soil. Automatic recording equipment has been designed for the latter purpose. The dispersal of pollen, also by insects, is discussed. Eradication of insect pests by sterilization with $\gamma$-radiation is described.

12 Spinks, J.W.T. STUDIES OF SPECIAL PROBLEMS IN AGRICULTURE AND SILVICULTURE BY THE USE OF RADIOISOTOPES. UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF.8/P/10 12 (1956) 75-86.

In tracer studies of insect dispersal and behaviour, insects were tagged with a suitable radioactive tracer, released, and followed by means of a suitable radiation detector. The tracer needs to be easily applicable, have a minimal effect on the insect, be easily recognized, persistent, possess a suitable half-life and be readily available. Experiments on mosquitoes, blackflies, grasshoppers, wireworms and cutworms are described, together with appropriate references. A method for the automatic plotting of the position of a tagged insect is discussed, including a block diagram, and a schematic diagram for interaction of a sensing-element carriage unit of the automatic following device. Work on the white-pine weevil is mentioned.

13 Шура-Бура, Б.Л. ПРИМЕНЕНИЕ МЕЧЕНЫХ АТОМОВ В ЭНТОМОЛОГИИ. Усп.совр. Биол. 44, 1 (1957) 103-20.

Обзор экспериментальных данных, охватывающих применение меченых атомов в экологии, при изучении переноса возбудителей инфекции, в физиологических исследованиях, в токсикологических исследованиях инсектицидов; затрагиваются также вопросы влияния радиации на насекомых и применения ионизирующих излучений для борьбы с насекомыми. Обзор содержит значительную библиографию, 32 ссылки которой относятся к Советским работам за период с 1950 до 1960гг.

Shura-Bura, B.L. THE APPLICATION OF TRACER ELEMENTS IN ENTOMOLOGY. Adv. mod. Biol. 44, 1 (1957) 103-20 (In Russian).

A review of experimental data covering the application of tracer methodology to basic and practical aspects of entomology (ecology, disease vectors, physiology, toxicology of insecticides, radiation effects on insects, and applications of ionizing radiations in insect control). The review contains a comprehensive bibliography, including 32 references to Soviet sources relevant to the present bibliography.

14 Spinks, J.W.T. NUCLEAR ENERGY IN AGRICULTURE AND BIOLOGY. "38th Annual Meeting and Convention of the Agricultural Institute of Canada, Acadia University, Wolfville, N.S. 24 June 1958".

Some reference works are cited, followed by a survey of relevant work in progress in the various laboratories of the Department of Agriculture, and of a number of universities. Work on bees, insect nutrition, the amino acid metabolism of the blowfly and others, $P^{32}$ in predator studies, and others using radiotracers are cited; also some Canadian publications that have appeared so far.

15 Hassett, C.C. ARMY ENTOMOLOGISTS FIND NEW USES FOR RADIOACTIVE ISOTOPES. Armed Forces Chem. J. 10, 1 (1956) 12.

The use of $C^{14}$- and $P^{32}$-labelled compounds is described briefly.

16 Huque, H. INSECTS TAGGING WITH RADIOISOTOPES. Pakistan J. Sci. 12, 3 (1960) 135-6.

17 Kips, R.H., Brande, J. van den RADIOACTIVE RAYS AND RADIOACTIVE ISOTOPES IN APPLIED ENTOMOLOGY AND PHYTOPHARMACY. Land- en Tuinbouw Jaarb. 13 (1958/59) 143-8. (In Flemish)

Review article.

18 Nichev, L. INSECT MARKING WITH RADIO ISOTOPES. Priroda (Sofia) 5, 4 (1956) 61-2. (In Bulgarian)

19 Pendleton, R.C. USES OF MARKING ANIMALS IN ECOLOGICAL STUDIES: LABELING ANIMALS WITH RADIOISOTOPES. Ecology 37 (1956) 686-9.

Applications of radioisotope labelling are reviewed, including their usefulness, hazards, cost, and the choice of isotope to be made for a particular study. One section is devoted to work on insects. The author warns against indiscriminate use of radiotracers. Literature references cite work after 1945.

20 Plichet, A. LE MARQUAGE DES INSECTES À L'AIDE DES RADIO-ISOTOPES. Pr. méd. 64 (1956) 824.

Une indication très brève du genre de recherches entreprises et des possibilités diverses pour l'avenir.

* Jenkins and Hassett 1950 - [808]

Aphids

21 Banks, C.J., Nixon, H.L. EFFECTS OF THE ANT, LASIUS NIGER L., ON THE FEEDING AND EXCRETION OF THE BEAN APHID, APHIS FABAE SCOP. J. expt. Biol. 35,4 (1958) 703-11.

Bean plants (Vicia faba) on which groups of A. fabae nymphs were feeding, were made radioactive by growing them in water culture with $P^{32}$ added, so that the aphids took up the isotope and excreted it in their honeydew. The radioactivity of the honeydew taken from them by attendant Lasius niger was then compared with that of the honeydew excreted concurrently by unattended control aphids on separate plants. By increasing their uptake of plant sap the ant-attended aphids produced twice as much radioactivity in their excreta as did the ant-free aphids. The aphids directly control their rates of excretion and feeding, which are not determined solely by forces within the plant. The aphid apparently controls its feeding by the "sucking pump" in its head. It is suggested that the pump is normally closed but that periodically it opens to admit sap into its lumen and then closes ventrally to force the ingested sap into the stomach. During normal feeding the pump probably opens and closes at regular intervals; but when the aphid is ant-attended it could operate more frequently so as to force sap into the stomach more often. The uptake of sap by normally feeding aphids is apparently not continuous. (from auth. summary)

22 Banks, C.J., Nixon, H.L. THE FEEDING AND EXCRETION RATES OF APHIS FABAE SCOP. ON VICIA FABA L. Ent. exp. et appl. 2 (1959) 77-81.

The feeding and excretion rates of nymphs of A. fabae, feeding on young leaves of Vicia faba, were studied, using host plants grown in water culture and made radioactive with $P^{32}$. The amounts of sap ingested at first were small but the rate of ingestion increased rapidly between 12 and 16 h. The maximum rate of feeding was estimated at 0.2 mg sap/h, an uptake of 59% of the mean body weight of the insects per hour. The results are discussed in relation to other recent work on aphid feeding and excretion. (auth.)

23 Day, M.F., Irzykiewicz, H. FEEDING BEHAVIOUR OF THE APHIDS MYZUS PERSICAE AND BREVICORYNE BRASSICAE, STUDIED WITH RADIOPHOSPHORUS. Aust. J. biol. Sci. 6, 1 (1953) 98-108.

The volume of material ingested and excreted by Myzus persicae (Sulz.) and Brevicoryne brassicae (L.) was measured by feeding apterae on sucrose solutions containing $P^{32}$ as disodium hydrogen phosphate or sodium dihydrogen phosphate through a plastic membrane or on isolated leaves of Brassica chinensis standing in a solution containing it. Myzus ingested approximately 0.07 mg plant material in one hour, and Brevicoryne less than one-twentieth of that amount. The results are discussed with reference to those obtained by other workers with M. persicae and Orosius argentatus (Evans) and to the mechanism by which aphids transmit plant viruses. Non-persistent viruses can be transmitted within a feeding period of 2 min, but in the present work no ingestion occurred so soon after insertion of the stylets. Short periods of starvation increase the amount ingested by Orosius, but not by Myzus. The long feeding period required for the latter to ingest enough material for accurate measurement may vitiate the effects of starvation, but it seems likely that the effect of starvation on the ability of aphids to transmit non-persistent viruses may be due to factors other than the amount subsequently ingested. This summary is largely based on that of the authors.

24 Henning, E. UNTERSUCHUNGEN AM SAUGAKT VON APHIS FABAE SCOP. MIT $^{32}P$ ($P^{32}$ Studies on the suction process in Aphis fabae Scop.). Naturwissenschaften 46,12 (1959) 410-1. (In German)

Young test plants of Vicia faba L. were made radioactive by placing them in a neutral $P^{32}$-solution (specific activity 16 mc/ml). Wingless virgins of A. fabae Scop. were placed on the plants and tested for individual radioactivity after various "sucking" periods and penetrations. It would appear that the phloem is the only source of nourishment. The duration of a feeding puncture is no evidence of whether suction has actually taken place or, if so, for how long it had continued. Radioactivity could usually only be detected once the Aphis had definitely settled down in one spot. The insects became radioactive on an average 25-60 min after the puncture.

25 Kloft, W. UNTERSUCHUNGEN ÜBER PFLANZENSAUGENDE INSEKTEN UND REAKTIONEN DES WIRTS-PFLANZENGEWEBES (Studies on plant-sucking insects and the reactions of the plant host-tissue). Ber. phys.-med. Ges. Würzburg 68 (1956-57) 64-72. (In German)

A preliminary note reports on results obtained with radioactively labelled aphids on the mechanism of secretion and the distribution of saliva. Results are presented in more detail in Z. angew. Entomol. 45 (1960) 337-81 and ibid. 46 (1960) 42-70.

26 Kloft, W., Ehrhardt, P. UNTERSUCHUNGEN ÜBER SAUGTÄTIGKEIT UND SCHADWIRKUNG DER SITKAFICHTENLAUS LIOSOMAPHIS ABIETINA (WALK.) (NEOMYZAPHIS ABIETINA WALK.) (Studies on the sucking activity and damaging effects of the Sitka spruce louse Liosomaphis abietina (Walk.) (Neomyzaphis abietina Walk.) Phytopathologische Z. 35 (1959) 401-10. (In German)

After dealing with the laboratory rearing of L. abietina, sucking behaviour and sucking effects on larch tissue, the authors describe work on the secretion and composition of the saliva. L. abietina was labelled with $P^{32}$ by placing them on larch branches stood in a $Na_3P^{32}O_4$ solution (specific activity 1 mc/ml). Maximum activity was reached after 24 h and radioactivity could subsequently be transferred by lice allowed to suck non-radioactive needles. Measurements indicated that the mechanism of saliva excretion is similar to that observed for Myzus ascalonicus, i.e., a phloem-sucker. In order to investigate the influence of sucking on the metabolism and physiology of the needles, variously damaged needles were placed in a $P^{32}$-labelled solution. Autoradiography showed that much less $P^{32}$ was deposited in regions of chlorotic spots than in undamaged portions.

27 Kloft, W. WECHSELWIRKUNGEN ZWISCHEN PFLANZENSAUGENDEN INSEKTEN UND DEN VON IHNEN BESOGENEN PFLANZENGEWEBEN. TEIL I & II (Exchange reactions between plant-sucking insects and host-tissues of the plant. Part I and Part II). Z. angew. Ent. 45 (1960) 337-81 Part I and Z. angew. Ent. 46 (1960) 42-70 Part II.(Habilitationsschrift, Würzburg). (In German)

An investigation by means of plant physiological methods was made into the reaction of plant tissue to the penetration by and feeding of plant lice. Results showed that spontaneous primary reactions and long term secondary reactions must be distinguished. Data on the mechanism of saliva secretion was found by the use of a tracer, $P^{32}$. In phloem-feeding aphids (Myzus ascalonicus Donc.), saliva is secreted only with insertion (6-8 min) and retraction of the styles, and not in the intervening time no matter how long the insect may feed. In contrast to this, parenchyma-feeders secrete more or less continuously and the fundamental differences between the two types of feeding are discussed fully. The mutual effects on plant and aphid, with a parenchyma-feeding species, are illustrated by histochemical and physiological methods. The spread of saliva in the plant is described in detail, using autoradiographic and x-ray techniques. Distribution occurs preferentially along veins of the leaf. On heavy infestation the saliva is distributed uniformly over the entire leaf surface.

28 Kloft, W., Kunkel, H. EINBLICKE IN DIE SPEICHELAUSSCHÜTTUNG BEI MYZUS ASCALONICUS DONC. MIT HILFE DER TRACER-METHODIK (Aspects of saliva release by Myzus ascalonicus Donc., elucidated by means of the tracer technique). p.746-9 (disc. p.749) in "Proceedings of the 11th International Congress on Entomology, Vienna 17-25 Aug. 1960", Vol.1. Strouhal, H., Beier, M., eds. (Naturhistorisches Museum, Vienna). Vienna, Christoph Reisser's Söhne. 1962. (In German)

The course of saliva injection was followed by means of $P^{32}$-labelled aphids (see Kloft, earlier work, publ. 1960). The increase in radioactivity of aphids on radioactive Allium schoenoprasum L. was measured in terms of the time elapsed from the penetration of the mandibles into the plant. Within 10 min, 5-10% of the aphids already showed appreciable activity. Several hours are required, however, before all pricking aphids show increased radioactivity, thus indicating that they have reached the phloem, and that food uptake has actually started. The interval was measured between tracer uptake via food taken from the plant, and its elmination after resorption by the intestines or by resecretion from the salivary gland. Results are discussed in their bearings on the transmission of plant diseases (virus) by sucking insects.

29 Lawson, F.R., Lucas, G.B., Hall, N.S. TRANSLOCATION OF RADIOACTIVE PHOSPHORUS INJECTED BY THE GREEN PEACH APHID INTO TOBACCO PLANTS. J. econ. Ent. 47, 5 (1954) 749-52.

Myzus persicae (Sulz.) has recently become an important pest of tobacco in the United States, not only excreting honeydew on which sooty moulds develop but also causing yellowing and stunting of the leaves on which it feeds. In experiments carried out in N. Carolina in 1951, $P^{32}$ was used to determine whether

the substances injected by this aphid into living plants are translocated. Aphids that fed on tobacco plants growing in soil treated with an aqueous solution of radioactive phosphoric acid became radioactive, and the tracer was found in their honeydew. It was also found in leaves on which the aphids had fed, into which it was probably injected with the salivary secretions. The $P^{32}$ introduced into the leaf by the aphid was translocated to other parts of the plant, and part of the injury to tobacco caused by M. persicae may thus be due to translocation of injected salivary secretions. (RAE-A 43: 308, 1955)

30 Pendleton, R.C., Grundmann, A.W. USE OF $P^{32}$ IN TRACING SOME INSECT-PLANT RELATIONSHIPS OF THE THISTLE, CIRSIUM UNDULATUM. Ecology 35 (1954) 187-91.

The thistle plant was labelled by placing a solution containing $P^{32}$ in a hollow cut into the pith of the main stem. The amount of uptake of $P^{32}$ from the plant by aphids, Anuraphis sp., ants, and other insects was measured. The series of transfers of P, and the level of labelling of various insects was noted. The accumulation of radioactivity in predators in units roughly equivalent to the average radioactive level of the prey was observed and termed "unit predation concentration". The status of several insects was determined by using unit predation concentration to identify their activities. (BA 30: 7027, 1956)

31 Watson, M.A., Nixon, H.L. STUDIES ON THE FEEDING OF MYZUS PERSICAE (SULZ.) ON RADIOACTIVE PLANTS. Ann. appl. Biol. 40, 3 (1953) 537-45.

Adult aptera of M. persicae were fed on leaves containing $P^{32}$ after fasting. The weight of sap imbibed by the aphids after varying feeding times was estimated, assuming that $P^{32}$ is uniformly distributed in the leaf tissues. The results are used in a discussion of the mechanism of aphid transmission of plant viruses. (auth. summary.)

## Jassid

32 Day, M.F., McKinnon, A. A STUDY OF SOME ASPECTS OF THE FEEDING OF THE JASSID OROSIUS. Aust. J. sci. Res., B 4, 2 (1951) 125-35.

In experiments on the transmission of the witches'broom disease of lucerne by Orosius argentatus (Evans) in Australia, transmission was somewhat irregular, and since a similar irregularity had been reported in work with other Jassids, tests were made to determine whether variations in feeding might be the cause and whether feeding was modified by routine procedures in handling. The method adopted was to confine the Jassids in cages on the leaves of young beet plants that had been left for 24 h with their roots in a culture solution containing tracer doses of sodium dihydrogen phosphate prepared with $P^{32}$ and to transfer them to a normal culture solution prior to infestation, or to feed them on a solution of sugars incorporating the radioactive material. O. argentatus ingested $P^{32}$ incorporated into the plant, and excreted approximately 65% of the amount ingested within 30 minutes after feeding had begun. The total amount ingested increased directly with the feeding period during an experiment lasting 3 days. There was considerable variation in uptake between individual Jassids, but the differences were usually insufficient to account for the observed differences in ability to transmit the virus. No evidence of transmission of $P^{32}$ to another plant was obtained. Anaesthesia by $Co_2$ had little or no effect on subsequent feeding. Starvation for about 30 minutes before feeding slightly increased the amount ingested in a 30-minute period. The pH and the sugar concentration of the artificial diet did not significantly alter the amount ingested. (from RAE-A 41: 404, 1953)

## Lygus

33 Flemion, F., Weed, R.M., Miller, L.P. DEPOSITION OF $P^{32}$ INTO HOST TISSUE THROUGH THE ORAL SECRETIONS OF LYGUS OBLINEATUS. Contr. Boyce Thompson Inst. 16, 9 (1952) 285-94.

Lygus oblineatus were made highly radioactive by feeding them with sucrose solution to which radioactive phosphate had been added. Techniques and precautions to avoid contamination are described. On subsequent feeding on bean (Phaseolus vulgaris L.) pods the insects transmit their radioactivity at the feeding site as shown by counting and by radioautographs. The results offer strong evidence that on feeding oral secretions are injected into the host tissue.

34 Flemion, F., Miller, L.P., Weed, R.M. AN ESTIMATE OF THE QUANTITY OF ORAL SECRETION DEPOSITED BY LYGUS WHEN FEEDING ON BEAN TISSUE. Contr. Boyce Thompson Inst. 16, 9 (1952) 429-33.

The quantity of saliva injected by Lygus oblineatus (Say) into bean tissue during feeding was determined by the use of $P^{32}$. Adults were fed on sucrose solutions containing large amounts of $P^{32}$ until they had taken up

amounts equivalent to about 500 000 cpm, and after a precautionary period, transferred to bean tissue prepared as previously described. Saliva was collected from them with a micropipette under the microscope as soon as possible after feeding. From the radioactivity per unit volume of the saliva and the radioactivity of the bean tissue it was calculated that volumes of 0.038-0.251 µl saliva were injected in feeding periods of about 20-108 min, but the amount of activity imparted was not directly associated with the length of the feeding period. The insects are apparently not necessarily feeding during the whole time that the proboscis is inserted into plant tissue.

35 Nourteva, P., Reinius, L. INCORPORATION AND SPREAD OF $C^{14}$-LABELED ORAL SECRETIONS OF WHEAT BUGS IN WHEAT KERNELS. Ann. ent. fenn. 19,3 (1953) 95-104.

In the course of investigations in Finland on the way in which cereal bugs injure wheat grains and reduce the baking quality of the flour, specimens of Dolycoris baccarum (L.) and Lygus rugulipennis Popp. (pubescens Reut.) were allowed to feed 1-4 days on leaves of Canna indica rendered radioactive by exposure to light in a chamber containing $C^{14}O_2$, prepared from a compound of $C^{14}$, and then enclosed in bags with wheat ears at various stages of ripeness. Most injured kernels were obtained from the bags containing L. rugulipennis. Positive radioautographs were obtained from 16 of these, 10 of which had been injured at the milky stage and 6 at the yellow stage of ripeness. In all of them, radioactivity was distributed over the whole kernel, indicating distribution of oral secretions, and in two it was relatively greater at the feeding point. Of the few kernels injured by D. baccarum, seven gave positive radioautographs. Radioactivity was strong at the feeding points, but evidence of spread of oral secretions was found only in two grains injured at a very early stage of ripeness. The great dilution in radioactivity during transfer from the leaves into the wheat kernels rendered measurements in the kernels difficult, and a G-M counter gave unsatisfactory results. The counts for all wheat samples, including the controls, differed significantly from the background, and this is attributed to the presence of the natural potassium isotope $K^{40}$. On the assumption that $C^{14}$ was present in the carbon of the saliva in the same ratio as in the body, it is calculated that the maximum concentration of possible proteolytic enzymes (containing about 50% carbon) in the saliva of D. baccarum was 1:40 000. (RAE-A 42: 376, 1954)

36 Miller, L.P., McCallan, S.E.A. SOME EXAMPLES OF THE USE OF RADIOISOTOPES IN STUDIES OF PESTICIDE ACTION. p.546-55 in "Proceedings of the 14th International Horticultural Congress, The Hague-Scheveningen", Vol.I. 1955.

The interaction between fungus spores and certain labelled toxicants was studied. Isotopes were also used to study the feeding habits of Lygus oblineatus which does severe damage to crops. Deposition of toxic salivary secretions was suspected and investigated by labelling the insect with $P^{32}$ (feeding treated sugar solutions). 0.05 - 0.25 µl of saliva were found to be deposited at each feeding whilst 0.2 - 2.0 µl of cell sap were sucked up. The quantity of fluid ingested by the insects on feeding was determined using $Ag^{110}$ and $Ce^{144}$.

## Mealybug

37 West African Cacao Research Institute. ANNUAL REPORT OF THE WEST AFRICAN CACAO RESEARCH INSTITUTE, APRIL 1952 - MARCH 1953. 1953, 39p.

Work described by R.M. Lister in this report included the development of a method for determining, by means of radioactive phosphorus as orthophosphoric acid, whether Pseudococcus njalensis used in experimental transmission has fed on the source plant; in tests, some of the mealybugs that had apparently settled on the plants did not pick up $P^{32}$ and so may not have fed. (see RAE-A 43: 79-82, 1955)

38 West African Cacao Research Institute. ANNUAL REPORT OF THE WEST AFRICAN CACAO RESEARCH INSTITUTE, 1955-56. 90, 1957, 20p.

The report contains numerous studies on mealybugs. Observations on their movements showed that first-instar nymphs and adults comprise over 90 and less than 2%, respectively, of the mobile population of Pseudococcus njalensis on cacao trees. Mobile individuals occurred at all levels, but 85% of both moving and static populations were found in the canopy. Over a period of four months, significant positive correlations were found between numbers of mobile mealybugs and temperature and, to a lesser extent, hours of sunlight, but not with changes in the evaporation capacity of the air. Sunlight begins to penetrate the canopy at about noon, and movement continues from then, probably in response to increased temperature in the carton tents built by ants over the colonies, until about 6 p.m., with a maximum at about 3 p.m.

It was confirmed by the use of mealybugs rendered radioactive with $P^{32}$ that movement occurs from tree to tree through the canopy where the branches interlock.

Mites

* Rodriguez 1954 - [301]

* Liesering 1960 - [408]

Mosquitoes

* Jenkins and Knight 1950 - [61]

* Jenkins and Hassett 1951 - [110]

39 Jenkins, D.W., West, A.S. PLANT FEEDING HABITS OF NORTHERN MOSQUITOES STUDIED WITH RADIOISOTOPES. Mosquito News 11,4 (1951) 217-9.

In studies at Churchill, Manitoba, various spp. of northern flowering plants took up and retained $P^{32}$ when their stems are put in a $P^{32}$ solution. Aedes communis males and females visited flowers and ingested plant juices and nectars as shown by their accumulation of $P^{32}$ from the activated flowering plants. This fact lends indirect support to the hypothesis that some arctic mosquitoes, observed to visit and probe flowers, may be able to produce viable eggs without a blood meal. (auth.-A.S.W.)

40 West, A.S., Jenkins, D.W. PLANT FEEDING HABITS OF NORTHERN MOSQUITOES STUDIED WITH RADIOISOTOPES. Mosquito News 11 (1951) 217-9.

Under laboratory conditions Aedes communis males and females visit $P^{32}$ -labelled northern flowers and ingest plant juices and nectars as shown by their accumulation of $P^{32}$ from the activated flowering plants. Northern mosquitoes have frequently been observed to visit and probe several species of arctic and subarctic flowers. Proof in the present studies that the mosquitoes ingest plant juices lends indirect support to the hypothesis that some arctic mosquitoes may be able to produce viable eggs without a blood meal from a mammalian or avian host. (from auth. summary)

Thrips

41 Kloft, W., Ehrhardt, P. ZUR FRAGE DER SPEICHELINJEKTION BEIM SAUGAKT VON THRIPS TABACI LIND. (THYSANOPTERA, TEREBRANTIA) (The problem of saliva injection during the suction process of Thrips tabaci Lind. (Thysanoptera, Terebrantia)). Naturwissenschaften 46 (1959) 586-7. (In German)

By means of radioactive labelling a glandular secretion was shown to be not merely a lubricant for the mouth parts but to be released into the plant during sucking. Adults of Thrips tabaci Lind. were left for about 24 h on cut chives (Allium schoenoprasum L.), placed in a radioactive phosphate solution. A measurable quantity was taken up by the thrips which were then transferred to moistened filter paper to get rid of external radioactive contamination. They were then caged in single-layered allium epidermis skins by means of glass rings. The thrips then punctured some cells. After various intervals, the allium epidermis was carefully cleaned to remove any radioactive faeces. Subsequent autoradiography showed clearly that radioactive saliva had been injected into the tissue. Individual points and also their distribution were recognizable. A contact-autoradiography is shown of an allium epidermis which had been sucked by Thrips tabaci Lind.

* Day and Irzykiewicz 1954 - [320]

Various

42 Ball, R.C., Hooper, F.F. PRELIMINARY REPORT ON TRANSLOCATION OF RADIOACTIVE PHOSPHORUS ($P^{32}$) IN A MICHIGAN TROUT STREAM. TID-12432, Technical Information Service, AEC, Progress Report 14 June 1958 - March 1959 on "A Study of Productivity in a Stream Ecosystem".

$P^{32}$ was added to the river in order to follow its translocation. One section of the report deals with the uptake of $P^{32}$ by 7 invertebrates, amongst them the black fly Simulium, the stone fly Pteronarcys, the caddis fly Brachycentrus, the burrowing may fly Hexagenia and tabanids. Differences and fluctuations in the rate of uptake are described. Corrected counts per min per g are tabulated and discussed.

43 Ball, R.C., Hooper, F.F. A SECOND REPORT ON TRANSLOCATION OF RADIOACTIVE PHOSPHORUS ($P^{32}$) IN A MICHIGAN TROUT STREAM. TID-12433, Michigan State Univ., East Lansing and Michigan. Inst. for Fisheries Research, Ann Arbor. 1959, 33p.

Phosphorus-32 was released in the West Branch of the Sturgeon River, Michigan, on July 8, 1959, at a theoretical maximum concentration of $1.22 \times 10^{-5}$ mc/ml. Studies were made on the movement of radiophosphorus through the food chain during a two-month period. Data are also presented on the activity of insects. Results are compared with results from a similar study done in 1958.

44 Ball, R.C., Hooper, F.F. A THIRD REPORT ON TRANSLOCATION OF RADIOACTIVE PHOSPHORUS ($P^{32}$) IN A MICHIGAN TROUT STREAM. TID-12309, Michigan State Univ., East Lansing and Michigan. Inst. for Fisheries Research, Ann Arbor. 1960, 20p.

Results are compared with results from similar studies during 1958 and 1959. An attempt was made to relate uptake to the amount of P present. The influence of chelating agents on the distribution of activity was also studied. The work on insects is somewhat incidental.

45 Сорокин, Ю.И., Мешков, А.Н. ПРИМЕНЕНИЕ РАДИОАКТИВНОГО УГЛЕРОДА ($C^{14}$) ДЛЯ ОПРЕДЕЛЕНИЯ УСВОЯЕМОСТИ ПРОТОКОККОВЫХ ВОДОРОСЛЕЙ МОТЫЛЕЙ. Доклады Акад. Наук СССР 118, 1 (1958) 205.

Взвеси протококковых водорослей Scenedesmus метились $C^{14}$ через фотосинтез с помощью $Na_2C^{14}O_3$. Меченые водоросли затем отмывались от радиоактивного карбоната и подсаживались мотыли Tendipes plumosus . Их активность варьировала от $1{,}10^4$ до $10{,}10^4$ имп/мин/мл. Они очень быстро выводились из организма, лишь незначительное количество усваивалось мотылями. Было найдено, что после кипячения водоросли и их гидролизаты усваиваются в значительно большей степени.

Sorokin, Yu.I., Meshkov, A.N. THE USE OF RADIOACTIVE CARBON ($C^{14}$) FOR DETERMINING THE ABSORPTION OF PROTOCOCCI ALGAE BY THE MOTH TENDIPES PLUMOSUS. Dokl. Akad. Nauk. SSSR 118, 1 (1958) 205.

A suspension of Scenedesmus was labelled with $C^{14}$ via $Na_2C^{14}O_3$. The algae were then washed free of contaminating matter, and fed to Tendipes plumosus. Their activity ranged from $1.10^4$ - $10.10^4$ cpm/ml They were excreted rapidly, very little being assimilated by the moth. On boiling the algae, the hydrolyzed material was found to be absorbed to a much greater extent.

## I-A-2-b TRANSMISSION OF FOOD

### Bee

46 Nixon, H.L., Ribbands, C.R. FOOD TRANSMISSION WITHIN THE HONEYBEE COMMUNITY. Proc. roy. Soc., Ser. B 140, 898 (1952) 43-50.

Six bees were trained to a dish, from which they collected 20 ml of sugar-syrup containing $P^{32}$. The distribution of radioactivity among the bees and larvae of their colony of 24 500 bees was then studied. 62% of the foragers and 16 to 21% of all the bees in the hive were radioactive within 4 h; 76% of the foragers and 43 to 60% of all the bees were radioactive within 27 h. The nurse bees were significantly less radioactive than the house bees and the foragers significantly more so. Within 48 h all the large larvae in unsealed cells were radioactive. These results are attributed to widespread food transmission. Food transmission is suggested as the foundation of the division of labour within the honeybee community and of the similar odour produced by the members of each colony, which serves for mutual recognition. Food transmission would enable slow-acting insecticides contained in their food to be widely distributed among the members of a honeybee colony. (auth.)

47 Oertle, E., Emerson, R.B., Wheeler, H.E. TRANSFER OF RADIOACTIVITY FROM WORKER TO DRONE HONEY BEES AFTER INGESTION OF RADIOACTIVE SUCROSE. Ann. ent. Soc. Amer. 46, 4 (1953) 596-8.

Caged drone honey bees, with access to sucrose sirup, received radioactive material through a dividing screen from worker bees that had access to radioactive sucrose sirup. After correction for time and background the net radioactivity counts per minute were 456 for drones and 9430 for workers of equal sample weight. It can be inferred that the drones had become at least partly dependent upon workers for food, or perhaps for an essential growth factor, or that they preferred regurgitated food to sucrose sirup. (auth. E.O.)

(A report was also published as AECU-2630, Bureau of Entomology and Plant Quarantine, Dept. of Agriculture. 1953, 7p.)

## Ant

48 Eisner, T., Wilson, E.O. RADIOACTIVE TRACER STUDIES OF FOOD TRANSMISSION IN ANTS. p.509-13 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug.1956", Vol.2. Becker, E.C., ed. Ottawa, Mortimer Ltd. 1958.

In a series of experiments, honey mixed with a radioactive isotope of iodine ($NaI^{131}$) was fed to colonies of several species of ants and the rate of intranidal transmission of this substance studied. Striking interspecific differences were noted, from very limited, almost negligible exchange in the myrmicine Pogonomyrmex badius (Latr.), to rapid transmission leading to near or complete colony saturation in the myrmicine Crematogaster lineolata (Say) and species of the formicine genus Formica. An unexpected additional discovery was that the nest queens and larvae were often the last individuals to receive honey and, as a rule, received less than the individual workers. (auth.)

49 Gösswald, K., Kloft, W. UNTERSUCHUNGEN UBER DIE VERTEILUNG VON RADIOAKTIV MARKIERTEM FUTTER IM VOLK DER KLEINEN ROTEN WALDAMEISE (FORMICA RUFOPRATENSIS MINOR) (Studies on the distribution of radioactively labelled food amongst ants of a colony of Formica rufopratensis minor) Waldhygiene 1 (1956) 200-2. (In German)

Honey water was labelled with $P^{32}$, at a dosage which gave measurable activity even on very wide distribution of the labelled food. Measuring techniques are described. One individual passes food to 8-10 fellow ants, 1/3 of the food being given away within 15 seconds. Group experiments gave varying results, not only depending on the size of the group but of the ants to be fed, the allocation of food being proportional to ant size. In Camponotus ligniperda Latr. distribution of essentially rather liquid food was found to be much more rapid which was also the case in Formica pratensis Retz.

50 Gösswald, K., Kloft, W. NEUE UNTERSUCHUNGEN ÜBER DIE SOZIALEN WECHSELBEZIEHUNGEN IM AMEISENVOLK, DURCHGEFÜHRT MIT RADIOISOTOPEN (New studies by means of radioisotopes on the social interrelations in the ant). p.543 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956", Vol.2. Becker, E.C., ed. Ottawa, Mortimer Ltd. 1958. (Details of this and further studies were presented at the 3rd International Congress of the International Union for the Study of Social Insects, Paris 9-13 July 1957) (In German)

$P^{32}$ was given in food or by injection into the hemolymph. The distribution of food was investigated, particularly in a group of Formica rufa. A worker ant can directly share food from the crop with 8 others, the contents of one crop being ultimately distributed between 80-100 animals. Winged and unwinged females, and males participate in distribution. Further problems studied were the speed of distribution, the effect of animal size on allocation, trophallaxis and general behaviour. Relations between social parasitic ants and their hosts and also myrmecophils were also investigated.

51 Gösswald, K., Kloft, W. RADIOBIOLOGISCHE UNTERSUCHUNGEN AN STAATENBILDENDEN INSEKTEN (Radiobiological investigations on colony-forming insects). Umschau 58 (1958) 743-5. (In German)

Metabolic processes of inhibition were investigated by which animals in a particular insect colony are maintained as worker or soldier members instead of becoming sexually potent. $P^{32}$ -labelled worker ants of known activity were placed with 1-100 unfed fellow ants. The radioactivity of every insect was measured individually at various intervals. The level of measurable activity made it possible to gauge, both qualitatively and quantitatively, the extremely wide distribution of regurgitated radioactive food available from one insect. Extent (primary, secondary, etc.) and speed of distribution were a function of temperature. Both imaginal males and workers in developmental stages receive merely regurgitated food whereas queen larvae are fed with superior gland extract. Winged males also work actively in food distribution. An interchange between nursing ants and larvae (trophallaxis) was confirmed. Queens also release food to workers. Individual food requirements are much greater for bees than for ants; food is quickly resorbed and distributed throughout the entire organism. Drones also actively participate in passing on food to worker bees. The termite, Calotermes flavicollis, does not show a genuine caste system. The allocation of work in supplying food is described at the different developmental and social levels. Distribution of food brought in by a few individuals was relatively rapid, though much slower than among bees or even ants.

52 Gösswald, K. EINBLICKE IN DAS STAATENLEBEN DER INSEKTEN AUF GRUND VON RADIOBIOLOGISCHEN STUDIEN (New data on colony life amongst insects on the basis of radiobiological studies). Natur u. Volk 89 (1959) 209-13, 249-59. (In German)

The paper is a summary of results obtained by means of radioisotopes, and published by the author and his collaborators in a series of papers. They concern the exchange of substances between different castes and individuals as well as developmental stages in social insects. An analysis is also made of the interchange relations existing in the case of different types of hosts as well as for social parasites and ants.

53 Gösswald, K. DER AMEISENSTAAT (The ant colony). Math. Naturwiss. Unterricht 12 (1959) 208-23. (In German)

The paper is a review of the interchange of substances which takes place in labelled ants between different castes, and different developmental stages, and also between the ant population and its hosts and social parasites. Results obtained by means of the radio-tracer technique allow further insight into the sociological structure within an ant colony.

54 Gösswald, K., Kloft, W. NEUERE UNTERSUCHUNGEN ÜBER DIE SOZIALEN WECHSELBEZIEHUNGEN IM AMEISENVOLK, DURCHGEFÜHRT MIT RADIOISOTOPEN (Recent studies by means of radioisotopes on the social interrelations amongst ants). Zool. Beitr., Berl. 5 (1960) 519-66. (In German)

(Paper presented at the 3rd International Congress of the International Union for the Study of Social Insects, Paris 9-13 July 1957)

After discussing techniques (radiation sources, application of radioisotopes, measurements and methods of calculation) the data thus obtained on the distribution of food among ants is described. A number of sub-families were used in the study. The distribution of labelled food in the individual ant (here, Formica polyctena Foerst.) is described. Resorption only takes place in the mid gut, whilst regurgitated food is concentrated in the crop. Contact-autoradiography was used for following distribution with time; a very high activity was found in the labial gland. Food transmission within a group of workers (speed and extent) depends on several factors including temperature (opt. 22°C) and the size of the group; uniform distribution will ultimately be reached. The polymorphism within the worker caste has a direct influence on the quantity of food received: the larger ones appear better fed both quantitatively and qualitatively. Regurgitated food is accepted by queens although they normally receive gland-secreted food. The males participate actively in food transmission. Some problems of trophallaxis are discussed; uptake of larval material by nursing ants and vice versa is confirmed. Special characteristics of different types of ants are also studied (independent and social parasitic types).

55 Gösswald, K., Kloft, W. UNTERSUCHUNGEN MIT RADIOAKTIVEN ISOTOPEN AN WALDAMEISEN (Radioisotope studies on forest ants). Entomophaga 5, 1 (1960) 33-41. (In German)

The distribution of $P^{32}$ -labelled food (honey water) among workers of the red forest ant was studied. The transmission process of the crop contents is a function of time and temperature. At optimal temperature (24-26°C) the contents of one single crop may be distributed amongst 80 workers, with a direct primary transmission to 6-8 workers, at most. Distribution is Gaussian. Winged and dewinged queens, and male ants also participate. Given a sufficiently large number of workers, the queens are fed with high-quality gland extracts. Similarly, larvae destined for a sexually active life are also given preferential treatment. Distribution amongst members of different species of Formica was also studied.

56 Wilson, E.O., Eisner, T. QUANTITATIVE STUDIES OF LIQUID FOOD TRANSMISSION IN ANTS. Insectes Sociaux 4 (1957) 157-66.

Transmission of honey in several species of ants was studied using $I^{131}$ as tracer. Great variation in transmission rates between species was noted, ranging from negligible transmission over a 10-day period (in Pogonomyrmex badius) to complete colony saturation within 30 h (in Formica spp.). The honey was passed mostly among workers, very little being given to the queens or larvae. Indirect evidence is cited which suggests the occurrence of chain transmission beyond the primary donations given by the original foragers. (auth. summary)

Termite

57 Alibert, J. LES ÉCHANGES TROPHALLACTIQUES CHEZ LE TERMITE À COU JAUNE (CALOTERMES FLAVICOLLIS FABR.) ÉTUDIÉS À L'AIDE DU PHOSPHORE RADIOACTIF (Trophallactic exchanges in the yellow-necked termite Calotermes flavicollis Fabr., studied by means of radioactive phosphorus). C.R. Acad. Sci., Paris 248 (1959) 1040-2.

By means of feeding filter paper soaked in $P^{32}$ to homogeneous groups of termites, all larvae and nymphs from the third stadium onwards could be shown to feed independently. First stage larvae and soldier termites absorb no food, and second stage larvae only very small quantities. Three-year old, sexually potent adults are able to feed independently, but only after having been separated from the larvae for 65-75 h. Trophallactic exchange takes place surprisingly slowly. When radioactive termites in the ratio of 1 : 10 are added to normal colonies then the level of radioactivity found in the insects is 40% after 12 h, 20% after 70 h and only reaches 100% after about 35 h. The older larvae and younger nymphs play the most important part in trophallaxis, in the sense of "chewing the cud".

58 Banks, C.J. THE SEARCHING BEHAVIOUR OF COCCINELLID LARVAE. Brit. J. anim. Behav. 2 (1954) 37-8.

Laboratory and field experiments are briefly recorded in which radioactive labels in the form of radium sulphate were attached to late stage larvae, thus permitting their detection at a distance of about 2 feet. Positions of larvae were recorded at intervals of several days. They are able to travel as much as 21 feet in 2 days. It is tentatively concluded from these preliminary experiments that ladybird larvae, while capable of making a thorough search of their surroundings, may be inefficient in finding their prey, which may be an important contributory cause of the high mortality suffered by the early-stage larvae.

59 Banks, C.J. THE USE OF RADIOACTIVE TANTALUM IN STUDIES OF THE BEHAVIOUR OF SMALL CRAWLING INSECTS ON PLANTS. Brit. J. anim. Behav. 3,4 (1955) 158-9.

For studies on the behaviour of unfed newly-hatched Coccinellidae on plants, the radioactive material has to be suitable for external application as small labels, yet have a sufficiently high specific activity for easy detection with a G-M counter from about 1 ft away. Radium labels are too large to use on first instar coccinellid larvae, and tantalum ($Ta^{182}$) was used instead, which has a half-life of 120 d, and emits a high-energy $\gamma$-radiation. The method and apparatus used for attaching labels to larvae are described, and experimental details (dimensions, etc.) given. Labels of two levels of radioactivity were used on 1st instar larvae of Coccinella septempunctata L. (250 $\mu$c/mg and 42 $\mu$c/mg). In the first case, the larvae became less and less active, ceased feeding and after 2-3 d died without ecdysis. The lower activity caused no noticeable effect on growth and behaviour, nor did the approximately 24% increase in weight due to the Ta-strip.

60 Banks, C.J. THE BEHAVIOUR OF INDIVIDUAL COCCINELLID LARVAE ON PLANTS. Brit. J. anim. Behav. 5,1 (1957) 12-24.

As the survival of a larva depends primarily on the ability of its 1st instar to find aphids, observations were made on larvae recently dispersed from their egg shells. The species studied, Adalia bipunctata (L.), Coccinella septempunctata L. and Propylea quatuordecempunctata (L.), are common predators of Aphis fabae and others. Larvae were either labelled with metal foil disks containing radium sulphate or with strips of radioactive tantalum ($Ta^{182}$). The behaviour of the larvae appeared to be rather random in their search for food, and it is considered likely that in areas of low prey density many larvae, especially newly hatched ones, die of starvation because they do not find food. Larvae which encountered aphid colonies tended to stay near them, because after feeding they made small turning movements from side to side, which increased the chance of meeting another aphid of a colony. This behaviour differed from that before feeding. Larvae, especially the 1st and 2nd instar, took a comparatively long time to consume aphids and, in the field, one of them was prevented from feeding on an aphid colony by the attacks of their attending ants.

* Fuller et al. 1951 - [358]

61 Jenkins, D.W., Knight, K.L. ECOLOGICAL SURVEY OF THE MOSQUITOES OF GREAT WHALE RIVER, QUEBEC. Proc. ent. Soc. Washington 52, 5 (1950) 203-23.

Fifteen species of culicids were collected from tundra, alpine, and northern conifer forest habitats. The breeding habitats, dates, adult activity and biting habits are presented for each species. The most important pest species were Aëdes communis, A. pullatus, and A. excrucians. Radioactive ($P^{32}$) test pools were used and acquired radioactivity measured in the mosquitoes. Odonata nymphs and some corixid adults were observed eating larvae of A. pullatus in the field. Dytiscid and gyrinid larvae were observed pursuing larvae of A. pullatus and A. excrucians in the field, and eating them in the laboratory. Large dytiscid larvae showed a radioactivity of 8.5 mr/h in a radioactive pool which indicated that they had fed on radioactive A. pullatus and A. excrucians larvae.

62 Kannowski, P.B. THE USE OF RADIOACTIVE PHOSPHORUS IN THE STUDY OF COLONY DISTRIBUTION OF THE ANT LASIUS MINUTUS. Ecology 40, 1 (1959) 162-5.

Five widely-separated groups of mounds of this hypogeic ant were studied in a swamp in South East Michigan. Honey mixed with $P^{32}$ was placed in a mound of each group to determine whether or not each mound represented a separate colony. The honey was quickly fed upon by workers of these mounds and passed to other members of each colony. Within 6-8 h food had spread throughout each colony. Sampling of adjacent mounds showed the presence of radioactive ants in some of them. Occurrence of radioactive ants in nearby mounds indicated that some mounds are interconnected by tunnels. Thus, a colony may occupy one or more mounds. (auth.)

63 Long, W.H., Lilly, J.H. WIREWORM BEHAVIOR IN RESPONSE TO CHEMICAL SEED TREATMENTS. J. econ. Ent. 51, 3 (1958) 291-5.

Orientation reactions of the wireworm, Melanotus communis Gyll., to various insecticide seed treatments were studied by following the movements of individual larvae tagged with $Co^{60}$ in the soil. It was found that the repellency of certain insecticide seed treatments to wireworms apparently has two components: (1) inhibition of the feeding reaction, and (2) orientation of the insects away from treated seeds. For convenience these are referred to as type one and type two repellency, respectively. Type two repellency does not preclude contact with treated seeds, and varies in degree depending on the insecticide used. Aldrin, Dieldrin, Endrin, heptachlor and Lindane seed treatments all appeared to possess considerable type one repellency. Type two repellency was most pronounced with Lindane-treated seeds, and with Aldrin-treated seeds where this insecticide was not used in excess of 1 oz of actual toxicant per bushel of seed. Dieldrin, Endrin and heptachlor seed treatments showed a degree of type two repellency intermediate between Lindane and Aldrin on the one hand and untreated control seed on the other. (auth.)

* (An abstract of earlier work appeared in Bull. ent. Soc. Amer. 2, 3 (1956) 27, abstr. 18 under "Effects of insecticide seed treatments on wireworm activities")

64 Nagel, R.H., Davis, J.M. RESULTS FROM STUDIES ON THE ENGELMANN SPRUCE BEETLE (DENDROCTOMUS ENGELMANNI) IN 1955. Ent. Soc. Amer. North Central States Br. Proc. 11 (1956) 20-1.

The device described here was used in the treatment of about 19 000 beetles with $I^{131}$ in Colorado. The beetles were treated in batches of about 1000 each, and the entire lot treated and released in about 2 hours' time. Mortality, as indicated by those remaining in the trays the following day, was about 15%. This loss was not considered excessive as many were in poor health when treated. The treated beetles were fairly easily located beneath the bark of trees, by use of portable scintillation counters, for a period of about 2 weeks following the treatment. At this time the radioactivity of the isotope was only about one fourth of its original value. About 830 beetles (ca. 5%) were later relocated by their radioactive tag. A few tagged beetles were examined by peeling the bark from over them. They appeared to be making typical galleries and laying eggs in typical numbers, indicating that little adverse effect had resulted from their treatment.

65 Rings, R.W. FRUIT INSECT BEHAVIOUR STUDIES AIDED BY RADIOISOTOPES. Bull. Ohio agric. Exp. Sta. 725 (1953) 59-60.

A solution of at least 50 μc/ml of $P^{32}$ was required for labelling peach terminals. Plum curculios (Conotrachelus nenuphar) then reached an activity of 5 mr/h within 3-4 d, $P^{32}$ being present nearly throughout the body. No mass movement of the curculios into the centre of the orchard from the outside rows bordering woodlands was indicated. The greatest proportion of hibernating curculios can be found in the orchard rather than in the adjoining woodland.

* Rings and Layne 1953 - [370]

66 Schmidt, C.H., LaBrecque, G.C. ACCEPTABILITY AND TOXICITY OF POISONED BAITS TO HOUSE FLIES RESISTANT TO ORGANOPHOSPHORUS INSECTICIDES. J. econ. Ent. 52 (1959) 345-6.

Laboratory-reared Malathion-resistant flies (Grothe) were tested for any behavioural resistance in terms of an avoidance reaction to Malathion and Dipterex baits. The baits, which contained 1% toxicant, and the plain sugar standards were mixed with $P^{32}$-phosphoric acid. Mortality was determined after 24 h. The Malathion bait killed 40% of the Grothe females, 85% of the Grothe males, and 100% of the normal flies. All the flies of both colonies were killed by the Dipterex bait. No mortality was observed with the sugar controls. Both physiological and behavioural resistances to Malathion were involved in the survival of the Grothe females. The results of the test with Dipterex bait run on female flies only, showed no such evidence. The laboratory experiments are not strictly comparable with field conditions.

## I-A-3 POPULATION DYNAMICS (DISPERSAL, FLIGHT RANGE, ETC.)

### Conotrachelus

67 Layne, G.W. STUDIES OF THE MOVEMENTS OF THE PLUM CURCULIO, CONOTRACHELUS NENUPHAR HERBST., IN A PEACH ORCHARD WITH RADIOPHOSPHORUS ($P^{32}$) AS A TRACER. M.S. Thesis. Ohio State Univ., Columbus. 1951.

* Rings 1954 - [369]

### Cockroach

68 Jackson, W.B., Maier, P.P. DISPERSION OF MARKED AMERICAN COCKROACHES FROM SEWER MANHOLES IN PHOENIX, ARIZONA. Amer. J. trop. Med. Hyg. 4,1 (1955) 141-6.

Studies of this type have assumed increasing importance since the cockroach has been proved to be a potential vector of several filth diseases (amongst them poliomyelitis). Its capacity for transmission needs evaluation under varied field conditions. Movements of Periplaneta americana from sewer manholes were studied by a trap, mark, release, and recapture technique using paint or $P^{32}$ (about 100 cc of a 5% aqueous casein solution containing 10 $\mu$c of $P^{32}$/cc per group of roaches treated). In 2 experiments where only the resident manhole populations were marked, very limited emigration was observed, only 4 of 800 marked cockroaches being recovered by intensive trapping in yards, homes and neighbouring manholes. However, when 1200 marked roaches were super-imposed on a resident manhole population of 300, 71 tagged individuals were recovered within 15 d: 1 in a home, 5 in yards, and 65 still in the sewer system at distances up to 350 ft. from the release point. This suggests that a sudden increase in population over that of the carrying capacity of the environment may incite emigration from the centre of pressure.

69 Schoof, H.F., Siverly, R.E. THE OCCURRENCE AND MOVEMENT OF PERIPLANETA AMERICANA (L.) WITHIN AN URBAN SEWERAGE SYSTEM. Amer. J. trop. Med. Hyg. 3,2 (1954) 367-71.

Cockroaches are known to be able to harbour Salmonella for several days, the collection of Periplaneta americana (L.) contaminated with 3 species of Salmonella from sewer manholes in Texas was reported by R.S. Bitter and O.B. Williams (1949), and J.T. Syverton and others (1952) recorded the isolation of 4 strains of poliomyelitis virus from P. americana, Blattella germanica (L.) and Supella sepellectilium (Serv.) caught on the premises of patients ill with paralytic poliomyelitis. The movements of P. americana in and from city sewerage systems, which might affect its importance as a transmitter of disease, was studied at Phoenix, Arizona, in Oct. 1952. Surveys at 22 manholes for 7 weeks had shown a weekly average of 92-143 cockroaches, all of this species, whereas the predominant cockroaches in dwellings were S. supellectilium and B. germanica. Some 6500 individuals of P. americana were trapped in sewer manholes, marked with radioactive phosphorus by spraying with a solution containing 5% casein and 10 mc $P^{32}$/ml, and released in 4 manholes. During the next 8½ weeks, traps at 3 of the release sites yielded 929 cockroaches, of which 906 were radioactive; 34 traps in other manholes of which most were less than half a mile and the others up to one mile from the release sites yielded 16 021 cockroaches, of which none was radioactive, and 10 traps on premises in blocks adjacent to the release sites yielded only one cockroach which was radioactive and was caught 60 ft from the nearest release site. The lack of evidence of movement was surprising in view of an observed tendency of the species to disperse and the likelihood of induced population pressure at the points at which the cockroaches were released. (RAE-B 43: 150, 1955)

Dendroctonus

70 Nagel, R.H. INFLUENCE OF NEMATODES AND A TAGGING SOLUTION ON THE FLIGHT PERFORMANCE OF THE ENGELMANN SPRUCE BEETLE. Bull. ent. Soc. Amer. 5,3 (1959) 131, abstr.185.

By means of flight mills, flight performances with captive beetles were recorded and compared for (1) possible adverse effects of tagging solutions used earlier in dispersal studies; and (2) the influence of nematodes on flight in the case of infested specimens. (See Davis and Nagel, 1956)

Flea

71 Hartwell, W.V., Quan, S.F., Scott, K.G., Kartman, L. OBSERVATIONS ON FLEA TRANSFER BETWEEN HOSTS; A MECHANISM IN THE SPREAD OF BUBONIC PLAGUE. Science 127 (1958) 814.

There is circumstantial evidence that fleas of ground-squirrels can transmit plague bacilli from wild rodents to rats in rural areas of the western United States, and the development of a method for tagging fleas with radioactive cerium ($Ce^{144}$) made possible the direct investigation of the transfer of fleas from host to host. One male and two female voles (Microtus californicus), marked by clipping their toes, were placed in each of a number of experimental plots simulating field conditions, in which they could establish nests; 10-40 radioactive fleas (Malaraeus telchinum (Roths.)) were put on certain of them. The animals caught in traps set each day were lightly anaesthetized and any fleas were removed, examined for radioactivity and returned to the hosts. Fleas were found to have transferred from one vole to another in all of five trials and were found in nests in the three trials in which nests were established. In a second type of experiment, none of 30 tagged fleas on three voles transferred to three rats (Rattus norvegicus), kept in an adjacent enclosure, while the voles were alive. After the latter had been killed, seven fleas moved to rats that were allowed to enter the area with the dead voles, but no transfers were noted on three new voles put in the enclosure after the rats had again been removed to the adjacent one. Of 30 tagged fleas put on the new voles, 12 moved to rats in the same area. None of the 60 fleas was found in the nests of the voles, but 27 were recovered from those of the rats. Radioactivity was twice detected in the Microtis faeces and once in rat faeces. (RAE-B 48: 32, 1960)

72 Hanec, W. A STUDY OF THE ENVIRONMENTAL FACTOR AFFECTING THE DISPERSION OF HOUSE FLIES (MUSCA DOMESTICA L.) IN A DAIRY COMMUNITY NEAR FORT WHYTE, MANITOBA. Canad. Ent. 88,6 (1956) 270-2.

The following is based on the author's summary and conclusions. Two releases of radioactive houseflies (Musca domestica L.) were made in a dairy community near Fort Whyte, Manitoba, during the summer of 1954 to investigate the effect of wind direction and wind-borne odours on dispersion and to determine whether houseflies dispersed from one farm unit to another within the experimental area. The flies were tagged by feeding on $P^{32}$ in aqueous solution sweetened with sucrose. The recaptures from the two releases indicated that houseflies orientate themselves to wind-borne odours from farmyards, and migrate from one farmstead to another in appreciable numbers even in weather that is not optimal for flight. This suggests the need for community rather than individual attempts at control.

73 Jenkins, D.W. A QUELLE DISTANCE UNE MOUCHE PEUT-ELLE VOLER? Naturaliste Canadien 83,5 (1956) 95-102.

Although some results are presented on the dispersion of flies and mosquitoes marked with radioactive isotopes, the article is mainly a summary of the use of these isotopes in marking insecticides, insects and protozoa in research on disease vectors and disease organisms. (BA 33: 7816, 1959)

74 Lindquist, A.W., Yates, W.W., Hoffman, R.A., Butts, J.S. STUDIES OF THE FLIGHT HABITS OF THREE SPECIES OF FLIES TAGGED WITH RADIOACTIVE PHOSPHORUS. J. econ. Ent. 44,3 (1951) 397-400.

Three specimens of flies were tagged by feeding them solutions of $P^{32}$ -labelled phosphoric acid and then released. A total of approximately 36 000 Musca domestica (L.), 15 000 Phaenicia sericata (Meig.), and 1 200 Phormia regina (Meig.) flies were released, of which the following ratios of tagged to untagged flies were caught in the traps: - 1:11 for Musca domestica, 1:70 for Phaenicia spp., and 1:758 for P. regina. P. regina comprised approximately 50%, Phaenicia spp. 15, and M. domestica 7% of the total number of flies caught. Most of the tagged flies were caught the first day in the traps 0.5 mile from the release point. Tagged flies had moved outward 4 miles in each cardinal direction the first 24 h after release. Traps set in barnyards caught several times as many houseflies and Phaenicia as those set in open fields. The use of radioactive $P^{32}$ as a means of tagging flies has proved satisfactory and reduced the

amount of work in examining large catches of flies over that necessary when pigmented dusts are used to colour insects. (from auth. summary)

75 Long, D.B. FIELD OBSERVATIONS ON ADULTS OF THE WHEAT BULB FLY (LEPTOHYLEMYIA COARCTATA (FALL.)). Bull. ent. Res. 49,1 (1955) 77-94.

In a field study of adult populations (Rothamsted) it was found that the males emerge slightly before the females and that the emergence period may cover at least 3 weeks in late June and early July. Although the number of males may exceed the number of females at first, the females predominate later in the season due to the shorter life span of the males. The numbers of flies on the wheat fluctuate appreciably throughout the day. During the 1st week of the emergence period the number of flies taken increased steadily thoughout the day. After the date of population peak, however, the max. numbers occurred in the crop in the very early morning and the late evening, which suggested a daily flight dispersion followed by a general or localized return of the flies to the crop. Further study of the data showed that the daily temperature rhythm was only partly responsible for this daily flight dispersion, and that there appeared to be an active return flight to the crop in the evening. Generally the males were more active than the females and did not settle so deeply in the crop. Recaptures of $P^{32}$-labelled flies indicated that the extent of the sometimes rapid dispersions was not very great. The females dispersed more than the males, and were somewhat influenced by the occurrence of wheat in flower. Frequently flies were found to have congregated on the lee edge of the crop, but other preferred regions have been observed which could not be attributed to wind influence. (from auth. summary)

76 MacLeod, J., Donnelly, J. METHODS FOR THE STUDY OF BLOWFLY POPULATIONS. II. THE USE OF LABORATORY-BRED MATERIAL. Ann. appl. Biol. 44,4 (1956) 643-8.

The use of laboratory-bred blowflies for experiments on release and capture of marked flies is briefly discussed. In an experiment to test the possibility of a rhythmic protein-hunger cycle complicating the results when flies with a uniform history of protein hunger are used, no difference was observed in the response to carrion-baited traps of groups of flies from whom protein had been withheld for 3, 2, 1 and 0 days. In release experiments the ratio of marked to unmarked flies in trapped samples differed irregularly between laboratory-bred and wild flies, apparently depending on whether the climatic conditions at release were markedly or only slightly different from those of the insectary. (auth.)

* Kartmann et al. 1958 - [406]

## Flies

* Freeden et al. 1953 - [334]

77 MacLeod, J., Donnelly, J. INDIVIDUAL AND GROUP MARKING METHODS FOR FLY-POPULATION STUDIES. Bull. ent. Res. 48,3 (1957) 585-592.

Four different methods of marking insects are described in detail. Although they have been applied by the present authors only to the British Calliphorinae, they should be of value in ecological studies of mobile arthropods in general. These methods are: individual marking with paints, mass powdering with dyes, radioactive labelling with $P^{32}$, and a combination of the last two. A fifth method in which the emerging fly labels itself with fluorescent dust, is briefly described. The circumstances affecting the choice of method are outlined. Technical details are given concerning the supply and dilution of $P^{32}$, given in a sucrose solution. Alternatively, it was added to the drinking water instead. Experiments were made using the following flies: C. erythrocephala, C. vomitoris (L.), Lucilia spp.

78 Quarterman, K.D., Mathis, W., Kilpatrick, J.W. URBAN FLY DISPERSAL IN THE AREA OF SAVANNAH, GEORGIA. J. econ. Ent. 47,3 (1954) 405-12.

Employing as marking agents a combination of radioactive chemicals ($P^{32}$, $Ca^{45}$, and $I^{131}$) incorporated in their food and a variety of dyes dusted on them before release, dispersal habits of the common species of flies in urban areas were studied. $Ca^{45}$, used as calcium chloride, proved unsuitable since causing considerable mortality among flies marked with it. It was also rapidly excreted, and no dispersal data was obtained for flies marked with it. The iodine caused considerable mortality among male flies. Flies marked

with phosphorus and iodine were separated by the differences in types of emissions. Dispersal was rapid, continuous and independent of direction. Large numbers of Callitroga macellaria (F.) and some of all species were recovered in vacant areas considerably removed from major fly-breeding foci. Sources of heavy breeding near the city were found to contribute substantially to the city's fly population. Flies from dairies, an abattoir and a garbage dump situated outside the city moved into all parts of the city and right across it. From the relation between the release and trapping points for Musca domestica L., blowflies of the genus Lucilia (Phaenicia), C. macellaria, L. cuprina cuprina (Wied.) (pallescens Shann.), L. sericata (Mg.), Fannia pusio (Wied.) and Sarcophaga sueta Wulp. it was concluded that municipal fly control should be city-wide and should in some instances include the most important of the immediately outlying foci of production. (from auth. summary)

79 Quarterman, K.D., Kilpatrick, J.W., Mathis, W. FLY DISPERSAL IN A RURAL AREA NEAR SAVANNAH, GEORGIA. J. econ. Ent. 47, 3 (1954) 413-9.

Dispersal tests were conducted with natural populations of wild house flies and Callitroga macellaria, obtained by trapping adult flies on the rural premises used as the release points. They were marked by feeding them with $P^{32}$ -labelled milk. The marked flies were released where they had originally been caught. To minimize the effects of temporary caging, the releases of the marked flies were made at dusk after it had become too dark for them to migrate. In a test in early May, only one release point was used. In another test in late June, five release points were used simultaneously. Dyes were used in combination with $P^{32}$ to mark the test flies. Houseflies were recovered up to 5 miles from the release points in less than 24 hours after release, with a range and pattern of flight apparently quite similar to those of Callitroga macellaria. The higher percentages of C. macellaria taken in the recovery traps tends to substantiate the general belief that it is the more migratory of the two species. In both tests the flies apparently dispersed at random over an area 8 to 10 miles in diameter, with a few individuals being trapped up to 10 miles from the release point. Within the general dispersal area, the flies tended to congregate more at premises where food and breeding material were favourable. The availability of these materials, however, did not prevent great numbers of flies from leaving any given location, indicating that movement over this relatively large area is a normal pattern of fly activity. (from auth. summary)

80 Schoof, H.F., Siverly, R.E., Jensen, J.A. HOUSE FLY DISPERSION STUDIES IN METROPOLITAN AREAS. J. econ. Ent. 45, 4 (1952) 675-83.

In studies of the dispersal range of flies, principally Musca domestica L., made at Phoenix, Arizona, in 1951, 31 000 flies marked with $P^{32}$ were released in June and 56 000 in September. Catches made subsequently from baited traps distributed over the metropolitan area in concentric rings or segments included 227 and 284 marked flies, of which 88 and 81% respectively were found within a mile of the place of release. The proportion of radioactive flies in the catches varied inversely with the distance from the place of release, except that more were taken at one mile than 0.5 mile in June and about equal numbers in September. Some flies travelled a mile within 24 h, three miles within 48 h and four miles within 72 h. The numbers of marked flies collected three, four and five miles from the release points were small, but the fact that 10.1% of the marked flies recovered in June-July and 13% of those recovered in September-October were taken two miles from the release point indicates that movement to this distance may be of practical importance. The importance to a community of an area of high fly production situated a mile or more away from it depends on the sources of attraction in the intervening zone. In view of the influence of attractants on the infiltration of Musca domestica into an area, removal of these substances is as important a part of a community fly control programme as the elimination of breeding media. (from RAE-B 41: 42, 1953)

81 Schoof, H.F., Mail, G.A. DISPERSAL HABITS OF PHORMIA REGINA IN CHARLESTON, WEST VIRGINIA. J. econ. Ent. 46, 2 (1953) 258-62.

Release of about 8000 marked adults of Phormia regina (Mg.) from each of two sites in Charleston, West Virginia, during 1951 and 1952, and subsequent trapping revealed dispersal for distances up to nearly 10 miles in 3 d and just over 10 miles on the 4th d, though most of the marked flies recaptured were taken within 5 miles of the site of release. It was shown that flies moved from a zone with a low standard of sanitation to all parts of the city, and that their migration was not prevented by the presence of wooded ridges 400-500 ft high or by watercourses. The findings supported the recommendation that to effect the maximum reduction of P. regina within a community, control operations should be extended to sites of prolific breeding 3-4 miles beyond the boundaries of the urban area. The method adopted to mark the flies was to feed them on radioactive milk (containing 1 mc/l $P^{32}$ as phosphoric acid) and then to

dust them with a red or green dye. They were detected in the trap catches by their radioactivity and then treated with acetone to expose the dye characteristic of the point of release. (RAE-B 41: 172, 1953)

82 Schoof, H.F., Siverly, R.E. MULTIPLE RELEASE STUDIES ON THE DISPERSION OF MUSCA DOMESTICA AT PHOENIX, ARIZONA. J. econ. Ent. 47, 5 (1954) 830-8.

The relative importance of five major sources of houseflies (Musca domestica L.) near Phoenix, Arizona, on the control programme in operation in the town was studied in 1952. Flies marked with $P^{32}$ and a dye characteristic of the site were released simultaneously from the 5 sites, and catching stations were operated at the release sites themselves, 0.5 and 1 mile from each site in all directions and 2, 3 and 4 miles from each site in the direction of the centre of town. The recaptures are discussed in some detail. The following is based on the authors' summary of the findings. Flies from three sites, two on the periphery of the town and one 0.5 mile away, readily infiltrated into the town itself, but comparatively few flies from sites 1.8 and 2 miles away did so. From 59 to 81% of the marked flies recovered were taken within 1 mile of the release points and from 86 to 94% within 2.3 miles. Maximum recovery of marked flies occurred at release sites on the first day after release and at other sites on the fourth day. Available evidence indicates that although house-flies can travel 5-20 miles, the dispersion capacity of the mass population is expended within 0.5-2 miles because of the randomized, reciprocal type of meandering that characterizes housefly movement. One mile is the distance to which it is recommended that fly control operations should be extended outside most communities. (RAE-B 43: 156, 1955)

83 Schoof, H.F., Siverly, R.E. URBAN FLY DISPERSAL STUDIES WITH SPECIAL REFERENCE TO MOVEMENT PATTERN OF MUSCA DOMESTICA L. Amer. J. trop. Med. Hyg. 3, 3 (1954) 539-547.

In continuation of investigations carried out in the summer of 1952, about 147 000 radioactive houseflies (Musca domestica L.) were liberated at a primary release site at Phoenix, Arizona, on 30th Oct. For the next two days, 15 fly traps were operated at three secondary sites half a mile from the primary release point. The flies collected at each secondary site were then dusted with a characteristic dye and liberated. Catches at 48 collection stations within a mile of the primary release point indicated that, although fly dispersion from that site followed a general random design, radioactive flies were recaptured at a higher rate in one sector of the recovery zone than in the other two. In all, 104 dyed radioactive houseflies were caught. Movement from each of the secondary release sites was random; some individuals reversed their initial path of migration and returned in the general direction of the primary release site. The findings indicate that M. domestica is essentially a species of migrating habits. The flies apparently spend most of their lives moving from site to site not only in search of suitable places in which to feed and breed but also from an inherent instinct to wander. (from auth.)

84 Schoof, H.F. HOW FAR DO FLIES FLY? AND WHAT EFFECT DOES FLIGHT PATTERN HAVE ON THEIR CONTROL? Pest Control 27, 4 (1959) 16-24.

The report covers a number of fly dispersal studies conducted by investigators in Arizona, Oregon, West Virginia and Georgia. Flies were tagged by feeding on $P^{32}$-labelled milk-honey or sugar solutions (1 mc/l of milk) for a 24-h period. Dispersal from each site proved random in pattern. Specimens congregate in areas or sites having suitable feeding or breeding sites. In some studies, flies liberated from several sites were dusted with different dyes. It was concluded that flies can move rapidly from site to site; overall movement of the population is from 1-2 miles for Musca domestica. Maximum dispersal distance for this species is 20 miles. Blow flies generally migrate farther and more rapidly than houseflies. Maximum dispersal distance for Phormia regina is 28 miles. Other species investigated were Callitroga macellaria, Ophyra leucostoma, O. aenescens, Phaenicia cuprina, P. sericata, P. caeruleviridis, Fannia pusio, Sarcophaga sueta, S. bullata, Muscina stabulans. In some instances abatement measures 0.5 to 1 mile around the periphery of a municipality will suffice for housefly control. With blow flies, control treatments 3 to 4 miles beyond the city may be necessary.

85 Shura-Bura, B.L., Ivanova, E.V., Onuchin, A.N., Glazunova, A. Ya., Shaikov, A.D. WAYS OF FLY DISPERSION FROM PLACES OF MASS BREEDING IN LENINGRAD. Rev. Ent. URSS 35, 2 (1956) 334-6. (Ent. Obozrenie). (In Russian)

The range of dispersal of flies from a garbage dump situated about half a mile from densely inhabited districts of Leningrad was studied between 22nd June and 25th July 1954. Identification of 2 000 adults taken on the dump in June showed that Phormia (Protophormia) terraenovae R.-D., constitutes 82.5, 12.8, 2.0 and 0.5% of the population. Dishes of a bait consisting of a liquid mixture of sugar, yeast, flour and water,

with the addition of 10% meat paste and enough $P^{32}$ as sodium phosphate to give a radioactivity of 1.8 mc/lb were exposed for 4 d on the dump, and it was found that about 8% of the first two species were rendered radioactive. Traps were subsequently operated at various distances from the dump, and radioactive examples of P. terraenovae, Musca domestica, Muscina stabulans and L. caesar were taken at distances ranging up to 2.86, 2.4, 1.3 and 2.86 miles, respectively. Dispersion occurred in all directions, but inhabited districts were the most attractive. It was mainly due to active flight, though many flies were carried for up to about five miles on vehicles. (RAE-B 45: 210, 1957)

86 Shura-Bura, B.L. EMPLOI DES ISOTOPES RADIOACTIFS DANS L'ÉTUDE DU RÔLE ÉPIDÉMIOLOGIQUE DES MOUCHES. J. Hyg. Epidem. Microbiol. Immunol. (Prague) 1 (1957) 249-55. (In French)

Cess pools in a town were labelled with $P^{32}$ in $Na_2HP^{32}O_4$ solution. 0.8% of flies captured subsequently was found to be radioactive. Privy pits located not far from the town were marked similarly. Flies (Musca domestica) were found to move as far as 5 km from the pits towards the town. Maximal flight ranges were studied in another experiment. M. domestica covered as much as 3.84 km and, in a trial run in a sparsely populated area, up to 10.7 km. Other species of synanthropic flies behaved similarly. Sanitary measures (protection belts around towns), as at present, evidently need revision. On feeding flies a labelled culture of dysentery type Flexner 1/3 to 2/3 of the radioisotope was found in the intestinal content whilst the remainder had already been incorporated in the fly tissues. It is inferred that the insect digests the agent of dysentery and resorbs the radioactive phosphorus.

87 Shura-Bura, B.L., Shaikov, A.D., Ivanova, E.U., Glazunova, A. Ya., Mitryukova, M.S., Fedorova, K.G. SUR LE CARACTÈRE DE LA DISPERSION DE CERTAINES MOUCHES SYNANTHROPES À PARTIR DU LIEU DE LEUR MISE EN LIBERTÉ. Rev. Ent. URSS 37,2 (1958) 336-346 (Ent. Obozrenie). (In Russian)

87 000 exemplaires de mouches (dont 50 000 exemplaires de Musca domestica L.) marquées avec du phosphate de Na radioactif, administré dans la nourriture, furent mises en liberté dans une localité peu peuplée des environs de Leningrad. Il a été capturé pendant les 2-12 jours suivants dans des localités voisines 281 exemplaires de ces mouches radioactives, soit environ 0,3% du total. La principale direction de leur migration a été vers Leningrad, la distance maximum parcourue de 15 km et la volée moyenne de migration de 1 km par h. (BS 20: 229962, 1959)

88 Smith, A.H., Bohart, R.M. EVALUATING FLY NUISANCE SOURCE. Calif. Agric. 10,7 (1956) 11-12.

The results were obtained for a natural population. The test consisted of labelling flies with $P^{32}$ by suspending 10 treated strings 3 ft long which had previously been soaked in a 5% sugar solution containing 3 mc $P^{32}$ and then dried under a heat lamp. The strings were placed in a steer shed and left for 24 h. Fly populations from 4 nearby barns were sampled by using insecticide-treated strings. Seven percent of the flies in the steer shed were radioactive on the following day while only 1% and 0,5% were radioactive in the horse and the artificial insemination barn. No radioactive flies were found in the swine barn 1400 ft away, indicating very little dispersion under prevailing conditions.

89 Waldrop, R.H., Peel, R., Schoof, H.F. FLY MOVEMENT STUDY SHOWS BENEFITS OF CONTROL PROGRAM. Mod. Sanit. Build. Maint. 10,9 (1958) 19, 43-5.

$P^{32}$ -labelled flies were released in 2 adjoining communities. The release sites could be distinguished by additional marking with dyes. Attached-bait-pan type traps were used. The resultant captures reflect the levels of sanitation existing in the particular area. Maximum benefits in fly control are only achieved if both communities undertake control programs.

90 Yates, W.W., Lindquist, A.W., Butts, J.S. FURTHER STUDIES OF DISPERSION OF FLIES TAGGED WITH RADIOACTIVE PHOSPHORIC ACID. J. econ. Ent. 45 (1952) 547-8.

This further study into flight habits was made on laboratory-reared flies which were fed radioactive phosphoric acid. Details are given. The investigation was made on Phormia regina (Meig.), Musca domestica (L.) and Phaenicia sp., their activity ranging from 200 to 8000 cpm/insect. A standard laboratory monitor equipped with a thin-walled Geiger-Müller tube was used for testing. Details of the type and spacing of traps are given, and the results of the various collections. Both sexes of Phormia were shown to have the capacity for long flight; a maximum of 8 miles was observed. The remarkable flight range of 20 miles was noted for Musca domestica.

91 Barnes, M.M. RADIOTRACER LABELLING OF A NATURAL TEPHRITID POPULATION AND FLIGHT RANGE OF THE WALNUT HUSK FLY. Ann. ent. Soc. Amer. 52,1 (1959) 90-2.

About 15% of a naturally occurring population of Rhagoletis suavis completa Cress. in a 5-acre walnut grove in California were labelled within 26 h by spraying small areas of foliage on 15 trees with a water solution including 5% of a liquid maize protein hydrolysate, a powerful attractant, containing 0.05 mc $P^{32}$/ml. The recovery of radioactive flies in traps at various distances from the baited trees showed that populations redistributed themselves fairly rapidly through the grove and that the comparatively mature population there contributed about 7% of the individuals in the surrounding area, to a distance of 0.125 mile, and about the same proportion in an orchard 0.3 mile away. As labelled flies were caught almost a mile away in the third week after baiting, it is concluded that the species may easily spread a few miles in a season under reasonably favourable conditions. In the treated orchard, 56% of the females contained eggs, and radioactive eggs were readily collected from the walnuts. (RAE-A 48: 513, 1960)

92 Christenson, L.D., Foote, R.H. BIOLOGY OF FRUIT FLIES. Annu. Rev. Ent. 5 (1960) 171-92.

General review article covering representative fruit flies. Mention is made of a radioisotope study on the migration of Ceratitis capitata. A naturally emerging male tagged with $P^{32}$ was recovered more than 20 miles away, with the distance traversed including at least 9 miles or more of open sea.

93 Jones, S.C., Wallace, L. CHERRY FRUIT FLY DISPERSION STUDIES. J. econ. Ent. 48,5 (1955) 616-7.

Investigations in Oregon in 1950 showed that $P^{32}$-labelled phosphoric acid could be combined with sucrose as a food for adults of Rhagoletis cingulata (Lw.) without shortening their life. The flies ingested the food readily, and those with an initial radioactivity of 6000 cpm could be detected for 6 weeks with a portable survey meter. There were considerable variations in the amount of radioactivity retained by individual flies, but 80 selected at random after feeding on radioactive sucrose for 2-4 days showed an average of 8893 cpm. Females that received heavy dosages of radioactive phosphoric acid failed to oviposit in cherries, and their excreta and the juice and pulp of the cherries caged with them became radioactive. On 16th July 1951, 2010 radioactive adults were released in a cherry orchard, and captures in traps containing ammonium carbonate, with an insect net or under trees sprayed with nicotine sulphate were made until 9th August. In all, 39 radioactive individuals were recovered, including 14 from the point of release, seven 205 ft away and one each 555 and 942 ft away; one was taken in another cherry orchard on the far side of a beet field, 560 ft from the release point.

94 Pimentel, D., Fay, R.W. DISPERSION OF RADIOACTIVELY TAGGED DROSOPHILA FROM PIT PRIVIES. J. econ Ent. 48,1 (1955) 19-22.

Three tests were carried out at Edcouch and Pharr, Texas, in 1951 to determine the extent to which Drosophila migrated from privy pits into houses, using flies marked with $P^{32}$. In the first test, treated baits were placed in the pits of 10 privies and marked flies were subsequently recovered in 8 of the 10 adjacent houses. In the second test, flies were trapped, marked, and released in a privy pit; during the following 4 nights marked specimens were recovered in houses and privy pits as far as 500 ft from the release point In the third test approximately 1000 marked D. melanogaster were released in one privy pit, and 3000 marked D. repleta were released in another privy pit 100 ft away. Subsequent trapping indicated that both species dispersed rapidly from the release privies to other privies and houses in a nearby area. Drosophila melanogaster were recaptured as far as 500 ft from the release point and D. repleta almost 1000 ft from the release point. The three tests demonstrated there was extensive migration of Drosophila from privy pits to houses in the area studied. The indications were that a major portion of the Drosophila which were found in the houses had, at one time or another, frequented privies. (auth. summary)

95 Roan, C.C. TAGGING ORIENTAL FRUIT FLIES WITH RADIOACTIVE PHOSPHORUS FOR FIELD-MOVEMENT STUDIES. J. econ. Ent. 45, 5 (1952) 826-8.

Various methods of marking Diptera with radioactive phosphorus for field-movement studies were tested for use on Dacus ferrugineus dorsalis Hendel. In the first test, potassium dihydrogen phosphate containing $P^{32}$ was added to the carrot medium used for routine rearing of the larvae at the rate of 0.1 or 0.34 $\mu$c $P^{32}$/ml, and 500 eggs were placed on 200 ml of the mixture. Differences due to the two concentrations of $P^{32}$ were not adequate to distinguish between individuals from different samples. However, the fruitflies were sufficiently radioactive to permit their identification in releases made at time intervals of the half-life of

$P^{32}$ (14.3 d) by taking advantage of radioactivity decay and excretion losses. In the second test, 600 adults were kept without food or water for 24 h, allowed to feed for 24 or 48 h on a sugar solution containing 3.9 μc $P^{32}$/ml, and then restored to the normal diet. Assays showed that the differences in radioactivity between the two groups were inadequate for positive identification of all adults according to the period of feeding. Assay of individuals at different intervals after marking showed that the rate of loss of radioactivity differed with the method of marking, probably owing to differences in the biochemical distribution and rate of turnover of the $P^{32}$. Females reared from marked larvae lost $P^{32}$ more rapidly than the males, and 80 mg eggs collected from them 15 d after emergence gave a reading of 1 000 cpm. Neither treated adults nor adults from treated larvae showed adverse effects from exposure to the different levels of radiation. Those from treated larvae resembled the normal laboratory strain in percentage emergence from pupae, fecundity, fertility, viability of larval progeny and length of life under laboratory conditions, and the use of $P^{32}$ did not complicate normal rearing unduly.

* Rings 1953 - [65]

96 Steiner, L.F., Mitchell, W.C., Holloway, J.R., Nakagawa, S. LURE EFFICIENCY AND MOVEMENT STUDIES WITH TAGGED FRUIT FLIES. Bull. ent. Soc. Amer. 5,3 (1959) 117, abstr.66.

$P^{32}$ was used for labelling several hundred thousand flies of all 3 species (Dacus orientalis Hendel, the Mediterranean fruit fly Ceratitis capitata Wied., and the melon fly D. cucurbitae Coq.). Recoveries revealed flights up to 26 miles over 12 miles of ocean. Up to 55% recovery of released oriental fruit fly males occurred with methyl eugenol. One release of this species spread over an area of 100 sq. miles. Females spread as far as males with heaviest recaptures made downwind.

(Work to be published in near future, according to personal communication from the author, dated Aug.7, 1962)

97 Warner, R.M. RADIOACTIVE TAGGING FOR TRACING MOVEMENTS OF DROSOPHILA. Calif. Fig. Inst. Proc. Annu. Res. Conf. 13 (1959) 35-7.

## Forest insects

98 Beal, J.A. STATUS AND TRENDS IN FOREST INSECT RESEARCH IN THE UNITED STATES. p.323-30 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956", Vol.4. Becker, E.C., ed. Ottawa, Mortimer Ltd. 1958.

Review article. Brief mention is made of radioisotope applications to forest insects. Tagged Dendroctonus engelmanni have been located underneath log bark up to 3 miles from the release point.

99 Godwin, P.A., Jaynes, H.A., Davis, J.M. THE DISPERSION OF RADIOACTIVELY TAGGED WHITE-PINE WEEVILS IN SMALL PLANTATIONS. J. econ. Ent. 50,3 (1957) 264-6.

The overwintering females of Pissodes strobi (Peck) which infest white pine, Pinus strobus, disperse from their hibernation quarters and oviposit from mid-April to mid-June. Reports as to their capability of flight are conflicting, and as it affects the degree of control afforded by the sprays normally applied at their first appearance, 1600 adults were tagged with radioactive scandium ($Sc^{46}$), applied as the chloride in solution, and liberated under pine trees in a plantation 900 ft × 600 ft in area. The distribution pattern suggested the occurrence of direct uninterrupted flight of 300-400 ft, the distance from the release trees to the edge of the plantation, and total movement covering at least 724 ft. It is concluded that experimental plots should be separated from infested areas by at least 800 ft., and that the practice of spraying a few trees round the infested ones to remove the residual population is of doubtful value. A hardwood over-story appears to act as a mechanical barrier to penetration by the weevil.

100 Jaynes, H.A. SOME RECENT DEVELOPMENTS IN WHITE-PINE WEEVIL RESEARCH IN THE NORTHEAST. Bull. ent. Soc. Amer. 3,3 (1957) 40, abstr.19.

Spring emergence of white-pine weevil, Pissodes strobi (Peck), the most serious insect pest of eastern white pine, can now be predicted by using cumulative degree hours above 40°F. Dispersion of weevils in a small plantation has been recorded by tagging with a radioisotope. (from abstr.)

* Nagel and Davis 1956 - [64]

101 Sullivan, C.R. USE OF RADIOACTIVE COBALT IN TRACING THE MOVEMENTS OF THE WHITE-PINE WEEVIL, PISSODES STROBI PECK. (COLEOPTERA: CURCULIONIDAE). Canad. Ent. 85,8 (1953) 273-6.

Since radioactive cobalt ($Co^{60}$) has a long half-life and emits gamma rays, a method was devised for tagging adults of Pissodes strobi (Peck) with it so as to facilitate studies of their behaviour during periods of their life when ordinary observation is difficult. The amount of $Co^{60}$ applied per insect was found to be about 200 μc for 47 of them, and about 500 for the rest. A plantation of white pine (Pinus strobus), 190 ft x 170 ft, in Ontario was divided into 9 ft squares, since it was calculated that the amount of $Co^{60}$ applied would be sufficient for detection at a distance of 9 ft, and the 56 weevils were liberated on the evenings of 31st August and 1st September 1951. Two were removed after a week because of peeling of the cobalt, and on 1st November, 21 of the remainder were alive and had entered hibernation quarters; among the rest, 46% had died from unknown causes, as compared with 43.5% mortality among the controls. In spring, only 19% of the adults that entered hibernation were still alive, though the survival percentages among untreated adults caged in the open and in a closed group of white pines were 68 and 56, respectively; it is therefore concluded that the amount of $Co^{60}$ used was excessive. The cellulose cement adhered well until spring, when peeling increased. In subsequent tests, cellulose acetate was combined with or replaced by Glyptal, with satisfactory results. (RAE-A 43: 70, 1955)

## Grasshopper

102 Baldwin, W.F., Riordan, D.F., Smith, R.W. NOTE ON DISPERSAL OF RADIOACTIVE GRASSHOPPERS. Canad. Ent. 90,6 (1958) 374-6.

A method is described for tagging grasshoppers with $P^{32}$ in the form of $H_3P^{32}O_4$. Nymphs and adults of Camnula pellucida (Scudd.) had previously been found to disperse for up to 240 yd in 6 d when released on bare, cultivated fields but to be a unable to orientate themselves towards a food supply. In 1953, tagged Melanoplus bilaturatus (Wlk.) (mexicanus, auct.) were released at the centre of a 10-acre field, 8000 in the 3rd and 4th instars, and later 7500 adults. Adequate food was available. The range of movement under those conditions was found scarecely to exceed 30 yd in 3 weeks. The findings are discussed with respect to earlier experiments.

103 Riegert, P.W., Fuller, R.A , Putnam, L.G. STUDIES ON DISPERSAL OF GRASSHOPPERS (ACRIDIDAE) TAGGED WITH PHOSPHORUS-32. Can. Ent. 86,5 (1954) 223-232.

$P^{32}$ was shown to be a useful tag for field studies of grasshopper movement and dispersal over a relatively short period. About 15 000 - 20 000 individuals were conveniently tagged at a time by feeding on wheat seedlings, growing on an area of 4 $ft^2$ that had been sprayed with 50 $cm^3$ solution containing 0.5 mc $P^{32}$. About 14% of the applied radioactivity was taken up and retained by the grasshopper. (RAE-A 44: 110, 1956)

## Mealybug

104 Cornwell, P.B. SOME ASPECTS OF MEALYBUG BEHAVIOUR IN RELATION TO THE EFFICIENCY OF MEASURES FOR THE CONTROL OF VIRUS DISEASES OF CACAO IN THE GOLD COAST. Bull. ent. Res. 47,1 (1956) 137-66.

The mealybug migration from infected slash is discussed, as are the results from tests on $P^{32}$ -labelled mealybugs at various ages.

105 Cornwell, P.B. MOVEMENT OF THE VECTORS OF VIRUS DESEASES OF CACAO IN GHANA. I. CANOPY MOVEMENT IN AND BETWEEN TREES. Bull. ent. Res. 49,3 (1958) 613-30.

An examination was made of the movements of Pseudococcus njalensis Laing, the dominant vector of swollen-shoot disease, on cacao in Ghana. The mobile population is composed almost entirely of first-instar nymphs (92%). Movement is initiated at about 23.5°C and activity becomes more pronounced at higher temperatures. Movement is maximal during mid-afternoon when many hundreds of insects become mobile on heavily infested trees. The density of mobile mealybugs increases from the base of the trunk and reaches a maximum at a few feet below the top of the canopy. Under experimental conditions, nymphs walked at least 28 ft in search of favourable feeding sites and their dispersion increased proportionately with the number of canopy bridges. On cacao, adults are occasionally carried by the ant, Crematogaster striatula Emery. Using insects labelled with $P^{32}$ the assumption was confirmed that P. njalensis is capable of walking from tree to tree via the canopies of farmers' cacao. In a plantation of 8-year-old Amelonado cacao, 40%

of the branches were in contact at 4-ft spacing and about 20% at spacings between 5 and 7½ ft . No branches were in contact, where the trees were spaced more than 12 ft apart. At the closest spacing, the ratio between the number of mobile mealybugs that reached adjacent contact trees and those that did not was about 9:100, this ratio being reduced to 1 or 2:100 amongst trees growing 5 to 7½ ft. apart. The significance of the movement of mealybugs in the canopy in relation to virus spread is emphasized. Methods of preventing vector dispersal by pruning, wide spacing and interplanting with a secondary tree crop are discussed. The importance of a closed canopy in preventing attack on the trees by Miridae is stressed. (auth. summary)

106 Ward, A.A. OUTLINE OF THE USE OF RADIO-ISOTOPES AT THE WEST AFRICAN COCOA RESEARCH INSTITUTE. p.89-91 in "Radioisotopes". CSA publ. no. 28, Scientific Council for Africa South of the Sahara, Pretoria. 1957.

Article includes a brief review of the uses to which radioisotopes have been put in studies of the mealybugs (Pseudococcus njalensis) that transmit the swollen-shoot virus disease of cacao in Ghana. In 1952, the mealybugs were placed on agar containing $P^{32}$ , to estimate the interval before feeding began. The results indicated that the preliminary resting period was long and variable, which possibly explains the low and unequal percentages of transmission obtained when viruliferous mealybugs were artificially transferred in experiments. The results were confirmed in 1953, when mealybugs were allowed to feed on cacao seedlings with their roots in radioactive solution. The isotopes used in this were first $Sr^{90}$ and then $P^{32}$ . The latter was used in 1953-54 to assist in discovering the distances traversed by mealybugs dispersing from piles of slash from felled diseased cacao trees; the distance proved to be short. The uptake and translocation of $P^{32}$ in cacao trees was also investigated, in connection with attempts to label mealybugs in their natural habitat in the tree-canopy. Application to the soil resulted in the most even distribution of radioactivity. (RAE-A 47: 511, 1959)

## Mosquitoes

107 Aragão, M.B. UTILIZACÃO DO MOSQUITOS RADIOACTIVOS NA AVALIACÃO DO RAIO DR VÔO. (Use of radioactive mosquitoes to determine flight-range). Rev. bras Malariol. 5,2 (1953) 137-43. (In Portug.)

Larvae were raised in a 1:10 000 solution of thorium nitrate. The abdomens of captured mosquitoes were burned and the ashes tested with G5 (Ilford) nuclear track plates. Radioactive specimens were captured in all catching stations. The longest flight recorded was 800 m. (BA 28: 14876, 1954)

108 Bidlingmayer, W.L., Schoof, H.F. THE DISPERSAL CHARACTERISTICS OF THE SALT-MARCH MOSQUITO, AEDES TAENIORHYNCHUS (WIEDEMANN), NEAR SAVANNAH, GEORGIA. Mosquito News 17,3 (1957) 202-12.

Mosquitoes were produced by collecting mosquito-egg - infested sod samples or by inducing captive ♀♀ to oviposit on soil media. Radioactive marking was done at the 3rd instar by $H_3P^{32}O_4$. From a release of approx. 2 million radioactive A. taeniorhynchus near Savannah, Georgia, 428 marked specimens, of which 13% were ♂♂, were recovered. Recapture of tagged ♀♀ was made at the maximum distances of trap locations (18-21 miles). However, most of the radioactive ♀♀ (90%) were collected within 4 miles of the release point, the number of recoveries decreasing as the distance increased. Females were observed to bite readily prior to their departure from the release site. Radioactive ♂ A. taeniorynchus were recovered at maximum distances of 12 miles and for periode of 12 to 20 days after release. The majority of the ♂ recaptures occurred near the release point, but recoveries were made at 2,4,8,10 and 12 miles. Some results are also given for A. sollicitans.

109 Bruce-Chwatt, L.J. RADIOISOTOPES FOR RESEARCH ON AND CONTROL OF MOSQUITOES. Bull. World Health Org. 15, 3-5 (1956) 491-511.

Review article. The application of radioisotopes to studies concerned with Anopheline control is discussed, particularly in connection with ecological problems which cannot be solved by other means. Larvae of Aëdes aegypti (L.) were labelled by immersion. Both $P^{32}$ and $Sr^{89}$ were readily absorbed; in view of their half-lives of 04.3 and 54 days, $Sr^{89}$ is preferable because of its slower rate of decay. The flight ranges of various mosquitoes have been determined by means of radiotracers (references included). Methods of labelling with radioisotopes are described, and observations on physiological and biological effects of radiation mentioned. The use of radiotracers in the study of insecticides is discussed, with numerous examples. A promising use of tracers would appear to lie in the determination of the area of dispersal aerosols dispensed from aircraft by means of isotopes with strong radiation incorporated into the insecticides.

110 Jenkins, D.W., Hassett, C.C. DISPERSAL AND FLIGHT RANGE OF SUBARCTIC MOSQUITOES MARKED WITH RADIOPHOSPHORUS. Canad. J. Res. D-Canad. J. Zool. 29,3 (1951) 178-87.

The dispersal and flight range of Aëdes communis (Deg.), a mosquito characteristic of the northern coniferous forest, were studied at the timberline at Churchill, Manitoba, during the summer of 1950. Four million larvae were collected and reared in four shallow wooden tanks containing a total of 1200 l water, and $P^{32}$ in the form of a solution of $KH_2P^{32}O_4$ was added at a total rate of 206.3 mc $P^{32}$ (0.05 μc/larva) as soon as the larvae reached the late 4th instar. About 3 million adults with an average radioactivity of 775 cpm emerged and dispersed in the Warkworth area. Of the 141 radioactive mosquitoes recovered in the course of 6 weeks, 63 had dispersed 150 - 5 000 ft, the average dispersal being 500 ft. A possible variable results from the presumed occurrence of two races of A. communis in the Churchill area; the larger adults dispersed further than the more numerous smaller ones. The effective dispersal (dispersal in numbers sufficient to constitute a pest) was determined to be about a quarter of a mile. This study indicates that A. communis is a relatively sedentary mosquito and has a limited flight range in the northern coniferous forest in comparison with arctic tundra species. It rests in vegetation and does not attack man during the daytime. Additional data are given on the habits of this and other northern species of mosquitoes. (RAE-B 40: 134-135, 1952)

111 Provost, M.W. THE DISPERSAL OF AEDES TAENIORHYNCHUS. I. PRELIMINARY STUDIES. Mosquito News 12 (1952) 174-90.

Radioactive A. taeniorhynchus adults were produced by exposing the larvae to $P^{32}$. The subsequent dispersion from Sanibel Island, Florida, was studied from the time and space distribution of marked recapture. Other collecting methods were used but only light traps yielded significant numbers of recoveries. Migration, as a special non-purposive flight, occurs from 1-4 d after emergence. This initial exodus carried females to the limits of the collecting area, 20 miles, and probably beyond. The males probably did not migrate beyond 2 miles. This main flight was deflected to the northwestward, possibly by prevailing southeasterly winds and by the NW-SE alignment of the coastline and topography. Light traps collected females on a 5-d cycle of numbers; the last one was caught 19 d after emergence. Males entered light traps the first 3 d only after emergence. There is some indication that females may migrate early in each 5-d progenitive period. Dispersion of female A. taeniorhynchus appears to be random, omnidirectional, and appetential, periodically repeated from foci established by a previous migratory channeled, non-appetential dispersal. Males accompany the females on the initial exodus but probably drop out of the migration within a mile or two and thereafter settle down to a sedentary life characterized by swarming during twilight periods for 2-3 weeks. (from auth. summary)

112 Provost, M.W. THE DISPERSAL OF AEDES TAENIORHYNCHUS. II. THE SECOND EXPERIMENT. Mosquito News 17 (1957) 233-47.

A technique was developed for producing large numbers of A. taeniorhynchus in the field under controlled conditions. The Philoxerus sod in egg-laden swale was cut out and transported to a "nursery" pool when water was immediately pumped in and the sods flooded. A yield of 2½ million mosquitoes were obtained. Larvae were then transferred from "nursery" to wooden vats for $P^{32}$ -introduction. 1½ million radioactive mosquitoes were then allowed to disperse freely from the middle of Sanibel Island. Females were recovered up to 25 miles away and until the 24th night after emergence. Only a few males were recovered, all within 3 ml. The dispersal was generally downwind. It was considered that migration occurs the night of departure only, the twilight departures resulting in longer migrations than middle-of-the night departures. Appetential flights expand the range of occupation by a brood much beyond what is established by the migration.

113 Provost, M.W. THE DISPERSAL OF AEDES TAENIORHYNCHUS. III. STUDY METHODS FOR MIGRATORY STUDIES. Mosquito News 20,2 (1960) 148-61.

Two field studies of the migratory exodus in the salt-marsh mosquito, A. taeniorhynchus, in Florida are described. Techniques described from the Ft. Pierce 1952 study are: (1) inducing mosquitoes in nature to lay their eggs where they can be gathered, in this case 3 million eggs, were laid on 1280 $ft^2$ of sod; (2) production of larvae by flooding egg-laden sods placed on the bottom of specially dug pools; (3) marking the larvae, and resultant adults, with radioactive phosphorus, emphasizing the inter-relationship of larval feeding and $P^{32}$ dosage in affecting degree of marking; and (4) recovering of departing mosquitoes in directional, stationary nets to learn direction and angle of migratory exodus. The Vero Beach 1958 study involved the following described techniques: (1) sampling the resting population at the emergence site for determination of age, sexual state, feeding state; (2) sampling the departing mosquitoes by sticky nets and kytoon net. In the Vero Beach experiment emphasis is placed on the coordination of field observational techniques, field collecting techniques, and laboratory examination techniques. (auth.)

114 Quarterman, K.D., Jensen, J.A., Mathis, W., Smith, W. FLIGHT DISPERSAL OF RICE FIELD MOSQUITOES IN ARKANSAS. J. econ. Ent. 48,1 (1955) 30-2.

Using field-collected mosquitoes which were tagged with $P^{32}$ in the larval and adult stages, preliminary studies were made on the flight habits of rice field mosquitoes, Psorophora spp., in the Grand Prairie section of Arkansas. Efforts at mass-rearing of field-collected early 4th instar Psorophora larvae for tagging with $P^{32}$ were only partially successful. Marked rice field mosquitoes dispersed in many directions from the release point, but tended to move mostly with the wind. Psorophora confinnis travelled at least 6 miles and traversed heavily wooded areas over 1 mile in width. P. discolor was recovered up to 1.5 miles from the release site, but the number of specimens of this species, tagged and recovered, was too low to provide significant information on its flight habits. (auth. summary)

115 Shemanchuk, J.A., Fredeen, F.J.H., Kristjanson, A.M. STUDIES ON FLIGHT RANGE AND DISPERSAL HABITS OF AËDES FLAVESCENS (MÜLLER) (DIPTERA: CULICIDAE) TAGGED WITH RADIO-PHOSPHORUS. Canad. Ent. 87, 9 (1955) 376-9.

About 415 000 larvae of Aëdes flavescens (Müll.) were collected from sloughs at Indi (Saskatchewan) in May 1952, kept in tubs in water containing 0.1 μc $P^{32}$/ml for periods (19-45 h) long enough for the average radioactivity of sample larvae to exceed 3 000 cpm, and then returned to one of their natural habitats. The batches of tagged larvae were released daily from May 10-15, and about 1 500 000 adults collected with hand nets between May 17 and June 20 at up to 14 miles from the release site. These included 82 tagged mosquitoes (0.02% of the tagged larvae), all of which were obtained between May 21 and June 6, and at distances from the release site ranging up to 6.6 miles for females and 1 400 yd for males. The average radioactivity of the tagged larvae and adults were 8 130 and 640 disintegrations per minute, respectively, indicating a loss of 93% of the original radioactivity, of which about 56% could be accounted for by decay of the $P^{32}$. It was observed in this experiment that the larvae needed the longer periods of treatment to acquire adequate radioactivity when the weather was cool, and the effect of temperature was confirmed by a laboratory test in which disintegration per minute for larvae kept for 15, 40 and 60 h in pond water containing 0.1 μc $P^{32}$/ml at 34 and (in brackets) 76°F were 1 250 (33 000), 2 860 (82 200) and 3 320 (121 000). Of larvae kept for 24 h in water containing 1 and 0.1 μc $P^{32}$/ml, 100 and 41% died in 4 d, while control mortality was 36.5%. Treatment at 0.1 μc retarded the emergence of adults by about 3 d, but did not appreciably affect their life-span. (from RAE-B 45: 95, 1957)

116 Shura-Bura, B.L. AN ATTEMPT TO STUDY THE MIGRATION OF HOUSE FLIES BY USING RADIOACTIVE TRACERS. Zool. Zh. 31,3 (1952) 410-2. (In Russian).

117 Шура-Бура, Б.Л. ОПЫТ ИЗУЧЕНИЯ МИГРАЦИИ МУХ СО СВАЛКИ МЕТОДОМ МЕЧЕНЫХ АТОМОВ. Гигиена и Санитария 9 (1955) 12-5.

В статье освещаются вопросы о правильной организации мероприятий по борьбе с комнатной мухой и, в основном, вопрос о естественных миграциях мух. При помощи метода радиоактивных индикаторов получены доказательства миграции мух со свалки в жилые кварталы города и в расположенные на его окраине поселки. Миграция мух со свалки происходит как путем активного полета, так и пассивно с транспортом, вывозившим отбросы. Предельная дальность миграции прослежена на расстоянии до 5 км.

Shura-Bura, B.L. STUDYING FLY MIGRATION FROM A GARBAGE DISPOSAL DUMP BY THE TRACER TECHNIQUE. Hyg. & Sanit. Moscow 9 (1955) 12-5.

Possible effective measures against Musca domestica are discussed and the problem of its natural migration. Data are given on migration from the dump to the living-quarters and outskirts of cities. The migration habits were studied by means of tracer techniques. Migration is effected both actively, by their flight, and through transporting the garbage. The maximum distance of fly migration was 5 km.

118 Thurman, D.C., Husbands, R.C. PRELIMINARY REPORT ON MOSQUITO FLIGHT DISPERSAL STUDIES WITH RADIOISOTOPES IN CALIFORNIA, 1950. US Pub. Health Serv. CDC Bull. 10,4 (1951) 1-9.

Large scale tagging of mosquitoes with $P^{32}$ was effected near Turlock, California. Of the approximately 400 000 mosquitoes about 90% were Aëdes nigromaculis (Lud.) The mosquitoes in the release area were recovered by means of light traps, and an aspirator technique collected them off people. A total of 475 tagged mosquitoes were recovered; 17 were taken between 0.75-1 mile from the release point, and 10 between 1 and 2 miles.

119 Washburn, G.E. PROGRESS REPORT ON MOSQUITO STUDIES IN CALIFORNIA. Mosquito News 12,4 (1952) 235-8.

Various studies on problems of mosquito control by different workers are reported. Flight studies were carried out on Aëdes nigromaculis in which the dye Rhodamine "B" and $P^{32}$ were used.

120 Welch, H.E. TWO APPLICATIONS OF A METHOD OF DETERMINING THE ERROR OF POPULATION ESTIMATES OF MOSQUITO LARVAE BY MARK AND RECAPTURE TECHNIQUE. Ecology 41 (1960) 228-9.

A method for determining the error of population estimates is outlined, and used to test the decrease in density of prey described by Baldwin, James and Welch (1955), and to compare larval densities in permanent and temporary pools. The earlier work had used radioactive larvae, labelled by means of $H_3P^{32}O_4$. The technique and analysis are easy to use in the field. It is important that a) a large number of larvae be tagged; b) the experiment be of short duration; and c) as many samples as possible be taken. The technique is in general more satisfactory in permanent or discrete pools.

Various

* Arnason, Fuller and Spinks 1950 - [350]

121 Cherepanov, A.I., Volgina, K.P. DETERMINING THE MOVEMENT OF WIREWORMS IN THE SOIL BY THE METHOD OF TAGGED ATOMS. Dokl. Akad. Nauk SSSR. 98 (1954) 301-2. (In Russian).

Agriotes obscurus was used in this study.

* Courtois and Lecomte 1958 - [353]

122 Dow, R.P. DISPERSAL OF ADULT HIPPELATES PUSIO, THE EYE GNAT. Ann. ent. Soc. Amer. 52 (1959) 372-81.

Female eye gnats maintained on honey in the laboratory retained more than half their original radioactivity 5 days after being tagged with $P^{32}$. When tagged gnats were released at the center of three concentric circles of traps on a windy day, some moved 25 ft directly upwind but an equally large number was caught 75 ft downwind in traps on the outermost circle, on both sides of the mean downwind direction. Releases of tagged gnats ½ and 1 mile from a rural population center in southwestern Georgia resulted in almost complete penetration of the small town on the day of release. In one test, traps more than a mile from the release box caught 15 gnats in less than 3½ h after it was opened. Chi-square analysis was used to test the hypothesis that tagged gnats are distributed like the wild ones. Local departures from an overall equilibrium between tagged and untagged gnats could be recognized, and progress of the dispersal could be followed by comparing successive collections. (auth.)

* Foott 1954 - [333]

* Fuller et al. 1951 - [358]

123 Green, G.W., Baldwin, W.F., Sullivan, C.R. THE USE OF RADIOACTIVE COBALT IN STUDIES OF THE DISPERSAL OF ADULT FEMALES OF THE EUROPEAN PINE SHOOT MOTH, RHYACIONIA BUOLIANA (SCHIFF.). Canad. Ent. 89,8 (1957) 379-83.

A solution containing $Co^{60}$ as nitrate was applied to the first 7 abdominal segments of the pine shoot moth which had been anesthetized with $CO_2$. The majority of insects carried 25-50 μc of $Co^{60}$. Tagging appeared to have no effect on behaviour, life expectancy or reproduction. Recoveries indicated that the insects tended to remain in the stand of pine in which they were released. Radioactivity was subsequently detected in bird droppings, pine needles, and preying insects. Dispersal of the moths was never beyond 50 m from the point of release, in spite of strong counter winds.

* Kannowski 1959 - [62]

* Kartman et al. 1958 - [406]

124 Kettlewell, H.B.D. USE OF RADIOACTIVE TRACER IN THE STUDY OF INSECT POPULATIONS (LEPIDOPTERA). Nature 170 (1952) 584-5.

The species studied were Panaxia dominula and Arctia caja. The food plants selected for them were dead nettle (Lamium spp.) and dock (Rumex spp.) respectively, and these were treated with $S^{35}$. The radioactive imagines hatched gave counts far in excess of those observed from the larvae and pupae, probably due to a much greater surface. Methods are discussed possibly useful for ascertaining mortality, total populations, larval death-rates, dispersal activity, and other aspects of population dynamics as well as pigment chemistry in many orders of insects.

125 Lebedev, D.V. STUDY ON THE MIGRATION OF TAGGED WIREWORMS IN SOIL. Priroda 12 (1950) 56-7. (In Russian)

126 Mulla, M.S., March, R.B. FLIGHT RANGE, DISPERSAL PATTERNS AND POPULATION DENSITY OF THE EYE GNAT, HIPPELATES COLLUSOR. Ann. ent. Soc. Amer. 52 (1959) 641-6.

Gnats tagged with $P^{32}$, released in the Palm Desert and Indio areas of the Coachella Valley in southern California, generally dispersed into agricultural areas and adjacent residential sections where favourable conditions existed for their feeding and breeding activities. They avoided virgin desert and barren hills, but were found to half a mile of desert to suitable habitats on the far side. Dispersal occurred both upwind and downwind, but the greatest distance travelled in both experiments (4.1 and 4.3 miles, respectively) was with the wind. In one experiment, the population density was estimated at 3-5 000 gnats/acre. Gnats were found resting at night on dry or damp ground, on soil clods, on dried rootlets protruding above ground, and on foliage of low-growing plants. (auth.)

127 Stern, V.M., Schlinger, E.I. A STUDY OF THE DISPERSAL HABITS OF TRICHOGRAMMA FASCIATUM PERKINS USING RADIO-ACTIVE $P^{32}$. Bull. ent. Soc. Amer. 6, 3 (1960) 153, abstr. 80.

Trichogramma fasciatum is a key parasite of certain field crop pests in California. Its dispersal habits were studied by feeding individuals $P^{32}$ mixed in honey. In one test two million individuals were released and in a second test ten million individuals.

128 Walker, D., Harwood, R., Groves, K. DETERMINING INSECT POPULATIONS IN EMPTY GRAIN BINS BY THE USE OF $P^{32}$. Bull. ent. Soc. Amer. 2, 3 (1956) 25, abstr. 5.

Lots of 1 000 red flour beetles, Tribolium confusum, each tagged with $P^{32}$-labelled phosphate were released in empty grain bins which were subsequently sprayed with DDT as a residual spray. Tagged insects were recovered from 17 of the 30 bins so treated in 1955 and from 9 of the 34 bins in 1956. The actual numbers of insects originally in the bin were calculated on the basis of the ratio of the number of radioactive insects recovered to the total number of insects recovered. Considerable variation was found in the numbers of insects and the various species in different bins.

* Banks 1957 - [60]

* Banks and Nixon 1958 - [21]

## I-A-4 PARASITES AND PREDATORS

* Ahmed et al. 1954 - [732]

* Auerbach 1958 - [2]

129 Baldwin, W.F., James, H.G., Welch, H.E. STUDY OF PREDATORS OF MOSQUITO LARVAE AND PUPAE WITH A RADIOACTIVE TRACER. Canad. Ent. 87 (1955) 350-5.

The prey-predator relationship of Aedes stimulans (Wlk.) and A. trichurus (Dyar) at Chatterton, Ontario, were investigated by $P^{32}$. Larvae and pupae were made radioactive by placing them in $H_3P^{32}O_4$ at 0.05 µc/ml, the larval density in the trays being ca. 200 larvae/litre. The larvae were left for 2 more days in fresh pond water to rid themselves of radioactive excreta, then examined or returned to the ponds. Several species of pond animals were found to be predators of larvae and pupae. The importance of these predators in control was evident from the numbers that become radioactive, and also from the high radioactivity of certain species, dytiscids and limnephilids being the most important. Three new records of mosquito predators were obtained, Limnephilus indivisus Wlk. amongst them. As the generations of pond animals developed, more predators fed on the mosquitoes. The resulting decrease in the population density of the mosquitoes coincided with the increase in the density of the predators.

130 Cunliffe, F. BIOLOGY OF THE COCKROACH PARASITE PIMELIAPHILUS PODAPOLIPOPHAGUS TRAGARDH, WITH A DISCUSSION OF THE GENERA PIMELIAPHILUS AND HIRSTIELLA (ACARINA, PTERYGOSOMIDAE). Proc. ent. Soc. Washington 54,4 (1952) 153-69.

A species of mite, P. podapolipophagus, was found to be parasitic rather than commensal in habit when the mites became radioactive after feeding on roaches which had been fed on radioactive salt. The use of radioactive salts in studying its host-parasite relationship is described. Its relationship to the lizard mite is discussed. P. triatomae, from Triatoma infestans, Chile, is new; brief diagnoses are given of P. podapolipophagus and P. isometri. The relationship of Hirstiella to Pimeliaphilus is discussed. H. bakeri from Iguana, Calf. California, and H. boneti from Ctenosaura multispinis, Nebraska, are new; brief diagnoses are given for H. insignis, H. trombidiformis, H. pelaezi, and H. tenuipes. Keys to the spp. in both genera are given.

131 George, K.S. PRELIMINARY INVESTIGATION ON THE BIOLOGY AND ECOLOGY OF THE PARASITES AND PREDATORS OF BREVICORYNE BRASSICAE (L.). Bull. ent. Res. 48,3 (1957) 619-29.

$P^{32}$ was applied to turnip seedlings. Brevicoryne brassicae feeding on them became radioactive. Parasites bred through the aphids also became radioactive. On subsequent breeding in other aphids no counts were obtained. The experiment was designed to test the specificity of aphid parasites. It was concluded that at the existing level of contamination by radio-phosphorus insufficient deposits are made in the eggs for detection.
(The tracer experiment forms only a small part of the whole paper)

* Gösswald 1959 - [52]

* Ibid 1959 - [53]

132 Grosch, D.S., Sullivan, R.L. SEQUELAE OF REARING HABROBRACON ON RADIOACTIVE HOST LARVAE. Growth 18 (1954) 191-205.

$P^{32}$ at 48 dilutions was injected by capillary needle into paralyzed Ephestia larvae. Habrobracon eggs were then transferred to these hosts as well as to controls, both injected and non-injected. Radioactive food did not affect hatchability significantly although deleterious effects appeared at later developmental crises. Most noticeable was the failure of treated braconids to accomplish metamorphosis. The degree of lethality was related to the level of treatment. At higher dosages a developmental delay appears for the survivors along with increased frequency of developmental abnormality of treated males. Females, the diploid type, were more radioresistant (metamorphosis and structural abnormalities). The life span of males achieving adulthood was not affected nor was there any apparent influence on $F_1$ egg production although embryo survival appeared slightly decreased. The discussion points out similarities between internal irradiation and irradiation from external sources. The question of different periods of sensitivity for developing structures as well as the variability due to leakage from an injection site are discussed. (from auth.)

* Jenkins and Hasset 1950 - [808]

* Jenkins and Knight 1950 - [61]

* Kartman et al. 1958 - [406]

* Kuper and Pelc 1952 - [405]

* Nagel 1959 - [70]

133 Narayanan, E.S. THE PHENOMENA OF INSECT PARASITISM AND THEIR PRACTICAL UTILISATION IN THE BIOLOGICAL CONTROL OF INSECT PESTS. Proc. Indian Soc. Congr. 44,2 (1957) 167-89.

The usefulness is stressed of morphological, biological and ecological studies of the insects in question. Cases of multi- and super-parasitism, and genetic factors are considered, and the use of radioisotope labelling. Examples of biological control are given. 106 references altogether.

134 Narayanan, E.S., Ratan Lal, Rahalkar, G.W., Sethi, G.R., Saxena, P.N. LABELLING OF ADULTS OF AN INSECT PARASITE BRACON GELECHIAE ASHMEAD WITH RADIOACTIVE PHOSPHORUS ($P^{32}$). Proc. Indian Acad. Sci., Sec.B: 49,3 (1959) 149-55.

Labelling of the adults of Bracon gelechiae by allowing them to feed on 10% glucose solution containing phosphoric acid ($H_3PO_4$) with $P^{32}$ is not practicable as the adult parasites are unable to pick up enough radioactivity. On the other hand, labelling of the adults by rearing them on host caterpillars of Corcyra cephalonica, the latter being fed on crushed maize mixed with radioactive phosphoric acid, is quite a convenient and satisfactory method for the purpose of mass release of the parasite under natural conditions. Such individuals show a tolerably high degree of radioactivity and are therefore easy to detect. Moreover, the developmental period of the parasite by rearing it on radioactive host caterpillars is not adversely affected and the adults remain alive for a considerable period. (auth. summary)

* Pendleton and Grundmann 1954 - [30]

135 Quednau, W. RADIOAKTIVE MARKIERUNG VON SCHLUPFWESPEN (Radioactive labelling of certain hymenoptera). Atompraxis 6, 10/11 (1960) 427-31. (In German)

The uptake of $P^{32}$ is possible during the parasite's (Hymenoptera) development in the radioactive host. The contamination by 1.6 mc per 3 l of nutrient solution was as follows: leaf sample 89 000 cpm, aphids of first generation 29 000 cpm, aphids of second generation 15 000 cpm, parasites 3 600 cpm (at the saturation point). The transmission of 150 cpm into the host eggs parasitized by labelled Trichogramma proved to be adequate for a distinction from hosts which could be naturally infested. (auth.)

* Spinks 1958 - [14]

* Stern and Schlinger 1960 - [400]

## I-B Insect Physiology and Metabolism

### I-B-1 CARBOHYDRATES

136 Avi-Dor, Y., Gonda, O. STUDIES ON THE ADENOSINETRIPHOSPHATE - PHOSPHATE EXCHANGE AND THE HYDROLYSIS OF ADENOSINETRIPHOSPHATE CATALYZED BY A PARTICULATE FRACTION FROM THE MOSQUITO. Biochem. J. 72 (1959) 8-14.

ATP and the enzyme system catalyzing the incorporation of $P^{32}$ into ATP have been studied in resporatory particles prepared from the mosquito Aedes aegypti L. Addition of ethylenediaminetetra-acetic acid to the isolation medium and of ethylenediaminetetra-acetic acid and albumin either to the washing liquid or to the assay medium have been found obligatory for the exchange reaction. The effect of nucleotides, respiratory inhibitors and inhibitors of oxidative phosphorylation on the exchange reaction and the ATP activity has been investigated. Quantitative differences exist between the response of insect and mammalian respiratory particles to 1,1,1-trichloro-2,2-di-(p-chlorophenyl)-ethane (DDT). 0.1 mM DDT inhibits the exchange reaction by more than 50% in insect sarcosomes whereas the inhibition in mammalian liver mitochondria is less than 10%. (auth. summary)

137 Candy, D.J., Kilby, B.A. SITE AND MODE OF TREHALOSE BIOSYNTHESIS IN THE LOCUST. Nature 183 (1959) 1594-5.

A short note reports results of a study on trehalose biosynthesis. The authors have shown the locust fat body to be an important site. Generally labelled D-glucose-$C^{14}$ was incubated with fat-body tissue from Schistocerca (5th instar) and the products examined by paper chromatography. Hemolymph, leg muscle, fore, mid and hind gut tissues were also tested but found to be largely inactive in converting glucose into trehalose. The probable mode of biosynthesis is discussed.

138 Gonda, O., Kaluszyner, A., Avi-Dor, Y. EFFECT OF 1 : 1 : 1-TRICHLORO-2 : 2-DI-(p-CHLOROPHENYL) ETHANE (DDT) AND RELATED COMPOUNDS ON THE ADENOSINE TRIPHOSPHATE - PHOSPHATE EXCHANGE CATALYSED BY A PARTICULATE FRACTION FROM THE MOSQUITO. Biochem. J. 73, 4 (1959) 583-7.

The effect of the above compound and its analogues on the ATP-$P^{32}$ exchange reaction in mosquito [Aedes aegypti (L.)] sarcosomes has been compared. All analogues of DDT tested inhibited the exchange reaction to nearly the same extent when the concentration in the particles reached the same level. No correlation was found between the toxicity for mosquito larvae of the compounds tested and their effect in vitro on

the exchange reaction. The analogue tested included: 1,1-dichloro-2,2-bis-(p-chlorophenyl)ethane, 1,1,1-trichloro-2,2-bis(p-methoxyphenyl)ethane, 1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene, bis(p-chlorophenyl) acetic acid, 1,1,1,2-tetrachloro-2,2-bis(p-chlorophenyl)ethane, 1,1-bis(p-chlorophenyl) ethanol, 1,1,1-trichloro-2,2-diphenylethane, 1,1-bis(p-chlorophenyl)-2,2,2-trifluoroethanol, and 1,1-bis(p-chlorophenyl)-2,2,2-trichlorethyl acetate.

139 Gray, R.A. COMPOSITION OF HONEYDEW EXCRETED BY PINEAPPLE MEALYBUGS. Science 115 (1952) 129-33.

The general view that plant-sucking insects which excrete copious quantities of excess carbohydrates in their honeydew must take in large amounts of plant juice in order to get sufficient amounts of amino acids and proteins, was not found to be the case with pine apple mealybugs. Relatively large amounts of as many as 19 different amino acids have been found in the honeydew excreted by pineapple mealybugs (Pseudococcus brevipes, Ckll.) by the method of paper chromatography. The number of amino acids excreted was shown to increase with the period of feeding. Sixteen amino components of the honey dew have been identified from their $R_f$ values. Three ninhydrin spots have not been identified. At least 5 amino acids were found in the honeydew which were not found in the food source. The carbohydrate components identified by different sprays and radiograms of radioactive honeydew were fructose, glucose, sucrose, glucose-1-phosphate, and possibly maltose. Malic acid, citric acid, and salts of citric acid were also found.

140 Hassett, C.C. TRANSFORMATION OF HEXOSEPHOSPHATES BY THE COCKROACH. Fed. Proc. 10,1 (1951) 61.

Fructose diphosphate, glucose-1-phosphate, glucose-6-phosphate, and fructose-6-phosphate passed from the intestine to the muscle in rates which decreased in the above order. $P^{32}$-labelled compounds were used. (BA 25: 26759, 1951).

141 Hassett, C.C., Summerson, W.H., Solomon, F. A BIOSYNTHESIS OF $C^{14}$-LABELLED GLYCOGEN. Nucleonics 12,4 (1954) 59-60.

Newly emerged adults of Drosophila melanogaster are known to be low in glycogen. When ample food is available the glycogen content increases rapidly in the first few days. Unfed adults less than 24 h old were exposed to an atmosphere containing $C^{14}O_2$. Experimental details are given, and of the steps taken to identify the radioactive carbohydrate obtained as glycogen. The mechanism of labelling and the positions occupied by the $C^{14}$ (presumably random) were not investigated.

* Nourteva and Reinius 1953 - [35]

142 Novotný, I. THE EFFECT OF UNCOUPLING AGENTS ON THE METABOLISM OF INSECT MUSCLE. p.660-3 in "Proceedings of the 11th International Congress on Entomology, Vienna 17-25 Aug. 1960", Vol.1. Strouhal, H., Beier, M., eds. (Naturhistorisches Museum, Vienna). Vienna, Christoph Reisser's Söhne, 1962.

The study was aimed at finding the conditions under which the uncoupling agents provoke increased metabolic rates and at determining the resultant changes in carbohydrate and phosphate metabolism. Periplaneta americana was used. Stimulation of glycolysis was observed, and two independent regulatory reactions appear to take place resulting from dinitrophenol. Attention is focussed on phosphate metabolism. A special technique is cited for studying it in intact muscle preparations. The animals were injected with $P^{32}$-labelled Ringer solution and left for 4 or more days to ensure equal labelling in all P compounds. Subsequent steps consisted of freezing and pulverizing in liquid air, separation of individual P compounds by paper ionophoresis and estimating the activity preferably after elution from individual parts of the paper after autoradiography. The changes in phosphate compounds after application of 2,4-dinitrophenol are very profound. Within 20 min of injecting $10^{-3}$ M dinitrophenol there is a pronounced decrease in high energy phosphate compounds, accompanied by an increase in anorganic phosphate. The change in ADP is small. The ATP : ADP ratio shifts in favour of ADP, with a simultaneous increase in $\alpha$-glycerophosphate. Tentative explanations of the mechanism of dinitrophenol action on muscle are offered.

143 Treherne, J.E. GLUCOSE ABSORPTION IN THE COCKROACH. J. exp. Biol. 34 (1957) 478-485.

The absorption of glucose from the gut of the cockroach, Periplaneta americana, was studied by feeding starved insects with $C^{14}$-labelled glucose together with a dye, Amaranth. This dye is not absorbed from the lumen of the intestine, and the net percentage glucose absorption was calculated from the glucose/dye

ratio in various parts of the intestine. Glucose absorption is largely confined to the mid-gut ceca. The rate of crop emptying, which is an exponential function of time, is related to glucose concentration, so that the amount of fluid leaving the crop decreases with increasing concentration. This effect is determined by the osmotic pressure of the ingested fluid. Total glucose absorption shows a linear relation with crop emptying, suggesting that crop emptying is the limiting process in glucose absorption. (from CA 52: 4040e, 1958)

144 Treherne, J.E. FACILITATED DIFFUSION AND EXCHANGE IN THE ABSORPTION OF GLUCOSE BY THE LOCUST, SCHISTOCERCA GREGARIA (FORSK.). Nature 181 (1958) 1280-1.

Preliminary account of investigation into the movement of glucose between the gut and the hemolymph at low concentrations. The uptake of $C^{14}$-labelled glucose was studied under conditions in which the specific activity of labelled glucose in the hemolymph, where it is in equilibrium with trehalose approximated to that in the gut lumen. The results were compared with those for the uptake of labelled glucose by insects initially containing no radioactive material in the hemolymph.

145 Treherne, J.E. THE ABSORPTION OF GLUCOSE FROM THE ALIMENTARY CANAL OF THE LOCUST SCHISTOCERCA GREGARIA. J. exp. Biol. 35 (1958) 297-306.

The absorption of glucose was studied by filling the gut with a saline solution containing $C^{14}$-labelled glucose together with a dye, Amaranth, which was used as a marker. The net percentage absorption was calculated from the glucose/dye ratio in various parts of the alimentary canal. Most of the glucose was absorbed from the mid-gut ceca, lesser amounts by the ventriculus. The percentage absorption was similar at concentrations of 0.002 and 0.02 M, but was significantly less at 0.20 M. The absorbed glucose was rapidly converted to trehalose in the hemolymph. At the high concentration this mechanism became saturated and the excess glucose accumulated in the hemolymph. The absorption in vitro from a gut suspended in saline containing KCN and iodoacetic acid was similar to that in the intact insect. Glucose is apparently absorbed by diffusion across the gut wall and this process is facilitated by rapid conversion to trehalose in the hemolymph, which tends to maintain a steep concentration gradient across the gut wall. (CA 52: 20705c, 1958)

146 Treherne, J.E. THE ABSORPTION AND METABOLISM OF SOME SUGARS IN THE LOCUST, SCHISTOCERCA GREGARIA (FORSK.). J. exp. Biol. 35, 3 (1958) 611-25.

The uptake of $C^{14}$-labelled glucose, mannose, and fructose was confined to the mid-gut, the proportion absorbed by the ceca depending on the type of sugar and its concentration in the gut lumen. The absorbed sugars were converted, in varying degrees, to trehalose which accumulated in the hemolymph. The extent of this conversion paralleled the rate of absorption of these sugars. It is suggested that the sugars are absorbed by diffusion across the gut wall, this process being facilitated by the rapid conversion to trehalose. At very low concentrations in the gut lumen much of the uptake of labelled glucose occurred as a result of exchange with the small amount of glucose in equilibrium with the trehalose in the hemolymph. (auth.)

147 Treherne, J.E. THE DIGESTION AND ABSORPTION OF TRIPALMITIN IN THE COCKROACH, PERIPLANETA AMERICANA L. J. exp. Biol. 35, 4 (1958) 862-70.

A partial hydrolysis of $C^{14}$-labelled tripalmitin was demonstrated in the crop of this insect. No significant absorption could be demonstrated in the crop, whether the tripalmitin was suspended in an experimental fluid or dissolved in emulsified oleic acid. Absorption occurred in the mid-gut and was largely confined to the caeca and the anterior part of the ventriculus. Total absorption of tripalmitin showed a linear relation with crop emptying. Apparently the rate at which the material left the crop, rather than the uptake in the mid-gut, was the limiting factor in absorption. (auth.)

148 Treherne, J.E. THE NUTRITION OF THE CENTRAL NERVOUS SYSTEM IN THE COCKROACH, PERIPLANETA AMERICANA L. THE EXCHANGE AND METABOLISM OF SUGARS. J. exp. Biol. 37 (1960) 513-33.

A rapid influx from the hemolymph of $C^{14}$-labelled trehalose and glucose has been demonstrated in the intact abdominal nerve cord. Approximately half of the absorbed $C^{14}$ was incorporated as glutamic acid and glutamine in the nervous tissue. Smaller amounts of glycogen, trehalose, glucose, aspartic acid and occasional traces of alanine were also found. These results demonstrate a linkage of carbohydrate and amino acid metabolism and represent circumstantial evidence for the presence of the tricarboxylic acid cycle enzymes in the central nervous system of this insect. (BA 36: 7813, 1960).

149 Treherne, J.E. THE EXCHANGE AND METABOLISM OF SUGARS IN THE CENTRAL NERVOUS SYSTEM OF PERIPLANETA AMERICANA. p. 632-5 in "Proceedings of the 11th International Congress on Entomology, Vienna 17-25 Aug. 1960", Vol.1. Strouhal, H., Beier, M., eds. (Naturhistorisches Museum, Vienna). Vienna, Christoph Reisser's Söhne. 1962.

An adequate exchange of nutritive materials between the hemolymph and the central nervous system across the perilemma must take place. In order to study this function the exchange and metabolism of some $C^{14}$-labelled sugars in the abdominal nerve cord (n.c.) of P. americana, $C^{14}$-labelled glucose solution was injected into the hemolymph. Graphs illustrate the rate of conversion to trehalose as it accumulated in the hemolymph, compared with the entry of radioactivity into the n.c. expressed as the ratio: activity in n.c./activity in hemolymph. Approximately 7 molecules of trehalose may be stimated to pass into the n.c. for every molecule of glucose. Since the trehalose molecules are, however, 17 times more concentrated than those of glucose, individual glucose molecules were therefore passing into the n.c. at approximately 2.5 times the rate of the disaccharide molecules. The metabolism of the sugars within the CNS was followed by separating the extracts of radioactive n.c. on paper chromatograms. At least 7 peaks of radioactivity were found (trehalose, glucose, glycogen, aspartic acid, glutamic acid, glutamine and alanine). Their proportions are tabulated, and the significance of the findings discussed.

150 Shigematsu, H. UTILIZATION OF GLUCOSE BY FAT BODY OF THE SILKWORM IN VITRO. J. sericul. Sci., Tokyo 29 (1960) 22-7. (In Japanese)

151 Silva, G.M., Doyle, W.P., Wang, C.H. GLUCOSE CATABOLISM IN THE AMERICAN COKROACH. Nature 182 (1958) 102-4.

Time-course studies on the utilization by intact cockroaches (Periplaneta americana) of glucose-$C^{14}$ were carried out. Radioactive assay of the respiratory $CO_2$ samples provided confirmatory evidence for the operation of glycolysis and a direct oxidative pathway for the primary breakdown of glucose in this species. It was found that in intact male adult cockroaches, glucose is catabolized by way of the direct oxidative pathway to an extent of only 4-9%, and the bulk of glucose is catabolized via the Embden-Meyerhof-Parnas glycolytic pathway. The latter, in conjunction with tricarboxylic acid cyclic processes, is probably responsible for the respiratory activity and biosynthetic functions in this insect. It is possible that the observed small amount of activity of the direct oxidative pathway is primarily for the purpose of pentose production. (CA 52: 20697c, 1958)

152 Vyskrebentseva, E.I. CARBOHYDRATE TRANSFORMATION IN THE COELOMIC FLUID OF THE SILKWORM BOMBYX MORI DURING METAMORPHOSIS. Biokhimia 22 (1957) 657-66, (English translation) Biochemistry Leningr., Moscow 22 (1957) 613-25.

Uniformly labelled $C^{14}$ sucrose, radioactive carbon dioxide ($C^{14}O_2$) and also various glycolysis inhibitors (NaF and $CH_2ICOOH$) were employed in order to investigate the transformation of carbohydrates in the cavity fluid of the silkworm during metamorphosis. Oxidation of sugar in the cavity fluid could be shown to produce phosphoric esters and organic acids. The presence of radioactivity in malic, fumaric and succinic acids when labelled sugar is administered in the cavity fluid shows that conversion of pyruvic acid is essentially linked with its role in dicarboxylic acid synthesis by means of carboxylation. Synthesis of tricarboxylic acids, and in particular citric acid, is insignificant. The latter is formed chiefly, not from carbohydrates, but as a result of carboxylation of organic acids, probably decomposition products of fats. This fact strongly suggests that in the cavity fluid anaerobic oxidation of carbohydrates is the predominant process. Sucrose introduced in the cavity fluid may be subjected not only to oxidative transformations, but may be used in the synthesis of a complex, unidentified high-molecular weight phosphorus compound. On suppression of glycolysis this method of transformation predominates. Study of carbohydrate transformation during metamorphosis showed that hystolysis substantially reduces the capacity of the cavity fluid to synthesize phosphoric esters and organic acids from the introduced sugar, while, in the course of histogenesis and differentiation, this capacity is restored.

The abstract is essentially that of the paper given at the "All-Union Conference on the Application of Radioactive and Stable Isotopes and Radiation in the National Economy and Science" (Session: Biology, Medicine and Agriculture), Moscow, 2-5 April 1957. Engl. trans. p.152, Consultants Bureau, Inc.

(For a more detailed abstract of the paper see CA 52: 4873 b,c. 1958).

153 Vyskrebentseva, E.I. CARBOHYDRATE TRANSFORMATION PATHWAYS IN THE CAVITY FLUID OF THE SILKWORM BOMBYX MORI IN THE METAMORPHOSIS PERIOD. p.137-42 in "Application of Radioactive Isotopes in the Food and Fishing Industries and in Agriculture. A portion of the Proceedings of the All-Union Scientific and Technical Conference on the Application of Radioactive Isotopes. Moscow 1957". New York, Consultants Bureau, Inc. 1959 (English transl.)

[For detailed abstr. see "Nature of carbohydrate conversion in the cavity fluid of mulberry silkworm (Bombyx mori) in the metamorphosis period". p.152 in Abstracts of papers given at the "All-Union Conference on the Application of Radioactive and Stable Isotopes and Radiation in the National Economy and Science. (Session: Biology, Medicine and Agriculture), Moscow 2-5 Apr. 1957". AEC-tr-2925(III). New York, Consultants Bureau, Inc. 1957 (English translation)]

154 Vyskrebentseva, E.I. MEANS FOR THE CONVERSION OF CARBOHYDRATES OF THE CAVITY FLUIDS OF BOMBYX MORI DURING ITS PERIOD OF METAMORPHOSIS. Izuchenie Zhivotn. Organizma (Moscow; Akad. Nauk SSSR) Sbornik 1959: 145-51; Referat. Zhur. Khim., Biol. Khim. 1959, abstr. no. 5521)

Results of experiments with $C^{14}$-labelled sucrose showed that the carbohydrates in the body cavity fluids of Bombyx mori underwent a continuous change during the period of metamorphosis with an accompanying formation of phosphate esters and organic acids. The rate of such conversion of carbohydrates abated during the period of histolysis and rose again during the period of histogenesis and differentiation. The injection into the body cavity of glycolytic poisons hampered the process of phosphate ester synthesis and the formation of organic substances from the carbohydrates. About 1 h after the injection into the body cavity of the labelled sugar, the specific activity became concentrated in malic, fumaric, and succinic acids. Within the body cavity of B. mori anaerobic oxidation of carbohydrates and their conversion predominated which resulted in the production of pyruvic acid; such processes seem to be associated with the synthesis of dicarboxylic acids by way of decarboxylation; in the case of tricarboxylic acid synthesis, and particularly in citric acid formation, the process is considerably depressed.

(CA 53: 20588i, 1959)

* Winteringham et al. 1955 - [311]

* Winteringham 1956 - [156]

155 Winteringham, F.P.W. COMPARATIVE ASPECTS OF INSECT BIOCHEMISTRY WITH PARTICULAR REFERENCE TO INSECTICIDAL ACTION. p.201-10 (dis. p.211-5) in "Proceedings of the 4th International Congress on Biochemistry, Vienna 1958", Vol.12. Levenbock, L., ed. London, Pergamon Press. 1959.

Possible differences in basal metabolism between insects and vertebrates have been critically examined in the light of recent work. There is evidence that trehalose plays the part of mammalian glucose in insect tissues and that trehalose is broken down glycolytically as far as pyruvate and then to acetate as in vertebrate tissues. Data on the metabolism of uniformly labelled ($C^{14}$) glucose by the adult housefly, Musca domestica, in vivo are tabulated, showing the distribution of total soluble $C^{14}$ recovered from thoracic tissues (flight muscle) after different treatments. There is evidence that lactic acid does not accumulate significantly in insect flight muscle even under anaerobic conditions. The reported accumulation of $\alpha$-glycerophosphate and the failure to find significant lactic acid formation under conditions of anoxia are discussed. Experiments on the fate of [2-$C^{14}$]acetate injected intrathoracically into adult M. domestica showed that there was a rapid incorporation of $C^{14}$ into the free amino acids. This and other results suggest that the significance of the high concentrations of free glutamate (and free amino acids) in insect tissues may lie in their providing a soluble and readily available substrate reserve for the Krebs tricarboxylic acid cycle, liberated ammonia being trapped as glutamine.

156 Winteringham, F.P.W. PRESENCE AND SIGNIFICANCE OF $\alpha$-GLYCEROPHOSPHATE IN INSECT TISSUE. Biochem. J. 71 (1959) 21 P.

The labelled pool technique has been used to determine the relative concentrations of the principal soluble phosphorus compounds in the adult housefly. One fraction, which was resistant to acid hydrolysis and which represented some 20% of the total acid-soluble phosphorus of the thoracic tissues, was tentatively identified as phosphoglyceric acid by paper cochromatography with the 'authentic' compound but there was an element of doubt because the latter was not chromatographically pure (Winteringham, Bridges and Hellyer, 1955). The possible importance of $\alpha$-glycerophosphate in insect metabolism prompted a re-examination of the compound recovered from the housefly. The insect compound which had been labelled with $P^{32}$ in vivo

was separated from all the known compounds except α-glycerophosphate on paper chromatograms. Added α-glycerophosphate co-chromatographed exactly with the insect compound in all the systems tried. The implications of these results are discussed briefly.

## I-B-2 PROTEINS AND AMINO ACIDS

157 Bheemeswar, B. SOME ASPECTS OF AMINO ACID METABOLISM IN INSECTS. p.78-87, disc. 87-9 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956". Vol.2. Becker, E.C., ed. Ottawa, Mortimer Ltd. 1958.

Available information on general biochemical reactions undergone by amino acids is divided into data on deamination, transamination, decarboxylation, and peptide and protein synthesis. Radioisotopes have been used in work on transaminases in connection with the silkworm, Bombyx mori (references cited). The author describes work on inorganic nitrogen metabolism where pyruvic oxime-2-$C^{14}$ and pyruvate-2-$C^{14}$ were either injected or fed, in order to study (1) $C^{14}$-activity in the blood following injection of either; (2) $C^{14}$-incorporation into gut and "body" proteins after injection; (3) respired $C^{14}O_2$ after injection; (4) $C^{14}$-activity of faecal pellets excreted after feeding either substance; (5) identification by chromatography of the excreted end products following such radioactive feeding. The results revealed that pyruvic oxime-2-$C^{14}$ is removed from the blood at a faster rate than pyruvate-2-$C^{14}$. Contrary to the first, the latter is incorporated into the "body" and gut proteins. It further appears to enter the tricarboxylic acid cycle and is rapidly metabolized to $C^{14}O_2$, whereas the labelled oxime is not metabolized in such a way but rapidly excreted in the pellets as oxime-2-$C^{14}$. It is suggested that the conversion of oximes into amino compounds is of little, if any, importance in the silkworm. Radiotracers are cited in work on peptide and protein synthesis.

158 Bricteux-Grégoire, S., Verly, W.G., Florkin, M. UTILIZATION OF THE CARBOXYL CARBON OF L-PHENYLALANINE FOR THE SYNTHESIS OF THE AMINO-ACIDS OF SILK BY BOMBYX MORI. Nature 177 (1956) 1237-8.

$C^{14}$-labelled phenylalanine was used to demonstrate that carboxyl phenylalanine was not utilized for the synthesis of alanine. The technique used for labelling the compound is indicated; the silkworms were injected when they had already stopped eating and their silk glands were swollen prior to spinning their cocoons. Fibroin was isolated from the cocoons, and the tyrosine, glycine and alanine isolated. Only the purified tyrosine was found to be radioactive (not due to contamination by the labelled phenylalanine). Results indicate that phenylalanine is converted to tyrosine by the silkworm by a fairly direct process, since radioactivity was exclusively localized in the carboxyl group of the injected phenylalanine and the isolated tyrosine. About 15% of the injected phenylalanine radioactivity was found in the tyrosine of the silk fibroin. On the other hand, the carboxyl carbon of phenylalanine is not utilized for the synthesis of alanine or glycine of the silk of B. mori. *

159 Bricteux-Grégoire, S., Duchateau, G., Florkin, M., Jeuniaux, C. SUR LE MÉTABOLISME DE LA GLYCINE PLASMATIQUE CHEZ LE VER À SOIE. Arch. int. Physiol. et Biochim. 66,1 (1958) 111-2.

Pour déterminer le sort de la glycine prélevée par la glande pour la synthèse de la soie, les auteurs ont injecté de la glycine-1-$^{14}C$, dans l'hémolymphe de vers à soie au début du filage ("montée"). Un quart de l'activité totale injectée a été retrouvée dans la fibroïne du cocon. Cette activité se répartit, dans l'ordre des activités spécifiques décroissantes, entre la glycine, la sérine et l'alanine. La tyrosine n'a incorporé aucune activité.

160 Bricteux-Grégoire, S., Verly, W.G., Florkin, M. UTILIZATION OF THE CARBOXYL GROUP OF GLYCINE FOR THE SYNTHESIS OF THE AMINO ACIDS OF SILK BY BOMBYX MORI. Nature 182 (1958) 1515.

When fasting and ready to spin their cocoons, the silk worms were each injected with 112 μg (2.1 μc) of glycine-1-$C^{14}$. One quarter of the total activity injected appeared in silk fibroin. The injected glycine was found diluted about 1000-fold, which was most probably not uniformly labelled. Direct conversion of glycine to serine keeping the label in the C-1 position occurs in the silkworm. Glycine is also converted to alanine, possibly through serine and pyruvic acid, but in any case introducing the C-1 of glycine exclusively into the carboxyl group of alanine. Tyrosine did not incorporate any radioactivity from glycine-$C^{14}$; the phenylalanine-tyrosine pair would appear to be essential to the silkworm.

---

* But cf. Fukuda, Nature 177 (1956) 429.

161 Bricteux-Grégoire, S., Verly, W.G. UTILIZATION OF FORMATE FOR THE BIOSYNTHESIS OF GLYCINE CARBON-1 and -2 IN BOMBYX MORI. Nature 182 (1958) 1515-6.

Just prior to spinning their cocoons, each of 20 silkworms was injected with 1.7 mg (25 μc) of $C^{14}$-labelled formate. The isolated glycine was decarboxylated; C-1 was isolated as barium carbonate and C-2 as formaldimedone. Their specific activities are tabulated. The degradation procedure was checked on synthetic glycine-1-$C^{14}$ and glycine-2-$C^{14}$. Formate carbon may be concluded to be utilized for the synthesis of glycine C-1 and C-2 in B. mori. 1.5% of the injected radioactivity appeared in the fibroin glycine, while 2% was found in fibroin serine which had a specific activity 6 times greater than glycine. Various possible biochemical pathways are postulated.

162 Bricteux-Grégoire, S., Verly, W.G., Florkin, M. BIOSYNTHÈSE DE LA GLYCINE À PARTIR DU FORMIATE CHEZ LE VER À SOIE. Arch. int. Physiol. et Biochim. 67,3 (1959) 503-4.

Du $^{14}$C-formiate a été injecté à des larves de Bombyx mori au 5e âge, juste avant le début du filage. La fibroïne de la soie a été hydrolysée et la glycine a été isolée et purifiée. La glycine a ensuite été dégradée par la ninhydrine, le C-1 isolé sous forme de carbonate de baryum et le C-2 sous forme de formaldimédone. La formaldimédone et la glycine ont été brûlées et transformées en carbonate de baryum avant les mesures de radioactivité. Les procédés de dégradation ont été vérifiés au moyen de glycine-1-$^{14}$C et de glycine-2-$^{14}$C. L'activité spécifique de la glycine isolée était répartie pour les 2/3 dans le C-1 et pour 1/3 dans le C-2. (Note entière)

163 Bricteux-Grégoire, S., Fukuda, T., Dewandre, A., Florkin, M. BIOCHEMISTRY OF THE SILK WORM. VIII. CONVERSION OF PYRUVATE INTO ALANINE, GLYCINE, AND SERINE OF SILK FIBROIN. Arch. int. Physiol. et Biochim. 67 (1959) 545-52.

Five-tenths μc of Na pyruvate-1-$C^{14}$ (I), Na pyruvate-2-$C^{14}$ (II), or Na pyruvate-3-$C^{14}$ (III) were given per os to 3 groups of about 20 silkworms in the stage of development in which fibroin synthesis begins in the silk gland. The fibroin isolated from the cocoons of each group was hydrolyzed with HCl, the acid was removed by evaporation and the amino acids were adsorbed on Dowex 50. The adsorbate was eluted with 3N $NH_4OH$, the eluate was evaporated, and the tyrosine ppt. removed. Glycine, alanine, and serine were isolated as salts of nitronaphthalenesulfonic acid, azobenzene-p-sulfonic acid, and 4'-hydroxyazobenzene-4-sulfonic acid, resp. The sulfonates were then placed on a column of Dowex 50 and the amino acids eluted with 3N $NH_4OH$. When the silkworms had been fed with I, the radioactivity was found exclusively in the $C_1$ of these amino acids. When II had been fed, the radioactivity was equally distributed in $C_1$ and $C_2$ of glycine and in $C_1$, $C_2$, and $C_3$ of serine; alanine was mostly labelled in $C_2$. If III had been given, the activity was highest in $C_2$ of glycine and in $C_3$ of serine and alanine. Of the ingested pyruvate 7-10% was converted into the alanine of the silk fibroin and smaller amounts into glycine and serine. (CA 54: 14482d, 1960)

164 Bricteux-Grégoire, S., Verly, W.G., Florkin, M. BIOCHEMISTRY OF THE SILK WORM. IX. UTILIZATION OF THE CARBOXYL-C OF PHENYLALANINE FOR THE SYNTHESIS OF THE AMINO ACIDS OF SILK FIBROIN. Arch. int. Physiol. et Biochim. 67 (1959) 563-6.

L-Phenylalanine (I) labelled with $C^{14}$ in the carboxyl group was prepared from glycine-1-$C^{14}$ by a modification of the method of Bergmann et al. (CA 21: 61). Ten silkworms in the stage in which the silk production begins were anesthesized with $Et_2O$ and injected with 0.2 mg (= 0.078 μc) of I. From the cocoons produced, silk fibroin was prepared 6 days later. The glycine, alanine, and serine isolated from the fibroin hydrolyzate did not contain $C^{14}$; the tyrosine contained $C^{14}$ exclusively in the carboxyl group. About 17% of the injected I was transformed into silk tyrosine. (CA 54: 14482g, 1960)

165 Bricteux-Grégoire, S., Dewandre, A., Florkin, M., Veryl, W.G. CONTRIBUTIONS À LA BIOCHIMIE DU VER À SOIE. XII. UTILISATION DES DEUX CARBONES DE LA GLYCINE POUR LA BIOSYNTHÈSE DES ACIDES AMINÉS DE LA FIBROINE DE LA SOIE. Arch. int. Physiol. et Biochim. 67,4 (1959) 693-8.

Une fraction très importante de l'activité injectée à des vers à soie (des larves de Bombyx mori au 5e âge, juste avant le début du filage) sous forme de $^{14}$C-glycine a été retrouvé dans la glycine, la sérine et l'alanine de la fibroine de la soie. Après injection de glycine-1-$^{14}$C, le radioisotope apparait uniquement dans la 1e carboxyle de la glycine, de l'alanine et de la sérine de la fibroine. Après injection de glycine-2-$^{14}$C, le radioisotope apparait principalement dans le C-3 de ces acides aminés, mais aussi dans tous leurs autres carbones. Les voies métaboliques unissant la glycine, la sérine et l'alanine chez B. mori sont discutées à la lumière de ces observations.

166 Corrigan, J.J. METABOLISM OF SOME FREE AMINO ACIDS IN DDT-POISONED PERIPLANETA AMERICANA L. Ph.D. Dissertation. Illinois, Univ., Urbana. 1959.

During DDT prostration, the free proline in the blood and central nervous cord is selectively depleted to about 1/4 the normal level. By using $C^{14}$-labelled proline it was found that as proline was depleted, there was a corresponding rise in $C^{14}$-labelled glutamine. If the temperature was raised so that the roach recovered, the proline and glutamine contents were restored to a normal level.

167 Cotty, V.F., Henry, S.M. GLUTATHIONE METABOLISM IN DDT RESISTANT AND SUSCEPTIBLE HOUSE FLIES. Contr. Boyce Thompson Inst. 19,5 (1958) 393-401.

Glutathione concentration was measured in prepupae, pupae and newly emerged susceptible and DDT-resistant houseflies through its adduct with $C^{14}$-labelled N-ethylmaleimide. Free glutathione in both strains followed the same general pattern, no over-all difference being noted. During the pupal period the glutathione concentration decreased during the first two days, showed a relative increase on the 3rd, and fell to a low level on the 4th day. The newly emerged adult had a higher level of glutathione than any other stage studied. Measured amounts of $S^{35}$ labelled cysteine were injected into DDT-resistant and susceptible flies. At timed intervals the flies were killed and the glutathione was coupled with N-ethylmaleimide and isolated chromatographically for radioassay of $S^{35}$. Susceptible flies appeared to incorporate injected cysteine into gluthathione and to metabolize the newly synthesized glutathione more rapidly than did resistant flies. (auth.)

168 Demyanovsky, S. Ya., Vasileva, N.V., Konikova, A.S. INVESTIGATION OF THE PROTEIN METABOLISM IN THE OAK SILKWORM (ANTHERAEA PERNYI) WITH THE HELP OF RADIOACTIVE METHIONINE. Biokhimia 17 (1952) 529-34.

Methionine-$S^{35}$ (I) was injected into the hemolymph on the basis of 10 000 cpm/g. After a definite time the proteins were separated from the hemolymph, fatty material, muscle, intestinal lining, and other organs, and the amount of $S^{35}$ detected. In the larvae an increase in the intensity of protein metabolism was observed up to the middle of the 5th larval stage. The maximum incorporation of $S^{35}$ occurred on the 11th-12th day; a decrease was noticed on the 19th-20th day. As to the individual tissues, the largest amount of $S^{35}$ was incorporated in the hemolymph during the second half. At the end of the larval stage the intestinal walls possessed the least intensity of protein metabolism. A high metabolic rate from the very beginning of the 5th stage was noted in the walls of the silk-forming gland. In spinning of the cocoon, the incorporation of $S^{35}$ was on a low level and the synthesis of protein in the organism of the silkworm almost stopped, when silk appeared. After the end of silk formation, an increase in protein metabolism was noted. A gradual increase in the $S^{35}$ incorporation occurred during the 1st-3rd day of development of the summer pupal stage with a maximum after 48 h. The most intense protein metabolism during the pupal stage occurred in the fatty material, and then in the hemolymph. Protein metabolism, especially in the muscles, varied with sex. No I was incorporated into the proteins of dead cocoons. Hence, the radioactivity of the proteins separated from live organisms was not the result of adsorption of I, but was caused by the incorporation of I into the protein molecules. (CA 47: 4000c, 1953)

169 Faulkner, P., Bheemeswar, B. METABOLISM OF OXIMES IN THE SILKWORM BOMBYX MORI L. II. METABOLISM OF PYRUVIC OXIME-2-$^{14}$C. J. Insect Physiol. 4,1 (1960) 14-9.

Pyruvic oxime-2-$C^{14}$ and pyruvate-2-$C^{14}$ were injected into larvae. The label in pyruvate-2-$C^{14}$ is incorporated into the gut and body proteins, but the small amount of activity found in protein following injection of pyruvic oxime-2-$C^{14}$ is of a much lower order. The amount of $C^{14}O_2$ expired is also negligible. Chromatographic analysis of aqueous extracts of fecal pellets following injection or feeding indicates that pyruvic oxime-2-$C^{14}$ is rapidly excreted unchanged and is not converted to pyruvate-2-$C^{14}$. The results suggest that transoximase and oximase, if they are present, are of little importance in the protein and carbohydrate metabolism of the silkworm.

170 Faulkner, P., Bheemeswar, B. STUDIES ON THE BIOSYNTHESIS OF PROTEINS IN THE SILKWORM, BOMBYX MORI (L.). Biochem. J. 76,1 (1960) 71-8.

The incorporation of $C^{14}$-labelled glycine into tissue proteins of injected silkworm larvae was studied, and depends on the stage of development of the larvae. The rate is low during the 4th molt and increases progressively during the 5th larval instar. Just before spinning the rate of incorporation is again low. Incorporation in vitro into silk-gland minces is an aerobic process depending upon the presence of bivalent ions. It is enhanced by the addition of intermediates of the tricarboxylic acid cycle, particularly by malate, citrate, succinate, fumarate and $\alpha$-glycerophosphate. A pH 5 extract was prepared by precipitating at pH 5.1 an

ultracentrifugate of brei obtained from the posterior portion of the silk gland and subsequently dissolving the precipitate at pH 7.8. Incorporation of $C^{14}$ -labelled glycine into this extract is rapid, and is stimulated by Mg ions and either adenosine or guanosine triphosphate. In addition to $C^{14}$ -labelled glycine, labelled phenylalanine and glutamate are incorporated into the pH 5 extract but at a slower rate; in mixture, the 3 amino acids are incorporated additively. The [1-$C^{14}$ ] glycine-pH 5 extract complex is decomposed by heating at pH 7.8 by treatment with hot trichloracetic acid, and by the action of ribonuclease. A glycine-activating enzyme has been purified 20-fold by ammonium sulfate precipitation of the pH 5 extract. The purified preparation no longer incorporates $C^{14}$ -labelled glycine, which indicates that separate enzymes are involved in activation and incorporation. (auth.)

171 Florkin, M. THE FREE AMINO ACIDS OF INSECT HEMOLYMPH. p. 63-73 (disc. p. 73-5) in "Proceedings of the 4th International Congress on Biochemistry, Vienna 1958", Vol. 12. Levenbock, L., ed. London, Pergamon Press. 1959.

A section is devoted to the aminoacidemia of Bombyx mori. The author discusses aminoacidemia and amino acid components of tissues, and the free amino acids taken up by the silk-gland from the hemolymph, where extensive use has already been made of $C^{14}$ -labelling (cf. Fukuda 1955, 1956, 1959). The fate of the amino acid taken up by the gland from the hemolymph has also been traced. Radioactive serine is found in the silk after injection of glycine-1-$C^{14}$ (Fukuda 1956); the activity of glycine-1-$C^{14}$ injected into the hemolymph has been found (Bricteux-Grégoire 1957) in decreasing order of specific activities in the glycine, serine and alanine of the silk. Changes in the pattern of aminoacidemia during the development of Bombyx mori are discussed.

172 Fukuda, T. A STUDY OF SILK PROTEIN SYNTHESIS BY MEANS OF $C^{14}$ . p. 528-31 in "Proceedings of the 1st Japan Conference on Radioisotopes, 1956". Tokyo, Japan Atomic Industrial Forum, Inc. 1956. (In Japanese)

The biosynthesis of $C^{14}$ -labelled phenyl-alanine into tyrosine in the silkworm was confirmed by means of paper chromatography and autoradiography. $C^{14}$ -labelled glycine was shown to be converted into serine. The degree to which 4 radioactively labelled amino acids (glycine-2-$C^{14}$ , DL-alanine-1-$C^{14}$ , L-phenyl alanine-2-$C^{14}$ and glutamic acid-1-$C^{14}$ ) were incorporated into silk protein was shown. The significance of the findings is discussed.

173 Fukuda, T. BIOCHEMICAL STUDIES ON THE FORMATION OF THE SILKPROTEIN. III. THE CONVERSION OF $C^{14}$ -LABELED PHENYLALANINE TO TYROSINE IN THE SILKWORM LARVA (BOMBYX MORI). J. Biochem., Tokyo 43, 2 (1956) 137-42.

After the injection of phenylalanine-2-$C^{14}$ to silk worm (Si 122 x Nichi 122) on the 4th day at 5th instar in an amount of 0.5 μc/larva), the specific radioactivities of sericin and fibroin separated from cocoon fibers were 1407 and 4531 cpm/100 mg, respectively. Among amino acids composing fibroin, tyrosine possessed exclusively high activity (41 147 cpm/μmole). This was also proved by paper chromatography with a phenol--0.1% $NH_3$ mixture (85 : 15), which was followed by radioautogram as well as by radioactivity estimation with a SC-16 gas flow windowless counter. (BA 31: 3767, 1957)

174 Fukuda, T. CONVERSION OF PHENYLALANINE INTO TYROSINE IN THE SILKWORM LARVA (BOMBYX MORI). Nature 177 (1956) 429-30.

$C^{14}$ -labelled phenylalanine was used in a study to determine whether phenylalanine is a precursor of tyrosine. 0.5 μc of radioactive phenylalanine per worm was injected into the body cavity of the silkworms, on the 4th day of the 5th instar. The techniques are described. On examining the radioactivities of the amino acids isolated from fibroin almost all the activity was found to be located in tyrosine. Analysis of isolated tyrosine by paper chromatography and radioautography gave results which suggest that the tyrosine is labelled with $C^{14}$ . The synthesis of tyrosine from phenylalanine in vivo was confirmed, as was its subsequent utilization for biosynthesis of the silk proteins.

175 Fukuda, T. CONVERSION OF PYRUVIC ACID TO ALANINE IN THE SILKWORM LARVA. Nature 180 (1957) 245.

A solution prepared from silkworm larvae by homogenization and freezing of the silk-glands, the alimentary canals, and fat tissues, was used as an enzyme preparation. To 1 ml of the enzyme solution was added 0.5 ml

of 0.1 M L-glutamic acid, 0.5 ml of 1 M Na pyruvate, and 0.1 ml of M/15 phosphate buffer, pH 7.4, containing 0.1 μc of Na pyruvate-2-$C^{14}$, and the mixture was incubated for 60 min at 38°C. Analysis by paper chromatography resulted in 2 spots, one of which was alanine ($R_f$ 0.42) in which most of the radioactivity was concentrated, and another spot for the remaining glutamic acid. This indicated the conversion of pyruvate to alanine, an important constituent of the silk protein. (CA 51: 16986g, 1957)

176 Fukuda, T. THE FORMATION OF SILK PROTEIN. IV. THE CONVERSION OF PYRUVIC ACID TO ALANINE IN THE SILKWORM LARVA. J. Biochem., Tokyo 44 (1957) 505-10.

After the peroral administration of 17.5 γ of Na pyruvate-2-$C^{14}$ (500 mc) per silkworm (Bombyx mori Nichi 122 x Si 115 strain) per day for 3 days from the 4th day of the 5th instar, the $C^{14}$-incorporation into cocoon fibre (I) amounts to 3443 counts/min/100 mg of specific activity. The $C^{14}$-distribution in alanine (II) molecule isolated from I is determined as follows: COOH-C 5, α-C 80, β-C 2 counts/min/mg. With the enzyme solution prepared by homogenizing the tissues with M/15 phosphate buffer of pH 7.4, freezing-thawing, and centrifuging off the insoluble protein, successively, the production of $C^{14}$-II occurs by posterior division of silk gland, alimentary canal, muscle plus fat tissue preparations in the presence of L-glutamic (III) or L-aspartic acid (IV). The transaminase activity of silk gland to convert pyruvic acid to II is markedly high when III, or to a less extent, IV is used as $NH_2$-donator. (CA 51: 16971b, 1957)

177 Fukuda, T., Florkin, M. BIOCHEMISTRY OF THE SILK WORM. V. TIME OF BIOSYNTHESIS OF FIBROIN AND ITS LOCATION IN THE SILK OF BOMBYX MORI. Arch. int. Physiol. et Biochim. 67 (1959) 185-9.

Silkworms of the European race of B. mori were given 0.5 μc of L-alanine-$C^{14}$ from the 1st to the 12th day of the 5th stage. Alanine is a major constituent of the fibroin of silk and presumably is transferred from the hemolymph to the silk gland while fibroin synthesis is in progress. Thread from the cocoons was unwound, degummed by boiling in a 0.02 M solution of $Na_2CO_3$, washed with EtOH, $Et_2O$, dried, and laid out in horizontal segments. Autoradiographs of the thread segments showed that a relation existed between $C^{14}$ in the hemolymph and the different segments of the silk thread spun by the animals. (from CA 54: 14482a, 1960)

178 Fukuda, T., Florkin, M. BIOCHEMISTRY OF THE SILK WORM. VI. TIME OF BIOSYNTHESIS OF FIBROINOGEN AND ITS LOCATION IN THE RESERVOIR OF THE SILK GLAND AT THE END OF THE FIFTH STAGE. Arch. int. Physiol. et Biochim. 67 (1959) 190-4.

B. mori was fed 1 μc of glycine-2-$C^{14}$. Radioautographs of degummed and dried slices of isolated frozen silk glands showed that high radioactivity appeared in a definite section of the fibroinogen stored in the reservoir of the middle portion of the gland. The macromolecules of fibroinogen synthesized in the posterior division of the silk gland were stored in order of their synthesis. (CA 54: 14482b, 1960)

179 Fukuda, T., Florkin, M. BIOCHEMISTRY OF THE SILK WORM. VII. ORDERED PROGRESSION OF FIBROINOGEN IN THE RESERVOIR OF THE SILK GLAND DURING THE 5TH INSTAR. Arch. int. Physiol. et Biochim. 67 (1959) 214-21.

To further test the hypothesis that macromolecules of fibroinogen move in an ordered fashion in the reservoir of the silk glands of B. mori, 1 μc of glycine-2-$C^{14}$ was fed to silkworms of the European race on the 6th day of the 5th instar. Radioautographs were taken of sliced silk glands and the results showed that the fibroinogen synthesized at different periods was deposited in the reservoir in order of succession and appeared in the fibroin of the silk thread in this order. (CA 54: 14482c, 1960)

180 Fukuda, T. BIOCHEMICAL STUDIES ON THE FORMATION OF THE SILKPROTEIN. VI. CONVERSION OF SERINE TO GLYCINE IN THE SILKWORM LARVA. J. Biochem., Tokyo 47 (1960) 581-3.

Oral administration of uniformly $C^{14}$-labelled serine to Bombyx mori at the 5th instar resulted in glycine-$C^{14}$-rich cocoon (silk fibroin) in the posterior silk gland. Alanine in the isolated cocoon was slightly labelled by $C^{14}$. Glycine had approximately equal $C^{14}$ at C-1 and C-2. (CA 54: 23078i, 1960)

181 Fukuda, T. BIOCHEMICAL STUDIES ON THE FORMATION OF THE SILKPROTEIN. VII. THE CONVERSION OF GLYCINE TO SERINE IN THE SILKWORM LARVA. J. Biochem., Tokyo 47 (1960) 720-5.

Following oral administration of glycine-1-$C^{14}$ and -2-$C^{14}$ to silkworm the serine residue of fibroin and sericin was labelled in the carboxyl (C-1) and side chain (C-2 and C-3), respectively. At the same time glyoxylic acid in body fluid was highly labelled. The following reactions are suggested for in vivo synthesis of serine: glycine ⇌ glyoxylate → HCHO+$CO_2$; glycine + HCHO → serine. (CA 54: 23078i, 1960)

182 Fukuda, T., Hayashi, T. BIOCHEMICAL STUDIES ON THE FORMATION OF THE SILK PROTEIN. VIII. THE SYNTHESIS OF α-KETOGLUTARIC ACID, OXALACETIC ACID AND GLYOXYLIC ACID FROM GLUCOSE IN THE SILKWORM. J. Biochem., Tokyo 48 (1960) 9-12.

After oral administration of glucose-$C^{14}$ to the silkworm, keto acids were separated as the dinitrophenyl compounds by paper chromatography, and analysed for radioactivity. α-Ketoglutaric acid was most highly enriched with $C^{14}$. Oxalacetic acid was labelled considerably, but glyoxylic acid was almost free of $C^{14}$ incorporation. (CA 55: 4799e, 1960)

183 Fukuda, T. BIOCHEMICAL STUDIES ON THE FORMATION OF SILK PROTEIN. IX. THE DIRECT AND INDIRECT FORMATION OF SILK PROTEIN DURING THE GROWTH OF THE SILKWORM LARVA. Bull. agric. chem. Soc. Japan 24 (1960) 396-401.

The distribution of $C^{14}$ was studied in the silk produced by the silkworms fed 1 $cm^2$ of radioactive mulberry leaf or some radioactive amino acids on the different days of the 5th instar. The 1st 100, 200-400, and 700-1000 m of silk unwound from a cocoon was made mainly from the amino acids taken on the 4th, 6th, and 8th day, respectively. The radioactivity taken on the 1st through 3rd day appeared at the very beginning and at the last part (700-1200 m) of the silk. (CA 55: 824c, 1961)

184 Fukuda, T., Suto, M., Nakagawa, Y. BIOCHEMICAL STUDIES ON THE FORMATION OF THE SILK PROTEIN. X. ORDERED PROGRESSION OF FIBROIN IN THE INSIDE OF THE SILK GLAND DURING THE FIFTH INSTAR. (CONTINUATION). Bull. agric. chem. Soc. Japan 24 (1960) 501-5.

The movement of fibroin in the silk gland of the 5th instar silkworm was studied by using glycine-$C^{14}$ as the tracer. Fibroin was synthesized in the posterior division of the gland, and moved toward the middle and anterior divisions. (CA 55: 3859e, 1961)

185 Fukuda, T., Kameyama, T. BIOCHEMICAL STUDIES ON THE FORMATION OF THE SILKPROTEIN. XI. THE KINDS OF FREE AMINO ACIDS CONCERNED IN THE BIOSYNTHESIS OF THE SILKPROTEIN. (CONTINUATION). J. sericul. Sci., Tokyo 29 (1960) 120-4. (In Japanese)

186 Fukuda, T., Matsuda, M. BIOCHEMICAL STUDIES ON THE FORMATION OF THE SILKPROTEIN. XII. THE FUNCTIONAL LOCALIZATION OF THE SILK GLAND ON THE AMINO ACID ABSORPTION. J. Sericul. Sci., Tokyo 29 (1960) 415-9. (In Japanese)

187 Fukuda, T. THE CORRELATION BETWEEN THE MULBERRY LEAVES TAKEN BY THE SILKWORM, THE SILK PROTEIN IN THE SILK GLAND AND THE SILK FILAMENT. Bull. seric. Exp. Sta., Japan 15 (1960) 595-610. (In Japanese, summary in English)

188 Fukuda, T., Sudo, M., Matsuda, M., Hayashi, T., Kurose, T., Horiuchi, Y., Florkin, M. FORMATION OF THE SILK PROTEINS DURING THE GROWTH OF THE SILKWORM LARVA (BOMBYX MORI). p. 90-8 (disc. p. 98-9) in "Proceedings of the 4th International Congress on Biochemistry, Vienna 1958", Vol. 12. Levenbock, L., ed. London, Pergamon Press. 1959.

1 $cm^2$ of mulberry leaves labelled with $C^{14}$ or 0.5 μc of $C^{14}$-labelled amino acid was fed to single silkworm larva at different stages of development from the beginning of the 3rd to the end of the 5th instar. The larvae were then reared on normal mulberry leaves until they produced cocoons. The silk filament was unwound and the radioactivity located by a radioautograph. There were two pathways for the formation of silk proteins during growth of the silkworm larva. About 70% of the silk proteins produced by one silkworm was derived directly from the proteins of the mulberry leaves, but approx. 30% came from the tissue and blood proteins. Direct formation of silk protein occurred during the period from the 3rd day of the 5th instar to maturity, while the indirect formation occurred from the 7th day of the 5th instar to just before termination of the spinning after reaching maturity. Fibroin (I), from the anterior portion of the middle division of a mature larva silk gland, was derived from mulberry leaves eaten at the beginning of the 5th stage and was used for the formation of the first part of the silk filament unwound from the cocoon. I from the rear portion of the middle division was from leaves eaten during the middle of the 5th instar and was used for the formation of the middle part of the filament, while I from the posterior division was from leaves eaten on the 8th day of the 5th stage and formed the next segment of filament. The last part of the thread was derived from tissue proteins synthesized from leaves eaten at the beginning of the 4th and 5th stages. (CA 54: 15724f, 1960)

189 Fuzeau-Braesch, S. UTILISATION D'ACIDES AMINÉS MARQUÉS DANS L'ÉTUDE DES PIGMENTS TÉGUMENTAIRES DES INSECTES. C.R. Soc. Biol., Paris 152, 5 (1958) 715-8.

L'utilisation de tyrosine et de tryptophane marqué de $^{14}C$ a permis l'étude des pigments de la cuticule et de l'hypoderme de Gryllus bimaculatus; les granules hypodermiques ont pu être identifiés aux "ommochromes" dérivés du tryptophane. (BS 20-230478, 1959)

190 Hyland, K.E., Hammar, J.L. TRANSOVARIAL PASSAGE OF RADIOACTIVITY IN TICKS LABELED WITH $C^{14}$ GLYCINE. (abstr.) J. Parasit. 45 (4, sect. 2, suppl.) (1959) 24-5.

Preliminary to field studies of Dermacentor variabilis a consideration of various techniques was undertaken for the internal labelling of adult female ticks, the goal being to pass to the offspring a degree of radioactivity. Female ticks were administered the tracer through a glass capillary tube which was fitted over the hypostome and chelicerae (after the techniques of Chabaud and of Bergdorfer). The tube was calibrated to accept 0.01 ml of glycine, which contained 0.5 $\mu$c of $C^{14}$. Each tick after imbibing the radioactive glycine was allowed to finish engorging on laboratory rabbits. Eggs and resulting larvae were found to be radioactive although there was a decrease of approximately 55% in the activity between egg and larvae. Preliminary results indicate that there is no reduction in the egg laying capacity of the females, nor is there a decrease in the hatchability of the radioactive eggs. The effects of $C^{14}$ on the remainder of the life cycle have not been investigated.

191 Ishi, S., Hirano, C. BIOSYNTHESIS OF TYROSINE FROM $C^{14}$-PHENYLALANINE IN THE LARVA OF THE RICE STEM BORER, CHILO SUPPRESSALIS WALKER. p.295-8 in "Proceedings of the 10th International Congress on Entomology, Montreal, 17-25 Aug. 1956", Vol.2. Becker, E.C., ed. Ottawa, Mortimer Ltd. 1958.

The nutritional requirement of the larva of the rice stem borer, Chilo suppressalis Walker, was studied by synthetic media under aseptic conditions. Amino acids and vitamins required by the larva have been reported in the previous papers. Tyrosine, one of the non-essential amino acids, is derived from other compounds in the larval body, but the course of metabolism is still unknown. In the present experiment, biosynthesis of tyrosine was studied by using $\alpha$-labelled-$C^{14}$-L-phenylalanine. The radioactive tyrosine was detected by radiometric analysis in the larvae which were reared with a tyrosine free synthetic diet containing the labelled phenylalanine. Phenylalanine is converted to tyrosine, and not to alanine during the couse of metabolism. (auth.)

192 Ito, H. ON THE BIOSYNTHESIS OF FIBROIN IN THE POSTERIOR SILKGLANDS OF SILKWORM. Bull. Soc. Franco-Jap. Biol. 14, 5 (1960) 13-20. (In Japanese)

193 Kasting, R., McGinnis, A.J. USE OF GLUCOSE LABELLED WITH CARBON-14 TO DETERMINE THE AMINO ACIDS ESSENTIAL FOR AN INSECT. Nature 182, 4646 (1958) 1380-1.

Third-instar larvae of the blowfly Phormia regina Meig. were injected with 3-6 $\mu$l of a solution of uniformly labelled glucose-$C^{14}$ containing 5000 cpm/$\mu$l. After 24 h the $CO_2$ was found to be radioactive, indicating that glucose-$C^{14}$ when injected into the larvae, was metabolized during this stage of development. A table gives the specific activities of carbon from amino-acids isolated from the blowfly after injection, and the amino-acid requirements as determined by the deletion procedure. The presence of intermediate quantities of radioactivity in proline and alanine indicates that both were synthesized from glucose. The radioactivity method described gave results for the blowfly that were sufficiently comparable to those of the classical deletion procedure to warrant application to insects that cannot yet be reared on chemically defined diets.

194 Kasting, R., McGinnis, A.J. USE OF GLUTAMIC ACID-U-$C^{14}$ TO DETERMINE NUTRITIONALLY ESSENTIAL AMINO ACIDS FOR LARVAE OF THE BLOW FLY, PHORMIA REGINA. Canad. J. Biochem. Physiol. 38, 11 (1960) 1229-34.

The production of $C^{14}O_2$ by third-instar larvae of the blow fly, Phormia regina Meig., after it was injected with glutamic acid-U-$C^{14}$, indicates that this substrate was metabolized under these conditions. However, the nutritionally essential amino acids lysine, phenylalanine, valine, isoleucine, leucine, and threonine, isolated from the injected larvae, contained little radioactivity. A low level of radioactivity in arginine, histidine, and methionine suggests that they were slowly synthesized. The nutritionally non-essential amino acids alanine, serine, aspartic acid, and proline contained large quantities of radioactivity; tyrosine and glycine were exceptions. These results, in agreement with earlier work that used glucose-U-$C^{14}$, show that radioactivity data are useful for determining certain of the nutritionally essential amino acids. (auth.)

195 Levy, M., Slobodian, E. SEQUENCES OF AMINO ACID RESIDUES IN SILK FIBROIN. J. biol. Chem. 199 (1952) 563-72.

Partial hydrolysates of silk fibroin (Bombyx mori) have been analysed by the isotope derivative technique, for glycine, alanine, glycylalanine, alanylglycine, and glycylglycine. (In order to obtain distribution data in several immiscible solvent systems, following purification, minute amounts of each derivative were also prepared from radioactive ($I^{131}$) pipsyl chloride). Complete hydrolysates have been analysed for certain amino acids. The results showed little glycylglycine in partial hydrolysates, while the amounts of alanylglycine are so large as to eliminate the possibility of a random amino acid arrangement in fibroin. All of the analytical data, from studies of complete and partial hydrolysates, can be accounted for by the sequence -X-Ala-Gly-Ala-Gly-X-Gly-, which is proposed as a minimum repeating unit for fibroin.

196 Miura, Y., Ito, H., Tanaka, S., Momose, K., Moriyama, A. TRANSFER OF RADIOACTIVITY FROM THE PRELABELED CELL DEBRIS TO THE MICROSOMAL PROTEIN. Biochim. biophys. Acta 43 (1960) 362-4.

The transfer of radioactivity from $C^{14}$-labelled cell debris of silk glands to microsomal protein was measured in the presence of various subcellular fractions. Considerable radioactivity was transferred to the protein under appropriate conditions. When glycine-$C^{14}$ was used as the source of radioactivity instead of labelled cell debris, the relative sp. activity of the microsomal protein was less than 0.0001%, compared to around 20% in the case of the cell debris. (CA 55: 10536a, 1961)

197 Oratz, M. STUDIES ON THE AMINO ACID SEQUENCE OF SILK FIBROIN. Diss. Abstr. 21 (1960) 41-3.

Silk fibroin was reacted with $S^{35}$-labelled pipsyl chloride (p-iodophenyl-sulfonyl chloride) in 50% aqueous acetone containing an excess of $NaHCO_3$. Hydrolysis and paper chromatography yielded 3 peaks which were identified as $(Glycine)_3$ $(Alanine)_2$ O-pipsyl Tyrosine, O-pipsyl tyrosylalanylglycine and glycyl O-pipsyl tyrosine. These 3 peptides isolated accounted for at least 35% of the total tyrosine in the sample of fibroin taken. The yields of these peptides exceed the statistically indicated yields based on a random distribution of amino acids in fibroin. The amino acid sequences found are compatible with the proposed repeating sequence of fibroin.

198 Passonneau, J.V., Williams, C.M. THE MOLTING FLUID OF THE CECROPIA SILKWORM. J. exp. Biol. 30 (1953) 545-60.

During the first 2/3 of adult development the molting fluid is a dilute aqueous proteinaceous gel resembling egg albumen; at this time it is without effect on the pupal cuticle. On approximately the 14th day the gel is converted into a sol and shows considerable increase in chitinase activity and the first demonstrable proteolytic activity. The active molting fluid then begins to hydrolyze the protein and chitin in the overlying pupal endocuticle. Finally, the molting fluid is completely resorbed into the underlying insect. The molting fluid shows numerous quantitative and qualitative differences from the blood. A dynamic state exists between the molting fluid and the underlying insect. Radioactive glycine, injected into the molting fluid, was promptly resorbed and incorporated into the protein of the adult moth. (CA 48: 8969a, 1954)

199 Rabinovitch, M., Vugman, I. AUTORADIOGRAPHIC OBSERVATIONS ON THE SILK GLANDS OF BOMBYX MORI. J. biophys. biochem. Cytol. 6 (1959) 293-4.

Glycine-1-$C^{14}$ was administered to B. mori larvae and its incorporation in the silk glands followed autoradiographically. After 15 and 30 min the autoradiographs showed strong and diffuse activity in the cell cytoplasm. At 1 h it was mainly found over the cell apex and newly formed secreted material. At 12 and 24 h the activity was localized mainly in the material secreted into the lumen. (auth.)

200 Shigematsu, A. INCORPORATION OF $C^{14}$-AMINO ACIDS INTO PROTEINS AND LIPID FRACTIONS OF SILKWORMS. J. Biochem., Tokyo 32 (1960) 519-24. (In Japanese)

201 Shigematsu, H. SYNTHESIS OF BLOOD PROTEIN BY THE FAT BODY IN THE SILKWORM, BOMBYX MORI L. Nature 182, 4639 (1958) 880-2.

It is not yet clear which organ is concerned in the synthesis of blood protein in the larval stage. The protein content in the fat body of an individual has been shown to remain almost constant after the middle period of the last larval instar, whereas protein synthesizing activity of the tissue during the same period was rather high. In the first experiment described here, net synthesis and secretion of protein by the fat body was demonstrated. In the second experiment, the incorporation of amino acids labelled with $C^{14}$ into protein

was investigated to confirm the synthesis and the secretion of protein by the tissue. (The labelled amino-acid mixture was isolated from Euglena cultured in a $C^{14}O_2$ atmosphere). In the third experiment, the nature of the protein secreted by the fat body was investigated by paper electrophoresis. The author proposes that the fat body of the silkworm synthesizes globulins and secretes them into the blood circulation during the larval stage, at least in the 5th larval instar.

202 Shigematsu, H. PROTEIN METABOLISM IN THE FAT BODY OF THE SILKWORM, BOMBYX MORI L. Bull. seric. Exp. Sta., Japan 16 (1960) 141-70. (In Japanese, with summary in English)

203 Shimura, K., Fukai, H., Sato, J., Saeki, R. NONUNIFORM LABELING OF THE SILK FIBROIN SYNTHESIZED IN VIVO. J. Biochem., Tokyo 43 (1956) 101-2.

After the administration of $CH_2NH_2C^{14}O_2H$ (5 mg, $1.2 \times 10^4$ cpm) to each silk worm larva on the 3rd-4th day of the 5th instar, silk fibroin was isolated from the posterior gland by washings with 0.14 M and M NaCl, distilled water, EtOH, and ether, in that order, and the radioactivity of the fibroin was then determined. The labelled glycine was shown to be incorporated non-uniformly but to be present predominantly in N-terminal amino acids of the fibroin molecule.

204 Shimura, K., Fukai, H., Suto, S., Hoshi, R. BIOSYNTHESIS OF SILK FIBROIN. I. INCORPORATION OF GLYCINE-1-$C^{14}$ INTO FIBROIN IN VIVO. J. Biochem., Tokyo 45 (1958) 481-8.

After the injection of glycine-1-$C^{14}$ (I) ($1.4 \times 10^5$ counts/min/worm) to Bombyx mori on the 3rd-5th day of the 5th instar, I is incorporated promptly into posterior silk gland (II), the $CCl_3CO_2H$ (III)-precipitated protein of which shows the maximum radioactivity at the 4th h. Radioactivity of III-precipitated protein of middle silk gland rises slowly in initial 4-6 h and then increases rapidly up to the 10th h, while that of the 70% alcohol-precipitated protein of blood is far lower up to 24 h. Of protein fractions of posterior II prepared by the Griffin's method ( cf. CA 43: 2314a) fibroin (IV) is predominantly radioactive, but this Griffin IV fraction is impure in comparison with IV prepared by precipitating off other proteins by III. Of intracellular fractions of Schneider et al. (cf. CA 45: 8110e) of posterior II large granules (V) strongly incorporate I and small granules (VI) also do to a lesser extent. V and VI have 9.8 and 5.3 for total N/ribonucleic acid P ratio, and 462 and 73 for succinic oxidase activity (as $Q_{02}$ /mg N). The I incorporation into IV (the III-method) of posterior II shows a lag phase of 30 min, which is not the case with Griffin's IV fraction. Column (Dowex 50) chromatography of the hydrolyzate of IV (the III method) of posterior II gives the following pattern of radioactive amino acid distribution: I 95, serine 3, alanine 1, and threonine 0.5-1%. The incorporation pathway of I is presented: free I in blood → synthesis to IV in posterior II → IV in middle silk gland by simple transport. (CA 52: 18918d, 1958)

205 Shimura, K., Kobayashi, H., Hoshi, R., Sato, J. BIOSYNTHESIS OF SILK FIBROIN. II. NONUNIFORM LABELING OF SILK FIBROIN SYNTHESIZED IN VIVO. J. Biochem., Tokyo 46 (1959) 849-55.

After injecting glycine-1-$C^{14}$ or alanine-1-$C^{14}$ - in Bombyx mori (strain Si 122 × Nichi 122) at the 3rd-5th day of the 5th instar, the incorporation of $C^{14}$ in N-terminal amino acids of silk fibroin of the posterior silk gland was 2-5 times that in nonterminal amino acids of silk fibroin. The radioactivity of the N-terminal amino acids decreased at a rate higher than that of nonterminal groups. Similar tendencies were demonstrated with tissue protein, fraction IV (Coleman and Howitt, CA 42: 4216e), of the silk gland. A stepwise synthesis of silk fibroin is suggested. (CA 53: 22103c, 1959)

206 Sisakyan, N.M., Kuvaeva, E.B. EFFECT OF ENERGY DONORS AND INHIBITORS ON INCLUSION OF $C^{14}$ -GLYCINE INTO PROTEINS OF CAVITY FLUID OF BOMBYX MORI. Dokl. Akad. nauk. SSSR 113 (1957) 873-6. (In Russian)

The ability of the pupal cavity fluid to incorporate $C^{14}$ -labelled glycine varies with time of metamorphosis, being low at 25-30% pupal age and intense at 65% pupal age. Addition of sucrose increases the incorporation at histolysis stage by some 47%, while at histogenesis stage the addition causes a 3-fold increase of incorporation. Adenosinetriphosphate (ATP) greatly increases the rate of incorporation at the histolysis stage, and almost stops it at histogenesis stage. The results were similar with pupae of Antheraea pernyi*). At histolysis stage NaF inhibits the incorporation and either has no effect or a slight stimulating effect during histogenesis stage. (CA 51: 13243b, 1957)

---

* The Chinese oak silkworm

207 Slobodian, E., Levy, M. THE SEQUENCE GLYCYLALANYLGLYCINE IN SILK FIBROIN. J. biol. Chem. 201 (1953) 371-5.

In the silk fibroin of Bombyx mori the major portion of the nitrogen is accounted for by the amino acids glycine and alanine. The amino acid sequence in the protein may be studied through the identification and estimation of the peptides obtained on partial hydrolysis of the protein. The tripeptide glycylalanylglycine was identified in partial hydrolysates by a technique using $I^{131}$-labelled pipsyl chloride. Analysis by the isotope derivative technique indicated amounts of this peptide well in excess of the maximum value to be expected from a random arrangement of amino acid residues in silk. Evidence is thus provided for the view of a non-random, ordered amino acid arrangement in silk fibroin, with the sequence glycylalanylglycine as an important structural element.

* Spinks 1958 - [14]

208 Suzuka, I., Shimura, K. BIOSYNTHESIS OF SILK FIBROIN. I. INCORPORATION OF GLYCINE-$C^{14}$ INTO PARTICLES OF POSTERIOR SILK GLAND IN VITRO. J. Biochem., Tokyo 47 (1960) 551-4.

The large particulate fraction (I) capable of incorporating glycine, was purified as follows: the posterior silk glands of Bombyx mori were homogenized in 0.4 M sucrose-0.0025 M KCl-0.005 M $MgCl_2$ (pH 8.0), centrifuged and the debris (700 g) removed. I was precipitated at 14 000 g. The supernatant was then adjusted to pH 6.1, centrifuged, the precipitants removed, the supernatant acidified to pH 4.9 and the glycine-incorporation stimulating factor (II) brought down by precipitation. The glycine-$C^{14}$ incorporation into protein of I catalyzed by I cannot be stimulated by II or any other intra-cellular fractions. Deoxycholate (2%)-treated I (III) in 0.4 M sucrose at pH 8.0 is not active and required II for glycine incorporation which is markedly stimulated by the addition of $2 \times 10^{-4}$ M guanosine triphosphate. II cannot be replaced by ribonucleic acid or other intra-cellular fractions. II does not catalyze the formation of glycine hydroxamate or the exchange reaction between adenosine triphosphate and phosphate or $P^{32}$-labelled pyrophosphate.

209 Suzuka, I., Shimura, K. BIOSYNTHESIS OF SILK FIBROIN. II. INCORPORATION OF SPECIFIC $C^{14}$-LABELLED AMINO ACIDS INTO PROTEINS OF POSTERIOR SILK GLAND IN VITRO. J. Biochem., Tokyo 47 (1960) 555-7.

The relative rate of incorporation of glycine-, alanine-, and leucine-$C^{14}$ by I was determined as 5:2.5:1 for Bombyx mori whereas the fraction for Attacus ricini, whose fibroin is rich in alanine, incorporated alanine at the highest rate. The amino acid incorporation took place by combining either rat-liver microsomes (IV) or III preparation of B. mori or A. ricini with rat liver pH 5 enzyme or II preparation of B. mori or A. ricini. The bulk of the incorporated amino acids was determined as leucine, glycine, and alanine with the use of III of B. mori and A. ricini, respectively, regardless of the sort of activating or stimulating factor supplemented.

(For key to notation used, see abstract for part I of the study)

210 Suzuka, I., Tanaka, S., Shimura, K. AMINO ACID INCORPORATION ENZYME IN POSTERIOR SILK GLAND. J. Biochem., Tokyo 48 (1960) 774-6.

211 Telfer, W.H., Williams, C.M. INCORPORATION OF RADIOACTIVE GLYCINE INTO THE BLOOD PROTEINS OF THE CECROPIA SILKWORM. Anat. Record 122 (1955) 441-2.

Injection of radioactive glycine ($C^{14}$ carboxyl-labelled) intrahemally into the Cecropia silkworm leads to the appearance of radioactivity in the proteins of both blood and tissues. Ninhydrin tests revealed that the radioactivity of the blood proteins occurred in carboxyl groups associated with peptide bonds. Pupae in the overwintering state of diapause readily incorporated $C^{14}$ into their blood proteins, although this occurred at a slow rate. The termination of diapause, which is marked by the initiation of adult development, was accompanied by a four-fold increase in the rate of incorporation of $C^{14}$ into the blood proteins. Diapausing pupae in which the end of the abdomen had been replaced by a plastic coverslip incorporated $C^{14}$ into blood proteins at a rate characteristic of developing adults. The capacity of diapausing pupae to respond to injury in this manner indicates that their inability to grow and differentiate is not due to an inability to synthesize proteins. The effects of injury, carbon monoxide and stage of metamorphosis on the rate of incorporation of $C^{14}$ into blood proteins parallel the effects of these same factors on the rate of oxygen consumption (Schneiderman and Williams, Biol. Bull. 105: 320-34).

(Abstract of paper presented before the 52nd Ann. Meeting of the American Society of Zoologists, 6-8 Sept. 1955)

212 Telfer, W.H., Williams, C.M. THE EFFECTS OF DIAPAUSE, DEVELOPMENT, AND INJURY ON THE INCORPORATION OF RADIOACTIVE GLYCINE INTO THE BLOOD PROTEINS OF THE CECROPIA SILKWORM (HYALOPHORA CECROPIA). J. Insect Physiol. 5,1 (1960) 61-72.

Radioactive glycine, injected into the haemocoele of diapausing pupae and developing adults, is incorporated into the proteins of the blood. The rate of incorporation parallels previously described rates of O consumption under a variety of conditions. The incorporation of amino acids can be added to the list of metabolic processes which proceed at depressed rates during diapause, but which accelerate temporarily in response to injury. (CA 55: 4802a, 1961)

213 Treherne, J.E. AMINO ACID ABSORPTION IN THE LOCUST (SCHISTOCERCA GREGARIA FORSK.) J. exp. Biol. 36 (1959) 533-45.

Chromatographic analysis of the hemolymph revealed the presence of 10 amino acids of which glycine and serine occurred in the relatively high concentrations of 33.2 and 34.6 millimoles/l, respectively. After injection of $C^{14}$-labelled glycine and serine into the gut lumen, uptake was shown to occur rapidly in the mid-gut region and especially from the lumen of the caeca. The concentrations of glycine and serine, and also of glutamine in the caecal fluid, were found to increase significantly above the concentrations in the hemolymph, an effect which was paralleled by a relatively rapid decrease in fluid volume. During this time rapid exchange of $C^{14}$-labelled glycine and serine between the hemolymph and the gut lumen was demonstrated. Absorption of these amino acids depends, in part at least, upon the diffusion gradient created by the relatively rapid movements of water into the hemolymph. (CA 54: 16673g, 1960)

* Winteringham and Harrison 1956 - [782]

## I-B-3 NUCLEIC ACIDS

214 Bishop, G.H., Friedkin, M. UTILIZATION OF THYMIDINE-$C^{14}$ BY QUEEN BEE LARVAE. J. exp. Zool. 141 (1959) 245-56.

Tissues of queen bee larvae were incubated with thymidine-$C^{14}$ at various stages of larval and pupal development. The radioactivity/mg/h of incubation of the acid-insoluble fraction and per mg wet weight of tissue decreased sharply with the age of the larva. The activity per unit larva, however, increased with age, but less steeply. The implications of these findings are discussed. Despite the massive breakdown of the fat body cells prior to transformation of the larva, the biochemical and histological data suggest that DNA synthesized during early larval stages, or at least its nucleotides, may be utilized intact during later periods of cellular differentiation in the queen bee. Larvae fed thymidine-$C^{14}$ in royal jelly apparently digested it, since the greatest activity was then found in the silk cocoons spun at maturity. The $C^{14}$ was not in the protein of the cocoon since only an insignificant amount of activity appeared in the acid-insoluble fraction of the silk after alkaline treatment. Injection of thymidine into the blood space of the pupa lead to some utilization, activity being still present after emergence of the mature queen, mating and beginning of egg-laying. (auth. summary)

215 Ficq, A., Pavan, C. AUTORADIOGRAPHY OF POLYTENE CHROMOSOMES OF RHYNCHOSCIARA ANGELAE AT DIFFERENT STAGES OF LARVAL DEVELOPMENT. Nature 180 (1957) 983-4.

Tritiated thymidine (0.01-0.1 μc) was injected into larvae of Rhynchosciara angelae. The sites of greatest incorporation of thymidine into the chromosome vary with the age of the larvae, but are constant at the same stage of larval development, and much more evident in certain loci of the chromosomes than in others. The authors conclude that the intense incorporation of thymidine in "puff" loci of the polytene chromosomes show that DNA plays a very active part in the puffing. "Puffs" which are characteristic for the larval stages are interpreted as indicating special gene activity which is localized and confined to certain periods. The gene metabolism in R. angelae appears to be linked with DNA synthesis.

216 Ficq, A., Pavan, C. AUTORADIOGRAPHIC STUDY OF ISOLATED CHROMOSOMES. 2nd UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF.15/P/114. 25 (1958) 211-3.

The metabolism of the chromosomes of the salivary glands of Rhynchosciara angelae were studied by means of the specific radioactive precursors of the nucleic acids (thymidine-$H^3$ and adenine-$C^{14}$) and proteins. Doses of the order of 0.01 to 0.1 μc of thymidine-$H^3$, adenine-8-$C^{14}$, or phenylalanine-2-$C^{14}$ were administered to the larvae by microinjection. The larvae were then sacrificed, usually after 24 h, and after appropriate treatment the chromosomes were autoradiographed. The "puffs" show a higher incorporation of

the two precursors, indicating a concomitant synthesis of DNA and of proteins at this level. This confirmed earlier results.

217 Gaulden, M.E. DNA SYNTHESIS AND X-RAY EFFECTS AT DIFFERENT MITOTIC STAGES IN GRASSHOPPER NEUROBLASTS. Genetics 41 (1956) 645.

A study has been initiated to determine at what stage or stages of mitosis synthesis of deoxyribonucleic acid (DNA) occurs in the grasshopper neuroblast, to determine the effects of irradiation on this synthesis, and to determine whether radiation-induced mitotic inhibition can be correlated with an inhibition of DNA synthesis. - Grasshopper embryos were observed in living culture preparations. When a neuroblast entered a given stage of mitosis, $C^{14}$ -labelled thymidine was added to the culture medium. When the cell reached the end of the given mitotic stage, the embryo was fixed immediately and washed with water to remove unincorporated thymidine. It was subsequently sectioned, stained with Feulgen reagent, and covered with stripping film. The cell originally observed in living condition was then examined for presence of grains in film above it. (Since fractionation of embryos revealed that the $C^{14}$ was in the DNA fraction, it is assumed that uptake of thymidine indicates synthesis of DNA.) - Uptake of thymidine in neuroblasts begins in the middle telophase and continues into very early prophase. Maximum uptake occurs during late telophase and interphase, rate of uptake being approximately the same in both stages. Thus the stages of mitosis most sensitive to x-rays, namely middle and late prophase, are not involved in synthesis of DNA Data accumulated thus far indicate that interference with uptake of thymidine occurs only in cells that have received a dose of x-rays much higher than that sufficient for blocking mitosis.

(Abstract of paper presented at the 1956 meetings of the Genetics Society of America, Storrs, Connecticut 27-29 Aug. 1956)

218 Gross, J.D. INCORPORATION OF PHOSPHORUS-32 INTO SALIVARY-TYPE CHROMOSOMES WHICH EXHIBIT "PUFFS". Nature 180 (1957) 440.

A preliminary study was made into the rate of incorporation of $P^{32}$ into the chromosomes and associated structures in the salivary gland of the Chironomid, Metriocnemus hygropetricus. Larvae were grown on medium containing $P^{32}$ (as phosphate) for 2-24 h, and the incorporation studied in autoradiographs of squashes and sections, which were stained with methyl-green-pyronin and in some cases extracted with ribonuclease or hydrochloric acid. Incorporation of tracer was adequate after feeding the larvae on labelled medium for 4-8 h. The puffs appear to concentrate the $P^{32}$ much more actively than the remainder of the chromosome which show an incorporation little above the background. Staining reactions indicate that ribonucleic acid is much more highly concentrated in the puffs than in the remainder of the chromosome.

* Horikawa and Sugahara 1960 - [914]

219 Ito, T., Horie, Y., Tanaka, M. PHOSPHORUS COMPOUNDS OF THE MIDGUT IN THE SILKWORM. p.283-9 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956", Vol.2. Becker, E.C., ed. Ottawa, Mortimer Ltd. 1958.

During the 4th and 5th larval instars of the silkworm, Bombyx mori, nucleic acid P occupies one-third of total P of the midgut. Just before cocoon-spinning, nucleic acid P and lipid P decrease gradually, while acid-soluble P increases rapidly. This is caused by the increase in inorganic P, suggesting the excretion of P as a form of inorganic P into the midgut cells from other parts of the body at this period. There is almost no change in protein P throughout larval stage. As the result of using $P^{32}$, it was shown that the part absorbing P actively is the posterior midgut. The total $P^{32}$ of the midgut reaches the maximum 2 h after feeding $P^{32}$, then decreases gradually. The same is true for the acid-soluble fraction, which, however, decreases more rapidly with time than the total $P^{32}$. Lipid $P^{32}$ reaches the highest level 14 h after feeding. The changes relating to the turnover in the midgut were also observed in various P fractions of the blood. There are some differences in paperchromatograms and radioautograms between the midgut and the blood. (auth.)

220 Kaplan, W.D., Sisken, J.E. GENETIC AND AUTORADIOGRAPHIC STUDIES OF TRITIATED THYMIDINE IN TESTES OF DROSOPHILA MELANOGASTER. Experientia 16 (1960) 67-9.

Autoradiographic studies were made of D. melanogaster larvae at various intervals after removal from a thymidine-containing diet up to 56 h. The preliminary data show that spermatocytes reduplicate their chromosomes very early and move posteriorly as additional cells are proliferated from the apical spermatogonia. The mutagenic effect of tritiated thymidine was studied genetically. Unquestionably the thymidine produces a mutagenic effect. (auth.)

221 Karnkowska-Gorska, Z. INCORPORATION OF TRITIUM-LABELLED THYMIDINE INTO THE SPINNING GLANDS OF THE SILK WORM BOMBYX MORI L. Bull. Acad. Polon. Sci., Sér. Sci. Biol. 8,8 (1960) 353-6. (In Polish)

222 King, R.C., Falk, G.J. IN VITRO INCORPORATION OF URIDINE-$H^3$ INTO DEVELOPING FRUIT FLY (DROSOPHILA MELANOGASTER) OÖCYTES. J. biophys. biochem. Cytol. 8,2 (1960) 550-3.

The excised ovaries of 3-day-old female D. melanogaster were immersed in a solution containing TC 199 and uridine-$H^3$. The $H^3$ was incorporated into ribonucleic acid within 4 min and localized in the dense ribbon-like chain of plasmasomes found in the nuclei of nurse cells associated with the oöcyte. (CA 55: 12674e, 1961)

* Kogure and Nakajima 1958 - [1148]

223 McMaster-Kaye, R., Taylor, J.H. EVIDENCE FOR TWO METABOLICALLY DISTINCT TYPES OF RIBONUCLEIC ACID IN CHROMATIN AND NUCLEOLI. J. biophys. biochem. Cytol. 4,1 (1958) 5-11.

Patterns of radioisotope incorporation are useful characteristics in describing cellular RNA fractions, and have indicated a distinctive "nuclear" RNA. In order to characterize the RNA fractions of the two nuclear components, nucleoli and chromatin, and to determine thereby the precise localization of the RNA typical of isolated nuclei, time-courses of $P^{32}$ incorporation into nucleolar, chromosomal, and cytoplasmic RNA of Drosophila salivary glands have been determined from autoradiograms. Two experiments are reported which cover 12 and 18 h periods including an initial 2 h feeding on $P^{32}$. Concentrations of RNA-$P^{32}$ (identified by ribonuclease digestion) were determined by grain counts. After 1 h only the nucleolar RNA is labelled. Activity is detectible in chromosomal and cytoplasmic RNA after the 2nd h. The nucleolar fraction reaches its maximum activity shortly after transfer of the larvae to non-radioactive food, the other fractions several hours later. Maximum activities persist in the chromosomal and cytoplasmic fractions; nucleolar activity decreases after the 9th h. The observed differences in times at which incorportion begins and maximum activities are reached, and in maintenance of maximum activities indicate that chromosomal and nucleolar RNA are distinct fractions. The metabolic characteristics which have been ascribed to "nuclear" RNA apply only to the nucleolar fraction. (auth.)

224 Miura, Y., Ito, H., Shigematsu, A. MICROAUTORADIOGRAPHIC STUDIES ON THE METABOLISM OF PROTEIN AND RIBONUCLEIC ACID IN POSTERIOR SILKGLANDS. Jap. J. appl. Ent. & Zool. 4,2 (1960) 123-6. (Nihon Ôyô Dôbutsu Konchû Gakkai-shi) (In Japanese, with English summary)

Data was obtained for Bombyx mori.

* Pavan 1960 - [375]

225 Pelc, S.R., Howard, A. METABOLIC ACTIVITY OF SALIVARY GLAND CHROMOSOMES IN DIPTERA. Exp. Cell Res. 10 (1956) 549-52.

Larvae of Drosophila melanogaster were given $S^{35}$-DL-methionine (I), 8-$C^{14}$-adenine (II), or $Na^{35}{}_2SO_4$ (III) with their food. The salivary glands were removed 24 h later and autoradiographs prepared. The autoradiographs with I were not sufficiently strong to decide the relative concentration in small portions. With II, good autoradiographs were obtained in the chromosome bands. After treatment with ribonuclease, the preparations showed no autoradiographs, suggesting the incorporation of II into ribosenucleic acid. No autoradiograph of the chromosomes or cytoplasm was obtained with III. (CA 51: 2186i, 1957)

226 Pelling, G. CHROMOSOMAL SYNTHESIS OF RIBONUCLEIC ACID AS SHOWN BY INCORPORATION OF URIDINE LABELLED WITH TRITIUM. Nature 184 (1959) 655-6.

The investigation was made on the gland chromosomes of Chironomus tentans. Special staining techniques for showing up RNA within the chromosomes were used. Sites of RNA were determined by autoradiography; 0.25 - 1.25 μc of tritium-labelled uridine was injected into larvae, with special precautions to avoid loss of haemolymph. The uptake of uridine was allowed to continue for 15 min to 24 h. Nucleolar RNA was found to be synthesized at the nucleolar organizer only. Synthesis is continuous. Many other sites of the chromosomes are also involved in RNA synthesis, but the bulk is produced by a few very active loci. This confirms earlier interpretations of the phenomenon of differential puffing in dipteran giant chromosomes. RNA synthesizing structures show no activity after short application (up to 2 h) of radioactive amino-acids (glycine-$C^{14}$, tryptophan-$H^3$, methionin-$S^{35}$). Protein synthesis seems not to be correlated with RNA synthesis.

227 Rudkin, G.T., Woods, P.S. INCORPORATION OF $H^3$ CYTIDINE AND $H^3$ THYMIDINE INTO GIANT CHROMOSOMES OF DROSOPHILA DURING PUFF FORMATION. Proc. nat. Acad. Sci., Washington 45, 7 (1959) 997-1003.

The morphological change involving a local increase in diameter of the chromosome, frequently called "puff", was examined in terms of its chemistry, particularly a comparison of the metabolic activities of puff and non-puff regions with respect to both DNA and RNA. Methods are described for the incorporation of tritium-labelled thymidine and cytidine into puff regions. Results with $H^3$-thymidine indicated that DNA synthesis is not a necessary concomitant of puff formation and disproportionate synthesis does not occur during puff formation. $H^3$-cytidine incorporation was interpreted to indicate the presence of RNA, and was found to label cytoplasm, chromosomes and nucleoli of all cells; puff regions were more heavily labelled than on administration of thymidine.

228 Shigematsu, A., Miura, Y., Ito, H. ETUDES AUTORADIOGRAPHIQUES SUR LA RELATION ENTRE LES BIOSYNTHÈSES DE L'ACIDE RIBONUCLÉIQUE ET CELLES DE LA PROTÉINE DANS LES GLANDES SÉRICIGÈNES CHEZ BOMBYX MORI L. C.R. Soc. Biol., Paris 154, 4 (1960) 892-5.

Les auteurs on mis en évidence que la synthèse de l'acide ribonucléique précède celle des protéines dans les glandes séricigènes, ainsi confirmant leurs conclusions basées sur l'experimentation in vivo. Les auteurs ont utilisé Bombyx mori L., ayant atteint le 5e âge et une heure après injections de la solution de $^{32}P$ ou glycine-1-$^{14}C$ (1$\mu$c/g) la partie sécrétrice des glandes séricigènes a été fixée à la solution de Carnoy. Le résultat de l'autoradiographie a été résumé dans un tableau.

229 Takeyama, S., Ito, H., Miura, Y. FIBROIN SYNTHESIS AND RIBONUCLEIC ACID (RNA) METABOLISM IN THE SILK GLAND. Biochim. biophys. Acta 30 (1958) 233-43.

The posterior silk glands of the 5th instar larvae of silkworms were incubated with RNA and protein precursors. Glycine-$C^{14}$ was actively incorporated into the protein fraction and orotic acid-$C^{14}$ into the RNA fraction. The greater part of the radioactivity incorporated into protein represented fibroin synthesis. Orotic acid was incorporated into RNA uracil. Impairment of orotic acid incorporation by inhibitors of RNA metabolism (6-uracilmethyl sulfone) was not accompanied by impairment of the incorporation of glycine into protein. Apparently, the simultaneous renewal of RNA was not necessarily required for the synthesis of fibroin. Ribonuclease (200 $\gamma$/ml) almost completely inhibited fibroin synthesis. Neither the metabolic renewal of RNA nor the RNA remaining after enzyme treatment was able to restore this synthesis, nor was it restored by the addition of RNA obtained from the same tissue. Thus, fibroin synthesis was dependent on the existence of intact RNA. (CA 53: 3516g, 1959)

230 Taylor, J.H., McMaster, R.D., Caluya, M.F. AUTORADIOGRAPHIC STUDY OF INCORPORATION OF PHOSPHORUS-32 INTO RIBONUCLEIC ACID AT THE INTRACELLULAR LEVEL. Exp. Cell Research 9 (1955) 460-73.

Larvae of Drosophila repleta were given food containing $P^{32}$-labelled phosphate for 1 to 2 h and then transferred to non-labelled food. The larvae were fixed at intervals of $\frac{1}{2}$ or 1 h and the incorporation of $P^{32}$ into ribonucleic acid (RNA) determined in the cytoplasm, chromosomes, and nucleoli of the salivary glands. Incorporation was high in all cells during the first half of the third instar but then decreased so that no radioactive RNA could be detected in the last third of the instar. Labelled RNA was detected after 1 h in sectors of chromosomes lying near the nucleolus and in the nucleolus itself. Within 3 h the activity in the nucleolus increased so that RNA appears in cytoplasm about this time and in 5-6 h is as high as in the nucleolus. From activity-time relation study, the cytoplasmic RNA could originate from nucleolar RNA or both could have a common precursor. (CA 50: 9630b, 1956)

231 Weygand, F., Waldschmidt, M. ÜBER DIE BIOSYNTHESE DES LEUCOPTERINS, UNTERSUCHT MIT $^{14}C$-MARKIERTEN VERBINDUNGEN AM KOHLWEISSLING (On the biosynthesis of lecopterin, studied in the cabbage moth by means of $C^{14}$-labelled compounds). Angew. Chem. 67, 12 (1955) 328. (In German)

In a preliminary experiment, larvae of Gonepterix rhamni and Pieris brassicae, napi and rapae were allowed to feed on $C^{14}$-labelled folic acid-[2-$C^{14}$], guanine-[2-$C^{14}$], guanine-[8-$C^{14}$], hypoxanthine-[2-$C^{14}$], 2,4,5-triamino-6-oxy-pyrimidine-[2-$C^{14}$]-hydrochloride, glycine-[1-$C^{14}$] and sodium formate-[$C^{14}$]. The uptake of radioactivity from the various compounds was tested, and considerable variation found. Glycine-[1-$C^{14}$] (37$\gamma$/larva) and sodium formate (100$\gamma$/larva) were injected into the legs. By separating the leucopterin in both cases, and from analysis of the degradation products (degradation taking place in two ways) it was possible to show that pterine synthesis in the cabbage moth follows an analogous pattern to that of the puriness and lactoflavins.

232 Agarwal, H.C., Kapadia, G.G., Casida, J.E., Beck, S.D. PRELIMINARY STUDIES ON INSECT STEROLS AND THEIR METABOLISM. Bull. ent. Soc. Amer. 5, 3 (1959) 138, abstr. 241.

The metabolism of $C^{14}$-labelled cholesterol and cholesterol acetate was studied in the adult cockroach and housefly, and larvae of confused flour beetle. Sterols from the housefly were isolated and at least three compounds separated chromatographically. An attempt was made to characterize these sterols.

233 Bloch, K., Langdon, R.G., Clark, A.J., Fraenkel, G. IMPAIRED STEROID BIOGENESIS IN INSECT LARVAE. Biochim. biophys. Acta 21 (1956) 176.

Cholesterol (I) synthesis in Dermestes vulpinus larvae was studied with the aid of the tracer technique. Acetate-I-$C^{14}$ was utilized for the synthesis of both fatty acids and unsaponifiable material during larval growth. However, synthesis of I from the acetate did not occur. Dermestes larvae were unable to use squalene in lieu of I for growth and development. Since acetate-$C^{14}$ is incorporated into squalene, but was not incorporated into either I or lanosterol the sterol requirement of Dermestes may be attributed to an interruption of I biogenesis at the squalene stage. (CA 50: 15975e, 1956)

234 Casida, J.E., Beck, S.D., Cole, M.J. STEROL METABOLISM IN THE AMERICAN COCKROACH. J. biol. Chem. 224 (1957) 365-71.

Certain aspects of insect sterol metabolism were investigated with Periplaneta americana. The normal distribution of free and esterified sterols among the organ systems was determined and compared with the distribution of cholesterol-4-$C^{14}$ 16 h after injection. The rate of colour formation with the Schoenheimer-Sperry reagent from the sterols in the various organs differed greatly. Injection of acetate-1-$C^{14}$ into cockroaches and mice resulted in almost the same percentage recovery of labelled digitonides. Cockroach cholesterol esterase was investigated in relation to distribution among the organs and substrate specificity. (CA 51: 8311d, 1957)

235 Clark, A.J., Bloch, K. THE ABSENCE OF STEROL SYNTHESIS IN INSECTS. J. biol. Chem. 234 (1959) 2578-84.

Larvae of the beetle Dermestes vulpinus reared on diets containing 1-$C^{14}$-acetate or randomly labelled $C^{14}$-fructose failed to form radioactive squalene or sterols. The nonsaponifiable matter isolated from these insects contained two radioactive fractions. One of them is shown to be a saturated aliphatic hydrocarbon, or mixture of hydrocarbons, with an average molecular weight of 346 and an unbranched carbon chain. The second fraction has been characterized as a primary aliphatic alcohol with an average molecular weight of $395 \pm 17$. The cholesterol necessary for the growth of Dermestes larvae cannot be replaced or spared by mevalonic acid, squalene, lanosterol, or $\Delta^8$-4,4-dimethylcholesterol. It is suggested that the pathways of cholesterol biogenesis are multiply blocked in this organism. 24-Dehydrocholesterol can substitute for cholesterol in supporting the growth of Dermestes larvae. (auth. summary)

236 Clark, A.J., Bloch, K. CONVERSION OF ERGOSTEROL TO 22-DEHYDROCHOLESTEROL IN BLATTELLA GERMANICA. J. biol. Chem. 234 (1959) 2589-94.

The utilization of dietary ergosterol by nymphs of the German cockroach, Blattella germanica, was investigated. The insects were given ergosterol which had been uniformly labelled with $C^{14}$. The formation of a new radioactive sterol was observed. This conversion product could not be demonstrated with ergosterol labelled at C-28 only, which showed that it no longer contains the C-28 methyl substituent of ergosterol. By isotopic techniques the demethylation product of ergosterol was shown to be 22-dehydrocholesterol. A small amount of crystalline sterol was isolated from a large number of ergosterol-fed nymphs and shown to be identical with authentic 22-dehydrocholesterol. The significance of this conversion is discussed. (from auth. summary)

237 Clements, A.N. STUDIES ON THE METABOLISM OF LOCUST FAT BODY. J. exp. Biol. 36 (1959) 665-75.

The incorporation of glycine-$C^{14}$, leucine-$C^{14}$, NaOAc-2-$C^{14}$, and glucose-$C^{14}$ into Schistocerca fat body was studied under in vitro conditions, and the distribution of radioactivity in the various fat body fractions and the labelling of compounds in the fractions are described. There was high incorporation into fat and protein and very low incorporation into glycogen. Incubation with glycine-$C^{14}$ led to the appearance of

radioactivity in the glycine and serine of the protein and of the amino acid pool. Incubation with labelled acetate led to radioactivity in glutamic acid, proline, aspartic acid, and alanine, showing that the intermediates of the tricarboxylic acid cycle provided the C skeletons of the amino acids. Glucose was largely converted to trehalose. Succinic dehydrogenase and the condensing enzyme system were shown to be present in the fat body, contrary to previous reports. The succinic acid oxidase system was highly labile on homogenizing the tissue. Fat body, unlike flight muscle, used glycine and leucine as respiratory substrates. It is suggested that fat body acts like the vertebrate liver by transaminating amino acids and making them available for further metabolism by other tissues. (CA 54: 16674 f, 1960)

238 Kaplanis, J.N., Monroe, R.E., Robbins, W.E., Louloudes, S.J. THE FATE OF DIETARY $H^3$-β-SITOSTEROL IN THE ADULT HOUSE FLY. Bull.ent. Soc. Amer. 6,3 (1960) 151, abstr.38.

When houseflies were fed a diet containing $H^3$-β-sitosterol the sterol was found to be efficiently absorbed and utilized in egg production. Analysis of the $H^3$-compounds from the adults and eggs indicated the presence of several metabolites.

239 Kaplanis, J.N., Robbins, W.E., Tabor, L.A. THE UTILIZATION AND METABOLISM OF 4-$C^{14}$-CHOLESTEROL BY THE ADULT HOUSEFLY. Ann. ent. Soc. Amer. 53,2 (1960) 260-4.

The metabolism and excretion of ingested 4-$C^{14}$-cholesterol was studied in the housefly (Musca domestica). Only low levels of excretion (2.0% - 2.5%) were found 3 days after treatment and about 10% of this behaved as acidic material. When female flies were treated and the eggs collected, 78% of the radioactivity was recovered 3 weeks after treatment. The high recovery and low excretion rate indicate a strict sterol economy in the housefly. The administered cholesterol was efficiently utilized in egg production. Some of the radioactive sterols were found to be esterified in both egg and adult. Analysis by column chromatography and reverse isotope dilution demonstrated the presence of 2 major compounds - unchanged cholesterol and 7-dehydrocholesterol - and a lesser fraction consisting of unidentified polar steroids. (auth.)

240 Kodicek, E., Levinson, Z.H. METABOLISM OF β-SITOSTEROL AND OTHER LIPIDS IN THE PRESENCE OF ACETATE-2-$^{14}$C BY BLOWFLY LARVAE. Nature 188, 4755 (1960) 1023-5.

Larvae of Calliphora erythrocephala were fed some sodium acetate-2-$C^{14}$ in their diet. Details of the technique are given. The distributions of radioactivity in the total lipid content, unsaponifiable matter, digitonin-precipitable sterols, digitonin-non-precipitable, fatty acids, lipid-free residue and total $CO_2$ expired by the larva were tabulated. Results show that Calliphora larvae are unable to synthesize sterols from $C^{14}$-labelled acetate, but indicate also that the cholesterol side-chain is not formed by re-synthesis from acetate, but rather by de-ethylation of the β-sitosterol side-chain at position $C_{24}$. Acetate would appear to be utilized at least as efficiently for biosynthesis of fatty acids as for biosynthesis of unsaponifiable matter, other than sterols. Significant amounts of $C^{14}$ were incorporated into unsaponifiable lipids other than sterols; they were investigated by reversed-phase paper chromatography and radioautography. From the still significant radioactivity remaining in the larvae after removal of lipids it may be assumed that acetate was also used for the synthesis of non-lipid constituents of the body.

241 Louloudes, S.J., Kaplanis, J.N., Robbins, W.E., Monroe, R.E. LIPOGENESIS FROM $C^{14}$-ACETATE IN THE AMERICAN COCKROACH. Bull. ent. Soc. Amer. 5,3 (1959) 138, abstr.245.

The incorporation of radioactivity into the saponifiable and unsaponfiable fractions of male and female American cockroaches was determined following injection of 1-$C^{14}$-acetate. The unsaponifiable material was fractionated by chromatography and digitonin precipitation and the methyl esters of the fatty acids were analysed by gas chromatography.

* (Published more fully in Ann. ent. Soc. Amer. 54,1 (1961) 99-103, not included in this bibliography)

242 Robbins, W.E., Kaplanis, J.N., Monroe, R.E., Tabor, L.A. METABOLISM OF $C^{14}$-CHOLESTEROL BY NYMPHAL GERMAN COCKROACHES. Bull. ent. Soc. Amer. 5,3 (1959) 137, abstr. 229.

Only low levels of $C^{14}$ compounds were excreted following injection of 4-$C^{14}$-cholesterol to female flies. Most of the administered material was utilized in egg production. The $C^{14}$ compounds present in the adults and eggs were characterized by column chromatography and reverse isotope dilution.

243 Robbins, W.E., Dutky, R.C., Monroe, R.E., Kaplanis, J.N. THE METABOLISM OF $H^3$-β-SITOSTEROL BY NYMPHAL GERMAN COCKROACHES. Bull. ent. Soc. Amer. 6,3 (1960) 151, abstr.39.

When houseflies were fed a diet containing $H^3$-β-sitosterol the sterol was found to be effficiently absorbed and utilized in egg production. Analysis of the $H^3$-compounds from the adults and eggs indicated the presence of several metabolites. Nymphal German cockroaches were reared on a synthetic diet containing $H^3$-β-sitosterol. The isolated $H^3$-compounds were fractionated by chromatography and further analysed to determine the nature of the metabolites.

244 Robbins, W.E., Kaplanis, J.N., Louloudes, S.J., Monroe, R.E. UTILIZATION OF 1-$C^{14}$-ACETATE IN LIPID SYNTHESIS BY ADULT HOUSE FLIES. Ann. ent. Soc. Amer. 53 (1960) 128-9.

Houseflies (Musca domestica L.) were injected with an aqueous solution of 1-$C^{14}$-sodium acetate and held for 18 h. On analysis, the rate of fatty acid synthesis from $C^{14}$ acetate was found to be 3.7 to 8 times greater in female than in male flies. The males and females incorporated about the same percentage of radioactivity into the unsaponifiable fraction (1.3 to 2%). Further fractionation by column chromatography demonstrated that 80 to 88% of this radioactivity behaved as hydrocarbon (s) and less than 2% as sterols. When the sterol fraction was analysed by digitonin precipitation, no radioactivity was detected in the precipitate representing cholesterol and companions. (auth.)

245 Robbins, W.E., Kaplanis, J.N., Monroe, R.E., Tabor, L.A. THE UTILIZATION AND METABOLISM OF 4-$C^{14}$-CHOLESTEROL BY THE ADULT FLY. Ann. ent. Soc. Amer. 53, 2 (1960) 260-4.

The metabolism and excretion of ingested 4-$C^{14}$-cholesterol was studied in the housefly (Musca domestica). Only low levels of excretion (2.0% - 2.5%) were found 3 d after treatment, and about 10% of this behaved as acidic material. When female flies were treated and the eggs collected, 78% of the radioactivity was recovered 3 weeks after treatment. The high recovery and low excretion rate indicate a strict sterol economy in the housefly. The administered cholesterol was efficiently utilized in egg production. Some of the radioactive sterols were found to be esterified in both the egg and adult. Analysis by column chromatography and reverse isotope dilution demonstrated the presence of 2 major compounds - unchanged cholesterol and 7-dehydrocholesterol - and a lesser fraction consisting of unidentified polar steroids. (auth.)

(An earlier report appeared as an abstract in Bull. ent. Soc. Amer. 5, 3 (1959) 137, abstr. 233).

## I-B-5 ELEMENTS

246 Babers, F.H., Mitlin, N., Shortino, T.J. THE FATE OF RADIOPHOSPHORUS INGESTED BY HOUSE FLIES AND GERMAN COCKROACHES. J. econ. Ent. 49, 6 (1956) 820-2.

Houseflies (Musca domestica L.) and German cockroaches (Blattella germanica (L.)) were fed $P^{32}$ to study its effect on their fertility. In houseflies the biological half-life of the ingested $P^{32}$ was about 0.8 d, whereas in female cockroaches the radioactivity did not fall to 50% in the 14-day observation period. In male cockroaches this point was reached about the 9th day. Houseflies fed $P^{32}$-labelled food continuously for 6 days did not oviposit, but 2 days after they had been returned to a normal diet a few eggs of low viability were deposited. Flies kept on the $P^{32}$ for shorter periods showed inhibited oviposition and fertility. Their ovaries were immature, but they recovered partially after a normal diet was given. Larvae reared on $P^{32}$ medium (15.3 μc/g) developed into normal adults. Some German cockroaches fed $P^{32}$ developed oöthecae, but they were flaccid and contained no eggs.

247 Block, R.J. INORGANIC SULFUR IN THE SYNTHESIS OF PROTEIN IN THE RUMEN FROM NON-PROTEIN SOURCES WITH A NOTE ON THE SYNTHESIS OF CYSTINE AND METHIONINE IN BLATTELLA GERMANICA. TID-5115, Oak Ridge National Lab., Tenn. 1953, 492p.

Some experiments on the synthesis of protein-bound sulfur from inorganic sulfate were carried out on the German cockroach, Blattella germanica (L.). $H_2S^{35}O_4$ was added to the drinking water under controlled conditions (sterile, to eliminate possible bacterial contamination). Results indicate that cystine and methionine may have separate as well as combined synthetic pathways in Blattella.

248 Bowen, V.T. MANGANESE METABOLISM OF SOCIAL VESPIDAE. J. exp. Zool. 115 (1950) 175-205.

Wasps accumulate Mn during larval life, lose much of it at pupation, and accumulate it again as adults. Accumulation takes place rapidly in the cells of the mid-gut epithelium. Male wasps never build up Mn stores in their bodies; queen wasps only after leaving the nest; but workers store Mn almost immediately after emerging from the pupa. Manganese isotopes $Mn^{52}$, $Mn^{54}$ and $Mn^{56}$ were used. No evidence of a nutritional basis for wasp sex development was furnished by these studies. The distribution of Mn throughout each intestinal cell (radiotracer technique) is not rapid and transfer to the hemolymph may be discontinuous.

The cells of the wasp mid-gut offer a mineral-holding protein shelter of high stability. Larval and worker hornets store Mn in excess of any known metabolic use, probably due to inefficient Mn excretion coupled with lack of control over absorption. 49 references. (from auth.)

(See earlier report AECU-825, Technical Information Service, AEC. 43p)

249 Bowen, V.T. THE UPTAKE AND DISTRIBUTION OF BARIUM$^{140}$ AND LANTHANUM$^{140}$ IN LARVAE OF DROSOPHILA REPLETA. J. exp. Zool. 118,3 (1951) 509-29.

The barium metabolism of D. repleta larvae, studied by use of radioactive $Ba^{140}$, is described as involving uptake from the anterior part of the mid-gut, and to a less extent from the bases of the caecae. The absorbed material is rapidly transferred to the lumen of the ascending portions of the anterior malpighian tubules, where it is stored in a somewhat soluble form, until after pupation. Smaller amounts of the element appear in scattered patches of cells of the posterior mid-gut, and some is excreted from the anterior malpighian tubules. Lanthanum-140 is not found to be absorbed by D. repleta larvae, nor does it appear to be excreted when formed in the body by decay of $Ba^{140}$. The observation is made that material may be held for 10 to 20 h in the space between the peritrophic membrane and the anterior mid-gut epithelium. Partition of foodstuff between this slow-moving stream and the rapidly moving contents of the peritrophic membrane is seen to be of great importance in determining efficiency of absorption by the larvae. It is concluded that the location of Ba uptake indicates a functional localization of treatment of dissolved as opposed to particulate food, and not a localization of uptake of a particular ion or ions. (auth.)

(See earlier report BNL-1018, Brookhaven National Lab., Upton, N.Y. 26p.)

250 Bruce-Chwatt, L.J., Hayward, J. UPTAKE OF RADIOACTIVE PHOSPHORUS BY LARVAE AND ADULTS OF MOSQUITOES. Nature 177 (1956) 661-2.

Larvae of Aëdes aegypti were immersed in mixtures of $Na_2HP^{32}O_4$, water, and rolled oats; the concentration of the radioisotope ranged from 17 to 4480 mμc/ml. The higher the concentration, the greater was the delay in pupation of the larvae, although at the end of two weeks, all larvae had pupated except those in the 4480-mμc/ml bath. At 2240 mμc/ml, the larvae remained normal for more than 3 weeks, but produced dead pupae. Apparently, a concentration of radioactivity greater than 100 mμc/ml decreased the number of emerged adults. Females were (average) 1.6 times heavier than the males, but were 2.5 times more radioactive. (CA 50: 10289g, 1956)

251 Cotty, V.F., Henry, S.M., Hilchey, J.D. THE SULFUR METABOLISM OF INSECTS. III. THE METABOLISM OF CYSTINE, METHIONINE, TAURINE, AND SULFATE BY THE HOUSE FLY, MUSCA DOMESTICA L. Contr. Boyce Thompson Inst. 19 (1958) 379-92.

Houseflies were either fed or injected with $S^{35}$-labelled cystine, cysteine, methionine, taurine or sulfate. Extracts, hydrolyzates, and feces were then analysed by chromatography and autoradiography for radioactive metabolites. Cysteine-sulfinic acid, a key intermediate in sulfate formation, appeared on chromatograms of flies injected with cysteine-$S^{35}$. There appeared to be two pathways for the synthesis of taurine. Taurine seemed to arise from cystine via hypotaurine. When methionine was the precursor, hypotaurine was not found in detectable quantities but there was an increase in cysteic acid, a recognized intermediate in taurine synthesis. In the latter case relatively more taurine-$S^{35}$ was formed than when cystine-$S^{35}$ was administered. Sulfate-$S^{35}$ was not incorporated into soluble organic compounds. Taurine-$S^{35}$ gave rise to three unidentified metabolites, one of which may be isethionic acid. The results indicate that houseflies possess an active transulfuration system. (auth.)

252 Crossley, D.A., Jr., Pryor, M.E. THE UPTAKE AND ELIMINATION OF CESIUM-137 BY A GRASSHOPPER ROMALEA MICROPTERA. Health Phys. 4 (1960) 16-20.

Adults of Romalea microptera, the eastern lubber grasshopper, were fed cesium-137 in bean plants to investigate uptake and elimination of this isotope. A biological half-life of 4 to 5 d was obtained. In experiments where grasshoppers were allowed to feed repeatedly on cesium-contaminated food, the biological half-life was used to predict the equilibrium values. Most of the ingested $Cs^{137}$ was concentrated on muscular tissue, but some was also found in the digestive tract and reproductive organs. Only trace amounts were found in the exoskeleton. (auth.)

253 Darwish, R.O., Abdel Salam, F.A., Mahmoud, K.A. SOME SOMATIC CHANGES OBSERVED IN CULEX MOLESTUS FORSKAL 1775. A/AC.82/Gr. 193 Report presented by the Egyptian Delegation to the UN Scientific Committee on the Effects of Atomic Radiation. March 1958.

A study on Culex molestus which, in the larval or pupal stage, had been placed in solutions containing $NaH_2P^{32}O_4$ with an activity of 0.106 μc/ml showed the radiation to be detrimental to the lifespan, sex organs, and reproduction rate of the mosquitoes. The general average activity of adult females appears to be 2.3 times higher than of males. Pupal activity was found to be proportional to the initial uptake of the larvae. Larval saturation occurred on the 4th and 5th day (32 000 cpm).

254 Demyanovsky, S. Ya., Rusakova, N.S. THE PHOSPHORUS METABOLISM IN THE ORGANISM OF THE OAK SILK WORM ANTHERAEA PERNYL. Biokhimia 20,4 (1955) 466-9. (Translation)

$P^{32}$ was used in chemical and isotopic studies to trace the changes in the metabolism of phosphorus compounds in the tissues of the larvae and pupae of the oak silk worm. Intensity of the phosphorus metabolism at the beginning of the 5th larval stage of the caterpillar decreased, increased towards the middle and dropped again towards the end of that stage. The intensity of phosphorus metabolism reached its minimum on the 8th day of development of the non-diapause pupa. The intensity of phosphorus metabolism in the diapausing pupa reached its maximum on the 8th day.

(For abstract see Referat. Zhur. Biol. No.4722, 1956)

255 Demyanovsky, S.Ya., Rusakova, N.S. DIAPAUSE OF OAKTREE SILKWORM. Uchenye Zapiski Moskov. Gosudarst. Pedagog. Inst. im. V.I. Lenina (Kafedra), Org. i. Biol. Khim. 98 (1957) 49-58.

Fats do not affect the start of diapause in the oaktree silkworm. During the diapause only the metabolism of low molecular weight P compounds is observed. Intensity of glycine metabolism in the tissues of summer and hibernating larvae differ from the 1st days of larval existence. (CA 52: 6651, 1958)

256 Demyanovsky, S.Ya., Rusakova, N.S. PHOSPHORUS METABOLISM IN THE ORGANISM OF THE OAKTREE SILKWORM. Uchenye Zapiski Moskov. Gosudarst. Pedagog. Inst. im. V.I. Lenina (Kafedra), Org. i. Biol. Khim. 98 (1957) 61-4.

(See abstract for Demyanovsky and Rusakova 1956).

In the summer larvae the P metabolism decreases up to the 8th day of life when it increases again. In winter larvae only the low molecular weight P compounds participate in metabolism and the intensity of P metabolism in all tissues except muscle tissues increases toward the 8th day of life and decreases towards the end of larval development.

257 Demyanovsky, S.Ya., Vasileva, N.V. THE RATE OF METABOLISM IN DIAPAUSING OAK SILKWORM PUPAE. Uchenye Zapiski Moskov. Gosudarst. Pedagog. Inst. im.V.I. Lenina (Kafedra), Org. i. Biol. Khim. 98 (1957) 65-70.

It was shown with labelled methionine that the protein metabolism in the diapausing pupae of the oak silkworm was on a high level in all tissues and especially in the muscles. The addition of vitamin $B_1$ had no noteworthy effect on the metabolic rate of the proteins; there was a slight augmentation in the rate of fat metabolism. (CA 52: 2286 f, 1958)

258 Dissanaike, A.S., Dissanaike, F.A., Niles, W.J., Surendranathan, R. FURTHER STUDIES ON RADIOACTIVE MOSQUITOES AND FILARIAL LARVAE USING AUTORADIOGRAPHIC TECHNIQUES. Expt. Parasitol. 6,3 (1957) 261-70.

Third-stage larvae of Wuchereria bancrofti and Setaria digitata were obtained with a radioactivity that would enable them to be traced in the definitive host. This was 174 β-counts/min in the case of the S. digitata larvae. The larvae had been produced in the respective vectors, Culex pipiens fatigans Wied. and Armigeres obturans Wlk., which had been kept for one to several days during the second to third larval stages in baths of $P^{32}$ (orthophosphate) of activity 1 μc/ml. C.p.fatigans females were allowed to feed on human volunteers infected with W. bancrofti, and A. obturans on cows infected with S. digitata. In spite of the large dose of radiation to which the filarial larvae were exposed in the mosquito their development was not seriously affected. The distribution of $P^{32}$ in mosquitoes, pupae and infective filarial larvae were studied by means of autoradiographs. The highest amounts were found in the thoracic region of the male and in the ovarial region of the female mosquito. (from Helmint. Abstr. 26,2: 95 c, for 1957)

259 Donnelly, J. METHODS FOR THE STUDY OF BLOWFLY POPULATIONS. III. THE FATE AND DISTRIBUTION OF $P^{32}$ IN BLOWFLIES LABELLED IN THE LARVAL STAGE. Ann. appl. Biol. 46 (1958) 243-53.

A simple method of radioactive labelling of Lucilia sericata larvae is described. More uniform count levels are obtained in individuals which have fed entirely on radioactive foods than in those which first feed on nonactive food. The radioactive count rates of the larvae are correlated with larval live weight and the counting rates of resulting imagines correlated both with corresponding larval counting rates and with imaginal live weight. The loss of $P^{32}$ in the larvae due to causes other than decay of the isotope is traced from the prepupal stage to 3 weeks after emergence. The first and major loss occurs at emergence, when about 10% of the original $P^{32}$ is shed as empty puparium and meconium. Adults lose about 1.5% per day. The distribution of $P^{32}$ in the adult body of L. sericata labelled in the larval stage has been determined. The abdominal tissues have a lower activity than the rest of the body. (abstr. 147 in TID-3078, Technical Information Service, AEC)

260 Fang, S.C., Allen, D. DISTRIBUTION AND INCORPORATION OF RADIOACTIVE PHOSPHORUS IN THE DOUGLAS-FIR BEETLE. J. econ. Ent. 48, 1 (1955) 79-82.

The distribution of $P^{32}$ in different parts of the body of Dentroctonus pseudotsugae Hopk. and its incorporation into phosphorylated intermediates was studied. Adult bark beetles were allowed to feed on 2.5% glucose solution containing 2.5 μc/ml $P^{32}$-labelled phosphoric acid for 2 days. Only 2% of the total radioactivity was removed by washing. Dissection showed that about 16.6, 14 and 53% of the remainder were in the head, thorax, and abdomen, and 6.8 and 9.3% in the legs and wings respectively. In the alcohol extract, about 93% of the $P^{32}$ was in phosphorylated intermediates, and in the water extract more than half was in the inorganic form. The glycolytic cycle is considered to be present in the beetle, since most of the phosphate esters that are known to be intermediates of glycolysis were found.

261 Fuller, R.A., Riegert, P.W., Spinks, J.W.T. PERSISTENCE OF RADIO-ACTIVITY IN GRASSHOPPERS (ACRIDIDAE) TAGGED WITH PHOSPHORUS-32. Canad. Ent. 86, 5 (1954) 201-3.

Nymphs of Camnula pellucida (Scudd.), allowed to feed in the first instar for 24 h on wheat seedlings sprayed with an aqueous solution containing $P^{32}$ in the form of phosphate ion, retained sufficient radioactivity for it to be readily detected with a portable Geiger counter throughout their development. Loss of radioactivity through excretion was very great at first, but decreased steadily and almost ceased 14 d after treatment. Loss of radioactivity through moulting was negligible. The survival of treated grasshoppers was as high as that of untreated ones.

262 Gamô, T., Nishiyama, H., Tsukuda, M., Yanagizawa, T. SOME OBSERVATIONS OF BIOLOGICAL INFLUENCES OF RADIOACTIVE ISOTOPES UPON PHYSIOLOGICAL FUNCTIONS OF SILKWORMS. II. ON INFLUENCE OF RADIOACTIVE PHOSPHORUS $P^{32}$ UPON DEVELOPMENT AND NUMBER OF LEUCOCYTES OF SILKWORMS. p.524-7 in "Proceedings of the 1st Japan Conference on Radioisotopes, 1956". Tokyo, Japan Atomic Industrial Forum, Inc. 1956. (In Japanese)

Mulberry leaves were labelled with $P^{32}$ by spraying with $H_3P^{32}O_4$, and silkworm were allowed to feed on them. A series of experiments were carried out in which groups of 100 worms were tested. Varying levels of radioactivity were fed, the feeding of radioactive material starting at different larval stages. Controls were fed on leaves sprayed only with unlabelled phosphoric acid. The cocoons were weighed in each case. The ingested radioactivity caused reduction in silk production. The results are tabulated. The hemolymph was also tested and variations in the radiosensitivity of different cell types observed. Experiments were carried out in the spring and autumn.

263 Gamô, T., Nishiyama, H. SOME OBSERVATIONS OF BIOLOGICAL INFLUENCES OF RADIO-ACTIVE ISOTOPES UPON THE PHYSIOLOGICAL FUNCTIONS OF THE SILKWORM. (1) ON THE ABSORPTION OF $Ca^{45}$ ADMINISTERED THROUGH THE MOUTH INTO SEVERAL TISSUES OF THE SILKWORM AND ITS INJURIOUS EFFECTS UPON THE RESPIRATORY FUNCTION. Shinshu Daigaku Sen Igakubu Kenkyû Hôkoku (Research Reports of the Faculty of Textile and Sericulture, Shinshu University) 6 (1956) 37-41. (In Japanese, summary in English)

$Ca^{45}Cl_2$ was administered orally either (1) in the course of feeding mulberry leaves, (2) in the surfeit or (3) in the hungry state. The maximum quantity of absorbed $Ca^{45}$ was found in the blood in (2). In the hungry state $Ca^{45}$ was more quickly absorbed into blood than in the other two cases. Uptakes of $Ca^{45}$ by the nervous system, sexual organs, fatty tissue, muscle, and the silk gland were measured 20, 30, and

60 min after administration of $Ca^{45}Cl_2$. The nervous system generally took up the largest amount of $Ca^{45}$, and the sexual organs, muscles, and fatty tissue followed successively in this order. The injurious effects of $Ca^{45}$ were assayed by measuring the $O_2$ consumption per unit weight of the silkworm larva, pupa and imago.

264 Gamô, T., Nishiyama, H., Midorigawa, S. EFFECT OF CALCIUM-45 ON THE BLOOD CELLS OF SILKWORM. Dai-2-kai Genshiryoku Shimpojiumu Hôbunshû 4 (1958) 206-12. (In Japanese)

$Ca^{45}Cl_2$ solution was administered orally to silkworms at various growing stages, and variations in the blood picture were studied. Proleucocyte number was most extensively influenced by this administration and decreased to an average of 12% of the original value. The decrease in phagocytes was 68%, globule cells 67%, and oenocytoids 57%. The effects of radioactivity were greater in male than in female silkworms.

265 Gamô, T., Nishiyama, H., Midorigawa, S. STUDIES ON THE INFLUENCE OF RADIOACTIVE-RAYS UPON THE HEMOCYTES OF THE SILKWORM BOMBYX MORI, L. (IV) ON THE SEXUAL DIFFERENCES BETWEEN THE EFFECTS OF THE INGESTED RADIOISOTOPES ON THE NUMBER OF HEMOCYTES OF THE SILKWORM. Radioisotopes, Tokyo 1, 9 (1960) 17-21. (In Japanese)

Attempts were made to show some sexual differences in the destructive influences of radiation upon the numbers of hemocytes of the silkworm. Just moulted silkworm larva of the fifth stage were administered 0.1 cc of 0.5% solution $Ca^{45}Cl_2$ or 0.3% solution of $H_3P^{32}O_4$ through the mouth. It was concluded from the results that the largest damage of $Ca^{45}$ and $P^{32}$ was inflicted on the proleucocyte, especially in the male silkworm. (NSA 15: 22142, 1961)

266 Getsova, A.B. ON THE ELIMINATION OF RADIOACTIVE ISOTOPES (DESORPTION) IN SOME AQUATIC INVERTEBRATES. p. 744-6 in "Proceedings of the 11th International Congress on Entomology, Vienna 17-25 Aug. 1960", Vol. 1. Strouhal, H., Beier, M., eds. (Naturhistorisches Museum, Vienna). Vienna, Christoph Reisser's Söhne. 1962.

The practical importance of such data for pollution probelms is stressed. The elimination of radioactive substances (here, $Sr^{90}$, $Ru^{106}$, $Cs^{137}$, $Ce^{144}$) from aquatic insects (Culex pipiens pipiens L. and Halesus interpunctatus Zett.) was, like accumulation, found to proceed in different ways, and to depend on the chemical element and the species. Mosquitoes eliminated $Sr^{90}$ most slowly, caddis-flies $Cs^{137}$. The accelerating effect on desorption of the addition of EDTA (the sodium salt of ethylene diamine tetra-acetic acid) was studied and confirmed except for $S^{90}$. Two tables list concentration and desorption in larvae, in clear water and EDTA.

267 Getsova, A.B. ON THE DESORPTION OF RADIOACTIVE ISOTOPES OF CERTAIN REPRESENTATIVES OF AQUATIC INVERTEBRATES. Dokl. Akad. Nauk. SSSR 133 (1960) 459-61. (In Russian)

The desorption of radioactive isotopes from mosquitoes (Culex pipiens pipiens L.), caddis flies (Halesus interpunctatus Zett.), and mollusks (Aplexa hypnorum L.) was studied in order to determine the retaining time in live organisms after they are transferred from contaminated media to clean water, and also to find the effect of water-soluble complex ethylene diamine tetra-acetate (EDTA) on incorporated radioisotopes. The tests were made in lakewater-filled aquariums contaminated with $Sr^{90}$, $Ru^{106}$, $Cs^{137}$, and $Ce^{144}$. The results show that EDTA aids the adsorption process except for $Sr^{90}$. The uptake and desorption of $Sr^{90}$ is slowest in mosquitoes; $Cs^{137}$ is the slowest in caddis flies; and $Ce^{144}$ is the slowest in mollusks. An intensive adsorption of $Sr^{90}$ and $Ce^{144}$ was observed during the first 2-4 d, after which it was stabilized; desorption of $Cs^{137}$ was much slower. In spite of a high percentage of desorption, the organisms carry a considerable amount of the radioactive substance into the clean water. (NSA 14: 23893, 1960)

268 Гецова, А.Б., Тимофеева-Ресовская, Е.А., Тимофеев-Ресовский, Н.В. О ВЛИЯНИИ ЭТИЛЕНДИАМИНТЕТРААЦЕТАТА НА НАКОПЛЕНИЕ РАЗЛИЧНЫХ РАДИОИЗОТОПОВ ИЗ ВОДНОГО РАСТВОРА ПИЯВКАМИ И КОМАРАМИ. Доклады Акад. Наук СССР 160, 2 (1960) 440-2.

В сообщении приводятся данные по влиянию комплексона этилендиаминтетраацетата /ЭДТА/ на коэффициенты накопления 11-ти радиоактивных изотопов ($S^{35}$, $Fe^{59}$, $Co^{60}$, $Zn^{65}$ $Sr^{90}$, $Y^{91}$, $Zr^{95}$ $Nb^{95}$, $Ru^{106}$, $Cs^{137}$, $Ce^{144}$) малой ложноконской пиявкой из рода Herpobdella и 4-х элементов ($Sr^{90}$, $Ru^{16}$, $Cs^{138}$, $Ce^{144}$) разными стадиями комара Culex pipiens pipiens. Эффект ЭДТА основан на общих физико-химических закономерностях действия водорастворимых комплексонов на минеральный обмен пресноводных организмов.

Getsova, A.B., Timofeeva-Resovskaya, E.A., Timofeev-Resovsky, N.V. THE EFFECT OF EHTYLENE-DIAMINETETRAACETATE ON THE ACCUMULATION OF DIFFERENT ISOTOPES FROM AQUEOUS SOLUTIONS BY LEECHES AND MOSQUITOES. Dokl. Akad. Nauk. SSSR 160,2 (1960) 440-2.

Results are discussed on the effect of the EDTA complex on the accumulation of 11 radioisotopes by a type of small horse leech of the Herpobella kind and of $Sr^{89}$, $Ru^{106}$, $Cs^{139}$ and $Ce^{144}$ by various developmental stages of the mosquito Culex pipiens pipiens. The EDTA effect is based on the general physico-chemical laws of the action of water-soluble complexes on the mineral metabolism in fresh-water organisms.

269 Grosch, D.S., Sullivan, R.L. THE FATE OF RADIOPHOSPHORUS INGESTED BY HABROBRACON FEMALES. Biol. Bull. 105 (1953) 296-307.

The distribution of radiophosphorus was studied in female wasps, Habrobracon juglandis, after a single feeding of $P^{32}$ in honey. The biological half-life of $P^{32}$ in egg-laying females is 4-5 d. 60% of the $P^{32}$ lost appeared in the deposited eggs. The radioactivity of eggs rises to a peak the second day after feeding and drops sharply to a relatively low plateau. Radioactivity measurements were also made on excreta and various parts of the wasp. (CA 48: 6033g, 1954)

270 Haines, T.H., Henry, S.M., Block, R.J. THE SULFUR METABOLISM OF INSECTS. V. THE ABILITY OF INSECTS TO USE SULFATE IN THE SYNTHESIS OF METHIONINE. Contr. Boyce Thompson Inst. 20,6 (1960) 363-4.

$Na_2S^{35}O_4$ was administered to 13 species of insects. The Japanese beetle, Popillia japonica New., was able to utilize the sulfur of $Na_2S^{35}O_4$ for the synthesis of methionine and other divalent sulfur-containing compounds. Of the remaining insects only the cockroaches, known to contain intracellular symbionts, were able to effect this reduction.

271 Hassett, C.C. RADIOPHOSPHORUS IN MOSQUITOES (AEDES AEGYPTI) (abstr.) Fed. Proc. 9,1pt.1 (1950) 58.

Data are presented showing paths of absorption of $P^{32}$ and its distribution in the tissues of Aëdes aegypti, as studied by radioautographs and by Geiger-tube counting techniques. (B. Ag. 14: 55450, 1950).

272 Hassett, C.C., Jenkins, D.W. THE UPTAKE AND EFFECT OF RADIOPHOSPHORUS IN MOSQUITOES. Physiol. Zool. 24 (1951) 257-66.

Throughout most of the laboratory experiments the yellow-fever mosquito, Aëdes aegypti, was used, but additional tests were made on the A. atropalpus, Culex pipiens, and the malaria mosquito, A. quadrimaculatus. All species became radioactive under treatment. The degree of radioactivity of the adults depended on the age of the larvae at the time of treatment, the concentration of radiophosphorus and of the larvae, and the sex of the resulting adults. The most satisfactory method of producing radioactive adults for large-scale uses was treatment of late third- and fourth-instar larvae with about 0.1 μc of $P^{32}$ per larva in 1 ml of water. Both higher and lower concentrations of P resulted in adults with lower radioactivity. Females contained about three times as much phosphorus as males. The larvae are able to concentrate $P^{32}$ at least 75 times its concentration in the medium. P enters the mosquito larvae through the gut, from ingested food, through the anal gills, and perhaps through the integument. Removal of the anal gills retards the uptake of phosphate but does not affect the final level. The distribution of the entering $P^{32}$ is general throughout the organism, with somewhat heavier concentrations in the Malphigian tubes and in parts where rapid metabolic processes are occurring. Radiation effects were noticed at relatively low concentrations of $P^{32}$ in the rearing medium (0.05 μc/ml) in the earlier instars. Resistance increased with age, but at concentrations above 5.0 μc/ml practically no adults emerged. Radiation effects, such as retardation or inhibition of growth, and death occurred at high concentrations. Mating and egglaying occurred normally in adults reared from larvae in $P^{32}$ solutions of 1.0 or less μc/ml. Adult mosquitoes were also made radioactive by feeding them on $P^{32}$-labelled substances, such as animal blood, raisins, flowers, and sugar solutions. (from auth. summary)

273 Hassett, C.C. UPTAKE OF $P^{32}$ BY PERIPLANETA AMERICANA; PASSAGE THROUGH THE FORE-, MID-, AND HINDGUT. Fed. Proc. 13, 1 (1954) 68.

Investigations on $P^{32}$-labelled phosphates introduced into the intestine of the cockroach show that the midgut is the chief site of absorption. Other factors affecting movement of phosphate ions through the intestine have been examined. KCN, for example, has no inhibitory effect; low temperatures decrease rate of passage.

(Abstract of paper presented before the American Physiological Society, 72nd Meeting, Atlantic City, N.J. 12-14 Apr. 1954)

274 Heller, J., Chojnacki, T. PYROPHOSPHATES IN THE HAWK-MOTH, CELERIO EUPHORBIAE. III. TRACER STUDIES WITH $P^{32}$. Bull. Acad. polon. Sci., Ser. Sci. biol. 5,9 (1957) 277-9.

A study is reported on the incorporation of $P^{32}$-labelled orthophosphate in the pyrophosphates of the ejaculatory duct of the adult male. Data is presented which proves the enzyme found by Heppel and Hilmoe in bovine sperm to be present in the genital passage of C. euphorbiae.

275 Heller, J., Piechowska, M.J., Chojnacki, T. INORGANIC POLYPHOSPHATES IN THE HAWK-MOTH (CELERIO EUPHORBIAE L.). Acta biochim. polon. 5,4 (1958) 343-54.

The genital pouch and the spermiduct of the male moth are rich in pyrophosphate which originates from nucleotide phosphorus. When $P^{32}$ is injected into the abdomen of males immediately on hatching or 3 d prior to or little after metamorphosis it is found in the same location. After mating, the polyphosphate is not rediscovered in the egg.

276 Henry, S.M., Block, R.J. THE SULFUR METABOLISM OF INSECTS. IV. THE CONVERSION OF INORGANIC SULFATE TO ORGANIC SULFUR COMPOUNDS IN COCKROACHES. THE ROLE OF INTRACELLULAR SYMBIONTS. Contr. Boyce Thompson Inst. 20,5 (1960) 317-29.

The intermediary metabolism of inorganic sulfur into organic compounds in cockroaches was investigated by either feeding or injecting $Na_2S^{35}O_4$ into Blattella germanica (L.) and Periplaneta americana (L.). The possible role of the gut microorganisms and the intracellular symbionts of B. germanica on the metabolic pathways was studied by determining the $S^{35}$-labelled compounds developed in normal insects and aspectically reared insects containing the symbionts and in cockroaches freed of symbionts. In both normal and aspetic insects the $S^{35}$ was found primarily in glutathione, cysteine, methionine, and methionine sulfoxide and only in limited quantities in taurine, sulfite, and several unidentified compounds. In symbiont-free B. germanica the $S^{35}$ was detected only in sulfite and two unidentified compounds. (auth.)

(See earlier report in Bull. ent. Soc. Amer. 5, 3 (1959) 141, abstr. 271 under "Sulfate utilization and the role of intracellular symbionts in cockroaches (Orthoptera: Blattidae)")

277 Heslop, J.P., Ray, J.W. PHOSPHORUS COMPOUNDS OF COCKROACH NERVE AND THE EFFECT OF DDT. Biochem. J. 70, (1958) 16 P (Proc. Biochem. Soc.)

The labelled-pool technique of Winteringham (1956) was applied to the study of $P^{32}$-labelled compounds in Periplaneta americana nerve extracts. Seven days after injection of 400 μc of carrier-free $P^{32}O_4^{3-}$, the abdomen of each cockroach was opened and part of the ventral nerve cord dissected free from all other tissues. Only actively conducting cords, as indicated by electrical monitoring, were used. The cord was raised clear of the animal on hooks, the whole preparation flooded with liquid nitrogen and a cord sample rapidly transferred to a glass homogenizer immersed in liquid nitrogen. Six to ten samples were extracted three times with N-formic acid in 50% aqueous ethanol and the combined extracts analysed and resolved into five fractions (I-V) by ascending paper chromatography at 5°C in the acetone/formic acid/water solvent of Burrows, Grylls & Harrison (1952). Some constituents have been tentatively identified by co-chromatography. The amounts of $P^{32}$ in fractions II, III and IV, measured by radiometric scanning (Winteringham, Harrison & Bridges, 1952), have been expressed as percentages of the total $P^{32}$ in the three fractions. Where DDT was used 100 μg was applied topically in 5 μl of acetone 24 or 48 h before dissection. Animals showing early (Tremulous) and later (Prostrate) signs of DDT poisoning were used. Results and identifications are discussed.

278 Hilchey, J.D., Block, R.J., Miller, L.P., Weed, R.M. THE SULFUR METABOLISM OF INSECTS. I. THE UTILIZATION OF SULFATE FOR THE FORMATION OF CYSTINE AND METHIONINE BY THE GERMAN COCKROACH, BLATELLA GERMANICA (L.). Contr. Boyce Thompson Inst. 18,2 (1955) 109-23.

Adult male and immature B. germanica (L.) can utilize inorganic sulfate for the production of both cystine and methionine. The sulfate ion was provided in the form of trace amounts of $H_2S^{35}O_4$ which was offered ad libitum at 0.0136 mc/ml. The procedures followed for chromatography and radioassay are described. The two amino acids appear to be synthesized by independent routes. The degree of utilization depends on the developmental stage of the test animals; growing nymphs use sulfate at a more rapid rate than do adult males. The rate of utilization also depends on whether or not the insects are reared aseptically. The in-

corporation of inorganic sulfur into methionine and cystine can be carried on to a moderate degree under aspetic conditions and at a high rate under nonaseptic conditions.

279 Hilchey, J.D., Cotty, V.F., Henry, S.M. THE SULFUR METABOLISM OF INSECTS. II. THE METABOLISM OF CYSTINE-$S^{35}$ BY HOUSE FLY, MUSCA DOMESTICA L. Contr. Boyce Thompson Inst. 19,2 (1957) 189-200.

$S^{35}$-labelled cystine fed to adult male or female houseflies was converted into taurine and sulfate. The hydrolysates and extracts as well as excreta from the flies were examined by paper chromatography. The peaks of radioactivity after hydrolysis and extraction occur in cystine and taurine. Taurine was partly retained in the body and partly excreted, while virtually all of the sulfate was excreted within 24 to 48 h after it was formed. Flies are unable to synthesize methionine from cystine.

280 Huot, L., Verly, W.G. DOSAGE DU $^{32}P$ TOTAL D'UNE LARVE VIVANTE DE TENEBRIO MOLITOR L. (COLÉOPTÈRE: TENEBRIONIDAE). J. Insect Physiol. 4,3 (1960) 202-8.

Les résultats démontrent qu'il est possible de mesurer le $^{32}P$ total d'une larve vivante de T. molitor avec une erreur de ± 5% qui dépend essentiellement de l'erreur sur le facteur de correction appliqué. La très faible variation de ce facteur de correction en fonction du poids de la larve a été interprétée.

281 Huque, H., Myser, W.C. FATE OF RADIOSTRONTIUM IN THE MADEIRA COCKROACH (LEUCOPHAEA MADERAE) (abstr.). Ent. Soc. Amer. Proc. North Central States Br. Proc. 14 (1959) 33-4.

282 Irwin, R.L.B., Spinks, J.W.T., Arnason, T.J. DEPOSITION OF $P^{32}$ IN DEVELOPING DROSOPHILA. Canad. J. Res., D-Canad. J. Zool. 28 (1950) 247-42.

Eggs of Canton Special stock of Drosophila were hatched and larvae reared on medium containing $P^{32}$. Alternate radioautographed and stained sections were made of larvae, pupae, and adults. Depositions of $P^{32}$ were heavy in fat bodies, nervous structures, and in organs of digestion and excretion. Very high concentrations of $P^{32}$ occurred in imaginal disks. Discharged materials and nuclei from fat bodies had much $P^{32}$ in early pupal stages, the activity becoming concentrated at sites of organ differentiation in later pupae. In the adults, the gonads, the nervous system, and the digestive tract contained much $P^{32}$. (auth.)

283 Iyengar, R., Panigel, M. SUR L'EXCRÉTION DE $^{32}P$ CHEZ DROSOPHILA MELANOGASTER ET GRYLLUS DOMESTICUS. C.R. Acad. Sci., Paris 241 (1955) 823-4.

Plusieurs générations de Drosophiles sont élevées sur un milieu contenant du $N_2HPO_4$ à P radioactif. La plus grande partie du phosphate radioactif ingéré par la Drosophile pendant la vie larvaire est éliminée lors des cinq premiere jours de vie de l'imago. La perte en radioactivité se fait ensuite beaucoup plus lente. Les auteurs ont pensé que les tubes de Malpighi pouvaient être l'organe responsable de cette élimination rapide des phosphates. On effectue chez des Grillons adultes surtout des injections intra-thoraciques ou intra-abdominales d'une solution de phosphate de Na à $^{32}P$ (1 à 2 μc). La mesure de la radioactivité de poids équivalents de certains organes (les tubes de Malpighi, les ovaires, les testicules, le tube digestif, la 3e patte et l'aile postérieure) montre que 4-5 jours après l'administration de phosphate marqué ce sont les tubes de Malpighi qui ont emmagasiné le plus de matérial radioactif, vraisemblablement en vue de son excrétion. Par la suite, le $^{32}P$ se concentre dans les ovaires, phénomène qui doit être liée à la vitellogenèse.

* Khudakov 1959 - [337]

284 King, R.C. STUDIES WITH RADIOPHOSPHORUS IN DROSOPHILA. 3. THE TURNOVER OF PHOSPHORUS IN ADULT D. MELANOGASTER AND D. SIMULANS. BNL-1405, Brookhaven National Lab., Upton, N.Y. 1953, 11p.

The turnover of phosphorus by adult males and females of Drosophila melanogaster and D. simulans was studied utilizing $P^{32}$. The half times of phosphorus turnover by adult male and female D. melanogaster and adult D. simulans males and females are 3⅓, 2, 3½ and 3 d, respectively. All 4 classes of flies lose phosphorus by two phase systems. The turnover of phosphorus by female D. melanogaster is faster than that of males because their fast phase has a shorter half time than that of males. Male D. simulans lose phosphorus more slowly than females because of the longer half time of the slow phase of the males. (auth.)

(This work is followed up in J. exp. Zool. 125 (1954) 331).

285 King, R.C. STUDIES WITH RADIOPHOSPHORUS IN DROSOPHILA. 4. THE DISTRIBUTION AND TURNOVER OF PHOSPHORUS IN THE TISSUES OF DROSOPHILA MELANOGASTER. BNL-1416, Brookhaven National Lab., Upton, N.Y. 1953, 24p.

See King, J. exp. Zool. 125 (1954) 331, and King and Wilson, J. exp. Zool. 126 (1954) 401.

The distribution, concentration, and turnover of phosphorus in the tissues of Drosophila were studied utilizing tracer techniques. Data are presented in tabular form on the distribution of $P^{32}$ in various tissues of totally labelled adult flies of both sexes. (NSA 7: 5011, 1953)

286 King, R.C. STUDIES WITH RADIOPHOSPHORUS IN DROSOPHILA. II. TURNOVER AND DISTRIBUTION OF PHOSPHORUS IN ADULT DROSOPHILA. J. exp. Zool. 125 (1954) 331-52.

Male flies of D. melanogaster (I) and D. simulans turn over phosphorus more slowly than females. Both sexes of I turn over about half of their phosphorus by a fast phase and half by a slow phase. Tissue studies of I indicate that the majority of P is in the thoracic region, with large amounts in the hemolymph and head; 94% of the P in the female reproductive system occurs in the ovaries. Large amounts of P occur in the various parts of the male reproductive system with 63% of this P in the testes. During development, over 99% of the total P resides in the metamorphosed insect; 1% remains in the pupal case. The hemolymph of freshly hatched adults of each sex is quite low in P, but it rises with feeding. Calculated values are given for P turnover in a 24-h period by various regions of the adult body of each sex of I. (CA 48: 7212b, 1954)

287 King, R.C. THE EFFECT OF A YEAST UPON THE INCORPORATION OF PHOSPHORUS INTO THE TISSUE OF ADULT FRUIT FLIES. Evolution 9 (1954) 93-4.

(See article in Amer. Nat. 88 (1954) 155-8)

288 King, R.C. THE EFFECT OF YEAST ON PHOSPHORUS UPTAKE BY DROSOPHILA. Amer. Nat. 88 (1954) 155-8.

The paper describes striking differences in the uptake of $P^{32}$ by adults of two related species of Drosophila (melanogaster and simulans) feeding on different yeast species (Saccharomyces cerevisiae, Candida albicans, Debaryomyces matruchoti, Hansenula subpellicosa, and Schizosaccharomyces pombe). It was found that phosphorus uptake by both species is increased on medium containing live yeast. The rate is increased more in females than in males. Phosphorus uptake is sometimes strikingly different for flies of different species feeding on the same yeast.

289 King, R.C., Wilson, L.P. STUDIES WITH RADIOPHOSPHORUS IN DROSOPHILA. V. QUANTITATIVE STUDIES ON THE PHOSPHORUS BALANCE OF ADULT FEMALE FLIES FEEDING UPON YEAST. J. exp. Zool. 130 (1955) 71-82.

$P^{32}$ was employed as a tracer in a study of the phosphorus metabolism of yeast by adult Drosophila. Data are presented on the incorporation of P into tissues and eggs, P excretion, the relationship between endogenous and exogenous P and differences in P turnover demonstrated in male and female Drosophila. Female flies weighing 1.5 mg each, when fed $P^{32}$-labelled Saccharomyces cerevisiae ingested about $6 \times 10^{-3}$ mg P per d per fly. An equal amount was lost during the day.

(See also BNL-1979, Brookhaven National Lab., Upton, N.Y. 1954, 28p.)

290 King, R C., Rubinson, A.C. DISTRIBUTION OF CALCIUM IN ADULT DROSOPHILA MELANOGASTER. Science 125 (1957) 546.

Autoradiographic studies of $Ca^{45}$ localization in adult and larval stages of D. melanogaster indicate rapid transfer and storage in the excretory organs of the insect. It is concluded that the insect requires only trace amounts of Ca and that the concentration in the chromosomes is no higher than that in the cytoplasm and body fluids. (CA 51: 10772c, 1957)

291 Kogure, M., Nakajima, M., Murati, K., Tsujii, T. STUDIES ON $P^{32}$ IN THE SILKWORM. Zool. Mag., Tokyo 60 (1951) 24. (In Japanese)

The uptake of $P^{32}$ by silkworm larvae was studied, and the role of the digestive tract in phosphorus metabolism discussed.

292 Kogure, M., Yoshida, R., Murati, K., Minamizawa, K., Nakajima, M. STUDIES ON THE PHYSIOLOGY OF THE SILKWORM AND THE MULBERRY TREE BY MEANS OF RADIOACTIVE PHOSPHORUS. Annu. Rep. of the Research Committee on Application of Artificial Radioactive Isotopes in Japan 1, 1 (1951) 94-7.

5th instar silkworms were injected with $H_3P^{32}O_4$ diluted with $Na_2HPO_4 \cdot 12\ H_2O$ solution. The distribution with time and the concentration of $P^{32}$ is discussed for various tissues (alimentary canal, silk gland, sexual gland, Malpighian tubules) and for blood, following injection and also after the administration of $P^{32}$-labelled mulberry leaves. Results on the uptake and translocation of $P^{32}$ in mulberry trees (seedlings) are also summarized.

293 Limpel, L.E., Casida, J.E. IODINE METABOLISM IN INSECTS. I. IN VIVO METABOLISM OF RADIOIODIDE. J. exp. Zool. 135 (1957) 19-27.

The fate of radioiodide was investigated in several insects: Aeschna sp., a dragon fly; the American cockroach, Periplaneta americana (L.); the German cockroach, Blattella germanica (L.); a cicada, Tibicen sp.; the squash bug, Anasa tristis (DeGeer); the larger cabinet beetle, Trogoderma versicolor (Creutz.); the locust borer, Megacyllene robinae (Forst.); the greater wax moth, Galleria mellonella (L.); the gay harlequin caterpillar, Euchaetias egle Drury; a mud dauber, Sceliphron cementarium (Drury); the yellow fever mosquito, Aëdes aegypti (L.); and the housefly, Musca domestica (L.). Iodide, iodine, 2(or 4)-monoiodohistidine, 3-monoiodotyrosine, 3,5-diiodotyrosine, and thyroxine have been recovered from various tissues together with one or possibly two unidentified iodocompounds. Ratios of the $I^{131}$ intermediates vary greatly among the organs of Periplaneta and within the class Insecta. (from auth. summary)

294 Limpel, L.E., Casida, J.E. IODINE METABOLISM IN INSECTS. II. IN VIVO DISTRIBUTION AND METABOLISM OF IODOAMINO ACIDS AND RELATED STUDIES WITH PERIPLANETA. J. exp. Zool. 136 (1957) 595-613.

The distribution and metabolism of certain radioiodine compounds and radiobromide within Periplaneta americana L. were investigated. In vitro metabolism studies supported the findings reported in part I., and further demonstrated that thiouracil and thiosulfate do not inhibit the cuticle in iodine absorption. The biological half-life of iodine in cockroaches was established as about 27 h. An examination was made of the in vivo metabolism of $I^{131}$-labelled monoiodohistidine and iodide, and of the excretory products. Distribution studies with radioiodide revealed that the cuticle was able to absorb iodine from the blood, and the entire alimentary canal absorbed iodine more efficiently than the other internal tissues. Thiouracil and resorcinol did not decrease the ability of cuticle to absorb iodine from the blood; they did, however, promote the concentrating ability of most other tissues. The fumigant, methyl iodide, was concentrated by the cuticle and hindgut, apparently undergoing rapid excretion. Compared with radioiodide, radiobromide was concentrated from the blood by the cuticle, muscle, nerve cord and Malpighian tubules. Distribution studies with labelled monoidodohistidine, diiodotyrosine and thyroxine indicated rapid excretion via the Malpighian tubules and the hindgut. (from auth. summary)

295 Lüdicke, M., ÜBER DIE AUFNAHME VON RADIOAKTIVEM, SEKUNDÄREM NATRIUMPHOSPHAT BEI LUCANUS CERVUS L. (On the uptake of radioactive secondary sodium phosphate by Lucanus cervus L.) Z. vergl. Physiol. 34 (1952) 508-24. (In German)

The uptake and distribution of orally administered $Na_2HP^{32}O_4$ solution in the wings, legs and antennae of Lucanus cervus L. was investigated. Relative concentrations of radioactivity in the different organs, and the effects of the level of the initially administered dose and of time are discussed. Use is also made of autoradiography. Thus, in addition to studying the distribution of radioactivity in the above organs, autoradiographs were further made of sternite fragments, muscle fibres, ovarioles, fat bodies, the intestine with the Malpighian tubules, the thoracic ganglion and the brain. The results are discussed.

296 Lüdicke, M. ÜBER DIE RADIOAKTIVE STRAHLUNG DES INSEKTENFLÜGELS NACH FÜTTERUNG MIT $^{32}$P-DINATRIUMHYDROGENPHOSPHAT (Studies on the radioactivity of insect wings after feeding with $P^{32}$-labelled disodium hydrogen phosphate). Zool. Anz. Suppl. 18, Verh. dtsch. zool. Ges. 1953, 412-7. (In German)

Different methods were used for labelling various insects by means of $P^{32}$-labelled $Na_2HPO_4$ (direct feeding, via a radioactive host, via an artificial membrane, etc.). The orthoptera, coleoptera, lepidoptera and heteroptera examined showed a distribution of radioactivity which corresponded to the system of veins in the wings. In the coleoptera examined (Lucanus, Melolontha and various carabidae) the elytrae were much more radioactive than the hind wings. The relative hemolymph distribution within the wing is discussed.

Among the orthoptera (Phyllodramia, Blatta and Gryllotalpa) the difference between the wing pairs is not so pronounced. In heteroptera (Rhodnius and Triatoma) radioactivity originates almost entirely from the corium portion. Lepidoptera studies (e.g. Inachis (Vanessa) io L.) showed an apparently similar distribution in both wing pairs. Results of other workers are discussed.

297 Lüdicke, M. ÜBER DIE VERTEILUNG DES IM RAUPENSTADIUM AUFGENOMMENEN $^{32}P$-DINATRIUM-HYDROGENPHOSPHATS BEI DER SCHLÜPFENDEN IMAGO VON VANESSA IO L. (On the distribution in the emerging imago of Vanessa io L. of $P^{32}$-labelled $Na_2HP^{32}O_4$ solution, taken up at the larval stage). Z. vergl. Physiol. 36 (1954) 508-30. (In German)

Distribution was tested by means of autoradiographs and a G-M counter. Both pairs of wings showed practically equal radioactivity, essentially concentrated in the veins of the wings. Radioactivity increases immediately after eclosion, followed by a drop. Dissected organs such as the intestine, the Malpighian tubules, muscles, fat bodies, the central nervous system, and chitin and the haemolymph were also tested for their activity, the intestine (in contrast to the Malpighian tubules) and muscles showing high values. The time for radioactive food to pass through the intestine of the larva is 124 ± 3 minutes. Experimental results on pupae of Deilephila euphorbiae L. are also recorded, and some work on orthoptera and coleoptera, the orthoptera being intermediate to coleoptera and lepidoptera with regard to the localization and relative distribution of radiation from the wings. Details are given.

The following were studied: orthoptera: Phyllodromia germanica L., Blatta orientalis L., Gryllotalpa gryllotalpa L.
coleoptera: Carabus hortensis L., Carabus auratus L., Carabus ullrichi Germ., Melolontha vulgaris L.
lepidoptera: Deilephila euphorbiae L., Vanessa io L.

298 Poulsen, D.F., Bowen, V.T. THE COPPER METABOLISM OF DROSOPHILA. Science 114 (1951) 486.

The uptake, distribution, and excretion of copper by larvae of four species of Drosophila, D. ananassae, D. melanogaster, D. repleta, and D. virilis, were followed by determining activities of whole and dissected larvae at intervals after the feeding of $Cu^{64}$ in various media, at a series of copper concentrations.

(Abstract of paper presented at the autumn meeting of the National Academy of Sciences, 5-7 Nov. 1951, Yale Univ., New Haven, Conn., USA)

299 Poulson, D.F., Bowen, V.T. ORGANIZATION AND FUNCTION OF THE INORGANIC CONSTITUENTS OF NUCLEI. Exp. Cell. Res., Suppl. 2 (1952) 161-70. "The Chemistry and Physiology of the Nucleus. Brookhaven Symposia in Biology Aug. 1951". Brookhaven National Lab., Upton, N.Y. 1952.

A review article. For this bibliography, the sections dealing with autoradiographic localization of minerals are of interest. Autoradiographic studies of iron metabolism in larvae of various species of Drosophila (virilis, repleta, melanogaster, funebris) by means of $Fe^{59}$, showed some tissues to contain considerably higher iron concentrations in the nucleus than others. Results obtained with $Cu^{64}$ on the uptake, distribution and excretion of copper (D. repleta) are reviewed, and correlations between copper and fluorescence discussed. Radiocalcium gave no indication of nuclear localization in D. repleta. Work with radiobarium is also mentioned. New methods and techniques and their possibilities are discussed.

300 Poulson, D.F., Bowen, V.T., Hilse, R.M., Rubinson, A.C. THE COPPER METABOLISM OF DROSOPHILA. Proc. nat. Acad. Sci., Washington 38 (1952) 912-21.

The radioisotope $Cu^{64}$ was produced by neutron irradiation. The uptake of copper by larvae of species of Drosophila (repleta, ananassae, melanogaster) traced by $Cu^{64}$, is proportional to the copper concentration in the medium over the range 0.25 - 10× μg Cu/g. Above this level uptake falls off. Rates of excretion as well as distribution in the tissues have also been determined. From these data factors relating copper content of larvae to copper concentration in the medium have been calculated. Both counting and autographic methods demonstrate that a large fraction of the tissue copper of Drosophila is in a form not demonstrable with presently available histochemical techniques. Further support is lent to the hypothesis, previously advanced, of a profound difference in copper metabolism between two of the major subgenera (Drosophila and Sophophora) of this genus. It is shown that $Cu^{64}$ ingested as part of the yeast cell is absorbed without an opportunity of mixing with stable ionic copper simultaneously ingested. Thus there appear to be at least two pathways of copper uptake, one for ionic, the other for bound forms. (from auth. summary)

301 Rodriguez, J.G. RADIOPHOSPHORUS IN METABOLISM STUDIES IN THE TWO-SPOTTED SPIDER MITE. J. econ. Ent. 47,3 (1954) 514-7.

The numbers of Tetranychus bimaculatus Harvey developing on tomato leaves have been shown to be positively correlated with the phosphorus content of the latter up to about 0.3% dry weight of foliage. Since this P-content is common in food plants of the mite, bean plants were grown in a solution containing $P^{32}$ and the radioactivity of the mites and eggs determined at intervals throughout 10 d. Almost half the acquired $P^{32}$ was taken up during the first 8 h of feeding. Full capacity (2007 cpm) was reached in about 36 h; subsequently, uptake continued slowly as the mites increased in size. The $P^{32}$-content of the egg to that in the adult mite maintained an approximately constant ratio. Utilization of P in egg production proceeded at a similar rate to its uptake, but utilization in the body of the mite was much slower, since about 20 h were required for half the $P^{32}$ to be used. P was 3 times as concentrated in the egg as in the mite body. The females lived for an average of 10.85 d, laying about 10.3 eggs/day during that time. Egg production therefore consumes relatively large quantities of P. On transferring radioactive mites to leaf disks, these became radioactive, showing that a P-containing secretion, thought to originate in the tracheal salivary gland was injected into the leaf.

302 Sasaki, R. SOME OBSERVATIONS ON THE BIOLOGICAL INFLUENCES OF RADIOACTIVE ISOTOPES UPON PHYSIOLOGICAL FUNCTIONS. Un International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 8/P/1067. 12 (1956) 330-3.

The absorption of orally administered radioactive $Ca^{45}$ (as $Ca^{45}Cl_2$ solution) into certain tissues and organs of silkworm larvae (Bombyx mori) was studied on normal 5th instar larvae. Results are tabulated. The nervous system generally took up the largest amount of $Ca^{45}$, and the sexual organs, muscle and fatty tissue followed in that order. The injurious effects of $Ca^{45}$ on respiration was checked. The distribution of $P^{32}$ (administered intrahumorally or orally) was also investigated; further, the turnover of phosphorus compounds during metabolism, and the role of the alimentary canal in phosphorus metabolism. The excretion of considerable amounts of phosphorus in the later days of 5th instar is due to degradation in the silk glands and alimentary canal, and the diminution of absorption by the larva itself.

303 Semenova, L.M. STUDY OF THE PERMEABILITY OF THE INTEGUMENT OF SOIL INSECTS TO SALT BY THE METHOD OF TAGGED ATOMS, FOR EXAMPLE THE LARVAE OF THE CRANE FLY, TIPULA PALUDOSA. MTIG. (DIPTERA, TIPULIDAE). Zool. Zh. 36, 12 (1957) 1826-30. (In Russian, with summary in English)

Solutions of $Na_2HP^{32}O_4$ and $K^{42}H_2PO_4$ were made in concentrations employed for fertilizers in hydroponics: 0.005, 0.025, 0.05, 0.1%. The $K^{42}$ penetrated the larval cuticle in greater amounts than did $P^{32}$. The quantity of isotope permeating the cuticle was related to the concentration in the medium, but the rate of absorption was depressed by the higher concentrations of phosphate. The permeability of cuticle of these larvae was one-sided for the salts tested. (CA 52: 12247 d, 1958)

304 Sivarama Sastry, K., Radhakrishna Murty, R., Sarma, P.S. ZINC TOXICITY IN THE LARVAE OF THE RICE MOTH, CORCYRA CEPHALONICA. Biochem. J. 69 (1958) 425-8.

The levels at which dietary Zn becomes toxic to rice-moth larvae have been determined. At lethal levels (1.6% $ZnCl_2$ in diet) supplementation of the diet with vitamin $B_{12}$ or liver extract checked mortality. None of the B vitamins except thiamine and $B_{12}$ was effective in reversing the inhibition of growth induced by 0.4% $ZnSO_4$. Vitamin $B_{12}$ was more effective in prolonging the survival of the larvae than in promoting growth in this condition. Liver extract, as well as its alkaline-stable fraction, partially reversed the inhibition of growth from Zn toxicity. Deoxyribonucleic acid and ribonucleic acid at 0.5-1.0% levels in the diet reversed the inhibition of growth from Zn toxicity completely. Dietary deoxyribonucleic acid did not influence the uptake of $Zn^{65}$ from the diet. (CA 52: 18919d, 1958)

305 Slipka, J. INTAKE OF $I^{131}$ THROUGH CUTICLE OF LARVA OF TIPULA MAXIMA. Biol. Listy, Prague 32 (1952) 316-22.

Preliminary experiments were performed in order to explain the metabolism of iodine in its relation to proteins, especially to arthropoidin, present in cuticle of arthropods. Iodine reacts with tyrosine present in arthropoidin, and mono- and di-iodotyrosine are formed. Living larvae were exposed in water to $I^{131}$ for 24 h, then fixed in Carnoy's liquid, embedded in paraffin, and cut in sections 10 $\mu$ thick. Histo-radiographic analysis demonstrated that $I^{131}$ accumulated in the outermost layer of epicuticle (which is free of chitin). Greatest intensity of $\beta$- and $\gamma$-radiation was in the region of anal papillae. (CA 48: 7211 d, 1954)

306 Stich, H., Grell, M. INCORPORATION OF PHOSPHORUS-32 INTO THE MALPIGHIAN TUBES DURING THE METAMORPHOSIS OF CULEX PIPIENS. Nature 176 (1955) 930-1.

Early and late 4th instar larvae of C. pipiens placed in tap water containing $P^{32}$ for 24 h and then removed to plain tap water followed in 24 h by removal of the Malpighian tubes show great accumulation of $P^{32}$ in the tubes near the time of pupation, and the amount remains constant during the rest of metamorphosis. The majority of the $P^{32}$ is in material soluble in 10% $CCl_3CO_2H$ and is localized in granules (probably polyphosphate) of 1-3 μ diameter which appear in the Malpighian tubes near pupation and which show a strong affinity for basic dyes and are soluble in 10% $Cl_3$ $CCO_2H$ or 2% $HClO_4$. Accumulation of $P^{32}$ in the granules also occurs if the gut does not show radioactivity; this shows it must be taken up from the blood. In the change from early 4th instar larvae to early pupae the amount of $P^{32}$ extracted by EtOH-$Et_2O$ falls (35.4 to 24.7%), while the amount extracted by 2% $HClO_4$ rises (22.4 to 45.3%), and that extracted by 10% $HClO_4$ falls (28.8 to 21.6%). It has been shown (unpublished) that the phosphorus arises from histolyzed organs (especially the gut) during metamorphosis and this is taken up from the blood by the Malpighian tubes which are thus active in the regulation of the phosphorus balance. (CA 50: 6695a, 1956)

307 Tomizawa, C., Fukami, J. BIOCHEMICAL STUDIES ON THE ACTION OF INSECTICIDES. III. PHOSPHORUS METABOLISM OF INSECTS AND THE INFLUENCE OF INSECTICIDES. Botyu-Kagaku, (Bull. Inst. Insect Control) 21 (1956) 133-9.

The influence of DDT (I), Lindane (II), methyl-Parathion (III), and Rotenone (IV) on the distribution of radioactive phosphate in the different tissues of the cockroach. Periplaneta americana, and the incorporation of radioactive phosphate into phosphorylated intermediates in the nerve cord and the femur muscle of the insect were studied. Radioactive phosphate injected into the abdomen of the insect translocated quickly to the head, legs, wings, nerve cord, and femur muscle. The feature of the distribution of radioactive phosphate in the different tissues of the insect body was similar to that of other insects which consumed orally radioactive phosphate: 6.5 h after the injection, the order of the accumulation of radioactive phosphate in the tissue was gut > nerve cord > legs > head > wings. The radioactive phosphorylated intermediates contained in the nerve cord and the femur muscle were traced by paper chromatography. Orthophosphate, ATP, ADP, glucose-1-phosphate, glucose-6-phosphate, fructose-6-phosphate, hexosediphosphate, 3-phosphoglycerate, and 2 unidentified compounds were found in the nerve cord, while the same 8 compounds and 6 unidentified compounds were found in the muscle. In both tissues, most radioactive phosphate esters which are known to be intermediates of glycolysis were also found to be present in both tissues, but in relatively small amounts. The ratio of orthophosphate-$P^{32}$ to ATP + ADP-$P^{32}$ was higher in the muscle than in the nerve cord. The incorporation of radioactive phosphate into phosphorylated intermediates in the nerve cord and the muscle was inhibited by treatment with insecticide in the following order: III > I > II > IV. Also, the incorporation of radioactive phosphate into lipide and residual parts in the trichloroacetic acid-insoluble fraction was inhibited by III or I. II and III had a little effect on the incorporation of radioactive phosphate into the above fraction. (CA 51: 9070i, 1957)

308 Treherne, J.E. THE EXCHANGE OF LABELLED SODIUM IN THE LARVA OF AEDES AEGYPTI L. J. exp. Biol. 31 (1954) 386-401.

The exchange of $Na^{24}$-labelled sodium between the external medium and the haemolymph and whole body was investigated in the larva of A. aegypti. The time for half exchange was ~62 h. Most of the exchange of labelled sodium was found to occur through the anal papillae, although smaller amounts entered the haemolymph through the gut and general body surface. Transfer constants were used to describe the resultant turnover of labelled Na in the whole system. The rate of uptake of Na was independent of the external concentrations used in these experiments. K-ions do not compete with Na for uptake, which suggests separate mechanisms for the accumulation of these two ions. The effect of temperature on the rate of uptake of labelled Na was also investigated.

309 Wheeler, B. HALOGEN METABOLISM OF DROSOPHILA GIBBEROSA. I. IODINE METABOLISM STUDIED BY MEANS OF $I^{131}$. J. exp. Zool. 115, 1 (1950) 83-107.

I-metabolism in third instar larvae and pupae was studied by means of a Geiger counter, historadioautographs, and filter paper chromatography. The I was concentrated by the skeletal parts of the larva; the tanned larval structures, i.e., buccopharyngeal armature and spiracles, concentrated somewhat larger quantities of I than the untanned larval skin. The tanned puparia likewise showed an I concentration higher than that in the untanned larval skin. The pupa cases, in contrast to fresh larval skins, incorporated I non-metabolically when placed in an I solution. Data obtained from Geiger counts suggested that I was accumulated by the

larval ring gland. A region of extremely high I concentration located posteroventrally in the larva is described. Black pigment formation occurred in this same area when larvae were placed in methyl alcohol. The region is histologically distinguished by very large hypodermal cells, an epicuticle free of setae, and a somewhat narrowed endocuticle. One-dimensional filter paper chromatograms run in phenol were made from a $Ba(OH)_2$ hydrolysate of larvae which had fed on $I^{131}$. Four peaks of radioactivity were determined by scanning the chromatogram with a Geiger counter. One peak of radioactivity was identified as free iodine; it is suggested that the other peaks may indicate monoiodotyrosine, diiodotyrosine, and free iodine. (auth.)

310 Winteringham, F.P.W., Loveday, P.M., Hellyer, G.C. PHOSPHORUS METABOLISM IN THE HOUSEFLY MUSCA DOMESTICA. (abstr.) Biochem. J. 55,5 (1953) xxxiii-xxxiv

The distribution of phosphorylated intermediates in normal and poisoned flies was investigated in order to study the biochemistry of insecticidal action mechanisms in vivo. Adult flies were fed some $P^{32}$. The methods of feeding and killing the flies is described, also the determination of $P^{32}$ by autoradiography; phosphorus compounds contained in the muscle extracts are resolved by ascending unidimensional paper chromatography. Subsequent quantitative determinations of very small samples of labelled compounds are described. Autoradiographs demonstrated a high concentration of labelled material in the gut wall.

311 Winteringham, F.P.W., Bridges, P.M., Hellyer, G.C. MODE OF INSECTICIDAL ACTION STUDIED WITH LABELLED SYSTEMS. PHOSPHORYLATED COMPOUNDS IN THE MUSCLE OF THE ADULT HOUSEFLY, MUSCA DOMESTICA, L. Biochem. J. 59,1 (1955) 13-21.

As disturbance by an insecticide of the distribution of phosphorylated intermediates in an insect is likely to be of significance in the insecticide's mode of action, their distribution in normal and poisoned flies (Musca domestica L.) was studied by a technique that involves feeding the insects on $P^{32}$ so that the intermediates become labelled, extracting the labelled compounds under conditions likely to preclude their decomposition, resolving them by means of unidimensional paper chromatography, and scanning the chromatograms radiographically. This paper contains a description and discussion of the technique and the results obtained in an investigation of the intermediates in the thoracic tissue of normal flies. The effects of insecticides on the distribution found is described elsewhere.

312 Winteringham, F.P.W. PHOSPHORYLATED COMPOUNDS IN THE HEAD AND THORACIC TISSUES OF THE ADULT HOUSEFLY, MUSCA DOMESTICA L., DURING FLIGHT, REST, ANOXIA AND STARVATION. Biochem. J. 75 (1960) 38-45.

In order to facilitate interpretation of data on the effects of insecticides on the relative concentrations of the soluble phosphorus compounds in adult M. domestica, the effects of physical activity, starvation, etc. were studied alone. The techniques are described in some detail. Usually, soluble phosphorus compounds were uniformly labelled with $P^{32}$ in vivo, to obtain the same specific radioactivity of the P for each compound. The presence of $\alpha$-glycerophosphate was confirmed enzymically. The transition from cyclopropane-induced rest to normal activity was associated with a fall in thoracic $\alpha$-glycerophosphate. Anoxia due to drowning caused an accumulation of thoracic $\alpha$-glycerophosphate and a slower breakdown of ATP, with the formation of inorganic phosphate and possibly adenosine monophosphate. Starvation to the point of prostration caused a fall in head-ATP which could be reversed by injection of aqueous glucose. Extended cyclopropane anaesthesia, injected water or acetone were apparently without effect on P distribution. Changes in head and thoracic P compounds could occur independently in the same insect.

313 Wyatt, G.R. PHOSPHORUS COMPOUNDS IN INSECT DEVELOPMENT. p.161-78 (disc. p.179-84) in "Proceedings of the 4th International Congress on Biochemistry, Vienna 1958", Vol.12. Levenbock, L., ed. London, Pergamon Press. 1959.

The importance of P metabolism in insect development is stressed, and work in the field reviewed. In metabolic studies on Cecropia silkworm, $P^{32}$ was injected to study the exchange of inorganic phosphate between the blood and the tissues, the specific activities of orthophosphate in Cecropia plasma for both pupae in diapause and adults were determined and plotted. The shape of the curves and variations in the rate of exchange are discussed. At an early stage of adult development the rate of exchange has apparently increased above that in diapause, similar to the increase in respiration rate. Blood phosphates are considered to be produced more or less continuously, supported by experiments where radioactive inorganic phosphate had been injected into pupae and developing adults. The results are tabulated. In some studies of nucleic acids in insect development, tracer doses of $P^{32}$-labelled orthophosphate were injected into pupal Cecropia

wing. $P^{32}$ incorporation into nucleotides of wing tissue RNA was determined, in diapause and on 2nd day of adult development. The activities of adenylic, uridylic, cytidylic and guanylic acids are shown graphically and discussed. Experiments on incorporation during 2 time intervals after injection showed that the rate of RNA synthesis increases sharply early in adult development and then declines again. The significance of the results is discussed.

## I-B-6 VIRUS DISEASES

314 Bergold, G.H. RADIOACTIVE EXPERIMENTS WITH SILKWORMS. Canad. Dep. Agric., For. Biol. Div., Bi-monthly Progr. Rep. 10,3 (1954) 2.

In the spring of 1953 about a hundred Bombyx mori L. larvae were injected with polyhedral virus suspended in $C^{14}$-labelled alanine and glycine (about 10 µc per larva). Unexpectedly, the β-radiation inhibited the virus multiplication and about 40% of the silkworms overcame the virus infection and developed to adults. These produced eggs which still had enough radiation to be counted readily. The offspring from these eggs as well as the next following generation (in toto about 20 000 individuals) were reared. Possible genetic effects of the radiation are being studied in co-operation with Dr. G. Stehr. About 200 mg radioactive polyhedral bodies were purified from the 60 silkworms which died from polyhedral disease. This material was radioactive to the extent of about 1300 cpm per mg. The virus particles were liberated from the polyhedral bodies and separated from the polyhedral protein, and they gave about 3800 cpm per mg. Several injection experiments with this radioactive virus and polyhedral protein are under way with silkworm and gypsy moth. (auth.)

315 Yamafuji, K., Omura, H. STUDY OF POLYHEDRAL VIRUS FORMATION WITH RADIOACTIVE PHOSPHORUS. Enzymologia 17 (1954) 28-30.

Larvae of the silkworm, Bombyx mori, were either inoculated with the virus or fed $KNO_2$ and then given an injection of $P^{32}$. On testing the isotope concentration it was found to be highest in virus obtained from larvae which had been treated with $P^{32}$ in the later stage of the development of the disease. Only a small amount of the administered dose, however, was incorporated into the polyhedral crystals.

316 Yamafuji, K., Omura, H., Watanabe, K. DISTRIBUTION AND TRANSMISSION OF RADIOACTIVE PHOSPHORUS DURING DEVELOPMENT OF VIRAL POLYHEDROSIS. Enzymologia 19,3 (1958) 157-62.

Polyhedra were labelled with $P^{32}$ and intact as well as inactivated $P^{32}$-polyhedral solutions were injected into larvae or pupae. About 0.1% of $P^{32}$ is transferred from parental to offspring virus; the isotope in inactive polyhedral crystals is assimilated in viral particles to almost the same degree. The incorporation of inorganic $P^{32}$ into polyhedra also was about 0.1%. Viral P is transferred very feebly from pupa to egg. (CA 53: 22535 b, 1959)

## I-B-7 MISCELLANEOUS

317 Berwig, W. UNTERSUCHUNGEN ÜBER CUTICULARE STOFFABGABE BEI AMEISENWEIBCHEN, DURCHGEFÜHRT MIT RADIOISOTOPEN (A radioisotope study on cuticular excretion in female ants.). Naturwissenschaften 46,21 (1955) 610-1. (In German)

No accurate data is, so far, available on the distribution by worker ants of cuticular substances given off by sexually potent animals. Work was done on Formica polyctena Först., $P^{32}$-labelled orthophosphate being injected by a glass capillary into the thorax. Autoradiography showed that radioactivity was distributed over the entire organism within 48 h. Precautions were taken to ensure that only cuticularly excreted radioactivity would be considered in subsequent measurements. Cuticular excretion in sexually potent ants was confirmed, and followed an exponential law. Worker ants were rendered radioactive by licking, and being licked in turn. The distribution of $P^{32}$ was examined. Hypodermal gland cells and the gland complex of the metathoracic glands would appear to be responsible for substances excreted by the cuticle.

318 Boudreaux, H.B. FURTHER INVESTIGATIONS ON SEX-RATIO AND FERTILIZATION IN SPIDER MITES. Bull. ent. Soc. Amer. 6,3 (1960) 155, abstr. 112.

The ratio of females to males is correlated with the amount of sperm furnished in a single mating. This supply depends upon the condition of the male and the time spent in copula. Males labelled with $H^3$-thymidine were used to investigate the site of fertilization.

319 Craig, R., Olson, N.A. RATE OF CIRCULATION OF THE BODY FLUID IN ADULT TENEBRIO MOLITOR LINNAEUS, ANASA TRISTIS (DE GEER), AND MURGANTIA HISTRIONICA (HAHN). Science 113 (1951) 648-50.

The speed of mixing in the blood of an injected solution containing $P^{32}$ was determined in the adults of the yellow meal worm, Tenebrio molitor Linneaeus; the squash bug, Anasa tristis (de Geer); and the harlequin cabbage bug, Murgantia histrionica (Hahn). Details of the techniques are given. The times required for uniform mixing of injected radiophosphorus are tabulated for the different species and appendages.

320 Day, M.F., Irzykiewicz, H. PHYSIOLOGICAL STUDIES ON THRIPS IN RELATION TO TRANSMISSION OF TOMATO SPOTTED WILT VIRUS. Aust. J. biol. Sci. 7, 3 (1954) 274-81.

Thrips that are vectors of tomato spotted wilt cannot acquire the virus except by feeding on diseased plants as nymphs, though both nymphs and adults transmit it. The reason for this inability was investigated in tests with Thrips tabaci Lind. in the laboratory. Both nymphs and adults were fed on radioactive sucrose solution and on radioactive leaves, and no effective difference was noticed in the amount of food ingested at the different stages, nor could any physiological differences be detected. Some difference may nevertheless exist in the permeability of the midgut of the two stages, and it is further possible that the virus may be unable to multiply in the tissues of the adult.

321 Fuzeau-Braesch, S. FRACTIONNEMENT DES PIGMENTS OXYDORÉDUCTEURS DE L'HYPODERME ET DES YEUX D'UN GRILLON.. C.R. Acad. Sci., Paris 245 (1957) 2401-4.

Les pigments de l'hypoderme et des yeux du Grillon Gryllus bimaculatus de Geer comportent au moins trois fractions: ommine, xanthommatine et un pigment jaune, auxquelles il faut peut-être ajouter une quatrième fraction dont l'identité avec une rhodommatine est douteuse. L'origine de ces pigments a été étudiée à l'aide de tryptophane radioactif marqué au $^{14}C$. (auth.)

322 Fuzeau-Braesch, S. RECHERCHE DE L'ORIGINE DES PIGMENTS CUTICULAIRES D'UN INSECTS PAR LA MÉTHODE DES ÉLÉMENTS MARQUÉS. C.R. Acad. Sci., Paris 248, 6 (1959) 856-8.

Les expériences réalisées avec des substances marquées au $^{14}C$ montrent que les pigments noir et jaune de la cuticule d'un Insecte (le Gryllus bimaculatus de Geer (Orthop.)) - dont la formation est chimiquement distincte du processus de durcissement de cette cuticule - réstultent tous deux du métabolisme de la tyrosine après la mue.

323 Henry, S.M., Cotty, V.F. THE REARING OF ASEPTIC ADULT HOUSE FLIES FOR PHYSIOLOGICAL STUDIES. Contr. Boyce Thompson Inst. 19, 2 (1957) 227-9.

An improved method for the rearing of houseflies free of microorganisms is described. Eggs are subjected to tryptic digestion for 2 h, rinsed in water, placed in 1% calcium hypochlorite for 2.5 minutes, and rinsed again in sterile water. They are then suspended in 4% formaldehyde or tincture of Zephiran chloride, shaken, and finally rinsed with sterile water. Bacteria-free colonies are then reared on a sterile medium prepared from Gained dog food and yeast. A procedure for maintaining sterility while adult flies are feeding on a synthetic medium supplemented with isotopically labelled compounds is described. (auth. -M.S.H.)

324 Kaplan, W.D., Pelc, S.R. AUTORADIOGRAPHIC STUDIES OF DROSOPHILA GONADS FOLLOWING THE FEEDING OF CARBON-14-LABELED FORMALDEHYDE. Z. indukt. Abstamm.-VererbLehre 87 (1956) 356-64.

Autoradiographs prepared of 24-96 h old male and female larvae of D. melanogaster which had been fed standard food containing added radioactive HCHO (I) (cf. Auerbach, Heredity 6, Suppl. 247 (1953)) for varying lengths of time showed that I enters the male and female gonads with equal penetration in all regions. The differential sensitivity shown by genetic techniques appears to be a result of differential response to the presence of I rather than of differential penetration. A positive autoradiograph indicates the presence of $C^{14}$ atoms but cannot determine the compounds in which they are present. (CA 50: 13308e, 1956)

* Kováč and Taimr 1959 - [412]

325 Levenbook, L. INSECT BIOCHEMISTRY. A REPORT ON SYMPOSIUM XII. p. 239-52 in "Proceedings of the 4th International Congress on Biochemistry, Vienna 1958", Vol. 12. Levenbock, L., ed. London, Pergamon Press. 1959.

The most important thoughts presented in the various papers are summarized. A number of these studies included work with radioisotopes (Florkin, Bheemeswar, Fukuda et al., Wyatt, Winteringham and Casida)

326 Levenbook, L. INTRACELLULAR WATER OF LARVAL TISSUES OF THE SOUTHERN ARMYWORM (PRODENIA ERIDANIA) AS DETERMINED BY THE USE OF $C^{14}$-CARBOXYL-INULIN. J. cell. comp. Physiol. 52, 2 (1958) 329-39.

$C^{14}$-carboxyl-inulin, injected into the 6th instar Prodenia eridania (Southern Armyworm) larva, can be recovered quantitatively from the blood, is not bound by the hemolymph proteins, and is neither metabolized nor excreted. A method employing $C^{14}$-carboxyl-inulin for the determination of tissue extracellular water, and hence the intracellular water content of insect tissues, is described. The method serves also to measure the total extracellular fluid volume of insects. Values are presented for the intracellular water content of the fat-body, gut and combined internal tissues of the mature Prodenia eridania larva, together with measurements of the total extracellular fluid volume. (auth. summary)

327 Lindquist, A.W. RADIOACTIVE TRACER METHODS. p. 76-82 in "Methods of Testing Chemicals in Insects", Vol. 1. Shepard, H.H., ed. Minneapolis, Burgess. 1958, 356p.

Brief review.

328 Lu, C.-P. EFFECTS OF ATOMIC ENERGY ON SILKWORM AND MULBERRY TREE. J. agric. Assoc. China (Taipei) 15 (1956) 99-103. (Summary in English)

A review of Japanese investigations during 1950-6 on the uses of $C^{14}$ and $P^{32}$ in varietal and pest-control studies. (Ca 52: 4095f, 1958)

329 Marouzzi, G. ACQUA TOTALE E LIQUIDO INTERSTIZIALE NEGLI INSETTI. (NOTA PRELIMINARE) (L'eau totale et le liquide interstitiel chez les Insectes. Note préliminaire). Boll. Zool. 23, 2 (1959) 609-20. (In Italia

A l'aide de colorants vitaux et de $^{35}S$, il est possible de déterminer le volume des liquides organiques composant l'hémolymphe. Ce volume est beaucoup plus élevé que celui que l'on trouve par "saignée" directe. Il semblerait que les Insectes ne possèdent pas de sang véritable, mais un liquide extra-cellulaire assimilé à l'hémolymphe, correspondant au sang liquide interstitiel des Vertébrés. (BS 19-145, 573, 1958)

330 McEnroe, W., Forgash, A. THE IN VIVO INCORPORATION OF CARBON-14 FORMATE IN THE UREIDE GROUPS OF URIC ACID BY PERIPLANETA AMERICANA. Ann. ent. Soc. Amer. 50 (1957) 429-31.

$C^{14}$-labelled formate (I) injected into the female roach was incorporated into the ureide C atoms of the uric acid recovered from the fat body. A rapid decrease in the rate of $C^{14}O_2$ production during the 15-h period following injection indicates that I rapidly becomes unavailable for oxidation. No significant amount of I was found in the excreta. Since the activity in the fat body uric acid accounted for only 3-5% of the injected activity, the major portion of the I must be incorporated into urates not located in the fat body or into other metabolic pathways. It is postulated that a transformylase system similar to that found in other organisms accounts for the metabolism of I in the roach. (CA 52: 8389a, 1958)

331 McEnroe, W.D., Forgash, A.J. FORMATE METABOLISM IN THE AMERICAN COCKROACH, PERIPLANETA AMERICANA (L.). Ann. ent. Soc. Amer. 51, 2 (1958) 126-9.

Studies with $C^{14}$-formate show that the adult roach metabolizes injected formate to serine and proline. In vitro studies with fat body tissue show that incorporation of formate into serine occurs primarily in the $\beta$ position and the addition of glycine accelerates this process. Fat body can also incorporate $C^{14}$-formate into uric acid, the majority of activity appearing at carbons 2 and 8 (ureide carbons). (auth.)

332 Takahashi, J., VITAMIN $B_{12}$ IN SILKWORM. III. Nippon Nōgei-Kagaku Kaishi 30 (1956) 563-5.

Larvae of Bombyx mori were fed with Morus bombycis leaves, which were previously soaked in $Co^{60}Cl_2$ solution. Vitamin $B_{12}$ (I) was assayed with the Euglena gracilis method on several organs of larvae, and the radioactivity of I fraction measured. A I fraction containing $Co^{60}$ was found in the intestinal canal, and the amount of the fraction increased by administering Actinomycetes and/or non-labelled Co as the I precursor. It was suggested that I was synthesized by Actinomycetes in the digestive tract of the worm. (CA 52: 11298a, 195

# I - C Insect Labelling

## Survey Articles

* Ankersmit 1958 - [1]

* Comar 1955 - [769]

* Jenkins and Hassett 1950 - [808]

## Flies

* Donnelly 1958 - [259]

333 Foott, W.H. PHOSPHORUS-32 LABELLING OF THE ADULTS OF THE CABBAGE MAGGOT, HYLEMYIA BRASSICAE (BOUCHÉ) (DIPTERA: ANTHOMYIIDAE). Rep. ent. Soc. Ont. 85 (1954) 56-61.

Two methods for tagging H. brassicae (Bch.) with $P^{32}$ were developed for studying the dispersal of adults, and consisted of spraying $P^{32}$-labelled phosphoric acid or of feeding labelled sucrose solution. Although some radioactive eggs were laid, following the first treatment, it was generally found to reduce the life span and not all flies in a group necessarily received sufficient spray. The second method produced a significant count within a few days which was maintained for a considerable period beyond that of feeding radioactive material. Since there was no apparent effect on survival or oviposition, this method was considered satisfactory. It consisted of feeding $P^{32}$ in dilute ½-1 mc in 100 cc of 5-7% sucrose solution.

334 Fredeen, F.J.H., Spinks, J.W.T., Anderson, J.R., Arnason, A.P., Rempel, J.G. MASS TAGGING OF BLACK FLIES (DIPTERA: SIMULIDAE) WITH RADIOPHOSPHORUS. Canad.J.Res., D-Canad.J. Zool. 31, 1 (1953) 1-15.

A method for tagging large numbers of Simulium spp. for flight-range investigations, devised in the course of work in Saskatchewan during 1950-51, is described. Radioactive larvae, pupae and adults that were readily detected with a Geiger counter were obtained by keeping the larvae for 24 h in a very dilute solution of a compound containing $P^{32}$ (0.2 μc/ml) and then returning them to non-radioactive water to complete their development. The treatment did not visibly harm the larvae or adults. Larvae were treated in the laboratory in small containers of water that was circulated and aerated with air jets, and in the field in galvanized iron tubs placed in the river and filled to a depth of 8 in with river water, which was kept in motion by means of a paddle wheel on a shaft driven by a larger paddle wheel dipping into the river. In field tests, tagged larvae and pupae were found as far as 520 yd downstream from the point at which they were returned to the river. Tagged adults were taken in cages placed over radioactive larvae and pupae in the stream, but only one was caught in the open, and this only 100 yd from the stream. Failure to find more tagged adults was believed to be due mainly to inadequate collecting methods. (from auth. summary)

335 Hoffman, R.A., Lindquist, A.W., Butts, J.S. STUDIES ON TREATMENT OF FLIES WITH RADIOACTIVE PHOSPHORUS. J. econ. Ent. 44, 4 (1951) 471-3.

In 1949 studies on the treatment of houseflies, Musca domestica L., with $P^{32}$ were undertaken at Corvallis, Oregon, to determine its possibilities as a means of tagging flies for flight studies, and also to learn the effect on egg production and subsequent generations of flies. A few tests were also conducted with the blow fly Phaenicia sericata (Meig.). The flies were either fed sugar solutions of radioactive phosphoric acid or reared in a medium containing this radioactive material. In the preliminary tests flies were made radioactive by both feeding and rearing, the treatment had some effect on fertility, and when large dosages were fed some radioactivity was carried over into the next generation. Subsequent tests with known amounts of $P^{32}$ supported the results. It was also indicated that feeding adult flies a solution containing $P^{32}$ was the more economical and efficient method of tagging with $P^{32}$. (auth. summary).

336 Jensen, J.A., Fay, R.W. TAGGING OF ADULT HOUSE FLIES AND FLESH FLIES WITH RADIOACTIVE PHOSPHORUS. Amer. J. trop. Med. 31, 4 (1951) 523-30.

A method is described for labelling adult Musca domestica (L.), Callitroga mascellaria (F.) and Lucilia cuprina cuprina (Wied.) [Phaenicia pallescens (Shann.)], the most prevalent flies in trap catches in southeastern Georgia. $P^{32}$ was either incorporated in ground fish or in milk fed to larvae and to adults respectively. Low activity was shown by adult flies from larvae reared in $P^{32}$-containing media. Females took up more $P^{32}$ than did the males on all the feeding routines. Females took up and retained appreciably more $P^{32}$ when the feeding period was longer than one day, but males did not. C. macellaria attained the highest level of radioactivity and M. domestica the lowest. Adults from 1-6 d old showed only minor differences in initial

uptake of $P^{32}$ with a 1-d feeding period. The initial uptake of $P^{32}$ was approximately proportional to the concentration of $P^{32}$ in the various milk solutions within the range tested. Decline in radioactivity was influenced by different diets of the adult flies after $P^{32}$ feeding and may be correlated with the phosphorus content of these diets. Practical tests have shown that tagged flies can be detected in dead samples from trap catches or in living material at bait stations. The former method is more efficient.

337 Khudakov, G.D. A METHOD OF TAGGING INSECTS BY GIVING THEM RADIOACTIVE ISOTOPES WITH FOOD. Byull. Moskov. Obshchestva Isphytalei Prir., Otdel Biol. 64, 3 (1959) 35-45. (Tr. from Russian) *)

338 Kilpatrick, J.W., Fay, R.W., Baker, J.T. THE REARING AND RADIOACTIVE TAGGING OF FANNIA CANICULARIS. Bull. ent. Soc. Amer. 3, 3 (1957) 35, abstr. 26-7.

Adults of Fannia canicularis, were allowed to feed for 24 to 48 h on cotton pads saturated with milk or honey water containing concentrations of 0.5, 1.0, 2.0, 2.5, and 5.0 millicuries $P^{32}$/liter. Measurement of radioactivity at daily intervals after feeding showed that F. canicularis could be satisfactorily tagged for a period of 10-12 d with either honey water or milk containing 2.0 or 2.5 mc $P^{32}$/liter. Feeding for 48 h was not considered necessary. Dosages of less than 2.0 mc $P^{32}$/liter provided insufficient activity. A technique for rearing F. canicularis using a standard CSMA media with twice the normal volume of water, was devised. The method provided unlimited production of adults, the cycle from egg to adult requiring 14 d. Tightly-rolled corrugated cardboard placed over the rearing medium provided a highly satisfactory pupation site.

* King and Wilson 1954 - [391]

* MacLeod and Donnelly 1957 - [77]

339 Oughton, J. "TAGGING" ROOT MAGGOT FLIES (HYLEMYIA SPP., ANTHOMYIDAE) BY MEANS OF RADIOACTIVE PHOSPHORUS. Rep. ent. Soc. Ont. 1950 81 (1951) 91-2.

An account is given of experiments carried out in Ontario in 1950, in a field of early turnips that was heavily infested with Hylemyia spp. early in the season. On 4th July, a dilute solution containing $P^{32}$ was poured on the soil at the base of the plants, so that two lots of 24 plants received totals of 0.8 and 0.2 mc $P^{32}$, respectively, and a third lot was left untreated. Half the plants in each series were covered with a cheese-cloth cage from 13th July to 14th August, and adults of Hylemyia taken in the cages were tested for radio-activity with a G-M counter. Of 10 taken on the plot treated with 0.8 mc $P^{32}$, 3 (all males) were radio-active, whereas none of 6 taken on that treated with 0.2 mc and none of 3 taken on the untreated plants were radioactive. Net sweeps were made twice in July and six times in August at 4 positions in the field, one including treated plants and the most distant being about 300 yards away. The Anthomyids taken were killed and examined, but none was radioactive. Examination of one turnip and the surrounding soil from the heavily treated lot on 19th July revealed 4 puparia and 2 larvae of Hylemyia, all of which were strongly radioactive. Marking in this way with $P^{32}$ may facilitate the study of the dispersal, local distribution and habits of Hylemyia spp. and their parasites. (RAE-A 41: 379, 1953)

340 Radeleff, R.D., Bushland, R.C., Hopkins, D.E. PHOSPHORUS-32 LABELING OF THE SCREW-WORM FLY. J. econ. Ent. 45, 3 (1952) 509-12.

Experiments are described in which Callitroga americana were produced, labelled with phosphorus 32, by rearing in artificial medium containing $P^{32}$, and in natural hosts by administering $P^{32}$-labelled phosphoric acid to the host. Several dosages and variations of technique are described. The regional distribution of $P^{32}$ in larvae and adults was determined and the counting rates of eggs and larvae from flies reared on radio-active media are given. Callitroga americana is easily labelled with $P^{32}$. Only minor manipulation is required. For field studies a concentration of 0.2 μc $P^{32}$/g of artificial medium appears to give adequate labelling for positive identification of flies and their egg masses. (auth. summary)

* Roan 1952 - [95]

341 Roth, A.R., Hoffman, R.A. A NEW METHOD OF TAGGING INSECTS WITH $P^{32}$. J. econ. Ent. 45, 6 (1953) 1091.

The authors describe a method for rendering insects radioactive by dipping them in a solution of phosphoric acid prepared from $P^{32}$, with or without a wetting agent, and give the results of experiments in which it was applied to flies. It was also used successfully with wasps, several species of Coleoptera, grasshoppers and

* The abstracts (Russian and English) have become available since going to press and are given on p.104.

emerging from the strongest concentration showed signs of retarded growth and the females did not feed. For the production of radioactive infective larvae of W. bancrofti, see Trans. R. Soc.-trop. Med. Hyg. 50 (1956) 425. (RAE-B 47: 67, 1959)

346 Fay, R.W., Baker, J.T., Jensen, J.A. RADIOACTIVE TAGGING OF CULEX QUINQUEFASCIATUS (SAY) WITH $P^{32}$. Mosquito News 19, 3 (1959) 139-43.

Since larvae of uniform age are suited for tagging with $Na_2HP^{32}O_4$ solution, laboratory studies were undertaken to determine (a) the rate of egg production of adult females, and (b) the possibilities of delaying egg hatch so that eggs from several days could be combined. Experimental details are given. One million tagged females for dispersion studies can be obtained by (a) the collection of 100 000 pupae in a 2-day period and the rearing of the eggs produced in the first 4 days by the resultant adults, (b) by the collection of about 16 000 egg rafts within a 4-day period and the rearing of the resultant larvae, or (c) by a combination of methods (a) and (b). Based on insectary studies, production values are as follows: 35 egg rafts/100 females in a 4-day period, a mean of 158 eggs/raft, 98% egg hatch, 87% pupation and 92.4% adult emergence, with equal sex division. Exposure of 6- to 8-day-old larvae at concentrations of 10 000 larvae/ $ft^2$ of water surface for periods of 24 h or longer in 0.05 to 0.1 mc $Na_2HP^{32}O_4$ solutions will yield adults with activity levels detectable for a period of at least 2 weeks.

* Hassett and Jenkins 1951 - [272]

347 Ильинская, Н.Б., Трошин, А.С. МАРКИРОВКА МУХ И КОМАРОВ ПРИ ПОМОЩИ РАДИОАКТИВНОГО ФОСФОРА. Зоол.Журн. 33, 4 (1954) 841-7.

1. При помощи радиоактивного фосфора (в форме $Na_2HP^{32}O_4$ или $K_2HP^{32}O_4$) можно легко пометить любое количество мух и комаров на достаточно длительный срок. 2. Маркировку мух легко производить кормлением имаго в течение 1 - 1,5 суток сахарным раствором с примесью $P^{32}$ при удельной радиоактивности раствора 1 микрокюри на 1 мл. 3. Для маркировки комаров личинки не позднее чем за 2 - 3 дня до окукливания помещаются (в количестве 10 - 20 шт. на 100 мл) в богатую микрофлорой среду, к которой добавлен $P^{32}$. Удельная радиоактивность среды доводится до 0,075 микрокюри на 1 мл. 4. Маркировку мух при помощи радиоактивного кальция ($Ca^{45}$) производить нецелесообразно, так как он очень быстро выводится из организма этих насекомых, ввиду чего радиоактивность их во времени очень быстро уменьшается.

Ilinskaya, N.B., Troshin, A.S. TAGGING FLIES AND MOSQUITOES WITH RADIOACTIVE PHOSPHORUS. Zool. Zh. 33, 4 (1954) 841-7.

Any quantity of flies (Musca domestica, Calliphora) or mosquitoes [Culex, Aëdes (diantaeus, cataphylla)] may easily be labelled by means of $Na_2HP^{32}O_4$ or $K_2HP^{32}O_4$). Flies are easily labelled by feeding the imago on sugar solution with added $P^{32}$ (specific activity 1 µc/ml) for 1-1.5 d. Mosquito larvae, not more than 2-3 d before pupation (10 - 20 mosquitoes per 100 ml) are placed in a $P^{32}$-containing medium, rich in microflora. The specific radioactivity of the medium is 0.075 µc/ml. Labelling of flies with $Ca^{45}$ proved unsuitable since it was quickly lost from the insect body, with subsequent very rapid loss of radioactivity.

* Jenkins and Hassett 1951 - [110]

* Kuper and Pelc 1952 - [405]

* Provost 1957 - [112]

* Provost 1960 - [113]

348 Shemanchuk, J.A., Spinks, J.W.T., Fredeen, F.J.H. A METHOD OF TAGGING PRAIRIE MOSQUITOES (DIPTERA: CULICIDAE) WITH RADIOPHOSPHORUS. Canad. Ent. 85 (1953) 269-72.

Tagged adults were obtained from 4th instar mosquito larvae [mostly Aëdes spencerii (Theo.), and A. campestris (D. & K.)] kept for 24 h in a 0.1 µc/ml solution of $P^{32}O_4$, at a density of 1 larva/ml of radioactive solution. After exposure the larvae could be returned to their normal, non-radioactive habitat for further development. Adults were found to retain readily detectable amounts of radioactivity. Field experiments were carried out with the above and, in addition, with A. flavescens (Müll.) and A. dorsalis (Meig.) from

spring flood pools. The short exposure method reduced the possibility of over-exposure to surface irradiation, and reduced mortality caused by prolonged artificial rearing conditions. There is also less chance of the larvae assimilating lethal doses of $P^{32}$. The simplicity of the equipment and method is stressed.

349 Жадин, В.И., Ильинская, Н.Б., Световидов, А.Х., Трошин, А.С. ЗАДАЧИ И МЕТОДЫ МЕЧЕНИЯ НАСЕКОМЫХ И РЫБ РАДИОАКТИВНЫМИ ИЗОТОПАМИ. Труды научной сессии по достижениям и задачам Советской биофизики в сельском хозяйстве, Москва (1955) 276-84.

Описываются методы мечения Musca domestica, Calliphora vomitoria радиоактивным фосфором (P-32) путем добавления к молоку $K_2HP^{32}O_4$ или $Na_2HP^{32}O_4$ на стадии личинки и куколки или же для взрослых особей $K_2HP^{32}O_4$ к 2% раствору глюкозы или галактозы. Удельная активность раствора глюкозы составляла 1 мкюри/мл. В течение 24 часов все мухи стали радиоактивными и сохраняли эту радиоактивность на всю жизнь. Также описана методика мечения комаров с помощью P-32 (Aëdes и Culex ). Она представляет значительную модификацию метода Дженкинса и Хассета, 1951. Личинки комаров отбирались в водоемах и прудах и помещались в деревянные ящики, заполненные речной водой, из расчета 10 мл/личинку. P-32 вводили в воду (средняя удельная активность 0,075 мккюри/мл, или 0,008 мккюри/личинку) на 3 или 4 стадии развития, во всяком случае не позже чем через 2-3 дня до окукливания. В этих условиях личинки хорошо развиваются, окукливаются и производят взрослые особи с высокой радиоактивностью на протяжении всей их жизни.

Zhadin, V.I., Ilinskaya, N.B., Svetovidov, A.Kh., Troshin, A.S. PROBLEMS AND METHODS OF TAGGING INSECTS AND FISH WITH RADIOISOTOPES. p.276-84 in Trudy nauchnoy sessy po dostnzheniyam i zadacham Sovetskoy biofiziki v selskom khozyaistve, Moskva 1955.

Methods of labelling Musca domestica and Calliphora vomitoria by $P^{32}$ in the larval and pupal stage, by adding $K_2HP^{32}O_4$ or $Na_2HP^{32}O_4$ to milk or, for adults, $K_2HP^{32}O_4$ to a 2% glucose or galactose solution are described. The glucose solution had a specific activity of 1 mc/ml. Within 24 h all flies were radioactive and remained easily detectable throughout their lives. A $P^{32}$-tagging technique for mosquitoes (Aëdes and Culex) is also described which represents a rather substantial modification of the technique of Jenkins and Hassett, 1951. Mosquitoe larvae were obtained from reservoirs and pools, and put into wooden boxes filled with river water (10 ml/larva). At the 3rd or 4th stage, in any case not later than 2-3 d before pupation, $P^{32}$ was introduced into the water (average specific activity 0.075 μc/ml, or 0.008 μc/larva). Under such condition larvae develop well, form pupae, and later adults whose radioactivity remains high throughout their lives.

## Miscellaneous

350 Arnason, A.P., Fuller, R.A., Spinks, J.W.T. AN ELECTRONIC METHOD OF TRACING THE MOVEMENTS OF SOIL-INHABITING INSECTS. Science 111 (1950) 5-6.

The wireworm, Ctenicera aeripennis destructor Brown, was labelled by inserting a $Co^{60}$-wire into the body cavity of the larvae rather than by feeding, which has proved impractical for several reasons. External application is only appropriate between molts, because activity is shed at each ecdysis. The worm can be followed through a depth of several inches by means of an outside G-M counter. The method is applicable to studies on response to different conditions and investigations on other species.

351 Babers, F.H., Roan, C.C., Walker, R.L. TAGGING BOLL WEEVILS WITH RADIOACTIVE COBALT. J. econ. Ent. 47 (1954) 928-9.

A preliminary note. In order to study the overwintering habits of the boll weevil, Anthonomus grandis Boh., it became necessary to tag several thousand adults with a material the activity of which could still be detected 5 months after application. The solutions used were 1) stock solution: 5 mc of $Co^{60}$ (chloride) in 0.2 ml of 0.34 N HCl was diluted to 10 ml with distilled water; 2) working solution: 2 ml of stock diluted with 198 ml of distilled water, giving a specific activity of $6.6 \times 10^5$ cpm/ml. A wetting agent ("Tergitol No.7") greatly increased the amount of radioactive solution retained and reduced the amount removed by washing. It was found possible to obtain slow labelling of cotton plants by a $Co^{60}$ solution.

* Banks 1954 - [58]

* Banks 1955 - [59]

* Berwig 1959 - [37]

* Bjorling et al. 1951 - [407]

352 Cornwell, P.B. TECHNIQUES FOR LABELLING TREES WITH RADIOACTIVE PHOSPHORUS. Nature 175 (1955) 85-7.

The methods described are suitable for obtaining radioactive host plants of insect populations in the field. All three techniques mentioned suffer from two disadvantages, namely, the translocation of $P^{32}$ from the point of application is small and the distribution of tracer within the tree is localized. Similar results were obtained with $Ca^{45}$ and rubidium-86 injected into yellow birch. Future methods will be carried towards methods of root application. These techniques were studied with a view to investigating the movement of the mealybug vectors of swollen-shoot disease of cacao. Since the artificial release of labelled insects in the field is unsatisfactory in this case, it is aimed to achieve labelling of insects at their feeding sites under field conditions.

353 Courtois, G., Lecomte, J. SUR UN PROCÉDÉ DE MARQUAGE DES ABEILLES BUTINEUSES AU MOYEN D'UN RADIOISOTOPE (Concerning a method for marking worker bees by means of a radioisotope). C.R. Acad. Sci. 247 (1958) 147-9.

Colloidal radioactive gold, $Au^{198}$, was added to food. Bees from a particular hive and from neighbouring hives were tested for radioactivity after certain time intervals. Radioactivity was found in nearly all bees of the hive within a few hours, and some bees were occasionally found erring to neighbouring hives. It could also be shown that the flight range was relatively small, and that the bees from each hive had their own narrowly circumscribed field of action.

354 Davis, J.M., Nagel, R.H. A TECHNIQUE FOR TAGGING LARGE NUMBERS OF LIVE ADULT INSECTS WITH RADIOISOTOPES. J. econ. Ent. 49, 2 (1956) 210-1.

Techniques were devised for applying enough $\gamma$-emitter (ca. 20 $\mu$c/insect) to forest insects, in this case primarily to Engelmann spruce beetles (Dendroctonus engelmanni Hopk.) to permit their being rapidly located when under the bark of trees or under debris on the forest floor. $NaI^{131}$, $Sc^{46}Cl_3$ and $Na_2Ir^{192}Cl_6$ were used successfully, whereas $Ag^{110}NO_3$ and $Rb^{86}Cl$ were toxic in the amounts required. The insects were apparently unaffected by the treatment.

* Donnelly 1958 - [259]

355 Entomol. Soc. Ontario, PHOSPHORUS-32 LABELLING THE ADULTS OF THE CABBAGE MAGGOT, HYLEMYA BRASSICAE (BOUCHÉ) (DIPTERA: ANTHOMYIDAE). Rep. ent. Soc. Ont. 85 (1955) 51-61.

In the course of investigations in Ontario on the dispersal of adults of Hylemya brassicae (Bch.), two methods of tagging the flies with $P^{32}$ were developed. In 1951, spraying about 40 caged adults with 0.5 $\mu$c $P^{32}$ (in phosphoric acid) diluted to 5 $cm^3$ with distilled water resulted in counts per minute of 1 200 - 1 600 after 24 h, 200 - 1 600 after a week and 400 after a fortnight, when only one fly survived. In 1952, similar treatment of 50 flies with 0.25 mc $P^{32}$ in 5 $cm^3$ resulted in averages of 245 cpm after one day and 75 after 12, when all but two flies were dead. The radioactivity was not removed by washing, and radioactive eggs were laid by some females, indicating that the solution had been absorbed, but as the length of life was reduced and all the flies in a group might not receive sufficient spray, the method was considered unsatisfactory. About 100 flies that were allowed to feed on a solution of 0.5 mc $P^{32}$ in 100 $cm^3$ 7% sucrose solution from a wick of dental cotton which was soaked in the solution every day, showed on average of 340 cpm after a week in 1951. In 1952, when flies were provided with a solution of 0.75 - 1 mc $P^{32}$ in 100 $cm^3$ 5% sucrose solution daily for 13 d, the average cpm rose from 300 on the second day to 960 on the 12th and fell thereafter to 150 on the 42nd, when only one fly survived. Females developed significantly more radioactivity than males, and some laid radioactive eggs; larvae from the latter showed no radioactivity. As a significant count for a considerable period after feeding with radioactive material ceased, and as there was no apparent effect on survival or oviposition, this method is considered satisfactory. (RAE-A 45: 344, 1957)

* Flemion et al. 1952 - [33]

356 Food and Agriculture Organization of the United Nations, Rome. European Commission on Agriculture. REPORT OF THE FIRST MEETING OF THE EUROPEAN CONTACT GROUP ON THE USES OF ISOTOPES AND RADIATION IN AGRICULTURAL RESEARCH. Held in Wageningen, Netherlands, 10-14 December 1956. FAO/57/3/1637, NP-6353, 41p.

Very general survey of European research programs engaged on so far, and to be envisaged for the future. Mention is made of Finnish studies with $C^{14}$ on the wheat bugs Dolycoris baccarum and Lygus rugulipennis. No details are given. - Some introductory reading is listed for the whole field.

357 Fredericksen, C.F., Lilly, J.H. MEASURING WIREWORM REACTIONS TO SOIL INSECTICIDES BY TAGGING WITH RADIOACTIVE COBALT. J. econ. Ent. 48,4 (1955) 438-42.

Wireworms of the genus Melanotus were tagged with $Co^{60}$ by having a small piece of cobalt wire (initial activity about 0.07 mc) cemented to the dorsal surface of the caudal segment after which the wireworm reactions to 4 different soil insecticides (Aldrin, Dieldrin, heptachlor or Lindane - almost pure $\gamma$ BHC -) were studied. The subsequent vertical and horizontal positions were determined by a G-M counter. Movement was found to be greatest in untreated soil, with greatest reduction in soil treated with Aldrin or BHC. Dieldrin had the least effect. However, all wireworms that entered treated soil and stayed in it were dead or moribund after 4 d, so that all the insecticides were toxic to them, and all from the boxes containing some treated soil were dead within 2 weeks, even though they had not actually entered the treated areas; some fumigant effect is thus implied. The wireworms in untreated soil survived normally.

358 Fuller, R.A., Spinks, J.W.T., Arnason, A.P., McDonald, H. USE OF RADIOACTIVE TRACERS IN INVESTIGATIONS ON SOIL-INHABITING INSECTS. Rep. ent. Soc. Ont. 81 (1951) 7-15.

The authors describe experiments carried out in Canada, in which wireworms [Ctenicera aeripennis destructor (Brown)] and cutworms [Euxoa ochrogaster (Gn.) and Agrotis orthogonia (Morr.)] were marked with $Co^{60}$ for observations on their behaviour in the soil. This material was chosen because the comparatively high energy of its $\gamma$-radiation makes detection possible through several inches of soil, and its long half-life minimizes corrections for decay; the larvae studied are slow-moving and unlikely to be lost, so that an isotope with a long half-life could be used without much danger. The technique and its effects on the worms are described, including the distribution of radioactivity within them. A number of experiments were carried out by means of a probe which allowed the positions of radioactive larvae to be determined to within $\frac{1}{4}$ in to a depth of 5 in. Curves are given to show absorption of $\gamma$-rays from $Co^{60}$ by soil of different thickness. The effect of temperature on wireworms was tested. Wireworms were also offered alternative soil-moisture conditions. In another experiment, the paths of several wireworms seeking food were followed; both rates and routes varied greatly. Insertion of $Co^{60}$ on wire into the body cavity proved highly toxic for wireworm larvae, but gave only a small percentage of mortality in cutworms.

* Gillies 1958 - [771]

* Godwin et al. 1957 - [99]

359 Gösswald, K., Kloft, W. ZUR LABORATORIUMSPRÜFUNG VON TEXTILIEN AUF TERMITENFESTIGKEIT MIT CALOTERMES FLAVICOLLIS FABR. (Laboratory testing of textile fabrics for termite resistance by means of Calotermes flavicollis Fabr.). Ent. exp. et appl. 2 (1959) 268-78.

Experiments were made over a period of two years on the resistance of various materials, especially textiles, to termites. The dry wood termite, Calotermes flavicollis Fabr. was used as a test animal, as this insect is resistant to environmental conditions and it readily attacks hard materials. Quantitative radio-biological investigations (the insects were rendered radioactive by feeding them $P^{32}$-labelled filter paper) showed that fifth-instar larvae and "Pseudergates", which both feed actively, are good test animals. After moulting, larvae do not feed for 4 d. It is advisable therefore to use large batches (30 larvae in each) to ensure that some are trying to feed at any time. Experiments should last 21 d at least. The method used in testing the effects of C. flavicollis on textiles, and the way the insect is acclimatized, are described. A useful new technique for these tests consists of pulling the textile into the metal frame of a projector-slide. Termites can gnaw through materials otherwise resistant when they are covered by a thin perforated film of termite-proof material. If the perforations are of the same diameter as the termite's head they serve as innate releasing mechanisms for "food-tunnel gnawing". This method should only be used in special cases, e.g. testing for repellency, surface hardness, etc. (auth. summary)

* Green et al. 1957 - [123]

* Holling 1958 - [1560]

* Hyland and Hammar 1959 - [190]

360 Jacob, J., Sirlin, J.L. LABELLING OF INSECT SPERMATOZOA BY ADENINE-8-$^{14}$C. Experientia 14, II (1958) 402-3.

A labelling technique for mature spermatozoa of Ptinus hirtellus (Coleoptera) and of Drosophila melanogaster is described. About 0.01 $cm^3$ of a solution of adenine-8-$C^{14}$ (10 $\mu c/cm^3$, 9.6 pc/mM) was injected into each larva of P. hirtellus using a microneedle. Drosophila larvae fed on dead yeast medium containing adenine-8-$C^{14}$ (10$\mu c/cm^3$ of medium). Autoradiographs of sections, squashes or smears of adult testes were made.

* Kartman et al. 1958 - [406]

361 Kettlewell, H.B.D. LABELLING LOCUSTS WITH RADIOACTIVE ISOTOPES. Nature 175, 4462 (1955) 821-2.

Experiments are described in which hoppers and adults of Schistocerca gregaria were fed on materials containing $P^{32}$. This method would make it possible to mark hoppers, for which external markings are of no use because they shed their skins frequently. However, it would be costly and difficult. Unless some automatic recording device can be found, it seems that the radioactive isotopes have no advantages over colour paints for labelling adult locusts. (BA 29: 27205, 1955)

362 Kettlewell, H.B.D. LABELLING OF LOCUSTS WITH RADIOACTIVE ISOTOPES. UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF.8/P/1079, 12 (1956/214-5.

Locusts (Locusta migratoria L. and Locusta pardalina Walk.) were labelled with $P^{32}$ in the nymph and adult stages. $P^{32}$ was rapidly absorbed in the organic or inorganic form. Autoradiography showed differences in localization of radioactivity, depending on whether the $P^{32}$ had been acquired before or after reaching the adult stage. The author concludes, however, that without the use of some automatic recording device, radioactive labelling of locusts has little advantage over colour paints since these can be recorded by untrained workers.

* Kloft 1960 - [27]

* Kloft and Ehrhardt 1959 - [41]

363 Knapp, S.E., Farinacci, C.J., Herbert, C.M., Jr., Saenger, E.L. A METHOD FOR LABELING THE LONE STAR TICK WITH A RADIOACTIVE INDICATOR ($P^{32}$). J. econ. Ent. 49, 3 (1956) 393-5.

About 1 300 ticks (Amblyomma americanum (L.)) were made radioactive by submersion in a solution containing $P^{32}$ as sodium dihydrogen phosphate and having a specific activity of 10 $\mu c/ml$. The ticks (in lots of up to 200) were confined in a Büchner funnel by a disk of 36-mesh brass wire, with a 1/4-inch hole in the centre through which they were inserted. The solution was poured into the funnel, allowed to stand for one minute and then drawn off. This procedure was carried out three times with the same solution. The ticks were then transferred to clean petri dishes. They were measured for uptake and retention of $P^{32}$ with a mica end-window G-M tube attached to an autoscaler. They were held in place individually under the window and ½ inch from it in a rubber retaining ring with a lens-paper cover on a stainless steel planchet. The mean counts per minute for lots of about 25 individuals treated 14 d before in solution containing no wetting agent were 278 for males and 397 for females. Addition of a wetting agent to the solution did not increase uptake or retention of $P^{32}$ but substantially reduced survival of female ticks. The use of wetting agents is therefore not recommended. (RAE-B 45: 115, 1957)

364 Корш. МЕЧЕНЫЙ ШЕЛКОПРЯД. Наука и Жизнь, Москва 6 (1959) 61-4.

Korsh, Y.M. THE MARKED SILKWORM. Sci. and Life, Moscow 6 (1959) 61-4.

were used. $P^{32}$ and $Sr^{89}$ were quickly absorbed by the peach foliage, optimum concentrations being 100 μc/ml and 2 μc/ml respectively. $Sr^{89}(NO_3)_2$ was unsatisfactory and replaced by $Sr^{89}Cl_2$. $P^{32}$ is suitable for dispersal studies but not for determining hibernation sites. $Zn^{65}$ was found to be either extremely toxic to foliage or else not to activate the beetles sufficiently. Attempts to produce $I^{131}$-labelled foliage proved unsuccessful, partly because of uneven distribution. $Co^{60}$ was absorbed unevenly by the weevils. Whereas they did not retain sufficient activity for exact site determinations, overwintering in the orchards could be confirmed after 8.5 months.

371 Speers, C.F. RADIOISOTOPES IN FOREST INSECT STUDIES. Proc. Ass. Sth. agric. Wkrs 53 (1956) 130.

$Ir^{192}$ was used in an attempt to determine flight range of the Southern pine beetle, Dendroctonus frontalis Zimmermann. Some preliminary results are given. For determining the movement of white grubs through the soil, pieces of activated tantalum were injected into the body cavity of each grub. Details of the technique are given. The grubs were replaced in the soil under 5 different conditions of ground cover to determine whether the type of ground cover affected larval movement. Ant predation proved annoying. Treated larvae were able to transform to adult stage and still retain their activity.

* Spinks 1956 - [12]

* Sullivan 1953 - [101]

372 Sundby, R. THE MARKING OF THE MOTH PHYLLOCNISTIS LABYRINTHELLA BJERK. WITH RADIOACTIVE PHOSPHURUS. Oikos 9,2 (1958) 253-9.

Phyllocnistis labyrinthella (lepidoptera) is a small leaf-mining moth. Mass emergence of imagoes occurs in July, after which the moths disappear and cannot be traced by usual methods. The following spring they reappear and breed. Newly emerged imagoes were fed a mixture of sugar, water and $P^{32}$-labelled phosphoric acid in the laboratory. They survived well, even when fed with a solution containing 100 μc of $P^{32}$ per ml. Moths fed with this concentration could be detected by a Geiger counter 0.5 m away. Two hundred tagged moths were liberated in the field and then detected 8 d later. They were in the ground, some distance below the surface. Subsequent searches showed very little change of location by the moths up until the first frost arrived in September. Unfortunately, the short half-life of $P^{32}$ prohibited detection of the imagoes the following spring. (BA 33: 27682, 1959)

373 Vanderplank, F.L. STUDIES ON THE COCONUT PEST, PSEUDOTHERAPTUS WAYI BROWN (COREIDAE), IN ZANZIBAR. I. METHOD OF ASSESSING THE DAMAGE CAUSED BY THE INSECT. Bull. ent. Res. 49,3 (1958) 559-84.

Nymphs were reared on coconut inflorescences placed in distilled water containing $P^{32}$ or $S^{35}$ at the rate of 2 mc per pint. The $P^{32}$ was in the form of carrier-free orthophosphate in dilute HCl (pH 3-5), with original activity 8.83 mc/ml. The $S^{35}$ was in the form of a sulphate containing a little NaCl (pH 1-2) with the carrier-sulphate not exceeding 100 μg/ml and an activity 5 mc/ml. The inflorescence became radioactive within 24 h and sections (autoradiographed) showed that, whereas the P was distributed chiefly in the meristematic tissues, on some of which P. wayi feeds, the distribution of the S was more uniform. Nymphs reared on these inflorescences became strongly radioactive. Adults reared from such nymphs gave 600 cpm above the 100 cpm background. For release-capture studies, the longer-lived $S^{35}$ is more suitable than $P^{32}$. Several hundred radioactive adults were released in a relatively isolated plantation, with palms spaced roughly 10 X 10 yd apart. The method used for tracing insects proved too clumsy for use as a basis for determining the size of a population. (Summary of radioactive marking technique)

374 Yates, W.W., Gjullin, C.M., Lindquist, A.W., Butts, J.S. TREATMENT OF MOSQUITO LARVAE AND ADULTS WITH RADIOACTIVE PHOSPHORUS. J. econ. Ent. 44,1 (1951) 34-7.

Studies were made to determine how to introduce $P^{32}$-labelled phosphoric acid into both larvae and adult mosquitoes in amounts that would be detectable with radioactive measuring devices. Aëdes sticticus (Meig.) and A. vexans (Meig.) mosquitoes gave 544 to 897 cpm above background after they had been allowed to feed on the blood of rats that had received 0.375 mc of $P^{32}$ in aqueous solution intraperitoneally 24 h earlier. In three dissected specimens an average of 72% of the radioactivity was found in the abdomen and 4% in the legs. Second- and third-instar larvae of Culex tarsalis (Coq.) reared in water having an unknown concentration of $P^{32}$ had radioactivity ranging from 164 to 417 cpm. Fifteen percent of this radioactivity was present in the legs and 45% in the abdomen. Aëdes sticticus females fed on water having an unknown con-

centration of $P^{32}$ gave readings of 577 to 1192 cpm 1 to 13 d after. The legs had approximately 9% and the abdomens 41% of the total radioactivity. Aëdes sticticus and A. vexans adults reared from the second-stage larvae in water containing 0.05% µc of $P^{32}$/ml gave average readings of 41 147 cpm for females and 39 072 cpm for males. In later tests dosages of 0.01, 0.001, and 0.0001 µc per ml gave 14 911, 1 612, and 522 cpm, respectively, for the females. It is suggested that a concentration of approximately 0.0001 µc of radioactive phosphoric acid per ml may be a practical dosage for the larvae in flight studies of adults. Adults may be readily tagged by feeding them sugar solutions containing small amounts of $P^{32}$. (auth. summary)

## I - D Developmental and Genetic Effects Incurred Through Labelling

### $H^3$

Kaplan and Sisken 1960 - [220]

375 Pavan, C. EFFECT OF RADIATION ON PUFFS OF POLYTENIC CHROMOSOMES OF RHYNCHOSCIARA ANGELAE. p. 42-52 in "Radioisotopes and Radiation in the Life Sciences. 2nd Inter-American Symposium on the Peaceful Application of Nuclear Energy, Buenos Aires 1959". TID-7554. Washington, D.C., Pan American Union. 1960.

Radiation effects from internally applied tritium (by injecting $H^3$-labelled thymidine) or external x-irradiation do not appear to have any appreciable effect on puff formation. Techniques and implications of the results are discussed.

### $C^{14}$

376 Suomalainen, E., Turpeinen, O., Niini, R. MUTATIONS IN DROSOPHILA MELANOGASTER GROWN ON MEDIA CONTAINING CARBON-14-LABELED SUGARS. Nature 178 (1956) 357-8.

The mutagenic action of $C^{14}$ was investigated by rearing D. melanogaster individuals from eggs to adults on media containing $C^{14}$-labelled sugars prepared photosynthetically by Canna indica leaves. The culture media contained 1, 0.1, or 0 mc radioactivity per culture bottle. The male offspring of the first and second generations reared on these media were tested for the presence of the X-chromosome lethals by the Muller-5-technique of Demerec (cf. CA. 42: 7453c). The number of mutations observed in flies reared on the 0.1-mc-medium (total radiation approximately 75 r) was not significantly different from 0. For the 1-mc-medium (800 r) a significant frequency of mutation (2.2 - 2.8%) was observed. (CA 50: 17211i, 1956)

### $P^{32}$

377 Arnason, T.J., Irwin, R.L.B., Spinks, J.W.T. $P^{32}$-INDUCED LETHAL MUTATIONS IN DROSOPHILA. Canad. J. Res., D-Canad. J. Zool. 29, 3 (1951) 234-9.

X-chromosomes of $P^{32}$-treated wild-type D. melanogaster were tested for recessive lethal mutations. Treated larvae were reared in food medium containing initially 6.5, 32.5, 65.0 or 162.5 mrd.$P^{32}$/ml. Of 838 tested chromosomes 42 had recessive lethals. The frequency of mutation was roughly proportional to $P^{32}$-content of the food. An initial concentration of 18.8 mrd $P^{32}$ in larval food is expected to produce about the same frequency of recessive lethal mutations as is obtained with 1000 r of x-rays applied to mature sperm. A fly reared in a medium having an initial concentration of 32.5 mrd per ml receives, prior to mating, a calculated total radiation dose of 0.62 gram roentgens. At this dosage 4.2% recessive lethals were recorded. For equivalent amount of ionization $P^{32}$ is here apparently 2.3 times as effective as x-rays. (auth.)

378 Bateman, A.J. THE TIME FACTOR IN $P^{32}$-INDUCED MUTATIONS IN MALE DROSOPHILA. Heredity 9, 2 (1955) 187-98.

♂♂ fed as larvae on medium containing $P^{32}$ were mated daily to fresh batches of attached-X yellow ♀♀. The mutation rate in daily sperm samples was measured as the incidence of non-yellow daughters (hyperploid for a deleted-X). The $P^{32}$ content varied greatly during the life of the fly, according to the rates of absorption and excretion as well as radioactive decay. The variation in mutation rate between daily sperm samples was related to the $P^{32}$ content of the fly, pupa, or larva and to the presence or absence of active food medium, when the sperm sampled was in its hypersensitive stage, 7-8 d before maturity. (auth.)

379 Bateman, A.J., Sinclair, W.K. MUTATIONS INDUCED IN DROSOPHILA BY INGESTED PHOSPHORUS-32. Nature 165 (1950) 117-8.

$P^{32}$ was administered to the larvae of D. melanogaster in order to determine the number of mutations which could be induced by the radioisotope. The highest specific amount introduced in the larvae bottles was 1 mc per bottle; this resulted in the death of all the insects before pupation. A 0.1 mc amount resulted in the death of an appreciable number of the specimens, while the introduction of 0.01 mc of $P^{32}$ resulted in no appreciable number of deaths. Flies emerging from the 0.1 mc bottles were further studied; their activity was measured and, though it was variable, the mean figure was 0.0122 μc/fly 2-3 d after emergence. The overall lethal mutation rate observed (7.3%) is the rate which would be expected for an x-ray dose of 2 500 r. The lethal mutation-rate/g-r was derived for the $P^{32}$ and for a dose of 2 500 r of x-rays, and was found to be similar, but the authors caution against attaching too much significance to this similarity. The high mutation rate of visibles produced by the $P^{32}$ corresponds to the expectation from 12 000 r of x-rays. It is concluded that additional work is necessary to confirm whether $P^{32}$ is really four times as efficient as x-rays in the production of visible mutations. (NSA 4: 1629, 1950)

380 Blumel, J. THE ACTION OF RADIOPHOSPHORUS IN DROSOPHILA. Science 111 (1950) 205-6.

In the present investigation, $P^{32}$ was used to study the action of β rays on D. melanogaster and D. virilis. Pairs of mature flies were placed in shell vials containing a culture medium, consisting of a standard Drosophila culture medium and added radioactive $H_3P^{32}O_4$; the original volume (about 300 ml) of medium, with a count of 265 000 cpm/ml, was distributed among 50 vials in 6 ml amounts. Twelve days after exposure, the distribution of radioactivity in the various tissues of the insects was determined; few of the D. virilis generation hatched in the radioactive solution survived, and none of the adults were tested, but in the case of D. melanogaster, the hatch was normal and all present, adults and larvae, were examined. All hatched individuals of D. virilis strain were morphologically abnormal, the abnormalities pertaining mostly to the eyes, legs, abdomen, wings, and genitalia. Other data indicate that radioactive $P^{32}$ not only produces mutations in D. virilis but also chromosomal rearrangements. The tolerance to such irradiation is considered to be high. (NSA 4: 2507, 1950)

* Darwish et al. 1958 - [253]

* Dissanaike et al. 1957 - [345]

* Gamð et al. 1950 - [262]

* Grosch and Sullivan 1954 - [132]

381 Grosch, D.S. LETHALITY INDUCED BY FEEDING RADIOPHOSPHORUS TO MALE HABROBRACON. Amer. Nat. 90 (1956) 200-2.

Feeding of $P^{32}$-labelled honey to male wasps (starved) and subsequent mating under the experimental conditions described gave rise to a sex ratio of nearly 1:1 instead of the typical 60-70% predominance of females. In females similar feeding can cause permanent cessation of egg production. Even when successful, radiophosphorus feeding experiments show considerably less effect when males rather than females are used. In order to corroberate evidence of dominant lethality, the cocoons holding uneclosed pupae were openened and the contents identified where possible. Nearly twice as many unemerged females were obtained from treated fathers as from controls. Possible reasons for the relative ineffectiveness of $P^{32}$ fed to males are suggested in terms of recent studies.

* Grosch 1958 - [1137]

382 Grosch, D.S., Sullivan, R.L. THE EFFECT OF INGESTED RADIOPHOSPHORUS ON EGG PRODUCTION AND EMBRYO SURVIVAL IN THE WASP HABROBRACON. Biol. Bull. 102,2 (1952) 128-40.

Unmated females of Habrobracon juglandis, wild type 33, starved for 5 d at 30°C and then fed a droplet of white-clover honey containing varying doses of $P^{32}$ delivered to the side of the storage vial to prevent external irradiation, were permitted to oviposit on two pre-stung caterpillar wasps. Collected eggs were incubated in mineral oil (nujol) at 30°C for 48 h to test viability. At doses of higher than 200 μc/g egg production was halted in a few days, between 50 to 200 μc/g initial egg production was reduced, followed by recovery; below 50 μc/g no decrease in egg production was observed. With doses above 200 μc/g the viability

of embryos from eggs oviposited within the first 2/3 of life were correlated with the level of radioactivity ingested. With doses above 200 μc/g the viability of embryos from eggs produced during the 2/3 of life was correlated with the level of ingested radioactivity. None of the animals showed a decrease in longevity as a result of radioexposure. (CA 46: 7664a, 1952)

383 Grosch, D.S., Sullivan, R.L., LaChance, L.E. THE COMPARATIVE EFFECTIVENESS OF FOUR BETA-EMITTING ISOTOPES FED TO HABROBRACON FEMALES ON PRODUCTION AND HATCHABILITY OF EGGS. Radiation Res. 5,3 (1956) 281-9.

Precision weighing is used to determine the amount of radioisotope required to cause temporary and permanent sterility. The entire wasp, Habrobracon juglandis, is weighed before and after feeding an honey adulterated with radioisotope. As shown by lowered egg production and hatchability, the descending order of effectiveness of the ingested radioisotopes is the same as the ascending order of physical half-life: $P^{32}$, $Sr^{89}$, $S^{35}$, $Ca^{45}$. Permanent sterility was obtained only after feedings of $P^{32}$ and $Sr^{89}$. Experimental results support the concept that effectiveness of a given isotope is correlated with the number of particles received by an organism within a critical period of time after ingestion, and with the energy of these emissions. (auth. D.S.G.)

* Grosch et al, 1957 - [830]

384 Hahn, P.F., Haas, V.H., Wilcox, A. ARREST OF DEVELOPMENT OF PLASMODIUM GALLINACEUM IN MOSQUITOES (AËDES AEGYPTI) BY RADIATION EFFECT OF $P^{32}$. Science 111 (1950) 657-8.

A total of 250 Aëdes aegypti mosquitoes were allowed to engorge on chicks which were infected with Plasmodium gallinaceum and that showed many gametocytes in their peripheral blood. Thereafter 150 of the mosquitoes were provided daily with 5% glucose solution containing radioactive sodium acid phosphate (with a total radioactivity of about 30 mc of $P^{32}$). The remaining mosquitoes served as controls and were provided with nonradioactivé glucose solution. Nine days following the blood feeding, 10 mosquitoes from each group were dissected for determination of the presence of oöcysts in their stomachs; all 10 of the irradiated specimens contained oöcysts, as did 8 of the controls. Five days later, mosquitoes from the two groups were dissected and no sporozoites were found in the salivary glands of the irradiated specimens, but 11 out of 15 control specimens showed these forms. The lowest activity for any salivary gland in the specimens administered the $P^{32}$ solution was 334 cpm, while the average was 2400 cpm; calculations suggest a very high equivalent roentgen dosage was delivered to the salivary gland tissue, despite the apparent absence of any deleterious effects. The author concludes that the radiation delivered by the ingested $P^{32}$ was sufficient to arrest the development of the parasites during the oöcyst stage. (NSA 4: 4425, 1950)

* Hassett and Jenkins 1951 - [272]

* Hoffman et al. 1951 - [335]

385 King, R.C. GENETIC CHANGES ACCOMPANYING THE UPTAKE OF $P^{32}$ BY DROSOPHILA MELANOGASTER. Genetics 35,1 (1950) 118-9.

Males show a higher percentage of sex-linked lethals than females. Developmental stages are very sensitive to radiation and fail to survive treatments which would result in very low mutant induction in adults. $P^{32}$ is distributed among the head, thorax, gut, gonad and abdominal shell in the ratio of 20:50:10:10:10 regardless of the total activity of the fly for males labelled as adults. Radioautographs (spermathecae, associated organs of inseminated females) showed radioactive sperm. As high as 26% sex-linked lethal mutation rates have been induced in adult males of an inbred Canton-S stock by the M5 technique. Out of a total of some 1951 X's treated so far, 90 sex-linked recessive lethals and 11 viable mutations have been recovered. By changing the initital activity - feeding time relations or by increasing the number of $P^{31}$ atoms in the medium while keeping the number of $P^{32}$ atoms constant it is possible to expose different groups of flies to an equal flux of high energy β-particles from the medium but to an entirely different internal radiation dose from the radioactive decay of $P^{32}$ atoms incorporated into tissue.

Abstract of paper presented at the 1949 meetings of the Genetics Society of America, New City, 28-30 Dec. 1959.

386 King, R.C. CALCULATION OF RADIATION DOSES TO $P^{32}$-LABELED MALE DROSOPHILA MELANOGASTER. Nucleonics 10,11 (1952) 88-9.

A method is described for calculating the geometrical factor necessary for determining the radiation dose absorbed by the gonad of the male. A very simple model of a male fruitfly is proposed, consisting of 3 spheres of water, corresponding in weight to the head, thorax, and abdomen. A homogeneous distribution of $P^{32}$

atoms is assumed. It is calculated that about 12.6% of the total energy dissipated by particles originating from internally decaying $P^{32}$ is absorbed by the tissue of male D. melanogaster. Radiation contributed to the gonad by $P^{32}$-labelled tissue of the head and thorax is negligibly small when compared to that contributed by abdominal tissue.

See also BNL-1230, Brookhaven National Lab., Upton, N.Y. 11p.

387 King, R.C. THE MUTAGENIC EFFECTIVENESS OF RADIOACTIVE PHOSPHORUS IN DROSPHILA MELANOGASTER (abstr.). Genetics 37 (1952) 595.

The mutagenic effectiveness of radiophosphorus in D. melanogaster has been studied using the Muller-5 method for recovering sex-linked recessive lethal mutations. Methods are described for varying the radiation dose from the radioactive medium and the dose from $P^{32}$ within tissue with respect to each other. The radiation dose from the medium is determined by actual measurement, while the radiation dose to the male gonad from $P^{32}$ in tissue is calculated. It is shown that radiations from internally located $P^{32}$ atoms are mutagenically effective. However, in the case of male Drosophila fed upon $P^{32}$ as adults there is no indication that internal $P^{32}$ is more efficient mutagenically than external $P^{32}$. Among the genetic changes recovered following $P^{32}$ treatment are sex-linked recessive lethal and viable mutations, inversions and dominant lethals. $P^{32}$ treatment also increases somatic crossing over and produces potential chromosome breaks leading to the production of unilateral mosaicism. The importance of this work in the study of genetic effects ascribable to the actual transmutation of $P^{32}$ to $S^{32}$ is discussed.

Abstract of paper presented at the 1952 meetings of the Genetics Society of America, Ithaca, New York 8-10 Sep. 1952.

388 King, R.C. STUDIES WITH RADIOPHOSPHORUS IN DROSOPHILA. 2. THE EFFECT OF $P^{32}$ TREATMENT UPON DEVELOPMENT. BNL-1406, Brookhaven National Lab., Upton, N.Y. 1953, 13p.

Exposure of developmental stages of D. melanogaster to media of activities above 5 $\mu$c/g results in the killing of embryos, larvas, and pupas, in the retardation of development, and in the production of sterile adults. Females are more resistant to $P^{32}$ treatment than males. The external radiation from the medium is shown to be relatively unimportant in killing insects. (auth.)

389 King, R.C. STUDIES WITH RADIOPHOSPHORUS IN DROSOPHILA. I. THE MUTAGENIC EFFECTIVENESS OF RADIOACTIVE PHOSPHORUS IN ADULT MALE DROSOPHILA MELANOGASTER. J. exp. Zool. 122 (1953) 541-75.

Freshly hatched males were given $P^{32}$-labelled food. Methods are described for varying the radiation dose from the radioactive medium and from $P^{32}$ in tissue with respect to eachother. The former is determined by actual measurement, the latter by calculation from the dose to the $\sigma$ gonad from $P^{32}$ in tissue. Radiations from internally located $P^{32}$ atoms are shown to be mutagenically effective. Calculations lead to an erroneously high value describing gonad absorption of energy liberated by decaying $P^{32}$ in tissue. Only 2% of such energy is absorbed in the gonad; $1.5 \times 10^9$ disintegrations/adult $\sigma$ will produce a 1% sex-linked lethal mutation frequency. Some sex-linked recessive lethal and sex-linked viable mutations, inversions and dominant lethals were among the genetic changes recovered following treatment with $P^{32}$. It also increased somatic crossing over. Potential chromosome breaks leading to unilateral mosaicism were also produced. The significance of this work in the study of genetic effects in the transmutation of $P^{32}$ to $S^{32}$ is examined.

See also BNL-1237, Brookhaven National Lab., Upton, N.Y. 36p.

390 King, R.C. STUDIES WITH RADIOPHOSPHORUS IN DROSOPHILA. III. THE LETHAL EFFECT OF $P^{32}$-TREATMENT UPON DEVELOPING FLIES. J. exp. Zool. 126 (1954) 323-36.

The effect of various concentrations of $P^{32}$ in the medium upon the development of Drosophila was studied. Flies reared from a medium containing 50 $\mu$c/g of $H_3P^{32}O_4$ showed high embryonic, larval and pupal mortality, and there was a retardation in development depending on the concentrations involved. Fertile adults appeared in cultures containing 5 $\mu$c/g or lower. Concentrations low enough to allow complete development may produce sterility. Females, probably as the result of their X-chromosomal diploidy are more resistant to treatment than males. Under the experimental conditions applied here radiation from the medium is relatively unimportant in producing lethality. Of the energy liberated by $\beta$-particles from decaying $P^{32}$ in tissue sufficient is absorbed by the fly to account for the lethal effects observed.

391 King, R.C., Wilson, L.P. STUDIES WITH RADIOPHOSPHORUS IN DROSOPHILA. IV. EXPERIMENTS ON FLIES HOMOGENEOUSLY LABELED WITH $P^{32}$. J. exp. Zool. 126 (1954): 401-17.

Drosophila homogeneously labelled with $P^{32}$ have been produced by rearing flies for their entire life cycle on homogeneously labelled yeast growing on a solid $P^{32}$-labelled synthetic medium. Drosophila adults contain 3 mg P/g wet weight and maintain their phosphorus content at this level, even when forced to feed on media abnormally rich in phosphorus. Death to adults occurs when the overall phosphorus content of all tissues rises above 0.4%. A study of the variation of P content during development showed the egg to contain the highest P concentration of any stage. The relation between total P and wet weight for 1st and 2nd instar larvae was found to bradyauxetic; for 3rd instar larvae tachyauxetic. The daily radiation dose to homogeneously labelled Drosophila developing on labelled medium was calculated. Under the experimental conditions ($1.24\ P^{32}/1 \times 10^8\ P^{31}$ at $T_0$) no detectable difference was noted between labelled and control Drosophila with respect to egg hatchability, eclosion, time required for development from egg to adult, and sex ratio of the resting adults. Fecundity and fertility of $F_1$-labelled females was lowered, and evidence is presented relating this to transmutation of internal $P^{32}$ to $S^{32}$ rather than to ionization. (auth.)

392 Kogure, M., Nakajima, M. THE EFFECT OF $P^{32}$ ON THE SILKWORM, ADMINISTERED TO THE BODY WITH MULBERRY LEAVES. J. sericul. Sci., Tokyo 25 (1956) 238.

* Kogure and Nakajima 1958 - [1147]

393 Mossige, J. TRANSLOCATIONS AND RECESSIVE SEX-LINKED LETHALS INDUCED IN DROSOPHILA MELANOGASTER BY INGESTED RADIOPHOSPHURS (ABSTR.). p.197 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol.2. Toronto, University of Toronto Press. 1958.

The findings of Oftedal and Mossige that incorporation of $P^{32}$ in sperm followed the same curve as the mutation rate for sex-linked recessive lethals in daily broods suggested the possibility that some of the mutations might be due to the disintegration of $P^{32}$ incorporated in the genetic material. In an attempt to elucidate this question the day-to-day mutation curve for II-III translocations was determined. After an acute dose of radiation to newly eclosed males, the daily sensitivity pattern for translocations and recessive lethals has been determined. If, after ingestion of $P^{32}$, an appreciable number of mutations is due to disintegrations in the genetic material, and if these disintegrations are able to produce breaks leading to translocations as well as to sex-linked lethals, translocations should be found among the progeny of days 9 and later as these could be induced by disintegration in postmeiotic sperm. No such translocations have been found.

394 Mossige, J., Oftedal, P. THE MUTAGENIC EFFICIENCY OF $P^{32}$ CONTAINED IN DROSOPHILA MELANOGASTER MALES. Radiation Res. 9 (1958) 156.

In previous communications concerning the incorporation and mutagenicity of radiophosphorus during Drosophila spermatogenesis, the authors have emphasized the difficulty of calculating the fraction absorbed in the testes of the total dose delivered by the phosphorus contained in the fly. In the present paper this fraction has been estimated genetically. The genetic experiments have been made on mature sperm only, feeding 3-day old males which have not previously been mated, storing them for an additional 24 h, and then mating them for a few hours only so as to limit the variation in exposure time of the sperm utilized for testing. The recessive sex-linked lethal mutation rate in these sperm is then compared with mutation rates obtained with acute doses of X-rays. Taking into consideration the biological decay of $P^{32}$ in the fly during the first 24 h after ingestion, the result is found to be equivalent to between 1 and 2 r per hour per 1000 cpm in the fly as measured by our technique. Calculations based on the total amount of radioactivity contained in the fly give a total dose of some 50 rad/h/1000 cpm. Thus only a very small amount of the energy, approximately 2-4%, is absorbed in the testes. This agrees with King's (1953) results obtained by a different technique.

(Abstract of paper presented at the Intern. Congr. of Radiation Research, Burlington, Vermont 10-16 Aug. 1958)

395 Oftedal, P. THE PREDICTION OF MUTATION PATTERNS AFTER EXPOSURE TO CHRONIC IRRADIATION. 2nd UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF.15/P/588 22(1958) 298-302.

Biological decay curves of $P^{32}$ and $Y^{91}$ in Drosophila males are shown, and recessive sex-linked lethal mutations after 1000 r x-rays, and mutation curves after $P^{32}$ feeding, together with theoretical curves. Efficiency factors are given. A mutation curve is also shown for $Y^{91}$ citrate injection, with theoretical curves. It is not possible, from the curves, to obtain insight into whether all the mutations observed after $P^{32}$-ingestion could be explained on the basis of radiation effects of $P^{32}$ in the fly or whether some mutations were caused by the transmutation of the $P^{32}$ incorporated into the sperm. The significance of the results is discussed.

* (This paper was also published in p.82-91 in "Progress in Nuclear Energy. Series 6: Biological Sciences". Bugher, J.C., Coursaget, J. Loutit, J.F., eds. London, Pergamon Press, Ltd. 1956, 205p. There are some differences in the references cited).

396 Oftedal, P. STUDY OF THE RETENTION AND THE MUTAGENIC MODE OF ACTION OF RADIOACTIVE PHOSPHORUS IN DROSPHILA MELANOGASTER. Hereditas 45, 2-3 (1959) 245-331.

The retention of $P^{32}$ by Drosophila females after a single meal of contaminated sugar solution may be adequately described as a sum of three exponential processes, all of which are influenced by diet and/or mating. Differences in retention between groups on diets of low or normal phosphorus content are in the expected direction. $P^{32}$ incorporated into the DNA of mature sperm is recovered 7 or 8 d after a single meal, under conditions of excessive mating, which coincides with maximum genetic effect. The number of $P^{32}$ atoms per sperm is calculated. Radioactive yttrium is retained completely after injection in the form of citrate. The fraction of dose absorbed in the tests is calculated to be 5.8%. On the basis of this absorbed fraction of dose, the pattern of sensitivity to acute irradiation, the retention curve for $P^{32}$, and the shift in $P^{32}$ distribution and the mutations to be expected from $P^{32}$ radiation are calculated. Discrepancies between the observed genetic effect and calculations are found on days with high incorporation of $P^{32}$ into sperm DNA, and transmutation of $P^{32}$ to $S^{32}$ is taken to be responsible for the unexplained genetic effect. The efficiency of the transmutation in producing recessive lethals is found to be 1 in 100. (from auth. summary)

397 Oftedal, P., Mossige, J. INCORPORATION OF PHOSPHORUS-32 AND MUTAGENESIS DURING SPERMATOGENESIS IN DROSOPHILA. Nature 179 (1957) 104-5.

The incorporation of $P^{32}$ was followed during spermatogenesis at the same time as the genetic effect of the radioactive decay was measured. Experimental procedure is described. Results are tabulated, and mutations and incorporation given in a graph. The close correlation found between incorporation and mutation might tempt one to suggest the following alternatives: (1) mutations are caused by transmutation of $P^{32}$ atoms incorporated in the genic material, and the correlation reflects a true causal relationship, and (2) mutations are caused by radiation emitted from the $P^{32}$ contained in the whole fly, and the whole correlation reflects a coincidence in time of incorporation activity and mutagenesis.

398 Oftedal, P., Mossige, J.C. INCORPORATION AND MUTAGENICITY OF $P^{32}$ IN DROSOPHILA SPERM. p. 457 - 62 in "Advances in Radiobiology. Proceedings of the 5th International Conference on Radiobiology, Stockholm 15-19 Aug. 1956". de Hevesy, G.C., Forssberg, A.G., Abbatt, J.D., eds. London, Oliver and Boyd. 1957.

Newly eclosed Drosophila males were fed a sugared solution of $P^{32}$. The procedures for testing male productivity and for assaying $P^{32}$ incorporation during spermatogenesis are described. Two graphs show corrected $P^{32}$ incorporation and mutation curves. The amount of $P^{32}$ incorporated during spermatogenesis was found to vary with time. A close correlation between the mutation curve and time was noted. The significance of the results is discussed.

399 Ray-Chaudburi, S.P., Sarkar, I. THE EFFECT OF $P^{32}$ ON THE MEIOTIC CHROMOSOMES OF THE GRASSHOPPER, GESONULA PUNCTIFRONS. Nucleus 1,1 (1958) 123-30.

A quantitative and qualitative study is described in which adults were injected with $P^{32}$ (3.75 - 60 $\mu c/cm^3$ concentrations) and the resulting meiotic anomalies observed. Chromatid breaks, dicentric bridges, sticking, etc. occurred as after x-ray treatment. Considerable quantitative fluctuations were observed under similar experimental conditions. The frequency of bridges and fragments increased with concentration and with duration of treatment. The variation with concentration of the bridge: fragment ratio is discussed.

* Sullivan and Grosch 1953 - [1295]

$S^{35}$

* Grosch et al. 1956 - [383]

$Ca^{45}$

* Gamô and Nishiyama 1956 - [263]

* Gamô et al. 1958 - [264]

* Gamô et al. 1960 - [265]

* Grosch et al. 1956 - [383]

400 Steffensen, D., LaChance, L.E. RADIOISOTOPES AND THE GENETIC MECHANISM: CYTOLOGY AND GENETICS OF DIVALENT METALS IN NUCLEI AND CHROMOSOMES. p.132-45 in "Symposium on Radioisotopes in the Biosphere". Caldecott, R.S., Snyder, L.A., eds. Minneapolis, Univ. of Minneapolis. 1960, 597p.

Cytological studies with Tradescantia have indicated that metal deficiencies result in higher frequencies of spontaneous chromosome breakage and that calcium, magnesium and strontium are likely metals involved in chromosome stability. The frequency of chromosome breakage in microspores is dependent on the temperature at which the cells passed through meiosis. Isotope studies with Lilium longiflorum and Habrobracon juglandis have shown that $Ca^{45}$ and $Sr^{90}$ are incorporated into the chromatin material of nuclei and is apparently firmly bound in the chromosomes. The possibility of mutational consequences resulting from the incorporation of isotopes in the hereditary material and the possible role for divalent metal ions in the chromosome structure are discussed. 28 references. (auth.)

$Co^{60}$

* Grosch 1958 - [1137]

$Sr^{89}$ or $^{90}$

401 Grosch, D.S., LaChance, L.E. FATE OF RADIOSTRONTIUM FED TO HABROBRACON FEMALES. Science 123 (1956) 141-2.

The tissue distribution of $Sr^{89}$ was studied in virgin females (wild stock 33) of H. juglandis, following feeding with $Sr^{89}$-labelled citrate in honey (277 μc/g of mixture), and maintained at 30°C. Eggs laid within the first days of feeding only showed some slight radioactivity. The radioactivity was mainly concentrated in the abdomen. Half the Sr absorbed is eliminated within a day. Irreversible sterility was produced in Habrobracon females.

* Grosch et al. 1956 - [383]

* Grosch et al. 1957 - [830]

402 Mitlin, N., Babers, F.H. THE ACTION OF RADIOSTRONTIUM IN THE HOUSE FLY AND THE GERMAN COCKROACH. J. econ. Ent. 49, 5 (1956) 714-5.

The feeding of radiostrontium, $Sr^{89}$, to houseflies, Musca domestica L. for 18 h caused varying degrees of sterility. Continuous feeding inhibited oviposition entirely, while feeding for shorter periods, although allowing oviposition, caused a marked decrease in egg viability. Fly eggs apparently slowly absorb and retain $Sr^{89}$. The average biological half-life for the element was 15.4 h. A similar experiment performed with the German cockroach, Blattella germanica L., gave inconclusive results concerning sterility. The biological half-life for this species was 3.5 d for males and 0.95 d for females. (BA 31: 10254, 1957)

* Steffensen and LaChance 1960 - [395]

$Y^{91}$

* Oftedal 1958 - [395]

## I-E Insects as Disease Vectors in

### I-E-1 MAN

Survey Articles

403 Jenkins, D.W. PARASITOLOGICAL REVIEW. ADVANCES IN MEDICAL ENTOMOLOGY USING RADIOISOTOPES. Exp. Parasit. 3, 5 (1954) 474-90.

Radiotracer techniques applied to ecology and dispersal studies are reviewed. In experiments on the radioactive marking of Plasmodium gallinaceum, however, it was observed that ingestion of $P^{32}$ by Aëdes aegypti (L.) during the period of extrinsic incubation caused the development of the parasite to be arrested in the oöcyst stage. The results are cited of unpublished experiments by the author and his associates in which bacteria labelled with $P^{32}$ were used to study the persistence and multiplication of Escherichia coli in Musca domestica L. when ingested with food. The difficulty was to ensure that the tracer was chemically bound. Thus in one experiment in which the time and amount of regurgitation and excretion of the bacteria by the flies was checked quantitatively by plating bacteria and determining radioactivity, correlation between radioactivity and bacterial counts was good during the first few days of the test. Subsequent accumulation of $P^{32}$ in the flies implied that the bacteria were probably not tagged molecularly. Radiotracers for insecticides have proved very valuable for studying the site of entry or physiological action, and have also facilitated distribution studies on a treated surface. They have shown promise in assessments of the dissemination of sprays applied from aircraft.

* Jenkins 1956 - [73]

---

* Bruce-Chwatt 1956 - [109]

404 Dissanaike, A.S., Dissanaike, G.A., Niles, W.J. INFECTED MOSQUITO LARVAE TAGGED WITH PHOSPHORUS-32. Trans. R. Soc. trop. Med. Hyg. 50 (1956) 425.

Culex fatigans larvae reared in baths containing varying concentrations of $P^{32}$ as the orthophosphate developed into radioactive adults, the females having an activity 3 times greater than that of the males. Only adult females reared in a medium containing 0.1 $\mu$c $P^{32}/cm^3$ took a blood meal, and they were fed on patients having a high count of filarial larvae of Wuchereria bancrofti. The activity of the microfiliarial larvae isolated from the dissected mosquitoes was consistent at about 22 $\beta$-counts/min. The successful tagging of filarial larvae will aid in studying their further development in the definite host. (CA 51: 12365g, 1957)

* Dissanaike et al. 1957 - [345]

* Dissanaike et al. 1957 - [258]

* Hartwell et al. 1958 - [71]

* Jackson and Maier 1955 - [68]

* Knapp et al. 1956 - [363]

405 Kuper, S.W.A., Pelc, S.R. RADIOACTIVE LABELLING EXPERIMENTS WITH PLASMODIUM. Parasitology 42 (1952) 269-71.

Plasmodium gallinaceum was selected for tests because of the ready availability of gametocytes, the occurrence of cryptozoites at the site of inoculation, and the ease of rearing and maintaining the insect host, Aëdes aegypti. An account is given of the methods used to produce radioactive oöcysts of P. gallinaceum. Both $P^{32}$ and $S^{35}$ were used. Feeding the radioisotope to mosquitoes that had already become infected with malaria finally proved most appropriate as technique. Autoradiographs demonstrated early pre-erythrocytic forms of the malarial parasite.

## I-E-2 ANIMAL

* Dissanaike et al. 1957 - [258]

* Hahn et al. 1950 - [384]

406 Kartman, L., Prince, F.M., Quan, S.F., Stark, H.E. NEW KNOWLEDGE ON THE ECOLOGY OF SYLVATIC PLAGUE. Ann. N.Y. Acad. Sci. 70 (1958) 668-711.

In the course of this review article data is presented on the direct observations of flea transfer between host species. Fleas and other arthropods were labelled with $Ce^{144}$. Fleas were bathed for less than 5 min in aqueous solutions of $Ce^{144}$-$Pr^{144}$ containing 10 $\mu$c/ml. Tagging was accomplished by a stable combination of Ce with

exoskeleton. Work is described on 2 rodents, Microtus californicus and Rattus norvegicus, and tagged fleas, Malaraeus telchinum. Fleas were found to transfer between individual Microtus. The data are tabulated. Radioactive fleas were also recovered from vole nests; radioactive feces confirmed some ingestion of fleas. Tests with domestic rats showed that the fleas would transfer readily from the field vole to domestic rats under certain conditions. Fleas were combed from rats and also obtained from rat nests. Data are tabulated. In all trials, tagged fleas showed an initial average count of 6.2 to 8.5 x $10^2$ counts/flea/min and, after 56 days, 3.6 to 5.1 x $10^2$ counts/flea/min. Undoubtedly, other important wild-rodent flea vectors of plague will also transfer to rats.

## I-E-3 PLANT

407 Bjorling, K., Lihnell, D., Ossiannilsson, F. MARKING VIRULIFEROUS APHIDS WITH RADIOACTIVE PHOSPHORUS. Acta agric. Scand. 1 (1951) 301-17.

Preliminary experiments (laboratory) showed that aphids (Myzus persicae Sulz. and Aphis fabae Scop.) became radioactive when living on broad bean plants watered with labelled sodium orthophosphate (0.05 - 0.35 mc $P^{32}$). The radioactivity of the aphids could easily be demonstrated autoradiographically. Details of techniques are given. Aphids retained their radioactivity for at least 2-3 weeks after removal to non-radioactive plants. The radioactivity was "inherited" by the offspring for at least 2 generations. The main experiments which were carried out on sugar beets in the field, were arranged in such a way that the distribution of aphids (M. persicae and A. fabae) from a radioactive centre (plants watered with 0.4 - 1.5 mc $P^{32}$ as sodium orthophosphate) to the surrounding plants in the plot and the spread of yellow virus from the same centre could be studied. The conclusions drawn on the movements of the aphids, their average speed, the distances covered, the effectiveness of the aphids as virus vectors, etc. are discussed from different points of view, including the limitations of the method in its present form.

(An abridged report was read by D.L. at the Potato Virus Conf. in Wageningen, 13-16 Aug. 1951, and is published in the proceedings of the conference)

* Cornwell 1956 - [104]

* Cornwell 1958 - [105]

* Day and McKinnon 1951 - [32]

* Day and Irzykiewicz 1953 - [23]

* Day and Irzykiewicz 1954 - [320]

* Kloft and Kunkel 1960 - [28]

408 Liesering, R. BEITRAG ZUM PHYTOPHATHOLOGISCHEN WIRKUNGSMECHANISMUS VON TETRANYCHUS URTICAE KOCH (TETRANYCHIDAE, ACARI.) (Contribution to an understanding of the phytopathological mechanism of action of Tetranychus urticae Koch (Tetranychidae, Acari). Z. PflKrankh. 67 (1960) 524-42.

In order to settle the question of whether the spider mite injects material into the plant during suction, mites were labelled with $P^{32}$. This was done via the host plant (young bean leaves, placed in solutions of a specific activity from 1-2 mc/ml $P^{32}$). These were left in the solution for 3 d and then populated with spider mites. A further 2 d were required before the spider mite acquired a sufficiently high activity to be measurable in its saliva. Intermediate passages were introduced in order to avoid faulty deductions from possible radioactive contamination of the mandibles (cf. Kloft's methods for aphids). It was clearly established by measurement and autoradiography that Tetranychus urticae releases substances to the plant tissue during suction. This result is of great importance phytopathologically, particularly for the mechanism by which plant diseases are transmitted by insects and spider mites.

337*) Худаков, Г.Д. МЕТОД МЕЧЕНИЯ НАСЕКОМЫХ ПОСРЕДСТВОМ ДАЧИ ИМ РАДИОАКТИВНЫХ ИЗОТОПОВ С КОРМОМ. Бюллетень Моск.Общества Испытателей Природы,Отдел биологич. 64, 3(1959)35-45.

1. Для целей маркировки насекомых посредством дачи им радиоизотопа с кормом пригодны те радиоактивные изотопы, которые обладают бета-излучением со средней энергией высших энергетических уровней бета-спектров порядка 0,8 Мэв и выше, а также имеющих период полураспада не меньше недели. 2. При увеличении концентрации радиоизотопа в корме пропорционально увеличивается и радиоактивность насекомых, питающихся на нем. 3. Для проведения опытов с мечеными насекомыми в течение 10-20 дней можно их метить посредством дачи им корма, содержащего радиоизотопы в концентрации 1-3 микюри на 1 мл. Для проведения более длительных опытов концентрацию изотопа в корме необходимо соответственно увеличивать.

Khudakov, G.D. A METHOD OF TAGGING INSECTS BY GIVING THEM RADIOACTIVE ISOTOPES WITH FOOD. Byull. Moskov. Obshchestva Isphytalei Prir., Otdel Biol. 64, 3 (1959) 35-45. (Tr. from Russian)

A study was made to determine the best method of labelling insects (Musca domestica and Blattella germanica) using radioactive food. Flies and roaches were used in the study which compared $P^{32}$, $Ca^{45}$, $Fe^{59}$, $Zn^{65}$, $Sr^{89}$, $Y^{91}$, $Cd^{115}$, $I^{131}$, $Ba^{140}$, and La in various food preparations. It was found that a 24-h exposure was required for 100% tagging, the best results being obtained with $P^{32}$ in a mixture of 3 parts milk and 1 part 10% sugar water. A direct relation was found between $P^{32}$ concentration in food and the radioactivity of the flies, and the females were twice as radioactive as males, being twice as heavy. The effects of elimination, isotope decay, and energy of the emitted ray were considered. Radioisotopes with a beta emission above 0.8 MeV and a half life not less than 1 week are suitable. The food for studies running 10 to 20 d should contain 1 to 3 μc. (NSA 14: 13548, 1960)

*) Post-script to reference 337, cited on p. 86.

# II INSECTICIDES

## II-A Survey Articles

409 Dahm, P. A. RADIOACTIVE TRACERS IN INSECTICIDE RESEARCH. Soap, N. Y. 29 (1953) (9) 136-7, 139, 161; (10) 148-9, 151, 153, 163, 165; (11) 141, 143, 145, 147, 165; (12) 167-8, 175.

Review Article. The principles of applying radioisotopes generally and in this field, in particular, are discussed. A survey of the way in which radiotracers have already been applied is given, references to individual research being given.

* Dahm 1953 - [805]

* Dahm 1957 - [806]

410 Haller, H. L. RADIOACTIVE MATERIALS IN INSECT CONTROL. p. 215-21 in "Conference on Radioactive Isotopes in Agriculture, 12-14 Jan. 1956 at Michigan State Univ.". TID-7512, Argonne National Lab., Council of Participating Institutions, Lemont, Ill. 1956.

Review article. Applications of radioisotopes to chlorinated hydrocarbon, organic phosphorus, and systemic insecticides are reviewed, followed by a discussion on penetrating radiations. Radioisotopes have been applied for tagging insects used in flight, migration and dispersal studies.

* Hinton 1954 - [6]

* Jenkins 1954 - [403]

411 Kirchberg, E. ZUR VERWENDUNG RADIOACTIVER ISOTOPE IN DER SCHÄDLINGSBEKÄMPFUNG (On the application of radioisotopes to pest control). Prakt. Schädlingsbekämpfer 8, 11 (1956) 129-32. (In German)

Short review article.

412 Kováč, J., Taimr, L. RÁDIOIZOTÓPY V OCHRANE RASTLÍN POUŽITIE RÁDIOIZOTÓPOV VO VÝSKUME INSEKTICÍDOV A TOXIKOLÓGII HMYZU (Use of radioisotopes in research on insecticides and the toxicology of insects). Československ. Akad. Zeměděl. Věd. Šborn. Rostlinná Výroba 32, 3 (1959) 447-56. (In Slovak)

Except for the very end where some research in Leningrad is described, the paper is a review article of foreign publications. Experiments (USSR) are described on the decomposition products and isomers of $S^{35}$-labelled Parathion, identified by a paper-chromatographic technique. Fatty solutions of Parathion were shown to possess greater penetrating powers than water emulsions. This was also true of cold aerosols relative to "water"-sprays. Autoradiographically, the insecticide could be proved to have greater spread when applied as a fatty solution. A radiometric separation method (Gar) was employed for testing the stability of fatty solutions of Parathion. No hydrolysis was found after they had been subjected to 110°C for 48 h. The importance of being able to measure the penetrating ability of aerosols is stressed. Further useful applications of radioisotopes to related problems are discussed.

* Lindquist 1957 - [9]

* McCormick 1958 (Bibliography) - [797]

413 Metcalf, R. L. RADIOISOTOPES IN THE STUDY OF THE MECHANISMS OF ACTION OF INSECTICIDES. p. 237-52 in "Radioisotopes and Radiation in the Life Sciences. 2nd Inter-American Symposium on the

Peaceful Application of Nuclear Energy, Buenos Aires 1959". TID-7554. Washington, D.C., Pan American Union. 1960.

A review article, illustrated by specific examples. Ancillary techniques valuable with radiotracer insecticides are discussed: paper chromatography, column chromatography, partition coefficients, and radioautography. Further sections are devoted to tracer work on the chemistry of insecticides, plant systemic insecticides (absorption, translocation and metabolism), insect resistance to insecticides and the study of the mechanisms of action of insecticides by the labelled metabolic pool technique of Winteringham. An appendix gives a source list for descriptions of syntheses of most of the labelled insecticides reported up to 1959.

414 Ripper, W.E., Greenslade, R.M., Hartley, G.S. SELECTIVE INSECTICIDES AND BIOLOGICAL CONTROL. J. econ. Ent. 44, 4 (1951) 448-59.

Review article. The respective efficacity and application of selective insecticides are discussed, also the usefulness of radioisotopes in investigations on translocation, decomposition, etc.

415 Taimr, L. RADIOISOTOPES DANS LES RECHERCHES SCIENTIFIQUES SUR LES INSECTICIDES. Bull. radiobiol. Komise 3 (1958) 241. (In Czech)

416 Thomas, W.D.E. AN INTRODUCTION TO WORK ON RADIOACTIVE TRACERS. Sci. Hort. 12 (1955/56, pub. 1957) 104-9.

A general article, dealing with radioisotope tracers in plant nutrition and insecticide research.

417 Winteringham, F.P.W. SOME ASPECTS OF INSECTICIDE BIOCHEMISTRY. Endeavour 11 (1952) 22-8.

Review article. Investigations into insecticide biochemistry are surveyed, concerned with such problems as insecticide absorption, distribution, their decomposition or metabolic products and residues, etc. The application of radioisotopes (e.g. a radioactive Br-analogue of DDT was used, $C^{14}$-labelled fumigants, $I^{131}$-labelled methyl iodide) and their scope in such studies, also in combination with other techniques (paper chromatography, autoradiography, etc.) is discussed.

## II - B Fumigants

418 Winteringham, F.P.W. RADIOISOTOPES IN MICRO-BIOCHEMICAL RESEARCH. p.305-18 in "Proceedings of the International Symposium on Microchemistry". (1958)

The impact of the combined application of radioactive tracers and micro-fractionation techniques such as chromatography in bringing new fields of biochemical research within the range of quantitative analysis are discussed. Successful application involves first the introduction of suitable radioisotopes into the system to be studied followed by adequate techniques of fractionation and identification. Methods of using labelled reagents, radioactivation, and the labelled pool technique for fulfilling the first condition are described. Methods for characterizing and identifying labelled compounds separated on paper chromatograms in amounts below the limits of chemical detection are also discussed. (from auth.)

419 Андреева, О.И., Костикова, Г.И. ИЗУЧЕНИЕ РЕАКЦИЙ ИЗОТОПНОГО ОБМЕНА УГЛЕРОДА МЕЖДУ ЦИАНИСТЫМ КАЛИЕМ И КАРБОНАТАМИ И ПРИМЕНЕНИЕ ИХ ДЛЯ ПОЛУЧЕНИЯ ЦИАНИСТОГО КАЛИЯ, МЕЧЕННОГО ИЗОТОПОМ $C^{14}$. Труды Конференции по Использованию радиоактивных изотопов в физ. науках и пром., Копенгаген, 6-17 сентября 1960 г., том 3, стр. 111-22. Вена, Международное агентство по атомной энергии, 1962.

Разработана методика получения меченого цианида калия, которая базируется на следующих основных операциях: 1)Проведение реакции изотопного обмена $KC^{12}N - BaC^{14}O_3$ при 800° в течение 2-х часов. 2) Разделение смеси KCN + $BaCO_3$ путем экстракции KCN жидким аммиаком в циркуляционном экстракторе. При обмене эквимолекулярных количеств KCN и $BaCO_3$ получен цианистый калий с химическим выходом выше 90% и содержанием основного вещества 96 - 97%. При применении $BaCO_3$ с высокой удельной активностью (60 - 70 мкюри/г) удельная активность KCN получается выше 80 мкюри/г. Углекислый барий, обедненный изотопом $C^{14}$, регенерируется после экстракции аммиаком без заметных потерь.

Andreeva, O.I., Kostikova, G.I. STUDY OF CARBON-ISOTOPE EXCHANGE REACTIONS BETWEEN POTASSIUM CYANIDE AND SOME CARBONATES, AND THEIR USE FOR OBTAINING $C^{14}$-LABELLED POTASSIUM CYANIDE. p. 111-22 (disc. p. 122) in "Radioisotopes in the Physical Sciences and Industry. Conference Proceedings, Copenhagen, 6-17 Sep. 1960", Vol. 3. Vienna, International Atomic Energy Agency, 1962. (In Russian)

The authors obtained cynanide-labelled potassium by the following method: (1) The isotope exchange reaction $KC^{12}N\text{-}BaC^{14}O_3$ is produced at 800°C in 2 h. (2) The mixture $KCN + BaCO_3$ is separated by extracting the KCN with liquid ammonia in a circulating extractor. By exchanging the equimolecular quantities KCN and $BaCO_3$, potassium cyanide is obtained with a chemical yield of more than 90% and a basic-substance content of 96-97%. By using $BaCO_3$ with a high specific activity (60-70 mc/g), a KCN specific activity of over 80 mc/g may be obtained. The barium carbonate depleted of isotope $C^{14}$ regenerates after the ammonia extraction without appreciable loss.

420 Belleau, B., Heard, R.D.H. SYNTHESIS OF $C^{14}$-SODIUM CYANIDE FROM CARBON DIOXIDE. J. Amer. chem. Soc. 72 (1950) 4268-9.

The method of preparation described offers several worthwhile advantages: (a) in one convenient reaction, a gaseous low-molecular-weight starting material ($C^{14}O_2$; mol. wt. 46) leads to a solid high-molecular-weight product (triphenylacetic acid-1-$C^{14}$, mol. wt. 290, melting point 267); (b) it is equally adaptable to a micro- or macro-scale; and, (c) other useful one carbon compounds such as formate, methylamine, etc., may be obtainable directly (in the course of exploration).

421 Bond, E.J. THE METABOLISM OF HYDROGEN CYANIDE BY SITOPHILUS GRANARIUS (L.) Bull. ent. Soc. Amer. 5, 3 (1959) 120 abstr. 92.

The uptake of hydrogen cyanide by this species increased linearly during fumigation even after absorption of a lethal dose. Respiratory inhibition did not appear to be the direct cause of death by this poison. The fate of $C^{14}$-labelled hydrogen cyanide within the insect was studied.

* Bridges 1955 - [765]

* Bridges 1956 - [766]

422 Cox, J.D., Warne, R.J. SYNTHESIS WITH ISOTOPIC TRACER ELEMENTS. III. THE PREPARATION OF ETHYLENE OXIDE AND ETHANOL LABELLED WITH CARBON ISOTOPES. J. chem. Soc. 1951; 1893-6.

A synthesis of ethylene oxide-1, 2-$C^{14}$ is described. The compound is of interest as a fumigant. Details are given of apparatus and methods for the preparation from $BaC^{14}O_3$ of $C_2H_2$ through barium carbide (in 97% isotopic yield), $C_2H_4$ (quantitative yield) and $ClCH_2CH_2OH$ (82% recovery of isotope); KOH gives 85-95% $(CH_2)_2O$; reduction with $LiAlH_4$ gives 93% $\alpha,\beta$-labelled EtOH (over-all isotopic recovery of 76% based on $BaCO_3$).

423 Foreman, W.W., Murray, A. III., Ronzio, A.R. MICROSYNTHESES WITH TRACER ELEMENTS. II. METHYLBIS-(2-CHLOROETHYL)AMINE HYDROCHLORIDE (NITROGEN MUSTARD) AND METHYL BROMIDE LABELED WITH CARBON$^{14}$. J. org. Chem. 15 (1950) 119-22.

$MeN(CH_2\text{-}CH_2Cl)_2$ (I) has been labelled in the Me group with $C^{14}$ for a study of the mechanism of the cell damage caused by I. $C^{14}H_3OH$ (0.8-10 mmol.) is converted in a specially designed apparatus by means of 5 cc of a mixture of 3.6 cc concentrated $H_2SO_4$ and 23.03 g 48% HBr into 94-6% $C^{14}H_3Br$ (II). II is allowed to react in a special apparatus with $HN(CH_2CH_2\text{-}OH)_2$ (III) in absolute EtOH, and the mixture, containing $C^{14}H_3N\text{-}(CH_2CH_2OH)_2$ and III, treated in $C_6H_6$ saturated with HCl with the calculated amount of $SOCl_2$, giving 52.5% (based on the $CH_3OH$ used) $C^{14}H_3N(CH_2CH_2Cl)_2HCl$, melting point 109-110°C, with an activity corresponding to 22 μc/mg ($HAuCl_4$ salt, m. 82-4°). When the ratio of II and III is 1:1, 20-35% $(C^{14}H_3)_2N(CH_2CH_2Cl)_2Br$, m. 217-18° is obtained. (CA 44:4419c, 1950).

424 Gordon, H.T., Thornburg, W.W., Werum, L.N. HYDROXYETHYL DERIVATIVES IN PRUNES FUMIGATED WITH $C^{14}$-ETHYLENE OXIDE. J. agric. Food Chem. 7, 3 (1959) 196-200.

Dried prunes fumigated with ethylene oxide-$C^{14}$ react with the fumigant to give non-volatile and relatively nontoxic alkylation products. Over 50% of the total radioactivity is combined as insoluble hydroxyethyl cellulose in the prune skin, 30% as hydroxyethylated sugars in the pulp, and 3% as glycols

(mostly diethylene glycol). The remainder has been tentatively identified as hydroxyethylated amino acids and proteins. (auth.)

425 Johnson, R. K., Huston, J. L. PREPARATION OF RADIOACTIVE SULFUR DIOXIDE FROM BARIUM SULFATE. J. Amer. chem. Soc. 72 (1950) 1841-2.

The combustion in oxygen of an intimate mixture of barium sulfate and red phosphorus was found to give a good yield of pure $S^{35}O_2$. Experimental and analytical procedures are described. The method is rather tedious.

426 McCarter, J. A. PREPARATION OF C-14-CYANIDE FROM C-14-CARBONATE. J. Amer. Chem. Soc. 73 (1951) 483.

The author describes a, relatively, simple and inexpensive procedure for obtaining a 90% yield of $HC^{14}N$ with a specific activity essentially unchanged from that of the $K_2C^{14}O_3$ used as starting material.

* McCollister et al. 1951 - [744]

* Perlowagora-Szumlewicz 1953 - [456]

427 Selff, R.E., Tolbert, B.M. NOTES ON THE PREPARATION OF HYDROGEN CYANIDE-$C^{14}$ FROM $BaC^{14}O_3$. UCRL-1299, California Univ., Berkeley, Radiation Lab. 1951, 5p.

Experimental details are presented on the preparation of $HC^{14}N$ from $BaCO_3$ by reduction with K metal in the presence of $NH_3$. The procedure used was essentially that of Cramer and Kistiakowsky (J. Biol. Chem. 137, 547 (1941)), as modified by Loftfield (Nucleonics 1, (3) 54 (1947)) except that dilute $H_2SO_4$ was used to generate the HCN. No difficulties were encountered, and yields of 80 to 90% were obtained. (NSA 5: 4406, 1951).

428 Strittmatter, C., Peters, T., Jr., McKee, R.W. METABOLISM OF LABELED CARBON DISULFIDE IN GUINEA PIGS AND MICE. Arch. Industr. Hyg. 1 (1950) 54-64.

When $CS_2$ containing $S^{35}$ was administered intraperitoneally, subcutaneously, intracardially, or by inhalation to guinea pigs and mice, the distribution was general throughout the body tissues, with more retained in the liver than other tissues. The nonmetabolized $CS_2$ was excreted rapidly, but the tissues retained a large proportion and gave it up slowly. Approximately 30% of the retained $CS_2$ was excreted in the urine, largely as inorganic sulfates. (CA 44: 4131e, 1950)

429 Tomisek, A.J., Mahler, H.R. THE SYNTHESIS OF ETHYLENE OXIDE-1,2-$C^{14}$. J. Amer. chem. Soc. 73 (1951) 4865-6.

Ethylene oxide-1,2-$C^{14}$ was isolated in 30% yield from the reaction of ethylene-1,2-$C^{14}$ with perbenzoic acid in tetrachloroethane solvent in the presence of iodine catalyst. A procedure was developed for the determination of ethylene oxide in tetrachloroethane solution. (auth.)

* Winteringham and Hellyer 1954 - [729]

* Winteringham 1955 - [767]

* Winteringham 1955 - [764]

* Winteringham 1957 - [761]

* Winteringham et al. 1958 - [730]

## II – C Halogenated Hydrocarbons

### Survey Articles

430 Perry, A.S. FACTORS ASSOCIATED WITH DDT-RESISTANCE IN THE HOUSE FLY MUSCA DOMESTICA L. p. 157-72 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956", Vol. 2. Becker, E.C. ed. Ottawa, Mortimer Ltd. 1958.

The author reviews the protective mechanisms concerned with DDT-resistance in M. domestica, which may be characterized as morphologic, physiologic and behaviouristic. They are discussed in some detail. Numerous studies from which data are drawn have used radioisotopes. Among the factors reported, some are directly concerned with protecting the insect from the lethal action of DDT; others supplement a protective mechanism already present. Still others, i.e., certain structural differences, etc., are incidentally associated with resistant strains but offer no protection to the fly ("resistance-markers"). The complex nature of DDT-resistance makes it difficult to characterize this phenomenon in terms of a single common factor. It is likely that each strain possesses a combination of attributes for resistance which are different from that found in other strains.

431 Perry, A.S. BIOCHEMICAL ASPECTS OF INSECT RESISTANCE TO THE CHLORINATED HYDROCARBON INSECTICIDES. p. 119-37 in "Research Progress on Insect Resistance. Symposium, Washington, D.C. 7-8 Oct. 1959", Vol. 2, No. 1. Miscellaneous Publications of the Entomological Society of America. College Park, Md., 1960, 175p.

An excellent review article, discussing detoxication mechanisms, which may bring about (a) conversion of insecticide to nontoxic metabolites which are either excreted or retained within the tissues; (b) excretion in the unchanged form; or (c) storage in non-sensitive tissues of toxic metabolites or of the unchanged chemical. Work with radioisotopes is cited freely. Reference is also made to unpublished work by Perry (1957) on the metabolism of $Cl^{36}$-labelled Lindane in houseflies. Topical application (4 µg/resistant fly) led to rapid toxicant metabolism. After 24 h 60% of the total radioactivity was in the excreta. Partition of the $Cl^{36}$-labelled compounds in excreta between water and cyclohexane showed 44% to be water-soluble. The amount of $Cl^{36}$ in the fly also indicated a non-toxic, dechlorinated product. Investigations with the $Cl^{36}$-α-isomer of BHC indicated that both resistant and susceptible flies metabolized and excreted the product at an approximately equal rate. However, smaller amounts of water-soluble metabolites were indicated.

432 Murray, A., III., Williams, D.L. ORGANIC SYNTHESES WITH ISOTOPES. COMPOUNDS OF ISOTOPIC CARBON. ORGANIC COMPOUNDS LABELED WITH ISOTOPES OF THE HALOGENS, HYDROGEN, NITROGEN, OXYGEN, PHOSPHORUS, AND SULFUR. New York, Interscience Publishers, Inc. 1958. 2096p.

A reference book. The various compounds are listed with their formulae, procedures for their preparation, notes, references and other preparations. To quote just the example of DDT, the $Br^{82}$ analogue is discussed on pages 1157, 1158, the $I^{131}$ analogue on p. 1229, DDT labelled at $C_1^{14}$ on p. 888, and at $C_2^{14}$ on p. 892.

433 Winteringham, F.P.W., Barnes, J.M. COMPARATIVE RESPONSE OF INSECTS AND MAMMALS TO CERTAIN HALOGENATED HYDROCARBONS USED AS INSECTICIDES. Physiol. Rev. 35 (1955) 701-39.

A review article. It includes a discussion of biochemical, physiological effects, the metabolic fate and possible mode of toxic action of MeBr, $CH_2BrCH_2Br$, $CH_2ClCH_2Cl$, dichlorobenzenes, DDT and its analogues, hexachlorcyclohexane isomers, Aldrin, Dieldrin, and Chlordan. Amongst the 335 references are numerous references to work utilizing radioisotopes although these are not mentioned specifically in the text.

## Aldrin and Dieldrin

434 Chang, S.C., Kearns, C.W. STUDY OF DIELDRIN METABOLISM IN HOUSE FLIES. Bull. ent. Soc. Amer. 5, 3 (1959) 118, abstr. 77.

Tagged Dieldrin was used in a metabolism study in susceptible and resistant houseflies. Paper chromatographic separation of the benzene-extracted dose demonstrated only one radioactive spot with identical Rf value of reference Dieldrin in three solvent systems. A constant specific activity was shown for three successive crystallizations.

435 McKinney, R.M., Pearce, G.W. SYNTHESIS OF $C^{14}$-LABELLED ALDRIN AND DIELDRIN. J. agric. Food. Chem. 8 (1960) 456-9.

The insecticides 1, 2, 3, 4, 10, 10-hexachloro-1, 4, 4a, 5, 8, 8a-hexahydro-1, 4-endo-exo-5, 8-dimethanonaphthalene (Aldrin) and 1, 2, 3, 4, 10, 10-hexachloro-6, 7-epoxy-1, 4, 4a, 5, 6, 7, 8, -8a-octahydro-1, 4-endo-exo-5, 8-dimethanonaphthalene (Dieldrin) were prepared labelled with carbon-14. They were synthesized by labelling hexachlorocyclopentadiene and subsequent reaction with 2, 5-norbornadiene. Starting with

$BaC^{14}O_3$, a 28% yield of Aldrin (melting point 102.5°C) and a 22% yield of Dieldrin (melting point 181°C) were obtained. The specific activities were 3.6 and 3.5 ± 0.1 mc per gram for Aldrin and Dieldrin, respectively. (auth)

436 Winteringham, F.P.W., Harrison, A. ABSORPTION AND METABOLISM OF $^{14}$C-LABELLED ALDRIN BY SUSCEPTIBLE AND RESISTANT MOSQUITO LARVAE (Unpublished observations) WHO Information Circular on Insecticide Resistance No. 21, (1959) item 55.

The absorption and metabolism of $C^{14}$-labelled Aldrin by susceptible and Dieldrin-resistant larvae of Anopheles gambiae have been compared. Both strains absorbed about one quarter of the Aldrin initially added to the water (5 ppm) after 4 h at 25°C but this was largely recovered by rinsing the cuticles in acetone and relatively little had penetrated the internal tissues of either strain. There were similar but small conversions of Aldrin to Dieldrin in the tissues of both strains. The data suggest that resistance of the larvae is not due to lack of cuticular penetration or detoxication in the tissues as a whole.

437 Winteringham, F.P.W., Harrison, A. MECHANISM OF RESISTANCE OF ADULT HOUSEFLIES TO THE INSECTICIDE DIELDRIN. Nature 184 (1959) 608-10.

The sulphur analogue of Dieldrin ($S^{35}$-labelled) was shown to be partly metabolized by resistant and susceptible houseflies. The results were determined as $S^{35}$-radioactivity, corrected for decay, self-absorption, etc., and expressed as a percentage of the dose applied. Unchanged insecticide and metabolites were determinated by radio-paper-chromatographic techniques. The rate of accumulation of $S^{35}$-metabolites in the abdomen of adult M. domestica is illustrated. A table gives details of the fate of the $S^{35}$ analogue of Dieldrin three hours after topical application to Dieldrin-resistant and susceptible adult houseflies, at a dose of 2 µg per insect. A bromine analogue of Dieldrin ($Br^{82}$-labelled) was shown to be excreted unchanged in equal proportion by both resistant and susceptible houseflies. Small amounts of water-soluble metabolites were also produced.

## BHC and Isomers

438 Barragat, P. A DISTRIBUIÇÃO DE INSECTICIDA EM SUPERFÍCIES TRATADAS E A PRECISÃO DO TESTE BIOLÓGICO, CONTROLADOS COM RÁDIO-ANÁLISE. Rev. bras. Malariol. 5, 1 (1953) 85-93. (Distribution of an insecticide on treated surfaces, and the accuracy of biological tests controlled by radio-analysis).

Benzene hexachloride was mixed with thorium and its distribution studied by analysis of its radioactivity. This gives depth of penetration as well and is useful in explaining discrepancies shown by biological tests. (BA 28: 4567, 1954)

439 Bradbury, F.R. ABSORPTION AND METABOLISM OF BHC IN SUSCEPTIBLE AND RESISTANT HOUSEFLIES. J. Sci. Food Agric. 8, 2 (1957) 90-6.

Experiments on the absorption and metabolism of BHC isomers in houseflies (Musca domestica L.) are described for a strain normally susceptible and a strain resistant to γ BHC. The flies were exposed to vapours of the isomers at 25°C [77°F], the isomers being labelled with $Cl^{36}$ or $C^{14}$. Radioactive material was recovered from the treated flies by extraction with carbon tetrachloride and with water. The ultimate production of 11 water-soluble compounds from both α and γ BHC was deduced from chromatographic data, and is discussed. The part played by metabolism in making an insect resistant to poisoning is discussed in terms of the effect of the product of concentration and time, and it is concluded that detoxication by metabolism is essential for the complete recovery of an insect following absorption of insecticide. Figures are given showing the extent to which α and γ BHC were metabolized to water-soluble material in susceptible insects of several species, including mosquitoes and cockroaches. It is evident from them that the susceptible strain of the housefly is in a class by itself in its ability to eliminate γ BHC as water-soluble products. It is thought that the existence in normal houseflies of a metabolic way of dealing with BHC predisposes the species to the acquisition of resistance. (from RAE-B 46: 52, 1958)

440 Bradbury, F.R., Nield, P., Newman, J.F. ACCOUNT OF GAMMA-BENZENE HEXACHLORIDE PICKED UP BY RESISTANT HOUSEFLIES BRED ON A MEDIUM CONTAINING BENZENE HEXACHLORIDE. Nature 172 (1953) 1052.

The gamma-benzene hexachloride was labelled with $C^{14}$. Normal flies (Hawthorne stock of Musca domestica) were used, with another strain originating in Uruguay, having a very high resistance. Results of

the particular techniques used might be taken to indicate that (1) the resistance by houseflies is not due to resistance to penetration of the insecticide; and (2) a detoxification mechanism is unlikely in flies resistant to benzene hexachloride since these carry over in their tissues from the larval stage enough insecticide to kill normal flies in a few minutes.

441 Bradbury, F.R., Standen, H. THE FATE OF γ-BENZENE HEXACHLORIDE IN NORMAL AND RESISTANT HOUSEFLIES. I. J. Sci. Food Agric. 6 (1955) 90-9.

The fate of γ-benzene hexachloride in both normal and benzene hexachloride-resistant houseflies (Musca domestica) has been studied by radiochemical methods by means of $C^{14}$-labelled γ-benzene hexachloride. After exposure to the insecticide the resistant flies showed less radioactivity in carbon tetrachloride extracts than did the normal flies, but paper chromatography of these extracts showed the radioactive compound present to be γ benzene hexachloride. A proportion of the absorbed benzene hexachloride in both kinds of flies is converted into water-soluble products which are not extracted by carbon tetrachloride, and the amount of this product is greater for resistant flies, being approximately 50% of the total benzene hexachloride absorbed during 6 hours' exposure of the insects to the insecticide. (auth.)

442 Bradbury, F.R., Standen, H. BENZENE HEXACHLORIDE METABOLISM IN ANOPHELES GAMBIAE. Nature 178 (1956) 1053-4.

The absorption and metabolism of BHC was examined in two laboratory strains of Anopheles gambiae Giles, of which one (R) was 26 times as resistant to γBHC as the other. Deposits of the α or γ isomer of BHC labelled with $C^{14}$ were made from carbon tetrachloride solution in flasks, and weighed batches of mosquitoes (50-100 of mixed sex) were exposed in the stoppered flasks at 25°C [77°F] for 24 h with pieces of untreated filter paper for them to rest on. The radioactive material was then recovered and estimated as fractions soluble in $CCl_4$ and in water. The α isomer was included as it is known that γ-resistant flies [Musca domestica L] can metabolize it as easily as the γ isomer, and it allows of longer survival of the S strain. The (tabulated) results show that the R strain absorbs as much BHC as the S strain and converts a smaller proportion (about 6 as compared with 11% in the case of the γ isomer) to water-soluble products. The radioactivity in the $CCl_4$ extracts revealed almost entirely unchanged BHC. As the S strain was knocked down by γ BHC after some 30 min and the R strain only after about 3 h, a further experiment was carried out in which the mosquitoes were exposed to γ BHC for 1 h and then kept for 24 h at 25°C in a clean flask. The pattern of absorption and metabolism was very similar to that shown with the longer exposure. Thus, insecticide resistance can occur in a strain of insects that is no more able to metabolize the poison than is a susceptible strain. A. gambiae can convert only 11% or less of absorbed γ BHC to excretable products, whereas houseflies of a resistant strain under similar conditions can convert more than 90%.

443 Bradbury, F.R., Standen, H. THE FATE OF γ BENZENE HEXACHLORIDE IN NORMAL AND RESISTANT HOUSEFLIES II. J. Sci. Food Agric. 7, 6 (1956) 389-96.

Studies were made of the pick-up and metabolism of BHC isomers by normal and resistant houseflies, employing the compound labelled with $C^{14}$. The α-, β-, γ-, and δ-isomers were all metabolized, conversion to water-soluble metabolites being in the order α- and γ->δ-> β-. Resistant flies showed a more rapid metabolism of the insecticide than did normal flies. They also absorbed less, with the result that their content of the γ-isomer was ¼ of that of normal flies 4 h after a 15-min exposure to the insecticide vapour. (CA 50: 13355i, 1956)

444 Bradbury, F.R., Standen, H. THE FATE OF γ-BENZENE HEXACHLORIDE IN RESISTANT AND SUSCEPTIBLE HOUSEFLIES. III. J. Sci. Food Agric. 9 (1958) 203-12.

A detailed study of the minor constituents of the carbon tetrachloride extracts of flies treated with $C^{14}$-labelled γ-BHC has established the presence of pentachlorocyclohexene, trichlorobenzene and acidic substances. Under various conditions of exposure and different dosage rates these compounds occur only in small amount (3% or less of the absorbed dose of γ-BHC). Pentachlorocyclohexene was never found in quantities greater than 3% of the γ-BHC absorbed and it is concluded that if this compound is an intermediate in the metabolism of γ-BHC by resistant houseflies, it has, in the γ-BHC-resistant Uruguay strain, only a very transient existence. One result of the discovery of these minor constituents in carbon tetrachloride extracts is to show that the resistant strain enjoys a greater advantage over the susceptible in rate of detoxication of γ-BHC than had previously been supposed. (from auth.)

445 Bradbury, F.R., Standen, H. METABOLISM OF BENZENE HEXACHLORIDE BY RESISTANT HOUSEFLIES MUSCA DOMESTICA. Nature 183 (1959) 983-4.

The Jealotts Hill strain of flies resistant to benzene hexachloride was exposed to α- or γ-benzene hexachloride labelled with $C^{14}$. The experimental procedures adopted are described. Alkaline hydrolysis of the metabolic products was found to give dichlorothiophenols. The results are tabulated, which show that about 68% of the water-soluble products from the α-isomer and 61% from the γ-isomer are produced. It is inferred that the metabolism of benzene hexachloride by the flies to produce water-soluble compounds involves the formation of a C — S bond. A scheme which would satisfactorily account for the production of dichlorothiophenols from benzene hexachloride is put forward.

446 Bradbury, F.R., Whitaker, W.O. THE SYSTEMIC ACTION OF BENZENE HEXACHLORIDE IN PLANTS: QUANTITATIVE MEASUREMENTS. J. Sci. Food Agric. 7, 4 (1956) 248-53.

Tests with seedlings grown for 14 days in solutions of γ BHC labelled with $C^{14}$ showed that the plants did not convert the insecticide into water-soluble products, so that the loss of insecticide must be ascribed to evaporation from the plant of either the unchanged insecticide or a volatile decomposition product. The results indicate that virtually all the γ BHC applied in a seed dressing may be absorbed and that the main effects of such treatment are systemic.

447 Bridges, R.G. FATE OF LABELLED INSECTICIDE RESIDUES IN FOOD PRODUCTS. VI. RETENTION OF γ-BENZENE HEXACHLORIDE BY WHEAT AND CHEESE. VII. THE FATE OF γ-BENZENE HEXACHLORIDE RESIDUES IN FLOUR DURING BAKING. J. Sci. Food Agric. 9, 7 (1958) 431-9, 439-48.

As γ BHC is being increasingly used for the control of insects and mites that infest stored foodstuffs and is persistent enough to leave a residue, especially in fatty materials, the fate of the residues in certain products was investigated. The results are given in these two parts of a series. BHC labelled with $C^{14}$ was used to study the rate of loss of the insecticide from whole wheat and its distribution between the flour and bran fractions after milling. Loss from exposed wheat was rapid, but when it was stored in closed containers no loss was detected. After milling the wheat, 40-50% of the initial residue was still present in the "fine" flour fraction, while the residue in the bran was increased between 2- and 4-fold. Loss of the insecticide from Cheddar and Stilton cheeses was slow, about 40% of the weight applied remaining after 44 weeks. Penetration of the insecticide into both types of cheese was slow, although appreciably more rapid in the Stilton cheese. Repeated applications caused a build-up of the insecticide in the outer few millimetres of the cheeses, but had little effect on the amount penetrating more deeply. The toxicological significance of such residues is discussed. $C^{14}$-labelled γ BHC was used to study the effect of heating at baking temperatures on the insecticide when present in wheat starch, gluten and milled wheat. The amounts of $C^{14}$-activity retained by the starch and gluten after heating for ½ h at 180°C (356°F) depend on the initial moisture content of the materials. With milled wheat at moisture contents between 0.4 and 17.3%, little difference in the amount of $C^{14}$-activity retained was observed, but when mixed into a dough with water prior to heating, a greater proportion of the initial $C^{14}$-activity was retained. The residue remaining after heating was "locked up" in desiccated starch granules and could not be extracted with acetone until the heated material was treated with water. The residue in the heated starch consisted mainly of unchanged BHC, but that in the flour was shown to be mainly a mixture of tri-, di- and monochlorobenzenes. The toxicological significance of these breakdown products in bread is discussed. (RAE-A 47: 233, 1959)

448 Bridges, R.G. PENTACHLOROCYCLOHEXENE AS A POSSIBLE INTERMEDIATE METABOLITE OF BENZENE HEXACHLORIDE IN HOUSEFLIES. Nature 184 (1959) 1337-8.

A Dieldrin-resistant (R-strain) and susceptible strain of Musca domestica were used. A simultaneous high resistance to γ-BHC was encountered. Studies of the resistance mechanism were made using $C^{14}$-labelled α-, γ- and δ-isomers of BHC. Details of the methods and their applications are given. Results suggest that monodehydrochlorination is not the first step in any major pathway for the metabolism of γ-BHC by houseflies. Detection of γ-PCCH together with other chlorinated benzenes may mean that an alternate pathway by dehydrochlorination is possible, though of secondary importance.

* Craig et al. 1953 - [778]

* Craig 1956 - [779]

* Craig 1960 - [780]

449 Elias, H., Lieser, K.H., Kohlschütter, H.W. RADIOCHEMISCHE UNTERSUCHUNG DER ISOMERISIERUNG DES 1,2,3,4,5,6-HEXACHLORCYCLOHEXANS (Radiochemical investigation into the isomerization of 1,2,3,4,5,6-hexachlorcyclohexane). Chem. Ber. 93, 9 (1960) 2128-37. (In German)

With the use of $C^{14}$-labelled γ-and α-HCH (i.e. 1,2,3,4,5,6-hexachlorcyclohexane) it was possible to follow quantitatively the isomerization of γ-HCH and α-HCH in the homogeneous system HCH/$AlCl_3$ / 1,1,2,2-tetrachlor ethane as a function of time in the temperature range from 100-130°C. Calculations based on experimental data showed that isomerization may be considered as equilibrium reactions of the type γ-HCH $\rightleftharpoons$ δ-HCH $\rightleftharpoons$ α-HCH. In the region 100-130°C the equilibrium is very markedly displaced towards α-HCH. Velocity constants and activation energies of intermediate stages were determined, assuming second order bimolecular reactions. (Tr. auth./MB)

450 Hill, R., Jones, A., Palin, D. THE DETERMINATION OF GAMMA ISOMER IN CRUDE BENZENE HEXACHLORIDE BY A CARBON-14 ISOTOPE DILUTION METHOD. Chem. and Industry (Rev.) (1954) 162-3.

A method of preparing $C^{14}$-labelled γ-BHC 1,2,3,4,5,6-hexachlorocyclohexane, is described. It was used as a laboratory check on other analytical procedures.

451 Hornstein, I. [ANALYSIS OF] BENZENE HEXACHLORIDE. J. Ass. off. agric. Chem. 38 (1955) 290-2.

The results for the γ isomer of benzene hexachloride obtained by the present AOAC method (AOAC Methods of Analysis, 7th ed., 1950, 5.153 (CA 45, 2824e)) were similar to those obtained by the modified procedure reported previously. Therefore no change in the present procedure is recommended. The results by the Craig and Tryon radioactive isotope dilution method (Craig et al., CA 48, 2967d) showed excellent agreement with those found by the infrared method. (CA 49: 9865g, 1955)

452 Hornstein, I. [DETERMINATION OF] BENZENE HEXACHLORIDE. J. Ass. off. agric. Chem. 39 (1956) 373-7.

As a result of a collaborative study, the present official partition chromatographic method for the determination of γ-benzene hexachloride (I) was revised (details given). The following average values were obtained on a 6% I dust (5.6% by infrared analysis): present method 5.70; revised 5.38; on a 13% I dust (13.1 by infrared and 13.0 by radioisotope dilution analysis); present 13.07; revised 12.90. (CA 50: 9681c, 1956).

453 Hornstein, I. [DETERMINATION OF] BENZENE HEXACHLORIDE. J. Ass. off.agric. Chem. 40 (1957) 737-43.

The Craig et al. radioactive-isotope dilution method for the determination of the γ-isomer content of technical BHC (I) was applied by 6 collaborators to 2 samples of technical I containing 13 and 15% of γ-I, a 35% concentrate of γ-I, and γ-I-reinforced samples prepared by adding known amounts of pure γ-I to technical grade I of previously established γ-I content. Statistical analysis of all samples except the concentrate revealed an over-all relative precision of ± 4.2% at the 95% confidence level. The accuracy and precision of the method is considered excellent. It was difficult to obtain representative samples of the concentrate. (CA 51: 13304b, 1957)

454 Palin, D. DETERMINATION OF GAMMA ISOMER IN CRUDE BENZENE HEXACHLORIDE BY A CARBON-14 DILUTION METHOD (abstr.). Analyt. Chem. 26 (1954) 1856.

A $C^{14}$-isotope dilution method for determining the Lindane content in crude BHC is described.

455 Pearce, G., Krause, S. CHLORINE EXCHANGE BETWEEN ALUMINIUM CHLORIDE AND γ-1,2,3,4,5,6-HEXACHLOROCYCLOHEXANE. J. Amer. chem. Soc. 79 (1957) 271-3.

Chlorinated hydrocarbon insecticides labelled with $Cl^{36}$ represent a most effective tool in studies of the fate and toxicology of this class of compounds in resistant strains of arthropods as well as in higher animals. The use of exchange reactions appeared to offer a simpler way of preparing $Cl^{36}$-labelled compounds than their complete synthesis. Chlorine exchanges readily between aluminium chloride and γ-1,2,3,4,5,6-hexachlorocyclohexane (γ-HCC) at temperatures above 100° with some decomposition and isomerization, primarily to α-HCC and δ-HCC. Mechanisms for both exchange and isomerization are proposed.

456 Perlowagora-Szumlewicz, A. THE TOXIC ACTION OF THE VAPORS OF HEXACHLOROCYCLOHEXANE ON TRIATOMA INFESTANS. Rev. bras. Malariol. 5,2 (1953) 171-81.

The toxic action of hexachlorocyclohexane (I), both as vapour and as a solid residue, was determined against all stages of development of T. infestans (Hemiptera), a vector of Trypanosoma cruzi. To test the action of solid residue the I solution in $C_6H_6$ was taken up by filter paper and, by the addition of thorium salts of known radioactivity, it was found that I spread evenly. The vapours are slow but effective; they are very dangerous for 1st-instar nymphs, adults are affected next, and 4th instar nymphs are hardest to kill. The vapours lose their efficiency over $1\frac{1}{2}$ months, but a spraying of huts, etc., once every 2 months is effective to rid them of the insects. If one succeeds in keeping the insects in constant contact with a surface containing solid I, the rate of knockdown is still greater. The results show that a spray of I will kill insects in crevices, cracks, etc., as vapours and solids are insecticidal.

## Chlorobenzene

457 Gessner, T., Smith, J.N. COMPARATIVE DETOXICATION. VII. THE METABOLISM OF CHLOROBENZENE IN LOCUSTS: EXCRETION OF UNCHANGED CHLOROBENZENE AND CYSTEINE CONJUGATES. Biochem. J. 75 (1960) 165-72.

The excretion and metabolism of $C^{14}$-labelled chlorobenzene was studied in the locust Schistocerca gregaria. About half the dose was excreted unchanged. The probable presence, in excreta, of o-, m-, and p-chlorophenyl-L-cysteine and smaller amounts of m- and p-chlorophenylmercapturic acid was shown by isotope-dilution techniques. These compounds were excreted as acid-labile precursors. A weak acylase is present in crop fluid and excreta which slowly hydrolyzes L-p-chlorophenylmercapturic acid to p-chlorophenyl-L-cysteine. p-Chlorophenyl-L-cysteine is enzymically degraded to unidentified products by crop fluid and excreta.

458 Gessner, T., Smith, J.N. COMPARATIVE DETOXICATION. VIII. THE METABOLISM OF CHLOROBENZENE IN LOCUSTS: PHENOLIC METABOLITES, A COMPARISON WITH SOME VERTEBRATE SPECIES. Biochem. J. 75 (1960) 172-9.

Phenol, o-, m-, and p-chlorophenol, and 4-chlorocatechol have been detected in the excreta of locusts dosed with chlorobenzene. The amounts of these phenols present were determined by isotopic-dilution procedures after dosing locusts with chlorobenzene-$C^{14}$. Determination of o-, m-, and p-chlorophenol in locust excreta was carried out by a chromatographic-colorimetric method, and the results were compared with similar estimations on the urine of rats, cats, ferrets, and rabbits dosed with chlorobenzene. The significance of the ratio of o-chlorophenol: m-chlorophenol: p-chlorophenol excreted by different species is discussed. (CA 54: 15723a, 1960)

459 Kikal, T., Smith, J.N. METABOLISM OF CHLOROBENZENE-$C^{14}$ IN THE LOCUST. Biochem. J. 69 (1958) 52P.

The studies were carried out on Schistocerca gregaria. Half of an injected dose of chlorobenzene-$C^{14}$ (ring labelled) is eliminated unchanged in 48 h. The remaining $C^{14}$ is found in the excreta as m- and p-chlorophenols, 4-chlorocatechol, p-chlorophenylcysteine.

## DDT

460 Babers, F.H. THE SOLUBILITY OF DDT IN WATER DETERMINED RADIOMETRICALLY. J. Amer. chem. Soc. 77 (1955) 4666.

In a brief note the author described how the water solubility of $C^{14}$-labelled DDT was determined at 3 temperatures by radiochemical methods. It was found that in very thin layers and microgram quantities DDT is appreciably volatile at room temperatures.

461 Bowman, M.C., Acree, F., Jr., Corbett, M.K. SOLUBILITY OF DDT-$C^{14}$ IN WATER. J. agric. Food Chem. 8 (1960) 406-8.

A knowledge of the solubility of DDT in water was required to study the effect of dissolved and undissolved toxicant on bioassays with mosquito larvae. The DDT was analyzed radiometrically, undissolved particles (~41 Å) were removed by an average ultracentrifugal force of 84 150 g. The solubility of DDT in water was found to be 1.2 parts per $10^9$ or less at 25°C. Date on sizes of undissolved DDT particles and on recovery of DDT after ultracentrifugation at 1 g are presented.

462 Bowman, M.C., Acree, F., Jr., Schmidt, C.H., Beroza, M. FATE OF DDT IN LARVICIDE SUSPENSIONS. J. econ. Ent. 52, 3 (1959) 1038-42.

The toxicity of DDT in aqueous-acetone suspensions to mosquito larvae is affected by the volume of suspension and the type of the test container. To learn whether the differences are due to settling, settling rates for different concentrations of DDT suspensions were determined. Settling does take place at the 1 ppm level but not at 0.01 ppm, a concentration approximating that normally used in mosquito larvicide tests. In further studies of such suspensions, a high proportion of the DDT was found deposited on the inner walls of glass, aluminium, or paper containers when the liquid phase was withdrawn within minutes after preparation of the suspensions. The concentration of the DDT in suspension was thereby reduced. Another surprising finding was that more than 50% of the DDT from 0.001 ppm suspensions was lost by volatilization with the liquid phase during 24 hours. This volatilization plus the deposition on the walls of the container appear to account for the loss of DDT from larvicide test suspensions. A physicochemical explanation for these findings is presented. $C^{14}$-labelled DDT was used. (auth.)

463 Buhler, D.R., Wang, C.H., Christensen, B.E. SYNTHESIS OF TERTIARY CARBON$^{14}$-LABELED DDT. J. Amer. chem. Soc. 75 (1953) 4336.

A method is described very briefly to meet the need for uniquely labelled DDT; it represents a microscale adaptation of Fry's technique (J. Amer. chem. Soc. 71 (1949) 3238). The overall yield for this procedure was found to be 10%. The isolated product DDT gave a melting point 104-104.5° (lit. 108-108.5°), with a specific activity of $1.49 \times 10^8$ cpm/mM.

464 Butts, J.S., Chang, S.C., Christensen, B.E., Wang, C.H. DDT DETOXIFICATION PRODUCTS IN AMERICAN COCKROACHES. Science 117 (1953) 699.

2-$C^{14}$-labelled DDT was synthesized with a specific activity of 1.5 mc/mM, and injected into cockroaches. Among 29 roaches, each injected with 3 µl of ethanol containing 20 µg of radioactive DDT, 22 survived after 48 h in a respiratory chamber at 3-35°C. Various fractions were tested for radioactivity. The findings led the authors to speculate that the water-soluble radioactive principle in this case is probably a conjugated compound composed of a DDT derivative and another, possibly carbohydrate, fragment. This formation of a conjugate might be related to the detoxification mechanism of DDT in roaches.

465 Fields, M., Gibbs, J., Walz, D.E. THE SYNTHESIS OF 1,1,1-TRICHLORO-2,2-BIS-(4'-CHLOROPHENYL-4'-$C^{14}$)-ETHANE. Science 112 (1950) 591-2.

The authors undertook the synthesis of DDT labelled with $C^{14}$ in the benzene ring. Both benzene-1-$C^{14}$ and aniline-1-$C^{14}$ are readily available; the preparation of tagged chlorobenzene by direct chlorination of benzene was investigated, as well as by the Sandmeyer reaction with aniline. Experimental conditions and results are described. A sample of 1,1,1-trichloro-2,2-bis-(4'-chlorophenyl-4'-$C^{14}$)-ethane from chlorobenzene-1-$C^{14}$ under the condition described in the paper had a specific activity of approximately 54 µc/mM.

466 Gjullin, C.M., Lindquist, A.W., Butts, J.S. ABSORPTION OF RADIOACTIVE DDT BY RESISTANT AND NON RESISTANT MOSQUITOES. Mosquito News 12, 3 (1952) 201-5.

The amounts of $C^{14}$-labelled DDT absorbed by mosquito larvae and pupae were determined with a commercial type windowless gas-flow counter attached to a scaler. Fourth-instar larvae of Aëdes vexans and A. sticticus absorbed from 0.00310 to 0.00371 g of DDT in 24 h when subjected to kerosene films and from 0.00173 to 0.00324 g when treated with acetone suspensions of radioactive DDT. The mortalities ranged from 21-97%. Dead larvae absorbed about two-thirds as much DDT as did live larvae. Larvae tested in acetone suspensions of DDT absorbed nearly twice as much DDT at 90°F as at 70° and the mortality was lower at 90°. Further details are given of the absorption of pupae of these species, and of the reaction to treatment of the resistant Aëdes nigromaculid larvae which absorbed six times as much DDT as non-resistant larvae treated with 0.02 ppm. Bioassay of the extracts of these larvae with second-instar larvae of vexans and sticticus indicated that both resistant and non-resistant larvae had degraded a large amount of the DDT to non-toxic substances. (from auth. summary) (The salient features of this article were also briefly reported in Agric. Chemic. 7, 8 (1952) 70 under "Radio-DDT studies"

467 Hagley, E.A., Morrison, F.O. THE SYNERGISTIC ACTION OF CERTAIN CHEMICALS USED IN COMBINATION WITH DDT. p. 175-85 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956", Vol. 2. Becker, E.C., ed. Ottawa, Mortimer Ltd. 1958.

Four methylene dioxyphenyl compounds, 1, 1 bis (p-chlorophenyl) chloromethane (DBC): 1, 1 bis (p-chlorophenyl) ethanol (DMC); and 1, 1 bis (p-chlorophenyl) ethynyl carbinol (EC) were tested for synergistic action when applied topically to adult houseflies of two strains. The (p-chlorophenyl) compounds were all effective in increasing the lethal action of DDT. The other chemicals showed no synergism. The fly strain did not affect the results. Increasing the proportion of synergist from 1:1 to 1:10 increased the effect. Studies using $C^{14}$-labelled DDT revealed no increase in DDT penetration due to the synergist. When either DDT or synergist was applied in advance of the other, or when applications were made to different loci on the body, the synergistic effect was the same, but mixtures applied directly to the brain tissue were little more effective than DDT alone. When the synergist was applied to the proboscis, and the DDT to the thorax after the cervical region had been tightly ligated, the effect of the ligation in reducing mortality was still evident but was not so marked as with DDT alone applied to the thorax. (auth.)

468 Hallepanavar, N. L., Cutkomp, L. K., Patel, N. G. DENSITY OF GRANARY WEEVILS IN RELATION TO INSECTICIDAL EFFECTIVENESS. Bull. ent. Soc. Amer. 6, 3 (1960) 152, abstr. 44.

Sitophilus granarius (L.) mortality in wheat treated with DDT was greater when small numbers of weevils were present. $C^{14}$-labelled DDT was used to determine pickup. Several possible causes of the differences in mortality were investigated.

469 Hoffman, R. A., Roth, A. R., Lindquist, A. W. EFFECT ON HOUSE FLIES OF INTERMITTENT EXPOSURES TO SMALL AMOUNTS OF DDT RESIDUES. J. econ. Ent. 44, 5 (1951) 734-63.

Knockdown tests with non-resistant females showed that the total exposure time needed to effect knockdown also increased as the interval between exposures was lengthened. In a series of tests with radioactive DDT (containing $C^{14}$), resistant flies exposed intermittently for a total of 7 h to 5 mg per $ft^2$ had a mortality of 16%, whereas resistant flies exposed continuously for the same time had a mortality of 45%, although the radioactivities of the two lots (and therefore the amounts of DDT absorbed by them) did not differ significantly.

470 Hoffman, R. A., Roth, A. R., Lindquist, A. W., Butts, J. S. ABSORPTION OF DDT IN HOUSEFLIES OVER AN EXTENDED PERIOD. Science 115 (1952) 312-3.

The authors emphasize the importance of timing the analyses in absorption studies with DDT. A 5-day delay in the analysis of flies succumbing within 24 h after treatment increased the amount of DDT absorbed as much as 45%, and a one-day delay 62%. About the same increase was obtained for flies that survived the DDT treatment for five days, indicating that absorption of DDT proceeded at about the same rate in dead as in living flies. Treated flies radioassayed after a lapse of more than a year showed a large increase in the amount of DDT penetrating the integument.

471 Hoskins, W. M., Witt, J. M. TYPES OF DDT METABOLISM AS ILLUSTRATED IN SEVERAL INSECT SPECIES. p. 151-6 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956", Vol. 2. Becker, E. C., ed. Ottawa, Mortimer Ltd. 1958.

The metabolism of DDT in 30 spp. of insects fell into 3 types: (a) absorbed DDT remained unchanged and could be recovered by solvents, (b) much of the DDT was converted to dichlorobis-(p-chlorophenyl) ethylene (DDE), and (c) the products of metabolism of DDT did not respond to the Schechter-Haller (SH) test (cf. Schechter et al., CA 40, 2260) and hence were not DDT nor bis(chlorophenyl)acetic acid (DDA). The recovery of DDT from survivors of $LD_{50}$ dosages in 6 spp. were as follows: Bombyx mori, DDT 88, DDE 12, and non-SH 0%; Nymphalis antiopa, DDT 69, DDE 2, and non-SH 29%; Malacosoma americanum, DDT 15, DDE 66, and non-SH 19%; Musca domestica, DDT 6, DDE 60, and non-SH 34%; Plodia interpunctella, DDT 18, DDE 26, and non-SH 56%; and Ornithodoros coriaceous, DDT 4, DDE none, and non-SH 96%. The large milkweed bug (Oncopeltus fasciatus), the resistant housefly (Musca domestica), and the cockroach (Periplaneta americana) illustrated the 3 types of metabolism. Results of studies of these 3 spp. of insects with DDT tagged with $C^{14}$ were given. There was a definite sequence of metabolites in the 3 insect spp. The paper chromatogram strips were scanned by a gas-flow scanner of novel design. The $C^{14}$ on the strips could be measured if the counts were 100/min. or more. The apparatus was described. (CA 53: 22548d, 1959)

472 Jackson, P. C., Hopkins, H. T. STUDY OF THE PERSISTENCE OF $C^{14}$-LABELED p, p'-DDT IN VARIOUS SOILS. Bureau of Plant Industry, Soils, and Agricultural Engineering. Div. of Soil Management and Irrigation, Beltsville, Md. Progress Report 237 (1952).

Radioactive p,p'-DDT was incorporated in 18 representative soils at a normal rate of application. After storage periods of one and 6 months the soils were extracted with acetone and the amount of a radioactivity recovered from each soil was measured. Identification of the degradation products of DDT was made on soil extracts by means of paper partition chromatography. The following conclusions were reached: (1) Decomposition of p,p'-DDT is generally greatest in soils with a pH higher than 7.0; (2) the principal degradation products of p,p'-DDT found in 16 of the 18 soils was p,p'-DDE; (3) the phytotoxic derivative, p,p'-DDA, is not persistent in any of the soils studied in this work. (auth. summary)

(See also ARS 33-63)

* Jensen et al. 1957 - [738]

473 Jensen, J.A., Pearce, G.W. SYNTHESIS OF RADIOACTIVE IODINE$^{131}$ ANALOG OF DDT. J. Amer. chem. Soc. 74 (1952) 2436.

(Brief note). DDT has been labelled in various ways, particularly by means of $C^{14}$. The authors briefly discuss a technique for preparing 2,2-bis-(p-iodophenyl)-1,1,1-trichloroethane, the $I^{131}$ analoque of DDT.

A detailed description is given in Document 3488, American Documentation Institute, 1719 N Street, N.W., Washington 6, D.C.

474 LeRoux, E.J., Morrison, F.O. THE ADSORPTION, DISTRIBUTION, AND SITE OF ACTION OF DDT IN DDT-RESISTANT AND DDT-SUSCEPTIBLE HOUSE FLIES USING CARBON$^{14}$ LABELLED DDT. J. econ. Ent. 47,6 (1954) 1058-66.

Experimental techniques are described, and the results tabulated and discussed. When DDT is topically applied to adult houseflies, the locus of application greatly influences the rate of penetration, distribution and accumulation at the site of action. The DDT is distributed by way of the haemolymph, but not accumulated in it. Other tissues and organs, particularly the integument, absorb the DDT or its metabolites from the hemolymph. The rate at which DDT enters the hemolymph and is distributed to the various parts of the body is directly related to the area of contact. Distribution from the point of application continues at a reduced rate in dead flies. The site of action appears to be some organ or product in or produced within the head of the adult fly. Median lethal doses calculated from the topical application of DDT and estimates of the difference in susceptibility between fly strains are both influenced by the locus of application. The nearer it is to the site of action (in the case of the housefly the inside of the head), the lower the observed median lethal dose and the less the observed differential in strain susceptibility. The greater susceptibility of individuals treated near or on the site of toxic action offers a method of increasing the sensitivity of bioassay methods. (from RAE-B 43: 192, 1955)

475 LeRoux, E.J., Morrison, F.O. DOSAGE OF DDT NEEDED TO KILL A HOUSE FLY. J. econ. Ent. 46,6 (1954) 1109-10.

DDT was applied to the tibio-femoral joint of the metathoracic leg or to the labella of males of the housefly, Musca domestica L., by Fisher's method at at 2 μg per fly. Amputations of the treated leg after 30 minutes considerably reduced mortality, but amputation of the leg after 4 h or of labella after 30 min had no effect. When flies were similarly treated with radioactive DDT and later sectioned, the percentages of the total radioactivity that were in severed treated appendages were 91 in legs and 90 or 93 in labella after 30 minutes, and 80 in legs after 4 h. Thus, absorption and distribution of 10-20% of the applied dose produced the full lethal effect, and the site of application did not influence the rate of absorption but did influence effectiveness. (RAE-B 42: 139, 1954)

476 Lichtenstein, E.P., Schulz, K.R. TRANSLOCATION OF SOME CHLORINATED HYDROCARBON INSECTICIDES INTO THE AERIAL PARTS OF PEA PLANTS. J. agric. Food Chem. 8,6 (1960) 452-6.

The increased use of chlorinated hydrocarbon insecticides in soil has often raised the question of whether or not these insecticides might translocate into the aerial parts of plants from the soil in spite of their extremely low solubility in water. This was tested by resorting to very high concentrations of insecticide and using a soil of minimum sorptivity and complexity. Plants were also grown in insecticide-free sand within a glass container surrounded by insecticide-treated sand. Lindane, Aldrin, Dieldrin and heptachlor as well as $C^{14}$-labelled p,p'-DDT was used. Because a relatively small amount of DDT was available only one aluminium foil-covered pot containing DDT-treated quartz sand (30 ppm) was planted with peas. Pea plants grown in sand treated with $C^{14}$-labelled DDT did not show any translocation of this insecticide. On the basis of extraction of plant material and radioassay, less than 0.01 ppm of $C^{14}$ derived from DDT was found.

477 Lindquist, W. A., Dahm, P. A. METABOLISM OF RADIOACTIVE DDT BY THE MADEIRA ROACH AND EUROPEAN CORN BORER. J. econ. Ent. 49, 5 (1956) 579-84.

The absorption, metabolism and excretion of $C^{14}$-ring-labelled p,p'-DDT in adult females of the Madeira cockroach (Leucophaea maderae (F.)) and fifth-instar larvae of the European corn borer (Pyrausta nubilalis (Hb.)) were studied. The cockroach absorbed DDT rather slowly (about 90% in 20 days) and excreted 50% of the total applied radioactivity over a period of 36 days. Separation of the radioactive compounds excreted in faeces by DDT-treated cockroaches was accomplished by paper chromatography. The presence of DDT, DDE (2,2-bis (p-chlorophenyl)-1,1-dichloroethylene) and three unidentified metabolites was demonstrated. DDT was the predominant radioactive compound excreted in the first 24 hours after treatment, after which a metabolite with an $R_f$ value of about 0.88 was the major radioactive compound excreted. Metabolic pathways for the DDT in the cockroach are proposed. Fifth-instar larvae of P. nubilalis, have some tolerance of DDT and convert significant amounts of absorbed DDT to DDE. No evidence of DDT metabolites other than DDE was found. Both colorimetric and radiometric analyses were used in the study of P. nubilalis. (from auth. summary)

478 Lindquist, A.W., Roth, A.R., Hoffman, R.A., Butt, J. S. THE DISTRIBUTION OF RADIOACTIVE DDT IN HOUSE FLIES. J. econ. Ent. 44, 6 (1951) 931-4.

The distribution of $C^{14}$-labelled DDT in various internal organs and external parts of resistant houseflies, Musca domestica L., was studied. Flies topically treated with 8 to 11.25 mg of DDT each showed from 26-34% of the total absorbed in the internal organs and the remainder distributed throughout the cuticle. Flies exposed to a residual deposit of the DDT showed a similar distribution of the toxicants, but only ⅓ to ½ as much as in the topically treated flies. The prevention of ingestion of the DDT by removal of the proboscises did not appreciably alter the percentage recovery in the different parts. In another series of tests it was found that 13% of the total DDT absorbed was present in the body fluids. The intestinal tract, thoracic ganglion, reproductive system, and thoracic muscles of all flies examined showed some radioactivity. (auth. summary)

479 Lindquist, A.W., Roth, A.R., Yates, W.W., Hoffman, R.A., Butts, J.S. USE OF RADIOACTIVE TRACERS IN STUDIES OF PENETRATION AND METABOLISM OF DDT IN HOUSE FLIES. J. econ. Ent. 44, 2 (1951) 167-72.

Penetration of an insecticide through the cuticle of resistant Musca domestica was studied by applying 15 μg of $C^{14}$-labelled DDT. After 24 h, both the dead and surviving flies were washed in acetone to remove exterior DDT, and then macerated and the DDT or metabolites extracted with acetone. The quantities of DDT recovered in the wash and extract were determined by radioactivity measurements and calculating the equivalent weights and percentages. From the flies surviving the topical treatment 78% of the DDT applied was recovered and 82% of the recovered DDT was in the wash. Of the flies given a topical treatment an average of 2.1 and 2.3 μg of DDT or toxic metabolites was recovered, respectively, from surviving and dead flies. Approx. 1/10 less DDT or metabolites was recovered from the flies exposed to a residue. Bioassays of the fly extracts with mosquito showed that 63% of the total DDT absorbed by topically treated surviving flies was nontoxic and therefore metabolized. The 27% that was toxic was probably DDT, since neither of the metabolic products, 2,2-bis(p-chlorophenyl) acetic acid or 2,2-bis (p-chlorophenyl)-1, 1-dichloroethylene, killed mosquito larvae.

480 MacDonald, R., Baker, B.E. SYNTHESIS OF CARBON$^{14}$-LABELED DDT. Canad. J. Chem. 31 (1953) 517-9.

The authors described a method for synthesizing tertiary-$C^{14}$-labelled DDT, 2,2-bis (p-chlorophenyl)-1,1, 1-trichloroethane-2-$C^{14}$. The various steps in synthesis are discussed. $MeC^{14}O_2Na$ from labelled $BaCO_3$ was heated with p-$MeC_6H_4SO_2Cl$ 30 min at 180-200°C to give $(MeC^{14}O)_2O$. The labelled $Ac_2O$ with PhCl gave p-$ClC_6H_4C^{14}OMe$ by a Friedel-Crafts reaction. Direct chlorination yielded p-$ClC_6H_4C^{14}H(OH)CCl_3$. This product was condensed with PhCl by $H_2SO_4$ to give $(p\text{-}ClC_6H_4)_2C^{14}HCCl_3$ (DDT). The DDT contained 4.76% of the original $C^{14}$.

481 Miles, J.W., Pearce, G.W. RAPID METHOD FOR MEASUREMENT OF RATE OF SORPTION OF DDT BY MUD SURFACES. Science 126 (1957) 169-70.

A rapid method of assessment of loss of insecticidal activity of DDT and related compounds from mud surfaces has now been evolved, based on loss of radioactivity from surfaces dusted with $C^{14}$-labelled DDT. The $C^{14}$-labelled compound migrates to only slightly beneath the surface, and the weak β-rays are shielded

so that loss of insecticide from the surface may be followed by measuring loss in radioactivity. Different samples of mud were made into blocs under various conditions of humidity, and a homogeneous mixture prepared by dissolving 990 mg. pure p,p' DDT and 9.8 mg radioactive p,p' DDT (specific activity 0.48 mc/g) in carbon tetrachloride, evaporating the solvent, drying the residue over silica gel and grinding it to a fine powder. Each bloc was then dusted with the powder, with about 1 mg DDT particles ranging from 1-25 $\mu$ in diameter, deposited from a stream of nitrogen. An average count of 4220/min was obtained immediately after dusting. The subsequent rate of loss of radioactivity of the bloc in a dry atmosphere was tested, and the percentage of DDT in different layers determined. No DDT was found at a depth below 1.5 mm.

482 Morrison, F.O., LeRoux, E.J. HOUSE FLY HEAD AS SITE OF LETHAL ACTION OF DDT. Canad. J. agric. Sci. 34,3 (1954) 316-8.

DDT (2 $\mu$g per fly) was applied to the labella or to the tibio-femoral membrane of one leg of males of Musca domestica L. that had emerged four days before. Treatment of the labella gave 83% kill in 24 hours, and treatment of the leg gave 68%. When the cervical region of each fly was ligated with cotton thread, the mortality percentages were 91% and only 31% for flies treated on the labella and leg, respectively, and 14 for flies not treated with DDT. When DDT labelled with $C^{14}$ was used, and the heads and bodies of the flies were separated 24 hours after treatment and tested for radioactivity, all the radioactivity applied was recovered and the percentages of it recovered from the heads of non-ligated and (in brackets) ligated flies were 70 (98) after treatment on the labella and 5 (less than 1) after treatment on the leg. Radioactivity in the hemolymph of flies treated on the leg could be detected 30 seconds after treatment, rose fairly rapidly during the first 5 minutes and then remained at a more or less constant level for 24 hours. It is concluded from these results that DDT is translocated in the hemolymph of the fly, and that the head is probably a critical region for its lethal action. (RAE-B43: 188, 1955)

483 Pearce, G.W., Jensen, J.A. SYNTHESIS OF DDT LABELED WITH CARBON-14 IN THE TERTIARY POSITION. Science 118 (1953) 45-6.

A method has been developed for the synthesis of radioactive dichlorophenyl trichloroethane (DDT) of good yield, in which the tertiary carbon is labelled. (For details, see abstract under "Preparation of carbon-14-labeled DDT" in J. agric. Food Chem. 1,12 (1953) 776).

484 Pearce, G.W., Jensen, J.A. PREPARATION OF CARBON-14-LABELED DDT. J. agric. Food Chem. 1,12 (1953) 776-8.

The synthesis of DDT labelled with $C^{14}$ in the tertiary position was carried out in the following steps: barium carbonate to ethyl acetate to ethyl alcohol to chloral to DDT. Starting with 50 mM of barium carbonate containing 20 mc of activity, 15 g of crude DDT were obtained (42% yield based on ethyl alcohol). Two crystallizations from ethyl alcohol yielded 6.11 g of p,p'-DDT (17% yield) having a melting point of 107-107.5°C. The specific activity was approximately 0.5 mc/g. (auth.)

485 Perry, A.S., Jensen, J.A., Pearce, G.W. COLORIMETRIC AND RADIOMETRIC DETERMINATION OF DDT AND ITS METABOLITES IN RESISTANT HOUSEFLIES. J. agric. Food. Chem. 3 (1955) 1008-11.

Studies on degradation products of DDT in seven DDT-resistant strains of houseflies, using radioactive DDT ($C^{14}$-labelled in the tertiary position), showed that the only significant product of DDT metabolism was DDE. Both DDT and DDE were found in the ether-soluble portion of the excreta, the DDE-DDT ratio increasing with increasing time intervals. Very small amounts of a radioactive product were found in the water-soluble portion of the excreta. Losses of DDT were not consistent and are thought to be within the range of experimental error. No strain specificity was evident. In flies held 10 days after application of the insecticide, small but consistent losses of DDT were experienced, which might be attributed to incomplete recovery of material from excreta. (auth.)

486 Perry, A.S., Buckner, A.J. BIOCHEMICAL INVESTIGATIONS ON DDT-RESISTANCE IN THE HUMAN BODY LOUSE PEDICULUS HUMANUS HUMANUS. Amer. J. trop. Med. Hyg. 7 (1958) 620-6.

$C^{14}$-labelled DDT was incorporated into citrated human blood. This was fed to adult lice through chickskin membranes. The DDT-resistant (Korean strain) lice but not the susceptible ones (Orlando strain) could be shown to metabolize DDT to a water-soluble derivative giving a positive test when analysed by the Schechter-Haller method. The metabolite was not ether-extractable following acid hydrolysis but appeared to be in a conjugated form, possibly with a protein fraction.

487 Robbins, W.E., Dahm, P.A. ABSORPTION AND EXCRETION, DISTRIBUTION AND METABOLISM OF CARBON-14-LABELED DDT BY THE AMERICAN COCKROACH. J. agric. Food Chem. 3 (1955) 500-8.

Radioactive DDT and DDE, topically applied to American cockroaches, are rapidly absorbed and widely distributed internally. As much as 75% of the DDT applied is excreted as metabolite(s) in the faeces over a 24-d period. About 80% of the radioactivity in the faeces is due to metabolites containing the diphenyl-2-carbon moiety of DDT; less than 10% is due to DDT, DDE or DDA. Less than 1% of DDT applied or injected is excreted as $C^{14}O_2$. The synergist "piperonyl cyclonene" used with DDT, inhibits absorption of DDT and excretion of metabolites. (auth.)

488 Roth, A.R., Lindquist, A.W. EFFECT OF TEMPERATURE AND THE ACTIVITY OF HOUSE FLIES ON THEIR ABSORPTION OF DDT. J. econ. Ent. 46, 1 (1953) 127-30.

Resistant houseflies, Musca domestica L., treated individually with measured drops of radioactive DDT absorbed 64% more of the toxicant with a lower mortality when held during a 24-h period at 90°F than when held at 70°F. Absorption of the DDT began within the first hour after treatment and gradually increased over several hours. Approximately the same amount of DDT was absorbed irrespectively of whether the fly was immobilized with carbon dioxide or was active. The excrement of treated flies showed some radio-activity. Approximately 15% of the total absorbed was accounted for in the excrement over a 7-d period. No radioactivity could be demonstrated in the carbon dioxide collected from DDT-treated flies. (auth. summary)

489 Rothe, C.F., Mattson, A.M., Nueslein, R.M. Hayes, W.J. METABOLISM OF CHLOROPHENOTHANE (DDT). INTESTINAL LYMPHATIC ABSORPTION. Arch. industr. Health (Amer. Med. Ass.) 16 (July 1957) 82-6.

Radioactive DDT was used, labelled at the tertiary carbon with $C^{14}$ (cf. Pearce & Jensen, 1953). Of the intestinally absorbed, radioactive DDT administered orally to rats with their thoracic lymph ducts cannulated, 47-65% was recovered in the chyle. Furthermore, 14-46% of the absorbed DDT-derived materials found in the chyle were dehydrohalogenated into a neutral material (DDE).

490 Schmidt, C.H., Weidhaas, D.E. EFFECT OF VARYING CONDITIONS IN A LABORATORY TESTING TECHNIQUE ON THE MORTALITY OF MOSQUITO LARVAE. J. econ. Ent. 52, 5 (1959) 970-9.

Fourth-instar larvae were used in the tests. The insecticides used were Dieldrin, Lindane, Parathion, Malathion, and radioactive DDT (p,p'-DDT-4-$C^{14}$ with an activity of 2.1 μc/mg). The mortality of mosquito larvae increased as the volume of acetone-water suspensions or solutions of Dieldrin, Lindane, Malathion, and DDT was increased from 100 to 1000 ml. The increase was greater and more consistent with DDT than with the other larvicides and with larvae of Anopheles quadrimaculatus Say and Aëdes taeniorhynchus (Wied.) than with Aëdes aegypti (L.). No increase in mortality was caused with Parathion. When the diameter of the test containers was increased from 3 to 6 inches but the concentration and volume of the suspensions or solutions were constant, mortality of quadrimaculatus decreased when Dieldrin, Lindane, and DDT were used, but not with Malathion or Parathion. No difference in mortality was observed with the other two species of larvae. (from auth.)

* Terriere and Schonbrod 1955 - [728]

491 Weidhaas, D.E., Schmidt, C.H. TOXICOLOGICAL ACTION OF DDT ON THREE SPECIES OF MOSQUITO LARVAE. J. econ. Ent. 53, 1 (1960) 106-10.

The availability of $C^{14}$-labelled DDT and of radiometric methods permitted quantitative studies on the toxicological aspects of DDT poisoning in mosquito larvae. In tests by radiometric methods the amount of DDT picked up and its relation to the mortality of fourth-instar larvae of Anopheles quadrimaculatus Say, Aëdes taeniorhynchus (Wied.), and Aëdes aegypti (L.) varied with the exposure time and the concentration. Larvae did not excrete DDT except when exposed to concentrations above the minimum LC-100. The toxic action of DDT on quadrimaculatus larvae differed from that on aegypti. Resistance to DDT in a strain of taeniorhynchus was not related to the uptake or the excretion. Live quadrimaculatus larvae absorbed three times as much DDT as dead larvae; however, in a 24-h test period the surviving larvae had about the same dose as the nonsurvivors.

(An abstract of earlier work was published in Bull. ent. Soc. Amer. 4, 3 (1958) 103, abstr. 285)

492 Weidhaas, D.E., Schmidt, C.H., Bowman, M.C. EFFECTS OF HETEROGENEOUS DISTRIBUTION AND CODISTILLATION ON THE RESULTS OF TESTS WITH DDT AGAINST MOSQUITO LARVAE. J. econ. Ent. 53(1960) 121-5.

The concentration of DDT in suspensions was shown to be less than the theoretical, and to vary with the volume of the suspension and the size of the container. This variation resulted from differences in the loss of DDT by codistillation and/or by association with the water interfaces, which explained the resulting differences in mosquito mortality.* The mortality of Anopheles quadrimaculatus Say was influenced more than that of Aëdes aegypti (L.), owing to a difference in the behaviour of the larvae and the dosage-mortality response. Biological data obtained with Parathion, Malathion, Lindane, and Dieldrin indicate that insufficient quantities of these insecticides are lost from the containers to alter mortality under normal test conditions. (auth.)

* $C^{14}$-labelled DDT was used throughout.

* Winteringham et al. 1950 - [492]

493 Winteringham, F.P.W., Loveday, P.M., Harrison, A. RESISTANCE OF HOUSEFLIES TO DDT. Nature 167 (1951) 106-7.

Since the insecticidal properties of $DBr^{82}DT$ are similar to normal DDT and there is no reason to expect any fundamental differences in their metabolism, the penetration and metabolism of $(BrC_6H_4)_2CH.CCl_3$ by susceptible and resistant strains of the housefly Musca domestica were studied by labelling it with $Br^{82}$. Preliminary penetration studies indicated that DDT-resistant flies were also resistant to DBrDT but their resistance was not associated with decreased absorption of the applied insecticide. Metabolism of $DBr^{82}DT$ was only observed in DDT-resistant flies. Results suggest that the metabolism is enzymic in nature. Metabolism appears to be insufficiently rapid to account for the successful resistance of the flies used in these experiments. Alternatively, only a small fraction of the applied insecticide is involved at the site of action, but it is this fraction which is metabolized. To check whether the presence of "$DBr^{82}DE$" metabolite might account for the observed resistance, experiments were performed in which mixtures of $DBr^{82}DT$ and "$DBr^{82}DE$" were injected into or applied to susceptible flies. No evidence of protection was observed.

494 Winteringham, F.P.W. CONFERENCE ON INSECTICIDE RESISTANCE AND INSECT PHYSIOLOGY. Bull. nat. Res. Council US Publ. 219(1952) 61-99.

The author used a bromine ($Br^{82}$) analogue of DDT for treating two resistant and two susceptible strains of houseflies (from Italy and Sardinia, and from Italy and England respectively). Both adults and larvae were used for studying the metabolism of $DBr^{82}DT$. Both strains were able to metabolize the compound provided the dose absorbed was sufficiently low; the resistant strains degraded the insecticide more rapidly than the susceptible strains did, however. Only the intact, living flies were capable of metabolically degrading the absorbed insecticide. At least two kinds of DDT-resistance were observed, one represented by the Italian strain in which survival appeared to depend upon a mechanism such as enzymatic dehydrohalogenation and the enhanced metabolism was a consequence rather than a cause of survival.

* Winteringham et al. 1952 - [786]

* Winteringham et al. 1952 - [787]

495 Winteringham, F.P.W., Hellyer, G.C., McKay, M.A. EFFECTS OF THE INSECTICIDES DDT AND DIELDRIN ON PHOSPHORUS METABOLISM OF THE ADULT HOUSEFLY MUSCA DOMESTICA L. Biochem. J. 76 (1960) 543-8.

The $P^{32}$-labelled-pool technique was used for studying the effects of DDT and Dieldrin. Experimental details are given. The principal soluble phosphorus compounds were uniformly labelled in vivo, extracted and assayed as explained elsewhere (Winteringham, 1960). A significant breakdown of thoracic ADT in DDT-poisoned houseflies was noted at the late prostrate stage. This fall could be reversed by injecting aqueous glucose. A significant breakdown in insects spared the hypermotor activity by cyclopropane anaesthesia. cycloPropane also failed to prevent the enhanced desiccation associated with DDT poisoning. The fall in ATP and respiration rate of DDT-poisoned houseflies is not due to the exhaustion of endogenous reserves or to the hypermotor activity induced by DDT. In both DDT- and Dieldrin-poisoned houseflies there was a fall in the level of thoracic α-glycerophosphate, which could not be reversed by cyclopropane anaesthesia.

## Endrin and Isodrin

496 Brooks, G. T. SYNTHESIS OF CARBON-14-LABELED 1,2,3,4,11,11-HEXACHLORONAPHTHALENE (ISODRIN) Chem. and Industry (Rev.) (1958) 194.

Adipic acid-1,6-$C^{14}_2$ (I) pyrolyzed with $Ba(OH)_2$ gave cyclopentanone-1-$C^{14}$, which reduced with $NaBH_4$ gave cyclopentanol-1-$C^{14}$, dehydration of which with $H_3PO_4$ gave cyclopentene-1-$C^{14}$, which brominated gave 1,2-dibromocyclopentane-1-$C^{14}$, which dehydrobrominated gave cyclopentadiene-1-$C^{14}$, which condensed with excess 1,2,3,4,7,7-hexachlorobicyclo[2.2.1] hepta-2,5-diene gave "Isodrin"-6- and 7-$C^{14}$ (II). I containing 0.1 mc $C^{14}$ gave 7% II. (CA 52: 10986a, 1958)

497 Brooks, G. T. THE SYNTHESIS OF $^{14}$C-LABELLED 1,2,3,4,10,10-HEXACHLORO-6,7-EPOXY-1,4,4a,5,6,7,8,8a-OCTAHYDRO-EXO-1,4-EXO-5,8-DIMETHANONAPHTALENE(ENDRIN). J. chem. Soc. (1958) 3693-7.

A study of the absorption, metabolism, and excretion of insecticides derived from decahydro-1,4,5,8-dimethanonaphthalene required a method for the preparation on a millimolar scale of such compounds labelled with $C^{14}$. $C^{14}$-labelled Endrin has now been synthesized by peracetic acid oxidation of $C^{14}$-labelled Isodrin prepared by Diels-Alder addition of [2-$C^{14}$] cyclopentadiene to 1,2,3,4,7,7-hexachlorobicyclo [2,2,1]hepta-2,5-diene.

498 Brooks, G. T. MECHANISM OF RESISTANCE OF THE ADULT HOUSEFLY (MUSCA DOMESTICA) TO 'CYCLODIENE' INSECTICIDES. Nature 186 (1960) 96-8.

Topically applied Isodrin and Endrin ($C^{14}$-labelled in the terminal unchlorinated ring) were found to be less toxic than Aldrin and Dieldrin to susceptible houseflies but more toxic to Dieldrin-resistant houseflies. Both strains of houseflies converted Isodrin to the corresponding epoxide Endrin. Small amounts of Endrin also were recovered in the external rinse. The penetration, metabolism and excretion of the insecticides and the presence of residual material in tissues are discussed. Endrin was not formed in the tissues of heat-killed insects, suggesting an enzymic epoxidation. Acetone-extracts of live houseflies treated with Isodrin or Endrin contained small amounts of a nontoxic water-insoluble product, which behaved as a ketone derivative of Endrin. There was no evidence that radioactive material was excreted.

## Miscellaneous

499 Bettini, S., Boccacci, M., Rossi, C. DESTINO DELL'ACIDO BROMOACETICO MARCATO CON $C^{14}$ INOCULATO IN PERIPLANETA AMERICANA (The fate of $C^{14}$-labelled bromacetic acid on injection into Periplaneta americana. Riv. Parassit. 16,2(1955)103-12. (in Italian)

Bromacetic acid disappeared from the blood in 45 minutes. Radioactivity of the tissues varies directly with the dose administered, except in the intestine and the Malpighian tubes where it varies a little. The radioactivity in muscle is slight, and occurs mostly in the most highly pigmented muscles which are richest in succinic dehydrogenase. When the deproteinated extracts are separated by electrophoresis, 5 electropositive and 2 electronegative compounds may be distinguished by autoradiography. (BS: 17-105748, 1956)

500 Bettini, S., Boccacci, M. POISON MECHANISM OF THE ACTION OF IODO-, BROMO-, AND CHLOROACETIC ACIDS ON INSECTS AND THE INSECTICIDAL PROPERTIES OF SOME OF THEIR DERIVATIVES. R.C. Ist. sup. Sanit. 21 (1958) 278-95.

Doses of 90, 180, and 360 $\gamma$ of bromoacetic acid-2-$C^{14}$ (I)/g were injected into cockroaches (Periplaneta americana) and their blood was studied. A maximum of activity appeared 5 - 10 minutes after injection, and it disappeared within 60 minutes. Radioactivity rose proportionally to the amount injected in various parts of the roach, but not in the colon and the Malpighian tube. Electrophoresis on paper of deproteinized roach extracts produced 2 electropositive and 5 electronegative radioactive components (after injection of I), the major component resembling S-(carboxymethyl)glutathione in migration rate. Earlier work on the subject is also reviewed. (CA 52: 14874, 1958)

501 Foreman, S.E., Gilbert, B.L., Johnson, G.S., Erickson, C.A., Adelman, H. ISOTOPE-LABELED INSECTICIDE, THIODAN-5a, 9a-$C^{14}_2$. J. agric. Food Chem. 8, 3 (1960) 193-6.

The insecticide 6,7,8,9,10,10-hexachloro- 1,5,5a,6,9,9a-hexahydro-6, 9-methano-2,4, 3-benzodioxathiepin 3-oxide-5a, 9a-$C^{14}_2$ (Thiodan-5a, 9a-$C^{14}_2$) was prepared for use in biological studies which required that quantities as low as 1 part per billion be detectable. Starting with a 411-mc quantity of

barium carbonate-$C^{14}$, the quantity of final product obtained was 210 mc, which represents a radiochemical yield of 51%.

502 Halberstadt, J. SOME EXPERIMENTS WITH RADIOACTIVE PREPARATIONS OF 2,4,5,4'-TETRACHLORODIPHENYL SULPHONE, A NEW ACARICIDE. Meded. LandbHoogesch. Gent. 23, 3-4 (1958) 788-94.

A scientific note on the method of preparation of the compound, and on experiments in which it was applied to apple trees. Toxicity tests on rats and their results are reported. $S^{35}$ was used for labelling.

503 Halberstadt, J. EXPERIMENTS WITH RADIOACTIVE PREPARATIONS OF THE ACARICIDE "TEDION V 18" Philips tech. Rev. 21, 9 (1959/60) 278-9.

Radioactive tracer techniques are applied to investigations into the behaviour in plants and animals of "Tedion V 18" (an acaricide for the control of spider mites). The sulphur in the active ingredient of Tedion, which is 2,4,5,4'-tetrachlorodiphenyl sulphone, is partly replaced by the radioactive isotope $S^{35}$. Apple trees were sprayed with preparations of this radioactive Tedion in two formulations: as a wettable powder and as a miscible oil. Radioactivity measurements showed that an active residue remains on the leaf for a long period, whilst the Tedion taken up in the leaf is subject to conversion and transport within the plant, being continuously supplemented from the surface residue. The miscible oil proves to be more economical in use than the wettable powder. Administered to rats (max. dose 100 mg per kg body weight), about 40 to 45% of the Tedion is found unchanged after 48 h, mainly in the faeces; the remainder is broken down. (auth. summary)

(An earlier abstract "Determination of uptake and loss in plants and animals of 2,4,5,4'-trichlorodiphenyl sulfone, a new acaricide as measured with the aid of $S^{35}$" appeared in Inter. J. appl. Radiation and Isotopes 2 (1957) 217)

## II - D Organophosphates

### Survey Articles

504 Heath, D.F. SOME APPLICATIONS OF $^{32}P$ TO THE STUDY OF SYSTEMIC INSECTICIDES. p. 136-40 in "Comptes Rendus du 3e Congrès International de Phytopharmacie 1952", Vol. 3, No. 2 Paris. 1954.

505 Lüdicke, M. ÜBER DIE AUFNAHME RADIOAKTIVER KONTAKTINSEKTIZIDE BEI PFLANZEN UND TIEREN (Study on the absorption of radioactive contact insecticides by plants and animals). NachrBl. dtsch. PflSchDienst, Berl. 6, (1954) 122-4. (In German)

Relevant work reviewed from 1944 to 1954. With one exception, the radioisotope employed was $P^{32}$.

506 Metcalf, R.L. RADIOTRACERS IN STUDY OF SYSTEMIC INSECTICIDES. Agr. Chemic. 9, 3 (1954) 33-35, 128-30.

A review article of a general, introductory nature. 8 references.

507 Metcalf, R.L., March, R.B., Fukuto, T.R. STUDY OF SYSTEMIC INSECTICIDES. Calif. Agric. 8, 6 (1954) 5-6.

Schradan (octamethyl pyrophosphoramide) and Demeton or Systox (O,O-diethyl O-ethyl-betamercaptoethyl thiophosphate) and their derivatives have shown unusual promise for the control of mites and aphids and other sucking insects on a variety of agricultural crops. These materials are freely transported in the plant and concentrate in certain rapidly growing tissues. It is necessary, therefore, to have detailed knowledge of possible undesirable residues in edible produce. Radio-phosphorus tracers were found to aid basic studies on biochemical behaviour and routine analysis of residues in treated produce. (BA 29: 20080, 1955)

508 Mühlmann, R., Schrader, G. HYDROLYSE DER INSEKTIZIDEN PHOSPHORSÄUREESTER (Hydrolysis of insecticidal phosphoric acid esters). Z. Naturf. 12 b (1957) 196-208. (in German)

The practical applicability of phosphoric esters depends largely on their hydrolytic stability. The hydrolysis constants in the temperature range 20-70°C and for pH 1-9 were determined. The results are presented in tabulated form. $P^{32}$ was used throughout for labelling.

509 O'Brien, R.D. COMPARATIVE TOXICOLOGY OF SOME ORGANOPHOSPHORUS COMPOUNDS IN INSECTS AND MAMMALS. Canad. J. Biochem. Physiol. 37 (1959) 1113-22.

A review article. Principles of selective toxicity are discussed. Some unpublished work by Krueger is mentioned who investigated Malathion metabolism in insects employing unusual hot $P^{32}$-labelled compounds, and separating the metabolites by column chromatography. Results of chromatographic analysis on an ion-exchange column of metabolites in the bodies of flies 4 h after topical application of radioactive Malathion (150 mg/kg) are shown in a figure. Nine water-soluble degradation products, not the expected 2 were produced. Periplaneta americana, Blattella germanica and Musca domestica all degraded Malathion to the same extent and to the same products but the toxicity, particularly for the roaches, differed widely.

510 O'Brien, R.D. TOXIC PHOSPHORUS ESTHERS. New York, Academic Press, 1960.

A section (p.346-53) in chapter 10 (Techniques) is devoted to radiotracer synthesis using $P^{32}$. The phases in synthesis are (a) exchange, whereby the initial radioactivity is transferred to the starting material; (b) synthesis of a P intermediate such as $(RO)_2P(S)SH$; (c) coupling the intermediate with the appropriate compound to yield the product; and (d) purification. Almost all currently used organophosphates can be prepared from (1) $PCl_3$ and $P(O)Cl_3 \rightarrow$ phosphates or phosphorothiolates; for nearly all subsequent syntheses (except of phosphoramides) $PCl_3$ gives by far the best yield. (2) $P(S)Cl_3 \rightarrow$ phosphorothionates. (3) $P_2S_5 \rightarrow$ phosphorothioates. Exchange reactions, the reparation of intermediates, activites and yield, coupling and purification are discussed. Numerous references are cited.

* Spencer 1959 - [748]

511 Spindler, M. INNERTHERAPEUTISCHE INSEKTIZIDE (Insecticides with internal therapeutic action) Z. PflKrankh. 62 (1955) 98-165. (In German)

The review gives an outline of the development and present state of knowledge in the internal therapy of plants, and deals chiefly with products which have a systemic action. Pyrazoxon [O, O-diethyl O-5-(methylpyrazolyl)phosphate] (water-soluble 10 000 ppm) showed good systemic action after trunk application to apples, root absorption in beans and seed treatment of radish. Experiments with $P^{32}$-labelled Pyrazoxon showed that it was distributed throughout the entire apple plant following application to roots, stem or a single branch.

* Wedding 1953 - [756]

## Amiton

512 Baldit, G.L. AMITON - A NEW ACARICIDE AND SCALICIDE. J. Sci. Food Agric. 9, 8 (1958) 516-24.

Investigation on the behaviour of $P^{32}$-labelled Amiton (O, O-diethyl S-2-(diethyl-amino) ethyl phosphorothioate) and its salts in plants showed that Amiton oxalate penetrates the cuticle and is translocated readily through the plant in solutions of pH 7.5 or more but not in acid solutions, probably because dissociation of the salt does not occur in these. Acaricidal concentrations have little effect on insect predators, probably because the oxalate has no fumigant action and only low contact action. At five times the acaricidal concentration, the Amiton oxalate had no effect on Hippodamia quinquesignata ambigua Lec. and killed less than 50% of Stethorus picipes Csy., but it was slightly more harmful to Aphycus (Metaphycus) luteolus Timb. and Orius insidiosus (Say).

## Co-Ral

* Claborn et al. 1960 - [758]

513 Kaplanis, J.N., Hopkins, D.E., Treiber, G.H. DERMAL AND ORAL TREATMENTS OF CATTLE WITH PHOSPHOROUS-32-LABELED CO-RAL. J. agric. Food Chem. 7, 7 (1959) 483-6.

Only small amounts of $P^{32}$ were absorbed through the skin and eliminated in the urine following dermal application of the compound to cattle. High levels of the unchanged toxicant were found on the hair several weeks after treatment. The compound was ineffective as a systemic against stable flies and screwworm larvae but highly effective against these insects by contact. On oral treatments, at 10 and 20 mg per kg, approximately 38% of the dose was excreted in urine as polar degradation products and about 35% in the faeces 7 days after treatment. (auth.)

514 Krueger, H.R., Casida, J.E., Niedermeier, R.P. BOVINE METABOLISM OF ORGANOPHOSPHORUS INSECTICIDES. METABOLISM AND RESIDUES ASSOCIATED WITH DERMAL APPLICATION OF CO-RAL TO RATS, A GOAT, AND A COW. J. agric. Food Chem. 7, 3 (1959) 182-8.

Co-Ral was applied dermally to rats, a cow, and a goat at 30 to 45 mg per kg. The animals were sacrificed at predetermined intervals and the tissues were tested, chromatographically, for residues of the insecticide. Other factors investigated were the in vitro and in vivo opening of the pyrone ring in Co-Ral and its oxygen analogue, the ease of excretion of Co-Ral and the oxygen analogue from proteinaceous solutions, levels of Co-Ral and metabolites appearing in blood, and the effect on the blood cholinesterase activity, milk residues, and the nature of the products excreted in the urine and faeces. $P^{32}$ was used for labelling. (auth.)

515 Lindquist, D.A., Burns, E.C., Pant, C.P., Dahm, P.A. FATE OF $P^{32}$-LABELLED BAYER 21/199 IN THE WHITE RAT. J. econ. Ent. 51, 2 (1958) 204-6.

The fate of orally administered Bayer 21/199 [O, O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] which has shown systemic activity against Hypoderma in cattle, was studied by administration of the $P^{32}$-labelled compound to white rats at an average dosage of 20 mg/kg body weight. The compound was rapidly metabolized and excreted. About 78% of the radioactivity of the original dose was excreted in the urine within 24 h. Paper chromatographic analysis indicated that the radioactivity in the urine was not due to the Bayer 21/199 but was associated with more polar compounds. Smaller amounts of radioactivity were found in the feces, bile, lymph and blood. Among samples of various tissues taken 24 h after dosage, small but significant amounts of radioactivity were found in bone, liver and kidney. (from auth.)

(See also abstract in Bull.ent. Soc. Amer. 3, 3 (1957) 26, abstr. 34)

516 Radeleff, R.D., Claborn, H.V. EXCRETION OF CO-RAL IN THE MILK OF DAIRY CATTLE. J. agric. Food Chem. 8, 6 (1960) 437-9.

Co-Ral, O-(3-chloro-4-methylumbelliferone) O, O-diethyl phosphorothioate, also known as Bayer 21/199, is an effective systemic and contact insecticide for livestock use. To determine whether it would be excreted in milk of sprayed cattle, dairy cows were sprayed with 0.5 and 0.75% concentrations. Maximum organo-soluble extractive (Co-Ral plus other organo-soluble compounds) was approximately 0.2 and 0.25 ppm, respectively, for the 0.5 and 0.75% concentrations, reached 5 h after treatment. These levels declined gradually over 7 days, being only a trace at 10 days. $P^{32}$-labelled Co-Ral was used.

517 Robbins, W.E., Hopkins, T.L., Darrow, D.I. SYNERGISTIC ACTION OF PIPERONYL BUTOXIDE WITH BAYER 21/199 AND ITS CORRESPONDING PHOSPHATE IN MICE. J. econ. Ent. 52, 4 (1959) 660-3.

The joint oral administration of piperonyl butoxide (1:5) increased the toxicity of both Bayer 21/199 (O-(3-chloro-4-methylumbelliferone) O,O-diethyl phosphorothioate) and its corresponding phosphate to mice four- to six-fold. This increase in toxicity was also found when synergist and toxicant were administered by different routes. Piperonyl butoxide increased the in vivo but not the in vitro inhibition of mouse brain cholinesterase by 21/199 or its phosphate. Preliminary studies with $P^{32}$-labelled 21/199 demonstrated that the joint administration of piperonyl butoxide inhibited its metabolism to more polar metabolites. (auth.)

518 Robbins, W.E., Hopkins, T.L., Darrow, D.I., Eddy, G.W. STUDIES WITH $P^{32}$-BAYER 21/199 SPRAYED ON CATTLE. J. econ. Ent. 52, 2 (1959) 214-7.

The metabolism, excretion, and tissue distribution of $P^{32}$-labelled Bayer 21/199 have been studied following spray application of two Hereford bulls. Only low levels of radioactive compounds were found in the blood, and these behaved like polar degradation products. The compound appears to have been sparingly absorbed, about 2.4% (suspension) and 6.3% (emulsion) of the applied dose being accounted for in the urine of the two animals 2 weeks after treatment. At that time only very low levels of organo-soluble compounds which behaved like 21/199 were present in the tissues, but a considerable residue of unchanged 21/199 was present externally. (auth.)

* Schmidt and Weidhaas - [737]

519 Vickery, D.S., Arthur, B.W. ANIMAL SYSTEMIC ACTIVITY, METABOLISM AND STABILITY OF CO-RAL. J. econ. Ent. 53 (1960) 1037-43.

$P^{32}$-labelled Co-Ral (Bayer 21/199) (O, O-diethyl O-(3-chloro-4-methylumbelliferone) phosphorothioate) was prepared. The bed bug (Cimex lectularius L.) and the Gulf Coast tick (Amblyomma maculatum Koch) were utilized to evaluate the animal systemic activity of Co-Ral and Potasan. Rabbits were treated orally, dermally, subcutaneously, or intramuscularly with Co-Ral, and orally or dermally with Potasan. The numbers of animals treated, dosages in mg/kg, numbers of insects tested, and mortality data are given. The relative toxicity of Co-Ral, oxygen analogue of Co-Ral, chloroferron, and Potasan were compared from $LD_{50}$ determinations made with adult 3-d old female houseflies (Musca domestica L.), adult bed bugs, 4th-instar larvae of the yellow-fever mosquito (Aëdes aegypti L.) and mixed sexes of white rats. Co-Ral® was more stable in several species of insects than in mammals. Metabolites isolated from insects and mammals consisted of the oxygen analogue, O-ethyl and O,O-diethyl phosphoric acid, O,O-diethyl phosphorothioic acid, and possibly "desethyl" Co-Ral. The cumarinyl ring structure was not opened in vitro as was demonstrated by alkaline degradation. The same metabolites were recovered from insects and rats but different quantities of each metabolite were formed. The ability of rats to degrade Co-Ral to water-soluble products more rapidly and completely than insects is probably a significant factor in determining the selective toxicity of Co-Ral.

## Delnav

520 Arthur, B.W., Casida, J.E. BIOLOGICAL ACTIVITY AND METABOLISM OF HERCULES AC-528 COMPONENTS IN RATS AND COCKROACHES. J. econ. Ent. 52, 1 (1959) 20-7.

Technical Hercules AC-528 (Delnav) was separated by partition chromatography into 8 different fractions. The major components were the cis and trans isomers of 2,3-p-dioxanedithiol S, S-bis (O, O-diethyl phosphorodithioate). The structure, toxicity to houseflies and rats, anti-cholinesterase activity and stability to alkaline hydrolysis were studied for these 8 Hercules AC-528 components. Radioactive Hercules AC-528 was prepared and the metabolism in rats and cockroaches studied for the cis and trans isomers, 2-p-dioxenethiol S-(O, O-diethyl phosphorodithioate) and bis (diethoxyphosphinothioyl) disulfide. In a wide variety of in vivo and in vitro biological systems the cis and trans isomers were the most stable of the radioactive components; the single exception was a study on hydrolysis by human plasma where the dioxene derivative was the most stable. In a sub-acute feeding study with rats, Hercules AC-528 was found to accumulate to a small degree in fat. However, the residues disappeared rapidly when feeding of Hercules AC-528 was discontinued. Other factors in investigating Hercules AC-528 included: cholinesterase depression and recovery in rats following administration of a sub-lethal dose; the effect of sub-acute feeding on rat plasma, red blood corpuscle and brain cholinesterase activity; metabolism of the components of Hercules AC-528 by Periplaneta americana L. and rat liver slices; the formation of more polar, non-hydrolyzed metabolites from the radioactive components by rats and cockroaches; and the nature of the hydrolysis products formed from the components in human plasma and following oral administration to rats. (auth.)

521 Plapp, F.W., Jr., Bigley, W.S., Darrow, D.I. STUDIES ON THE METABOLISM AND RESIDUES OF $P^{32}$-LABELED DELNAV IN A HEREFORD STEER. J. econ. Ent. 53 (1960) 60-4.

$P^{32}$-Delnav® (2,3-p-dioxanedithiol S,S-bis(O,O-diethyl phosphorodithioate) was applied as a spray to a Hereford steer and the residues and metabolic pathway were determined. Fatty tissues accumulated small amounts of the insecticide, but 7 d after treatment most of the dose was still on the hair. No residues were found in meat samples. The metabolic degradation of the insecticide in mice was not affected by the route of administration. Paper and alumina chromatography demonstrated the presence of phosphate and/or phosphorothiolate compounds in some of the minor fractions of technical Delnav. (auth.)

Note by the editor: Delnav® is also known as Hercules AC-528.

(An abstract of earlier work was published in Bull. ent. Soc. Amer. 4,3 (1958) 96, abstr. 196, under "Residues following spray application of $P^{32}$-labeled Hercules AC-528 (Delnav) to a Hereford steer")

## DFP

522 Cohen, J.A., Warringa, M.G.P.J. METHODS TO ESTIMATE THE TURNOVER NUMBER OF PREPARATIONS OF OX RED CELL CHOLINESTERASE. Biochim. biophys. Acta 11 (1953) 52-8.

Jansen's method (J. biol. Chem. 179 (1949) 189) for calculating the initial concentration of enzyme active centres and the turnover number can only be applied to enzyme preparations of a purity which has not been achieved for most esterases known. Such preparations of esterase contain non-enzymic groups

(impurities and perhaps fractions of the esterase molecule itself) which would then also combine with $DFP^{32}$. The combination product thus contains more DFP than enzyme-active groups since groups other than the ones accociated with enzyme activity are labelled. The paper presents two methods employed successfully to overcome these difficulties, which result in reliable figures for molar concentrations of active centres and for the turnover number in crude and partly purified preparations of ox red cell cholinesterase.

523 Cohen, J. A., Oosterbaan, R. A., Warringa, M. G. P. J. THE TURNOVER NUMBER OF ALI-ESTERASE, PSEUDO- AND TRUE CHOLINESTERASE AND THE COMBINATION OF THESE ENZYMES WITH DIISOPROPYLFLUOROPHOSPHONATE. Biochim. biophys. Acta 18 (1955) 228-35.

Bovine red cell stroma was capable of combining with $DFP^{32}$. The combination was found to be mainly due to the ali-esterase present in the stroma. The true cholinesterase of the stroma accounts for only a minor percentage of the $P^{32}$ bound. The reaction products of $DFP^{32}$ with highly purified preparations of true and pseudo-cholinesterase were prepared by incubation of the enzymes concerned with $DFP^{32}$. For these enzyme preparations turnover numbers could be established. The figure found for true cholinesterase confirmed the value previously reported (295 000). A turnover number of 50 000 was found for pseudo-cholinesterase. The reaction products of DFP with ali-esterase, true and pseudo-cholinesterase were hydrolyzed and subjected to chromatography on Dowex-50. In all three cases the bulk of the radioactivity proved to be associated with the inorganic phosphate and serine phosphate fractions of the chromatogram. The results suggest that the OH groups of serine might be of importance in the combination of DFP with the active centre of the esterases concerned.

524 Cohen, J. A., Warringa, M. G. P. J. THE LABELLING OF HUMAN SERUM BY $^{32}P$-DIISOPROPYLPHOSPHOROFLUORIDATE ($DFP^{32}$). Biochim. biophys. Acta 25 (1957) 600-7.

On paper electrophoresis the pseudo-cholinesterase activity of human serum is localized between the $\alpha$-2 and the $\beta$-peak. The same localization is found after electrophoresis on starch columns. Thoroughly dialyzed $DFP^{32}$-treated human sera as well as sera obtained from humans a few days after the injection of $DFP^{32}$ were submitted to zone electrophoresis. No radioactivity could be detected on the paper electrophoresis strips, but after column electrophoresis it was possible to localize the radioactivity between the $\alpha$-2 and the $\beta$-peaks. The conclusion is reached that in human sera, which have been in contact with $DFP^{32}$, only one component, the pseudo-cholinesterase, is irreversibly labelled by $P^{32}$. The values obtained for the turnover of serum proteins by means of $DFP^{32}$ therefore clearly reflect the turnover of the pseudo-cholinesterase component.

525 Dixon, G. H., Neurath, H. THE REACTION OF DFP (DIISOPROPYLPHOSPHOFLUORIDATE) WITH TRYPSIN. (Short communication) Biochim. biophys. Acta 20 (1956) 572-4.

A new technique was developed in order to facilitate the detection of unstable DIP-enzyme derivatives, whereby the phosphorylated enzyme could be rapidly separated from excess DFP and its hydrolysis product DIP. Use was made of a column of Dowex-50 x 2 cation exchange resin, 200-400 mesh, in the $NH_4^+$ form. The column was packed in a polyethylene tube and pre-treated with 0.1 M sodium citrate buffer pH 3.0; an aliquot of the reaction mixture of the enzyme with $DFP^{32}$ is then applied to the top of the column and forced through under pressure. Upon elution with 0.1 M acetic acid, DIP and DFP were rapidly eluted, with clear separation from each other, while the labelled protein was retained at the top of the resin. It could be located by monitoring the column, and then cutting through column and resin in that region and eluting the labelled protein by suspension of the resin in 1 N NaOH. The results of the above and of dialysis experiments are given in tabulated form. No evidence was found to support the hypothesis that the phosphorylation of imidazole constitutes the initial stage of the combination of DFP with tryspin.

526 Goutier, R. ETUDE ÉLECTROPHORÉTIQUE DES ESTÉRASES SÉRIQUES ET DE LA FIXATION DU $DF^{32}P$ DANS LE SÉRUM, CHEZ LE LAPIN ET LE COBAYE. Biochim. biophys. Acta 19 (1956) 524-34.

Rabbit and guinea-pig sera were submitted to electrophoresis on starch columns and on filter paper, in order to separate the serum esterases and cholinesterase and to determine the nature of serum proteins which are combined with $P^{32}$ after intra-muscular injection of $DFP^{32}$. Three days after injection, the radioactivity is located only in one part of the esterase activity (perhaps on B-esterase) in rabbit serum. In guinea-pig serum, it is located mostly on B-esterase and partly on another protein which is very probably cholinesterase. The implications of the results are discussed. (from auth. summary)

527 Iyatomi, K., Saito, T., Kanehisa, K., Nishizawa, T., Naruse, H. DISTRIBUTION AND METABOLISM OF $^{32}$P-LABELLED DFP IN THE AMERICAN COCKROACH, PERIPLANETA AMERICANA. Botyu Kagaku 22 (1957) 192.

528 Jansen, E.F., Jang, R., Balls, A.K. THE INHIBITION OF PURIFIED, HUMAN PLASMA CHOLINESTERASE WITH DIISOPROPYLFLUOROPHOSPHATE. J. biol. Chem.196, 1 (1952) 247-53.

When a preparation of purified, human plasma cholinesterase was inhibited by radioactive DFP, the phosphorus of the inhibitor was introduced into the inhibited enzyme. Hence the inhibition reaction of this enzyme by DFP was in this respect a similar reaction to the inhibition of the esterolytic proteinases. The amount of phosphorus introduced into the still impure cholinesterase was 0.0023%. (auth. summary)

529 Jansz, H.S., Posthumus, C.H., Cohen, J.A. ON THE ACTIVE SITE OF HORSE-LIVER ALI ESTERASE. I. REACTION OF THE ENZYME WITH DIISOPROPYLPHOSPHOROFLUORIDATE. Biochim. biophys. Acta 33 (1959) 387-95.

Horse-liver ali esterase reacts with DFP to form the enzymically inactive DP-enzyme. With isonitrosoacetone diisopropylphosphate is released from the inhibited enzyme; this is accompanied by a recovery of the enzymic activity. In order to investigate the chemical nature of the DFP-binding site of ali esterase the DP-enzyme was digested with pepsin. Essentially one DP-peptide was formed which contained per mole of DP-group the following moles of amino acid residues: alanine (1), glutamic acid or glutamine (2), glycine (3), and serine (2). DFP$^{32}$ of high specific activity (200 μc/mg DFP) was used.

530 Jansz, H.S., Posthumus, C.H., Cohen, J.A. ON THE ACTIVE SITE OF HORSE-LIVER ALI ESTERASE. II. AMINO ACID SEQUENCE IN THE DFP-BINDING SITE OF THE ENZYME. Biochim. biophys. Acta 33 (1959) 396-403.

The structure of a diisopropylphosphoryl-containing peptide obtained by digestion of DFP-inhibited horse-liver ali esterase by pepsin was established as follows: gly-glu-DP.O. ser-ala-gly-gly-(glu, ser). The DP$^{32}$-peptide was prepared as described by the authors (ibid. 387-95).

531 Michel, H.O., Krop, St. THE REACTION OF CHOLINESTERASE WITH DIISOPROPYL FLUOROPHOSPHATE. J. biol. Chem. 190 (1951) 119-25.

An investigation into the possibility of a compound being formed between the enzyme cholinesterase and diisopropyl fluorophosphate, the inhibitor, was possible by using P$^{32}$-labelled DFP of 2-10 mc/mM activity. It was found that: electric eel cholinesterase 1) reacts with DFP to form a compound which remains undissociated in 10% trichloracetic acid at room temperature, and 2) combines with $2.1 \times 10^{-10}$ mole of DFP per unit of activity, unit activity being defined as the amount of cholinesterase which will hydrolyze 1 g of acetylcholine in 1 h at pH 7.4 and 38°C with 0.015 M acetylcholine and an ionic strength of 0.14.

532 Oosterbaan, R.A., Kunst, P., Cohen, J.A. THE NATURE OF THE REACTION BETWEEN DIISOPROPYLFLUOROPHOSPHATE AND CHYMOTRYPSIN (Short Communication). Biochim. biophys. Acta 16 (1955) 299-300.

The work is aimed at obtaining data on the inhibition of crystalline chymotrypsin by DFP$^{32}$. It was assumed that this inhibition could serve as a satisfactory model for the corresponding reaction on cholinesterase. Details of the experimental procedure and results are given.

533 Oosterbaan, R.A., Kunst, P., Rotterdam, J. van, Cohen, J.A. THE REACTION OF CHYMOTRYPSIN AND DIISOPROPYLPHOSPHOROFLUORIDATE. I. ISOLATION AND ANALYSIS OF DIISOPROPYLPHOSPHORYLPEPTIDES. Biochim. biophys. Acta 27 (1958) 549-55.

After reaction with DFP$^{32}$, α-chymotrypsin was subjected to a proteolytic digestion. From the digest two related peptides containing the radioactive diisopropylphosphoryl-group were isolated. The amino acid composition of one peptide was established as aspartic acid or asparagine (1), serine (1), glycine (3), and proline (1). In addition to these amino acids, the second peptide contained a leucine residue.

534 Oosterbaan, R.A., Rotterdam, J. van. - SYNTHESIS OF P$^{32}$ LABELED DIISOPROPYLPHOSPHOROFLUORIDATE. J. Amer. chem. Soc. 78 (1956) 5641-3.

A method is described for the preparation of $P^{32}$-labelled diisopropylphosphorofluoridate in water or oil solution starting from radioactive phosphoric acid. The specific radioactivity amount to 200 mc/mg. (auth.)

535 Saunders, B.C., Worthy, T.S. ESTERS CONTAINING PHOSPHORUS. X. RADIOACTIVE DIISOPROPYL FLUOROPHOSPHONATE (D.F.P.). J. chem. Soc. (1950) 1320-2.

The preparation of $P^{32}$-labelled DFP is described. Details are given of the preparation of radioactive FPO $(OCHMe_2)_2$ (I) on a 1-g scale; a modified apparatus is described which is suitable for the small-scale operation and which takes into account the volatility of the radioactive intermediates and final product. The $P^{32}$ used had an activity of 28000 cpm/mg and the resulting I an activity of 2200 cpm/mg. The yield of I, prepared according to CA 42: 6740 h, is 62%. (cf. CA 45 (1951) 111f)

536 Schaffer, N.K., May, S.C., Jr., Summerson, W.H. SERINE PHOSPHORIC ACID FROM DIISOPROPYL-PHOSPHORYL CHYMOTRYPSIN. J. biol. Chem. 202 (1953) 67-75.

The nature of the combination between chymotrypsin and DFP was investigated with $P^{32}$-labelled DFP. The reaction product of diisopropyl fluorophosphate (DFP) and chymotrypsin, diisopropylphosphoryl chymotrypsin, was partially hydrolyzed by pepsin trypsin, and 2 N HCl or directly with 2 N HCl. L-Serine phosphoric acid was obtained in 30% yield from the hydrolysate by fractionation with Dowex 50 chromatography. The product has a nitrogen to phosphorus ratio of 0.9 to 1.1, contained 1 mole of serine per atom of phosphorus, and could not be distinguished from authenic serine phosphoric acid by paper chromatography, Dowex 50 chromatography, or fractional precipitation. (from auth. summary)

537 Schaffer, N.K., May, S.C., Jr., Summerson, W.H. SERINE PHOSPHORIC ACID FROM DIISOPROPYL-PHOSPHORYL DERIVATIVE OF EEL CHOLINESTERASE. J. biol. Chem. 206 (1954) 201-7.

The reaction product of diisopropyl fluorophosphate and eel cholinesterase, diisopropylphosphoryl cholinesterase, labelled with $P^{32}$, was partially hydrolyzed by pepsin, trypsin, and 2 N HCl or directly with 2 N HCl. Serine phosphoric acid was separated from the hydrolysate in approximately a 40% yield (based on phosphorus) by fractionation with Dowex 50 chromatography. Identity was established by comparison with synthetic serine phosphoric acid by fractional alcohol precipitation and Dowex 50 chromatography. (auth. summary)

538 Schaffer, N.K., Harshman, S., Engle, R.R. PHOSPHOSERYLGLYCINE FROM DIISOPROPYLPHOSPHORYL CHYMOTRYPSIN AND INVERSION OF ITS PEPTIDE SEQUENCE BY ACID. J. biol. Chem. 214 (1955) 799-806.

$P^{32}$-labelled diisopropylphosphoryl chymotrypsin was partially hydrolyzed with 2 N HCl at 100°C for 2.5 h. Serine phosphoric acid, phosphoserylglycine, and glycylserine phosphoric acid were separated from the hydrolysate by Dowex 50 chromatography. Phosphoserylglycine, hydrolyzed under the same conditions, was partly converted to glycylserine phosphoric acid. Evidence is cited that only phosphoserylglycine represents the normal dipeptide sequence in diisopropylphosphoryl chymotrypsin. (auth. summary)

539 Schaffer, N.K., Simet, L., Harshman, S., Engle, R.R., Drisko, R.W. PHOSPHOPEPTIDES FROM ACID-HYDROLYZED $P^{32}$-LABELED DIISOPROPYLPHOSPHORYL CHYMOTRYPSIN. J. biol. Chem. 225 (1957) 197-205.

$P^{32}$-labelled diisopropylphosphoryl chymotrypsin was partially hydrolyzed with 12 N HCl at 37°C for 3 d. Dowex 50 chromatography of the hydrolysate resulted in the separation of (1) phosphoserine, (2) aspartylphosphoserine, (3) phosphoserylglycine, (4) aspartylphosphoserylglycine, and (5) glycylaspartylphosphoserylglycine. Two other fractions have the same amino acid composition and sequence as peptides (2) and (4), and are believed to be isopropyl derivatives. Asparagine is not a constituent of these peptides. (auth. summary)

540 Schaffer, N.K., Lang, R.P., Simet, L., Drisko, R.W. PHOSPHOPEPTIDES FROM ACID-HYDROLYZED $P^{32}$-LABELED ISOPROPYL METHYLPHOSPHONOFLUORIDATE-INACTIVATED TRYPSIN. J. biol. Chem. 230 (1958) 185-91.

$P^{32}$-labelled Sarin (isopropyl methylphosphonofluoridate) was used. Sarin is an esterase inhibitor similar to those of DFP (diisopropyl phosphorofluoridate). The isopropyl methylphosphonofluoridate derivative of

trypsin, isopropyl methylphosphonyl trypsin, was partially hydrolyzed with 12 N HCl at 37°C for 3 d. Dowex 50 chromatography of the hydrolysate resulted in the separation of (1) methylphosphonylserine, (2) aspartylmethylphosphonylserine, (3) methylphosphonylserylglycine, and (4) aspartylmethylphosphonylserylglycine. Another peptide with the same amino acid composition and sequence as peptide (4) was separated and is believed to be its isopropyl derivative. Asparagine is not a constituent of these peptides.

* Winteringham and Harrison 1956 - [782]

* Winteringham et al. 1957 - [727]

## Diazinon and Related Compounds

541 Krueger, H.R., O'Brien, R.D., Dauterman, W.C. RELATIONSHIP BETWEEN METABOLISM AND DIFFERENTIAL TOXICITY IN INSECTS AND MICE OF DIAZINON, DIMETHOATE, PARATHION, AND ACETHION. J. econ. Ent. 53 (1960) 25-31.

The persistence and metabolism of Diazinon®, (O, O-diethyl O-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate) Dimethoate, Parathion, and Acethion (O, O-diethyl S-carboethoxymethyl phosphorodithioate) have been studied in the mouse, American cockroach (Periplaneta americana (L.)), and housefly (Musca domestica L.). The results have been used to explain the selective toxicity of three of these compounds toward insects as compared with mammals. For Diazinon, selectivity is attributed to high levels of oxygen analogue in the susceptible species. For Dimethoate and Acethion, selectivity is attributed to a persistence of unaltered parent compound in the whole body. Small differences were found in Diazinon absorption and metabolism by normal and Diazinon-resistant house flies.

References are quoted for the methods adopted for the preparation of radioactive Dimethoate, Acethion, Diazinon and Parathion.

542 Louloudes, S.L., Kaplanis, J.N., Roan, C.C. THE SYNTHESIS OF RADIOACTIVE DIAZINON USING $P^{32}$. J. org. Chem. 21 (1956) 685-6.

Diazinon may be labelled with $C^{14}$, $S^{35}$, or $P^{32}$. Since the last offers an easy synthetic route and is more readily measured radiometrically, elemental red phosphorus was selected as a starting material, after irradiating it to a specific activity of approximately 50 mc/g. The method of synthesizing phosphorus trichloride is described. The two step chlorination and the use of the powdered antimony were utilized to increase the specific activity and yield of phosphorus trichloride. Paper chromatography analyses of the labelled products were made. Experimental details of the methods employed for the synthesis of phosphorus trichloride, triphosphoryl trichloride, O,O-diethyl chlorothiophosphate and Diazinon are given.

* Mengle and Casida 1960 - [736]

543 Robbins, W.E., Hopkins, T.L., Eddy, G.W. METABOLISM AND EXCRETION OF PHOSPHORUS-32-LABELED DIAZINON IN A COW. J. agric. Food Chem. 5, 7 (1957) 509-13.

$P^{32}$-labelled Diazinon, administered orally to a cow at 20 mg/kg, is rapidly metabolized and excreted. Only low levels of unchanged toxicant were found in blood and milk samples. About 74% of the dose, excreted as polar degradation products, was accounted for in the urine 36 h after treatment. (auth.)

544 Vigne, J.P., Tabau, R.L., Fondarai, J. CHROMATOGRAPHIE ET DÉTECTION DU DIÉTHYL PHOSPHATE D'ISOPROPYL 2 MÉTHYL 4 OXY 6 PYRIMIDINE ET DU DIÉTHYLTHIONOPHOSPHATE D'ISOPROPYL 2 MÉTHYL 4 OXY 6 PYRIMIDINE. Bull. Soc. chim. France 22 (1955) 1282.

The two compounds were separated by inverse partition chromatography, impregnating the paper with a silicone grease and with $H_2O$-EtOH-$NH_4OH$ as the mobile phase. The spots were located by spraying with $I_2$ or with iodide-Bi reagent (containing Bi subnitrate, $CCl_3CO_2H$, KI, and $H_2O$) or, with radioactive products, by autoradiography. (CA 50: 1530d, 1956)

545 Vigne, J.P., Tabau, R.L., Fondarai, J. INSECTICIDES ORGANO-PHOSPHORÉS. I. SYNTHÈSE RADIOACTIVE DU DIÉTHYLTHIONOPHOSPHATE DE 2-ISOPROPYL 4-MÉTHYL 6-OXY PYRIMIDINE. Bull. Soc. Pharm. Marseille 5 (1955) 331-8.

Diazinon was labelled with $P^{32}$. A $C_6H_6$ solution of the enolic form of 2-isopropyl-4-methyl-6-hydroxypyrimidine and $P^{32}SCl_3$ form the corresponding dichlorthiophosphate ester which, with excess NaOEt, gives

active Diazinon purified by washing with $K_2CO_3$ solution and azeotropic distribution. Details of the microapparatus employed are given. The product is identified by paper chromatography. The analogous active diethyl phosphate was prepared similarly from $P^{32}OCl_3$. Active Diazinon was also prepared from the K enolate of the same 6-hydroxypyrimidine and $P^{32}SCl(OEt)_2$, but was contaminated with ethyl bis (2-isopropyl-4-methyl-6-pyrimidinyl) thiophosphate arising from $P^{32}SCl(OEt)$ present in the $P^{32}SCl(OEt)$. (CA 50: 17298g, 1956)

546 Vigne, J.P., Tabau, R.L. ORGANOPHOSPHOROUS INSECTICIDES. IV. SYNTHESIS OF COMPLEX THIONOPHOSPHORIC RADIOACTIVE ESTERS. APPLICATION TO THE SYNTHESIS OF DIETHYL THIONOPHOSPHATE OF 2-ISOPROPYL-4-METHYL-6-HYDROXYPYRIMIDINE. Bull. Soc. Pharm. Marseille 5 (1956) 321-3.

$P^{32}$ is introduced into $PSCl_3$ by exchange at 150°C after 24 h by using $H_3P^{32}O_4$. The reaction is carried out in a Carius tube. The tube is then cooled in $CO_2$ snow-acetone mixture. The $PSCl_3$ is distilled into a solution of 2-isopropyl-4-methyl-6-hydroxypyrimidine in benzene with a special apparatus. The diethyl thionophosphate ester is prepared as previously described (CA 49: 14739e). (CA 51: 13303e, 1957)

547 Vigne, J.P., Tabau, R.L., Fondarai, J. SYNTHÈSE DE CERTAINS ESTERS COMPLEXES PHOSPHORIQUES ET THIONOPHOSPHORIQUES MARQUÉS AVEC $^{32}$P-APPLICATION À LA SYNTHÈSE DU DIÉTHYLPHOSPHATE DE 2-ISOPROPYL-4 MÉTHYL-6 OXYPYRIMIDINE ET DU DIÉTHYLTHIONOPHOSPHATE DE 2-ISOPROPYL-4 MÉTHYL-6 OXYPYRIMIDINE. Bull. Soc. chim. France 23 (1956) 459-60.

Les auteurs décrivent une méthode de préparation d'esters complexes des acides phosphoriques et thionophosphoriques et son application à la préparation du diéthylphosphate de 2-isopropyl-4 méthyl-6 oxypyrimidine et du diéthylthionophosphate de 2-isopropyl-4 méthyl-6 oxypyrimidine marqués avec $^{32}$P.

(A comprehensive abstract may be found in CA 50: 14769d, 1956)

(Voir 548)

* Vigne et al. 1957 - [742]

548 Vigne, J.P., Tabau, R.L. PRÉPARATION DE COMPOSÉS HALOGÉNÉS DU PHOSPHORE MARQUÉ AU $P^{32}$, PAR UNE RÉACTION D'ÉCHANGE (Note de Laboratoire). Bull. Soc. chim. France 25 (1958) 1194-5.

Dans un précédent mémoire (1) nous avons décrit une méthode de synthèse du $^{32}$P, diéthylthionophosphate de isopropyl-2 méthyl-4 hydroxy-6 pyrimidine, dans laquelle nous introduisons le phosphore marqué sous forme de $^{32}PSCl_3$ préparé à partir du phosphate d'argent radioactif. Cette technique faisant intervenir un certain nombre de réactions délicates à réaliser sur de très petites quantités de composés volatils et radioactifs, nous avons cherché à tourner la difficulté en étudiant une réaction d'échange. Notre nouvelle méthode permet de préparer rapidement et avec un rendement intéressant, de petites quantités de composés halogénés radioactifs du phosphore en réduisant au minimum les manipulations et les dangers de contaminations.

(1) Voir 547

549 Vigne, J.P., Tabau, R.L., Chouteau, J., Fondarai, J. SYNTHÈSE RADIOACTIVE, DÉTECTION ET CHROMATOGRAPHIE D'UN INSECTICIDE ORGANO PHOSPHORÉ: LE DIÉTHYLTHIONOPHOSPHATE DE 2-ISOPROPYL 4-MÉTHYL 6-OXY PYRIMIDINE: APPLICATION À SON ÉVALUATION DANS LE LAIT. p. 45-61 in "Proceedings of the International Conference on Radioisotopes in Scientific Research, Paris, Sep. 1957", Vol. 3. Exterman, R.C., ed. London, Pergamon Press, 1958.

Les auteurs, désirant en doser des traces dans des substances alimentaires provenant d'animaux nourris avec des végétaux traités par cet insecticide, ont réalisé: 1. Une nouvelle méthode de synthèse de cette série chimique, avec du $^{32}$P. 2. Une nouvelle technique de chromatographie de partition (chromatographie en phase mi-inversée), ainsi qu'une série de méthodes sensibles de détection colorimétrique de ce composé. 3. L'isolement d'une quantité notable de l'insecticide chimiquement pur, ce qui a permis l'étude de son activité anticholinésterasique qui s'est révelée importante. 4. L'application de ces deux techniques au dosage dans le lait d'animaux ayant reçu des doses considérables de cet insecticide. Très vite métabolisé, le DTP n'est pratiquement pas retrouvé dans le sang, le lait et les fèces, et n'est présent qu'en quantités minimes dans l'urine de l'animal en expérience (chèvre).

## Dimethoate

550 Apple, J. W., Dauterman, W. C., Casida, J. E. DIMETHOATE FOR PEA APHID CONTROL AND CHEMICAL FATE ON THE PEA PLANT. Bull. ent. Soc. Amer. 5, 3 (1959) 113, abstr. 32.

Dimethoate was superior to standard and other candidate insecticides against the pea aphid. Residues were determined for whole plants treated with 0.25 pound per acre. Studies with radioactive Dimethoate on and in pea plants showed seven compounds, including Dimethoate, its oxygen analogue, and five hydrolysis products with phosphoric acid predominating.

551 Dauterman, W. C., Viado, G. B., Casida, J. E., O'Brien, R. D. PERSISTENCE OF DIMETHOATE AND METABOLITES FOLLOWING FOLIAR APPLICATION TO PLANTS. J. agric. Food Chem. 8, 2 (1960) 115-9.

Dimethoate (O, O-dimethyl S-(N-methylcarbamoylmethyl) phosphorodithioate is known to be effective as a systemic insecticide following foliar application. Analyses were made of surface and absorbed residues following foliar treatment of corn, cotton, pea, and potato plants with Dimethoate. The insecticide was rapidly absorbed and decomposed both on the surface and inside the foliage by phosphorothionate oxidation and hydrolysis. Only trace amounts of Dimethoate and its oxygen analogue were present 32 d after treatment. Of the five identified hydrolysis products, the predominant one from near mature peas was phosphoric acid and from the other plants used as seedlings was O, O-dimethyl S-carboxymethyl phosphorothiolate on the surface and O-methyl O-hydrogen S-(N-methylcarbamoylmethyl) phosphorodithioate within the leaf tissue. Limited studies were also made on the persistence of the N-ethyl analogue of Dimethoate. (auth.)

(An abstract of earlier work was published in Bull. ent. Soc. Amer. 4, 3 (1958) 84, abstr. 23, under "The metabolism and residues of the systemic insecticide Dimethoate in plants")

552 Dauterman, W. C., Casida, J. E., Knaak, J. B., Kowalczyk, T. BOVINE METABOLISM OF ORGANOPHOSPHORUS INSECTICIDES. METABOLISM AND RESIDUES ASSOCIATED WITH ORAL ADMINISTRATION OF DIMETHOATE TO RATS AND THREE LACTATING COWS. J. agric. Food Chem. 7, 3 (1959) 188-93.

Dimethoate is active as a systemic insecticide for cattle. Three lactating cows were treated orally with the $P^{32}$-labelled compound and analysis of blood, tissues, excreta, and milk showed Dimethoate to be rapidly metabolized and excreted. Twelve days after treatment, the insecticide was found in trace amounts only in the cow tissues. Hydrolysis of Dimethoate by rats and cows occurred initially at the methyl-phosphate, phosphate-sulfur, sulfur-carbon, and particularly at the carbonyl-nitrogen bonds. Phosphorothioate oxidation occurred with certain of the hydrolysis products and was assumed to occur also with Dimethoate. (auth.)

553 Kaplanis, J. N., Robbins, W. E., Darrow, D. I., Hopkins, D. E., Monroe, R. E., Treiber, G. H. THE METABOLISM OF DIMETHOATE IN CATTLE. J. econ. Ent. 52, 6 (1959) 1190-4.

The metabolism of $P^{32}$-Dimethoate was studied following oral and intramuscular administration (10 mg/kg) to cattle. By both routes high radioactivity was detected in the blood shortly after administration. The radioactivity, representing both total and organosoluble compounds, was observed earlier and dissipated faster in the intramuscular treatment. Chromatographic analyses of blood extracts indicated the presence of both Dimethoate and unknown(s), with the latter several times more toxic than the parent compound as determined by enzymic analyses and bioassay. About 87 to 90% of the oral dose was eliminated in the urine at the end of 24 h. The same percentage of intramuscular dose was excreted after 9 h. The major metabolic products were dimethyl phosphate, dimethyl phosphorothioate, and several unknowns. Only 3.7 to 5% of the oral dose and about 1.1% of the intramuscular dose were eliminated in the faeces. Analyses of tissues from an orally treated calf showed only very low levels (0.02 to 0.07 μg/g) of organoextractable radioactive compounds present in the brain, liver, testes, and lungs. (auth.)

## Dipterex

554 Acree, F., Jr., Babers, F. H., Mitlin, N. PREPARATION OF $P^{32}$-LABELED BAYER L13/59 AND DDVP, AND THEIR ABSORPTION AND TRANSLOCATION IN THE AMERICAN COCKROACH. J. econ. Ent. 49, 6 (1956) 808-12.

Details are given of the preparation of $P^{32}$-labelled Bayer L 13/59 (dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate) from radioactive red phosphorus, and of labelled DDVP (dimethyl 2,2-dichlorovinyl phosphate) by dehydrochlorination of L 13/59, and also of studies of their absorption by and translocation in last-instar nymphs of Periplaneta americana (L.). The compounds were applied in solution in ethanol to the dorsal cervical membranes, and both were readily absorbed through it. In the case of L 13/59, the haemolymph and all tissues became radioactive. After 20 h, most of the internal radioactivity was in the gut, though some remained in all tissues examined, and much activity remained external. The haemolymph of

the cockroaches treated with DDVP did not become demonstrably radioactive, and many tissues became only slightly so. After 2 h, much of the radioactivity was concentrated in the heart. After 22 h, most of it was in the fat-body and only a small amount in the gut. The failure to detect radioactivity in the haemolymph was probably attributable to the low specific activity of DDVP, the small amounts applied in view of its high toxicity, and deposition in the tissues. No radioactivity could be removed from outside two hours after treatment. (RAE-B 46: 22-3, 1958)

555 Arthur, B. W., Casida, J. E. METABOLISM AND SELECTIVITY OF O, O-DIMETHYL 2,2,2-TRICHLORO-1-HYDROXYETHYL PHOSPHONATE AND ITS ACETYL AND VINYL DERIVATIVES. J. agric. Food. Chem. 5, 3 (1957) 186-92.

The insecticide, called Bayer L 13/59, and its derivatives were investigated with $P^{32}$ as to metabolism and selective toxicity. The $LD_{50}$ values in rats, flies, cockroaches, cabbage worms and pea aphids varied widely between compounds and species; the acetyl form was generally least and the vinyl most toxic. Antiesterase activity appeared to be caused by dimethyl phosphorylation of enzymatically active sites. Mammalian toxicity was relatively low. Relations of the latter two observations to chemical structure and mechanisms are discussed. Data are given on detoxification, hydrolysis rates, volatility, and tissue distribution in insects and plants. (BA 31: 26099, 1957)

556 Arthur, B. W., Casida, J. E. BIOLOGICAL ACTIVITY OF SEVERAL O, O-DIALKYL ALPHA ACYLOXY-ETHYL PHOSPHONATES. J. agric. Food Chem. 6, 5 (1958) 360-5.

The synthesis and characterization of radioactive ($P^{32}$-) Dipterex and butonate are described. Several O, O-dialkyl 2,2,2-trichloro-1-acyloxyethyl phosphonates and related derivatives were compared as to toxicity and anticholinesterase activity. O, O-dimethyl 2,2,2-trichloro-1-n-butyryloxyethyl phosphonate was the most selectively toxic to houseflies of all the phosphonates studied. In vivo and in vitro metabolism studies with insects and rats showed that this phosphonate was hydrolyzed at the acyl group, the phosphorus-carbon bond, and possibly the phosphorus-oxygen-methyl bond. The initial site of in vivo hydrolysis appeared to be a major factor in the selective toxicity of this compound.

557 Metcalf, R. L., Fukuto, T. R., March, R. B. TOXIC ACTION OF DIPTEREX AND DDVP TO THE HOUSE FLY. J. econ. Ent. 52, 1 (1959) 44-9.

Dipterex or O, O-dimethyl 1-hydroxy-2,2,2-trichloroethyl phosphonate under mildly alkaline conditions is rapidly degraded to DDVP. The half-life values for this reaction are: pH 8.0 - 63 min, pH 7-386 min, and pH 6.0 - 89 h. The rate of reaction is very slow at pH 5.4. The in vitro inhibition of housefly head cholinesterase by $10^{-7}$ M Dipterex showed marked pH dependency and ranged from 11% at pH 5.4 to 100% at pH 8.0, thus clearly demonstrating that DDVP formation is necessary for in vitro cholinesterase inhibition. In vivo studies of the mode of action of Dipterex showed that the rate of knock-down of houseflies feeding on Dipterex-treated moist sugar bait was much more rapid at pH 7.0 than pH 5.4. This, together with the 4- to 7-fold greater toxicity of DDVP over Dipterex and the isolation of about 5% of $P^{32}$ DDVP from the total $P^{32}$ metabolites in Dipterex-poisoned houseflies, strongly indicates that DDVP is responsible for the in vivo toxic action of Dipterex.

## Di-Syston

558 Carter, W., Gortner, W. A. THE TRANSLOCATION OF RADIOACTIVE ($S^{35}$) BAYER 19639 IN PINEAPPLE PLANTS. J. econ. Ent. 51, 6 (1958) 905-7.

Radioautographs revealed that the radioactive sulfur in $S^{35}$-tagged Bayer 19639 (Di-Syston) is translocated from the soil through the entire pineapple plant. Absorption is greatest in the roots and decreases to barely discernible quantity in the green half-developed fruit. Bioassays revealed that only in the region of greatest absorption, the roots, was the concentration of Bayer 19639 high enough to be toxic to mealybugs. (auth.)

559 Metcalf, R. L., Reynolds, H. T., Winton, M., Fukuto, T. R. EFFECTS OF TEMPERATURE AND PLANT SPECIES UPON THE RATES OF METABOLISM OF SYSTEMICALLY APPLIED DI-SYSTON. J. econ. Ent. 52, 3 (1959) 435-9.

The rates of oxidative metabolism and of hydrolytic decomposition of Di-Syston, or O,O-diethyl S-ethyl-2-thioethyl phosphorodithioate (formerly called Bayer 19639) were measured at various temperatures and in several plant species using a $P^{32}$-radiotracer. The rates of oxidation of the Di-Syston metabolites in isolated

cotton leaves were accelerated by increased temperatures between 37° and 100°F, and from the Arrhenius energy of activation 10200 cal per mole it was determined that the rate of oxidation of Di-Syston sulfoxide increased about 1.9 times for each 10°C rise in temperature. Metabolism of Di-Syston sulfoxide and hydrolytic decomposition of the toxic products occurred from 2 to 3 times as fast in tomato leaves at 70°F as in cotton leaves. The rates in a number of other plants studied appeared to be intermediate between those in tomato and cotton. (auth.)

(See earlier report by Metcalf, Winton and Reynolds "Comparative rates of metabolism of Di-Syston at various temperatures and in various species of plants" in Bull. ent. Soc. Amer. 3, 3 (1957) 23, abstr. 4)

560 Reynolds, H. T., Metcalf, R. L., Winton, M. EFFICIENCY OF PLANT UPTAKE OF DI-SYSTON FOLLOWING VARIOUS METHODS OF TREATMENT. Bull. ent. Soc. Amer. 3, 3(1957) 23, abstr. 4.

Using $P^{32}$-Di-Syston, O, O-diethyl S-ethyl-2-mercaptoethylphosphorodithioate the efficiency of plant uptake was measured after soil treatment with various methods of side dressings. The theoretical and practical applications of this work will be discussed.

## Guthion (Gusathion)

561 Tietz, H., Fukuto, T. R., Metcalf, R. L. UNTERSUCHUNG MIT $^{32}$P-MARKIERTEN VERBINDUNGEN ÜBER DAS VERHALTEN DES INSEKTIZIDS GUSATHION BEI BAUMWOLLPFLANZEN UND DAS DAMIT VERBUNDENE RÜCKSTANDSPROBLEM BEI BAUMWOLLSAMEN (Studies, by means of $P^{32}$-labelled compounds, of the behaviour of the insecticide Gusathion in cotton plants and of the subsequent residue problem in cotton seeds). Verhandl. d. IV. Intern. Pflanzenschutz-Kongresses, Hamburg 1957, 2 Braunschweig 1960) 1645-6. (In German)

After spraying the plants at intervals of 4 days, and by means of paper chromatography and autoradiography, unchanged Gusathion was found on the leaves plus two lipophilic metabolites and two other fractions. Seed analysis and plant data indicate that Gusathion is unable to diffuse through the capsule into the seed, nor can it penetrate from the leaf into the sap.

562 Tietz, H., Metcalf, R. L., Fukuto, T. R. DAS VERHALTEN DES INSEKTIZIDS "GUSATHION" AUF BAUMWOLLPFLANZEN UND DAS RÜCKSTANDSPROBLEM IN BAUMWOLLSAMEN (Action of the insecticide "Gusathion" on cotton plants, and the problem of residues in cotton seed). HöfchenBr. Wiss. 10 (1957) 273-84. English edition 10, 5 (1957) 279-89.

"Gusathion" has proved effective against such cotton pests as Anthonomus grandis, Aphis gossypii, Tetranychus bimaculatus, Alabama argillacea and Thrips spp. In the present studies it was labelled with $P^{32}$, and details of concentration and frequency of spraying are given. Leaves were analyzed at different intervals by means of microchemical methods and paper chromatography. Apart from radioactive hydrolysis products, $P^{32}$ was recovered from the assimilation products of the plant as radioactive phospholipoids. Seeds which were still immature at the time of spraying contained much more $P^{32}$ than mature ones, and much greater quantities of $P^{32}$-labelled phosphatide could also be precipited from their oil. No seed contained any traces of radioactivity in their oil after phosphatide precipitation. No residues were found in the press cakes. "Gusathion" did not have any systemic effect.

## Malathion

563 Darrow, D. I., Plapp, F. W. STUDIES ON RESISTANCE TO MALATHION IN THE MOSQUITO, CULEX TARSALIS. J. econ. Ent. 53 (1960) 777-81.

An investigation was made on the extent of cross-resistance to other insecticides in a Malathion-resistant strain, and on the rate and nature of the detoxification of Malathion by larvae of a resistant and of a susceptible strain of Culex tarsalis. $P^{32}$-labelled samples of Malathion and Acethion were used. A colony of Culex tarsalis Coq., 60 times resistant to Malathion, was found to be resistant to Malaoxon (S-[1,2-bis (ethoxycarbonyl)ethyl] O,O-dimethyl phosphorothioate), and the diethyl homologue of Malathion (S-[1,2-bis(ethoxycarbonyl) ethyl] O,O-diethyl phosphorodithioate), although to a lesser degree. Slight resistance to Co-Ral® (O-(3-chloro-4-methylumbelliferone) O,O-diethyl phosphorothioate) was also observed, but no resistance was found to any other of a series of 14 organophosphorus insecticides. Two-to three-fold resistance to DDT and Dieldrin was also found. Larvae of the resistant and a susceptible colony degraded Malathion at about the same rate and in the same manner, largely through the formation of carboxylic acid derivatives.

564 Knaak, J. B., O'Brien, R. D. EFFECT OF EPN ON IN VIVO METABOLISM BY THE RAT AND DOG. J. agric. Food Chem. 8, 3 (1960) 198-203.

The mechanism by which pre-treatment with EPN (O-ethyl O-p-nitrophenyl phenyl-phosphonothionate) increases the subsequent toxicity of Malathion was investigated. $P^{32}$-labelled Malathion was used. In both the rat and dog EPN resulted in a marked shift in the initial detoxification site of the Malathion molecule from the carboxyester to the thiolophosphate bond. The percentage of the administered Malathion excreted as metabolites in urine was increased by EPN in the dog but unchanged in the rat. Malathion levels in rat tissues were increased by EPN, whereas Malaoxon levels in rat blood were reduced. Potentiation appears to result from an increased persistence rather than an increased concentration of Malaoxon in the tissues.

565 Krueger, H. R., O'Brien, R. D. METABOLISM OF MALATHION BY SEVERAL SPECIES OF INSECTS. Bull. ent. Soc. Amer. 4, 3 (1959) 84, abstr. 22.

$P^{32}$-labelled Malathion of very high specific activity was topically applied to several species of insects, and the water soluble metabolites extracted and identified by means of ion-exchange chromatography. Considerable variation in metabolism was noted with as many as 9 or more water-soluble degradation products found.

566 Krueger, H. R., O'Brien, R. D. RELATIONSHIP BETWEEN METABOLISM AND DIFFERENTIAL TOXICITY OF MALATHION IN INSECTS AND MICE. J. econ. Ent. 52 (1959) 1063-7.

An attempt has been made to account for the selective toxicity of Malathion on the basis of differences in its metabolism by various species. Eleven metabolites were found in the German cockroach (Blattella germanica (L.)), and American cockroach (Periplaneta americana (L.), and housefly (Musca domestica L.), seven in the mouse. Most metabolites were identified. Degradation of Malathion is much more extensive in the mouse than in the insect and Malaoxon production is correspondingly lower; these effects account satisfactorily for the low toxicity of Malathion to the mouse. The low toxicity of topically applied Malathion to the German cockroach is attributable to poor penetration through the integument. Technical steps in the preparation of $P^{32}$-labelled Malathion are discussed.

567 March, R. B., Fukuto, T. R., Metcalf, R. L., Maxon, M. G. FATE OF $P^{32}$-LABELED MALATHION IN THE LAYING HEN, WHITE MOUSE, AND AMERICAN COCKROACH. J. econ. Ent. 49, 2 (1956) 185-95.

The fate of $P^{32}$-labelled Malathion has been extensively studied in the laying hen and, for comparative purposes, in the white mouse and in Periplaneta americana L. The experiments also included preparation of expected metabolites of Malathion and tests of their toxicity to various arthropods and their activity in inhibiting cholinesterase of the housefly (Musca domestica L.). The metabolism of Malathion in the cockroach is apparently less extensive and complex than it is in warm-blooded animals. The less effective metabolism in the insect may explain why Malathion is much more toxic to insects than to warm-blooded animals, in which most of the rapidly formed metabolites are apparently of a low order of toxicity. (from auth. summary)

568 Mengle, D. C., Casida, J. E., O'Brien, R. D. METABOLISM OF $P^{32}$-LABELED MALATHION, DIAZINON AND METHYL PARATHION IN NORMAL AND PHOSPHATE-RESISTANT STRAINS OF THE HOUSE FLY. Bull. ent. Soc. Amer. 5, 3 (1959) 117, abstr. 73.

The rate of penetration, hydrolysis and phosphorothionate oxidation was studied in vivo for the insecticides in one normal and three resistant strains. An attempt was made to correlate the degree of resistance with the rate of insecticide metabolism and the extent of in vivo cholinesterase depression.

569 Seume, F. W., O'Brien, R. D. METABOLISM OF MALATHION BY RAT TISSUE PREPARATIONS AND ITS MODIFICATION BY EPN. J. agric. Food Chem. 8, 1 (1960) 36-41.

Homogenates of 11 rat tissues metabolized Malathion at comparable rates, and to similar metabolites. The main hydrolysis occurred at the carboxyester linkage. The hydrolysis at this linkage, the over-all hydrolysis, and the formation of Malaoxon by various tissues in vitro were all inhibited by EPN in vivo. The synergism of EPN and Malathion in vivo is therefore probably not attributable to an increased level of Malaoxon in the body, but to a greater persistence of Malathion and Malaoxon in the tissues. The techniques used are described in some detail, also the synthesis of the $P^{32}$-labelled Malathion used.

570 Tomizawa, C., Sato, T. FATE OF ORGANOPHOSPHORUS INSECTICIDES SPRAYED ON RICE PLANT. Botyu Kagaku 25, 3 (1960) 99-105.

A study on the translocation of radioactive Malathion and methyl Parathion.

## Parathion

571 Ahmed, M.K., Casida, J.E., Nichols, R.E. BOVINE METABOLISM OF ORGANOPHOSPHORUS INSECTICIDES: SIGNIFICANCE OF RUMEN FLUID WITH PARTICULAR REFERENCE TO PARATHION. J. agric. Food Chem. 6, 10 (1958) 740-6.

In laboratory tests, rumen fluid from a cow hydrolyzed 16 organophosphorus insecticides to varying degrees. Malathion and TEPP (tetraethyl pyrophosphate) were the most susceptible. Oxidation reactions were of much less importance than reduction reactions in metabolizing the compounds, and phosphorothioates were hydrolyzed much more rapidly than phosphates. The rate of reduction of radioactive Parathion in the rumen fluid of a cow that ingested it was similar to that in vitro. Parathion, Paraoxon, and their amino derivatives (O,O-diethyl O-p-aminophenyl phosphorothioate and phosphate) were found circulating in the blood of the animal and were secreted in small amounts in the milk. Amino-Parathion constituted a major excretory metabolite of Parathion, together with diethyl phosphoric and phosphorothioic acids. The toxicological significance of these findings is discussed in relation to the toxicity of the various derivatives. The two amino compounds are much less toxic to houseflies (Musca domestica L.) and rats than Parathion and Paraoxon. (from auth. summary)

572 Gar, K.A., Mandelbaum, Ya.A., Melnikov, N.N., Chernetsova, V.I., Shevtsova-Shilovskaya, K.D. THE USE OF LABELED ATOMS FOR THE STUDY OF STABILITY OF DUSTS OF ORGANOPHOSPHORUS INSECTICIDES. Dokl. Akad. Nauk. SSSR 94 (1954) 729-32.

$P^{32}$-labelled Parathion (I) and bis(p-nitrophenyl) ethyl thiophosphate (II) and similarly $S^{35}$-labelled specimens were used for stability studies on 1% dusts. In covered dishes in the dark at 16-45° the loss of P is more rapid from I than from II (curves shown); at 45° in 100 h the I specimen lost over 50% of its P content, while II lost that much only in 650 h. At lower temperatures the durability is much higher. Thus the disappearance of insecticidal action 1-2 d after field spraying is not mere evaporation. Similar tests under sunlight (temperature below 37°) show a rapid loss of P with some 50% being lost after 1.5 h exposure of I, the rest being lost in 100 h. In diffuse sunlight some 50% loss of I occurred in 20 h; this is comparable to loss of activity from 30% emulsions of I. The loss of II is much slower in sunlight than that of I; in 70 h a 40% loss occurs. The process appears to be a complex photochemical reaction. Conclusion: fruit surface residues of I after 4 d of weather exposure should not exceed 0.25 mg per kg (apples) (CA 48: 9009d, 1954)

573 Gar, K.A., Mandelbaum, Ya. A., Melnikov, N.N., Shvetsova-Shilovskaya, K.D., Chernetsova, V.I. AN APPLICATION OF THE METHOD OF LABELED ATOMS IN THE STUDY OF THE RESISTANCE OF EURYGASTER INTEGRICEPS PUT TO TWO ORGANOPHOSPHORUS INSECTICIDES, AND AN EXPERIMENTAL STUDY OF THEIR PENETRATION INTO PLANTS. Dokl. Akad. Nauk. SSSR 94 (1954) 1189-92.

$P^{32}$-labelled specimens of $(EtO)_2PS(OC_6H_4NO_2\text{-}p)$ and Et-OPS$(OC_6H_4NO_2\text{-}p)_2$ were used in 1% dusts which were applied to male and female specimens of the insects. Females were generally more resistant to both insecticides than the males. A direct relation was found between the amount of P which penetrated the insect body and the degree of poisoning, within each experimental group. Death occurs with lower level of the di-Et derivative than mono-Et derivative, but this is caused not by a mere difference of diffusion, since in dead specimens the difference in permeability disappears between females and males. Chrysanthemum plants were allowed to absorb through the roots aqueous emulsions of the di-Et derivative (0.05 to 0.2%) and the penetration to the leaves was studied radiometrically. A spraying with even 0.2% emulsion failed to give complete control of Aulacorthum pelargonii although the amount of the insecticide which penetrated the plant mass reached 0.003% of the green mass at room temperature. This corresponds to 20-30 mg/kg. At lower temperature, when this value reached 60 mg/kg a considerable degree of control was attained and the insects contained up to 22 mg/kg of the di-Et derivative. The penetration into chrysanthemum was substantially like that found in beets. However, on cabbage cultures no control was achieved by this method against Brevicoryne brassicae, although withering of leaves was observed at 0.05% concentration of the emulsion, or higher. In cabbage and chrysanthemum expts. considerable hydrolysis of the insecticide took place and after 30 d only the hydrolysis products remained; this process is accelerated by sunlight. Dusting with 1% dust on shaded kidney beans showed 42% hydrolysis after 16 d; in sunlight

almost all was hydrolyzed in 4 d. On wheat the process takes but 2 d. Thus Parathion is not truly a systemic insecticide, owing to its poor penetration and stability in the plant. (CA 48: 9008g, 1954)

574 Gar, K. A., Kipiani, R. Y. RESEARCH BY MEANS OF RADIOACTIVE ISOTOPES CONCERNING PENETRATION AND RESIDUES OF PHOSPHO-ORGANIC INSECTICIDES IN PLANTS. UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 8/P/701. 12 (1956) 185-99.

The authors summarize Russian research with several radioactive organic phosphorus insecticides including: $P^{32}$- and $S^{35}$-labelled Parathion, methyl Parathion or O,O-dimethyl O-p-nitriphenyl thiophosphate, NIUIF-101 or O-ethyl O,O-di-(p-nitrophenyl)-thiophosphonate, $P^{32}$-labelled Malathion, and Carbophos or O,O-diethyl-S-(1,2-dicarbethoxymethyl) dithiophosphate. The photochemical stability of formulations of NIUIF-101 and Carbophos was greater than that of Parathion and Malathion. Formulations of Parathion and Malathion were about equal in their stability to heat, and NIUIF-101 and Carbophos were approximately the same; the latter two were slightly more stable than the former. The plant systemic properties of Parathion and methyl Parathion were slight; hydrolysis of both compounds proceeds rapidly inside plants. Paper chromatographic studies of alkaline hydrolysates and extracts from plants treated with methyl Parathion revealed similar decomposition products; there was no evidence of oxidation and upgrading of toxicity of the insecticide by plants. It was recommended that several of these insecticides could be used on plants shortly before harvesting.

575 Hein, R. E., McFarland, R. H. THE SYNTHESIS OF DOUBLY LABELED PARATHION. J. Amer. chem. Soc. 74 (1952) 1856-7.

The insecticide was labelled with both $P^{32}$ and $S^{35}$. Phosphorus trichloride was used as starting material. Synthesis progressed via O,O-diethyl-chlorothiophosphate. The various steps in the experimental procedure are described.

576 Jäger, A. VERSUCHE MIT RADIOAKTIVEM $^{32}$P-O, O-DIÄTHYL-O, p-NITROPHENYL-MONOTHIOPHOSPHAT AM GOLDHAMSTER (MESOCRICETUS AURATUS WATERH.) (Experiments on the golden hamster (Mesocricetus auratus Waterh.) with radioactive $P^{32}$ labelled O,O-diethyl-O,p-nitrophenyl-monothiophosphate) Naturwissenschaften 40 (1953) 534-5. (In German)

The absorption and distribution of $P^{32}$-labelled Parathion or its breakdown products were studied in active and hibernating hamsters. Artificial "hibernation" was obtained by injecting insulin and maintaining the the animals at lowered temperatures. The lethal dose in active animals was 7-8 mg/kg of body weight. Cumulative dosage effects were observed. The symptoms and characteristics of Parathion action in active and hibernating animals are described.

577 Jensen, J. A., Durham, W. F., Pearce, G. W. STUDIES ON FATE OF PARATHION IN RABBITS, USING RADIOACTIVE ISOTOPE TECHNIQUES. Arch. industr. Hyg. 6 (1952) 326-31.

A study on the fate of Parathion in rabbits treated dermally and intravenously with radioactive $S^{35}$-labelled Parathion has been made. Evidence was obtained that there is very little accumulation of Parathion or a sulfur-bearing portion of the molecule in the blood, organs, or tissues. The compound or sulfur-containing degradation products are rapidly excreted in the urine. The excreted moiety appears to be the inorganic residue of Parathion and is absorbed by anion exchange resins, from which it can be regenerated and precipitated by ammonium molybdate. (auth. summary)

578 Jensen, J. A., Pearce, G. W. SYNTHESIS OF RADIOACTIVE PARATHION USING $S^{35}$. J. Amer. chem. Soc. 74 (1952) 3184.

A very brief description of the steps in the preparation of $S^{35}$-labelled Parathion is given. The specific activity obtained was 220 μc/mM.

579 Kipiani, R. Y., Gegenava, G. V. A STUDY OF THE PENETRATION OF THE INSECTICIDE THIOPHOS INTO THE PLANT AND THE EFFECT OF EXTERNAL FACTORS ON ITS STABILITY BY THE METHOD OF MARKED ATOMS. Soobshch. Akad. Nauk. Gruz. SSR 16 (1955) 557-64. (In Russian)

580 Lichtenstein, E. P. MOVEMENT OF INSECTICIDES IN SOILS UNDER LEACHING AND NON-LEACHING CONDITIONS. J. econ. Ent. 51, 3 (1958) 380-3.

In 1954 a Miami silt loam and a muck soil were treated with Aldrin, Lindane and DDT. Seventeen months later, testing of the soil showed no noticeable difference in the distribution between individual insecticides, in a vertical sense; Lindane was found to be unequally distributed in a horizontal direction. Distribution was again tested three years after treatment. Experiments, conducted under laboratory conditions, showed that Lindane was leached to some extent from a treated soil into an untreated one. The leaching was most noticeable in Plainfield sand and least noticeable in muck soil. Under non-leaching conditions, Lindane also moved into the untreated layer, but more was retained in a muck soil than in a Plainfield sand. When radioactive Parathion ($P^{32}$) was used, it was found that during a period of 6 d Parathion moved upwards, downwards and sideways as well. The results obtained seem to indicate that the movement of Parathion is more rapid in a Plainfield sand than in a muck soil, as the latter retains the insecticide to a greater extent. Preliminary experiments with Aldrin under non-leaching conditions indicate movement of this insecticide to a considerable extent. (from auth. abstr.)

(Earlier work was reported as abstract in Bull. ent. Soc. Amer. 3,3 (1957) 42, abstr. 36).

581 Lockau, S., Lüdicke, M., Weygand, E. DARSTELLUNG VON RADIOAKTIVEM DIÄTHYL-p-NITROPHENYL-MONOTHIOPHOSPHAT UND BEISPIELE SEINER BIOLOGISCHEN ANWENDUNG (Preparation of radioactive diethyl-p-nitrophenyl-mono thiophosphate, with examples of its biological applications) Naturwissenschaften 38, 15 (1951) 350. (In German)

Parathion was labelled with $P^{32}$ and used for determining its uptake by insects, and its ability to penetrate into plants. Cuticular applications were made with a water emulsion of the compound, and amounts of Parathion sufficient to produce mortality were determined with the American roach, Periplaneta americana (L.) and Drosophila melanogaster. The penetration of a water emulsion of the radioactive compound into apples was also studied.

582 Lockau, S., Lüdicke, M. DIE DARSTELLUNG VON RADIOAKTIVEM $^{32}$P-O, O-DIÄTHYL-O, p-NITROPHENYLMONOTHIOPHOSPHAT, SEINE AUFNAHME UND WEITERLEITUNG IM INSEKTENKÖRPER (The synthesis of $P^{32}$-O,O-diethyl-O,p-nitrophenyl monothiophosphate, its uptake and distribution in the insect body) Z. Naturf. 7b, 7 (1952) 389-97.

The compound is synthesized from red radioactive phosphorus via $P^{32}$-labelled phosphorus pentachloride, $P^{32}$-labelled phosphorus sulfochloride and $P^{32}$-dichloro-O,p-nitrophenyl-thiophosphoric acid. After application to the pronotum, this radioactive phosphoric acid ester penetrates into the body of Periplaneta americana L. and leads to the symptoms typical for Parathion poisoning. The compound or its $P^{32}$-containing metabolites are distributed differently in the various organs. The head is highly radioactive, probably due to the lipoid-soluble components of the cerebral ganglion. The high radioactivity of the intestine may in part be explained by its excretory function. The total average radiation for the whole insect corresponds to 3,57 γ of the compound. The lethal dose is below this value, since part of the poison, on penetration and distribution through the organism may be resorbed in the fore-gut intestine, where it may be suffering breakdown or have been broken down previously.

583 Lüdicke, M. ÜBER DAS VERHALTEN VON RADIOAKTIVEM O, O-DIÄTHYL-O, p-NITROPHENYL-MONOTHIOPHOSPHAT AUF DER PFLANZE (The behaviour of radioactive O,O-diethyl-O,p-nitrophenyl-monothiophosphate applied to a plant) Z. PflKrankh. 59, 11/12 (1952) 451-9. (In German; Engl. summary.)

$P^{32}$-labelled Parathion was applied locally to leaves of Ligustrum ovafolilium Hassk and Polystichum falcatum (L.) Diels, to twigs of various ages of Prunus cerasus, wild plums, peaches, and to stored apples. Parathion was used in a concentration of 0,05% in distilled water. Its absorption and conductivity or that of its decomposition products in these plant tissues was studied by a G-M counter and autoradiography. The diffusion capacity in terms of $P^{32}$-labelled compounds was studied.

584 Lüdicke, M. 16. ÜBER DIE AUFNAHME VON E 605 UND PARATHION BEI PFLANZE UND TIER (On the uptake of E 605 and Parathion by plants and animals) p.139-56 in "Insektizide Heutzutage". Eichler, W. D., ed. Berlin, Volk und Gesundheit. 1954, 579p. (In German)

The author reviews his own and other work done in the field. The first part covers treatment of plants by E 605 (essentially dimethyl-p-nitrophenyl-monothiophosphate, with the addition of a little Parathion, i.e. O,O-diethyl-O-p-nitrophenyl-monothiophosphate) and by Parathion, in order to test their distribution within the plant, and the terms of a possible "internal therapy" against pests from outside, as observed for some phosphoric acid esters. The second part is concerned with the uptake of E 605 and of Parathion by animals. References are numerous but incomplete, i.e. the authors and year are quoted but not the source.

585 Mandelbaum, Ya. A., Vladimirova, I.L., Melnikov, N.N. SYNTHESIS OF DIETHYL p-NITROPHENYL THIOPHOSPHATE AND ETHYL BIS (p-NITROPHENYL) THIOPHOSPHATE, LABELLED WITH RADIOACTIVE PHOSPHORUS AND SULFUR. Dokl. Akad. Nauk. SSSR 100 (1955) 77-9.

Details are given of a study in which Parathion and O-ethyl O,O-di-(p-nitrophenyl)-thiophosphonate (NIUIF-101) were labelled with $P^{32}$ and $S^{35}$. (Technical details may be found in abstract CA 50: 1650f, 1956).

586 Murray, D.H., Spinks, J.W.T. SYNTHESIS OF $P^{32}$-LABELED PARATHION. Canad. J. Chem. 30 (1952) 497.

Labelled Parathion (I) was prepared for investigations of insect toxicology. The method used was a modification of a previously reported preparation (CA 43, 1313i). Quantitative yields of $P^{32}OCl_3$ were obtained from $H_3P^{32}O_4$ and $PCl_5$. The oxychloride gave 65% $P^{32}Cl_3$ when reduced over carbon granules at 1000°; this was converted to 53% $P^{32}SCl_3$ when heated in a sealed tube with sulphur. $P^{32}SCl_3$ with NaOEt gave 65% $(ETO)_2PSCl$, which with aqueous p-$O_2NC_6H_4ONa$ yielded 16% I (on $PCl_3$(?)). (CA 47: 2725b, 1953)

587 Sato, T., Tomizawa, C. CERTAIN PROPERTIES OF METHYL PARATHION EXAMINED BY TRACER TECHNIQUE (RADIOACTIVE). Botyu Kagaku 25, 3 (1960) 85-90.

588 Tomizawa, C., Sato, T., Fukami, J., Mitsuhashi, J. BEHAVIOR OF METHYL PARATHION IN CERTAIN INSECTS. Botyu Kagaku 25, 3 (1960) 91-9

The fate of the labelled insecticide was studied in the rice stem borer Chilo suppressalis (lepidoptera), Periplaneta americana, and the weevil Callosobruchus chinensis.

## Phorate (Thimet)

589 Bowman, J.S., Casida, J.E. METABOLISM OF THE SYSTEMIC INSECTICIDE O, O-DIETHYL S-ETHYL-THIOMETHYL PHOSPHORODITHIOATE (THIMET) IN PLANTS. J. agric. Food Chem. 5, 3 (1957) 192-7.

Thimet is metabolized by plants to form very potent anticholinesterase agents. When used as a systemic insecticide for seed treatment of cotton, the metabolites within the plant consist of O,O-diethyl S-ethylsulfinyl-methyl phosphorodithioate, O,O-diethyl S-ethylsulfinylmethyl phosphorothiolate, and O,O-diethyl S-ethylsulfonylmethyl phosphorothiolate. The last of these metabolites is the most active cholinesterase inhibitor and provides a method of residue analysis. Such analysis is based on chloroform extraction of $P^{32}$-labelled compounds and is made on various soluble, insoluble, hydrolyzed and oxidized fractions. Cotton seeds treated with Thimet on charcoal at concentrations as high as 32 pounds of Thimet per 100 pounds of seed showed less than 0.03 ppm of Thimet or metabolites in the seeds maturing from the treated plants. The residual persistence following soil and foliage application was studied with 6 vegetable crops and radioactive Thimet. (from auth.)

590 Bowman, J.S., Casida, J.E. FURTHER STUDIES ON THE METABOLISM OF THIMET BY PLANTS, INSECTS, AND MAMMALS. J. econ. Ent. 51, 6 (1958) 838-43.

The oxidative and hydrolytic metabolism of Thimet by plants, insects and mammals were further studied with chromatographic and radiotracer techniques. Bean plants, southern armyworm (Prodenia eridania (Cram.)), albino rats, and a cow were utilized. The proportions of Thimet, oxidized derivatives, and hydrolysis products were determined with bean plants which had absorbed Thimet through their roots, with armyworms which had fed on these plants, and with the faeces of the armyworms. Armyworms were more efficient than bean plants in vivo in oxidation of the phosphorothioate group of Thimet and in hydrolysis of the oxidation products. With the mammals, the excretory products and tissue residues were investigated. Extreme difficulty was encountered in extraction of the radioactivity from the tissue of the treated rats and cow. (The Thimet had been synthesized with $P^{32}$). The relative insect and mammalian toxicity and stability to hydrolysis by alkali are reported for Thimet and its oxidation products. (from auth.)

591 Bowman, J.S. METABOLISM OF CERTAIN THIOPHOSPHATE SYSTEMIC INSECTICIDES BY PLANTS, INSECTS, AND MAMMALS. Ph.D. Thesis, Wisconsin Univ., Madison. 1958.

$P^{32}$-labelled organothiophosphate insecticides were used throughout. The work was published in three articles:

Bowman, J. S., Casida, J. E. METABOLISM OF THE SYSTEMIC INSECTICIDE O,O-DIETHYL S-ETHYL-THIOMETHYL PHOSPHORODITHIOATE (THIMET) IN PLANTS. Agric. Food Chem. 5, 3 (1957) 192-7.

Ibid. SYSTEMIC INSECTICIDES FOR THEOBROMA CACAO L., THEIR TRANSLOCATION AND PERSISTENCE IN FOLIAGE AND RESIDUES IN CACAO BEANS. J. econ. Ent. 51, 6 (1958) 773-80.

Ibid. FURTHER STUDIES ON THE METABOLISM ON THIMET BY PLANTS, INSECTS, AND MAMMALS. J. econ. Ent. 51, 6 (1958) 838-43.

592 Getzing, L. W., Chapman, R. K. THE FATE OF PHORATE IN SOILS. J. econ. Ent. 53 (1960) 47-51.

Studies were conducted to determine the hydrolysis, oxidation, insecticidal efficiency, persistence, and the degree of binding of Phorate, formerly designated as Thimet (O,O-diethyl S-(ethylthio) methyl phosphorodithioate) in three soils and quartz sand. Phorate applied as a soil treatment in the field was more available to cabbage and potatoes grown in a sandy soil than in a clay-loam soil as indicated by insect-control data amd anticholinesterase assay. A measurement of $P^{32}$-labelled phosphate uptake by peas from three soils and quartz sand showed that the largest amounts of toxicant were taken from quartz sand and followed by lesser amounts from a sandy soil, clay loam, and muck, in that order. Extraction, column chromatographic and partitioning techniques showed that soil applications of Phorate are partially oxidized, hydrolyzed, and bound to the soil. Chloroform extractions of radioactivity from the soils at 7, 14, and 28 days after treatment were identified as Phorate plus a mixture of the phosphorodithioate sulfoxide and the phosphorodithioate sulfone of Phorate. Only a very small amount of the radioactivity extracted from the soils could be identified as hydrolysis products. A large portion of the radioactivity remained bound to the soil and could not be identified. Radioactive Phorate added to quartz sand was rapidly hydrolyzed, but no oxidation products were detected. A study of Phorate volatilization from the soils showed that within an hour after treatment the sandy soil, silt loam, and muck had lost respectively, 25%, 20%, and 18% of the radioactivity applied. However, after this initial loss, very little or no volatilization occurred. Phorate was lost rapidly from quartz sand and a steel surface with less than 10% of the radioactivity remaining 24 h after treatment. (auth.)

593 Hacskaylo, J., Lindquist, D. A., Davich, T. B. ABSORPTION OF PHORATE FROM SOLUTION "CULTURE" AND ITS EFFECT ON PHOSPHORUS UPTAKE BY COTTON PLANTS. Bull. ent. Soc. Amer. 5, 3 (1959) 119, abstr. 81.

Absorption of $P^{32}$-labelled Phorate from nutrient solution by cotton plants was linear through 72 h and proportional to the applied level. Subsequent uptake was inversely correlated with plant content. The absorption of inorganic phosphate was reduced by Phorate additions to the solution.

(This work was continued and published in J. econ. Ent. 54, 2 (1961) 379-82, and 54, 3, 411-3, as "LABORATORY AND FIELD INVESTIGATIONS WITH PHORATE-TREATED COTTON SEEDS" and "PHORATE ACCUMULATION BY COTTON PLANTS AND RECOVERY FROM SOIL")

594 Lindquist, D. A., Hacskaylo, J., Davich, T. B. ABSORPTION OF PHORATE BY COTTON SEEDS. Bull. ent. Soc. Amer. 5, 3 (1959) 119, abstr. 84.

The uptake of $P^{32}$-labelled Phorate by cotton seeds, following seed treatment, was studied in the laboratory, greenhouse and field. Data are presented on the effect of removing cotton seed hulls prior to treatment and the effect of temperature on Phorate uptake by cotton seeds.

595 Reynolds, H. T., Fukuto, T. R., Metcalf, R. L., March, R. B. SEED TREATMENT OF FIELD CROPS WITH SYSTEMIC INSECTICIDES. J. econ. Ent. 50, 5 (1957) 527-39.

Tests have shown that systemic insecticides applied to the seeds of cotton, lucerne and sugar-beet at the time of sowing protected the seedling from attack by a wide range of insects. Studies with radioactive Bayer 19639, Thimet and Demeton-S showed that, after seed treatment, the cotyledons contained the highest concentrations of toxicant and that this was not translocated in substantial amounts to other plant parts. The toxicant therefore existed in the plants in a considerable concentration gradient, ranging from the highest value in the oldest leaves to the lowest in the youngest. Effective toxic concentrations of the different insecticides are discussed, as applied to the various plants and their infesting insects.

## Phosdrin

596 Gatterdam, P.E., Knaak, J.B., Niedermeier, R.P., Casida, J.E. METABOLISM AND RESIDUES OF PHOSDRIN INSECTICIDE FED TO DAIRY CATTLE. Bull. ent. Soc. Amer. 3, 3(1957) 23, abstr. 10.

Studies with 12 lactating cows were conducted to determine the toxicity and residues in the meat and milk resulting from 90 d feeding of 0, 1, 5, and 20 ppm of Phosdrin in the diet. Further metabolism studies were made with radioactive Phosdrin at 2 mg/kg in a single dose and at 1 mg/kg daily for 7 d.

597 Getzin, L.W., Chapman, R.K., EFFECT OF SOILS UPON THE UPTAKE OF SYSTEMIC INSECTICIDES BY PLANTS. J. econ. Ent. 52 (1959) 1160-5.

The effectiveness of insecticide applications to soil often depends upon soil conditions. Experiments were therefore conducted to determine 1) the effect of various soil types upon systemic insecticide absorption by plants from the soil, and 2) the characteristics of soil which bind the insecticides against the leaching action of water. The absorption of some systemic insecticides by peas from four soils and two sands was measured by aphid bioassay and anticholinesterase analysis. The pea aphid (Macrosiphum pisi (Harris)) was used in conjunction with Thimet® (O,O-diethyl S-(ethylthio) methyl phosphorodithioate), Schradan, Isolan® (dimethyl 5-(1-isopropyl-3-methyl-pyrazolyl) carbamate), and Phosdrin® (1-methoxycarbonyl-1-propen-2-yl dimethyl phosphate, 60% technical). The binding of an insecticide in soil was studied by leaching radioactive Phosdrin through columns of 12 soils. The amount of Phosdrin bound by the various soils correlated in a positive manner with the base exchange capacity, organic matter content and nitrogen content, but it was concluded that the organic matter content was primarily responsible for insecticide binding. Other chemical and physical properties of the soil did not correlate with the binding of Phosdrin.

598 Spencer, E.Y., Robinson, J.R. METABOLISM OF THE SYSTEMIC INSECTICIDE O, O-DIMETHYL 1-CARBOMETHOXY-1-PROPEN-2-YL PHOSPHATE (PHOSDRIN) IN THE PEA PLANT. J. agric. Food Chem. 8, 4(1960) 293-5.

$P^{32}$-labelled Phosdrin and $P^{32}$-labelled cis-Phosdrin acid were used in this study. It was undertaken to define the degradation mechanism of Phosdrin isomers in plants, because alkaline hydrolysis yields different degradation products with the two isomers. The two isomers were found to degrade in the same manner but at different rates in pea plants. By administering one metabolite, Phosdrin acid, to plants it was possible to recover a monodealkylated derivative. The enzymatic degradation of Phosdrin in pea plants differs from the alkaline hydrolysis in that at least two pathways are involved, the major one being via dimethyl phosphate directly. (auth.)

## Ronnel

599 Hopkins, T.L. FUNCTIONS OF THE MADEIRA ROACH ALIMENTARY TRACT IN THE ABSORPTION, METABOLISM, AND EXCRETION OF O, O-DIMETHYL O-(2,4,5-TRICHLOROPHENYL) PHOSPHOROTHIOATE (RONNEL). Diss. Abstr. 21, 3 (1960) 707-8.

The role of the alimentary tract of the roach Leucophaea maderae (F.) in the in vivo processes of absorption, transport, metabolism and excretion of Ronnel was investigated together with the effect of the compound on the rate of the phosphorus-containing metabolites eliminated. The insecticide was labelled with $P^{32}$.

600 Louloudes, S.J. THE SYNTHESIS OF $P^{32}$-LABELED TROLENE, ITS ABSORPTION, DISTRIBUTION, AND EXCRETION BY THE COCKROACH, LEUCOPHEA MADERAE (F.), AND WHITE MOUSE, MUS MUSCULUS. Diss. Abstr. 18, 5 (1958) 1601-2.

The synthesis, purification, identification (by chromatographic analyses and the infra red) and the fate of $P^{32}$-labelled insecticide in the organism are described. Oral and topical applications are considered.

601 Plapp, F.W., Casida, J.E. BOVINE METABOLISM OF ORGANOPHOSPHORUS INSECTICIDES. METABOLIC FATE OF O, O-DIMETHYL O-(2,4,5-TRICHLOROPHENYL) PHOSPHOROTHIOATE IN RATS AND A COW. J. agric. Food Chem. 6, 9 (1958) 662-7.

O,O-dimethyl O-(2,4,5-trichlorophenyl) phosphorothioate is susceptible to hydrolysis at either the methyl-phosphate or phenyl-phosphate bond. Both sites of hydrolysis have been demonstrated with alkali and bovine rumen juice and in rats, houseflies, and a cow. The oxygen analogue of this insecticide undergoes similar hydrolytic cleavage. The excretory metabolites of O,O-dimethyl O-(2,4,5-trichlorophenyl)

phosphorothioate and three derivatives were established for rats. A slower detoxification and excretion of the insecticide metabolites occurred with the cow compared to rats, but the same metabolic pathway was demonstrated for each. $P^{32}$ was used for labelling.

602 Robbins, W.E., Hopkins, T.L., Eddy, G.W. THE FATE OF $P^{32}$-LABELED DOW ET-57 IN THE BOVINE BODY. Bull. ent. Soc. Amer. 2, 3 (1956) 17, abstr. 23.

The metabolism and excretion of $P^{32}$-labelled Dow ET-57 (O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate) in a Guernsey bull calf has been studied following its oral administration at the rate of 100 mg/kg. Analysis of the blood sampled at intervals and the quantitatively collected urine and faeces by radiometric assay, partition coefficients, and paper chromatography demonstrated the efficient absorption, degradation, and excretion of the compound. Approximately 50% of the total dose was accounted for in the urine at 30 h and about 90% in the urine and faeces at the end of 10 d. Unchanged Dow ET-57 was present in the extracts of blood and faeces while only metabolic products were found in the urine.

603 United States Department of Agriculture. CATTLE-GRUB CONTROL WITH SYSTEMIC INSECTICIDES. ARS 22-37, Agricultural Research Service. 1957, 8p.

A number of compounds were tested against the "warble flies", Hypoderma lineatum (Vill.) and H. bovis (Deg.) in cattle as systemic insecticides, prior to 1945. Experiments with Dow ET-57 in 1955 showed it to cause a high mortality in the larvae of both species when they are encysted in the backs. There was no indication that ET-57, administered orally at 100 mg/kg affected the health of the cattle or meat production. It was slightly toxic at 150 mg, but recovery was rapid. The meat of treated animals was eaten without ill effect. Two calves dosed with $P^{32}$-labelled ET-57 were found to contain 50 to 70 parts per million in the fat when slaughtered after 3 and 14 d, respectively. Limited tests with Bayer 21/199 [O, O-diethyl O-3-chlor-4-methyl-7-coumarinyl phosphorothioate] showed that this compound also destroys Hypoderma larvae before they can damage the hide of the hosts and that, unlike ET-57, it does so when applied as a spray. It is concluded that both show promise for the control of Hypoderma but neither can be recommended until more complete toxicological information is available.

## Schradan

604 Arthur, B.W., Casida, J.E. BIOLOGICAL AND CHEMICAL OXIDATION OF TETRAMETHYL PHOSPHORODIAMIDIC FLUORIDE (DIMEFOX). J. econ. Ent. 51, 1 (1958) 49-56.

Comparative radiotracer experiments were carried out on the chemical oxidation and metabolic metabolism of Dimefox [bis(dimethylamino)fluorophosphine oxide], Schradan and hexamethylphosphoramide (containing $P^{32}$) in insects, mammals and plants. Their distribution and absorption is discussed. Within insects, plants and mammals investigated, each of the three compounds was metabolized to oxidized derivatives that decomposed on treatment with acid to yield formaldehyde. With all three compounds, one oxidative derivative was more and another less polar than the original phosphoramide. Except for the greater instability of Dimefox and its derivatives, the metabolic intermediates appeared to be similar to those of Schradan and hexamethylphosphoramide.

605 Batt, R.F., Bennett, S.H., Thomas, W.D.E. THE ABSORPTION, TRANSLOCATION AND BREAKDOWN OF SCHRADAN APPLIED TO LEAVES, USING $^{32}P$-LABELLED MATERIAL. I. EXPERIMENTAL TECHNIQUES. Ann. appl. Biol. 41 (1954) 475-83.

Methods for the preparation of radioactive Schradan in solution, and the general experimental technique and procedure adopted throughout are described. This includes the methods for propagation of plant material for experimental use, and the application of the radioactive insecticide to leaves either by dipping or spraying. An account is given of the conditions under which the plants were kept, the procedure adopted at sampling involving leaching of the treated leaves, subdivision of the plant and preparation of samples for determination of "Schradan" and "Schradan equivalent" by liquid counting. The methods of compiling results to determine the distribution and status of the applied Schradan in or on the leaves at harvest, are outlined.

[Cf. II. "Evaporation and absorption," by Bennett and Thomas, 1954, and
III. "Translocation and breakdown," by Thomas and Bennett, 1954]

606 Bennett, S.H., Thomas, W.D.E. EXPERIMENTS ON THE ABSORPTION AND FATE OF A SYSTEMIC INSECTICIDE BIS(BIS DIMETHYLAMINO PHOSPHONOUS) ANHYDRIDE $[(CH_3)_2N]_2PO\text{-}O\text{-}PO[(CH_3)_2N]_2$ IN PLANTS. p. 981-6 in "Transactions of the 9th International Congress on Entomology, Amsterdam 17-24 Aug. 1951", Vol. 1. The Hague, Excelsior Photooffset. 1952.

Aqueous solutions of $P^{32}$-labelled compound were applied at concentrations between 0.6% and 0.025%; usually, between 1 and 2 ml were given to each plant by spraying or dipping. The activity was always below 2.5 μc/ml. Differences in absorption are observed between plant species, upper and lower leaf surfaces, and the effects of some physical factors on the process are noted. The main translocation is upwards from treated leaves. Decomposition of the insecticide is more rapid in broad and runnerbeans and in apples, than in chrysantemums and Coleus.

607 Bennett, S.H., Thomas, W.D.E. EXPERIMENTS ON THE ABSORPTION AND FATE OF SYSTEMIC INSECTICIDE BIS(BISDIMETHYLAMINO PHOSPHONOUS) ANHYDRIDE IN PLANTS. p. 439-44 (disc. p. 444-5) in "Radioisotope Techniques, Proceedings of the Isotope Techniques Conference, Oxford, July 1951", Vol. 1. London, Her Majesty's Stationary Office, 1953.

The absorption, translocation and breakdown of Schradan in plants was studied by means of $P^{32}$-labelled Schradan. Maximum absorption by the leaves occurred if the leaves were treated when their carbohydrate content was low, but it was more important that the application should be followed by a period of active photosynthesis. The lower leaf surface in chrysanthemum was more absorptive than the upper surface. Translocation of Schradan from sprayed leaves was slow, and only a small amount was absorbed. Translocation was generally found to occur towards the younger leaves and to be closely associated with active physiological processes. Breakdown varied considerably between the plant species tested.

608 Bennett, S.H., Thomas, W.D.E. THE ABSORPTION, TRANSLOCATION AND BREAKDOWN OF SCHRADAN APPLIED TO LEAVES, USING $^{32}P$-LABELLED MATERIAL. II. EVAPORATION AND ABSORPTION. Ann. appl. Biol. 41, 3 (1954) 484-500.

When $P^{32}$-labelled Schradan was sprayed on the leaves of apple stocks and seedlings, broad and runner beans, Coleus and chrysanthemums, some was absorbed, some evaporated and the rest remained for a considerable time on the leaf surface as a residue removable by aqueous leaching. Some breakdown of Schradan may occur within the cuticular layer. Comparisons of the absorption rates of upper and lower surfaces of leaves support the theory that absorption proceeds through the cuticle in preference to vapour phase entry through the stomata. Temperature and illumination were found to have important effects on absorption. Losses due to evaporation were lower than expected. Young leaves have been shown to be generally more absorptive than the older leaves. Comparisons have also been made of the absorption by different species to be interpreted cautiously. Absorption was found to take place rapidly through detached leaves, in which stomata are closed, and it was also absorbed by the upper and lower surfaces of Coleus leaves at equivalent rates, although the upper surface of this leaf has no stomata. Schradan was decomposed much more rapidly in the bean than in chrysanthemum and Coleus.

[cf. I."Experimental techniques," by Batt et al.
and III."Translocation and breakdown," by Thomas and Bennett].

609 David, W.A.L. INSECTICIDAL ACTION OF RADIOACTIVE BIS(BISDIMETHYLAMINO) PHOSPHONOUS ANHYDRIDE. Nature 166 (1950) 72-4.

The toxicity of bis(bisdimethylamino) phosphonous anhydride-$P^{32}$(I) was detected against Aphis fabae on broad beans, Myzus persicae on cabbage, and Acyrthosiphum onobrychidis on peas with solution equivalent to 10 mc/l. Assays of radioactivity were made in a liquid-type counter after treating plant material with boiling NaOH solutions. The roots, and to a less extent, the leaves of bean plants quickly absorbed I from culture solutions in concentrations which caused aphids to fall from the plant. Culture solutions increased in radioactivity; this indicates preferential absorption on nonradioactive I. Absorption of I was more rapid from sand than from soil with radioactivity being greater in top and bottom leaves. I concentration of 100 mg/kg plant tissue was lethal to aphids. Translocation of I was observed in leaves of the cabbage, peas, strawberry, hops, and, to a lesser extent, broad beans. Leaves of runners became radioactive after application of I to the leaf of the parent plant. Radioactive material was not given off by plants absorbing I through the roots. The honey dew of aphids feeding on I-treated plants was radioactive. (CA 45: 3548i, 1951)

610 Gardiner, J.E., Kilby, B.A. SOME OBSERVATIONS OF THE FATE OF BIS(DIMETHYLAMINO) PHOSPHONOUS ANHYDRIDE IN THE RABBIT. Biochem. J. 46 (1950) xxxii-xxxiii.

A dose of 50 mg/kg of Schradan $(Me_2N)_2$ PO. O. PO $(NMe_2)_2$, injected into rabbits leads to death within a few hours with typical symptoms of acetylcholine poisoning (excessive salivation, fibrillary twitchings, etc.) as produced by fluorophosphonates and other anticholinesterases. However, when the action of this anhydride on cholinesterases is measured in vitro, surprisingly high concentrations are required to produce 50% inhibition, in contrast with other organic phosphorus compounds which are effective at concentrations of the order of $10^{-7}$ to $10^{-8}$ M. This apparent anomaly was investigated by comparing the effects of the anhydride on rabbit blood cholinesterase activity in vivo and in vitro by means of $P^{32}$-labelled anhydride. The results can be explained by postulating the conversion of the anhydride in vivo into some more active inhibitory compound, the liver being one place where this can occur. The formation of the half molecule, $(NMe_2)_2$ PO(OH), is excluded as this is inactive.

611 Gardiner, J.E., Kilby, B.A. ORGANIC PHOSPHORUS INSECTICIDES. PART I. SYNTHESIS OF BIS-DIMETHYLAMINOPHOSPHONOUS ANHYDRIDE CONTAINING $^{32}P$. J. chem. Soc. (1950) 1769-72.

A method is described for the conversion of radioactive phosphoric acid into phosphoryl chloride on a small scale, and thence through chlorobisdimethylaminophosphine oxide into bisdimethylaminophosphonous anhydride (cf. preliminary note, Research, 2, (1949) 590). The labelled product is suitable for tracer work in plants (in which the compound acts as a systemic insecticide) and in animals (where it shows anticholinesterase activity). Preparation of the non-radioactive form on a larger scale is also described.

612 Gardiner, J.E., Kilby, B.A. BIOCHEMISTRY OF ORGANIC PHOSPHORUS INSECTICIDES I. THE MAMMALIAN METABOLISM OF BIS(DIMETHYLAMINO) PHOSPHONOUS ANHYDRIDE (SCHRADAN). Biochem. J. 51 (1952) 78-85.

A 50% inhibition of whole rabbit blood cholinesterase is caused by incubation for 1 h with $2{\cdot}6 \times 10^{-2}$ M-Schradan, bis(dimethylamino) phosphonous anhydride. In spite of this low inhibitory action, injection into rabbits leads to death with the symptoms of acetylcholine poisoning. Using radioactive Schradan, it is shown that the compound is converted in vivo into some more active anti-cholinesterase. Incubation of Schradan in vitro with rat- or rabbit-liver slices leads to a similar enhancement of activity. The active material after liver-slice incubation can be dialysed into buffer and extracted with chloroform; it is labile and is destroyed by 5 s exposure to 0·033 N-alkali, but is slightly more stable to acid. (auth. summary)

613 Glynne Jones, G.D., Thomas, W.D.E. CONTAMINATION OF NECTAR WITH SYSTEMIC INSECTICIDE "SCHRADAN". Nature 171 (1953) 263.

The possible presence of unchanged insecticide in the nectar of flowers and its subsequent appearance in honey was examined. An aqueous solution of "Schradan" containing $P^{32}$-labelled insecticide and a wetter were sprayed on the leaves of white mustard plants (Sinapis alba). The sequence followed in spraying and collecting is described. Concentrations of unchanged Schradan in nectar were determined by radio-assay. Another test was made with borage (Borago officinalis) for Schradan content in nectar.

614 Glynne Jones, G.D., Thomas, W.D.E. THE POSSIBLE CONTAMINATION OF HONEY WITH SCHRADAN. Ann. appl. Biol. 40, 3 (1953) 546-55.

The reported low toxicity of Schradan to honey bees was confirmed. Using Schradan labelled with $P^{32}$, it was shown that spray applications of this insecticide on mustard and borage plants does result in the contamination of nectar. A series of nectar samples taken over a 4-week period following spraying showed on radio-assay a progressive decrease in total $P^{32}$ content and also in the amount of Schradan present in proportion to the decomposition products. The highest figure recorded for the Schradan content of nectar was 21 ppm. Tests on stability of Schradan in contact with the honey stomach of the bee and also in contact with the enzyme invertase, in vitro, showed that no appreciable breakdown occurred. Schradan, moreover, was stable in contact with honey over a period of 2.5 months. It is concluded that this systemic insecticide may appear in an unchanged form in the honey obtained from the nectar of plants which have been sprayed less than 4 weeks previously. (auth. summary)

615 Hartley, G.S., Heath, D.F., Hume, J.M., Pound, D.W., Whittacker, M. STUDIES ON COMMERCIAL OCTAMETHYLPYROPHOSPHORAMIDE (SCHRADAN). I. COMPOSITION AND ANALYSIS. J. Sci. Food Agric. 2 (1951) 303-9.

$P^{32}$ was used for preparing Schradan in the laboratory, following the commercial method of preparation. Commercial OMPA was shown to contain, in addition to octamethylpyrophosphoramide, a comparable amount of triphosphoric acid pentadimethylamide. This latter compound was apparently as good a systemic insecticide as the former but much less toxic to mammals. A separate synthesis of the triphosphoric acid pentadimethylamide containing $P^{32}$ was carried out in order to study more thoroughly the behaviour of this compound in biological and analytical tests. A smaller amount of orthophosphoric acid tridimethylamide and minor amounts of perdimethylamides of higher polyphosphoric and cyclic metaphosphoric acids were also found in the commercial material. A method of analysis for OMPA, based upon the various rates of alkaline hydrolysis and differences in the partition coefficients of the compounds listed above, was described.

616 Hartley, G.S., Heath, D.F. DECOMPOSITION OF RADIOACTIVE OCTAMETHYLPYROPHOSPHORAMIDE IN LIVING PLANTS. Nature 167 (1951) 816.

The systemic insecticide bis(bisdimethylaminophosphonous) anhydride (octamethylpyrophosphoramide) was synthesized as $P^{32}$-labelled OMPA. In order to study the chemical fate of the substance on its uptake by living plants activities of about 400 μc/gm were used in order to obtain the necessary sensitivity in analysis. No preparative details are given in this paper. Within 4 weeks of spraying only about 10% of the toxic product originally present absorbed by the plant remain unchanged; up to 50% is present as decompositions product. By following the fate of hexamethylorthophosphoramide it is possible to throw some light on the mechanism of decomposition in the plant. It is probably entirely different from that of inanimate hydrolysis.

617 Heath, D.F., Lane, D.W.J., Llewellyn, M. STUDIES ON COMMERCIAL OCTAMETHYLPYROPHOSPHORAMIDE. III. DECOMPOSITION OF THE INSECTICIDE IN PLANTS, USING $P^{32}$ AS A TRACER. J. Sci. Food. Agric. 3 (1952) 60-9.

Test plots of strawberries, sugar beets, hops, and Brussels sprouts were sprayed at various times from May to October with radioactive material containing approximately equal proportions of the systemic insecticides octamethylpyrophosphoramide and its higher homologue, triphosphoric acid pentadimethylamide. On analysing the sprayed crops at various times after spraying, it was found that the concentration of both compounds in the plant fell at much the same rate, and that this rate varied little among the plant species treated providing all were treated at the same time of year. The rate of lowering the concentration slowed as the year progressed from May to September and became very slow in October. It was shown that the plants decomposed the insecticidal compounds, and that the lowering of insecticidal concentration with time was probably due largely to this decomposition within the plants.

618 Heath, D.F., Lane, D.W.J., Llewellyn, M. STUDIES ON COMMERCIAL OCTAMETHYLPYROPHOSPHORAMIDE. IV. THE DECOMPOSITION OF PYROPHOSPHORIC ACID TETRA (DIMETHYLAMIDE) AND ORTHOPHOSPHORIC ACID TRI(DIMETHYLAMIDE). J. Sci. Food. Agric. 3 (1952) 69-73.

Sugar beets and strawberry plants were treated with octamethylpyrophosphoramide and orthophosphoric acid tridimethylamide or tri-(dimethylamino) phosphine oxide, both labelled with $P^{32}$. Both compounds were decomposed at similar rates in the two species of plants. When sugar beet plants treated with the first compound were analysed 10 to 14 d after treatment, it was shown that the $P^{32}$ in the beet existed only as the unchanged compound and products not extractable from water by chloroform. When sugar beet plants treated with the second compound were analysed it was found that, besides the unchanged compound and non-chloroform extractable compounds, some material less extractable by chloroform than the tri-(dimethylamino) phosphine oxide was produced. The authors theorized that the plants probably attacked both compounds in the same way, oxidizing them by enzyme action.

619 Heath, D.F., Llewellyn, M.V. SYSTEMIC INSECTICIDES ON SPRAYED SURFACES. p. 445-51 (disc. p. 451) in "Radioisotope Techniques. Proceedings of the Isotope Techniques Conference, Oxford, July 1951", Vol. 1. London, Her Majesty's Stationery Office, 1953.

The fate of some systemic insecticides and allied compounds after spraying on foliage was studied using $P^{32}$ as a trace element in them. The results show that, under certain conditions, a fairly high proportion of the applied material may evaporate before there is time for it to be absorbed. Some crop plants absorb bis(bisdimethylamino)phosphonous anhydride and bis-isopropylaminophosphonous fluoride at about the same rate as the insecticides are lost by evaporation under windy conditions. The absorption rates on brassica seedlings vary somewhat with the compound applied, and the results fit in best with a theory of absorption through a semi-permeable membrane. The rate is very sensitive to incident radiation, both

visible and infra-red, an increase in the radiation increasing the uptake. The effect is not, however, completely reversible - once sensitized a plant remains unusually absorptive for several days. (auth. summary)

620 Heath, D.F., Lane, D.W.J., Park, P.O. DECOMPOSITION OF SOME ORGANOPHOSPHORUS INSECTICIDES AND RELATED COMPOUNDS IN PLANTS. Phil. Trans. 239B (1955) 191-214.

Octamethylpyrophosphoramide (Schradan) containing radioactive $P^{32}$ was degraded in white clover (Trifolium repens), turnips, Brussels sprouts seedlings, and French beans; heptamethylpyrophosphoramide, a powerful anticholinesterase (probably either hydroxymethyl heptamethylpyrophosphoramide or octamethylpyrophosphoramidic oxide), and ionizable compounds were produced. Oxygenated liver slices and oxidation with $H_2O_2$ produced the same products in similar proportions. Turnips degraded the dimethylamide, monomethylamide, butylamide, isopropylamide, and Et ester of tetramethylphosphorodiamidic acid. The dimethylamide was demethylated to its monomethyl compound; in the other compounds only the dimethylamido groups were attacked. O,O-diethyl O-ethylthioethyl phosphorothionate was converted by plants into at least 3 compounds soluble in $CHCl_3$ and of unknown structure. O,O-diethyl S-ethylthioethyl phosphorothiolate was oxidized in plants rapidly to O,O-diethyl S-ethylsulfinylethyl phosphorothiolate and another compound of unknown structure; $H_2O_2$ produced the same products. 32 references. (CA 50: 6736f, 1956)

621 Heath, D.F., Cleugh, J., Otter, I.K.H., Park, P.O. DETERMINING TRACERS OF OCTAMETHYLPYROPHOSPHORAMIDE (SCHRADAN) IN CROPS. J. agric. Food. Chem. 4, 3 (1956) 230-3.

It was desirable to develop a new technique, dependent on microdistillation, for separating the insecticide from natural products in crop extracts. The high efficiency of the initial recovery methods, (a) maceration of the crop sample with water, followed by chloroform extraction of the macerate, and (b) direct solvent extraction by boiling under reflux, is proved. The recovery of Schradan added to untreated crops is proved representative of the recovery from a treated crop. The complete analytical technique is described, and blanks and recoveries are listed. This technique should be generally applicable also to determination of residues of other toxic pest control compounds of volatility similar to or greater than that of Schradan. It is possible to determine the $P^{32}$-labelled insecticide and any phosphorus compounds derived therefrom through various operations, regardless of the large amounts of natural phosphorus compounds present. This makes it possible to account for all the relevant material in a way not possible by orthodox analytical technique. (from auth.)

622 Kilby, B.A. BIOCHEMISTRY OF SCHRADAN. Chem. and Industry (Rev.) (1953) 856-61.

Review article with 28 references on Schradan. Mention is made of the synthesis of $P^{32}$-labelled Schradan and its metabolism in the rabbit following injection.

623 March, R.B., Fukuto, T.R., Metcalf, R.L. RADIOTRACERS IN STUDY OF SYSTEMIC INSECTICIDES. Agr. Chemic. 9, 5 (1954) 107.

$P^{32}$-labelled Schradan and Systox, organic insecticides, were synthesized and used in studies of spray residues and of their metabolism in the plant. Residues were measured to 0.001 ppm and fell between 0.007 and 0.07 ppm on tree fruits, nuts and potatoes after 4 weeks. After 41 d cotton seed oil contained 109 ppm Schradan while the seed cake contained 167 ppm of non-toxic metabolic products, which were separated from the insecticide by solvent partition. Autoradiographs showed deposition in orange peel and cotton seeds. Metabolic products were separated by countercurrent distribution and by chromatography on treated filter paper. (BA 29: 22631, 1955)

624 Metcalf, R.L., March, R.B. BEHAVIOR OF OCTAMETHYL PYROPHOSPHORAMIDE IN CITRUS PLANTS. J. econ. Ent. 45, 6 (1953) 988-97.

$P^{32}$-labelled OMPA was employed in order to study its behaviour in citrus plants, particularly in the lemon, Citrus limon (L.) Burm., the sour orange, C. aurantium L., and the Valencia orange, C. sinensis (L.) Osbeck. Technical details of the methods and materials used are given. The absorption of the labelled insecticide and $H_3P^{32}O_4$ from water culture by the roots of the lemon was compared. No significant differences could be detected as measured by translocation and storage in the leaves. After 24 h an average of 29% of the activity was found in the basal leaves (on a ppm basis), 41% in the median leaves, and 30% in the terminal leaves. Over a 28-d period, the distribution was: basal leaves 13%, median 22%, terminal 65%. Absorption and translocation of OMPA following application to bark, leaves and peel are

discussed. Lethal dosage levels /g of leaf for adult female citrus red mite (Paratetranychus citri (McG.)) and greenhouse thrips (Heliothrips haemorrhoidalis (Bch)) are cited. Radioautographs showing the distribution of OMP$^{32}$ A in orange and lemon leaves were obtained. (See also AECU-2214, California Univ., Citrus Experiment Station, Riverside. 33p.)

625 Metcalf, R.L., Fukuto, T.R., Reynolds, H.T., March, R.E. SCHRADAN RESIDUES IN COTTON AND COTTONSEED PRODUCTS. J. agric. Food. Chem. 3, 12 (1955) 1011-3.

P$^{32}$-labelled Schradan was sprayed on cotton at the rate of 1.0 pound per acre and after 41 d the extent of contamination of leaves, seeds, raw and refined oils, cake, cottonseed meal, and soapstock was evaluated. Schradan showed a surprising affinity for the oily seeds, and about 8 to 16 ppm was present in the raw oil. Upon refining, this was decreased to 0.02 ppm and the Schradan was transferred to the soapstock. Ground cottonseed meal and cake contained 70 to 80 ppm of radioactive P$^{32}$ calculated as Schradan, but the very low chloroform-1N sodium hydroxide partition ratios indicated that this material was completely metabolized to acidic products. The experiment demonstrates the value of radiotracer studies in evaluating the behaviour of systemic insecticides. (auth.)

626 Pietri-Tonelli, P.de, March, R.B. RELATION OF THE ACTIVATION OF SCHRADAN IN PLANT TISSUES TO ITS TOXICITY TO INSECTS AND MITES. J. econ. Ent. 47, 5 (1954) 902-8.

The authors describe investigations with insects and a mite to compare the toxicity of unmetabolized Schradan with that of Schradan after contact with plant or mammalian tissue. The highly purified compound proved to be appreciably toxic by direct contact or ingestion to first-instar nymphs of Aphis medicaginis Koch, adults of Paratetranychus (Metatetranychus) citri (McG.), and third- or fourth-instar larvae of Culex pipiens fatigans Wied. (quinquefasciatus, auct.), and a comparative test showed that samples of technical Schradan, purified Schradan and Schradan prepared from radioactive phosphorus (P$^{32}$) had median lethal dosages in 48 h for the mosquito larvae 49, 35, and 28 parts per million, respectively, indicating that toxicity is directly related to purity. In tests with the aphid, after introducing Schradan into bean leaves by infiltration or translocation, a much better correlation was found between toxicity and the total content of radioactive compounds in the leaves, than between toxicity and the amount of Schradan metabolized. Observations on mosquito larvae in solutions of radioactive Schradan showed that similar amounts of Schradan were contained in living and dead larvae, proportional to the concentration of the solution and to the mortality caused. Principal mode of entry into larvae may be by ingestion. (RAE-A 43: 321, 1955)

627 Stein, L.H., Alper, T., Anderssen, E.E. THE MOVEMENT OF A RADIO-PHOSPHORUS-LABELED INSECTICIDE IN GROUNDNUT PLANTS. J. Sci. Food Agric. 3 (1952) 31-7. (See also Chem. Zbl. 123 (1952) 5595)

An aphid (Craccivora sp.) is known to be the vector for an economically important virus which infects peanut plants in the Transvaal, producing an external or visible foliage and growth symptom locally referred to as "rosette". Tracer-labelled OMPA was used in the field, together with the non-radioactive compound, to study the translocation of the insecticide in the plants. A small plot of the plants was sprayed; samples were taken immediately afterwards and at intervals of a few days, up to 25 d. Roots, nuts, and soil samples were tested for total radioactivity only. It was found that decrease in radioactivity in the parts above ground was due to loss of OMPA as a whole. The heaviest loss was due to evaporation immediately after spraying, and further loss took place by translocation within the roots, nuts, and soil. There was no decomposition of OMPA until more than 18 d after spraying. The radioactivity in the roots and soil samples increased steadily with time.

628 Thomas, W.D.E. THE BEHAVIOUR OF SYSTEMIC INSECTICIDES IN PLANTS: A SURVEY OF RESULTS OBTAINED WITH P$^{32}$-LABELLED SCHRADAN AND DEMETON-S. J. Sci. Food Agric. 7 (1956) 565-73.

Following application of Schradan (I) to leaves, some was absorbed and some evaporated. Whilst the two surfaces of broad bean and Coleus leaves were equally absorptive, the lower surface of apple and chrysanthemum leaves absorbed more than their upper surface. Application of Demeton-S(II) to leaves was followed by 3 processes - evaporation, change into less volatile, toxic derivatives, and absorption, - and the chemical was effectively removed from the leaf surface within a few hours. Translocation of I from treated leaves to other parts of the plant occurred, mainly in an upward direction and in amounts sufficient to kill aphids. I appeared to be translocated in the phloem. Translocation from leaves treated with II was never sufficient to kill aphids feeding elsewhere on the plant. Species differences were found in the rate of breakdown of

I after absorption from leaves. The primary derivatives of II were retained for several weeks, especially within treated leaves. Following root application to broad beans in sand or soil, unchanged II was absorbed and detected in the shoot tip where concentrations of II and its primary derivatives were present in amounts sufficient to kill Aphis fabae. Movement in xylem following root application seems to occur freely.

629 Wedding, R.T., Metcalf, R.L. TRANSLOCATION OF RADIOACTIVE OCTAMETHYLPYROPHOSPHORAMIDE (OMPA) IN BLACK VALENTINE BEAN PLANTS. Bot. Gaz. 114 (1952) 180-9.

The systemic insecticide, OMPA, was labelled with $P^{32}$, and supplied to the roots of bean plants (Phaseolus vulgaris). After uptake it moved through the stem at approximately 20 cm/h, but < 1% of the OMPA supplied had been removed in the above-ground portions after 120 h. OMPA tended to accumulate more rapidly in younger than in older tissues, both in stem and leaf tissues. The $P^{32}$-containing compounds detected in the plant were toxic to insects, as determined by bioassay using the two-spotted spider mite, Tetranychus bimaculatus Harvey. Insecticidally inactive breakdown products of OMPA were found after 8 d.

(Also published as AECU-2184, California. Univ., Riverside. Citrus Experiment Station. 20p.) Articles of the same title were also published in Citrus Leaves 33 (1953) 22, 24 and in the Calif. Citrogr. 38 (1953) 138, 140, 142. It was concluded that leaf-spraying or injection into the stem might be better methods of applying OMPA.)

## Systox (Demeton)

630 Ahmed, M.K., Newsom, L.D., Roussel, J.S., Emerson, R.B. TRANSLOCATION OF SYSTOX IN THE COTTON PLANT. J. econ. Ent. 47 (1954) 684-91.

Experimental techniques are described. Some days before the tests the plants were infested with the cotton aphid, Aphis gossypii Glov. Reduction in aphid populations was taken as an indication that toxic amounts of the insecticide were present in that portion of the plant on which the insects were feeding. The radioactive Systox had a specific activity of 4.7 mc/mg, and was diluted with water at 1:800. Translocation of Systox in the cotton plant was found to occur only in the xylem tissues. It moved in both directions simultaneously but movement in an upward direction was more rapid. Seed from fruit treated at flowering with Systox tagged with $S^{35}$ showed measureable amounts of radioactivity 35 d after treatment, with a progressive decrease during this period of time. The insecticide was found to be concentrated in the more rapidly growing young tissues.

631 Chatters, R.M. A SUMMARY OF RESEARCH ON A $P^{32}$ AND $S^{35}$ LABELED TRIALKYL THIOPHOSPHATE SYSTEMIC INSECTICIDE, SYSTOX. Oklahoma Agricultural and Mechanical Coll., Stillwater, 1953, 5p. (mimeographed)

The labelled sulphur was apparently on the phosphorus in the Systox, O,O-diethyl-O-2-(ethylmercapto)-ethyl thiophosphate. Among the studies carried out with this insecticide are translocation experiments, seed treatments, volatilization studies, vapour pressure studies, and phytotoxicity studies.

632 David, W.A.L. INSECTICIDAL ACTION STUDIES WITH DEMETON-O AND DEMETON-S. Bull. ent. Res. 48, 1 (1957) 91-107.

The two isomers Demeton-O and Demeton-S occur as a mixture in the commercial insecticide Systox, and act on Aphis fabae Scop. as contact and systemic insecticides and as fumigants. When applied in the experiments described, as a contact insecticide or systemically through the roots from solution or from soil, Demeton-S was about ten times as toxic to A. fabae on broad beans (Vicia faba) as Demeton-O. Using Demeton-S containing $P^{32}$, it was shown that, when applied to the roots, radioactive material passed to all parts of the plants and that the concentration in the aerial parts was higher than in the roots. Leaf samples were more active than stem samples. By radioassay and by the cut-taproot technique, it appeared that the lethal dose of Demeton-S was equivalent to about 1 mg/kg fresh plant tissue. The lethal dose of Demeton-O, by the taproot technique was 3 mg/kg. From solutions of Demeton-S, the plants first absorbed Demeton-S preferentially, then water preferentially. Demeton-S was more rapidly absorbed from sand than from soil. Both isomers were translocated from older to younger leaves of broad beans, usually in sufficient quantities to kill aphids, but the results were more consistent with Demeton-S. The quantity translocated downwards was small. A low light intensity before and after treatment reduced the quantity of Demeton-S translocated. There was also a reduction in the quantity translocated when the plants were shaded only before treatment. One day of shading was sufficient to cause the maximum reduction. Solutions of the two

isomers gave off toxic vapours, and plants treated through the roots gave off toxic vapours from the foliage. (RAE-A 45: 218, 1957)

633 Eldefrawi, M.E., Gordon, H.T. METABOLISM OF $C^{14}$-LABELED SYSTOX IN THE GERMAN COCKROACH, BLATTELA GERMANICA L. Bull. ent. Soc. Amer. 4, 3 (1959) 84, abstr. 27.

$C^{14}$-Systox and phosphate analogue were synthesized from 2-ethylmercaptoethanol-1,2-$C^{14}$, through ethyl mercaptan and 2-bromoethanol-1,2-$C^{14}$. Isomerization of Systox gave isosystox. Sulfoxides and sulfones of the ethylmercaptoethanol and sulfoxides of the insecticides were prepared by peroxide oxidation and characterized by paper chromatography. Systox in the cockroach is converted to sulfoxide and polar compounds.

634 Fukuto, T.R., Metcalf, R.L. ISOMERIZATION OF β-ETHYLMERCAPTOETHYL DIETHYL THIONOPHOSPHATE (SYSTOX) J. Amer. chem. Soc. 76 (1954) 5103-6.

The rearrangement of β-ethylmercaptoethyl diethyl thionophosphate to its isomer β-ethylmercaptoethyl diethyl thiophosphate has been investigated using $P^{32}$-labelled phosphate and paper chromatography and found to show first-order kinetics. The effect of solvents also has been investigated. Ethyl alcohol markedly increases the isomerization rate, chloroform to a lesser degree, while ethyl acetate, dioxane, methyl ethyl ketone, benzene and 2,2,4-trimethylpentane have little or no effect. (auth.)

Preparative details are given.

635 Fukuto, T.R., Metcalf, R.L., March, R.B., Maxon, M.G. CHEMICAL BEHAVIOR OF SYSTOX ISOMERS IN BIOLOGICAL SYSTEMS. J. econ. Ent. 48, 4 (1955) 347-54.

The seven oxidation products of the thiono and thiol isomers, O,O-diethyl O-ethyl-2-sulfinylethyl phosphorothionate (thionophosphate sulfoxide), O,O-diethyl S-ethyl-2-sulfinylethyl phosphorothiolate (thiolphosphate sulfoxide), O,O-diethyl O-ethyl-2-mercaptoethyl phosphate (phosphate), O, O-diethyl O-ethyl-2-sulfinylethyl phosphate (phosphate sulfoxide), O,O-diethyl O-ethyl-2-sulfonylethyl phosphate (phosphate sulfone), O,O-diethyl S-ethyl-2-sulfonylethyl phosphorothiolate (thiolphosphate sulfone), and O,O-diethyl O-ethyl-2-sulfonylethyl phosphorothionate (thionophosphate sulfone) have been synthesized and some of their properties were compared with the metabolic products of the Systox isomers obtained after topical applications to the base of the cotton plant. The comparison of the results obtained from paper chromatography, cholinesterase activity, systemic activity, mammalian and insect toxicities of the oxidation and metabolic products indicates that the thiono isomer of Systox is converted to the thionophosphate sulfoxide, which is then converted to the thionophosphate sulfone or phosphate sulfoxide, or to both. A similar comparison of the oxidation and metabolic products of the thiol isomer indicates that it is converted to the thiolphosphate sulfoxide and then possibly to the thiolphosphate sulfone. $P^{32}$-labelled O,O-diethyl O-ethyl-2-ethyl-2-mercaptoethyl phosphorothionate and O,O-diethyl S-ethyl-2-mercaptoethyl phosphorothiolate were used. Toxicity tests were made on Metatetranychus citri (McG.), Heliothrips haemorrhoidalis (Bch.), Musca domestica L., Tetranychus telarius (L.) and Aphis gossypii Glov. (Includes auth. summary)

636 Fukuto, T.R., Wolf, J.P., III., Metcalf, R.L., March, R.B. IDENTIFICATION OF THE SULFOXIDE AND SULFONE PLANT METABOLISM OF THE THIOL ISOMER OF SYSTOX. J. econ. Ent. 49, 2 (1956) 147-51.

In this fifth paper of a series, an account is given of further investigations on the chemical behaviour of O,O-diethyl S-2-(ethylthio) phosphorothioate (Demeton-S), one of the two isomers present in Systox, in which the infra-red spectra of its metabolic products were compared with those of the synthetic oxidation products, in order to confirm the suspected identity of the metabolites. Demeton-S labelled with $P^{32}$ was applied to the bases of young cotton plants and its metabolites were recovered from the leaves and isolated by the methods that are described. The results showed that the major metabolic product in the plant 4-6 d after application was identical with O,O-diethyl S-2-(ethylsulphinyl)ethyl phosphorothioate (the thiolphosphate sulphoxide). When this compound labelled with $P^{32}$ was applied to plants in the same way, the spectrum from the metabolite isolated after two weeks proved that subsequent oxidation of O,O-diethyl S-2-(ethylsulphonyl) ethyl phosphorothioate (the thiolphosphate sulphone) occurs at a somewhat slower rate than the conversion of Demeton-S to the thiolphosphate sulphoxide. (RAE-A 45: 181, 1957)

637 Gardner, K., Heath, D.F. QUANTITATIVE DETERMINATION OF ISOMERS OF O, O-DIETHYL ETHYLMERCAPTOETHYL THIOPHOSPHATE. Analyt. Chem. 25, 12 (1953) 1849-53.

Pure O,O-diethyl O-ethylmercaptoethyl thiophosphate (I) prepared in the laboratory showed different physical and toxicological characteristics from those of the active constituent of the insecticide Systox, which is started to be this compound. In view of the fact that many compounds of the S = P - O type - e.g., Parathion - are known to be thermally unstable, it was presumed that the discrepancies were due to partial isomerization of the commercial product. Concurrent partition chromatography of a mixture of radioactive preparations ($P^{32}$) of pure O,O-diethyl O-ethylmercaptoethyl thiophosphate and O,O-diethyl S-ethylmercaptoethyl thiophosphate (II), with the active ingredient isolated from Systox demonstrates the presence of both I and II in Systox. It is also shown that I isomerizes to II on heating. A chromatographic method of analysis is described for determination of the two active ingredients in O,O-diethyl (O,S)-ethylmercaptoethyl thiophosphate preparations. The analytical identification technique described - concurrent partition chromatography of the unknown sample with radioactive components of established structure and purity - may find more general application, particularly to preparations of the S=P− O and O=P− S types. (auth.)

638 Hartley, G.S. RESEARCH DEVELOPMENTS. THE ANOMALY OF SYSTOX. World Crops 4 (1952) 397.

The anomaly of Systox lies in the fact that it acts as a systemic insecticide while only soluble to the extent of 1 part in 15 000 of water. Systox contains 2 active ingredients, the S-P-O-C and the O-P-S-C compounds. $P^{32}$-labelled O-P-S-C compound when applied to roots of brassica seedlings could be shown to be rapidly converted into a more water-soluble compound within the living plant, a derivative being responsible for the systemic insecticidal action. The derivatives were separated and concentrated. A third, even more water-favourable compound was also discovered, and shown to possess anti-cholinesterase activity. The original compounds may thus be seen to be rapidly and completely converted into the derivatives, which persist for several weeks. This may explain why it has been reported that toxic residues disappear very rapidly with Systox treatment, despite its persistence as an insecticide.

639 March, R.B., Metcalf, R.L., Fukuto, T.R. PAPER CHROMATOGRAPHY OF THE SYSTEMIC INSECTICIDES DEMETON AND SCHRADAN. J. agric. Food Chem. 2 (1954) 732-5.

The components of technical Demeton and related compounds have been separated by means of 2 paper chromatographic techniques, and of technical Schradan and related phosphoramide esters by means of a 3rd paper chromatographic technique. $P^{32}$ or $S^{35}$ were used for labelling. The above techniques have materially aided in investigations on systemic insecticides, for the preparation and determination of purity of $P^{32}$-labelled Demeton and its isomerization to the thiol isomer (see Fukuto & Metcalf, J. Amer. Chem. Soc. 76 (1954) 5103); the translocation and biochemistry of Systox (Demeton) in plants; the determination and characterization of residues of Systox in citrus, walnut, apples, pears, potatoes and sugar beets; the preparation and the determination of purity of $P^{32}$-labelled Schradan, determination of its residues in cotton, and some studies in comparative biochemistry.

640 March, R.B., Metcalf, R.L., Fukuto, T.R., Maxon, M.G. METABOLISM OF SYSTOX IN THE WHITE MOUSE AND AMERICAN COCKROACH. J. econ. Ent. 48, 4 (1955) 355-63.

$P^{32}$-labelled thiono and thiol isomers of Systox were found to be rapidly metabolized, degraded, and eliminated in the white mouse and the American cockroach. Metabolism, degradation and elimination are somewhat slower in the cockroach than in the mouse, but in gross aspects they are the same. The foregut exhibits a marked selective absorption of the isomers, and the gut is the principal avenue of elimination. Although the gut appears to be the most active tissue in the role of metabolism and degradation, other tissues such as nerve and muscle are more active in the roach than in the mouse. The principal pathway of metabolism to toxic metabolites for both isomers is the oxidation of the mercapto sulfur of the ethylmercaptoethyl moiety to the sulfoxide and sulfone. A secondary pathway in the case of the thiono isomer involves the oxidation of the thiono sulfur to produce the phosphate and its sulfoxide and sulfone. Both isomers and their toxic metabolites are degraded by hydrolysis and of the P−O− or P−S−bond to form the alcohol and acid. The routes of metabolism and the toxic metabolites formed are the same in plants and animals. Thus toxic residues in edible products present no peculiar hazard as a result of biochemical activity in the plant. (from auth. summary)

641 Metcalf, R.L., March, R.B., Fukuto, T.R., Maxon, M. THE BEHAVIOR OF SYSTOX-ISOMERS IN BEAN AND CITRUS PLANTS. J. econ. Ent. 47, 6 (1954) 1045-55.

The $P^{32}$-labelled isomers were readily absorbed by the roots and stems of the lemon seedlings and translocated to the leaves in amounts toxic to Paratetranychus (Metatetranychus) citri (McG.), and Heliothrips haemorrhoidalis (Bch.). The translocated materials were present in greater quantity in the peripheral growing areas of the upper leaves, and the systemic behaviour closely resembled that of Schradan. After topical application to the stems, radioactivity accumulated in the upper leaves of bean and lemon 5-10 times as fast for Demeton-S as for Demeton-O. Studies of the quantitative metabolism of the two isomers in bean and lemon leaves by paper chromatography indicated a rapid metabolism of both. Contact toxicity studies in which oranges were dipped in standard solutions and the dry residues tested showed that Demeton-S is 3-5 times as toxic as Demeton-O to P. citri and H. haemorrhoidalis; the metabolite of the former caused total mortality at an estimated concentration of less than 40 µg/g leaf, and the metabolite of the latter at about 300 µg/g. Pure Demeton-O was a poor inhibitor of fly-brain cholinesterase, but Demeton-S and the principal metabolites of both isomers were highly active. No radioactive vapours were recovered from the leaves of plants of which the stems had been treated with the radioactive isomers. (RAE-A 43: 421, 1955)

642 Metcalf, R.L., Fukuto, T.R., March, R.B., Stafford, E.M. THE SYSTEMIC BEHAVIOUR OF SYSTOX THIOL ISOMER SULFOXIDE AND METHOSULFATE IN PLANTS. J. econ. Ent. 49, 6 (1956) 738-41.

The systemic behaviour of Demeton-S and its methosulfate and sulfoxide (O,O-diethyl S-ethyl-2-sulfinyl-ethyl phosphorothioate) applied topically to the stems of young cotton plants was studied by means of $P^{32}$ radiotracers and paper chromatography. Demeton-S was absorbed and translocated much more rapidly than the sulfoxide for up to 7 d after application. At 14 d, the amounts were nearly equal, and at 30 d the sulfoxide was present in appreciably greater amounts. The methosulfate accumulated much more slowly, indicating a lower degree of penetration of this strongly polar compound through the plant cuticle. The rates of metabolism and decomposition of Demeton-S and its sulfoxide were approximately the same, and small amounts of the sulfone were formed from both. Radioautography after topical application to young lemon leaves showed that the penetration and spread in the leaf interior was most rapid for Demeton-S and least so for its methosulfate, but more rapid for O,O-diethyl O-2-(ethyl-thio)ethyl phosphorothioate [Demeton-O] than for Demeton-S sulfoxide. (from auth. summary)

643 Metcalf, R.L., March, R.B., Fukuto, T.R., Maxon, M.G. THE NATURE AND SIGNIFICANCE OF SYSTOX RESIDUES IN PLANT MATERIALS. J. econ. Ent. 48 (1955) 364-9.

The investigations were largely carried out by means of $P^{32}$-labelled Systox isomers, O,O-diethyl O-ethyl-2-mercaptoethyl phosphorothionate (thiono isomer) and O,O-diethyl S-ethyl-2-mercaptoethyl phosphorothiolate (thiol isomer), and paper chromatography. Samples of apples, pears, oranges, walnuts, potatoes, and sugar beets were processed for analysis. The metabolism of the isomers and their residue products, and the action of air and sunlight on surface residues are discussed. In addition to activation within the plant tissues to oxidative metabolites, these are subsequently hydrolyzed to nontoxic, diethyl phosphoric acids and alcohols. The thiol isomer metabolites persist in leaf and fruit tissues about twice as long as the thiono isomer metabolites. The hydrolysis of the toxic metabolites in plant materials to non-toxic phosphoric acid derivatives is a further safeguard against the retention or accumulation of the toxic esters over a long period of time. Average residue values of toxic Systox metabolites 2 and 4 weeks after application were substantially below 0.1 ppm, i.e., so that they could not have been determined precisely by other (non-tracer) methods.

644 Metcalf, R.L., Stafford, E.M., Fukuto, T.R., March, R.B. THE SYSTEMIC BEHAVIOR OF O, O-DIETHYL S-2-(DIETHYLAMINO) ETHYL PHOSPHOROTHIOLATE AND ITS SALTS. J. econ. Ent. 50, 2 (1957) 205-10.

The translocation of O,O-diethyl S-2-(diethylamino)ethyl phosphorothioate (thiol isomer) and its salts, particularly the hydrogen oxalate, in plants was investigated by the use of compounds labelled with $P^{32}$ and compared, in some cases, with that of its thiono isomer (O,O-diethyl O-2-(diethylamino) ethyl phosphorothioate) and Demeton-S [O,O-diethyl S-2-(ethylthio)ethyl phosphorothioate]. Cotton, lemon and orange plants were used in experiments, and the distribution and metabolism of thiol isomer and its oxalate discussed. (from RAE-A 46, 5: 182-3, 1958)

645 Mühlmann, R., Tietz, H. THE CHEMICAL BEHAVIOUR OF METHYLISOSYSTOX IN THE LIVING PLANT AND THE PROBLEM OF RESIDUES. HöfchenBr., Wiss. (English edition) 9 (1956) 116-40.

The chemical behaviour of Methylisosystox, O,O-dimethyl S-(2-ethyl-mercaptoethyl)-thiolphosphate, Methylisosystoxsulphoxide and Methylisosystox-sulphone was examined in the plant in the mammalian

organism by means of $P^{32}$-labelled compounds. Two toxic transformation products were found in the plant. In addition to suphoxide, Methylisosystoxsulphone was also identified in plants treated with Methylisosystox. Both Methylisosystox and its oxidation products, sulphoxide and sulphone are exposed to the normal hydrolytic decomposition to non-toxic compounds in the living plant. The first decomposition product is dimethyl phosphoric acid, the end product orthophosphoric acid. It could be proved that the phosphoric acid formed by complete decomposition of the "Systox" active substances is largely used by the plant for the synthesis of phosphatides (particularly lecithin). True residual values were found considerably below those calculated at random on the basis of the total $P^{32}$-content. The sulphoxide primarily formed in the plant is excreted quantitatively from the organism of warm-blooded animals within a short time. Cases of chronic poisoning cannot be caused following the consumption of such small quantities as represented by the residues in the harvest crops.

646 Stein, L.H., Smith, A.J. UPTAKE AND DEGRADATION OF LABELED SYSTEMIC INSECTICIDES. II. TREATMENTS OF TOBACCO AND POTATOES WITH SYSTOX. J. S. Afr. chem. Inst. 7 (1954) 114-9.

A 0.05% Systox spray was used in which the thiol isomer of Demeton, Demeton-S, was labelled with $P^{32}$, and used in a determination of the dissipation of residues in tobacco and potatoes at various times after application. A soil application of 0.05% at the rate of 2 gal/$yd^2$ resulted in 566.5 to 425.9 ppm in tobacco leaves 53 d later, and 83.6 ppm (wet weight) in potatoes.

647 Stein, L.H., Smith, A.J. UPTAKE AND DEGRADATION OF LABELED SYSTEMIC INSECTICIDES. III. ESTIMATION OF THE MORE TOXIC DEGRADATION PRODUCTS OF SYSTOX. J. S. Afr. chem. Inst. 7 (1954) 120-4.

Sprays were used where the Systox ingredients were present in their normal proportion but the Demeton-S was labelled with $P^{32}$. The method of spraying and sampling as applied to tobacco and potato plants is described, and was also used to determine how much of the insecticide or of its more toxic degradation products is present in potatoes and tobacco at various intervals after treatment (cf. Stein and Smith, 1954). The $CHCl_3$ extract which contains the toxic portions of Systox degradation products was found to be 5 ppm (dry weight) in tobacco leaves and 1.2 ppm (wet weight) in potato tubers 53 d after soil applications of 0.05% at the rate of 2 gal/$yd^2$.

648 Thomas, W.D.E., Glynne Jones, D.G. THE SYSTEMIC PROPERTIES OF DIETHYL-S-2-(ETHYLTHIO-ETHYL) PHOSPHOROTHIOLATE (DEMETON-S) WITH REFERENCE TO THE CONTAMINATION OF NECTAR. Ann. appl. Biol. 43, 2 (1955) 182-91.

The systemic insecticide Systox normally contains a mixture of the two isomers, diethyl 2-(ethylthio) ethyl phosphorothionate and diethyl S-2-(ethylthio) ethyl phosphorothiolate, or Demeton-O and Demeton-S, respectively. Demeton-O is toxic to honey bees, and sublethal amounts may possibly be transported in nectar by them and contaminate the honey. Demeton-S has been shown to be about ten times as toxic as Demeton-O to mammals and insects, and investigations were therefore carried out to ascertain whether it, or any derivative, appears in the nectar of sprayed plants; also, its rate of translocation and breakdown in the plant. $P^{32}$-Demeton-S was used. The fate of Demeton-S in white mustard (Brassica alba), borage (Borago officinalis) and field beans (Vicia faba) was followed over several weeks by means of the radioactive tracer technique. Radioassay of nectar samples from flowers that opened a few days after spraying showed no unchanged Demeton-S, but degradation products were present in small amounts. The highest value for total radioactivity found in the nectar corresponds to 2.7 parts per million expressed as Demeton-S. Radioassay of treated leaves and new growth after spraying confirmed that Demeton-S is rapidly converted in the plant into two primary degradation products extractable by chloroform. Further breakdown occurs and is still more rapid in new growth, but appreciable quantities of the two primary degradation products are retained by treated leaves for several weeks after spraying. Chrysanthemum cuttings which had absorbed an extract of them proved toxic to Macrosiphum (Macrosiphoniella) sanborni (Gill.). It is concluded that the extent to which Demeton-S appears in the nectar is negligible, but that some contamination by degradation products, possibly toxic to man, occurs. (RAE-A 43: 405, 1955)

649 Thomas, W.D.E., Bennett, S.H., Lloyd-Jones, C.P. THE ABSORPTION, BREAKDOWN, AND SYSTEMIC BEHAVIOR IN PLANTS OF $P^{32}$-LABELED DEMETON-S. Ann. appl. Biol. 43 (1955) 569-93.

Following leaf application of diethyl S-(2-(ethylthio) ethyl) phosphorothiolate (Demeton-S) (I), labelled with $P^{32}$, to beans, apples, and coleus, evaporation, breakdown into toxic non-volatile compounds, and absorption occurred concurrently and effectively removed unchanged I from the leaf surface within a few

hours. Evaporation gave rise to a fumigant action on Aphis fabae. Both I and its degradation products were absorbed, I degrading rapidly within the tissue. Translocation from treated leaves was insufficient to kill aphids feeding on untreated foliage, and no unchanged I could be found in the plant other than in the leaves. Following root application to bean plants in soil or sand, aphids feeding on the shoot tips were killed after 2 d; unchanged I was translocated following root application. I and its toxic derivatives appeared to move much more freely in xylem than in phloem tissue. (CA 50: 6737c, 1956)

650 Tietz, H. "METASYSTOX" RÜCKSTANDSUNTERSUCHUNGEN 1956 (1956-Studies on "Metasystox" residues). HöfchenBr. Wiss. 9, 2 (1956) 286-8. (in German)

A brief note is added to an earlier communication (Mühlmann and Tietz, HöfchenBr. Wiss. 9, 2 (1956) 116). Whereas the previous study described data under conditions designed to obtain maximum residue, normal spraying with $P^{32}$-labelled insecticide in early summer instead of autumn was applied. Results show that fruit and vegetables are prefectly safe for human consumption after 8-10 d from the last spraying.

651 Tietz, H. DER MIT $^{32}P$ MARKIERTE DIÄTHYLTHIONOPHOSPHORSÄUREESTER DES β-OXYÄTHYL-THIOÄTHYLÄTHERS (WIRKSTOFF DES SYSTEMISCHEN INSEKTIZIDES "SYSTOX"), SEINE AUFNAHME IN DIE HÖHERE PFLANZE UND SEIN WANDERUNGSVERMÖGEN (The $P^{32}$-labelled diethylthionophosphoric acid ester of β-oxyethylthioethyl ether, the active substance of the systemic insecticide Systox, its uptake by higher plants and its translocation) HöfchenBr. Wiss. 7, 1 (1954) 1-56. (in German)

E 1059 (the active substance of Systox) was labelled with $P^{32}$ (supplied by G. Schrader, Farbenfabriken Bayer) and applied to roots or leaves, in order to study its absorption through roots, its upward movement, and its accumulation in the leaves. Penetration and movement were traced after leaf application, and residual effects, including storage and detoxification by plants were studied. The insecticide was absorbed freely from solution by the intact root. The quality of treated soil was found to influence uptake and concentration limit. The permeability of the root for water increased over a long period, then dropped below the normal value, and finally adjusted to it. After absorption by the root, the insecticide was translocated to shoot organs above the ground. Temporary storage, particularly peripherally, was observed in leaves. Spraying or brushing of the leaf with Systox solution allowed greater inward penetration, the degree depending on several factors. Treatment of individual leaves resulted in a displacement towards untreated parts of the plant, particularly apically. Once within the leaf, the insecticide did not appear to diffuse widely. Autoradiographs of leaf cross-sections indicated temporary storage by living cells, particularly in the epidermis and in cells of the connecting bundle parenchyma. Loss from the plant occurred chiefly through exudation via cuticle pores, translocation after treatment of the shoot part above the ground primarily via the phloem. Evaporation or rain remove the eliminated toxic parts from the surface.

652 Tietz, H. METABOLISME DES INSECTICIDES ET ACARICIDES DU GROUPE DEMETON-MÉTHYL. Phytiatrie-Phytopharmacie 9 (1960) 167-80.

Le Méthylisosystox (marqué au $P^{32}$) est transformé en composés toxiques conformement aux observations de Heath. Les sulfoxydes et les sulfones des matières actives, du "Systox" sont identiques aux dérivés $D_1$ et $D_2$. On a pu prouver que les acides phosphoriques résultant de la décomposition complète de la matière active se transforment dans une large mesure en phosphatides végétaux (surtout en lécithine). Le sulfoxyde que se produit en premier lieu dans la plante est éliminé quantitativement en peu de temps de l'organisme des animaux à sang chaud. En cas d'intoxication aiguë chez la souris blanche, 97% du sulfoxyde sont éliminés (15 h); il en resulte que l'absorption de faibles quantités du produit comme p. e. des résidus se trouvant dans les produits de récolte ne peut conduire à des intoxications chroniques.

## Tepp

653 Roan, C.C., Fernando, H.E., Kearns, C.W. A RADIOBIOLOGICAL STUDY OF FOUR ORGANIC PHOSPHATES. J. econ. Ent. 43, 3 (1950) 319-25.

TEPP (tetraethyl pyrophosphate), tetraisopropyl pyrophosphate, tetra-n-butyl pyrophosphate and O,O-diethyl O-paranitrophenyl phosphate were synthesized with $P^{32}$ and used in studies employing the techniques of radiobiological assays. Among others, experiments were made to determine the tissue concentration of radioactive TEPP or its metabolite after topical application which showed that the highest concentration occurred in the fore gut, with the concentration in the body fluid rising rapidly at first and then falling sharply; slight increases were noted in muscle tissue during the first hour after treatment. After both sublethal and lethal administrations, the fore gut showed a marked selective absorption of TEPP in the tissues of surviving and prostrate cockroaches (Periplaneta americana (L.)) showed considerably higher concentrations

of radioactive material in the fore gut of surviving than of prostrate cockroaches, and higher concentrations in the muscles of prostrate than of surviving ones. Although no radioactive materials were detected in the central nervous system, the authors do not consider that this necessarily indicates a complete absence of such materials from this region, since the specific activity of the tracer compound employed had deteriorated to a rather low level when the experiment was performed.

654 Robinson, J.R. TETRAETHYL PYROPHOSPHATE LABELED WITH PHOSPHORUS-32. Canad. J. Chem. 33 (1955) 722-3.

A method for the synthesis of $P^{32}$-labelled tetraethyl pyrophosphate (TEPP) is described. The corresponding specific activity of the product is 65 μc/g but this could be increased by altering the ratio of active to inactive P and no major modification of the technique would be required. The over-all chemical yield based on $H_3PO_4$ is 49%. (CA 49: 939a, 1955)

## Thiodan

655 Klee, O. ÜBER DEN EINFLUSS DER TEMPERATUR UND LUFTFEUCHTIGKEIT AUF DIE TOXISCHE WIRKUNG ORGANISCH-SYNTHETISCHER INSEKTIZIDE. (Study on the influence of temperature and humidity on the toxic effects of organically synthesized insecticides) Z. angew. Zool. 47 (1960) 183-229. (In German)

Insects were exposed to the vapour phase of the $S^{35}$-labelled insecticide Thiodan®. Contamination of any one part of the body which might be in contact with precipitated material could thus be avoided. By measuring the radioactivity taken up from the vapour at different temperatures and levels of humidity it was possible to determine the extent to which insecticide efficacy was a function of these factors, and to demonstrate the great importance of the vapour phase.

## Miscellaneous

656 Benjamini, E., Metcalf, R.L., Fukuto, T.R. THE CHEMISTRY AND MODE OF ACTION OF THE INSECTICIDE O, O-DIETHYL O-p-METHYLSULFINYLPHENYL PHOSPHOROTHIONATE AND ITS ANALOGUES. J. econ. Ent. 52 (1959) 94-8.

The insecticide (Bayer 25141) was studied with regard to its chemical instability to heat, hydrolysis, and oxidation and to the effect of the products formed upon insect toxicity. The compound is readily oxidized to the sulfone and upon heating undergoes internal oxidation-reduction to also form the sulfide. Additionally, the compound apparently isomerizes very readily to form the S-ethyl-isomer. The oxidation and isomerization products also form in aqueous systems such as the insects body and as they possess enhanced anticholinesterase activity apparently contribute to the mechanism of toxic action which appears to be that of inhibition of cholinesterase. The bimolecular rate constant for reaction with cholinesterase and the hydroxyde-ion catalyzed hydrolysis constant for p-substituted methylthio-, methylsulfinyl-, and methylsulfonylphenyl diethyl phosphates and phosphorothionates can be satisfactorily correlated with the electron-withdrawing capacities of the aryl substituents. A $P^{32}$-labelled form was used, the insect studied being Periplaneta americana. The techniques for paper chromatography, quantitative evaluation of $P^{32}$-labelled compounds and identification of the various metabolites are given.

657 Benjamini, E., Metcalf, R.L., Fukuto, T.R. CONTACT AND SYSTEMIC INSECTICIDAL PROPERTIES OF O, O-DIETHYL O-p-METHYLSULFINYLPHENYL PHOSPHOROTHIONATE AND ITS ANALOGUES. J. econ. Ent. 52 (1959) 99-102.

The above insecticide (Bayer 25141), its dimethyl analogue, and several reduced and oxidized derivatives were investigated as contact and systemic insecticides. The more active compounds studied were of the same order of contact toxicity as Parathion and were also effective systemic insecticides. In plant tissue, the sulfoxides are oxidized to sulfones and also appear to isomerize to S-ethyl-isomers. Compounds p-$CH_3SOC_6H_4OP(S)(OEt)_2$ and p-$CH_3SOC_6H_4OP(S)(OMe)_2$ were available in highly purified and in $P^{32}$-labelled preparations. Experiments were carried out on Musca domestica Linn., Periplaneta americana (Linn.), Metatetranychus citri (McGregor), Tribolium confusum (Duval), Laphygma frugiperda (J.E. Smith), and Brevicoryne brassicae (L.), and contact toxicity of p-substituted phenyl dialkyl phosphorothionates and phosphates determined. Results on contact toxicity, systemic toxicity, rates of absorption and translocation are discussed.

658 Bowman, J.S., Casida, J.E. SYSTEMIC INSECTICIDES FOR THEOBROMA CACAO L., THEIR TRANSLOCATION AND PERSISTENCE IN FOLIAGE AND RESIDUES IN CACAO BEANS. J. econ. Ent. 51, 6 (1958) 773-80.

From preliminary screening of 14 systemic compounds with cacao seedlings in Costa Rica, Thimet, Chipman R-6200 (O,O-diethyl S-(2-diethylamino)ethyl phosphorothiolate), Demeton, Isolan and Dimefox were selected for further study. These five systemics were compared on the basis of their translocation and persistence in the foliar parts of mature cacao trees after trunk implantation, their effect on the flavour of chocolate produced from beans from the treated trees, and the level and nature of residues in the beans using radiotracer and anticholinesterase methods of analysis. Thimet and Chipman R-6200 were readily translocated into the foliar portions of cacao trees and persisted for as long as 20 months after a single implantation treatment. Little or no residues were found in the cacao beans at any time after treatment regardless of the position on the trees in relation to the site of implantation. Studies with radioactive R-6200 (labelled with $P^{32}$) demonstrated a high concentration of phosphorus-containing residues in the cotyledons of the cacao beans but these materials did not partition into chloroform and did not inhibit cholinesterase, and therefore cannot be considered as hazardous residues. No off-flavours were detected in chocolate from beans harvested from any of the systemic treatments but definite off-flavours were obtained when BHC was used as a foliar spray. (auth.)

659 Casida, J.E. ISOMERIC SUBSTITUTED-VINYL PHOSPHATE AS SYSTEMIC INSECTICIDES. Science 122 (1955) 597-8.

The biological distribution and fate of the cis isomer of compound 2046, O,O-dimethyl 1-carbo-methoxy-1-propen-2-yl phosphate, was studied after being labelled with $P^{32}$, since substituted-vinyl phosphates are noted for frequently high insecticidal activity. It was found that in contrast to other systemic insecticides currently available, compound 2046 does not require preliminary "metabolic activation" within the plant to produce the effective toxicant. The substituted-vinyl phosphates had the shortest residual period of 20 organo-phosphates studied on carrots, potatoes and cabbage. Distribution and detoxification were studied. Accumulation seemed to occur in the mid- and hindgut; detoxification appeared to take place in the gastric caeca and nerve cord of the roach, Periplaneta americana.

660 Casida, J.E., Gatterdam, P.E., Getzin, L.W., Jr., Chapman, R.K. RESIDUAL PROPERTIES OF THE SYSTEMIC INSECTICIDE O, O-DIMETHYL 1-CARBO-METHOXY-1-PROPEN-2-YL PHOSPHATE. J. agric. Food Chem. 4, 3 (1956) 236-43.

O,O-dimethyl 1-carbomethoxy-1-propen-2-yl phosphate (compound 2046) offers considerable promise as a short-residual systemic insecticide. The potential hazard of residues in crop plants was investigated. Compound 2046 consists of about $\frac{2}{3}$ cis and $\frac{1}{3}$ trans isomers. The cis is about 100 times more toxic than the trans to insects and mammals. Despite the greater residual persistence of the trans isomer within the plant, its residual hazard was negligible compared to the less stable but more toxic cis material. The initial enzymatic attack on both isomers within the plant appeared to be on the carboxylic ester group, followed by hydrolysis of the vinyl phosphate bond. Foliage application to vegetable crops in the field resulted in a 90% residual loss in less than 2 d and over 99% loss in 4 d based on anticholinesterase determinations. The toxic 2046-residues in crop plants treated at dosage levels used for insect control were essentially dissipated within 2 d following insecticide application. The residual properties of compound 2046 were determined by several different techniques, amongst them radioactive insecticide, using $P^{32}$ as tracer. Its synthesis is described. (auth.)

661 Heath, D.F., Casapieri, P. HYDROLYSIS OF DIMETHYLAMIDES OF PHOSPHORIC ACIDS. Trans. Faraday Soc. 47 (1951) 1093-101.

Some phosphoramides show remarkable toxic properties towards mammals and insects. The study was undertaken to measure the hydrolysis rates of some dimethylamides of phosphoric acids in acids, alkalis and water. It was found that the P—N link is about as easily broken by acids as the C—N link in organic amides, but is extremely stable to alkalis. Only in acid amides, containing the group N—P—OH, is the P—N group broken by water at a measurable rate. Other modes of hydrolysis of some of these compounds are described, and all the results considered in relation to the behaviour of organic amides. A radioactive, $P^{32}$-labelled form of $R_4P_2O_3$ was used in the study. (auth.)

662 Heath, D.F. THE EFFECTS OF SUBSTITUENTS ON THE RATES OF HYDROLYSIS OF SOME ORGANO-PHOSPHORUS COMPOUNDS. PART II. RATES IN ALKALINE SOLUTION. J. chem. Soc. (1956) 3796-804.

The rates of hydrolysis, in alkaline solution, of compounds of the types RR'P(O)X and RR'P(S)X, where R and R' are alkoxy- or alkylamino-groups and X is an acidic group, are summarized, and more results are given. The mechanism is of type $S_N2$. The electromeric and inductive effects of substituents are usually very

similar to those found in carbon chemistry for reactions of this type. However, ethyl NN-dimethylphosphoramidocyanidate and compounds containing P–S–C bonding are hydrolyted exceptionally rapidly, perhaps because the cyanide group and the sulphur atom are very readily polarized relatively to the other substituents considered. In the phosphorodiamidic fluoride series, those compounds containing four alkyl substituents are hydrolyzed markedly more slowly than those containing only three, owing to a steric effect. For the same reason diisopropyl phosphorofluoridate is hydrolyzed more slowly than would be expected from its structure. All rates of reaction in neutral solution and several of the slower ones in alkaline solution were determined on compounds labelled with $P^{32}$. This is the most accurate of the methods used.

663 Heath, D.F. THE EFFECTS OF SUBSTITUENTS ON THE RATES OF HYDROLYSIS OF SOME ORGANOPHOSPHORUS COMPOUNDS. PART II. RATES IN NEUTRAL SOLUTION. J. chem. Soc. (1956) 3804-9.

The approach used in the preceding paper is extended to cover rates of hydrolysis in compounds under conditions such that catalysis by hydroxyl ions can be neglected. Hydrolysis rates were obtained using very dilute solutions of $P^{32}$-labelled compounds. Salts catalyses hydrolysis of NN'-diisopropyl- and NN-dimethyl-N'-isopropyl-phosphorodiamidic fluoride. $k_w$ for the first compound is probably composite, water acting as both an anionoid and a cationoid reagent. Generally, however, water acts as an anion by an $S_N2$ mechanism. Substituents have similar effects to those described in Part I, except that in the tetra-alkyl pyrophosphates steric effects are more important than inductive effects, and that P—S—C groups accelerate the rates less in neutral than in alkaline solution.

664 Kossobutsky, V.I. STUDY OF THE ACTION OF ORGANOPHOSPHORUS INSECTICIDES ON THE GRAIN BUG (EURYGASTER INTEGRICEPS PUT.) WITH THE AID OF TAGGED ATOMS. Zool. Zh. 34 (1955) 800-5. (In Russian)

665 Plapp, F.W., Casida, J.E. HYDROLYSIS OF THE ALKYL-PHOSPHATE BOND IN CERTAIN DIALKYL ARYL PHOSPHOROTHIOATE INSECTICIDES BY RATS, COCKROACHES, AND ALKALI. J. econ. Ent. 51, 6 (1958) 800-3.

The nature of the products formed by in vitro and in vivo hydrolysis of Parathion, methyl Parathion, Diazinon, Dow ET-57, Chlorthion, and Dicapthon was studied. All these dialkyl aryl phosphorothioates were hydrolyzed at both the alkyl-phosphate and the aryl-phosphate bonds. Alkyl-phosphate hydrolysis was proportionately greater with the dimethyl than with the diethyl phosphorothioates in rats and under the alkaline conditions employed. Very little alkyl-phosphate hydrolysis occurred with cockroaches with five of the six compounds studied. The lower alkyl-phosphate hydrolysis with cockroaches as compared to rats may contribute to the lower relative toxicity of the dimethyl aryl phosphorothioates to mammals. Differences were also noted in the rate of oxidation of the various hydrolytic metabolites between rats and cockroaches. Six phosphorothioate insecticides (Dow ET-57, Dicapthon, Chlorthion, methyl Parathion, Parathion, and Diazinon) used in the study were synthesized from $P^{32}$ pentasulfide prepared by isotope exchange. Subsequent treatments are described. (from auth.)

## II - E Pyrethrins and related Compounds

666 Acree, F., Jr., Babers, F.H. SEPARATION OF dl-cis FROM dl-trans LABELED AND UNLABELED CHRYSANTHEMUMIC ACID ON PAPER. Science 120 (1954) 948-9.

$C^{14}$-labelled dl-cis, trans-Allethrin has been synthesized. The procedure for a successful paper separation of the dl-cis from the dl-trans chrysanthemumic acid is described. A comparison of the 8 isomeric labelled Allethrins was of interest. Some attempts were made to analyse certain zones of impurities also obtained, but present data do not permit an interpretation of their nature and origin.

667 Acree, F., Jr., Roan, C.C., Babers, F.H. THE SYNTHESIS AND CHROMATOGRAPHIC PURIFICATION OF RADIOACTIVE ALLETHRIN. J. econ. Ent. 47, 6 (1954) 1066-70.

Radioactive Allethrin has been synthesized to facilitate a study of the metabolic fate of toxic esters of chrysanthemumic acid after their application to houseflies and cockroaches. After having been purified by chromatography, the radioactive Allethrin appeared to be approximately 98% pure. (auth. summary)

668 Acree, F., Jr., Babers, F.H. CONTAMINANTS IN RADIOACTIVE ALLETHRIN DETERMINED BY PAPER CHROMATOGRAPHY. A SCIENTIFIC NOTE. J. econ. Ent. 49, 1 (1956) 135.

Traces of five contaminants were found in the reversed-phase chromatogram of $C^{14}$-Allethrin with respect to ammoniacal ethanol: one (A) at $R_f$ 0.0 and a mixture of four (C) at $R_f$ 0.84. This mixture, with respect to ammoniacal isopropyl acetate, consisted of an unknown D at $R_f$ 0.0, both dl-cis and trans-2-$C^{14}$-chrysanthemumic acids, and a mixture at $R_f$ 0.98. The last mixture consisted, with respect to ammoniacal Skellysolve B, of an unknown E at $R_f$ 0.0 and dimerized allethrolone at $R_f$ 0.89. At present, the most logical explanation for the presence of chrysanthemumic acid and dimerized allethrolone is that traces of Allethrin are hydrolyzed during reversed-phase chromatography by the ammoniacal solvent. However, those products may be produced by some other reaction, such as photo-decomposition, because zones A and C also have been observed on chromatograms prepared in the absence of ammonia.

669 Blum, M.S., Kearns, C.W. TEMPERATURE AND THE ACTION OF PYRETHRUM IN THE AMERICAN COCKROACH. J. econ. Ent. 49, 6 (1956) 862-5.

Increased toxicity at lower temperatures has been reported for various insecticides, including pyrethrum. This phenomenon was investigated for a possible correlation between toxicity and penetration, and for the relationship between toxic materials in the blood and symptomatic reaction. Pyrethrin solutions labelled with $C^{14}$ were used. The symptoms of poisoning manifested by pyrethrum-treated cockroaches were correlated with the concentration of a toxin in the hemolymph as determined by bioassay from the duration of paralysis of adults of Sarcophaga crassipalpis Macq. into which 3 or 6 µl blood was injected. Blood from treated cockroaches kept at 15°C was toxic to the flies when the same amount from flies kept at 35°C was not. Absence of radioactivity in the blood of cockroaches treated with $C^{14}$-labelled pyrethrins indicated that the toxin was not a pyrethrin or metabolite. If cockroaches were treated with a high concentration of pyrethrins and became paralyzed almost immediately, the toxicity to flies of blood removed several hours later was about the same as that of blood removed as soon as prostration had occurred. Piperonyl butoxide applied with the pyrethrum extract increased the susceptibility of the cockroach to it at higher temperatures, as indicated by observation of paralysis and by demonstration of the existence of the toxin by bioassay. Analysis showed that the synergist was present in the fat-body and the central nerve cord of the cockroach and absent in the blood. The toxic agent in blood lost almost all its activity when the blood was stored for 3 h at room temperature (26-27°C). (from RAE-B 46:24-25, 1958)

670 Bridges, P.M. ABSORPTION AND METABOLISM OF [$^{14}$C] ALLETHRIN BY THE ADULT HOUSEFLY. Biochem. J. 66, 2 (1957) 316-20.

Allethrin (I) labelled with $C^{14}$ was incubated with enzyme extracts or homogenates or it was injected into adult houseflies. After a metabolism period any unchanged I and its metabolites were extracted, resolved by paper chromatography, and determined radiometrically. A considerable fraction of the I injected into female houseflies was metabolized in a period of 24 h. The proportion of the metabolism occurring in the 1st h of this period was 80%. The net weights of I metabolized by a male lipase extract and a female abdomen homogenate were small and of doubtful significance. Metabolism of I by female thoracic homogenates could not be detected. A sublethal exposure to MeBr inhibited the metabolism of I. There was some evidence that benzaldehyde, a lipase inhibitor, reduced the metabolism of I in vivo at the higher concentrations used. Absorption of topically applied I-$C^{14}$ was rapid during the 1st 5-10 h after application. The fraction of the dose absorbed in 24 h approached unity at lower doses but fell off significantly at higher doses. (CA 51: 16971g, 1957)

671 Earle, N.W. MODE OF ACTION OF PIPERONYL BUTOXIDE AS A SYNERGIST FOR PYRETHRUM. Ph.D. Thesis. Illinois, Univ., Urbana. 1952.

The following insects were used in these experiments: a normal, or non-resistant strain of houseflies, Musca domestica L., a pyrethrum-piperonyl butoxide-resistant strain of houseflies; adult flesh flies, Sarcophaga crassipallus; and adult American cockroaches, Periplaneta americana L. When piperonyl butoxide and Allethrin in the ratio of 1:1 are applied to the housefly there is a resultant slight decrease in the rate of Allethrin penetration and initial lag in knock-down time. $C^{14}$-labelled pyrethrins and cinerins were found useful in this investigation. In general, the various experiments showed that piperonyl butoxide reduces the rate of detoxication of pyrethrins and cinerins in vivo.

672 Hopkins, T.L., Robbins, W.E. THE ABSORPTION, METABOLISM, AND EXCRETION OF $C^{14}$-LABELED ALLETHRIN BY HOUSE FLIES. J. econ. Ent. 50, 5 (1957) 684-7.

The fate of pyrethroid insecticide in female DDT-resistant houseflies (Musca domestica L.) has been studied, using Allethrin labelled with $C^{14}$ on the chrysanthemum monocarboxylic acid moiety. To study the

absorption and excretion of Allethrin or its degradation products quantitatively, a method was devised for attaching house flies in stationary positions throughout the experimental period. Allethrin was rapidly absorbed, metabolized, and excreted. The synergist piperonyl butoxide applied jointly with Allethrin at a 1:1 ratio retarded both absorption and excretion of the labelled insecticide. Almost all the absorbed dose of Allethrin was metabolized by houseflies in 24 h. The bulk of the radioactivity present in the homogenates and excreta behaved as an unknown metabolite, only trace amounts of unchanged Allethrin or free acids being detected. No qualitative differences in the metabolism of Allethrin applied alone or jointly with piperonyl butoxide were found in these experiments. (auth. summary)

673 Levy, L.W., Usubillaga, A. BIOSYNTHESIS OF RADIOACTIVE PYRETHRINS. Bol. Inform. scient. nac., Quito 9, 82 (1957) 42-9.

Young pyrethrum plants having numerous buds were grown for 12 d in an atmosphere containing 68 μc of $C^{14}O_2$/mg total C. The ligroin extract from the flowers was strongly radioactive. (CA 52: 8445a, 1958)

674 Levy, L.W., Usubillaga, A. EXPERIMENTS ON BIOSYNTHESIS OF RADIOACTIVE PYRETHRINS. p. 577-86 in "Radioisotopes and Radiation in the Life Sciences. 2nd Inter-American Symposium on the Peaceful Application of Nuclear Energy, Buenos Aires 1959". TID-7554. Washington, D.C., Pan American Union. 1960.

Pyrethrins are obtained from pyrethrum flowers (Chrysanthemum cinerariaefolium). Although the plants will grow in any part of the world, it has been observed that the flowers contain an appreciable amount of pyrethrins only when cultivated at high altitudes with temperate climates. Pyrethrins are substances of strong insecticidal actions but are completely non-toxic to warm-blooded animals and to man. The use of pyrethrins as insecticides is growing since insects develop no resistance to pyrethrins as they do to synthetic insecticides. The preparation of radioactive pyrethrum extract is reported following exposure of plants to an atmosphere containing carbon dioxide labelled with $C^{14}$. (NSA 13: 8537, 1959)

675 Pellegrini, J.P., Jr., Miller, A.C., Sharpless, R.V. BIOSYNTHESIS OF RADIOACTIVE PYRETHRINS USING $C^{14}O_2$. J. econ. Ent. 45, 3 (1952) 532-6.

A method is described for obtaining radioactive pyrethrins by growing pyrethrum plants (Chrysanthemum cinerariaefolium) for a prolonged period in an atmosphere containing radioactive carbon dioxide ($C^{14}O_2$) and isolating and purifying the pyrethrine from the $C^{14}$-labelled flowers. A mixture of $C^{14}O_2$ and normal carbon dioxide ($C^{12}O_2$) was generated from a mixture of radioactive and normal barium carbonates ($BaC^{14}O_3$ and $BaC^{12}O_3$) and their utilization by the plant described. The method is given in some detail. About 400 mg pure pyrethrins were extracted from the flowers. Tests showed that the pyrethrins had the expected insecticidal activity against houseflies (Musca domestica L.) and cockroaches, and that they were labelled with $C^{14}$ in both alcohol and acid portions of the molecules at levels high enough for qualitative and quantitative determinations. Detailed observations made throughout the work, precautions taken and improvements that could be made in the method are discussed. (from RAE-A 40: 349, 1952)

676 Schmidt, C.H., Dahm, P.A. THE SYNTHESIS OF $C^{14}$-LABELED PIPERONYL BUTOXIDE AND ITS FATE IN THE MADEIRA ROACH. J. econ. Ent. 49, 6 (1956) 729-35.

As an aid to study of the mode of action of piperonyl butoxide, a pyrethrum synergist, radioactive piperonyl butoxide was prepared. A study was made of the absorption and excretion of radioactive piperonyl butoxide after its topical application to the ventral thoracic area of males and females of Leucophaea maderae (F.). About 88% was absorbed in 3 d. About half the radioactivity in the applied dose was recovered from the faeces in 7 d. Paper chromatographic analysis of faecal extracts showed that less than half of the radioactivity was from piperonyl butoxide; the remainder consisted of unidentified, water soluble metabolites. The internal distribution of radioactivity in female cockroaches showed that the brain and thoracic ganglia, fore-gut, and hind-gut and Malpighian tubules contained the greatest amounts of radioactivity per unit weight. Since little radioactivity was found in the other tissues, it is postulated that the nervous tissue, fore-gut, and hind-gut and Malpighian tubules are involved in the breakdown of radioactive piperonyl butoxide in females of L. maderae. (from auth. summary)

(An abstract of this paper was published in Iowa State Coll. J. Sci. 32, 2 (1957) 159-60. See also Bull. ent. Soc. Amer. 2, 3 (1956) 17, abstr. 22)

677 Schmidt, C.H. SYNTHESIS OF RADIOACTIVE PIPERONYL BUTOXIDE AND ITS METABOLISM IN THE MADEIRA ROACH, LEUCOPHAEA MADERAE (F.) Iowa State Coll. J. Sci. 32, 2 (1957) 259-60.

Abstract of doctoral thesis. See also Schmidt and Dahm, 1956.

678 Winteringham, F.P.W. SEPARATION AND DETECTION OF THE PYRETHRIN-TYPE INSECTICIDES AND THEIR DERIVATIVES BY REVERSED PAPER CHROMATOGRAPHY. Science 116 (1952) 452-3.

For the purpose of studying the metabolic fate of $C^{14}$-labelled insecticides of the pyrethrin type a method was applied which separated the esters and their acid and alcohol products of hydrolysis. These had to be separated under conditions unfavourable to their further decomposition after extraction from insect tissue or other, on unidimensional paper chromatograms so that they could be asseyed radiometrically by scanning techniques. The method of reversed phase paper chromatography developed for the separation of bromine analogues of DDT and its derivatives was found to be applicable, with minor modifications.

679 Winteringham, F.P.W., Harrison, A., Bridges, P.M. ABSORPTION AND METABOLISM OF $^{14}C$ PYRETHROIDS BY THE ADULT HOUSEFLY, MUSCA DOMESTICA L., IN VIVO. Biochem. J. 61 (1955) 359-67.

A natural mixture of (biosynthetically) $C^{14}$-labelled pyrethroids were resolved by reversed-phase paper chromatography into chrysanthemic and pyrethric esters, and unidentified non-insecticidal impurities. Allethrin, labelled with $C^{14}$ in the alcohol portion of the molecule, was prepared on the millimole scale at a specific activity of about 60 $\mu c/g$ of pure esters and purified by means of reversed-phase paper chromatography. Allethrin, the natural mixture of pyrethroids, or the chrysanthemic esters separated chromatographically was injected into or applied topically to adult houseflies. After a metabolism period the unchanged esters and their metabolites were extracted, resolved by paper chromatography and determined by radioactivity assay. Significant and comparable fractions of all the applied pyrethroids were metabolized to relatively non-insecticidal substances within 24 h. When the synergist piperonyl cyclonene was applied simultaneously with the pyrethroid, the metabolism was substantially inhibited, but least effectively in the case of Allethrin. Absorption of the pyrethroids applied topically was almost complete within 24 h and was apparently non-selective from an applied mixture of esters. The presence of piperonyl cyclonene invariably retarded absorption in 24 h, presumably by dilution of the pyrethroid on the insect integument. (from auth. summary)

680 Zeid, M.M.I., Dahm, P.A., Hein, R.E., McFarland, R.H. TISSUE DISTRIBUTION, EXCRETION OF $C^{14}O_2$ AND DEGRADATION OF RADIOACTIVE PYRETHRINS ADMINISTERED TO THE AMERICAN COCKROACH. J. econ. Ent. 46 (1953) 324-36.

The tissue distribution and metabolism of $C^{14}$-labelled pyrethrins and cinerins in the American cockroach, Periplaneta americana (L.), were determined in male and female roaches, and the data summarized in tabular form. A rather extensive distribution of the insecticides or their metabolites is implied. A comparison was also made of the conversion of pyrethrins and cinerins to $C^{14}O_2$ following administration to both sexes by several routes. The highest percentage of excreted $C^{14}O_2$ (measured as $BaC^{14}O_3$) occurred after interspiracular perfusion. Results are presented as tables and graphs. A large portion of the radioactive pyrethrins and cinerins may be taken to have undergone hydrolysis in the insect to corresponding keto-alcohols and chrysanthemum acids, plus unchanged esters, and several unidentified metabolites. Eight to 12% of the radioactivity was excreted as $C^{14}O_2$.

(Also published as AECU-2411, Kansas Agricultural experimental Station, 43 p.)

## II - F Nicotine, Carbamates and other Compounds

### Nicotine

681 Bennett, D.R., Tedeschi, R.E., Larson, P.S. STUDIES ON THE FATE OF NICOTINE IN THE BODY. VII. OBSERVATIONS ON THE EXCRETION OF NICOTINE AND ITS METABOLITES BY THE DOG. Arch. int. Pharmacodyn. 98 (1954) 221-7.

Isotopically labelled nicotine was obtained from tobacco plants grown in an atmosphere containing $C^{14}O_2$. The nicotine isolated had a specific activity of 0.187 $\mu c/mg$. After the intravenous injection of 1-10 mg/kg of $C^{14}$-labelled nicotine into dogs, 95% appeared in the urine within 36 h. There appears to be no prolonged storage of nicotine or its metabolites in body tissues. No radioactivity was detected in the expired air.

682 Bowden, K. BIOGENESIS OF NICOTINE. Nature 172 (1953) 768.

DL-Tryptophane, containing $C^{14}$ in the β-position, was fed as its acetate to young tobacco plants via the roots. The leaves became radioactive. The nicotine from the plant was separated from other products. The spots obtained chromatographically were found to exhibit no radioactivity, the results so far obtained lending no support to the theory that the tryptophane molecule in toto is converted into nicotine.

683 Brown, S.A. Byerrum, R.U. THE ORIGIN OF THE METHYL CARBON OF NICOTINE FORMED BY NICOTIANA RUSTICA L. J. Amer. chem. Soc. 74 (1952) 1523-6.

Tracer experiments with $C^{14}$ have established that the methyl carbon of methionine can act as a precursor of the nicotine methyl carbon in intact Nicotiana rustica plants. A lesser incorporation of formate carbon into the methyl group of nicotine was observed. It is considered probable that formate is employed by the plant in the synthesis of labile methyl groups, which then undergo transmethylation to nicotine. (auth.)

684 Byerrum, R.U., Wing, R.E., THE ROLE OF CHOLINE IN SOME METABOLIC REACTIONS OF NICOTIANA RUSTICA. J. biol. Chem. 205 (1953) 637-42.

Tracer studies with $C^{14}$ showed that the methyl carbons of choline can be transferred to give the methyl group of nicotine in N. rustica. The methyl carbons of choline and methionine were donated to nicotine at about the same rate. No phospholipides could be isolated from the growing tobacco plants by the method employed, and it was concluded, therefore, that no significant amount of choline was involved in the synthesis of phospholipides. (auth, summary)

685 Byerrum, R.U., Hamill, R.L., Ball, C.D. INCORPORATION OF GLYCINE INTO NICOTINE FORMED BY TOBACCO PLANTS. Fed. Proc. 13 (1954) 188, abstr. 626.

In order to ascertain the possible metabolic origin of the N-methyl group of nicotine, each of 30 tobacco plants, 3 months old, was fed $1.34 \times 10^{-5}$ moles of glycine labelled with $C^{14}$ in the alpha-carbon and having a radioactivity of $1.0 \times 10^{5}$ cpm. After the desired feeding period, the plants were dried and nicotine isolated from them as the dipicrate. From a group of plants supplied glycine for 10 d nicotine dipicrate having a specific activity of $11.6 \times 10^{3}$ cpm/mM was obtained whereas another group of plants to which glycine was fed for 7 d yielded nicotine dipicrate with a specific activity of $8.5 \times 10^{3}$ cpm/mM. The nicotine from both groups of plants was demethylated using hydriodic acid to discover how much of the radioactivity was in the N-methyl carbon. The methyl iodide formed upon demethylation of the nicotine was reacted with triethylamine to give methyltriethylammonium iodide which was counted for radioactivity. About 75% of the radioactivity of the nicotine from plants fed glycine for 10 d was recovered in the quaternary iodide whereas the nicotine from plants fed glycine for 7 d yielded about 100% of the radioactive carbon on demethylation. Glycine labelled with $C^{14}$ in the carboxyl carbon when fed to tobacco plants under the same conditions did not give rise to radioactive nicotine. (auth)

686 Byerrum, R.U., Ringler, R.L., Hamill, R.L. BIOSYNTHESIS OF THE N-METHYL GROUP OF NICOTINE FROM FORMALDEHYDE AND BETA-CARBON OF SERINE. (abstr.) Fed. Proc. 14 (1955) 188.

Previous studies in our laboratory have indicated that in tobacco plant metabolism an N-methyl group of nicotine may arise by transmethylation from methionine or by reduction of either formate or the alpha-carbon of glycine. In a comparative study it was found that, in one week, the alpha-carbon of glycine was incorporated to a greater extent than any of the other methyl group precursors used. In the present work $C^{14}$ formaldehyde and serine labelled with $C^{14}$ in the beta-position have been administered to tobacco plants in an effort to ascertain other precursors of the nicotine methyl group. Nicotine isolated from plants fed these compounds was radioactive, and demethylation showed that the radioactivity was located almost entirely in the N-methyl group. It was further demonstrated that formaldehyde was incorporated into methyl groups to a greater extent than to alpha-carbon of glycine in one week, whereas the beta-carbon of serine was introduced to a lesser extent. These results suggest that the alpha-carbon of glycine and the beta-carbon of serine may be converted either to formaldehyde or an 'active' formaldehyde which is then reduced to the methyl group of nicotine.

687 Dawson, R.F., Christman, D.R., Anderson, R.C. ALKALOID BIOGENESIS. IV. THE NON-AVAILIBILITY OF NICOTINIC ACID-CARBOXYL-$C^{14}$ AND ITS ETHYL ESTER FOR NICOTINE BIOSYNTHESIS. J. Amer. chem. Soc. 75 (1953) 5114-5.

Nicotinic acid had (elsewhere) been regarded as a possible precursor of the pyridine moiety of the Nicotiana alkaloids. An isotopic test was devised for checking on the availibility of nicotinic acid and its ethyl esters as precursors for nicotine biosynthesis. Carboxyl-labelled nicotinic acid was prepared from 3-bromopyridine,

n-butyllithium and $C^{14}O_2$, giving an activity of 3.59 μc/mg C. Ethyl-$C^{14}$ nicotinate with a radioactivity of about 0.1 μc/mg C was also prepared. Tobacco roots (Nicotiana tabacum, var. Turkish) were grown in culture and in due course given aqueous solutions of the acid or of its ester. A table gives data on nicotine from $C^{14}$ feeding experiments. The negligible activity of the carbonate samples indicates that neither nicotinic acid nor its ethyl ester had been incorporated into nicotine during the culture period. The results are discussed. It appears that whatever the relationship between nicotinic acid and nicotine in the living plant it is confined to the catabolic side of metabolism and is unconcerned with nicotine biosynthesis.

688 Dawson, R.F., Christman, D.R., D'Adamo, A. INTERMEDIATES IN THE BIOSYNTHESIS OF NICOTINE. Plant Physiol. 31, 1 (1956) xxxvii.

Ring-labelled $H^3$ - and $C^{14}$-nicotinic acids were prepared by recoil reactions accompanying neutron bombardment in the Brookhaven pile. These acids were supplied to sterile excised root cultures of Turkish tobacco. The nicotine produced by these cultures contained $C^{14}$ and $H^3$ in significant ranges of specific activity. Degradation experiments demonstrated that the isotopes were confined to the pyridine ring of nicotine. Nicotine is thus produced from nicotinic acid and ornithine (data of Byerrum et al. and of Leete). Specifically labelled nicotinic acids were employed to clarify details of the pathway of nicotinic acid utilization.

(Abstract of paper presented at the meetings of the American Society of Plant Physiologists and the Physiological Section, Botanical Society of America, Univ. of Connecticut, Storrs, Connecticut, 26-30 Aug. 1956)

689 Dawson, R.F., Christman, D.R., Anderson, R.C., Solt, M.L., D'Adamo, A.F., Weiss, U. BIOSYNTHESIS OF THE PYRIDINE RING OF NICOTINE. J. Amer. chem. Soc. 78 (1956) 2498-9.

Ring-labelled T-nicotinic acid and nicotinic acid containing $C^{14}$ in both ring and carboxyl positions were supplied to sterile cultures of excised roots of Turkish tobacco. Substantial amounts of radioactivity were found in the nicotine produced by the roots during their growth. Oxidation of the T-labelled nicotine with $HNO_3$ or $KMnO_4$ indicated an almost complete recovery of the T from the nicotine in the nicotinic acid. Conclusion: the pyridine ring of nicotinic acid is the biosynthetic precursor of the pyridine ring of nicotine and related alkaloids. (CA 50: 11447d, 1956)

690 Dawson, R.F., Christman, D.R., D'Adamo, A., Solt, M.L., Wolf, A.P. THE BIOSYNTHESIS OF NICOTINE FROM ISOTOPICALLY LABELLED NICOTINIC ACIDS. J. Amer. chem. Soc. 82 (1960) 2628-33.

The four specific ring hydrogen-labelled nicotinic acids were prepared and fed to tobacco root cultures in sterile media, then the nicotine produced by the roots was isolated and analysed. Recoil tritium and carbon-14 labelled nicotinic acid were similarly employed. The nicotine from all of these except nicotinic acid-6-t show similar and substantial incorporation into the nicotine. Oxidation of nicotinic acid, obtained from the nicotine, to the corresponding 2- and 6-pyridones indicate that the position of hydrogen label is conserved during the conversion to nicotine. The 6-labelled acid gave less than 10% of the amount of incorporation shown by the other acids, indicating the probability of enzymatic attack on the 6-position of nicotinic acid during its conversion to nicotine by the tobacco roots. The conversion probably does not proceed via oxidation at the 6-position, since both 6-hydroxynicotinic acid-$N^{15}$ and 1-methyl-6-oxy-nicotinamide-2-t failed to be incorporated. The possibility that the acid is incorporated into nicotine via a 1,6-dihydro intermediate is being investigated. Nicotinamide is incorporated to at least as great an extent as is the corresponding labelled acid. (auth.) (NSA 14: 16518, 1960)

691 Dawson, R.F. BIOSYNTHESIS OF THE NICOTIANA ALKALOIDS. Amer. Scient. 48 (1960) 321-40.

The author discusses the tobacco alkaloids, biosynthetic intermediates, the rate stability of alkaloid production and the possible nature of the rate-limiting steps, the dependency of nicotine production rate upon growth rate, and possible botanical correlations. Ring-labelled nicotinic acid ($C^{14}$ and $H^3$) and specifically synthesized nicotinic acid (-2-$H^3$) were supplied to root cultures (Turkish variety and N. glauca), and radioactivity was found to be incorporated to different degrees into nicotine and anabasine. This and other results indicate that nicotine and anabasine, respectively, may be synthesized in the plant from the universal metabolites nicotinic acid and ornithine, and nicotinic acid and lysine. Nicotinic acid may undergo some modification prior to reaction with the corresponding amino acid derivative. There is no indication in these experiments of the nature of the circumstances which compel the plant to synthesize apparently terminal products from such metabolically useful intermediates.

692 Dewey, L.J., Byerrum, R.U., Ball. C.D. THE ORIGIN OF THE METHYL GROUP OF NICOTINE THROUGH TRANSMETHYLATION. J. Amer. chem. Soc. 76, 15 (1954) 3997-9.

A study in which methionine, doubly labelled in the methyl group with $C^{14}$ and deuterium, was administered to intact tobacco plants has established that the methyl group of methionine can give rise to the methyl group of nicotine through transmethylation. (auth.)

693 Dewey, L.J., Byerrum, R.U., Ball, C.D. BIOSYNTHESIS OF THE PYRROLIDINE RING OF NICOTINE. Biochim. biophys. Acta 18 (1955) 141-2.

By the use of ornithine-2-$C^{14}$ it was shown that part of the ornithine (I) is incorporated into the pyrrolidine ring of nicotine (II) in Nicotiana rustica. Approximately half of the II synthesized by plants fed radioactive I was recovered in the nicotinic acid (III) obtained by permanganate oxidation of II. All of the radioactivity in the III was located in the carboxyl group, and none was present in the pyridine ring. Therefore, about half of the $C^{14}$ in the original II was located in the 2-position of the pyrrolidine ring. The remaining half of the radioactivity was somewhere in the 3, 4, and 5 positions of the ring. The $\alpha$-C atom of I is a very inefficient precursor of the N-Me group of II. (CA 49: 16089b, 1955)

694 Ganz, A., Kelsey, F.E., Geiling, E.M.K. BIOSYNTHESIS OF RADIOACTIVE NICOTINE. Bot. Gaz. 113 (1951) 195-203.

Descriptions are given of the incorporation of $C^{14}O_2$ in the tobacco plant and isolation of radioactive nicotine (I). The identity of the extracted and purified compound as nicotine was evidenced by spectrophotometric data, precipitation with silicotungstic acid, solubility in alkali, ether, and acid, and the melting point of the picrate. A spectrophotometric method was developed with readings at 260 mμ. The highest activity of I obtained was 501 000 cpm (0.3503 μc/mg). The value of the specific radioactivity of extracted I per unit of radioactivity administered to the plant is roughly constant when different amounts of radioactivity are given. This value averaged 529 cpm/mg I/μc of $C^{14}$ injected. (CA 46: 4178g, 1952)

695 Ganz, A., Kelsey, F.E., Geiling, E.M.K. EXCRETION AND TISSUE DISTRIBUTION STUDIES ON RADIOACTIVE NICOTINE. J. Pharmacol. 103 (1951) 209-14.

Radioactive nicotine (I) obtained from Nicotiana rustica plants grown in the presence of $C^{14}O_2$ was used. In mice the main excretion route of I is via the urine and approximately 50% of the radioactivity is recovered in the urine within 6 h after injection. The liver showed the highest radioactivity of the tissues examined. No radioactivity was found in the expired air; this indicates no metabolic breakdown of I to $CO_2$. In rats the urinary excretion of I begins almost immediately after injection; about 40% is excreted in 3 h, 85% in 6 h, and practically all in 16 h. When the isolated guinea-pig is perfused with a radioactive I solution an appreciable uptake of I occurs only during the initial period of heart block. Almost all of the radioactivity taken up by the heart is released during subsequent perfusion with fresh Ringer-Locke solution. No appreciable amount of I is metabolized by the heart tissue. (CA 46: 184c, 1952)

696 Larson, P.S., Harlow, E.S. SOME CURRENT APPLICATIONS OF CARBON-14 TO ANIMAL AND HUMAN PHYSIOLOGICAL RESEARCH: STUDIES WITH TOBACCO AND ITS CONSTITUENTS. p. 62-78 in "Proceedings of the International Conference on Radioisotopes in Scientific Research, Paris, Sep. 1957", Vol. 3. Exterman, R.C., ed. 1958.

Greenhouse preparation of randomly labelled plant materials through photosynthesis in an atmosphere containing $C^{14}O_2$ is described. Some aspects of the metabolism of nicotine in the body were studied.

697 Leete, E. BIOGENESIS OF NICOTINE. Chem. and Industry (Rev.) (1955) 537.

Ornithine (I) has been shown to be an indirect precursor of nicotine (II). DL-I($\alpha$-$C^{14}$) was administered to Nicotiana tabacum and the II, purified by distillation and conversion to the diperchlorate, had only one-half the original activity. The MeI evolved by demethylation of a portion of the II, isolated as $Et_3$MeNI, was inactive. The activity was shown to be in the $\alpha$-carbon of the pyrrolidine ring by oxidation of the II perchlorate and decarboxylation of the nicotine acid to give $CO_2$ containing one-fourth of the original activity. A scheme is suggested for the biogenesis of II. (CA 50: 439c, 1956)

698 Leete, E. THE BIOGENESIS OF NICOTINE AND ANABASINE. J. Amer. chem. Soc. 78 (1956) 3520-3.

The metabolism of lysine-2-$C^{14}$ in nicotine-producing Nicotiana tabacum and in anabasine-producing Nicotiana glauca has been studied. The nicotine isolated from the plant was inactive, but the anabasine was radioactive. Systematic degradation of the anabasine (2-(3-pyridyl)-piperidine) indicated that all the radioactivity resided in the α-carbon atom of the piperidine ring attached to the pyridine ring. The significance of these results is discussed. (auth.)

699 Leete, E., Siegfried, K.J. THE BIOGENESIS OF NICOTINE. III. FURTHER OBSERVATIONS ON THE INCORPORATION OF ORNITHINE INTO THE PYRROLIDINE RING. J. Amer. chem. Soc. 79 (1957) 4529-31.

Radioactive nicotine was isolated from two groups of Nicotiana tabacum plants, which were harvested one and three weeks after the administration of equal counts of ornithine-2-$C^{14}$. The nicotine from the two experiments had almost the same specific activity, indicating that little or no metabolic breakdown of nicotine had occurred during the last two weeks of the second experiment. The nicotine from both experiments was degraded unambiguously and all the activity in the alkaloid was shown to be equally divided between the two α-carbons of the pyrrolidine ring. (auth.)

700 Leete, E. BIOGENESIS OF NICOTINE. V. NEW PRECURSORS OF THE PYRROLIDINE RING. J. Amer. chem. Soc. 80 (1958) 2162-4.

Nicotiana tabacum plants were grown for varying lengths of time up to 9 weeks after feeding ornithine-2-$C^{14}$ to the roots of the plant. The activity of the nicotine reached a maximum after 3 weeks and then slowly decreased. When glutamic acid-2-$C^{14}$, uniformly labelled proline-$C^{14}$, and putrescine-1,4-$C^{14}$ were fed to the plant, radioactive nicotine was obtained in each case. Degradation of the nicotine from these experiments showed that all the activity occurred in the pyrrolidine ring. Under similar conditions the incorporation of ornithine, putrescine, proline, and glutamic acid into nicotine was 0.48, 0.12, 0.032, and 0.0078%, respectively. The significance of the results is discussed. (CA 52: 13022a, 1958)

701 Toczko, K. BIOSYNTHESIS AND DEGRADATION OF NICOTINE. UCRL-tr.-626, 17p. tr. from Postepy Biochem. No. 6 (1960) 43-58. (In Polish)

Isolated root cultures of tobacco were fed with compounds labelled with $C^{14}$. Chemical transformations involved in the biosynthesis and degradation of nicotine were studied. Reaction mechanisms are discussed. Results are compared with those previously reported. (NSA 15: 5891, 1961)

## Carbamates

702 Baldwin, R.E., Freed, V.H., Fang, S.C. ABSORPTION AND TRANSLOCATION OF CARBON-14 APPLIED AS O-ISOPROPYL-N-PHENYL CARBAMATE IN AVENA AND ZEA. J. agric. Food Chem. 2 (1954) 428-30.

The compound was absorbed through the cut surface of leaves, cutsurfaces of roots, and intact roots (in descending order of absorption rate). Intact leaf surfaces did not absorb it in appreciable amounts. The absorption through roots was greater in corn plants than in oat plants. (CA 48: 7708b, 1954)

703 Eldefrawi, M.E., Hoskins, W.M. THE METABOLISM OF $C^{14}$-SEVIN BY SUSCEPTIBLE AND PARATHION-RESISTANT HOUSE FLIES. Bull. ent. Soc. Amer. 5, 3 (1959) 123, abstr. 119.

Topical application of $C^{14}$-Sevin results in rapid absorption and excretion. By use of paper chromatography and paper electrophoresis, at least three metabolites are demonstrated in both tissues and excreta after four hours. Susceptible and resistant strains show differences in amount and proportion of the metabolites.

704 Eldefrawi, M.E. ABSORPTION AND METABOLISM OF $C^{14}$-SEVIN BY THE SUSCEPTIBLE AND RESISTANT HOUSE FLY, THE GERMAN COCKROACH, AND THE MILKWEED BUG AND THE INHIBITORY EFFECT OF SYNERGIST. Doctoral Thesis. California, Univ., Berkeley. 1960.

705 Fang, S.C., Theisen, P. UPTAKE OF RADIOACTIVE ETHYL-N, N-di-n-PROPYLTHIO CARBAMATE (EPTC-$S^{35}$) AND TRANSLOCATION OF SULFUR-35 IN VARIOUS CROPS. J. agric. Food Chem. 8, 4 (1960) 295-8.

A study of the absorption of radioactive EPTC by crops in pre-emergence application indicated an uptake of this chemical from soil. By use of a radioautographic technique the differences in accumulation patterns of $S^{35}$ from EPTC-$S^{35}$ among crops were demonstrated; above-ground portions of beans, peas, and corn

contained slightly more sulfur-35 than the roots, while above-ground portions of radishes, carrots, and other plants contained 70 to 94% of the $S^{35}$ from the absorbed EPTC-$S^{35}$. Total absorption by individual crops at various stages of growth was determined. Generally, an increase in applied EPTC-$S^{35}$ increased absorption, but not in proportion to the increase in the rate of application. (auth.)

706 Skraba, W.J., Young, F.G. RADIOACTIVE SEVIN (1-NAPHTHYL-1-CARBON-14 N-METHYLCARBAMATE), A CONVENIENT SYNTHESIS. J. agric. Food Chem. 7, 9 (1959) 612-3.

The commercial introduction of Sevin as a broad spectrum insecticide of low mammalian toxicity has created interest in the study of the mechanism of its insecticidal action and its metabolism in insects. A convenient synthesis of $C^{14}$-labelled material is described to provide a tool for these studies at normal dose levels. (auth.)

## Other Compounds

707 Fleischer, M.L., King, R.C., Harnly, M.H. THE EFFECT OF 2,4 DINITROPHENOL UPON THE UPTAKE, LOCALIZATION AND TURNOVER OF $P^{32}$ IN ADULT DROSOPHILA PSEUDOOBSCURA FEMALES. Genetics 42 (1957) 369.

Newly emerged flies were placed on standard corn meal-molasses food to which tracer amounts of $P^{32}$ and 2,4 dinitrophenol (0.0001 M, 0.0005 M and 0.001 M) were added. Females were dissected after varying intervals; the amount of $P^{32}$ taken up by various tissues was determined. Initially, most of the phosphorus is found in the gut and haemolymph; later, the ovaries and thorax have the highest percentage. Although females fed 0.0005 M and 0.001 M DNP incorporate less phosphorus, the distribution of phosphorus within the body appears normal if ovarian growth is comparable to that of the controls. However, ovaries from flies fed DNP seem to mature more slowly than ovaries from controls. Upon being removed to unlabelled food, control females excrete phosphorus more rapidly. Thus, it is concluded that both phosphorus uptake and turnover are reduced in the presence of 0.0005 M and 0.001 M DNP.

(Abstract of paper presented at the 1957 meetings of the Genetics Society of America, Stanford, California, 26-28 Aug. 1957)

708 Levy, L.W., Munoz, R.A. BIOSYNTHESIS OF RADIOACTIVE ROTENONE. p. 225-8 in "Radioisotopes and Radiation in the Life Sciences. 2nd Inter-American Symposium on the Peaceful Application of Nuclear Energy, Buenos Aires 1959". TID-7554. Washington, D.C., Pan American Union. 1960.

Acetate labelled with $C^{14}$ in position one ($CH_3C^{14}OONa$), two ($C^{14}H_3COONa$) and in both was used as precursor of Rotenone. It could be shown that both carbon atoms are incorporated in Rotenone in barbasco plants, that the acetate can be administered by means of foliar absorption, and that the method described is an easy way of preparing radioactive Rotenone.

709 Sacks, J., Marott Sinex, F. THE EFFECT OF 2,4-DINITROPHENOL ON THE TURNOVER OF THE ACID-SOLUBLE PHOSPHORUS OF RAT DIAPHRAGM. Arch. Biochem. Biophys. 39 (1952) 205-13.

The effects of dinitrophenol (DNP) on phosphorylation have been studied in the isolated rat diaphragm. Three concentrations of DNP were used: one which stimulated respiration, a higher one which gave initial stimulation followed by depression, and a still higher one which gave principally profound depression. With all concentrations of DNP phosphocreatine was completely hydrolyzed and the concentration of adenosine triphosphate (ATP) was reduced markedly. The concentration of hexose monophosphate (HMP) was reduced when respiration was depressed. The turnover rate of ATP was not affected by a concentration of DNP which stimulated respiration, but was decreased by the higher concentrations which depressed respiration. The turnover of HMP was increased by the stimulating concentration and not reduced below the control level by the higher concentrations of DNP. This suggests that there are pathways for the formation of HMP in the intact cell which are resistant to DNP and therefore different from those found in particulate fractions. $P^{32}$ was used as tracer element throughout. (from auth.)

710 Turrell, F.M. PHYSIOLOGICAL EFFECTS OF ELEMENTAL SULFUR DUST ON CITRUS FRUITS. Plant Physiol. 25 (1950) 13-62.

Rate of volatilization of elemental S increased logarithmically with temperature. $S^{35}$ dusted on lemon fruit penetrated the peel to a depth of 340 μ when the fruit was incubated 6 h at 15.6°C. The release of gases, and specifically of $H_2S$ and $SO_2$ under different conditions (aerobic, anaerobic, while incubated at different temperatures) is discussed. Catalase of the peel was inactivated by dust treatment and incubation. S-dusted fruits in comparison with non-dusted had higher $SO_4^-$ in the peel and sap; there was more $SO_4^-$ in the peel of fruits burned on the tree; there was more on the burned side than on the unburned.

(For detailed abstract, see CA 44: 3649b, 1950)

711 Turrell, F.M., Chervenak, M.B. METABOLIC PRODUCTS OF ELEMENTAL SULFUR 35 APPLIED TO LEMONS AS AN INSECTICIDE. Advanc. Chem. Ser. 1 (1959) 250-9.

When lemon fruit is dusted with sulfur containing $S^{35}$ and incubated (41.1°C for 68 h), a large proportion of the S in the $H_2S$ formed is derived from the S applied. The sulfate formed in the fruit peel can also be derived similarly provided large amounts of S are applied, whereas the $SO_2$ formed is derived largely from a source within the plant. Elemental S-vapour penetrates lemons producing compounds similar to those produced by topical dust. The quantity of S-products formed is influenced by the area of the S-layer from which vaporization occurs and the duration of the exposure at 41.1°C. Radioautographs of the peel of dusted lemons suggest that the S has been incorporated into the tissue proteins.

712 Wilson, L.P., King, R.C. STUDIES WITH RADIOPHOSPHORUS IN DROSOPHILA. VI. THE EFFECT OF DNP ON PHOSPHORUS INCORPORATION BY ADULT DROSOPHILA MELANOGASTER. J. exp. Zool. 130 (1955) 341-52.

A study was made of the effect of dinitrophenol upon viability, growth, and phosphorus incorporation by adult Drosophila melanogaster. Results are tabulated and presented graphically. Data are included on normal phosphorus metabolism in Drosophila. Adult females were found less susceptible to toxic effects of 0.001 M DNP than males. The minimum value for the ingested amount of DNP toxic to male and female flies is $1 \times 10^{-4}$ mg DNP/mg wet weight fly. DNP reduces the rate at which exogenous P is incorporated into male and female flies; the reduction is more marked in females. The general action of DNP in females is to reduce the rate at which exogenous phosphorus is incorporated into the haemolymph, thorax, head, legs, gut, Malpighian tubes, wings, and abdominal residue. DNP acts specifically on the ovary to completely block exogenous phosphorus uptake after an exogenous P-concentration 30% the control value is reached. Cessation of P incorporation is accompanied by a cessation of ovarian growth, which partially accounts for the fact that DNP-treated females do not increase in weight at the control rate. Per unit weight the ovary of control females incorporates 1.7 times as much exogenous phosphorus as the testis of control males in a 30 h period. Per unit weight there is no sexual dimorphism in exogenous P incorporation by control heads and thoraxes. It was found that over a wide range of incorporated exogenous P-concentrations 75 - 80% of the phosphorus entering the haemolymph is withdrawn rapidly by the various tissues. (from BA 30: 28374, 1959)

## II - G Repellents

### Diethyltoluamide

713 Bar-Zeev, M., Schmidt, C.H. ACTION OF A REPELLENT AS INDICATED BY A RADIOACTIVE TRACER. J. econ. Ent. 52, 2 (1958) 268-9.

$P^{32}$-phosphoric acid was used as a tracer in experiments with Aëdes aegypti (L.) feeding through a membrane on citrated blood. When diethyltoluamide was present in the blood at a concentration that prevented the mosquitoes from engorging, the mosquitoes barely touched the membrane and did not insert their proboscises into the blood. When the concentration was lowered to one that allowed about half the mosquitoes to become engorged, those that did not feed spent slightly more time in contact with the membrane, and about a third of them inserted their proboscises into the blood but did not imbibe. It was concluded that most of the repellency was due to vapour action, but at a low concentration contact chemoreceptors on the labella may have been involved. (auth.)

714 Green, N. SYNTHESIS OF CARBOXY-LABELED $C^{14}$-N, N-DIETHYL-m-TOLUAMIDE, AN INSECT REPELLENT. J. econ. Ent. 51, 5 (1958) 707-10.

For studies of the various properties of N, N-diethyl-m-toluamide, an outstanding all-purpose insect repellent, this compound was prepared in radioactive form. The molecule was labelled in the carboxy position by carbonating m-toluene magnesium bromide with $C^{14}O_2$ to give $C^{14}$-m-toluic acid. The m-toluic acid chloride was then combined with diethyltoluamide to give the final product, of which the specific activity was $5.7 \times 10^7$ disintegrations per second per gram. (auth.)

715 Schmidt, C.H., Acree, F., Jr., Bowman, M.C. FATE OF $C^{14}$-DIETHYLTOLUAMIDE APPLIED TO GUINEA PIGS. J. econ. Ent. 52, 5 (1959) 928-30.

Little information is available as to why certain compounds act as insect repellents, and why they are effective for such short periods of time. Diethyltoluamide labelled with $C^{14}$ was applied to the skin of guinea pigs at 6.97 - 7.11 mg/in$^2$. After 6 h 0.96 - 0.98 mg/in$^2$ had been lost by evaporation and 1.32 - 3.40 mg/in$^2$ by absorption. The remaining repellent was removed. The radioactivity in the urine reached a peak within 12 h after application, and over 80% of the absorbed dose was excreted in 24 h. However, diethyltoluamide as such was not found in the urine. Only 0.75% of the absorbed dose was excreted in the faeces during 8 d, whereas 93% appeared in the urine. Very small amounts of radioactivity were found in the blood, skin, and hair. (from auth.)

(An abstract of earlier work was published in Bull. ent. Soc. Amer. 4, 3 (1958) 95, abstr. 188)

### Dimethyl Phthalate

716 Barker, D.Y., Christian, J.E. THE SYNTHESIS OF CARBON$^{14}$-CARBONYL LABELED DIMETHYL PHTHALATE. J. Amer. pharm. Ass., Sci. Ed. 44 (1955) 105-7.

$C^{14}$-labelled dimethyl phthalate was prepared by treating o-$MeC_6H_4MgBr$ with $C^{14}O_2$ (obtained from $BaC^{14}O_3$), oxidizing the resulting o-toluic acid to phthalic acid, and esterifying by the acid chloride. The over-all yield, calculated on $BaC^{14}O_3$, was 80.4%. (CA 49: 7195c, 1955)

717 Gerding, P.W., Sperandio, G.J., Christian, J.E. THE RETENTION OF AN INSECT REPELLENT IN EMULSIFIED BASES AT THE SITE OF APPLICATION. J. Amer. pharm. Ass., Sci. Ed. 44 (1955) 574-7.

The retention of NaI, MeI, and dimethyl phthalate (I) on the skin in various ointment bases was studied under 3 experimental conditions (normal, exposure to a fine spray of $H_2O$, and conditions of sensible perspiration) with radioactive tracer techniques. Under normal conditions, an oil/water base gave better retention for NaI and MeI than a water/oil base, but the reverse held true when the bases were subjected to fine $H_2O$ sprayings. Under conditions of perspiration, NaI was retained well in water/oil base but MeI was retained better in the oil/water base. A water/oil emulsion containing 40% I provided better retention under all conditions. On the basis of the data obtained, an improved cream for I containing 15% of acetostearin was evaluated and found superior to 7 other bases. (CA 49: 16310i, 1955)

## II - H Insecticide Metabolism in

### II-H-1 INSECTS

#### Surveys

718 Brown, A.W.A. MECHANISM OF RESISTANCE AGAINST INSECTICIDES. Annu. Rev. Ent. 5 (1960) 301-26.

Review article dealing with resistance to DDT, Prolan, Dieldrin, BHC, organophosphorus insecticides, pyrethrin, cyanide, and arsenic. 229 references. Work with radioisotopes is included but not emphasized.

719 Casida, J.E. THE METABOLISM OF INSECTICIDES BY INSECTS. p. 216-36 (disc. p. 236-8) in "Proceedings of the 4th International Congress on Biochemistry, Vienna 1958", Vol. 12. Levenbock, L., ed. London, Pergamon Press. 1959.

After sketching the main lines of interest in insecticide research, the author considers general detoxication mechanisms. A section on chlorinated hydrocarbons is divided into DDT metabolism in houseflies, DDT-dehydrochlorinase of resistant houseflies, synergists for DDT-resistant flies, DDT metabolism in insects other than houseflies, hexachlorocyclohexane (BHC) metabolism in houseflies, and insect metabolism of cyclodiene insecticides. A shorter section deals with pyrethroids and miscellaneous insecticides. Organophosphorus insecticides are discussed in terms of their oxidation reactions, reactions other than oxidation and phosphoryl or alkyl phosphate hydrolysis, phosphoryl and alkyl phosphate hydrolysis, their selectivity in relation to the metabolism of organophosphorus insecticides and acquired resistance to them. Relevant work with radioisotopes is cited throughout.

720 Fay, R.W. USE OF RADIOACTIVE COMPOUNDS IN THE STUDY OF INSECTICIDE METABOLISM. Annu. Mtg. Amer. Ass. chem. Specialities Mfrs. 43 (1957) 153-5.

Some of the advances in insecticide metabolism studies that have occurred through the use of radioactively tagged insecticides, e.g., DDT, are reviewed. The advantages of such methods as well as the limitations are indicated. (18 references).

721 Kearns, C.W. BIOCHEMICAL ASPECTS OF RESISTANCE. p. 113-7 in "Research Progress on Insect Resistance, Symposium", Vol. 2, No. 1. College Park, Md., Entomological Society of America. 1959, 175p.

A review of recent advances in the biochemistry of the action of toxicants in insects and of their enzymatic detoxification, and of knowledge gained concerning the metabolism of both resistant and susceptible insects.

722 Metcalf, R.L. PHYSIOLOGICAL BASIS FOR INSECT RESISTANCE TO INSECTICIDES. Physiol. Rev. 35 (1955) 197-232.

A general survey paper, with some mention of how the use of radioisotopes in specific cases has given new insight into some of the problems involved.

* Metcalf 1960 - [413]

* O'Brien 1959 - [509]

* Perry 1958 - [430]

* Perry 1960 - [431]

723 Perry, A.S. METABOLISM OF INSECTICIDES BY VARIOUS INSECT SPECIES. J. agric. Food Chem. 8, 4 (1960) 266-72.

Review article with 78 references. Most chlorinated hydrocarbon insecticides and many organophosphorus compounds are metabolized by insect species, the metabolic processes which bring about these chemical changes being classifiable as "activating" and "detoxifying". Activating mechanisms usually involve epoxidation reactions, such as conversion of heptachlor to heptachlor epoxide and Aldrin to Dieldrin; or oxidation reactions, such as conversion of thionophosphates to phosphates, oxidation of thiol ethers to sulfoxides and sulfones, and oxidation of phosphoramides to more potent cholinesterase inhibitors. Detoxifying processes may convert insecticide to nontoxic metabolites, which are retained in the tissues or rapidly excreted. Detoxication of organophosphorus compounds in most cases involves hydrolytic reactions. The type of change is dependent on the chemical structure of the compound and the insect species - DDT is metabolized by the housefly, body louse, certain mosquitoes, American roach, Mexican bean beetle, boll weevil, milkweed bug, fruit fly, etc., - but this process follows four or five metabolic pathways. Many of these reactions are enzymatically catalyzed. Work with radioisotopes is discussed in connection with $C^{14}$, $Cl^{36}$- and $S^{35}$-labelled Dieldrin, a $Br^{82}$ analogue of Dieldrin, $C^{14}$-labelled Isodrin, Pyrethrins, Allethrin and labelled $\alpha$-, $\beta$- and $\delta$-BHC, and $P^{32}$-labelled Malathion, Dipterex, DDVP and Delnav.

* Winteringham and Barnes 1955 - [433]

724 Winteringham, F.P.W. COMPARATIVE BIOCHEMICAL ASPECTS OF INSECTICIDAL ACTION. Chem. and Industry (Rev.) 36 (1957) 1195-1202.

The complexity of selective insecticidal action and biochemical selectivity is reviewed. Glycolysis, oxidative and amino acid metabolism in insects and mammals, the metabolism of acetate (traced in the insect by the injection of acetate-2-$C^{14}$), and the chemical identity of the metabolites are discussed. In considering the biochemical differences between insects and mammals, variations in enzyme vulnerability under different conditions must be taken into account (e.g., insect enzymes at different stages of insect development). Resistance, physiological differences between insects and mammals, and comparative mechanisms of insecticidal action are discussed.

725 Winteringham, F.P.W. BIOCHEMICAL MECHANISMS OF INSECT RESISTANCE. WHO/Insecticides/76 (1958) 92-106.

(Presented at the Seminar on "The Resistance of Insects to Insecticides" New Delhi, India Feb. 27-March 7, 1958)

Review article. The author discusses indentification of the resistance mechanism (reduced uptake or absorption of the insecticide, detoxication or excretion of the insecticide so that the rate of arrival at the sites of action is below the tolerance threshold, abnormal biochemistry or physiology at the sites of action) and possible countermeasures based on biochemical studies. (52 references, including numerous refs. on application of radioisotopes)

Aldrin and Dieldrin

* Chang and Kearns 1959 - [434]

* Winteringham and Harrison 1959 - [436],[437]

Bayer 22408

726 Boyd, N.R., Jr., Arthur, B.W. BIOLOGICAL DEGRADATION OF O,O-DIETHYL O-NAPHTHALIMIDO PHOSPHOROTHIOATE (BAYER 22408). J. econ. Ent. 53 (1960) 848-53.

$P^{32}$-labelled Bayer 22408 (O,O-diethyl O-naphthalimido phosphorothioate) was converted to the oxygen analogue, O-ethyl phosphoric, O,O-diethyl phosphoric, O,O-diethyl phosphorothioic acid and at least three other metabolites by rats, several species of insects, and cotton plants. Differences in the degradation of Bayer 22408 by the three biological systems were not the result of the number of metabolites but of the amount of each metabolite formed. Bayer 22408 was stable in insects and most of the absorbed material was recovered as administered; the oxygen analogue was formed to a limited extent. Rats degraded Bayer 22408 rapidly to water-soluble phosphoric acids, which were eliminated primarily in the urine. Some Bayer 22408 escaped degradation and was eliminated intact in the feces. Bayer 22408 was not effective as an animal systemic against several ectoparasites feeding on treated rabbits. Bayer 22408 was quite stable on the foliage of cotton plants but was not translocated to untreated portions of plants. (auth.)

BHC

* Bradbury et al. 1953 - [440]

* Bradbury and Standen 1955 - [441]

* " " 1956 - [442],[443]

* Bradbury 1957 - [439]

* Bradbury and Standen 1958 - [444]

* " " 1958 - [445]

* Bridges 1959 - [448]

* Perlowagora-Szumlewica 1953 - [456]

Chlorobenzene

* Gessner and Smith 1960 - [457],[458]

* Kikal and Smith 1958 - [459]

Co-Ral

* Vickery and Arthur 1960 - [519]

Delnav

* Arthur and Casida 1959 - [520]

Diazinon

* Krueger et al. 1960 - [541]

DFP

* Iyatomi et al. 1957 - [527]

727 Winteringham, F.P.W., Harrison, A., McKay, M.A., Weatherley, A. BIOCHEMISTRY OF DIISOPROPYL-PHOSPHOROFLUORIDATE POISONING IN THE ADULT HOUSEFLY. Biochem. J. 66 (1957) 49P-50P.

A considerable reduction in the rate of [$C^{14}$] acetylation of choline by the insect in vivo as the result of DFP is reported. The stimulated respiration and glutamine accumulation indicate possibly fatal biochemical lesions in addition to that of cholinesterase inhibition in the DFP-poisoned insect. This view is supported by the fact that massive doses of pyridine-2-aldoxime methiodide (PAM) failed to protect the DFP-treated fly from the stimulated respiration and some delayed lethal effect, although it protected the insect from the typical paralysis. The same dose of PAM alone did not have toxic effects on the insect. It is a potent reactivator of inhibited mammalian cholinesterase in vitro and in vivo, and will protect mammals from otherwise lethal doses of DFP.

DDT

* Butts et al. 1953 - [464]

* Gjullin et al. 1952 - [466]

* Hagley and Morrison 1958 - [467]

* Hoffman et al. 1951 - [469]

* " 1952 - [470]

* Hoskins and Witt 1958 - [471]

* LeRoux and Morrison 1954 - [474], [475]

* Lindquist et al. 1951 - [478], [479]

* Lindquist and Dahm 1956 - [477]

* Morrison and LeRoux 1954 - [482]

* Perry et al. 1955 - [485]

* Perry and Buckner 1958 - [486]

* Robbins and Dahm 1955 - [487]

* Roth and Lindquist 1953 - [488]

* Schmidt and Weidhaas 1959 - [490]

728 Terriere, L.C., Schonbrod, R.D. THE EXCRETION OF RADIOACTIVE METABOLITE BY HOUSE FLIES TREATED WITH CARBON$^{14}$ LABELED DDT. J. econ. Ent. 48, 6 (1955) 736-9.

The study was aimed at investigating the fate of DDT in resistant and susceptible flies. The observations of previous authors concerning the production of a metabolite other than DDE have been confirmed. Resistant and susceptible houseflies have been examined for evidence of metabolism of DDT up to 14 days after treatment with radioactive insecticide. Susceptible flies, given sublethal doses, have been shown to excrete up to 88% of the dose in the form of a water-soluble conjugate. Resistant flies show a similar detoxification and excretion capacity. The excretion begins during the first day after treatment and appears to continue until all of the absorbed dose has been metabolized. The conjugate is hydrolyzable with acid to produce a compound weakly acidic in nature. Attempts to identify this compound have met with no success although several possible structures have been eliminated.

* Weidhaas and Schmidt 1960 - [491]

* Weidhaas et al. 1960 - [492]

* Winteringham et al. 1951 - [493]

* Winteringham 1952 - [494]

Dipterex

* Acree et al. 1956 - [554]

* Arthur and Casida 1957 - [555]

* Arthur and Casida 1958 - [556]

* Metcalf et al. 1959 - [557]

DNP

* Fleischer et al. 1957 - [707]

Endrin & Isodrin

* Brooks 1960 - [498]

Fumigants

729 Winteringham, F.P.W., Hellyer, G.C. EFFECTS OF METHYL BROMIDE, ETHYLENE DIBROMIDE, AND ETHYLENE DICHLORIDE ON THE PHOSPHORUS METABOLISM OF MUSCA DOMESTICA L. Biochem. J. 58 (1954) xlv-xlvi.

A comparison was made of the effects of methyl bromide, ethylene dibromide, and ethylene dichloride on $P^{32}$-labelled intermediates extracted from the thoracic muscles of houseflies. The slow depletion of phosphoglycerate by the first two chemicals suggested a common inhibition of triose phosphate dehydrogenase; they thus resembled iodoacetate in their action. Depletion of ATP and arginine phosphoric acid by methyl bromide indicated a rapid blocking of the phosphorylation of nucleotide acceptors.

730 Winteringham, F.P.W., Hellyer, G.C., McKay, M.A. EFFECTS OF METHYL BROMIDE ON PHOSPHORUS METABOLISM IN THE ADULT HOUSEFLY. Biochem. J. 69 (1958) 640-8.

A quantitative study is described (see preliminary communication by Winteringham and Hellyer, 1954). Techniques described earlier (Winteringham, Bridges and Hellyer, 1955) were used with only minor modifications for $P^{32}$-labelling of the soluble intermediates of the adult insect in vivo, and for their extraction. The paper-radiochromatographic techniques used were also very similar to the previous ones. The chemical identity of the labelled fractions is discussed, and details are given of the ages and conditions of the insects used, and of their treatment. Tabulated data are presented on the distribution of soluble phosphorus in tissues of the adult insect; the effects of methyl bromide on the distribution of soluble P..., in vivo; of the effects of ethylene dichloride vapour and injected iodoacetic acid on the distribution of soluble P..., in vivo, and of the effect of methyl bromide on tissue nucleotides of the adult housefly in vivo. The significance of the results are discussed, particularly with regard to changes in ATP-levels.

Malathion

* Darrow and Plapp 1960 - [563]

* March et al. 1956 - [567]

* Mengle et al. 1959 - [568]

* Krueger and O'Brien 1959 - [565]

* Krueger and O'Brien 1959 - [566]

Paraoxon

731 Mengle, D.C., Lewallen, L.L. METABOLISM OF $P^{32}$-LABELED PARAOXON IN NORMAL AND PHOSPHATE-RESISTANT STRAINS OF THE MOSQUITO AEDES NIGROMACULIS LUDLOW. Bull. ent. Soc. Amer. 6, 3 (1960) 153, abstr. 72.

The nature and quantity of hydrolysis products were determined following administration of Paraoxon to mosquito larvae. Chromatographic results indicate differences in detoxification rate between the resistant and normal strains. Additional studies were made with $P^{32}$-labelled material attempting to correlate resistance with rate of hydrolysis.

Parathion

* Gar et al. 1954 - [573]

* Lockau et al. 1951 - [581]

* Lockau and Lüdicke 1952 - [582]

* Tomizawa et al. 1960 - [588]

Phorate

* Bowman and Casida 1958 - [590], [591]

Pyrethrins

* Blum and Kearns 1956 - [669]

* Bridges 1957 - [670]

* Earle 1952 - [671]

* Hopkins and Robbins 1957 - [672]

* Pellegrini et al. 1952 - [675]

* Schmidt and Dahm 1956 - [676]

* Winteringham 1952 - [678]

* Winteringham et al. 1955 - [679]

* Zeid et al. 1953 - [680]

Ronnel

* Hopkins 1960 - [599]

* Louloudes 1958 - [600]

Schradan

* Arthur and Casida 1958 - [604]

* David 1950 - [609]

* David 1951 - [750]

* Metcalf and March 1953 - [626]

* Pietri-Tonelli and March 1954 - [626]

Sevin

* Eldefrawi 1960 - [740]

Systox

732 Ahmed, M.K., Newsom, L.D., Emerson, R.B., Roussel, J.S. THE EFFECT OF SYSTOX ON SOME COMMON PREDATORS OF THE COTTON APHID. J. econ. Ent. 47, 3 (1954) 445-9.

Aphids which had been rendered moribund were supplied twice a day for a week as food to the predators in petri dishes. The predators tested were the Syrphids, Baccha clavata (F.), Metasyrphus wiedemanni (Johnson) and Allograpta obliqua (Say), the Coccinellids, Scymnus haemorrhous Lec., S. creperus Muls., Hippodamia convergens (Guér.), Ceratomegilla (Coelomegilla) maculata (Deg.) and Cycloneda sanguinea (L.), and the Chrysopids, Chrysopa rufilabris Burm. and C. oculata Say; larvae of all these species and adults of the Coccinellids were used and mortality counts were made daily. The different susceptibilities shown by the results are discussed. In some of the tests, Systox prepared from radioactive sulphur ($S^{35}$) was used, and the predators were dried, ground and assessed for radioactivity. The radioactive material apparently accumulated in the bodies of the larvae, since third- and fifth-instar individuals that survived treatment showed 4.26 and 7.29 cpm/mg, as compared with 22.8 and 15.32 for those that were killed, respectively. Adults of H. convergens showed much less radioactivity than larvae when both fed on radioactive aphids, and adults that developed from such larvae showed less than the prepupae; the cast pupal skin showed much more than either. Larvae of Chrysopa oculata that fed for 8 d showed 1.54 cpm/kg, but survived.

* David 1957 - [632]

* Elderfrawi and Gordon 1959 - [633]

* Fukuto et al. 1955 - [635]

* March et al. 1955 - [640]

Tepp

733 Fernando, H.E., Roan, C.C., Kearns, C.W. THE PENETRATION, DISTRIBUTION AND METABOLISM OF ORGANIC PHOSPHATES IN THE AMERICAN COCKROACH, PERIPLANETA AMERICANA (LINN.). Ann. ent. Soc. Amer. 44, 4 (1952) 551-65.

In order to study the fate of organic phosphates in Periplaneta americana (L.), radioactive TEPP and Parathion were dissolved in acetone and administered to adults of both sexes by topical application to the cervical membrane or by mouth with a microsyringe. Quantitative data on the concentrations of the compounds in the tissues and blood after various periods were obtained by assay with a counter, and radioautographs were used to study the gross distribution of TEPP after topical application. The method of preparing them, which is suitable for use with compounds soluble in water and in the organic solvents used in the preparation of tissues for microtomy, is described. The distribution and relative concentrations of TEPP, Parathion and Paraoxon in the body of the cockroach are discussed, and also their rate of penetration. The effects of different dosages are described. Blood was found to be the chief medium of transmission of all the compounds in the body.

* Roan et al. 1950 - [653]

Miscellaneous

734 Babers, F.H., Roan, C.C. DISTRIBUTION OF RADIOACTIVE PHOSPHORUS IN SUSCEPTIBLE AND RESISTANT HOUSE FLIES. J. econ. Ent. 47, 6 (1954) 973-5.

The strains of houseflies compared were the susceptible S-F, derived from NAIDM 1948 stock, and the resistant R-OB, selected for DDT resistance for 143 generations. Fly eggs were added to what amounted to a solution of about 0.135 mc $P^{32}$/ml. The culture was maintained in a room held at 26.2°C and 50.5% relative humidity. The resulting adults were fed, and later extracted by the methods described. It is concluded that housefly larvae are able to utilize inorganic phosphorus to synthesize phosphates of widely differing chemical nature. The radioactive phosphorus decreased rapidly in the adult insects except in the lipoid fraction. The biological half life of the radioactive material was 4.7 d for the trichloracetic acid fraction,

5.3 d for the residue, but more than 11 d for the lipoid fraction. This work emphasizes the necessity for supplementing radioisotopic techniques with routine chemical procedures in the study of biological processes.

* Benjamini et al. 1959 - [656],[657]

* Bettini et al. 1955 - [499]

* Bettini and Boccacci 1958 - [500]

* Casida 1955 - [659]

735 Casida, J.E. TOXICITY OF AROMATIC ACIDS TO THE LARVAE OF THE MOSQUITO AEDES AEGYPTI L. AND THE COUNTERACTING INFLUENCE OF AMINO ACIDS. Biochem. J. 59, 2 (1955) 216-21.

The toxicity of benzoic acid to these larvae was reduced in the presence of glycine. The efficiency of this counteraction decreased as the larvae matured, and was greatest at pH 7 or below. The quantitative relationship of the decrease in benzoic acid toxicity in the presence of low glycine concentrations suggested an equimolar detoxication reaction. Benzoic acid was 15 times as toxic as hippuric acid to these larvae. Using [$\alpha$-$C^{14}$] glycine it was shown that mosquito larvae can synthesize hippuric acid and probably excrete the conjugated product. Thirty amino acids and closely related compounds were tested for their efficiency in reducing the toxicity of benzoic acid. Although glycine was the most efficient amino acid, in its absence many others were capable of reducing the toxicity of benzoic acid. The structural specificity for this counteraction is discussed. The toxicity of 50 aromatic or closely related compounds was determined. The relation of structure to the toxicity and mechanism of action of these acids is discussed. An example is presented for a synergistic action through competition for a common detoxication mechanism. (auth. summary)

* David 1952 - [751]

* Fredericksen and Lilly 1955 - [357]

* Kossobutsky 1955 - [664]

736 Mengle, D.C., Casida, J.E. BIOCHEMICAL FACTORS IN THE ACQUIRED RESISTANCE OF HOUSEFLIES TO ORGANOPHOSPHATE INSECTICIDES. J. agric. Food Chem. 8, 6 (1960) 431-7.

The metabolic fate of $P^{32}$-labelled Diazinon, Malathion, and methyl Parathion was studied in three housefly strains, two of which were resistant to organophosphates. Rate differences between the strains in cuticle penetration, phosphorothionate oxidation, or phosphate hydrolysis did not appear to explain the resistance. The lesser in vivo cholinesterase inhibition in resistant than susceptible flies treated with the same dose of the organophosphate probably results from some other mechanism than detoxification. Flies treated with the organophosphate immediately after decapitation were similar to whole flies in the symptomology of poisoning and degree of resistance. Evidence is presented for a "factor" in the thorax and/or abdomen which contributes to resistance by reducing the rate of cholinesterase inhibition without destroying active antiesterase organophosphate.

* Plapp and Casida 1958 - [665]

737 Schmidt, C.H., Weidhaas, D.E. ABSORPTION AND TOXICITY OF THREE RADIOACTIVE INSECTICIDES IN LARVAE OF TWO SPECIES OF MOSQUITOES. J. econ. Ent. 51, 5 (1958) 640-4.

Acetone-water suspensions of solutions of radioactive DDT, Bayer 21/199, and Am. Cyanamid 12880 (O,O-dimethyl S-(N-methyl-carbamoylmethyl)-phosphorodithioate), labelled with $C^{14}$ and $P^{32}$ respectively, were tested against 4th-instar Anopheles quadrimaculatus Say and Aëdes taeniorhynchus (Wied.) larvae (Culicidae: Diptera). Concentrations required for equivalent 24 h mortality were in the order of DDT <21/199<12880. A. quadrimaculatus were more susceptible to DDT and 12880 but less to 21/199 than taeniorhynchus; however, at the $LD_{50}$ only small differences (0.0033-0.0142 µg/larva) were seen between species and chemicals. Increasing the number of quadrimaculatus larvae per unit volume resulted in lower mortalities with DDT, but no change with 21/199 and 12880. A. quadrimaculatus larvae exposed to 21/199 for 48 h absorbed a maximum amount in the first few hours but the mortality increased with time. When quadrimaculatus larvae were transferred to clean water, 73% of the acquired dosage of 21/199 was excreted in 12 h. Live larvae of both species absorbed more 21/199 than did dead larvae. (from auth.)

* Winteringham 1959 - [155]

## II-H-2 MAMMALS

### Surveys

* Lüdicke 1954 - [505]

* Winteringham and Barnes 1955 - [433]

* Winteringham 1957 - [724]

### Bayer 22408

* Boyd and Arthur 1960 - [726]

### Co-Ral

* Kaplanis et al. 1959 - [513]

* Krueger et al. 1959 - [514]

* Lindquist et al. 1958 - [515]

* Radeleff and Claborn 1960 - [516]

* Robbins et al. 1959 - [517],[518]

* Vickery and Arthur 1960 - [519]

### DDT

738 Jensen, A.J., Cueto, C., Dale, W.E., Rothe, C.F., Pearce, G.W., Mattson, A.M. DDT METABOLITES IN FECES AND BILE OF RATS. J. agric. Food Chem. 5, 12 (1957) 919-25.

A study of DDT-derived products occurring in rat feces and bile, following the ingestion of DDT, show that the major products are complexed forms of DDA [bis(p-chlorophenyl) acetic acid] in both bile and feces. Uncomplexed DDA is found in the bile, and insignificant amounts of DDE [1,1-dichloro-2,2-bis(p-chlorophenyl)-ethylene] are present in both bile and feces. DDT-$C^{14}$ was used to demonstrate that the Schechter-Haller method fails to account, quantitatively, for these metabolites. Biliary excretion is responsible for almost all of the DDT metabolites in feces. Although bile and fecal metabolites have certain similarities, they are not necessarily identical. (from auth.)

* Rothe et al. 1957 - [489]

### Delnav

* Arthur and Casida 1959 - [520]

739 Chamberlain, W.F., Gatterdam, P.E., Hopkins, D.E. METABOLISM OF $P^{32}$-DELNAV IN CATTLE. J. econ. Ent. 53 (1960) 672-5.

$P^{32}$-labelled Delnav® (2,3-p-dioxanedithiol S, S-bis (O,O-diethyl phosphorodithioate)) was applied to steers dermally and orally. Analyses of blood, urine, and feces indicated that the insecticide was rapidly metabolized and excreted. After 7 d both animals showed only trace amounts of radioactivity in the urine and feces, but the elimination of 20.4% of the dermal treatment indicates efficient absorption of the insecticide in comparison with other organophosphorus insecticides. The presence of three major hydrolysis products in the urine of both animals indicates a cleavage of Delnav at the P⁄S+C as well as the P⁄S−C bond, with oxidation before or after hydrolysis. (auth.)

* Plapp et al. 1960 - [521]

## DFP

740 Jandorf, B.J., McNamara, P.D. DISTRIBUTION OF RADIOPHOSPHORUS IN RABBIT TISSUES AFTER INJECTION OF PHOSPHORUS-LABELED DIISOPROPYL FLUOROPHOSPHATE. J. Pharmacol. 98 (1950) 77-84.

When $P^{32}$-labelled diisopropyl fluorophosphate (DFP), a highly toxic phosphoric ester, is injected intravenously in rabbits, $P^{32}$ is retained in relatively large amounts by kidney, liver, and lung; other organs take up only small amounts. No correlation seems to exist between the cholinesterase activity (I) of rabbit organs and their ability to retain DFP-derived P. No significant retention of $P^{32}$ in any tissue was found when labelled diisopropyl phosphate was administered. Of the total amount of DFP-derived $P^{32}$ retained in liver, lung, and kidney, about 100% of it is protein-bound within 4 h after injection. In plasma of rabbits injected with labelled DFP, most of the $P^{32}$ originally present is eliminated before regeneration of I has started. In the erythrocytes a maximum value of $P^{32}$ associated with the cells is not attained until about an hour after injection and this level is maintained for at least 9 h. Maximum inhibition of I is maintained for the same length of time, then both the radioactivity and I inhibition decrease at the same rate and return to zero at approximately the same time. This indicates destruction of erythrocytes whose I was destroyed by DFP, and their replacement with new cells containing active cholinesterase. (CA 44: 4578e, 1950)

## Diazinon

* Krueger et al. 1960 - [541]

* Robbins et al. 1957 - [543]

741 Vigne, J.P., Chouteau, J., Tabau, R.L., Rancien, P., Karamanian, A. SUR LE MÉTABOLISME D'UN INSECTICIDE ORGANO-PHOSPHORÉ, LE DIÉTHYLTHIONOPHOSPHATE DE 2 ISOPROPYL 4 MÉTHYL 6 OXYPYRIMIDINE, CHEZ LA CHÈVRE. Bull. Acad. Vét. 30 (1957) 85-92.

Les auteurs ont préparé un diazinon marqué avec du phosphore radioactif. Après en avoir administré per os 235 mg à une chèvre en fin de lactation, ils ont mesuré la radioactivité des urines, des fèces, du sang et du lait. Cette étude montre une élimination rapide et complète du produit en 3 ou 4 jours. Seule l'élimination radioactive, d'ailleurs extrêmement faible du lait reste linéaire et correspondrait au $^{32}P$ provenant des réserves osseuses après métabolisme de l'insecticide. Le dosage de l'insecticide lui-même, soit par extraction, soit par la mesure de l'activité anticholinestérasique des excrétions montre une élimination très minime (2 à 3 mg) de la dose totale en 4 jours, indiquant que la quasi-totalité de l'insecticide est métabolisé et le $^{32}P$ éliminé sous forme de phosphates organiques ou minéraux autres que l'insecticide. Ce comportement différencie nettement les insecticides organophosphorés des insecticides chlorés.

742 Vigne, J.P., Chouteau, J., Tabau, R.L., Rancien, P., Karamanian, A. CONTRIBUTION À L'ÉTUDE DU MÉTABOLISME D'UN INSECTICIDE ORGANOPHOSPHORÉ: LE DIÉTHYLTHIONOPHOSPHATE DE 2 ISOPROPYL 4 MÉTHYL 6 OXYPYRIMIDINE. Ann. Epiphyt. 8, 2 (1957) 225-34.

A female goat (36.5 kg) was given a single oral dose of $P^{32}$-labelled Diazinon (O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate) towards the end of the lactation period. Excretion of radioactive material in the urine, faeces and milk, measured with a G-M counter was completed within 4 d, and the blood was free within 2 d. Only very small amounts were found in the milk or blood. Only the urine showed any ability to inhibit horse-serum cholinesterase, and this was of a low order and persisted only for 3 d. The trial was repeated with similar results a month later, and it is concluded that Diazinon, unlike the chlorinated-hydrocarbon insecticides, is rapidly metabolized in the animal body. (from RAE-A 47:214, 1959)

## Dimethoate

* Chilwell and Beecham 1960 - [763]

* Dauterman et al. 1959 - [552]

* Dauterman et al. 1960 - [551]

* Kaplanis et al. 1959 - [553]

Dipterex

* Arthur and Casida 1958 - [556]

743 Robbins, W.E., Hopkins, T.L., Eddy, G.W. THE METABOLISM OF $P^{32}$-LABELED BAYER L13/59 IN A COW. J. econ. Ent. 49, 6 (1956) 801-6.

A study was made of the metabolism and excretion of $P^{32}$-labelled Bayer L13/59 (dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate) by a lactating Hereford cow to which it was administered orally at the rate of 25 mg/kg and of its uptake by larvae of Hypoderma bovis (Deg.) in cysts in the cow's back. Radioactivity appeared to be dissipated more slowly in the exudate in the cysts of H. bovis than in the blood. Only low levels of radioactivity were detected in larvae removed at various times after treatment, and the maximum per unit weight was found in those removed after 6-24 h. The percentage of radioactivity administered appearing up to 144 h after treatment in the milk is discussed. L13/59 was rapidly metabolized by the cow and eliminated in the urine. The rate of elimination is described. Ready absorption of L 13/59 by the cow was implied by the small amount of radioactivity in the feces. Less than 3% of the dose was accounted for in all fecal samples collected. (RAE-B 46: 21-22, 1958)

DNP

* Sacks and Marott Sinex 1952 - [709]

Fumigants

744 McCollister, D.D., Beamer, W.H., Atchison, G.J., Spencer, H.C. ABSORPTION, DISTRIBUTION, AND ELIMINATION OF RADIOACTIVE CARBON TETRACHLORIDE BY MONKEYS UPON EXPOSURE TO LOW VAPOR CONCENTRATIONS. J. Pharmacol. 102 (1951) 112-4.

The distribution of radioactive material in different tissues was examined, following absorption of $C^{14}Cl_4$. In order to study the metabolism of $CCl_4$, monkeys were exposed to low vapour concentrations of the radioactive form. Rhesus monkeys inhaled air containing 46 ppm of $C^{14}$-labelled $CCl_4$ for 139-300 minutes. About 30% of the inhaled $CCl_4$ was absorbed. The highest concentration of deposited radioactive material was in the fat (7.94 times the concentration in the blood). $C^{14}$ was found in the blood carbonate, exhaled $CO_2$ and urinary urea and carbonate. Most of the radioactivity in the urine appeared to be present in a non-volatile fraction other than urea, carbonate, or amino acids. This material was retained on anion-exchange resin and was converted to another unidentified substance by acid hydrolysis. The equivalent of at least 51% of the absorbed $CCl_4$ was eliminated in the expired air within 1800 h. The remainder was excreted to a large extent in the urine and feces. In monkeys receiving skin exposures to radioactive $CCl_4$ vapour for 4 h negligible amounts of radioactive material were found in the blood and expired air. (cf. CA 45: 8136i, 1951)

* Strittmatter et al. 1950 - [428]

Malathion

* Knaak and O'Brien 1960 - [564]

* March et al. 1956 - [567]

745 March, R.B., Metcalf, R.L., Fukuto, T.R., Gunther, F.A. FATE OF $P^{32}$-LABELED MALATHION SPRAYED ON JERSEY HEIFER CALVES. J. econ. Ent. 49, 5 (1956) 679-82.

Two Jersey heifer calves were each treated twice at an interval of two weeks with one US pint spray containing 0.5% $P^{32}$-labelled Malathion, and the fate of the Malathion and its metabolites was studied after the second application. The Malathion was rapidly absorbed, metabolized and eliminated in the urine; 96-99% of the radioactive material eliminated was in the form of water-soluble metabolites and degradation products, and the amount of activity appearing in the urine was greatest in the first 24 h, after which it gradually decreased. The calves were killed one and two weeks after the second spraying, and residues in ten cuts of the meat and in tongue, brain, spinal cord, thymus, thyroid, pancreas, kidney, liver, heart, rumen, suet, bone, marrow and hide were determined radiometrically. Only water-soluble metabolites and degradation products were present in detectable quantities in the tissues, except in the hide, where some of the labelled compounds recovered after two weeks was in the form of unchanged Malathion and chloroform-soluble metabolites. Total residues in the meat cuts were low (0.05 - 0.15 ppm)

and indicated very uniform distribution throughout the animal. Somewhat higher values (0.15 - 0.18 ppm) for the tongue were probably attributed to the heifers' habit of licking themselves. Higher residues (0.2 - 2 ppm) were found in thymus, thyroid, pancreas, liver and bone, and indicated that phosphorus from the degraded compounds was being used in the normal metabolic activities of the animal. The largest amounts (3 - 18 ppm) were found in the hide. Chemical analysis for Malathion in tissues of foreleg, hind leg and rump of the two heifers showed no detectable Malathion (less than 0.2 ppm). (RAE-B 45: 177, 1957)

* Seume and O'Brien 1960 - [569]

Nicotine

* Bennett et al. 1954 - [681]

* Ganz et al. 1951 - [995]

* Larson and Harlow 1958 - [696]

Parathion

* Ahmed et al. 1958 - [571]

* Jäger 1953 - [576]

* Jensen 1952 - [577]

* Lüdicke 1954 - [584]

Phorate

* Bowman and Casida 1958 - [590],[591]

Phosdrin

746 Casida, J.E., Gatterdam, P.E., Knaak, J.B., Lance, R.D., Niedermeier, R.P. BOVINE METABOLISM OF ORGANOPHOSPHATE INSECTICIDES. SUBACUTE FEEDING STUDIES WITH O,O-DIMETHYL 1-CARBOMETHOXY-1-PROPEN-2-YL PHOSPHATE. J. agric. Food. Chem. 6,9(1958)658-62.

Dairy cows that ingested subacute doses of Phosdrin (dimethyl 2-methoxycarbonyl-1-methylvinyl phosphate) daily in capsules for a period of 12 weeks showed marked blood-cholinesterase inhibition, but the insecticide was not detected in their milk or tissues. Tests with radioactive Phosdrin confirmed the lack of significant residues in milk or tissues and showed that the chemical was rapidly detoxified and excreted as dimethyl phosphoric acid. Calves that were fed on milk from the cows also showed reduced blood-cholinesterase activity. The compound was hydrolyzed by cow, calf and human plasma to yield dimethyl phosphoric acid. (from auth. summary)

* Gatterdam et al. 1957 - [596]

Ronnel

* Louloudes 1958 - [600]

* Plapp and Casida 1958 - [601]

* Robbins et al. 1956 - [602]

Schradan

* Arthur and Casida 1958 - [604]

* Gardiner and Kilby 1950 - [610]

* Gardiner and Kilby 1952 - [612]

747 Hofmann-Credner, D., Siedek, H. DISTRIBUTION AND FATE OF SCHRADAN (BIS-DIMETHYL-AMINO-PHOSPHONOUS ANHYDRIDE) IN MAMMALS, USING A RADIOACTIVE COMPOUND. Arch. int. Pharmacodyn. 89, 1 (1952) 74-81.

The distribution, destruction and excretion of the above named compound (I), an anticholinesterase, was investigated in rats and rabbits. I is less toxic than DFP. High concentrations of unchanged I were found in the liver and skeletal muscles, and in the latter most was found when the animal was convulsed. Little is found in brain in acute or subacute poisoning. Metabolic products were excreted in bile, urine and feces. The intraperitoneal route was the most effective mode of administration. (EM 2: 447, 1953)

* Kilby 1953 - [622]

Systox

* Fukuto et al. 1955 - [635]

* March et al. 1955 - [640]

* Tietz 1960 - [652]

Miscellaneous

* Halberstadt 1958 - [502]

" 1959/1960 - [503]

* Plapp and Casida 1958 - [665]

II-H-3 PLANTS

Surveys

* Lüdicke 1954 - [505]

* Metcalf 1960 - [413]

748 Spencer, E.Y. SIGNIFICANCE OF PLANT METABOLITES OF INSECTICIDES. Canad. J. Biochem. Physiol. 37 (1959) 1145-50.

Review article. The metabolites of insecticides produced by plants are known to be mostly derived from the organophosphorus insecticides with the exception of Aldrin which may be oxidized to Dieldrin. The residue of the relatively stable chlorinated hydrocarbons is largely reduced by the microflora in the soil. Activation, degradation, selective toxicity, etc., are discussed with frequent reference to results obtained by means of radioisotopes.

Amiton

* Baldit 1958 - [512]

Bayer 22408

* Boyd and Arthur 1960 - [726]

BHC

* Bradbury and Whittaker 1956 - [446]

Carbamate

* Fang and Theisen 1960 - [705]

* Baldwin et al. 1954 - [702]

DDT

* Lichtenstein and Schulz 1960 - [476]

* Winteringham 1951 - [761]

Delnav

749 Casida, J. E., Ahmed, M. K. MECHANISM OF RESIDUE LOSS OF HERCULES AC-528 COMPONENTS ON PLANT FOLIAGE. J. econ. Ent. 52 (1959) 111-6.

The acaricide and insecticide, Hercules AC-528 (Delnav) is a mixture of the cis and trans isomers of 2,3-p-dioxanedithiol S,S-bis(O,O-diethyl phosphorodithioate) along with certain other phosphorodithioates. Loss of the Hercules AC-528 components from plants resulted from volatilization, hydrolysis, and the formation of more polar derivatives and more potent anticholinesterase agents. The cis and trans isomers were similar in persistence so that the isomer ratio did not change during residue loss from that of the insecticide initially applied to the plants. No inter-conversion occurred on plants between the cis and trans isomers and the dioxene derivative, which is an impurity in the technical insecticide. The components of Hercules AC-528 were only slowly hydrolyzed on the plant surface but rapidly when absorbed into the plants. Several of the components were converted to more polar derivatives and more potent anticholinesterase agents when applied to plants. This conversion may be due in part to the formation of phosphorothiolate derivatives. Attempts at chemical oxidation of certain components of Hercules AC-528 to yield the phosphorothiolate derivatives were only partially successful. Several components of technical Hercules AC-528 and certain non-hydrolyzed derivatives formed from the Hercules AC-528 components after application to plants are not determined by the residue analysis procedure of Dunn. The toxicological significance of the organophosphate present in residues of Hercules AC-528 on crops but not determined by the colorimetric method of analysis cannot be fully evaluated with the limited data presented in the paper. Hercules AC-528 was labelled with $P^{32}$ by preparation and purification techniques described earlier (Casida and Arthur 1958). (auth.)

Di-Syston

* Carter and Gortner 1958 - [558]

* Metcalf et al. 1959 - [559]

* Reynolds et al. 1957 - [560]

Gusathion

* Tietz et al. 1957 - [562]

* Tietz et al. 1960 - [561]

Malathion

* Tomizawa and Sato 1960 - [570]

Nicotine

* Toczko 1960 - [701]

Parathion

* Gar and Kipiani 1956 - [574]

* Kipiani and Gegenava 1955 - [579]

* Lüdicke 1952 - [583]

* Lüdicke 1954 - [584]

Phorate

* Bowman and Casida 1957 - [589]

* Bowman and Casida 1958 - [590], [591]

* Haczkaylo et al. 1959 - [593]

* Reynolds et al. 1957 - [595]

Phosdrin

* Getzin and Chapman 1959 - [597]

Sulphur-35

* Turrell 1950 - [710]

* Turell and Chervenak 1959 - [711]

Schradan

* Arthur and Casida 1958 - [604]

* Batt et al. 1954 - [605]

* Bennett and Thomas 1952 - [606]

* " " " 1953 - [607]

* " " " 1954 - [608]

* David 1950 - [609]

750 David, W.A.L. INSECTICIDAL-ACTION STUDIES WITH BISDIMETHYLAMINOPHOSPHONOUS ANHYDRIDE CONTAINING 32-PHOSPHORUS. Ann. appl. Biol. 38, 2 (1951) 508-24.

The radioactive anhydride was absorbed by the roots of broad bean plants placed in culture solutions containing it. The level of radioactivity in the plant increased as the solution was absorbed and was higher in the washed roots than in the rest of the plant. The activity of the remaining culture solutions increased as more was absorbed, showing that the roots selectively reject the radioactive anhydride. The material was absorbed more slowly from soil than from sand. In both cases, the concentration per gram of tissue was highest in the leaves on the middle part of the stem. By introducing the insecticide by the cut tap-root technique, it was shown that 50% of the anhydride is decomposed within the plant in 8 d. The concentration of undecomposed anhydride in the plant necessary to give a complete kill of Aphis fabae Scop. was found to be about 50 mg/kg plant tissue. Dead aphids were found to contain about 15 - 20 mg/kg radioactive material calculated on the assumption that it was undecomposed anhydride. The honeydew of aphids feeding on treated plants was also radioactive. Absorption and translocation of the radioactive material occurred following application to the leaves of broad bean, cabbage, hop, pea and strawberry. In broad bean, radioactive material was detected within the leaf a few hours after it had been applied to the surface. In all plants, there was evidence that radioactive material is translocated to untreated parts. Much more was translocated to leaves younger than to leaves older than those treated. In favourable cases, where a large number of leaves on the plant was treated, where the plant held a large quantity of the anhydride applied, or where a heavy dose was given, either by repeated treatments or by the use of high concentrations, insecticidal quantities of what was presumed to be the anhydride were translocated to untreated young growing parts of the plants. No measurable quantity of radioactive material was transpired by plants taking up the material through the roots.

751 David, W.A.L. INSECTICIDAL-ACTION STUDIES WITH BISDIMETHYLAMINO FLUOROPHOSPHINE OXIDE CONTAINING $^{32}$PHOSPHORUS. Ann. appl. Biol. 39, 2 (1952) 203-10.

The absorption of the systemic insecticide bis(dimethylamino) fluorophosphine oxide containing $P^{32}$ was studied and, where possible, comparisons were made with Schradan (bisdimethylaminophosphonous anhydride). The radio-oxide was absorbed by the roots of broadbean plants from culture solutions. The level of radioactivity in the plant increased as the solution was absorbed and was higher in the roots than in the rest of the plant. The radioactivity of the remaining culture solution decreased as more of it was taken up by the plants, showing that the roots selectively absorb the oxide from solution. In this respect, it differs from Schradan, which is selectively rejected at similar rates of transpiration. At the end of a day with roots in the culture solution, the plants became free from aphids. The radio-oxide was absorbed more rapidly by

plants growing in sand than in soil, and aphids were killed at lower dosages and in shorter periods on the former plants than on the latter. An appreciable part of the oxide absorbed by the roots is given off as vapour by the leaves. This vapour was collected and shown to be radioactive and toxic to Aphis fabae Scop. on the cut tops of broad bean plants. Examples of A. fabae feeding on treated plants were shown to contain radioactive material. The radio-oxide was less soluble in lipoids than Schradan and did not penetrate as readily into leaves of broad beans. Since it is also lost by vaporization from the plants, only small amounts were translocated following leaf applications to broad bean, cabbage and hops.

* Hartley and Heath 1951 - [616]

* Heath et al. 1952 - [618]

* " " 1953 - [617]

* Heath and Llewellyn 1953 - [619]

* Heath et al. 1955 - [620]

* Metcalf and March 1953 - [624]

* Metcalf et al. 1955 - [625]

* Stein et al. 1952 - [627]

752 Thomas, W.D.E., Bennett, S.H. THE ABSORPTION, TRANSLOCATION AND BREAKDOWN OF SCHRADAN APPLIED TO LEAVES, USING $^{32}$P-LABELLED MATERIAL. III. TRANSLOCATION AND BREAKDOWN. Ann. appl. Biol. 41, 3 (1954) 501-19.

The translocation of $P^{32}$-labelled Schradan from dipped or sprayed leaves was studied in apples, chrysanthemums, broad and runner beans and Coleus. Light was found to be perhaps the most important single factor in promoting translocation in bean, apple, and chrysanthemum, suggesting that the insecticide moved along with the products of photosynthesis. The direction of translocation from lower or middle leaves was predominantly upward toward new growth although small amounts were found in the lowest leaves of apple and chrysanthemum following application to middle leaves. Upward translocation occurred largely in the phloem in apple stocks. Although limited upward translocation also occurred in the xylem, downward translocation occurred exclusively in the phloem. No major difference has been observed in the ratio translocated/absorbed for Coleus, beans and chrysanthemums but in apples this proportion is greater. The breakdown of Schradan into non-chloroform-extractables varies between plant species and is far greater in beans than in Coleus. In chrysanthemums and apples the breakdown appears similar throughout the plant whilst in beans and, possibly, Coleus the breakdown in the untreated sections is higher. Concentrations necessary for the kill of certain species of aphids are given (80% mortality for Aphis fabae Scop. with 10 - 15 µg/g of fresh weight of plant tissue, 20-25µg/g for Macrosiphum (Macrosiphoniella) sanborni Gill. and 20 - 30 µg/g for Aphis pomi Deg.)

(cf. I. "Experimental techniques" by Batt et al., and
II. "Evaporation and absorption" by Bennett and Thomas)

* Wedding and Metcalf 1952 - [629]

Systox

* Ahmed et al. 1954 - [630]

* Chatters 1953 - [631]

753 David, W.A.L., Gardiner, B.O.C. THE APHICIDAL ACTION OF SOME SYSTEMIC INSECTICIDES APPLIED TO SEEDS. Ann. appl. Biol. 43, 4 (1955) 594-614.

The authors studied the process of absorption of systemic insecticides by seeds. $P^{32}$-Systox thiol isomer was not selectively absorbed by broad bean seeds from 0.05% solution, but penetrated at an equal rate with the water. Maximum absorption occurred over a 24-h period but was quite variable with individual seeds. In comparing the amount of radioactivity in seed coat and cotyledons, it was found that after 4 h of soaking an

average of ca. 73% of the material was in and on the seed coat, but after 24 h only 35% remained. Removal of the seed coat from seeds treated for 4 h showed that insecticide held in the seed coat at time of planting was subsequently translocated into the growing plant in quantities lethal to Aphis fabae. Translocation occurred directly from the material absorbed in the cotyledons which passed to the leaves along with the food reserves. However, some of the toxicant was also found to have diffused out of the treated seed into the soil where it was subsequently absorbed by the roots. It is clear that these two methods of absorption also apply to seed coats where the relative rates of absorption depend upon the lipoid and water solubility of the toxicant; the sorptive power of the coating substance, generally charcoal; and the adherence of the coating to the treated seed.

* David 1957 - [632]

* Fukuto et al. 1955 - [635]

* Fukuto et al. 1956 - [636]

754 Fukuto, T.R., Wolf, J.P., III., Metcalf, R.L., March, R.B. IDENTIFICATION OF THE SULPHONE PLANT METABOLITE OF THE THIONO ISOMER OF SYSTOX. J. econ. Ent. 50, 4 (1957) 399-401.

Experiments are described on the metabolism of O,O-diethyl O-2-(ethylthio)ethyl phosphorothioate [Demeton-O] in cotton plants. Demeton-O prepared with $P^{32}$ was applied to the bases of young plants, and leaves were picked after 10 d and treated by methods that are described to recover and isolate the metabolites. One of these was found by examination of its infra-red spectrum to be identical with O,O-diethyl O-2(ethylsulphonyl) ethyl phosphorothioate (the thionophosphate sulphone), which is therefore shown to be a metabolite of Demeton-O. It is a secondary one, since the first step in the metabolism of Demeton-O in plants has been found to be conversion to the sulphoxide, O,O-diethyl O-2-(ethylsulphinyl)-ethyl phosphorothioate. (from RAE-A 46: 336, 1958)

* Hartley 1952 - [638]

* Metcalf et al. 1954 - [641]

* Metcalf et al. 1956 - [642]

* Metcalf et al. 1957 - [644]

755 Metcalf, R.L., Fukuto, T.R., March, R.B. PLANT METABOLISM OF DITHIO-SYSTOX AND THIMET. J. econ. Ent. 50, 6 (1958) 338-45.

When the bases of young cotton and lemon plants were treated with dithio-Systox [O,O-diethyl S-2-(ethylthio) ethyl phosphorodithioate] and Thimet (O,O-diethyl S-ethylthiomethyl phosphorodithioate) synthesized from $P^{32}$, they were absorbed and translocated at about equal rates, but only about 0.5 - 0.75 times as fast as Demeton-S [O,O-diethyl S-2-(ethylthio) ethyl phosphorothioate], which was found to be much more soluble in water. The processes of metabolism for the two compounds were primarily oxidative. After uptake of dithio-Systox by cotton, lemon, bean or lucerne plants, the compound was oxidized very rapidly to produce the sulphoxide, [O,O-diethyl S-2-(ethylsulphinyl)ethyl phosphorodithioate], and more slowly to produce the corresponding sulphone, [O,O-diethyl S-2-(ethylsulphonyl)ethyl phosphorodithioate]. The sulphoxide and sulphone, were also oxidized to produce O,O-diethyl S-2-(ethylsulphonyl)ethyl phosphorothioate and O,O-diethyl S-2-(ethylsulphonyl)ethyl phosphorothioate, respectively. Thus, at intervals of a few days to a month after application, all 4 oxidation products may be present in plant residues, but no dithio-Systox remains. Thimet behaved in an analogous manner, but showed different rates of metabolism. The sequence of consecutive reactions for dithio-Systox and Thimet in isolated cotton leaves was plotted, and preliminary investigations on their kinetics were made. All the simple oxidative metabolites of dithio-Systox and Thimet were prepared in the pure state, and their properties recorded; the successive steps in oxidation increased the anti-cholinesterase activity of both compounds, as measured against fly-brain cholinesterase, the Thimet series being somewhat the more active of the two. Typical harvest residues of the dithio-Systox metabolites were evaluated in experiments in which the radioactive compound was used as a direct spray on cotton plants 52 d before harvest and as a seed treatment for lucerne. The results indicated that the ultimate toxic residues are present in only fractional parts per million. The application of the knowledge of the metabolism of these compounds in plants to analytical studies by cholinesterase assay is briefly discussed. (from auth. summary)

* Mühlmann and Tietz 1956 - [645]

* Stein and Smith 1954 - [646],[647]

* Thomas and Glynne Jones 1955 - [648]

* Thomas et al. 1955 - [649]

* Tietz 1954 - [651]

756 Wedding, R.T. PLANT PHYSIOLOGICAL ASPECTS OF THE USE OF SYSTEMIC INSECTICIDES. J. agric. Food Chem. 1, 13 (1953) 832-4.

Partly review. Investigations are reported in which radioactive tracer-labelled Systox ($S^{35}$) and OMPA ($P^{32}$) have been used. When Systox is applied to the stem or leaves of citrus plants it is translocated both up and down in the phloem at first, but gradually diffuses into the xylem. The rate of movement in the phloem was determined to range from 2.5 to 10 cm/h.

Miscellaneous

* Bowman and Casida 1958 - [658]

* Halberstadt 1959/1960 - [503]

757 Voight, G.K. EFFECT OF FUNGICIDES, HERBICIDES, AND INSECTICIDES ON THE ACCUMULATION OF PHOSPHORUS BY PINUS RADIATA AS DETERMINED BY THE USE OF PHOSPHORUS$^{32}$. Agron. J. 46 (1954) 511-3.

Results of greenhouse trials indicated that some of the eradicating agents inhibited the absorption of P and arrested the development of seedlings. This was especially true of $Al_2(SO_4)_3$ and benzene hexachloride. Determinations of O uptake and P content of excised root tips showed that reduction of P accumulation in the tissue was accompanied by a decrease in the rate of O consumption. This response occurred within a relatively short time after the tissues had been exposed to the biocides, and was especially marked in the case of benzene hexachloride. The results point out the importance of obtaining uniform distribution of biocides in the soil as well as using the proper application rate to avoid injury to planting stock. (from CA 49: 5754d, 1955)

## II - I Insecticide Residues in

### II-I-1 MAMMALS

Bibliography

* McCormick 1958 - [799]

Co-Ral

758 Claborn, H.V., Bushland, R.C., Mann, H.D., Ivey, M.C., Radeleff, R.D. MEAT AND MILK RESIDUES FROM LIVESTOCK SPRAYS. J. agric. Food Chem. 8, 6 (1960) 439-42.

Before an insecticide can be recommended for use on livestock, studies must be made to determine whether it will contaminate meat and dairy products. Results of residue studies show that all the chlorinated hydrocarbon insecticides, Co-Ral, and Malathion were excreted in the milk after spray treatments. Studies were also made on DDT, TDE, methoxychlor, Chlordan, gamma Chlordan, Heptachlor, Dieldrin, Lindane, Strobane, Toxaphene, Malathion, and Co-Ral in the fat of beef cattle following spray treatments. $P^{32}$-labelled Co-Ral and Delnav were employed.

(A more detailed report was published in Dec. 1960 by Claborn and Radeleff "Pesticide residues in meat and milk" Agr. Res. Serv. US Dept. Agric., ARS-33-63, which also includes results on residues from insecticides on pasture and forage crops)

* Kaplanis et al. 1959 - [513]

* Krueger et al. 1959 - [514]

* Radeleff and Claborn 1960 - [516]

* Robbins et al. 1959 - [518]

Delnav

* Plapp et al. 1960 - [521]

Diazinon

* Robbins et al. 1957 - [543]

Dimethoate

* Dauterman et al. 1959 - [552]

* Kaplanis et al. 1959 - [553]

Phosdrin

* Casida et al. 1958 - [746]

* Gatterdam et al. 1957 - [596]

Ronnel

* Robbins et al. 1956 - [602]

* USDA 1957 - [603]

## II-I-2 PLANTS

### Surveys

* Metcalf et al. 1954 - [507]

* Redemann and Meikle 1958 - [781]

759 Zeumer, H. RÜCKSTÄNDE VON PFLANZENSCHUTZ- UND VORRATSSCHUTZMITTELN, VON SONSTIGEN SCHÄDLINGSBEKÄMPFUNGS- UND UNKRAUTBEKÄMPFUNGSMITTELN SOWIE VON MITTELN ZUR BEEINFLUSSUNG DES PFLANZENWACHSTUMS. LITERATUR-ÜBERSICHT. (Residues of materials used for the protection of plants and stored products, of miscellaneous materials used for the control of pests and weeds, and also of substances regulating plant growth. A review of the literature) Mitt. biol. Bundesanst. f. Land- u. Forstwirtschaft, Berlin-Dahlem. pt. 94, 124 p. Berlin 1958. (In German)

This is a bibliography of the literature published principally in 1955-57, arranged in sections concerned mainly with the level of residues on foodstuffs of plant origin, the effects of residues on domestic animals and plants, residues in soils, and methods of residue determination, including bioassay. Includes references relevant to the present bibliography. Alphabetical listing by first author. No index.

### BHC

* Bridges 1958 - [447]

### DDT

760 Winteringham, F.P.W., Harrison, A., Jones, C.R., McGirr, J.L., Templeton, W.H. THE FATE OF LABELED INSECTICIDE RESIDUES IN FOOD PRODUCTS. I. STUDIES WITH A RADIOACTIVE BROMINE ANALOGUE OF DDT. J. Sci. Food Agric. 1 (1950) 214-9.

A radioactive bromine analogue, 1:1:1-trichloro-2:2-di-(4-bromo*phenyl)ethane, of the insecticide DDT has been used to indicate the fate of DDT sprayed on to wheat grain which is subsequently milled, baked

and fed to animals. $Br^{82}$ of high specific activity was prepared in the Harwell pile by the Szilard-Chalmers method and was used for the synthesis of the analogue. Grain carrying 40.2 ppm of the labelled insecticide was milled under typical conditions. A concentration of 14.6 ppm was found in the flour (85% extraction) and 11.2 ppm in bread made from the flour. There was evidence that some of the insecticide was in a combined form in the bread. Some of the grain and bread were fed to hens and rats respectively. The insecticide was found in all the tissues examined. A fraction of the radioactivity found in the excreta behaved as the di-(4-bromo*phenyl) acetic acid metabolite. This metabolite was identified in the urine of a man following ingestion of some of the bread. (auth.)

*) $Br^{82}$-labelled material.

761 Winteringham, F.P.W. RADIOACTIVE TRACER STUDIES ON THE FATE OF INSECTICIDES (abstr. and discussion) Chem. and Industry (Rev.) (1951) 405-6.

Use of a radioactive bromine analogue of DDT allowed the fate of the insecticide on contamination of the wheat grain to be followed. The suspected decomposition of residues in bread during baking was confirmed. $Br^{82}$-labelled decomposition products were located and estimated radiometrically, the greater part of the residual DDT having been oxidized to the benzophenone derivative; some ethylene derivative was also found. Fumigation of wheat by methyl bromide was studied by means of labelling methyl bromide with $C^{14}$. The fate of the methyl groups introduced in milled wheat is described. In the discussion, D.F. Heath drew attention to somewhat similar work being done by his group on the fate of systemic phosphorus insecticides, using $P^{32}$.

## Dimefox

762 Dupée, L.F., Heath, D.F., Otter, I.K.H. DETERMINING TRACES OF TETRAMETHYL-PHOSPHORODIAMIDIC FLUORIDE (DIMEFOX) IN CROPS. J. Agric. Food Chem. 4, 3 (1956) 233-6.

A satisfactory method for the determination of Dimefox residues in food crops must achieve a sensitivity of 0.1 ppm or less. The most general method consists of macerating a 50 g sample of the crop with water, filtering, extracting with chloroform, evaporating the chloroform to a low bulk, transferring to a microdistillation apparatus, and distilling in the presence of a few drops of glycerolglycol mixture. The Dimefox in the distillate is estimated as phosphate by the method of Berenblum and Chain. An abbreviated version can sometimes be used. The second method, used for oily crops, consists of distilling a macerate in oil and separating the Dimefox from interfering compounds in the oily distillate. Satisfactorily low blanks were obtained on 15 crops, and satisfactory recoveries on 10 crops investigated further. Recovery data were obtained by adding known quantities of $P^{32}$-labelled Dimefox at an early stage in the analysis procedure. (from auth.)

## Dimethoate

763 Chilwell, E.D., Beecham, P.T. RESIDUES OF O,O-DIMETHYL S-(N-METHYLCARBAMOYLMETHYL) PHOSPHOROTHIOLOTHIONATE (DIMETHOATE) IN SPRAYED CROPS. J. Sci. Food Agric. 11 (1960) 400-7.

A method for the determination of residues of the insecticide O,O-dimethyl S-(N-methylcarbamoylmethyl) phosphorothiolothionate (Dimethoate) in crops is described. $P^{32}$ was used for labelling the insecticide. Radiochemical and biochemical investigations indicate that the method can be applied to growing crops without interference from metabolites in the plant derived from Dimethoate. The limit of sensitivity of the method is about 5 µg of Dimethoate, equivalent to 0.1 ppm in the plant tissue by the method described. Harvest residues found in many British and overseas crops 1-3 weeks after spraying with Dimethoate are given. (from auth.)

## Fumigants

764 Winteringham, F.P.W., Harrison, A., Bridges, R.G., Bridges, P.M. THE FATE OF LABELLED INSECTICIDE RESIDUES IN FOOD PRODUCTS. II. THE NATURE OF METHYL BROMIDE RESIDUES IN FUMIGATED WHEAT. J. Sci. Food Agric. 6 (1955) 251-60.

The chemical fate of methyl bromide absorbed by wheat under conditions of fumigation has been studied. Whole-wheat flour was exposed to $C^{14}$-labelled methyl bromide. The fat, starch, gluten, and water-soluble fractions were prepared from the exposed flour and their $C^{14}$-content assayed. The gluten or protein fraction was responsible for some 80% of the decomposition of the absorbed fumigant. By measuring the $C^{14}$ of the volatile products obtained on treating the gluten with sodium hydroxyde or hydriodic acid under different

conditions, it was shown that the decomposition of methyl bromide in gluten was due almost entirely to methylation with the formation of 50% of N-methyl derivatives, 30% of dimethyl sulphonium derivatives, and of 20% of methoxyl and thiomethoxyl derivatives in about equal proportions. Similar results were obtained when gluten alone was exposed to the labelled fumigant. The production of free methanol in the flour by hydrolysis of the absorbed fumigant was about 10% or less. The rate of spontaneous decomposition of the dimethyl sulphonium compounds formed as a result of fumigation was estimated by using wheat which had been grown on $S^{35}$-labelled sulphate. (auth.)

765 Bridges, R.G. THE FATE OF LABELLED INSECTICIDE RESIDUES IN FOOD PRODUCTS. III. N-METHYLATION AS A RESULT OF FUMIGATING WHEAT WITH METHYL BROMIDE. J. Sci. Food. Agric. 6 (1955) 261-8.

The principal reaction between $C^{14}$-labelled methyl bromide and the nitrogen-containing groups of wheat protein has been shown, by combined radioactive tracer-chromatographic techniques, to be with the histidine residue. Three methylated histidines are present in the hydriodic acid hydrolysate of the protein that has been exposed to methyl bromide, and these have been identified as 1-N-methylhistidine, 3-N-methylhistidine and 1:3-N-dimethylhistidine. The amount of reaction occurring under typical fumigation conditions is so small that the loss of the semi-essential amino acid, histidine, is negligible. (auth.)

766 Bridges, R.G. THE FATE OF LABELLED INSECTICIDE RESIDUES IN FOOD PRODUCTS. V. THE NATURE AND SIGNIFICANCE OF ETHYLENE DIBROMIDE RESIDUES IN FUMIGATED WHEAT. J. Sci. Food Agric. 7, 5 (1956) 305-13.

Ethylene dibromide labelled with radioactive bromine ($Br^{82}$) was used to study the absorption in wheat during fumigation and on subsequent airing and heating. In spite of the high physical sorption of the fumigant and its slow rate of dispersal by airing, there is little chemical reaction between it and the wheat at room temperature. When fumigated wheat that has been imperfectly aired is heated, part of the ethylene dibromide sorbed on it undergoes decomposition to ethylene glycol and inorganic bromide, the remainder being lost by volatilization; as ethylene glycol is a less toxic material, heating provides a safeguard against possible poisoning due to ethylene-dibromide residues. There is some evidence that the glycol formed reacts with the wheat protein. The hydrogen bromide liberated when the ethylene dibromide is decomposed by heating appears to cause some splitting of the starch-granule sheaths. It is concluded that no significant changes appear likely to take place in the nutritive value of wheat as a result of fumigation.

767 Winteringham, F.P.W. THE FATE OF LABELLED INSECTICIDE RESIDUES IN FOOD PRODUCTS. IV. THE POSSIBLE TOXICOLOGICAL AND NUTRITIONAL SIGNIFICANCE OF FUMIGATING WHEAT WITH METHYL BROMIDE. J. Sci. Food Agric. 6, 5 (1955) 269-74.

The major products of the chemical reactions between methyl bromide and the constituents of wheat under the conditions of fumigation have been characterized or identified. Their rate of absorption by an adult human consuming fumigated flour products has been estimated. The likely nature of the effective end-products of human digestion has been considered and is believed to be represented by the compounds methanol, methylglucoses, S-methylcysteine, methyl methionine sulphonium salts, and N-methyl derivatives of histidine and lysine. These appear to be compounds which have been fed experimentally to mammals at concentrations very much larger than those likely to obtain in fumigated wheat. In some cases their metabolism in vivo has also been studied. On the basis of all the available data an appraisal has been made of the toxicological and nutritional significance of consuming fumigated flour products. There is no evidence that the principal fumigant decomposition products are toxic or that their formation would be associated with any significant reduction in essential food constituents. $C^{14}$-labelled methyl bromide was used (see Winteringham, Harrison, Bridges and Bridges, 1955) (from auth.)

## Gusathion

* Tietz et al. 1957 - [562]

* Tietz et al. 1960 - [561]

## Malathion

768 Matsumura, F. MALATHION RESIDUES ON AND IN THE LEAVES OF PHASEOLUS VULGARIS. J. econ. Ent. 53 (1960) 452-4.

By using $P^{32}$-labelled Malathion, the speed of migration of Malathion in the tissues of P. vulgaris L. was measured. Speed of migration was found to be very low in leaves. Malathion was taken up by the leaf tissues very rapidly, and the rate of entry of Malathion into the tissue was found to satisfy Langmuir's absorption equation. It was found also that the slow dissipation of Malathion residues in the later stage (persistence stage) in this experiment was owing to the lower rate of evaporation effected by absorption of the insecticide by plant tissue. (auth.)

Parathion

* Gar and Kipiani 1956 - [574]

$S^{35}$

* Turrell 1950 - [710]

* Turrell and Chervenak 1959 - [711]

Schradan

* Glynne Jones and Thomas 1953 - [613], [614]

* Heath et al. 1952 - [618]

* " 1953 - [617]

* Heath and Llewellyn 1953 - [619]

* Heath et al. 1956 - [621]

* March et al. 1954 - [623]

* Metcalf et al. 1955 - [625]

Systox

* David and Gardiner 1955 - [753]

* Hartley 1952 - [638]

* Metcalf et al. 1955 - [643]

* Mühlmann and Tietz 1956 - [645]

* Stein and Smith 1954 - [646], [647]

* Thomas and Glynne Jones 1955 - [648]

* Thomas et al. 1955 - [649]

* Tietz 1956 - [650]

Miscellaneous

* Casida et al. 1956 - [660]

* Halberstadt 1959/1960 - [503]

II-1-3 SOIL

DDT

* Jackson and Hopkins 1952 - [472]

* Miles and Pearce 1957 - [481]

Parathion

* Lichtenstein 1958 - [582]

Phorate

* Getzin and Chapman 1960 - [592]

# III TECHNIQUES

## Survey

769 Comar, C. L. RADIOISOTOPES IN BIOLOGY AND AGRICULTURE. PRINCIPLES AND PRACTICE. New York, McGraw-Hill Book Company, Inc. 1955, 481p.

Very useful book, with extensive bibliography. The principles of tracer methodology are discussed in detail, including isotope dilution techniques and double labelling. Different chapters deal with basic difficulties; facilities and handling of radioisotopes in animals and plants; general procedures for radioassays; properties and procedures for individual radioisotopes; autoradiography; paper chromatography; and radioactivation analysis. An author and subject index are included.

## III - A Autoradiography

770 Duncombe, W. G. AN AUTORADIOGRAPHIC METHOD FOR DISTINGUISHING SAMPLES LABELLED WITH PHOSPHORUS-32 AND SULPHUR-35. Nature 183 (1959) 319.

The method used by Gillies (1958) for studying insects labelled with both $P^{32}$ and $S^{35}$ was modified by using film coated with photographic emulsion on both sides such as in most commercial x-ray films. Kodak "Kodirex" film was used for radiography of chromatograms which enables the two isotopes to be distinguished easily. It might be feasible to distinguish more than 2 isotopes by this method.

771 Gillies, M. T. A SIMPLE AUTORADIOGRAPHIC METHOD FOR DISTINGUISHING INSECTS LABELLED WITH $P^{32}$ AND $S^{35}$. Nature 182 (1958) 1683-4.

Specimens labelled with both $S^{35}$ or $P^{32}$ could be distinguished by covering them with two pieces of x-ray film, and preparing autoradiographs. The low-energy $S^{35}$ $\beta$-particles (0.167 MeV) were found to blacken only one film, while the high-energy $P^{32}$ $\beta$-particles (1.71 MeV) penetrated the first film and blackened the second as well. $S^{35}$, in addition to $P^{32}$, is being used for field studies on Anopheles gambiae. The technique is described.

772 Mazia, D., Plaut, W. S., Ellis, G. W. A METHOD FOR THE QUANTITATIVE ASSESSMENT OF AUTORADIOGRAPHS. Exp. Cell Res. 9 (1955) 305-12.

An optical system for scanning autoradiographs is described. It is based essentially on forming a band pattern of the grains in a strip of the autoradiograph by means of a cylindrical lens camera and on the photoelectric recording of the distribution of band intensities along the strip. Examples in which Drosophila salivary gland preparations are used for measurements are given, where the DNA was measured in terms of $P^{32}$.

* Metcalf 1960 - [413]

773 Sirlin, J. L. AUTORADIOGRAPHY OF NUCLEOLAR CONTENTS. Exp. Cell Res. 14, 3 (1958) 447-53.

Work on nucleoli of somatic cells, including those of the salivary gland of Drosophila, is described where $S^{35}$-labelled methionine was used. This and other results are discussed, emphasis being placed on the relations between DNA, RNA, and associated and non-associated proteins.

774 Winteringham, F. P. W., Harrison, A., Hammond, J. H. AUTORADIOGRAPHY OF WATER-SOLUBLE TRACERS IN HISTOLOGICAL SECTIONS. Nature 165, 4187 (1950) 149-50.

One method tried for locating water-soluble $Br^{82}$ in larvae of Calliphora erythrocephala (alcoholic $AgNO_3$ was used for dehydration and precipitation of the halide in situ) caused some damage to the tissue and the stripping emulsion applied afterwards. Useful autoradiographs of $I^{131}$ have been obtained of larvae poisoned by methyl iodide, by a combination of the Altmann-Gersh process and a modified stripping-emulsion technique. The method is described in some detail with some illustrations.

## III - B Dosimetry

775 Gaulden, M.E., Sheppard, C.W., Cember, H. TECHNIQUE FOR EXPOSING GRASSHOPPER NEUROBLASTS TO BETA-RAYS. Nature 169 (1952) 228-9.

Mechanical details of an apparatus for exposing grasshopper embryos to radiation from $P^{32}$-bakelite plaques are illustrated. An accurate determination is possible of the amount of radiation to which the cells have been exposed. Maximum protection is provided for the operator. (NSA 6: 3887, 1952)

776 Hilchey, J.D., Cooper, R.D. DOSIMETRY FOR STUDIES ON THE RADIOBIOLOGY OF TRIBOLIUM CASTANEUM USING THE VAN DE GRAAFF ELECTRON ACCELERATOR. J. econ. Ent. 53 (1960) 496-500.

A means is given for calculating the dose of radiation, in rads, absorbed by adult Tribolium castaneum (Hbst.) when irradiated with high-energy electrons from a Van de Graaff accelerator. The expression for dose is based on (1) the power output of the accelerator; (2) the amount of time the target (insect) is in the beam; (3) the fraction of the scanned area occupied by the target; (4) the fraction of the energy of the incident electrons which is lost in the target; and (5) the mass of the target. The expression is developed in detail on the basis of the ideal case, but possible departures from the ideal in practice are discussed. The physical parameters of the insect which pertain to the calculation of dose are reported. (auth.)

* King 1952 - [386]

777 Kloft, W. DIREKTES UND INDIREKTES VERFAHREN ZUR MESSUNG DER BETA-STRAHLENABSORPTION VON KLEINEN GEWEBESCHICHTEN AN INSEKTEN. (Direct and indirect techniques for measuring β-ray absorption) G-I-T Glas+Instrumenten-Technik 3, 3 (1959) 79-110. (in German)

In order to determine directly the absorption coefficients for β-rays of different tissues, the various tissue layers of the $P^{32}$-labelled insects are removed. Changes in radiation intensity thus produced are measured. For a known, microscopically determined tissue thickness the true activity (minus the absorbing tissue) may be calculated from the measured impulse rate. In the indirect method, the original impulse rate is re-established by interposing aluminium foils of known surface density, which will give data on the chitinous cuticle. Possible errors and experimental details are discussed, and also other applications of the technique.

## III - C Isotope Dilution

778 Craig, J.T., Tyron, P.F., Brown, W.G. DETERMINATION OF THE GAMMA ISOMER CONTENT OF BENZENE HEXACHLORIDE BY CHLORINE-36 ISOTOPE DILUTION METHOD. Analyt. Chem. 25, 11 (1953) 1661-3.

Considerable disagreement among a number of analytical methods for determination of the γ-isomer of benzene hexachloride led to the development of a new isotope dilution method using $Cl^{36}$-labelled pure γ-isomer as a tracer. A known quantity of chemically pure radioactive γ-isomer of benzene hexachloride, labelled with $Cl^{36}$, is added to a known weight of a technical benzene hexachloride sample of unknown γ-content. A sample of pure γ-isomer is then isolated from the mixture by an extraction procedure. The specific activity of the isolated material is compared to that of the original labelled isomer. The standard deviation of the method is ± 0.2% in γ-isomer content. Four determinations can be made by one analyst in an 8 h day. This analytical procedure can be classified as an absolute method and is being used as a referee for other routine methods for the determination of the γ-isomer. It is being used to analyse benzene hexachloride samples having γ-contents ranging from 1 to 50%. (auth.)

779 Craig, J.T. MEASURING THE ACTIVE INGREDIENT IN AN INSECTICIDE. CASE STUDY. Nucleonics 14, 3 (1956) 60-1.

The essentials of the isotope dilution method are outlined. $Cl^{36}$-labelled pure γ-isomer was used as tracer, primarily because of the ease of affixing the labelled atoms to the molecule of BHC. Technical details are given. (See also Craig 1960, where methods and results are discussed in some detail)

780 Craig, J.T. APPLICATION OF ISOTOPE DILUTION TECHNIQUE TO THE ANALYSIS OF AN INSECTICIDE AND AN ANTIBIOTIC. p. 73-88 in "Radioactivity for Pharmaceutical and Allied Research Laboratories". Edelman, A., ed. New York, Academic Press. 1960.

Labelling of benzene hexachloride by means of the $Cl^{36}$-labelled pure γ-isomer is described, including precautions taken to ensure purity and safety. Some details of assay procedure (see Craig et al., 1953) are given, and the accuracy and uniformity of the results discussed. Tabulated results indicate the precision of the isotope dilution method, also compared with the infra-red method and with paper chromatography. Collaboration studies between different laboratories on the percentages of γ-isomer in various samples of technical grade BHC indicate close agreement as well as fine precision within each lab.

* Palin 1954 - [454]

781 Redemann, C.T., Meikle, R.W. ISOTOPE DILUTION TECHNIQUES FOR THE DETERMINATION OF PESTICIDE RESIDUES. p. 183-206 in "Advances in Pest Control Research", Vol. 2. Metcalf, R.L., ed. New York, Interscience Publishers, Inc. 1958, 426 p.

A method of residue determination is described which involves dilution of the material initially present in the sample with a precisely known quantity of a particular isotopic form (either stable or radioactive) of the same substance. The various experimental steps and general procedure are discussed. Attention is paid to the dilution of non-radioactive residues with radioactive isotopes, and illustrated with data from work with a herbicide.

## III - D Labelled Pool Technique

* Winteringham and Hellyer 1954 - [729]

782 Winteringham, F.P.W., Harrison, A. STUDY OF ANTICHOLINESTERASE ACTION IN INSECTS BY A LABELLED POOL TECHNIQUE. Nature 178 (1956) 81-3.

For the study of adult houseflies under the influence of an insecticide, 1 μl $H_2O$ containing 18 γ Na acetate-2-$C^{14}$, equivalent to 2 μc $C^{14}$, was injected intrathoracically. Immediately afterwards, 1 μl $Me_2CO$ (control) or 1 μl $Me_2CO$ containing 10 γ diisopropyl phosphofluoridate (I) was applied topically. By paper chromatographic separation (Winteringham et al., CA. 49: 5691h) of extracts of heads and thoraxes, 7 distinct $C^{14}$-labelled fractions were resolved. The mean $R_f$ values ($H_2O$-formic acid-acetone) were: (1) 0, (2) 0.25, (3) 0.47, (4) 0.58, (5) 0.66, (6) 0.75, and (7) 0.91. Fractions 3, 5 and 6, representing 75% of the total soluble $C^{14}$, were identified as glutamine, glutamic acid, and proline. Hydrolysis of the insoluble thoracic protein showed that almost all the protein $C^{14}$ was present as glutamate and proline only. No detectable fraction of the soluble $C^{14}$ behaved as free choline. The proportion of $C^{14}$ found in the acetylcholine (II) fraction was independent of the weight of unlabelled II added at any stage of the fractionation, which fact showed that no isotope exchange occurred between carrier and some other labelled metabolite. II was labelled in vivo in the acyl moiety only. The glutamine accumulation suggested that I may have rendered necessary an $NH_3$ detoxification mechanism. There was a relative rise of II after ½ h, followed by a fall to normal after 2 and 5 h; this suggests that the cholinesterase inhibition was reversible. (CA 51: 1343c, 1957)

783 Winteringham, F.P.W. LABELLED METABOLIC POOLS FOR STUDYING QUANTITATIVELY THE BIOCHEMISTRY OF TOXIC ACTION. Intern. J. appl. Radiation and Isotopes 1, (1956) 57-65.

By feeding suitably labelled substrates to insects, well-defined metabolic pools become rapidly labelled which may then be separated and resolved by suitable chromatographic techniques. Multi-dimensional paper chromatography may be used; separated compounds may be scanned on uni-dimensional strips for a quantitative evaluation of the particular labelled compound. The soluble phosphorus pool of adult Musca domestica L. was studied by feeding carrier-free $P^{32}O_4$. The nature and relative specific activities of the $P^{32}$-labelled intermediates extracted from tissues were determined by co-chromatographic and neutron activation techniques. This technique has also been extended to the use of $C^{14}$-labelled pools.

* Winteringham 1958 - [418]

* Winteringham et al. 1958 - [730]

* Winteringham 1959 - [156]

* Winteringham et al. 1960 - [495]

## III - E Paper Chromatography

* Metcalf 1960 - [413]

784 Winteringham, F. P. W., Harrison, A., Bridges, R. G. ANALYSIS OF DDT DERIVATIVES BY REVERSED-PHASE PARTITION CHROMATOGRAPHY. Nature 166 (1950) 999.

In order to study the metabolism in insects of a radioactive bromine analogue of DDT, $(BrC_6H_4)_2CH.CCl_3$ (I), a method was developed for the separation and estimation of (I) and the possible metabolites, $(BrC_6H_4)_2C{:}CCl_2$ (II) and $(BrC_6H_4)_2CH.COOH$ (III) on the micro-mole scale. Mixtures of such compounds labelled with $Br^{82}$ were analysed by reversed phase uni-dimensional paper partition chromatography. Details of the resolution obtained and the time factors involved are given. No isotope exchange between compounds was detected when a mixture containing radioactive (I) and inactive (II) and (III) were resolved.

785 Winteringham, F. P. W. RADIOCHEMICAL TECHNIQUES IN ANALYSIS. Nature 168 (1951) 153-5.

Summary of a meeting of the Society of Public Analysts and Other Analytical Chemists. For relevant paper presented, see 786 and 787.

786 Winteringham, F. P. W., Harrison, A., Bridges, R. G. RADIOACTIVE TRACER-PAPER CHROMATOGRAPHY TECHNIQUES. Analyst 77 (1952) 19-28.

An example of the application of this technique is cited where mixtures of $DBr^{82}DT$ and its metabolites, "$DBr^{82}DE$" and "$DBr^{82}DA$", were resolved. The uses and potentialities of combined radiochemical and papers chromatography techniques are discussed. The principle of the methods is to associate one or more radioactive isotopes with one or more substances separated on a paper chromatogram. The labelled substances can then be located and estimated by scanning the paper radiometrically. A simple device for doing this automatically, and its use in quantitative work is described. (from auth.)

787 Winteringham, F. P. W., Harrison, A., Bridges, R. G. RADIOACTIVE-TRACER TECHNIQUES IN PAPER CHROMATOGRAPHY. Nucleonics 10, 3 (1952) 52-7.

Their application to paper chromatography may permit the separated components not only to be located and characterized but to be estimated quantitatively. The principle is to associate one or more suitable radioisotopes with one or more of the components of the mixture, either before or after chromatography. The components separated on the chromatogram are then located and estimated by their associated radioactivity. Three methods of associating the isotope with one or more bands of the resolved components of the chromatogram are described, as follows: labelling of mixture before paper chromatography, treatment of chromatogram with labelled reagent, and neutron activation of the chromatogram. Diagrams are presented of a device which automatically scans the chromatogram. Methods of quantitative interpretation of the results and necessary corrections are discussed. This method has been used to resolve mixtures of $DBr^{82}DT$ and its metabolites, "$DBr^{82}DE$" and "$DBr^{82}DA$".

* Winteringham, et al. 1958 - [730]

## III - F Miscellaneous

788 Green, B. C., Spinks, J. W. T. AUTOMATIC PLOTTING OF THE POSITION OF A MOVING RADIOACTIVELY TAGGED OBJECT. Canad. J. Res., C - Canad. J. Technol. 33 (1955) 307-16.

An apparatus is described for automatically registering the movement of an object in the three dimensions of space and in time. It has been designed specially in order to register the movements of a Myriapod burrowing into the ground. The fundamental principles in which the apparatus is based are discussed. The description includes a thyrode, a Geiger counter, and a container for 20 $\mu c$ of $Co^{60}$.

789 Green, B. C., Spinks, J. W. T., LAPSE-TIME MOTION PICTURE STUDIES OF SOIL-BURROWING INSECTS. Nature 181 (1958) 434-5.

A machine had been developed for the automatic recording of radioactively tagged insects such as a wireworm. By means of the tag and the machine the wireworm was effectively provided with a pencil. The movements of the pencil and the machine were photographed, using lapse-time technique. A tagged

wireworm was liberated in a tray of soil placed on the floor. The machine was placed on a table above the tray, and a sheet of glass over the machine. A piece of grease pencil was attached to the machine on the Geiger axis, and held in contact with the under-surface of the glass by a spring. The path taken by the worm was thus traced on the lower side of the glass sheet. A 16 mm ciné camera was mounted above the machine for viewing through the glass sheet. The particular wireworm travelled at the rather high speed of 23 in/h.

790 Jones, J. C., Perry, A. S. A NIB-POINT MICROLOOP AND ITS CALIBRATION. Mosquito News 19, 1 (1959) 26-7.

A simple modification of a microloop is described which enables a drop of 0.1-0.8 µl of insecticide or another substance in a suitable solvent to be placed with precision on a selected area of a small organism (e.g. as required for topical applications to insects). The construction is described, and also methods for calibration. The three methods were (1) spectrophotometric; (2) colorimetric; and (3) radioassay, using 1.0% p, p'-DDT-$C^{14}$ (one loopful applied to a filter paper disc of 2.97 $cm^2$), activity being measured in a Q-gas flow counter.

791 Oftedal, P. HANDLING RADIOACTIVE FLIES. Drosphila Inform. Serv. 30 (1956) 163-4.

An apparatus made of perspex is described for handling flies (both insertion and removal from a capsule) which eliminates the need for repeated etherizations. It is illustrated by two figures.

792 Oftedal, P. MEASURING THE VOLUME OF INJECTION NEEDLES. Drosphila Inform. Serv. 30 (1956) 165.

A simple tracer method is proposed. A very weak solution of a fairly high-energy β-emitter (e.g., $P^{32}$) is expelled into a drop of water on one of the usual plaquettes used in most scaler assemblies. The solution is then diluted 1:100 or 1:1000, and a known volume, e.g., 5 µl of it pipetted onto a similar plaquette. After evaporation to dryness, the plaquettes are placed under the G-M tube for radioassay. A comparison of the 2 activities, corrected for the relevant dilution factor, gives the volume with a high degree of precision. To minimize inaccuracies due to adsorption to the pipette walls, the solution used should contain inactive carrier isotope.

793 Smales, A. A., Pate, B. D. DETERMINATION OF SUBMICROGRAM QUANTITIES OF ARSENIC BY RADIOACTIVATION. GENERAL METHOD AND APPLICATION TO GERMANIUM OXIDE. Analyt. Chem. 24 (1952) 717-21.

By irradiation with the Harwell pile followed by distillation from HCl and free Cl solution, precipitation by $(NH_4)H_2PO_2$ and counting it was possible to detect 0.001 γ of As within 10% of the truth. With Ge present, the counting is done through an absorber or better by scintillation spectrometer to diminish the contribution of the low-energy As activity desired from Ge. (CA 46: 11021h, 1952)

794 Jenkins, D. W., Davis, J. M. FIELD ASSESSMENT OF AIRPLANE SPRAYED INSECTICIDES WITH RADIOACTIVE GOLD. Proc. Ann. Mtg. Amer. Mosq. Control Ass. 1952.

# IV BIBLIOGRAPHIES AND GENERAL SURVEYS

## IV - A Bibliographies

795 Anonymous A CLASSIFIED BIBLIOGRAPHY ON THE APPLICATION OF ISOTOPES IN PURE AND APPLIED RESEARCH - I AGRICULTURE - ENTOMOLOGY 47-49. Intern. J. Appl. Radiation and Isotopes 3 (1958) 46-77.

This bibliography covers the period 1955-1956,"to be continued in subsequent issues."

796 McCormick, J. A., comp. ISOTOPE TECHNIQUES IN BIOLOGICAL SCIENCES. TID-3512, Technical Information Service, AEC. Feb. 1958, 44p.

Amongst the 807 selected references on techniques for the use of radioactive and stable isotopes in the biological sciences, taken from the 1948-1956 open literature, there are some which are relevant to this bibliography. The percentage is not very high. An author index and an alphabetical listing of literature reference sources is are included.

797 McCormick, J.A., comp. ISOTOPES IN BIOCHEMISTRY AND BIOSYNTHESIS OF LABELED COMPOUNDS. A selected list of references. TID-3513, Technical Information Service, AEC. March 1958, 89p.

This bibliography contains 2430 selected references on uses of radioisotopes in biochemistry and biosynthesis of labelled compounds, taken from the 1948-1956 open literature. Some references come within the range of the present bibliography. A list of the journals from which the references were selected and an author index are included.

798 McCormick, J.A., comp. ISOTOPES... A BIBLIOGRAPHY OF UNITED STATES RESEARCH AND APPLICATION 1955-1957. TID-3076, Technical Information Service, AEC. May 1958, 267p.

The contents include sections on A. Diagnostic Medicine B. Therapeutic Medicine C. Clinical Research D. Human Physiology E. General Medical Research F. Immunology G. Metabolite Physiology in Animals H. Non-Metabolite Physiology in Animals I. Injurious Agent Physiology in Animals J. General Animal Physiology K. Animal Husbandry L. Bacteriology M. Fertilizer Uptake by Plants N. Plant Physiology O. Photosynthesis P. Radiation Effects on Living Organisms Q. Biochemistry R. Biosynthesis of Labeled Compounds S. Chemical Synthesis of Labeled Compounds T. General Chemistry U. Reaction Mechanisms and Kinetics V. Radiochemistry W. Radiation Detection X. Radiation Physics Y. Nuclear Properties of Isotopes Z. General Physics AA. General Topics BB. Isotope Techniques CC. Applied Industrial Use DD. Entomology.

Nearly 6000 references cover work with radioactive and stable isotopes. Reference is only made to material appearing in scientific technical and professional journals during the 3 years ending Dec. 1957 or, more specifically, since publication of Isotopes: An Eight-Year Summary of United States Distribution and Utilization, dated March 1955. An author index and a key to journal abbreviations are included. Sections of interest are underlined.

799 McCormick, J.A., comp. RADIOISOTOPES IN ANIMAL PHYSIOLOGY. A selected list of references. TID-3515, Technical Information Service Extension, Oak Ridge, Tenn. Dec. 1958, 118p.

The 2439 references cited in this bibliography, and obtained from 1948-1957 open literature, include those that have appeared in ISOTOPES: A Three-Year Summary of U.S. Distribution (1949); ISOTOPES: A Five-Year Summary of U.S. Distribution (1951); ISOTOPES: An Eight-Year Summary of U.S. Distribution and Utilization (1955); ISOTOPES: A Bibliography of United States Research and Application 1955-1957 (1958). A list of journals from which these references were selected and an author index are provided.

800 McCormick, J.A., comp. RADIOISOTOPES IN AGRICULTURE: ANIMAL HUSBANDRY, BACTERIOLOGY, FERTILIZER UPTAKE, PLANT PHYSIOLOGY, PHOTOSYNTHESIS, AND ENTOMOLOGY. A selected list of references. TID-3516, Technical Information Service, AEC. Jan. 1959, 67p.

This bibliography contains 1335 selected references on uses of radioactive and stable isotopes in animal husbandry, bacteriology, fertilizer uptake by plants, plant physiology, photosynthesis, and entomology. These references were selected from scientific journals published during 1948-1957. They include those that have appeared in ISOTOPES: A Three-Year Summary of U.S. Distribution (1949); ISOTOPES: A Five-Year Summary of U.S. Distribution (1951); ISOTOPES: An Eight-Year Summary of U.S. Distribution and Utilization (1955); and ISOTOPES: A Bibliography of United States Research and Application 1955-1957 (1958). A list of the journals from which the references were selected and an author index are included. (auth.)

801 McCormick, J.A., comp. RADIOISOTOPES IN AGRICULTURE: FERTILIZER UPTAKE, PLANT PHYSIOLOGY, PHOTOSYNTHESIS, AND ENTOMOLOGY. A selected list of references. TID-3516 (Suppl. 1), Technical Information Service, AEC. 1959, 22p.

This bibliography contains 151 selected references on the uses of radioactive and stable isotopes in animal husbandry and in studies of fertilizer uptake by plants, plant physiology, photosynthesis, and entomology. These references were selected from scientific journals published during the period 1957 to 1958. An author index is included. (auth.)

802 McCormick, J.A., Voress, H.E., comps. RADIOISOTOPES IN AGRICULTURE: ANIMAL HUSBANDRY, FERTILIZER UPTAKE, PLANT PHYSIOLOGY, PHOTOSYNTHESIS, AND ENTOMOLOGY. TID-3078, Technical Information Service, AEC. Dec. 1960, 39p.

This bibliography supersedes TID-3516, Suppl. 1. The 148 references cited are those which have appeared in scientific journals published during the period 1957-1958. The section on entomology contains only 7 references. An author and a subject index are supplied.

803 Smetana, O. BIBLIOGRAFIE ČESKOSLOVENSKÝCH ENTOMOLOGICKÝCH PRACÍZA ROK 1952. Bibliography of Czechoslovak entomological literature - 1952) Acta Soc. ent. Bohem. (Čsl.) 51 (1954) 237-53. (In Czech)

(It has not been possible to obtain this publication. It is presumed to contain some references to the use of radioisotopes in the field)

## IV - B Surveys

804 Asperen, K. van DE TOEPASSING VAN RADIOISOTOPEN IN DE INSEKTENFYSIOLOGIE EN HET INSEKTICIDENONDERZOEK (The application of radioisotopes in insect physiology and insecticide research). Landbouwk. Tijdschr., Groningen 70 (extra no.) (1958) 358-69. (In Dutch)

Review article. The section on insecticides lists radioisotope-labelled insecticides reported to date, and studies on their uptake, transport and breakdown in plants, and the various lines of research being followed at present. 50 refs.

805 Dahm, P.A. STUDIES OF INSECTS AND INSECTICIDES WITH TRACERS. p.162-99 in "Conference on the Use of Isotopes in Plant and Animal Research. 12-14 Apr. 1952". TID-5098, Kansas State Coll. and Argonne National Lab. and Isotopes Div., AEC. 1953.

A review is presented of the fast-growing literature dealing with studies of insects and insecticides employing tracers. The literature has been divided into five broad categories: tagging insects and related arthropods with radioelements, physiological studies with insects, biological effects of irradiation, studies relating to medical and veterinary entomology, and the preparation and use of labelled insecticides. Summaries of the observations reported in the literature on the use of radioelements to tag insects and related arthropods and the preparation methods and uses of radioisotope-labelled insecticides and related compounds are presented in tabular form. Experimental results are presented dealing with the distribution and metabolism of doubly labelled ($P^{32}$ and $S^{35}$) Parathion in the goat and the American cockroach. 149 references. (auth.)

806 Dahm, P.A. USES OF RADIOISOTOPES IN PESTICIDE RESEARCH. p.81-146 in "Advances in Pest Control Research", Vol.1. Metcalf, R.L., ed. New York, Interscience Publishers, Inc. 1957.

A very important and comprehensive review of the whole field. The topics covered are: insecticides (DDT and related chemicals, Lindane and BHC, organic phosphorus insecticides, pyrethroids and piperonyl butoxide, nicotine, fumigants, and miscellaneous insecticidal chemicals), fungicides, herbicides and

plant growth regulators, the tagging of insects, mites, and ticks with radioisotopes, epidemiology and public health, and food preservation and pest control through radiation effects. Special techniques and equipment are mentioned only where they have some bearing on the pest control problem. 323 references.

807 Fisher, W. RADIOISOTOPE IN PHYTOPHATHOLOGIE UND PFLANZENSCHUTZ. (Radiosiotopes in phytophathology and plant protection) NachrBl. dtsch. PflSchDienst, Berl. 9 (1957) 88-94. (In German)

This review article is divided into two parts. One deals with radiation effects in terms of induced mutations, and the sterilization of food, stored products, pharmaceuticals and packaging materials, with some discussion of radiation sources. The second part is concerned with the use of radioisotopes as tracers as applied in studies on pests, plants and plant protection. 64 references.

808 Jenkins, D.W., Hassett, C.C. RADIOISOTOPES IN ENTOMOLOGY. Nucleonics 6, 3 (1950) 5-14.

Applications of radioisotopes to a variety of entomological problems are reviewed, from 1927 onwards. A type of application is described here which uses isotopes to study phenomena without actually interfering with them. Migration, feeding and breeding habits of many insects have been reported, and studies mentioned on the role of insects in disease transmission, and on predation. Some unpublished work (Hassett & Jenkins) is quoted in which malaria, house, and rockpool mosquitoes, houseflies, fruitflies, and screwworm flies were made radioactive by mixing $P^{32}$ with the food of the larvae. Cockroaches and flesh flies were injected with $\gamma$-emitting $Zr^{95}$ to study the possibility of locating insects at greater distances than is possible with $\beta$-emitting $P^{32}$. Cunliffe (unpublished) confirmed a suspected mite parasite of the cockroach by introducing $P^{32}$ into the roaches. $P^{32}$-labelled mosquitoes and fruitflies were shown (H. & J.) to be caught and eaten by praying mantids (laboratory). - Feeding by mosquitoes on plants was confirmed (H. & J.) by $P^{32}$-labelling plant juices which were later found to have been absorbed by yellow-fever and house mosquitoes. Some work in physiology is mentioned, including some initial work on labelled inorganic insecticides. Studies on the effects of radiation on growth and reproduction are cited. - 41 references.

# PART II

# IONIZING RADIATIONS

# I RESEARCH

## I-A Radiosensitivity

### I-A-1 RADIOSENSITIVITY TO DIFFERENT TYPES OF RADIATION

#### Survey

809 Langham, W. H., ed., Bell, P., Godfrey, L., Stearns, H., comps. LITERATURE SEARCH ON THE RELATIVE BIOLOGICAL EFFECTIVENESS (RBE) OF IONIZING RADIATIONS. LAMS-2343, Los Alamos Scientific Laboratory, New Mexico, 1960, 251 p.

Numerous references are relevant, in part, to the present bibliography. Results of a literature search to aid in establishing appropriate values for relative biological effectiveness (RBE) are presented. RBE may be defined as the ratio of the dose of 200- to 250-kV x-rays required to produce a specific biological effect to the dose of another radiation required to produce the same level of effect. Although some references may have been missed, the compilation is believed to be relatively complete up to mid-year 1959. The references are listed in alphabetical order, according to author. In most cases, the abstracts given are those of the author or the abstracting medium from which the reference was taken. Approximately 500 references are given.

---

* Alexander 1958 - [1165]

810 Amy, R. L. (Univ. Virginia, Charlottesville) A COMPARATIVE STUDY OF THE EFFECTS OF BETA RAYS, GAMMA RAYS AND X-RAYS ON DEVELOPMENT IN HABROBRACON (WITH APPENDIX. DESCRIPTIVE STUDIES ON THE EMBRYOGENESIS AND ORGANOGENESIS OF HABROBRACON). Diss. Abstr. 15, 11 (1955) 2347.

An appendix to the dissertation describes typical embryological development.

(For abstract, and publication of the dissertation in part, see Radiation Res. 3, 2 (1955) 166.

811 Amy, R. L. A COMPARATIVE STUDY OF THE EFFECTS OF $\beta$-RAYS, $\gamma$-RAYS AND X-RAYS ON DEVELOPMENT IN HABROBRACON. Radiation Res. 3, 2 (1955) 166-81.

Eggs of Habrobracon juglandis (Ashmead) were subjected, 1-3 h after they were laid, to $\beta$-rays ($P^{32}$), $\gamma$-rays ($Co^{60}$), or 125-kV potential x-rays under equivalent physical conditions. At each of the 7 dose levels used dosages were adjusted so that the amount of energy dissipated within the eggs was approximately the same for all three types of radiation. X-rays were most effective in reducing the percentage of eggs hatching, $\beta$-rays were less effective and $\gamma$-rays were least effective in this respect. Histological observations made on embryos exposed at the highest dose level are described. Enlargement of nuclei (up to 3 times the diameter of those found in untreated animals) was a prominent feature of the degenerative changes observed. Although there was indication that cell division continued for a time after exposure, other developmental processes were for the most part completely inhibited. Externally visible structural derangements were seen in damaged eggs but none which were interpreted as being peculiar to any of the types of radiation employed. In general, the time between irradiation and the appearance of visible signs of injury was inversely proportional to the amount of radiation received by the eggs. (auth.)

(An abstract of earlier work appeared in Anat. Rec. 115 (1953) 273)

* Baeumer and Müller 1952 - [1169]

812 Bateman, A. J. RELATIVE MUTAGENIC EFFICIENCY OF 4 MeV X-RAYS AS ASSESSED BY THE INDUCTION OF DOMINANT LETHALS IN DROSOPHILA. p. 144-9 (disc. 149-55) in "Progress in Radio-

biology. Proceedings of the 4th International Conference on Radiobiology, Cambridge 14-17 Aug. 1955". Mitchell, J. S., Holmes, B. E., Smith, C. L., eds. London, Oliver and Boyd.

There are indications that the Linear Accelerator (4M 4 MeV) is less efficient than the conventional Resomax (300 keV), at least as regards its mutagenic effects on Drosophila.

813 Bateman, A. J. THE RELATIVE BIOLOGICAL EFFICIENCY OF 4 MeV AND 300 KV RADIATIONS. V. THE INDUCTION OF DOMINANT LETHALS IN DROSOPHILA SPERM. Brit. J. Radiol. 30 (1957) 347-9.

Production of mutations and lethal dominants are always proportional to the dose administered. The relative efficacity is 0.83. (BS 19: 105255, 1958)

814 Bertram, C., Höhne, G. ÜBER DIE MUTATIONSAUSLÖSUNG MIT SCHNELLEN ELEKTRONEN (Induction of mutations by fast electrons). Strahlentherapie 106 (1958) 269-72. (In German)

The authors report about comparative investigations on the induction of mutations in Drosophila by fast electrons of a betatron and by conventional x-rays. The rates of radiation-induced, sex-linked recessive lethal mutations were determined by means of the Muller-5-(Basc) method. Under the described conditions of equivalent doses (4000 and 2000 r resp. rep) 15 MeV electrons and 200 kV x-rays were found to produce the same mutation rates within the range of statistical error. The relative biological effectiveness of the betatron electron is approximately 1. (auth.)

* Brandt and Höhne 1952 - [1372]

815 Brandt, H. von, Höhne, G. MUTATIONSAUSLÖSUNG BEI DER TAUFLIEGE DROSOPHILA MELANOGASTER DURCH SCHNELLE ELEKTRONEN EINES 6 MeV- BETATRONS (Production of mutations in Drosophila melanogaster by fast electrons from a 6-MeV betatron). Strahlentherapie 90 (1953) 93-9. (In German)

In studying the mutagenic activity of fast electrons from a 6-MeV betatron it is shown that, as concerns the elicitation of recessive sex-limited lethal factors in D. melanogaster, there does not exist a significant difference between fast electrons and the röntgen radiations conventionally used for therapeutic purposes. For mature male generative cells as well as for immature germ-cells, the relative biologic activity is $\approx 1$. If equal doses are applied, then the rate of mutation induced in immature germ-cells lies considerably below that induced in mature male generative cells. (CA 47: 6993b, 1953)

816 Brandt, H. von, Höhne, G. ÜBER DIE AUSLÖSUNG AUTOSOMALER CHROMOSOMENMUTATION BEI DROSOPHILA DURCH SCHNELLE ELEKTRONEN UND RÖNTGENSTRAHLEN (On the induction of autosomal chromosome mutation in Drosophila by fast electrons and x-rays). Zool. Anzeiger, Suppl. 17 - Verh. dtsch. zool. Ges. 1952 (1953) 365-9. (In German)

Since the rate of radiation-induced chromosome mutations depends very considerably on the stage of development of the irradiated gamete, translocations were only considered for mature sperm, with copulation limited to one day. Dosages used for both types of radiation (3 MeV electrons and 200 kV x-rays) ranged from 1000 r to 6000 r. The percentages of II/III translocations induced in D. melanogaster were tabulated. The results of the study were discussed. The effectiveness of fast electrons relative to x-rays was found to scarcely deviate from 1.

817 Brandt, H. von, Dittrich, W. INDUZIERTE BRÜCHE DES RING-CHROMOSOMS $X^{C2}$ VON DROSOPHILA MELANOGASTER NACH BESTRAHLUNG MIT RÖNTGENSTRAHLEN UND SCHNELLEN ELEKTRONEN (Induced breaks of the $X^{C2}$ ring chromosome of Drosophila melanogaster after irradiation with x-rays and fast electrons). Strahlentherapie 91 (1953) 149-56. (In German, but see AEC-tr-3478, 12p.)

Males of an $X^{C2}$ strain of D. melanogaster were irradiated with various doses of fast electrons from a 6-MeV betatron and with x-rays (180 kV). Immediately after irradiation the males were bred with Berlin normal females. The $F_1$ generation produced by fully-developed spermatozoa exhibited a more or less marked deficit of females, the investigations covering a total of 350 000 flies. The results were compatible with the assumption of a linear increase of the deficit of females with dosage within the dosage range investigated, from 0 - 6000 r. The x-ray experiments made it at least highly probable that the effect increases with the dose for x-rays, and the same holds true for fast electrons in the more highly scattering electron experiments. No difference in the action of the two types of rays could be found. The ring-X method is not very suitable in the form employed here for a more precise comparison of the biological activity of different types of ionizing rays. (auth.)

* Dittrich et al. 1950 - [989]

* Dittrich et al. 1950 - [1182]

818 Edington, C. W. THE INDUCTION OF RECESSIVE LETHALS IN DROSOPHILA MELANOGASTER BY RADIATIONS OF DIFFERENT ION DENSITY. Genetics 41, 6 (1956) 814-21.

It has been shown that fast neutrons are 1.62 times more effective than $Co^{60}$ γ-rays in inducing sex-linked recessive lethals. Since the frequency of recessive lethals induced by x-rays increases with increasing dose more rapidly than one would expect on the basis of linearity, the relative biological effectiveness for x-rays as compared to fast neutrons or gamma rays is dependent upon the dose of x-rays used. It was also shown that the frequencies of recessive lethals induced by x-rays in acrocentric- and a ring-X chromosome were significantly different. The possible reasons for this ring-rod difference and the non-linear dose response for x-ray-induced recessive lethals are discussed. (auth.)

819 Edington, C. W., Randolph, M. L. A COMPARISON OF THE RELATIVE EFFECTIVENESS OF RADIATIONS OF DIFFERENT AVERAGE LINEAR ENERGY TRANSFER ON THE INDUCTION OF DOMINANT AND RECESSIVE LETHALS IN DROSOPHILA. Genetics 43 (1958) 715-27.

An investigation was made of the effects of monochromatic 14-MeV fast neutrons and $Co^{60}$ gamma rays on the induction of dominant lethals and of 14-MeV neutrons on the production of sex-linked recessive lethals in Drosophila. These results were compared with those of other reports from this laboratory, in which radiations of different average LET were used. It was shown that the RBE of different radiations for the induction of both genetic effects studied is dependent on the LET of the radiation used. 34 references. (auth. summary)

820 Evans, T. C., Yu Ying Fu. RELATIVE EFFECTIVENESS OF FAST NEUTRONS AND X-RADIATION ON EMBRYOS OF THE GRASSHOPPER. (abstr.) Radiation Res. 5 (1956) 477.

Eggs of Melanoplus differentialis were irradiated on the 4th day of development (25°C). They were examined 3 weeks later, at which time the controls were in the diapause stage. Radiation effect was indicated as either injured or complete destruction of the embryo. X-ray doses were from 100 r to 450 r in increments of 50 r. Two sources of fast neutrons were utilized. The first was the direct beam of the Argonne 60-in cyclotron and was produced by bombarding a beryllium target with deuterons. The second was a field at the rear of the target (180° from first field utilized). The second irradiation field differed from the first in including lower energy neutrons, and the intensity was lower by a factor of 2. Exposures were measured in air with thimble ion chambers. Neutron doses in rep were calculated by a conversion factor based on studies employing different methods of measuring neutron dose. The results of two experiments were consistent in that the $LD_{50}$ for the x-radiation was 265 and 257 r; for the higher energy neutron beam 133 and 112 rep; and for the lower energy neutron beam 63 and 49 rep. Based on the 250 kV potential x-radiation as unity, the RBE of the higher energy neutron beam was 2 to 2.3 and that for the lower energy beam was 4.2 to 5.3. So far, the results of another criterion (that of complete destruction) have given similar conclusions in that the relative effectiveness appears of the same order. Attempts to determine whether qualitative as well as quantitative differences exist are now being investigated.

821 Frey, E. STRAHLENWIRKUNG EINES 31-MeV BETATRONS AUF EIER VON DROSOPHILA MELANOGASTER (Radiation effect of a 31-MeV betatron on the eggs of Drosophila melanogaster). Oncologia 4, 4 (1952) 191-208. (In German)

Lethal dose curves were established in eggs of various ages and compared with that caused by 180 keV x-radiation. In 3-h eggs 31-MeV radiation was less effective than the x-rays or the fast electrons of 3 MeV. In 4-h eggs the curves of 3-MeV and 31-MeV radiation coincide, both being less effective than x-rays. In 7.5-h eggs 31-MeV radiation is less effective than 3-MeV, both being less effective than x-rays. (BA 26: 26952, 1952)

822 Fritz-Niggli, H. ERSTE BIOLOGISCHE VERSUCHE MIT DEM 31-MeV-BETATRON (First biological experiments with a 31-MeV betatron). Arch. Klaus-Stift. VererbForsch. 26 (1951) 454-9. (In German)

Drosophila melanogaster pupae of various ages were subjected to 50- and 180-keV and 31-MeV radiation. Pupae of 5 h, 15 h, 22 h and 40 h were given doses of 12 000 r, 36 000 r and 80 000 r. Relative developmental changes are described briefly.

* Fritz-Niggli 1952 - [1185]

* Fritz-Niggli 1955 - [1186]

823 Fritz-Niggli, H. DOMINANT LETHAL FACTORS AND EMBRYONIC MORTALITY AFTER IRRADIATION AT 180 kV AND 31 MeV. UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 8/P/1070. 11 (1956) 179-83.

Non-irradiated females of Drosophila melanogaster mated with irradiated males (3000 r) lay eggs which show different rates of hatchability depending on the time after treatment. The peak of reduced hatchability lies between the 5th and 7th day. This effect must be caused not only by dominant lethal factors but also by a lack of normal active sperms. Histological studies show that spermatocytes and spermatogonia are resistent to irradiation. On the other hand the stage during late spermatogenesis is very sensitive. 31 MeV photons are less effective than 180 kV photons. (auth. summary)

824 Fritz-Niggli, H. QUALITATIVE AND QUANTITATIVE DIFFERENCES IN THE INDUCTION OF DOMINANT LETHALS IN DROSOPHILA BY 31 MeV X-RAYS, 30 MeV ELECTRONS, AND 180 kV X-RAYS. Drosophila Inform. Serv. 31 (1957) 171.

The tests described consisted of determining the percentage of unhatched embryos in different periods after irradiation of the male parents. This and data from other tests proved the effectiveness of 30-MeV electrons and 31-MeV x-rays from a betatron in inducing dominant lethals as compared with ordinary x-rays. Four strictly marked stages of spermatogenesis with different reaction patterns were distinguished. A strict dependence of RBE (relative biological effectiveness) on the age of irradiated gametes and also on dosage can be observed.

825 Fritz-Niggli, H. DIFFERENT RESPONSES (PRODUCTION OF MUTATIONS) OF DIVERSE STAGES OF SPERMATOGENESIS TO CHANGES IN OXYGEN TENSION, CHEMICAL ENVIRONMENT, AND QUALITY OF RADIATION (10-30 MeV-ELECTRONS, 31 MeV- AND 180 keV-PHOTONS). Radiation Res. 9 (1958) 117.

It is well known that the number of certain mutations depends on the developmental stage of the irradiated germ cells. In the hope of elucidating this differential sensitivity, there were irradiated sperms of Drosophila (in adult males) spermatids (in 48 h pupae and adult males), spermatocytes (in 0-2 h prepupae and adult males), spermatogonia (in 4 h larvae and adult males) in $N_2$, air, $O_2$, $CO_2$, etc. Experiments were also carried out with radiations of different ionization densities (180 keV- and 31 MeV-photons, 10 and 30 MeV-electrons). The production of visible mutations, recessive and dominant lethal factors, chromosome losses, gynander, and translocations was tested. We found the most radiosensitive stages (spermatocytes and spermatids) are very sensitive to a reduction of oxygen tension, whereas mature sperms show little response. The pronounced effects of other chemical factors are also discussed. A strict dependence of relative biological effectiveness upon the age of the irradiated gametes and also upon the dosage can be observed. There is no manifest influence of varying radiation qualities upon the relatively radioresistant stage of sperms, whereas in spermatids and specifically spermatocytes, the high-energy radiations are less effective. The following problems are discussed: Whether the differential sensitivity of sperms, spermatids and spermatocytes may be due to different oxygen tensions (depending on the cell function) and whether in different stages there are two types of induction of mutation (by the OH-H radicals and $H_2O_2$).

(Abstract of paper presented at the Intern. Congr. of Radiation Res., Burlington, Vermont 10-16 Aug. 1958)

826 Fritz-Niggli, H. ABHÄNGIGKEIT DER MUTATIONSENTSTEHUNG VON DER STRAHLENQUALITÄT (30 MeV-ELEKTRONEN, 31 MeV-PHOTONEN UND 180 keV-PHOTONEN) (The dependence of mutation development on the quality of irradiation (30 MeV-electrons, 31 MeV- and 180 keV-photons)). Naturwissenschaften 45 (1958) 117-8. (In German)

Drosophila males were irradiated with 180 keV x-, 31 MeV $\gamma$-, x- and 30 MeV $\beta$-rays from a betatron. When developing sperm were irradiated quantitative differences could be observed. The lower-energy radiation (180 keV) proved more effective in terms of translocations and chromosome breaks. Such differences were not observed on irradiating mature sperm where one assumes that it is mostly the free radicals which are effective whereas $H_2O_2$ plays a highly active part in developing sperm. The life time of free radicals and the production of $H_2O_2$ will depend on linear energy distribution (ionization density) which will differ with the type of radiation employed.

827 Gaulden, M.E., Loemker, K., Darden, E.B., Jr. FRAGMENTATION OF CHROMOSOMES IN GRASSHOPPER NEUROBLASTS BY BETA RAYS AND X-RAYS (abstr.). AECU-1898, Oak Ridge National Lab., Tenn. 1p.

Dissected 14-d-old embryos of Chortophaga viridifasciata were exposed to 1.7 MeV β-rays from $P^{32}$ and some to 125 kV potential x-rays, conditions for exposure being identical in both cases. A dose of 64 r of x-rays and 70.4 rep of β-rays was used, the amount of energy dissipated in the tissue being equal for the two types of radiation. The embryos were made into hanging drop preparations following irradiation and placed at 38°C. At intervals of 44, 220, 264 and 352 minutes after irradiation the embryos were fixed and stained. Cells in late anaphase and very early telophase were examined for chromosome fragments and the number of single fragments produced were the same in both x-rayed and β-irradiated cells. The number of β-ray induced double fragments observed in cells fixed 352 minutes after irradiation, however, was greater than the number observed in x-rayed cells, fixed at the same interval. This difference was statistically significant at the 0.02 level. Since the mitotic rate of β-irradiated cells differs from that of x-rayed cells, the difference observed in frequency of double fragments may be due to the fact that cells analysed 352 minutes after irradiation were treated in different stages of mitosis and not due to a difference in effectiveness of the two types of radiation in producing fragments at one stage of mitosis.

(Entire report. Abstract of paper for Atlanta meeting of Association of Southeastern Biologists, April 18-19, 1952)

(An abstract was also published in J. Tenn. Acad. Sci. 27 (1952) 211)

828 Gaulden, M.E., Nix, M., Darden, E.B., Jr. EFFECTS OF BETA RAYS AND X-RAYS ON MITOTIC RATE OF LIVING GRASSHOPPER NEUROBLASTS (abstr.). AECU-1896, Oak Ridge National Lab., Tenn., 1p.

14-d-old embroys of Chortophaga viridifasciata were removed from eggs and dissected as for hanging preparations. Some were exposed to 1.7-MeV β-rays from $P^{32}$ and some to 125-kV potential x-rays, conditions for exposure being identical in both cases (Gaulden, Sheppard and Cember, Nature 169 (1952) 228). Two doses of radiation were used, namely, 8 r and 64 r of x-rays and 8.8 rep and 70.4 rep of β-rays; dose rates were adjusted so that the amount of energy dissipated in the tissue at a given dose level would be the same for both types of radiation. The irradiated and control embryos were made into hanging drop preparations following irradiation and the neuroblasts observed with a microscope enclosed in an incubator maintained at 38°C. The number of cells in mid-mitosis (prometaphase, metaphase, and anaphase) was recorded every 22 minutes for 6 h. Twenty-two minutes is the average duration of mid-mitosis and the doses of radiation used do not affect it, consequently, the number of cells going through mitosis in a given period of time can be determined. At both doses x-rays and β-rays affect mitotic activity similarly with respect to the extent to which it is depressed but differently with respect to recovery - a greater number of cells recover after treatment with β-rays than with x-rays. This difference in recovery is statistically significant at the 0.02 level.

(Entire report. Abstract of paper for Atlanta meeting of Association of Southeastern Biologists, April 18-19, 1952)

(An abstract was also published in J. Tenn. Acad. Sci. 27 (1952) 211)

829 Giux Melcior, L.R. ESTUDIO COMPARATIVO ENTRE UNA MISMA DOSIS DE RADIACIÓN GAMMA DEL RADIUM Y DE RAYOS X, DESDE EL PUNTO DE VISTA DE SU ACCIÓN BIOLÓGICA (A comparative study of the same dose of gamma-radiation of radium and of x-rays from the point of view of biological action). An. Med. Cirurg., Paris 29, 70 (1951) 316-37.

In tests using Drosophila, 50% of the eggs were killed by 240 r γ-rays or 210 r x-rays. (EM 14, 6: 1238, 1952)

* Glemobitsky et al. 1960 - [993]

830 Grosch, D.S., Sullivan, R.L., LaChance, L.E. BIOLOGICAL RESPONSE TO MIXED RADIATIONS. Nucleonics 15, 12 (1957) 64, 66.

In reactor and certain accelerator situations radiation is often present as a mixture of radiations. To study the additive effects of such mixtures, a series of experiments was made on the combined sterilizing effects of external x-rays and ingested β-emitters ($P^{32}$ and $Sr^{89}$) on the ectoparasitic wasp, Habrobracon juglandis. (NSA 12: 2666, 1958)

831 Gund, K., Paul, W. EXPERIMENTS WITH A 6-MeV BETATRON. Nucleonics 7, 1 (1950) 36-45.

The relative biological efficiency of fast electrons is compared to 200 kV x-rays, and data presented for 3-, 4- and 7 ½-h old Drosophila eggs and chrysales.

832 Heidenthal, G., Clark, L. B., Gowen, J. W. COMPARATIVE EFFECTIVENESS OF X-RAYS OF 124 kV AND 50 MeV ON HABROBRACON EGGS (abstr.). Radiation Res. 1 (1954) 499.

First meiotic metaphase eggs of Habrobracon were used to test the comparative effectiveness of 124 kV and 50 MeV x-radiations. Dosages ranged from 100 r to 1750 r for low-voltage work and from 100 r to 1500 r for high-voltage studies. Failure of unfertilized eggs to hatch has been attributed to the presence of dominant and, to a lesser extent, of recessive lethals. Dose action curves are approximately exponential. Test for difference between the slopes of the two curves when these were plotted and fitted on a semi-logarithmic scale revealed no statistically significant difference. Variance analysis of data within dose and for each voltage of radiation used showed that the data for each dosage appeared to be conveying the same information from experiment to experiment. Comparisons between data for 124 kV and 50 MeV indicated that for a given dosage radiations of low and high voltage were revealing similar effects. A review of previous work by Whiting, on which the method was based, has led to the conclusion that x-radiation induced chromosome breakage, terminal deletions, and the formation of chromosomal bridges in most of the eggs which died. Thus dominant lethals were mainly responsible for failure of eggs to hatch as larvae. It is concluded that equivalent x-ray dosages from 124-kV and 50-MeV machines appear to be equally effective in inducing lethals in Habrobracon eggs treated in first meiotic metaphase.

This study was reported in detail in the Amer. J. Roentgenology 74 (1955) 677-85.

833 Heidenthal, G., Clark, L. B., Gowen, J. W. COMPARATIVE EFFECTIVENESS OF ROENTGEN RAYS OF 124 kV and 50 MeV ON HABROBRACON EGGS. Amer. J. Roentgenology 74 (1955) 677-85.

An abstract of this paper was published in Radiation Res. 1 (1954) 499.

834 Höhne, G., Schubert, G. DIE AUSLÖSUNG VON CHROMOSOMENMUTATIONEN BEI DROSOPHILA MELANOGASTER DURCH SCHNELLE ELEKTRONEN UND RÖNTGENSTRAHLEN (Induced chromosome mutations in Drosophila melanogaster by fast electrons and X-radiation). Strahlentherapie 94 (1954) 72-8. (In German).

D. melanogaster was exposed to a 3-MeV electron beam from a betatron and to 200-kV x-radiation, such as is generally used in therapy, for the purpose of studying the effect of these radiations on chromosome mutations. With respect to the reciprocal translocations between the second and third chromosome that were covered by the analysis of the crossing over, it was found that the increase in the rate of mutation induced by the radiation was a little greater than proportional to the dose. No differences were found between the effects produced by these two radiations of unlike differential ionization. (auth.)

(Also available in English, cf. AEC-tr-3474, Atomic Energy Commission, Washington, D. C., 11 p.)

835 Kayhart, M. (Pennsylvania Univ., Philadelphia) A COMPARATIVE STUDY OF DOSE-ACTION CURVES FOR VISIBLE EYE-COLOR MUTATIONS INDUCED BY X-RAYS, THERMAL NEUTRONS, AND FAST NEUTRONS IN MORMONIELLA VITRIPENNIS. Diss. Abstr. 14, 9 (1954) 1480-1.

Part of this work was published subsequently in Radiation Res. 4 (1956) 65.

836 Kayhart, M. A COMPARATIVE STUDY OF DOSE-ACTION CURVES FOR VISIBLE EYE-COLOUR MUTATIONS INDUCED BY X-RAYS, THERMAL NEUTRONS, AND FAST NEUTRONS IN MORMONIELLA VITRIPENNIS. Radiation Res. 4 (1956) 65-76.

Virgin female wasps (70 449) were treated with a series of doses of x-rays, thermal neutrons, and fast neutrons. They were set unmated, and their haploid sons (354 439) were examined for bright eye-colour mutants. Dose-action curves for production of visible eye-colour mutations by each of the three radiations were obtained. The shape of the curves is similar; each shows an initial linear portion and then a rise more rapid than that calculated for proportionality. It is suggested that the mutations occurring at the lower doses, forming the linear part of the curve, are due to single hits, and that the proportion of two-hit mutations (small deletions and inversions) increases rapidly at the higher doses, causing the curve to rise steeply. The neutron data adequately fit this one-hit two-hit hypothesis, but in spite of the general resemblance of the three curves the x-ray data do not. With visible eye-colour mutations in Mormoniella as a criterion, the relative biological efficiency at higher doses is to be expected if many of the visible mutations are due to minute rearrangements and deletions. (auth.)

837 Kimball, A. W. SHORTCUT FORMULAS FOR THE EXACT PARTITION OF CHI-SQUARE IN CONTINGENCY TABLES. Biometrics 10, 4 (1954) 452-8.

Short-cut formulas are given which permit the exact partition of chi-square from an r x c contingency table into (r-1) x (c-1) individual degress of freedom. Each single degree of freedom chi-square is computed from a formula which is a function only of the observed frequencies. A general expression is given which permits the construction of such formulas for contingency tables of any order. The method is applied to some experiments which compare the effects of x- and β-radiation on mitotic rates in grasshopper neuroblasts (Chortophaga viridifasciata). (auth.)

838 Lamarque, P., Gary-Babo, J. A STUDY OF RECOVERY FOLLOWING EXPOSURE OF PART OR THE WHOLE OF THE BODY TO IONIZING RADIATION. UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 8/P/372. 11 (1956) 351-61.

Insect eggs were amongst the various types of biological material subjected to various doses of x-radiation, mixed γ- and β-radiation ($I^{131}$) and pure β ($P^{32}$). The insects were Bombyx mori and Bacillus Rossii (phasmatidae). Two sets of experiments were made for testing recovery following (1) total irradiation, and (2) partial irradiation. In each part, recovery was made evident by (a) the study of massive irradiation in a single dose and (b) the study of fractionated irradiation. In addition, the effect of cold on recovery was studied for insect eggs. Results are illustrated by graphs and discussed. Cold did not completely eliminate recovery in this study. The time during which the cold acts appears to have a certain influence, the existence of an optimal duration for the action of the cold being observed, which also corresponds to the optimal interval for recovery.

* Löbbecke and Müller 1959 - [1025]

* Löbbecke and Müller 1960 - [1026]

* Medical Research Council 1957 - [1034]

839 Mickey, G. H. VISIBLE AND LETHAL MUTATIONS IN DROSOPHILA. Amer. Nat. 88 (1954) 241-55.

Fast neutrons from the Oak Ridge National Laboratory 86-inch cyclotron and from nuclear test devices (about 1 MeV) are approximately four times as efficient in producing specific loci mutations at the res markers in the third chromosome of Drosophila melanogaster as are x-rays of 250 kV potential. Dominant visible mutations are produced at a much higher rate per rep of neutrons than per r of x-rays, the RBE of neutrons for all observed variants being from 6 to 37 and for the proved dominant mutations from 3 to 22. The relative biological effectiveness of fast neutrons as compared to x-rays in the production of dominant mutations likewise is quite high. Contrary to reports of previous investigators that fast neutrons are only about two-thirds as effective as x-rays in producing sex-linked recessive lethal mutations, it was found that the neutrons have an RBE of 2. Dominant lethals are produced at a much higher frequency per rep of fast neutrons than per r of x-rays, the RBE at lower doses being about 7 and at higher doses falling off to about 4. It appears, therefore, with all the biological criteria used to measure the genetic damage of radiations in Drosophila, that fast neutrons cause a much greater effect than do x-rays. (auth.)

(An abstract of earlier work "Comparison of rates of visible mutations produced by fast neutrons and by X-rays at specific loci in the third chromosome of Drosophila melanogaster" by Mickey and A. F. Yanders was published in Genetics 38 (1953) 676-7)

840 Mickey, G. H., Yanders, A. F. THE PRODUCTION OF DOMINANT MINUTES IN DROSOPHILA (MELANOGASTER) SPERM IRRADIATED WITH X-RAYS, GAMMA RAYS AND FAST NEUTRONS (abstr.). Genetics 39 (1954) 983.

Mature sperm of D. melanogaster (Oregon-R) were given doses ranging from 1500 to 9000 r of either $Co^{60}$ gamma rays of 250 kV potential x-rays or from 250 rep to 2000 rep of fast neutrons. Treated males were mated to wild type virgins and transferred to fresh cultures each day through four cultures. The dominant Minutes were detected in the $F_1$ flies. Rates of Minutes induced by these high energy x-rays did not differ statistically from those induced by gamma rays. The fast neutrons, however, were much more efficient per unit of dose in producing Minutes; their RBE was about 4.5. Measured in terms of Minutes induced, the effects of these agents appear to be directly proportional to dose and also related to specific ionization density of the path.

841 Mossige, J. THE RELATIVE BIOLOGICAL EFFICIENCY OF 31 MeV BETATRON X-IRRADIATION AND 175 keV X-RAYS AS MEASURED BY RECESSIVE SEX-LINKED LETHALS IN DROSOPHILA MELANOGASTER. p. 137-43 in "Progress in Radiobiology. Proceedings of the 4th International Conference on Radiobiology, Cambridge 14-17 Aug. 1955". Mitchell, J.S., Holmes, B.E., Smith, C.L., eds. London, Oliver and Boyd. 1956.

The average number of offspring/male/day of irradiation with 2500 r and 500 r of 175 keV x-rays is plotted. Both curves show a typical increase from the 1st to the 2nd day (particularly where newly emerged males are used) associated with a slight decrease in recessive lethals. The curves fall, more sharply with higher doses, to a practically sterile period of varying length, depending on dose. The percentage of sex-linked lethals after irradiation at 31 MeV and 175 keV (1000 r and 2500 r) are given, also the RBE curves. On the whole, the RBE is lowest during the period of highest mutational sensitivity.

842 Mossige, J., Oftedal, P. ON THE CONSTANCY OF THE RELATIVE BIOLOGICAL EFFICIENCY OF β-PARTICLES DURING SPERMATOGENESIS IN DROSOPHILA MELANOGASTER. p. 245-52 in "25th Anniversary Publication from the Norwegian Radium Hospital". Oslo, H. Aschehoug and Co. (W. Nygaard), 1958, 323 p.

An apparatus for external irradiation of flies with β particles from a solution containing radioactive isotopes is described, and the biologic dosimetry of the source is reported. The apparatus has been used for obtaining the sex-linked recessive lethal mutation curve after irradiation with $P^{32}$ β particles, using a dose biologically equivalent to 930 r for the induction of dominant lethals in mature sperm. The curve was found similar to the one obtained after 1000 r of x-rays. (auth.)

843 Muller, H.J. CHARACTERISTICS OF THE FAR STRONGER BUT "SPOTTIER" MUTAGENICITY OF FAST NEUTRONS AS COMPARED WITH X-RAYS IN DROSOPHILA SPERMATOZOA (abstr.). Genetics 39 (1954) 985.

Experiments of 1953 establish frequency of translocations connecting second and third chromosomes at approx. $68 \times 10^{-6}$ per rep, practically independently of dose, for neutrons from either the Oak Ridge cyclotron or pile, applied to mature spermatozoa in young males. This effectiveness is 2.4 times that of 4000 r x-rays, varying with x-ray $(\text{dose})^{-1/2}$. - NXE (neutron:x-ray effectiveness) in inducing male exceptions, lacking either paternal sex-chromosomes or its marked portion, was 3-5. However, subtraction of partial losses, estimated by tests, indicated that NXE for complete losses, presumably representing isochromatid bridges derived from individual breaks, was about 7. Causes of lower NXE for eucentric rearrangements than for individual breaks are listed. - NXE for producing separately registered sex-linked recessive lethals was 2.4. However, for all visible changes of expression of specific loci, NXE was about 4, as it was for proved "point-mutations" of these loci (this holds also for female germ cells). This difference from lethals is caused by multiple neighbouring effects with neutrons, which hide some third of point-mutational lethals, yet cause neutron-induced rearrangements to affect more loci (hence to give more "visibles") than x-ray-induced rearrangements. (from abstr.)

* Naville 1955 - [1045]

* Paul and Schubert 1950 - [1051]

* Regehr et al. 1950 - [1056]

844 Rudnicki, T. DETERMINATION OF THE RELATIVE BIOLOGICAL EFFECTIVENESS OF $P^{32}$ BETA RADIATION. p. 754-6 in "Pierwsze Krajowe Sympozjum Poswiecone Stosowaniu Izotopow Promientiotworczych W Biologii, Medycynie, I Rolnictwie, 2 i 3 Kwietnia 1959, Warszawa", Warsaw, Bur. of the At. Energy Ministry, 1959. (In Polish)

The comparison of the biological effectiveness of $P^{32}$ β radiation and 70-keV γ radiation was made for three biological specimens; the specimens were fruit fly eggs, pea sprouts, and the tops of the sprouts of Vi. faba. A large number of batches of fruit fly eggs, specially prepared and incubated, were irradiated with 70-keV x-rays and $P^{32}$ betas. One set of batches was irradiated after 1 h of incubation and another set after 3 h. The number of irradiated eggs hatched after 48 h was in each case compared with an unirradiated control batch. A plot of fatality vs. dose was thus obtained for each case. The 1-h incubated eggs were much less resistant to radiation than the 3-h eggs. A value of 1.0 for the RBE of $P^{32}$ betas was obtained with the former and 0.85 with the latter by comparing the β- and x-ray doses required to produce a 50% fatality.

The stastical uncertainty of these two determinations did not clearly establish that the RBE for $P^{32}$ betas was different from 1.0. It did, however, in measurements of rate of growth of the sprout specimens. The doses required to reduce the rate of growth by 50% yielded a value of RBE of 0.6 for both pea sprouts and the tops of the sprouts of Vi. faba. It is concluded that the value of RBE depends on experimental conditions as well as on the biological specimen, that extreme care must be taken in any attempts to carry over results with biological specimens to the realm of human pathology, and that concrete experimental conditions must be chosen and clearly stated in determining the RBE in biological radiation-damage studies as well as in medicinal methods. (NSA 15: 13204, 1961)

845 Russell, W. L., Kelly, E. M. RADIATION DOSE RATE AND MUTATION FREQUENCY. Science 128 (1958) 1546-50.

New data have clearly confirmed the earlier finding that specific locus mutation rates obtained with chronic γ-irradiation of spermatogonia are lower than those obtained with acute x-rays. Since this result is in contrast to classical findings for Drosophila spermatozoa, and apparently contradicts one of the basic tenets of radiation genetics, it was important to determine the factors responsible for it. Experiments undertaken for this purpose reveal the following: the lower mutation frequency is due mainly to difference in dose rate of radiation, rather than quality; a dose-rate effect is not obtained in experiments with mouse spermatozoa, confirming classical findings for spermatozoa, and indicating that the explanation for intensity dependence in spermatogonia resides in some characteristic of gametogenic stage; and a dose-rate effect is found not only in spermatogonia but also in oöcytes, where cell selection is improbable, indicating that the radiation intensity effect is on the mutation process itself. A threshold response for all mutations in spermatogonia and oöcytes is not a necessary consequence of the findings. Plausible hypotheses consistent with the present results can lead to other predictions. From a practical point of view, the results indicate that the genetic hazards, at least under some radiation conditions, may not be as great as those estimated from the mutation rates obtained with acute irradiation. However, it should not be forgotten that even the lower mutation rates obtained with the present intensity levels are still appreciable. (auth.)

846 Schmid, W. VERGLEICH DER GENETISCHEN WIRKSAMKEIT DER 31-MeV-BETATRONSTRAHLUNG MIT 180 keV-RÖNTGENSTRAHLUNG DURCH ERZEUGUNG VON SICHTBAREN REZESSIVEN MUTATIONEN UND BEI DROSOPHILA MELANOGASTER (Comparison of the genetic effectiveness of radiation from a 31 MeV betatron and 180 keV x-rays in terms of the production of visible recessive mutations and gynandry in Drosophila melanogaster). Oncologia 11 (1958) 218-43. (In German)

In order to compare the biological efficiency of the 2 sources, some normal Drosophila males from a wild inbred strain were subjected to 2000 r of β-radiation (31 MeV) and others to an equal dose from a conventional x-ray source (180 keV). Similar experimental conditions were ensured. After mating with females homozygous for 5 factors, the descendants were examined for radio-induced visible, recessive mutations. Values for mutation rates and the number of XO-males and gynanders were found to be of the same order. There appeared to be no essential quantitative difference in the genetic effects of the two qualities of radiations used.

847 Shenfield, A.J. DIE ERZEUGUNG VON REZESSIVEN GESCHLECHTSGEBUNDENEN LETALFAKTOREN BEI DROSOPHILA MELANOGASTER DURCH SCHNELLE 30-MeV ELEKTRONEN UND DURCH 180-keV RÖNTGEN-STRAHLEN (The response of sex-bound lethal factor in Drosophila melanogster to irradiation by 30-MeV electrons and 180 keV x-rays). Oncologia 10 (1957) 281-94. (In German)

The relative effects of 180 keV conventional rays and of fast 30 MeV electrons, both at 3000 r, were investigated on immature male germ cells of Drosophila melanogaster which were irradiated 5-11 d before fertilization. The Muller-5 method was employed, and the lethal and sublethal factors resulting in the $F_2$ generation were counted. Using fast electrons, 6.07% lethal factors were obtained, compared to 5.18% with conventional rays, i.e., the mutagenic effect of fast electrons was 1.17 times stronger. This difference, however, could not be verified statistically. The number of sublethal factors produced was too minute for quantitative evaluation. It may be presumed from the experiments that fast 30 MeV electrons possibly have a stronger mutagenic action than 180 keV roentgen rays. (auth.)

(For translation see AEC-tr-3443, tr. for Los Alamos Scientific Lab. 1959)

* Stone et al. 1954 - [1068]

* Sullivan and Grosch 1953 - [1295]

848 Tahmisian, T. N., Vogel, H. H., Jr. RELATIVE BIOLOGICAL EFFECTIVENESS OF FAST NEUTRONS, GAMMA-RAYS, X-RAYS ON GRASSHOPPER NYMPH OVARIOLES (MELANOPLUS DIFFERENTIALIS). Proc. Soc. exp. Biol., N. Y. 84 (1953) 538-43.

Fifth or sixth instar grasshopper nymphs were used. In order to destroy every egg in each grasshopper ovariole, with the exception of the most advanced, it was necessary to irradiate the total body with 350 r (200 kV) x-rays, 420 r $Co^{60}$ gamma rays, or 22.5 rep of fast neutrons. Thus, the relative biological effectiveness of $Co^{60}$ gamma rays: 200 kV x-rays: fast neutrons, for this specific effect, is 1.0:1.2:19. This is correlated with relative specific ionization and linear energy transfer. It is suggested that damage to the grasshopper ovariole could be used as a biological dosimeter for fast neutron doses in the range 10 - 15 rep. The high anabolic rate in the formation of the grasshopper egg within the ovariole may well be a major cause for its sensitivity to ionizing radiation.

849 Vogel, H. H., Jr., Clark, J. W., Jordan, D. L. RELATIVE BIOLOGICAL EFFECTIVENESS OF FAST NEUTRONS AND Co-60 GAMMA RAYS. Radiation Res. 1 (1954) 233.

During the past several months, the Neutron Radiobiology group at Argonne National Laboratory has had the opportunity to test various organisms in a gamma/neutron chamber. Comparisons of the relative biological effectiveness of the two radiations have been made for a variety of biological materials, including the incidence of chromosomal aberrations in Drosophila melanogaster and the destruction of egg nuclei of grasshopper (Melanoplus differentialis) nymphs.

(See also M-5225, Argonne National Lab., Dec. 1953, 7p.)

850 Witte, E. EXPERIMENTELLE UNTERSUCHUNGEN ÜBER DEN BIOLOGISCHEN EFFEKT INTERMITTIERENDER RÖNTGENBESTRAHLUNG (Ultra-fractionated x-ray treatment. I. Experimental study of the biological effect of an intermittent irradiation). Strahlentherapie 82 (1950) 209-22. (In German)

Experiments on the biological action of intermittent (so-called "ultra-fractionated") roentgen irradiation showed that the effects become noticeable only when the elementary periods of irradiation and intermission are very small. The effect, which is a weakening of the x-ray action as compared with that of a continuous treatment, can exceed 50%. As a working hypothesis, it can be surmised that the effect of a quantum hit within the limits of an elementary target in a living cell lasts for a certain time interval; if another hit reaches the same target before the expiration of that interval, the effect is increased; this is the case of a continuous irradiation. Experiments with 12-h-old Drosophila pupae showed that the width of elementary targets is at least 0.1 mm (10 to 100 cells), and that the hit effect lasts for about 1/350 s. (auth.)

851 Zirkle, R. E. RADIOBIOLOGICAL ADDITIVITY OF VARIOUS IONIZING RADIATIONS. Amer. J. Roentgenology 63, 2 (1950) 170-5.

A discussion is presented on the problem of additivity of various types of ionizing radiations. A summary is included which outlines the degree of additivity found in various experiments by the author and others through combinations of $\alpha$-, $\beta$-, $\gamma$-, fast-neutron and x-rays on the mouse, bean roots, Drosophila eggs, Drosophila pupae and the human skin. It is concluded from the analysis of these studies that incomplete additivity of two types of radiation indicates some difference in the mechanism of action of the radiations. Complete additivity indicates that the mechanisms of action of the radiations are identical in their most essential feature, the promotion of the same determinative events (one of a succession of unknown relevant events leading to the production of the known biological effects), but are not necessarily alike otherwise. It is concluded that it is probably wise to assume that additivity of fast-neutrons and $\gamma$-rays is the complete type. (NSA 4: 2142, 1950)

852 Zirkle, R. E., Parrish, M. E. COMPARATIVE LETHAL ACTION OF X-RAYS AND CYCLOTRON NEUTRONS ON DROSOPHILA EGGS. CH-3904, Univ. Chicago Metallurgical Laboratory, Dec. 1950, 6p.

The x-rays were generated at 200 kV and 5 mA and were filtered by 0.5 mm of Cu and 1 mm of Al. The target-to-object distance was adjusted to give a dose rate of about 10 r/min. The fast neutrons were generated by 8 MeV deuterons impinging on a beryllium probe in the University of Chicago cyclotron. The eggs were exposed in a leadwalled chamber which was so constructed that radiation directly from the probe was filtered through 4 inches of lead, while scattered radiation from other directions was filtered through at least 2 inches. Various lots of eggs were given graded doses of x-rays, of fast neutrons, and of mixed neutrons and $\gamma$-radiation. The $LD_{50}$ of x-rays is 170 r, that of fast neutrons is 31 n, and that of the mixed

cyclotron emission is 43 Victoreen scale units. Accordingly the x/n dosage ratio is 170/31 or 5.5, whereas the apparent x/n ratio, from data obtained when γ-rays were present, is 170/43 or 4.0. (NSA 5: 911, 1951)

## I-A-2 RADIOSENSITIVITY OF ONE OR MORE STAGES OF DEVELOPMENT

853 **Абелева, Э.А., Потехина, Н.А. РАДИОЧУВСТВИТЕЛЬНОСТЬ РАЗНЫХ СТАДИЙ СПЕРМАТОГЕНЕЗА У DROSOPHILA MELANOGASTER. АН СССР, Москва, 1960, 8 стр.**

**Приводятся данные по частоте возникновения доминантных леталей у Drosophila melanogaster при суточном облучении сперий и сперматид рентгеновскими лучами. Использовались однократная доза в 2400 р и фракционированное облучение, даваемое трехкратно по 800 р через полуторачасовый интервал, а также однократные облучения 400 р и 1200 р и 3 фракционированных облучения дозами в 400 р через такие же промежутки времени. Дается оценка радиочувствительности разных стадий сперматогенеза.**

Abeleva, E. A., Potekhina, N. A. RADIOCHUVSTVITEL'NOST RAZNYKH STADIJ SPERMATOGENEZA U DROSOPHILA MELANOGASTER (The radiosensitivity of different stages of spermatogenesis in Drosophila melanogaster). A/AC. 82/G/L. 409, Akademiya Nauk SSSR, 1960, 8 p.

The development of dominant lethals in irradiated 24-h-old Drosophila melanogaster sperm and spermatids was investigated. Single exposure to 2400 r, 3 exposures to 800 r at 1.5-h-intervals, single exposure to 400 and to 1200 r, and 3 exposures to 400 r at 3-h-intervals were used. Radiosensitivity at various stages of spermatogenesis was evaluated. (NSA 15: 15395, 1961)

854 Alexander, M. L. RADIOSENSITIVITY AT SPECIFIC AUTOSOMAL LOCI IN MATURE SPERM AND SPERMATOGONIAL CELLS OF DROSOPHILA MELANOGASTER. Genetics 45 (1960) 1019-22.

The mutation rate, when calculated with point mutations, was higher in mature sperm than the rate for spermatogonia with 900 r of x-radiation. The higher rate in sperm shows a difference in the mutational sensitivity of the two types of cells. Selection of chromosome breakage types from spermatogonia cannot account for the difference. The spermatogonial mutants show the same proportion of viable and lethal mutations as obtained with mature sperm with 900 r. The absence of chromosome aberrations remained characteristic of spermatogonial mutants. (auth.)

* Alexander and Stone 1955 - [1156]

855 Brockway, A. P. THE EFFECTS OF X-RADIATION ON LARVAL AND PUPAL STAGES OF THE YELLOW MEALWORM, TENEBRIO MOLITOR LINN. Biol. Bull. 109 (1955) 355. (Paper read by title only)

In preliminary experiments, dosages of 4600 to 46 000 r were used on larvae of T. molitor Linn. Since the precise age of the larvae was unknown, specimens were divided into two weight groups. There was no observable difference in effects between doses ranging from 2750 to 4600 r when given to pupae within 6 h after formation. The time required for pupation was increased. Irradiation thus tends to inhibit the pupation of larvae and also prevents the formation of normal adults. In determining $LD_{50}$ values, it appears that the lighter larvae are more radiosensitive than the heavier and presumably older larvae. Details are given.

856 Brockway, A. P. THE EFFECT OF X-IRRADIATION ON THE PUPAE OF THE YELLOW MEALWORM, TENEBRIO MOLITOR LINN. (abstr.) Biol. Bull. 111 (1956) 297-8. (Paper read by title at Marine Biological Laboratory)

A genetically mixed culture of larvae was used. All pupae used as controls or given 500 r and 1000 r hatched normally. After 2000 r, only 33% did so. From 2500 r to 20 000 r all hatched abnormally. The region between 1000 r and 2500 r appeared to be quite critical. Some effect was also observed on the length of the pupal stage. Pupation of controls was 8.15 d; 500 r increased it to 9.0 d, 4000 r to 10.0 d,

5000 to 20,000 r to 11 d. At 2500 r the emerging adult was unable to shed the pupal cuticle. The tanning process of the new cuticle was incomplete in all adults irradiated with 3000 r at the pupal stage. Blistering was also observed.

857 Chandley, A. C., Bateman, A. J. MUTAGENIC SENSITIVITY OF SPERM, SPERMATIDS, SPERMATOCYTES AND SPERMATOGONIA IN DROSOPHILA MELANOGASTER. Heredity 15 (1960) 363-75.

$F_1$ males irradiated with 1000 r x-rays were mated with different classes of females 2, 5, 8 and 11 d after treatment. The incidence of dominant lethals, hyperploids and translocations (structural changes) and recessive autosomal and sex-linked lethals (gene changes) were recorded for each day (tables and graphs). Estimates of induced crossing-over in the b pr vg region, made in daily samples from the 2nd to the 13th day, were used to identify specific stages of germ cell development. In addition, the excess of animals showing a single recessive marker over those showing two markers was used to estimate the proportion of "mutations" or small deletions. The pattern of sensitivity was similar for recessive autosomal and sex-linked lethals and translocations, showing a rise from the 2nd day (sperm) to the 5th (spermatids) followed by a fall on the 8th (spermatocytes or later spermatogonia?). Deleted X's showed a unique sensitivity pattern with a peak on the 8th day. This was attributed to the high sensitivity of spermatocytes to intra-changes and in particular to deletions. (auth. summary)

858 Clark, A. M. RESEARCH PERTAINING TO X-RADIATION DAMAGE IN THE PARASITIC WASP, HABROBRACON. FINAL REPORT FOR THE PERIOD JULY 1, 1950 TO AUGUST 31, 1953. AECU-2764, Delaware. Univ., Newark. 1953, 29 p.

Results are reported in an investigation of the relationship between chromosome number and radiosensitivity in the parasitic wasp, Habrobracon. In this species haploid males and diploid females occur normally. Data on the differential radiosensitivity of the cleavage stage of the embryo, larval stage, and pupal stage indicate that the differential radiosensitivity between haploids and diploids is dependent upon the stage of development at which the organisms were irradiated and cannot be correlated with gene number. No direct correlation was found between the radiosensitivity pattern and oxygen consumption, phosphatase activity, nucleic acid changes, and catalase activity. (NSA 8: 973, 1954)

859 Clark, A. M. THE RELATION OF GENOME NUMBER TO RADIOSENSITIVITY IN HABROBRACON. (abstr.) Radiation Res. 1 (1954) 491.

Haploids and diploids of the parasitic wasp, Habrobracon, were x-irradiated at different stages during their development. Their radiosensitivity was measured by counts of adults that emerged from cocoons. The data show that the differential radiosensitivity between haploids and diploids does not remain constant throughout the life cycle but varies with the stage of development. During the cleavage stages of the embryo, haploids are more radio-resistant than diploids. At later embryonic stages, haploids and diploids are equal in radiosensitivity. In the larval stages the differential radiosensitivity varies with age; among young larvae, diploids are only slightly more resistant than haploids, whereas among older larvae, diploids are markedly more resistant than comparable haploids. This increase in differential radiosensitivity becomes greater during the prepupal and pupal stages. It is concluded, therefore, that there exists no simple correlation between genome number and radiosensitivity throughout the life cycle of Habrobracon.

860 Clark, A. M. SENSITIVE PERIODS AND APPARENT FRACTIONATION EFFECTS IN IRRADIATED DROSOPHILA. Amer. Nat. 89 (1955) 179-81.

Five successive matings, 72 h apart, of newly emerged Canton S males treated with 4 doses of 700 r delivered at 24 h intervals were compared to a group receiving 2800 r at 72 h of age. No significant overall differences were seen; the distribution of lethals and translocation was altered, however, so that the peak seen at the 2nd and 3rd brood was not marked in the fractionated group. Both translocations and lethals were significantly lower in the 4th and 5th broods of the fractionated series.

861 Clark, A. M. THE RELATION OF GENOME NUMBER TO RADIOSENSITIVITY IN HABROBRACON. Amer. Nat. 91 (1957) 111-9.

Haploids and diploids of the parasitic wasp Habrobracon were x-irradiated during known stages of embryonic and post-embryonic development, and compared with regard to their sensitivity to damage by x-rays. The ability to continue development and to emerge from cocoons as adults was used as the criterion of injury. The ratio of haploid to diploid radiosensitivity is different for different stages of development. During cleavage stages of embryonic development haploids and diploids are equal in sensitivity; during the post-

embryonic stages diploids are more resistant than haploids. The bearing of these data on determining the site of injury from radiation is discussed. (auth.)

862 Clark, A. M. THE RELATION OF GENOME NUMBER TO RADIOSENSITIVITY. TID-6051, Delaware. Univ., Newark. 7 June 1960.

Progress is reported in studies on the effects of oxygen on insects, a comparison of radiation damage and oxygen poisoning, and the effects of x-radiation on the life span in haploids and diploids of Habrobracon. (NSA 14: 15526, 1960)

863 Clark, A. M., Kelly, E. M. DIFFERENTIAL RADIOSENSITIVITY OF HAPLOID AND DIPLOID PREPUPAE AND PUPAE OF HABROBRACON. Cancer Res. 10 (1950) 348-52.

Habrobracon prepupae and pupae were exposed to x-radiation, and the lethal effects of the radiation were studied. Eclosion ratios show that x-rays have a greater lethal effect upon haploid males than upon diploid females. Diploid males and diploid females are equally susceptible to the lethal effects of x-radiation. Prepupae are more sensitive than pupae. No significant difference in eclosion ratios was obtained for adults given the same total dose but at different intensities. The response, therefore, seems to be independent of intensity. Comparison of adults developing from irradiated prepupae and pupae shows that a greater number of haploid males show structural malformations than diploids irrespective of sex and that the haploids show these malformations to a greater degree. Comparison of individuals unable to emerge from cocoons shows that the diploids are in general more advanced in their development than are the haploids. The data show that diploids are more resistant than haploids to the lethal action of x-rays, suggesting that the number of chromosome sets is a factor in determining the radiosensitivity of cells. (auth.)

864 Clark, A. M., Mitchell, C. J. RADIOSENSITIVITY OF HAPLOID AND DIPLOID HABROBRACON DURING PUPAL DEVELOPMENT. J. exp. Zool. 117 (1951) 489-98.

The study was aimed at establishing whether there exists a constant difference in resistance during different stages of pupal development. Diploids were found to be more radioresistant than haploids during all stages of pupal development. During the earlier pupal stages, diploids are about three times as resistant as comparable haploids while during the later pupal stages the differential radiosensitivity is not as great. Resistance increases with age. For haploid pupae, the increase in resistance is exponential for the period from 5 to 8 d. The increase in resistance for 5-7 d diploid pupae is identical with the haploids; the older diploid pupae (7-8 d) do not, however, increase as rapidly in resistance. The deleterious action of radiation on somatic tissues is interpreted to be due primarily to injury to the genetic mechanism. (auth.)

(A report, AECU-1444, Technical Information Service, AEC. 15 p., was published, also an abstract in Genetics 36 (1951) 547)

865 Clark, A. M., Mitchell, C. J. EFFECTS OF X-RAYS UPON HAPLOID AND DIPLOID EMBRYOS OF HABROBRACON. Biol. Bull. 103, 2 (1952) 170-7.

Haploid and diploid embryos of Habrobracon were x-rayed at known stages of development in order to determine to what extent radiosensitivity can be correlated with genome number. When embryos are x-rayed during cleavage, haploids are more resistant than diploids; when embryos are x-rayed immediately after cleavage has been completed, haploids and diploids are equally radiosensitive. Embryos x-rayed during cleavage or early blastema are deleteriously affected during the egg stage or not at all. Older embryos when x-rayed may hatch, but show post-embryonic injury. Embryos that are x-rayed during cleavage and fail to hatch are arrested before blastulation. The nuclei are arrested at interphase and become enlarged up to four times the diameter of untreated nuclei. Since the differential radiosensitivity between haploids and diploids depends upon the stage of development at which they are irradiated, it is difficult to pose a single hypothesis that will account for these facts. (auth.)

866 Colombo, G. DIFFERENT SENSITIVITIES OF X-RADIATION WITH RESPECT TO THE STAGE OF DEVELOPMENT OF THE EMBRYOS OF LOCUSTA MIGRATORIA MIGRATORIOIDES (R. AND F.) R. C. Accad. Lincei Sed. solen. 26 (1959) 583-91. (In Italian)

The variation in the radiation sensitivity of Locusta embryos was studied with various x-radiation exposures at embryonic ages from 1 to 6 d. The $ED_{50}$ was determined as a measurement of the sensitivity. These values are tabulated, and show that the resistance to irradiation increases rapidly with the age, varying

from an $ED_{50}$ of 136 r on the 1st day to 6900 r on the 6th day. The high resistance of insects to radiation was shown to develop during the embryonic stage after organogenesis. (NSA 14: 3415, 1960)

867 Erdman, H. E. DIVERGENCE BETWEEN LETHAL DOSES AND STERILIZING DOSES OF X-RAYS WITH PROGRESSIVE DEVELOPMENT IN HABROBRACON FEMALES. Nature 186 (1960) 254-5.

Data are presented on Habrobracon juglandis (Ashmead), and a figure is given which shows the pattern of radiation-induced effects for most of the life-cycle, to demonstrate the divergence between sterilizing and lethal doses. (Doses of up to 15 000 r at 600 r/min were given, the age in hours ranging from 0 to 180.) The weakest link in an insect life-cycle was determined and related to the quantitative differences between the sterility and lethality doses when virgin females were irradiated at various developmental stages. The curve for increased radiosensitivity does not progress smoothly. Biological considerations are offered in explanation.

868 Erdman, H. E. ADULT LONGEVITY AS A SENSITIVE CRITERION OF RADIATION-INDUCED DAMAGE WHEN 24-HOUR HABROBRACON EMBRYOS ARE X-RAYED. J. econ. Ent. 53 (1960) 971-2.

Evidence is presented to show that adult longevity of Habrobracon juglandis (Ashmead) is a sensitive criterion of radiation damage compared with other parameters when the wasps are x-rayed as 24-h-old embryos. The performance of adult females thus x-rayed as 24-h-old embryos is tabulated in terms of adult females eclosed, and egg hatchability and longevity. On the basis of longevity, the wasps were damaged by a 900 r exposure, with a striking effect at a 1500 r-dose.

* Fritz-Niggli 1952 - [1305]

869 Fritz-Niggli, H. MÖGLICHE URSACHEN DER VERSCHIEDENEN STRAHLENEMPFINDLICHKEIT DES ERBMATERIALS IN KEIMZELLEN UNTERSCHIEDLICHEN ALTERS (Possible causes of the differences in radiosensitivity of genetic material observed in germ cells of different ages). Naturwissenschaften 45 (1958) 557-64. (In German)

Much of the experimental data is derived from Drosophila melanogaster. Radiation-induced mutation rates depend on the age of the germ cells, and they may be raised or lowered by a variety of factors which are discussed. It may be supposed that the differences in sensitivity may, at least in part, be due to changes in intracellular oxygen content.

* Gray 1956 - [1311]

* Heidenthal 1953 - [999]

870 Luce, W. M., Quastler, H., Chase, H. B. REDUCTION IN FACET NUMBER IN BAR-EYED DROSOPHILA BY X-RAYS. Genetics 36 (1951) 488-99.

The paper deals with a quantitative well-controlled response to x-rays: reduction of eye facet number in Bar-eyed flies. Larvae of Bar-eyed Drosophila, kept at a temperature of 28°C, which were irradiated with x-rays of dosages varying from 115 to 1840 r, developed into adult flies whose compound eyes had a smaller number of facets than untreated controls. With a dosage of 920 r the effect of the x-rays was largely confined to a radiosensitive period extending from about 55 to 70 h of egg-larval life, with a maximum reduction occurring between 57 and 67 h. The radiosensitive period closely corresponds to similar sensitive periods for other environmental agents affecting facet number in Bar-eyed Drosophila. The reduction in facet number following application of x-rays during the sensitive stage was nearly proportional to the dosage applied. In males the reduction in facets per unit dose was always greater than in females. The biological effect of the x-rays and the nature of the mode of action of the Bar mutants are discussed.

* Lüning 1954 - [1400]

* Lüning 1958 - [1288]

* Lüning and Jonsson 1956 - [1210]

* Lüning and Jonsson 1957 - [1031]

871 Nakanishi, Y. H. PHASE CINEMATOGRAPHY STUDIES ON THE EFFECTS OF RADIATION AND CHEMICALS ON THE CELL AND THE CHROMOSOMES. III. IMMEDIATE EFFECTS OF BETA-IRRADIATION, FROM A STRONTIUM-90 SOURCE AT SOME DIFFERENT STAGES, ON MEIOSIS OF GRASSHOPPER (PODISMA SAPPORENSE) SPERMATOCYTES. Hokkaido Univ. Facul. Sci. J. Ser. VI. Zool. 14, 2 (1959) 157-65.

872 Nishiwaki, Y., Tamagusuku, S., Shinozaki, K., Murata, S. ON THE LETHAL EFFECT OF X-RAY ON THE EGGS AND SPERM OF MOSQUITOES. Nippon Acta Radiol. 13, 2 (1953) 94-8.

The lethal effects of x-rays on sperm and unfertilized eggs of mosquitoes, Aëdes togoi and Culex pipiens pallens, were studied. The x-ray dose was 100-1000 r and the dose rate was 93-115 r/min at 60 kV potential. $LD_{50}$ in fertilized eggs was 500 r in Aëdes togoi and 150 r in Culex pipiens pallens. A marked discontinuous change in radioresistance was observed in fertilized eggs between 2-3 h after oviposition which seems to indicate that cleavage accompanying mitosis or nuclear division might be occurring at that age. The hatching rate of unfertilized eggs and sperm showed no marked decrease with doses less than 500 r. Sperm seemed to be more sensitive to irradiation in vivo than unfertilized eggs. (BA 28: 2896, 1954)

873 Olenov, Yu. M., Galkovskaya, K. F., Pushnitsyna, A. D. MATERIALS FOR DESCRIBING THE EFFECT OF IONIZING RADIATION ON INDIVIDUAL DEVELOPMENT. Tsitologiya 1 (1959) 293-305. (In Russian, translation into English issued June 1960: JPRS-3398, p. 60-77)

Roentgen exposure of larvae and pupae of Drosophila melanogaster causes the destruction of part of the cells of the imaginal disks, the rudiments of definite organs of the insect. X-ray mutations are the result of the incomplete repair of this injury. Their frequency depends upon the time of repair. The data obtained permit one to give a new interpretation of the concept of the sensitive period in ontogenesis. The stage for which the repair process caused by the inflicted injury coincides with sensitive period for a given indication, for a given external influence. The destruction of part of the undifferentiated cells and the deviations caused by it in the further course of ontogenesis are obviously a general characterization of the effect of ionizing radiation on the developing organism. One should have this picture in mind when working out a theory of the biological action of ionizing radiation. (auth.)

* Oster 1959 - [1047]

874 Potts, W. H. SOME EFFECTS OF GAMMA RAYS ON TSETSE PUPAE (GLOSSINA MORSITANS WESTW.) (abstr.) Proc. R. ent. Soc. Lond. - Ser. C (J. Mtg.) 22, 4 (1957/58) 2.

875 Ray, D. T. X-RAY SENSITIVITY OF MEIOTIC STAGES OF MORMONIELLA EGGS. Genetics 42 (1957) 391.

Female wasps were treated with x-rays of different doses (1000 r — 1500 r — 2000 r — 2500 r — 3000 r), and set with host pupae of the fly Sarcophaga bullata. They were transferred to new host pupae at frequent intervals. Eggs laid at successive times after treatment were treated at different meiotic (and even pre-meiotic) stages. Eggs laid within 6 h after x-raying had been rayed during the first meiotic metaphase. Since the females were unmated they produced all haploid males parthenogenetically. Offspring per females as compared to controls furnished a rough estimate of the presence of lethals. Results seem to indicate that while the fecundity of treated females decreased with the increase of x-ray treatment, as expected, there was a drastic reduction in the number of offspring secured from eggs laid during the first 6 h after treatments above 1500 r. Reduction in the number of offspring as treatment increased from eggs laid in successive hours was not nearly as drastic. This indicates a higher sensitivity of the first meiotic metaphase to high doses of radiation with sensitivity decreasing in the earlier meiotic and pre-meiotic stages. A more accurate estimate is being made by egg counting. This was made possible by investigations during the summer of 1955, demonstrating rearing offspring from counted eggs (damp chamber technique) hitherto not possible.

(Abstract of paper presented at the 1957 meetings of the Genetics Society of America, Stanford, California, Aug. 26 to 28, 1957)

876 Ray, D. T. SENSITIVITY OF DIFFERENT STAGES OF THE EGGS OF MORMONIELLA TO X-RAYS. (abstr.) p. 230 in "Proceedings of the 10th International Congress of Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958).

Female Mormoniella wasps were irradiated with varied dosages (500 r — 1000 r — 1500 r — 2000 r — 2500 r).

They were placed with host pupae of the fly Sarcophaga bullata and transferred to new host pupae at frequent intervals. Eggs (laid at successive times after irradiation) had been irradiated at different meiotic stages. Eggs laid within 6 h after irradiation have been x-rayed during the first meiotic metaphase. Egg counts were made using the damp chamber technique. Because of the parasitic nature of Mormoniella an accurate count of eggs can only be made by removing them from their host. The counted eggs must be placed in another host for further development. The new host pupae were first stung by sterile female wasps. A small aperture was made in the stung pupae and the eggs inserted within. The pupae were then placed in open mouth vials and suspended by metal racks over a saturated solution of NaCl in large covered jars, to ensure the correct humidity and discourage mold. The eggs were observed for hatching and development without being disturbed. Results indicate that while the number of eggs hatching decreased as expected with increase in x-ray treatment, the number of offspring from eggs laid during the first 6 h decreased drastically. Only 8% of these eggs from females given 1000 r developed as against 20% of eggs laid after 24 h. No eggs developed from wasps given dosages above 1500 r in this group. Reduction in the number of offspring from eggs laid in successive hours was not nearly as drastic. This seems to indicate a higher sensitivity of the first meiotic metaphase to irradiation, with the sensitivity decreasing in the earlier meiotic and premeiotic stages.

877 Sävhagen, R. RELATION BETWEEN X-RAY SENSITIVITY AND CELL STAGES IN MALES OF DROSOPHILA MELANOGASTER. Nature 188, 4748 (1960) 429-30.

An attempt is made to find the time of appearance of sperm irradiated in meiosis by a direct method, and at the same time to correlate it with the sensitivity pattern. It could be shown that the treated meiotic cells become available for insemination during the 7th day after irradiation and onwards. The peak of sensitivity would appear to correspond to cells treated during metaphase I or before anaphase I is completed.

878 Séréno, C. EVIDENCE OF RADIOSENSITIVE STAGES DURING THE EMBRYONIC DEVELOPMENT OF GRYLLUS BIMACULATUS. C. R. Acad. Sci., Paris 251 (1960) 2430-2.

The radiosensitivity of the cricket embryo at various stages of development was studied. Embryos were exposed at ages 2, 24, 48 and 72 h and 4, 5, 6, 7, 8 and 9 d to 250 and 350 r. The variations in the percentage of hatching and the variation in the length of embryogenesis were used as the criteria to evaluate the radiation effects. The two radiation doses had essentially the same effect. The results showed that the radioresistant stages are characterized by zero (2 h) or slow (48 h) mitotic activity. In the radiosensitive stages corresponding to periods of intense mitotic activity, the radiation doses used appeared to either completely stop the embryonic development or to have no effect at all. (NSA 15: 8540, 1961)

879 Тульцева, Н.М., Астауров, Б.Л. ПОВЫШЕННАЯ УСТОЙЧИВОСТЬ ПОЛИПЛОДОВ ШЕЛКОВИЧНОГО ЧЕРВЯ (BOMBYX MORI, L) К ЛУЧЕВЫМ ПОВРЕЖДЕНИЯМ, В СВЯЗИ С ОБЩЕЙ ТЕОРИЕЙ БИОЛОГИЧЕСКОГО ДЕЙСТВИЯ ИОНИЗИРУЮЩИХ РАДИАЦИЙ. Биофизика 3, 2 (1958) 197-205.

Использовался Bombyx mori, L.

Tultseva, N. M., Astaurov, B. L. INCREASED RADIO-RESISTANCE OF BOMBYX MORI L. POLYPLOIDS AND THE GENERAL THEORY OF THE BIOLOGICAL ACTION OF IONIZING RADIATIONS. Biophysics (USSR) (English Translation) 3 (1958) 183-9.

The radio-resistance of silkworm embryos in the stages from diapause to middle spring development increases with the degree of polyploidy, other things being equal. There is a marked rise in resistance between diploid and triploid, and a lesser one between triploid and tetraploid. The data support the ideas as to the essence of the biological effects of ionizing radiations. They show that the main causes of such effects as radiation damage to embryos of multicellular organisms are genotype changes in the cell nucleus. (auth.)

880 Ulrich, H. RÖNTGENTEILBESTRAHLUNG VON DROSOPHILAEIERN (Partial x-irradiation of Drosophila eggs). Naturwissenschaften 38, 5 (1951) 121. (In German)

Drosophila eggs 1 h after being laid were irradiated with 200 r of x-rays. By using a screen with a splitlike window it was possible to investigate the influence of irradiation on 5 successive zones each 0.1 mm wide. A maximal sensitivity, expressed in percentages of non-hatchability, could be established for the second region of the anterior part of the egg. (EM 14, 7: 32, 1953)

881 Ulrich, H. ERGEBNISSE EINER PARTIELLEN RÖNTGENBESTRAHLUNG VON DROSOPHILA EIERN (Results of partial irradiation of Drosophila eggs). Biol. Zbl. 70 (1951) 274-85.

On exposing different portions of 1 - 2 h-old Drosophila eggs to an x-ray dose of 200 r, the percentage of dead eggs demonstrate a non-uniform radiosensitivity. Maximum sensitivity occurs in the anterior second fifth portion of the egg, effectively at the cleavage centre, beyond which the sensitivity decreases. A similar but somewhat shifted curve for the distribution of radiosensitivity is obtained for the posterior portion of the egg, with a maximum in the third or middle fifth of the egg.

882 Ulrich, H. SINGLE EVENT IN KILLING OF DROSOPHILA EGGS BY X-RAYS? Drosophila Inform. Serv. 27 (1953) 117-8.

883 Ulrich, H. DIE BEDEUTUNG VON KERN UND PLASMA BEI DER ABTÖTUNG DES DROSOPHILA-EIES DURCH RÖNTGENSTRAHLEN (The significance of nucleus and cytoplasm in the killing by x-rays of the Drosophila egg). Naturwissenschaften 42 (1955) 468. (In German)

Dose-effect curves obtained from 10-20 minute-old Drosophila eggs prior to cleavage can be used for a quantitative investigation into the significance of nucleus and cytoplasm in the process of killing the egg by irradiation. Irradiation was applied either to the anterior or the posterior half of the egg. Anterior and total irradiation showed that damage to the nucleus caused death, whereas posterior irradiation indicated that cytoplasmic damage can also be responsible for death. The possible mechanism of killing is discussed.

884 Ulrich, H. EIN VERGLEICH DER RÖNTGENSTRAHLENWIRKUNG AUF KERN UND PLASMA DES DROSOPHILA-EIES (A comparison of the effects of x-rays on the nucleus and cytoplasm of Drosophila eggs). Biol. Zbl. 74, 9/10 (1955) 498-515. (In German)

10-20 min-old eggs from mated wild-type females were irradiated in late telophase of the second maturation division, during first and second cleavage. The nucleus of the unfertilized egg lies in the anterior half. The radiation effects, both qualitatively and quantitatively, were found to be quite different for separate irradiation of the anterior and posterior halves. Results for anterior irradiation correspond quantitatively with lethality records for whole-egg irradiation. The sensitivity ratio of nucleus to cytoplasm certainly exceeds 182:1 (in terms of equivalent lethality at the 50% lethality dose).

(A note also appeared in Drosophila Inform. Serv. 29: (1955) 170-1, under "Comparative studies on the lethal action of x-rays on nucleus and cytoplasm of Drosophila eggs before cleavage")

885 Ulrich, H. DIE STRAHLENEMPFINDLICHKEIT VON ZELLKERN UND PLASMA UND DIE INDIREKTE MUTAGENE WIRKUNG DER STRAHLEN (Sensitivity of the nucleus and cytoplasm to irradiation, and the indirect mutagenic effects of radiation). Zool. Anz. Suppl. 20 - Verh. dtsch. zool. Ges. 1956 (1957) 150-82.

10-20 min-old Drosophila eggs were used to further study the differences in radiosensitivity and dosis-dependence of the nucleus and plasma, and to investigate radiation death. Death from irradiation of the nucleus appears to result from a dominant lethal mutation. Such irradiation leads to an early death of the individual still during early embryonic development whereas irradiation of the plasma leads mostly to death of the larvae, i.e. later death. Physiological damage (segmentation disturbances) frequently occur in surviving flies. When death resulted from damage to the plasma ( irradiation of posterior half), recessive lethal mutations were also found in the screened-off nucleus. Further work is required to determine whether this indirect effect on the nucleus is due to scattered radiation or chemical action resulting from irradiation.

886 Van den Bruel, W.E., Bollaerts, D. RESISTANCE DES DIVERS STADES DE DÉVELOPMENT DE SITOPHILUS GRANARIUS L. ET S. ORYZAE L. AUX IRRADIATIONS PAR LES RAYON GAMMA ($Co^{60}$) Bull. Inst. agron. Gembloux hors sér. 2 (1960) 883-905.

A dose of 20 000 rad did not destroy all pupae and adults in wheat grain. A dose of 1000 rad applied within 2 d of deposition prevented almost all the eggs of S. oryzae from giving rise to adults but reduced the number of adults that developed from those of S. granarius and their larval progeny by 40 and 27% respectively. Irradiation of the 1st and 2nd instar larvae of both species at 1000 rad had little effect on the number and fertility of the adults; but at 2500 rad a sterilizing effect on the adults was noticed, especially when applied to 2nd and 3rd instars of S. granarius and 3rd instar pupae and adults and to a lesser extent 2nd instar S. oryzae. No adults were produced by eggs and 1st instars of this species following irradiation at 2500 rad.

In both species 5000 rad prevented the development of adults when applied to the 3rd instar or to younger stages and greatly reduced the numbers that developed when applied to later stages; virtually all the adults produced were sterile.

887 Wharton, D. R. A., Wharton, M. L. THE EFFECT OF RADIATION ON THE LONGEVITY OF THE COCKROACH, PERIPLANETA AMERICANA, AS AFFECTED BY DOSE, AGE, SEX AND FOOD INTAKE. Radiation Res. 11, 4 (1959) 600-15.

A 2-MeV Van de Graaff electron accelerator was used for irradiation. The technique for irradiating individual cockroaches under controlled conditions is described. The exposure dose was 10 000 rads. The sensitivity of the adult cockroach, Periplaneta americana, to radiation increases with age, as measured by the change in ratio between the $T_{50}$'s (time in days when 50% mortality occurs) of irradiated and unirradiated insects of different ages. Irradiated females survive longer than males. Survival is affected by the state of nutrition. Death due primarily to irradiation with 10 000 rads has been demonstrated to occur independently of starvation effects. Post- as well as preirradiation starvation reduced resistance to radiation injury. Free-feeding after irradiation increases the longevity of the male but does not affect the survival of the female. Irradiated and starved insects of both sexes die sooner than starved controls. They lose a smaller fraction of their weight than the controls but at a greater rate. The effect of a divided dose at any given time is less than that of the single total dose. The results are discussed with special reference to the nutritional state of the insects and to the change of radiosensitivity with age.

## I-A-3 RADIOSENSITIVITY OF DIFFERENT SPECIES OR STRAINS

* Baker et al. 1953 - [1239]

* Baker et al. 1954 - [1241]

* Baker et al. 1953 - [1240]

* Baker and Edington 1952 - [1360]

* Borstel and Pardue 1956 - [979]

* Borstel and Pardue 1957 - [980]

* Borstel and Rekemeyer 1959 - [982]

888 Cole, M. M., LaBrecque, G. C., Burden, G. S. EFFECTS OF GAMMA RADIATION ON SOME INSECTS AFFECTING MAN. J. econ. Ent. 52, 3 (1959) 448-50.

The $LD_{50}$ of gamma radiation from $Co^{60}$ against the body louse (Pediculus humanus humanus L.), housefly (Musca domestica L.), American cockroach (Periplaneta americana L.), German cockroach (Blattella germanica L.), firebrat (Thermobia domestica (Pack.)), bed bug (Cimex lectularius L.), and Pharaoh ant (Monomorium pharaonis L.) ranged from 130 r for half-day old fly eggs to 190 000 r for body louse nymphs and Pharaoh ant queens. Doses required to cause 100% mortality ranged from 600 r to 250 000 r. Among the species tested, the $LD_{50}$ varied inversely with the size of the insect. Reproduction in body lice was inhibited at dosages of 75 000 r or higher. DDT-resistant body lice were as susceptible to gamma rays as non-DDT-resistant lice. (auth.)

* Cornwell and Burson 1958 - [1304]

889 Cornwell, P. B., Morris, J. A. SUSCEPTIBILITY OF THE GRAIN AND RICE WEEVILS CALANDRA GRANARIA L. AND C. ORYZAE L. TO GAMMA RADIATION. AERE R. 3065, Atomic Energy Research Establishment, Harwell, Berks, England. Sep. 1959, 32 p.

For abstract only, see 891.

(This paper was presented at the "Conference on the Application of Large Radiation Sources in Industry, Warsaw 8-12 Sep. 1959", Conf. Proc., Vol. 2. Vienna, International Atomic Energy Agency, 1960)

890 Cornwell, P. B., Morris, J. A. SUSCEPTIBILITY OF LABORATORY AND WILD STRAINS OF CALANDRA GRANARIA L. TO GAMMA RADIATION. AERE R. 3163, Atomic Energy Research Establishment, Harwell, Berks, England. Dec. 1959, 36 p.

A comparison was made of the susceptibility to γ-radiation of adults of 5 laboratory strains and 30 wild strains of Calandra granaria L. with that of the Pest Infestation Lab., used as a standard. It was concluded that the dose level of 16 500 rep evaluated for the sterilization of large populations of the standard strain of C. granaria might safely be recommended for the commercial disinfestation of naturally occurring populations.

891 Cornwell, P. B., Morris, J. A. SUSCEPTIBILITY OF THE GRAIN AND RICE WEEVILS CALANDRA GRANARIA L. AND C. ORYZAE L. TO GAMMA RADIATION. p. 291 in "Large Radiation Sources in Industry. Conference Proceedings, Warsaw 8-12 Sep. 1959", Vol. 2, Vienna, International Atomic Energy Agency, 1960.

The paper forms a contribution to present knowledge of the entomology of radiation treatment of grain. An examination is made of the effects of γ-radiation on the two principal grain pests, when these are reared and retained under near optimum conditions for the species. The effects of radiation on the complete life-history of a laboratory strain (ex Pest Infestation Laboratory, D. S. I. R.) of the grain weevil, C. granaria, were examined at 24-hourly intervals during the life-history. Each stage of development was subjected to 17 doses ranging from 250 - 20 000 rep. Three criteria were used to determine radiation susceptibility: (1) emergence of immature stages as adults from grain, (2) survival after emergence and (3) the production of adult progeny. Similar observations on all stages of the rice weevil, C. oryzae, allow a comparison of susceptibility in the two species. Additional studies with C. granaria include: (1) radiation susceptibility of the sexes and (2) periodicity in fertility at sub-sterilizing doses. Doses evaluated for commercial disinfestation are tested against massive populations and under a limited range of commercial storage conditions. The relative merits of fumigation treatment and radiation desinfectation are compared.

(This paper was published in full as AERE R. 3065, Atomic Energy Research Establishment, Harwell, Berks, England, 1959, 32 p.)

* Fluke 1957 - [1184]

* Gray 1956 - [1311]

* Hassett 1957 - [1253]

892 Ives, P. T., Conklin, P. M., Burwell, L. R. RADIATION EFFECTS ON DIFFERENT STRAINS OF DROSOPHILA MELANOGASTER (abstr.) Genetics 44 (1959) 517.

Tests were carried out on male mutational, and male and female longevity responses to γ-radiation using various strains of D. melanogaster. Both mutational and longevity responses to radiation appear to be subject to genetic modification in phenotypically normal Drosophila.

* Kaufmann et al. 1955 - [916]

* Kihara 1953 - [934]

* Lee 1956 - [1019]

* Lee 1958 - [1020]

* Nishiwaki et al. 1953 - [872]

893 Передельский, А.А. ДЕЙСТВИЕ ИОНИЗИРУЮЩИХ ИЗЛУЧЕНИЙ НА НАСЕКОМЫХ. В кн. "Итоги науки. Биологические науки", I. Радиобиология. Биологическое действие ионизирующих излучений. Под общ.ред. А.М. Кузина. М., Акад.наук СССР, стр.313-28 (1957).

Раздел I. Радиорезистентность насекомых. а) Изменение дозы летального действия иони-

зирующих излучений в связи с возрастом. б)Зависимость радиорезистентности от рода и характера облучения. г)Механизм радиорезистентности. Влияние обмена веществ и защитных веществ. д)Сравнительная радиорезистентность в состояниях анаболизма, катаболизма, деления клеток и во время процесса дифференцировки.

Раздел II. Вопросы борьбы с вредными насекомыми с помощью ионизирующих излучений. а)Ионизирующие излучения в борьбе с вредителями продовольственных товаров. б)Ионизирующие излучения в борьбе с мухой Callitroga.

Исследовано отношение к ионизирующим излучениям ряда вредных насекомых: Calandra (Sitophilus) granaria, C. oryzae, Tribolium confusum, Tenebrio molitor, Oryzaephilus surinamensis, Rhizopertha dominica, Lasioderma sericorne, Acanthoscelides obtectus и др. Во всех исследованиях показаны сходство действия различных родов облучения и нецелесообразность применения высоких доз порядка 100 000 р и более, так как даже при 200 000 р 100% насекомых вымирает лишь к 7-му дню после облучения. Подобные дозы неэкономичны и приводят к нежелательным изменениям зерна. Поэтому была предложена половая стерилизация, т.е. применение доз, вызывающих прекращение размножения вредителя и некоторое ускорение вымирания облученных особей.

Peredelsky, A.A. THE EFFECT OF IONIZING RADIATION ON INSECTS. p. 313-28 in "Itogi Nauki. Biol. Nauki", Vol. 1, Radiobiology. Biological effects of ionizing radiations. Kuzin, A.M., ed. Moscow, Izdatel. Akad. Nauk SSSR. 1957.

Part I. Radioresistivity of insects.
a) Variation of lethal dose from ionizing radiations with age.
b) Dependence of radioresistivity on the type and quality of the radiation.
c) The mechanism of radioresistivity. Influence of metabolism and protective substances.
d) Comparative radioresistivity during anabolism, catabolism, division of cells and during differentiation.
Part II. Problems in the control of insect pests by ionizing.
a) Ionizing radiation for controlling insects infesting food stuffs.
b) Ionizing radiations for controlling Callitroga.

The action of ionizing radiation has been studied on a number of insect pests: Calandra (Sitophilus) granaria, C. oryzae, Tribolium confusum, Tenebrio molitor, Oryzaephilus surinamensis, Rhizopertha dominica, Lasioderma sericorne, Acanthoscelides obtectus and others. All experiments show the similarity in the effect of different kinds of radiation and the inexpediency of using high doses (~ 10 000 r or even higher), as with 200 000 r 100% of insects are only killed 7 d after irradiation. Such doses are uneconomical and result in undesirable changes in the crops. Instead, doses are proposed for causing sterilization and stopping reproduction or resulting in a certain accelerated mortality in irradiated individuals.

* Ray and Whiting 1954 - [1056]

894 Rohde, C.J. STUDIES ON THE BIOLOGY OF THE MITE CALOGLYPHUS MYCOPHAGUS MEGN., 1874 (ACARINA: ACARIDAE) INCLUDING THE EFFECTS OF GAMMA RADIATION UPON CERTAIN DEVELOPMENTAL STAGES. Bull. ent. Soc. Amer. 3, 3 (1957) 30-1, abstr. 14.

(See later article in Ecology 40 (1959) 572-9 for fuller account)

895 Rohde, C.J. STUDIES ON THE BIOLOGIES OF TWO MITE SPECIES, PREDATOR AND PREY, INCLUDING SOME EFFECTS OF GAMMA RADIATION ON SELECTED DEVELOPMENTAL STAGES. Ecology 40 (1959) 572-9.

A preliminary study. The life history of Caloglyphus mycophagus (prey) is presented in detail (life-cycle 4-9 d). Fuscuropoda marginata (predator) has a life-cycle of 30-40 d. A $Co^{60}$-radiation chamber was used, the doses delivered ranging from 250 to 3750 r at 19 r/s. The predator male is rendered permanently sterile by doses that produce temporary sterility in the prey male. Data on the effects of irradiation on egg hatchability and on the viability of eggs from irradiated virgin adults are presented. F. marginata eggs are insensitive to doses producing 50% mortality in C. mycophagus eggs of comparable age ($LD_{50}$ for Caloglyphus eggs = 2930 ± 75 r).

* Russell 1956 - [1063]

896 Schinz, H. R., Fritz-Niggli, H. DIE STRAHLENEMPFINDLICHKEIT FRÜHER EMBRYONALSTADIEN VON DROSOPHILA HYDEI STURTEVANT IM VERGLEICH ZU DROSOPHILA MELANOGASTER MEIGEN (A comparison of the radiosensitivity of early embryonic stages of Drosophila hydei Sturtevant and Drosophila melanogaster Meigen). Strahlentherapie 104 (1957) 328-37. (In German)

Experiments were carried out to test whether number of chromosomes affected radiosensitivity. No increase in resistance was found with higher chromosome number. It is assumed that lethal effects are due more to biochemical changes than to chromosome damage.

897 **Шапиро, Н.И., Страшненков, С.И., Плотникова, Е.Д., Сусликов, В.И. СРАВНИТЕЛЬНАЯ ОЦЕНКА ПОВРЕЖДАЮЩЕГО ДЕЙСТВИЯ ИОНИЗИРУЮЩЕЙ РАДИАЦИИ НА НАСЛЕДСТВЕННОСТЬ МЫШИ И ДРОЗОФИЛЫ. Журнал общей Биологии 21, 2 (1960) 104-12.**

**I. Генетическая радиочувствительность мыши, определяемая по частоте возникновения доминантных леталей, выше, чем дрозофилы, в среднем в пять - десять раз.**
**2. Частота возникновения доминантных леталей у мыши и дрозофилы пропорциональна общему размеру хромосом сравниваемых видов.**

Shapiro, N. I., Strashnenkov, S. I., Plotnikova, E. D., Suslikov, V. I. A COMPARATIVE EVALUATION OF THE GENETIC DAMAGE FROM IONIZING RADIATION TO MOUSE AND DROSOPHILA MELANOGASTER. J. gen. Biol., Moscow 21, 2 (1960) 104-12.

The genetic radiosensitivity of mouse, determined from the rate of formation of dominant lethals is, on an average, 5-10 times higher than for D. melanogaster. The dominant-lethal mutation rates in mouse and Drosophila are directly proportional to the overall chromosome size of the species.

(See also report received from Moscow, USSR, by the UN Scientific Committee on the Effects of Atomic Radiation, A/AC. 82/G/L. 415, 1960, 31p.)

898 Strømnaes, Ø. X-RAY INDUCED LETHAL MUTATIONS IN SEVERAL STRAINS OF DROSOPHILA MELANOGASTER. Hereditas 37 (1951) 532-59.

Males from 31 strains of D. melanogaster were tested in regard to their sensitivity to the induction of dominant lethal mutations by 2300 r x-rays. Genetic differences in the sensitivity to induction of dominant lethal mutations by x-rays were found to exist between unrelated strains. (NSA 6: 770, 1952)

899 Strømnaes, Ø. STOCK DIFFERENCES IN X-RAY MUTATIONAL SENSITIVITY PATTERN OF DROSOPHILA MELANOGASTER. Hereditas 45, 2-3 (1959) 221-9.

These may be ascribed to differences in metabolic and maturation rates in the two stocks tested (Iso-Amherst and Oslo).

900 **Струнников, В.А. ОТНОСИТЕЛЬНЫЙ ЭФФЕКТ ПЕРВИЧНЫХ РАДИАЦИОННЫХ ПОВРЕЖДЕНИЙ ЯДРА И ЦИТОПЛАЗМЫ ПОЛОВЫХ КЛЕТОК ТУТОВОГО ШЕЛКОПРЯДА (BOMBYX MORI). Цитология (СССР) 2 (1960) 573-80.**

**В 4 опытах с помощью метода экспериментального андрогенеза изучался относительный эффект первичных радиационных повреждений ядра и цитоплазмы половых клеток тутового шелкопряда. С этой целью неосемененные бабочки-самки облучались рентгеновскими и гамма-лучами в дозах от 20 до 1100 кр, после чего спаривались с необлученными самцами. Одна часть отложенной грены каждого варианта не подвергалась (контроль), а вторая подвергалась термическому воздействию с целью индукции андрогенеза. Не прогретая, зиготически развивающаяся грена контрольных серий погибала после всех доз облучения, включая и наименьшую (20 кр), вследствие участия в развитии облученного женского ядра. Прогреванием грены из оплодотворения устранялось облученное женское ядро, и развитие яйца переключалось на андрогенетический путь с участием дипольного ядра дробления, образованного слиянием двух необлученных мужских ядер. Резкое снижение выхода андрогенетических гусениц при облучении дозами выше 60-90 кр и гибель яиц при самых больших дозах являются доказательствами наличия первичных радиационных повреждений цитоплазмы. Облучение**

цитоплазмы 20-54 кр не приводит к стерильности и понижению жизнеспособности андрогенетических особей.

Strunnikov, V. A. OTNOSITEL'NYI EFFEKT PERVICHNYKH RADIATSIONNYKH POVREZHDENII YADRA I TS ITOPLAZMY POLOVYKH KLETOK TUTOVOGO SHELKOPRYADA (The relative effect of primary radiation damage to the nucleus and cytoplasm of the germ cells of Bombyx). Tsitologya 2, 5 (1960) 573-80.

By means of experimental androgenesis the relative effect of primary radiation damage to nuclei and cytoplasm of the germ cells of Bombyx was studied. Unfertilized female moths were x-irradiated with doses of 20-1100 kiloroentgens, and then mated with nonirradiated males. The unheated zygotically developing worm eggs of the control series died after all doses of irradiation. Heating the eggs after fertilization eliminated the irradiated female nucleus; the development of the eggs switched over to the androgenetic path with the division of the diploid nucleus formed by the merging of 2 unirradiated male nuclei. The appearance of single androgenetic caterpillars from eggs, the cytoplasm of which had been irradiated with 500 kiloroentgens, was noted in 2 experiments. Irradiation of cytoplasm with doses of 20-54 kiloroentgens did not result in sterility or decrease in vitality of androgenetic individuals. (BA 37: 4851, 1962)

(The article may also be found in Referat. Zhur., Biol., No. 13 A 107 (1961))

901 Tazima, Y. DIFFERENCES IN SENSITIVITY OF GERM-CELLS AND CHROMOSOMES TO RADIATION AMONG SOME MUTANT STRAINS OF THE SILKWORM. p. 280-6 in "Proceedings of the International Genetics Symposia, Tokyo & Kyoto, Sep. 1956". Suppl. to Cytologia 1957. Tokyo, Science Council of Japan. 1957, 702 p.

The results indicate that the sensitivity to x-rays of the same locus is clearly different according to the mutant strain, even in the same developmental stage of the same sex. Marked differences were observed, especially in the male germ-cells. The rb strain of silkworm contains a large quantity of reducing substances in its body fluid; contrary to expectations, its sensitivity was considerably higher than that of other strains. The role of reducing substances in determining the effects of irradiation is not clear.

* Bruel and Bollaerts 1960 - [886]

## I-A-4 RADIOSENSITIVITY AT THE CELLULAR LEVEL

### Survey

902 Carlson, J. G. IMMEDIATE EFFECTS ON DIVISION, MORPHOLOGY AND VIABILITY OF THE CELL. p. 763-824 in "Radiation Biology", Vol. 1, Hollaender, A., ed. New York, McGraw-Hill 1954.

Comprehensive review of the action of high-energy as compared with ultraviolet radiations, in terms of mitotic, morphological and cell viability effects, and their possible interpretation. Amongst the examples cited is work on grasshopper (Chortophaga) and Drosophila. The extensive literature (p. 817-24) goes back to the beginning of the century.

903 Астауров, Б.Л. ДИФФЕРЕНЦИАЛЬНЫЙ ЭФФЕКТ РАДИАЦИОННЫХ ПОВРЕЖДЕНИЙ ЯДРА И ЦИТОПЛАЗМЫ КАК СЛЕДСТВИЯ ИХ ФУНКЦИОНАЛЬНОЙ СПЕЦИФИЧНОСТИ Бюллетень Моск. Общества Испытателей Природы, Отдел биологич. 63, 1 (1958) 35-48.

Использовался Bombyx mori, L.

Astaurov, B. L. DIFFERENTIAL EFFECT OF RADIATION DAMAGE TO NUCLEUS AND CYTOPLASM, RESULTING FROM THEIR SPECIFIC FUNCTIONS. Byulleten Mosk. Obshshestva Ispytatelei Prirody, Otdel biologich. 63,1 (1958) 35-48.

A study on Bombyx mori.

904 Астауров, Б.Л. ФУНКЦИОНАЛЬНЫЙ ПРИНЦИП В ОЦЕНКЕ ОТНОСИТЕЛЬНОЙ ЗНАЧИМОСТИ РАДИАЦИОННЫХ ПОРАЖЕНИЙ ЯДРА И ЦИТОПЛАЗМЫ И ГЕНЕТИЧЕСКАЯ ТЕОРИЯ ЛУЧЕВОЙ БОЛЕЗНИ. Тезисы докладов и выступлений на симпозиуме "Первичные механизмы биологич. действия иониз. излучений", изд. МОИП, Москва 30/V-1/VI(1960)37-9.

Astaurov, B. L. INTERPRETING THE DIFFERENCES IN RADIATION DAMAGE TO THE NUCLEUS AND CYTOPLASM, IN CONNECTION WITH THEIR RESPECTIVE FUNCTIONS AND THE GENETIC THEORY OF RADIATION SICKNESS. Tezisy dokladov i vystupleny na Simpoziume "Pervichnye mekhanismy biologich. deistviya ioniz. izlucheny", 30 May - 1 June 1960, 37-9. Izd. MOIP, Moskva (1960). (In Russian)

Work on Bombyx mori is described.

905 Bonnier, G., Lüning, K. G., Arnberg, B. ON A POSSIBLE MUTAGENIC EFFECT OF X-RAYED EGG CYTOPLASM. (abstr.) Hereditas 38, 1 (1952) 109-12.

Experiments were made on the mutagenic effect on paternal chromosomes of x-raying egg cytoplasm in Drosophila melanogaster. The results indicate that if fertilization takes place shortly after irradiation such an effect may be produced. Further experiments are, however, desirable. (auth. summary)

906 Borstel, R. C. von, Rogers, R. W. ALPHA-PARTICLE BOMBARDMENT OF THE HABROBRACON EGG II. RESPONSE OF THE CYTOPLASM. Radiation Res. 8 (1958) 248-53.

Alpha-radiation was used to kill newly laid Habrobracon eggs by inactivation of the cytoplasm. Cytoplasmic inactivation is kinetically and morphologically distinct from nuclear inactivation. The egg nucleus is inactivated by one $\alpha$-particle; the 50% lethal dose is approximately $16 \times 10^6$ $\alpha$-particles per egg when the cytoplasm is irradiated. Death occurs late in development when the cytoplasm is $\alpha$-irradiated, and in most respects the morphology of the dead embryos resembles that from ultraviolet irradiation of the cytoplasm. (auth. summary)

907 Carlson, J. G. EFFECTS OF RADIATION ON MITOSIS. J. cell. comp. Physiol. 35, Suppl. 1 (1950) 89-101. (This work was published in a 22p-report ORNL-570, Oak Ridge National Lab., Tenn., in 1950)

Neuroblasts of grasshopper (Chortophaga viridifasciata DeGeer) embryos were used, growing in hanging-drop culture preparations. Instead of reverting to an earlier stage, cells which had passed the "critical" period completed mitosis regardless of the dose given (which ranged from 4 r to 8000 r of x-rays). Subsequent mitoses are discussed. The effects of ultraviolet radiation are described. Dosage rate effects were also tested for $\gamma$-rays (from activated tantalum), and the relation of mitotic rate to time after irradiation shown graphically for 3 different doses given at 0.25 r/min. This rate appears to be so low that the recovery processes in the cells are able to keep pace with the radiation effects, at least between $2\frac{1}{2}$ and $8\frac{1}{2}$ h after treatment has begun. Observed changes in cell morphology are described.

908 Carlson, J. G., Harrington, N. G., Gaulden, M. E. MITOTIC EFFECTS OF PROLONGED IRRADIATION WITH LOW-INTENSITY $\gamma$-RAYS ON THE CHORTOPHAGA NEUROBLAST. Biol. Bull. 104, 3 (1953) 313-22.

Prolonged treatment of neuroblasts of Chortophaga viridifasciata (DeGeer) with low intensity $\gamma$-rays reduced mitotic activity much less than a comparable dose at high intensity. Details of the source, calibration, treatment, and a summary of data and biometrical analysis for dose rates of 3.4 and 0.80 r/h are given. The results demonstrate that radiation can retard but not stimulate the mitotic progress of cells. It appears that any increase in the number of cells in a given stage of mitosis soon after treatment can be interpreted to result from either retardation of mitotic progress within that stage resulting in an accumulation of cells or in entry into that stage, in a brief period of time, of an abnormally large number of cells that accumulate in a preceding stage as a result of mitotic retardation.

* Gaulden and Nix 1950 - [1385]

* Gaulden et al. 1953 - [1386]

909 Gaulden, M. E., Kokomoor, K. L. INFLUENCE OF YOLK ON MITOTIC RATE IN UNTREATED AND X-RAYED GRASSHOPPER NEUROBLASTS IN VITRO. Proc. Soc. exp. Biol. Med., N.Y. 90 (1955) 309-14.

Neuroblasts of the Chortophaga viridifasciata embryo were studied in hanging-drop cultures. Frequency of mid-mitotic neuroblasts was found to increase as the quantity of yolk in the culture was increased up to a quantity equivalent to 1/4 that in an egg. The influence of yolk on mitosis in the untreated neuroblast is

interpreted as indicating that, in this cell at least, the first half of prophase does not operate solely on energy stored within the cell but is dependent on an outside source of energy for continuance of mitosis. In x-rayed embryos it was found that the duration of the radiation-induced mitotic inhibition is shorter and the beginning and completion of recovery is faster in the neuroblasts of embryos cultured in yolk than in those of embryos cultured without yolk. The pronounced positive effect of yolk on recovery of neuroblasts from radiation damage demonstrates that, in this cell, some extracellular substance or substances can greatly enhance repair of mitotic damage. (BA 30: 13945, 1956)

* Gaulden 1956 - [217]

910 Gaulden, M. E. EFFECTS OF LOW-LEVEL RADIATION (1 to 3 r) ON MITOTIC RATE OF GRASSHOPPER NEUROBLASTS. ORNL-2267, Oak Ridge National Lab., Tenn. (Part of Semiannual Progress Report for period ending 15 Feb. 1957 of the Biology Division).

It would appear that low doses of radiation affect mitotic rate in the grasshopper (Chortophaga viridifasciata) neuroblasts not by inhibiting DNA synthesis but by altering in some unknown way the physical structure of the chromosome. No influence of oxygen on mitotic effects of low doses of x-rays has yet been demonstrated. It should be noted that although the neuroblasts are extremely sensitive to the effects of radiation in producing temporary mitotic inhibition, they are fairly "resistant" to its effects in producing permanent inhibition.

911 Geyer-Duszynska, I. X-RAY INDUCED FRAGMENTATION OF SALIVARY GLAND CHROMOSOMES IN DROSOPHILA MELANOGASTER. Zool. Polon. 6 (1953-5) 250-82.

912 Harrington, N. J., Koza, R. W. EFFECT OF X-RADIATION ON THE DESOXYRIBONUCLEIC ACID AND ON THE SIZE OF GRASSHOPPER EMBRYONIC NUCLEI. Biol. Bull. 101 (1951) 138-50.

Cytological and cytochemical studies were made on embryonic nuclei of the grasshopper, Chortophaga viridifasciata, after x-ray doses of 4000, 10 000 and 12 500 r. The changes were measured photometrically by using (1) the Feulgen reaction to determine relative changes in the desoxyribonucleic acid (I) desoxypentose, and (2) the methyl green stain to indicate the degree of polymerization of the nucleic acid. X-radiation caused swelling of the nuclei. When correction was made for this, the Feulgen-stained nuclei showed no significant loss of I after irradiation, but the nuclei stained with methyl green disclosed loss of stainability. This indicates that x-rays do not destroy I but rather induce depolymerization of the nucleic acid; hence, estimates of I in tissues stained with Feulgen or methyl green are not reliable. (CA 46: 9634c, 1952)

913 Horikawa, M., Sugahara, T. STUDIES ON THE EFFECTS OF RADIATION ON LIVING CELLS IN TISSUE CULTURE. I. RADIOSENSITIVITY OF VARIOUS IMAGINAL DISCS AND ORGANS IN LARVAE OF DROSOPHILA MELANOGASTER. Radiation Res. 12 (1960) 266-75.

In order to study the effect of radiation on larvae of D. melanogaster, various imaginal discs and organs of 3rd instar larvae were cultured in a synthetic medium together with cephalic complexes as a source of the metamorphic hormone. Irradiated discs or organs were used for culture in one series, and irradiated cephalic complexes were used in the other. From the difference in results obtained in the two series, it was concluded that the decrease in % ecdysis was caused by a functional disturbance of the cephalic complex induced by radiation. It was shown that the brain, the wing disc, and the testis were more radiosensitive than the eye disc, the leg disc, the salivary gland, and the fat body. (auth.)

914 Horikawa, M., Sugahara, T. STUDIES ON THE EFFECTS OF RADIATION ON LIVING CELLS IN TISSUE CULTURE. II. RADIOSENSITIVITY OF CELLS ISOLATED FROM VARIOUS IMAGINAL DISCS AND ORGANS OF LARVAE OF DROSOPHILA MELANOGASTER. Radiation Res. 13 (1960) 825-31.

In the present experiment, from the degree of incorporation of radioactive thymine-$C^{14}$ into single cells isolated from irradiated larvae, differences in radiosensitivity of their constituent cells were found corresponding to the previous results. The ratio of $P^{32}$ incorporation into the whole tissue compared to DNA was highest in the cephalic complex, which may indicate an increased metabolic activity of the cytoplasm. The primary sites of the radiation attack were the large and the small cells of the ring gland, which is a part of the cephalic complex. Those are assumed to be the most active cells for the secretion of the metamorphic hormone in Drosophila larvae. (auth.)

915 Howard, A. INFLUENCE OF RADIATION ON DNA METABOLISM. p. 196-206 (disc. p. 206-11) in CIBA Foundation Symposium on "Ionizing Radiations and Cell Metabolism". Wolstenholme, G. E. W., O'Connor, C. M., eds. London, J. & A. Churchill Ltd. 1956.

Interference with DNA synthesis is known to be one of the most general and important biological effects of radiation. The effect of irradiation on DNA metabolism in some mammalian tissues is discussed, and also the radiosensitivity of DNA metabolism. Radiation-induced changes in cell populations, and the results of changes in cell populations are described. Mention is made of mitotic delay in grasshopper neuroblast caused by radiation. The significance of the findings is considered. In the discussion, Hollaender cited work by Gaulden on the grasshopper neuroblast, where radiation effects were counteracted by placing the neuroblast in a hypertonic solution immediately after irradiation. Experimental details were described. Reference was further made to work by Harrington and Koza who had found swelling of the cell immediately after a certain minimum dose, suggesting a radiation-induced change in osmotic-pressure relationships in the cells.

916 Kaufmann, B. P., McDonald, M. R., Bernstein, M. H. CYTOCHEMICAL STUDIES OF CHANGES INDUCED IN CELLULAR MATERIALS BY IONIZING RADIATIONS. Ann. N. Y. Acad. Sci. 59, 4 (1955) 553-66.

Cytochemical methods were used to study the alterations effected by ionizing radiations in nucleoproteins of dividing cells. In the studies on grasshopper embryos (Melanoplus femur-rubrum, Trimerotropis maritima, and Chortophaga viridifasciata), comparisons were made between irradiated and nonirradiated (shielded) halves of the embryos, as well as between individuals removed from the same egg pod. The capacity of salivary-gland cells of larvae of Drosophila melanogaster to swell when treated with an aqueous solution of trypsin, with water, with a solution of electrolytes, and finally with water was reduced when the larvae had been exposed to ionizing radiation, demonstrating that structural nucleoproteins were partially degraded by the x-rays.

917 King, R. C. THE CYTOLOGY OF THE IRRADIATED OVARY OF DROSOPHILA MELANOGASTER. Exp. Cell Res. 13 (1957) 545-52.

A cytological study was made of ovaries from 12-d-old flies, irradiated with 4000 r (about 100 r/s) of γ-rays from a $Co^{60}$-source shortly after emergence. Irradiated and control ovaries amounted to about 500. Many severely damaged oöcytes underwent pycnotic degeneration. The number of developing eggs was reduced to 80% of the control value. Treated ovaries showed abnormalities which are ascribed to radiation-induced disturbances of cell growth, division, migration and differentiation. The abnormalities are described.

(An abstract was published in Anat. Rec. 128: (1957) 576, abstr. 14)

* Limbaugh and Gaulden 1957 - [1259]

918 Mounter, L. A. STUDIES OF THE EFFECTS OF RADIATION ON ENZYMES. I. INACTIVATION OF CHYMOTRYPSIN AND CHYMOTRYPSINOGEN BY X-RAYS. Radiation Res. 12 (1960) 487-94.

The effect of x-irradiation on the esterase and protease activities of chymotrypsin and chymotrypsinogen has been studied. The degree of inactivation has been compared to results obtained in a study of the ability of the irradiated samples to react with a specific inhibitor ($DFP^{32}$). The data suggest that radiation damage to enzyme molecules may result in impairment of catalytic efficiency without complete destruction of biological activity. These results are discussed. (auth. summary)

919 Oster, I. I. SUGGESTED MECHANISM UNDERLYING THE DIFFERENTIAL RADIOSENSITIVITY OF CELLS HAVING CONDENSED CHROMOSOMES. Genetics 42 (1957) 387.

Both spermatids and spermatozoa have condensed chromosomes, found to be the most radiosensitive state in many organisms. The differential radiosensitivity found in Drosophila melanogaster spermatids and spermatozoa was investigated by x-irradiation in nitrogen, air and oxygen of spermatids, and of mature spermatozoa in 3-4 d-old males and in 2 d-old females with 1200 r and 2800 r (both single and fractionated dose). In spermatids, $O_2$ produced no appreciable effect over air but $N_2$ lowered radiation effects (autosomal translocations) considerably. In spermatozoa, in the male or in the female, $N_2$ and $O_2$ modified the dose response below and above the air response about equally. The high sensitivity of the spermatids may be due to more intra- and/or intercellular $O_2$ being normally present (or available) in these cells. (from abstr.)

920 Rogers, R. W. A MODIFIED PHOTOMULTIPLIER SCINTILLATION DETECTOR FOR ALPHA-PARTICLE DOSIMETRY IN SINGLE CELL BIOLOGICAL IRRADIATION. (abstr.) J. Tenn. Acad. Sci. 28 (1953) 187.

Includes tests with preparations of grasshopper embryos. (See application of technique in study on α-particle dosimetry and the inhibition of mitosis in the grasshopper neuroblast by low dosage α-irradiation, Radiation Res. 3: 18-37, 1955)

921 Rogers, R. W. α-PARTICLE DOSIMETRY AND THE INHIBITION OF MITOSIS IN THE GRASSHOPPER NEUROBLAST BY LOW DOSAGE α-IRRADIATION. Radiation Res. 3 (1955) 18-37.

Polonium α-particle sources and a microscope-adapted source holder were utilized for irradiating special mica hanging-drop, living culture preparations of grasshopper embryos. The technique is described in some detail. The effects of 56 rad of α-radiation on the mitotic rate of grasshopper neuroblast cells were determined. Comparison with similar studies of β- and x-ray inhibition indicated that α-particles were most and β-particles least effective in inhibiting mitosis. A comparison of inhibition of the midprophase and late prophase stages by x-rays and α-particles (56 rad) showed greater radiosensitivity in early midprophase, the effectiveness of both radiations becoming inappreciable by prometaphase. At this dose level, α- and x-radiation effects on early and late midprophase are indistinguishable in terms of mitotic inhibition or failure to inhibit division.

922 Rogers, R. W., Borstel, R. C. von. ALPHA-PARTICLE BOMBARDMENT OF THE HABROBRACON EGG. I. SENSITIVITY OF THE NUCLEUS. Radiation Res. 7, 5 (1957) 484-90.

Dose-hatchability experiments were conducted on newly laid eggs of Habrobracon irradiated by a polonium-210 α-particle source. Lethality is induced by the passage of one α-particle through the nucleus. From target considerations, it is concluded that an α-particle must pass through the nucleus to induce lethality. It is unnecessary to assume that lethality is caused by diffusion of "mutagenic substance" from the irradiated cytoplasm to the nucleus. Dose-action analysis of the different species of morphological appearance of dead embryos suggests that different modes of death from nuclear irradiation are independent in origin. (auth. summary)

923 St. Amand, W. DIFFERENTIAL FREQUENCY OF ACENTRIC FRAGMENTS INDUCED IN GRASSHOPPER NEUROBLASTS BY X-IRRADIATION AT KNOWN MITOTIC STAGES. Genetics 38 (1953) 688-9.

The x-ray sensitivities of the stages of mitosis were determined in hanging-drop preparations of neuroblasts of the grasshopper, Chortophaga viridifasciata (DeGeer), at 38 ± 0.5°C. Cells were mapped and identified as to stage of mitosis just before treatment with 32 r of x-rays. The mapped cells were examined immediately after treatment and then re-examined at short time intervals for as long as 8 h to detect acentric fragments as the cells passed through subsequent anaphases. All determinations were made in living, unstained cells at the first anaphase following treatment. The highest frequencies of fragments are found in cells irradiated in middle and late anaphase and telophase. The sensitivity of cells in interphase at the time of treatment is slightly lower than that of cells irradiated in early prophase. The numbers of fragments induced decreases from early to late prophase and reaches a minimum in cells irradiated in prometaphase. During metaphase and early anaphase sensitivity increases to reach the anaphase-telophase peak.

(Abstract of paper presented at the 1953 Meetings of the Genetics Society of America, Boston, Mass., 28-30 Dec. 1953)

* St. Amand 1953 - [1229]

924 St. Amand, W. THE RELATIVE RADIOSENSITIVITY OF GRASSHOPPER NEUROBLAST CHROMOSOMES X-IRRADIATED AT KNOWN MITOTIC STAGES. (abstr.) J. Tenn. Acad. Sci. 29 (1954) 186.

The breakage frequency of neuroblast chromosomes in each of the stages of mitosis was determined in hanging-drop preparations of grasshopper embryos (Chortophaga viridifasciata), at 38 ± 0.5°C. Cells were mapped and identified as to stage of mitosis before treatment with 32 r of x-rays. The mapped cells were examined immediately after treatment and re-examined at short intervals for 8 h or longer. Breakage frequencies have been determined from acentric fragments detected as cells progressed through anaphase. The sensitivities reported here are based on the combined breakage frequencies found at the first and second anaphases following treatment. The curve of chromosome breakage frequency shows two maxima and two minima. The maximum frequency is found in cells irradiated in middle telophase; a smaller peak occurs in middle prophase. Cells in interphase and in very late prophase at the time of treatment show minimum

sensitivities. Middle telophase (most sensitive) is about twice as sensitive as very late prophase (least sensitive).

925 St. Amand, W. X-RAY-INDUCED MITOTIC AND CHROMOSOMAL EFFECTS IN THE GRASSHOPPER NEUROBLAST AND IN THE EHRLICH ASCITES CARCINOMA. Radiation Res. 3, 3 (1955) 344.

The response of the ascites tumor cell to x-rays is identical to that of the grasshopper neuroblast. In both forms there is an initial decrease followed by a compensatory rise in mitotic activity. Maxima of chromosomal effects correspond to maxima of mitotic inhibition. The neuroblast study, in which cells in known stages of mitosis were irradiated, shows that the temporal correspondence of mitotic inhibition and chromosome breakage is not a causal relation. The relative sensitivities of mitotic stages in populations of dividing cells cannot be determined by the use of devices such as "time after irradiation" or "hours before metaphase" because of the mixture in terms of stage treated represented by cells in meta- or anaphase at any given time after treatment. The admixture of cells is a function of (1) different degrees of inhibition exhibited by cells irradiated in any given stage, (2) stage differences in inhibition sensitivity, (3) reversion of cells irradiated in some prophase stages, and (4) differences in inhibition in cells which show chromosomal damage as compared with those which have suffered no apparent chromosomal damage. (Almost entire abstract)

926 St. Amand, W. MITOTIC INHIBITION AND CHROMOSOME BREAKAGE INDUCED IN GRASSHOPPER NEUROBLASTS BY X-IRRADIATION AT KNOWN MITOTIC STAGES. Radiation Res. 5 (1956) 65-78.

Using living, unstained cells, the relative sensitivity of each stage of mitosis in the neuroblasts of the grasshopper Chortophaga viridifasciata (DeGeer) was determined with respect to mitotic inhibition and chromosome breakage induced by 32 r of x-radiation. The stage of mitosis at the time of irradiation is known for all cells from direct observation. The sensitivity curve of chromosome breakage shows 2 maxima (middle prophase and middle telophase) and 2 minima (interphase and very late prophase). The sensitivity curve relating mitotic stage to chromosome breakage obtained is strikingly similar to that relating mitotic stage to viability obtained for other kinds of cells. The sensitivity curves for viability and chromosome breakage differ in mitosis and meiosis.

927 Stone, W. S., Haas, F. L., Alexander, M. L., Clayton, F. E. STUDIES IN THE GENETICS OF DROSOPHILA. VIII. COMMENTS ON THE MECHANISM OF ACTION OF RADIATIONS ON LIVING SYSTEMS. Univ. Tex. Publ. No. 5422 (1954) 244-71.

D. virilis males, 15 to 30 h after eclosion, were irradiated with 2000 r in 1 minute at 0-5°C in different gas environments. The number of dominant lethals and translocations induced in cells which were in the different stages of spermatogenesis were scored using sequential multiple matings over a three-week test period. The stages from meiosis through spermiogenesis were much more susceptible to x-rays than spermatogonia or mature sperm. The cycle of damage for dominant lethals is similar to that for translocations but does not coincide with it completely. Pupae were irradiated in air 1-3 d after pupation, the period during which larval structures including protein systems are being broken down. The rate of chromosomal abnormality produced is very high for the cells past spermatogonia. Complex translocations which involve 3 or more chromosomes occur much more frequently than in tests of mature sperm and rejoining of broken ends is not at random. Several enzyme systems are involved in a reduction of radiation damage or in the attachment of broken chromosomes. (BA 30: 15812, 1956)

928 Tahmisian, T. N., Adamson, D. M. A PHASE CONTRAST MICROSCOPY STUDY OF X-RAY-INDUCED PYKNOSIS IN THE LIVING CELL. Soc. Exp. Biol. & Med. Proc. 78 (1951) 597-602.

Melanoplus differentialis embryos were used. The effect of 25 000 r of x-rays can be kept latent for 6 months by maintaining the eggs at sub-metabolic temperatures. When the eggs are irradiated and immediately placed at 0°C, and are thus maintained for 6 months no immediate morphological or physiological changes are observed upon returning them to 25°C. However, pyknosis occurs by 8 d at 25°C, depending on the irradiation and on the metabolic activity of the cell. Various changes in the cell are discussed.

(This work was also published on p. 54 in ANL-4488, Argonne National Lab., 1950, 149 p, and as abstr. 134 in Anat. Record 108: 72-3, 1950)

929 Tahmisian, T. N., Adamson, D. M., Passonneau, J. V. THE RESPONSE OF MELANOPLUS DIFFERENTIALIS CELLS TO X-IRRADIATION BEFORE AND AFTER INDUCTION. Anat. Record 111 (1951) 574, abstr. 274.

Prior to induction, cells in the grasshopper embryo are very susceptible to x-irradiation. A cell that has responded to the evocator, although it is undifferentiated morphologically but differentiated physiologically, is not easily affected by x-irradiation. Before induction, the ability of cells to differentiate into tissue can be inhibited with 2500 r. After induction, a dose of 25 000 r will not inhibit tissue differentiation. The cell will differentiate and the embryo will hatch. The time of x-irradiation, in relation to physiological processes is, therefore, of great importance.

930 Whiting, A. R. ABSENCE OF MUTAGENIC ACTION OF X-RAYED CYTOPLASM IN HABROBRACON. Proc. nat. Acad. Sci., Washington 36, 7 (1950) 368-72.

Results on the response of Habrobracon eggs to x-rays are consistent in indicating two kinds of changes in the cell: (1) chromosome alterations connected with the production of dominant and recessive lethal and visible mutations, and (2) a lethal cytoplasmic effect. In the Habrobracon egg this cytoplasmic injury is constant with respect to doses for incidence and complete lethal action, regardless of the stage of the chromosome at time of treatment. It is concluded from the experimental data that x-rays can induce permanent changes in the egg cytoplasm, which may have a lethal effect on the egg without, however, inducing visible mutations in untreated chromosomes.

(Earlier work was reported as abstract in Genetics 35 (1950) 139-40, under the title "The non-induction of mutations by x-rayed cytoplasm")

931 Whiting, A. R. ANDROGENESIS AS EVIDENCE FOR THE NATURE OF X-RAY-INDUCED INJURY. Radiation Res. 2 (1955) 71-8.

Irradiated cytoplasm of Habrobracon eggs was found to function normally after exposure to doses of x-rays many times greater than that lethal to the nucleus. High doses of irradiation prevented normal function, even in combination with an uninjured nucleus. The phenomenon of androgenesis was used as a source of evidence. (NSA 3: 2573, 1955)

## I-B Genetic Effects

### I-B-1 GENERAL

#### Surveys

932 Ehrenberg, L. RADIOBIOLOGICAL MECHANISMS OF GENETIC EFFECTS. A REVIEW OF SOME CURRENT LINES OF RESEARCH. Radiation Res., Suppl. 1 (1959) 102-23.

Contents include a discussion of the limitations of the field (genetic changes investigated; mutagenic agents; chemical nature of the genetic material; influence of variables); radiation-induced mutations-dependence on dose; questions related to target and gene size; influence of ion density; substructure of the gene; specifity of mutagenic agents; back mutations; sensitive stage for the induction of mutation; modifying factors; and radiomimetic effects of oxygen. Citations of work include data on Drosophila and Mormoniella.

933 Kaufmann, B. P. CHROMOSOME ABERRATIONS INDUCED IN ANIMAL CELLS BY IONIZING RADIATIONS. p. 627-711 in "Radiation Biology", Vol. 1, Part 2, Hollaender, A., ed. New York, McGraw-Hill, 1954.

A very comprehensive review article, dealing with the nature of the induced arrangements (methods of diagnosis, types of induced chromosomal aberrations), the process of structural rearrangement (the breakage process), differences in sensitivity to ionizing radiations (relative sensitivity of different organisms, effect of ploidy, relative sensitivity of chromosomes in different types of cells of the same species, changes in sensitivity of chromosomes in cells of the same type), and chemical and cytochemical studies. Many references to work on insects are included. Extensive bibliography, going back far beyond 1950.

934 Kihara, H. GENETICS OF BOMBYX AND DROSOPHILA: A COMPARISON OF MATERIALS, METHODS AND RESULTS. Seiken Ziho 6 (1953) 15-29.

Bombyx is one of the best materials for genetic research. Many findings of sex-determination, crossing-over, linkage analysis and artificial mutation correspond in general to those in Drosophila. A comparison of the two insects is therefore of interest. Based on a bibliographical survey, Tanaka's book "Genetics of Bombyx" (1952) mentions 1241 titles of papers which deal with Bombyx genetics, about 90% of which are Japanese. The genetics of Bombyx and of Drosophila were compared with respect to chromosomes, sex-determination, linkage groups, crossing-over, physiological genetics, and practical applications. In physiological genetics, the excellent contribution of Kikkawa's biochemical studies and Morohoshi's developmental genetics were introduced. In practical applications, heterosis and induced mutations were discussed. Tazima's discovery that the sexes in larval and egg stages may be distinguished with the help of induced mutations is of great importance for commercial purposes. (from BA 30: 205, 1956)

935 Muller, H.J. SOME PRESENT PROBLEMS IN THE GENETIC EFFECTS OF RADIATION. J. cell. comp. Physiol. 35 (Suppl. 1) (1950) 9-70.

A review paper of wide scope. Experimental data largely based on work with Drosophila. Discussion: p. 62-70.

936 Muller, H.J. THE NATURE OF THE GENETIC EFFECTS PRODUCED BY RADIATION. p. 351-473 in "Radiation Biology", Vol. 1. Hollaender, A., ed. New York, McGraw-Hill, 1954.

Comprehensive review and assessment of present day data, with extensive bibliography. Results obtained with Drosophila are cited throughout. The most recent work quoted dates from 1952; most references cover publications between 1935 and 1945.

937 Peredelsky, A. A. THE EFFECT OF IONIZING RADIATION ON INSECTS. Itogi Nauki. Biol. Nauki. Akad. Nauk SSSR Radiobiol. (Moscow: Izdatel. Akad. Nauk. SSSR) (1957) 313-27. (In Russian)

938 Stone, W. S. INDIRECT EFFECTS OF RADIATION ON GENETIC MATERIAL. p. 171-90 in "Brookhaven Symposia in Biology, 15-17 June 1955", Vol. 8. BNL-350 (C-22), Brookhaven National Lab., Upton, N. Y. 1957.

The author presents a review of work done on Drosophila, and the different implications of the results obtained. Different types of radiation are known to produce measurably different effects on the genetic system. Spontaneous and induced mutagens are also discussed. Chemical effects are a further complication. Radiation damage in relation to cell cycle and susceptibility (as in spermatogenesis) represent complex problems of interpretation. Mention is made of numerous publications in which the general view of the action of radiation chemical mutagens as well as their synergistic effect with the direct action of radiation is discussed.

939 Tanaka, Y., ed. GENETICS OF THE SILKWORM. Tokyo, Shokabô (1952). (In Japanese)

Very comprehensive work, particularly on Japanese research. More than 100 references, including much work on radiation-induced mutations.

---

940 Baker, W. K. CONSEQUENCES OF RADIATION-INDUCED CHROMOSOME BREAKAGE IN DROSOPHILA SPERM. p. 235-8 in "Proceedings of the International Genetics Symposia, Tokyo & Kyoto, Sep. 1956". Suppl. to Cytologia 1957. Tokyo, Science Council of Japan. 1957.

Experiments are described which were designed to measure three criteria of radioinduced chromosome breakage. These criteria were measured on three types of Drosophila sex chromosomes. Correct interpretation of experiments using ring chromosomes are discussed. (NSA 12: 15263, 1958)

* Bonnier et al. 1952 - [905]

941 Burdick, A. B., Mukai, T. EXPERIMENTAL CONSIDERATION OF THE GENETIC EFFECT OF LOW DOSES OF IRRADIATION ON VIABILITY IN DROSOPHILA MELANOGASTER. 2nd UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 15/P/895. 22 (1958) 325-9.

The observed mutations are dominant in the sense that they produce a phenotypic effect in heterozygous condition. Their effect in homozygous condition is not predictable from results which could be gene changes that only give a detectable effect in heterozygous condition. The variance increases are more prominent than the mean increases, indicating that both viability-increasing and viability-decreasing mutations have been observed and that a substantial number of each has been produced. A mutation rate of at least $1\times10^{-5}$/r or $1\times10^{-6}$/r is required to obtain a sufficient number of mutations to explain the variance increases.

(A paper of the same title has also appeared on p. 38 in "Proceedings of the 10th International Congress on Genetics, Montreal, 1958", Vol. 2. Toronto, University of Toronto Press. 1958)

942 Carlson, J. G., Harrington, N. G. X-RAY-INDUCED "STICKINESS" OF THE CHROMOSOMES OF THE CHORTOPHAGA NEUROBLAST IN RELATION TO DOSE AND MITOTIC STAGE AT TREATMENT. Radiation Res. 2(1955) 84-90.

Observations of x-rayed hanging-drop preparation of grasshopper neuroblasts in artificial medium at short time intervals immediately after treatment demonstrate that of the mitotic stages examined, namely, very late prophase, prometaphase, metaphase and anaphase, the earlier the stage, the greater the effect for a given dose. This may indicate either that a positive correlation exists between the degree of "stickiness" produced and the time interval available for it to develop between treatment and detection or that the susceptibility of the chromosomes to this effect diminishes as cells progress through the mitotic stages studied. (auth.)

(An abstract was published earlier in Radiation Res. 1 (1954) 491)

943 Clark, A. M. GENETIC EFFECTS OF X-RAYS IN RELATION TO DOSE-RATE IN DROSOPHILA. Nature 177 (1956) 787.

Using dose rates of 1000 r/min and 2000 r/min, it has been confirmed that, for a given dose, a greater amount of genetic damage is produced if the radiation is delivered at high intensity. With a total dose of 2000 r, the high dose rate gives an increase of up to 25% in the yield of recessive sex-linked lethals and of translocations. The intensity effect is enhanced if the flies are injected with 0.005 M sodium azide in saline just prior to irradiation.

944 Downes, J. A. THE GYPSY MOTH AND SOME POSSIBILITIES OF THE CONTROL OF INSECTS BY GENETIC MEANS. Canad. Ent. 91, 10 (1959) 661-4.

Available basic information on mating habits, etc. is reviewed. A preliminary assessment is made of the conditions under which induced mutations might be used to control the gypsy moth, Porthetria dispar (L.).

* Glass and Plaine 1950 - [1307]

945 Gowen, J. W., Umaerus, M. BIOLOGICAL RECOVERY FROM RADIATION EFFECTS AS RELATED TO GENETICS. p. 101 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958.

Cells of the Drosophila germ tracts were exposed to multiples of 2000 r given on 0 d after emergence and at 14, 28 and 42 d thereafter. Eight days immediately following the first irradiation the percentage of sex-linked lethal mutations were: no radiation, 0.0; 2000 r, 3.6; 4000 r, 10.3; 6000 r, 13.5; and 8000 r, 18.3. A 14-d interval between irradiation of the germ cell sample had reduced the initial percentages to one-fifth, a 28-d interval to one-seventh, a 42-d interval to one-eleventh. The potential germ cell population has undergone biological improvement. To allow time for repair irradiations were spaced: 2000 r at 0 d; 2000 r at 14; 2000 r at 28; and 2000 r at 42 d, giving an accumulated series of 2000, 4000, 6000 and 8000 r to each male. Sperm from these periods showed mutation rates of 4.9, 5.2, 5.9 and 10.7% as contrasted with 3.6, 10.3, 13.5 and 18.3% where the corresponding irradiation dosages were received in single periods. The populations of repeatedly irradiated sperm recovered most of their normal characteristics before the following irradiation again raised the mutation percentages. Mutations in early germ cell lines appear to increase somewhat the observed lethals in the

progenies of the 42-day males receiving high irradiation dosages. Biological recovery has significance in clearing radiation damage from both the soma and populations of germ cells.

Haas et al. 1952 - [1388]

946 Haas, F. L., Dudgeon, E., Clayton, F. E., Stone, W. S. MEASUREMENT AND CONTROL OF SOME DIRECT AND INDIRECT EFFECTS OF X-RADIATION. Genetics 39, 4 (1954) 453-71.

The translocation rate in Drosophila virilis was used to measure the biological effect of x-radiation. Variables tested included the dosage rate, the temperature, and the gaseous environment ($O_2$, mixtures of $O_2+N_2$, $O_2+CO_2$, $O_2+CO$, $O_2+CO+CO_2$) of the organisms during irradiation. It was found that x-radiation damage was greater at 3±2°C, and with a fast dose rate (about 1900 r/min) than a slow (100 r/min). More damage was induced in $O_2$, $CO+O_2$, and $CO_2+O_2$ than in air or 96% $N_2$+4% $O_2$. The amount of $O_2$ and other factors which influence the oxidative metabolism of the cell modify the radiation damage. (BA 23: 18296, 1955)

947 Herskowitz, I. H. THE RELATION BETWEEN X-RAY DOSAGE AND THE FREQUENCY OF SIMULATED HEALING OF CHROMOSOME BREAKAGES IN DROSOPHILA MELANOGASTER FEMALES. Proc. nat. Acad. Sci., Washington 40 (1954) 576-586.

Female Drosophila were treated with two different dosages of x-radiation, and the number of exceptional $F_1$ individuals of appropriate types were determined. Analysis of the data indicates that all the exceptional flies may be considered to carry gross chromosomal rearrangements, and that gross rearrangements occur more frequently after x-irradiation of oöcytes than after x-irradiation of oögonia. (NSA 8: 5474, 1954)

* Herskowitz 1954 - [1192]

* Herskowitz 1957 - [1195], [1196]

* Herskowitz and Abrahamson 1957 - [1199]

* Herskowitz 1958 - [1200]

* Hollaender et al. 1952 - [1390]

* Kaufmann and Wasserman 1957 - [1121]

948 Keyl, H.-G. UNTERSUCHUNGEN AM KARYOTYPUS VON CHIRONOMUS (i.e. TENDIPES) THUMMI. II. STRUKTURVERÄNDERUNGEN AN DEN SPEICHELDRÜSEN-CHROMOSOMEN NACH RÖNTGENBESTRAHLUNG VON EMBRYONEN UND LARVEN (Studies on the karyotype of Chironomus (i.e. Tendipes) thummi. II. Structural modifications of the salivary gland chromosomes after x-irradiation of embryos and larvae). Chromosoma 9, 5 (1958) 441-83. (In German)

Embryos of Chironomus thummi thummi at 4 different stages and larvae up to 150 h-old were irradiated with x-rays, and the resultant modifications are described. The most frequent types of 2-break-recombination (deletion with open fragment, and open inversions) show different distributions of inter-break-spacing. Some deductions on the possible structure of the embryonic salivary gland chromosomes may be made, based on the experimental data collected.

* Koiwai 1957 - [1204]

949 Laven, H. GENETICS OF CULEX PIPIENS (DIPTERA: CULICIDAE). p. 875-9 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956", Vol. 2. Becker, E. C., ed. Ottawa, Mortimer Ltd. 1958.

Fundamental genetic research in Culicidae is desirable for several reasons, e. g. for the study of crossing relations in the Culex pipiens complex, for the problems of susceptibility to infection, resistance to insecticides and others. Several mutations have been produced in Culex pipiens by means of x-rays. These and some spontaneous ones are enumerated. The phenomena associated with reproductive incompatibility in the Culex pipiens complex are briefly reviewed. By means of marker genes it could be demonstrated that

the crossing type is determined by extra-chromosomal cytoplasmic factors. This intrinsic incompatibility mechanism seems to be a specific mechanism of evolution in Culicidae. (auth.)

950 Lewis, E. B. THEORY AND APPLICATION OF A NEW METHOD OF DETECTING CHROMOSOMAL REARRANGEMENTS IN DROSOPHILA MELANOGASTER. Amer. Nat. 88 (1954) 225-39.

A new type of position effect called the "trans-vection effect" permits rapid and highly efficient detection of chromosomal rearrangements in the first generation following an induction treatment. By the use of this new method fast (pile) neutrons have been found to be more effective than x-rays or γ-rays in producing rearrangements in Drosophila, and estimates of the dose of fast neutrons at different stations during a nuclear detonation have been derived. (from auth. summary)

951 Lindsley, D. L., Edington, C. W., Halle, E. S. von. THE RELATION OF THE GENETIC CONSTITUTION OF DROSOPHILA SPERMATOZOA TO THEIR X-RADIATION. Radiation Res. 9 (1958) 145.

The relation between sex ratio and dose was used to investigate the effect of sex chromosome constitution on sperm sensitivity. As has been repeatedly demonstrated, irradiation of a normal male has little or no effect on the sex ratio of its progeny, suggesting nearly equal sensitivity of X-bearing and Y-bearing sperm. Irradiation of XY/Y males produces a slight shift in ♀♀/♂♂ from 0.890 with no irradiation to 0.806 with 4000 r, whereas irradiation of XY/O males produces a spectacular shift in ratio from 0.743 with no irradiation to 0.435 after 4000 r. These observations have been interpreted to indicate that (a) XY-bearing sperm are much more sensitive than nullo-X, nullo-Y sperm, and slightly more sensitive than Y-bearing sperm; consequently (b) Y-bearing sperm are considerably more sensitive than nullo-X, nullo-Y sperm, and this difference may be directly attributable to the presence of the Y in the former; (c) since X- and Y-bearing sperm exhibit similar sensitivity, X-bearing sperm are also considerably more sensitive than nullo-X, nullo-Y sperm. (from auth.)

952 Luce, W. M. REDUCTION IN FACET NUMBER IN FULL-EYED (REVERTED BAR) DROSOPHILA BY X-RAYS. (abstr.) Genetics 36 (1951) 563.

Larvae of an inbred full-eyed (reverted to full from Bar) strain of Drosophila melanogaster, kept at 28°C, were treated with x-ray dosages ranging from 1000 to 3000 r applied at the rate of 500 r per min. The corneas of the eyes of the imagoes which developed from the treated larvae were dissected off, mounted on slides, projected, and the facets counted. The x-rays produced a reduction in facet number. The rate of reduction was approximately 0.075 facets per r. The x-rays when applied before the larvae were 54 h old (reckoned from the time when the larvae were laid as eggs) had no effect. Larvae treated at any time when they were from 59 to 80 h of age responded with essentially similar rates of reduction in facet number per r applied, with some evidence that the rate was less for the lowest dosage used (1000 r). The x-rays prolonged larval development. The rate of prolongation, approximately 0.011 h per r, appeared nearly constant for all x-ray applications within the age limits (38-80 h) used in this experiment with the qualification that the 3000 r treatments had a slightly diminished effect on the rate of prolongation.

* Luce et al. 1951 - [870]

* Lüning 1952 - [1206]

953 Lüning, K. G., Jonsson, S. DOES THERE EXIST MUTATIONAL ADAPTATION TO CHRONIC IRRADIATION? Radiation Res. 8 (1958) 181-6.

This study concerns the possible mutational adaptation due to incorporation in the population of mutational isoalleles with lower mutability than the alleles originally present. A comparison was made between the rates of recessive lethals and y, w and sn mutations induced by x-rays in males from Drosophila melanogaster stocks kept at normal background radiation versus those under constant γ-irradiation (5 r/h). No difference in mutability was found between these two stocks, and hence there are no indications of mutational adaptation due to mutational isoalleles. These negative results do not exclude a possible mutational adaptation, or recovery phenomenon, which is discussed. (auth.)

(A report of the same title has also been published in A/AC.82/G/R.69, Stockholm, Univ., Inst. Genetics. 1957, 7 p)

954 Oster, I. I. THE CONSEQUENCES OF X-IRRADIATING MORPHOLOGICALLY DISSIMILAR CHROMOSOMES Radiation Res. 9 (1958) 163-4.

On the expectation that the morphology of the chromosomes may affect their radiosensitivity several investigators have irradiated ring-shaped chromosomes and ordinary rod-shaped ones in spermatozoa of Drosophila melanogaster. In general, they found that although rings are lost more often than rods, both chromosome types yield similar lethal mutation frequencies. To investigate further this problem special stocks were constructed which permitted the simultaneous detection of lethal mutations, genetically demonstrable chromosome deficiencies, and nonlethal visible mutations. Homogeneous samples of spermatozoa containing either ring- or rod-shaped sex chromosomes were treated in inseminated females. X-raying rods yielded 46/1366 (i.e. lethals among tested chromosomes) for 1000 r, 65/1208 for 2000 r, 436/3693 for 4000 r, while the controls gave 41/10 268; X-raying rings yielded 44/1063 for 1000 r, 31/501 for 2000 r, 187/2201 for 4000 r, while the controls gave 14/4967. With high doses significantly more lethals were recovered from rods than from rings. Significantly more chromosome deficiencies were induced in the rod-X (16/17 436) than in the ring-X (4/12 300) by 4000 r, the control count for deficiencies being 1/41 524 for rods and 0/23 504 for rings. Nonlethal visible mutations were rare and induced in similar frequency in both stocks, there being none among controls. Thus treatment with high doses of x-rays results in a greater loss of those mutations associated with structural changes in the case of ring-shaped than of rod-shaped chromosomes. These findings supply additional evidence against the view that point mutations originate via the restitution of chromosome breaks.

(Abstract of paper presented at the Intern. Congr. of Radiation Res., Burlington, Vermont, 10-16 Aug. 1958)

955 Parker, D. R., McCrone, J. A GENETIC ANALYSIS OF SOME REARRANGEMENTS INDUCED IN OÖCYTES OF DROSOPHILA. Genetics 43 (1958) 172-86.

The technique of detachment of attached-X chromosomes has supplied a means of studying translocation processes in Drosophila females. The analysis was based on data obtained from x-irradiation.

956 Ray-Chaudhuri, S. P., Pyne, C. K. THE FREQUENCY OF INDUCED DICENTRIC BRIDGES IN MEIOSIS IN THE GRASSHOPPER, GESONIA PUNCTIFRONS, IN RELATION TO THE INTENSITY OF RADIATION. (abstr.) Indian Sci. Cong. Ass. Proc. 41 (Section VII. Zoology and Entomology) (1954) 167.

Gesonia punctifrons males were subjected to γ-rays from Ra. The frequency of bridges were shown to be independent of the intensity of radiation within the limits of the experiment (80 r given in ½ h or in 23 h), counts on cells in anaphase I being made on material fixed 30 h after irradiation. The significance of these data with respect to the hypothesis put forward by Ray-Chaudhuri and Sarkar (1952) is discussed. (from abstr.)

* Ray-Chaudhuri et al. 1957 - [1227]

957 Schmid, W. SIND DIE SICHTBAREN MUTATIONEN BEI DROSOPHILA MELANOGASTER FÜR QUANTITATIVE STRAHLENGENETISCHE UNTERSUCHUNGEN GEEIGNET? (Are the visible mutations in Drosophila melanogaster significant for quantitative radiogenetic investigations?) Strahlentherapie 109 (1959) 79-96. (In German)

Applications of data on dominant and recessive viable mutations and gynandromorphs in Drosophila melanogaster in quantitative radiation genetic experiments are discussed. Data are reviewed from a number of genetic studies on Drosophila. Somatic mutations and modifications, as well as induced somatic cross-overs, are discussed. (NSA 13: 16727, 1959)

958 Strangio, V. A. A STUDY OF THE PERIOD OF ACTION IN A SERIES OF SEX-LINKED RECESSIVE LETHALS IN DROSOPHILA. Austr. J. exp. Biol. med. Sci. 36, 5 (1958) 425-32.

Sixty-eight sex-linked, recessive lethals were recovered following the irradiation of Drosophila males with 2150 r, 31 at the dose-rate of 2000 r/min and 37 at 100 r/min. Except for the rare extended phase lethal, the lethals were individually stage specific and also tended to group about sensitive stages in the developmental cycle. The relative frequencies of these lethal clusters tally with previous published estimates. A cytogenetic approach was used to interpret one such exceptional lethal. Some evidence already exists for a relationship between the time of onset of genetically-induced developmental abnormality and the magnitude of the chromosomal aberration involved. Intensity differences are responsible for a differential yield

of gross rearrangements. An attempt to demonstrate a more obvious embryonic trend in the sensitivity pattern of the high dose-rate lethals mirroring this intensity effect was unsuccessful. Visible abnormalities associated with the lethals were tabulated. (auth.)

959 Strunnikov, V. A. OBTAINING BIPATERNAL ANDROGENETIC HYBRIDS IN THE MULBERRY SILKWORM. Dokl. Akad. Nauk SSSR (Biol. Sci. Sect. Trans.) 122, 1/6 (1958) 768-71. tr. from: Dokl. Akad. Nauk SSSR 122, 3 (1958) 516. (In Russian)

960 Strunnikov, V.A. OBTENTION D'UNE DESCENDANCE NON HYBRIDE ISSUE DE DEUX MÂLES ET PROVENANT D'UNE MÊME FEMELLE DE VER À SOIE. Vest. Selskokhoz. Nauk SSSR 5 (1960) 126-8. (In Russian)

961 Tazima, Y. ALTERATION OF FOOD SELECTING CHARACTER BY ARTIFICIAL MUTATION IN THE SILKWORM. Intern. Silk Ass. B, 20 (1954) 27-9.

* Wallace 1956 - [1459]

962 Whiting, A. R. ABSENCE OF MUTAGENIC EFFECT OF HEAVILY IRRADIATED HOST ON THE PARASITIC WASP HABROBRACON. Anat. Record 111 (1951) 565, abstr. 256.

Eighty-seven freshly emerged females were mated and kept without food until only oögonia and very young oöcytes remained in their ovaries. They then fed and oviposited on host Ephestia caterpillars immediately after these had been x-rayed with doses ranging from 40 000 r to 160 000 r. They were transferred every third day to freshly irradiated caterpillars. No evidence of a lethal effect of irradiated food was observed. Females appeared reluctant to sting and feed on most heavily irradiated hosts although they did so. It is evident that heavily irradiated host caterpillars exerted no mutagenic effect on the parasite. (from auth.)

## I-B-2 INDUCED MUTATIONS

### Surveys

963 Blair, H. A., ed. BIOLOGICAL EFFECTS OF EXTERNAL RADIATIONS. New York, McGraw-Hill Book Company, Inc. 1954, 522p.

Results are reported from a series of studies on the biological effects of x-radiation and the chronic effects of neutron irradiation. Amongst many others, experiments on the relation of mutation frequency to x-ray dose in Drosophila are reported; the influence of chronic irradiation with $\gamma$-rays at low dosages on the mutation rate in Drosophila is considered. A list of references is included with each chapter, and a complete subject index is provided.

964 Glass, B. INDUCTION OF MUTATIONS WITH RADIATION. p. 569-75 (disc. p. 575-6) in TID-7554, John Hopkins Univ., Baltimore, "Proceedings of the Inter-American Symposium on the Peaceful Application of Nuclear Energy, 13-17 May 1957". Brookhaven National Lab., Upton, N. Y.

Review article, freely illustrated with data from Drosophila.

965 Muller, H. J. GENERAL SURVEY OF MUTATIONAL EFFECTS OF RADIATION. p. 145-77 in "Radiation Biology and Medicine". Claus, W. D., ed., Reading, Mass., Addison-Wesley Publishing Co. 1958, 944p.

Review article. The nature and incidence of induced gene mutations are discussed, and the estimation of genetic damage. Work is cited on Drosophila, also on grasshopper. General bibliography: 121 refs.

---

* Abeleva and Potekhina 1960 - [853]

* Abrahamson and Telfer 1956 - [1157]

* Abrahamson and Herskowitz 1957 - [1158]

966 Alexander, M. L. X-RAY INDUCED MUTATION RATES AT SPECIFIC LOCI ON THE THIRD CHROMOSOME OF DROSOPHILA MELANOGASTER. (abstr.) Genetics 37 (1952) 563.

The mutation rates were obtained both for irradiated spermatogonia and mature sperm. Special techniques were employed (1) to limit the sperm sample from treated adult males, (2) to detect "spontaneous cluster" mutations, (3) to assure samples from treated spermatogonia by use of early larval stages. An average rate of $5.72 \times 10^{-8}$ mutations per r per locus is reported in some 50 000 flies in testing the effects of 3000 r of x-rays on the 8 loci of the res group of mutations. The rates per locus varied from 1.35 to $8.75 \times 10^{-8}$ per r. The induced mutations from treated sperm were lethal, semilethal, viable, or phenotypically normal when tested in the homozygous condition. No mutations were observed in the unirradiated sperm. (from abstr.)

(For critical discussion, cf. Ives 1954 - [1002])

* Alexander 1954 - [1159]

* Alexander 1956 - [1161]

* Alexander 1957 - [1162]

* Alexander 1958 - [1163], [1166]

* Alexander 1959 - [1134]

* Annan 1954 - [1134]

* Arnason et al. 1951 - [377]

967 Atwood, K. C., Borstel, R. C. von, Whiting, A. R. AN INFLUENCE OF PLOIDY ON THE TIME OF EXPRESSION OF DOMINANT LETHAL MUTATIONS IN HABROBRACON. Genetics 41 (1956) 804-13.

The frequencies of x-ray-induced dominant and recessive lethal mutations in Habrobracon oöcytes are unchanged by subsequent fertilization with unirradiated sperm. A significant proportion of the dominant lethal effect induced at metaphase I is expressed at a later stage in diploids than in haploids. When dominant lethals are induced at prophase I, the proportion expressed after hatching is the same in diploids as in haploids. The dependence of delayed expression on the stage irradiated is consistent with the assumption that lethality caused by observable chromosome breakage can be delayed, whereas that due to other causes cannot. Chromosome breakage is apparently a more frequent cause of lethality after irradiation of oöcytes in metaphase than in prophase. (auth. summary)

* Baker and Sgourakis 1950 - [1359]

* Baker and Edington 1952 - [1360]

* Baker and Halle 1953 - [1362]

968 Baker, W. K., Halle, E. S. von. THE PRODUCTION OF DOMINANT LETHALS IN DROSOPHILA BY FAST NEUTRONS FROM CYCLOTRON IRRADIATION AND NUCLEAR DETONATIONS. Science 119 (1954) 46-9.

Data are presented on the relative biological effectiveness of fast neutrons from cyclotron irradiation and from nuclear detonations as determined by means of induction of dominant lethals in Drosophila. It is concluded that the frequency of dominant lethals may be useful as a rather rapid, but crude, biological measurement of fast neutron dosage at high levels. Findings are compared with similar data on Tradescantia. (NSA 8: 3652, 1954)

* Bateman and Sinclair 1950 - [379]

* Bateman 1955 - [812], [378]

* Bateman 1956 - [1172]

* Bateman 1957 - [1173], [813]

* Bateman 1958 - [1174]

969 Becker, H. ÜBER RÖNTGENMOSAIKFLECKEN UND DEFEKTMUTATIONEN AM AUGE VON DROSOPHILA UND DIE ENTWICKLUNGSPHYSIOLOGIE DES AUGES (Study on x-ray induced mosaic spots and deletion mutations and on the developmental physiology of the Drosophila eye). Z. indukt. Abstamm.-VererbLehre 88, 3 (1957) 333-73. (In German)

Drosophila eggs and larvae at different stages were subjected to x-rays which caused changes that ultimately led to spots in the adult eye. An interpretation of the complex process involved is attempted. It appears that the definite delimitation of the eye occurs certainly not earlier than at the end of the 2nd larval stage.

* Belgovsky 1958 - [1175]

* Belgovsky et al. 1959 - [1176]

970 Benz, G. DER FAKTOR LETAL-BLUTER (lbl) BEI DROSOPHILA MELANOGASTER (The lethal-bleeding factor (lbl) in D. melanogaster). Arch. Klaus-Stift. VererbForsch. 29, 3/4 (1954) 346-52. (In German)

A recessive x-ray mutation is described. Its gene lies in the left arm of the second chromosome. The pupal development is normal, but the pupal covering is twice the normal thickness, the protein and not the chitin sheath being thickened. As a result, in escaping from its covering the hemolymph is lost, apparently through an opening in the anterior wall of the thorax, and the animal dies. If carefully removed by hand, the apparently normal fly survives and is fertile, but its offspring are 84% lethal, the remainder escaping normally. The thickened puparium is thus the only apparent abnormality.

* Bertram and Höhne 1958 - [814]

* Bertram et al. 1960 - [1371]

971 Bonnier, G. INDIRECT EFFECTS OF X-RAYS ON CHROMOSOMES. Brit. J. Radiol. 25 (1952) 180-2.

Work is reviewed which has been completed to date on the induction of mutations in Drosophila by indirect x-irradiation.

972 Bonnier, G. SECONDARY INFLUENCES FROM X-RAY IRRADIATION ON MUTATIONAL PROCESSES IN DROSOPHILA MELANOGASTER. Heredity 8, 3 (1954) 199-210.

It is shown that certain aberrations occurring in irradiated paternal X-chromosomes are produced at a higher rate when the chromosomes are irradiated in impregnated females than when they are irradiated in males. It is furthermore shown that the rates are dependent on the strain from which the females, which harbour the sperm, are taken. In one instance it was also found that the rate of fractionals due to breaks in the paternal chromosomes produced by irradiation of males was enhanced if the females were irradiated, prior to mating. (auth.)

973 Bonnier, G. SECONDARY CAUSES OF VARIATION IN THE RATES OF X-RAY INDUCED MUTATIONAL PROCESSES IN DROSOPHILA MELANOGASTER. (abstr.) p. 892-3 in "Proceedings of the 9th International Congress on Genetics, Bellagio, Italy 1953", Suppl. to Caryologia 6(II). Montalenti, G., Chiarugi, A., eds. Florence, 1956.

Spermatozoa in D. melanogaster may be irradiated in males or impregnated females. In studies which were begun some years ago it was found that sex-linked lethals were produced in male gametes at a slightly higher rate when the treatment was given to impregnated females, confirmed in experiments on a larger scale. The differences in the rates, though still small, were clearly significant. It was further found that other mutational processes also obey the same rule. Dr. Lüning has investigated the nature of those processes which show the mentioned differences in rates. When irradiating male spermatozoa containing the "Muller-5" X-chromosome, breaks in this chromosome produce, after mating the males to yellow females, fractional yellow females at a low rate. This rate was slightly, but significantly, increased if the females as well were irradiated — even if before mating. This effect was, however, influenced by the

genotype of the females, also found true with regard to the differences mentioned earlier. Possible explanations are discussed. (from abstr.)

974 Bonnier, G. RATE OF DEVELOPMENT OF X-RAY-INDUCED DETRIMENTALS AND THE INFLUENCE OF SELECTION PRESSURE. p. 433-6 in "Advances in Radiobiology. Proceedings of the 5th International Conference on Radiobiology, Stockholm 15-19 Aug. 1956". de Hevesy, G. C., Forssberg, A. G., Abbatt, J. D., eds. London, Oliver and Boyd. 1957.

Some preliminary experiments on Drosophila and their results are reported. A growth rate index is used. Several detrimentals, though perhaps not all, could have been picked out by their average rates of development alone.

975 Bonnier, G., Jonsson, U.-B. STUDIES ON X-RAY INDUCED DETRIMENTALS IN THE SECOND CHROMOSOME OF DROSOPHILA MELANOGASTER. Hereditas 43, 2 (1957) 441-61.

A study is reported on problems concerning x-ray induced subvitals in the second chromosome of D. melanogaster. The frequency of such viability mutations are considered, and the comparisons made are in some cases also combined with the effects of different degrees of environmental stresses. The study is divided into a discussion of the material used, estimates of the frequency of subvitals, partitioning of the variance into its components, discussion on survival rates, larval competition tests, and considerations concerning the study and the structure of irradiated populations.

976 Bonnier, G., Lüning, K. G. X-RAY INDUCED DOMINANT LETHALS IN DROSOPHILA MELANOGASTER. Hereditas 36, 4 (1950) 445-56.

Wild-type males of D. melanogaster were irradiated with about 2900 r and mated to y w sn females of a maximum age of 3 d. Corresponding controls (without irradiation) were available. The hatchability of the eggs was studied after varying the age of the males at fertilization and after varying the length of time between irradiation and fertilization. It was found that both these factors were active in decreasing the hatching rate. The decline ranged from about 50% to about 30% or still lower. In the controls a normal hatching rate of between 80 and 90% was found without any effect from aging the males. Unmated or mated state of the males prior to the present mating had no effect on the hatchability. (from auth.)

977 Bonnier, G., Lüning, K. G. SEX LINKED LETHALS IN DROSOPHILA MELANOGASTER FROM DIFFERENT MODES OF X-RAY IRRADIATION. Hereditas 39, 1-2 (1953) 193-200.

It is shown that x-ray irradiation of male X-chromosomes of D. melanogaster produces a higher rate of recessive lethals if the irradiation is given to spermatozoa which are stored in impregnated females than if the irradiation is given to males. This effect is probably not caused by the irradiation per se of the females, but may perhaps be due to a difference in the state of the spermatozoa when being within the seminal receptacles of the females as compared with their state within the males. (auth. summary)

978 Borstel, R. C. von, Atwood, K. C., Whiting, A. R. DELAYED EXPRESSION OF INDUCED DOMINANT LETHALS IN DIPLOID HABROBRACON. Genetics 40 (1955) 564.

In Habrobracon unfertilized eggs develop normally to become haploid males; fertilized eggs become diploid females. Females which had stored eggs in the first meiotic metaphase were x-irradiated and one half of them subsequently mated. The fertilized eggs had a much higher hatchability frequency than the unfertilized eggs; however, adult survival did not differ markedly in the two groups. The higher frequency of death during the larval stage in the diploid embryos accounts for the difference. Those mutations which cause death of diploid embryos at a later stage of development than haploid embryos are referred to as conditionally delayed dominant lethal mutations; up to 25% or more of dominant lethals can be of this class in eggs irradiated in metaphase I. Examination of unfixed dead embryos also shows that fertilized eggs die at later stages than do unfertilized ones when the eggs are irradiated in either the first meiotic metaphase or prophase, but a higher proportion of eggs, fertilized and unfertilized, die early in the latter case. Conditionally delayed dominant lethals by criterion of hatchability do not occur to any appreciable extent when eggs are irradiated in the first meiotic prophase.

(Abstract of paper presented at the 1955 meetings of the Genetics Society of America, East Lansing, Michigan, 6-8 Sep., 1955)

979 Borstel, R. C. von, Pardue, M. L. ON THE NATURE OF RADIATION-INDUCED DOMINANT LETHAL MUTATIONS IN HABROBRACON AND DROSOPHILA. Genetics 41 (1956) 665.

In Habrobracon and Drosophila, induction of the breakage-fusion-bridge cycle with consequent gene imbalance has been considered as the primary source of dominant lethality. Habrobracon eggs irradiated in the first meiotic metaphase show terminal deletions that result in bridges in the second meiotic anaphase and bridge-breakage during cleavage. Since the breakage-fusion-bridge cycle does not appear to become established in eggs irradiated in the first meiotic prophase, the question arises as to the cause of dominant lethality in these eggs. Examination of dead Habrobracon embryos from irradiated eggs (unfertilized, or fertilized subsequent to x-irradiation) at about the 50% lethal dose (15 000 r) shows that approximately 80% have been blocked in development at the sixth or seventh cleavage and the nuclei are Feulgen negative. Thus it appears that dominant lethality in these eggs is associated with interruption of deoxyribonucleic acid synthesis. Approximately 90% of dead Drosophila embryos from irradiated sperm (ca 50% lethality; 2000 r) die under similar circumstances. These resemble the specific lethality in Habrobracon in that death occurs during the early cleavage stages. In order to test whether this action is caused by induced chromosomal deletions, the dead embryos from unirradiated triploids were examined. The chromosome complements of such embryos comprise a variety of aneuploid types. Since all eggs from Habrobracon triploids and most eggs from Drosophila triploids died during later development, it appears likely that radiation-induced dominant lethal mutations are not necessarily brought about by induction of chromosomal deficiencies. In particular, those dominant lethals associated with the radiation effect on deoxyribonucleic acid synthesis in Habrobracon are clearly not the result of chromosomal deficiencies.

(Abstract of paper presented at the 1956 meetings of the Genetics Society of America, Storrs, Connecticut, 27-29 Aug. 1956)

980 Borstel, R. C. von, Pardue, M. L. COMPARISON OF RADIATION-INDUCED AND GENETICALLY CONTRIVED DOMINANT LETHALITY IN HABROBRACON AND DROSOPHILA. Genetics 42 (1957) 401.

In Habrobracon and Drosophila most of the deaths from irradiation of eggs and sperm occur early in embryonic development before the blastoderm is formed. The problem exists as to whether this early type of radiation-induced lethality can be attributed to gene imbalance. A solution to this problem may be reached by determining the time of death of inviable progeny of triploids or translocation heterozygotes. It has been found that aneuploid embryos from Habrobracon and Drosophila females die after blastoderm formation unlike the majority of radiation-induced dominant lethals. Corroborative evidence was obtained from examination of dead embryos from heterozygotes of two different Drosophila translocations and four different newly induced Habrobracon translocations; it was found in each instance that death is expressed after blastoderm formation. Since aneuploidy in neither Drosophila nor Habrobracon brings about death during early development that is most characteristic of radiation-induced lethality, it appears that radiation induces in large measure a type of dominant lethality that is not attributable to the loss of chromosomes or chromosome parts resulting from chromosome breakage.

(Abstract of paper presented at the 1957 meetings of the Genetics Society of America, Stanford, California, 26-28 Aug. 1957)

981 Borstel, R. C. von. DOMINANT LETHAL MUTATIONS IN HABROBRACON AND DROSOPHILA. (abstr.) p. 303 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958.

In the parasitic wasp Habrobracon, unfertilized eggs become normal haploid males; fertilized eggs, diploid females. Three types of dominant lethal mutations have been identified in Habrobracon. Type I dominant lethality kills the embryo during the first few cleavages and is believed to represent a defect in deoxyribonucleic acid synthesis. These account for 60-80% of the deaths when eggs or sperm are irradiated and Type I lethality is unaffected in expression by fertilization. Type II kills the embryo after blastula formation and before the embryo hatches if the embryo is haploid, after hatching if the embryo is diploid. These are called conditionally delayed dominant lethal mutations and are characteristic, with Type I, of Habrobracon eggs irradiated in the first meiotic metaphase. They are believed to be manifestations of chromosome imbalance. Type III kills the embryo after blastula formation and before hatching whether the embryo is haploid or diploid. Death may occur later in embryogeny in the diploids than in the haploids, but always before hatching. Type III, with Type I, is characteristic of Habrobracon eggs irradiated in the first meiotic prophase. In Habrobracon, five translocations, when heterozygous, produced aneuploid embryos that all died under the same circumstances that characterize Type II dominant lethality. Type III dominant lethals

are exactly mimicked by aneuploid embryos from triploid Habrobracon females, indicating that Type III radiation-induced dominant lethality may be caused by chromosome loss. Type I dominant lethality remains specifically induceable only with mutagenic agents. In Drosophila, dominant lethal analogues of Type I and Type III have been observed following x-irradiation. Type III is mimicked in Drosophila by aneuploids from triploid females or translocation heterozygotes; Type I is specifically induced by radiation. Even Drosophila zygotes deprived by genetic means of the X and Y chromosomes and lacking the associated nucleoli develop further than Type I dominant lethal embryos.

982 Borstel, R.C. von, Rekemeyer, M.L. RADIATION-INDUCED AND GENETICALLY CONTRIVED DOMINANT LETHALITY IN HABROBRACON AND DROSOPHILA. Genetics 44 (1959) 1053-74.

Three kinds of dominant embryo lethals, distinguished phenotypically, are induced by radiation in Habrobracon; a similar situation exists in Drosophila but only two kinds are distinguished by the criteria specified in the paper. Although chromosome imbalance phenomena can mimic some of the dominant lethality induced by radiation, the majority of radiation-induced dominant lethals in Habrobracon and Drosophila are not mimicked by genetically contrived loss of chromosomes or loss of chromosome parts.

* Borstel 1960 - [1436]

983 Borstel, R. C. von. NATURE OF THE DOMINANT LETHALITY INDUCED BY RADIATION. Atti Ass. genet. ital. 5 (1960) 35-50. (In Italian)

In the wasp Habrobracon it was found that radiation-induced dominant lethality is a complex consisting of at least three types distinguished phenotypically and genotypically. In Drosophila, two types are phenotypically distinguishable. By comparing radiation-induced with genetically contrived dominant lethality, it is possible to show that one of the three types of dominant lethality can be attributed to chromosome imbalance and that another type is possibly caused by chromosome loss or severe chromosome imbalance. The most common type of dominant lethality appears to be caused by excessive depression of the mitotic rate. The slowing of the rate of mitosis does not appear to be caused by inactivation of the nucleolus or nucleolus organizer but can be brought on by induction of the breakage-fusion-bridge cycle. It is possible that any other action of radiation that depresses the mitotic rate also will induce this type of dominant lethality. (auth.)

* Brandt and Höhne 1952 - [1372]

* Brandt and Höhne 1953 - [815], [816]

984 Buzzati-Traverso, A. A. ON THE ROLE OF MUTATION RATE IN EVOLUTION. p. 450-62 in "Proceedings of the 9th International Congress on Genetics, Bellagio, Italy 1953", Suppl. to Caryologia 6. Montalenti, G., Chiarugi, A., eds. Florence. 1954.

It was shown that, under the experimental conditions described, an artifically (x-ray induced) raised mutation rate proved an advantage to the Drosophila population and raised its productivity. The evolutionary implications of these observations are discussed.

* Buzzati-Traverso and Scossiroli 1958 - [1437]

985 Caspari, S. B. AN X-RAY SPERM-DOSE-ACTION CURVE FOR MUTATIONS AT A SINGLE LOCUS IN MORMONIELLA. Radiation Res. 8, 3 (1958) 273-83.

A study of mutants and mutation rates for a single locus, R, in Mormoniella was made by x-raying (at doses of 1000 to 5000 r) wild-type males, mating them to females of a double recessive peach stock, and counting and analysing the mutants appearing among the $F_1$ daughters. Analyses were made for four kinds of mutations: S, O, recessive lethals and recessive sterile. (from auth. summary)

986 Clark, A. M., Rubin, M. A., Fluke, D. ALPHA-PARTICLE-INDUCED DOMINANT LETHAL IN THE MATURE SPERM OF HABROBRACON. (abstr.) Radiation Res. 7 (1957) 461.

Males from stock No. 1 were irradiated with 40 MeV $\alpha$-particles from a cyclotron at doses ranging from 1150 to 58 500 rep. At a dose of 6700 rep, 98% of the sperm carried at least one dominant lethal. X-irradiation of males with 7000 r showed that 98% of the sperm carried at least one dominant lethal. These

x-ray data are comparable to those reported by Heidenthal (1945). Thus, for equal expenditures of energy, the same number of dominant lethals are obtained for $\alpha$-particles and for x-rays.

987 Clayton, G., Robertson, A. MUTATION AND QUANTITATIVE VARIATION. Amer. Nat. 89 (1955) 151-8.

Selection for abdominal chaetae has been carried out in an inbred line of D. melanogaster, both with and without irradiation by 1800 r x-rays of each generation. The response in the control stocks in 17 generations was not significant. The irradiated lines responded to selection but slowly compared with wild populations. This is discussed in relation to the results of other workers. Two papers by Mather and co-workers are found to give consistent estimates of the rate of spontaneous production of new variance in abdominal chaetae of the order of 0.01 units each generation, which is not inconsistent with our results. The variance found in several wild populations is about 5 units. The evolutionary aspect of these results is discussed. (auth. summary)

988 Colombo, G. PRIME RICERCHE SUI LETALI DOMINANTI INDOTTI DAI RAGGI X SU MASCHI DI LOCUSTA MIGRATORIA MIGRATORIOIDES R. AND F. (ORTHOPTERA) (Initial research on the dominant lethals induced with x-rays on the males of Locusta migratoria migratorioides R. and F. (Orthoptera)). Ric. Sci. 29, 10 (1959) 2133-41. (In Italian)

Males of L. m. migratorioides at 4th instar, just after the last moult and a month after the last moult were irradiated with x-rays from 50 to 1600 r. The irradiated males were mated to non-irradiated virgin females and the offspring scored for embryo mortality. Dominant lethals induced in spermatogonia, spermatocytes and sperm were studied. The relation of dosage to effect, for dominant lethals induced on sperm, follows a one-event curve; but it is possible that doses high enough to produce multi-event effects were not used. The sex ratio was observed to be altered in favour of males. The frequencies of dominant lethals increase when more mature germ cells are irradiated. This result is explained as cell selection against germ cells irradiated in premeiotic and meiotic stages. This view is supported by several experiments on chromosome and cell damage by x-rays on Orthoptera. The percentages of embryo death at different stages of development were determined. When sperm were irradiated there was a higher mortality during segmentation, whereas when spermatogonia were irradiated mortality was higher in later stages of the embryonic development. This result is considered to be further evidence of cell selection against germ cells irradiated during premeiotic stages. (auth. summary)

* Cunha et al. 1958 - [1439, 1440]

* Cunha et al. 1959 - [1441]

989 Dittrich, W., Höhne, G., Paul, W., Schubert, G. ÜBER DIE AUSLÖSUNG REZESSIV-GESCHLECHTS-GEBUNDENER LETALFAKTOREN BEI DROSOPHILA DURCH SCHNELLE ELEKTRONEN EINES 6 MeV-BETATRONS (Production of recessive sex-linked lethals in Drosophila by fast electrons of a 6 MeV betatron). Naturwissenschaften 37, 23 (1950) 545-6. (In German)

Fast electrons (>3 MeV) were found more effective in inducing recessive sex-linked lethal mutations in D. melanogaster than equal x-ray doses in experiments of Timoféeff-Ressovsky (1944) and others. This difference, however, is not statistically significant. Spontaneous mutations of this kind did not occur. (BA 26: 17130, 1952)

990 Edington, C. W. A NONLINEAR FREQUENCY-DOSE RELATION FOR RECESSIVE LETHALS INDUCED BY X-RAYS IN DROSOPHILA. Genetics 41 (1956) 640.

It has been found that the frequency of recessive lethals induced by x-rays in Drosophila melanogaster increases more rapidly with increasing dose than is expected on the basis of linearity. This nonlinear increase may be due to the increasing frequency at higher doses of one, two, or all of the following two-hit genetic effects: (1) two independent semilethals, which together act as a recessive lethal, (2) gross deficiencies, and (3) "position-effect" lethals, which are dependent on gross chromosome aberrations for their expression. (from abstr.)

(Abstract of paper presented at the 1956 meetings of the Genetics Society of America, Storrs, Connecticut, 27-29 Aug. 1956)

* Edington 1956 - [818]

* Edington 1958 - [1377]

* Erdman 1960 - [867]

991 Falk, R. STUDIES ON X-RAY-INDUCED VIABILITY MUTATIONS IN THE THIRD CHROMOSOME OF DROSOPHILA MELANGASTER. Hereditas 41, 1/2 (1955) 259-78.

An isogenic Drosophila stock was irradiated with an x-ray dose of 2000 r. Forty-seven experimental stocks were isolated in such a way that in each only the third irradiated chromosome was left for the study of viability mutations. Hatchability was used as a measure of viability, and thus it was possible to study the effect of the mutations in the homozygous as well as the heterozygous flies. The lethal and part of the subvital mutations only were left for the viability test. Of the tested experimental stocks, 73% were affected in their viability. Among these the subvitals occurred about 3. 5 times more frequently than the lethals. Among the subvital mutations, those less affected occurred more frequently. In about 1/3 of the mutations the effect was partially or completely dominant. (auth.)

992 Falk, R. STUDIES ON X-RAY INDUCED VIABILITY MUTATIONS. Bull. Res. Council, Israel, Sec. B. 5 (1956) 314.

Subvital mutations were induced in an isogenic stock of Drosophila by 2000 r of x-rays. Third chromosome mutations only were studied. Among the stocks tested the subvitals were about 3. 5 times more abundant than the lethals. 73% of the tested chromosomes carried lethal or subvital mutations. The mutations with the lesser detrimental effect were the more frequent ones. In at least 1/3 of the mutations the effect was partially or completely dominant. The theoretical expectation that the more detrimental mutations are the less dominant ones could only be confirmed in part.

* Fritz-Niggli 1956 - [823]

993 Глемобицкий, Я.Л., Абелева, Э.А., Лапкин Ю.А. ВЛИЯНИЕ МАЛЫХ ДОЗ ИОНИЗИРУЮЩЕЙ РАДИАЦИИ НА ЧАСТОТУ ВОЗНИКНОВЕНИЯ СЦЕПЛЕННЫХ С ПОЛОМ РЕЦЕССИВНЫХ ЛЕТАЛЬНЫХ МУТАЦИЙ У ДРОЗОФИЛЫ. Журнал общей Биологии 21 (1960).

1. Облучение γ-лучами в дозе 5 р спермиев и сперматид у дрозофилы индуцирует появление рецессивных летальных мутаций. Фракционированное облучение дозой в 20 р и по 5 р за сеанс с полуторачасовыми промежутками между сеансами облучения сопровождается кумулятивностью мутагенного эффекта. Относительная частота (на 1р) рецессивных леталей, индуцированных в спермиях при фракционированном облучении дозами по 5 р, соответствует данным, полученным другими исследователями при единовременном облучении более высокими дозами. 2. Одинаковые малые дозы быстрых нейтронов давали в 1½ – 2 раза больший мутагенный эффект, чем γ-лучи. 3. Сперматиды, по сравнению со спермиями, при использовании малых доз радиации были примерно в два раза мутабильнее при облучениях как γ-лучами, так и быстрыми нейтронами. 4. Данные опыта при использовании малых доз вплоть до 5 р указывают на отсутствие порога для мутагенного эффекта ионизирующей радиации. В основном следует считаться с отсутствием пороговых доз. Если пороговые дозы и будут обнаружены, то они будут характерны лишь для данного вида радиации, для определенных типов мутаций и при воздействии на определенную стадию гаметогенеза конкретного вида организмов.

Glemobitsky, Ya.L., Abeleva, E. A., Lapkin, Yu. A. EFFECT OF SMALL DOSES OF IONIZING RADIATIONS UPON THE RATE OF FORMATION OF SEX-LINKED RECESSIVE LETHALS. J. gen. Biol., Moscow 21 (1960) n. p. (Preprint!); see A/AC. 82/G/L/408.

Irradiation of Drosophila sperm and spermatids by a 5 r-dose of γ-rays gives rise to the formation of recessive lethals. Fractional irradiation with a dose of 20 r, given 5 r at a time at 1½ h-intervals, increases the mutagenic effect. The relative rate of recessive lethals per r induced in sperm by fractional doses of 5 r corresponds to the results obtained by other workers with higher single doses. Equal small doses of fast neutrons have a mutagenic effect 1. 5 - 2 times higher than that of γ-rays. At small doses of either γ-rays or fast neutrons spermatids prove twice as mutable as sperm. Results from small doses up to 5 r point to the absence of a threshold. The absence of threshold values must be borne in mind. If threshold doses should

eventually be found they will be characteristic only for the particular radiation, the particular mutations and the particular stage in gametogensis of that one species.

994 Green, M. M. RADIATION INDUCED REVERSE MUTATIONS IN DROSOPHILA MELANOGASTER. Proc. nat. Acad. Sci., Washington 45 (1959) 16-23.

Evidence is presented that x-rays and γ-rays can induce back mutations which, according to current criteria, do not differ from spontaneous mutations. D. melanogaster females homozygous for one or the other forked pseudoalleles, $f^{3n}$ and $f^{1}$, both known to back-mutate spontaneously, were irradiated. A comparison of the induced and spontaneous rates of reversals shows that 4000 r x-rays increased $f^{3n}$ reversals 7 fold, whereas equivalent γ-irradiation somewhat more than tripled the reversal frequency. Back mutations of $f^{3n}$ were significantly increased; those of $f^{1}$ apparently not. The back mutations are not associated with detectable chromosome alterations.

995 Guyénot, E., Thélin, L., Kiortsis, V. ACTION MUTAGÈNE DE PETITES DOSES DE RAYONS X. (abstr.) 2nd UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF.15/P/237. 22 (1958) 292.

(For details see ref. 996)

996 Guyénot, E., Thélin, L., Kiortsis, V. ACTION MUTAGÈNE DE FAIBLES DOSES D'IRRADIATION CHEZ DROSOPHILA MELANOGASTER. Arch. Klaus-Stift. VererbForsch. 24, 1/4 (1959) 256-64.

L'étude des mutations létales récessives, liées au sexe chez D. melanogaster montre que le pourcentage des mutations spontanées apparaissant dans la souche utilisée s'élève à 0.0881%; des doses de rayons X aussi faibles que 40 r ou 20 r peuvent augmenter de façon appréciable le taux de mutabilité (respectivement à 0.3078% et 0.1919%); les mêmes quantités totales de rayonnement, fractionnées en doses partielles de 1 r sont encore efficaces; le fractionnement de la dose a pour conséquence la diminution relative du pourcentage des mutations induites par l'irradiation (0.1944% au lieu de 0.3078%). Il semble que le raccourcissement des intervalles entre les expositions partielles conduit à une augmentation progressive du taux des mutations, qui tend vers celui obtenu après irradiation continue. (auth.)

997 Hasimoto, H. TRANSLOCATION OF A PIECE OF AN AUTOSOME TO THE W CHROMOSOME, AND INDUCTION OF A DOMINANT LETHAL FACTOR IN THE SILKWORM BY X-RAYS. p. 248-51 in "Proceedings of the International Genetics Symposia, 1956, Tokyo & Kyoto, Sep. 1956". Suppl. to Cytologia 1957. Tokyo, Science Council of Japan. 1957, 702 p.

The translocation induced by chromosome irradiation is probably a reciprocal interchange involving the W chromosome and a Zebra-lemon autosome, where a W chromosome segment bearing the female-determining factor is combined with a segment bearing the Zebra gene, while the rest of the W chromosome is united with the part of the autosome bearing the lemon locus. The lemon locus-bearing segment apparently carries the lethal factor in question. In ordinary circumstances the W chromosome is transmitted in the female line, but when the segment enters a male as in the present case, it produces a lethal effect. Therefore, it may be concluded that the W chromosome has a regional differentiation, and the female-determining factor occupies a certain restricted region of the chromosome, while the other region has a lethal effect for the male which carries it. (auth.)

998 Heidenthal, G. X-RAY INDUCED RECESSIVE LETHALS IN HABROBRACON. Genetics 37 (1952) 590.

A method for detecting x-ray induced recessive lethals has been developed as follows: Virgin females which have been forced to store 1st meiotic metaphase eggs were irradiated and then outcrossed to haploid males. $F_1$ virgins which developed only from eggs x-rayed in 1st metaphase were then tested by allowing each to lay eggs. These were counted and later examined for hatchability. Control hatchability for comparable $F_1$s was well above 90%; for no female was it as low as 50%. In the experimental series, any $F_1$ which laid eggs 50% or fewer of which hatched, was tallied as bearing one or more recessive lethals. The eggs counted were haploid; therefore, a recessive lethal on any chromosome, which would act prior to hatching of larva, would give approximately a 1:1 ratio of dead eggs to live larvae; those bearing two independently assorting lethals a ratio of 3 dead eggs to 1 live larvae etc. The data thus far indicate a ratio for one or more lethals of approximately 5.1% for 500 r and 14.2% for 1000 r. Comparable data for recessive

lethals induced in sperm give 5.0% and 10.7% for the same dosages respectively. The above method has also been shown to be applicable to the much more resistant prophase stage.

(Abstract of paper presented at the 1952 meetings of the Genetics Soc. of America)

999 Heidenthal, G. A COMPARISON OF X-RAY INDUCED DOMINANT AND RECESSIVE LETHALS IN FIRST MEIOTIC METAPHASE EGGS AND IN SPERM OF HABROBRACON. (abstr.) Genetics 38, 7 (1953) 668.

Methods have been developed for estimating x-ray induced dominant and recessive lethals. Natural parthenogensis has permitted study of rates for the entire chromosomal complement. For the metaphase eggs the dominant lethal curve is a simple exponential function with the 50% lethal point at about 375 r and the 90% at about 1600 r. The dominant lethal curve for the sperm is markedly different. The metaphase eggs were found to be more radiosensitive than the sperm. The effect of dose rate on induction of dominant and recessive lethal factors is discussed. (from abstr.)

1000 Henke, K., Pohley, H.-J. DIFFERENTIELLE ZELLTEILUNGEN UND POLYPLOIDIE BEI DER SCHUPPENBILDUNG DER MEHLMOTTE EPHESTIA KÜHNIELLA Z. (Differential cell divisions and polyploidy in the scale formation of the flour moth Ephestia kühniella Z.). Z. Naturf. 7, 2 (1952) 65-79. (In German)

The cells of the rudimentary hind wings of Ephestia pass through 5 — not 4, as previously supposed — differential steps of cell division in the course of the mitoses of the prepupal and pupal period. A somatic mutation in the form of dark scales is often observed as the result of irradiation. The frequency of appearance of such mutant aggregates and their dependence on the moment of irradiation which is fixed somewhere between the last larval moult and before the onset of the prepupal mitotic period is discussed.

* Herskowitz and Abrahamson 1955 - [1193]

* Herskowitz 1956 - [1192]

* Herskowitz and Schalet 1957 - [1198]

1001 Herskowitz, I. H., Baumiller, R. C. PHENOTYPIC EFFECTS OF HETEROZYGOUS, X-RAY-INDUCED MUTATIONS IN DROSOPHILA. Science 130, 3368 (1959) 162-3.

Heterozygous mutations produced by 3000 r delay pupation in about 9% of larvae of D. melanogaster under nutritional stress and kill approximately 6%. The effects are less, though appreciable, when there is excess nutrient; no effects are detectable after oögonia are irradiated. Irradiated sperm and oöcytes cause detriment, partly via different types of mutations, in approximately equal amounts. (auth.)

* Herskowitz et al. 1959 - [1202]

* Höhne and Schubert 1954 - [834]

* Höhne et al. 1955 - [1389]

1002 Ives, P. T. RADIATION INDUCED MUTATION RATES IN DROSOPHILA AND MICE. Amer. Nat. 88 (1954) 361-4.

A comparison is made of radiation-induced mutation rates in Drosophila melanogaster and mice by considering principally the data of Russell (Symp. Quant. Biol. 16(1951) 327-36), Alexander (Rec. Gen. Soc. America 21(1952) 7) and the author. It is argued that the comparison should be made on the basis of $F_1$ results using only autosomal loci. Considering also the extreme non-randomness of the mutation rates of the few autosomal loci so far studied it is concluded that for the present the radiation-induced mutation rate per r per locus appears to be similar in flies and mice.

1003 Ives, P. T., Levine, R. P., Yost, H. T. THE PRODUCTION OF MUTATIONS IN DROSOPHILA MELANOGASTER BY THE FAST NEUTRON RADIATION OF AN ATOMIC EXPLOSION. Proc. nat. Acad. Sci., Washington 40 (1954) 165-71.

The fast neutrons of an atomic explosion were three to four times as effective as x-rays in producing sex-linked lethal and autosomal visible mutations in the mature sperm of D. melanogaster. About 42% of the sex-linked lethal chromosomes gave evidence of containing gross chromosomal aberrations, eight times as

many as appeared in a group of mutator-caused lethals. The increase in mutation rate with increasing dosage of fast neutrons appeared to be linear for sex-linked lethals, both with and without gross chromosomal aberrations; but the rate may not have been linear in the case of the autosomal visibles. (auth. summary)

1004 Ives, P. T. THE MUTATION RATE IN DROSOPHILA SPERM AFTER COBALT-60 γ-RADIATION. p. 132 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958.

Spermatozoa from 2 d-old inbred Oregon-R males were tested by Basc after exposure to $Co^{60}$ γ in doses ranging from 300 r to 12 500 r in intervals of 700 r to 2500 r. For each of 7 doses a minimum of 1202 X-chromosomes was tested and a minimum of 112 lethal chromosomes was observed. Plotted directly the data fit a straight line with a slope of 1.85% lethal chromosomes per 1000 r. Individual mutational events probably occurred at a greater than linear rate of increase with increase in dose. Tests with 438 lethal chromosomes from 300 r showed only 2 instances of separable lethal genes and 23 cases with reduced crossing-over of which 9 were translocations and 14 inversions. These results are comparable to those in a previously published study of lethals produced by a genetic mutator except that in that study all of the 13 analysed cases of reduced crossing-over were inversions. (from abstr.)

1005 Ives, P. T. THE RELATIONSHIP BETWEEN RADIATION DOSE AND DOMINANT VISIBLE MUTATION RATE IN DROSOPHILA MELANOGASTER. Genetics 44 (1959) 967-78.

Mature sperm of Drosophila melanogaster were subjected to γ-radiation from a $Co^{60}$-source. Tests were made of the frequency of easily seen visible mutations, chiefly autosomal dominants, induced at ten radiation dosage levels in the 0.5 to 10 kr range. Results are related to findings in sex-linked lethal tests.

1006 Ives, P. T. CHROMOSOMAL DISTRIBUTION OF MUTATOR- AND RADIATION-INDUCED MUTATIONS IN DROSOPHILA MELANOGASTER. Evolution 13 (1959) 526-31.

Three series of X-chromosome lethal mutations, from the mutator hi, from 300 r and from 12.5 kr of cobalt-60 γ-radiation were analysed for distribution of lethal loci, chiefly with respect to the four regions set off by the marker genes. The distributions are compared to each other and to proportions of available genetic material in each region. The difference between mutator and radiation lethal loci distribution is consistent with the hypothesis that mutator genes are genetically more specific, ionizing radiations more general, in their mutagenic effects. It is suggested that series of spontaneous lethals from strains of D. melanogaster derived recently from different geographic areas may be expected sometimes to show different chromosomal distributions but that series of lethals induced in such strains by a given radiation treatment should be generally alike. (from auth.)

1007 Ives, P. T. THE MUTATION RATE IN DROSOPHILA AFTER HIGH DOSES OF GAMMA RADIATION. Proc. nat. Acad. Sci., Washington 45 (1959) 188-92.

Data are presented from a study of the sex-linked mutation rate in mature sperm of Drosophila melanogaster at seven dosage levels of $Co^{60}$ γ-radiation in the 300 r to 12.5 kr range. Lethal chromosomes from the lowest and highest doses were analysed genetically, and the results are compatible with the interpretation that a Poisson-like accumulation of lethal mutations occurred throughout this dosage range, with an average increase of 2% lethal mutations per kr. (auth.)

1008 Käfer, E. VITALITÄTSMUTATIONEN, AUSGELÖST DURCH RÖNTGENSTRAHLEN BEI DROSOPHILA MELANOGASTER (Study on mutations affecting vitality, induced by x-rays in Drosophila melanogaster). Z. indukt. Abstamm.-VererbLehre 84 (1953) 508-35. (In German)

A comparison of x-ray-induced mutations in the x- and in the second-chromosome in sperm was made. It was found that in both types of chromosomes slightly higher rates of recessive lethals were induced than of strong detrimentals.

* Kaplan and Lyon 1953 - [1391]

* Kayhart 1954 - [835]

* Kayhart 1956 - [836]

1009 King, R. C. REDUCTION IN PRODUCTIVITY AND RECESSIVE LETHAL MUTATION FOLLOWING X-IRRADIATION OF FEMALE DROSOPHILA MELANOGASTER. Amer. Nat. 86 (1952) 391-8.

Sex-linked recessive lethals were recovered from successive batches of eggs laid by female Drosophila melanogaster irradiated with 4000 r of x-rays. While the initial frequency of lethals (10%) is similar to that of males treated in an identical manner, there is an immediate linear decline in lethal frequency which reaches a value only 60% the initial frequency in eggs laid 7-12 d after irradiation. The decline in frequency is taken to represent the elimination in immature germ cells of induced lethal effects belonging to the class of chromosome aberrations. The fecundity and/or fertility of irradiated females is greatly reduced for the first four days after treatment. A rise in female productivity occurs between days 4 and 5. After a week has passed the productivity of treated females is almost normal, although the eggs produced by the females contain 60% as many sex-linked lethals as the eggs produced immediately after irradiation. The rise in productivity of females from 4 to 5 d after treatment is explained by assuming that the eggs laid at this time were 16-cell cysts at the time of irradiation and were resistant to irradiation in much the same fashion as is polyploid tissue. (auth. summary)

* King 1953 - [389]

1010 King, R. C. MUTATION IN DROSOPHILA MELANOGASTER MALES EXPOSED TO β-RADIATION FROM NEUTRON-ACTIVATED PHOSPHORUS-BAKELITE PLAQUES. Radiation Res. 1 (1954) 369-80.

The x-ray-induced recessive lethal mutation rate in D. melanogaster has been found to be the same whether or not X chromosomes are modified by the attachment of fragments of the Y chromosome. β-rays from neutron-activated, phosphorus-Bakelite plaques are found to be 60% as efficient as 90 kV x-rays in producing sex-linked recessive lethal mutations. This difference is attributed to differences in the distribution of ionization produced in tissue by the two classes of radiation. Recalculation of earlier data leads to the conclusion that the experimental and calculated values for the fraction of the total $P^{32}$ β-particle energy absorbed by the gonad of $P^{32}$-labelled Drosophila male are not in disagreement as was previously thought. (auth. summary)

(See also BNL-1849, Brookhaven National Lab., Upton, N.Y. 1954, 21p)

1011 King, R. C., Wood, E. M. SEX-LINKED LETHAL MUTATIONS INDUCED BY THERMAL NEUTRONS IN MALE AND FEMALE DROSOPHILA MELANOGASTER (abstr.) Genetics 39 (1954) 977-8.

The recessive lethal mutation rate/thermal neutron dose relation appears to be linear for sperm up to the highest dosage tested ($4.6 \times 10^{13}$ $N_{th}/cm^2$). The relation is also linear for oöcytes and oögonia for doses up to $3.5 \times 10^{13}$ $N_{th}/cm^2$. The average mutation rate per unit dose for oöcytes is 75% the male rate; for oögonia 38% the male rate. The mutation rate in the most mature egg cells appears to be similar to the rate for sperm. To explain the lower frequency of mutations recovered from oögonia than from oöcytes it is assumed that either the mutation process occurs at a lower frequency in oögonia than in oöcytes, or that a large fraction of the potential recessive lethal mutants are drawn off into inviable chromosome recombinations. On the basis of energy liberated per unit weight of gonadal tissue, thermal neutrons are found to be 2.5 times as effective as 90 kV x-rays in inducing sex-linked recessive lethal mutations in sperm and 1.8 times as effective in inducing mutation in oöcytes and oögonia. This greater efficiency is not related to the higher mean ionization density of the nitrogen capture protons which form the physical basis of the action of this radiation. More likely the increased efficiency is due to a greater than average nitrogen content for the Drosophila gonad. (from abstr.)

1012 King, R. C., Wood, E. M. SEX-LINKED MUTATIONS INDUCED BY THERMAL NEUTRONS IN MALE AND FEMALE DROSOPHILA MELANOGASTER. Genetics 40 (1955) 490-9.

Germinal tissue of D. melanogaster males and females was used. Nitrogen capture protons (which are primarily responsible for the biological effects of thermal neutrons in the fruit fly) are approx. 1.5 times as effective in producing sex-linked lethal mutations in sperm as are 90 kV x-rays. Over the range of doses used the lethal mutation rate/dosage relation for X chromosomes of sperm appears to be linear. The mutation rate detected in viable eggs laid following treatment remains fairly constant for the first 6 d. Eggs laid 6-8 and 8-10 d following exposure have mutation rates 70% and 30% the original value. This original rate is only 75% the rate for sperm. The difference in the mutation rates induced in the male and female germ line may be due to a difference in mutability between sperm and egg chromosomes treated in late stages of gametogenesis or to differences in the nitrogen concentration between the male and the female gonad. In the female germ line the lower frequency of mutations recovered from premeiotic and early meiotic stages than from late meiotic stages may mean that the mutation process occurs at a lower

frequency in less mature cells or that a larger fraction of the potential lethal mutations are drawn off into inviable chromosome recombinations. Exposure of males and females to thermal neutrons also produces loss and fragmentation of X chromosomes in germ cells. (auth.)

(Earlier work was published under the same title as BNL-1778, Brookhaven National Lab., Upton, N. Y. 1953, 28 p.)

1013 King, R.C. DOMINANT LETHAL MUTATION AND X-CHROMOSOME ELIMINATION AFTER X-IRRADIATION OF FEMALE DROSOPHILA MELANOGASTER. Radiation Res. 3 (1955) 143-52; see also Radiation Res. 3 (1955) 333, abstr. 81.

A study was made of the frequency of dominant lethals and X-chromosome losses found in eggs laid at successive daily intervals after x-ray treatment (2000 r) of female Drosophila. Successive batches of eggs represent cells which were at increasingly early meiotic stages at the time of treatment. No significant difference in fecundity was detected between control and irradiated female flies, which indicates that there is little or no selection for mutant-free cells. The induced mutation rate relation in successive batches of eggs was found to be similar for the two types of mutation studied. The rate is fairly constant in the first eggs laid; it then falls abruptly to a lower constant rate and subsequently declines. The reduction in the rate of dominant lethals in successive batches of eggs is far greater than the reduction in the rate of X-chromosome losses in dominant lethal-free eggs or in the rate of sex-linked recessive lethals in dominant lethal-free, X-bearing eggs. The data are interpreted by assuming that x-irradiation induces more chromosome breaks in mature than in immature ovarian cells. The observed rates for sex-linked recessive lethals and X-chromosome losses in mature cells are reduced to a proportionally greater degree than in immature cells, because where higher primary breakage occurs more potential mutants are lost by being drawn into chromosome configurations which function as dominant lethal mutations. (auth.)

* King (undated) - [1145]

1014 King, R.C., Darrow, J.B., Weber Kaye, N. STUDIES ON DIFFERENT CLASSES OF MUTATIONS INDUCED BY RADIATION OF DROSOPHILA MELANOGASTER FEMALES. Genetics 41 (1956) 890-900.

The sensitivity of the germ cells in D. melanogaster to radiation-induced chromosome breakage (measured by dominant lethality and X-chromosome loss) varies strikingly during oögenesis. Exposures to 2000 r of γ-rays from a $Co^{60}$-source were used, delivered in 40 s. Many dominant lethals were induced in old oöcytes, a few in young oöcytes and none in oögonia. The damage to X-chromosomes showed a similar gradation. Recessive lethal mutations were induced in all three stages. Chromosome diakinesis and metaphase I are extremely sensitive, those in diplotene moderately sensitive, and those in prediplotene stages relatively insensitive to radiation-induced breakage.

See also research report BNL-2562, Brookhaven National Lab., Upton, N. Y.

1015 King, R.C. RADIATION-INDUCED MUTATIONS IN FEMALE DROSOPHILA MELANOGASTER. (abstr.) p. 855 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956", Vol. 2. Becker, E.C., ed. Ottawa, Mortimer Ltd. 1958.

In D. melanogaster sensitivity to radiation-induced mutation varies strikingly during the development of the egg, and ovarial oöcytes may be subdivided into three categories. Cells of Class A show a high rate of dominant lethal mutation and of X-chromosome loss and recessive lethal mutation; whereas cells of Class B show lower rates of all three types of mutation. The difference in sensitivity to mutation is not the result of germinal selection, and it can be correlated with cytological differences between the two groups of cells (although both are in diplotene). In group A cells the nuclear membrane has broken down and the chromosomes are maximally condensed; whereas the relatively diffuse chromosomes of group B cells lie in a typical nucleus. Cells of Class C (which include those which are in pre-diplotene stages of meiotic prophase as well as oögonia) contain few or no induced dominant lethal mutations and X-chromosome losses; but the frequency of sex-linked recessive lethal mutations is not significantly different from that found in cells of Class B. Perhaps the probability of breakage is low or the probability of restitution high in chromosomes of Class C cells. If such were the case, dominant lethal mutations and X-chromosome losses would not be produced, but subtler types of genetic change such as recessive lethals would still occur. Since the latter type of mutation is not eliminated from the germ tract it is this class of mutations which should be studied in populations of higher animals exposed to radiation.

1016 Kitzmiller, J. B. X-RAY INDUCED MUTATION IN THE MOSQUITO, CULEX FATIGANS. Exp. Parasitol. 7 (1958) 439-62.

60 newly eclosed ♂♂ of a Texas strain were given 2820 r x-rays and mated with untreated ♀♀. Neither $F_1$ (1200 animals) nor $F_2$ (50 000) showed any visible mutations; only $F_3$ (150 000 adults) showed 91 variant forms among 76 $F_3$-brother-sister-matings; 7 mutations are described in some detail. Mutations in natural populations are extremely rare. The gene content appears, however, to be relatively vulnerable to x-rays in certain positions as revealed by a mutation rate of at least 9%.

* LaChance 1958 - [1395]

1017 LaChance, L. E. INDEPENDENCE OF INTENSITY FOR EMBRYO DOMINANT LETHALS INDUCED BY X-RAYS IN FIRST MEIOTIC METAPHASE EGGS OF HABROBRACON. Genetics 45 (1960) 665-8.

Dominant lethals induced in metaphase I eggs of Habrobracon are chromosomal in nature and are dose-rate independent, indicating only one-hit events. (auth.)

1018 Laven, H. STRAHLENINDUZIERTE MUTATIONEN BEI CULEX PIPIENS I. (Radiation-induced mutations in Culex pipiens I.). Z. Naturf. 10 b (1955) 320-2. (In German)

Differences in the mutual crossing ability of different species of Culex pipiens were interpreted in terms of plasmatic heredity. To show that this phenomenon was not due to a chromosome mechanism which deviates from the normal fertilization and nuclear division, 4 mutations which occurred after subjecting 2-3 d-old males to x-rays (4000 r) were studied. Since the mutations studied followed the same course of heredity, whether in plasma of their own or other species, the interpretation postulated appears to be correct.

(Translated from Berichte der gesamten Biologie, A, 100 (1956) 345)

* Lee 1956 - [1258]

1019 Lee, W. R. RADIATION INDUCED DOMINANT LETHAL MUTATIONS IN THE HONEY BEE. Genetics 41 (1956) 650.

A queen bee ordinarily lays fertilized eggs in worker (female) comb cells and unfertilized eggs in larger drone (male) cells. In these experiments queens were inseminated with sperm from unrelated males treated with gamma radiation from $Co^{60}$. The viability of the eggs in worker cells decreased with increasing dose until at 10 000 r virtually no eggs hatched, indicating that almost every sperm carried at least one dominant lethal. However, when the dosage was further increased to beyond 35 000 r the eggs began to develop normally. This must be the result of sperm inactivation since the eggs, even though in worker cells, developed into males. Therefore the sperm inactivation dose is several fold higher than the 100% dominant lethal dose, as in Habrobracon. Nearly all the lethals caused death in the egg stage. There was no significant fractionation effect, the percentage of dominant lethals being the same when 2000 r was given in a continuous dose as when given in two fractions separated by 1 or 4 h. The proportion of lethals in sperm did not change after one year of storage in the spermatheca of the queen. The curve relating dominant lethals to dose is in quantitative agreement with those of Drosophila and Habrobracon. It shows a highly significant departure from linearity (after correction for natural mortality and saturation), but approaches linearity at low doses. This is consistent with the hypothesis that dominant lethals are due primarily to single chromosome breaks at low doses and multiple break phenomena at higher doses.

(Abstract of paper presented at the 1956 meetings of the Genetics Society of America, Storrs, Connecticut, 27-29 Aug. 1956)

1020 Lee, W. R. THE DOSAGE RESPONSE CURVE FOR RADIATION INDUCED DOMINANT LETHAL MUTATIONS IN THE HONEY BEE. Genetics 43 (1958) 480-92.

The dosage of γ-radiation required to inactivate honeybee sperm is 7 times higher than the nearly 100% dominant lethal dosage, as in Habrobracon. Nearly all the induced dominant lethals caused death in the egg stage. The proportion of dominant lethals in irradiated spermatozoa did not change after a year of storage in the spermatheca of the queen. There was no significant fractionation effect, the percentage of dominant lethals being the same after 2000 r given in a continuous dose, or in 2 equal fractions separated by one hour. The curve relating dominant lethals to dosages is in quantitative agreement with those of Drosophila and Habrobracon. It shows a highly significant departure from linearity (after correction for natural mortality and saturation), but approaches linearity at low dosages. This is consistent with the

hypothesis that dominant lethals are due primarily to single chromosome breaks at low dosages and multiple break phenomena at higher dosages. (from auth.)

1021 Lee, W. R. RADIATION INDUCED VIABILITY MUTATIONS IN THE HONEY BEE. TID-6877, Durham Univ., England. 1959, 3p.

An improved technique for partial-body irradiation of bees is described. The parental queen is placed in a block of lead with the last two visible segments of the abdomen extending into a 50 kV x-ray beam. The technique enables comparison to be made between control and irradiated groups, all of which were progeny of the same queen and haploid male. Experimental irradiations using this technique to study viability of mutations are described. Some results of the study are reported, but data are insufficient to make conclusions. The technique is very successful. (NSA 15: 1241, 1961)

1022 Lefevre, G., Jr. X-RAY INDUCED GENETIC EFFECTS IN GERMINAL AND SOMATIC TISSUE OF DROSOPHILA MELANOGASTER. (abstr.) Genetics 35 (1950) 120.

The rate of x-ray induced direct mutation was compared following irradiation of germinal and somatic tissue. Serious question is thrown on the reliability of early reports of x-ray induced reverse mutation in Drosophila. A comparison of the published data regarding the influence of various intrinsic and extrinsic factors on x-ray induced and spontaneous mutation suggests that the two mutation processes are qualitatively different.

(This paper was published more fully in Amer. Nat. 84 (1950) 341-65, see ref. 1023)

1023 Lefevre, G., Jr. X-RAY-INDUCED GENETIC EFFECTS IN GERMINAL AND SOMATIC TISSUE OF DROSOPHILA MELANOGASTER. Amer. Nat. 84 (1950) 341-65.

Attempts were made to induce reverse mutations in both germinal and somatic tissue of Drosophila melanogaster. No evidence of reverse germinal mutation was found following irradiation with 5000 r of some 166 000 recessive X-chromosome loci. In the somatic studies no reverse mutations of white were found in tests equivalent to the exposure of 600 000 white loci to 5000 r. White alleles of three diverse origins were used: (a) spontaneous, (b) x-ray-induced, and (c) mustard-gas-induced. The reliability of the early reports of x-ray-induced reverse mutation in Drosophila are seriously questioned on the basis of the results obtained. The conclusion was also reached that x-ray-induced mutability of the $w^+$ locus is not significantly affected by the kind of cell in which it is located. A comparison of the influence of various intrinsic and extrinsic factors on x-ray-induced and spontaneous mutation indicates that the two mutation processes are qualitatively different. In all likelihood mutations induced by ionizing radiation in Drosophila, as in maize, are losses or destructions of genetic material; and unlike spontaneous mutations, induced mutations are incapable of further change. 50 references. (NSA 4: 6026, 1950)

1024 Lindsley, D. L., Edington, C. W., Halle, E. S. von. SEX-LINKED RECESSIVE LETHALS IN DROSOPHILA WHOSE EXPRESSION IS SUPPRESSED BY THE Y CHROMOSOME. Genetics 45 (1960) 1649-70.

A method has been devised that allows the detection and recovery of sex-linked recessive lethals whose lethal phenotype is suppressed by the Y chromosome, as well as orthodox lethals that are inviable with or without a Y. With doses of 3 and 4 kr, ca. 20% of all induced sex-linked recessive lethals survive in the presence of a Y chromosome, and are consequently overlooked by currently used methods of lethal detection. The continuity of the X chromosome is postulated to play an important role in normal spermiogenesis, this continuity being disrupted by reciprocal translocations. (from auth. summary)

(This report was previously published as a USA report received by UN Scientific Committee on the Effects of Atomic Radiation. A/AC. 82/G/L. 431. 44 p)

1025 Löbbecke, E. A., Müller, L. ÜBER DIE AUSLÖSUNG VON SOMATISCHEN MUTATIONEN BEI EPHESTIA KÜHNIELLA Z. DURCH WEICHE UND MITTELHARTE RÖNTGENSTRAHLEN (10-100 kV) (On the induction by soft and medium-hard x-rays (10-100 kV) of somatic mutations in Ephestia kühniella Z.) Z. indukt. Abstamm.-VererbLehre 90 (1959) 421-7. (In German)

Developing Mediterranean flour moths (Ephestia) were exposed to x-rays of 10 kV up to 100 kV and certain changes in the pattern of the winglets of grown up animals were interpreted to constitute somatic mutations. The series of tests were carried out at three different times and resulted in scatterings which were so strong that there was no distinct correlation between the frequency of somatic mutations on the one hand and the type of radiation on the other.

1026 Löbbecke, E. A., Müller, L. DAS SOMATISCHE MUTANTENSPEKTRUM VON EPHESTIA (i.e. ANAGASTA) KÜHNIELLA Z. BEI VERSCHIEDENEN DOSEN WEICHER 10 kV- UND MITTELHARTER 100 kV-RÖNTGEN-STRAHLEN SOWIE DER HARTEN $^{60}$Co-STRAHLUNG (The somatic mutation spectrum of Ephestia (i.e. Anagasta) kühniella Z. following different doses of radiation: soft x-rays at 10 kV, medium x-rays at 100 kV, and hard γ-radiation from $Co^{60}$). Z. indukt. Abstamm.-VererbLehre 91, 3 (1960) 338-49. (In German)

The dose-effect curves for the four somatic scale mutations of Ephestia, ES 1, 2, 3 and 4, were determined for 10 kV and 100 kV x-rays and $Co^{60}$ γ-rays. After double logarithmic transformation the relation between the dose and the mutation rate is expressed by a straight line. The regression coefficients of this line are the same within each treatment series as well as between them for all four somatic mutants. In all experiments the mutation rate increased in the same proportion to the dose, although each mutant had a characteristic rate. The dose does not selectively alter the mutation rate. The mutation spectrum remains the same within each series at a particular dose. The mutation spectra of the five experimental series showed differences greater than expected by random deviation. These variations are discussed. (from auth. summary)

1027 Lüning, K. G. STUDIES ON X-RAY INDUCED MUTATIONS IN VARIOUS STAGES OF SPERMATOGENESIS IN DROSOPHILA MELANOGASTER. Doctoral Diss., Stockholm Univ., Stockholm, Albert Bonnier's Press, (1952).

* Lüning 1952 - [1205]

1028 Lüning, K. G. X-RAY INDUCED MUTATIONS IN DROSOPHILA MELANOGASTER. (abstr.) Hereditas 38, 1 (1952) 108-9.

A high rate of hyperploid males was obtained from treated spermatids; from this it would appear that the high rate of dominant lethals in the same period is partly due to more assymmetrical interchanges. One might then have to suppose a higher rate of breaks in mature spermatozoa. As many breaks are apparently induced in spermatids by a dose of 960 r than by 3000-4000 r in mature spermatozoa. No increase was observed in the rate of gynandromorphs with an increase in the rate of hyperploid males. A hypothesis is proposed: breaks leading to gynandromorphism are induced as potential breaks which are not separable by movements of the chromosomes, but which break up in the next chromosome division. Thus, they are independent of breaks leading to dominant lethals.

1029 Lüning, K. G. STUDIES ON THE ORIGIN OF APPARENT GENE MUTATIONS IN DROSOPHILA MELANOGASTER. Acta Zool. 33 (1952) 193-207 (Verh. schweizer naturf. Ges.).

The paper deals with x-ray induced apparent gene mutations (invisibles and recessive lethals) in various stages of spermiogenesis of D. melanogaster. Details of methods and results are given. It is supposed that the breaks are distributed in a similar manner for all stages of spermiogenesis and thus that the differential breakability is a peculiarity of material along the whole chromosome. It is concluded that apparent gene mutations are not only due to intergenic changes but also to intragenic changes, and that the latter are only slightly (if at all) subject to variations between different stages of spermiogenesis. A considerable section is devoted to discussion.

1030 Lüning, K. G., Lindell, B., Falk, R. THE EFFECT OF HIGH AND LOW ROENTGEN INTENSITY ON DOMINANT LETHALS IN DROSOPHILA MELANOGASTER. Acta radiol., Stockh. 43 (1955) 89-92.

By means of a discharge roentgen tube, the authors have tested the biologic effectiveness of high-intensity radiation. Drosophila males were irradiated with 800 to 900 r and, after 7 d, mated to selected females of high egg-laying capacity. No significant difference in hatchability could be seen when high as compared to low intensity radiation was used, though the high intensity produced the irradiation dose within only 50 microseconds and the low intensity dose was given over 15 min. (auth.)

* Lüning 1956 - [1401], [1209]

1031 Lüning, K. G., Jonsson, S. THE INDUCTION OF DETRIMENTAL MUTATIONS IN DROSOPHILA BY X-RAYS. p. 425-32 in "Advances in Radiobiology. Proceedings of the 5th International Conference on Radiobiology, Stockholm 15-19 Aug. 1956." de Hevesy, G. C., Forssberg, A. G., Abbatt, J. D., eds. London, Oliver and Boyd, 1957.

The results indicate that the rates of detrimentals induced in sperm chromosomes vary with the stage

treated in a manner similar to that shown for visibles and recessive lethals. The proportion of weak detrimentals appeared to be at least 5 times as high as the proportions of strong detrimentals or recessive lethals, which are similar to one another. In the female irradiation series the results have not contradicted the earlier observations that recessive lethals induced in unfertilized eggs appear at a slightly lower rate than in sperm, used the first 3 d after irradiation. Further, the relation between the rates of recessive lethals and "strong" detrimentals need not be different from that observed in the male irradiation series. It is a remarkable fact that "weak" detrimentals are so rare in the female irradiation series.

* Lüning and Hendriksson 1959 - [1290]

1032 Martin, A., Jr. A MORPHOLOGICAL STUDY OF SEVEN ABNORMALITIES IN HABROBRACON JUGLANDIS ASHMEAD. Proc. P. Acad. Sci. 24 (1950) 48-59.

Recent investigations on the effects of $P^{32}$ on H. juglandis indicate that deviations from the normal occur after exposure. Several of the abnormalities produced give evidence of being true mutations. Each of the mutations following beta radiation resembles one segregated earlier from the progeny of x-radiated females. Such similarity indicates parallel mutation, and the apparent instability of various chromosome segments. The fact that identical phenotypic deviates have occurred following x-radiation and beta radiation lends support to the hypothesis that chromosomes in general are composed of units with varying degrees of stability. (auth. conclusions)

1033 Martin, A., Jr. THE SIGNIFICANCE OF THE ACTION OF RADIOACTIVE PHOSPHORUS ON HABROBRACON JUGLANDIS ASHMEAD. Proc. P. Acad. Sci. 24 (1950) 60-4.

Female wasps were picked at random from normal wild-type population. Among progeny of exposed females there were an avg. of 28% abnormal individuals as compared with 1-2% in controls. Abnormalities were most common in the wings. Some of the evidence indicates that $P^{32}$ may produce sterility and mutations as well as increase of atypical individuals. Such evidence should be taken into account in the use of $P^{32}$ for treatment of human disorders. (BA 26: 2852, 1952)

1034 Medical Research Council THE RELATIVE BIOLOGICAL EFFICIENCY OF 4 MeV and 300 kV RADIATIONS. A REPORT FROM THE MEDICAL RESEARCH COUNCIL UNIT, CHRISTIE HOSPITAL AND HOLT RADIUM INSTITUTE, MANCHESTER 20. I. INTRODUCTION. Brit. J. Radiol. 30 (1957) 337-8.

A comparison is made between the radiations from a linear accelerator at 4 MeV and 300 kV x-rays. Among other tests, the mutations induced in Drosophila were examined. (Further papers are published in this series.)

* Mickey 1954 - [839]

* Mickey and Yanders 1954 - [840]

1035 Mossige, J. SPERM UTILIZATION AND BROOD PATTERNS IN DROSOPHILA MELANOGASTER. Amer. Nat. 89 (1955) 123-7.

It is found that Drosophila males will fertilize as many as 10 virgin females per day and that, in order to achieve maximum utilization of sperm, it is necessary to mate males with large numbers of virgin females daily. It is demonstrated that mature sperm are retained in the testis at least a few days. When newly emerged males are irradiated with 2500 r and mated according to the above system, there is a decided decrease in mating activity and an increase in dominant lethals on the 6th to 9th day after irradiation. (auth. summary)

* Mossige 1956 - [841]

* Mossige 1958 - [393]

* Mossige and Oftedal 1958 - [394]

* Muller et al. 1950 - [1211]

1036 Muller, H.J., Valencia, J.I. THE LOCALIZATION OF THE MUTAGENIC ACTION OF NEUTRON-INDUCED IONIZATIONS IN DROSOPHILA. (abstr.) Genetics 36 (1951) 567-8.

The frequency of translocations induced by fast neutron irradiation of Drosophila spermatozoa was found to vary linearly with dose even at doses sufficient to produce multiple proton tracks per sperm. This shows that broken chromosome ends derived from different breaks caused by the same track undergo recombination with one another much oftener than with those of different tracks. Our interpretation is that breaks caused by the same track tend to occur near together, this proximity favouring union between the broken ends. Thus the pieces would usually unite before greatly changing their relative positions. It must further be inferred that in this material a break usually occurs close to the point of origin of the ionization that induces it, i.e., that remote breakage effects, resulting from migration of ionization-induced, relatively stable mutagens over microsocopically appreciable distances, are uncommon. Further evidence for this conclusion is provided by the finding that loci, like that for white eyes, which with x-rays give "visible mutations" seldom accompanied by a lethal effect unless there is a microscopically visible deficiency or other rearrangement, give with neutrons "visible mutations" that are usually accompanied by a lethal effect, even when there is no cytologically demonstrable alteration. This concatenation of two mutagenic effects in close proximity (whether in these cases usually breaks or gene mutations or both is not yet decided) would result from the crowding of ionizations in proton tracks, provided the mutagenic action of the ionizations remained narrowly localized.

(See Rec. Genet. Soc. Amer. 20 (1951) 115-6)

1037 Muller, H.J. THE RELATION OF NEUTRON DOSE TO CHROMOSOME CHANGES AND POINT MUTATIONS IN DROSOPHILA. I. TRANSLOCATIONS. Amer. Nat. 88 (1954) 437-59.

The production of gene and chromosome changes by the application of fast neutrons to Drosophila spermatozoa is reviewed. Comparable series of experiments with x-rays are also considered. The results and their interpretation are discussed. At a level of doses yielding a 10% frequency of the translocations under consideration, neutrons as observed under the experimental conditions described are 2.5 times as efficient as x-rays in their production of translocations; with lower doses their efficiency in this respect, relative to that of x-rays, would rise until that very low level of dosage was reached below which, according to theory, the production of translocations by x-rays also became linear.

* Muller 1954 - [843]

1038 Muller, H.J., Herskowitz, I.H., Abrahamson, S., Oster, I.I. A NONLINEAR RELATION BETWEEN X-RAY DOSE AND RECOVERED LETHAL MUTATIONS IN DROSOPHILA. Genetics 39 (1954) 741-9.

From the experimental data obtained, the authors inferred that heterogeneity in susceptibility of the germ cells at the time of radiation must be taken into account when interpreting results. There is a strong positive correlation between susceptibility to the chromosome breaking and that to the recessive lethal inducing effect of x-rays. It is pointed out that heterogeneity of a similar kind probably exists, to a lesser extent, in the germ cells of a period shortly before ejaculation, when older males are used, and that it may even be present to some extent in the germ cells of that period in young males. In view of these considerations, and the fact that in most earlier work the importance of exactly controlling paternal age and germ-cell stage was not realized, the significance of earlier data purporting to show the continuing linearity of the lethal frequency-dosage relation at high doses becomes uncertain, and conclusions based on a supposed linearity in this dosage region should be held in abeyance until more definitive data can be obtained on material of maximal homogeneity. (from auth. summary)

1039 Muller, H.J. ADVANCES IN RADIATION MUTAGENESIS THROUGH STUDIES ON DROSOPHILA. 2nd UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 15/P/893, 22 (1958) 313-21.

Review article. The author reviews the significance of Drosophila-data by various workers. After discussing the frequency-dose relation at low and moderate doses, the author considers the different susceptibilities of different cell types. A section is devoted to discussing the relation between the induced point-mutation rate and the spontaneous rate. Mutational mechanism, the conditions under which they operate, and difficulties in interpretion are considered. 68 refs.

(Also published in Progress in Nuclear Energy, Ser. VI., Biological Sciences 2 (1959) 146-60, Bugher, J.G., Coursaget, J., Loutit, J.F., eds. Pergamon Press 1959. London, New York, Paris, Los Angeles)

* Murati et al. 1957 - [1212]

1040 Murati, K., Moriwaki, D., comps. THE SUMMARY OF RESEARCHES IN JAPAN PARTICULARLY RELATED TO THE DOCUMENT A/AC.82/R.87. A/AC.82/G/L.473. 1960, 27 p.

Summaries are presented from studies on the genetic effects of radiation on populations of Drosophila and yeast. A discussion is included of methods for the determination of optimum mutation rate and degree of dominance by the principle of minimum genetic load. (NSA 15: 8508, 1961)

1041 Nabours, R. K., Stebbins, F. M. X-RAY INDUCED TRANSLOCATIONS AMONG THE CHROMOSOMES OF APOTETTIX EURYCEPHALUS HANCOCK. (abstr.) Genetics 36 (1951) 568-9.

Three x-ray induced translocations among the chromosomes of A. eurycephalus (Orthoptera) have been observed, and are described.

1042 Nakao, Y. ACTION OF IRRADIATED CYTOPLASM ON UNTREATED CHROMOSOMES OF THE SILKWORM. Nature 172 (1953) 625-6.

Genetic effects of irradiated cytoplasm on untreated introduced chromosomes were demonstrated by the appearance of mosaic eggs in the progeny of x-irradiated female silkworms of genotype pe re/pe re, mated to wild-type unirradiated males. Since it was considered that the mutagenic power of irradiated cytoplasm might be lost if the interval between irradiation and fertilization was too long, and in order to shorten the interval between irradiation and egg laying, the females were kept at about 10°C for 12 h previous to irradiation, and the period within which mating was possible was restricted to 2 or 4 h. (NSA 7: 6335, 1953)

1043 Nakao, Y., Tazima, Y., Sugimura, T. FAILURE OF MERCAPTOETHYLAMINE AND CYSTEINE TO PROTECT THE SILKWORM AGAINST THE MUTAGENIC AND LETHAL EFFECTS OF RADIATION. Radiation Res. 3, 4 (1955) 400-6.

An attempt was made to determine whether mercaptoethylamine (MEA) and cysteine protect the silkworm against mutagenic and lethal effects of radiation, using visible mutations (egg colour mutants) and hatchabilities. The wild-type female moths, which received the injection of MEA, cysteine or physiological salt solution (control), were irradiated with x-rays and then mated to double recessive pe re/pe re males. In other experiments laid eggs from the mating of wild females and $w_2/w_2$ males were immersed in MEA solution before irradiation. In either case, the mutation rates were estimated as uncoverings of marked loci by examining the egg colour. There was no protective action of MEA and cysteine against the mutagenic and lethal effects of irradiation in these experiments. (auth. summary)

1044 Nakao, Y. DIFFERENCE BETWEEN MALE AND FEMALE TREATMENTS IN VISIBLE X-RAY INDUCED MUTATION RATES IN THE SILKWORM. p. 260-4 in "Proceedings of the International Genetics Symposia, Tokyo & Kyoto, Sep. 1956", Suppl. to Cytologia 1957. Tokyo, Science Council of Japan. 1957, 702 p.

An attempt is made to compare the pattern of x-ray induced mutation rates at two loci (pe and re) along the same chromosome (V). Both control egg and eye colours. The results are tabulated. The total mutation rates increased more rapidly following irradiation of females than of males. The results of some unpublished work by Y. Tazima are quoted who irradiated pupae and larvae. The total mutation rates produced by the same dose of x-rays at both loci were higher after female than after male treatment; the ratio of mutation rates at the pe- and the re-locus proved >1 (2 to 8) after treatment of males, and <1 after treatment of females.

* Nakao 1957 - [1403]

* Nakao 1958 - [1213]

1045 Naville, B. DIE BEEINFLUSSUNG DES BORSTENMUSTERS DER DROSOPHILA MELANOGASTER DURCH RÖNTGENSTRAHLEN (180 keV UND 31 MeV) (Effects of x-rays on the bristles of Drosophila melanogaster (180 keV and 31 MeV). Oncologia 8, 1 (1955) 55-67. (In German)

Dose-effect curves for the two radiations were established for bristle damage induced in the 5 h-old chrysalid stage of Drosophila. Individual bristles showed variable radiosensitivity and a linear damage curve with increasing dose. The changes induced were interpreted as representing phaenocopies of known mutations, caused by chromosome damage.

1046 Nordback, K., Auerbach, C. RECOVERY OF CHROMOSOMES FROM X-RAY DAMAGE. p. 481-4 (disc. p. 484-5) in "Advances in Radiobiology. Proceedings of the 5th International Conference on Radiobiology, Stockholm 15-19 Aug. 1956". de Hevesy, G. C., Forssberg, A. G., Abbatt, J. D., eds. London, Oliver & Boyd. 1957.

Experiments were carried out in order to study the causes of the difference in dominant lethals carried by spermatozoa on the first and second day following irradiation. The problems involved and their possible explanation are discussed in the light of some experimental data obtained by the authors on Drosophila.

* Oftedal and Mossige 1957 - [397]

* Oftedal and Mossige 1957 - [398]

* Oftedal 1958 - [395]

* Oftedal 1959 - [396]

* Oster 1955 - [1217]

* Oster 1956 - [1218]

* Oster 1957 - [1219]

1047 Oster, I. I. THE GENETIC BASIS OF X-RAY INDUCED SOMATIC DAMAGE. p. 268-71 in "Radiation Biology. Proceedings of the 2nd Australasian Conference held at the University Melbourne 15-18 Dec. 1958". Martin, J. H., ed. New York, Academic Press Inc., and London, Butterworths Scientific Publ. 1959.

The exposure of individuals to radiation, besides resulting in damage to various organ systems, was found to lead to an acceleration of the so-called "natural" ageing processes. A breakthrough on this problem occurred when it was found that male larvae of Drosophila melanogaster are more susceptible to killing by x-rays than females. Experiments were conducted using hybrid third instar larvae from crosses of two unrelated stocks. This avoided the use of individuals already homozygous for deleterious genes. The individuals were exposed to 1280 r (135 kV, 20 mA; 1 mm Al filtration; 160 r/min) when their outer surfaces were fairly dry. The males and females resembled each other genotypically and phenotypically but differed in chromosomal morphology. The scheme used to obtain ring- and rod-shaped chromosome-bearing individuals is shown. The majority of the irradiated individuals which reached adulthood showed extreme wing abnormalities, lack of many bristles, and marked weakness which was presumably due to damage to the musculature. Mortality, in those cases in which it occurred during the pre-imaginal stages, occurred most frequently among late pupae and very rarely during the late larval and early pupal instars. These results demonstrate that this x-ray induced life-span shortening has a genetic basis, and they complement data obtained previously concerning the susceptibility to x-ray induced somatic damage of male and female larvae having one and two X chromosomes, respectively. (NSA 14: 24012, 1960)

1048 Ostertag, W., Muller, H. J. GENETIC BASIS OF SOMATIC DAMAGE PRODUCED BY RADIATION. (abstr.) Science 130, 3386 (1959) 1422-3.

The reasons for the mortality caused by irradiating Drosophila larvae are discussed, in the light of Oster's work and the authors' own findings.

1049 Oster, I. I., Zimmering, S., Muller, H. J. EVIDENCE OF THE LOWER MUTAGENICITY OF CHRONIC THAN INTENSE RADIATION IN DROSOPHILA GONIA. (abstr.) Science 130, 3386 (1959) 1423.

Experiments were carried out to test whether the principle of lower mutagenic effectiveness of chronic than of acute γ-radiation reported for mouse oögonia also holds for Drosophila. This was found to be the case. Less conclusive evidence indicates that the same principle holds in Drosophila spermatogonia, both for the production of ordinary lethals and of minute deficiencies. The respective dosages applied were 4000 r from a $Co^{60}$ source, one group of flies getting 11 r/h for 2 weeks, the other the whole dose in 31 s. (from abstr.)

* Paget 1954 - [1446]

1050 Pal, R., Krishnamurthy, B. S. INDUCED MUTATIONS OF X-RAY IRRADIATIONS IN CULEX FATIGANS WIED (1828). Nature 184, Suppl. No. 9 (1959) 658.

Mutations were induced in Culex fatigans by exposure to x-radiation. Four morphological aberrations were observed in the first generation following exposure of normal laboratory-bred pupae. Mosquitoes with only one of the mutations were bred successfully. Details of the $F_2$ generation are tabulated. (NSA 14: 1380, 1960)

* Parker 1959 - [1225]

* Parker and Hammond 1958 - [1224]

* Parker 1960 - [1226]

1051 Paul, W., Schubert, G. ÜBER BIOLOGISCHE WIRKUNGEN SCHNELLER ELEKTRONEN EINES 6-MeV BETATRONS (The biological effects of fast electrons from a 6 MeV betatron). Z. Naturf. 5b, 7 (1950) 390-4. (In German)

For the majority of the biological reactions to radiation previously investigated, including the killing of Drosophila eggs and larvae by radiation, fast electrons are less effective than x-rays (200 kV). In the determination of sex-bound lethal factors induced by radiation in Drosophila no difference was found between the 2 qualities of radiation regardless of whether mature or immature sperm were exposed. The same applies to the behaviour induced by irradiation of single chromosome fragments in Drosophila. The results are discussed with reference to the theory of hits.

1052 Pohley, H.-J. UNTERSUCHUNGEN ÜBER DIFFERENTIELLE ZELLTEILUNGEN UND SOMATISCHE MUTATIONEN AM SCHUPPENKLEID DER MEHLMOTTE EPHESTIA KÜHNIELLA Z. (Investigations of differential cell division and somatic mutations in the scales of the Mediterranean flour moth, Ephestia kühniella Z.) Biol. Zbl. 72, 11/12 (1953) 577-98. (In German)

The complexity of scale formation at the base of the wing is described. Irradiation of larvae in the final stage with x-rays causes the heterogamous females to develop dark scales, singly or in patches, on their hind wings; this rarely occurs in the homogamous males. These may be traced to somatic mutations which give rise to a recessive sex-linked factor. The size and frequency of occurrence of such spots following irradiation of larvae of different ages is described. Mutations and their qualitative and quantitative significance are discussed.

1053 Pohley, H.-J. ÜBER DIE SOMATISCHE MUTABILITÄT BEI EPHESTIA KÜHNIELLA (Somatic mutability in Ephestia kühniella). Biol. Zbl. 74 (1955) 474-80. (In German)

Treatment of 4 d-old larvae of the last stage with 1500 r of hard x-rays produced isolated or clusters of mutant scales on the hind wings. They belong to different types of mutation, with very different frequencies of occurrence, and may be divided into two groups. Their distribution amongst the sexes, location on the wing surface, frequency of occurrence, and the effect of increasing larval age at the time of irradiation are discussed.

1054 Pohley, H.-J., Esser, H. ÜBER DAS VERHALTEN MUTANTER SCHUPPEN AUF DEN HINTERFLÜGELN DER MEHLMOTTE EPHESTIA KÜHNIELLA NACH PUPPENBESTRAHLUNGEN (Study on the reaction of mutant scales on the hind wings of the Mediterranean flour moth, Ephestia kühniella, following irradiation of pupae). Z. indukt. Abstamm.-VererbLehre 89, 5 (1958) 707-14. (In German)

Pupae of various ages were subjected to hard x-rays. The scaled hind wings of the moth were checked for mutant scales. The appearance of concentrations of such mutants, their frequency and reaction under different conditions of irradiation are discussed. The frequency was found to drop with increasing age of the pupae at the time of irradiation.

1055 Ray, D. T. PRODUCTION OF EYE-COLOR MUTATIONS IN MORMONIELLA BY LOW X-RAY DOSES AND A DOSE-ACTION CURVE. Genetics 38 (1953) 684.

Unmated females x-rayed with doses ranging from 1340 to 5360 r have given bright eye-colour mutant sons in percentages ranging from 0.14 to 0.85. Similar mutants are found less frequently at lower doses. Data are thus far consistent with direct proportionality.

(Abstract of paper presented at the 1953 meetings of the Genetics Society of America, Boston, Mass., Dec. 28-30, 1953)

1056 Ray, D. T., Whiting, P. W. AN X-RAY DOSE-ACTION CURVE FOR EYE-COLOR MUTATIONS IN MORMONIELLA. Biol. Bull. 106 (1954) 100-6.

X-ray dose-action curves for visible mutations in Drosophila are discussed and a curve for eye-colour mutations in Mormoniella presented. They were essentially linear, indicating single hits producing the mutations. An insignificant dip at 2680 r was observed in Mormoniella.

1057 Ray, D. T. X-RAY DOSE-ACTION CURVES FOR EYE-COLOR MUTATIONS IN MORMONIELLA (i.e. NASONIA VITRIPENNIS). Pennsylvania, Univ., Philadelphia. Original diss. publ. no. 13427. 1955, 61 p. Diss. Abstr. 15, 10 (1955) 1706.

Mormoniella vitripennis Walker, a chalcidoid wasp parasitic on blowfly pupae is especially suitable for the study of dose-action curves, especially for the low dosages of x-radiation. By irradiating virgin females and examining their offspring (which are all haploid males) it is possible to obtain the large numbers of organisms necessary to reduce the confidence limits of dose-action curves. The numerous x-ray induced eye-colour mutations from wild type present a group of mutants easy to score. The wild-type eye colour of Mormoniella is a dark brown. The eye-colour mutations vary from dark red through oyster white: the intermediate colours within these limits are tomato, red, scarlet and orange (peach). Twenty-six high-dosage experiments and 49 low-dosage experiments were performed with reference to dose action. Additional low and high dosage experiments were performed with reference to the testing of mutants. (from abstr.)

1058 Ray-Chaudhuri, S. P., Sarkar, L. FREQUENCY OF DICENTRIC BRIDGES IN MEIOSIS IN THE GRASSHOPPER GESONIA PUNCTIFRONS, PRODUCED BY DIFFERENT DOSAGES OF X-RAYS. Science 116 (1952) 479-82.

Quantitative data on the frequency of dicentric bridges with fragments in irradiated meiotic chromosomes of grasshoppers were obtained by direct cytological examination. The dicentric bridges were detected at the first anaphase of meiosis by irradiating the testes of the grasshopper Gesonia punctifrons, a species with 23 acroncentric chromosomes in the males. (NSA 7: 1041, 1953)

1059 Ray-Chaudhuri, S. P., Pyne, C. K. TIME-INTENSITY FACTOR IN THE PRODUCTION OF DICENTRIC BRIDGES WITH GAMMA RAYS OF RADIUM DURING MEIOSIS IN THE GRASSHOPPER, GESONULA PUNCTIFRONS. Science 119 (1954) 685-6.

The frequencies of bridges were found to be independent of the intensity of the $\gamma$-radiation within the limits of the experiments described in this study. These results, coupled with the fact that the frequencies of bridges are in direct proportion to x-ray doses confirm the impression that the bridges originated not through 2 independent breaks in a chromosome but largely from a single break in an unsplit chromosome, caused by a single ionization track.

1060 Reeve, E. C. R. THE INDUCTION, BY X-RAYS, OF MUTATIONS AFFECTING QUANTITATIVE CHARACTERS IN DROSOPHILA MELANOGASTER. p. 231 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958.

A method which enables the mutational variance of several characters to be measured at the same time was used. By a suitable crossing scheme with Drosophila melanogaster it is possible to make standard irradiated third chromosomes homozygous in a genetic background identical with the inbred line providing the third chromosomes. A number of such strains have been produced, using an x-ray dosage of 4000 r, and both the homozygous strains and intercrosses between them have been raised under standard conditions. Wing and thorax length and the numbers of sternite and stemopleural hairs were estimated on these strains and crosses, and also on control strains obtained by the same mating scheme without irradiation. Strains in which third chromosomes from a wild stock were made homozygous in the same inbred genetic background were also studied, to give a standard against which the radiation-induced genetic variance could be compared. The environmental variance in body size among individuals of the same genotype was, on the average, greater for the homozygous strains than for their intercrosses. This suggests that the third-chromosome heterozygosity induced by 4000 r of x-rays was sufficient to increase the environmental stability of the intercrosses over that of the homozygotes. (from auth.)

1061 Regehr, H., Arnason, T.J., Johns, H.E. INDUCTION OF MUTATION BY HIGH-ENERGY X-RADIATION PRODUCED BY A 23-MeV BETATRON. Nature 166 (1950) 228-9.

Male Drosophila melanogaster received a single dose of 2000, 5000 or 7000 r of x-radiation at 100 r/min. All the irradiated X-chromosomes which were tested for mutations were obtained from sperm which functioned in fertilization within 20 d of the treatment. The average percentage mutation per 1000 r high-energy x-rays is 1.70%. The corresponding figure for ordinary x-rays as given in the literature is 2.89%. This would indicate that the high-energy radiations are only 0.59 as efficient as ordinary x-rays for the production of lethal mutations. The reason for the difference in effectiveness is discussed. (NSA 4: 5573, 1950)

1062 Rothfels, K.H. SPONTANEOUS AND INDUCED CHROMOSOME ABERRATIONS IN THE GRASSHOPPER CHLOEALTIS CONSPERSA. (abstr.) Genetics 35 (1950) 687.

The incidence of spontaneous chromosome aberrations in first meiotic metaphases of Chloealtis males is estimated to be 0.1 incomplete breaks, 0.01 complete breaks, and 0.01 interchanges per cell. After an x-ray dose of 100 r the following classes of induced chromosome aberrations come successively into maximum: (1) incomplete breaks (24 h), (2) "stickiness" (5 d), (3) complete breaks (10 d), (4) interchanges (15 d), (5) incomplete nuclei (17 d). Over the range 2 to 300 r, 0.05 incomplete breaks are obtained per nucleus per r. If the dose-effect curve remains linear at even lower doses, natural ionizing radiations cannot account for more than 1% of the spontaneous abnormalities of this type. Similar conclusions were obtained with regard to the complete breaks and interchanges. These findings were tested directly by exposing grasshoppers at various distances from a $Co^{60}$ source for 20 d. A dose rate of 500 x background was required to produce a clearly significant increase in chromosome aberrations over control animals.

1063 Russell, W.L. COMPARISON OF X-RAY-INDUCED MUTATION RATES IN DROSOPHILA AND MICE. Amer. Nat. 90 (1956) 69-80.

New data was obtained from irradiation of the same cell stage as that investigated in the mouse, i.e. the spermatogonial stage. Comparing the mouse radiation-induced mutation rate based on genetically tested mutations with comparable data in Drosophila gives an estimate of 15 as the ratio of the mouse rate to the Drosophila rate. The general magnitude of this ratio is also supported by several recent estimates of Drosophila mutation rates for autosomal loci in post-spermatogonial cell stages, provided due regard is paid to the differences between cell stages. Ives' (1954) conclusion that the radiation-induced mutation rate "appears to be similar in flies and mice" is disputed on several grounds. Comparison between species as different as Drosophila and the mouse is difficult. It is not maintained that a final answer has been reached on the relative radiation-induced mutation rates of the two species.

* Russell and Kelly 1958 - [845]

1064 Saul, G.B., II. THE INDUCTION BY X-RAYS OF RECESSIVE LETHALS IN THE MATURE SPERM OF MORMONIELLA VITRIPENNIS (WALKER). Radiation Res. 2 (1955) 447-60.

Mature males of the chalcidoid Hymenopteron Mormoniella vitripennis (Walker) were treated with x-rays at doses between 568 r and 5112 r and were then mated to virgin females differing from them by an allele at a single locus. A statistically significant deviation from a 1:1 ratio of the alleles in the $F_2$ progeny of an unmated $F_1$ female was taken to indicate the presence of a recessive lethal linked to the genetic marker. The numbers of lethals linked to two separate loci were computed for each dose administered. No evidence was obtained against the assumption of a linear dose-action curve for recessive lethals linked to either of the visible markers studied. The combined data for the two loci also showed no significant departure from linearity. Mutation rate/r was calculated as 0.004% for lethals linked to one locus, known as the R locus, and as 0.001% for lethals linked to another locus, known as the black locus. The combined rate for both groups of lethals was 0.005%. The method did not measure the spontaneous rate of mutation or indicate any differences in the numbers of lethals carried in the stocks used in the experiments. The proportion of lethals linked to the R locus is greater than the proportion linked to the bk locus at all doses of x-rays. This may be due to differences in radiosensitivities or crossing-over frequencies of the chromosomes involved, or to the possible location of bk close to the end of a chromosome. Recessive lethals can exert their effects at any stage of development between the egg and the adult. (auth.)

1065 Schacht, L. E. THE TIME OF X-RAY INDUCTION OF CROSSOVERS AND OF TRANSLOCATIONS IN DROSOPHILA MELANOGASTER MALES. Genetics 43 (1958) 665-78.

A comparison was made between the time of recovery of induced crossovers and time of recovery of induced translocations in the chromosomes of irradiated Drosophila. (NSA 13: 8566, 1959)

* Seto 1954 - [1262]

1066 Shaw, E. I. THE EXISTENCE OF TWO TYPES OF X-RAY-INDUCED MITOTIC INHIBITION. (abstr.) Radiation Res. 9 (1958) 181.

The extreme sensitivity of the grasshopper neuroblast to radiation-induced mitotic inhibition makes the determination of the dose-effect relationship very difficult, because 50% inhibition may be produced by as little as 4 r of 120-kV potential x-rays with 3.5 mm of Al filtration. By the use of sodium hydrosulfite ($Na_2S_2O_4$) treatment during irradiation, a fourfold reduction of the sensitivity of the neuroblast was produced by the anoxic conditions. The dose-effect relationship was proved to be logarithmic in the range 8-64 r. There was no threshold and the 37% dose was approximately 20 r. Carlson, Snyder, and Hollaender found that under aerobic conditions the amount of mitotic inhibition was independent of dose rate (2-32 r/min) in the range 8 - 32 r. In the low dose range x-ray-induced mitotic inhibition occurs as a phenomenon of short duration caused by a mechanism involving first-order kinetics. In contrast, a major portion of the mitotic inhibition caused by doses of x-rays greater than 128 r is of long duration, is dose-rate dependent, and has a threshold. It appears, therefore, that x-ray-induced mitotic inhibition in the dose range below 64 r under anoxic conditions and below 32 r under aerobic conditions is caused by a mechanism distinct from the one that produces the major portion of mitotic inhibition at doses of 128 r or greater.

* Shenfield 1957 - [847]

1067 Sheppard, C. W., Slater, M., Darden, E. B., Jr., Kimball, A. W., Appa, G. J., Edington, C. W., Baker, W. K. BIOLOGICAL EFFECTS OF FAST NEUTRONS FROM AN INTERNAL TARGET CYCLOTRON: PHYSICAL METHODS AND DOMINANT LETHALS IN DROSOPHILA. Radiation Res. 6 (1957) 173-87.

Production of dominant lethal mutations in Drosophila by fast neutrons has been reinvestigated with the ORNL 86-in cyclotron. A number of changes, checks and improvements in dosimetry are described. With these improvements, the new RBE's are from 4.5 at low to 2.9 at high doses. Results of experiments at different times by various investigators here are now consistent. The RBE values are still not in accord with the earlier literature, presumably owing to physical dosimetry errors. Even in our own earlier studies, errors occurred, resulting in doses which were too high by 30 to 100%. References to which corrections are to be applied are given. Typical sources of error are lack of saturation of ion chambers, misuse of tissue-equivalent chambers, and spectral dependence of chamber response. (auth. summary)

* Sobels 1955 - [1410]

* Sobels 1956 - [1411, 1412]

* Sobels 1957 - [1413]

* Sobels 1960 - [1417, 1418]

1068 Stone, W. S., Alexander, M. L., Clayton, F. E., Dudgeon, E. PRODUCTION OF TRANSLOCATIONS IN DROSOPHILA VIRILIS BY FAST NEUTRONS FROM A NUCLEAR DETONATION. Amer. Nat. 88 (1954) 287-93.

D. virilis were placed at neutron stations at different distances from the centre of detonation, screened from $\gamma$- and other ionizing radiation, and from excessive heat. The complex translocations obtained are tabulated. Translocation rates were plotted against estimated rep calculated for each test station. The data support the theory that the number of translocations produced is directly proportional to dosage of fast neutrons. Fast neutrons are much more effective than x-rays in producing genetic damage measured as translocations. This difference is more marked at lower doses. A rough equivalence in damage exists for 100 rep and 750 r, 500 rep and 2000 r, and 1300 rep and 4000 r. The direct proportionality between fast neutron dosage and translocation frequency indicates that small doses of neutrons are relatively more dangerous to genetic systems

than small doses of x-rays. The estimates of equivalent damage showing the difference in effectiveness of neutrons and x-rays agree with the report of Baker and von Halle (1954) using dominant lethals in Drosophila.

* Strømnaes 1951 - [898]

* Strømnaes 1959 - [899]

* Strunnikov and Gulamova 1957 - [1557]

* Strunnikov and Gulamova 1959 - [1558]

1069 Sullivan, R. L. MUTATIONS IN THE HOUSEFLY (MUSCA DOMESTICA L.) Genetics 42 (1957) 400.

A search of the offspring of irradiated houseflies has resulted in the discovery of a number of mutations. Most of the mutations affect the wings. Breaks were found in the subcosta, the anterior and posterior cross veins, and the anterior and posterior regions of the fourth longitudinal vein. Additional veins have been found arising from the posterior cross vein and in the posterior regions of the fourth longitudinal vein. Other wing characters are: curly wings, vestigial (unexpanded) wings, and scalloping of the posterior margin and wing tip. Some of these are similar to mutants found by Dr. Milani of Pavia, Italy. One mutation affects the legs, causing a swelling, shortening and twisting of the femora. In all the above cases the penetrance and expressivity of the characters is highly variable. There is considerable serial and bilateral asymmetry in the expression of various characters. The character "shaven" causes a reduction of all bristles on the head, thorax and abdomen, leaving a short stubble. This character is lethal to flies prior to oviposition, lacking visible effect in heterozygous flies. Another character has been found which causes all male progenies. This character does not alter the size of progenies produced, indicating action prior to oviposition. All characters found to date appear to be recessive.

(Abstract of paper presented at the 1957 meetings of the Genetics Society of America, Stanford, California, 26-28 Aug. 1957)

1070 Takasaki, T. STUDIES ON THE SECOND LINKAGE GROUP IN THE SILKWORM, BOMBYX MORI L. II. PALE STRIPED ($p^{st}$) AND SECOND STRIPED ($S^2$) INDUCED BY X-RAYS. Bull. seric. Exp. Sta. Japan 14 (1952) 10-21. (In Japanese, with summary in English)

Two mutants of larval marking pale striped ($p^{st}$) and second striped ($S^2$) were found in the $F_1$ of the crossing of $p^sY$ +/p + Oa female with a p + $^{Y}$Oa male, the female having been treated with x-rays 7 to 8 d after pupation. The mutants and their genetic origin are described in detail. A lengthy English summary presents all significant data. (NSA 7: 1345, 1953)

1071 Tazima, Y. RADIATION MUTAGENESIS IN THE SILKWORM. III. COMPARISON OF X-RAY INDUCED MUTATION RATES IN THE SILKWORM WITH THOSE OF DROSOPHILA AND MOUSE. Mishima, Nat. Inst. Genet. Annu. Rep. 8 (1957, pub. 1958) 74-5.

Since mutant characters have not been expressed with respect to the same stage (e. g., egg or adult) this also affects the evaluation of relative mutation rates.

* Tazima 1958 - [939]

1072 Tazima, Y., Onimaru, K. RADIATION MUTAGENESIS IN THE SILKWORM. I. CHANGES IN SENSITIVITY OF SILKWORM GERM CELLS TO X-RAYS AT DIFFERENT STAGES OF GAMETOGENESIS. Mishima, Nat. Inst. Genet. Annu. Rep. 8 (1957, pub. 1958) 71-3.

In the silkworm the development of the germ cells in the gonads is in direct accordance with the development of the individual (both male and female), thus facilitating interpretation of results. Wild type adults were irradiated with dosages from 250 to 4000 r at various stages of larval and pupal development and mated to non-irradiated partners. At 2000 r, a noticeable decrease in oviposition resulted in early-irradiated females. Males reacted very differently. A markedly sensitive period was discovered at the early 5th stadium (early spermatocyte stage of germ cells) leading to a marked decrease in subsequent oviposition even at 500 r. The frequencies of unfertilized eggs and early lethals are analysed.

1073 Tazima, Y., Onimaru, K. RADIATION MUTAGENESIS IN THE SILKWORM. II. MUTATION RESPONSE PATTERN OF SILKWORM GERM CELLS TO X-RAYS ACCORDING TO STAGE AND SEX. Mishima. Nat. Inst. Genet. Annu. Rep. 8 (1957, pub. 1958) 73-4.

Recessive mutation rates at specific gene loci, and the incidence of dominant lethals were examined. It was concluded that the germ cells of the silkworm are most sensitive to x-rays at some stages of spermiogenesis and as oöcyte, whereas the oögonium, spermatogonium and mature sperm are less sensitive.

1074 Traut, H. ÜBER DIE ABHÄNGIGKEIT DER RATE STRAHLENINDUZIERTER TRANSLOKATIONEN UND REZESSIV GESCHLECHTSGEBUNDENER LETALFAKTOREN VOM STADIUM DER SPERMATOGENESE BEI DROSOPHILA MELANOGASTER (The dependence of the rate of radioinduced translocations and recessive sex-linked lethal factors on the spermatogenesis stage in Drosophila melanogaster). Z. indukt. Abstamm.-VererbLehre 91 (1960) 201-5. (In German, with summary in English)

Utilizing a dual-purpose stock of Drosophila melanogaster the dependence of radiation induced translocations and recessive sex-linked lethals on the stage of spermatogenesis was investigated and is discussed. A formerly existing discrepancy in the dependence of radiation induced translocations on the stage of maturity of the irradiated germ cells is explained by differences in experimental procedure: besides an adequate subdivision of the brood pattern an excess of P-females in the ratio of 3:1 was necessary for obtaining the maximum sensibility expected for immature germ cells. (auth.)

* Traut 1960 - [1422]

1075 Ulrich, H. THE MUTAGENIC ACTION OF X-RAYS ON UNCLEAVED DROSOPHILA EGGS AND ITS DEPENDENCE UPON OXYGEN. (abstr.) p. 298 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958.

Eggs of D. melanogaster were x-rayed totally or partially, the nucleus-containing anterior and the non-nucleated posterior halves being treated separately. Embryonic and post-embryonic mortality was registered, and dose-effect curves constructed. Killing of eggs by x-raying totally or anteriorly appears to be due to the induction of dominant lethals in the irradiated nucleus, whereas x-raying posteriorly kills the egg by damaging the cytoplasm. Irradiation of posterior halves with much higher doses induces recessive lethals, on account of their lower radiosensitivity. The method of irradiation of uncleaved eggs rather than of adult flies seems to offer some advantages in analyzing the mutagenic action of radiation, especially the indirect or delayed effects, dependence on $O_2$ and other chemicals, and other problems.

1076 Ulrich, H. STRAHLENGENETISCHE UNTERSUCHUNGEN AN DROSOPHILA-EIERN (Studies in radiation genetics on Drosophila eggs). Arch. Klaus-Stift. VererbForsch. 33, 3/4 (1958) 90-7. (In German)

The mutation rates obtained after irradiation (~ 1000 r of x-rays) of zygotes (fertilized eggs prior to first cleavage) were consistently much higher than those obtained after irradiation of adult males. A modified Muller 5-method was used. The results are tabulated and their implications discussed.

1077 Ulrich, H. DIE MUTAGENE RÖNTGENSTRAHLENWIRKUNG AUF DAS UNGEFURCHTE DROSOPHILA-EI UND IHRE SAUERSTOFFABHÄNGIGKEIT (The mutagenic effects of x-rays on the uncleaved Drosophila egg, and their oxygen dependence). Rev. suisse Zool. 65 (1958) 442-8. (In German)

When 10-20 min-old Drosophila eggs were irradiated with x-rays, the $LD_{50}$ was 270 r, with an occurrence of 7.27% of sex-linked recessive lethals (tested by irradiating $F_1$-eggs from a cross between wild females mated with Muller 5-males). Irradiation in a nitrogen atmosphere instead of in air reduced these effects, the $LD_{50}$ being 580 r and sex-linked recessive lethals only 4.25%. Nitrogen treatment before or after irradiation had no effect.

1078 Valencia, J. I. CHROMOSOME CHANGES IN DROSOPHILA MELANOGASTER SPERMATOZOA INDUCED BY MUTAGENICALLY COMPARABLE DOSES OF X-RAYS AND ULTRAVIOLET. (abstr.) Genetics 37 (1952) 633.

Mature spermatozoa were given a rather low dose of x-rays (about 650 r) in order to obtain recessive sex-linked lethals at a frequency (1.8%) comparable with that (1.3%) with which they had previously been produced in spermatozoa by ultraviolet. Detailed cytogenetic analysis showed that 75 of these x-ray lethals included 11 to 12 cytologically visible chromosome changes. Allowing for the moderate difference in the mutagenic doses of the two agents, the gross changes appear to be produced more readily by x-rays

than by u. v. The present difference is not yet statistically secure, however. On the other hand, the apparent similarity in frequency of deficiencies at these comparable doses is unexpected. Although the material was carefully scrutinized for very minute deficiencies and inversions, none were found in either series. (from abstr.)

(Abstract of paper presented at the 1952 meetings of the Genetics Society of America, Ithaca, New York, 8-10 Sept. 1952)

1079 Valencia, J. I. A CYTOGENETIC ANALYSIS OF LETHALS INDUCED BY A LOW AND BY A HIGH DOSE OF X-RAYS IN DROSOPHILA MELANOGASTER. p. 895-6 in "Proceedings of the 9th International Congress on Genetics, Bellagio, Italy 1953", Suppl. to Caryologia 6. Montalenti, G., Chiarugi, A., eds. Florence. 1954.

A number of lethals were produced, and examined genetically and cytologically in order to determine accurately the relationship between point mutation lethals and lethals associated with different types of cytologically detectable changes in chromosome structure. A low (700 r) and a high (2800 r) x-ray dose was used in order to determine the dosage relationship of the lethals. The results are tabulated. At the high dose, more of the lethals are associated with structural changes than at the low dose. Thus, structural change lethals apparently increase at a greater rate than do point mutation lethals. Point mutation lethals more nearly agree with a linear relationship, while the lethals associated with chromosome rearrangements vary approximately as the 3/2 power of the dose.

1080 Valencia, R. M., Valencia, J. I., Kirschbaum, W. F. A QUANTITATIVE AND QUALITATIVE ANALYSIS OF MUTATIONS INDUCED BY FAST NEUTRONS. p. 300 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958.

Drosophila melanogaster males of a stock which has no visible genetic markers but inversions in the X-chromosome (H. J. Muller's "Insc" stock) were irradiated with fast neutrons delivered by a cascade accelerator. The 3 doses given were equivalent in effectiveness (in terms of % of recessive lethals in the X) to approximately 750 r, 1500 r and 2500 r of x-rays. The offspring of the different broods was arranged to represent sperm that was irradiated in successively earlier stages of spermatogenesis. All mutations, visibles and lethals, are being analysed cytogenetically. A considerable number of mutations have already been collected. (from abstr.)

1081 VandeHey, R. C., Craig, G. B., Jr. RADIATION-INDUCED MUTATIONS IN AËDES AEGYPTI (L.) Bull. ent. Soc. Amer. 5, 3 (1959) 113, abstr. 31.

Newly emerged males of A. aegypti (L.) were treated with 3000-4000 r from x-rays or γ-radiation. Their progeny were bred to the $F_3$ generation and examined for inheritable morphologic variation. Nine kinds of visible, viable mutations were isolated and are being maintained.

1082 Virk, D. S. GENETICAL STUDIES ON THE EFFECTS OF X-RAYS IN THE SILKWORM, BOMBYX MORI L. I. Jap. J. Genet. 34, 9 (1959) 285-92. (Idengaku Zasshsi)

1083 Virk, D. S. GENETICAL STUDIES ON THE EFFECTS OF X-RAYS IN THE SILKWORM, BOMBYX MORI L. II. RELATIONSHIP BETWEEN GROWTH STAGE AND X-RAY INDUCED CHROMOSOMAL FRAGMENTATION. Jap. J. Genet. 35, 7 (1960) 179-86. (Idengaku Zasshsi) (In English)

1084 Virk, D. S. GENETICAL STUDIES ON THE EFFECT OF X-RAYS IN THE SILKWORM (BOMBYX MORI L.). III. ON THE DIFFERENCE IN THE X-RAY INDUCED DEFICIENCIES AT pe AND re LOCI IN VARIOUS STRAINS. Indian J. Genet. 20, 3 (1960) 178-83.

1085 Wallace, B. ALLELISM OF SECOND CHROMOSOME LETHALS IN DROSOPHILA MELANOGASTER. Proc. nat. Acad. Sci., Washington 36, 11 (1950) 654-7.

Through an analysis of the frequency of allelism of 100-sec chromosome lethals induced in D. melanogaster by chronic γ-ray treatment, it has been estimated that the minimum number of loci capable of mutating to lethality under these conditions is 400 (237-718). (auth.)

(See also AECU-990, Cold Spring Harbor Biological Lab., 5p.)

1086 Wallace, B. MUTATIONS INDUCED BY CHRONIC RADIATION. (abstr.) Genetics 35 (1950) 698.

Males and females of the ore-R strain of Drosophila melanogaster were subjected to chronic irradiation in a number of experiments. In one series, chronic x-irradiation was applied at approximately 108 r per d, over different periods. The sex-linked lethals in males were studied. The proportion of recoverable lethals increases linearly with dose for 20 d; there is no increase after that time. In a second series of tests, males and females carrying lethal-free second chromosomes were exposed continuously to γ-rays for 18 d (approx. 2200 r) at 25° while they developed from eggs to adults. A significant difference between the frequencies of recoverable lethals in the two sexes was found. Some further details and results are given.

(Paper presented at the 1950 meeting of the Genetics Society of America, Columbus, Ohio, 11-14 Sep. 1950)

* Wallace 1950 - [1456]

* Wallace 1951 - [1457]

1087 Ward, C. L., Alexander, M. L. A CYTOLOGICAL ANALYSIS OF X-RAY INDUCED MUTATIONS IN DROSOPHILA MELANOGASTER. Genetics 37, 5 (1952) 634-5.

A cytological study of x-ray-induced mutations has been undertaken to determine the proportion of point mutations to those mutations which are associated with various types of structural changes of the chromosome. The mutations at eight specific loci in the third chromosome, $ruh\,th\,st\,p^{P}\,cu\,sr\,e^{s}$, were obtained by Alexander from irradiated sperm and spermatogonia. A cytological analysis of the offspring of an individual showing two mutations, thread and scarlet, reveals a deletion of approximately 25 bands in regions 72 and 73A of the left arm of the third chromosome. The deletion includes the region which has been assigned to thread by an earlier investigator but not that which has been assigned to scarlet. Analyses of other scarlet mutations show a deletion of the regions 72F and 73A and a translocation with the break in region 73A. These three chromosomal abnormalities indicate that the scarlet gene is located in either 72F or 73A of the third chromosome. (from abstr.)

(Abstract of paper presented at the 1952 meeting of the Genetics Society of America, Ithaca, New York, 8-10 Sep. 1952)

1088 Ward, C. L., Alexander, M. L. CYTOLOGICAL ANALYSIS OF X-RAY-INDUCED MUTATIONS AT EIGHT SPECIFIC LOCI IN THE THIRD CHROMOSOME OF DROSOPHILA MELANOGASTER. Genetics 42, 1 (1957) 42-54.

Among mutations from mature sperm which were studied, 53.6% were associated with no chromosomal aberrations, 23.2% with deficiencies, 8.9% with inversions, and 14.3% with translocations. Of those 33 mutations which were lethal in the homozygous condition, 42.4% had no detectable chromosomal aberrations, 39.4% were deficiencies, 3.0% were inversions, and 15.2% were translocations. All spermatogonial mutations were point mutations but represented all viability categories. The genetic damage to mature sperm is higher than that for spermatogonia when the calculation of the mutation rate for mature sperm is based on total genetic damage. (from auth.)

* Whiting 1950 - [930]

1089 Whiting, P. W. MULTIPLE COMPLEMENTARY ALLELES IN HABROBRACON AND MORMONIELLA. J. Genetics 50 (1951) 206-14.

Numerous x-ray-induced eye-colour mutations from wild type (dark brown) are reported in the chalcidoid wasp Mormoniella vitripennis (Walker). They range from dark red to "oyster" (devoid of pigment and transparent). All of these induced mutations were obtained by irradiation of females. Their hereditary character is discussed.

1090 Whiting, P. W. X-RAY INDUCED EYE COLOR MUTATIONS IN CHALCIDOID WASP. Anat. Record 111 (1951) 476, abstr. 72.

Oyster white eyes and several reds have been obtained in Mormoniella vitripennis (Walker) and their method of heredity has been in part reported. Phenotypically similar eye colours have been induced in a parasite of Drosophila pupae, Pachycrepoideus dubius. Rate of mutation is high in both species.

1091 Whiting, P. W. X-RAY INDUCTION OF EYE-COLOR MUTATIONS IN WASP PARASITES OF BLOW-FLY PUPAE, A GENETICS CLASS LABORATORY EXERCISE. Proc. P. Acad. Sci. 26 (1952) 21-2.

Nasonia vitripennis (Walker), also called Mormoniella, is a chalcidoid-wasp parasite of blowfly pupae. Spontaneous mutation rate is very low but many eye-colour mutations have been induced by x-rays resulting in brilliant scarlet and in other reds, also in pigmentless eyes called oyster, through which the underlying black integument shows. In the experiments described both pupae and adults of unmated females were exposed to 2500 r and the offspring haploid males bred and studied.

* Whiting 1953 - [1424]

1092 Whiting, P. W. COMPARABLE MUTANT EYE COLORS IN MORMONIELLA AND PACHYCREPOIDEUS (HYMENOPTERA: PTEROMALIDAE). Evolution 8, 2 (1954) 135-47.

The similarities and differences between two species of wasps, Mormoniella and Pachycrepoideus were studied. They belong to the same family but to two different sub-families. Both are parasites of Diptera eggs and, under the influence of x-rays, give rise to parthenogenic offspring. A series of mutants responsible for eye colour is found in Mormoniella. Two series of alleles are involved. In the same way x-rays may produce mutations in eye colour. Locus R appears to be homologous for the two species. The two sub-families appear to have had a common ancestor at the beginning. The first parasite preys on a large number of species, the second on a more limited number.

1093 Whiting, A. R., Atwood, K. C. CONDITIONALLY DELAYED DOMINANT LETHAL MUTATIONS IN HABROBRACON. Radiation Res. 3 (1955) 215, abstr. 16.

In the wasp Habrobracon, unfertilized eggs develop normally to become haploid males; fertilized eggs become diploid females. Females which had stored eggs in the first meiotic metaphase were x-irradiated, and one-half of them were subsequently mated. The fertilized eggs had a much higher hatchability frequency than the unfertilized eggs; however, adult survival did not differ markedly between the two groups. It appears that two classes of dominant lethal mutations can be induced: one class, comprising 60% of dominant lethal mutations, kills the eggs in a specific developmental stage whether the embryo is haploid or diploid. The other class comprises conditionally delayed dominant lethal mutations which result in death of diploid embryos at a later stage of development than haploids. Dominant lethal mutations of the former class only are induced when eggs are irradiated in the first meiotic prophase.

1094 Whiting, P. W., Kayhart, M. MUTATIONS AT A SINGLE LOCUS IN THE WASP MORMONIELLA. Amer. Nat. 90 (1956) 111-8.

X-rayed wild-type females were mated to untreated males with peach eyes, a recessive at the R locus. Daughters produced were, therefore, wild-type unless a mutation occurred at this locus. Mutation rate could thus be studied at a single locus and mutant types with recessive lethal effect were recovered as well as viables. It has been shown that, within the limits of the data, this total mutation rate at the single locus R is high, being not significantly less than the rate for viables at all loci including R. Androgenetic offspring, both males and females, were produced following irradiation of eggs. (from auth. summary)

* Whiting et al. 1958 - [1267]

1095 Whittinghill, M. SOME EFFECTS OF GAMMA RAYS ON RECOMBINATION AND ON CROSSING OVER IN DROSOPHILA MELANOGASTER. Genetics 36, 4 (1951) 332-55.

γ-ray treatment of 4000 r given to adult D. melanogaster females altered crossover values in a regular pattern in rucuca heterozygotes. Increases were greatest, relative to controls, in the spindle attachment region in the middle of the 3rd chromosome, progressively lesser in each successive region farther out, and negative in the two most distal regions. Great individual variation in crossover production after irradiation was shown by regular females, by inversion females, and by regular males. The changes might have originated in meiotic or in gonial cells. The results are discussed in some detail. The crossovers induced in 14 of 59 treated males showed an even greater non-random distribution from spermatogonial crossing over. A new crossover-selector system of testing was employed.

(See also earlier abstract in Genetics 35 (1950) 140-1 and ORNL-817, Oak Ridge National Lab., Tenn. 1950, 43 p.)

1096 Whittinghill, M., Giles, A. R. AN INFLUENCE OF X-RAY INDUCED CROSSING OVER ON THE TRANSMISSION OF LETHAL GENES IN DROSOPHILA (MELANOGASTER). Anat. Record 111 (1951) 465-6, abstr. 49.

1097 Whittinghill, M. CROSSOVER VARIABILITY AND INDUCED CROSSING OVER. J. cell. comp. Physiol. 45 (1955) 189-220, Suppl. 2.

X- and γ-rays are able to induce crossing over where it does not occur spontaneously, in Drosophila males, and to increase crossover production by Drosophila females of widely different constitutions. The induction in males and the increases in females show similarities as to time of appearance of crossovers, region of the chromosome usually affected, and lack of randomness. The implications of the results are discussed in some detail.

* Wolff and Lindsley 1960 - [1428]

1098 Yanders, A. F. X-RAY-INDUCED CHROMOSOMAL ABERRATIONS OF DOMINANT LETHALS IN DROSOPHILA ROBUSTA. Genetics 37, 5 (1952) 638.

Newly emerged males and females were separated for 10 d prior to treatment of the males with doses of x-rays of 5000, 7500 and 10 000 r units. The percentage of dominant lethals induced in the sperm of the irradiated males was determined by comparisons with non-irradiated controls of offspring resulting from eggs laid within 10 d after irradiation. Some of the progeny of the groups treated with 5000 r units were dissected as larvae for the detection of induced chromosome aberrations. At this dose, a much smaller percentage of induced chromosome aberrations was recovered than anticipated from published results with other species. Slightly higher values for induced dominant lethals were obtained in all groups, although the trend of reduction of offspring number closely parallels that in other species. Since it has been shown in D. melanogaster that dominant lethals are induced more easily in sperm of aged males and immature germ cells than in sperm which has just matured, with a corresponding decrease in viable aberrations, it seems most probable that both the higher values for dominant lethals and the lower ratio of recoverable chromosome aberrations in D. robusta are due to different responses to irradiation of germ cells of different physiological age.

(Abstract of paper presented at the 1952 meetings of the Genetics Society of America, Ithaca, New York, 8-10 Sep. 1952)

1099 Yanders, A. F. GENETIC EFFECTS OF X-RAYS ON DROSOPHILA ROBUSTA. (abstr.) Neb. Acad. Sci. Proc. 62 (1952) 10.

Newly emerged Drosophila robusta males and females were separated for 10 d, after which the males were treated in groups of 20 to 25 with doses of x-radiation ranging from 5000 to 10 000 r, and placed immediately after irradiation with equal numbers of females. The offspring resulting from eggs laid within 10 d after irradiation were either dissected as larvae for salivary gland chromosome smear preparations or allowed to emerge from the pupae for determination of the frequency of dominant lethals. The proportion of dominant lethals, as determined by counts of emerging flies in the controls as compared to treated groups, is greater at the higher doses than has been reported for any species previously studied. The percentage of aberrations found indicates that a much smaller proportion is recovered in this species than in any previously reported. The present data suggest that aberrations are produced with equal frequency as in other species, but a larger proportion are lethal to the individuals receiving them.

1100 Yanders, A. F. THE EFFECTS OF X-RAYS ON THE CHROMOSOMES OF DROSOPHILA ROBUSTA. Nebraska University Abstr. Doctoral Dissertation (1953) 305-10.

1101 Yanders, A. F. X-RAY-INDUCED DOMINANT LETHALS IN DROSOPHILA. Genetics 39 (1954) 558-64.

Drosophila robusta males, aged 10 d or 17 d, were exposed to 0 (control), 2500 or 5000 r of x-rays and mass mated. Eggs were collected at 24-h-intervals for a period of 10 d, and records of egg fertility, formation of pupae, and emergence of adult progeny were obtained. Values for induced dominant lethals in the groups aged 10 d are similar to the values for D. melanogaster at corresponding dosages. Sperm of males aged 17 d, however, exhibit a greater sensitivity, agreeing with the hypothesis of a greater breakability of chromosomes in sperm of aged males. A gradual decrease in the number of dominant lethals was noted over the 10 day-period following irradiation; it is suggested that restitution of induced breaks is responsible. The fact that this increase in fertility is noted throughout the 10-d period over which eggs

were collected, with no subsequent drop as noted after 7 d with D. melanogaster, may indicate that physiological processes involved in spermiogenesis occur at a slower rate in D. robusta than in D. melanogaster. (auth.)

1102 Yanders, A. F. AN INFLUENCE OF AGE AT TIME OF (X-RAY) TREATMENT ON THE INDUCTION OF MINUTE EFFECTS IN THE SPERM OF DROSOPHILA MELANOGASTER. (abstr.) Genetics 39 (1954) 1002.

Adult males of D. melanogaster (Oregon-R) were exposed to 4500 r of x-rays at 1, 7 or 14 d after eclosion. The occurrence of dominant Minute characteristics believed to be due to small deletions, was observed in the progeny. The frequency was highest in the oldest group, intermediate in the middle group, and lowest in the youngest group. The mean percentage of Minutes on successive days after irradiation showed a characteristic pattern in each age group. Curves of these values exhibit a striking similarity in form to those plotted for induced dominant lethals (from the data of Lüning, Hereditas 38 (1952) 91), suggesting that similar mechanisms are responsible for both dominant lethals and Minutes.

1103 Yanders, A. F. AN INFLUENCE OF AGING MATURE SPERM UPON X-RAYS INDUCTION OF SEX-LINKED RECESSIVE LETHALS. Genetics 41 (1956) 667.

Groups of adult Drosophila melanogaster (Oregon-R) males were aged in the absence of females for various periods after eclosion. Twenty-four hours prior to irradiation, each group was divided into halves, one of which was placed with an excess of females and permitted to mate ("pre-mated"); the other half remained unmated. Just before irradiation the pre-mated males were separated from the females (which were discarded), and all groups were irradiated simultaneously with 4500 r of x-rays and mated immediately to Muller-5 females. Care was taken to test only progeny resulting from sperm used within twenty-four hours after irradiation. Sex-linked recessive lethals occurred in substantially the same proportion regardless of age among all groups of pre-mated aged males and non-aged males (0-1 d old at irradiation). However, the proportion recovered from groups aged 7 d or more and not pre-mated was significantly greater. These data are in agreement with previous studies showing higher incidences of radiation-induced dominant lethals and Minutes occurring in the sperm of aged males. In addition, it is clearly indicated that some sperm storage must occur in Drosophila males, and that the increased susceptibility to irradiation is related to the age of the mature sperm rather than the age of the male at treatment.

(Abstract of paper presented at the 1956 meetings of the Genetics Society of America, Storrs, Connecticut, 27-29 Aug. 1956)

1104 Yanders, A. F. THE EFFECT OF DOSE RATE ON GENETIC DAMAGE FROM FAST ELECTRONS IN DROSOPHILA SPERM. Radiation Res. 10, 1 (1959) 30-6.

Mature sperm of male Drosophila melanogaster were exposed to 3200 rads of fast (1-6 MeV) electrons from a Van de Graaff accelerator, given at rates ranging from 210 rads/min to 6400 rads/min. The amount of genetic damage was assessed by measurements of the frequency of induction of sex-linked recessive lethal mutations and dominant Minute effects. No significant differences attributable to radiation dose rate were found between treated groups. The dose-rate effects reported by other authors using x-rays are not found with fast electrons. Possible reasons for the disagreement are discussed. (auth. summary)

(A 17p-report, USNRDL-TR-217, was published in 1958)

1105 Yoshida, Y. H. ON THE GENETIC EFFECTS OF RADIATIONS UPON THE VARIOUS SYSTEMATIC GROUPS IN DROSOPHILA. I. Jap. J. Genet. 32, 8 (1957) 266. (Idengaku Zasshsi) (In Japanese)

1106 Yoshida, Y. H. ON THE GENETIC EFFECTS OF RADIATIONS UPON THE VARIOUS SYSTEMATIC GROUPS IN DROSOPHILA. II. (abstr.) Jap. J. Genet. 33, 9 (1958) 331. (Idengaku Zasshsi) (In Japanese)

## I-B-3 INDUCED STERILITY

### Books

1107 Demerec, M., ed. BIOLOGY OF THE DROSOPHILA. New York, Wiley. 1950.

Chapter 1 on spermatogenesis, chapter 2 on embryology, and chapter 6 on internal anatomy are especially valuable to workers interested in insect sterilization.

* Dick 1957 - [4]

1108 Patterson, J. T., Stone, W. S. EVOLUTION IN THE GENUS DROSOPHILA. New York, McMillan. 1952.

Of real interest to workers interested in insect sterilization. Of particular value is the discussion of mating habits, and the reactions which take place in females which only mate once.

* Baker et al. 1953 - [1239], [1240]

* Baker et al. 1954 - [1241]

1109 Baumhover, A. H. INFLUENCE OF AERATION ON RADIATION DOSE REQUIRED TO STERILIZE SCREW-WORM PUPAE. Bull. ent. Soc. Amer. 5, 3 (1959) 129, abstr. 171.

Previous work showed need for increasing dose level as pupae develop. Tests reported here show that dose level ($Co^{60}$), as it affects degree of sterilization, is independent of pupal age when aeration is provided. Increase in dose level required without aeration closely parallels increase in respiration rate.

* Bletchly and Fisher 1957 - [1245]

1110 Bushland, R. C., Hopkins, D. E. EXPERIMENTS WITH SCREW-WORM FLIES STERILIZED BY X-RAYS. J. econ. Ent. 44, 5 (1951) 725-31.

Callitroga americana males were sterilized by irradiating young adult flies, but it was most efficient to irradiate pupae within 2 d of emergence with a dosage of 2500 r of direct irradiation plus an additional 50% due to backscatter and secondary irradiation. A dosage of 5000 r direct irradiation was required to sterilize females, and that treatment also rendered the females incapable of producing normal egg masses. When sterilized males were confined with normal males and normal females in laboratory cages, most of the normal females did not become fertilized if the sterilized males outnumbered the normal males by a ratio of 5 or 10 to 1. Adding sterilized females to the caged population along with sterilized males did not affect the end result. Laboratory observations showed that male flies will mate as many as 11 times if virgin females are available. Most females mated only once although mated females remained attractive to males. (auth. RCB)

1111 Bushland, R. C., Hopkins, D. E. STERILIZATION OF SCREW-WORM FLIES WITH X-RAYS AND GAMMA-RAYS. J. econ. Ent. 46, 4 (1953) 648-56.

Experiments were aimed at developing procedures for sterilizing large numbers of screwworm flies, Callitroga hominivorax (Coq.). Irradiation effects of x-rays and $\gamma$-rays were tested, and the effects of different doses of $\gamma$-rays on fly emergence, adult longevity, fecundity and fertility when pupae were treated at different ages. Observations on the hatching of eggs obtained from normal females mated to irradiated males showed that male pupae treated on the 6th and 7th d were not as easily sterilized as were younger pupae. Females showed a similar response in so far as fertility was concerned. It was indicated that no dose of less than 5000 r could be depended upon to produce total sterility, and that it was best to sterilize pupae after they had completed 5 d of development. When normal and sterilized screwworm flies were caged together, the $\gamma$-irradiated males competed for mates about equally with the normal males. (from auth. summary)

* Bushland et al. 1956 - [1472]

* Bushland 1960 - [1474], [1476], [1477]

1112 Carney, G. C. DIFFERENTIAL RESPONSE OF MALE AND FEMALE ADULTS OF TROGODERMA GRANARIUM EVERTS TOWARDS STERILIZING DOSES OF GAMMA RADIATION. Nature 183 (1959) 338-9.

Adults of Trogoderma granarium Everts were irradiated with sterilizing doses of $\gamma$-radiation (administered from a $Co^{60}$ source at 570 r/min) to study the differential response of the male and female. Results show that a dose of $5 \times 10^3$ rads is sufficient to sterilize only the females of the species. The males are able to retain some fertility at dosages up to $15 \times 10^3$ rads which is three times that required to sterilize the females. (NSA 13: 7433, 1959)

1113 Cornwell, P. B., Crook, L. J., Bull, J. O. LETHAL AND STERILIZING EFFECTS OF GAMMA RADIATION ON INSECTS INFESTING COMMODITIES. Nature 179 (1957) 670-2.

The effects of γ-radiation on insects infesting cereal commodities were investigated. Tests were carried out on insects of 17 species, and a $Co^{60}$ source that provided a dose-rate of 6000 r/h was used. The effects of different dosages on adults, larvae and pupae is discussed in terms of mortality, development and fertility. A high level of sterility was obtained at 6000 r.

* Cornwell and Morris 1959 - [889], [890]

* Cornwell and Morris 1960 - [891]

1114 Crook, L. J., Bull, J. O., Cornwell, P. B. SOME BIOLOGICAL AND ECOLOGICAL STUDIES ON THE FLOUR-MILL MOTH, ANAGASTA (EPHESTIA) KÜHNIELLA ZELL., FOR AN APPRAISAL OF STERILE MALE RELEASE. AERE R. 3297, Atomic Energy Research Establishment, Harwell, Berks, England. 1960.

An investigation was made of certain aspects of the biology and ecology of the moth in an infested mill to appraise the suitability of "sterile male release" for the eradication of this species. A. kühniella was concluded to be an unsuitable species for control by this technique.

1115 Davich, T. B., Lindquist, D. A. EFFECT OF GAMMA IRRADIATION ON THE BOLL WEEVIL. Bull. ent. Soc. Amer. 5, 3 (1959) 142, abstr. 280.

Boll weevil (Anthonomus grandis) adults, pupae, and eggs have been exposed to various doses of γ-irradiation. Male boll weevils were sterilized with a dose of about 15 000 r; however, extremely high mortality resulted.

1116 Davis, A. N., Gahan, H. B., Weidhaas, D. E., Smith, C. N. EXPLORATORY STUDIES ON GAMMA RADIATION FOR THE STERILIZATION AND CONTROL OF ANOPHELES QUADRIMACULATUS. J. econ. ent. 52, 5 (1959) 868-70.

In the laboratory studies on the effect of gamma radiation on Anopheles quadrimaculatus Say, it was found that dosages of 8865 to 12 900 r applied in the pupal or adult stage were required to cause complete sterility. Irradiated females mated to unirradiated males produced no eggs, whereas unirradiated females mated to irradiated males produced a normal number of eggs but none hatched. When irradiated males were introduced into caged populations of normal males and females at ratios of 4:1:1 or less, usually no reduction in the total number of viable eggs was produced, but at ratios of 6:1:1 and 10:1:1 there was a reduction of about 80%. The dosages (r) required to cause 50% and 100% mortality in 48 h were: for eggs, 2600 and >11 000; for larvae, 32 000 and 120 000; for pupae, 22 000 and 40 000. (auth.)

(An abstract was published in Bull. ent. Soc. Amer. 4, 3 (1958) 102, abstr. 277 under "Reduction in the reproductive rate of Anopheles quadrimaculatus caused by the presence of irradiated males in a normal population")

* Dent and Amy 1950 - [1276]

1117 Grosch, D. S., Sullivan, R. L. THE QUANTITATIVE ASPECTS OF PERMANENT AND TEMPORARY STERILITY INDUCED IN FEMALE HABROBRACON BY X-RAYS AND β-RADIATION. Radiation Res. 1 (1954) 294-320.

Permanent sterility could be induced in females by feeding above 200 μc $P^{32}$/g of honey mixture. At values below 200 and down to 175 μc $P^{32}$/g temporary sterility was induced, starting about the 10th d. Relatively intense x-rays of 2650 r/min induce permanent sterility above about 4800 r. Below such dosages, down to 3300 r, temporary sterility may be expected. The number of eggs deposited is negatively correlated with the dosage. The onset of sterility (4th-7th d) occurs earlier than after $P^{32}$. Onset, and number of eggs laid are influenced by starvation. Fractionation and intensity experiments demonstrate that the manner in which ionizations from radiation are distributed in time is important when sterility is considered. Data on egg production and hatchability following exposure to various doses of x- and β-radiation are presented and factors influencing the induction of sterility are discussed.

* Grosch and LaChance 1956 - [401]

* Grosch et al. 1956 - [383]

* Grosch et al. 1957 - [830]

* Grosch 1958 - [1137]

1118 Jaynes, H. A., Godwin, P. A. STERILIZATION OF THE WHITE-PINE WEEVIL WITH GAMMA RADIATION. J. econ. Ent. 50, 4 (1957) 393-5.

In dispersion studies of the white-pine weevil it was contemplated that large numbers of weevils, tagged with an isotope, would be released in the field. Since external tagging with $P^{32}$ does not sterilize the weevils, a simple method of mass sterilization was sought. Adult weevils were exposed to 5000, 10 000, and 20 000 r from a $Co^{60}$ source. Both sexes were sterilized at all radiation levels. Non-irradiated females mated with irradiated males produced infertile eggs. These females produced fertile eggs when normal males were introduced in the culture. It is concluded that if pairing is repeated as frequently under natural conditions as in the laboratory, the release of sterilized males to reduce the population would not be effective. For sterilizing weevils for use in dispersal studies, a dosage of 5000-10 000 r appeared the best, though the diminished feeding and oviposition rates suggested that other activities, such as frequency of flight, might also be affected.

(An abstract of earlier work appeared in Bull. ent. Soc. Amer. 2, 3 (1956) 17, abstr. 26)

* Jefferies and Cornwell 1958 - [1144]

1119 Kaplan, W. D., Tanaka, T., Tanaka, K. THE STERILITY COMPONENT OF X-RAY INDUCED DOMINANT LETHALS IN D. MELANOGASTER. Genetics 41 (1956) 649.

The determination of dominant lethals in D. melanogaster is based upon egg hatchability measurements. Brooding techniques, the mating of treated males to a succession of virgin females, permit the determination of mutation rates in sperm that were successively younger at the time of irradiation. However, there is no direct way in D. melanogaster to distinguish between eggs that have failed to hatch because they remained unfertilized and eggs that have failed to hatch because development of the embryo has broken down as a result of an induced genetic event. For this reason a cytological study paralleling the genetic determination of dominant lethality was carried out for three broods of eggs following the irradiation of a group of adult males with a 2000 r dose of x-rays. The data thus obtained provide evidence for the fact that in both the control and irradiated series unfertilized eggs contribute significantly to the dominant lethality rate as determined by hatchability tests.

(Abstract of paper presented at the 1956 meetings of the Genetics Society of America, Storrs, Connecticut, 27-29 Aug. 1956)

1120 Kaplan, W. D. THE STERILITY COMPONENT OF X-RAY INDUCED DOMINANT LETHALS IN DROSOPHILA MELANOGASTER. p. 142 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958.

A sample of eggs from each dominant lethal determination was fixed and sectioned and studied for evidence of sperm entrance. It was found that unfertilized eggs contribute significantly to the dominant lethality rate based upon hatchability tests. The present report presents data on sterility obtained when the x-ray dosage and the mating intensity (number of females per male) are varied. Three x-ray dosage levels, 500, 1500 and 2500 r units, were used. At each dosage level three broods each of one female per male, two females per male, and three females per male were carried out. Each male was permitted to mate over a period of nine days, three days per brood. The data show that sterility (failure of sperm to enter an individual egg) increases with dosage and is highest in the third brood; but brooding itself is no cause of sterility. The high sterility observed in the treated third brood fertilizations (sperm that were spermatocytes or younger at time of irradiation) seems to be a combination of factors produced by the radiation and the utilization of sperm.

See preliminary study by Kaplan, Tanaka and Tanaka (Genetics 41 (1956) 649)

1121 Kaufman, G., Wasserman, M. EFFECTS OF IRRADIATION ON THE SCREW-WORM, CALLITROGA HOMINIVORAX (COQ.). p. 246-59 in "Studies in the Genetics of Drosophila", Vol. 9, Wheeler, M. R., ed. Austin, University of Texas, 1957, 316 p.

The dosage was 7500 r x-rays. Insemination studies showed that in the first week after emergence from the pupae cases the irradiated males could inseminate as many females as could the normal males when both types were isolated with a maximum number of normal virgin females. No larvae developed from matings

between irradiated males and normal females, even after 3 weeks of matings. This dosage produced complete sterility, with no recovery of fertility in the male. The dominant lethal effect in the sperm was probably due to induced chromosome breakage. The irradiation caused permanent genetic damage to both spermatogonial cells and spermatocytes, as well as to spermatid and sperm, as evidenced by the presence of stickiness and bridge formation in all of the dividing cells seen, the great number of degenerating nuclei observed, and the fact that there was no apparent increase in the amount of sperm in the testes after irradiation. The bridges seen in the dividing cells could have been due to recombinations, or chromosome stickiness, or both.

* King 1953 - [389]

* King (undated) - [1145]

* Knipling 1960 - [222]

* LaChance 1955 - [1149]

* LaChance 1959 - [1396]

* MacLeod 1955 - [1500]

* Melville 1958 - [1150]

1122 Mortreuil, M. ACTION STÉRILISANTE DES RAYONS X SUR LE CHARANÇON DU BLÉ. C. R. Soc. Biol., Paris 153 (1959) 1165-6.

Les charançons, Calandra granaria L., âgés de 15 à 30 jours après émergence, sont irradiés à 500 r/min. L'auteur étudie l'influence de doses croissantes (0 - 16 000 r) de rayons x sur la reproduction; l'effet stérilisant n'apparait qu'à partir de 2000 r, la dose minimum désinsectisante se situe vers 16 000 r.

* Nicholas & Wiant 1959 - [1515]

* Potts 1958 - [1494]

* Rohde 1959 - [895]

1123 Румянцев, П.Д., Ратанова, В.Ф. ВЛИЯНИЕ ИОНИЗИРУЮЩИХ ИЗЛУЧЕНИЙ НА ХЛЕБНЫХ КЛЕЩЕЙ. Труды всес. н.-и. ин-та зерна и продуктов его переработки, Москва 35 (1958) 55-7.

**Действие рентгеновых лучей в дозах 5 - 300 тыс. р испытывали в 10 сериях опытов на удлиненном клеще. От облучения в дозе 5 тыс. р погибло 84% яиц, большей частью более молодых (1 - 3-дневных). Половая стерилизация личинок, нимф и взрослых клещей достигалась облучением в дозе 60 - 80 тыс. р. Дозы 300 тыс. р вызывали гибель всех стадий клеща в течение 2 недель. Удлиненный клещ в 20 - 30 раз устойчивее других вредителей хлебных запасов к действию ионизирующих излучений. Дозы облучения < 100 тыс. р снижают посевные качества зерна и применимы лишь для обеззараживания продовольственных хлебных запасов.**

Rumyantsev, P. D., Ratanova, V. F. EFFECT OF IONIZING RADIATION ON GRAIN MITES. Trudy vses. n.-i. in-ta zerna i produktov ego pererabotki (Trans. All-Un. sci Res. Inst. Grains and Products of Processed Grain) 35 (1958) 55-7.

The action of x-rays (for doses from 5000 - 300 000 r) on the elongated mite Tyrophagus noxius was studied in 10 series of tests. An exposure to a dose of 5000 r destroyed 84% of the mostly younger (1 - 3 d old) eggs; 60 000 - 80 000 r resulted in sexual sterilization of larvae, nymphs and adults; at the end of 2 weeks, exposure to 300 000 r had produced lethal effects on all metamorphosing stages. The elongated mite is 20 to 30 times more resistant to ionizing radiations than other cereal pests. Doses above 100 000 r have an adverse effect on the sowing quality of seeds and can only be used for the decontamination of cereals stored as food supplies. (from Referativny Zhurnal Biologia 1 (1959) 7081)

* Simpson 1958 - [1496]

1124 Vasilyan, V. V. THE EFFECT OF RADIATION ON THE DEVELOPMENT OF PECTINOPHORA MALVELLA. Rev. ent. URSS 39, 3 (1960) 599-604. (In Russian)

The cotton-infesting Pexicopia (Pectinophora) malvella (Hb.) necessitates internal quarantine measures, and measures are also taken to prevent the introduction of Pectinophora gossypiella (Saund.). Since existing methods of disinfestation are not entirely satisfactory and the two moths have similar habits, x-ray treatment was tested against the former, with a view to the control of either species. Larvae of the overwintering and summer generations of Pexicopia were subjected to various doses of x-rays in petri dishes at 18-20°C. After 1000 r (with filter), the overwintering larvae, treated in their cocoons, showed 65. 5% mortality, the adults emerging reproducing normally; 5000 r gave a 91. 3% kill with, and 84. 5% kill without filter. Emerging adults were abnormal. Mortality after 10 000 r and 15 000 r was complete (or nearly), with or without filter. Mortality of untreated insects was 23 - 33%. Some of the individuals of the summer generation were irradiated in the last larval instar, and the remainder 2 - 3 d after pupation, 1000 r and higher doses being used. The results are discussed. When a few adults of the summer generation were treated, 1000 r did not affect fecundity, 5000 r led to complete sterility (with filter). Without filter, ovipositing was reduced to 30. 8% and the number of eggs laid to 74%; 15 000 r were required for complete sterilization. Radiation did not affect longevity of adults. (from Rev. Appl. ent. A50 (1962) 113)

## I - C Effects on Development

### I-C-1 SURVEY ARTICLES

1125 Boell, E. J. THE EFFECTS OF RADIATIONS ON RESPIRATORY METABOLISM. J. cell. comp. Physiol. 39, suppl. 2 (1952) 19-42.

Review article. Interest lies in determining whether x-rays influence the respiratory process and, if so, whether the effects observed can be attributed to direct injury of the respiratory mechanism of the embryo or to secondary effects from interference with development. The effect of x-rays on respiration of grasshopper eggs and embryos during diapause are tabulated, also the respiration of developing eggs exposed to different environmental temperatures after irradiation. Table 3 gives data on respiration of developing embryos after x-irradiation in vitro with 2040 r. Graphs illustrate earlier work (Fig. 2: respiration of control and x-rayed diapause embryos in the presence of $2 \times 10^{-4}$M and $5 \times 10^{-4}$M 3, 5-dinitro-o-cresol 5 and 12 d after irradiation). The effect of irradiation on hatching of eggs is tabulated. Except for the period immediately after irradiation, respiration in the embryo, especially during diapause, appears to be remarkably resistant to x-rays. For the dosages used they usually develop normally to hatching. The lethal effects are expressed in the inability of the embryo to hatch. (Data on x-ray effects are also compared for studies on sea urchin gametes, frogs, and a variety of other biological specimens)

1126 Fisher, R. C. CURRENT PROBLEMS IN WOODWORM CONTROL. A SURVEY OF RECENT DEVELOPMENTS. Ann. appl. Biol. 46, 1 (1958) 111-7.

This paper was presented at a symposium of the Assoc. of Applied Biologists. The main insects considered were Lyctus powder-post beetles (L. brunneus Steph.), the house longhorn beetle (Hylotrupes bajulus L.), the Death-watch beetle (Xestobium rufovillosum Deg.), and the common furniture beetle (Anobium punctatum Deg.). The effectiveness of preventive treatments, problems of eradication, fumigation and sterilization of timber by heat were discussed, and also radiation treatments, the last in a still experimental stage. Insects in different stages of development, and infested samples of wood were exposed to γ-rays from a $Co^{60}$-source at Harwell, and the material subsequently examined and used for breeding experiments. The general results are discussed. While information on the effect of irradiation on larvae is incomplete, experiments with Lyctus indicate that resistance increases with age, and that completion of development can be prevented. Much more data is required before such a method can become applicable commercially.

1127 Fritz-Niggli, H. STRAHLENBIOLOGIE, GRUNDLAGEN UND ERGEBNISSE (Radiobiology, Basis and Conclusions). Stuttgart, Georg Thieme Verlag, 1959, 390 p. (In German)

Textbook. Section 3 of part VI deals with radiation effects on insect embryos, taking Drosophila as example (p. 206-18). Subsections are devoted to radiosensitivity, analysis of lethal effects, the variation of different

degrees of damage with age at the time of radiation, and with dose levels, partial irradiation, the dose-effect relation, the RBE of different kinds of radiation, pupae reactions to irradiation including radiosensitivity and its variation with stage in development, and radiation-induced phaenocopies. Over 1000 references.

1128 Kraybill, H. F. THE EFFECT OF IONIZING RADIATION ON INSECTS. Intern. J. appl. Radiation and Isotopes 6 (1959) 187.

The use of ionizing radiation usually required 25 000 - 50 000 rads to destroy insect eggs; 300 000 - 600 000 rads will be lethal to all insects. A dose of 25 000 rads prevents development of insects from one metamorphic stage to the next, and also prevents reproduction in the female. The dose selected applies equally to all insect species. The determining factor in application of radiation is the effect on the quality of the product. The effects on wheat, flour, oats and spices are described. The species studied were the confused flour beetle (Tribolium confusum), the yellow mealworm (Tenebrio molitor (L.)), the saw-toothed grain beetle (Oryzaephilus surinamensis (L.)), the lesser grain borer (Rhizopertha dominica (F.)), and the cigarette beetle (Lasioderma serricorne (F.)).

* Peredelsky et al. (1957) 1959 - [1518]

1129 Stephens, S., Boche, R. D. ANNOTATED BIBLIOGRAPHY IN RADIOBIOLOGY. ANL-5111, Argonne National Lab., Lemont, Ill. 1953, 367 p.

This bibliography contains 2153 abstracts covering all phases of the biological effects of radiation. Abstracts are arranged in sections covering general information, effects of external radiation, effects of internal radiation and metabolism and toxicology of internally deposited radioelements, radiation sickness, mechanisms of radiation effects and effects of radiation on growth and development, genetics, and cytology. Numerous early references, relevant to the present bibliography, are included.

1130 Wood, T. H. CELLULAR RADIOBIOLOGY. Ann. Rev. Nuclear Sci. 8 (1958) 343-86.

Review article on radiobiology. Some reference is made to work on insects (Drosophila, Habrobracon). The article is useful as a review of the field rather than in terms of having any exclusive bearing on entomology. It deals with models for primary radiation damage (direct and indirect action-, and modifiable direct action models), some factors which influence radiation response (radiation parameters, environmental factors, post-irradiation, physical and biological factors), some effects of radiation (cytological effects, nucleic acid synthesis and growth, mutagenic, biochemical and miscellaneous effects), and with some aspects of cellular radiobiology, such as mathematical radiobiology, target theory, etc.

1131 Yeomans, A. H. RADIANT ENERGY AND INSECTS. p. 411-21 in "Yearbook of Agriculture 1952". Washington, D. C., US Government Printing Office.

Very general review article. Applications of ionizing radiations are included.

## I-C-2 FECUNDITY

1132 Annan, M. E. EFFECTS OF X-RAYS ON THE FECUNDITY OF INDIVIDUAL DROSOPHILA FEMALES. (abstr.) Neb. Acad. Sci. Proc. 62 (1952) 10.

Since it was thought desirable to use flies having at least one marked chromosome, multiple mutant X-chromosome D. melanogaster stocks were used. Preliminary work indicated that relatively low dosages would not yield appreciable results and that the observations should be limited to the number of eggs laid. The results suggest that the 2000 r treatment, as compared with untreated controls, did not produce a striking effect. The 5000 r treatment, however, seemed to reduce the fecundity of the females appreciably. (from abstr.)

1133 Annan, M. E. THE EFFECTS OF X-RAYS ON THE FECUNDITY AND FERTILITY OF DROSOPHILA ROBUSTA FEMALES. Diss. Abstr. 14, 8 (1954) 1130.

Experiments were designed to measure certain effects of x-rays on D. robusta females. The variables were treatment, age (at the time of treatment) and days (following treatment). The effects were observed on fecundity (number of eggs laid) and fertility (proportion of eggs cultured to complete a particular stage of

development). 0 (controls), 2500 and 5000 r of x-rays were used. Treating females with 5000 r considerably reduced fertility, even sterilizing many of them. The reduction of fertility (as measured by egg-hatch) was nearly proportional to the dosage. The 2500 r series had a reduction of fertility nearly half as great as that of the 5000 r series. This was true, however, for the first 10-d period of observation only. From then on, variable recovery was exhibited.

1134 Annan, M. E. EFFECTS OF X-RAYS ON DROSOPHILA ROBUSTA FEMALES. (abstr.) Genetics 39 (1954) 957.

Groups of ten virgin D. robusta females, 10 or 17 d old, were either exposed to x-rays (2500 or 5000 r units) or served as untreated controls. Immediately after treatment each female was placed in a vial with two males. For 10 d after treatment, observations were made on fecundity and fertility. The number of eggs laid was reduced by x-rays. Even though total egg production was reduced by 2500 r, the reduction was less than 1/2 as great as in the 5000 r treated series. Dissection of the females on the 21st d showed the ovaries of those females which had been exposed to 5000 r x-rays to be considerably atrophied. There were no detectable differences between the ovaries from females of different age groups treated alike or between the 2500 r and control groups. The reduction of egg-hatch by x-rays was nearly proportional to the dose for the first 10 d following treatment. From then on, variable recovery was exhibited. A generally higher rate of x-ray induced dominant lethality was noted than that reported by Yanders (1954) in his study of D. robusta males. Whereas Yanders found a greater induction of dominant lethality in older flies compared to younger ones, there was no such effect of age when females served as the x-rayed parents.

1135 Bertzbach, R. EXPERIMENTALE UNTERSUCHUNGEN ÜBER DEN EINFLUSS VON RÖNTGENSTRAHLEN AUF DIE EMBRYONALENTWICKLUNG DER HONIGBIENE (Study on the effect of x-rays on the embryonic development in the honey bee). Roux Arch. EntwMech. Organ. 152, 4 (1960) 524-51. (In German)

1136 Colombo, G. X-RAY INDUCED IMPAIRMENT OF FECUNDITY AND FERTILITY OF BOMBYX MORI FEMALES. p. 57 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958.

Females of the silkworm Bombyx mori L. lay all their eggs at one time, and the steps of egg maturation are rather strictly related to the developmental stages. Females, as well as males, were irradiated by x-rays (Therapeutic Philips Apparatus, 50 kV, 2 mA, 950 r/min) at 3rd and 5th larval stage and early and late pupae with 1000 r, 2000 r, 4000 r and some with 8000 r, by varying the length of exposure. The irradiated females were crossed with untreated males of the same egg-brood, the males with untreated females of another egg-brood of the same race. The number of laid eggs (fecundity) and that of hatched larvae (fertility) were recorded. Above 2000 r fecundity decrease is higher among the females treated at the fifth larval stage and early pupae than among the irradiated late pupae. These effects show that the sensitivity of the oöcytes is higher during the 2nd period of growth than during vitellogenesis. Fertility, which can be considered a test for induced dominant lethals, is more affected in later stages of oögenesis than in earlier ones, which means that metaphase chromosomes are more sensitive than prophasic ones. These results are in agreement with those obtained in Drosophila. A stage of oöcyte growth particularly sensitive to x-rays is the second period of growth when nurse cells produce large amounts of RNA which is used for the synthesis of structurally homogeneous cytoplasm in the oöcytes. X-ray treatment probably interferes with RNA production and/or RNA utilization. (from abstr.)

1137 Grosch, D. S. THE QUANTITATIVE ALTERATIONS IN HABROBRACON FECUNDITY INDUCED BY $Co^{60}$ EXPOSURES. Radiation Res. 9 (1958) 123-4.

For $\gamma$-ray exposure, wasps held in gelatin capsules were lowered into a repeatable position within a concentric arrangement of radiocobalt needles. One facility delivered 3000 r/h. the other delivered 140 r/h. Graded doses from the former demonstrated that 11 000 r was required to halt egg production. This is twice the dose required from a 250 kV generator adjusted to deliver x-rays at the same rate. With the less intense $\gamma$-source, 13 700 r had to be delivered to obtain the result desired. This latter source has been followed for four years. Increasingly longer exposures have been necessary to halt egg production with the $\gamma$-source weakening through decay, provided the temperature during exposure was above 20°C. On the other hand, if exposures were made at 5°C the sterilizing dose was, and has remained, about 11 000 r. This is a temperature low enough to slow down enzyme controlled life processes to a degree that renders them ineffective. Thus recovery processes involving biosynthesis can not take place. Evidence from other types of experiments implicate a chromosomal rejoining mechanism. The restoration mechanism also enters the picture when other radiations are used in combination with $\gamma$-rays, as was demonstrated by additivity experiments

involving β-rays from ingested $P^{32}$. Combinations of 25/75, 50/50, and 75/25, set up from the definitive dose approach, did not prove additive in halting Habrobracon egg production.

1138 Grosch, D. S. WASP EGG PRODUCTION AND HATCHABILITY AFTER THE MOTHERS HAVE BEEN EXPOSED TO MIXTURES OF RADIATIONS. Atompraxis 5 (1959) 290-2.

Definitive doses of a combination of x- and β-rays and of γ- and β-rays are not additive in the induction of permanent cessation of insect egg production. Also, hatchability, used in further assessment of radiation damage, reflects predominance of one component. Recommendations for radiation pest or parasite control should be based upon the component determined predominant by biological experiments, rather than on total dose. The study was carried out on Habrobracon. (auth.)

1139 Grosch, D. S. PROTECTIVE EFFECTS ON FECUNDITY AND FERTILITY FROM FEEDING CYSTEINE AND GLUTATHIONE TO HABROBRACON FEMALES BEFORE X-IRRADIATION. Radiation Res. 12 (1960) 146-54.

Protective effects on oviposition and egg hatchability were shown for both cysteine and glutathione when fed to female wasps before irradiation. The effect, detected only during a period of 3 to 12 d after treatment, was therefore limited to cells in transition from oögonia to differentiated trophocyte-oöcyte units. Transition involves completion of a series of mitotic divisions. Although a direct effect on cell division may be reflected in the number of eggs produced per unit of time, a response deferred until the crises of embryonic development implies alteration in the genetic rather than the kinetic mechanism. Indeed, both the effects on oviposition and egg hatchability could trace back to modifications of chromosomal damage, immediate and delayed. (auth. summary)

1140 Herskowitz, I. H. INDUCED CHANGES IN FEMALE GERM CELLS OF DROSOPHILA. III. THE EFFECT OF MATERNAL DEHYDRATION ON OVIPOSITION RATE AND MORTALITY OF X-RAYED OÖCYTES. Genetics 42 (1957) 289-98.

The mortality in oöcytes caused by x-rays is considerably greater in dehydrated females than in normally hydrated ones. The rate of oviposition is highest amongst untreated females, reduced amongst those receiving a fractionated dose of x-rays, and still further reduced when irradiation takes the form of a single dose.

1141 Howden, H. F. INVESTIGATIONS ON STERILITY AND DEFORMITIES OF ONTHOPHAGUS (COLEOPTERA, SCARABAEIDAE) INDUCED BY GAMMA RADIATION. Ann. ent. Soc. Amer. 50, 1 (1957) 1-9.

The biology of O. texanus is given, and the effects of γ-radiation on both the adults and larvae are discussed. There was no reproduction when 2nd instars were irradiated with doses of 2000 r or greater. A dose of 4000 r to 2nd instars either killed the larvae, or delayed development with the resulting adults being badly deformed. Irradiation of adults with 3000 - 5000 r halted reproduction, but did not affect the length of the expectancy. (auth.)

1142 Ives, P. T. THE EFFECTS OF γ-RAYS ON FECUNDITY AND MUTAGENESIS IN OREGON-R MALES OF DROSOPHILA. Intern. J. Radiation Biol. 2, 1 (1960) 54-67.

Oregon-R males were tested in day-by-day sperm samples for dominant visible and hemizygous sex-linked mutations, fecundity (number of offspring produced), and crossing-over after exposure to cobalt-60 γ in the 100 r to 10 kr range. Tests totalled 42 184 X-chromosomes and 210 111 flies. Mutations were most frequent after irradiation during meiosis and spermiogenesis in low doses. Only sperm and gonial cells subsequently produced adult flies after exposure to 5 kr and 10 kr. After 500 r fecundity was reduced chiefly in cells in late mitosis, and in earlier and later stages with increasing doses. Reduced fecundity may not be due to the kind of mutation detected here, but both effects may combine to influence the frequency of mutations recovered, particularly from irradiated meiotic and spermiogenic cells. Males receiving 500 r might contribute more mutations to a population's gene pool than competing males after a substantially higher dose. (auth.)

1143 Ives, P. T., Richman, M. W. THE EFFECT OF $Co^{60}$ γ-RADIATION ON THE FECUNDITY OF DROSOPHILA MALES. Radiation Res. 9 (1958) 133.

The results suggest (1) that the extent of the fecundity effect of radiation depends upon the genetic constitution of the male, (2) that the fecundity effect may be chiefly nongenetic and (3) that it occurs, after low

radiation doses, at a stage in spermatogenesis earlier than the time of highest recovered mutational effects, possibly near or during the primary spermatocyte stage. (from abstr.)

1144 Jefferies, D. J., Cornwell, P. B. LETHAL AND STERILIZING EFFECTS OF SINGLE AND FRACTIONATED DOSES OF GAMMA RADIATION ON CALANDRA GRANARIA L. Nature 182 (1958) 402-3.

Preliminary work is reported on recovery to lethal and sterilizing effects of radiation examined on developmental stages, using 5 fractions of γ-radiation from $Co^{60}$. Single doses of 4012 rep were given, when larvae grew into very few adults, or 5 fractions of 802 rep each at 1 min to 10 min intervals. Intervals of up to 5 d were tested. The existence of a recovery process, and effects on the production of progeny are discussed. The efficiency of direct irradiation of infested products could be seriously jeopardized by the use of repeated doses if intervals between them exceed a few minutes. The increase of longevity, on the other hand, obtained by the use of fractionated doses at daily intervals, could considerably increase the efficiency of insect control by the release of sterile adults, provided permanent sterilization was achieved.

1145 King, R. C. STERILITY AND RECESSIVE LETHAL MUTATION FOLLOWING X-IRRADIATION OF FEMALE DROSOPHILA MELANOGASTER. BNL-1198, Brookhaven National Lab., Upton, N. Y. 14 p.

Sex-linked recessive lethals were recovered from successive batches of eggs laid by female D. melanogaster irradiated with 4000 r of x-rays. While the initial frequency of lethals is identical to that of males treated in a similar manner, there is an immediate linear decline in lethal frequency which reaches a value only 60% of the initial frequency in eggs laid 7 to 12 d after irradiation. The decline in frequency is taken to represent the elimination in immature germ cells of induced lethal effects belonging to the class of chromosome aberrations. The fecundity and/or fertility of irradiated females is greatly reduced for the first four days after treatment. A rise in female productivity occurs between days 4 and 5. After a week has passed the productivity of treated females is almost normal, although the eggs produced by the females contain 60% of the sex-linked lethal frequency of eggs produced immediately after irradiation. This rise in productivity of females from 4 to 5 d after treatment is explained by assuming that the eggs laid at this time were 16-cell cysts at the time of irradiation and were resistant to irradiation in much the same fashion as is polyploid tissue. (auth.)

1146 Kishin, A. F. E. THE RESPONSE OF THE IMMATURE TESTIS OF DROSOPHILA TO THE MUTAGENIC ACTION OF X-RAYS. Z. indukt. Abstamm. -VererbLehre 87 (1955) 97-112.

D. melanogaster males were irradiated at various stages of pre-imaginal development, and mutation rates were compared between first broods of different age groups, and between successive broods in the same age group. The findings were correlated with observations on germ cell development in the larval and pupal testis. Sensitivity to the mutagenic effect of x-rays is low in all premeiotic stages. It increases suddenly and dramatically with the onset of meiosis, remains stationary through meiosis, and subsequently increases again up to a peak in the late spermatid stage when transformation into morphologically mature spermatozoa is taking place. This stage provides sperm for the first brood from males treated at about the middle of the pupal period, and mutation rate for a given dose of x-rays is here about 4 times as high as in mature sperm and about 1½ times as high as during meiosis. Subsequently, mutation rate drops again gradually to the level characteristic for mature sperm. Germinal selection cannot account for any of these changes; but it may be the main cause for the slight increase in response which occurs during spermatogonial development. (auth. summary)

1147 Kogure, M., Nakajima, M. DIFFERENT RADIATION SENSIBILITY OF SILKWORM TESTIS TO THE FALL OF EGG HATCHABILITY, WITH SPECIAL REFERENCE TO CYTOLOGICAL AND BIOMETRICAL EVIDENCE. p. 473-80 in "Proceedings of the 2nd Japan Conference on Radioisotopes, 1956". Tokyo, Japan Atomic Industrial Forum, Inc. 1958. (In Japanese*)

Male silkworms were fed with $Na_2HP^{32}O_4$, and the percentage of infertile eggs resulting from subsequent matings was determined. Exposure of 5th instar larvae to 3000 r of γ-rays from a $Co^{60}$-source gave rise to similar values for infertile-egg percentages. Radiation-induced dominant lethal eggs reached a peak at the mid-stage of the 5th instar. A predominance of anuclear spermatozoa below a certain level is considered to be responsible for infertile eggs. Abnormalities in metaphase chromosomes also appeared to have some bearings on the emergence of dominant lethal eggs. An anatomical study was made

* (An English translation of this article under the title of "Stages of developmental variation in radiation susceptibility of the silkworm seminal gland especially low hatching rate, and its histocytological and biochemical proof" appeared on p. 1295-1312 of AEC-tr-4482)

of the genital organs, and the effects of irradiation on nucleic acid content investigated biochemically. Autoradiography was used throughout.

1148 Kogure, M., Nakajima, M. DIFFERENTIAL RADIOSENSITIVITY OF SILKWORM TESTIS FOR DECLINE OF EGG HATCHABILITY, WITH SPECIAL REFERENCE TO CYTOLOGICAL AND BIOCHEMICAL EVIDENCE. 2nd UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 15/P/1344. 22 (1958) 351-9.

Male silkworms were subjected to 3000 r of γ-rays from a $Co^{60}$ source at the beginning of the (2nd), middle (5th) and end (8th day) of the 5th instar. The percentages of unfertilized eggs and of dominant lethal eggs induced by γ-rays were determined. Biochemical and histocytological studies of the irradiated testis, with special reference to nucleic acid metabolism were also carried out. In other experiments, $P^{32}$ was made available as a tracer by administering $Na_2HP^{32}O_4$. Phosphorus specific activities in DNA and RNA could be measured by using $Na_2HP^{32}O_4$ as a precursor. The rate of occurrence of unfertilized eggs and dominant lethal eggs was found to be dependent on radiation sensitivity in the different stages of spermatogenesis. The mechanisms responsible for these phenomena are discussed.

1149 LaChance, L. EFFECTS OF DELAYED OVIPOSITION ON X-RAY-INDUCED STERILITY. Nucleonics 13, 4 (1955) 49-50.

The effect of delaying the period of observation on induced sterility was investigated from irradiation studies on the parasitic wasp Habrobracon. Egg production curves are given for groups having oviposition delayed for various times after irradiation, all having received 3750 r x-rays expected to produce temporary sterility. The replacement of eggs caused by delayed oviposition is considered a valid interpretation of the trend shown in the curves, and also the increased hatchability. The data (days 1-8 post-irradiation) indicate that retention (ovipositional delay) favours deposition of fewer non-viable eggs. The hatchability data for days 9-20 suggest that, with retention of eggs, fewer damaged oögonial cells survive differentiation. If egg production begins immediately, more damaged gametes complete the maturation trip down the ovariole and are oviposited. Delay in egg laying therefore affects hatchability during the entire reproduction cycle.

* LaChance 1958 - [1395]

* LaChance 1959 - [1397]

1150 Melville, C. AN APPARENT BENEFICIAL EFFECT OF GAMMA RADIATION ON THE FLOUR MITE. Nature 181 (1958) 1403-4.

A single irradiation at $5\times10^3$ and also at $10^4$ rad γ-radiation resulted in an increase in the number of eggs laid and hatched by the flour mite, Tyroglyphus farinae. In contrast, irradiation at $2\times10^4$ rad significantly reduced the number of eggs laid and hatched, and a dose of $4\times10^4$ rad apparently sterilized the population. (NSA 12: 10311, 1958)

1151 Park, T., DeBruyn, P. P. H., Bond, J. A. THE RELATION OF X-IRRADIATION OF THE FECUNDITY AND FERTILITY OF TWO SPECIES OF FLOUR BEETLES. Physiol. Zoöl. 31, 2 (1958) 151-70.

Young adults of two species of flour beetles (Tribolium confusum and T. castaneum) were subjected to 4 initial doses of x-rays (2000, 3000, 4000 and 5000 r). Within each dose, the beetles were further partitioned, so that in one set only males received irradiation, in another only females; and in one, both males and females. The number of eggs laid ("fecundity") and larvae hatched ("fertility") was counted every 3 d until the female beetles died. Reproduction by non-irradiated controls was also followed in precisely the same way. The experimental design thus discriminates these components: differences between species; fecundity from fertility; the effect of parental aging; irradiation from non-irradiation; the influence of dosage intensity; and the sexual pathway through which reproduction is affected. The major conclusions drawn were as follows: (1) There are differences between the two species in fecundity and fertility when neither, as well as when both receive x-rays; (2) fertility is more affected by practically all components of treatment than is fecundity; (3) the relation of increase in dosage to decrease in reproduction is essentially linear; and (4) irradiation, at the levels given, does not appear to reduce adult longevity.

1152 Potts, W. H. THE EFFECT OF GAMMA RAYS ON REPRODUCTIVE ORGANS OF FEMALE GLOSSINA MORSITANS WESTW. Trans. R. Soc. trop. Med. Hyg. 51 (1957) 292.

Three slides were exhibited (at a laboratory meeting of the Royal Soc. Trop. Med. Hyg., March 21, 1957) to show the prevention of ovarian development in G. morsitans by irradiation of the pupal stage with γ-rays

from an activated Co-source (Harwell). A brief note was presented on how this effect, coupled with the sterilization of males by the same means, could be used to a limited extent in the control of tsetse flies.

* Potts 1958 - [1494]

1153 Terzian, L. A., Stahler, N. A STUDY OF SOME EFFECTS OF GAMMA RADIATION ON THE ADULTS AND EGGS OF AËDES AEGYPTI. Biol. Bull. 115 (1958) 536-50.

Studies were undertaken to evaluate some of the biological effects produced by γ-radiation in the mosquito, Aëdes aegypti. It has been shown that egg production was reduced either by mating normal females with males which had been exposed 8 or 15 d previously to dosages of about 30 000 r, or by irradiating females with dosages in excess of 2500 r (with no oviposition at 10 000 r). Reduction in egg hatch was proportionate to dosages in excess of 2500 r, applied to either adult males or females, with no eggs hatching at 10 000 r. Egg hatch was less if females had been inseminated prior to exposure than if insemination had occurred after irradiation. It required dosages of 10 000 r to inhibit egg production in females exposed 4 h after a blood meal, and 100 000 r to cause the same effect in mosquitoes which had had a blood meal 42 h previously. Viable, fertile $F_1$ progeny could be produced only from females which had been irradiated at dosages less than 5000 r. Eggs were found to be most sensitive to irradiation during the prehatching period, the $LD_{50}$ varying from 800 r to 7500 r, and most resistant when 3 to 5 d old, the $LD_{50}$ ranging from 30 000 r to 75 000 r. Progeny could be reared only from eggs which had been irradiated at dosages less than 2500 r. Whenever larvae could be grown successfully to adults, the resulting adults proved to be fertile and capable of producing viable eggs if physically capable of mating. (auth.)

(Also published as 13 p-report, NM 52 01 00. 05. 01, Naval Medical Res. Inst. Bethesda, Maryland 16 (1958) 583-96)

## I-C-3 GERM CELLS (INCLUDING OÖGENESIS AND SPERMATOGENESIS)

1154 Abrahamson, S., Telfer, J. D. SEX CHROMOSOME LOSS AND TRANSLOCATION FREQUENCIES IN DROSOPHILA MELANOGASTER AFTER X-RAYING SPERM IN MALES OR IN FEMALES. (abstr.) Genetics 39 (1954) 955-6.

Studies are described to test the effect of homogeneity, age, and stage of germ cells on x-ray mutagenesis. Sperm either in males or females were x-rayed and frequency of sex-chromosome loss (partial or complete) and translocations determined by Muller's genetic stocks and procedures. The experimental plan is described. Both loss and translocation frequencies were lower from sperm treated in males than in females. No difference was found for loss in first and second day inseminations, while the decline shown by the translocation frequency on second day is somewhat doubtful statistically. Mean losses of maternal X's, for eggs laid on first 12 d are given. The extent of participation of maternal chromosomes in the translocations is being investigated. (from abstr.)

1155 Abrahamson, S., Herskowitz, I. H. THE EFFECT OF X-RAY INTENSITY AND DOSE ON EGG MORTALITY FOLLOWING IRRADIATION OF FEMALE DROSOPHILA. Drosophila Inform. Serv. 29 (1955) 101.

1156 Alexander, M. L., Stone, W. S. RADIATION DAMAGE IN THE DEVELOPING GERM CELLS OF DROSOPHILA VIRILIS. Proc. nat. Acad. Sci., Washington 41, 12 (1955) 1046-57.

The relationship between x-ray dosage and genetic damage was determined throughout the meiotic cycle. Damage was measured as dominant lethals and translocations. The number of aberrations varies from 2 - 100 fold between stages, depending on the physiological conditions at irradiation. Susceptibility and damage are discussed in detail. Radiation damage to the different stages of oögenesis in the female Drosophila has been shown to be similar to that in Sciara and Habrobracon. The comparable stages in the male respond to radiation very much as the female. The enzyme activity as modified by the gaseous environment influenced the amount of damage to pupae. Even without an external source of oxygen, irradiation in carbon monoxide modified the internal environment and increased radiation damage above that in nitrogen at all stages. The sensitive stages of the maturation cycle in the male Drosophila are particularly useful in studying the relations between physiological activity and genetic damage from radiations. (from auth. summary)

1157 Abrahamson, S., Telfer, J. D. THE RELATIVE CONSTANCY OF THE X-RAY INDUCED MUTATION FREQUENCY OF DROSOPHILA MELANOGASTER SPERM IN INSEMINATED FEMALES. Genetics 41, 5 (1956) 677-84.

Experiments were performed to test the influence of aging on the mutation frequency of sperm irradiated in females under different conditions: 1. There was no significant difference in the II-III translocation frequencies obtained when sperm were not aged and irradiated, aged and irradiated, and irradiated then aged. 2. When sperm discharged from aged versus non-aged males was irradiated in females no significant difference was found in the sex-linked recessive lethal frequencies obtained. Significantly higher mutation frequencies were again obtained, however, for sperm irradiated in females as compared to sperm irradiated in males. Moreover, sperm ejaculated on the second day after treatment had a translocation frequency about half as great as those ejaculated on the first day after treatment, and the frequency of this latter group was almost half that of sperm treated in females. (auth.)

* Abrahamson 1957 - [1354]

1158 Abrahamson, S., Herskowitz, I. H. INDUCED CHANGES IN FEMALE GERM CELLS OF DROSOPHILA. II. OVIPOSITION RATE AND EGG MORTALITY IN RELATION TO INTENSITY AND DOSAGE OF X-RAYS APPLIED TO OÖCYTES. Genetics 42 (1957) 405-20.

Doses up to 2500 r produced no grossly observable reduction in the number of eggs laid, while higher doses did. The results prove that there is an intensity-dependent fraction of induced egg mortality which can, under certain conditions of irradiation, result in the death of at least 22.5% of all eggs oviposited during the first 5 d after treatment. Parallelism was found between half-translocations and the intensity-dependent component of egg mortality in all comparisons of behaviour which were made, comprising evidence that the latter is largely if not entirely the result of multiple x-ray-induced events. It is postulated that at least part of the intensity-dependent fraction of egg mortality represents dominant lethal mutations which have their basis in two or more independently produced breaks in the maternal chromosomes. In addition to the intensity-dependent fraction of egg mortality there is an intensity-independent (relatively independent) fraction.

* Abrahamson 1959 - [1355]

1159 Alexander, M. L. MUTATION RATES AT SPECIFIC AUTOSOMAL LOCI IN THE MATURE AND IMMATURE GERM CELLS OF DROSOPHILA MELANOGASTER. Genetics 39 (1954) 409-28.

Mutation rates were obtained for 8 specific loci on the third chromosome of D. melanogaster. With a dose of 3000 r of x-radiation, the rates for mature sperm varied from $2.7 \times 10^{-8}$/r for the thread locus to $8.75 \times 10^{-8}$/r for the peach and ebony loci. The 8 loci gave an average rate of $5.98 \times 10^{-8}$/r/locus. Of the 58 x-ray-induced mutations, 20 were viable, 35 were lethal, and 3 were semi-lethal, when homozygous. Spermatogonial cells in larvae 20 to 22 h old were irradiated with 900 r of x-radiation. Single mutant individuals and clusters of the same mutation were recovered from adult males which had been treated as larvae. A variation in the size of the clusters indicated that the number of spermatogonia under test varied from 7 to more than 100. The spermatogonial mutation rate is estimated to be approximately $1.52 \times 10^{-8}$/r/locus. Four spermatogonial mutants were viable, 3 lethal and 1 semilethal in the homozygous condition. A lower average mutation rate obtained for spermatogonia than for sperm can be better explained by a differential genetic sensitivity of the 2 stages than by germinal selection. (auth.)

1160 Alexander, M. L., Clayton, F. E., Stone, W. S. THE INDUCTION OF TRANSLOCATIONS BY X-RADIATIONS AT DIFFERENT STAGES OF GERM CELL DEVELOPMENT IN DROSOPHILA VIRILIS. (abstr.) Genetics 39 (1954) 956.

Induced translocations were used to demonstrate genetic damage to different stages of developing germ cells under several different physiological conditions. Males, 15 to 30 h after eclosion, were x-radiated 2000 r in 1 min at 0-5°C in a gas mixture with suitable pre- and post-treatment, mated individually to three marker females for 5 d; thereafter each male was remated every 48 h for 9 (A-I) mating periods. The first sperm used in inseminating females in lots A and B represent the advanced stages at irradiation; sperm used in subsequent matings were from earlier stages back to spermatogonia by H and I. In most tests the percent of translocation in B (7-9 d) corresponded to the values obtained for mature sperm treated under the same conditions. By D (11-13 d) or E (13-15 d) the frequency increased two or threefold. The values for air at the peak were 25 to 28% as compared to 17.2% for mature sperm from earlier experiments; in 96% $N_2$ + 4% $O_2$

the rate was 32% compared to 14%. In 95% CO+5% $O_2$ there was a 39% peak at D and E, then an increase to 76% at F. After the peak, the rate drops to a value of 1% and less (spermatogonia). Early pupae produced a few offspring from meiotic or post meiotic stages with a translocation rate equivalent to that in the carbon monoxide mixture, then the rate fell to that of spermatogonia.

1161 Alexander, M. L. DOMINANT LETHAL AND TRANSLOCATION DAMAGE IN THE IMMATURE GERM CELLS OF DROSOPHILA VIRILIS FROM FAST NEUTRONS. Genetics 41 (1956) 631-2.

The postmeiotic germ cells of Drosophila virilis show an increase in translocation damage which follows a "one-hit" curve and increases in proportion to the increase in the dose of fast neutrons. The damage in the more mature cells (A & B) was 2.47% translocations at the lowest dose (estimated dose of 65 rep) and increased to 5.95% when the dose was doubled (130 rep) and 13.78% for 260 rep. The most sensitive cells recovered were from mating period D and gave values of 6.03% translocations for the lowest dose, 8.29% for the second and 20.00% for the highest dose. The intermediate period (C) gave values which were intermediate between these two types. The most sensitive cells show 2.4 times more damage than the less sensitive cells of period A and B at the 65 rep dose level. No translocations were recovered from the premeiotic cells (periods F, G, H). The dominant lethal damage was measured throughout the cycle in both pre- and postmeiotic cells. In the postmeiotic cells, the highest peak of damage measured as dominant lethals coincided with the high point of translocation damage and the dominant lethal damage was increased about 1.5 to 2 times in the most sensitive cells at the 65 rep dose level. The damage in premeiotic cells dropped to a value of 14 to 17% as compared to 40% for the most sensitive cells recovered from mating periods D and E. Small egg samples were checked for the presence of sperm in some mating periods to distinguish between cell degeneration, as expressed as an absence of mature sperm, and genetic lethality. None of the eggs checked in period G contained sperm thus showing the absence of available sperm in this period. Neither the previous period (F) nor following period (H) showed an indication of this type damage.

(Abstract of paper presented at the 1956 meetings of the Genetics Society of America, Storrs, Conn., USA 27-29 Aug. 1956)

1162 Alexander, M. L. DOMINANT LETHAL DAMAGE IN THE IMMATURE GERM CELLS OF DROSOPHILA VIRILIS FROM 220 kV X-RAY, 1.17 - 1.33 MeV GAMMA RAYS AND 22 MV X-RAY. Genetics 42 (1957) 357.

Young males of D. virilis (18-21 h old) were treated with one of three types of irradiation: 200 kV x-ray, 1.17 - 1.33 MeV gamma rays from a cobalt-60 source, and 22 MV x-ray from a betatron source. The treated males were remated every two days to females which were obtained from a heterosis cross of two other virilis strains. Samples of the germ cells treated in various pre- and postmeiotic stages were obtained by this remating procedure. The dominant lethal damage in the different types of cells was measured by the percentage of pupae development from the egg samples obtained from females used for the different mating periods. Translocation tests were used to distinguish the postmeiotic from meiotic and premeiotic cells. With all three types of radiations, the highest percentage of dominant lethals in the postmeiotic cells was produced in the young spermatids. Less damage was observed in the more mature cells. With the dose expressed in rads, the gamma rays and 22 MV x-rays were similar in their efficiency for producing dominant lethal damage and with 200 kV x-ray as the standard radiation, both given an average relative biological efficiency of 0.72 for postmeiotic cells. The high proportion of dominant lethals induced in young spermatids was retained in sperm samples from germ cells treated in the meiotic and premeiotic stages both with gamma rays and 22 MV x-rays. With 200 kV x-rays, however, dominant lethal damage decreased more rapidly through these mating periods. The characteristics of the radiation damage in both the pre- and postmeiotic cells for each of the three types of radiation were consistent at levels of 500, 1000 and 2000 r.

(Abstract of paper presented at the 1957 meetings of the Genetics Society of America, Stanford, California, USA, 26-28 Aug. 1957)

1163 Alexander, M. L. DOMINANT LETHAL DAMAGE IN MEIOTIC AND SPERMATOGONIAL CELLS OF DROSOPHILA VIRILIS WITH 22 MV X-RAY AND 200 kV X-RAY. Radiation Res. 9 (1958) 85.

Dominant lethals produced by radiations in meiotic and spermatogonial cells result from at least two observable radiobiological actions. Some cells degenerate in the testes of treated males, and periods of sterility result from a reduction in the number of mature sperm. Another type acts as a lethal after fertilization and prevents completion of embryonic development. With fast neutrons and gamma rays, both lethal types were recovered, although the proportions of the two may not be the same. Lethal damage

produced in spermatogenesis with 22 MV x-ray (betatron source) was previously obtained for doses from 435 to 2000 rads. In meiotic and especially spermatogonial cells, equal or even greater amounts of lethal damage were recovered with the same dose of 22 MV x-ray as with 200 kV x-ray. Sensitivity of meiotic and some spermatogonial cells in Drosophila have been underestimated. Increases of 20% lethals have been recovered with 190 rads of 200 kV x-ray and 22 MV x-ray (170 rads). Doses of 2000 rads of both radiations produced maximum damage: 98% of the cells contain lethals. Genetic lethals account for one-half the damage, cell degeneration the other half. Estimates of the relative dose for genetic lethals in 50% of the cells were as high as two. Only about one-half the dose of 22 MV x-ray was necessary than with 200 kV x-ray. In postmeiotic, immature spermatids, 200 kV x-ray produced higher lethal values than 22 Mv x-ray and RBE values from 0. 64 to 0. 76 were obtained.

(Abstract of paper presented at the Intern. Congr. of Radiation Research, Burlington, Vermont, 10-16 Aug. 1958)

1164 Alexander, M. L. BIOLOGICAL DAMAGE IN DEVELOPING GERM CELLS OF DROSOPHILA VIRILIS IN OXYGEN AND NITROGEN WITH 14-MeV NEUTRONS. Proc. nat. Acad. Sci., Washington 44 (1958) 1217-28.

Germ cells of D. virilis were exposed in spermatogenesis to neutrons in oxygen and nitrogen atmospheres. Dominant lethals and translocations induced in the post-meiotic stage were considerably higher in an $O_2$- than in an $N_2$-atmosphere. Spermatids showed a greater difference than spermatozoa. The similarity in shape of the two curves for induced translocations indicates that the difference in radiosensitivity is not a function of the gaseous environment in terms of the frequency of chromosome breaks. Dominant lethals produced in the developmental stages tested occurred with various frequencies in $O_2$ but with the same frequency in $N_2$. The particular gas used had no effect on the number of lethals induced by radiation in spermatogonia.

1165 Alexander, M. L. RADIATION DAMAGE IN THE DEVELOPING GERM CELLS OF DROSOPHILA VIRILIS FROM FAST NEUTRON TREATMENT. Genetics 43 (1958) 458-69.

The radiation damage produced by the densely ionizing radiations from fission neutrons was tested by studies of various stages of post- and premeiotic germ cells of Drosophila virilis. Young males were treated with doses of 600, 1200 and $2400 \times 10^8$ $n^f/cm^2$ and the various types of cells sampled by successive remating periods. The induction of translocations and dominant lethals in the various stages of spermatogenesis was tested. Translocation and dominant lethal damage produced from neutron treatment in the immature germ cells increased proportionally with an increase in dose. The damage obtained for each type of cell in the spermatogenic cycle resulted in a curve which would be expected when multiple chromosome breakage is produced from a single proton hit. The radiation damage increased linearly with dose in the various types of cells although the relative sensitivity of the various stages was not the same. Postmeiotic germ cells (B-D) varied in sensitivity to chromosome breakage with the sensitivity peak occurring in the spermatozoa sampled 13 - 15 d after treatment (Period D). A neutron dose of 1. 5 to 2 times greater is required to produce the same amount of radiation damage in the more mature type of cells (B) as the D types. Cells treated in meiotic and premeiotic stages contained fewer translocations and lower percentages of dominant lethals than postmeiotic cells. The reduction in the number of spermatozoa in the treated males in mating period G indicated that some types of spermatogonial germ cells degenerate as a result of neutron irradiation. The relative biological efficiency of fission neutrons and 200 kV x-rays differ in mature sperm, spermatids and meiotic cells. Fission neutrons are at least six times more effective than x-rays in mature sperm; in spermatids, the difference is only 2 - 3 times larger for neutrons. In meiotic cells fission neutrons are only 1. 6 times more efficient. (auth. )

* Alexander 1958 - [1356]

1166 Alexander, M. L. THE EFFECT OF RADIATION OF DIFFERENT ION DENSITIES ON THE GERM CELLS OF DROSOPHILA VIRILIS. p. 51-70 in "Radiation Biology and Cancer. A collection of papers presented at the 12th Annual Symposium on Fundamental Cancer Research 1958". Austin, University of Texas Press. 1959, 493 p.

Studies of the radiation damage in cells undergoing spermatogenesis in Drosophila virilis showed quantitative and qualitative differences from radiation treatment. The biological damage from radiation was found to depend on a number of factors including the physical characteristics of the radiation and the interaction of the radiations with the biological system. An inverse relationship was found for the amount of lethal damage and the ion density of the radiation in meiotic and spermatogonial cells. Environmental changes

were found to enhance or suppress biological damage to a greater degree with x-rays than with neutrons. Data are presented from a series of studies on dominant lethal and translocation damage in spermatogenesis; radiation damage with 200 kV x-radiation, 1.71 and 1.33 MeV gamma rays, and 22 MV x-radiation; the effect of fast neutrons on gametogenesis; and the influence of environmental factors on radiation damage. (NSA 13: 21905, 1959)

1167 Alexander, M. L., Bergendahl, J., Brittain, M. BIOLOGICAL DAMAGE IN MATURE AND IMMATURE GERM CELLS OF DROSOPHILA VIRILIS WITH IONIZING RADIATIONS. Genetics 44 (1959) 979-99.

Data on translocation and dominant lethal damage are tabulated for 200 kV x-rays, γ-rays from $Co^{60}$ and 22 MV x-rays from a 31 MeV betatron source, from 500 - 2000 r. The comparative effectiveness is discussed. The average RBE values for postmeiotic cells were 1.00: 0.86: 0.70 for therapy x-rays, γ-rays and betatron x-rays. The percentage of biological damage produced by the various radiations agree in a quantitative manner with the physical measurements of linear transfer or ion density per micron of the radiations. The agreement in the differences in ion density and difference in biological damage depends upon the method for calculating the LET. The biological results suggest that any one set method will not be sufficient to wholly describe the radiobiological action dependent upon the physical characteristics of the radiation. The physiology of the cells and the interactions of the cell to environmental conditions must be included in such an evaluation.

* Alexander 1960 - [854]

1168 Auerbach, C. SENSITIVITY OF THE DROSOPHILA TESTIS TO THE MUTAGENIC ACTION OF X-RAYS. Z. indukt. Abstamm. -VererbLehre 86 (1954) 113.

Young males which had undergone irradiation were mated at set intervals, and the resultant "brood pattern" of mutation frequencies analysed to give a sensitivity pattern for the different cell types from the irradiated testes. Spermatogonia are the least sensitive stage, whereas sensitivity rapidly rises to a peak during meiosis, the peak probably only being reached in spermiogenesis. With maturation of the sperm, sensitivity declines again to about half its peak-period value.

1169 Baeumer, J., Müller, K. BEITRAG ZUR DOSIERUNG DER BETA-STRAHLEN DES RADIUMS NACH DER BIOLOGISCHEN METHODE. I. MITTEILUNG (Dosimetry of β-rays from radium by the biological method. I.) Strahlentherapie 87, 2 (1952) 310-4. (In German)

1 - 3 h old Drosophila eggs were used for the measurement of β-radiation from radium in r units. The damage curve of a Ra preparation, prefiltered with 2 mm monel, was compared with that of known hard roentgen radiation. From the ratio between total radiation and γ-radiation, the β-radiation could be determined. At a 1 cm local distance the proportion of γ : β was 1 : 8. It was confirmed that the sensitivity of D. eggs to radiation is independent of wave length as long as this is below 0.05 Å. (EM 14, 7 (1953) 1739)

1170 Baeumer, J., Hofmann, D., Kepp, R. K., Müller, K. BEITRAG ZUR DOSIERUNG DER BETASTRAHLEN DES RADIUMS NACH DER BIOLOGISCHEN METHODE (Dosimetry of β-rays from radium by the biological method). Strahlentherapie 90 (1953) 143-7. (In German)

In Drosophila eggs of a medium age of 2 h, the depth of penetration was determined and the spatial dose distribution of the total radiation from a Ra preparation (filtered through 2-mm monel metal) in an aluminium phantom. From the relation of the density of Al to the density of water, a rise of the dose up to 29% in 25-mm depth was determined for the β-radiation. The practical range of the radiation amounts to 4.2 mm. The share of the γ-radiation can be neglected. (CA 47: 6993c, 1953)

* Baker 1957 - [940]

1171 Balock, J. W., Christenson, L. D., Burr, G. O. EFFECT OF GAMMA RAYS FROM COBALT-60 ON IMMATURE STAGES OF THE ORIENTAL FRUIT FLY (DACUS DORSALIS HENDEL) AND POSSIBLE APPLICATION TO COMMODITY TREATMENT PROBLEMS. (abstr.) Proc. Hawaii. Acad. Sci. 31 (1956) 18.

Young eggs up to 6-h old were killed by approximately 4000 r (from a 1-c $Co^{60}$-source); 24-h old eggs in which embryonic development was about 50% complete were much more resistant and hatch was unaffected by irradiations up to 36 000 r, reduced ~ 24% by 60 000 r and 46% by 120 000 r. Complete development from irradiated egg to adult was possible with a dosage of approximately 2000 r, and the resulting adults

mated and produced normal progeny. Dosages in the range of 7500 to 60 000 r permitted puparial development but this was greatly reduced at 30 000 and 60 000 r at which levels the pupation was only 0.5%; 120 000 r permitted development to 3rd-instar larva but prevented puparial formation. Third-instar larvae exposed to irradiations from 15 000 to 240 000 r survived and from 37 to 70% formed puparia but were unable to develop to the adult stage. The results are promising for irradiation as a quarantine treatment for fresh fruits and vegetables infested by fruit flies and possibly other insects. Although the lethal effects are not immediately apparent up to 300 000 r, the complete development of irradiated eggs and larvae to the adult stage is prevented by dosages of 7500 and 15 000 r. (from abstr.)

1172 Bateman, A.J. MUTAGENIC SENSITIVITY OF MATURING DROSOPHILA SPERM. I. DOMINANT LETHALS. J. Genet. 54 (1956) 400-10.

The dominant lethal rate was followed in daily sperm samples from males irradiated on their first day with 1000 r and various higher doses up to 30 000 r. The control rate of non-hatching eggs, 0.83%, was taken to be the spontaneous rate of dominant lethal mutations. Irradiation of mature sperm gave an induced dominant lethal rate of 12.23%, corresponding to a doubling dose of 68 r. The change in dominant lethal rate from day to day was interpreted as a 10-fold increase in sensitivity to mutagens in the immediately post-meiotic spermatids followed by a gradual decrease from 6 d prior to maturity until the day before full maturity. The last 2 d were the only period (since the pre-meiotic stages) over which no change in sensitivity was detectable. The doubling dose for the most sensitive stage is 7 r. Whilst mature sperm have remained viable at the highest dose used (30 000 r), immature sperm were killed by 10 000 r. The sensitivity of spermatogonia to chromosome breakage is probably of the same order as for mature sperm. Meiotic stages are probably killed by a dose of the same order as produces 100% dominant lethals in immature sperm. (from auth. summary)

1173 Bateman, A.J. MUTAGENIC SENSITIVITY OF MATURING DROSOPHILA SPERM. II. DELETED X'S. J. Genet. 55 (1957) 467-75.

It is known that the early post-meiotic stages of Drosophila sperm are more sensitive than mature sperm to the mutagenic effects of x-rays. To study this phenomenon in more detail and in a more quantitative way the authors chose the dominant lethal response as the simplest genetic change available for study. The incidence of deleted X's is measured as hyperploid females in the progeny of irradiated wild-type males mated to attached-X-females. A re-estimation is made of the dose dependence of this rearrangement, using several doses from 1000 to 10 000 r on mature sperm (utilized within 3 d of irradiation). The fit of the regression line is good over the whole range studied. In samples of sperm from 1 to 10 d after irradiation of the male with 1000 r, the variation in frequency of hyperploids is, by and large, consistent with the data for the variation in dominant lethals and the dose dependence of hyperploids. This would lead one to expect that a 10-fold increase in sensitivity to dominant lethals would be accompanied by a 30- to 50-fold increase in yield of hyperploids. It is concluded that both phenomena are due to the increased breakability of the chromosomes of spermatids. There are indications that spermatids may have opportunities for rearrangements which no longer exist at later stages.

1174 Bateman, A.J. MUTATIONS IN IRRADIATED SPERMATOCYTES. Drosophila Inform. Serv. 32 (1958) 113.

From the Drosophila data obtained the author concludes that, if a broad classification of germ cells according to their response to mutagens is to be made, it should be into spermatogonial and post-spermatogonial rather than into pre- and post-meiotic.

1175 Belgovsky, M.L. THE SHAPE OF FREQUENCY-DOSAGE CURVE FOR RECESSIVE LETHALS IN DROSOPHILA IN RELATION TO DIFFERENTIAL RADIOSENSITIVITY OF DIFFERENT STAGES OF GERM CELL DEVELOPMENT. p. 19 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958.

Wild-type Drosophila males were treated with 1000 r and 4000 r of x-rays and the frequency of recessive lethals recorded for gametes which, at the time of irradiation, were at the stages of mature sperm, spermatids and spermatogonia. The shape of the integral frequency-dosage curve for lethals was found to be wholly determined by the mode of dependence upon dosage of the frequency of lethals in mature sperm. The lagging of the lethal frequency in spermatids behind that expected on the basis of a direct proportionality rule is practically not at all reflected in the shape of the integral curve. This is evidently to be explained by the fact that the absolute number of lethals originating in spermatids is very small, as compared with that of lethals originating in mature sperm, because at any given moment the latter are much

more numerous than the former. This study shows that the possible heterogeneity of the stage of development of the treated germ cells, not considered in many previous investigations of the dependence of mutation frequency upon the dose of radiation, does not invalidate the conclusions drawn from such investigations, provided these conclusions refer to mature sperm only.

1176 Belgovsky, M. L., Abeleva, E. A., Potekhina, N. A. THE NATURE OF THE RELATION OF THE FREQUENCY OF LETHALS ARISING AT DIFFERENT STAGES OF SPERMATOGENESIS TO THE DOSE OF X-RAYS. Dokl. Akad. Nauk SSSR 124 (1959) 922-4. (In Russian)

A series of special experiments was carried out in order to discover the dependence on dose (for 1000 - 4000 r) of lethals arising in Drosophila melanogaster (Algerian and Ebreo) mature sperm, spermatids and during spermatogenesis. The tabulated data show that the frequency of lethals in spermatids induced by 4000 r increased by a factor of 1.4. In mature sperm, however, the increased dosage induces a linear increase in the frequency of lethals. (NSA 13: 9587, 1959)

* Bender 1958 - [1370]

1177 Borstel, R. C. von. FEULGEN-NEGATIVE NUCLEAR DIVISION IN HABROBRACON EGGS AFTER LETHAL EXPOSURE TO X-RAYS OR NITROGEN MUSTARD. Nature 175 (1955) 342-3.

Female Habrobracon were treated with a lethal dose of x-radiation or an equivalent dose of nitrogen mustard. The developmental pattern of eggs which were in metaphase-I during the time of treatment is described and possible mechanisms of action of the mutagens discussed. (NSA 9: 3024, 1955)

* Borstel and Rogers 1958 - [906]

* Brandt and Höhne 1952 - [1372]

1178 Bucher, N. ZUR ENTWICKLUNG RÖNTGENBESTRAHLTER OVARIEN VON DROSOPHILA MELANOGASTER (Concerning the development of x-irradiated ovaries of D. melanogaster). Arch. Klaus-Stift. VererbForsch. 26 (1951) 479. (In German)

The Drosophila ovary is composed of 2 different elements having different origin and time relations. These elements are the germ cells and the mesodermal somatic cells. In the present experiments the germ cells were x-rayed later, in female larvae ready for pupation, and in 8-h pupae (3500 - 5000 r). Nowhere were follicles formed before treatment, and the complete extirpation of ovarian cells could be accomplished with practically no damage to somatic tissues. In flies which had been x-rayed as 24-h old pupae no undivided ovarioles could be found. Instead of ripe egg cells many small, undeveloped egg cells were present in each follicle. It is concluded that the influence of the germ cells on the somatic ovarian tissue begins very late in development, always more than 8 h after pupation. If follicle formation is stimulated, this is independent of the development of the enclosed germ cells. In the genesis of the ovary both dependent and autonomous phenomena of development occur.

1179 Buretz, K. M. THE EFFECTS OF VARIOUS IONIZING RADIATIONS ON THE SURVIVAL OF METAPHASE I AND PROPHASE I EGGS OF HABROBRACON JUGLANDIS (ASHMEAD). Bachelor's Thesis. Delaware, Univ., Newark, 1956.

1180 Buzzati-Traverso, A. A. DIFFERENTIAL EFFECT OF X-RAYS ON DROSOPHILA EGGS DERIVED FROM RECIPROCAL CROSSES IN DROSOPHILA MELANOGASTER. Atti Ass. genet. ital. 5 (1960) 113-5. (CNEN-12) (In Italian)

According to a general rule, the behaviour of identical genotypes is identical, short of maternal effects, in a diploid zygote, irrespective of whether they are carried via the sperm or the egg. In order to ascertain whether mutation rates of the same genes are different when derived from the male, as contrasted to the female, batches of 1-h-old eggs of D. melanogaster obtained from the cross ♂ y $w^a$ cv v f × ♀+ and its reciprocal y $w^a$ cv v f ♂+ × ♀ were x-rayed with doses of 340 and 680 r. While no significant differences were found in the frequencies of somatic mutants, as revealed by mosaics, unexpected differences were found in the egg mortality and in the sex ratio of the surviving adults. The data are tabulated. (from auth.)

* Chandley and Bateman 1960 - [857]

* Colombo 1959 - [1247]

* Crook et al. 1960 - [1114]

1181 Crouse, H. V. THE DIFFERENTIAL RESPONSE OF MALE AND FEMALE GERM CELLS OF SCIARA COPROPHILA (DIPTERA) TO IRRADIATION. Amer. Nat. 84 (1950) 195-202.

Comparative studies have been made on the response of male and female germ cells of S. coprophila to irradiation. The following results were obtained: (1) When adult females are exposed to x-rays 43 to 45.5 h after eclosion, no gross rearrangements of any type are recovered; but oöcytes irradiated between 46 and 72 h of adult life yield inversions. (2) Approximately the same number of breaks leading to gross rearrangements are induced by 2000 r in oöcytes and 4000 r in sperm. (3) Irradiation of sperm results in both reciprocal translocations and inversions. (4) Tests for reciprocal translocations involving the X-chromosome yielded 9 such translocations among 108 sperm tested but none among the 42 oöcytes examined. The failure to recover interchromosomal exchanges following irradiation of oöcytes is discussed. (auth.)

1182 Dittrich, W., Fass, H., Höhne, G., Schubert, G. DIE WIRKUNG SCHNELLER ELEKTRONEN EINES 6 MeV-BETATRONS AUF EIER VON DROSOPHILA MELANOGASTER (The effects of fast electrons from a 6 MeV-betatron on eggs of Drosophila melanogaster). Strahlentherapie 81, 2 (1950) 223-32. (In German)

Lethal dose rates on Drosophila eggs of different ages were determined for fast electrons and x-rays, in order to test differences in their biological effects. For 3-h eggs the curves for rate of damage coincided. The exponential rise in the case of fast electrons also points to the existence of a single-hit reaction. On $7\frac{1}{2}$-h eggs they are somewhat less effective than x-rays. Multiple-hit reactions are caused by both radiations, with a greater number of hits from fast electrons. Differences in the effects of the two kinds of radiation may be assigned to differences in differential ionization.

1183 Fiala, Y., Neubert, J. DIE ERZEUGUNG VON CHROMOSOMENDISLOKATIONEN DURCH RÖNTGEN-STRAHLEN IN DER KEIMBAHN UND IN GESCHLECHTSZELLEN VERSCHIEDENEN ALTERS BEI DROSOPHILA HYDEI STURT (X-ray-induced chromosome dislocations during gametogenesis and in germ cells of various ages in Drosophila hydei Sturt.). Chromosoma 4 (1952) 577-84. (In German)

X-ray-induced chromosome dislocations could be observed in the giant chromosomes of $F_1$-larvae. Dislocation rates following irradiation are given for mature spermatozoa, spermatocytes and unfertilized eggs. By irradiating mature larvae and pupae it is also possible to induce dislocations in the early stages of gametogenesis, which are then passed on through the germ cells.

1184 Fluke, D. J. THE EFFECT OF X-RAYS ON EGG HATCH AND EGG LAYING IN MORMONIELLA. (abstr.) Radiation Res. 7, 3 (1957) 315.

An egg-hatch test on agar plates for Mormoniella has been applied to study stages of radiosensitivity in oögenesis in comparison with results of other workers with Habrobracon and Drosophila. Unmated females which had previously fed and laid eggs were starved and then x-rayed (250 kV potential or heavily filtered 50 kV). The hatch of an initial group of eggs showed sensitivity corresponding generally to the stage correlated with metaphase I by A. R. Whiting in Habrobracon or to stage 14 defined by R. C. King in Drosophila. The number of eggs in this stage was several times the number for Habrobracon. As egg laying was continued an intermediate phase of radiosensitivity appeared, but the egg hatch did not recover to a resistant phase corresponding to Habrobracon prophase I or to Drosophila stage 7. In an attempt to find such a resistant phase, females in successively earlier stages were x-rayed. Females x-rayed after eclosion but before first feeding did succeed in reaching a resistant phase before egg laying ceased. As progressively earlier pupal stages were irradiated the resistant phase was reached sooner, but progressively fewer eggs were laid before egg laying stopped. The effect on number of eggs laid set in so sharply with increasing dose that it has not been possible to compare the resistant phase very definitely with Habrobracon prophase I or with Drosophila stage 7.

* Frey 1952 - [821]

1185 Fritz-Niggli, H. BIOLOGISCHE ANALYSE DER STRAHLENSCHÄDIGUNG VON DROSOPHILA-EIERN DURCH 180 kV RÖNTGENSTRAHLEN UND ULTRAHARTE 31 MeV-STRAHLEN (Biological analysis of the radiation damage to Drosophila eggs during 180-kV x-radiation and ultrahard 31-MeV radiation). Naturwissenschaften 39 (1952) 485-6. (In German)

Dose-effect curves which show, in per cent of hatching, the dependence of radiation sensitivity on the age of D. melanogaster eggs exposed to 180-kV or 31-MeV x-rays are presented and discussed. Early embryonic stages show very high mitotic activity, maximum duration of a mitotic cycle only being 10 minutes. Sensitivity varies markedly with the age of the egg. The results are illustrated graphically, with maximum sensitivity occurring at 1¾ h. The mechanism of action varies with the stage of development and dose given. In 1-2 h-old eggs damage is caused by some intoxication which only becomes evident later. In order to kill 5½-8 h-old eggs a certain threshold of irradiation must be exceeded before damage becomes noticeable. A hit-theory explanation of the results is shown to be inadmissible.

1186 Fritz-Niggli, H. VERGLEICHENDE ANALYSE DER STRAHLENSCHÄDIGUNG VON DROSOPHILA-EIERN MIT 180 keV UND 31 MeV (Comparative analysis of irradiation damage to Drosophila eggs caused by 180 keV and 31 MeV). Fortschr. Röntgenstr. 83 (1955) 178-200. (In German)

In view of the variation of radiosensitivity with egg age, only an age spread of ± ½ h was admitted. The effects of x-rays (180 keV) and β-rays (31 MeV) were compared on 112 014 eggs. Methods and calculations are set down in detail, and the results tabulated and discussed. Maximum sensitivity was observed at 1¾ ± (0)¼ h. Prior to differentiation cells are particularly sensitive. The kind of radiation effect (moment of occurrence, etc.) depends on dosage and age. An equal dose of 31 MeV and 180 keV radiation on 1 and 1¾ h old eggs had similar effects both qualitatively and quantitatively. On 4, 4½ and 7 h old eggs the lethal effects of 180 keV radiation was greater. With 3 h eggs, results seem to be similar but the wide spread has made it impossible to secure a mathematical comparison.

* Fritz-Niggli 1957 - [824]

* Fritz-Niggli 1958 - [825], [826], [869]

1187 Fritz-Niggli, H. DIE VERSCHIEDENE BEEINFLUSSUNG DER MUTABILITÄT REIFER UND UNREIFER KEIMZELLEN DURCH BESTRAHLUNG IN $N_2$-, $O_2$- UND CO-ATMOSPHÄRE (The varying influences on the mutability of mature and immature germ cells by irradiation in $N_2$, $O_2$, and CO atmospheres). Strahlentherpie 109 (1959) 402-11. (In German)

The rate of mutations of dominant and recessive lethal factors and translocations in Drosophila depends on the stage of development of the germ cells irradiated in air. The scale of sensibility is the same for all types of mutations, beginning at the most sensitive stage: spermatocytes, spermatids, mature sperms, spermatogonia. Irradiation in pure $N_2$ and CO atmosphere decreases the rate of mutation. The protection effect of CO is less than of $N_2$. The protection effect depends on the stage of development of the irradiated germ cell. Mature sperms respond little to protection factors. Their rate of mutations is increased by irradiation in pure $O_2$ atmosphere. The rate of mutation of irradiated spermatids and spermatocytes can be decreased considerably by irradiation in pure $N_2$. Spermatogonia are indifferent to irradiation in $N_2$ atmosphere. The possibility exists that an increased proportion of $O_2$ of spermatids and spermatocytes, as compared to mature sperms, may explain their sensibility to milieu factors. (auth.)

* Giux Melcior 1951 - [829]

1188 Glass, B. A COMPARATIVE STUDY OF INDUCED MUTATION IN THE OÖCYTES AND SPERMATOZOA OF DROSOPHILA MELANOGASTER. I. TRANSLOCATIONS AND INVERSIONS. Genetics 40, 2 (1955) 252-67.

Spermatozoa and oöcytes irradiated simultaneously with x-rays yielded only 1 translocation in 2599 oöcytes compared to 150 in 2357 spermatozoa. The frequency of translocations from treated spermatozoa utilized 8 to 11 d after treatment was almost twice as great as the frequency in spermatozoa used sooner after treatment. All translocations induced in oöcytes occurred in the first brood (1-3 d after treatment). Inversions, detected genetically, are induced by x-rays about 3 to 4 times as frequently in spermatozoa as in oöcytes. The ratio inverted ♀/inverted ♂ is 40 to 50 times as great as the corresponding ratio for translocations. This is interpreted to mean that the frequency of chromosome breakage in oöcytes differs little from that in

spermatozoa, and that the difference in the frequency of rearrangements results from a difference in the probability of recombination related to the proximity of the breaks.

1189 Glass, B. A COMPARATIVE STUDY OF INDUCED MUTATION IN THE OÖCYTES AND SPERMATOZOA OF DROSOPHILA MELANOGASTER. II. DEFICIENCIES AND MINUTES. Genetics 40, 2 (1955) 281-96.

Dominant Minute-bristle mutations attributable to chromosome deficiencies were produced at x-ray doses from 1000 r to 4000 r with equal frequencies in oöcytes and spermatozoa. The dosage curve is rectilinear up to 2000 r, and above that the curve increases approximately as the 1.5 power of the dose; hence at low doses most Minutes result from single "hits" but at higher doses there is an increase in 2-hit effects. The study confirms that chromosomes are broken by x-rays with equal frequency in spermatozoa and mature oöcytes. The failure of gross chromosomal rearrangements to occur in the latter must be attributed to a diminution, more rapid in the oöcytes than in spermatozoa, of the probability of recombination between breaks as distance between them increases.

1190 Glass, B. DIFFERENCES IN MUTABILITY DURING DIFFERENT STAGES OF GAMETOGENESIS IN DROSOPHILA. p. 148-67 (disc. p. 167-70) in "Brookhaven Symposia in Biology, 15-17 June 1955", Vol. 8. BNL-350 (C-22), Brookhaven National Lab., Upton, N.Y. 1957.

The author reviews many aspects of the subject. Great differences have been found to exist in the induced mutation rates in mature germ cells as compared with immature ones. The effect of sex on x-ray induced mutation rate, and of the period of gametogenesis on the induced mutation rate in males and in females are examined in some detail. If the genetic effects of high energy radiation are to be assessed successfully, the differences in mutability exhibited by various stages of gametogenesis or by the male and female germ lines must be established, particularly in those phases of the germ line in which the germ cells persist for the longest periods.

* Glemobitsky et al. 1960 - [993]

* Grosch 1960 - [1139]

* Gund and Paul 1950 - [831]

* Heidenthal and Clark 1951 - [1254]

* Heidenthal 1952 - [998]

* Heidenthal et al. 1954 - [832]

* Heidenthal et al. 1955 - [833]

1191 Heidenthal, G. GENETIC EFFECTS OF X-RAYS AND CATHODE RAYS ON OÖCYTES OF HABROBRACON. Genetics 45 (1960) 633-9.

This paper is concerned with the problem of difference in dose rate. Are genetic effects the same, or different, when dose rates are widely different, but total dose accumulated the same? A conventional 124 kV x-ray machine was used for the low dose rate work; an electron beam generator which yielded a rate as high as 5000 r/s was the source of high dose rates. The materials irradiated were Habrobracon oöcytes in first meiotic prophase and metaphase stages. These were studied for hatchability or presence of dominant and recessive lethals. $F_1$ virgin females were reared from prophase oöcytes treated with 12 000 r. These were tested for heterozygosity with respect to recessive lethals. The data so accumulated indicate that with these materials, when total doses of x-rays and cathode rays are the same, the wide difference in dose rate has no significant effect. (auth.)

1192 Herskowitz, I. H. THE JOINABILITY OF CHROMOSOME BREAKAGE POINTS PRODUCED BY X-RAYS IN DROSOPHILA OÖCYTES. Science 119 (1954) 581.

Oöcytes, containing an attached-X but no Y chromosome, were x-rayed with 1000 and 4000 r to obtain the detachments of the arms of the attached-X, which in Rapoport's view represent "healed" breakages. The data indicate a less random distribution of the breakage points among the autosomes partaking in translocations in the case of oöcytes than is known for spermatozoa. These observations make untenable the view

that new telomeres are formed following x-ray breakage of oöcyte chromosomes. They suggest that the orientation of the chromosomes during and after irradiation is a major factor influencing the numbers and kinds of joinings by points of chromosome breakage. (from abstr.)

1193 Herskowitz, I. H., Abrahamson, S. THE EFFECT OF X-RAY INTENSITY ON THE RATE OF SEX-LINKED RECESSIVE LETHAL MUTATION INDUCED FOLLOWING TREATMENT OF DROSOPHILA OÖCYTES. Drosophila Inform. Serv. 29 (1955) 125.

A concentrated treatment of oöcytes with about 3264 r produced significantly more sex-linked recessive lethals than did this dose delivered in a protracted manner. The data obtained strongly suggest that as many as half the lethals produced by the intense treatment are connected with multiple x-ray hits.

1194 Herskowitz, I. H. STUDIES ON THE NATURE OF RECESSIVE LETHAL MUTATIONS INDUCED IN OÖCYTES BY X-RAYS. Drosophila Inform. Serv. 30 (1956) 117-8.

Two types of adult female Drosophila ("rod/rod" and "rod/ring") were irradiated with 2300 r either in 94 s or over a 25 min period. Intense or protracted irradiation was given. About 20% more eggs were laid by rod/ring than by rod/rod females following intense treatment but this could not account for the significantly higher mutation rate of the rod X in the rod/rod female. The intensity effect on lethals demonstrates that a considerable proportion of such mutations induced in oöcytes are multi-hit events. Since it is known that broken ends produced by x-rays in oöcyte chromosomes can join soon after their production, it is suggested that the intensity-dependent lethals are connected in their origin with multi-break exchanges. Such exchanges could include small deficiencies and duplications acting as recessive lethals produced by "pseudo crossing over" — intra-tetrad exchange between nearby but nonhomologous loci.

1195 Herskowitz, I. H. A RELATIONSHIP BETWEEN TRANSLOCATION FREQUENCY AND AGE AT FERTILIZATION FOR SPERM X-RAYED IN FEMALES OF D. MELANOGASTER. Genetics 42 (1957) 375-6.

II-III translocation frequencies were determined in $F_1$ males from successive groups of eggs laid following treatment of inseminated females with approximately 3360 r. For the first 4 consecutive 4-d oviposition periods after treatment the rates, combined for different experiments, were, respectively, 12.3% (111/906), 14.1% (203/1432), 16.8% (201/1194), and 19.7% (115/584). (The same dose given to females before mating resulted in only one translocation in 1814 tests, hence the above translocations were paternal.) The translocation rate also increased in successive broods in each separate experiment even though the irradiation was delivered in different ways, continuously either at 1000 r/min or 1900 r/min, or discontinuously at 1900 r/min, as described in the preceding abstract.

(Abstract of paper presented at the 1957 meetings of the Genetics Society of America, Stanford, California, 26-28 Aug. 1957)

1196 Herskowitz, I. H. INTENSITY-INDEPENDENCE OF TRANSLOCATIONS FROM SPERM X-RAYED IN FEMALES OF D. MELANOGASTER. Genetics 42 (1957) 375.

Approximately 3360 r were delivered to inseminated females at about 1900 r/min either (A) continuously (in 1 min 45 s) or (B) interruptedly (in 49 min 45 s) in seven 15-s irradiations given 8 min apart. The continuous treatment was also given to virgins subsequently mated with untreated males (C). The II-III translocation rates for all $F_1$ males tested were 0% for C (no translocations in 422 tests), 14.3% for A (121/844), and 13.7% for B (135/982). Included here are counts for A and B of all $F_1$ males from eggs laid in the first 4 successive 4-d periods following irradiation. When individual 4-d periods were compared, the differences between results for A and B remained without significance (note following abstract). It is concluded that under these experimental conditions protracting the irradiation has no significant effect on translocation rate.

(Abstract of paper presented at the 1957 meetings of the Genetics Society of America, Stanford, California, 26-28 Aug. 1957)

1197 Herskowitz, I. H., Abrahamson, S. INDUCED CHANGES IN FEMALE GERM CELLS OF DROSOPHILA. I. DEPENDENCE OF HALF-TRANSLOCATION FREQUENCY UPON X-RAY DELIVERY RATE. Genetics 41 (1956) 420-8.

Half-translocations (of the type in which an attached-X chromosome is broken into two arms, only one of which is retained in the egg after joining eucentrically to a piece of another broken chromosome, the other, reciprocal, pieces becoming lost) were employed as a measure of multi-break chromosomal rearrangements induced by x-rays administered at various concentrations to D. melanogaster oöcytes. Higher concentrations

produced more half-translocations than lower ones, proving that breaks in oöcytes can join in new arrangements before fertilization, not as breaks in fully mature spermatozoa (those in inseminated females). The results show that, of the joinings which will take place, the great majority do so within 8 h, and that about 1/2 do so within 4 h. Under certain experimental conditions at least 1/2 the breaks that join can do so within 1/4 h, but under other conditions joinings in this period were not detected. The relation of the results to earlier work on the dosage-frequency relationship for half-translocations is discussed and the influence of a modified Y chromosome on their increased frequency is confirmed. It was found again that, among oöcytes oviposited during the first 4 d following treatment, there were significantly more mutations in the eggs laid in the first days than in those oviposited later. There was also a significant decrease in fecundity of the parent females in this 4-d period when the treatments were more concentrated. (from auth.)

1198 Herskowitz, I. H., Schalet, A. INDUCED CHANGES IN FEMALE GERM CELLS OF DROSOPHILA. V. THE CONTRIBUTION OF HALF-TRANSLOCATION AND NONDISJUNCTION TO THE DOMINANT LETHALITY INDUCED BY X-RAYING OÖCYTES. Genetics 42 (1957) 648-60.

Experiments are described which determined the frequencies with which about 2000 r delivered in an intense manner to oöcytes produced real and apparent nondisjunctions of the X chromosome or eucentric half-translocations resulting in mature eggs hyperploid for all or almost all of IIR. The product of the latter event, inviable in the egg stage after fertilization by normal sperm, was made viable, by crossing treated females to males which produce sperm some of which are hypoploid for IIR, and also recognizable, by both parents having their chromosomes suitably marked with genetic factors. The genetic basis for at least 1/9 of the 40% egg mortality induced by 2000 r, including 1/6 of the established intensity-dependent component, is accounted for, following analysis of the data obtained. (from summary)

* Herskowitz 1957 - [1140]

1199 Herskowitz, I. H., Abrahamson, S. INDUCED CHANGES IN FEMALE GERM CELLS OF DROSOPHILA. IV. DEPENDENCE OF INDUCED CROSSOVER-LIKE EXCHANGES IN OÖCYTES AND OÖGONIA UPON X-RAY INTENSITY. Genetics 42 (1957) 444-53.

The frequency of x-ray induced crossovers depend on the way in which the treatment is given; it reaches a maximum when the full dose is applied at one time, and reduced with a fractionated dose.

1200 Herskowitz, I. H. GENETIC RECOMBINATION INDUCED BY X-RAYS IN FEMALE GERM CELLS OF DROSOPHILA. p. 118 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958.

The kinds and frequencies of x-ray induced genetic recombination in female germ cells of Drosophila depend upon their stage in differentiation. In most mature cells many breaks are produced. Some rejoining occurs soon after certain treatments, but is delayed after higher doses are delivered more quickly. The effects of irradiating progressively immature germ cells are described.

1201 Herskowitz, I. H. INDUCED CHANGES IN FEMALE GERM CELLS OF DROSOPHILA. VI. THE EFFECT OF DEHYDRATION UPON THE X-RAY-INDUCED FREQUENCIES OF CROSSOVER-LIKE EXCHANGES AND OF GROSS CHROMOSOMAL REARRANGEMENTS. Genetics 44 (1959) 329-39.

Dehydration of Drosophila melanogaster females significantly increases the rate of crossover-like exchanges induced by x-rays in the proximal region of the X chromosome (between carnation and the centromer). This dehydration effect was found in eggs laid both at the beginning and end of the first 8 days after irradiation, that is, periods when the eggs at the time of irradiation were past, and before or during, the stage of spontaneous crossing over, respectively. The frequency of gross chromosomal rearrangements, as detected by detaching attached-X's, induced by x-rays is also increased by prior maternal dehydration. These results permit the hypothesis that the increase in egg mortality, obtained earlier when dehydration preceded x-raying, has a genetic basis, and that on this view it is to be considered as resulting from dominant lethal mutations. Although no cytological study was made, it is suggested that the dehydration effect may have been produced by shrinking nuclei, resulting in an increased chance for broken ends to interchange rather than restitute. (auth.)

* Herskowitz and Baumiller 1959 - [1001]

1202 Herskowitz, I. H., Muller, H. J., Laughlin, J. S. THE MUTABILITY OF 18 MeV ELECTRONS APPLIED TO DROSOPHILA SPERMATOZOA. Genetics 44 (1959) 321-7.

Sperm in inseminated females were either untreated or treated with 600, 1500 or 3750 rads of 18 MeV electrons and different types of mutation involving the paternal chromosomes were detected among the offspring. Partial or complete sex chromosome loss increased slightly, but significantly, faster than linearly with dose; II-III reciprocal translocations increased approximately as the 3/2 power of the dose; and sex-linked recessive lethal mutations increased approximately linearly with dose. The shapes of all three curves are in good agreement with previous x-ray results. (auth.)

* Hirobe and Oi 1958 - [1556]

1203 Ives, P. T. RELATIONSHIP BETWEEN RADIATION DOSE AND DOMINANT VISIBLE MUTATION RATE IN DROSOPHILA MELANOGASTER. Genetics 44, 2 (1959) 967-78.

Over a broad dosage range, the relationship between rate of sex-linked lethal mutations and radiation dose ($Co^{60}$ $\gamma$-radiation was used) is apparently linear. Results of tests are presented on the frequency of easily seen visible mutations, chiefly autosomal dominants, at 10 dosage levels in the 0.5 kr to 10 kr range. Their relation to data from the sex-linked lethal tests is discussed. The total mutation rate increased as the 1.2 power of the dose between 0.5 and 4 kr, and as the 1.5 power at higher doses, suggesting a mixture of one-hit and two-hit mutations at the lower doses and chiefly position effect rearrangements in the 5 - 10 kr range. The two-phase exponential rate-dose relationship observed for visibles is compared to the linear relationship observed for X-lethals and is attributed in part to the apparently much lower proportion of chromosomal rearrangements in lethal X chromosomes and, in part, to a combination of other factors which are discussed.

* Kaufman and Wasserman 1957 - [1121]

* Kenworthy 1954 - [1393]

* King 1955 - [1013]

* King and Wood 1955 - [1012]

* King et al. 1956 - [1014]

* King 1957 - [917]

* King 1958 - [1015]

* Kishin 1955 - [1146]

* Kogure and Nakajima 1958 - [1147]

1204 Koiwai, S. MEIOTIC ABNORMALITIES INDUCED BY THE EXPOSURE TO RADIUM IN GRASSHOPPER (PODISMA SAPPORENSE) SPERMATOCYTES. Jap. J. Genet. 32, 5 (1957) 165-7. (In Japanese, summary in English)

Nymphs of a grasshopper (Podisma sapporense) were exposed to Ra in two groups for 1 and 3 h. Various kinds of meiotic abnormalities were found to occur in the first and second meiotic divisions of male germ-cells. They were as follows: coalescence and stickiness of chromosomes, formation of chromosome bridges, varying numbers of chromosomes, irregular arrangement of chromosomes in the metaphase plate fragmentation of chromosomes. The types of abnormality closely resembled that caused by a treatment with high or low temperature, and by exposure to supersonic waves.

* Lamarque 1951 - [1282]

* Lamarque 1952 - [1283]

* Lamarque and Gary-Babo 1956 - [838]

* Langendorff and Sommer 1950 - [1256]

* Lefevre 1950 - [1022], [1023]

* Lindsley et al. 1958 - [951]

1205 Lüning, K. G. X-RAY INDUCED DOMINANT LETHALS IN DIFFERENT STAGES OF SPERMATOGENESIS IN DROSOPHILA. Hereditas 38, 1 (1952) 91-107.

Wild type, $sc^{51}$ B In-S $w^a$ $sc^8$ (Muller-5) and y w sn males of Drosophila melanogaster were irradiated with 2900 r and mated immediately or after some days in mass or in pair cultures to y w sn females. In most series the males were transferred to new females every single or every third day. In the first 5 d after treatment the rate of dominant lethals is practically constant. There is then a more or less sharp increase in the rate, which remains until the 11th day when there is a sharp decrease which continues to the 20th day. Males irradiated at an age of 0 - 1 d showed a sharper increase in the rate of dominant lethals than males which were 6 - 7 d at treatment. (from auth. summary)

1206 Lüning, K. G. X-RAY INDUCED CHROMOSOME BREAKS IN DROSOPHILA MELANOGASTER. Hereditas 38, 3 (1952) 321-38.

Details of irradiation and mating procedures are given. A much higher rate of x-ray induced chromosome aberrations was observed in spermatids than in spermatozoa whereas the rates of induced recessive lethals showed little difference. Sensitivity is found to be not only dependent on the stage of spermatogenesis treated but also on the age of the male being treated. The implications of the discrepancy between the results of dominant lethals and hyperploid males versus gene mutations and gynandromorphs are discussed; it is supposed that — at least in some stages — breaks are induced that are not associated with gene mutations.

1207 Lüning, K. G. THE BREAKABILITY OF CHROMOSOMES IN DROSOPHILA MELANOGASTER SPERMATOZOA AFTER X-RAY IRRADIATION OF IMPREGNATED FEMALES AND OF MALES. (abstr.) p. 893 in "Proceedings of the 9th International Congress on Genetics, Bellagio, Italy 1953", Suppl. to Caryologia 6. Montalenti, G., Chiarugi, A., eds. Florence, 1954.

In a recent study it was shown that a higher rate of sex-linked lethals is induced in Drosophila melanogaster spermatozoa when these are x-ray irradiated in impregnated females than when irradiated in males. It has also been shown that the rate of chromosome breaks varies during spermiogenesis. Therefore, in order to investigate if the differences in the rates of sex-linked lethals also could be due to differential breakability of the chromosomes, a comparison was made of the rates of certain types of mutations which were known to be the result of intergenic rearrangements. These types were: yellow mutations produced by irradiation of the "Muller-5" X-chromosome of males; and hyperploid males produced after irradiating of both "Muller-5" and of Canton-S males. Furthermore, by a special technique, the rates of losses of whole X- and Y-chromosomes were checked. In all these cases the rates were higher when the spermatozoa were irradiated in impregnated females than when irradiated in males. By analogy, then, it is supposed that it is an increase in breakability of the chromosomes which is responsible for the higher rate of sex-linked lethals in the paternal chromosomes when comparison is made between irradiation of impregnated females and irradiation of males.

* Lüning 1954 - [1400]

1208 Lüning, K. G. VARIATIONS IN THE BREAKABILITY OF CHROMOSOMES IN MATURE SPERMATOZOA OF DROSOPHILA MELANOGASTER AT DIFFERENT MODES OF IRRADIATION. Heredity 8, 3 (1954) 211-33.

Slightly more recessive lethals are induced in spermatozoa when irradiated within females than when in males (cf. Bonnier and Lüning, 1953). It is now shown that the same is true for minute and gross rearrangements and chromosome losses. It is suggested that more breaks are induced at irradiation of spermatozoa in females than in males. The difference is greater than that for recessive lethals, to be expected on the hypothesis that only part of the recessive lethals are due to breaks, and the rate of break-independent recessive lethals is not at all, or only to a very low degree, influenced by the mode of irradiation. (from auth.)

(A brief note on the same subject was published in Drosophila Inform. Serv. 27 (1953) 99, when a higher percentage of chromosome breaks and an increase in recessive lethals were reported for sperm irradiated in females.)

1209 Lüning, K. G. STUDIES ON INDUCED MUTATIONS IN MALE AND FEMALE GERM LINES OF DROSOPHILA MELANOGASTER. Hereditas 42 (1956) 483-6.

A comparison of the mutagenic effects of x-rays on mature sperm and oöcytes shows a difference for two types of mutation, fractionals and variegated-yellow mutations. In sperm a rather high rate of fractionals is induced, rare in oöcytes. A considerable frequency of variegated-yellow mutations are, on the other hand, induced in oöcytes, a type rarely induced in sperm. A locus known "frequently" to mutate to variegated-states, i.e. white, did not show such a predominance in irradiated oöcytes. This shows that the mutation spectrum within a very small chromosomal region may differ appreciably between the sexes.

1210 Lüning, K. G., Jonsson, S. EFFECT OF FAST NEUTRONS ON DIFFERENT STAGES OF SPERMIOGENESIS IN DROSOPHILA MELANOGASTER. Nature 178 (1956) 1123-4.

1-24 h old males were irradiated by fast neutrons, and then subsequently mated to virgin females at intervals of 24, 48 and 96 h after irradiation. The offspring were analysed. It would appear that fast neutrons induce about the same rate of chromosome breaks in sperm to be inseminated during the first two days but a significantly higher rate in sperm matured for the 5th-6th day mating period. This is in agreement with the results after x-ray irradiation and consistent with the hypothesis of a differential sensitivity of various stages in spermiogenesis. It is, however, not possible to determine whether the degree of sensitivity is the same for x-rays and fast neutrons.

* Lüning and Jonsson 1957 - [1031]

* Lüning 1958 - [1288]

* Lüning and Hendriksson 1959 - [1290]

* Mossige and Oftedal 1958 - [842]

* Muller et al. 1954 - [1038]

1211 Muller, H. J., Valencia, R. M., Valencia, J. I. THE PRODUCTION OF MUTATIONS AT INDIVIDUAL LOCI IN DROSOPHILA BY IRRADIATION OF OÖCYTES AND OÖGONIA. (abstr.) Genetics 35 (1950) 126.

To study mutagenesis in interphase nuclei, females undergoing semi-starvation were x-rayed with 4600 r and then passed through a series of cultures, usually at 4-d intervals. Offspring from first cultures represented irradiated later oöcytes, with chromosomes relatively condensed, and those from later cultures "resting" oögonia or, more rarely, early oöcytes, with chromosomes attenuated. The results are summarized. None of the mutations analysed involved gross rearrangements. Chromosome breakage evidently occurs as frequently here as in spermatozoa, but union of fragments must occur fairly promptly, i.e. prior to the movements of the meiotic divisions. (from auth.)

* Muller and Valencia 1951 - [1036]

1212 Murati, K., Itô, T., Moriwaki, D., Yoshida, Y. H. AFTER EFFECT OF IRRADIATION OF THE GERM CELL OF DROSOPHILA MELANOGASTER. p. 256-9 in "Proceedings of the International Genetics Symposia, Tokyo & Kyoto, Sep. 1956". Suppl. to Cytologia 1957. Tokyo, Science Council of Japan. 1957, 702p.

Some adult males which had been x-irradiated with 6. 60 r and 4400 r were immediately mated with females, others only after 4, 8, 12, 16 and 20 d. Measured in terms of the egg-hatching rate, the rate of dominant lethals for both sets of experiments gave a steep rise between the 2nd and 10th day after irradiation, with a continued drop thereafter. With a different system of mating, irradiation by 3000 r gave a lethal rate of 7. 0% on the 5th day, and 2. 1% on the 19th day after treatment.

* Murphy 1954 - [1402]

* Nakanishi 1959 - [871]

1213 Nakao, Y. X-RAY-INDUCED VISIBLE MUTATION RATES AT THREE STAGES IMMEDIATELY AFTER OVIPOSITION IN THE SILKWORM. Radiation Res. 9 (1958) 158-9.

In the silkworm, the eggs are laid at the stage of anaphase of the first meiotic division. The second meiotic division begins 60 min after oviposition, and finishes in 20 min. The fusion of male and female pronuclei requires about 40 min thereafter. Therefore, the time between egg-laying and fertilization of pronuclei is about 2 h at 25°C. The mutation rates and the rates of lethality induced by x-rays were examined dividing this time into three stages. As the markers, egg colour mutants were used. In the silkworm, pe and re are located on the chromosome V at 0.0 and 31.7. Both of them control the colour of the egg (and also of the eye) which is a character of the $F_1$ generation. Whereas the normal colour is black, pe/pe eggs are white and re/re eggs are red. Eggs homozygous for both pe and re are also white. Eggs collected from the mating of ++/++ females with pere/pere males were divided into three groups of 0-40 min, 40-80 min and 80-120 min after oviposition. Each of them was irradiated with the doses of 768 r and 1536 r of x-rays (x-ray apparatus was operated at 80 kV potential and 4 mA and the dose rate was 192 r/min). The mutation rates were calculated as the percentages of the eggs of deficient types (white or red eggs, including mosaic eggs for white or red) in the total pigmented eggs. The lethalities were also examined; susceptibility of the eggs gradually increased with progress of the stages.

(Abstract of paper presented at the Intern. Congr. of Radiation Research, Burlington, Vermont, USA, 10-16 Aug. 1958)

1214 Narayanan, E.G., Ratan Lal, Rahalkar, G.W., Sethi, G.R., Saxena, P.N. STUDIES ON THE EFFECT OF BETA RADIATIONS ON INSECTS. I. EFFECT OF BETA RADIATIONS (IRRADIATION OF EGGS AND 1ST INSTAR LARVAE) ON THE LIFE HISTORY OF CORCYRA CEPHALONICA STAINTON. Proc. Indian Acad. Sci., Sec. B 50 (1959) 82-7.

* Nickerson 1959 - [1516]

1215 Ohnuki, Y. PHASE CINEMATOGRAPHY STUDIES ON THE EFFECTS OF RADIATION AND CHEMICALS ON THE CELL AND THE CHROMOSOMES. I. TYPES OF X-RAY INDUCED CHROMOSOME ABNORMALITIES IN GRASSHOPPER SPERMATOCYTES, WITH A NOTE ON THE NORMAL COURSE OF THE FIRST DIVISION AS CONTROL. J. Fac. Sci. Hokkaido Univ. Ser. VI, 14 (1958) 83-91.

1216 Ohnuki, Y., Makino, S. PHASE CINEMATOGRAPHY STUDIES ON THE EFFECTS OF RADIATION AND CHEMICALS ON THE CELL AND THE CHROMOSOMES. II. FORMATION OF ANUCLEAR BUDS, CONTINUATION OF CHROMOSOME STICKINESS AND FORMATION OF AN ACCESSORY NUCLEUS IN GRASSHOPPER SPERMATOCYTES FOLLOWING X-IRRADIATION. Tex. Rep. Biol. Med. 18 (1960) 66-74.

1217 Oster, I.I. MODIFICATION OF X-RAY MUTAGENESIS IN DROSOPHILA. I. REUNION OF CHROMOSOMES IRRADIATED DURING SPERMIOGENESIS. Genetics 40 (1955) 692-6.

The ends of chromosomes broken during spermiogenesis undergo reunion before fertilization while the breaks produced in mature spermatozoa remain open and reunite during fertilization. In these stages of germ cell development prior irradiation does not lead to an alteration in their reactions to subsequent doses of x-rays. (auth.)

1218 Oster, I.I. (Indiana Univ., Bloomington, USA) EXPERIMENTS FOR THE MODIFICATION OF X-RAY MUTAGENESIS IN DROSOPHILA MELANOGASTER. Diss. Abstr. 16, 11 (1956) 2248. Thesis, 60 p.

In order to obtain further information about the conditions affecting the sensitivity of germ cells to the induction of mutations by ionizing radiation, a series of experiments was undertaken which involved studying the effects of varying different cytophysiological factors or adding supplementary chemical treatments [mustard gas (ββ'-dichlorodiethyl sulfide), urethane (ethyl carbamate), colchicine and acenaphthene] on the radiosensitivity of Drosophila melanogaster. A number of specially constructed stocks which allowed for the detection of the frequencies of induced chromosome loss, lethal mutations, and translocations were used. Modified mating procedures insured that the germ cells which were treated and tested were relatively homogeneous as regards their stage of development. An analysis of the results obtained from fractionating the dose delivered to spermatozoa and spermatids confirmed the fact that chromosome breaks produced by x-rays in mature spermatozoa do not undergo restitution or reunion until fertilization whereas breaks induced during the spermatid stage were found to undergo joining during spermiogenesis. Spermatids were shown to represent the most radiosensitive stage of germ cell development. The possible cause(s) for the similar

rates obtained after irradiating spermatids and spermatozoa bearing either a rod, a ring or Novitski's X and the dissimilar ones obtained after treating the same chromosome types during the spermatogonial stage are discussed.

1219 Oster, I. I. MODIFICATION OF X-RAY MUTAGENESIS IN DROSOPHILA. RELATIVE SENSITIVITY OF SPERMATIDS AND MATURE SPERMATOZOA. p. 475-80 in "Advances in Radiobiology. Proceedings of the 5th International Conference on Radiobiology, Stockholm 15-19 Aug. 1956". de Hevesy, G. C., Forssberg, A. G., Abbatt, J. D., eds. London, Oliver and Boyd, 1957.

A series of experiments showed that spermatids represent the most radiosensitive stage of gametogenesis in Drosophila. This did not appear to be due merely to a separation of broken chromosomes favouring disarrangement of pieces during spermiogenesis.

* Oster 1957 - [919]

1220 Oster, I. I. FREQUENCY-DOSAGE RELATIONS FOR MUTATIONS FOLLOWING X-IRRADIATION OF SENSITIVE AND RESISTANT GERM CELLS. p. 210 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958.

Since it is now well established that even the post-meiotic stages of spermatogenesis of Drosophila differ tremendously in their radiosensitivity and since knowledge of the relationship of lethal mutation frequency to dosage employed has a bearing on the interpretation of mutational mechanisms it was decided to reinvestigate this problem with the latest genetic techniques available. Homogeneous samples of the most radiosensitive and the most radioresistant stages of gametogenesis, represented by spermatids and oögonia, respectively, were treated. X-raying spermatids yielded 195/8978 (i. e., lethals among tested chromosomes) for 250 r and 130/1859 for 1000 r, while the controls gave 19/2392. This gives induced rates of 1. 38 ± 0. 24% and 6. 20 ± 0. 39%, indicating a linear relationship. The translocation frequencies obtained were 1. 32 ± 0. 20% (45/3421) and 9. 65 ± 0. 75% (148/1533), thereby showing a rise for these multi-break events proportional to $(dose)^{1.4}$. Irradiation of oögonia in third instar larvae yielded 117/16 064 for 600 r and 33/2056 for 2400 r, while the controls gave 49/11 630. This gives induced rates of 0. 31 ± 0. 09% and 1. 19 ± 0. 30%, again a linear relationship. For equal doses, spermatid frequencies were 12 times oögonial frequencies. Special methods ruled out the presence of pre-existing lethals as well as the inclusion of large clusters of mutations arising from one mutated cell by mitotic division. Thus at the dosages studied the strictly linear relation of lethal frequency to dosage employed was upheld for the most radiosensitive germ cells and extended to the least sensitive ones known in Drosophila. (from abstr.)

1221 Oster, I. I. RADIOSENSITIVITY. Genen en Phaenen 3 (1958) 53-66.

The condensed state of the chromosomes of many organisms is the most sensitive to x-rays. A comparison of the radiosensitivity of Drosophila melanogaster spermatids and spermatozoa, both having condensed chromosomes, indicated that some other factor(s) is responsible, in part at least, for the greater sensitivity of the former cells. X-irradiation of mature sperm and spermatids in either nitrogen, air or oxygen which indicated a relatively greater effect of reducing the oxygen tension and a relatively lesser effect of increasing the oxygen tension from that present in air on the radiosensitivity of spermatids as compared to spermatozoa lends support to the suggestion that the high sensitivity of spermatids may at least in part be due to more intra- and/or inter-cellular oxygen being normally present (or available) in these cells. It would be of interest to determine whether such a mechanism can account for the variations noted in the radiosensitivity of other chromosomes having otherwise similar morphological properties. (auth.) (NSA 14: 47, 1960)

* Oster 1958 - [1404]

* Oster et al. 1959 - [1049]

1222 Oster, I. I. THE SPECTRUM OF SENSITIVITY OF DROSOPHILA GERM CELL STAGES TO X-IRRADIATION. p. 253-67 in "Radiation Biology. Proceedings of the 2nd Australasian Conference held at the University, Melbourne 15-18 Dec. 1958". Martin, J. H., ed. New York, Academic Press Inc., and London, Butterworths Scientific Publ. 1959.

Various external and internal conditions are known to affect the sensitivity of chromosomes to ionizing and nonionizing radiations. Although there is no a priori reason to believe that one or even similar mechanisms underlie the sensitivity of all cell stages and organisms to radiation, it seems reasonable to suppose that

elucidation of the variation in the sensitivity of different cell stages of one cell type under a variety of conditions may help to shed light on the basis for the different differences in radiosensitivity among different organisms. It was found that the fruit fly, Drosophila melanogaster, is most suited for such a determination of sensitivity, since not only can induced heritable variations be easily detected and analysed, but techniques are available which ensure that one is treating and testing cells that represent homogeneous samples of distinct stages of mitosis or meiosis. The procedure is outlined which was used in the treatment of the male germ cells of the fruit fly. The results show that although the spermatid stages received less than one-half as much radiation as the spermatozoa in the female, they yielded one-half again as many translocations. Results of the x-irradiation on cell stages in the male and female Drosophila melanogaster are tabulated. (NSA 14: 24011, 1960)

1223 Ott, A.H. DIE STRAHLENINDUZIERTE MUTATIONSRATE FÜR REZESSIV GESCHLECHTSGEBUNDENE LETALFAKTOREN IN SPERMATOGONIEN UND REIFEN SPERMIEN VON DROSOPHILA MELANOGASTER NACH BESTRAHLUNG IN LUFT UND STICKSTOFF (The radiation-induced mutation rate for recessive sex-bound lethal factors in spermatogonia and mature sperm of Drosophila melanogaster after irradiation in air and nitrogen). Strahlentherapie 110 (1959) 57-65. (In German)

The mutation rate (MR) for recessive sex bound lethal and semilethal factors was determined on sperms of Drosophila melanogaster which fertilized 0 to 24 ± ½ h and spermatogonia which fertilized 21 to 24 d after irradiation by 2000 r in air. On irradiated mature sperms a MR of 3.42% for lethal and of 0.73% for semilethal factors was found. After irradiation of spermatogonia 0.41% lethal and 0% semilethal factors were observed. Therefore about 9 times more recessive lethal factors were observed on the mature sperms than on the spermatogonia. The same types of germ cells were irradiated in pure nitrogen with the same dose and the MR determined for lethal and semilethal factors. On sperms a MR of 2.86% lethal and 0.30% semilethal factors was found. On spermatogonia the MR was 0.40% lethal and 0.20% semilethal factors. The presence of pure nitrogen during the irradiation therefore has no protective effect on the formation of recessive sex bound lethal factors in spermatogonia. There seems to be a slight protective effect in mature sperms which is, however, not well enough founded by statistical data. (auth.)

1224 Parker, D.R., Hammond, A.E. THE PRODUCTION OF TRANSLOCATIONS IN DROSOPHILA OÖCYTES. Genetics 43 (1958) 92-100.

Attached-X female Drosophila oöcytes of various ages were irradiated, and the frequency of detachment determined in females of various ages. There is an increase in radiation sensitivity of oöcytes with aging up to 3 d, after which there is no evident increase. A two-hit formation of detachment is found both in young and old oöcytes. Dose fractionation experiments show that breaks in stage 7 rejoin in about 10 min, while those in stage 14 do not rejoin until fertilization. There is evidently a change in the proportions of the various kinds of exchanges obtained when females are aged before treatment. Speculations are made as to the possible role of cytochrome oxidase activity in the changing sensitivity of oöcytes. (auth.)

* Parker and McCrone 1958 - [955]

1225 Parker, D.R. DOMINANT LETHAL MUTATION IN IRRADIATED OÖCYTES. Univ. Tex. Publ., Biol. Contribs. 5914 (1959) 113-27.

Dominant lethals induced in stage 7 were found to follow a "2-hit" curve, while those in stage 14 were "1-hit". Evidence of participation of breakage and rejoining of chromosomes in the origin of dominant lethals is given by the finding that fractionation of the irradiation decreases while centrifuging after irradiation increases the incidence of dominant lethals in stage 7. Evidence that sister unions may occur following irradiation is given by the induction of compound X's by irradiation of inversion heterozygotes. This shows that anaphase II bridge formation might account for some dominant lethality.

(An abstract of earlier work "The origin of dominant lethals in irradiated oöcytes of Drosophila" appeared in Genetics 40 (1955) 589)

1226 Parker, D.R. THE INDUCTION OF RECESSIVE LETHALS IN DROSOPHILA OÖCYTES. Genetics 45 (1960) 135-8.

Recessive lethal induction by x-irradiation of stages 7 and 14 of primary oöcytes of Drosophila melanogaster was studied. Stage 14 gives about a twofold increase in lethals over stage 7. There is evidence for the occurrence of some two-hit lethals. Speculation is made on possible relations between sensitivity changes, breakage and rejoining, and recessive lethals. (auth.) (NSA 14: 13606, 1960)

* Passonneau 1954 - [1321]

* Ray 1957 - [875]

* Ray 1958 - [876]

1227 Ray-Chaudhuri, S. P., Ghosh, T. N., Nandi, A. K., Banerjee, G. C. X-RAY INDUCED CHROMOSOME BREAKS IN GRASSHOPPER SPERMATOCYTES UNDER VARYING CONDITIONS OF WAVELENGTH AND TEMPERATURE, AND THEIR LOCALIZATION. Proc. zool. Soc. Mookerjee Mem. (Calcutta) (1957) 115-28.

Male Gesonula punctifrons were irradiated with x-rays. The effects of different wavelengths on spermatocytes in terms of dicentric bridge formation were investigated. The chromosomes most frequently involved in bridge formation were those of medium length, not the longest. Distal breaks, i. e. relatively small fragments, are far more frequent than proximal ones. The number of dicentric bridges at longer wavelength is 3. 5 times greater, but as pointed out in the discussion, the ion density/$\mu$ at 200 kV, $\lambda = 0.06$ Å is 5 times greater than at 1000 kV, $\lambda = 0.01$ Å.

* Rogers and Borstel 1957 - [922]

* Rudnicki 1959 - [844]

* Sävhagen 1960 - [877]

1228 Schinz, H. R., Fritz-Niggli, H., Frey, E. EFFECT OF ULTRA-HARD RADIATION (31-MeV-BETATRON) ON THE EGGS OF DROSOPHILA MELANOGASTER. Experienta 8 (1952) 16-8. (In German)

The following $LD_{50}$'s were determined for Drosophila melanogaster eggs of 3-, 4-, and 7. 5-h age, respectively; 200, 460 and 825 r for 180-keV x-radiation; 200, 1225 and 1060 r for 3-MeV electrons; and 237, 1117 and 1167 r for 31-MeV x-radiation. Lethal-dose curves are plotted. Reasons for the lower biological effectiveness of the hard 31-MeV radiation are discussed. (NSA 6: 2266, 1952)

1229 St. Amand, W. RADIOSENSITIVITY OF THE UNFERTILIZED HABROBRACON EGG DURING MEIOSIS AND EARLY CLEAVAGE. (abstr.) J. Tenn. Acad. Sci. 31, 2 (1956) 138.

In Habrobracon oögenesis is arrested near the end of the first meiotic division, and meiosis continues only after passage of the egg through the ovipositor. Stage of meiosis or mitosis can be related to time after laying, and the radiosensitivity of division stages can be determined from the hatchability of eggs treated at known intervals after oviposition. Eggs from virgin females were collected as soon as laid and kept at 20°C. At intervals after oviposition, eggs were either fixed for cytological observation or given 500 r of x-rays (ca. $LD_{50}$ dose for unlaid arrested eggs) for hatchability testing. The "age" of each egg (oviposition to fixation or irradiation) is known to within 1 min. The results indicate that (1) eggs just before or just after oviposition are about equally radiosensitive; (2) the meiotic stages from the arrested stage to anaphase II show no great fluctuations of radiosensitivity; (3) the pronuclear stage is much more radiosensitive than is prophase of the first cleavage division, and (4) there is a progressive increase in radiosensitivity from the first to the third cleavage division.

* Stone et al. 1954 - [927]

* Strunnikov 1960 - [900]

* Tahmisian and Adamson 1950 - [1420], [1323]

* Tahmisian and Adamson 1951 - [928]

* Tahmisian and Vogel 1953 - [848]

* Tahmisian and Devine 1954 - [1327]

* Tahmisian and Wright 1956 - [1329]

1230 Tazima, Y. RADIOBIOLOGICAL STUDIES ON THE SILKWORM. I. X-RAY IRRADIATION DURING PUPA STAGE AND SENSITIVITY OF GERM CELLS. Papers from Coordinating Committee for Research in Genetics 2 (1951) 153-62. (In Japanese, with summary in English)

1231 Tazima, Y., Ohta, N. RADIOBIOLOGICAL STUDIES ON THE SILKWORM. II. ON THE SENSITIVITY OF MALE GERM-CELLS OF THE FIFTH INSTAR LARVA TO X-RAYS. (abstr.) J. seric. Sci., Tokyo 21 (1952) 157. (In Japanese)

1232 Tazima, Y. COMPARATIVE STUDIES ON THE DIFFERENTIAL SENSITIVITY TO RADIATION OF SILKWORM GERM-CELLS AT DIFFERENT STAGES OF THE GAMETOGENESIS. I. Jap. J. Genet. 32, 8 (1957) 262-3. (Idengaku Zasshsi) (In Japanese)

* Tazima 1957 - [901]

1233 Tazima, Y. EFFECT OF EXTERNAL IRRADIATION WITH β-RAYS UPON THE GERM-CELLS OF THE SILKWORM. Mishima. Nat. Inst. Genet. Annu. Rep. 7 (1956, pub. 1957) 76-8. (In Japanese)

1234 Tazima, Y. GENIC CONTROL OF X-RAY SENSITIVITY OF SILKWORM GERM-CELLS. Mishma. Nat. Inst. Genet. Annu. Rep. 7 (1956, pub. 1957) 78-9. (In Japanese)

1235 Tazima, Y. CHANGES IN SENSITIVITY OF SILKWORM GERM CELLS TO X-RAYS WITH DEVELOPMENT. Radiation Res. 9 (1958) 193.

The sensitivity pattern of the germ cells to x-rays was studied by irradiating successive stages of gametogenesis in both sexes of the silkworm. The germ cells of this animal develop almost synchronously with the development of the parents, so that they may be estimated by the developmental stages of the parents. Wild type females and/or males were irradiated with 250-4000 r at several stages of the parents and were mated to non-irradiated partners; and the numbers of eggs laid, of unfertilized eggs, and of eggs that succumbed at several embryonic stages were recorded. Irradiation of the female with 1000 r gave no marked changes in sensitivity among different stages of the germ cells, but with 2000 r yielded a remarkable decrease in the number of eggs laid in early irradiated groups. Incidence of late embryonic lethals increased gradually in the latter half of the pupal period as parents grew older. Male germ cells, however, responded quite differently. A markedly sensitive period was revealed in the early fifth stadium when the germ cells are mostly in early spermatocyte. Irradiation at other stages with the same dose was less deleterious, which indicates that the spermatogonium, spermatid and mature sperm are fairly resistant to x-rays. The results are mostly consistent with those obtained in Drosophila by many workers. Differential incidence of eggs succumbing at various embryonic stages suggests a theoretical explanation of the differential sensitivity of germ cells to x-rays.

(Abstract of paper presented at the Intern. Congr. of Radiation Res., Burlington, Vermont, 10-16 Aug. 1958)

1236 Tazima, Y. MUTATION RESPONSE PATTERN OF SILKWORM GERM CELLS TO X-RAYS. p. 291 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958.

The use of silkworms is advantageous for analyzing mutation response (sensitivity and mutability) of spermatogenic cells with some precision since most of the germ cells develop almost synchronously with the development of the parents in both male and female. X-irradiation was administered to male and female germ cells of silkworm at definite stages from larval instar to post-pupa at 250, 500, 1000, 2000, 3000 and 4000 r and mating was made to non-irradiated double recessive pe re partners. Response patterns were determined with respect to visible mutation rates at marked loci and dominant lethal mutation rates. In treated males, visible mutation rates showed their peak on the 6th day of stadium 5 (larva), i.e., mostly at the spermatid stage; dominant lethals reached a maximum on the 2nd day of stadium 5, approximately at the spermatocyte stage, which coincided with marked damage to germ cells. The irradiated female germ cells showed nearly the same mutation rates at relatively low levels throughout varieties of stages of oögenesis before mid-pupal stage, after which a sudden increase in mutation rate brought it to the same level as the peak in the male germ cells. The induced visible mutation rates per r were several times higher in spermatogonia and 10 times higher in mature sperms than corresponding Drosophila values. (from abstr.)

* Tazima and Onimaru 1958 - [1072], [1073]

* Tazima 1959 - [1332]

* Telfer and Abrahamson 1954 - [1266]

* Terzian 1958 - [1153]

* Traut 1960 - [1074]

* Ulrich 1951 - [880], [881]

* Ulrich 1953 - [882]

* Ulrich 1955 - [883], [884]

* Ulrich 1956 - [885]

* Vasterling 1952 - [1423]

1237 Welshons, W.J., Russell, W.L. THE EFFECT OF X-RAYS ON THE DROSOPHILA TESTIS AND A METHOD FOR OBTAINING SPERMATOGONIAL MUTATION RATES. Proc. nat. Acad. Sci., Washington 43 (1957) 608-13.

Histological observations were made on the testes of irradiated adult Drosophila males. These experiments indicate that both secondary spermatogonia and young spermatocytes are sensitive to the killing effects of x-rays. The destruction of these sensitive cells results in a period of temporary sterility following irradiation of adult males. Therefore, this sterile period can be relied upon to separate cells irradiated as spermatogonia from those irradiated at a later spermatogenic stage. It follows that radiation-induced spermatogonial mutations, uncontaminated by mutations at later stages in spermatogenesis, can be obtained from irradiated adult Drosophila males in much the same way that they have been obtained from male mice. (auth.)

* Whiting 1950 - [930]

* Whiting 1953 - [1424]

* Whiting 1954 - [1425]

* Whiting 1955 - [931]

* Whiting and Atwood 1955 - [1093]

* Whiting and Murphy 1955 - [1426]

* Whiting and Murphy 1956 - [1427]

* Witte and Sigmund 1952 - [1337]

* Yanders 1959 - [1338]

* Zirkle and Parrish 1950 - [852]

## I-C-4 LETHAL EFFECTS

1238 **Арифов, У.А., Гуманский, Г.А., Клейн, Г.А., Пашинский, С.З., Щенков, С.Н. К ВОПРОСУ МОРКИ И КОНСЕРВАЦИИ КОКОНОВ ТУТОВОГО ШЕЛКОПРЯДА ГАММА-ЛУЧАМИ. Изв.Акад.наук Узб.ССР, Серия Физико-мат. наук 2 (1957) 65-72.**

**Описаны опыты, проведенные с целью установления дозы гамма-облучения, необходимой для полного умерщвления куколок коконов тутового шелкопряда. Были отобраны куколки шелкопряда весенней выкормки (май-июнь) и подвергнуты облучению от источника Co-60 активностью 15 кюри. Смертельной дозой следует считать дозу не менее 340 000 р при данной мощности**

дозы. Было также установлено, что при одинаковой дозе облучения скорее гибнут куколки зрелостью до 5 суток (при дозе 240 000 р ), тогда как куколки в возрасте выше 5 суток гибнут при 340 000 р. Следует поэтому при облучении живых куколок различной зрелости применять дозу в 340 000 р. Кроме того, дальнейшее хранение коконов с умервщленными куколками в различных атмосферных условиях показало, что морка коконов гамма-лучами не только пастеризует их, но и делает вещество куколки неподходящей средой для развития микроорганизмов. Растворимость серецина облученных коконов несколько снижается: если у контроля (живые коконы) растворимость составляет 10,11%, то при облучении дозой в 340 000 р она - 8,80%, а при дозе в 740 000 р - 8,22%.

Arifov, U. A., Gumansky, G. A., Klein, G. A., Pashinsky, S. Z., Shchenkov, S. N. KILLING AND PRESERVING SILKWORM COCOONS BY γ-RAYS. Izv. Akad. Nauk Uzbek. SSR., Ser. fizikomatem. Nauk 2 (1957) 65-72.

Experiments were carried out to find the dose necessary for killing silkworm pupae at the cocoon stage. Spring (May-June) pupae were exposed to radiation from a 15 c $Co^{60}$ source. The lethal dose was found to be < 340 000 r at a given dose rate. Pupae younger than 5 d were found to be more susceptible to radiation than older ones, the lethal dose of 240 000 r needing to be increased to 340 000 r for older pupae. For irradiating live pupae of different maturity a dose of 340 000 r should therefore be applied. Gamma-radiation used for killing the pupae was found not only to sterilize them but to make the pupal substance unsuitable for developing microorganisms. The solubility of sericin of irradiated cocoons decreased slightly: from 10. 11% of controls (live cocoons) the values dropped to 8. 80% after irradiation by 340 000 r, and 8. 22% after 740 000 r.

1239 Baker, V. H., Taboada, O., Wiant, D. LETHAL EFFECTS OF ELECTRONS ON INSECTS WHICH INFEST WHEAT AND FLOUR - PART I. Agric. Engng 34 (1953) 755-8.

A Van de Graaff accelerator was used as electron source. Insects such as Tribolium confusum and Sitophilus granarius (L.), which infest flour and wheat respectively, were studied. An electron dose of $10^5$ rep sterilized eggs of the confused flour beetle and the granary weevil; the same dose prevented the adults from reproducing. A dose of $5 \times 10^5$ rep proved lethal to adults of both insects. Wheat was damaged by a dose of $10^5$ rep which allowed it to germinate but inhibited further growth. A slight change was detected in the taste of bread made from irradiated flour.

1240 Baker, V. H., Taboada, O., Wiant, D. E. SOME EFFECTS OF ACCELERATED ELECTRONS OR CATHODE RAYS ON CERTAIN INSECTS AND ON THE WHEAT AND FLOUR THEY INFEST. I. Michigan Stage Coll., Agric. Exp. Sta., Quart. Bull. 36, 1 (1953) 94-106.

A Van de Graaff 2-MV electron accelerator was used to irradiate test lots of 50 adult granary weevils, Sitophilus granarius, in 9-cm petri dishes containing 30 g Cornell 595 wheat of 10% moisture content with various doses of accelerated electrons 3 d after the adults were placed in the petri dishes. Similar test lots of flour beetles, Tribolium confusum, each containing 100 adults were treated with various doses of accelerated electrons after allowing 3 d for the adults to oviposit. A dose of 10 000 rep sterilized flour beetle and granary weevil eggs and prevented adults from reproducing. Thirty percent of flour beetle eggs treated with 1000 rep hatched. A dose of $5 \times 10^5$ rep was lethal to 100% of flour beetles immediately after treatment, whereas a dose of $2.5 \times 10^5$ rep was lethal to 100% of adult granary weevils immediately after treatment. A dose of $2.5 \times 10^5$ was lethal to 92% of adult flour beetles 1 week after treatment; and a dose of $1 \times 10^5$ was lethal to 82% of adult granary weevils one week after treatment. Doses exceeding 10 000 rep were detrimental to wheat seed. Cornell 595 wheat and whole wheat flour were irradiated with a dose of $5 \times 10^5$ rep. Preliminary baking tests indicated a change in taste of bread, but was not undesirable. (auth.: D. E. W.)

1241 Baker, V. H., Taboada, O., Wiant, D. E. ELECTRON GUN AIMED AT INSECTS. Food Engng 26, 4 (1954) 64-6.

General article on the use of accelerated electrons from a Van de Graaff machine for disinfestation. For Tribolium adults 500 000 rep were lethal within a week, 250 000 rep sufficed for Sitophilus granarius. Egg sterility for both was ensured by 10 000 rep. The effects of irradiation on seed and baking quality, and on food value are discussed, also probable operating costs and production rate for possible future application of method. (See also Agric. Engng 34 (1953) 755, and 35 (1954) 407)

1242 Baker, V. H., Taboada, O., Wiant, D.E. SOME EFFECTS OF ACCELERATED ELECTRONS OR CATHODE RAYS ON CERTAIN INSECTS AND ON THE WHEAT AND FLOUR THEY INFEST. Michigan State Coll., Agric. Exp. Sta., Quart. Bull. 36, 4 (1954) 448-61.

Further information on the effects of accelerated electrons on insects which infest wheat, flour and beans is presented, as well as information on the method used to calculate dosage, penetration of electrons into wheat and flour, rate of treatment of products, cost of electrical energy for a given dose in rep., distribution of current density, calculation of the temperature rise in a given sample, and a review of literature on the effects of accelerated electrons on vitamins and enzymes. (from auth. conclusion)

1243 Baker, V. H., Taboada, O., Wiant, D.E. LETHAL EFFECTS OF ELECTRONS ON INSECTS WHICH INFEST WHEAT, FLOUR, AND BEANS. - PART II. Agric. Engng 35 (1954) 407-10.

Further information on the effects of accelerated electrons on insects which infest wheat, flour (see Part I), and beans is presented. An electron dose of 10 000 rep proved lethal to 100% of adult bean weevil [Acanthoscelides obtectus (Say)] in tests on infested Michigan navy beans. The methods are described which had been used to calculate dosage, penetrations of electrons into wheat and flour, rate of treatment of product, cost of electrical energy for a given dose in rep, distribution of current density, calculation of the temperature rise in a given sample, and a review of literature on the effects of accelerated electrons on vitamins and enzymes is given. The use of accelerated electrons to stop adult insects from reproducing and to sterilize insect eggs in wheat, flour and beans are concluded to offer promise for insect control; the need for further research is stressed before the process can pass from the experimental to the industrial stage.

1244 Baldwin, W. F. SIMILARITIES IN KILLING BY HEAT AND BY X-RADIATION IN THE INSECT DAHLBOMINUS FUSCIPENNIS (ZETT.). Radiation Res. 5 (1956) 46-51.

Parallels in response to heat and to x-irradiation were shown in the insect D. fuscipennis (Zett.). The immediate consequence of high doses in both cases is a coma from which the insects may recover, to die later of the delayed effects. Tolerance diminishes with age; prior conditioning with moderately high temperatures increases female tolerance; diploid females are more resistant than haploid males; sharp breaks were found in curves relating dose and effect. All these observations are true for both agents. (auth. summary)

(An earlier abstract was published in Radiation Res. 3 (1955) 213)

* Baldwin & Narraway 1957 - [1365]

* Baldwin & Narraway 1958 - [1366]

1245 Bletchly, J. D., Fisher, R. C. USE OF GAMMA RADIATION FOR THE DESTRUCTION OF WOOD-BORING INSECTS. Nature 179 (1957) 670.

Preliminary laboratory tests in Britain on the value of $\gamma$-ray treatment against wood-boring insects are summarized. Tests were carried out on Lyctus brunneus Steph., Anobium punctatum Deg. and Xestobium rufovillosum Deg. removed from wood or in samples approximately $\frac{1}{2}$ in thick. A $Co^{60}$ source was used. Eggs of Anobium and Xestobium irradiated within 1 - 4 d of being laid were killed by exposure to a dosage of 4000 r but the mature eggs required 48 000 - 68 000 and over 32 000 r respectively. Some evidence was obtained that the larvae which hatch from eggs irradiated at much lower dosages do not survive. The development of Lyctus larvae was arrested by treatment at 8000 r, but high doses were needed to produce rapid mortality. An apparently similar reaction was observed in Anobium larvae. Irradiation of Lyctus adults at dosages up to 48 000 r did not inhibit oviposition, but no fertile eggs were laid by females of any species following irradiation of both sexes at 8000 r. Adults of Xestobium remain within the timber for several months before emerging from it, and this may be of importance in relation to the period during which timber containing both adults and larvae could most effectively be irradiated. Further work with this species is in progress.

1246 Bletchly, J. D. SOME LABORATORY INVESTIGATIONS ON THE ERADICTION OF WOOD-BORING INSECTS BY GAMMA RADIATION. p. 385-9 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956", Vol. 4. Becker, E. C., ed. Ottawa, Mortimer Ltd. 1958.

Work is described on Xestobium rufovillosum Deg., Anobium punctatum Deg. and Lyctus brunneus Steph., the last being easily reared in the laboratory. A $Co^{60}$ source was used, irradiation ranging from 50 r/min

to 1200 and 1300 r/min. The effective lethal dosages required for the different stages of the life cycle may be summarized as follows: Eggs: newly laid – 4000 r (Anobium and Xestobium); mature eggs – > 32 000 r (Xestobium). The resistance of Anobium and Xestobium eggs increases with their stage of development, as in Drosophila. Larvae: Development is arrested at dosages of 8000 r (Lyctus), 6000 r and over (Anobium). Pupae: Little data are so far available but normal development is possible after irradiation at 4000 r (Lyctus). Adults: Egg-laying can occur after irradiation up to at least 48 000 r (Lyctus) but the eggs are sterile after both sexes have been irradiated at a dosage of 8000 r (Anobium, Lyctus, Xestobium). It is thought that females are more resistant (Lyctus). The use of γ-rays for the destruction of mature eggs and of larvae offers little hope of practical application but the sterilization of the adults of all three species can be achieved at much lower dosages.

1247 Colombo, G. THE LETHAL EFFECTS OF X-RAYS ON OÖCYTES OF THE SILKWORM (BOMBYX MORI L., LEPIDOPTERA). Caryologia 11, 3 (1959) 273-96. (In Italian, summary in English)

* Cornwell et al. 1957 - [1113]

1248 Courtois, G., Lecomte, J. SUR LA RÉSISTANCE AU RAYONNEMENT GAMMA DE L'ABEILLE OUVRIÈRE. Ann. abeille 4 (1959) 285-90.

L'Abeille butineuse irradiée par le rayonnement gamma issu d'une source de Cobalt 60 supporte sans dommages apparents une dose de 18 000 r. Des dommages très appréciables sont observés pour 90 000 r. Une dose de 200 000 r entraîne la mort immédiate de 100% des individus. L'état physiologique de l'Abeille joue un rôle important dans la résistance au rayonnement gamma.

(Also published as report CEA-1377, Commissariat à l'Energie Atomique, Paris)

1249 Cember, H. THE LETHAL RADIATION EFFECTS OF X-RAYS AND FAST NEUTRONS ON THE EMBRYO OF THE AMERICAN COCKROACH. M.S. Thesis. University of Pittsburgh, Pittsburgh, Pa. 1952.

* Davich and Lindquist 1959 - [1115]

1250 Egli, H. DIE EMBRYONALE STERBLICHKEIT BEI DROSOPHILA NACH BESTRAHLUNG IN LUFT, REINER STICKSTOFF- UND REINER SAUERSTOFFATMOSPHÄRE (Embryo mortality in Drosophila following irradiation in air, pure nitrogen and pure oxygen respectively). Doctoral Diss. Zürich, Switzerland. 1956, 19p. (In German)

0-24 h-old Drosophila males were irradiated in air, pure $N_2$ or pure $O_2$, dosed at 101.6 r/min, with a total dose = 2000 r. The radiosensitivity to x-rays of the various stages of spermatogenesis was observed, damage being measured in terms of embryonic mortality of the offspring of irradiated males, followed for 14 d. Between the 5th-11th d post-irradiation, the hatching rate dropped rapidly, i.e. spermatids which develop to mature sperm at that time are particularly radiosensitive. When $N_2$ is added during irradiation, radiation damage is clearly less than in air. Irradiation in pure $O_2$ as compared with air increases mortality already during the first few days. Mature sperm were also damaged more when $O_2$ was added. In no case could aspermia be established 8 - 9 d post-irradiation. Results were checked by the t-test.

* Erdman 1960 - [867]

* Frey 1952 - [821]

* Fritz-Niggli 1956 - [823]

1251 Hannan, R.S. ELECTRONIC STERILIZATION OF FOODS. Research 6 (1953) 376-83.

A summary is given of the basic facts emerging from work done on electronic sterilization of foods. High-energy electrons and γ-rays from radioactive sources were used. Some information on the dosages necessary for destroying bacteria, and insects and their eggs are given. Whereas γ-rays are not handicapped by very limited penetration, their use necessitates extensive safety precautions, and the cost of their application is very high.

(See abstract in Food Sci. Abstr. 26, 3 (1954) 338, no. 1947)

1252 Hassett, C. C., Jenkins, D. W. USE OF FISSION PRODUCTS FOR INSECT CONTROL. Nucleonics 10, 12 (1952) 42-6.

Lethal doses of high energy γ-radiation were studied for 8 species of insect pests of food, clothing, wood and other stored products. Doses of 1300 r/h from a $Ta^{182}$ source and 193 000 r/h from a $Co^{60}$ source were used; the latter was necessary since otherwise the time required for a lethal dose extended over several developmental stages, which show a different susceptibility to radiation. Dose mortality curves and mortality are given for Attagenus piceus, Dermestes ater, Lasioderma serricorne, Sitophilus oryza, Rhyzopertha dominica, Tribolium confusum, Lyctus planicollis, Drosophila melanogaster. While susceptibility of species varied, doses in excess of 20 000 r were required to produce deaths. Probable dose for insect destruction is of the order of $10^5$ r; fast-killing doses (65 000 r) can be used to stop damage by heavy infestations, lower doses to prevent reproduction. Lyctus showed peculiarity in that high doses were extremely depressive for the first two days, radiation having the effect of temporary knockdown. Sources of such radiation intensities could be prepared from fission products at negligible cost.

(See also Report 149, Army Chemical Center, Md. Chemical Corps Medical Labs.)

1253 Hassett, C. C. LETHAL RADIATION FOR STORED PRODUCTS INSECTS. Pest Control 25, 11 (1957) 13-4.

A brief informative survey of work on the effects of various doses of γ-rays on 6 insect species (adults of Lasioderma, Sitophilus, Attagenus, Tribolium and Rhyzopertha, and on larvae and adults of Dermestes). Various processing units and sources of radiation are mentioned, and some cost estimates given.

1254 Heidenthal, G., Clark, L. B. SURVIVAL RATES OF HABROBRACON EGGS TREATED IN FIRST MEIOTIC METAPHASE WITH LOW AND HIGH VOLTAGE X-RADIATION. (abstr.) Genetics 36 (1951) 554.

Studies were made on the survival of haploid eggs treated in first meiotic metaphase with low voltage (124 kV) and with high voltage (50 MeV) x-radiation. Dosage ranged from 100 r to 1750 r. Standard techniques previously developed by A. R. Whiting were used throughout. Since females were not mated in the first series of experiments, parthenogenetic development occurred among the surviving eggs up to larval stages when the observations were discontinued. The curves for low and high voltage are practically identical, survival following treatment with 400 r was 54% for high voltage and 51% for low; at 1500 r the viability was about 5% for both types of radiation. The curve for low voltage is essentially a confirmation of that found by A. R. Whiting. Other studies were made of eggs treated with low voltage but laid by females which were mated following irradiation. Under these conditions it would be expected that if recessive lethals were present, viability should increase. Since the curves for eggs from mated and from unmated females are so very nearly alike, it is tentatively concluded that death of eggs is to be attributed to dominant lethals.

* Jefferies & Cornwell 1958 - [1144]

* Kenworthy 1956 - [1394]

* King 1953 - [389]

* King 1954 - [390]

* King and Wilson 1955 - [1319]

1255 Кипиани, Р.Я., Цецхладзе, Т.В. ЗАМОРИВАНИЕ КУКОЛОК И КОНСЕРВАЦИЯ КОКОНОВ ТУТОВОГО ШЕЛКОПРЯДА ГАММА-ИЗЛУЧЕНИЕМ. Сообщ.Акад.наук Груз.ССР 17, 7 (1956) 657-62.

Куколки тутового шелкопряда поддаются гамма-лучевой заморке. Куколки разной выкормки характеризуются различной устойчивостью к гамма-излучению. 100% летальные дозы составляют: для I-й выкормки 200 000 фэр, для II-й выкормки 150-180 000 фэр, для III-й выкормки 100 000 фэр. После получения летальной дозы куколки постепенно перестают реагировать на внешнее воздействие, со временем темнеют и уменьшаются в весе. Имеется прямая зависимость между потерей в весе и дозой. Гамма-излучение вызывает затягивание фазы развития куколки на незначительное время, что не может иметь практического значения. На основании наблюдений над облученными коконами в течение 5 месяцев можно предположить, что летальная доза 200 000 фэр является также и консервационной.

Kipiani, R.Ya., Tsetskhladze, T. V. THE KILLING OF SILKWORM PUPAE AND THE PRESERVATION OF SILKWORM COCOONS BY GAMMA-RAYS. Soobshch. Akad. Nauk Gruz. SSR 17, 7 (1956) 657-62.

Silkworm pupae are susceptible to γ-radiation. Pupae produced in different seasons are characterized by different resistances to γ-rays, the lethal dose ($LD_{100}$) requiring 200 000 rep for the first, 150 - 180 000 rep for the second and 100 000 rep for the third season. On receiving a lethal dose a pupae gradually ceases to respond to external stimuli and, in time, turns black and loses weight. The weight loss and γ-dose are related linearly. Gamma irradiation brings about a slight delay in pupa development. Observations collected over 5 months suggest that a lethal dose of 200 000 rep also ensures preservation.

1256 Langendorff, H., Sommer, K. DIE ABTÖTUNG VON DROSOPHILA-EIERN DURCH ENERGIEREICHE STRAHLEN ALS BIOPHYSIKALISCHES PROBLEM (The killing of Drosophila eggs by high-energy radiation, treated as a biophysical problem). Strahlentherapie 82 (1950) 316-20. (In German)

The biophysical aspect of the influence of the biological variability on the shape of the killing curves was studied in a series of experiments with 1 to 4h-old eggs. Results pointed to a high degree of variability in younger (above ½ h-old) stages of egg development, and proved that many elementary ray hits were required for the killing action. Irradiation with grenz-rays showed that the damaged part of an egg is comparatively large relative to the egg volume.

1257 Lauffer, M. A., Cember, H. THE LETHAL RADIATION EFFECTS OF X-RAYS AND FAST NEUTRONS ON THE EMBRYO OF THE AMERICAN COCKROACH (PERIPLANETA AMERICANA). (abstr.) Biol. Bull. 109 (1955) 336.

Embryos of the cockroach, Periplaneta americana, at an average of 14 d, were irradiated with 50 and 100 kV filtered x-rays, of effective λ 0.479 and 0.563 Å, and also with fast neutrons of energies between 2 and 10 MeV. X-ray doses varied between 25 and 5000 r and dose rates between 25 and 100 r/min; neutron doses between 41 and 4426 rep. After irradiation, the embryos were incubated at 27°C for 70 d. The fraction of nymphs which hatched completely was determined and compared with non-irradiated controls. Details of these experiments are described in Cember's thesis on file at the University of Pittsburgh. The theoretical implications of the results are discussed. The effects were independent of λ and dose rate. (from abstr.)

1258 Lee, W. R., Jr. RADIATION INDUCED DOMINANT LETHAL MUTATIONS IN THE HONEYBEE. Ph. D. Thesis. Wisconsin Univ., Madison. Univ. Microfilm, Ann Arbor, Mich. Publication No. 18420 (1956).

This thesis was published in Genetics, see under Lee, W. R. 1958. An outline of this paper is published in the Abstracts of the Genetics Society of America, 1956, no. 25, see under Lee, W. R. 1956.

* Lee 1956 - [1019]

* Lee 1958 - [1020]

1259 Limbaugh, B., Gaulden, M. E. THE LETHAL EFFECTS OF X-RAYS ON THE NEUROBLASTS AND EMBRYOS OF THE GRASSHOPPER, CHORTOPHAGA VIRIDIFASCIATA. (abstr.) ASB Bulletin 4, 1 (1957) 14.

Embryo $LD_{50}$ (30 d) was found at 400 - 450 r; $LD_{100}$ (33 d) at ~ 600 r. For 600 - 17 000 r decreasing development with subsequent deterioration were observed. Neuroblasts recovered from mitotic inhibition (after 500 - 2000 r) divided at approximately the same rate as cells in unirradiated embryos. The neuroblasts were fairly "resistant" to permanent inhibition.

Abstract of paper presented at the 18th Annual Meeting of the Association of South-Eastern Biologists, Athens, Ga. 18-20 Apr. 1957.

1260 Mortreuil, M. ACTION LÉTHALE DES RAYONS X SUR CALANDRA GRANARIA L. C. R. Soc. Biol., Paris 153 (1959) 393-4.

Jusqu'à la dose de 2000 r, les rayons X n'induisent aucun effect léthal chez Calandra granaria L. irradié à l'état adulte. Au delà et jusqu'à 25 000 r, la survie moyenne des populations reste la même quelle que soit la dose reçue. Les irradiations supérieures à 25 000 r provoquent une mortalité de plus en plus rapide des Insectes. On note une inhibition irréversible de l'appareil reproducteur. Il semble y avoir aussi des modifications de l'appareil digestif et du système nerveux.

1261 Muller, H. J. THE CHROMOSOMAL BASIS OF THE MORTALITY INDUCED BY X-RAYS IN DROSOPHILA. p. 321-5 in "Immediate and Low Level Effects of Ionizing Radiations. Proceedings of the Symposium at Venice 22-26 June 1959". Buzzati-Traverso, A. A., ed. London.

Data are reviewed from a series of studies that demonstrate the permanent damage caused to individuals of an exposed generation of Drosophila by irradiation of their somatic cells. (NSA 15: 3948 (1961))

* Rogers and Borstel 1957 - [922]

* Rogers and Hilchey 1960 - [1343]

* Schinz et al. 1952 - [1228]

1262 Seto, F. TIME OF ACTION OF A SERIES OF RECESSIVE LETHAL FACTORS IN DROSOPHILA MELANOGASTER. J. exp. Zool. 126 (1954) 17-32.

Time of action studies were made on eggs, larvae, pupae and adults. Lethal effects were studied on natural poplations, populations raised in the laboratory, and others subjected to x-rays. Lethal effects were found to be selective, depending on the stage under investigation. The 7 spontaneous lethals obtained from a laboratory stock were effective in the larval stage. The lethals from natural populations were distributed, in respect to their time of action, as follows: 3 egg lethals (E), 10-egg larval (E/L), 16 larval (L), 6 larval-pupal (L/P), and 6 pupal lethals (P). The distribution of the x-ray induced lethals was: 7 E, 5 E/L, 12 L, 1 L/P and 2 P. These data, though showing no significant differences by themselves, when combined with similar data from Rizki show a significantly larger number of lethals acting in the early stages in the x-rayed group as compared with the two non-irradiated groups. A brief description of the action of 10 pupal lethals is given.

1263 Steger, R. EMBRYONALE STERBLICHKEIT DER NACHKOMMEN VON MÄNNLICHEN DROSOPHILA-FLIEGEN NACH BESTRAHLUNG MIT 180 keV UND 31 MeV (Embryo mortality among the progeny of male Drosophila flies following irradiation with 180 keV and 31 MeV). AEC-tr-3340, translated for Los Alamos Scientific Lab. from Oncologia 9 (1956) 12-32. (In German)

A quantitative study was made of the effectiveness of x-radiation produced by 180 keV and 31 MeV sources for inducing the occurrence of dominant lethal factors in the sex cells of male Drosophila. Following exposure to various radiation doses the male Drosophila were mated with previously unmated females and a count made of the ratio of hatched to unhatched eggs which resulted. A total of 94389 eggs were counted. It is suggested that the enormous increase of unhatched eggs between days 6 and 12 may not have resulted from lethal factors, but from azoöspermia induced by radiation. The 31 MeV betatron was shown to be only 0.8 times as effective as the stable voltage generator in producing dominant lethal factors. (NSA 12: 16088, 1958)

1264 Sugahara, T., Horikawa, M. TISSUE CULTURE ANALYSIS OF DELAYED LETHAL IRRADIATION EFFECT IN D. MELANOGASTER. Mishima. Nat. Inst. Genet. Ann. Rep. 8 (1957, pub. 1958) 75-6.

1265 Sumarokov, G. V. THE DYNAMIC RADIATION INJURY IN CALANDRA GRANARIA UNDER VARIOUS IRRADIATION CONDITIONS. Biophysics (USSR) (English Translation) 3 (1958) 359-61.

The effects of ionizing radiation on adult insects were studied following the exposure of the beetle, Calandra granaria, during the developing stage to various doses of $Co^{60}$ radiation under normal conditions and in air with varying amounts of oxygen. Death of the insects served as the indicator of radiation injury. Data are summarized from three repeated tests in which 25000 insects were used. (NSA 13: 9579, 1959)

1266 Telfer, J. D., Abrahamson, S. THE HIGHER EGG MORTALITY ASSOCIATED WITH INSEMINATION ON THE FIRST THAN THE SECOND DAY AFTER IRRADIATION OF DROSOPHILA MALES. (abstr.) Genetics 39 (1954) 998-9.

Egg mortality was compared following ejaculation of D. melanogaster sperm 0-24 and 24-48 h after x-irradiation. It seems that sperm ejaculated immediately following radiation are more susceptible to genetic radiation damage than those, apparently less mature at irradiation, which are ejaculated a day later. This higher "dominant lethal" rate during the first 24 h would be further augmented by "overripeness" if the males were not allowed to mate before irradiation. (from auth.)

* Tsetskhladze et al. 1957 - [1559]

* Whiting and Atwood 1955 - [1093]

1267 Whiting, A. R., Caspari, S. B., Koukides, M., Kao, P. STAGES OF DEATH OF X-RAY-INDUCED EMBRYO LETHALS IN HAPLOIDS AND IN HETEROZYGOTES OF HABROBRACON. Radiation Res. 8, 2 (1958) 195-202.

This study demonstrated that, for x-ray-induced embryo lethals, dominants in haploids, dominants in heterozygotes, and recessives in haploids kill at increasingly later stages, respectively; and haploid embryos with more than one recessive lethal respond differently in respect to mean stages at death depending on whether the lethals were induced by x-irradiation of oöcytes or of spermatozoa. In oöcytes x-ray-induced lethality appears to be due to recessive lethals sensu stricto, and there is no correlation between number of lethals present in an embryo and its stage at death, and no cumulative effect. In spermatozoa evidence suggests induction of translocations and inversions in addition to true recessive lethals. The significant positive correlation between numbers of lethals and stages at death may be due to these additional factors. (auth.)

* Woestijne and Brande 1960 - [1298]

1268 Yanders, A. F. RELATIVE TIME OF ECLOSION OF DROSOPHILA FEMALES HETEROZYGOUS FOR SEX-LINKED RECESSIVE LETHALS. USNRDL-TR-216 Naval Radiological Defense Lab., San Francisco. 1958, 15 p.

Male Drosophila melanogaster (Oregon-R) were irradiated with 3200 r of 1.6 MeV electrons and mated to Muller-5 females. The eclosing $F_1$ female progeny were collected at 12-h intervals and tested for the presence of sex-linked recessive lethal mutations in the irradiated X-chromosome. The probability that an emerging female possessed a lethal X-chromosome was found to increase significantly in each successive period of collection. Assuming a linear response, a weighted linear regression analysis of the data leads to the equation $\hat{Y} = 5.342 + 1.338\,X$, where $\hat{Y}$ is the expected percentage of lethals and $X$ is the sequential collection period. These results suggest that newly-induced recessive lethals prolong development in heterozygotes, and that at least part of the viability impairment of heterozygous lethals is a reflection of decreased developmental rate. (auth.)

## I-C-5 LONGEVITY AND RECOVERY PHENOMENA

### Survey

1269 Hilchey, J. D. ACTION OF IONIZING RADIATIONS ON INSECTS (chapter 25) p. 240 - 66 of "Radiation Preservation of Food" The US Army Quartermaster Corps, US Off. Tech. Serv., 1958.

Excellent review article, dealing with lethal effects, the effects of radiation on development, reproduction, longevity and miscellaneous responses. Separate sections are devoted to genetic effects, comparative biological effectiveness, and radiation disinfestation. 234 references are given. Results for the whole field are summarized in 5 invaluable tables, sources being cited throughout.

(An abstract of a review paper "A review of the uses of ionizing radiation in the disinfestation of foods" was published in Bull. ent. Soc. Amer. 2, 3 (1956) 26, abstr. 10)

---

1270 Baxter, R. C., Tuttle, L. W. LIFESPAN SHORTENING IN IRRADIATED DROSOPHILA MELANOGASTER. Radiation Res. 7, 3 (1957) 303.

Control survival curves were obtained for some 14 000 flies (D. melanogaster), and the median survival time for males and females was found to be 44 and 51 d. One-day-old imagoes were given single treatments with doses ranging up to 225 kr of $Co^{60}$ γ-rays. Life-span shortening was found to be proportional to dose, when the median survival time of the experimental group was subtracted from that of the controls, and the difference was expressed as a percentage of the control life span. A series of flies (both sexes) ranging in age from 1 through 25 d were given a single dose of 75 kr. There was no increase in radio-

sensitivity with age as the life expectancy diminished. Additional groups of flies received large single doses at 10 d of adult age. Comparable groups received daily fractionations of the same total doses commencing on their first day and ending on the tenth day. At all dose levels the flies in the fractionated dose experiments had significantly longer survival. This is considered to be a true recovery phenomenon, and the situation becomes unique when it is recalled that somatic cell division is almost completely lacking in the adult insect.

(Abstract of paper presented before the Radiation Res. Soc., Rochester, N.Y., 13-15 May 1957)

1271 Bochnig, V., Lüers, H., Winterfeld, G. DIE MITTLERE LEBENSDAUER VON DROSOPHILA MELANOGASTER NACH EINMALIGER RÖNTGENBESTRAHLUNG MIT HOHEN DOSEN (The average life span of Drosophila melanogaster after a single irradiation at high dosage). Zool. Beitr. Berl. 5, 2/3 (1960) 367-72. (In German)

"Berlin-wild" strain of D. melanogaster aged 24 - 48 h were subjected to 40 000 r, 70 000 r and 100 000 r. The techniques used are described. 11 600 adults were investigated. Male mortality was higher at all doses. Since male controls show much greater average longevity than the females the male adult must be much more radiation-sensitive. The life span of the female at 40 000 r is extended significantly compared with the non-irradiated controls. Whereas the drop in life span with increasing dose follows a linear relation in the male, this is not the case for the female. The $LD_{50}$ is 75 000 r for the female, and 30 000 r for the male.

1272 Burger, C. L., Jr. BIOLOGICAL EFFECTS OF X-RAYS ON PARTIALLY IRRADIATED LARVAE OF A BAR-EYED RACE OF DROSOPHILA MELANOGASTER MEIGEN. Diss. Abstr. 19, 12 (1959) 3418.

A technique was employed permitting partial x-irradiation of larvae, using eye facet number as a biological dosimeter. Partial irradiation shows more effect in terms of lethality. A general trend in eye facet reduction was noted with increasing dosage in all types of irradiation. Males show a greater reduction than females. Differences between totals, anteriors, and posteriors with regard to facet number are significant only in the females when an analysis of variance test is used, but the test is presumed invalid since the group tested (survivors) was no longer randomly distributed. It is concluded that the entire genome of the stock used is reacting in an aberrant fashion to the irradiation per se since great fluctuations are noted in all experimental groups but not in controls, with regard to eye facet number. Standard errors in experimental categories are uniformly > 1, while control categories show 0.53 for ♀ and 0.65 for ♂. (from abstr.)

1273 Clark, A. M. SOME EFFECTS OF X-RAYS ON LONGEVITY IN HABROBRACON FEMALES. TID-6053, Delaware, Univ., Newark and Oak Ridge National Lab., Tenn. (1958) 21 p.

Habrobracon females when exposed to x-rays as larvae, pupae, or adults show a decrease in adult life span which is shortened in proportion to the amount of radiation absorbed. Radiation damage to larvae and pupae which cannot be detected simply by observing the incidence of adults that emerge, is revealed when adult life span is measured. Groups irradiated as adults show no immediate decrease in survivors. The time of onset of death within the group depends upon the amount of radiation absorbed. Death is delayed for a longer time for smaller doses. Although adults will survive a dose of 200 000 r, as little as 5000 r causes a reduction in life span. (auth.)

* Clark 1960 - [862]

1274 Clark, A. M. THE MODIFICATION OF LIFE SPAN BY X-RAYS FOR HAPLOIDS AND DIPLOIDS OF THE WASP, HABROBRACON SP. Biol. Bull. 119 (1960) 292.

Haploid males, diploid males and diploid females of the wasp, Habrobracon sp. (an Indian species related to Habrobracon juglandis), show a decrease in adult life span following exposure to x-rays as larvae-in-cocoons, white pupae or adults. The median life span for non-irradiated adults was 62 d for haploid males and diploid males fed on honey-water, 92 d for diploid females fed on honey-water and 40 d for diploid females fed on larvae of the Mediterranean flour moth, Ephestia. This difference in life span related to sex, but not to genome number, indicates that the aging process is not due to an accumulation of somatic mutations during adult life. Haploid males exposed as adults to 10 000 - 50 000 r have a shorter life span than comparable diploid males. Diploid males and diploid females show similar decreases in life span relative to their controls. Pupae after exposure to 10 000 and 15 000 r and larvae after exposure to 2000 r are equal to controls in post-embryonic survival and in ability to develop into structurally normal adults. These adults, however, show a decrease in life span. Diploid males resulting from irradiated larvae or

pupae show a decrease in life span that is smaller than comparable haploid males but similar to diploid females. Radiation-induced decrease in life span is markedly influenced by genome number but not by sex. This indicates that in contrast to the normal aging process, the decrease in life span by x-rays is due to damage to the genetic material.

1275 Cork, J. M. GAMMA-RADIATION AND LONGEVITY OF THE FLOUR BEETLE. Radiation Res. 7 (1957) 551-7.

The author reports observations made over a period of 2 years which indicate that the life span of a given number of flour beetles (Tribolium confusum) can be extended by several per cent by irradiation with γ-radiation. This may be a single exposure of about 3000 r or chronic dosages of about 100 r. The results show that the cumulative effect of chronic irradiations is not equivalent to but less than that due to a single dosage of the same amount. Twenty per cent of the animals receiving the 100-r daily dosage lived more than 450 d. In that time they received 45 000 r, which is more than twice the amount that would have produced complete annihilation in a single irradiation. Organisms which survive a single large dosage of γ-rays appear to have a survival rate superior to that of those that receive no radiation.

1276 Dent, J. N., Amy, R. L. DEVELOPMENTAL EFFECTS OBSERVED IN HABROBRACON AFTER EXPOSURE TO BETA RADIATION. Growth 14 (1950) 113-21.

Developing individuals of H. juglandis were exposed to various levels of beta radiation for 48-h periods just before hatching or during the early larval period. At the highest levels of radiation used, the wasps died before hatching or in the larval stage. At intermediate levels death usually occurred during pupation with a considerable degree of inverse correlation between the extent of imaginal differentiation and the amount of radiation given off. At the lowest levels it was apparent that most of the animals attained adult form. The rate of development was somewhat reduced at the highest and intermediate levels but not at the lowest levels. Pupation without cocoon formation was a frequent occurrence at the intermediate levels. Evidence which indicates that irradiated animals reaching adulthood were sterile is presented. (auth.)

* Erdman 1960 - [868]

* Grosch 1956 - [1313]

* Gowen and Umaerus 1958 - [945]

1277 Grosch, D. S. INDUCED LETHARGY AND THE RADIATION CONTROL OF INSECTS. J. econ. Ent. 49, 5 (1956) 629-31.

The longevity of heavily irradiated (50 000 - 180 000 r) female wasps (Habrobracon) was determined in the presence of food (pre-stung host caterpillars) as well as under starvation conditions. An increase in life span of adult wasps irradiated with x-rays was found only under starvation conditions, most pronounced ~ 100 000 r, and is explained by the inactivity of the treated insects. This lethargy is induced at a much lower dose than that required to cause prompt adult death but exceeds dose levels which sterilize adults and kill all immature stages. Therefore, if the presence of adult insects is not objectionable, the induction of non-feeding lethargy may be a more feasible technical approach to insect control than quick-killing exposures. It seems likely that the nervous system may be more sensitive to irradiation than has been deduced from morphological studies. (from auth.)

1278 Howden, H. F., Auerbach, S. I. SOME EFFECTS OF GAMMA RADIATION OF TROGODERMA STERNALE JAYNE. Ann. ent. Soc. Amer. 51, 1 (1958) 48-51.

Some aspects of the biology of T. sternale and the effects of single and fractionated doses of γ-radiation (from $Co^{60}$) on reproduction and larval development are discussed. All doses applied to the larvae adversely affected the reproduction of the resulting adults, but the reduction in population caused by exposure to 4000 r or less may have been due to lowered vitality or morphological deformity. Continuous exposure to 5000 r and above inhibited reproduction, but when the dose was divided, the threshold for inhibition was 6000 r. At the lower levels, dividing the dose had no effect. Larval development was delayed more by continuous than by divided doses.

(Earlier work was published in Bull. ent. Soc. Amer. 2, 3(1956) 17, abstr. 25)

1279 Ito, T., Tanaka, M. EFFECT OF RADIATION ON THE GROWTH OF SILKWORM LARVAE. J. Sericult. Sci., Tokyo 28, 4 (1959) 220-6. (In Japanese)

* Ives et al. 1959 - [892]

* Kenworthy 1954 - [1393]

1280 Kroeger, H. EINE ANALYSE RÖNTGENINDUZIERTER MODIFIKATIONEN IM FLÜGELGEÄDER DER MEHLMOTTE EPHESTIA KÜHNIELLA ZELLER (An analysis of x-ray-induced modifications in the vein pattern in the wings of the flour moth Ephestia kühniella Zeller). Roux Arch. EngwMech. Organ. 150, 1 (1957) 77-104. (In German)

Abnormalities in the system of veins in the wings are examined, induced by x-radiation in the last larval stage. There are 2 types of modifications: (i) additional veins arise in the form of links between longitudinal veins, as a splitting up near the edge or as local eye-like doubling. They originate during the first 5 d of that larval stage and are accompanied by shorter and wider wings; (ii) reduction of veins results from localized merging of two longitudinal veins, which usually happens between the 6th and 9th d, when the wings are usually smaller than in the control. On the 5th d of the last larval stage when the trachae grow into the wing there is a change in metabolism accompanied by low radiosensitivity. The primary result of irradiation is disturbances in mitosis. The less shapely form of the wing is due to disorder in spindle directions. The wider significance of the results is discussed.

1281 LaChance, L.E. INGESTION OF ETHYLENEDIAMINETETRAACETIC ACID AND THE EFFECT ON LIFE SPAN OF IRRADIATED AND CONTROL HABROBRACON FEMALES. Nature 182, 4639 (1958) 870-1.

A number of experiments were carried out on the genetic damage induced in the reproductive tissues of Habrobracon females by chelating agents and x-irradiation. X-rays alone had no effect on the reduction of life span below that of the controls, whereas feeding with ethylenediaminetetraacetic acid had. Ingested ethylenediaminetetraacetic acid enhances the radiation effect when fertility or dominant lethals are the criterion of damage, but the combination of treatments does not shorten the life span in a synergistic manner.

1282 Lamarque, P. STUDY OF RECOVERY AFTER IRRADIATION WITH X-RAYS. J. Chim. Phys. 48 (1951) 252-5.

Hatching-rate curves of repeatedly x-irradiated eggs of the common silkworm (Bombyx mori) point to the existence of a recovery effect; the total dose of two irradiations, separated by a time interval, is larger than the dose of a single irradiation producing the same damaging effect. For a 7-h interval the optimal recovery is observed when the ratio between the first partial dose and the total dose is equal to $\frac{2}{3}$. Recovery processes are ascribed to metabolic activities of the cell. (NSA 5: 5482, 1951)

1283 Lamarque, P. LA RESTAURATION EN RADIOBIOLOGIE. Pr. méd. 60 (1952) 1039-41.

Bombyx mori silkworm eggs were exposed to single and fractionated instantaneous doses of up to 2000 r of x-rays. The effects on recovery, as measured by the per cent of hatching, of placing the eggs in an incubator or in a refrigerator during the interval between irradiations, of varying the length of the interval, and of varying the initial dose were studied. The existence of a critical radiation dose for optimum recovery is discussed. (NSA 7: 1884, 1953)

* Lamarque and Gary-Bobo 1956 - [838]

1284 Larsen, W.P., Grundmann, A.W. THE EFFECTS OF X-IRRADIATION ON THE EMBRYOS OF THE COCKROACH, BLABERUS CRANIIFER. Proc. Utah Acad. Sci., Arts and Let. 37 (1960) 51-2.

Gravid cockroaches containing developing embryos from 1 to 60 d old were given x-ray dosages varying from 50 to 1000 r. After 30 d embryos younger than 60 d were killed and fixed, whilst the older embryos were allowed to complete their development. They all hatched normally if older than 30 d at the time of irradiation. Malformation was found to correspond to the age of the embryo at treatment and the amount of x-irradiation. Various irradiation effects are discussed.

1285 Lüning, K. G., Hannerz, B. RECOVERY PHENOMENON AFTER IRRADIATION IN DROSOPHILA MELANOGASTER. I. RECOVERY OR DIFFERENTIAL SENSITIVITY TO X-RAYS. Hereditas 43, 3-4 (1952) 549-62.

Differential sensitivity versus recovery are the two hypotheses proposed to explain the effect of $O_2$ concentration as well as the influence of the mating period on the rate of x-ray induced chromosome aberrations. The results obtained from rod versus ring chromosomes were not conclusive as regards the $O_2$ effect but indicate that the difference between the mating periods was due to recovery. Studies with fractionated irradiation (at 15-min intervals) in air or at anoxia indicated that the same rate of primary chromosome breaks is induced but that when the whole treatment is at anoxia there is a certain rate of recovery. This was, in part, based on the fact that when half of the treatments was given at anoxia and the other in air the result was the same as when both fractions were given in air (each fraction being 1620 r). This dose, in air, was sufficient to block the recovery process. The implications are discussed.

1286 Lüning, K. G., Henze, A. THE RECOVERY PHENOMENON AFTER IRRADIATION IN DROSOPHILA MELANOGASTER. III. THE INACTIVATION DOSE OF THE RECOVERY PROCESS. Hereditas 43, 3-4 (1957) 571-7.

When a total dose of 6840 r is given, a dose of 1080 r in the presence of $O_2$ (air) is sufficient to block the partial recovery mechanism of the chromosomes which is still effective when 540 r are applied under the same conditions, the rest being given in a $N_2$ atmosphere. The form of the curve indicates that inactivation is the result of multiple hits.

1287 Lüning, K. G., Söderström, J. RECOVERY PHENOMENA AFTER IRRADIATION IN DROSOPHILA MELANOGASTER. II. RECOVERY OF RECESSIVE LETHALS. Hereditas 43, 3-4 (1957) 563-70.

The authors examine the relation between recessive lethals and chromosome breaks in D. melanogaster. It is concluded that breakage per se and rejoining by recovery were not the origin of recessive lethals. This conclusion was based on the assumption of the existence of a recovery process after irradiation at anoxia as proposed by Baker and von Halle (1953, 1955). (cf. confirmation by Lüning and Hannerz, 1957).

1288 Lüning, K. G. RECOVERY PHENOMENON AFTER IRRADIATION IN DROSOPHILA MELANOGASTER. IV. SPONTANEOUS RECOVERY OF IRRADIATED CHROMOSOMES VERSUS DIFFERENTIAL SENSITIVITY. Hereditas 44, 1 (1958) 161-8.

Data is presented which still further strengthens the hypothesis of a spontaneous recovery process in sperm irradiated in air. The hypothesis of differential sensitivity in various stages of spermiogenesis was re-investigated. The same technique was used as in the establishment of the spontaneous recovery process, i.e. eliminations of X- and Y-chromosomes in sperm from $X^{C2}$; $sc^8Y$ males. It is concluded that the high rate of chromosome aberrations induced in stages supposed to be spermatids was due to a greater sensitivity. Furthermore it is shown that the sensitivity in these stages depended on the age of the males at treatment. Hence, the co-existence of a spontaneous recovery and of differential sensitivity in spermiogenesis in Drosophila has been demonstrated.

1289 Lüning, K. G., Schuwert, B., Jonsson, S. THE RECOVERY PHENOMENON AFTER IRRADIATION IN DROSOPHILA MELANOGASTER. V. THE RELATION OF VIABILITY MUTATIONS TO BREAKAGE OF CHROMOSOMES. Hereditas 44, 1 (1958) 169-73.

Males (w) were irradiated in air or in anoxia, and then mated with Muller-5 females. An $F_1$ test gave no evidence that chromosome breakage or reunion by recovery had a genetic effect. However, the viability of offspring resulting from sperm irradiated in anoxia was greater than after irradiation in air.

1290 Lüning, K. G., Hendriksson, H. O. RECOVERABLE LETHAL MUTATIONS IN DROSOPHILA SPERM. Nature 183, 4669 (1959) 1211-2.

Four time intervals were used to test the possible existence of a recoverable mutation process, following irradiation at anoxia. The technique and lethality criteria are stated. A borderline was obtained for the recovery of potential recessive lethals which occurred between 30 and 40 min after irradiation, and is similar to that obtained for chromosome breaks.

1291 Mizell, F. M. SOME BIOLOGICAL EFFECTS OF RADIATION ON INSECTS. Ohio State Univ. Abstr. Doct. Diss. 66 (1954) 269-70.

Tests on Blattella germanica, Tribolium confusum, and Prodenia eridania.

1292 Moriwaki, D., Tobari, I. THE GENETIC EFFECTS OF RADIATION ON THE LONGEVITY OF PROGENY IN DROSOPHILA MELANOGASTER. J. Radiation Res. (Japan) 1 (1960) 14-22.

In order to estimate the genetic effects of radiation on longevity, the life span of the offspring from irradiated females and from irradiated males were measured. Controls were measured at the same time. The lives of the male offspring of these irradiated parents were significantly shorter than those of the controls. The female offspring of treated parents lived as long as those from the control when they were kept with males; however, they lived significantly shorter periods than the controls when kept alone, without males. The male offspring seemed to be more strongly affected by irradiation than the female offspring. These results suggest that mutations that have an effect on longevity may be induced by x-rays, but no linear relation between dose and effect was found. (auth.)

1293 Moriwaki, D., Yoshida, Y. H., Tobari, I., Kirimura, N. SURVIVAL RATES OF PROGENY OF IRRADIATED DROSOPHILA MELANOGASTER. Radiation Res. 9 (1958) 155.

It is generally accepted that there should be some specific differences in the genetic effects of radiation on different species. To study this problem, an analysis of the survival rates of different strains of Drosophila melanogaster was attempted. Young males of three strains, Canton-S, Oregon-R and Tokyo, each within 24 h after emergence, were irradiated with 2800 r of x-rays and mated with virgin 3- or 4-d-old females. The progeny were examined by counting daily the number of surviving adult flies until all had died. In another experiment, the progeny raised from the mating of irradiated females (900 r) with nontreated males were similarly examined. Some differences among strains were seen in these experiments. A differential survival between control and irradiated classes, with a longer survival observed in the control, was found sometimes in two strains, whereas no difference was found in the other strain. However, in cases where no considerable difference was found between control and experimental flies under usual conditions, if they were placed under unfavourable (e.g., crowded) conditions, a difference appeared in preliminary experiments. Further investigations are in progress.

(Abstract of paper presented at the Intern. Congr. of Radiation Res., Burlington, Vermont 10-16 Aug. 1958)

1294 Schneiderman, H. A., Weinstein, J., Horwitz, J. RECOVERY OF DIAPAUSING LARVAE OF A CHALCID WASP (NASONIA VITRIPENNIS) FROM X-IRRADIATION. Anat. Record 128, 3 (1957), 618-9, abstr. 219.

Diapausing larvae Mormoniella vitripennis provide an opportunity to study recovery from x-irradiation uncomplicated by cell division because during diapause all mitotic activity ceases, although metabolism continues. Diapause is terminated and cell division initiated by chilling larvae and then placing them at 25°C, whereupon pupation and adult development begin. In the present study diapausing larvae were irradiated with a single dose of 2000 to 5000 r, kept at 25°C for various periods of post-irradiation recovery, and then placed at 5°C for 12 weeks to terminate diapause. Following this, they were returned to 25°C and their development observed. The results revealed considerable post-irradiation recovery. For example, of larvae given 4000 r and immediately chilled, only 8% pupated. A post-irradiation recovery period of 5.5 h at 25°C enabled 55% to pupate, while a 10-d recovery period permitted 87% to pupate. These results were confirmed by split dose experiments in which it was shown that recovery took place between doses. The data demonstrate a marked and prolonged post-irradiation recovery in the non-dividing cells of the diapausing larva.

1295 Sullivan, R. L., Grosch, D. S. THE RADIATION TOLERANCE OF AN ADULT WASP. Nucleonics 11, 3 (1953) 21-3.

The effects of various x-ray dosages and ingested $P^{32}$ on the parasitic wasp Habrobracon were investigated. X-ray dosages of less than 108 150 r produced no visible effects, and 144 200 to 180 250 r caused sluggishness from which recovery was noted in about 30 min. Actually, both males and females showed increased life span following x-irradiation. The life span was not demonstrably affected by $P^{32}$ ingestions of 100 and 250 $\mu c/cm^3$ 15 references. (NSA 7: 2467, 1953)

1296 Sullivan, W. N., Smith, C. N. EXPOSURE OF HOUSE FLIES AND ORIENTAL RAT FLEAS ON A HIGH ALTITUDE BALOON FLIGHT. J. econ. Ent. 53 (1960) 247-8.

Houseflies (Musca domestica L.) and oriental rat fleas (Xenopsylla cheopis (Rothsch.)) were exposed inside an air-conditioned gondola during a balloon flight that maintained an altitude of 78 000 to 82 000 feet for 16 h. The purpose was to gather information on biological damage from cosmic and other radiations near the top of the atmosphere during a well-instrumented flight. Succeeding generations of the exposed insects

reproduced about normally and no physical abnormalities were noted. Fleas exposed outside the gondola were killed by the low temperature. (auth.)

1297 Tracey, Sr., K. M., Jakowska, S., Fodor, V. M. THE EFFECTS OF X-RADIATION ON THE LIFE CYCLE OF TENEBRIO MOLITOR. (abstr.) Radiation Res. 11, 3(1959) 473.

Whole-body x-radiation in a single dose of 50 or 300 r was administered to 6th instar larvae, newly formed pupae, and newly hatched adults, in groups of 50 animals each (140 kV, 20 mA, 5 mm Al, 0.3 mm Cu, dose rate 47 r/min). There was some mortality among the adults, highest within the first 48 h, and a noticeable shortening of the adult life span independently of the irradiated stage. The duration of the pupal stage in animals irradiated as either larvae or early pupae was shortened to 3 to 5 d instead of the usual 5 to 8 d; the last larval and prepupal stage was also shortened. The cystine-cysteine complex was missing in the free amino acid chromatograms of irradiated larvae; hence the irradiated animals resembled the larvae produced by old parents. X-irradiation of larvae and pupae retarded the development of pigmentation on the adult stage. The white form persisted for about 24 h, followed by the bronze-coloured phase for the subsequent 48 h. In some cases this continued for 6 d, whereas normally the black body is formed in 48 h. During this period the exoskeleton remained soft, since scleratinization is associated with pigment production. Uneven pigment patterns appeared in some adults, the head turning black before the rest of the body.

(Paper presented before the Radiation Res. Soc., Pittsburgh, Penn. 18-20 May 1959)

1298 Van de Woestijne, N., Van den Brande, J. RESISTANCE DES INSECTES AUX IRRADIATIONS IONISANTES. QUELQUES RESULTATS AVEC LA TEIGNE DE LA FARINE, EPHESTIA KUEHNIELLA Z. Bull. Inst. agron. Gembloux hors sér. 2 (1960) 872-82.

Eggs, larvae and pupae were exposed to gamma rays from a $Co^{60}$ source. Doses below 4500 rad had no harmful effects on the immature stages or on the adult to which they gave rise, and appeared to stimulate development. Seventy-two percent of eggs irradiated at 4500 rad gave rise to adults; emergence of these was delayed by two days, they were deformed and sluggish and few reproduced. Increasing the dose to 9000 rad reduced the percentage of adults to 5.7 and none of them reproduced. At both doses the effect on larvae was more pronounced with the exception that adult emergence was less delayed. At 18 000 rad both eggs and larvae were killed. When pupae received doses of 4500 and 9000 rad, the resulting adults were scarcely affected, but the numbers of $F_1$ larvae produced were reduced by about 60 and 80% respectively. A few adults emerged from pupae that received a dose of 18 000 rad, but they were unable to breed.

* Wharton & Wharton 1959 - [887]

1299 Yagi, N. SEXUAL MARK VARIATION IN MALE AND FEMALE PIERIS RAPAE PTERIN-PROTEIN COMPLEX BY FEEDING WITH $Ca^{45}$ AND RADIUM γ-RAY IRRADIATION. Dai-2-kai Genshiryoku Shimpojiuma Hobunshu 4 (1958) 218-21.

The pterin-protein body in scales of P. rapae was granular in the male, while needlelike in the female. Irradiation by γ-rays from Ra at the wing-forming stage of the butterfly reduced this difference and produced anomalous shapes in both sexes by heavy doses. Feeding pupae of this butterfly on cabbage supplemented by $Ca^{45}$ also reduced the difference in the pterin-protein body shape in both sexes.

## I-C-6 PHYSIOLOGICAL AND BIOCHEMICAL EFFECTS

* Amy 1955 - [810],[811]

1300 Baldwin, W. F., Salthouse, T. N. LATENT RADIATION DAMAGE IN THE BODY WALL OF THE INSECT RHODNIUS PROLIXUS. Radiation Res. 9 (1958) 89.

Cell division preparatory to molting takes place during a fixed period after feeding in the epidermis of the blood-sucking bug Rhodnius prolixus; thus, the insects can be irradiated while all of the epidermal cells are in a resting state, and mitosis can be initiated at any subsequent time by means of a meal. In insects irradiated from the dorsal side of the abdomen with a 2 mm beam of 2 MeV x-rays (dose 50 000 r), the development of the epidermal layer is quite normal during the first 5 d after feeding. By the 6th and 7th days, a large number of cells blocked at prophase and metaphase can be found in the irradiated areas; cell degradation begins on the 9th and 10th days. The "burned" area is eventually covered by an undifferentiated

chitin-protein layer secreted by epidermal cells migrating from the periphery of the "burn". The latent injury to the cells is permanent, and overt "burns" have been produced when feeding has been delayed for periods as long as three months after the irradiation. Also, the "burns" always reappear when the insects are induced to molt a second time. The latter effect can be attributed to the absence of specialized cells (oenocytes), which are required to form the outside epicuticular layer.

(Abstract of paper presented at the International Congress of Radiation Research, Burlington, Vermont, 10-16 Aug. 1958)

1301 Baldwin, W. F., Salthouse, T. N. LATENT RADIATION DAMAGE AND SYNCHRONOUS CELL DIVISION IN THE EPIDERMIS OF AN INSECT. I. NONREVERSIBLE EFFECTS LEADING TO LOCAL RADIATION BURNS. Radiation Res. 10 (1959) 387-96.

In the bloodsucking insect Rhodnius prolixus, cell division preparatory to molting takes place in the nymphal epidermis only during a fixed period after a meal of blood. Since feeding determines the time of mitosis in the epidermis, this insects serves as a good subject for studies of latent radiation damage. Results are presented from a study in which latent radiation damage in the epidermal layer was converted into visible burns after a blood meal. Photographs of histological studies and a timetable of events during development of latent radiation damage are included. (NSA 13: 10809, 1959)

1302 Baldwin, W. F., Salthouse, T. N. LATENT RADIATION DAMAGE AND SYNCHRONOUS CELL DIVISION IN THE EPIDERMIS OF AN INSECT. II. REVERSIBLE EFFECTS IN BURN REPAIR. Radiation Res. 10 (1959) 397-9.

The time required for healing and molting in irradiated nymphs of the bloodsucking insect Rhodnius prolixus can be reduced almost to normal if they are given a period in which to recover from some of the effects of irradiation before being fed. (NSA 13: 10810, 1959)

1303 Bourgin, R. C., Krumins, R., Quastler, H. RADIATION-INDUCED DELAY OF PUPATION IN DROSOPHILA. Radiation Res. 5, 6 (1956) 657-73.

X-irradiation induces pupation delay in D. melanogaster. A given dose causes the same delay, regardless of larvae age at the time of irradiation (within wide limits). Fractional irradiation established that the target zone for the induction of delay lies in the anterior third of the body; presumably, the ring gland is the target organ. The effect is not a simple delay; instead, an abnormal phase occurs between the time when a larva would normally pupate and the time when it actually does. This phase is characterized by slight weight loss of the whole larva, cessation of the growth of the ring gland, greatly reduced rate of growth of the cuticle and the fat bodies, and cytological changes in the large cells of the ring gland. It seems to be due to hormonal disturbance; detailed analysis of the radiation effects yields some implications on the nature of the normal hormonal control. Several direct radiation effects were also observed in organs rapidly dividing at the time of irradiation. Recovery from the direct effects is not coordinated with the over-all development; this results in morphological distortions. (auth: H. Q.)

1304 Cornwell, P. B., Burson, D. M. GRAIN WEEVILS, CALANDRA GRANARIA L. AND C. ORYZAE L., REARED ON IRRADIATED WHEAT. Nature 181 (1958) 1747-8.

Grain, having received doses up to $5 \times 10^4$ rad from $Co^{60}$, can be used for rearing C. granaria and C. oryzae, without in any way interfering with their development. The yield of progeny, their weight and rate of emergence were unaffected by radiation treatment.

1305 Fritz-Niggli, H. QUANTITATIVE UND QUALITATIVE ANALYSE DER RÖNTGENSCHÄDIGUNG IM DROSOPHILA-VERSUCH (Quantitative and qualitative analysis of roentgen ray injury in Drosophila melanogaster). Fortschr. Röntgenstr. 76, (1952) 218-54. (In German)

The pupa of Drosophila melanogaster represents a good subject for actinobiological and special ontogenetic experiments because tissue is found in histolysis as well as in morphologic and cytological differentiation and at rest. Irradiation of pupas of various ages (5, 15, 22, 30, 40, 50 and 72 h) with 6000, 12 000, 36 000 and 80 000 r (50 kV, 2 mA and 180 kV, 6 mA) showed that the radiosensitivity of the chrysalis diminishes with advancing age. Detailed studies on the changes in body wall, bristle design, hypodermis, muscles, fat cells, gonads, cell differentiation, etc. are reported. 35 figures. (NSA 6: 2665, 1952)

1306 Gaulden, M. E., Totter, J. R. EFFECT OF X-RAYS ON NUCLEIC ACID SYNTHESIS AND ON MITOSIS. p. 1095 in "Proceedings of the 9th International Congress on Genetics, Bellagio, Italy 1953", Suppl. to Caryologia 6. Montalenti, G., Chiarugi, A., eds. Florence. 1954.

Inhibition of mitosis in embryos of the grasshopper Chortophaga viridifasciata at low doses of radiation is not related to an alteration in nucleic acid synthesis. As the 100% lethal dose (approximately 300 r) is approached, interference with nucleic acid synthesis becomes evident.

1307 Glass, B., Plaine, H. L. THE IMMEDIATE DEPENDENCE OF THE ACTION OF A SPECIFIC GENE IN DROSOPHILA MELANOGASTER UPON FERTILIZATION. Proc. nat. Acad. Sci. Washington 36 (1950) 627-34.

X-ray treatments of embryos or early larval stages of D. melanogaster will block the action of a specific suppressor gene and allow the normally present but suppressed mutant gene "erupt" to manifest itself in the adult stage. The fact that the blocking action of x-rays was not carried over to the next generation indicated that the suppressor gene had not mutated, but that its product had been inactivated.

1308 Glass, B., Plaine, H. L. THE ROLE OF OXYGEN CONCENTRATION IN DETERMINING THE EFFECTIVENESS OF X-RAYS ON THE ACTION OF A SPECIFIC GENE IN DROSOPHILA MELANOGASTER. Proc. nat. Acad. Sci. Washington 38, 8 (1952) 697-705.

X-ray treatments of embryos of the suppressor-erupt stock block the action of a specific suppressor gene (Su-er) and allow the suppressed mutant gene erupt (er) to manifest itself in the adult stage. This stock also shows a high incidence of melanotic tumors (81.7%) induced by x-rays. When embryos were irradiated with 1000 r units at 10 ± 1 h in concentrations of 0% $O_2$, 10% $O_2$, 20% $O_2$, and pure oxygen, there was, with increasing oxygen concentration, (1) increased inhibition of the action of the suppressor gene, with corresponding increase in the expression of erupt; (2) increased mortality in the larval and pupal stages; (3) increased duration of development, with delayed pupation; and (4) increased incidence of tumors as well as increased number of tumors per affected larva. There is no observable effect when embryos are exposed to various $O_2$ concentrations without being x-rayed. The incidence of erupt and the incidence of tumors both increase significantly and linearly from 0 to 20% $O_2$, above which concentration there is only a small, though significant, further increase. The same treatment applied to an Oregon-R inbred strain gives similar results but at a much lower level. Mortality, extended and delayed development, and induction of melanomas all parallel the effects of x-rays on the suppression of erupt at given oxygen tensions; but further work will be required to make clear the nature of the relation between the suppressor of erupt and the parallel effects. (auth. summary)

1309 Gowen, J. W., Stadler, J. IRRADIATION EFFECTS ON VIABILITY OF DROSOPHILA MELANOGASTER. (abstr.) Anat. Record 111 (1951) 497.

Physiological effects of various doses of x-irradiation on day-old male and female imagoes were studied after repeated pair matings. Twenty-six different criteria for the physiological effects are discussed. (NSA 6: 1951, 1952)

1310 Gowen, J. W., Stadler, J. VIABILITY OF DROSOPHILA MELANOGASTER EXPOSED TO X-RAY IRRADIATION. Genetics 37, 5 (1952) 586-7.

2180 Drosophila adults were given single or multiple doses of x-rays. Treatment doses range up to 62 500 r. The flies were distributed in 5 factorial experiments. Twenty-six different criteria describe the physiological effects. Consideration is given to those factors which measure irradiation damage to the fly's life span and to the life of the progeny. Total eggs laid throughout the female's life presents a very complete measure of the functioning of the whole organism. Between 0 to 2500 r there was a 40% random variation in eggs laid. This seeming threshold indicates the female's physiological functions are not seriously altered. Irradiation fluxes of 2500 r or more show a linear decline in eggs laid as dosage increases; at 20 000 r productivity was but 2%, at 62 000 r less than 0.1%. Total days the female laid eggs measures the resistance to complete interference with functioning of reproductive system as distinct from rates of cell division. A threshold of little or no effect appeared between 0 and 2500 r. Days of egg laying were reduced linearly from 84 to 50% at 10 000 r. The capacity to lay eggs was reduced less than the eggs metabolized and laid. Life span of the females showed no reduction with exposures up to 12 500 r. Flies receiving 62 500 r lived about 60% as long as those without any treatment. Observations show that quantitatively the sexes behave in similar manner when exposed to irradiation. (from abstr.)

(Abstract of paper presented at the 1952 meetings of the Genetics Society of America, Ithaca, New York 8-10 Sep. 1952)

1311 Gray, L. H. PRIMARY SITES OF ENERGY DEPOSITION ASSOCIATED WITH RADIOBIOLOGICAL LESIONS. p. 255-70 (disc. p. 270-4) in CIBA Foundation Symposium on "Ionizing Radiations and Cell Metabolism", Wolstenholme, G. E. W., O'Connor, C. M., eds. London, J. & A. Churchill Ltd., 1956.

Metabolic pathways in the development of radiobiological damage are discussed. The question of nuclear transfers is considered in some detail, and the implications of findings reported elsewhere on Drosophila eggs, Habrobracon and silkworm are discussed. Mention is made in the general discussion (p. 272) that no difference in radiation sensitivity between the diploid and the triploid Drosophila has been found.

1312 Grégoire, C. COAGULATION DE L'HÉMOLYMPHE CHEZ LES INSECTES IRRADIÉS PAR LES RAYONS X. Arch. int. Physiol. Biochim. 63, 2 (1955) 246-8.

Les rayons x ont été administrés en une dose unique. Dans l'ensemble, le pourcentage de coagulocytes actifs diminue progressivement, mais temporairement. (BS 17-100055, 1956)

1313 Grosch, D. S. THE RESTORATION OF EGG PRODUCTION AFTER A RADIATION-INDUCED LAPSE IN HABROBRACON. J. Elisha Mitchell Sci. Soc. 72 (1956) 198.

1314 L'Héritier, M. P., Plus, N. INACTIVATION PAR LES RAYONS X DU VIRUS RESPONSABLE DE LA SENSIBILITÉ AU $CO_2$ CHEZ LA DROSOPHILE. C. R. Acad. Sci., Paris 231 (1950) 192-4.

La marche de l'inactivation du virus par les rayons X est du type courbe à un coup. Le diamètre de la cible est de 42 mμ. (auth.)

1315 Joly, P., Biellmann, G. EFFETS D'IRRADIATIONS CHEZ LOCUSTA MIGRATORIA L. C. R. Acad. Sci., Paris 247, 2 (1958) 243-6.

Cette étude montre qu'une dose de rayons X (4700 r) supportable pour un adulte tue une larve de Locusta migratoria. Si l'irradiation est pratiquée avant une certaine période critique, l'irradiation empêche la mue prochaine bien que l'animal survive au-delà de la date de mue des témoins; passé cette période critique, l'irradiation est sans aucun effet sur la prochaine mue qui se produit dans des délais parfaitement normaux mais empêche la mue suivante. Des recherches antérieures nous ont montré que la date de 60 h après la troisième mue coïncide approximativement avec la période des mitoses et du décollement cuticulaire préparant la quatrième mue. On peut donc songer à une action directe des rayons X sur l'hypoderme entravant les processus d'initiation de la quatrième mue. (conclusions)

1316 Kaplan, W. D., Hochman, B., Holden, J. T. PATTERNS OF FREE AMINO ACIDS IN DROSOPHILA MELANOGASTER. Genetics 42 (1957) 381.

A study by means of two-dimensional paper chromatography has been made of the free amino acid patterns of different life stages of wild type and several mutant strains of D. melanogaster before and after x-irradiation. Strain, male and female, and different life stage patterns have been compared. Amino acids occurring in high concentration are ethanolamine phosphate, glutamic acid, taurine, alanine, β alanine, glutamine, and proline. Lesser quantities of glutathione, the leucines, histidine, arginine, asparagine, lysine, aspartic acid, cystine, valine, tyrosine, serine and glycine have been found. A difference in the amount of a substance tentatively identified by chromatograph techniques as methionine has been found to exist between males and females. The level of this substance is higher in females than in males and is apparently intermediate in XO males. Data on the identification and quantitative determination of this substance will be presented.

(Abstract of paper presented at the 1957 meetings of the Genetics Society of America, Stanford, California 26-28 Aug. 1957.)

1317 Karpov, A. E. A COMPARISON OF THE INFLUENCE OF SOFT AND HARD X-RAYS ON THE MANIFESTATION OF POLYHEDRAL DISEASE IN THE SILKWORM. Rep. Acad. Sci. Ukr. No. 11, (1960) 1552-4. (In Ukrainian)

A comparative study was undertaken of the influence of soft and hard x-rays (dosage 5000 r) on the activation of the latent nuclear polyhedral virus in the silkworm (Bombyx mori L., breeds US-I and B-II). The incidence of induced polyhedrosis depends on the kind of irradiation, as well as on the hereditary properties

and stage of development. In caterpillars, soft x-rays induced polyhedrosis approximately twice as frequently as hard rays. Irradiation of pupae caused no activation of the latent virus. (auth.) (NSA 15: 10670, 1961)

1318 King, R. C. DOSE RECEIVED BY THERMAL NEUTRON TREATED DROSOPHILA MELANOGASTER. Nucleonics 12, 9 (1954) 58-9.

Data on the chemical composition and neutron capture reactions of Drosophila tissue are presented from which it was concluded that the biological effects of thermal neutrons in adult Drosophila result from ionizing radiations activated by protons resulting from nitrogen capture reactions. (NSA 8: 6387, 1954)

1319 King, R. C., Wilson, L. P. STUDIES OF THE RADIATION SYNDROME IN DROSOPHILA MELANOGASTER. Radiation Res. 2 (1955) 544-55.

Effects of single exposures to massive radiation doses on mortality, oxygen consumption, growth, feeding behaviour and certain aspects of phosphorus metabolism are described. Irradiation with approximately 60 000 r kills fasted adult D. melanogaster within 1 d and is lethal to 60% of the nonfasted flies within 2 weeks. Males die sooner than females, but show little or no modification of turnover and maintain their weights at control values. In contrast, the rate of growth of irradiated females is slowed down, but the flies eventually reach weights in excess of controls. Irradiated females have fast and slow phases of P turnover with lengthened half-times. The phase systems of fast and slow half-time are affected to different degrees by irradiation. However, irradiation does not affect the amount of P lost by each phase or the total P content of either sex of flies. The biological half-time for P is 0.9 d for normal females, 2.0 d for irradiated females and 1.8 d for normal or irradiated males. Irradiation does not have an immediate effect on the efficiency of P extraction from yeast by the gut. It does have an immediate depressing effect on food intake and a depressing effect 6 d after treatment on the oxygen consumption of the flies.

(See also research report BNL-1978, Brookhaven National Lab., Upton, N. Y., 1954, 24 p)

1320 Mortreuil-Langlois, M. EFFET DES RAYONS X SUR L'INTESTIN MOYEN DE BLABERA FUSCA BR. C. R. Soc. Biol., Paris 154 (1960) 1769-1770.

Nous avons étudié l'apparition des radiolésions de la muqueuse du mésentéron chez Blabera fusca Br. irradiée à la dose de 25 000 r. Les cellules les plus radiosensible sont celles de régénération, au moment de leur différentiation en éléments sécréteurs. L'irradiation ne supprime pas la sécrétion des cellules épithéliales. (auth.)

1321 Passonneau, J. V. THE EFFECT OF X-IRRADIATION ON THE METABOLISM OF PHOSPHORUS-CONTAINING COMPOUNDS IN MELANOPLUS DIFFERENTIALIS EGGS. Physiol. Zool. 27 (1954) 119-28.

X-irradiation could be shown to produce degradation and inhibition of nucleic acid synthesis in grasshopper eggs. Degradation was a delayed effect, and appeared to be a result of metabolic dysfunction rather than of direct depolymerization. The irradiated cell was unable to replace the nucleic acids as they broke down. The results of phosphorus content analyses are tabulated. Inhibition of nucleic acid synthesis was most marked in the post-diapause eggs. Whereas both the cytoplasm and the nucleus of diapause eggs were sensitive to irradiation, the nucleus appeared to be more susceptible than the cytoplasm in post-diapause eggs.

(A detailed 24 p-report was published in 1952. AECU-2304, Massachussetts Inst. of Technol., Cambridge and UAC-663, Argonne National Lab., Lemont, Ill.)

1322 St. Amand, W., Gaulden, M. E., Totter, J. R. EFFECT OF X-RAYS ON NUCLEIC ACID SYNTHESIS IN EMBRYOS OF THE GRASSHOPPER, CHORTOPHAGA VIRIDIFASCIATA. (abstr.) J. Tenn. Acad. Sci. 29 (1954) 185-6.

1323 Tahmisian, T. N., Adamson, D. M. OXIDASE INCREASE IN MELANOPLUS DIFFERENTIALIS EGGS CAUSED BY X-IRRADIATION. Anat. Record 108 (1950) 516, abstr. 16.

When diapause eggs of Melanoplus differentialis are x-irradiated (200 kV, 15 mA) with dosages ranging between 25 000 r and 200 000 r, the hydroquinone oxidase activity in the eggs is decreased immediately after the exposure. The enzyme activity increases with time so that the highest activity is obtained approximately 8 d after exposure. Oxidase activity after irradiation varies in the following sequence: 25 000 r > 50 000 r > 100 000 r > 200 000 r > control. The oxidase is inhibited by cyanide, carbon monoxide, and heat. Its activity is not affected by azide, phenylthiourea, nor diethyldithiocarbamate. The

oxidase is specific for hydroquinone and, in addition, it appears to have some effect on p-phenylene-diamine. It does not oxidize the -SH group in glutathione nor crysteine. Resorcinol or tyramine hydrochloride is also not oxidized by the enzyme. The nitroprusside test reveals that the native -SH groups are not oxidized as long as 124 h after x-irradiation. However, by 18 d practically all —SH groups are absent. The increase in hydroquinone oxidase may be due either to the abolition of check mechanisms that normally repress oxidation or to an increase in the oxidase itself resulting from the breakdown of zymogens in the egg.

1324 Tahmisian, T. N., Adamson, D. M. OXIDASE INCREASE IN MELANOPLUS DIFFERENTIALIS EGGS CAUSED BY X-IRRADIATION. J. exp. Zool. 115, 2 (1950) 379-97.

An abstract of this paper was published in Anat. Record 108 (1950) 516, abstr. 16.

1325 Tahmisian, T. N., Gasvoda, J. THE EFFECT OF β IRRADIATION ON THE RESPIRATION AND MORPHOLOGY OF MELANOPLUS DIFFERENTIALIS EMBRYOS. Trans. Ill. Acad. Sci. 44 (1951) 235-52.

Low dosages of β-radiation produced extensive damage in the embryonic cells of grasshoppers. The respiration of grasshopper embryos was increased during irradiation; irradiation was immediately afterwards followed by inhibition. By the use of Flemming's triple stain it was shown that β-irradiation caused pyknotic chromatin to remain as if it were in the metaphase condition. There is evidence that injury sustained by the chromosomes may be direct and indirect. β-irradiation caused the appearance of some osmophilic material associated with the chromosomes. The nature of this material is as yet unknown. Details of experimental procedure are given. The sources of β-radiation where $P^{32}$ and $Sr^{89}$. The embryos were treated with carrier-free $P^{32}$ containing 2.33 μc per 0.1 $cm^3$ calculated to give 3.1 r/h, and exposed to the above source from 2.5 - 24 h. Those used for respiration studies were exposed to $P^{32}$ and $Sr^{89}$ solutions containing from 2.25 μc to 2930 μc for periods from 1 - 6 h. Equivalent amounts of phosphate or strontium chloride were place in the vessels containing the controls.

(An abstract was also published as report UAC-350, Argonne National Lab., Lemont, Ill., Feb. 1951. Also published as AECU-1258, Nebraska Univ., 1951, 40 p)

1326 Tahmisian, T. N., Passonneau, J. V., Adamson, D. M. THE EFFECT OF X-IRRADIATION AND LOWERED METABOLIC RATE ON THE MORPHOGENESIS OF DEVELOPING MELANOPLUS DIFFERENTIALIS EMBRYOS. J. nat. Cancer Inst. 14 (1954) 941-53.

The extent of x-ray injury in developing grasshopper embryos was determined by cytological, morphological, and physiological examination. At an optimum dose of x-radiation the capacity of the cells to maintain organization was abolished, and they underwent regression in size. Under anaerobic conditions ten times the x-ray dose was required to elicit the same degree of damage observed aerobically, while the caloric output under aerobic conditions was about 300 times that measured anaerobically. The sequence of biological susceptibility to x-irradiation is: tissue differentiation > cell division > anabolism > catabolism. (auth.)

1327 Tahmisian, T. N., Devine, R. L. EFFECT OF METABOLIC POISONS ON IRRADIATION DAMAGE. Fed. Proc. 13 (1954) 150, abstr. 496.

Grasshopper embryos lend themselves to experimentation because of their ability to remain in a state of almost completely suspended animation for 48 h or longer. Grasshopper eggs in diapause were irradiated at 25 000 r in air and then in either $1 \times 10^{-3}$ M KCl, 100% CO, or mixtures of CO and $O_2$ or 95% $N_2$ 5% $CO_2$ 5 min after irradiation for 24 h. In each case negative growth, which occurs in air 16 d after this irradiation, was arrested 30 to 50%. Statistical analyses indicate that this trend is highly significant. If embryos were irradiated in CO, KCN, or 4 atmospheres of $O_2$ and then placed in air, the latter 2 resulted in greater regression while CO afforded almost complete protection. The ability of $O_2$ and KCN to form radicals at the time of irradiation is well known, and suggests that radical formation at the time of exposure is a factor in increased radiation susceptibility. On the other hand, metabolic stasis at the time of irradiation as previously reported with $N_2/CO_2$ (95% and 5%, respectively) and presently with CO, as well as lowering metabolism following irradiation with KCN, CO and $N_2/CO_2$ and $CO/O_2$ mixtures, suggests that the metabolic rate at the time of irradiation, or immediately after irradiation is directly proportional to the degree of damage produced.

1328 Tahmisian, T. N., Devine, R. L. REPRESSION AND ENHANCEMENT OF IRRADIATION EFFECTS ON GRASSHOPPER CELLS BY METABOLIC POISONS AND OXYGEN. Radiation Res. 3, 2 (1955) 182-90.

Diapause embryos of the grasshopper Melanoplus differentialis, when irradiated at 25 000 r in air, undergo negative growth. Conditions were altered by the presence of various metabolic poisons and $O_2$, either before and during, or after irradiation to study modifications of irradiation effects. The degree of negative growth was less if cyanide was given after irradiation. There was also protection when eggs were irradiated under 4 atmospheres of $O_2$ and then transferred to $N_2CO_2$, and particularly so when irradiated in air and then put in $N_2CO_2$. Protection was evident when eggs were irradiated in CO: $O_2$ (80%: 20%) in the dark (but not in the light or when added after) and when irradiated in CO in the dark. Ovarian eggs that have high tetrazolium-reducing capacity are more resistant. It is suggested that there may be a relationship between the resistance of tissue to irradiation and its dehydrogenase content. There is a strong indication that radioprotective substances depend on the H and electron transfer of tissues and cells. A statistical analysis of the methods is presented. (auth.)

1329 Tahmisian, T. N., Wright, B. J. IMMEDIATE EFFECT OF X-RAYS ON THE DPN-DPNH RELATIONSHIP IN GRASSHOPPER EGGS. Fed. Proc. 15 (1956) 184, abstr. 598.

Grasshopper eggs in the diapause stage of development were used to determine whether the DPN-DPNH balance in vivo is changed under irradiation. Theoretically, the radicals formed from $H_2O$ and $O_2$ by radiation have a half life of $1 \times 10^{-8}$ s to $1 \times 10^{-7}$ s. Therefore at any dose rate, the rate of disappearance of radicals should equal the rate of formation within 1 μs, and the resulting constant level attained should be dependent on dose rate rather than on accumulated dose. The grasshopper eggs, which are approximately 5 $mm^3$ in volume, were introduced into boiling water while under the x-ray beam, to fix the DPN-DPNH relationship during the period of irradiation. Controls consisted of eggs treated in the same manner except that they were not irradiated. A 3rd group of eggs was irradiated and then killed, to determine whether partial recovery toward the DPN-DPNH relationship of the controls would occur. In eggs killed while under x-ray beam the ratio of DPN to DPNH content is higher than that of the controls. In eggs killed a few minutes following irradiation, this ratio of DPN to DPNH is higher than that of the controls but lower than that of eggs killed under the beam. This suggests partial reduction following irradiation. On the basis of the above observations we may assume that when biological material is irradiated in the presence of oxygen more oxidative than reducing radicals are formed.

1330 Taira, T., Nawa, S. THE EFFECTS OF X-IRRADIATION ON NITROGEN METABOLISM IN DROSOPHILA MELANOGASTER. Mishima. Nat. Inst. Genet. Annu. Rep. 7 (1956, pub. 1957) 83-4.

1331 Tazima, Y. RADIATION BIOLOGY OF THE SILKWORM. Proc. 6th Mtg Tokai District Seric. Soc. Jap. (1958) 31-5. (In Japanese)

1332 Tazima, Y. RADIATION PHYSIOLOGY OF THE SILKWORM, WITH SPECIAL REFERENCE TO THE EFFECT OF RADIATION ON GERM-CELLS. p. 249-271 in "Recent Advance in Experimental Morphology". Takewaki, Harizuka, Fukaya, eds. Tokyo, Yokendo. 1959. (In Japanese)

1333 Terzian, L. A. THE EFFECT OF X-IRRADIATION ON THE IMMUNITY OF MOSQUITOES TO MALARIAL INFECTION. J. Immunol. 71, 4 (1953) 202-6.

The mosquito Aëdes aegypti, in common with other insects, is extremely resistant to high doses of x-irradiation. Mortality did not reach 100% in groups exposed to 40 000 r and 30 000 r until the 12th and 21st post-irradiation days, respectively, while in groups exposed to 20 000 r mortality was 95% on the 30th day. In groups exposed to 10 000 r and 5000 r mortality was 28% and 18%, respectively, at the end of 30 d. In non-irradiated control colonies mortality was 10% at the end of 30 d, and the average life span of these laboratory mosquitoes was approximately 45 d. X-irradiation doses ranging from 5000 to 30 000 r produces a significant increase in the innate resistance of A. aegypti to infection with the malarial parasite Plasmodium gallinaceum, and this effect is increased with increasing x-irradiation. Penicillin and sulfadiazine, when administered to x-irradiated mosquitoes prior to infection, are capable of reversing the effects on host immunity produced by exposure to x-irradiation and re-establishing what would appear to be a normal host-parasite equilibrium. (auth. summary)

1334 Tipton, S. R., St. Amand, G. S. THE EFFECTS OF X-RAYS ON THE RESPIRATORY METABOLISM OF EGGS AND EMBRYOS OF THE GRASSHOPPER CHORTOPHAGA VIRIDIFASCIATA. Physiol. Zool. 27, 4 (1954) 311-7.

The $O_2$ consumption of Chortophaga eggs measured at 38°C in $O_2$ averaged 78.8 ± 3.3 $mm^3$ $O_2$/100 eggs/h and increased 28% during a 4-h period of respiratory determination. When measured at 38°C in air, the rate of $O_2$ consumption did not change during a 4-h period. Winter embryos freed of yolk and placed in isotonic medium respired at a significantly lower rate than did spring and summer embryos treated in the same manner. The addition of glucose to the suspending medium had no effect on the respiration of embryos. Comparable rates were obtained with measurements of 40 embryos in Warburg flasks and of individual embryos in Gregg respirometers. X-ray doses of 10 000 r and above significantly reduced the $O_2$ consumption of 14-d Chortophaga eggs in the first hour after treatment. Doses of 3500 r and above significantly reduced the respiration of embryos in the hour following irradiation. The reduction in respiration increased with larger doses of x-rays. (auth. summary)

1335 Wharton, M. L., Wharton, D. R. A. THE PRODUCTION OF SEX ATTRACTANT SUBSTANCE AND OF OÖTHECAE BY THE NORMAL AND IRRADIATED AMERICAN COCKROACH, PERIPLANETA AMERICANA L. J. Insect Physiol. 1, 3 (1957) 229-39.

A correspondence has been shown to exist between the production of an attractant substance and the mating period of Periplaneta americana. The attractant is produced principally by virgin females and, sporadically, by mated females, and is conducive to mating; however, mating depresses the production of attractant. Production of attractant normally decreases with age and as oöthecal production increases. Mating induces an increase in oöthecal production, especially among younger cockroaches. Cathode-ray irradiation (from a 2-MeV Van de Graaff electron accelerator) damages oöthecal and attractant production. With oöthecal production totally inhibited by irradiation, the females recovered their capacity to produce attractant and exceeded the normal yield. A relationship is indicated between attractant production and the processes which regulate ovulation. (auth.)

1336 Whiting, A. R. FAILURE OF PUPATION OF EPHESTIA LARVAE FOLLOWING EXPOSURE TO X-RAYS. Anat. Record 108 (1950) 609.

The Mediterranean flour moth, E. kühniella, belongs to the group of insects (homodynamic) in which a a continuous succession of generations occurs so long as conditions are favourable. In the course of several experiments full-grown larvae were irradiated with doses ranging from 40 000 to 160 000 r. Following a short period of inactivity they moved about normally and were readily stung and fed upon by the parasitic wasp Habrobracon. Those not exposed to the parasite continued to crawl, and none pupated. All lived for at least a few days and some (41/177 or 23.16%) were still alive 30 to 40 d after exposure. Control larvae pupated 3 d after time of exposure of treated larvae. The behaviour of the irradiated larvae resembles that of diapause larvae in forms (heterodynamic) which show a prolonged arrest of growth in this stage. Whether the x-ray-induced inhibition is due to an interference with secretory processes controlling pupation or to injury to cells of the larval imaginal disks vital to pupal formation is not known. Two irradiated in the prepupal stage pupated but failed to eclose.

(Abstract of paper presented at the 47th Annual Meeting of the American Society of Zoologists, Cleveland, Ohio, 27-30 Dec. 1950.)

1337 Witte, E., Sigmund, R. ULTRAFRACTIONATION. II. ADDITIONAL EXPERIMENTAL STUDIES OF THE BIOLOGICAL EFFECT OF AN INTERMITTENT IRRADIATION. Strahlentherapie 88 (1952) 384-94.

Additional investigations on intermittent x-irradiation of Drosophila eggs and pupae are reported. Although the previously observed ultrafractionation effect was reproduced in the pupae, no effect was observed in 4.5 ± 0.25-h-old eggs for single irradiation times between 1 s and $4 \times 10^{-5}$ s. If such an effect exists for eggs it must appear at shorter irradiation times than $4 \times 10^{-5}$ s. Significance of the ultrafractionation effect for explaining the biological action of betatron radiation is discussed. (NSA 7: 726, 1953)

1338 Yanders, A. F. THE EFFECT OF X-RAYS ON SPERM ACTIVITY IN DROSOPHILA. (abstr.) Genetics 44 (1959) 545-6.

A study was made of the post-copulatory migration of spermatozoa from the vagina to the ventral receptacle of the female. The fullness of the excised receptacle was measured and used as a measure of the relative activity of control and irradiated spermatozoa. Immediately following doses of 2500 r a significant reduction

in the degree of successful insemination was observed but the males showed recovery if held for 24 h before mating. Recovery may be complete at doses below 10 000 r. This finding has a direct bearing on dominant lethal studies. Kaplan (1958) has shown that unfertilized eggs may contribute significantly to the dominant lethality rate as measured by hatching failures. Irradiation may contribute to fertilization failure by reducing the activity of individual sperm, and by lowering the number of sperm stored by a laying female.

## Effects on feeding activity

* Clark and Kelly 1950 - [863]

1339 Henderson, B. J., Baxter, R. C., Tuttle, L. W. THE EFFECT OF A HIGHLY IRRADIATED FOOD MEDIUM ON LIFE SPAN AND DEVELOPMENT OF DROSOPHILA MELANOGASTER. (abstr.) Radiation Res. 7, 3 (1957) 321.

Five successive generations of Drosophila melanogaster were grown on a brewer's yeast medium irradiated with 1 million rep of γ-rays from a $Co^{60}$ source. The irradiation dose selected lies between the pasteurizing dosage range and the so-called "sterilizing" dose for most micro-organisms. Studies of longevity, fecundity, egg hatchability and body weights of several thousand flies disclosed no significant detrimental changes in the characteristics studied when evaluated at the 95% significance level in comparison with flies grown on unirradiated medium. If toxic substances are produced in an aqueous yeast suspension by the application of $10^6$ rep of γ-radiation, the concentrations are such that no deleterious effects are grossly evident in flies grown solely on irradiated medium for several generations.

(The study was also published in UR-483, Rochester, N. Y. Univ., Atomic Energy Project, 1957, 86 p)

1340 Hodges, R., Guyer, G. THE EFFECTS OF AN IRRADIATED WHEAT DIET ON THE CONFUSED FLOUR BEETLE, GRANARY WEEVIL AND THE ANGOUMOIS GRAIN MOTH. J. econ. Ent. 51, 5 (1958) 674-5.

In experiments to determine whether grain irradiated with cathode rays in a Van de Graaf accelerator (cf. RAE-A 44: 272) differed from untreated grain as a food for Tribolium confusum Duv., Calandra (Sitophilus) granaria L. and Sitotroga cerealella (Ol.), wheat irradiated at $10^4$, $10^5$ or $10^6$ rep had no apparent deleterious effect on the reproduction potential of insects reared on it. When differences did exist, an increase in reproduction was evident. (RAE-A 48 (1): 29, 1960)

1341 Родионова, Л.З. ИЗМЕНЕНИЕ АКТИВНОСТИ ПИТАНИЯ ЖУКОВ АМБАРНОГО ДОЛГОНОСИКА, ОБЛУЧЕННЫХ Х-ЛУЧАМИ. Труды всес. н.-и. ин-та зерна и продуктов его переработки, Москва 35 (1958) 58-61.

Жуков (Ж) облучали из рентгеновской установки РУП-3 (200 кв, фильтр 0,5 мм Cu) дозой 10 000 р при мощности дозы 950 р в 1 мин. В 1-й серии опытов определяли через 10, 20 и 30 суток число зерен, поврежденных облученными и контрольными Ж. Через каждые 5 суток удаляли погибших подопытных Ж и столько же живых удаляли в контроле. Во 2-й серии в те же сроки определяли вес пшеницы, съеденной Ж в опыте и контроле, причем зерно предварительно очищали от экскрементов и наточенной Ж мучки. Через 10 и 20 суток зерно в образцах заменяли новым, чтобы исключить влияние личинок, отродившихся в старом зерне. Взамен погибших подсаживали из запаса Ж того же срока облучения. Среднее число зерен поврежденных облученными Ж, по сравнению с контрольными, постепенно уменьшается и через 30 дней достигает 57,2%. Средний вес пшеницы через 10, 20 и 30 суток, съеденной одним облученным Ж, постепенно увеличивается, а съеденной контрольным Ж почти не изменяется (3,43 - 4,03 мг). Вес пшеницы, съеденной в 1-ю и 2-ю декаду облученными Ж, почти в два раза меньше, чем контрольными Ж. Но к исходу 3-й декады это кол-во выравнивается, так как в первые 20 суток ~90% облученных Ж погибает, а выжившие, наиболее устойчивые Ж питаются так же активно, как и контрольные.

Rodionova, L. Z. CHANGE IN THE FEEDING ACTIVITY OF GRAIN WEEVILS (CALANDRA GRANARIA L.) AFTER X-IRRADIATION. Trudy vses. n.-i. in-ta zerna i produktov ego pererabotki (Trans. All-Un. sci. Res. Inst. Grains and Products of Processed Grain) 35 (1958) 58-61.

Grain weevils were irradiated at 10 000 r of x-rays at a dose rate of 950 r/min. The amount of damaged kernels was checked at 10, 20 and 30 d. At 5-d intervals dead weevils were removed and a similar number from the controls. By 30 d, the damage done by irradiated weevils was 57.2% less than by the controls.

The weight of wheat consumed by irradiated weevils at the end of 10 and 20 d was half that of the controls, but by 30 d it was about the same, since 90% of the irradiated weevils died during the first 20 d and the resistant ones fed with the same intensity as the controls. (from Referativny Zhurnal Biologia 1: 7083 (1959))

1342 Rogers, W. I., Hilchey, J. D. THE EFFECT OF BETA RADIATION ON THE FEEDING ACTIVITY OF TRIBOLIUM SPP. Bull. ent. Soc. Amer. 3, 3 (1957) 25, abstr. 24.

Irradiated Tribolium adults lived longer in a culture medium of wheat flour than in the absence of a medium or in the presence of Celite or powdered cellulose. When no culture medium was provided, there was no appreciable difference in the median lethal times between irradiated and unirradiated individuals. Living Tribolium fed on the carcasses of beetles which had died previously. The use of either flour or non-nutritive materials eliminated this response. The presence of a thin layer of medium provided no protection from radiation. Tribolium larvae were tested similarly. These tests indicate that Tribolium adults are capable of damaging or infesting subsistence items after the beetles have been exposed to doses of beta radiation which produce delayed lethal effects.

1343 Rogers, W. I., Hilchey, J. D. STUDIES ON THE POSTIRRADIATION FEEDING ACTIVITY OF TRIBOLIUM CASTANEUM (TENEBRIONIDAE: COLEOPTERA). Ann. ent. Soc. Amer. 53, 5 (1960) 584-90.

Adults that had been exposed to selected doses of high-speed electrons were subsequently offered various diets. Longevity studies and radioisotopic tracer studies showed that they fed to some degree after irradiation. After exposure to 27400 rads or more, feeding ceased for at least 2 d, then was resumed between the 2nd and 7th days, and the amount of feeding depended on the dose of radiation previously applied. The nutritional state of the beetles after exposure to certain dosages of radiation affected their life expectancy. At least two dose-dependent modes of mortal response to irradiation with high-energy electrons were exhibited by T. castaneum, and starvation was not a primary cause of death in irradiated individuals. (auth.)

## I-C-7 TUMOUR FORMATION

1344 Fahmy, O. G., Fahmy, M. J. CYTOGENETIC ANALYSIS OF THE ACTION OF CARCINOGENS AND TUMOR INHIBITORS IN DROSOPHILA MELANOGASTER. V. DIFFERENTIAL GENETIC RESPONSE TO THE ALKYLATING MUTAGENS AND X-RADIATION. J. Genet. 54 (1956) 146-64.

Work on the alkylating compounds, described here, gives the first decisive evidence for the nonrandomness of the mutation process. This evidence is based on three major differences in the mutagenic mode of action of the alkylating compounds and x-radiation, as regards: (a) the morphogenesis loci (or visibles) affected, (b) the ratio of the recessive visibles/lethals induced, and (c) the distribution of the loci of genetic effect along the X-chromosome. By the use of selected representatives of the alkylating compounds it was possible to induce nearly 200 "new" sex-linked recessive visibles, resulting in phenotypic expressions completely different from those induced by other mutagens, especially radiation. The great majority of these mutations are not associated with chromosome aberrations detectable in the salivary-gland chromosomes and apparently they are not allelic to any of the known x-ray visibles. The selectivity here discernible is for certain morphogenesis loci, rather than for certain chromosome segments, a selectivity of a very fine nature, probably on the molecular level. The ratio of sex-linked recessive visibles/lethals in the same sample of treated chromosomes is exceptionally high for a particular amino mustard [p, N-bis (chloroethyl) phenyl-alanine], which mutates 2-3 times as many morphogenesis loci as x-rays or any other alkylating compound. Among the sex-linked recessive lethals induced by various doses of tri(ethylenimino) triazine there is a fixed proportion showing cytologically detectable chromosome aberrations, i.e., major rearrangements and deficiencies. (CA 50: 5903g, 1956)

1345 Ghelelovitch, S. SUR LE DÉTERMINISME DE LA SENSIBILITÉ À L'ACTION TUMORIGÈNE DES RAYONS X CHEZ DROSOPHILA MELANOGASTER MEIG. C.R. Acad. Sci., Paris 260 (1960) 1387-8.

La réponse à l'irradiation par la formation des tumeurs mélaniques dépend, chez la drosophile, de la constitution héréditaire des individus irradiés. Cependant, la sensibilité à l'action tumorigène des rayons X ne peut être attribuée exclusivement à la présence dans le génotype du "gène tumoral" responsable de la prédisposition héréditaire à la tumorigénèse spontanée. (auth.)

* Glass and Plaine 1952 - [1185]

1346 Glass, B., Plaine, H. L. A BIOCHEMICAL ANALYSIS OF FACTORS PRODUCING MELANOTIC TUMORS AND ERUPT EYES IN THE SUPPRESSOR-ERUPT STOCK OF DROSOPHILA MELANOGASTER. p. 1163-7 in "Proceedings of the 9th International Congress on Genetics, Bellagio, Italy 1953", Suppl. to Caryologia 6. Montalenti, G., Chiarugi, A., eds. Florence, 1954.

D. melanogaster embryos of the suppressor-erupt stock, treated with x-rays showed a high incidence of melanotic tumours in 3rd instar larvae and manifestation of erupt eyes in adults. These effects depend on the concentration of oxygen in the atmosphere at irradiation. Effects of exposure to $O_2$ without irradiation and of exposure to $H_2O_2$ were also tested. The experiments indicated that the effect of the x-rays in producing both melanotic tumours and erupt eyes might result from the production by oxygen of $H_2O_2$ or potent oxidizing agents with an action analogous to that of peroxide. The effects of intermediates in tryptophan metabolism on the incidence of tumours and erupt eyes were also studied.

1347 King, R. C. OÖGENESIS IN ADULT DROSOPHILA MELANOGASTER. III. RADIATION-INDUCED OVARIAN TUMORS. Growth 21 (1957) 129-35.

Ovarian tumours are induced in D. melanogaster by ionizing radiation. A dose of 4000 r of $Co^{60}$ $\gamma$-rays produces an incidence of tumours 26 times the control rate. A mechanism of tumour formation is postulated.

1348 Plaine, H. L., Glass, B. THE EFFECT OF OXYGEN CONCENTRATION UPON THE INDUCTION BY X-RAYS OF MELANOTIC TUMOURS IN DROSOPHILA MELANOGASTER. Cancer Res. 12 (1952) 829-33.

A stock of Drosophila melanogaster contained a suppressor gene (I) inhibiting the manifestation of erupt (a mutant that produces an abnormal growth of tissue which erupts through the eye). When the embryos were x-rayed, I was blocked and melanotic tumours arose. On increasing oxygen concentrations from 0 to 20% at the time of irradiation, the incidences of tumours and erupt increased linearly; on further increase of oxygen concentration to 100% there was a small further increase in tumours and erupt. Mortality and duration of development also increased with increasing oxygen content at the time of x-ray treatment. The same differential responses to x-rays in varying oxygen concentrations (but with all responses showing a much lower incidence) also occurred in another tested stock. The incidence of melanotic tumours in both stocks was slightly increased by exposure of the embryos for 10 min to pure oxygen without x-rays, and was decreased by similar exposure to pure nitrogen. I was not affected by oxygen in the absence of x-rays. (CA 47: 5537i, 1953)

(An abstract of a similar paper, "The role of oxygen concentration in determining the effectiveness of x-rays on the action of a specific gene and on tumour formation in Drosophila melanogaster" by the same authors appeared in Genetics 37 (5) (1952) 614).

1349 Plaine, H. L. EFFECT OF OXYGEN AND HYDROGEN PEROXIDE ON THE ACTION OF A SPECIFIC GENE AND ON TUMOR INDUCTION IN DROSOPHILA MELANOGASTER. Genetics 40 (1955) 268-80.

The results obtained when embryos are exposed to solutions of hydrogen peroxide or to pure oxygen without irradiation, together with those obtained when embryos are irradiated in different concentrations of oxygen, suggest that x-rays may produce both melanotic tumours and erupt eyes by the production from oxygen of certain potent oxidizing agents analogous to and including hydrogen peroxide. (from auth. summary)

* Plaine 1955 - [1405]

1350 Tahmisian, T. N., Wright, B. J. TERATOGENESIS IN GRASSHOPPER (MELANOPLUS DIFFERENTIALIS) EMBRYOS AS A FUNCTION OF THE DOSE RATE OF X-IRRADIATION. (abstr.) Anat. Record 128, 3 (1957) 632.

Seven day prediapause grasshopper embryos Melanoplus differentialis differentialis Thomas were irradiated with 250 r of x-irradiation (200 kV, 15 mA) at dose rates of 1 r per min and 200 r per min. The embryos were dissected out of the eggs and observed at 21 d prediapause or 14 d postirradiation. Those embryos that received 200 r per min had terata at a ratio of 8 to 5 in comparison to those that received the same total dose at 1 r per min. Other embryos receiving 200 r per min were administered half of the dose in the beginning and the other half at the end of 248 min in order to compensate for the 250 min interval of irradiation at 1 r per min. Splitting the dose did not make any significant differences upon the incidence of teratogenesis in comparison to those that received 250 r in 1¼ min. This is indicative that there is an intrinsic mechanism for recovery from irradiation.

1351 Taira, T., Morita, T. MELANOTIC TUMORS INDUCED IN DROSOPHILA MELANOGASTER BY IONIZING IRRADIATION. Mishima. Nat. Inst. Genet. Annu. Rep. 8 (1957, pub. 1958) 82-4.

## I - D Combination or Comparison of Several Treatments (Other Radiations, Heat, Chemicals, etc.)

### Surveys

1352 Gray, L. H. CONDITIONS WHICH AFFECT THE BIOLOGIC DAMAGE RESULTING FROM EXPOSURE TO IONIZING RADIATION. Acta radiol., Stockh. 41 (1954) 63-83.

Some experimental studies on the effect of pre- and post-irradiation treatments of cells in damage resulting from exposure to ionizing radiation are reviewed. The influence of $O_2$ tension on damage induced by Röntgen radiation follows a strikingly similar pattern in the case of 5 different biologic responses in plant and insect cells, whereas its influence on $\alpha$-ray and neutron damage is relatively slight.

1353 Laser, H. THE INFLUENCE OF OXYGEN ON RADIATION EFFECTS. p. 106-16 (disc. p. 116-9) in CIBA Foundation Symposium on "Ionizing Radiations and Cell Metabolism". Wolstenholme, G. E. W., O'Connor, C. M., eds. London, J. and A. Churchill Ltd. 1956.

This is a general paper, giving an overall view of the problem. Mention is made of the variety of cells in which damage from ionizing radiation was enhanced when it occurred in the presence of $O_2$. The approach of the physicochemist to the problem of the $O_2$ effect is outlined, the author himself proposing a biochemical approach. Experimental data including some results for grasshopper eggs are cited in support of his argument.

---

1354 Abrahamson, S. CONCERNING THE EFFECTS OF DIFFERENT OXYGEN TENSIONS ON THE REARRANGEMENT PROCESSES WITH FRACTIONATED X-RAY TREATMENTS OF DROSOPHILA OÖCYTES. Diss. Abstr. 17, 2 (1957) 441-2.

1355 Abrahamson, S. THE INFLUENCE OF OXYGEN ON THE X-RAY INDUCTION OF STRUCTURAL CHANGES IN DROSOPHILA OÖCYTES. Genetics 44 (1959) 173-85.

Through the use of x-ray dosage fractionation methods, it became possible for the first time to demonstrate in Drosophila oöcytes effects of oxygen concentration on induced gross chromosomal rearrangements and to test separately the effect of different oxygen concentrations applied before, during, or after irradiation. $O_2$, present at the time of irradiation, results in a significantly greater frequency of half-translocations than produced in air. Anoxia ($N_2$) at the time of irradiation results in a drastic reduction in the frequency of half-translocations as compared with air. Oxygen between irradiations is not as effective as air in reducing the half-translocation frequency. Anoxia between the two x-ray fractions increases half-translocation frequency. Although a part of this effect may be by the prohibition of joining of broken ends it seems to be greater than can be expected simply on the basis of this passive role. Post-oxygen treatment had no detected effect but post-nitrogen exposure significantly increased the rearrangement frequency. (auth.)

(An abstract of an earlier paper "The effects on rearrangement frequency of different oxygen tensions either during or between fractionated x-ray treatment of Drosophila oöcytes" appeared in Genetics 41: 631, 1956)

* Alexander and Stone 1955 - [1156]

1356 Alexander, M. L. THE RELATIONSHIP OF RADIATIONS AND ENVIRONMENTAL CHANGES IN OXYGEN CONCENTRATIONS FOR BIOLOGICAL DAMAGE IN THE IMMATURE GERM CELLS OF DROSOPHILA VIRILIS. p. 3-4 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press, 1958.

Radiation treatment of post-meiotic cells of spermatogenesis in D. virilis resulted in differences in the number of translocations and dominant lethals. Qualitative as well as quantitative differences in radiobiological damage were found in meiotic and spermatogonial cells. Post-meiotic cells varied in sensitivity to x-rays, $\gamma$-rays, and fast neutrons. With these radiations, biological damage was considerably higher in spermatids than in mature sperm when $O_2$ was present during treatment. $O_2$ concentrations over 20% (air)

did not increase the damage in sperm cells; however, in spermatids an atmosphere of pure $O_2$ continued to increase the biological damage over the values obtained for air. Lethal damage in meiotic and spermatogonial cells was influenced by increase in $O_2$ concentrations with x-ray and fast neutrons. Differences in the lethal damage induced in spermatids by γ-rays in pure $O_2$ were obtained by varying the dosage of radiation. Mature sperm showed no difference in lethal damage, whether fast, slow, or fractional doses of γ-rays were used in an atmosphere of $N_2$. (CA 52: 20708a, 1958)

1357 Baker, V. H. SOME EFFECTS OF ELECTROMAGNETIC ENERGY AND SUBATOMIC PARTICLES ON CERTAIN INSECTS WHICH INFEST WHEAT, FLOUR AND BEANS. Ph. D. Dissertation. Michigan State College, Dept. of Agricultural Engineering, 1953.

The effects of infra-red and ultraviolet light, and of x-rays and accelerated electrons are described on Tribolium confusum, Duv., Sitophilus granarius (L.), and Acanthoscelides obtectus (Say). The physical aspects of the work are discussed. (See also Taboada 1953: M. S. Thesis)

1358 Baker, W. K., Sgourakis, E. ALTERATION OF THE X-RAY SENSITIVITY OF DROSOPHILA BY MEANS OF RESPIRATORY INHIBITORS. Genetics 35 (1950) 96.

Males of the Oregon-R strain of D. melanogaster were subjected to x-radiation (1000, 3000 or 5000 r units, 250 kV potential, 15 mA) while in an atmosphere of either $O_2$ or $N_2$ at an approximate temperature of either 27 or 2°C. The number of X-chromosomes which bear recessive lethal mutations was determined by mating the treated males to the females of Muller-5 stock using the technique outlined by Spencer and Stern (Genetics 33 (1948) 43-74. Depending upon the dosage, a 40 - 70 per cent reduction in the number of sex-linked lethal mutations is observed in the sperm from the flies irradiated in $N_2$ as compared to those treated in $O_2$. Indirect evidence also indicates that the induced frequency of dominant lethals is greatly reduced when the flies are x-rayed in $N_2$. A significantly greater number of mutations is induced in the flies treated in $O_2$ at the cold temperature than in those maintained in $O_2$ at the warm temperature. This "temperature effect" is not evident when the flies are irradiated in $N_2$ thus indicating that this effect is related to the $O_2$ concentration in the sperm. The data are compatible with the differences in solubility of $O_2$ at the temperatures used. Control experiments were performed in which series of flies were subjected to each gas at the two temperatures without irradiation. These experiments show no alteration of the spontaneous mutation rate.

(Abstract of paper presented at the 1949 meetings of the Genetics Society of America, New York City, 28-30 Dec. 1949)

1359 Baker, W. K., Sgourakis, E. THE EFFECT OF OXYGEN CONCENTRATION ON THE RATE OF X-RAY INDUCED MUTATIONS IN DROSOPHILA. Proc. nat. Acad. Sci., Washington 36 (1950) 176-84.

A striking reduction has been found in the number of recessive sex-linked lethal mutations induced in D. melanogaster males when they are exposed to x-rays while in an atmosphere of low concentration. Although an increased number of mutations were induced in flies irradiated in $O_2$ at 2°C over those treated in $O_2$ at 27°C, this increase was not due to the temperature per se but rather it was apparently caused by a higher oxygen tension within the irradiated sperm at the lower temperature. Additional evidence also indicates that fewer dominant lethal mutations and chromosome aberrations are induced in flies maintained in a near $O_2$-free atmosphere during irradiation. (auth.)

(This work was also published as report ORNL-575, Oak Ridge National Lab., Tenn. 1950, 18 p)

1360 Baker, W. K., Edington, C. W. THE INDUCTION OF TRANSLOCATIONS AND RECESSIVE LETHALS IN DROSOPHILA UNDER VARIOUS OXYGEN CONCENTRATIONS. Genetics 37 (1952) 665-77.

Translocations were induced in Drosophila virilis sperm by exposing to 2000 r of x-rays adult males maintained in various concentrations of oxygen during treatment. Less than ¼ as many translocations are induced in the absence of $O_2$ (in $N_2$) as is the case when the males are irradiated in 100% $O_2$. Studies on the production of sex-linked recessive lethals in D. melanogaster indicate that about ½ as many lethals are induced by 4000 r of x-rays when the males are exposed in a $N_2$ environment as compared with pure $O_2$. For the induction of both translocations and recessive lethals, the shape of the curves relating the genetic effect to $O_2$ concentration is strikingly similar. At low $O_2$ concentrations, small changes in the $O_2$ tension cause a rapid rise in the amount of genetic effect produced until a concentration of about 11% is reached. At this point the curves break sharply and further increase in the amount of $O_2$ has little or no effect on the frequency with which translocations or recessive lethals are induced by a given dosage of x-radiation. (auth.)

1361 Baker, W. K., Halle, E. S. von. THE EFFECT OF OXYGEN CONCENTRATION ON THE INDUCTION OF DOMINANT LETHALS. Genetics 37 (1952) 565.

The production of dominant lethals in males of D. melanogaster was studied as a function of x-ray dosage and oxygen concentration (air, 5% $O_2$ and $N_2$). The experiments were designed so that the dominant lethals induced in sperm which were ejaculated in copulation with single females during the first 24-h period after irradiation could be separated from lethals induced in sperm used during the second 24-h period. Dominant lethals were determined from counts of hatched and unhatched eggs laid by these females. Irradiating males in $N_2$ effectively reduces, as compared to air, the dosage by a factor of 1.5 in the first sperm batch but by only 1.2 in the second batch. Thus the end result of $O_2$ action is less in the case of dominant lethals than that reported for recessive lethals and chromosome aberrations. The further decrease in $O_2$ effect in the second sperm batch is due solely to a reduction in number of dominant lethals recovered in males treated in air and 5% $O_2$. The number induced in $N_2$-treated flies remains constant over the two-day period. It is generally agreed that dominant lethals induced in sperm are caused mainly by chromosome breakage with the resulting formation of inviable rearrangements. These data can best be interpreted on the view that the number of breaks induced by x-rays is independent of $O_2$ concentration but that the broken ends formed in $N_2$ are more likely to rejoin (either to restitute or to form new arrangements) than those induced in air.

(Abstract of paper presented at the 1952 meetings of the Genetics Society of America)

1362 Baker, W. K., Halle, E. S. von. THE BASIS OF THE OXYGEN EFFECT ON X-IRRADIATED DROSOPHILA SPERM. Proc. nat. Acad. Sci., Washington 39 (1953) 152-61.

A study of the relation between x-ray dosage and $O_2$ concentration on the induction of dominant lethals in mature sperm of D. melanogaster shows that the frequency of dominant lethals induced upon irradiation in $N_2$ is reduced much less than would be expected on the hypothesis that $O_2$ concentration is affecting the number of primary breaks induced. Fewer dominant lethals are recovered in sperm exposed in air when at least 24 h have elapsed between treatment and insemination than when insemination very shortly follows treatment. This effect is not observed in $N_2$-treated sperm. These data can be interpreted on the basis that the $O_2$ concentration affects the amount of restitution of chromosome breaks taking place in the sperm. A low $O_2$ concentration during irradiation makes restitution more likely, and the broken ends apparently restitute more quickly. Therefore, the data lend support to the differential reunion hypothesis of $O_2$ action rather than to the differential breakage hypothesis. (auth.)

1363 Baker, W. K., Halle, E. S. von. EVIDENCE ON THE MECHANISM OF THE OXYGEN EFFECT BY USE OF A RING CHROMOSOME. J. cell. comp. Physiol. 45, Suppl. 2 (1955) 299-308.

Drosophila melanogaster males having the $X^{Cl}$ chromosome and a marked Y were irradiated with x-rays while in an environment of either air or $N_2$. Induced loss of the ring chromosome was measured by determining the sex ratio in the offspring. At low dosages, only a very small $O_2$ effect was observed on either the sex ratio or the frequency of X-O males. The data favour the hypothesis that $O_2$ acts on the rejoining of broken chromosome ends rather than on the initial number of breaks induced by the radiation. (BA 33: 24324, 1959)

1364 Baker, W. K. THE OXYGEN EFFECT AND THE MUTATION PROCESS. p. 191-200 in "Brookhaven Symposia in Biology, 15-17 June 1955", Vol. 8, Brookhaven National Lab., Upton, N. Y. 1957.

The effect of low $O_2$ concentrations on the mutagenic activity of x-radiation is discussed. 24 references.

* Baldwin 1956 - [1244]

1365 Baldwin, W. F., Narraway, C. A. INTERACTION OF HEAT AND X-RAYS IN KILLING A CHALCID. Nature 179 (1957) 972-3.

Results of experiments carried out on Dahlbominus fuscipennis (Zett.) are presented in graphical form, and show the (24-h) mortality in the chalcid when held at different temperatures before, during and after exposure to 200 000 r of x-rays. A table also gives the effect of the sequence of exposures to heat and x-rays. The mechanism by which heat so drastically influences the killing when applied after x-rays is not clear. In an organism such as an insect where large x-ray doses are tolerated, x-rays and heat are not equivalent despite the striking similarities in lethal effects, since the end results depend on the sequence in which the two agents are administered.

1366 Baldwin, W. F., Narraway, C. A. THE INTERACTION OF HEAT AND X-RAYS ON KILLING IN DAHLBOMINUS FUSCIPENNIS (ZETT.). (abstr.) p. 291 in "Proceedings of the 10th International Congress on Entomology, Montreal, 17-25 Aug. 1956", Vol. 2. Becker, E. C., ed. Ottawa, Mortimer Ltd., 1958.

In previous studies, a marked similarity was found between killing by high temperatures and killing by very high doses of x-rays in adults of Dahlbominus (Baldwin, 1956). In the present experiments, the lethal effects of x-rays were drastically modified by temperatures which are normally non-lethal (10° to 36°C), the effect being observed when the temperatures were applied during or after the irradiation, but not when they were applied before the x-ray (e. g., an increase from 5% up to 100% kill). When sub-lethal x-ray doses were used, subsequent exposure to heat which would not normally give any mortality produced a high kill within 24 h. (In the reverse order, heat followed by x-rays, negligible killing occurred.) If a period of time was allowed to elapse between the x-ray and the heat exposures, significant recovery occurred during the intervening period; doses giving 100% mortality when the x-ray was followed immediately by heating resulted in progressively lower kills with longer delays between the two agents, mortality amounting to only 35% with a delay of 24 h. Apparently, some system (e. g., an enzyme system) becomes reversibly sensitized towards heat as a result of the x-ray exposure.

1367 Baldwin, W. F. RECOVERY FROM X-RAY-INDUCED SENSITIVITY TO HEAT IN AN INSECT. Radiation Res. 8 (1958) 17-21.

An investigation is described into the recovery of the hymenopterous parasite, Dahlbominus fuscipennis (Zett.) from x-ray-induced sensitivity to heat, and the effects of metabolic activity on the rate of this recovery. Recovery was tested at various temperatures; also, the influence of food, oxygen and carbon monoxide on the speed of recovery. The number of insects used for these tests were in excess of 200 for each point on the graphs given. A nonlethal dose of 80 000 r produces a linear sensitivity to heat shock. Thus, if the irradiation is followed immediately by exposure to 43°C for 60 min, which is nonlethal for unirradiated insects, most of the irradiated insects will die within 24 h. Over a period of time after x-irradiation this sensitivity to heat gradually declines. The rapidity of the decline varies widely with temperature, being about ten times as rapid at 32°C as at 12°C. Carbon monoxide inhibits the recovery while present, but recovery resumes when it is removed. Food and pure $O_2$ have little or no effect. In these experiments, heat exposure can be thought of as a means of detecting an otherwise "hidden" effect of the x-irradiation. The recovery from this "hidden" damage might be associated with (1) a loss of poisons resulting from the x-irradiation or (2) a repair or replacement of damaged molecules.

1368 Baldwin, W. F., Salthouse, T. N. OXYGEN DEFICIENCY AND RADIATION DAMAGE IN THE INSECT RHODNIUS. Nature 183 (1959) 974.

Unfed 4th instar Rhodnius prolixus nymphs were held in either $N_2$ or air and irradiated, then fed, and returned to a normal incubator. The delay in molting in $N_2$ was barely perceptible but was quite large for an equal dose in air. Burns did not develop in $N_2$ for doses below 120 kr, but were invariably present for 60 kr in air. (NSA 13: 11580, 1959)

1369 Baldwin, W. F., Salthouse, T. N. EFFECT OF OXYGEN DEFICIENCY ON RADIATION-INDUCED MITOTIC DAMAGE IN SYNCHRONOUSLY DIVIDING CELLS. Canad. J. Res., D-Canad. J. Zool. 37, 6 (1959) 1061-6.

The latent effects of x-irradiation in delaying mitosis are readily observable in the epidermis of the insect Rhodnius owing to the degree of synchrony of division in these cells following a blood meal. At the dose employed in these studies (~ 25 000 r), mitosis did not proceed beyond metaphase when the insects were exposed in air; after irradiation at the same dose in $N_2$, a prolonged division was completed with the greater part of the inhibition occurring during metaphase. (auth.)

1370 Bender, M. A. THE COMPARATIVE EFFECTS OF HARD AND SOFT IONIZING RADIATIONS ON MALE AND FEMALE RING X DROSOPHILA IN AIR AND NITROGEN. Genetics 43, 1 (1958) 122-38.

It was shown that breakage, measured as ring loss, is less frequent in x-rayed oöcytes than in x-rayed sperm. This finding and that of Glass (1955) that x-ray-induced Minute mutations in oöcytes are as frequent as those induced in males, are explained by means of an hypothesis. A further study is described of the rates of ring loss in males and in females, in both air and nitrogen, induced by soft x-rays and by hard γ-rays. With x-rays, there was a small but quite significant effect of $O_2$ on ring loss in $X^{Cl}$, Y males, and a larger $O_2$ effect on ring loss in $X^{Cl}$, Y females. With γ-rays, however, no demonstrable effect of $O_2$ on the frequency of ring loss in either sex was found. (from auth. summary)

Bertram, C., Höhne, G., Schubert, G. DER EINFLUSS VON RÖNTGENSTRAHLEN UND ZYTOSTATIKA AUF DIE MUTATIONSRATE VON DROSOPHILA (The effects of x-rays and cytostatics on the rate of mutation in Drosophila). Strahlentherapie 112 (1960) 70-3. (In German)

By means of the combined application of ionizing rays and the chemical mutagenic substance 2,5-bisethyleniminobenzochinon-1,4 (BBC) the authors have tested the degree of genetic effect on Drosophila. The application of the mutagenic agents in the sequence of BBC + x-ray irradiation caused the addition of the different mutageneous effects, whereas the same treatment in the order of x-ray irradiation + BBC resulted in a considerably reduced yield of mutations. (auth. summary)

* Borstel 1955 - [1177]

1372 Brandt, H. v., Höhne, G. MUTATIONSAUSLÖSUNG BEI DROSOPHILA DURCH SCHNELLE BETATRON ELEKTRONEN UND CHEMISCHE AGENZIEN (Production of mutations in Drosophila by fast betatron electrons and chemical agents). Zool. Anz., Suppl. 16 - Verh. dtsch. zool. Ges. 1951 (1952) 259-63. (In German)

3 MeV electrons were used in experiments on 3-6 d-old males of an inbred D. melanogaster wild strain. The rate of mutations induced depends on dosage. The results for recessive sex-linked lethals (%) induced in mature and immature sperm is tabulated for 3000 r of x-rays and fast electrons (listed for mature sperm 1-3 d and for immature sperm 21-27 d post-irradiation). The mutation rate in immature sperm was found to be 3-4 times higher than in immature gametes. In the immature gametes, the x-ray and electron-induced mutation rates are similar. The following substances were tested for induced mutation rates: ethyl urethane, trichlortriethylamine, 2-methyl-1,4-naphthohydrochinone, a clinically used vitamin K derivative, and p-dimethylaminoazobenzol.

1373 Clark, A. M., Herr, E. B., Conway, J. V. OXYGEN POISONING AND THE EFFECTS OF X-RADIATION ON HABROBRACON PUPAE IN THE PRESENCE OF OXYGEN AND NITROGEN. Genetics 38 (1953) 659-60.

Habrobracon, when exposed to $O_2$ during the early pupal stages of development, are deleteriously affected. A high proportion of pupae do not complete development and many of the adults that emerge exhibit wing and antennal abnormalities. The diploid female pupae are more sensitive to $O_2$ than are comparable haploid males. Habrobracon treated at larval and late pupal stages of development are not deleteriously affected. Haploid male and diploid female pupae were x-rayed in the presence of air, $O_2$ or $N_2$. The deleterious effects of x-radiation were compared using adult eclosion as the criterion of viability. Comparison of the 50% eclosion value for these groups shows that pupae irradiated in the presence of nitrogen are over twice as resistant as pupae treated in the presence of air or oxygen. Pupae irradiated in the presence of air are slightly more resistant than those treated in the presence of $O_2$. The increase in radioresistance with $N_2$ is proportional for the more radiosensitive haploid males and the less radiosensitive diploid females. Haploid males during the pupal stage are more sensitive to x-rays, but less sensitive to $O_2$ poisoning than comparable females.

(Abstract of paper presented at the 1953 meetings of the Genetics Society of America, Boston, Mass. 28-30 Dec. 1953)

1374 Clark, A. M., Beiser, W. C., Jr. USE OF HAPLOID AND DIPLOID EMBRYOS OF HABROBRACON IN THE STUDY OF CELL POISONS. Science 121 (1955) 469-70.

The differential toxic effects of chemical agents were evaluated using the hatchability of eggs from mated and unmated Habrobracon as the criteria. Data are tabulated on the response of both haploid and diploid embryos to x-radiation, methyl bis(β-chloroethyl)amine HCl, ethyl bis(β-chloroethyl)amine HCl, 2,2'-dichloro-diethylamine HCl, 2,2',2''-trichloro-triethylamine HCl, sodium azide, and potassium cyanide. (NSA 9: 5577, 1955)

1375 Clark, A. M., Herr, E. B., Jr. THE EFFECT OF CERTAIN GASES ON THE RADIOSENSITIVITY OF HABROBRACON DURING DEVELOPMENT. Radiation Res. 2 (1955) 538-43.

Habrobracon during postembryonic development were exposed to x-rays in the presence of air, $N_2$, $CO_2$, and $H_2$. The effects on development to adulthood were observed. Organisms irradiated in nitrogen were about three times as resistant as those irradiated in air at the three stages of development tested. Habrobracon during the larva-in-cocoon stage were more radioresistant when irradiated in the presence of $H_2$ than in the presence of air. Further, groups irradiated in $N_2$ or in $CO_2$ were more resistant to radiation damage than those treated in $H_2$. Thus, the radiosensitivity was modified by the presence of $H_2$. The authors conclude

that the data so far indicate no clear relation between $O_2$ poisoning and x-radiation damage in Habrobracon. (from auth. summary)

(An earlier report, BNL-1963, Brookhaven National Lab., Upton, N. Y., has appeared)

* Clark 1956 - [943]

1376 Clark, A. M., Cristofalo, V. J. SOME EFFECTS OF OXYGEN ON THE INSECTS, ANAGASTA KUEHNIELLA AND TENEBRIO MOLITOR. TID-6052, Delaware, Univ., Newark and Oak Ridge National Lab., Tenn., 1959, 20 p.

The effects of $O_2$ at increased partial pressures upon the development and $O_2$ consumption of larvae and pupae of Anagasta kuehniella and Tenebrio molitor were studied. Anagasta pupae exposed to 15 psi or more of $O_2$ are prevented from emerging as adults. For 15 psi of $O_2$, development of the pupae to the adult stage continues but most of these remain entrapped within the pupal skin. Pupae exposed to 30 psi or more of $O_2$ may become paralyzed and show a marked and irreversible decrease in $O_2$ consumption. Most of the Tenebrio pupae exposed to 120 psi of $O_2$ show a marked and irreversible decrease in oxygen consumption and an inability to become pigmented. Paralysis and inability to pigment are correlated with, and probably a consequence of, decreased $O_2$ consumption. Most of the Tenebrio pupae exposed to 60 psi of $O_2$ become pigmented but do not develop to the adult stage and emerge. Both larvae and pupae are injured by $O_2$ and by x-rays. Larvae, however, are more oxygen resistant and radiation sensitive than pupae. The $O_2$ consumption of pupae is not decreased by exposure to 50 000 r. These differences indicate that different mechanisms of action are involved in injury by $O_2$ and by x-rays. (auth.) (NSA 14: 15500, 1960)

1377 Edington, C. W. THE EFFECT OF S, 2-AMINOETHYLISOTHIURONIUM BROMIDE HYDROBROMIDE (AET) ON THE INDUCTION OF DOMINANT AND SEX-LINKED RECESSIVE LETHALS IN DROSOPHILA MELANOGASTER. Amer. Nat. 92, 867 (1958) 371-4.

A comparison of the effects of injections of S, 2-aminoethylisothiuronium Br. HBr(AET) and saline (as a control) prior to x-ray exposure (4000 r) indicates that AET (an effective agent in preventing acute radiation lethality in mammals) enhances the genetic effect of radiation. This effect was demonstrated for both genetic effects studied. Furthermore it was shown that AET alone did not behave as a mutagen. The difference in behaviour of AET on radiation induced physiological death in mammals and genetic lethality in Drosophila may reside in the nature of the biological mechanism, the inherent differences in the organisms, or in the somewhat greater radiation dose used in the Drosophila experiments. (auth.)

* Egli 1956 - [1250]

1378 Fahmy, O. G., Fahmy, M. J. CHEMICAL AND RADIATION MUTAGENESIS IN DROSOPHILA MELANOGASTER. p. 205-8 (disc. p. 208-10) in "Progress in Radiobiology. Proceedings of the 4th International Conference on Radiobiology, Cambridge 14-17 Aug. 1955". Mitchell, J. S., Holmes, B. E., Smith, C. L., eds. London, Oliver and Boyd. 1956.

The mutagens used were all alkylating compounds: mustards, epoxides, imines and mesyloxyalkanes. A similarity was observed in the distribution of the loci of action of different alkylating agents, which was also true for the cytologically detectable chromosome aberrations among the sex-linked recessive lethals. Both genetics and cytological data indicate a differential susceptibility of the X-chromosome loci to the action of the alkylating compounds as compared to x-rays. The effect of dose and the nature of the genetic damage are also discussed. The alkylating compounds are most effective in the induction of small deficiencies, involving less than 1% of the length of the salivary-gland X-chromosome. They induce 2-3 times as many small deficiencies as mutagenically equivalent doses of x-rays. A tentative interpretation is proposed.

* Fahmy and Fahmy 1956 - [1344]

1379 Fahmy, O. G., Fahmy, M. J. COMPARISON OF CHEMICALLY- AND X-RAY-INDUCED MUTATIONS IN DROSOPHILA MELANOGASTER. p. 437-47 (disc. p. 447-8) in "Advances in Radiobiology. Proceedings of the 5th International Conference on Radiobiology, Stockholm 15-19 Aug. 1956". de Hevesy, G. C., Forssberg, A. G., Abbatt, J. D., eds. London, Oliver and Boyd. 1957.

A differential genetic response to various mutagens was confirmed. Not only was this manifested in the different relative frequencies of the various types of mutations induced but in a selectivity for certain gene

loci. A dose rate of 250 - 260 r/min of 250 kV x-rays was used in the radiation part of the work. The mutagens tested were alkylating agents.

1380 Fahmy, O. G., Fahmy, M. J. RESPONSE OF SPECIFIC GENES IN DROSOPHILA MELANOGASTER, TO X-RADIATION AS COMPARED TO THE PHENYLALANINE-MUSTARD. Radiation Res. 9 (1958) 112.

An outstanding feature of the mode of mutagenic action of the alkylating compounds is that they seem to affect the genetic material differently from radiation (see reports of previous conferences). In order to establish how far this differential action operates at the gene level, we analyzed the degree of response of specific gene loci to the action of x-rays and a nitrogen mustard, viz., p-N-di(2-chloroethyl) aminophenyl-alanine. The technique used is that of scoring for certain sex-linked recessive "visibles" in the $F_1$ progeny of treated males. Females homozygous for the visible loci under test were mated to males who had been irradiated or injected with the chemical mutagen, and the $F_1$ daughters were scored for the marker genes. For both radiation and chemical experiments the following conditions were standardized: germ cells mutated (sperm and spermatids), chromosome sample scored (50 000 per locus), and mutagenic dose given (inducing about 6% sex-linked recessive lethals). Some of the gene loci tested were the "classic" visibles which are often encountered in radiation experiments and which also occurred spontaneously; but others were "new", ones that occurred frequently in our experiments with various alkylating compounds. The majority of the chemically induced visibles proved to be refractory to x-rays at the dose and size of sample utilized. Under the effect of the mustard, however, these genes did mutate and with an incidence in reasonable agreement with the Poisson expectations. This adds excellent support to the principle of differential gene response to various mutagens.

1381 Fahmy, O. G., Fahmy, M. J. DIFFERENTIAL GENE RESPONSE TO MUTAGENS IN DROSOPHILA MELANOGASTER. Genetics 44 (1959) 1149-70.

The authors carried out a very extensive analysis of the mutability of specific genes after x-rays and chemical agents in Drosophila. Not only were significant differences observed between x-rays and chemical agents but a variable spectrum of sensitivity was obtained when different chemical mutagens were employed.

1382 Falk, R. DELAY IN JOINING OF X-RAY INDUCED BREAKS BY ANOXIA IN DROSOPHILA MELANOGASTER. Genetics 44 (1959) 509. (abstr.)

A significant increase in the frequency of autosomal translocations could be demonstrated when anoxia was given for 7 h between irradiations. Nitrogen treatment between irradiations did not significantly augment lethal frequency, although there was a small increase, probably representing lethals connected with gross rearrangements.

1383 Fritz-Niggli, H. ULTRASCHALLSCHÄDIGUNGEN UND RÖNTGENEFFEKTE IN DROSOPHILA MELANOGASTER (Damage by ultrasonics and x-ray effects in D. melanogaster). Strahlentherapie 85, 2 (1951) 233-52. (In German)

The effects of ultrasonic irradiation (applied intensities: 0.3, 0.71 and 1.75 W/cm²) and of x-irradiation (180 kV, 6 mA, 1 mm Al, 21 cm target distance, 262 r/min) on eggs, larvae and pupae of D. melanogaster were compared and related to temperature shocks. In contrast to the effects produced by temperature shocks the responses to x-rays and to ultrasonic irradiation are analogous. Ultrasonic radiation, like x-rays, produces a delayed reaction, death occurring in later stages of development. The author speculates as to whether the biological effects of ultrasonic irradiation can be attributed to ionization, which leads to secondary chemical changes as in the case of x-rays. Since these chemical changes may occur in the cell (or nucleus) as well as outside of the cell, the target theory cannot be applied to the observed biological effects in Drosophila. (BA 27: 15431, 1953)

1384 Fritz-Niggli, H. BIOLOGISCHE VERSUCHE MIT DEM 31-MeV-BETATRON (Biological experiments using the 31-MeV betatron). Fortschr. Röntgenstr. 80 (1954) 28-38. (In German)

A preliminary study was made of differences observed following irradiation by 180 keV and 31 MeV, respectively. The ultra-hard radiation was less effective throughout. No reasons can yet be put forward to account for the differences observed in different species. The desirability of testing objects of uniform size, such as Drosophila eggs, was emphasized. A comparison is made for both radiations of data for the $LD_{50}$ for Drosophila eggs aged 1¾ and 4 h, the dose required to cause a 50% spread-wing effect in 5-h-old pupae, and for the frequency of occurrence of lethal factors after irradiation with 3000 r of either radiation.

* Fritz-Niggli 1958 - [825]

* Fritz-Niggli 1959 - [1187]

1385 Gaulden, M. E., Nix, M. EFFECTS OF OXYGEN TENSION ON X-RAY INDUCED MITOTIC INHIBITION. Genetics 35 (1950) 665.

The large neuroblast cells of the embryo of the grasshopper Chortophaga viridifasciata were given 64 r of x-rays while exposed to different tensions of $O_2$, namely, 100%, 21% (air), 2%, and 0% ($N_2$, $CO_2$, or vacuum). The embryos were made into culture preparations. The number of cells completing mitosis in a given period of time was determined, since 22 min is the average duration of mid-mitosis (at 38°C) and since the treatments used do not affect this duration. The results indicate that the sensitivity of mitosis to radiation is reduced when cells are irradiated at the lower $O_2$ tensions. In other words, the duration of the period of complete mitotic inhibition (period after irradiation during which there are no cells in the mid-mitosis stages) is shorter when cells are irradiated in 0 or 2% $O_2$ than when they are irradiated in 21 or 100% $O_2$. Experiments are now in progress to determine the sensitivity of cells to radiation in 5 and 10% $O_2$.

(Abstract of a paper presented at the 1950 meeting of the Genetics Society of America, Columbus, Ohio 11-14 Sep. 1950)

(An abstract of this paper also appeared in J. Tenn. Acad. Sci. 25 (1950) 222)

1386 Gaulden, M. E., Nix, M., Moshman, J. EFFECTS OF OXYGEN CONCENTRATION ON X-RAY-INDUCED MITOTIC INHIBITION IN LIVING CHORTOPHAGA NEUROBLASTS. J. cell. comp. Physiol. 41 (1953) 451-70.

An investigation is reported on the effects of $O_2$ concentration on radiation-induced mitotic inhibition in grasshopper neuroblasts. The grasshopper embryos were exposed to 3.5, 8 or 64 r of x-rays in $N_2$, $CO_2$, vaccuum, and 2, 5, 10, 21 and 100% $O_2$, and mid-mitotic counts of the living neuroblasts made at 22-min intervals during 6 h. Neuroblast mitosis in vivo was not affected by $O_2$ tension in the absence of radiation under the experimental conditions used. The depth of depression of mitosis was affected very little, if any, by the presence of $O_2$ during irradiation. At $O_2$ concentrations between 0 and 10% the duration of minimum mitotic activity and the interval between x-raying and maximum mitotic activity were correlated with $O_2$ concentration. The number of cells undergoing mitosis within 6 h of treatment was negatively correlated with $O_2$ concentration. The effects of 21 and 100% $O_2$ were not significantly different from those at 10%. It is concluded that the influence of $O_2$ tension on the response of these cells to radiation involves more than merely a change in the amount of injury produced by the radiation.

* Glass and Plaine 1952 - [1308]

1387 Grodner, R. THE EFFECT OF OXYGEN AND NITROGEN ON X-RAY-INDUCED TRANSLOCATIONS IN DROSOPHILA VIRILIS. M. A. Thesis, Univ. Tenn. 1950.

* Grosch and Sullivan 1954 - [1117]

1388 Haas, F. L., Dudgeon, E., Clayton, F. E., Stone, W. S. FREQUENCY OF CHROMOSOMAL REARRANGEMENTS AS RELATED TO RATE OF IRRADIATION, TEMPERATURE AND GASES. Genetics 37 (1952) 589-90.

The frequency of translocations induced in the sperm of adult Drosophila virilis males, irradiated at a rate of 2000 r/min, was used to measure radiation damage. Comparisons were made of the rates of translocations when x-radiation was applied at 0 - 3°C and at 24 - 26°C, using air, 95% $N_2$ + 5% $O_2$, CO + $CO_2$ + $O_2$, CO + $O_2$, or $CO_2$ + $O_2$ as the gases in several experiments. Other reports have indicated that a reduction in the amount of $O_2$ present during irradiation (at relatively slower rates of irradiation) reduces the radiation damage. Although this seems true at room temperatures, it does not occur at 0 - 3°C where reduction in $O_2$ has not lowered the translocation rate to a marked degree. There is a greater difference between the frequencies of translocations irradiated in air at the low and high temperatures than there is between the frequencies of translocations irradiated at low temperature in air and in 5% $O_2$. In some mixtures including CO, the frequency of translocations was reduced rather than increased, contrary to the situation reported in Tradescantia. It is obvious that the temperature and rate of irradiation are very important factors in determining the relations between the gases present and the amount of radiation damage.

(Abstract of paper presented at the 1952 meetings of the Genetics Society of America)

* Haas et al. 1954 - [946]

1389 Höhne, G., Künkel, H. A., Struckmann, R. DIE STRAHLENINDUZIERTE MUTATIONSRATE BEI DROSOPHILA NACH CYSTEINAPPLIKATION (The radiation-induced mutation rate in Drosophila, following the use of cysteine). Naturwissenschaften 42 (1955) 491-2. (In German)

The rates of lethal mutations in Drosophila after x-ray, cysteine and combined cysteine plus x-ray treatment are given in tabulated form. In view of the possibility that cysteine might become rapidly oxidized in the tissue fluid of the fly and not reach the germ cells to a sufficient extent, the apparent ineffectiveness of cysteine with regard to mutation should be accepted with reservations.

1390 Hollaender, A., Baker, W. K., Anderson, E. H. EFFECT OF OXYGEN TENSION AND CERTAIN CHEMICALS ON THE X-RAY SENSITIVITY OF MUTATION PRODUCTION AND SURVIVAL. p. 315-26 in "Cold Spring Harbor Symposia on Quantitative Biology", Vol. 16. N. Y., The Biological Lab. 1952, 521 p.

Review paper. Work done on Drosophila forms only a small part of the whole. Lethal effects, chromosome changes and mutations produced are reviewed, also studies of the effects of chemicals, and the mechanisms which may be involved in the action of these chemicals with regard to x-ray sensitivity. Compounds found to afford protection against radiation damage are discussed.

1391 Kaplan, W. D., Lyon, M. F. FAILURE OF MERCAPTOETHYLAMINE TO PROTECT AGAINST THE MUTAGENIC EFFECTS OF RADIATION. I. EXPERIMENTS WITH DROSOPHILA. Science 118 (1953) 776-7.

Bacq and Hervé (Bull. acad. roy. med. Belg. 17 (1952) 13) reported that β-mercaptoethylamine protects mice against the lethal effects of radiation. It does not, however, protect against the mutagenic effects of radiation. Day-old adult wild-type Drosophila males serve as test objects. Groups A and C received 0.25 γ of β-mercaptoethylamine while group B received 0.75% NaCl. Groups A and B received 2400 r of x-radiation 15 min after injection. Dominant lethality was measured by mating irradiated males to virgin Muller-5 females, collecting the eggs, and determining hatchability. There was a sharp decrease in hatchability as a result of irradiation, but no difference was observed between the saline-injected groups (B) and the amine-injected one (A). Sex-linked recessive lethals were determined and no difference was detected between group A and B. The amine did not protect against the lethal somatic effects of 82 000 r delivered during 41 min.

1392 Kenworthy, W. THE EFFECT OF OXYGEN CONCENTRATION ON THE INDUCTION OF LETHALITY AND CHROMOSOMAL ABERRATIONS BY X-RAYS IN HABROBRACON AND SCIARA. Dissertation (Publ. 4939). Pennsylvania Univ., Philadelphia, 1953, 59 p.

(See Diss. Abstr. 13 (1953) 157-8)

1393 Kenworthy, W. EFFECT OF OXYGEN CONCENTRATION ON THE SURVIVAL RATE OF IRRADIATED HABROBRACON EGGS. (abstr.) Genetics 39 (1954) 975-6.

Survival ratios were determined for 3998 Habrobracon eggs x-rayed during meiotic metaphase I in oxygen, air, or nitrogen. Survival of eggs irradiated in nitrogen ranged from 64.6% at 506 r to 10.6% at 2200 r. Survival of eggs irradiated in air ranged from 36.3% at 506 r to no survivors at 2200 r (1.9% survived at 1518 r). Survival of eggs irradiated in oxygen ranged from 27.5% at 506 r to no survivors at doses of 1518 r and above (2.6% survived at 1100 r). Survival ratios were determined for 1622 Habrobracon eggs irradiated during meiotic prophase in oxygen or nitrogen. Survival of eggs irradiated in nitrogen ranged from 92.7% at 1700 r to 20.0% at 24 000 r. Survival of eggs irradiated in oxygen ranged from 70.7% at 1700 r to 1.6% at 24 000 r. Dose-action survival curves for eggs irradiated in metaphase were exponential regardless of the gas in which irradiation took place. Dose-action curves for eggs irradiated in prophase were linear for the x-ray doses given. Cytological studies of eggs irradiated with 1000 r during meiotic metaphase I showed no chromosomal abnormalities other than terminal deletions. The percentage of such abnormalities was lower in eggs irradiated in nitrogen than in those irradiated in air or oxygen. Comparisons of chromosomal damage with survival data suggest that both dominant and recessive lethals decrease when irradiation takes place in the absence of oxygen.

For details, see Dissertation 4939, Pennsylvania Univ., Philadelphia, 1953.

1394 Kenworthy, W. THE EFFECT OF OXYGEN CONCENTRATION OF THE DOSE-ACTION SURVIVAL CURVES OBTAINED FOR HABROBRACON EGGS IRRADIATED DURING MEIOTIC PROPHASE AND METAPHASE. Amer. Nat. 90, 85 (1956) 119-26.

Studies of total embryo lethals induced in 4570 eggs x-rayed in $N_2$, air and $O_2$ during meiotic metaphase with doses ranging from 396 r to 2450 r were made. The $N_2$ series differed very significantly from the air and $O_2$ series with a maximum difference of 48.5% at one dose. Similar studies were made of 4846 prophase eggs x-rayed in $N_2$, air, and $O_2$ with doses ranging from 2100 r to 44 100 r. Again the nitrogen series differed significantly from the air and $O_2$ series with the maximum differences reaching 52.0% at one dose. The oxygen effect appears to be of the same magnitude in metaphase and prophase eggs despite a considerable difference in the x-ray dose necessary to induce lethality in each of these two stages. This similarity is believed by the author to support the initial damage hypothesis of $O_2$ action. (auth.)

1395 LaChance, L. E. THE ROLE OF CHELATION IN THE PRODUCTION OF X-RAY INDUCED DOMINANT LETHALS IN HABROBRACON. p. 156 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958.

Four groups of virgin Habrobracon wasps, comprising (1) controls, (2) EDTA-fed, (3) x-irradiated, and (4) EDTA-fed and x-irradiated, were compared for egg production and hatchability subsequent to treatment. The percentage of embryonic dominant lethals was calculated by the comparison of hatchability of the eggs from females given identical treatments, some mated and some left unmated for the parthenogenetic production of haploid males. Data were collected throughout the reproductive life of the females. Those embryos which were derived from eggs in different stages of meiosis and oögonial mitosis at the time of treatment were identifiable on the basis of ovariole morphology. Females were allowed only a single meal of the chelating agent, 0.1 M EDTA as the disodium salt. In those groups which were fed the chelator and then irradiated, the dominant lethality was much greater than it was in either the irradiated or the EDTA-fed groups. It was also greater than could be expected if the two agents were independent in action or merely additive. Thus the action of the two agents is believed to be synergistic. The role of EDTA in enhancing induced genetic lethals is discussed and several pathways of action proposed. (from abstr.)

* LaChance 1958 - [1281]

1396 LaChance, L. E. THE EFFECT OF CHELATION AND X-RAYS ON FECUNDITY AND INDUCED DOMINANT LETHALS IN HABROBRACON. Radiation Res. 11 (1959) 218-28.

The effects of ingested EDTA on radiation recovery and induction of embryo dominant lethals was studied in the wasp Habrobracon. It was found that recovery from temporary sterility induced by x-irradiation was retarded in those females which had ingested a meal of the chelating agent prior to the radiation treatment. The amount of dominant lethality induced in the germ cells of irradiated females was significantly increased by treatment with a chelating agent. (auth.)

1397 LaChance, L. E. (North Carolina State Coll., Raleigh) STUDY ON THE GENETIC DAMAGE INDUCED IN THE REPRODUCTIVE TISSUES OF HABROBRACON FEMALES BY CHELATING AGENTS AND X-IRRADIATION. Diss. Abstr. 19, 11 (1959) 2723.

Whereas low doses of irradiation have no effect on life span of females, the feeding of a chelating agent, EDTA, significantly reduced the life span of the females below that of controls. The ingestion of a chelating agent prior to irradiation resulted in an increase in the percentage of induced dominant lethals in the embryos. The increase in dominant lethals was greater than in groups given either a chelating agent or x-radiation alone. Evidence of synergistic action of the two treatments is presented. The enhancement of the radiation effect was noted in both oöcytes and oögonial cells. After a radiation dose of 2500 r, Habrobracon females undergo a period of temporary sterility followed by a period of marked recovery in egg production. EDTA ingestion prior to irradiation reduces the amount of recovery observed. The productivity in terms of larvae per female per day is significantly reduced and evidence of synergistic action of the two agents is presented. Cytological study of wholemounts of dissected ovarioles showed a degree of damage and degeneration in ovarioles which is attributed to the action of the chelating agent. Possible modes of action of chelating agents on genetic material are discussed. (from abstr.)

1398 Luce, W. M., Quastler, H., Lanzl, E. F. BIOLOGICAL EVALUATION OF 20 MILLION VOLT ROENTGEN RAYS. V. BAR EFFECT IN DROSOPHILA. Amer. J. Roentgenol. 64, 6 (1950) 963-7.

The efficiencies of 20 MeV x-rays from a betatron and x-rays from a conventional machine operating at 100 and 200 peak kV in reducing the eye facet number in Bar-eyed Drosophila were determined. The weighted mean of the 20 MeV x-rays for different doses and different control facet numbers was 0.0119 facets/r, while that of the 100 and 200 kV radiation for different doses, different dose rates, and different control facet numbers was 0.0141 facets/r. The ratio of the mean efficiency of the 20 MeV to that of the 100 and 200 peak kV x-rays was 0.0119/0.0141 or 0.85. All dose measurements were made with a single thimble chamber. (EM XIV (5): 1796, 1951)

1399 Lüers, H. MEGAPHEN-VORBEHANDLUNG UND STRAHLENINDUZIERTE MUTATIONSRATE BEI DROSOPHILA MELANOGASTER (Megaphen treatment and radio-induced mutation rates in Drosophila melanogaster). Atompraxis 5 (1959) 288-90. (In German)

Megaphen, administered alone or in combination with other substances, prevents somatic radiation injury to a recognizable extent, but does not reduce the radiation-induced mutation rate in Drosophila. X-radiation was used. (auth.)

* Lüning and Hannerz 1952 - [1285]

1400 Lüning, K. G. EFFECT OF OXYGEN ON IRRADIATED MALES AND FEMALES OF DROSOPHILA. Hereditas 40, 3-4 (1954) 295-312.

The protective action of low $O_2$ concentrations during irradiation is not fully understood; a breakage and a reunion hypothesis have been proposed. The present study deals with an analysis of $O_2$ concentration on the rate of chromosome aberrations induced either in Drosophila sperm inseminated the 1st d as compared to the 2nd and 3rd d after irradiation of newly hatched males, or in oöcytes. The results are discussed, and it is concluded that the variations in the breakability in various stages of spermiogenesis can not depend on variations in the $O_2$ concentration. In oöcytes irradiated in air less dominant lethals and more minute rearrangements are induced than in spermatozoa. The effect of anoxia is much greater in females than in males. The effect of the $O_2$ concentration during irradiation is discussed and a scheme of levels of possible effect, is presented.

1401 Lüning, K. G. THE EFFECT OF ANOXIA ON THE RATES OF X-RAY INDUCED MUTATIONS IN DROSOPHILA MELANOGASTER. p. 350-4 in "Progress in Radiobiology. Proceedings of the 4th International Conference on Radiobiology, Cambridge 14-17 Aug. 1955". Mitchell, J. S., Holmes, B. E., Smith, C. L., eds. London, Oliver and Boyd. 1956.

Muller-5 males were irradiated (3240 r) in air or nitrogen atmospheres and mated to y w sn females. $F_1$ offspring were analyzed, and the results discussed. The rates of recessive lethals do not show the same variations as the rates of the break-dependent aberrations, facts in favour of a double origin of recessive lethals: intergenic (break-dependent) and intragenic (seemingly break-dependent). It is concluded that both chromosome breaks and intragenic changes are affected to a similar degree of anoxia.

* Lüning and Jonsson 1958 - [953]

* Lüning et al. 1958 - [1289]

1402 Murphy, W. W. THE EFFECT OF OXYGEN ON THE FREQUENCY OF X-RAY INDUCED MUTATIONS IN HABROBRACON SPERM. Biol. Bull. 107 (1954) 301.

Females were mated to males irradiated with a sublethal dose of x-rays, in air or in nitrogen (4234 r in 100 s). The results are given in terms of hatchability of $F_1$ eggs, dominant lethal rate, number of females produced/day/female, recessive embryo lethals per $F_1$ female after irradiation of sperm and recessive post-embryo lethals carried, and visible mutations. The differences (when significant) were smaller than for Habrobracon eggs irradiated under comparable conditions. (from abstr.)

(Paper presented at Marine Biological Laboratory)

1403 Nakao, Y. THE EFFECT OF GLUTATHIONE UPON THE VISIBLE MUTATION RATES INDUCED BY X-RAYS IN THE SILK WORM. Jap. J. Genet. 32, 8 (1957) 253. (In Japanese)

* Oster 1957 - [919]

1404 Oster, I. I. INTERACTIONS BETWEEN IONIZING RADIATION AND CHEMICAL MUTAGENS. Z. indukt. Abstamm. -VererbLehre 89 (1958) 1-6.

X-rays in combination with urethane or mustard gas exhibit an additive effect as regards the formation of sex-linked recessive lethal mutations and chromosome breaks when applied to Drosophila melanogaster spermatozoa. Their action in combination on the formation of translocations is synergistic. The ends of chromosomes broken by x-rays, mustard gas, and urethane are as capable of rejoining with those produced by the same agent as the x-ray produced ones are of rejoining with those produced by either mustard gas or urethane to form chromosomal disarrangements. (auth. summary)

* Ott 1959 - [919]

* Plaine and Glass 1952 - [1348]

* Plaine 1955 - [1349]

1405 Plaine, H. L. THE COUNTERACTION BY CYSTEINE OF THE EFFECTS OF X-RAYS AND OF TRYPTOPHAN ON THE ACTION OF SPECIFIC SUPPRESSOR SYSTEMS IN DROSOPHILA MELANOGASTER. Cancer Res. 15 (1955) 151-8.

L-Cysteine was fed to larvae carrying both a suppressor-erupt and a suppressor-tumour system to test its effect in combination with x-ray treatments and with supplementary L-tryptophan in the diet. Cysteine itself had no effect on erupt eyes or on the incidence of melanotic tumours. Fed before or after x-ray treatment, cysteine greatly reduced the radiation effect which blocks the action of the suppressor genes and thus engenders both tumours and erupt eyes. Cysteine was more effective in counteracting the erupt eye effect when fed before the x-ray treatment; but it appeared to be more effective against the tumourigenic effect if fed after the x-ray treatment. The greatest protective effect was obtained when cysteine was fed both before and after the x-ray treatment, the incidence of tumours being reduced from 78 to 13% and that of erupt eyes from 90% to 14% when the larvae were x-rayed 24 h after hatching. Cysteine, to a considerable degree, counteracted the harmful effects of x-rays on viability, particularly those which occurred during the pupal period. Cysteine likewise counteracted in all respects the effects of feeding supplementary tryptophan. The feeding of L-tryptophan (0. 5%) plus L-cysteine (0. 1%) led to a significant reduction in the incidence of tumours from 63% to 24% and in the incidence of erupt eyes from 52% to 7%. The toxicity of tryptophan, during the pupal stage, was greatly reduced when cysteine was added to the medium. In all respects, the interaction of tryptophan with $O_2$ or cysteine is strikingly like that of x-rays with $O_2$ and cysteine. This might imply the operation of a similar mechanism in these cases. (auth.)

1406 Ray-Chaudhuri, S. P., Saha, A. K. ON THE PROTECTIVE ACTION OF VERSENE AGAINST RADIATION DAMAGE IN GRASSHOPPER CHROMOSOMES. Proc. nat. Inst. Sci. India Section B: Biol. Sci. 26, Suppl. (1960) 6-10.

The effect of treatment with versene solution before irradiation on the frequency of chromosome breakage was determined by counting the number of dicentric bridges in the first meiotic anaphase cells of the grasshopper, Gesonula punctifrons. In the controls (treated with 0. 67 percent saline plus 86 r of x-rays), 10. 18 ± 0. 27 bridges were recorded as compared to 8. 29 ± 0. 61 percent in the treated series ($10^{-3}$ M versene solution in 0. 67 percent saline plus 86 r of x-rays). The unirradiated versene treated group showed no bridges in 801 first anaphase cells. It was concluded that versene is a definite though feeble protector of radiation-induced chromosome breaks in our material. (auth.)

1407 Read, J. THE INFLUENCE OF OXYGEN ON THE X-RAY PRODUCTION OF CHROMOSOME BREAKS IN DROSOPHILA. J. Genet. 52, 3 (1954) 473-9.

Recent experiments by Baker and Edington have shown that the x-ray induction of chromosome translocations, sex-linked recessive lethal mutations, and dominant lethal mutations in Drosophila is affected by oxygen concentration in the atmosphere in which the flies are irradiated. The data agree with Haldane and Lea's (1947) mathematical theory if the coefficient of break production depends on oxygen in much the same way as several other radiobiological effects. It is suggested that some compound is produced (perhaps $H_2O_2$) which can cause a break if it diffuses to the chromosome in sufficient concentration. (BA 31: 191, 1957)

1408 Shaw, E. I. PROTECTION BY SODIUM HYDROSULFITE AGAINST X-RAY-INDUCED MITOTIC INHIBITION IN GRASSHOPPER NEUROBLAST. Proc. Soc. exp. Biol., N. Y. 92 (1956) 232-6.

In neuroblast cultures of the embryo of the grasshopper Chortophaga viridifasciata (De Geer) protection against x-ray-induced mitotic inhibition is conferred by pretreatment with sodium hydrosulfite. A concentration of $10^{-2}$M sodium hydrosulfite almost completely prevents the inhibition of mitosis caused by 8 r. The mitotic inhibition caused by 32 r is only partially prevented by the same pretreatment. The dose-reduction factor at 32 r is 8. The rate of recovery is the same in the cultures that received 32 r and that were also pretreated with $10^{-2}$M sodium hydrosulfite as in those that were irradiated but received no pretreatment. The earlier recovery of the pretreated cultures is accounted for on the basis of less demonstrable inhibition of mitotic activity by the radiations. The primary damage responsible for mitotic inhibition at low doses, and at least partially at high doses, may be due to the oxidation of intracellular components by $HO_2$ or similar oxidizing radicals whose formation is dependent on the presence of oxygen during irradiation. (auth. summary)

1409 Sobels, F. H. CHEMICAL STEPS INVOLVED IN THE PRODUCTION OF MUTATIONS AND CHROMOSOME ABERRATION BY X-RADIATION AND CERTAIN CHEMICALS IN DROSOPHILA. State Univ. Utrecht, Institute of Genetics, survey of studies from 1954-1956, 6 p.

A survey is given of studies conducted from 1954-1956 at the Institute of Genetics of the State University Utrecht. In view of the possible role of $O_2$ and $H_2O_2$ in the production of x-ray induced mutations, the effect of catalase-inhibiting mutation rates has been studied. The results showed an enhancement of the induced mutation rate in immature germ cells after pre-treatment with cyanide, azide, and by treatment with dihydroxydimethyl peroxide and formaldehyde. The effects of post-treatment with cyanide and their significance are discussed. Similarities between radiation- and chemical mutagenesis are considered briefly. 22 references are cited.

(See also Intern. J. Radiation Biol. 2, 1 (1960) 68-90)

1410 Sobels, F. H. THE EFFECT OF CYANIDE AND AZIDE ON THE RATE OF X-RAY INDUCED MUTATIONS IN DROSOPHILA. Z. indukt. Abstamm. -VererbLehre 86 (1955) 399-409.

Drosophila males were injected with a 0.008 M solution of potassium cyanide prior to x-radiation with doses varying from 980-2400 r. Compared to the controls, which were only x-rayed, the frequency of sex-linked lethals after cyanide pretreatment was significantly increased in germ cells which formed mature sperm 4-7 d after treatment. A similar enhancing effect on the x-ray induced mutation rate was obtained by pretreatment with sodium azide. The results are tentatively ascribed to an increased production of hydrogen peroxide in the pretreated irradiated germ cells. (auth. summary)

1411 Sobels, F. H. ORGANIC PEROXIDES AND MUTAGENIC EFFECTS IN DROSOPHILA. EFFECT OF PRE-TREATMENT WITH DIHYDROXYDIMETHYL PEROXIDE ON THE RATE OF MUTATIONS INDUCED BY X-RAYS. Nature 177 (1956) 980-2.

A particular stage of spermatogenesis which is characterized by peak sensitivity to the mutagenic action of x-radiation also shows a preferential response to pretreatment with an organic peroxide and other compounds which are thought to act via peroxide formation. It appears a reasonable assumption to suppose that the formation of peroxides accounts for at least part of the mutagenic action of x-rays on the genetic material of Drosophila.

1412 Sobels, F. H. THE EFFECT OF FORMALDEHYDE ON THE MUTAGENIC ACTION OF X-RAYS IN DROSOPHILA. Experientia 12 (1956) 318-21.

Drosophila males were exposed to 1700-2200 r of x-rays, after injections of low doses (0.28 $mm^3$ of 0.033-0.050 M) of formaldehyde. The incidence of sex-linked recessive lethals was determined by the Muller-5 method. Irradiation was at 100-kV potential and 5 mA, at 244 r/min, with 1-mm Al filter. Comparisons of mutation rates for flies treated with HCHO alone, with x-rays alone, and with both show that the pretreatment with the low concentrations of HCHO enhances the mutagenic action of x-rays. Mature sperm were evidently affected as well as cells which were spermatogonia at the time of treatment. It is suggested that the HCHO inhibits catalase and also forms peroxides; the peroxides are taken to sensitize the chromosomes to x-rays.

1413 Sobels, F. H. THE POSSIBLE ROLE OF PEROXIDES IN RADIATION AND CHEMICAL MUTAGENESIS IN DROSOPHILA. p. 449-54 (disc. p. 454-6) in "Advances in Radiobiology. Proceedings of the 5th International Conference on Radiobiology, Stockholm 15-19 Aug. 1956". de Hevesy, G. C., Forssberg, A. G., Abbatt, J. D., eds. London, Oliver and Boyd. 1957.

Injection of 0.033 M formaldehyde prior to irradiation with 1700 r caused, from the 2nd day onwards a significant enhancement of the mutation rates induced by irradiation. Fully mature sperm, however, did not respond any more to the potentiating effect of formaldehyde on x-ray mutagenesis. The findings support the assumption that an increased production of peroxides exerts a potentiating effect on the mutagenic action of x-rays in immature germ cells. Pretreatment with 0.0138 M of dihydroxydimethyl peroxide also caused a pronounced enhancement of the mutagenic effect of x-rays. A comparison with the effects of cyanide and azide shows that all three substances exert their potentiating action in one particular stage of spermatogenesis, characterized by peak sensitivity to the mutagenic action of x-rays. The observed correlation between peak sensitivity to irradiation and preferential response to pretreatment with an organic peroxide, and substances which are thought to increase the content of peroxide in the cell, suggests that the formation of peroxides may account for at least part of the genetic effects of x-rays in Drosophila.

1414 Sobels, F. H. PRESUMPTIVE INDICATION OF RADIATION-PRODUCED PEROXIDE AS SHOWN BY ITS GENETIC EFFECTS IN DROSOPHILA. Actions Chim. et Biol. des Radiations 4 (1958) 73-85.

The genetic effect of treatment of Drosophila males with HCN after irradiation with x-rays was investigated by studying sex-linked lethals and translocations involving the Y, second, third, and fourth chromosomes. A high dose rate of 2200 r/min to a total of 1650 r, and a low dose rate of 590 r/min to a total of 1180 r were used. HCN had no effect on lethals after the low dose rate, but after the high dose rate it increased the rate of lethals in the stage of spermatogenesis with peak sensitivity. HCN also increased the rate of translocations at both dose rates at the sensitive stage. These data indicate that the cyanide-produced increases in lethal rates cannot be caused by gross chromosome rearrangements, but are probably caused by catalase inhibition leading to greater accumulations of mutagenic peroxide at the high than at the low dose rate. This peroxide cannot be in the form of a short-lived radical since the catalase inhibition was still effective 6 min after irradiation ceased. This theory is also consistent with previous results on pretreatment with catalase inhibitors. (CA 53: 2302h, 1959)

1415 Sobels, F. H. PRESUMPTIVE INDICATION OF RADIATION-PRODUCED PEROXIDE AS SHOWN BY ITS GENETIC EFFECTS IN DROSOPHILA. p. 73-83 (disc. p. 83-5) in "Les Peroxydes Organiques en Radiobiologie. Actions chimiques et biologiques des radiations. Collection dirigée par M. Haissinsky", 4e série. Latarjet, R., ed. Paris, Masson et Cie. 1958.

Post-treatment of Drosophila males with cyanide significantly enhances the rate of sex-linked lethals induced by x-rays at a high (1800 r/min) but not at a low dose rate. The effect is mainly restricted to stages of spermatogenesis with peak radiosensitivity. It is suggested that catalase inhibition favours the accumulation of radiation-produced peroxide which is formed in greater concentrations at high than at low dose rates. The fact that catalase inhibition was still effective 6 min after irradiation was taken as evidence that short-lived radiation-produced OH and $HO_2$ radicals, and $H_2O_2$ in an excited state presumably are not the active mutagenic agents. These findings could also explain that in earlier experiments, even at low dose rates, cyanide and azide, if administered as pre-treatment, enhance the mutagenic effects of irradiation. (auth. summary)

1416 Sobels, F. H. THE EFFECT OF PRETREATMENT WITH CYANIDE ON RADIOSENSITIVITY IN NITROGEN AND OXYGEN. Drosophila Inform. Serv. 32 (1958) 159-61.

Flies were pre-treated with HCN in $N_2$ or $O_2$ and then irradiated in $N_2$ or $O_2$ respectively. It is suggested that inhibition of catalase by cyanide favours the accumulation of mutagenic peroxides produced by the irradiation. Since $O_2$ would be essential for the formation of peroxides by irradiation, the fact that cyanide treatment (pre- or post-) only affects spermatids is in keeping with the hypothesis, because it has been shown that more $O_2$ is available within spermatids than within mature sperm.

1417 Sobels, F. H. CHEMICAL STEPS INVOLVED IN THE PRODUCTION OF MUTATIONS AND CHROMOSOME ABERRATIONS BY X-IRRADIATION IN DROSOPHILA. I. THE EFFECT OF POST-TREATMENT WITH CYANIDE IN RELATION TO DOSE-RATE AND OXYGEN TENSION. Intern. J. Radiation Biol. 2, 1 (1960) 68-90.

Post-treatment with hydrocyanic acid results in a significant increase of the mutation frequency in spermatids, if x-radiation is delivered at a high dose-rate, but not after irradiation at a low dose-rate. A

greater overall genetic effect of intensity per se has not been observed. Following radiation at both low and high intensities, post-treatment with cyanide increases the frequency of translocations in spermatids. The increase in lethal frequency due to post-treatment may refer not only to position-effect lethals but also to gene mutations and possibly small deletions. Data relating differential sensitivity in successive broods to oxygen tension are presented. Post-treatment with cyanide is equally effective in raising the mutation rate if high-intensity radiation is given in pure $N_2$, as in $O_2$. It is assumed that cyanide inhibits a mechanism responsible for repair of the initial radiation damage. Recovery from changes leading to lethal gene mutations then seems a metabolic process, possibly connected with respiratory energy. Injury to this repair system is independent of oxygen tension, and the reparable fraction of the initial damage after radiation in $N_2$ is equal to that after radiation in $O_2$.

A brief report appeared under "Post-radiation modification of the mutation rate in Drosophila by cyanide" in Acta Physiol. -Pharmacol. Neerlandica 9, 1960.

1418 Sobels, F. H. EFFECTS OF POST-TREATMENT WITH CYANIDE ON THE INDUCTION OF MUTATIONS BY X-RAYS IN DROSOPHILA. (abstr.) Intern. J. Radiation Biol. 2, 2 (1960) 230.

Post-treatment with hydrocyanic acid results in a significant increase of the mutation frequency in spermatids, if x-radiation is delivered at a dose-rate of 2200 r/min (intense radiation), but not after a dose rate of 590 r/min (dilute radiation). In the absence of cyanide no dose-rate effect was observed. Following dilute radiation, the frequency of translocations in spermatids, unlike that of lethals, is significantly increased by cyanide. Various interpretations are proposed.

* Sumarokov 1958 - [1265]

1419 Taboada, O. SOME EFFECTS OF RADIANT ENERGY ON THE BEETLES, TRIBOLIUM CONFUSUM, DUV. SITOPHILUS GRANARIUS (L.), AND ACANTHOSCELIDES OBTECTUS (Say). M. S. Thesis, Dept. of Entomology, Michigan State Coll., East Lansing, 1953.

The effects of infra-red and ultraviolet light, and of x-rays and accelerated electrons were investigated.

(For the physical aspects of the work, consult Baker, 1953: Ph. D. Thesis)

1420 Tahmisian, T. N., Adamson, D. M. THE EFFECT OF ANOXIA ON X-RAY-INDUCED INJURY IN MELANOPLUS DIFFERENTIALIS EMBRYOS. Anat. Record 108 (1950) 516.

Melanoplus differentialis grasshopper embryos placed in an atmosphere of $N_2/CO_2$ (95%/5%) for 24 h developed normally. If these anoxic embryos are irradiated at 25 000 r after 24 h of anoxia and placed at 25°C in air, negative growth does not occur as with eggs irradiated in air. Upon interrupting diapause by cold treatment for 3 months these embryos, when returned to 25°C and on being irradiated under $N_2/CO_2$, show development unlike those irradiated in air. Thus, they undergo blastokinesis, increase in size, resting nuclei appear normal, respiration is normal, mitosis resumes, the embryos grow, and the oxidative enzyme due to x-radiation does not appear. They do not hatch, however. Since any $O_2$ which is dissolved in the egg is theoretically used up in ½ h the irradiation effect on these embryos under $N_2/CO_2$ is complete metabolic standstill. Evidently, in orthoptera no anaerobic glycolysis takes place, so that no known form of energy release is possible. Since the oxygen substrate moiety is interrupted, we may regard metabolism as stopped, and under such conditions irradiation damage is at a minimum. (from abstr.)

(Abstract of paper presented at the 47th Annual Meeting of the American Society of Zoologists, Cleveland, Ohio 27-30 Dec. 1950)

(An earlier report appeared on p. 55-8 in ANL-4488, Argonne National Lab., Lemont, Ill. Progress Report, 4 July 1950. An increase of about 80% in hydroquinone oxidase over a period of 14 d was reported for diapause eggs exposed to 25 000 r of x-rays in normal room atmosphere.)

1421 Tahmisian, T. N. STUDIES OF THE BIOLOGICAL BASIS OF RADIOSENSITIVITY. UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 8/P/83. 11 (1956) 256-9.

Grasshopper embryos irradiated in air undergo negative growth. The degree of negative growth is less if the embryos are irradiated in 20% $O_2$: 80% CO in the dark, but not in the light. The protection is greater under anaerobic conditions. Cyanide protects if administered after irradiation, but not prior to and during irradiation. Eggs that have high tetrazolium-reducing capacity are more resistant. It is suggested that there may be a relationship between the resistance of a tissue to irradiation and its dehydrogenase content; also, that

irradiation protection is dependent upon the hydrogen and electron transfer of tissues and cells. (Essentially auth. summary)

1422 Traut, H. ZUM PROBLEM DER WIRKUNG VON VERFÜTTERTEM EISENSACCHARAT AUF DIE DURCH RÖNTGENSTRAHLEN INDUZIERTE MUTATIONSRATE BEI DROSOPHILA MELANOGASTER (Concerning the effect of feeding iron-saccharate on the x-ray-induced mutation rate in Drosophila melanogaster). Z. indukt. Abstramm.-VererbLehre 91, 3 (1960) 325-32. (In German. Summary in English)

The increase in x-ray-induced rate of recessive sex-linked lethals in Drosophila melanogaster by feeding iron-saccharate, reported previously, had led to several conclusions about the participation of indirect mechanisms in the radiation-induced mutation process. The effect proved irreproducible in large-scale experiments. The earlier genetic and radiation procedures were repeated, and in some experiments further parameters (translocations, state of maturity of the irradiated germ cells, feeding of iron-II-gluconate) were considered. The discrepancy in results is probably due to the fact that the earlier technique did not allow for the dependence of the mutation rate on the state of maturity of the irradiated germ cells.

1423 Vasterling, H. W. VERGLEICH DER WIRKUNG VON RÖNTGENSTRAHLEN UND STICKSTOFFLOST AUF ZWEISTÜNDIGE DROSOPHILA EIER (Comparative studies on the effect of x-rays and that of nitrogen mustard on 2-h Drosophila eggs). Strahlentherapie 89, 2 (1952) 265-8. (In German)

The quantum-mechanical conception makes it possible to compare chemical and physical noxae. The noxious effect of various concentrations of nitrogen mustard on 2-h Drosophila eggs was determined (after 72 h exposure at a constant temperature). The lethal ratio of various x-ray doses was also established. As a half-value dose ($LD_{50}$), 14-15 mg nitrogen mustard is approximately equivalent to 195 r; 5 mg nitrogen mustard (6.4% lethality) is equivalent to 50 r; 30 mg nitrogen mustard corresponds with 400 r (lethal ratio 94 and 87%, respectively). The use of higher concentrations than 30 mg nitrogen mustard does not increase the effect. (EM XIV (8): 15, 1954)

1424 Whiting, A. R. FREQUENCIES OF DOMINANT AND RECESSIVE LETHALS INDUCED IN HABROBRACON EGGS BY X-RAYS IN AIR AND IN NITROGEN. Genetics 38 (1953) 701.

Eggs x-rayed in late metaphase I show high rate of terminal deletions correlated with dominant lethal effects. Recessive lethal rate is low. Chromosomes in this stage appear to be under tension and are not in contact. Dominant lethal rate may represent total original breakage because of tension while recessive lethals may result from minute changes within chromosomes. Eggs (n) from irradiated unmated females which hatch have no lethals. Surviving daughters (2n) from females mated to untreated males, when bred unmated, can be classified on basis of hatchability of their eggs into those with no recessive lethals (100% hatchability), those with one (50% hatchability), etc. Majority of lethals act before hatching. Unmated females were exposed to 1100 r in a current of air or of nitrogen, the latter during irradiation only, about 3 min. Results are given. The biologically equivalent dose in air for nitrogen data is about 400 r. The change in rates of both dominant and recessive lethals under conditions of this experiment suggests that there is a decrease in breakage in nitrogen. (from auth.)

(Abstract of paper presented at the 1953 meeting of the Genetics Society of America, Boston, Mass., 28-30 Dec. 1953)

1425 Whiting, A. R. THE EFFECTS OF OXYGEN ON THE FREQUENCY OF X-RAY-INDUCED MUTATIONS IN HABROBRACON EGGS. Genetics 39 (1954) 851-8.

Habrobracon metaphase I eggs were x-rayed in atmospheres of air and nitrogen, the latter being administered only during irradiation. Dominant embryo lethals, recessive embryo and postembryo lethals, and visible mutations were recorded. All types were reduced at the same relative frequency in nitrogen, 500 r in air producing almost identical percentages of mutations as 1100 r in nitrogen. This leads to the conclusion that reduction in oxygen concentration reduces primary breaks and that other factors influencing final conditions are unchanged in the irradiated cell.

1426 Whiting, A. R., Murphy, Wm. E. RESPONSES OF IRRADIATED HABROBRACON EGGS AND SPERM TO ANOXIA, AND THEIR THEORETICAL SIGNIFICANCE. Radiation Res. 3 (1955) 356-7, abstr. 143.

Eggs in first meiotic metaphase and prophase and mature sperm were x-rayed in air and in nitrogen, the latter administered during irradiation only. Dominant and recessive embryo and postembryo lethal and visible mutations were recorded. In all, 96301 eggs were observed. In the nitrogen series, dominant

lethals, the result of irreparable chromosome breaks (terminal deletions with lateral chromatid fusion), are reduced in the same proportion as other lethal changes caused by permanent chromosome alteration surviving restitution. This affords evidence for the breakage hypothesis, since, if the reunion hypothesis were correct as an explanation of lowered x-ray-induced change in lowered oxygen, the percentage of irreparable changes should remain constant. Data on visible mutations are too scanty to be significant, although their rate of induction is consistently lower in the nitrogen series. Larger cells, metaphase and prophase eggs, show a greater response to irradiation in nitrogen than do sperm in the reduction of lethal mutations. This correlation with amount of cytoplasm (water?) is perhaps significant from the point of view of the theory that hydrogen peroxide is involved in indirect effect of x-rays on chromosomes.

1427 Whiting, A.R., Murphy, Wm.E. DIFFERENCES IN RESPONSE OF IRRADIATED EGGS AND SPERMATOZOA OF HABROBRACON TO ANOXIA. J. Genetics 54, 2 (1956) 297-303.

All types of x-ray-induced mutations of Habrobracon eggs in prophase I and MI and in spermatozoa were fewer in atmospheres of nitrogen than in atmospheres of air. Dominant lethal mutations, apparently associated with isochromatid breakage and lateral sister union and with tension (conditions which prevent restitution) decreased in MI eggs in the same ratio as did recessive lethal and visible mutations. A consistently greater abundance of dominant and recessive lethals in eggs than in spermatozoa may have resulted from differences in amounts of cytoplasm and dissolved oxygen. The data appear to favour the "breakage" hypothesis, rather than the "reunion" hypothesis, to explain the protective effect of anoxia on x-ray-induced chromosome aberrations. (BA 31: 19514, 1957)

1428 Wolff, S., Lindsley, D. L. EFFECT OF OXYGEN TENSION ON THE INDUCTION OF APPARENT XO MALES IN DROSOPHILA. Genetics 45 (1960) 939-47.

The present experiments have demonstrated that, when the radiation is delivered at 1.0 atmosphere of oxygen, no saturation of the oxygen-sensitive system is achieved in Drosophila sperm. The results may be interpreted to indicate that at 0.2 atmosphere of oxygen and 1000 r of x-rays (where Lüning and co-workers had reported saturation), oxygen rather than a cellular component limits the amount of damage that may accrue. Alternatively, the results are also consistent with the existence of two oxygen-sensitive systems, one of which is exhausted by 1000 r at 0.2 atmosphere of oxygen and the other of which is insensitive to the difference between 0 and 0.2 atmosphere but is sensitive to 1.0 vs. 0.2 atmosphere of oxygen. This model is similar to the one proposed to account for the effect of oxygen tension on induced chromosome breakage and rejoining in Vicia faba, in which a rejoining system is extremely sensitive to oxygen tension, whereas breakage is less sensitive. (from auth. summary)

1429 Yost, H. T., Jr., Benneyan, R. N. THE EFFECTS OF COMBINED RADIATIONS ON CROSSING OVER IN DROSOPHILA MELANOGASTER. Genetics 42 (1957) 147-60.

Data are presented which show that infra-red radiation delivered for 24 h at 10°C is unable to modify the effect of ionizing radiations, such as x- or γ-rays, on the induction of crossing over. The problem of induced crossing over is considered in the light of an hypothesis that the effect is upon the coiling pattern of the chromosomes.

1430 Young, W. J., Yost, H. T., Jr., Ives, P. T., Levine, R. P. THE EFFECT OF PRETREATMENT WITH INFRA-RED RADIATION ON THE X-RAY INDUCED SEX-LINKED RECESSIVE LETHAL AND VISIBLE MUTATION RATE IN DROSOPHILA MELANOGASTER. Proc. nat. Acad. Sci., Washington 39 (1953) 488-95).

Pretreatment with infra-red radiation does not increase the number of sex-linked recessive lethal or visible mutations induced by x-radiation, even though the environmental factors known to influence the action of infra-red are favourable. Crossing over studies of the lethals failed to indicate any significant portion of the chromosomes with two or more lethals resulting from the combined radiations. It is concluded from these and other findings and from theoretical considerations that recessive lethal and visible mutations do not result from chromosome breakage and that neither type of mutation is to be expected as a result of infra-red radiation acting alone or in pretreatment before x-radiation. (auth. summary)

1431 Atwood, K. C. ABERRATION FREQUENCIES IN IRRADIATED POPULATIONS. Amer. Nat. 88 (1954) 379-80.

A brief note comments on some observations reported on salivary chromosomes from irradiated Drosophila populations (cf. Paget, 1954). It is pointed out that the relative frequencies of different aberrations are not solely the results of differential selection but also determined in part by a higher rate of origin of inversions than of translocations. The average selection pressure against the inversions must thus be somewhat greater than Paget estimated on the basis of equal rates of origin.

1432 Auerbach, S. I., Crossley, D. A., Jr., Engelmann, M. D. EFFECTS OF GAMMA RADIATION ON COLLEMBOLA POPULATION GROWTH. Science 126, 3274 (1957) 614.

Experiments were started with 61 reproducing population units of 10 individuals each of Proisotoma minuta Tull. The effects of radiation (single doses ranging from 3000 to 7000 r) from a $Co^{60}$-source were examined by checking on population size in bi-daily counts of individuals at food points and by counts of total numbers at the termination of the experiment. All population units appeared to have an initial threshold period followed by the typical phase of exponential growth. The effect of radiation seemed to be chiefly one of lengthening this threshold period, i.e. a lag effect.

(An earlier abstract was published in Bull. ent. Soc. Amer. 2, 3 (1956) 17, abstr. 24, by Auerbach and Engelmann)

* Bonnier 1957 - [974]

* Bonnier and Jonsson 1957 - [975]

1433 Bonnier, G., Jonsson, U.-B., Ramel, C. SELECTION PRESSURE ON IRRADIATED POPULATIONS OF DROSOPHILA MELANOGASTER. Hereditas 44, 2-3 (1958) 378-406.

A study (stressed to be preliminary) is described on the way in which selection pressure interacts with irradiation effects. Differences in strength of selection pressure between different populations of D. melanogaster were checked and maintained by larval competition. It was found that populations with a low selection pressure were much more difficult to keep alive than those with a strong one. When the accumulated dose had reached a certain level, the viability of all populations seemed to increase with further increase in accumulated dose, but much more quickly in populations with strong selection pressure than in the others. Despite strong indications of an effect of selection pressure, the various tests so far performed (e. g. on egg-laying capacity, hatchability of eggs, sterility of males, larval competitions, and on the number and spread into the populations of lethal genes) have not shown any clear-cut differences between the populations.

1434 Bonnier, G., Jonsson, U.-B., Ramel, C. EXPERIMENTS ON THE INFLUENCE OF SELECTION PRESSURE ON IRRADIATED POPULATIONS OF DROSOPHILA MELANOGASTER. 2nd UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 15/P/169. 22 (1958) 322-4.

Within each separate population (as defined) all flies of each generation were irradiated under a common x-ray beam with 1500 r. The techniques are described. It was attempted to collect 5000 - 6000 larvae per generation from each population. Results of the various experiments are given graphically for populations with low and with strong selection pressure. Certain consistent trends were observed and discussed.

1435 Bonnier, G., Jonsson, U.-B., Ramel, C. ADDITIONAL EXPERIMENTS ON IRRADIATED POPULATIONS OF DROSOPHILA MELANOGASTER. Hereditas 45, 2-3 (1959) 441-8.

This paper is a continuation of work reported earlier by the authors (Hereditas 44 (1958) 378-406), on the effect of selection pressures of different strengths on populations of D. melanogaster which had been subjected to x-rays. Experimental data are presented as graphs and an analysis of lethal chromosomes under prevailing conditions is given in tabulated form, as is the frequency of sterile males. The data obtained confirm earlier results.

1436 Borstel, R. C. von. POPULATION CONTROL BY RELEASE OF IRRADIATED MALES. Science 131 (1960) 878, 880-2.

The note is a searching comment on an article by Knipling (Science 130 (1959) 902). The effect of radiation which is probably also the most important in insect control is the induction of dominant lethality in the sperm, and not male sterility. With dominant lethality the results obtained are the same, whether monogamy or polygamy exist in the insect population. Data from work on Drosophila, Habrobracon and Callitroga hominivorax are cited.

1437 Buzzati-Traverso, A. A., Scossiroli, R. E. X-RAY-INDUCED MUTATIONS IN POLYGENIC SYSTEMS. 2nd UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 15/P/588. 22 (1958) 293-7.

In a study on the induction of polygenic mutations in artificial populations of Drosophila melanogaster it was shown that x-rays can increase the genetic variability of traits affecting the physiology and the morphology of the flies, and that natural selection is capable, under experimental conditions, of accumulating those variants which bestow a higher fitness on the individuals. Data are tabulated. Data on the induction of such polygenic mutations in artificially selected strains are given graphically. Genetic analysis showed a marked increase of variability in the irradiated lines, exhibited both at the phenotypic and genotypic levels. A new variability due to induction of polygenic mutations affecting the selected trait, may be assumed. The origin of new genetic variability is discussed.

(This paper was also published in Progr. nucl. Energy Ser. VI, Biol. Sci. 2 (1959) 249-57, Bugher, J. G., et al., eds. London, Pergamon Press. 1959)

1438 Carson, H. L. EFFECT OF IRRADIATION ON ARTIFICIAL POPULATIONS UNDER STRONG NATURAL SELECTION. (abstr.) Genetics 44 (1959) 503.

Four replicate populations of Drosophila melanogaster were run in vial populations in which food, space and change schedule were rigidly controlled, producing stringent natural selection. The conditions of irradiation are described. The irradiated populations declined precipitously in numbers but less in biomass. Thus, the mean size of the flies in the irradiated populations increased sharply; this appears to be a simple effect of decreased competition for food. During the two periods of relaxation of radiation, the experimental populations quickly rose again to the level of the controls but did not surpass them. (from abstr.)

* Clayton and Robertson 1955 - [987]

1439 Cunha, A. B. da, Toledo, J. S. de, Pavan, C., Souza, H. L. de, Melara, H. E., Gabrusewycz, M. R., Gama, M. R., Pires des Camargo, M. L., Mello, L. C. de. ANALYSIS OF EFFECTS OF NATURAL AND RADIATION-INDUCED LETHALS AND OF THEIR FREQUENCIES IN DROSOPHILA WILLISTONI. 2nd UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 15/P/2281. 22 (1958) 3303.

(Cf. Progr. nucl. Energy, Series VI, Biol. Sci. 2 (1959) 359-63)

1440 Cunha, A. B. da, Toledo, J. S. de, Pavan, C., Souza, H. L. de, Melara, H. E., Gabrusewycz, M. R., Gama, M. R., Pires de Camargo, M. L., Mello, L. C. de. A COMPARATIVE ANALYSIS OF THE EFFECTS OF NATURAL AND OF RADIATION-INDUCED LETHALS IN HETEROZYGOUS INDIVIDUALS AND OF THEIR FREQUENCIES IN NATURAL POPULATIONS OF DROSOPHILA WILLISTONI. p. 63 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958.

(Abstract of paper presented at the Congress)

(Cf. Progr. nucl. Energy, Series VI, Biol. Sci. 2 (1959) 359-63)

1441 Cunha, A. B. da, Toledo, J. S. de, Pavan, C., Souza, H. L. de, Melara, H. E., Gabrusewycz, M. R., Gama, M. R., Pires de Camargo, M. L., Mello, L. C. de. A COMPARATIVE ANALYSIS OF THE EFFECTS OF NATURAL AND OF RADIATION-INDUCED LETHALS IN HETEROZYGOUS INDIVIDUALS AND OF THEIR FREQUENCIES IN NATURAL POPULATIONS OF DROSOPHILA WILLISTONI. Progr. nucl. Energy, Ser. VI, Biol. Sci. 2 (1959) 359-63.

The authors tested the validity of the hypothesis that the lethal genes present in natural populations, and subjected to natural selection for generations, are less deleterious in the heterozygous condition than newly induced lethals. The data obtained do not support this. X-ray-induced and wild lethals are shown to be similar in their effects as well as in their frequencies in natural populations.

1442 Gregg, T.G. EXPERIMENTAL POPULATIONS OF DROSOPHILA ANANASSAE, DERIVED FROM IRRADIATED NATURAL POPULATIONS. Univ. Tex. Publ. 5914 (1959) 207-24.

(See Diss. Abstr. 19 (1959) 2217)

1443 Gregg, T.G. (Univ. Texas, Austin) STUDIES ON EXPERIMENTAL POPULATIONS OF DROSOPHILA ANANASSAE DERIVED FROM IRRADIATED NATURAL POPULATIONS. Diss. Abstr. 19 (1959) 2217.

Subpopulations of D. ananassae taken from populations on various atolls in the Marshall Islands in 1956 and 1957 were maintained in the laboratory in different types of experimental populations. These and a series of experiments are discussed. The results are taken as strong evidence that the low viability levels observed elsewhere (Bikini and Rongelap populations, 1955*) were actually the results of radiation from the thermonuclear tests 18 months previously and not due to normal population fluctuations.

* Stone et al "Genetic studies of irradiated natural populations of Drosophila". Univ. Tex. Publ. 5721 (1957) 261-316.

1444 Knipling, E.F. POPULATION CONTROL BY RELEASE OF IRRADIATED MALES. Science 131 (1969) 882.

Part of correspondence between von Borstel and the author concerning the relative effect of monogamy and polygamy on the application of the sterile-male technique of population control.

(See Science 130 (1959) 902, and ibid 131 (1960) 878).

1445 Paget, O.E. A CYTOLOGICAL ANALYSIS OF IRRADIATED POPULATIONS. Amer. Naturalist 88 (1954) 105-7.

Some data is presented concerning the frequencies of chromosomal aberrations within several experimental populations of Drosophila melanogaster, following irradiation with x-rays. Salivary-gland studies were carried out, and the frequencies of inversions and translocations investigated. They were found to be equal in the case of D. melanogaster.

1447 Prout, T. GENETIC DRIFT IN IRRADIATED EXPERIMENTAL POPULATIONS OF DROSOPHILA MELANOGASTER. Genetics 39, 4 (1954) 529-45.

The behaviour of second chromosome recessive lethal producing loci was studied in three experimental populations of Drosophila melanogaster. Of the three populations, one was a large population (~ 10 000 individuals) subject to chronic irradiation; one was a small population (~ 1000) also irradiated; and one was a large population receiving no treatment. The effect of genetic drift operating in the small population was demonstrated by determining the allelism of the lethals taken from the three populations and by analyzing the lethal accumulation curves in the populations. Also three population parameters were estimated for each population. These parameters were the effective population size; the mean selection coefficient of heterozygotes between lethal and non-lethal alleles; and the mean mutation rate per locus. The estimates showed that (A) the small population might have a genetically effective size less than its absolute size, and (B) the selection against heterozygotes was affected neither by population size nor by irradiation, but was of the same order of magnitude as those measured in several wild populations of Drosophila. (auth.)

1448 Ramel, C., Bonnier, G., Jonsson, U.-B. SELECTION PRESSURE ON IRRADIATED POPULATIONS OF DROSOPHILA MELANOGASTER. Radiation Res. 9 (1958) 170.

This paper describes the start and the first preliminary-results of an experiment on the influence of selection pressure on irradiated populations of Drosophila melanogaster. The populations included in the experiment emanate from one stock of non-irradiated wild type flies made homozygous for the three large chromosomes. The adult flies are kept in cages. Their progeny, in the stage of freshly hatched larvae, are collected and transferred to vials with a standard amount of food. The differences in strength of selection are checked by larval competition. Thus in the populations with a low selection pressure 25 larvae are transferred to each vial, while the corresponding amount of larvae for those populations with a high selection pressure is 200 and 400 per vial. The populations are further divided into two series. In one there is no control of the number of offspring per female, whereas in the other larvae are collected from groups of five females, the

progeny of which never includes more than 25 flies per group. After the emergence of a new generation all flies are irradiated by an acute x-ray dose of 1.5 kr. An effect of selection pressure is strongly indicated by the differences in the ease with which it has been possible to carry through the routine work and to keep the populations alive. The populations with a low selection pressure were much more difficult to keep alive than those with a strong selection pressure. When the accumulated dose had reached a certain level, the viability of all populations seemed to increase with further increase in accumulated dose; the increase, however, is much quicker in the populations with strong selection pressure than in those with low pressure. When testing irradiated second chromosomes a marked dominant effect in viability was found.

(Abstract of paper presented at the Intern. Congr. of Radiation Res., Burlington, Vermont 10-16 Aug. 1958)

1449 Scossiroli, R. E. EFFECTIVENESS OF ARTIFICIAL SELECTION UNDER IRRADIATION OF PLATEAUED POPULATIONS OF DROSOPHILA MELANOGASTER. Un. int. Sci. biol. Publ. Series B 15 (1954) 42-66, Symposium on Genetics of Population Structure.

Treatments with x-rays have made possible further progress in a selected line which had reached a plateau, as the result of increased variability in the irradiated lines. The progress of the selected trait is accompanied by an increase in sterility and decrease in fertility, mostly due to some effect related to the selected response. A small number of x-ray treatments of 3000 r each can induce so much variability that under the selection pressure applied there is no difference between the lines in which the x-ray treatments have been suspended after 6 applications and those in which the treatments have been continued. It seems that the artificial selection pressure applied which would otherwise result in continuous changes in the genetic composition of the population, is opposed by natural selection so that a condition of genetic homeostasis is attained.

1450 Scossiroli, R. E. SELEZIONE ARTIFICIALE PER UN CARATTERE QUANTITATIVO IN POPOLAZIONI DI DROSOPHILA MELANOGASTER IRRADIATIO CON RAGGI X (Artificial selection for a quantitative trait in Drosophila melanogaster population treated with x-rays). CNB-4, Comitato Nazionale per le Richerche Nucleari, Milan. 1959, 218 p. (In Italian)

Selection for high and low numbers of sternopleural hairs was conducted on x-irradiated plateaued lines of Drosophila to determine if x-irradiation can induce new variability for further selection. The results showed that in selection for high numbers of hairs, treatments with high doses of x-radiation (3000 r every other generation) were effective in producing a large selection response. Selection in non-irradiated lines were almost ineffective. The selection response in irradiated lines is associated with an increase of genetic variability. In the irradiated lines a strong reduction of fitness (increase of sterility and decrease of fertility) is observed. This decrease in the fitness is caused only in part by specific mutations induced by x-radiation; it is associated with the response to the intense selection applied. After a relaxation of the selection and a suspension of the treatment, there is a regression of the average value of the selection characteristic which is stabilized at a higher level, however, than that at the beginning of the experiment. An improvement in the fitness is also observed. The importance of polygene mutability, and the importance of the results obtained for plant and animal breeding are discussed. (tr-auth.)

1451 Scossiroli, R. E. ON THE RELATIVE ROLE OF MUTATION AND RECOMBINATION IN RESPONSES TO SELECTION FOR POLYGENIC TRAITS IN IRRADIATED POPULATIONS OF D. MELANOGASTER. Intern. J. Radiation Biol. 1 (1959) 61-9.

X-ray treatments are a very efficient tool for inducing polygenic mutation and therefore additive genetic variability for polygenic traits in Drosophila. Artificial selection can make use of the new genetic variability. X-ray-induced increase in recombination rates does not seem to be an important factor in determining the observed effects, at least in the described experiments. (auth.)

1452 Stern, C. RADIATION AND POPULATION GENETICS. p. 206-28 in "Radiation Biology and Medicine", Claus, W. D., ed. Reading, Mass. Addison-Wesley Publ. Co., Inc. 1958, 961p.

Gene effects in different individuals of a population are discussed, the heterozygosity of populations, and the genetics of irradiated experimental populations. Results obtained with Drosophila are used a great deal for illustration. General bibliography: 66 references.

1453 Stone, W. S., Wheeler, M. R., Spencer, W. P., Wilson, F. D., Neuenschwander, J. T., Gregg, T. G., Seecof, R. L., Ward, C. L. GENETIC STUDIES OF IRRADIATED NATURAL POPULATIONS OF DROSOPHILA. Univ. Tex. Publ. No. 5721 (1957) 260-316.

1454 Stone, W. S., Wilson, F. D. GENETIC STUDIES OF IRRADIATED NATURAL POPULATIONS OF DROSOPHILA. II. 1957 TESTS. Proc. nat. Acad. Sci., Washington 44 (1958) 565-75.

Genetic analyses were made of irradiated and control isolated populations of D. ananassae from the Pacific Proving Ground area, others of the Marshall Islands, and Ponape.

1455 Stone, W. S., Wilson, F. D. GENETIC STUDIES OF IRRADIATED NATURAL POPULATIONS OF DROSOPHILA. IV. Univ. Tex. Publ. No. 5914 (1958) 223-34.

1456 Wallace, B. AUTOSOMAL LETHALS IN EXPERIMENTAL POPULATIONS OF DROSOPHILA MELANOGASTER. Evolution 4 (1950) 172-4.

Preliminary work indicating that a large proportion of induced lethals in the second chromosome of D. melanogaster are incompletely recessive is reported. Three experimental populations of D. melanogaster were analyzed for lethal second chromosomes. The original flies of two of these populations were treated with x-rays. Frequencies of lethals in experimental populations is presented in tabular form. Data indicate that less than one-half of the original induced lethals persist through six generations. (NSA 6: 8, 1952)

(See also AECU-1716, Long Island Biological Assn., Biological Lab., Cold Spring Harbor, N.Y. 6p)

1457 Wallace, B. GENETIC CHANGES WITHIN POPULATIONS AFTER X-IRRADIATION. Genetics 36 (1951) 612-28.

Genetic analyses were made of populations of Drosophila melanogaster, known to carry second chromosomes free of lethals and drastic subvitals, and which were subjected to single x-ray treatments. The recessive lethals of population (1) (parental males had received 1012.5 r) decreased from an original 18.3% to 10.1% in about 4 generations, and then increased at a rate comparable to that of the control. The early elimination of lethals from (1) indicated a selective disadvantage of heterozygotes of 0.5, and was adequately explained by lethal-translocation association. Analyses of lethals, semi-lethals, average viabilities of flies homozygous for "normal" chromosomes, and variances of the array of "normal" viabilities indicate that changes occurred at a more rapid rate in (1) than in the control. It has been suggested that this was the result of a greater number of possible gene combinations in the irradiated population and that gene mutation was supplemented by gene recombination. The discussion touches briefly on general problems of irradiated populations. (from auth. summary)

(Also published as AECU-1107, Long Island Biological Assn., Biological Lab., Cold Spring Harbor, N.Y. 26p)

1458 Wallace, B. STUDIES OF POPULATIONS EXPOSED TO RADIATION. (abstr.) Science 115 (1952) 487.

Studies are reported on experimental populations of Drosophila melanogaster exposed to continuous γ-radiation or to a single massive dose of x-radiation. The analyses were primarily of two types: determination of the frequencies of second chromosomes carrying lethal and semilethal gene mutations in the several populations, and estimation by various techniques of the adaptive values or well-being of the populations. The findings are discussed. A lower adaptive value is indicated in those populations that have received the most chronic irradiation. The genetic structures of populations appear to be under constant review by natural selection; well-adapted structures are maintained in spite of mutagenic forces operating counter to natural selection.

1459 Wallace, B. STUDIES ON IRRADIATED POPULATIONS OF DROSOPHILA MELANOGASTER. J. Genet. 54 (1956) 280-93.

Previously reported results of genetical analyses of irradiated populations of D. melanogaster are summarized and extended. The Cy L and Cy L-Pm techniques were used to test 2d chromosomes for lethals. Data for nearly 150 generations demonstrated that the average viability of individuals carrying random combinations of chromosomes from each of 2 populations may not reflect the average effect of these chromosomes on the viability of homozygous individuals. The accumulation within an irradiated population of chromosomes deleterious when homozygous need not result in a generation-by-generation decline in viability of heterozygous individuals. It is suggested that the seemingly deleterious chromosomes found within the populations are retained by virtue of their characteristics in heterozygous individuals. In general, it is suggested that any new mutation retained by a population is retained because it is favourable in its heterozygous carriers. There is no necessity that the mutations be favourable as well when homozygous. By definition, the majority of mutations in a population should be heterotic within the genetic system of that population. (BA 31: 19588, 1957)

(A paper on the same topic also appears on p. 201-4 in "Progress in Radiobiology." Proceedings of the 4th International Conference on Radiobiology, Cambridge 14-17 Aug. 1955, Mitchell, J. S., Holmes, B. E., Smith, C. L., eds. London, Oliver and Boyd. 1956)

1460 Wallace, B. THE AVERAGE EFFECT OF RADIATION-INDUCED MUTATIONS ON VIABILITY IN DROSOPHILA MELANOGASTER. Evolution 12 (1958) 532-56.

X-rays were used to study the effects of new radiation-induced mutations in heterozygous condition on the viability of otherwise homozygous individuals were investigated in populations of Drosophila melanogaster, representing a diploid individual. Data are tabulated and results discussed.

1461 Wallace, B. THE ROLE OF HETEROZYGOSITY IN DROSOPHILA POPULATIONS. AECU-3851, Long Island Biological Assn., Biological Lab., Cold Spring Harbor, N. Y. 1958, 18 p.

An analysis was made of the viability effects of radiation-induced mutations in heterozygous condition in populations of Drosophila. The results of seven large experiments involving the examination of more than 9000 cultures and the counting of more than 3¼ million flies are summarized in tabular form. Limitations of the experimental procedures and results of the experiments are discussed. (NSA 13: 508, 1959)

1462 Wallace, B. THE INVESTIGATION OF THE GENETIC STRUCTURE OF POPULATIONS. TID-11062, New York State Coll. of Agriculture, Ithaca, 1960, 30 p.

The report discusses the results of three new experiments on the viability effects of newly induced mutations. Two of these deal with Drosophila melanogaster. Males carrying irradiated X-chromosomes have lower viabilities than males with non-irradiated chromosomes. This is true at the levels of 500 r, 1000 r and 2000 r used. Females carrying a single irradiated chromosome are affected only slightly, if at all, by mutations on this chromosome. Results of these and more complex studies are discussed.

1463 Wallace, B., King, J. C. RADIATIONS AND POPULATIONS. Cold Spring Harbor Biol. Lab. Ann. Rep. 61 (1950) 29-33.

Irradiated populations of Drosophila melanogaster were analysed in order to determine the extent to which induced mutations might modify the adaptive value of populations. Lethals accumulated much more rapidly in the irradiated populations than in the control. Difficulties in interpretation are discussed. The amount of genetic diversity present in natural populations is stressed.

1464 Wallace, B., King, J. C. GENETIC CHANGES IN POPULATIONS UNDER IRRADIATION. Amer. Naturalist 85, 823 (1951) 209-22.

An introductory account is given of experimental populations of Drosophila melanogaster under different conditions of acute and chronic irradiation. Two types of data are given: (1) chromosomal content of the population in terms of lethals, semilethals, and viability modifiers; (2) estimates of the adaptive values of the populations based on viabilities of random heterozygotes. The discussion deals with the establishment within populations of coordinated genetic systems and the bearing this process has on irradiated populations generally. (BA 25: 35617, 1951)

(Also published as AECU-1442, Long Island Biological Assn., Biological Lab., Cold Spring Harbor, N. Y. 19 p)

1465 Wasserman, M. STUDIES IN THE GENETICS OF DROSOPHILA. VIII. ARTICLES ON GENETICS, TAXONOMY, CYTOLOGY AND RADIATION. XII. POPULATION STUDIES WITH DROSOPHILA MULLERI. Univ. Tex. Publ. No. 5422 (1954) 166-88.

The fate of x-ray induced chromosomal abnormalities introduced into a small, semi-isolated population of Drosophila mulleri was investigated. By the sampling technique used no appreciable number of chromosome abnormalities were detected in the population at a later sampling period. Failure to detect them is related to low reproductive efficiency of the irradiated flies and possible failure of the flies to survive and compete even though reproductive efficiency is not lowered. (from auth. summary)

# II APPLICATIONS

## II - A Sterile Male Technique

### II-A-1 SCREWWORM FLY

1466 Baumhover, A. H., Graham, A. J., Bitter, B. A., Hopkins, D. E., New, W. D., Dudley, F. H., Bushland, R. C. SCREW-WORM CONTROL THROUGH RELEASE OF STERILIZED FLIES. J. econ. Ent. 48, 4 (1955) 462-6.

Experiments were carried out on the island of Curaçao to test whether an isolated population of Callitroga hominivorax (Cqrl.) could be eradicated through the release of sterilized flies. 5-d-old pupae were sterilized with γ-radiation and sent to Curaçao by air freight. Adults emerged after 2 d irradiation and were released within 24 h. Sterilized flies were released (ca. 100/square mile/week) and, subsequently, egg masses were collected and examined for hatching. The effect of weather on fly activity and of release rate were tested. Releases and observations were continued. They were stopped 8 weeks after the last egg mass had been collected. Eradication was achieved.

An early USDA release on this subject appeared in J. Amer. vet. med. Ass. 126 (1955) 229 briefly reporting the Curaçao experiments (see index for detailed articles).

1467 Baumhover, A. H., Skipper, C. C., New, W. D. FIELD OBSERVATIONS ON THE EFFECTS OF RELEASING STERILE SCREW-WORMS IN A 2000 SQUARE MILE AREA IN FLORIDA. Bull. ent. Soc. Amer. 3, 3 (1957) 35, abstr. 20.

From May 1, 1957 through August 16, 1957 approximately 2 000 000 sterile screwworms were released per week over a 2000 square-mile area in East Central Florida. The method of sterilization and packaging is discussed along with observations on the effect on the natural screwworm population as determined by egg mass collections and case incidence.

1468 Baumhover, A. H. FLORIDA SCREWWORM CONTROL PROGRAM. Vet. Med. 53 (1958) 216-9.

Brief popular outline of damage caused by the pest and measures taken for its control (rearing and distribution of irradiated flies). Illustrated by 15 photographs.

1469 Baumhover, A. H., Husman, C. N., Skipper, C. C., New, W. D. FIELD OBSERVATIONS ON THE EFFECTS OF RELEASING STERILE SCREW-WORMS IN FLORIDA. J. econ. Ent. 52 (1959) 1202-6.

Approximately 500 sterile male screwworm flies (Callitroga hominivorax (Cqrl.)) were released weekly per square mile over a 2000-square-mile area in Florida. The insects had been irradiated as pupae, within 2 d of adult emergence, within 6200 to 8300 r gamma rays from $Co^{60}$. They were packaged at the rate of 880 (later 550) pupae per release carton. Flies were distributed daily in 6-mile swaths by small aircraft. Shifting of flight lanes resulted in the area being covered in 1-mile swaths weekly. Egg-mass collections in the treated area declined from a weekly average of 41 per station during the first 2 months to 11 in the 12th week. Check stations indicated a continuing high population north of the treated area but a decline on the west and south. However, at the end of 3 months 70% of the egg masses were sterile. (auth.)

(See earlier abstract "Mechanical devices for dispersal of sterilized screwworm flies from aircraft" in Bull. ent. Soc. Amer. 3, 3 (1957) 35, abstr. 19)

* Borstel 1960 - [1436]

1470 Bull, J. O. INSECT ERADICATION BY STERILE MALE RELEASE. p. 117-29 in "The Technological Use of Radiation. Proceedings of the Conference on the Technological Use of Radiation, Sydney, Australia 23-25 May 1960". Sydney, Australian Atomic Energy Commission. 1961.

Eradication of insects by release of sterile males exploits the mating behaviour of the male to find and inseminate the female with sterile sperms. Operation of the method and factors essential for success are reviewed in relation to the eradication of screw-worm fly (Callitroga hominivorax) and its possible application to Australian sheep blowfly (Lucilia cuprina). The biology and ecology of the two species are compared. The effects of radiation are considered in relation to emergence, deformity, longevity, mating behaviour and sterility. (auth.)

* Bushland and Hopkins 1953 - [1111]

1471 Bushland, R. C., Lindquist, A. W., Knipling, E. F. ERADICATION OF SCREW-WORMS THROUGH RELEASE OF STERILIZED MALES. Science 122 (1955) 287-8.

An experiment was conducted on the island of Curaçao, which is beyond the flight range of screwworms (Callitroga hominivorax (Cqrl.)). Sterilized flies were released from the air at the rate of 100 males per square mile for half the island, and the other half at about 400 per square mile each week. The lower release rate caused approximately 31% sterility of egg masses, and the higher rate 49%. The egg masses were checked in wounded goat pens kept all over the island, which ultimately indicated that the screw-worm had been eradicated.

1472 Bushland, R. C., Knipling, E. F., Lindquist, A. W. ERADICATION OF THE SCREW-WORM FLY BY RELEASING GAMMA-RAY-STERILIZED MALES AMONG THE NATURAL POPULATION. UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 8/P/114. 12 (1956) 216-20.

An account is given of the background work which led to the eradication of the screwworm fly, Callitroga hominivorax (Cqrl.), after extensive laboratory and field tests. The gamma-ray source is described. An isolated area was essential for effective control. Data on egg masses in 11 goat pens during the release of sterilized flies over the entire island of Curaçao are given over the test period in terms of the number of males released per square mile and the percentage of sterile egg masses observed. Possible applications of the method elsewhere and on other insects are discussed.

1473 Bushland, R. C. USE OF RADIATION IN INSECT CONTROL. p. 711-5 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956", Vol. 3. Becker, E. C., ed. Ottawa, Mortimer Ltd. 1958.

Radiation may affect insect populations in three ways: 1. Massive doses sufficient to cause degeneration of cells and loss of function in vital somatic tissues are lethal. The practical application of gamma-rays to destroy insects infesting stored products is now under consideration. This use of radiation is analogous to such an operation as fumigation for insect control. 2. The gonads of adult insects are much more susceptible to radiation than are somatic tissues. Insects are sterilized by doses that do not kill them. The release of sterilized males to compete for mates with males of a natural population is a form of biological control now being tried on screwworms (Callitroga hominivorax (Cqrl.)). 3. Amounts of irradiation less than the sterilizing dose cause recessive lethal mutations which when recombined in succeeding generations are fatal to homozygous individuals. However, natural selection operates to eliminate recessive lethal mutations, and in the meantime heterozygous individuals may display hybrid vigor. Therefore, the introduction of harmful recessive mutations in a population as a form of biological control analogous to disease introduction seems not to have the promise of lethal or sterilizing radiations. (auth.)

1474 Bushland, R. C. INSECT ERADICATION BY MEANS OF STERILIZED MALES. Plants and Gns 16 (1960) 88-94.

General review (popular) of the scientific principles involved, illustrated by the fate of the screwworm fly in the southeastern United States.

1475 Bushland, R. C. INSECT ERADICATION BY RELEASE OF STERILIZED MALES. p. 273-89 in "Large Radiation Sources in Industry", Conference Proceedings, Warsaw, 8-12 Sep. 1959". Vienna, International Atomic Energy Agency, 1960.

Review article. The principles employed are discussed. Screwworms were thus eradicated from Curaçao in 1954 by 4 months of release. Possible further applications and related research in progress are discussed.

1476 Bushland, R. C. MALE STERILIZATION FOR THE CONTROL OF INSECTS. p. 1-25 in "Advances in Pest Control Research", Vol. 3, Metcalf, R. L., ed. New York, Interscience Publishers, Inc. 1960.

A very comprehensive survey is given of the whole problem of controlling insects by this technique, including basic questions (type of radiation, dosage, stage of development at irradiation, effects) of insect sterilization. The screwworm problem is reviewed, with a chronological account of the sterilization experiments and cytological studies, and studies on mating habits. These led to the mass production of sterilized flies and to the ultimate eradication of the pest on Curaçao. The use of sterilized males for the control of other insects is discussed (fruit fly, mosquito, codling moth, etc.). In many cases previous treatment with insecticide would enhance the effectiveness of the sterile-male technique. It is essential to know not only at what age mating occurs in various species, and how frequently each sex copulates but also details of spermatogenesis and oögenesis as they relate to establishing the time for a sterilizing dose of γ-rays.

1477 Bushland, R. C. SCREW-WORM RESEARCH AND ERADICATION. Advanc. Vet. Sci. 6 (1960) 1-18.

After discussing the biology and geographical distribution of the screwworm the author describes conditions of laboratory rearing. The origin of the theory of releasing sterilized males for screwworm eradication is traced and also the genetic basis for irradiation sterilization. After some field work in Florida the eradication campaign in Curaçao was started and completed successfully. Techniques for mass rearing, sterilizing and distributing the flies are described. Insecticides for screwworm control are also applied (dressings, sprays and dusts). Screwworm eradication programmes in the southeast of the USA are discussed.

1478 Graham, A. J., Dudley, F. H. CULTURE METHODS FOR MASS REARING OF SCREW-WORM LARVAE. J. econ. Ent. 52 (1959) 1006-8.

Screwworm (Callitroga hominivorax (Cqrl.)) larvae were reared in sufficient numbers to produce 2 million sterilized flies weekly for 15 consecutive weeks in a Florida field test. Five days each week eggs were obtained from 20 colony cages, each stocked with 700 8-d-old flies, by heating an attractive medium in the cages. Single cultures of 100 000 larvae were reared on a mixture of ground lean meat, blood, and water, in vats. Until irradiation as 6-d-old pupae, the insects were held at 80°F and 90+ per cent relative humidity. (auth.)

(Presented earlier, see Bull. ent. Soc. Amer. 3, 3 (1957) 35, abstr. 18)

1479 Jefferson, M. E. IRRADIATED MALES ELIMINATE SCREWWORM FLIES. Nucleonics 18, 2 (1960) 75-7.

Details of the irradiator (γ from $Co^{60}$), irradiation procedure (exposure of pupae 2 d before emergence), fly factory capacity (maximum 100 million flies/week), layout of safety precautions, operational procedure, value and cost of such an eradication programme are discussed. Other programmes (e. g., Belgian work on the tsetse fly, and work at Hawaii on several fruit flies) are mentioned.

1480 Knipling, E. F. POSSIBILITIES OF INSECT CONTROL OR ERADICATION THROUGH THE USE OF SEXUALLY STERILE MALES. J. econ. Ent. 48, 4 (1955) 459-62.

A number of key factors must be considered and resolved before the procedure can be regarded as feasible for eradicating or controlling any given pest. 1. A method of mass rearing of the insect must be available. 2. Adequate dispersion of the released sterile males must be obtained. 3. The sterilization procedure must not adversely affect the mating behaviour of the males. 4. The female of the insect to be controlled must normally mate only once, or if more frequent matings occur the sperms from γ-irradiated males must compete with those from fertile males. 5. The population density of the insect must be inherently low or the population must be reduced by other means to a level which will make it economically feasible to release a dominant population of sterile males over an extended period of time. Research to develop ways to induce sterility instead of death among field populations of pest species and the advantage of this approach over lethal measures is stressed. (from auth. summary)

1481 Knipling, E. F. CONTROL OF SCREW-WORM FLY BY ATOMIC RADIATION. Sci. Mon., Lond. 85 (1957) 195-202.

This article is an account of the research that has led to this unique method of insect control, based on an understanding of the life history, habits, and population dynamics of the screwworm fly, together with knowledge of the effects of atomic irradiation on genetic material in insects.

(See also TID-3078(143), Technical Information Service, AEC. 1960, 35 p)

1482 Knipling, E. F. SCREWWORM ERADICATION: CONCEPTS AND RESEARCH LEADING TO THE STERILE-MALE METHOD. Smithson. Inst., Ann. Rep. 1958 (1959) 409-18.

General review of the field and of the large-scale application of radiation effects to Callitroga hominivorax.

1483 Knipling, E. F. STERILE-MALE METHOD OF POPULATION CONTROL. SUCCESSFUL WITH SOME INSECTS, THE METHOD MAY ALSO BE EFFECTIVE WHEN APPLIED TO OTHER NOXIOUS ANIMALS. Science 130, 3380 (1959) 902-4.

The principle of the method, involved in control or elimination of an insect species through the release of a dominant population of sexually sterile males is discussed. Further possibilities for other species and animals beyond the already successful eradication of Callitroga hominivorax (achieved by the 4th generation) are pointed out. Theoretical population trends are considered in tabulated form and the efficacy of the sterile-male technique discussed for the various cases. The advantages of inducing sexual sterility in a natural population by chemical or other treatments over the method of rearing and releasing a dominating population of sterile males are considered. It is suggested that the sterile-male method may have practical application for undesirable populations of certain wild animals as well as for insects.

1484 Knipling, E. F. CONTROL OF SCREWWORM FLY BY ATOMIC RADIATION. p. 169-82 in "Biological and Chemical Control of Pests. Symposium". Washington, D.C., American Association for the Advancement of Science, Section O, Agriculture. 1960.

Callitroga hominivorax. (See other publications by Knipling on same subject)

* Knipling 1960 - [1444]

1485 Knipling, E. F. THE ERADICATION OF THE SCREW-WORM FLY. Sci. Amer. 203, 4 (1960) 54-61.

The author reviews problems caused by this destructive parasite of livestock. The ecology and characteristics of the pest are described, and some of the preliminary studies which preceded the large-scale application of sterile males. Millions of flies were reared in a screwworm factory, and made sexually sterile by exposure to high-energy radiation. Sustained release over the infested areas followed (details of rearing and release requirements are given). The sterile males, mating with females in the natural population, nullified their reproductive capacity. The complete elimination of the natural population was the ultimate result. The advantages of the method are its selectivity (not involving the general ecological system outside the particular species being sterilized); the fact that no species can acquire immunity to sterile matings as it can to insecticides; and the increasing efficiency of the method as the remaining population decreases, in contrast to other killing agents where efficiency goes down at this stage. Applications of the method to other pests are discussed, together with the limitations inherent in certain species and their geographical distribution.

1486 Knipling, E. F. USE OF INSECTS FOR THEIR OWN DESTRUCTION. J. econ. Ent. 53 (1960) 415-20.

Review article. In considering ways of controlling or eradicating insect populations, the importance of a fuller understanding of the population density in an area is stressed. Knowledge of the rate of increase of population from one generation to the next is basic to an understanding of the degree of control that is required to hold insects to noneconomic levels. Theoretical calculations are presented to show that a low-level mortality that is constant and superimposed on mortality produced by normal environmental resistance can in time lead to a greatly reduced population. The importance of applying control measures against the total population, rather than against segments of the population is pointed out. Four ways of using an insect species to destroy its own kind are: (1) the release of insects made sexually sterile by gamma radiation, (2) the use of chemicals that produce sexual sterility in the natural population of insects. (3) the release of adults infected with pathogens that would destroy larval progeny by transmitting the disease to other adults and contaminating the environment where the insect reproduces and develops; (4) the development and release of insect strains that carry deficient genetic characteristics. (auth.)

1487 Lindquist, A. W. SCREW-WORM CONTROL THROUGH RELEASE OF STERILIZED FLIES. J. econ. Ent. 48, 4 (1955) 467-9.

The screwworm, Callitroga hominivorax (Cqrl.), has a comparatively low natural population. Research conducted by the Entomology Research Branch showed that sterilized males released over small areas mated with native females, and that the eggs produced were infertile. The release of sterilized males on the

island of Curaçao at the rate of approximately 400 per square mile per week for 7 weeks caused an initial sterility of about 70% which increased to 100% sterility as the number of flies and egg masses declined. Releases were continued for 3 more months, during which time no eggs, flies, or screwworm cases could be found. Apparently eradication was achieved during a time of year when the infestation normally increases. The possibility of using this method of eradication in Florida is considered as promising by the authors. Eradication in Texas does not appear practical because the screwworm is present in Mexico. Temporary control might be achieved in overwintering areas of Texas, but the practicability of such an effort is dependent on costs of rearing and releasing screwworms.

1488 Lindquist, A. W. USE OF SEXUALLY STERILE MALES FOR ERADICATION OF SCREW WORMS. p. 229-35 in "Radioisotopes and Radiation in the Life Sciences. 2nd Inter-American Symposium on the Peaceful Application of Nuclear Energy, Buenos Aires 1959". TID-7554. Washington, D. C., Pan American Union. 1960.

Exploratory experimental work on Callitroga hominivorax control is reviewed. Its life history and its importance as a parasite of warm-blooded animals are discussed, the destructiveness of the screwworm to livestock being emphasized. Results are reported from experiments in which males were exposed to radiation doses of 2500 to 7500 r before release into the native population. Motile sperm of low viability are produced which impregnate eggs that die soon after penetration by the irradiated, damaged sperm. Since screwworm females mate only once a reduction in population is soon evident. Results are reported for an immense eradication program covering about 50 000 square miles in Florida.

1489 Smith, C. L. MASS PRODUCTION OF SCREW-WORMS (CALLITROGA HOMINIVORAX) FOR THE ERADICATION PROGRAM IN THE SOUTHEASTERN STATES. J. econ. Ent. 53 (1960) 1110-6.

From January 1958 to October 1959 slightly more than $3.75 \times 10^9$ pupae were produced, utilizing approximately 6⅛ million pounds of horse and whale meat, during the screwworm eradication programme conducted in the Southeastern States, by the procedures described. The number of grams of eggs obtained from the stock colony and the grams required to meet the weekly fly production quota; the amount of horse and whale meat utilized in producing the minimum of 50 million flies weekly required for field releases; and the number of pupae produced in relation to the number of flies released are shown graphically. (auth.)

## II-A-2 FRUIT FLIES

1490 Christenson, L. D. RECENT PROGRESS IN THE DEVELOPMENT OF PROCEDURES FOR ERADICATING OR CONTROLLING TROPICAL FRUIT FLIES. p. 11-6 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956", Vol. 3 Becker, E. C. ed. Ottawa, Mortimer Ltd. 1958.

The possible application of the sterile male release method is also discussed for application to fruit fly problems.

1491 Christenson, L. D., Steiner, L. F., Balock, J. W., Stone, W. E. APPLICATION OF STERILE FLY RELEASE AND OTHER RADIATION TECHNIQUES TO TROPICAL FRUIT FLY CONTROL, ERADICATION AND QUARANTINE PROBLEMS. Bull. ent. Soc. Amer. 5, 3 (1959) 116, abstr. 62.

Overflooding normal cage populations of tropical fruit flies with sterile flies greatly suppressed fertility, despite frequent mating. Pilot eradication tests with sterile males on isolated Pacific Islands are planned. Irradiation studies with immature fruit flies have suggested quarantine usefulness for an irradiation treatment applied to fresh fruits and vegetables.

1492 Monro, J. THE POSSIBLE USE OF STERILE MALES IN CONTROLLING OR ERADICATING QUEENSLAND FRUIT-FLY. p. 130-7 in "The Technological Use of Radiation. Proceedings of the Conference on the Technological Use of Radiation, Sydney, Australia 23-25 May 1960". Sydney, Australian Atomic Energy Commission, 1961.

The Queensland fruit-fly, Dacus tryoni, is a destructive pest in Queensland and New South Wales and an expensive potential pest in Victoria and South Australia. Selection at the southern limits of its distribution may yet give rise to a new permanently established race. Methods of mass-rearing have been developed at Sydney University, presumably adaptable to factory conditions. D. tryoni could probably be dropped by aircraft; the pattern of release would depend on fundamental knowledge of the movement and distribution of the flies. The effects of various radiation doses given at different pupal ages on subsequent mating

behaviour and male longevity are discussed. Mating behaviour of females has, so far, only been studied under laboratory conditions. The areas are discussed where such an eradication programme might be attempted economically. Most evidence to date suggests that D. tryoni is suited to this method but much research still remains to be done, particularly on the ecology. (Discussion: p. 135-7.)

1493 Steiner, L. F., Christenson, L. D. POTENTIAL USEFULNESS OF THE STERILE FLY RELEASE METHOD IN FRUIT FLY ERADICATION PROGRAMS. (abstr.) Proc. Hawaii. Acad. Sci. (31st Annu. Mtg 1955/6) (1956) 17-8.

Despite multiple mating and loss of sterility in the oriental fruit fly (Dacus dorsalis Hendel), the Mediterranean fruit fly (Ceratitis capitata Wied.), and the melon fly (Dacus cucurbitae Coq.), tests of populations containing various ratios of irradiated and normal flies indicated that under laboratory conditions the resultant egg fertility was proportional to the ratio of sterile and normal flies present. The nature of the effect of γ-irradiation on fruit flies has not been determined. In addition to the presumed production of a high percentage of dominant lethals in the motile spermatozoa, there appeared to be some reduction in the motile sperm-producing capacity. Despite the unfavourable factors encountered (along with the problem of vastly larger populations to be suppressed, than were encountered in the screwworm experiments) the method has promise of being a useful eradication tool against isolated fruit fly populations.

## II-A-3 TSETSE FLY

* Potts 1957 - [1152]

* Potts 1957/58 - [874]

1494 Potts, W. H. STERILIZATION OF TSETSE FLIES (GLOSSINA) BY GAMMA RADIATION. Ann. trop. Med. Parasit. 52, 4 (1958) 484-99.

Pupae of Glossina palpalis collected in the field in East Africa were sent to London where they were subjected to gamma irradiation from a $Co^{60}$ source. Dosage varied between $3\times10^3$ and $3\times10^4$ rep. Dissection of samples of pupae at the time of irradiation indicated that of those viable (2/3), 80% were in the middle stages of development (5th - 22nd d of a 27-d pupal period) and 20% were in late stages of development (23 - 27th d of pupal period). Fertility of females was determined by dissection. As the testes appeared completely normal after irradiation, fertility of males was gauged by mating with normal females. Pupal mortality was not increased by doses of irradiation of up to $12\times10^3$ rep but there was a decreased emergence at $3\times10^4$ rep. The life span of male flies was halved but mating ability was not affected. At $6\times10^3$ rep 10 - 20% of males were not sterilized, and at $3\times10^3$ and $12\times10^3$ rep 10 - 16% of females remained fertile. (BA 33: 47223, 1959)

1495 Ray, J. WILL ATOMIC RADIATION CONTROL AFRICA'S TSETSE FLY? Foreign Agric. (USA) 20, 6 (1957) 15 - 6.

Brief review of the prospects of controlling the species Glossina by means of atomic radiation.

1496 Simpson, H. R. THE EFFECT OF STERILISED MALES ON A NATURAL TSETSE FLY POPULATION. Biometrics 14 (1958) 159-73.

The use of artificially sterilized males has been suggested as a means of controlling tsetse populations. A mathematical model of a natural tsetse fly population is set up, and the theoretical effect of the introduction of sterilized males is examined. Numerical results obtained on an electronic computer are presented and discussed. It appears impractical to attempt the control of a high density tsetse population (~ 1000 males per sq. mile). Where the density is low, however, (~ 100/sq. mile), the irradiation method may prove effective, especially when the low density is produced by an insecticidal application immediately before the release of sterilized males. Experimental data show that both sexes are sterilized by γ-rays. Females from the irradiated pupae show no ovarian development, and the males produce spermatozoa which fail to fertilize even normal females. The effect is not absolute.

1497 Baccetti, B. NUCLEAR ENERGY FOR CONTROL OF INSECT PESTS. Ital. Agric. 95, 11 (1958) 713-7. (In Italian)

Review article.

1498 Knipling, E. F. PROGRESS AND PROBLEMS FOR THE FUTURE OF MEDICAL AND VETERINARY ENTOMOLOGY. p. 689-95 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956", Vol. 3, Becker, E. C. ed. Ottawa, Mortimer Ltd. 1958.

Review article of wide general interest.

1499 Singleton, W. R., ed. NUCLEAR RADIATION IN FOOD AND AGRICULTURE. Princeton, N. J., D. Van Nostrand Co., Inc. 1958, 387 p.

The chapters in this book are based on papers selected from those presented at the UN Conference on Peaceful Uses of Atomic Energy held in Geneva, Switzerland, in Aug. 1955. Selection was exercized not only in the individual papers chosen but also in the topics. Topics covered include the general use of radioisotopes in agriculture (p. 1-26 describe Canadian work, cf. Spinks, 12: 75); genetic and biological hazards of nuclear radiation; the genetic eradication of insect pests (p. 281-90, cf. Bushland et al., 12: 216); and applications of radiation in food sterilization and preservation.

* Crook et al. 1960 - [1114]

* Davis et al. 1959 - [1116]

1500 MacLeod, J. ATOMIC WAR AGAINST AN INSECT; BRITISH TRIALS OF A NEW INSECT CONTROL TECHNIQUE USING GAMMA RAYS TO STERILISE MALE FLIES. Chemist and Druggist 172, 4151 (1955) 4-6.

An attempt was made to eliminate the sheep maggot-fly, Lucilia sericata, by the sterile-male technique. The species can be sterilized in the pupal stage by a dosage of $\gamma$-rays which does not markedly reduce the vitality of the adult fly. In 1956-57 a field test was made on Holy Island, off the Northumberland coast. On that two square miles of land lying about a mile off-shore, the native population of maggot-flies was estimated as being in the region of one or two thousand only. A population of about 20 000 sterile flies, i. e., about 10 000 males, was established in early July, and maintained by weekly additions until the end of the blow-fly season in early October. The initial liberation in 1957 was of almost 20 000 males, and the population was maintained at over 10 000 males by twice-weekly additions until near the end of September. The consistent poor weather of those two summers prevented assessment of progress during the actual experiment, but tests in early summer of 1958 showed that fertile flies were as common on the Island as on the adjacent mainland. The unexpected negative result stresses the need for very careful preliminary study of all possible factors which may enter into play in the field.

* Vasilyan 1960 - [1124]

## II - B Stored Products Infestation and its Detection

### II-B-1 COMMODITIES

#### Survey articles

* Baker et al. 1954 - [1241]

1501 Cornwell, P. B. THE CONTROL OF PESTS IN GRAIN BY GAMMA IRRADIATION. New Scientist 4, 79 (1958) 30-33.

The possibilities of gamma irradiation of grains for control of insect pests are discussed. Because the cost of radiation treatment increases with the dose, its application to disinfecting grain would make use of the small dose (10 000 rad) for reproductive sterilization.

1502 Deschreider, A.R. LA MEUNERIE ET L'ENERGIE ATOMIQUE. Bull. Ec. off. Meun. belge, Gand 19, 6 (1957) 86-98.

Review article dealing with the effects of radiation on plants, insects, and, in particular, on wheat and flour. Practical implications are discussed.

1503 Deschreider, A.R. LA MEUNERIE ET L'ENERGIE ATOMIQUE. Bull. Ec. off. Meun. belge, Gand 20, 2 (1958) 16-30.

Practical applications are discussed.

* Hassett and Jenkins 1952 - [1252]

1504 Hassett, C.C. CURRENT STATUS OF INSECT CONTROL BY RADIATION. Science 124 (1956) 1011-2.

The vast losses due to insects in a variety of commodities are reviewed. Controls other than chemical are discussed, including various forms of radiation. Radiation exposure is considered as a safe, non-destructive means of ridding many stored products of insect pests. New sources of radiation from particle accelerators and radioisotopes are described, and estimates of capacity and cost given for facilities designed to treat stored products.

* Hassett 1957 - [1253]

1505 Kuprianoff, J. DIE MÖGLICHKEITEN DER ANWENDUNG IONISIERENDER STRAHLEN BEI GETREIDE UND GETREIDEPRODUKTEN (Scope of applying ionizing radiation to grain and grain products). Getreide 6 (1956) 81-5. (In German)

Review. Various aspects of grain preservation, the application of radiation and its effects on conservation and quality are discussed generally.

1506 Risø Research Establishment, Risø, Denmark. LEVNEDSMIDDELKONSERVERING VED BESTRALING. ORIENTERENDE MØDE PA RISØ DEN 25. FEBRUARY 1959 (Food Preservation by Radiation. Orientation Meeting at Risø, February 25, 1959). NP-7709, Denmark, Atomenergikommissionen. Forsøgsinstitut, Risø. 1959, 91p. (In Danish)

A résumé of the reports and discussions at the orientation meeting on Danish research on food preservation by irradiation is presented. The topics discussed included a description of irradiation facilities at Risø.

xxxxyxxx

* Baker et al. 1953 - [1240]

* Baker et al. 1954 - [1243]

* Balock et al. 1956 - [1171]

1507 Bletchly, J.D. STUDYING THE EGGS OF LYCTUS BRUNNEUS. Timber Technol. 68 (1960) 30-1.

In the course of studies on the possible use of $\gamma$-radiation in the control of wood-boring insects it was necessary to cut up a considerable number of Lyctus egg-laying blocks (Bletchly, 1956). The technique described here was evolved to provide a quicker method of obtaining data on oviposition by irradiated adults and on the effect of irradiating eggs. Tests were made on unseasoned European oak (Quercus robur L.) sapwood. Veneers cut at 150$\mu$ and 200$\mu$ proved to be the most suitable thickness. In general, blocks containing 3 or more veneers proved the most suitable.

* Brownell et al. 1954 - [1528]

* Brownell et al. 1956 - [1530]

* Brownell et al. 1957 - [1531]

1508 Brownell, L. E., Nehemias, J. V. GAMMA IRRADIATION OF WHEAT AND WHEAT PRODUCTS FOR INSECT CONTROL. Amer. Miller & Processor 85, 2 (1957) 19-20, 26, 28, 32.

* Cornwell et al. 1957 - [1113]

1509 Cornwell, P. B. EFFECTS OF γ-RADIATION ON THE TASTE AND MANUFACTURING PROPERTIES OF SOFT WHEAT. J. Sci. Food Agric. 10 (1959) 409-12.

A preliminary study was made of the effects of 3 dose levels of γ-radiation on the physical, biochemical and baking properties of English wheat. Products made from irradiated grain have been examined for organoleptic changes by a taste panel of selected members. The slight changes induced by irradiation are considered of little commercial significance. Disinfestation of grain by γ-irradiation could thus be applied without adversely affecting the baking quality of the milled product.

1510 Cornwell, P. B. THE DISINFESTATION OF FOODS, PARTICULARLY GRAIN. Intern. J. Appl. Radiation and Isotopes 6 (1959) 188-93.

There are two potential methods of controlling insect pests by irradiation; indirect control by the release of sterilized adults and the direct treatment of infested products. Application of the first method is limited to certain species by a number of biological and environmental factors. The second method could have wider application for the control of all species infesting stored materials. Among the factors which may influence its success, problems associated with bulk handling and the incorporation of treatment into established handling procedures must receive primary consideration. These could be most easily solved in the treatment of packaged goods where production and irradiation may be carefully integrated. (auth.)

1511 Cornwell, P. B., Bull, J. O. INSECT CONTROL BY GAMMA-IRRADIATION: AN APPRAISAL OF THE POTENTIALITIES AND PROBLEMS INVOLVED. J. Sci. Food Agric. 11, 12 (1960) 754-68.

Review article. Lethal and sterilizing effects have been examined on different species, strains and developmental stages to evaluate dose levels required for commercial treatment. Research results and problems of application are examined in relation to the two potential methods of controlling insect pests by irradiation: indirectly, by the release of sterilized adults, and by the direct treatment of infested products. The first can only be applied to very few species due to certain biological requirements involved. Products handled in bulk at particular centres are the ones most favourable for disinfestation by radiation. Treatment of grain has been examined in detail. The fundamental and applied problems of using γ-radiation are discussed, and the relative merits of fumigation and radiation sterilization compared. Among factors which may influence the success of radiation disinfestation, bulk handling and the incorporation of treatment into established handling procedures must receive primary consideration. γ-irradiation may eventually take its place as a useful means of insect control, but it is unlikely to displace conventional methods.

1512 Cornwell, P. B. INSECT CONTROL BY IONIZING RADIATIONS. - AN APPRAISAL OF THE POTENTIALITIES AND PROBLEMS INVOLVED. p. 104-16 in "The Technological Use of Radiation. Proceedings of the Conference on the Technological Use of Radiation, Sydney, Australia 23-25 May 1960". Sydney, Australian Atomic Energy Commission. 1961.

Following an introductory survey, the results of research and problems of application are examined in relation to the practical feasibility of applying radiation disinfestation to stored products commodities. The most favourable products for radiation disinfestation are those handled in bulk at particular centres, and therefore radiation treatment of grain has been examined in detail. The fundamental and applied problems of using ionizing radiation for sterilization are compared. It is concluded that among factors which may influence the success of radiation disinfestation, bulk handling and the incorporation of treatment into established handling procedures must receive primary consideration. Ionizing radiations may eventually take their place as a useful means of insect control but their adoption is unlikely to displace conventional methods. (from auth. summary)

* Crean et al. 1953 - [1533]

1513 Hall, R. L. THE EFFECT OF IONIZING RADIATION ON SPICES. AD-228151, Report No. 8 (Final) for 26 Sep. 1955 - 25 Sep. 1958. Technical Information Serv., Baltimore, McCormick and Co. 13 p.

Insect infestation can be eliminated in spice products by ionizing radiations. In practically every case, the irradiated spices examined showed no evidence of live insects after 3 months incubation; this was at levels

of 50 000 and 75 000 rep. When irradiated with $3 \times 10^6$ rep, no significant change in the character of the spice itself occurred, as measured by triangle comparisons using a panel of about 20 members. None of the spices investigated, when combined in frankfurters and pork sausage and irradiated at $0.75 - 3.0 \times 10^6$ rep, showed any tendency to significantly mask or prevent ionized flavour and odour. In general, irradiation appears to reduce the odour and flavour of spices in pork sausage. (auth.)

(See also Progress Reports Nos. 1 - 7, US Army Quartermaster Corps Con. No. QMR & D No. 28, (Natick) 1 Feb. - 30 Apr. 1956)

* Jefferies and Cornwell 1958 - [1144]

1514 Kuprianoff, J. ZUSAMMENFASSENDE ÜBERSICHTSBERICHTE. LEBENSMITTELKONSERVIERUNG DURCH IONISIERENDE β- UND γ-STRAHLEN (Comprehensive reviews. Food preservation by ionizing β- and γ-rays). Z. LebensmittUntersuch. 100 (1955) 275-303. (In German)

The subject is reviewed under the subtitles: (A) electron rays: irradiation effect, irradiation energy, irradiation dosage, irradiation time; irradiation sensitivity of micro-organisms, virus, enzymes, insects and food; influence of the size of the object, composition, temperature, atmosphere and packaging, apparent construction, tests with individual foods (meat, butter, eggs, milk, fruit and vegetables), usefulness of the process; (B) electromagnetic rays: ultraviolet light, x-rays, γ-rays, ray sources, irradiation effects, irradiation of foods (list same as in above parentheses), toxic products, usefulness; outlook for the processes. (CA 49: 8513g, 1955)

1515 Nicholas, R. C., Wiant, D. E. RADIATION OF IMPORTANT GRAIN-INFESTING PESTS: ORDER OF DEATH CURVES, AND SURVIVAL VALUES FOR THE VARIOUS METAMORPHIC FORMS. Food Technol 13 (1959) 58 - 62.

Twelve grain-infesting pests were treated with 1-MeV electrons at various doses to determine the lethal effect of the treatment on the metamorphic forms and to determine sterility effects on the adults. Order of death curves of survivors against time at near-100%-lethal doses, where obtained, verify the sigmoid shape of the curves at sub-100%-lethal doses. Plots of survivors against dose on log-normal coordinates represent the data. In general, graded resistance is exhibited within a species increasing with insect age from egg to adult. Of the insect species, the moths showed higher resistance to radiation than the beetles. Pests covered by the study were the Mediterranean flour moth (Ephestia kühniella Zell); the saw-toothed grain beetle (Oryzaephilus surinamensis (L.)); the Indian meal moth (Plodia interpunetella (Hbn.)); the lesser grain-borer (Rhyzopertha dominica (F.)); the granary weevil (Sitophilus granarius (L.)); the rice weevil (Sitophilus oryza (L.)); the Angoumois grain moth (Sitotroga cerealella Oliv.); the yellow meal worm (Tenebrio molitor (L.)); the cadelle beetle (Tenebriodes mauritanicus (L.)); the confused flour beetle (Tribolium confusum Duv.); book lice (Psocoptera); and the flour mite (Acarus siro (L.)(?)).

1516 Nickerson, J. T. R. EXTENSION OF STORAGE LIFE OF FOODS USING IONIZING ENERGY. p. 116-23 in "Proceedings of the International Conference on the Preservation of Foods by Ionizing Radiations 27 - 30 July 1959", Cambridge, Mass., Massachussetts Institute of Technology, 1959, 290 p.

A review article, divided into various sections dealing with the low-dose-level treatment of foods with ionizing radiations for different purposes. One section deals with results obtained with different dose levels and sources on insects and their eggs in grain, flour and meal. Running costs of exploiting cooling reactor fuel elements as gamma sources are estimated.

* Park et al. 1958 - [1151]

1517 Передельский, А.А., Родионова, Л.З., Бибергаль, А.В., Румянцев, П.Д., Перцовский, Е.С. РАЗРАБОТКА МЕТОДА БОРЬБЫ С НАСЕКОМЫМИ - ВРЕДИТЕЛЯМИ ХРАНЯЩЕГОСЯ ЗЕРНА ПРИ ПОМОЩИ ИОНИЗИРУЮЩИХ ИЗЛУЧЕНИЙ. Труды Всес. н.-и. ин-та зерна и продуктов его переработки, Москва 35 (1958) 28-42.

Против амбарного и рисового долгоносиков зерно облучали рентгеновыми аппаратами РУМ-3 (200 кв, фильтр 0,5 мм Cu) и РУП-3 (400 кв, фильтр 2 мм Cu + 0,25 мм Fe). Для обеззараживания зерна необходима доза 10 000 р, как и других излучений - потока быстрых электронов, γ-лучей. Для промышленной дезинсекции пригодными источниками излучений являются генераторы быстрых электронов и мощные изотопные источники γ-излучений.

**Наиболее перспективные источники γ-излучений – осколки деления ядер урана (стоимость этих отходов атомной промышленности низка). Во ВНИИЗ проектируется полупроизводственная γ-установка для дезинсекции зерна в потоке.**

Peredelsky, A. A., Rodionova, L. Z., Bibergal, A. V., Rumyantsev, P. D., Pertsovsky, E. S., DEVELOPMENT OF A METHOD FOR CONTROLLING INSECT PESTS OF STORED GRAIN BY MEANS OF IONIZING RADIATION. Trudy vses. n.-i. in-ta zerna i produktov ego pererabotki (Trans. All-Un. sci. Res. Inst. of Grains and Products of Processed Grain) 35 (1958) 28-42.

In order to control Sitophilus granarius and S. oryza, the grain was irradiated, using x-ray installations RUM-3 (200 kV, 0.5 mm Cu filter) and RUP-3 (400 kV, 2.0 mm Cu plus 0.25 mm Fe filter). 10 000 r were required, whether x-rays, fast electrons or γ-rays were used. For deinfestation, fast electron generators and powerful isotope sources of γ-radiation represent suitable sources. Fission fragments of uranium nuclei represent the most promising sources of γ-rays in view of the low cost of these waste materials from atomic industry. A pilot γ-installation is being designed at the Institute which should allow the deinfestation of grain on production lines. (from Referativny Zhurnal Biologia 1: 7082, 1959)

1518 Peredelsky, A. A., Rumyantsev, P. D., Rodionova, L. Z., Bibergal, A. V., Pertsovsky, E. S. IONIZING RADIATIONS AS MEANS OF COMBATING INSECT PESTS. p. 217-9 in English translation of orig. Russian "Application of Radioactive Isotopes in the Food and Fishing Industries and in Agriculture. A portion of the Proceedings of the All-Union Scientific and Technical Conference on the Application of Radioactive Isotopes, Moscow 1957", New York, Consultants Bureau, Inc., 1959.

The literature on the action of ionizing radiations on insects (work on grain weevils) and calculations show that technically, economically and biologically it is advisable, in destruction of pest populations, to use only comparatively small doses (10 000 r) of x- or γ-rays, which produce general infertility or fatal damage in the embryonic or post-embryonic development of the progeny of the irradiated parents. The extinction of weevils in all stages of development is, furthermore, accelerated, following irradiation. On irradiation the average food consumption of the dying weevil population falls perceptibly, which favours the use of such a method in combating grain stock pests. To facilitate dosage calculation, blue prints of a powerful γ-radiation installation suitable for pilot-plant testing of irradiation of consumer grain supplies are being drawn up. Radioactive isotopes of cobalt and cesium, and mixtures of nuclear reactor wastes are proposed as sources of radiations.

(See also "Use of ionizing radiation against pests of stored grain." Biophysics 2: 209-213, 1957)

(For detailed abstract see "Ionizing radiations as a means of controlling insect pests in grain stocks" p. 134-5 in Abstracts of papers given at the "All-Union Conference on the Application of Radioactive and Stable Isotopes and Radiation in the National Economy and Science. Session: Biology, Medicine and Agriculture. Moscow 2-5 Apr. 1957". AEC-tr-2925 (III). New York, Consultants Bureau, Inc. 1957)

1519 Pomerantz, R., Mastran, J. L. THE UNITED STATES ARMY IONIZING RADIATION CENTER. 2nd UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 15/P/739, 27 (1958) 406-9.

Plans for the layout and tasks of the USAIRC are outlined. A list is given of the foods which, to date, are of the greatest interest for processing during the initial operational phases of the USAIRC, and are given under fruits and vegetables, meats and poultry, and cereal and baked products. Operation will encompass the comparison of γ-radiation and electron treatment. Emphasis is to be placed not only on the sterilizing levels of irradiation, but also on pasteurization, surface treatment, insect de-infestation and the inhibition of sprouting in potatoes and other tubers. The linear-accelerator-conveyor complex will consist of a 24-MeV, 18 kW accelerator and its ancillary conveyor equipment, and will be the most powerful unit ever to be constructed for radiation processing.

1520 Porretta, A. L'IMPIEGO DELLE RADIAZIONI IONIZZANTI PER LA CONSERVAZIONE DEGLI ALIMENTI (The use of ionizing radiation for the preservation of food – the present state of knowledge and future prospects). CNB-19, Comi. naz. Richerche Nucleari, Milan, Notiziario. 1960, 148 p. (In Italian)

A review article. The author examines the problems connected with the use of ionizing radiation for the sterilization, pasteurization and disinfestation of foods. A total of 224 references is listed.

1521 Proctor, B. E., Goldblith, S. A. FOOD PROCESSING WITH IONIZING RADIATIONS. Food Technol. 5 (1951) 376-80.

The type of radiation necessary to sterilize foods and drugs, the specific inactivation doses of radiations, the effects of irradiation on flavour, colour, texture and nutrients and packaging problems are discussed. Results on work with cereals infested with Sitophilus granarius and Tribolium confusum are given. The adaptation of radiation processes to existing production lines are discussed and illustrated.

1522 Proctor, B. E., Lockhart, E., Goldblith, A. S., Grundy, A. V., Tripp, G. E., Karel, M., Broglé, R. C. THE USE OF IONIZING RADIATIONS IN THE ERADICATION OF INSECTS IN PACKAGED MILITARY RATIONS. Food Technol. 8, 12 (1954) 536-40.

The use of ionizing radiations for the control of insect infestation in certain packaged military ration components was investigated, and determinations were made of the doses of high-energy cathode rays, x-rays and γ-rays needed to destroy all metamorphic forms of different insect species. Organoleptic tests were made with cereal and fruit ration bars irradiated at dose levels found necessary for insect destruction, and the effects of these radiations on the functional properties of some packaging materials were studied. This irradiation did not adversely affect the acceptability of the food products or the physical and functional characteristics of the materials in which the foods were packaged. Specifications are given for the radiation sterilization of a typical ration component, and a conservative cost analysis of such a process is made. (from auth.)

1523 Richardson, H. H., Balock, J. W. TREATMENTS TO PERMIT MOVEMENT OF AGRICULTURAL PRODUCTS UNDER PLANT QUARANTINE. Agr. Chemic. 14 (1959) 43-6, 119.

General review article. Various kinds of quarantine treatment for plant products are reviewed. Results from irradiation indicate it to be a promising treatment for fresh fruit and vegetables infested with fruit flies and possibly other insects. Good tolerances were found, well below dosages which effectively inhibit fruit fly reproduction. Work on mango, cucumber, cantaloupe, peach, squash and tomato is mentioned.

1524 Shiroisi, M., Hayakawa, A., Watanabe, Y., Fukamachi, C., Sakurai, Y. PRESERVATION OF FOOD BY IONIZING RADIATION (PRELIMINARY REPORT); EFFECTS OF GAMMA-RAYS ON TRIBOLIUM CONFUSUM, GERMINATION OF WHEAT AND VITAMIN $B_1$ CONTENT OF WHEAT FLOUR. Tokyo Food Res. Inst. Rpt. 1956, 11, 57-62. (In Japanese)

1525 Trump, J. G., Proctor, B. E. STERILIZING WITH ELECTRONS. Modern Packaging 24 (1951) 105-6, 164.

Sterilization of certain foods and pharmaceuticals by passage through a stream of high-energy electrons has been made possible. A Van de Graaff electrostatic generator is used, the limiting factor being the penetration depth. The method is effective on dry or aqueous media. It is of interest in connection with cereals infected by Sitophilus granarius and Tribolium confusum.

## II-B-2 SOURCES FOR DISINFESTATION

1526 Anonymous. FIRST DESIGNS FOR COMMERCIAL GRAIN IRRADIATED EQUIPMENT REVEALED. Modern Sanit. 7, 5 (1955) 49.

* Baker et al. 1954 - [1241]

1527 Bibergal, A. V., Margulis, U. Y., Pertsovsky, E. S. THE USE OF POWERFUL RADIATION SOURCES FOR THE DISINFECTION OF GRAIN. Atomnaya Energia 2, 4 (1957) 376. (In Russian)

A design for an experimental pilot plant for the disinfestation of grain by means of $Co^{60}$ γ-irradiation is described. The source consists of a shallow cylinder with 20 rods, totalling an activity of 100 000 g. eq. Ra, spaced along its sides. The plant is provided with protective water shielding. The grain is fed in automatically for irradiation. $Co^{60}$ has been found to be uneconomical for large-scale grain disinfestation plants because of its prohibitive cost. It is much more profitable to use the uranium fission products available as atomic industry wastes. Due to the low specific activity of the fission products the selection of the most rational geometry of the irradiator requires special care. Cell irradiators were estimated to be the most advantageous. On testing three kinds (cylindrical, rod-shaped and one with a slot) the last was found by the authors to be the most efficient in practice per unit volume of the plant. The efficiency of such an

irradiator is 31 tons/h at a net activity of $3.72 \times 10^6$ c. The relatively low weight of the installation (including water shielding) makes its transportation from one granary to another an easy matter.

1528 Brownell, L. E., Anderson, L. C., Gomberg, H. J., Kempe, L. L., Martin, J. J., Nehemias, J. V., Wolfe, R. A. UTILIZATION OF THE GROSS FISSION PRODUCTS. PROGRESS REPORT NO. 7. AECU-2981, Engng Res. Inst., Univ. of Michigan, 1954, 249 p.

The use of gross fission products in the preservation of various food stuffs, and the results of tests are described. A γ-dose of 25 000 rep was sufficient to disinfest flour and wheat from insects and this amount of irradiation had no undesirable effects on taste and baking qualities.

1529 Brownell, L. E., Nehemias, J. V., Bulmer, J. J. OPERATION OF THE FISSION PRODUCTS LABORATORY. QUARTERLY PROGRESS REPORT NO. 1 FOR THE PERIOD JAN. 1, 1955 TO MARCH 30, 1955. AECU-3028, Michigan, Univ., Ann Arbor, Engng Res. Inst. 1955, 27 p.

The design of a mashbox to be used for feeding irradiated wet mash to pullets is given. An extensive discussion of flour irradiation is also given, including the effect of radiation on insects as a possible method of controlling insect infestation of flour, the effect of γ-radiation on the baking quality of wheat flours, types of facilities for flour irradiation with special emphasis on the use of cooling reactor-fuel elements as a radiation source, methods of radiation dose measurements, and cost estimates of such an irradiation. (NSA 9: 6507, 1955)

1530 Brownell, L. E., Nehemias, J. V., Bulmer, J. J. PLAN EINER GAMMABESTRAHLUNGSANLAGE ZUR VERHINDERUNG DES INSEKTENBEFALLS VON GETREIDE, MEHL UND FUTTERMITTELN (The design of a gamma irradiation plant for the prevention of infestation by insects of grain, flour and food stuffs). Atompraxis 2 (1956) 225-33. (In German)

After a discussion of the type of insect infestation occurring in cereals, of the known effects of ionizing radiations on insects, and of γ-rays on the baking quality of wheat, the authors describe one kind of γ-radiation plant. Activated fuel elements are used as a source. Doses, capacity and economical considerations are discussed. A routine dose of 25 000 rep is considered, which provides an adequate safety factor since only $10^4$ rep will sterilize the eggs of the confused flour beetle, Tribolium confusum, and the granary weevil, Sitophilus granarius. A bucket conveyor was used to treat 27 tons/h by reactor fuel elements. On the basis of an 8-h shift for 260 d in the year and allowing depreciation over 10 years, the cost of flour irradiation amounts to approximately $0.0373 per sack of 100 lb.

(For an earlier report, in English, see AECU-3050, 23 p, 1955, Univ. Michigan, Ann Arbor, Mich.)

1531 Brownell, L. E., Nehemias, J. V., Purohit, S. N. GAMMA-IRRADIATION FACILITIES DESIGNED TO PROCESS COMMERCIAL QUANTITIES OF FOOD PRODUCTS. p. 367-89 in "Atomic Energy and Agriculture" Publication No. 49, Comar, C. L., ed. Washington, D. C., American Association of Advancement of Science, 1957.

Grain, flour and meal irradiation for the control of insect infestation is discussed in the section dealing with the design of facilities (p. 371-2).

1532 Chamberlain, W. E. AMF (AMERICAN MACHINE AND FOUNDRY CO.) DESIGNS ATOMIC RADIATION UNIT TO KILL INSECTS IN STORED GRAIN. Wall Street Journal, April 5th 1955, 12.

Designs of a semi-mobile facility for treatment of bulk wheat are described. Designers have proposed using $Co^{60}$ to administer relatively low doses of radiation (10 000 to 16 000 r) in order to obtain effective control of Tribolium.

1533 Crean, L. E., Isaacs, P. J., Weiss, G. J., Fahnoe, F. RADIATION STERILIZATION - PART IV. APPLICATION OF ISOTOPIC SOURCES TO FOOD AND DRUG STERILIZATION. Nucleonics 11, 12 (1953) 32-7.

The use of fission-product sources for insect control in grain is described. An example is given of a multiple-unit rod source arranged similar to a vertical tube bundle. Each rod irradiates grain at 0.75 MeV and to a dose of 25 000 rep to a radical distance of 17.5 cm, about 1 mean-free-path in grain. The net volume of grain irradiated/rod = 977 140 $cm^3$; exposure time = 1000 s; weight of irradiated grain/rod = 1660 lb; process rate/rod = 5960 lb/h, giving a utilization efficiency = 14.7%.

1534 Darden, E. B., Jr., Maeyens, E., Bushland, R. C. A GAMMA-RAY SOURCE FOR STERILIZING INSECTS. Nucleonics 12, 10 (1954) 60-2.

A $Co^{60}$-irradiation unit is described which was constructed for the purpose of sterilizing insects, insect larvae, and insect-infested material. Techniques are described for utilizing radiation in large-scale control of the screwworm, and preliminary results are reported. (NSA 8: 6917, 1954)

1535 Duffey, D. FISSION-PRODUCT POTENTIAL OF COMMERCIAL REACTORS AND THEIR PROCESSES. Nucleonics 11, 10 (1953) 8-13.

The exploitation of $\beta$- and $\gamma$-sources represented by various forms of fission-products from reactors is discussed for several purposes, amongst them the insect control in grain. Future trends are considered.

* Murray 1959 - [1538]

1536 Nehemias, J. V., Brownell, L. E., Meinke, W. E., Coleman, E. W. INSTALLATION AND OPERATION OF TEN-KILOCURIE COBALT-60 GAMMA-RADIATION SOURCE. Amer. J. Phys. 22 (1954) 88-92.

Several 1-5 kc source of $\gamma$-radiation are now in use in the United States. Most of these have an irradiation volume similar to the 1 kc source in use at this laboratory. The source recently installed at this laboratory, however, contains 10 kc of $Co^{60}$ and has an inside irradiation volume about 9 inches in diameter and 10 inches long. In addition to this high-flux volume, the entire inside of the cave can be used for lower flux irradiation. With this source, it is possible to produce the relatively large quantities of irradiated materials required for pilot studies of possible biological uses of high-level $\gamma$-radiation and provide the flexibility required for chemical studies. One of the main applications of such a source lies in the irradiation of grain and of other agricultural products. (from auth. summary)

* Peredelsky et al. 1958 - [1517]

* Peredelsky et al. (1957) 1959 - [1518]

## II-B-3 ECONOMICS

* Baker et al. 1954 - [1241], [1243]

1537 Crowley-Milling, M. C. INSECT CONTROL BY RADIATION (Controversy following publication of Hassett's article). Science 125, 3252 (1957) 853.

In the article "Current status of insect control by radiation" [Science 124, (1956) 1011], Charles C. Hassett gives a table of costs per ton for a 50 000-r dose from various sources in which some of the data appear to be misleading. In particular, I think that the figures given for electron accelerators are a little unrepresentative and, in this connection, I would like to call attention to data given by Wolfgang Huber [Western Canner and Packer (Aug. 1956)]. Huber shows that, for a dose of 50 000 r (approximately 0.05 Megarep) at 50% utilization, machines are available that can treat more than 100 tons per hour at a cost of 40¢ per ton or less. I should also like to point out that there appears to be a discrepancy in Hassett's stated cost of the cobalt-60 irradiation unit: "$10 per ton (5¢ per pound)." M. C. CROWLEY-MILLING.

The article by Huber, referred to by M. C. Crowley-Milling, appeared after my article had been written and submitted for clearance; hence, it could not be included in my discussion. The data cited actually reinforced my conclusions: that these machines will soon make large-scale radiation economically feasible. With reference to Crowley-Milling's second point, the manuscript submitted to Science shows the correct values: "$10 per ton (0.5¢ per pound)." This typographic error unfortunately passed both Science's proof reading and mine. CHARLES C. HASSETT.

* Hannan 1953 - [1251]

1538 Murray, G. S. ECONOMICS OF GAMMA RADIATION PROCESSING. Intern. J. appl. Radiation and Isotopes 5 (1959) 211-5.

The estimates of costs are all related to package irradiation equipment. Where possible, the bulk handling of high rates of throughput as, for example, in disinfestation of grain, could lead to substantial reductions in cost. The $\gamma$-rays from $Co^{60}$ and $Cs^{137}$ do not induce radioactivity in any process material.

1539 Siu, R. G. H. FEASIBILITY OF FOOD IRRADIATION. p. 429-35 in "Atomic Energy and Agriculture", Publication No. 49. Comar, C. L., ed. Washington, D. C., American Association for the Advancement of Science, 1957, 450 p.

The requirements for economic feasibility are discussed. An estimate of $0.10 to $1 per ton is given for grain deinfestation.

## II-B-4 DETECTION

1540 Anonymous. I RAGGI X AL SERVIZIO DEL GRANO IMMASAZZINATO (X-rays in the service of stored grain). Molini d'Italia 3, 12 (1952) 540. (In Italian)

The use of x-ray equipment to detect infestation of grain is briefly described. (BA 27: 21771, 1953)

1541 Costa, A. G. NOTA SOBRE O MÉTODO DOS RAIOS X PARA A DETECÇÂO DE ATAQUES OCULTOS DE INSECTOS NOS CEREAIS (Note on the use of x-rays in the detection of insect pests in cereals). Brotéria 27, 3 (1958) 117-20. (In Portuguese)

An x-ray apparatus was used which operates between 10 and 25 kV. When grain is irradiated healthy kernels may easily be distinguished from infested ones since larvae, pupae or adults can be recognized inside them. Radiographs are shown of wheat infested with Calandra oryzae L., Rhizopertha dominica L., and Sitotroga cerealella Oliv.

1542 Dennis, N. M. TECHNIQUE OF GRAIN ORIENTATION FOR RADIOGRAPHIC ANALYSIS. The Northw. Miller 251, 2, Milling Production Section 7a (1954).

A technique is described for loading individual soda straws with wheat kernels via a small vacuum pump or aspirator. 144 8½ in-straws, holding 45 kernels each and a total of 6480, can be radiographed side by side in a grain x-ray machine on a 14×17 in x-ray film.

1543 Goodhue, R. D., Van Emden, H. F. DETECTION OF STEM BORERS IN GRAMINEAE BY X-RAYS. Plant Pathol. 9, 3 (1960) 94.

The x-ray equipment (a Picker-Waite US Army Field Unit), the tube head of which was mounted to give a vertical film-focal spot distance of 28 cm, was used to photograph infested oat plants. To reduce the inherent filtration of the x-ray tube the permanent 0.25 mm aluminium filter was removed. Using Ortho-Royal sheet film the best exposure factor was 28 kV potential and 30 mAS. (BA 35:35443, 1961)

1544 Johnson, R. K. X-RAYS SPUR INFESTATION CONTROL. Food Engng. 24, 9 (1952) 75-7, 168-70.

X-ray examination provides positive identification of hidden insects in grain and more accurate counting of infested kernels than previous methods. (CA 47: 12739d, 1953)

1545 Milner, M., Lee, M. R., Katz, R. APPLICATION OF X-RAY TECHNIQUE TO THE DETECTION OF INTERNAL INSECT INFESTATION OF GRAIN. J. econ. Ent. 43, 6 (1950) 933-5.

Wheat infested with the rice weevil, Sitophilus oryza, was x-rayed daily to provide a sequence of pictures showing the development of the insect. The technique is useful for studies of the physiology, growth characteristics, and feeding habits of stored grain pests, for determination of the effectiveness of insecticides and fumigants, and for the commercial grading of grain for internal infestation. (auth.)

1546 Milner, M., Lee, M. R., Katz, R. RADIOGRAPHY APPLIED TO GRAIN AND SEEDS. Food Technol., Lond. 6, 2 (1952) 44-5.

A radiographic method for the detection of internal insect infestation in grain by means of low energy radiation from a cobalt-target beryllium window x-ray tube is described. The utility of the technique for inspection of wheat, corn, rice and beans is illustrated with cuts made from original radiographs. (BA 26: 11846, 1952)

1547 Milner, M. RECENT DEVELOPMENTS IN METHODS FOR DETECTING INTERNALLY INFESTED WHEAT. Northw. Miller 245, 2 (1951) 1a, 6a-8a, 10a-11a.

Present methods for detecting internally infested wheat generally include the following: the acid fuchsin or iodine stain test, rendering the wheat translucent by boiling in caustic soda, the cracking-flotation test, mass wheat sectioning and examination under ultraviolet light, and the berberine sulfate stain test. All of these, however, have some disadvantages in that no single one gives a rapid and accurate picture of the condition of the wheat with a simple procedure. A recent development is the application of x-ray. X-ray photographs of infested wheat indicate the presence of insects at various stages of development, including even eggs. Also, when the infestation is present in the form of larvae, it is possible to determine if they are dead or alive. This new technique appears to offer possibilities as a rapid test for grading grain on the basis of internal infestation. (BA 25: 23195, 1951)

1548 Milner, M., Katz, R., Lee, M.R., Pyle, W.B. APPLICATION OF THE POLAROID-LAND PROCESS TO RADIOGRAPHIC INSPECTION OF WHEAT. Cereal Chem. 30, 2 (1953) 169-70.

The Polaroid-Land process has been adapted to x-ray inspection of wheat for internal insect infestation. A completed radiograph is obtained in a few minutes without a darkroom or routine photographic processing techniques. (BA 27: 27098, 1953)

1549 Monte, G. D. GRAIN INFESTATIONS AS SHOWN BY X-RAYS. Molini d'Italia 9 (1958) 422-3. (In Italian)

1550 Nicholson, J. F., Milner, M., Munday, W. H., Kurtz, O. L., Harris, K. L. AN EVALUATION OF FIVE PROCEDURES FOR THE DETERMINATION OF INTERNAL INSECT INFESTATION OF WHEAT. V. THE USE OF X-RAYS. J. Ass. off. agric. Chem. 36, 1 (1953) 146-50.

The examination for total insect damage is time consuming (1 - 1.5 h for 100 g of wheat) because suspected kernals must be dissected. Dehydrated insects are not visible. Examination limited to the more extensively (grossly) damaged kernels required 5 - 10 min. The correlation coefficient for grossly damaged kernels compared to the cracking-flotation test was 0.88. In all 173 samples the total x-ray results were 1.5 times that of the cracking-flotation test. (BA 27: 20735, 1953)

1551 Nicholson, J. F., Kurtz, O. L., Harris, K. L. AN EVALUATION OF FIVE PROCEDURES FOR THE DETERMINATION OF INTERNAL INSECT INFESTATION OF WHEAT. VI. INVESTIGATIONS ON THE X-RAY INSPECTION OF WHEAT. J. Ass. off. agric. Chem. 36, 1 (1953) 156-9.

Results confirmed that x-ray procedure can be used to measure internal insect infestation of wheat. Various energy levels, and the use of filters were investigated to produce proper degrees of contrast on X-ray film. A satisfactory radiograph of low contrast but with excellent detail can be obtained from an x-ray head with a glass tube, oil bath, and plastic exit port between target and film at 18 kV and 10 mA. Results with other filters and target tubes are discussed. (BA 27: 20737, 1953)

1552 Nicholson, J. F., Kurtz, O. L., Harris, K. L. X-RAY EXAMINATION FOR THE DETECTION OF INTERNAL INSECT INFESTATION IN CORN. J. Ass. off. agric. Chem. 36 (1953) 993-1001.

Internal insect damage as shown by characteristic radiographic shadows can be differentiated for the most part from the characteristic shadows of normal corn structures and the abnormalities of the corn kernel. The gross insect damage visible on the radiograph correlates well with the cracking-flotation results. As compared with previous methods of determining internal insect damage, the x-ray method (a grain inspection x-ray unit, Westinghouse model 475, was used and technical details are given) is the most rapid for an accurate evaluation of internal insect damage.

1553 Pedersen, J. R., Brown, R. A. X-RAY MICROSCOPE TO STUDY BEHAVIOR OF INTERNAL-INFESTING GRAIN INSECTS. J. econ. Ent. 53 (1960) 678-9.

X-ray inspection is widely used by commercial cereal grain handlers for mass detection and estimation of infestations. Radiographs made with the x-ray microscope show greater detail and sharpness, and permit the study of individual insects inside the infested grains. It would appear that much more comprehensive studies of the behaviour, development and responses to environmental conditions are thus possible; x-ray photos are shown of wheat kernels infested with rice weevil. The x-ray microscope used in the study is a General Electric model, with a point source for shadow projection, and electrostatic beam-focusing. A

narrow cone of electrons emerges from the electron gun, enters a condenser lens and is collimated. The collimated beam enters an objective lens which reproduces a reduced image of the electron source at the principal focus of the lens. This reduced electron source produces an equally small x-ray source on the target, a thin tungsten-coated beryllium window. The image is then projected onto a viewing screen or film. Magnifications up to 400 × can be obtained; the instrument operates up to 20 kV at 100 μA.

1554 Shellenberger, J. A., Farrell, E. P., Milner, M., Lloyd, N., Dahm, P. A., Hein, R. E., McFarland, R. H. AN INVESTIGATION OF INSECT FRAGMENT PRODUCTION IN MILLING USING RADIOACTIVE RICE WEEVILS. Northw. Miller 250, 23 (1953) 10a - 3a.

Methods used for determining insect contamination in wheat flour depend upon the identification and counting of insect fragments. There is uncertainty regarding the relationship between the extent of insect contamination by fragment count and the mass of contamination present. This was investigated by milling wheat containing $P^{32}$-labelled adults of the rice weevil, Sitophilus oryza. There does not appear to be a high correlation between the number of insect fragments in the flour and the mass of contamination deduced from the level of radioactivity measured.

1554 Zunick, M. J., Pace, A. X-RAYS SHOW MORE THAN INSECTS. Food Engng 26, 5 (1954) 64-5, 139-40.

General Electric Co. developed a special unit for grain inspection. It has a self-contained, shockproof x-ray generator that is operated from a standard 110-V, 60c output. It is rated at 10-25 kV peak and 5 mA. Controls, sample holder, and film cassette are located at the top of the cabinet (35 in from the floor). A thin beryllium window is used, of sufficiently large diameter to allow a standard 14×17 in x-ray film to be practically covered, thus permitting radiography of a large number of samples with each exposure. Mylar, a low-density plastic, is used for the front of the film cassette and for the sample tray. An industrial, fine-grained film is recommended. Kernels of grain may thus be checked for infestation. The method may be extended to other kernels and seeds.

## II - C Sericulture

* Arifov et al. 1957 - [1238]

1555 Arifov, U. A., Artmeladze, I. D., Baranov, V. A., Chkheidze, T. N., Gumansky, G. A., Klein, G. A., Pashinsky, S. Z., Shchenkov, S. N., Tkhelidze, L. M., Tsetskhaldze, T. V. THE USE OF RADIATION TO KILL SILKWORM COCOONS. 2nd UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 15/P/2321. 27 (1958) 444-50.

The lethal dose of radiation from a $Co^{60}$ source for silkworm pupae of different species and ages was determined. Smaller doses, not sufficient to cause wholesale destruction of pupae, affect the shape and viability of the moths. The sericin solubility, swelling properties and recovery factor of cocoons treated by gamma rays are better than those of heat-treated cocoons. The colloidal properties are also changed; in particular, the liophilic and adhesive properties are increased, which in turn give the raw silk better knitting properties. The killing of cocoons by γ-rays has a promising industrial future. The fact that it will probably be feasible under industrial conditions to cut out the costly process of drying the cocoons is of special importance. The effects of irradiation on raw silk, as measured by the dynamometer properties of the fibre and viscosity in solution are discussed.

* Bergold 1954 - [314]

1556 Hirobe, T., Oi, H. STUDIES ON SILKWORM BREEDING USING γ-RAYS ($Co^{60}$). I. Jap. J. Breeding 8 (1958) 200-1. (In Japanese)

* Kipiani and Tsetskhladze 1956 - [1255]

* Nako 1958 - [1213]

1557 Strunnikov, V. A., Gulamova, L. M. DEVELOPING A MULBERRY SILKWORM LINE BY USING RADIATION METHODS IN BREEDING. Vest. Sel'skokhoz nauk. 2, 8 (1957) 143-7. (Russian, summary in English)

1558 Strunnikov, V. A., Gulamova, L. M. AN EXPERIMENT ON BREEDING SEX-LABELED RACES OF THE MULBERRY SILK MOTH BY USING X-RAYS. p. 207-11 in "Application of Radioactive Isotopes in the Food and Fishing Industries and in Agriculture. A portion of the Proceedings of the All-Union Scientific and Technical Conference on the Application of Radioactive Isotopes. Moscow 1957". New York, Consultants Bureau, Inc. 1959.

Since males produce 20-30% more silk than females, successful breeding of sex-labelled races would lead to a 10-15% increase in silk content of live cocoons when only males are cultivated. A greatly increased yield from the rearing houses would further result from the inherently greater (10-15%) viability of the male compared with the female. An industrial increase of approximately 20-25% may thus be envisaged. Experimental work is described in which female pupae of the bivoltine breed SANIISh (Central Asian Sericulture Research Institute) No. 111 (characterized by dark grain) were irradiated with x-rays (2000, 2500, 3000, 3500 and 4000 r) at 90 r/min. The moths were then paired with non-irradiated females of breeds with white grain. The hybrids (dark grain) were again paired with normal males. Ultimately, females developed from dark and males from white grain. The viability appears satisfactory, so far. Work continues.

(For detailed abstract see The experimental cultivation of silkworm lines marked according to sex using röntgen rays. p. 6-7 in "Abstracts of papers given at the All-Union Conference on the Application of Radioactive and Stable Isotopes and Radiation in the National Economy and Science. Session: Biology, Medicine and Agriculture. Moscow 2-5 Apr. 1957". AEC-tr-2925 (III). New York, Consultants Bureau, Inc. 1957)

* Tazima 1954 - [961]

1559 Tsetskhladze, T. V., Baranov, V. A., Chikovani, V. E., Chkheidze, T. N., Tkhelidze, L. M. KILLING AND PRESERVATION OF MULBERRY SILK MOTH PUPAE BY GAMMA-RADIATION. p. 213-5 in "Application of Radioactive Isotopes in the Food and Fishing Industries and in Agriculture. A portion of the Proceedings of the All-Union Scientific and Technical Conference on the Application of Radioactive Isotopes. Moscow 1957". New York, Consultants Bureau, Inc. 1959.

1. The technique of preliminary treatment of cocoons is of fundamental importance for the quality of silk thread. The methods now applied of killing of the chrysalis and drying of the cocoons are labour-consuming and to a certain extent deform the membrane of the cocoons, produce a denatured sericin, impair unravelling capacity, reduce the dynamometric properties of the cocoon thread and the yield of raw silk. 2. Investigation of killing the mulberry silkworm chrysalis by γ-radiation showed it to be a promising process. 3. The average lethal dose for the spring fattened chrysalis was 200 000 rep, for the summer one 150 000 rep, and for the autumn one 100 000 rep. In a chrysalis receiving 30-40% of the lethal dose within the first days of radiation and later doses of 1000 rep the stage of metamorphosis was protracted for 10-12 d. 4. The value of the lethal dose depends on the age of the chrysalis; for a one d old chrysalis, 10 to 12 000 rep; for 5 d old ones, 50 000 rep; and from the eighth day, 100-200 000 rep. 5. Tagging of the irradiated parts showed that the dynamometric properties of the silk thread are improved as compared with box-dried cocoons. The raw silk yield was considerably increased. The irradiated cocoons were well preserved under usual storage conditions.

(For detailed abstract see "Killing and preservation of the mulberry silkworm cocoons by γ-radiation." p. 135 in "Abstracts of papers given at the All-Union Conference on the Application of Radioactive and Stable Isotopes and Radiation in the National Economy and Science. Session: Biology, Medicine and Agriculture. Moscow 2-5 Apr. 1957", AEC-tr-2925 (III). New York, Consultants Bureau, Inc. 1957)

## II-D Miscellaneous Applications

### II-D-1 TIMBER PROTECTION

* Fisher 1958 - [1126]

1560 Holling, C. S. A RADIOGRAPHIC TECHNIQUE TO IDENTIFY HEALTHY, PARASITIZED AND DISEASED SAWFLY PREPUPAE WITHIN COCOONS. Canad. Ent. 90, 1 (1958) 59-61.

In the course of work in Canada on the reactions of small mammal predators to sawfly cocoons containing healthy, parasitized or diseased prepupae, a radiographic method enabling the cocoons to be classified without being opened was found useful and is described. The radiographs permitted the detection within cocoons of Neodiprion sertifer (Geoff.), of Dahlbominus fuscipennis (Zett.), larvae or pupae of Exenterus

candensis Prov., sawfly prepupae attacked by fungus, and healthy prepupae, and 200 cocoons (subsequently dissected) were correctly classified from them. The technique was also used successfully with cocoons of N. lecontei (Fitch), N. pratti banksianae Rohw., and N. swainei (Middleton).

* Kloft and Ehrhardt 1959 - [26]

1561 Paton, J. M., Hearmon, R. F. S. EFFECT OF EXPOSURE TO GAMMA-RAYS ON THE HYGROSCOPICITY OF SITKA SPRUCE WOOD. Nature 180, 4587 (1957) 651.

In view of the possibility of controlling insect attack in wood by irradiation, the possible effects of radiation on the wood itself are of great importance. A graph is shown where equilibrium moisture content is plotted against relative humidity in an adsorption cycle for control and for irradiated Sitka spruce. It appears that the hygroscopic (and possibly other physical properties) of wood are only affected by very heavy doses of radiation. The effect is negligible below $10^7$ rad. Thus, any doses used for controlling wood-boring insects in practice are unlikely to have any significant physical effect on the wood itself.

1562 Sandermann, W., Casten, R. STUDIEN AUF DEM GEBIETE DER HOLZSCHUTZCHEMIE. 6. MITTEILUNG: UNTERSUCHUNGEN ÜBER DIE VERWERTBARKEIT RADIOAKTIVER ABFALLSTOFFE VON ATOMKRAFTWERKEN ALS HOLZSCHUTZMITTEL (Studies in the chemistry of wood protection. Sixth report: Investigating the exploitability of radioactive waste products from nuclear power plants for purposes of wood protection). Holz als Roh- u. Werkst. 14, 1 (1956) 11-14. (In German)

$Zr^{95}$ and $Ce^{144}$ have too short a half-life, whereas $Cs^{137}$ has a sufficiently long half-life but does not form salts which prove difficult to dissolve. $Sr^{90}$ was used because it has an acceptable half-life and forms barely-soluble sulphate. Only paper impregnated with $Sr^{90}$-nitrate solution of 1 mc/cm$^3$ proved termite-resistant. The insects were dead within 14 d and found to have stored a considerable portion of the radioactivity. If protection should last 65 years then impregnation would have to start with an activity of 8 mc/cm$^3$, i. e. 8 times the acceptable limit, thus greatly endangering man and warm-blooded animals, particularly in view of the fact that $Sr^{90}$ is stored in the bone.

## II-D-2 VARIOUS

1563 Hills, P. R., Roberts, R., Spindler, M. W. A COMPARISON OF THE PRODUCTION OF THE INSECTICIDE "GAMMEXANE" (1:2:3:4:5:6-HEXACHLOROCYCLOHEXANE) BY ULTRA-VIOLET AND $Co^{60}$ GAMMA RADIATION. p. 61 in "Large Radiation Sources in Industry. Conference Proceedings, Warsaw 8 - 12 Sep. 1959", Vol. 2. Vienna, International Atomic Energy Agency, 1960.

A comparative study has been made of the synthesis of the γ-isomer of 1:2:3:4:5:6-hexachlorocyclohexane "Gammexane", both by ultraviolet and $Co^{60}$ γ-radiation. Experiments with light of wave length 3650 A, employing a variety of experimental conditions, have established an optimum quantum yield of $8.67 \times 10^3$ for the production of the hexachloro compound which contains 13.2 ± 1.3% of the γ-isomer. The introduction of additives did not improve either the γ or γ-isomer yield. For radiation initiated experiments the "Gammexane" content is 15.3 ± 1.6% and is independent of dose rate, benzene concentration and duration of the chlorination process. Reaction at low temperatures effects small improvements in the γ-isomer yield. A comparison of both methods of initiation shows that the absorbed energy is utilized with equal efficiency in each case.

1564 Katznelson, H., Jamieson, C. A., Lawton, E. J., Bellamy, W. D. STUDIES ON THE TREATMENT OF CONTAMINATED COMBS AND HONEY WITH HIGH VELOCITY ELECTRONS. Canad. J. Res., C- Canad. J. Technol. 30 (1952) 95-103.

1565 Studier, H., Studier, R. THE STERILIZATION OF AMERICAN FOULBROOD BY IRRADIATION WITH GAMMA RAYS. Amer. Bee J. 98 (1958) 192.

# ADDENDUM

# NEMATODES

## A Radioisotope Studies

1566 Dropkin, V. H., King, R. C. PLANT PARASITIC NEMATODES HOMOGENEOUSLY LABELED WITH RADIOPHOSPHORUS. Expt. Parasitol. 5, 5 (1956) 469-80.

A quantitative study has been made of the volume and P content of root-knot and golden nematodes (Meloidogyne incognito acrita and Heterodera rostochiensis) during different stages of their life cycles. Galled tissues of plants infested with root-knot nematodes have accumulated $P^{32}$ from labelled nutrient at a lower rate than uninfected roots of the same plant. Infection in one part of a root system, therefore, does not impair the ability of uninfected roots of the same plant to take up P. The P content of the nematode population of an infected tomato plant makes up no more than 10% of the total P of the plant. It follows that the unhealthy condition of the plant is not caused by the parasite "robbing" the host of this vital element. Less P is translocated out of gall roots than out of ungalled roots.

1567 Hunter, A. H. NUTRIENT ABSORPTION AND TRANSLOCATION OF PHOSPHORUS AS INFLUENCED BY THE ROOT KNOT NEMATODE (MELOIDOGYNE INCOGNITO ACRITA). Soil Sci. 86 (1958) 245-50.

Greenhouse experiments with tomato plants grown in nutrient solution indicated that the observed detrimental effects of the root-knot nematode on growth cannot be attributed to an interference with the absorption or translocation of N, K, Ca, Mg, Fe, Cu or P. Although the rate of P absorption as indicated by use of $P^{32}$ was reduced in the infected plants, the total percentage of P content of infected plants was higher than in normal plants. (CA 53: 17405a, 1959)

1568 Oteifa, B. A., Barrada, Y., El Gindi, D. M. AN APPROACH FOR USING LABELLED RADIOACTIVE PHOSPHORUS IN PHYSIO-PATHOLOGICAL STUDIES OF PLANT NEMATODE DISEASES. 2nd UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 15/P/1494. 27 (1958) 48-50.

$P^{32}$-labelled ($KH_2P^{32}O_4$) nutrient solution was used to study the effects of the root-knot nematode, Meloidogyne javanica (Chitwood) on the physio-pathological status of tomato plants, Lycopersicum esculentum Mill. The phosphorus content and the physiological route of the element through host tissue were affected. The root parasitic nematodes incite gall formation. An infection in the early stages of plant growth makes the host utilize its energy in the production of new lateral rootlets, i. e. meristematic tissue capable of absorbing more nutrient. The new rootlets then become infected with the newly hatched larvae. Extensive gall formation subsequently causes a reduction in the root absorptive surface. The presence and activity of the parasite in the root interfere with the translocation of nutrient. Phosphorus uptake by the nematode is, however, only 10%. Reasons for the interference are discussed.

## B Ionizing Radiation Studies

1569 Anonymous. RADIATION OUT AS NEMATOCIDE. J. agric. Food Chem. 6, 8 (1958) 567.

USDA scientists are disappointed to find that nematodes can withstand large doses of radiation. It takes 120 000 r to kill the golden nematode, up to 20 000 r to sterilize the female. Some other nematodes require 350 000 to 640 000 r before giving up the ghost. (Humans will invariably die from a 650-r dose.) Plants cannot withstand the dosage necessary to kill nematodes, so there is no prospect that radiation can be used for killing nematodes on living plants. (from Research Newsletter)

1570 Fassuliotis, G. EFFECTS OF IONIZING RADIATIONS ON THE GOLDEN NEMATODE, HETERODERA ROSTOCHIENSIS. Radiation Res. 9 (1958) 112-3.

The golden nematode, H. rostochiensis, is a parasite of potatoes and tomatoes. The resistant stage of the nematode, the cyst, containing several hundred embryonated eggs, was irradiated with x-rays from a G. E.

Maxitron 250 delivering a dose rate of 1000 r/min and with γ-rays from a $Co^{60}$ source emitting 670 000 r/h at the Brookhaven National Laboratory, Upton, New York. The doses were 5, 10, 20, 40, 80, 160, 320, 640 and 1280 kr. Hatching tests from cysts exposed to both types of radiations revealed a disturbance in the response of the larvae, after a dose of 160 kr and above. A delay in the onset of hatching and a reduction in the total number of larvae emerging from the cysts resulted. No larvae hatched after 640 kr; they were found to be in a moribund condition one week after irradiation. Injury resulting in abnormal body movements became apparent after 80 kr. Eighty-four per cent of the females developing from larvae irradiated with 20 kr were sterilized, 98% after 40 kr, and 100% after 80 kr. However, no larvae hatched from the 20 and 40 kr-females. Viability was not altered in developing females following postirradiation storage of irradiated cysts for 6 months at 40°F. Chromosome aberrations in the form of fragments and bridges at anaphase were found in maturing eggs recovered from females which developed from irradiated larvae.

(Abstract of paper presented at the Intern. Congr. of Radiation Res., Burlington, Vermont, 10-16 Aug. 1958)

1571 Fassuliotis, G. OBSERVATIONS ON THE BIOLOGICAL EFFECTS OF IONIZING RADIATIONS ON THE LIFE CYCLE OF HETERODERA ROSTOCHIENSIS WOLLENWEBER, 1923. Ph. D. Thesis, New York Univ. 1958.

1572 Fassuliotis, G., Sparrow, A. H. PRELIMINARY REPORT OF X-RAY STUDIES ON THE GOLDEN NEMATODE. Plant Dis. Reptr. 39, 7 (1955) 572.

Data were obtained which indicate that the life cycle of Heterodera rostochiensis is interrupted by x-rays at dosages of 20 000 r and above. The lowest dose found to inhibit the development of embryonated eggs is the same as the dose found to inhibit completely the sprouting of potatoes. Although the nematode data were obtained from free cysts, the results indicate that irradiation of tubers infected with the golden nematode will not only inhibit sprouting, but will probably also interrupt the life cycle of the parasite, thus eliminating one of the possible routes of spread of the golden nematode.

1573 Myers, R. F., Dropkin, V. H. EFFECTS OF X-RAYS AND γ-IRRADIATION ON SOIL AND PLANT-PARASITIC NEMATODES. Radiation Res. 9 (1958) 158.

Ten genera of plant parasitic and three genera of free-living nematodes were exposed to graded doses of radiation. Pot experiments showed that some genera required up to 160 000 rep for complete sterilization, whereas other genera were sterilized at doses between 20 000 and 40 000 rep. Dosages necessary to kill 50% of Panagrellus silusiae adults in culture within 24 h were between 400 000 and 500 000 rep. Similar dosages killed Tylenchorhynchus claytoni in pot experiments. A marked reduction in population size of cultures and pot experiments was noted at dosages well below the sterilizing dose. A high percentage of embryos of Panagrellus were killed at 5000 r. The ability of nematodes to survive large doses of irradiation is probably correlated with the cell constancy in these forms. The dosage necessary to sterilize plant parasitic nematodes is too high to make radiation a feasible tool for soil sterilization or for treatment of living plants.

(Abstract of paper presented at the Intern. Congr. of Radiation Res., Burlington, Vermont, 10-16 Aug. 1958)

1574 Myers, R. F., Dropkin, V. H. IMPRACTICABILITY OF CONTROL OF PLANT PARASITIC NEMATODES WITH IONIZING RADIATIONS. Plant Dis. Reptr. 43, 3 (1959) 311-3.

Irradiation of 11 species of plant parasitic nematodes indicates that the dose required for complete sterilization is variable; reproduction being completely stopped with doses of 40 000 r in only one species. For six other species, doses above 160 000 r were required to stop reproduction. However, a large reduction in the reproduction of most species can be achieved with a dose of 80 000 r. The irradiation of nematodes in field soil with a $Co^{60}$ source is not practical because of the length of time required to irradiate even small areas. Since damage to plant roots occurs at levels of irradiation below those required to disrupt the nematode's life cycle, control of plant parasitic nematodes in and on plant roots by ionizing radiations is not feasible. (auth.)

1575 Myers, R. F. THE SENSITIVITY OF SOME PLANT-PARASITIC AND FREE-LIVING NEMATODES TO GAMMA AND X-IRRADIATION. Nematologica 5 (1960) 56-63.

The sterilizing effect of ionizing rays was examined on 14 free-living and plant-parasitic nematodes. Reductions in population could be obtained with considerably lower doses than those required for complete sterilization. The embryonic stage is the most sensitive stage in the developmental cycle of Panagrellus silusiae. Larvae and adults support much higher doses. Cell division took place up to 320 000 r provided

the gonads were already formed. In Tylenchorhynchus claytoni cells matured up to 500 000 r as judged from an increase in length, and the formation of vulva and spicula. Body changes due to radiation could take the form of an increase or decrease in body length. These opposite effects were due to damage which prevented uptake of nourishment, or to sterilization without accompanying effect on food intake. Morphological changes occurred in both cases, and include cuticular and internal damage.

1576 Weischer, B. DIE WIRKUNG IONISIERENDER STRAHLEN AUF DIE ENTWICKLUNG VON HETERODERA ROSTOCHIENSIS UND H. SCHACHTII (The effects of ionizing rays on the development of Heterodera rostochiensis and H. schachtii). Nematologica 2 (1957) 300-5. (In German)

Cysts of the golden and the turnip nematode were subjected to radiation from a radium source. The dose was of the order of 400 r/h. Only after 72 h irradiation could any effect be observed. The duration of treatment was extended to 196 h for the experiments. Hatching of larvae was speeded up in the case of the golden nematode, and slowed down for the turnip nematode. The former is, however, interpreted as a pathological stimulus which significantly reduced vitality. This may be seen in experiments on infectivity extended over two generations.

1577 Wood, F. C., Goodey, J. B. EFFECTS OF GAMMA RAY IRRADIATION ON NEMATODES INFESTING CULTIVATED MUSHROOM BEDS. Nature 180 (1957) 760-1)

Nematodes in a compost from infested mushroom beds were identified as Ditylenchus destructor and Saprobes, mostly Rhabditis spp. Duplicated 200 g samples were subjected to doses of 6000, 12 000, 24 000, 48 000 and 96 000 rep of $\gamma$-radiation from a $Co^{60}$-source. The inactivation dose for these nematodes appears to lie between 48 000 and 96 000 rep, more than twice as great as the 10 000 - 20 000 r found to inactivate cysts of potato-root nematode (Heterodera rostochiensis) (see Fassuliotis and Sparrow, Plant Disease Reporter 39 (1956) 572).

# APPENDIX

TABLE Ia

## DISPERSAL OF RADIOISOTOPE-MARKED FOREST INSECTS

| Insect | Isotope | No. released | Recovery and longevity | Maximum dispersal (km) | Authority |
|---|---|---|---|---|---|
| White Pine Weevil | | | | | |
| Pissodes strobi | $Co^{60}$ | 64 | 33% in 60 d | -- | [101] |
| " " | $Sc^{46}$ | 1600 | 60 - 70% up to 8.5 months | 0.22 | [99] |
| Douglas Fir Beetle | | | | | |
| Dendroctonus pseudotsugae | $P^{32}$ | -- | -- | -- | [260] |
| Southern Pine Beetle | | | | | |
| Dendroctonus frontalis | $Ir^{192}$ | 20 000 | -- | -- | [371] |
| Engelmann Spruce Beetle | $P^{32}$ | 19 000 | 5% up to 14 d | -- | [354] |
| Dendroctonus engelmanni | $I^{131}$ | | | | |
| " " | -- | -- | -- | 4.8 | [98] |
| European Pine Shoot Moth | | | | | |
| Rhyacionia buliana | $Co^{60}$ | 104 | 42.9 | 0.046 | [123] |
| White grubs | $Ta^{182}$ | Movement in soil | | -- | [371] |

Jenkins, D.W. Table II in "Radioisotopes in ecological and biological studies of agricultural insects." p. 3 - 21 in "Radioisotopes and Radiation in Entomology. Proceedings of a Symposium, Bombay 5 - 9 December 1960". Vienna, IAEA. 1962, 307.

TABLE Ib

# DISPERSAL OF RADIOACTIVE-MARKED ORCHARD INSECTS

| Insect | Isotope | No. released | Longevity | Maximum dispersal (km) | Authority |
|---|---|---|---|---|---|
| Plum curculio *Conotrachelus nenuphar* | $P^{32}$ | 62 | up to 120 d | 0.11 | [369] [370] |
| " " | $Co^{60}$ | 705 | up to 8.5 months | 0.27 | " " |
| " " | $Zn^{65}$ | 23 | up to 120 d | 0.041 | " " |
| " " | $Sr^{89}$ | 175 | 3 d | 0.123 | " " |
| " " | $I^{131}$ | 86 | -- | 0 | " " |
| Oriental Fruit Fly *Dacus dorsalis* | $P^{32}$ | -- | up to 40 d | -- | [95] |
| Fruit Fly *Drosophila melanogaster* | $P^{32}$ | 20 000 | -- | 3.84 | [97] |
| Mediterranean Fruit Fly *Ceratitis capitata* | $P^{32}$ | 944 | -- | 32.0 | [92] |
| Cherry Fruit Fly *Rhagoletis cingulata* | $P^{32}$ | 2010 | up to 42 d | 0.287 | [93] |
| Walnut Husk Fly *Rhagoletis completa* | $P^{32}$ | 15% of natural population | -- | 14.4 | [91] |

Jenkins, D.W. Table III in "Radioisotopes in ecological and biological studies of agricultural insects." p. 3 - 21 in "Radioisotopes and Radiation in Entomology. Proceedings of a Symposium, Bombay 5 - 9 December 1960". Vienna, IAEA. 1962, 307.

TABLE Ic

# DISPERSAL AND FLIGHT RANGE OF RADIOACTIVE-MARKED MOSQUITOES

| Species | Locality | No. mosquitoes released × 1000 | % Recovery | Maximum flight range (km) | Reference |
|---|---|---|---|---|---|
| Aedes communis | Churchill | 3000 | 0.005 | 1.6 | JENKINS and HASSETT [110] |
| Aedes flavescens | Saskatchewan | — | — | 0.16 | SHEMANCHUK et al. [348] |
| " " | Saskatchewan | 415 | 0.02 | 10.5 | Ibid. [115] |
| Aedes nigromaculis | California | 400 | 0.12 | 3.0 | THURMAN and HUSBANDS [118] |
| Aedes spencerii | Saskatchewan | — | — | 0.023 | SHEMANCHUK et al. [348] |
| Aedes taeniorhynchus | Florida | 1000 | 0.03 | 32.0 | PROVOST [111] |
| " " | Florida | 1560 | 0.12 | 40.0 | Ibid. [112] |
| " " | Georgia | 2000 | 0.023 | 32.6 | BIDLINGMAYER and SCHOOF [108] |
| Anopheles bellator | Brazil | 3 | — | 0.8 | ARAGÃO et al. [343] [107] [344] |
| Anopheles gambiae | Tanganyika | 60 | 0.5 | 3.8 | GILLIES [771] |
| Culex tarsalis | California | 10 | — | 1.6 | THURMAN and HUSBANDS [118] |
| Psorophora confinnis and P. discolor | Arkansas | 50<br>— | 0.09<br>— | 9.6<br>2.4 | QUARTERMAN et al. [114] |

Jenkins, D.W. Table VI in "Radioisotopes in entomological studies of endemic and tropical diseases." p. 233-66 in "Radioisotopes in Tropical Medicine. Proceedings of a Symposium, Bangkok, 12 - 16 December 1960". STI/PUB/31, Vinna, IAEA. 1962, 379p.

TABLE Id

# DISPERSAL AND FLIGHT RANGE OF RADIOACTIVE-MARKED FLIES

| Locality | Habitat | No. flies released × 1000 | % Recovery | Maximum flight range (km) | Reference |
|---|---|---|---|---|---|
| Housefly Musca domestica | | | | | |
| Oregon | Rural | 36 | 4.6 | 19.2 | LINDQUIST et al. [74] |
| Oregon | Rural | 54 | 2.78 | 32.0 | YATES et al. [90] |
| Arizona | City | 31 | 0.73 | 4.8 | SCHOOF et al. [80] |
| Arizona | City | 56 | 0.51 | 8.0 | SCHOOF et al. [80] |
| Arizona | City | 342 | 1.8 | 14.4 | SCHOOF and SIVERLY [82] |
| Georgia | Rural | 13.5 | 8.0 | 13.1 | QUARTERMAN et al. [78] |
| Georgia | City | 40 | 0.24 | 12.2 | QUARTERMAN et al. [79] |
| Blowfly Phormia regina | | | | | |
| Oregon | Rural | 1.2 | 14.0 | 12.8 | LINDQUIST et al. [74] |
| Oregon | Rural | 60 | 2.64 | 44.8 | YATES et al. [90] |
| West Virginia | City | 16 | 0.06 | 16.5 | SCHOOF and MAIL [81] |
| Georgia | City | -- | -- | 6.4 | QUARTERMAN et al. [79] |

Jenkins, D.W. Table VII in "Radioisotopes in entomological studies of endemic and tropical diseases." p. 233-66 in "Radioisotopes in Tropical Medicine. Proceedings of a Symposium, Bangkok, 12 - 16 December 1960". STI/PUB/31, Vienna, IAEA. 1962, 379p.

TABLE II

## RADIATION STERILIZATION OF MEDICALLY-IMPORTANT INSECTS

| Dosage (r) | Stage irrad. | % Sterility and egg laying | Insect | Reference |
|---|---|---|---|---|
| 2500 | male pupae | 100%; few sterile eggs laid | Callitroga hominivorax | BUSHLAND and HOPKINS [1111] |
| 5000 | female pupae | 100%; few sterile eggs laid | Ibid. | BUSHLAND and HOPKINS [1111] |
| 8050 | adults | few fertile eggs | Drosophila | HASSETT and JENKINS [1252] |
| 16100 | adults | 100%; no eggs | Ibid. | HASSETT and JENKINS [1252] |
| 3200 | pupae | few eggs | Anopheles quadri-maculatus | DAVIS et al. [1116] |
| 6400 | pupae | 50% reduction of sterile eggs | Ibid. | DAVIS et al. [1116] |
| 12900 | pupae | no decrease in fertile eggs | Ibid. | DAVIS et al. [1116] |
| 8865 | pupae | 2% eggs hatched | Ibid. | DAVIS et al. [1116] |
| 5000 | adults | 66% decrease in eggs, 89% hatch | Ibid. | DAVIS et al. [1116] |
| 8865 | adults | 100% sterile, few eggs, no hatch | Ibid. | DAVIS et al. [1116] |
| 10000 | nymph | 9 - 82% eggs hatched | Pediculus humanus | COLE et al. [888] |
| 10000 | adult | 100%, no hatch | Ibid. | COLE et al. [888] |

Jenkins, D.W. Table III in "Radioisotopes in entomological studies of endemic and tropical diseases." p. 233 - 66 in "Radioisotopes in Tropical Medicine. Proceedings of a Symposium, Bangkok, 12 - 16 December 1960". STI/PUB/31, Vienna, IAEA. 1962, 379 p.

TABLE III

## MORTALITY OF IRRADIATED INSECTS OF MEDICAL INTEREST

| Insect | Radiation | Dosage (r) | Mortality (%) | Time (days) | Reference |
|---|---|---|---|---|---|
| Aedes aegypti (adult) | x | 20 000 | 50 | 18 | TERZIAN [1333] |
| Ibid. | x | 30 000 | 50 | 12 | Ibid. |
| Ibid. | x | 40 000 | 50 | 9 | Ibid. |
| Ibid. | x | 20 000 | 100 | 30 | Ibid. |
| Ibid. | x | 30 000 | 100 | 21 | Ibid. |
| Ibid. | x | 40 000 | 100 | 12 | Ibid. |
| Drosophila adult (fasted) | B | 60 000 | 100 | 1 | KING and WILSON [1319] |
| Ibid. (fed) | B | 60 000 | 60 | 14 | Ibid. |
| Ibid. | γ | 64 000 | 100 | 21 | HASSETT and JENKINS [1252] |
| Ibid. | γ | 193 000 | 100 | 2 | Ibid. |
| Blattella germanica (60 days) | γ | 72 000 | 14 | -- | Ibid. |
| Musca domestica egg | γ | 130 | 50 | 1 | COLE et al. [888] |
| Ibid. larva | γ | 1 300 | 50 | 1 | Ibid. |
| Ibid. pupae | γ | 15 000 | 50 | 1 | Ibid. |
| Ibid. male | γ | 72 000 | 50 | 1 | Ibid. |
| Ibid. female | γ | 110 000 | 50 | 1 | Ibid. |
| Pediculus h. humanus egg | γ | 24 000 | 50 | 1± | Ibid. |
| Ibid. nymph ♂/♀ | γ | 170 000 | 50 | 1± | Ibid. |
| Blattella germanica nymph ♂/♀ | γ | 76 000 | 50 | 2 | Ibid. |
| Periplaneta americana nymph | γ | 28 000 | 50 | 1 | Ibid. |
| Ibid. adult | γ | 50 000 | 50 | 1 | Ibid. |

Jenkins, D.W. from Table IV in "Radioisotopes in entomological studies of endemic and tropical diseases." p. 233 - 66 in "Radioisotopes in Tropical Medicine. Proceedings of a Symposium, Bangkok, 12 - 16 December 1960". STI/PUB/31, Vienna, IAEA. 1962, 379 p.

TABLE IV

## REFERENCES FOR THE SYNTHESIS OF SOME RADIO-LABELLED ORGANIC INSECTICIDES AND RELATED COMPOUNDS

| Common name | Chemical name and isotope | Reference |
|---|---|---|
| Chlorinated Hydrocarbon | | |
| Endrin | 1, 2, 3, 4, 10, 10-hexachloro-6, 7-epoxy-1, 4, 4a, 5, 6, 7, 8, 8a-octahydro-1, 4-endo, endo-5, 8-dimethanonaphthalene-6, 7-$C^{14}$ | [497] |
| DDT | 2, 2-bis-(p-chlorophenyl)-1, 1, 1-trichloro-2-$C^{14}$-ethane<br>2, 2-bis-(p-chlorophenyl-4, 4′-$C^{14}$)-1, 1, 1-trichloroethane | [463] [480] [483]<br>[465] |
| Thiodan | 6, 7, 8, 9, 10, 10-hexachloro-1, 5, 5a, 6, 9, 9a-hexahydro-6, 9-methano-2, 4, 3-benzodioxathiepin-3-oxide-5a, 9a-$C^{14}_2$ | [501] |
| Organophosphorus | | |
| Co-Ral | O, O-diethyl O-3-chloro-4-methylumbelliferone-$P^{32}$-phosphorothioate | [514] |
| Demeton | O, O-diethyl S(and O)-2-(ethylthio)ethyl-$P^{32}$-phosphorothioate | [634] |
| DDVP | O, O-dimethyl 2, 2-dichlorovinyl-$P^{32}$-phosphate | [554] [555] |
| Diazinon | O, O-diethyl O-(2-isopropyl-6-methyl-4-pyrimidinyl)-$P^{32}$-phosphorothioate | [542] |
| Dimethoate | O, O-dimethyl S-(N-methylcarbamoylmethyl)-$P^{32}$-phosphorodithioate | [552] |
| Dipterex | O, O-dimethyl 1-hydroxy-2, 2, 2-trichloroethyl-$P^{32}$-phosphonate | [554] [555] |
| Malathion | O, O-dimethyl S-(1, 2-dicarbethoxyethyl)-$P^{32}$-phosphorodithioate | [567] [566] |
| Parathion | O, O-diethyl O-(p-nitrophenyl)-$P^{32}$-phosphoro-$S^{35}$-thioate<br>O, O-diethyl O-(p-nitrophenyl) phosphoro-$S^{35}$-thioate | [575]<br>[578] |
| Ronnel | O, O-dimethyl O-(2, 4, 5-trichlorophenyl)-$P^{32}$-phosphorothioate | [601] |
| Carbamate | | |
| Sevin | 1-naphthyl-1-$C^{14}$-N-methyl carbamate | [706] |
| Pyrethroid | | |
| Allethrin | d, l-allelrethonyl-d, l-cis, trans-2-$C^{14}$-chrysanthemate<br>d, l-3-allyl-2-$C^{14}$-methyl-4-oxo-2-cyclopenten-1-$C^{14}$-yl chrysanthemate | [667]<br>[679] |
| Synergist | | |
| Piperonyl Butoxide | α-[2-(2-butoxyethoxy)ethoxy]-4, 5-methylenedioxy-2-propyltoluene-1-$C^{14}$-methylene | [676] |
| Repellent | | |
| Deet | N, N-diethyl-m-toluamide ($C^{14}$-carboxy) | [714] |

Hopkins, T.L. Table I of "Radioisotope Techniques and Recent Research on Metabolism of Insecticides in Insects." p. 101 - 111 in "Radioisotopes and Radiation in Entomology. Proceedings of a Symposium, Bombay 5 - 9 December 1960". Vienna, IAEA. 1962, 307.

TABLE V

## RADIOTRACER STUDIES ON THE METABOLISM OF ORGANOPHOSPHATE INSECTICIDES BY PLANTS

(Abbreviations: Me = methyl, Et = ethyl, Ph = phenyl, antiChE = anticholinesterase agent or cholinesterase inhibitor)

| No. | Structure and name | Absorption and translocation | Hydrolysis products | Non-hydrolysed metabolites |
|---|---|---|---|---|
| 1 | $(MeO)_2P(O)OCH = CCl_2$<br>DDVP | pea [555] | pea [555] | |
| 2 | $(MeO)_2P(O)OC(Me) =$<br>$CHC(O)OMe$<br>Phosdrin or OS 2046<br>alpha and beta isomers<br>studied separately | Bryophyllum, cucumber, pea [660] | pea [1441] [660]: bean, Bryophyllum, corn, cucumber [660]: plants; $(MeO)_2P(O)OH$? and $(MeO)_2P(O)OC(Me) = CHC(O)OH$? [660]: pea; $(MeO)_2P(O)OH$ and $(MeO)_2P(O)OC(Me) = CHC(O)OH$ [598] | None in plants [1441] [660] |
| 3 | $(MeO)_2P(O)OC(Me) =$<br>$CHC(O)OH$<br>Carboxylic acid hydr. prod.<br>of alpha Phosdrin | | pea; $(MeO)_2P(O)OH$ and $(MeO)(HO)P(O)OC(Me) = CHC(O)OH$ [598] | |
| 4 | $(MeO)_2P(O)OCHBr \cdot CCl_2Br$<br>Dibrom | | plants?; $(MeO)_2P(O)OH$, $BrCl_2C \cdot CHO$, $Cl_2HC \cdot CHO$, and complex amino acid conjugates | plants?; $(MeO)_2P(O)OCH = CCl_2$ |
| 5 | $(MeO)_2P(O)CHOH \cdot CCl_3$<br>Dipterex, Dylox, Bayer L 13/59 | pea [555] | pea [555] | |
| 6 | $(MeO)_2P(O)\underset{\displaystyle CCl_3}{\overset{\displaystyle |}{C}}HOC(O)Me$<br>acetylated Dipterex | pea [555] | pea [555] | |
| 7 | $(MeO)_2P(O)SC_2H_4SEt$<br>methyl isosystox, thiol<br>isomer of meta-Systox | | many plants; $(MeO)_2P(O)OH$, $H_3PO_4$ and lecithins [645] | many plants; $(MeO)_2P(O)SC_2H_4S(O)Et$ and $(MeO)_2P(O)SC_2H_4S(O_2)Et$ [645] |
| 8 | $(MeO)_2P(O)SC_2H_4S(O)Et$<br>sulphioxide of methyl isosystox | | cabbage, potato; $(MeO)_2P(O)OH$, $H_3PO_4$ and lecithins [645] | cabbage, potato; $(MeO)_2P(O)SC_2H_4S(O_2)Et$ [645] |

TABLE V (cont'd)

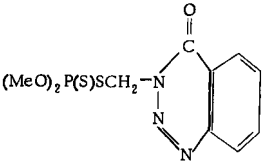
| No. | Structure and name | Absorption and translocation | Hydrolysis products | Non-hydrolysed metabolites |
|---|---|---|---|---|
| 9 | $(MeO)_2P(O)SC_2H_4S(O_2)Et$<br>sulphone of methyl isosystox | | cabbage, potato; $(MeO)_2P(O)OH$, $H_3PO_4$ and lecithins [645] | |
| 10 | $(MeO)_2P(S)OPh{-}NO_2{-}4$<br>methyl Parathion | many plants [574] | many plants [574]: hydrangea; $H_3PO_4$ and unident. metabolites [574] | |
| 11 | $(MeO)_2P(S)OPh{-}S(O)Me{-}4$<br>Bayer 25198 | cotton [657] | cotton [657] | |
| 12 |  <br>Guthion, Gusathion, Bayer 17147 | cotton [562] | cotton; hydr. prod's including phosphatides [562] | cotton; two strongly lipophilic unident. metabolites, of unknown toxicity, but no apparent P = O Guthion [562] |
| 13 | $(MeO)_2P(S)SCH_2C(O)NHMe$<br>Dimethoate, Rogor | corn, cotton, pea, potato [551] | corn, cotton, potato; $(MeO)_2P(O)OH$, $(MeO)_2P(S)OH$, $(MeO)(HO)P(S)CH_2C(O)NHMe$, and $(MeO)_2P(O)SCH_2C(O)OH$ [551]: pea; as above plus $H_3PO_4$ [551] | corn, cotton, pea, potato $(MeO)_2P(O)SCH_2C(O)NHMe$ [551] bean, lettuce; $(MeO)_2P(O)SCH_2C(O)NHMe$? and a less polar antiChE-agent [763] |
| 14 | $(CH_3O)_2P(S)SCH_2C(O)NHEt$<br>CL 18,706 | cotton [551] | cotton [551] | |
| 15 | $(MeO)_2P(S)SCH\cdot C(O)OEt$<br>$CH_2C(O)OEt$<br>Malathion | bean [50] | bean; $(MeO)_2P(S)OH$, $H_3PO_4$, $(MeO)_2P(S)SH$?, $(MeO)_2P(S)SCH\cdot(CO)OH$ and $CH_2C(O)OH$ $(MeO)_2P(S)SCH\cdot C(O)OH$ $CH_2C(O)OEt$? | bean; $(MeO)_2P(O)SCH\cdot C(O)OEt$? $CH_2C(O)OEt$ |
| 16 | $(EtO)_2P(O)SC_2H_4N(Et)_2$<br>Amiton | cotton, lemon [664] | cotton, lemon [664] | none in plants [664] |

TABLE V (cont'd)

| No. | Structure and name | Absorption and translocation | Hydrolysis products | Non-hydrolysed metabolites |
|---|---|---|---|---|
| 17 | $(EtO)_2P(O)SC_2H_4N(Et)_2 \cdot HX$ salts of Amiton (Tetram or Chipman R-6199 is hydrogen oxalate salt) | cotton; citrate, dimethyl sulphate, oxalate, picrate, phthalate, p-toluene sulphonate, trichloroacetate salts [644]: lemon; dimethyl sulphate, hydrochloride, oxalate, p-toluene sulphonate salts [644]: orange; oxalate salt [644]: cacao; p-toluene sulphonate salt [658] | cotton, lemon; oxalate salt [644]: cacao; p-toluene sulphonate salt [658] | none in plants [644] [658] |
| 18 | $(EtO)_2P(O)SC_2H_4S(Me)Et \cdot MeSO_4$ dimethyl sulphonium salt of isosystox | cotton, lemon [642] | | cotton; unidentified metabolite [642] |
| 19 | $(EtO)_2P(O)SC_2H_4SEt$ and $(EtO)_2P(S)OC_2H_4SEt$ Systox Demeton (mixed isomers) | cotton [630] [732]: lemon [756] | many plants; field residue data [643]: plants; $(EtO)_2P(O)OH$?, alcohols? [643] | apple, orange, walnut; $(EtO)_2P(O)SC_2H_4S(O)Et$, $(EtO)_2P(O)SC_2H_4S(O_2)Et$?, $(EtO)_2P(S)OC_2H_4S(O)Et$ plus $(EtO)_2P(S)OC_2H_4S(O_2)Et$ and/or $(EtO)_2P(O)OC_2H_4S(O)Et$ [643] |
| 20 | $(EtO)_2P(O)SC_2H_4SEt$ isosystox, thiol isomer of Systox or Demeton | cotton, lemon [644] [642]: bean, lemon [641]: potato, tobacco [646]: bean, borage, mustard [648]: apple, bean, coleus [649]: lettuce, nettles [620]: alfalfa, cotton, sugar beet [595]: cotton [755] | cotton [644]: bean, cotton [646] [647]: orange [643]: potato, tobacco [646] [647]: bean, borage, mustard [648]: apple, bean, coleus [649]: lettuce, nettles [620]: alfalfa, cotton, sugar beet [595]: cotton [755] | orange; $(EtO)_2P(O)SC_2H_4S(O)Et$, $(EtO)_2P(O)SC_2H_4S(O_2)Et$ [643]: cotton; $(EtO)_2P(O)SC_2H_4S(O)Et$, $(EtO)_2P(O)SC_2H_4S(O_2)Et$ [642] [635] [636]: Brassica, nettles, sugar beet, turnip; 3 unidentified metabolites [638]: bean, lettuce; unidentified metabolite(s) [641]; potato, tobacco; unidentified "more toxic" compounds [646]: bean, borage, mustard; 2 unidentified metabolites [648]: lettuce, nettles; $(EtO)_2P(O)SC_2H_4S(O)Et$ plus 1 unidentified oxidative metabolite plus 2nd unidentified metabolite [620] |

TABLE V (cont'd)

| No. | Structure and name | Absorption and translocation | Hydrolysis products | Non-hydrolysed metabolites |
|---|---|---|---|---|
| 21 | $(EtO)_2P(O)SC_2H_4S(O)Et$<br>sulphoxide of isosystoc | cotton, lemon [642] | cotton [642] | cotton; $(EtO)_2P(O)SC_2H_4S(O_2)Et$ [642] |
| 22 | $(EtO)_2P(S)OC_2H_4SEt$<br>Systox or Demeton | cotton, orange [643]: bean, lemon [641]: turnip [620]: many plants [651] | bean, cotton, orange [643] | orange; $(EtO)_2P(S)OC_2H_4S(O_2)Et$, $(EtO)_2P(O)OC_2H_4S(O)Et$ [643]: plants; unidentified metabolite(s) [638]: bean, lemon; unidentified metabolite(s) [641]: cotton; $(EtO)_2P(S)OC_2H_4S(O)Et$ plus $(EtO)_2P(S)OC_2H_4S(O_2)Et$ and/or $(EtO)_2P(O)OC_2H_4S(O)Et$ [635]: turnip; 3 unidentified metabolites [620] |
| 23 | $(EtO)_2P(S)OC_2H_4N(Et)_2$<br>thiono isomer of Amiton | cotton, lemon [644] | cotton, lemon [644] | |
| 24 | $(EtO)_2P(S)SCH_2SEt$<br>Thimet or Phorate | many plants [589]: alfalfa, cotton, sugar beet [595]: alfalfa, cotton, lemon [755]: bean [590]: pea [592] | many plants [589]: alfalfa, cotton, sugar beet [595]: cotton [755]: bean; $(EtO)_2P(S)SH$, $(EtO)_2P(S)OH$, $(EtO)_2P(O)OH$, $H_3PO_4$, unknown (maybe de-ethylated deriv.) [590]; pea [592] | cotton; $(EtO)_2P(S)SCH_2S(O)Et$, $(EtO)_2P(S)SCH_2S(O)_2Et$, $(EtO)_2P(O)SCH_2S(O)Et$, $(EtO)_2P(O)SCH_2S(O_2)Et$ [589]: pea; $(EtO)_2SP(S)SCH_2S(O)Et$, $(EtO)_2P(S)SCH_2S(O_2)Et$ [589]: alfalfa, cotton, lemon; as above on cotton [755]: bean; as above on cotton [590] |
| 25 | $(EtO)_2P(S)SC_2H_4SEt$<br>Disyston, Dithiodemeton, Ekatine | cotton [657]: alfalfa, cotton, sugar beet [595]: alfalfa, bean, cotton, lemon [755]: pineapple [558] | cotton [657]: alfalfa, cotton, sugar beet [595]: alfalfa, cotton [755]: cotton; diethyl phosphoric acids?, $H_3PO_4$?, phospholipids [755]: cotton, tomato and 10 other plants [559] | alfalfa, bean, cotton, lemon; $(EtO)_2P(S)SC_2H_4S(O)Et$, $(EtO)_2P(S)SC_2H_4S(O_2)Et$, $(EtO)_2P(O)SC_2H_4S(O)Et$, $(EtO)_2P(O)SC_2H_4S(O_2)Et$ [755]: cotton, tomato and 10 other plants; as above [559]: cotton; $(EtO)_2P(S)SC_2H_4S(O)Et$, $(EtO)_2P(S)SC_2H_4S(O_2)Et$ [754] |

TABLE V (cont'd)

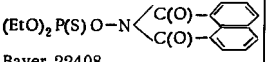
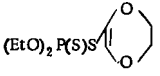
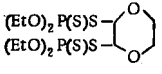
| No. | Structure and name | Absorption and translocation | Hydrolysis products | Non-hydrolysed metabolites |
|---|---|---|---|---|
| 26 | $(EtO)_2P(S)SP(S)(OEt)_2$ ? impurity in Delnav | bean, cotton, tomato [749] | bean, cabbage, cotton, tomato [749] | bean, cabbage; more polar derivatives, possibly phosphorothiolates [749] |
| 27 | $(EtO)_2P(S)OPh-NO_2-4$ Parathion | many plants [574]: apple [581] | many plants [574]: grape and lemon leaf juice [574] | |
| 28 | $EtOP(S)(OPh-NO_2-4)_2$ impurity in Parathion | plants [574] | plants [574] | |
| 29 | $(EtO)_2P(S)OPh-S(O)Me-4$ Bayer 25141 | cotton [657] | cotton [657] | cotton; $(EtO)_2P(S)OPh-S(O_2)Me-4$, $(EtO)_2P(S)OPh-SMe-4$ (trace), $(EtO)(EtS)P(O)OPh-S(O)Me-4$ (major), $(EtO)(EtS)P(O)OPh-S(O_2)Me-4$ [657] |
| 30 |  Bayer 22408 | cotton [726] | cotton: (EtO)(HO)P(O)O-naphthalimido?, $H_3PO_4$ incorporated into plant products? [726] | cotton: $(EtO)_2P(O)O$-naphthalimido [726] |
| 31 |  impurity in Delnav | bean, cotton, tomato [749] | bean, cabbage, cotton, tomato [749] | bean, cabbage; more polar derivative, probably $(EtO)_2P(O)S$-p-dioxene-2 [749] |
| 32 |  Delnav-studies on separate and combined cis and trans isomers | bean, cotton, tomato [749] | bean, cabbage, cotton, tomato [749] | bean, cabbage; more polar derivatives, more active antiChE agents, possibly phosphorothiolates [749] |
| 33 | $EtOP(O)(NMe_2)_2$ | turnip [620] | turnip [620] | turnip; $EtOP(O)(NMe_2)(NHMe)$? $EtOP(O)(NHMe)_2$ ? [620] |
| 34 | $MeHNP(O)(NMe_2)_2$ | turnip [620] | turnip [620] | turnip; $(MeHN)_2P(O)NMe_2$ ? [620] |
| 35 | i-PrHNP(O)$(NMe_2)_2$ | turnip [620] | turnip [620] | turnip; i-PrHNP(O)(NHMe)$(NMe_2)$? [620] |

TABLE V (cont'd)

| No. | Structure and name | Absorption and translocation | Hydrolysis products | Non-hydrolysed metabolites |
|---|---|---|---|---|
| 36 | n-BuHNP(O)$(NMe_2)_2$ | turnip [620] | turnip [620] | turnip; n-BuHNP(O)(NHMe)$(NMe_2)$?, n-BuHNP(O)$(NHMe)_2$? [620] |
| 37 | $(Me_2N)_3P(O)$ impurity in Schradan | bean [604]; turnip [620]; sugar beet, strawberry [618] | bean [604]; turnip [620]; sugar beet, strawberry [618]; plants [616] | bean; more and less polar derivative(s), some containing organically bound formaldehyde [604]: turnip; $(Me_2N)_2P(O)NHMe$? [620]: sugar beet; $(Me_2N)_2P(O)NMe\cdot CH_2OH$? [618]: plants; unidentified intermediate [616] |
| 38 | $(Me_2N)_2P(O)F$ Dimefox, Hanane | pea [604]: bean [751] | pea [604] | pea: less and probably also more polar derivative(s), some containing organically bound formaldehyde and antiChE activity [604] |
| 39 | (MeHN)$(Me_2N)P(O)OP(O)(NMe_2)_2$ demethylated Schradan | | turnip [620] | |
| 40 | $(Me_2N)_2P(O)OP(O)(NMe_2)_2$ and $(Me_2N)_2P(O)OP(O)NMe_2$ $(Me_2N)_2P(O)O$ Schradan or OMPA, technical | brussel sprout, hop, sugar beet, strawberry [617] | brussel sprout, hop, sugar beet, strawberry [617] | |
| 41 | $(Me_2N)_2P(O)OP(O)(NMe_2)_2$ Schradan or OMPA | sugar beet, strawberry [618]: bean, cabbage, hop, pea, strawberry [609] [750]: groundnut [627]: bean [756] [629] [626]: lemon, orange [624]: borage, mustard [614]: apple, bean, chrysanthemum, coleus [608] [752]: cotton [625] | clover, turnip [620]: sugar beet, strawberry [618]: plants [616]: bean [751] [629] [626]: groundnut [627]: lemon, orange [624]: borage, mustard [614]: apple, bean, chrysanthemum, coleus [608] [752]: plants; $(Me_2N)_2P(O)OH$, $(Me_2N)(Me_2NO)P(O)OH$? plus non-chloroform extractibles [620]: cotton, $(Me_2N)_2P(O)OH$?, $H_3PO_4$? [625]: many plants; $(Me_2N)_2P(O)OH$? [621] | plants; general reviews [414, 622]: bean; unidentified plant metabolite(s) [604]: bean, brussel sprout, clover, turnip; (MeHN)$(Me_2N)P(O)OP(O)(NMe_2)_2$ [620]: clover; (MeHN)$(Me_2N)P(O)OP(O)(NMe_2)$ plus antiChE agents [620]: plants; $(Me_2NO)(Me_2N)P(O)OP(O)(NMe_2)_2$, $(HOCH_2\cdot MeN)(Me_2N)P(O)OP(O)-N(Me_2)_2$, (MeHN)$(Me_2N)P(O)OP(O)-(NMe_2)_2$ [620]: plants; no non-hydrolysed intermediates [616]: bean; antiChE agent(s) [629] |



J. E. Casida. Table I in "Metabolism of organophosphate insecticides by plants: A review." p. 49-64 in "Radioisotopes and Radiation in Entomology. Proceedings of a Symposium, Bombay 5-9 December 1960".

# AUTHOR INDEX


Abdel Salam, F. A.: 253
Abeleva, E. A.: 853, 993, 1176
Abrahamson, S.: 1038, 1155, 1157, 1158, 1193 1197, 1199, 1266, 1354, 1355
Acree, F., Jr.: 461, 462, 554, 666, 667, 668, 715
Adamson, D. M.: 928, 929, 1323, 1324, 1326, 1420
Adelman, H.: 501
Agarwal, H. C.: 232
Ahmed, M. K.: 571, 630, 732, 749
Alexander, M. L.: 854, 927, 966, 1068, 1087, 1088, 1156, 1159-1167, 1356
Alibert, J.: 1162
Allen, D.: 260
Alper, T.: 627
Amy, R. L.: 810, 811, 1276
Anderson, E. H.: 1390
Anderson, J. R.: 334
Anderson, L. C.: 1528
Anderson, R. C.: 687, 689
Anderssen, E. E.: 627
Anonymous: 550, 795, 1540, 1569
Andreeva, O. I.: 419
Ankersmit, G. W.: 1
Annan, M. E.: 1132, 1133, 1134
Apple, J. W.: 550
Aragão, M. B.: 107, 343, 344
Arifov, U. A.: 1238, 1555
Arnason, A. P.: 282, 334, 350, 358, 377
Arnason, T. J.: 1061
Arnberg, B.: 905
Arthur, B. W.: 519, 520, 555, 556, 604, 726
Artmeladze, I. D.: 1555
Asperen, K. van: 804
Astaurov, B. L.: 879, 903, 904
Atchison, G. J.: 744
Atwood, K. C.: 967, 978, 1093, 1431
Auerbach, C.: 1046, 1168
Auerbach, S. I.: 1278, 1432
Avi-Dor, Y.: 136, 138
Babers, F. H.: 246, 351, 402, 460, 554, 666, 667, 668, 734
Baccetti, B.: 1497
Baeumer, J.: 1169, 1170
Baker, B. E.: 480
Baker, J. T.: 338, 346
Baker, V. H.: 1239, 1240, 1242, 1243, 1357
Baker, W. K.: 940, 968, 1358, 1359, 1360, 1361, 1362, 1363, 1390
Baldit, G. L.: 512
Baldwin, W. F.: 102, 123, 129, 702, 1244, 1300, 1301, 1302, 1365, 1366, 1367, 1368, 1369
Ball, C. D.: 685, 692, 693
Ball, R. C.: 42, 43, 44
Balls, A. K.: 528
Balock, J. W.: 1171, 1491, 1523
Banerjee, G. C.: 1227
Banks, C. J.: 21, 22, 58, 59, 60
Barker, D. Y.: 716
Barnes, J. M.: 433
Barnes, M. M. 91
Baranov, V. A.: 1555, 1559
Barrada, Y.: 1558
Barragat, P.: 438
Bar-Zeev, M.: 713
Bateman, A. J.: 378, 379, 812, 813, 857, 1172, 1173, 1174
Batt, R. F.: 605
Baumhover, A. H.: 1109, 1466, 1467, 1468, 1469
Baumiller, R. C.: 1001
Baxter, R. C.: 1270, 1339
Beal, J. A.: 98
Beamer, W. H.: 744
Beck, S. D.: 232, 234
Becker, H.: 969
Beecham, P. T.: 763
Beiser, W. C., Jr.: 1374
Belgovskii, M. L.: 420, 1175
Bellamy, W. D.: 1564
Belleau, B.: 420
Bender, M. A.: 1370
Benjamini, E.: 656, 657
Bennett, D. R.: 681
Bennett, S. H.: 605, 606, 649, 752
Benneyan, R. N.: 1429
Benz, G.: 970
Bergendahl, J.: 1167
Bergold, G. H.: 314
Bernstein, M. H.: 916
Beroza, M.: 462
Bertram, C.: 814, 1371
Bertzbach, R.: 1135
Berwig, W.: 317
Bettini, S.: 499, 500
Bheemeswar, B.: 157, 169, 170
Bibergal, A. V.: 1517, 1518, 1527
Bidlingmayer, W. L.: 108
Biellmann, G.: 1315
Bigley, W. S.: 521
Bishop, G. H.: 214
Bitter, B. A.: 1466
Bjorling, K.: 407
Blair, H. A.: 963
Bletchly, J. D.: 1245, 1246, 1507
Bloch, K.: 233, 235, 236

Block, R.J.: 247, 270, 276, 278
Blum, M.S.: 669
Blumel, J.: 380
Bochnig, V.: 1271
Boccacci, M.: 499, 500
Boche, R.D.: 1129
Boell, E.J.: 1125
Bohart, R.M.: 88
Bollaerts, D.: 886
Bond, E.J.:421
Bond, J.A.: 1151
Bonnier, G.: 905, 971, 972, 973, 974, 975, 976, 977, 1433, 1434, 1435, 1448
Borstel, R.C. von: 906, 922, 967, 978, 979, 980, 981, 982, 983, 1177, 1436
Boudreaux, H.B.: 318
Bourgin, R.C.: 1303
Bowden, K.: 682
Bowen, V.T.: 248, 249, 298, 299, 300
Bowman, J.S.: 461, 462, 589, 590, 591, 658
Bowman, M.C.: 492, 715
Boyd, N.R., Jr.: 726
Bradbury, F.R.: 439, 440, 441, 442, 443, 444, 445, 446
Brande, J. van den: 17, 1298
Brandt, H. von: 815, 816, 817, 1372
Bricteux-Grégoire, S.: 158, 159, 160, 161, 162, 163, 164, 165
Bridges, P.M.: 311, 670, 679, 764
Bridges, R.G.: 447, 448, 764, 765, 766, 784, 786, 787
Brittain, M.: 1167
Brockaway, A.P.: 855, 856
Broglé, R.C.: 1522
Brooks, G.T.: 496, 497, 498
Brown, A.W.A.: 718
Brown, R.A.: 1553
Brown, S.A.: 1467
Brown, W.G.: 778
Brownell, L.E.: 1508, 1528, 1529, 1530, 1531, 1536
Bruce-Chwatt, L.J.: 109, 250
Bruel, W.E. van den: 886
Bucher, N.: 1178
Buckner, A.J.: 486
Buhler, D.R.: 463
Bull, J.O.: 113, 114, 1470, 1511
Bulmer, J.J.: 1529, 1530
Burden, G.S.: 888
Burdick, A.B.: 941
Buretz, K.M.: 1179
Burger, C.L.: 1272
Burns, E.C.: 515
Burr, G.O.: 1171
Burson, D.M.: 1304
Burwell, L.R.: 892
Bushland, R.C.: 340, 758, 1110, 1111, 1466, 1471, 1472, 1473, 1474, 1475, 1476, 1477, 1534
Butts, J.S.: 74, 90, 335, 374, 464, 466, 470, 478, 479
Buzzati-Traverso, A.A.: 984, 1180, 1437
Byerrum, R.U.: 683, 684, 685, 692, 693
Caluya, M.F.: 230
Candy, D.J.: 137
Carlson, J.G.: 902, 907, 908, 942
Carney, G.C.: 1112
Carson, H.L.: 1438
Carter, W.: 558
Casapieri, P.: 661
Casida, J.E.: 232, 234, 293, 294, 514, 520, 550, 551, 552, 555, 556, 568, 571, 589, 590, 596, 601, 604, 658, 659, 660, 719, 731, 735, 736, 746, 749
Caspari, S.B.: 985, 1267
Casten, R.: 1562
Cember, H.: 775, 1249, 1257
Chamberlain, W.E.: 1532
Chamberlain, W.F.: 739
Chandley, A.C.: 857
Chang, S.C.: 434, 464
Chapman, R.K.: 592, 597, 660
Chase, H.B.: 870
Chatters, R.M.: 631
Cherepanov, A.I.: 121
Chernetsova, V.I.: 572, 573
Chervenak, M.B.: 711
Chikovani, V.E.: 1559
Chilwell, E.D.: 763
Chkheidze, T.N.: 1555, 1559
Chojnacki, T.: 274, 275
Chouteau, J.: 549, 741, 742
Christensen, B.E.: 463, 464
Christenson, L.D.: 92, 1171, 1490, 1491, 1493
Christian, J.E.: 716, 717
Christman, D.R.: 687, 688, 689, 690
Claborn, H.V.: 516, 758
Clark, A.J.: 233
Clark, A.M.: 235, 236, 858, 859, 860, 861, 862, 863, 864, 865, 943, 986, 1273, 1274, 1373, 1374, 1375, 1376
Clark, J.W.: 849
Clark, L.B.: 832, 833, 1254
Clayton, F.E.: 927, 946, 1068, 1160, 1388
Clayton, G.: 987
Clements, A.N.: 237
Cleugh, J.: 621
Cohen, J.A.: 522, 523, 524, 529, 530, 532, 533
Cole, M.J.: 234
Cole, M.M.: 888
Coleman, E.W.: 1536
Colombo, G.: 866, 988, 1136, 1247
Comar, C.L.: 769
Conklin, P.M.: 892
Conway, J.V.: 1373
Cooper, R.D.: 776

Cork, J.M.: 1275
Cornwell, P.B.: 104, 105, 352, 889, 890, 891, 1113, 1114, 1144, 1304, 1501, 1509, 1510, 1511, 1512
Corrigan, J.J.: 166
Costa, A.J.: 1541
Cotty, V.F.: 167, 251, 279, 323
Cox, J.D.: 422
Courtois, G : 353, 1248
Craig, J.B., Jr.: 1081
Craig, J.T.: 778, 779, 780
Craig, R.: 319
Crean, L.E.: 1533
Cristofalo, V.J.: 1376
Crook, L.J.: 1113, 1114
Crossley, D.A., Jr.: 252, 1432
Crouse, H.V.: 1181
Crowley-Milling, M.C.: 1537
Cueto, C.: 738
Cunha, A.B. da: 1439, 1440, 1441
Cunliffe, F.: 130
Cutkomp, L.K.: 468
D'Adamo : 688, 689, 690
Dahm, P.A.: 409, 477, 487, 515, 676, 805, 806, 1554
Dale, W.E.: 738
Darden, E.B., Jr.: 827, 828, 1067, 1534
Darrow, D.I.: 517, 518, 521, 553, 563
Darrow, J.B.: 1014
Darwish, R.O.: 253
Dauterman, W.C.: 541, 550, 551, 552
Davich, T.B.: 593, 594, 1115
David, W.A.L.: 609, 632, 750, 751, 753
Davis, A.N.: 1116
Davis, J.M.: 64, 99, 354, 794
Dawson, R.F.: 687, 688, 689, 690, 691
Day, M.F.: 3, 23, 32, 320
DeBruyn, P.P.H.: 1151
Demerec, M.: 1107
Demyanovsky, S.Ya.: 168, 254, 255, 256, 257
Dennis, N.M.: 1542
Dent, J.N.: 1276
Deschreider, A.R.: 1502, 1503
Devine, R.L.: 1327, 1328
Dewandre, A.: 163, 165
Dewey, L.J.: 692, 693
Dick, W.E.: 4
Dissanaike, A.S.: 258, 345, 404
Dissanaike, G.A.: 258, 345, 404
Dittrich, W.: 817, 989, 1182
Dixon, G.H.: 525
Donnelly, J.: 36, 77, 259
Dow, R.P.: 122
Downes, J.A.: 944
Doyle, W.P.: 151
Drisko, R.W.: 539, 540
Dropkin, V.H.: 1556, 1573, 1574
Duchateau, G.: 159
Dudgeon, E.: 946, 1068, 1388
Dudley, F.H.: 1466, 1478
Duffey, D.: 1535
Dugal, L.-P.: 5
Duncombe, W.G.: 770
Dupée, L.F.: 762
Durham, W.F.: 577
Dutky, R.C.: 243
Earle, N.W.: 671
Eddy, G.W.: 518, 543, 602, 743
Edington, C.W.: 818, 819, 951, 990, 1024, 1360, 1377
Egli, H.: 1250
Ehrenberg, L.: 932
Ehrhardt, P.: 26, 41
Eisner, T.: 48, 56
Eldeframi, M.E.: 633, 703, 704
El Gindi, D.M.: 1558
Elias, H.: 449
Ellis, G.W.: 772
Emerson, R.B.: 47, 630, 732
Engelmann, M.D.: 1432
Engle, R.R.: 538, 539
Entomological Society of Ontario: 355
Erdman, H.E.: 867, 868
Erickson, C.A.: 501
Esser, H.: 1054
Evans, T.C.: 820
Fahmy, O.G.: 1344, 1378, 1379, 1380, 1381
Fahmy, M.J.: 1344, 1378, 1379, 1380, 1381
Fahnoe, F.: 1533
Falk, G.J.: 222
Falk, R.: 991, 992, 1030, 1382
Fang, S.C.: 260, 702, 705
F.A.O. (see: Food and Agriculture Organization of the United Nations)
Farinacci, C.J.: 363
Farrell, E.P.: 1554
Fass, H.: 525
Fassuliotis, G.: 1570, 1571, 1572
Faulkner, P.: 169, 170
Fay, R.W.: 94, 336, 338, 346, 720
Feodorova, K.G.: 87
Fernando, H.E.: 653, 733
Fiala, Y.: 1183
Ficq, A.: 215, 216
Fields, M.: 465
Fisher, R.C.: 1126, 1245
Fisher, W.: 807
Fleischer, M.L.: 707
Flemion, F.: 33, 34
Florkin, M.: 158, 159, 160, 162, 163, 164, 165, 171, 177, 178, 179, 188
Fluke, D.J.: 986, 1184
Fodor, V.M.: 1297
Fondarai, J.: 544, 545, 547, 549
Food and Agriculture Organization of the U.N. (F.A.O.): 356
Foote, R.H.: 92
Foott, W.H.: 333
Foreman, W.W.: 423
Forgash, A.: 330, 331
Forman, S.E.: 501

Fraenkel, G.: 233
Fredeen, F.J.H.: 115, 334, 348
Freed, V.H.: 702
Fredericksen, C.F.: 357
Frey, E.: 821, 1228
Friedkin, M.: 214
Fritz-Niggli, H.: 822, 823, 824, 825, 826, 869, 896, 1127, 1185, 1186, 1187, 1228, 1305, 1383, 1384
Frota-Pessôa, E.: 343, 344
Fukai, H.: 203, 204
Fukamachi, C.: 1524
Fukami, J.: 307, 588
Fukuda, T.: 163, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188
Fukuto, T.R.: 507, 557, 559, 561, 562, 567, 595, 625, 634, 635, 636, 639, 640, 641, 642, 643, 644, 656, 657, 745, 754, 755, 823
Fuller, R.A.: 103, 261, 350, 358
Fuzeau-Braesch, S.: 189, 321, 322
Gabrusewycz, M.R.: 1439, 1440, 1441
Gahan, H.B.: 1116
Galkovskaya, K.F.: 873
Gama, M.R.: 1439, 1440, 1441
Gamô, T.: 262, 263, 264, 265
Ganz, A.: 694, 995
Gar, K.A.: 572, 573, 574
Gardiner, B.O.C.: 753
Gardiner, J.E.: 610, 611, 612
Gardner, K.: 637
Gary-Bobo, J.: 838
Gasvoda, J.: 1325
Gatterdam, P.E.: 596, 660, 746, 985
Gaulden, M.E.: 217, 775, 827, 828, 908, 909, 910, 1259, 1306, 1322, 1385, 1386
Gegenava, G.V.: 579
Geiling, E.M.K.: 694, 995
George, K.S.: 131
Gerding, P.W.: 717
Gessner, T.: 457, 458
Getsova, A.B.: 266, 267, 268
Getzin, L.W., Jr.: 592, 597, 660
Geyer-Duszynska, I.: 911
Ghelelovitch, S.: 1345
Ghosh, T.N.: 1227
Gibbs, J.: 465
Gilbert, B.L.: 501
Giles, A.R.: 1096
Gillies, M.T.: 771
Giux Melcior, I.R.: 829
Gjullin, C.M.: 374, 466
Glass, B.: 964, 1188, 1189, 1190, 1307, 1346, 1348
Glazunova, A.Ya.: 85
Glemobitsky, Ya. L.: 993
Glynne Jones, G.D.: 613, 614, 648
Godwin, P.A.: 99, 1118
Goldblith, S.A.: 1521, 1522
Gomberg, H.J.: 1528
Gonda, O.: 136, 138
Goodey, J.B.: 1577
Goodhue, R.D.: 1543
Gordon, H.T.: 424, 633
Gortner, W.A.: 558
Gösswald, K.: 49, 50, 51, 52, 53, 54, 55, 359
Goutier, R.: 526
Gowen, J.W.: 832, 833, 945, 1309, 1310
Graham, A.J.: 1466, 1478
Gray, R.A.: 139
Gray, L.H.: 1311, 1352
Greenslade, R.M.: 414
Gregg, T.G.: 1442, 1443, 1453
Grégoire, C.: 1312
Green, B.C.: 788, 789
Green, G.W.: 123
Green, M.M.: 123
Green, N.: 714
Grell, M.: 306
Grodner, R.: 1387
Grosch, D.S.: 132, 269, 381, 382, 383, 401, 830, 1117, 1137, 1138, 1139, 1277, 1295, 1313
Gross, J.D.: 218
Groves, K.: 128
Grundman, A.W.: 30, 1284
Grundy, A.V.: 1522
Gulamowa, L.M.: 1557, 1558
Gumansky, G.A.: 1238, 1555
Gund, K.: 831
Gunther, F.A.: 745
Guyénot, E.: 995, 996
Guyer, G.: 1340
Haas, F.L.: 927, 946, 1388
Haas, V.H.: 384
Hacskaylo, J.: 593
Hagley, E.A.: 467
Hahn, P.F.: 384
Haines, T.H.: 270
Halberstadt, J.: 502, 503
Hall, F.R.: 29
Hall, R.L.: 1513
Halle, E.S., von: 951, 968, 1024, 1361, 1362, 1363
Hallepanavar, N.L.: 468
Haller, H.L.: 410
Hamill, R.L.: 686
Hammer, J.L.: 1435
Hammond, A.E.: 1224
Hanec, W.: 72
Hannan, R.S.: 1251
Hannerz, B.: 1285
Harlow, E.S.: 696
Harnly, M.H.: 707
Harrington, N.G.: 908, 942
Harrington, N.J.: 912
Harris, K.L.: 1550, 1551, 1552
Harrison, A.: 436, 437, 679, 760, 764, 782, 784, 786, 787

Harshman, S.: 538, 539
Hartley, G.S.: 414, 615, 616, 638
Hartwell, W.V.: 71, 367
Harwood, R.: 128
Hasimoto, H.: 997
Hassett, C.C.: 15, 110, 140, 141, 271, 272, 273, 808, 1252, 1253, 1504
Hayakawa, A.: 1524
Hayashi, T.: 182, 188
Hayes, W.J.: 489
Hayward, J.: 250
Heard, R.D.H.: 420
Hearmon, R.F.S.: 1561
Heath, D.F.: 504, 615, 616, 617, 618, 619, 620, 621, 637, 661, 662, 663, 762
Heidenthal, G.: 832, 833, 998, 999, 1191, 1254
Hein, R.E.: 575,832
Heller, J.: 274, 275
Hellyer, G.C.: 310, 311, 495, 729, 730
Henderson, B.J.: 1339
Hendriksson, H.O.: 1290
Henke, K.: 1000
Hennig, E.: 24
Henry, S.M.: 167, 251, 270, 276, 279, 323
Henze, A.: 1286
Herbert, C.M.: 363
L'Héritier, M.P.: 1314
Herr, E.B., Jr.: 1373, 1375
Herskowitz, I.H.: 947, 1001, 1038, 1140, 1155, 1158, 1192, 1193, 1194, 1195, 1196, 1197, 1198, 1199, 1200, 1201, 1202
Heslop, J.P.: 277
Hilchey, J.D.: 251, 278, 279, 776, 1269, 1342, 1343
Hill, R.: 450
Hills, P.R.: 1563
Hilse, R.M.: 300
Hinton, H.E.: 6
Hirano, C.: 191
Hirobe, T.: 1556
Hochman, B.: 1316
Hodges, R.: 1340
Hoffman, R.A.: 74, 335, 341, 469, 470, 478, 479
Hofmann, D.: 1170
Hofmann-Credner, D.: 747
Höhne, G.: 814, 815, 816, 834, 989, 1182, 1371, 1372, 1389
Holden, J.T.: 1316
Hollaender, A.: 1390
Holling, C.S.: 1560
Holloway, J.R.: 96
Hooper, F.F.: 42, 43, 44
Hopkins, D.E.: 340, 513, 553, 739, 1110, 1111, 1466
Hopkins, H.T.: 472
Hopkins, T.L.: 517, 518, 543, 599, 602, 672, 743
Horie, Y.: 219
Horikawa, M.: 913, 914, 1264
Hornstein, I.: 451, 452, 453
Horiuchi, Y.: 188
Horwitz, J.: 1294
Hoshi, R.: 203, 205
Hoskins, W.M.: 471, 703
Howard, A.: 225, 915
Howden, H.F.: 1141, 1278
Hume, J.M.: 615
Hunter, A.H.: 1557
Huot, L.: 280
Huque, H.: 281
Husbands, R.C.: 118
Husman, C.N.: 1469
Huston, J.L.: 425
Hyland, K.E.: 190
Ilinskaya, N.B.: 347, 349
Ishi, S.: 191
Irwin, R.L.B.: 282, 377
Irzykiewicz, H.: 32, 320
Isaacs, P.J.: 1533
Ito, H.: 192, 196, 224, 228, 229
Ito, T.: 219, 1212, 1279
Ivanova, E.V.: 85, 87
Ives, P.T.: 892, 1002, 1003, 1004, 1005, 1006, 1007, 1142, 1143, 1203
Ivey, M.C.: 758
Iyatomi, K.: 527
Iyengar, R.: 283
Jackson, P.C.: 472
Jackson, W.B.: 68
Jacob, J.: 360
Jäger, A.: 576
Jakowska, S.: 1297
James, H.G.: 129
Jamieson, C.A.: 1564
Jandorf, B.J.: 740
Jang, R.: 528
Jansen, E.F.: 528
Jansz, H.S.: 529, 530
Jaynes, H.A.: 99, 100, 118
Jefferies, D.J.: 1144
Jefferson, M.E.: 1479
Jenkins, D.W.: 7, 39, 40, 61, 73, 110, 403, 794, 808, 1252
Jensen, A.J.: 738
Jensen, J.A.: 80, 114, 336, 346, 473, 483, 484, 485, 577, 578
Jeuniaux, C.: 159
Johns, H.E.: 1061
Johnson, G.S.: 501
Johnson, R.K.: 425, 1544
Joly, P.: 1315
Jones, A.: 450
Jones, C.R.: 760
Jones, J.C.: 790
Jones, S.C.: 93
Jonsson, S.: 953, 1031, 1210, 1289
Jonsson, U.B.: 975, 1433, 1434, 1435, 1448

Jordan, D.L.: 849
Käfer, E.: 1008
Kaluszyner, A.: 138
Kameyama, T.: 185
Kanehisa, K.: 527
Kannowski, P.B.: 62
Kao, P.: 1267
Kapadia, G.G.: 232
Kaplan, W.D.: 220, 324, 1119, 1120, 1316, 1391
Kaplanis, J.N.: 238, 239, 242, 243, 244, 245, 513, 542, 553, 1024
Karamanian, A.: 741, 742
Karel, M.: 1522
Karnkowska-Gorska, Z.: 221
Karpov, A.E.: 1317
Kartman, L.: 71, 406
Kasting, R.: 193, 194
Katz, R.: 1545, 1546, 1548
Katznelson, H.: 1564
Kaufman, G.: 1121
Kaufmann, B.P.: 916, 933
Kayhart, M.: 835, 836, 1094
Kearns, C.W.: 434, 653, 669, 721, 733
Kempe, L.L.: 1528
Kelly, E.M.: 845, 863
Kelsey, F.E.: 694, 995
Kenworthy, W.: 1392, 1393, 1394
Kepp, R.K.: 1170
Kettlewell, H.B.D.: 124, 361, 362
Keyl, H.-G.: 948
Khudakov, G.D.: 337
Kihara, H.: 934
Kikal, T.: 459
Kilby, B.A.: 137, 610, 611, 612, 622
Kilpatrick, J.W.: 78, 79, 338
Kimball, A.W.: 837, 1067
King, J.C.: 1463, 1464
King, R.C.: 222, 284, 285, 286, 288, 289, 290, 385, 386, 387, 388, 389, 390, 391, 712, 917, 1009, 1010, 1011, 1012, 1013, 1014, 1015, 1145, 1318, 1319, 1347, 1394, 1556
Kiortsis, V.: 995, 996
Kipiani, R.Ya.: 574, 579
Kips, R.H.: 17
Kishin, A.F.E.: 1146
Kirchberg, E.: 411
Kirimura, N.: 1293
Kirschbaum, W.F.: 1080
Kitzmiller, J.B.: 1016
Klee, O.: 655,
Klein, G.A.: 1238, 1555
Kloft, W.: 25, 26, 27, 28, 41, 49, 50, 51, 54, 55, 359, 777
Knaak, J.B.: 552, 596, 746
Knapp, S.E.: 363
Knight, K.L.: 61
Knipling, E.F.: 1444, 1471, 1472, 1480, 1481, 1482, 1483, 1484, 1485, 1486, 1498
Kobayashi, H.: 205
Kodicek, E.: 240
Kogure, M.: 291, 292, 392, 1147, 1148
Kohlschütter, H.W.: 449
Koiwai, S.: 1204
Kokomoor, K.L.: 909
Konikova, A.S.: 168
Korsh, Y.M.: 364
Kossobutsky, V.I.: 664
Kostikova, G.I.: 419
Koukides, M.: 1267
Kováč, J.: 412
Kowalczyk, T.: 552
Koza, R.W.: 912
Krause, S.: 455
Kraybill, H.F.: 1128
Krishnamurthy, B.S.: 1050
Kristjanson, A.M.: 115
Kroeger, H.: 1280
Krop, St.: 531
Krueger, H.R.: 514, 541, 565, 566
Krumins, R.: 1303
Kunkel, H.: 28
Künkel, H.A.: 1389
Kunst, P.: 532, 533
Kuper, S.W.A.: 405
Kuprianoff, J.: 1514
Kurose, T.: 188
Kurtz, O.L.: 1550, 1551, 1552
Kuvaeva, E.B.: 206
La Brecque, G.C.: 66, 888
LaChance, L.E.: 383, 400, 401, 830, 1017, 1149, 1281, 1395, 1396, 1397
Lamarque, P.: 838, 1282, 1283
Lance, R.D.: 746
Lane, D.W.J.: 617, 618, 620
Lang, R.P.: 540
Langdon, R.G.: 233
Langendorff, H.: 1256
Langham, W.H.: 809
Lanzl, E.F.: 1398
Lapkin, Yu.A.: 993
Larsen, W.P.: 1284
Larson, P.S.: 681, 696
Laser, H.: 1353
Lauffer, M.A.: 1257
Laughlin, J.S.: 1202
Laven, H.: 949, 1018
Lawson, F.R.: 29
Lawton, E.J.: 1564
Layne, G.W.: 67, 370
Lecomte, J.: 353, 1248
Lee, M.R.: 1545, 1546, 1548
Lee, W.R., Jr.: 1019, 1020, 1021, 1258
Leete, E.: 697, 698, 699, 700
Lefevre, G., Jr.: 1022, 1023
LeRoux, E.J.: 474, 475, 482
Levenbook, L.: 325, 326
Levin, M.D.: 365

Levine, R. P.: 1003
Levinson, Z. H.: 240
Levy, L. W.: 673, 674, 708
Levy, M.: 195, 207
Lewallen, L. L.: 731
Lewis, E. B.: 950
Lichtenstein, E. P.: 476, 580
Lieser, K. H.: 449
Liesering, R.: 408
Lihnell, D.: 407
Lilly, J. H.: 63, 357
Limbaugh, B.: 1259
Limpel, L. E.: 293, 294
Lindell, B.: 1030
Lindquist, A. W.: 8, 9, 10, 74, 90, 327, 335, 374, 466, 469, 470, 477, 478, 479, 488, 515, 594, 1115, 1471, 1472, 1487, 1488
Lindquist, D. A.: 593
Lindsley, D. L.: 951, 1024, 1428
Llewellyn, M.: 617, 618, 619
Lloyd, N.: 1554
Lloyd-Jones, C. P.: 649
Löbbecke, E. A.: 1025, 1026
Lockau, S.: 581, 582
Lockhart, E.: 1522
Loveday, P. M.: 310, 493
Loemker, K.: 827
Long, D. B.: 75
Long, W. H.: 63
Louloudes, S. J.: 241, 244, 542, 600
Lu, C.-P.: 328
Lucas, G. B.: 29
Luce, W. M.: 870, 952, 1398
Lüdicke, M.: 295, 296, 297, 505, 581, 582, 583, 584
Lüers, H.: 1271, 1399
Lüning, K. G.: 905, 953, 976, 977, 1027, 1028, 1029, 1030, 1031, 1205, 1206, 1207, 1208, 1209, 1210, 1285, 1286, 1287, 1288, 1289, 1290, 1400, 1401
Lyon, M. F.: 1391
MacDonald, R.: 480
MacLeod, J.: 76, 77, 1500
Maeyens, E.: 1534
Mahler, H. R.: 429
Mahmoud, K. A.: 253
Maier, P. P.: 68
Mail, G. A.: 81
Makino, S.: 1216
Mandelbaum, Ya. A.: 572, 573, 585
Mann, H. D.: 758
March, R. B.: 126, 507, 557, 567, 595, 623, 624, 625, 626, 635, 636, 639, 640, 641, 642, 643, 644, 745, 754, 755
Marcuzzi, G.: 329
Margem, N.: 343, 344
Margulis, U. Y.: 1527
Marrot Sinex, F.: 709
Martin, A., Jr.: 1032, 1033
Martin, J. J.: 1528
Mastran, J. L.: 1519
Mathis, W.: 78, 79, 114
Matsuda, M.: 186, 188
Matsumura, F.: 768
Mattson, A. M.: 489, 738
Maxon, M. G.: 567, 635, 640, 641, 643
May, S. C., Jr.: 536, 537
Mazia, D.: 772
McCallan, S. E. A.: 36
McCarter, J. A.: 426
McCollister, D. D.: 744
McCormick, J. A.: 796, 797, 798, 799, 800, 801, 802
McCrone, J.: 955
McDonald, H.: 358
McDonald, M. R.: 916
McEnroe, W.: 330, 331
McFarland, R. H.: 575, 1554
McGinnis, A. J.: 193, 194
McGirr, J. L.: 760
McKay, M. A.: 495, 727, 730
McKee, R. W.: 428
McKinney, R. M.: 435
McKinnon, A.: 32
McMaster, R. D.: 230
McMaster-Kaye, R.: 223
McNamara, P. D.: 740
Medical Research Council (M. R. C.): 1034
Meikle, R. W.: 781
Meinke, W. E.: 1536
Melara, H. E.: 1439, 1440, 1441
Mello, L. C. de: 1439, 1440, 1441
Melnikov, N. N.: 572, 573, 585
Melville, C.: 1150
Mengle, D. C.: 568, 731, 736
Meshkov, A. N.: 45
Metcalf, R. L.: 413, 506, 507, 557, 559, 560, 561, 562, 567, 595, 623, 624, 625, 629, 634, 635, 639, 640, 641, 642, 643, 644, 656, 657, 722, 745, 754, 755
Michel, H. O.: 531
Mickey, G. H.: 839, 840
Middleton, L. J.: 11
Midorigawa, S.: 264, 265
Miles, J. W.: 481
Miller, A. C.: 675
Miller, L. P.: 33, 34, 36, 278
Milner, M.: 1545, 1546, 1547, 1548, 1550, 1554
Minamizawa, K.: 292
Mitchell, C. J.: 864, 865
Mitchell, W. C.: 96
Mitlin, N.: 224, 246, 554
Mitryukova, M. S.: 87
Mitsuhashi, J.: 588
Miura, Y.: 196, 224, 228, 229
Mizell, F. M.: 1291
Momose, K.: 196

Monro, J.: 1492
Monroe, R. E.: 238, 241, 242, 243, 244, 245, 553
Monte, G. D.: 1549
Morita, T.: 1351
Moriwaki, D.: 1040, 1212, 1292, 1293
Moriyama, A.: 196
Morris, J. A.: 889, 890, 891
Morrison, F. O.: 467, 474, 475, 482
Mortreuil, M.: 366, 1122, 1260
Mortreuil-Langlois, M.: 1320
Moshman, J.: 1386
Mossige, J.: 393, 394, 397, 398, 841, 842, 1035
Mounter, L. A.: 918
Mühlmann, R.: 508, 645
Mukai, T.: 941
Mulla, M. S.: 126
Muller, H. J.: 843, 935, 936, 965, 1036, 1037, 1038, 1039, 1048, 1049, 1202, 1211, 1261
Müller, I.: 1025, 1026
Müller, K.: 1169, 1170
Munday, W. H.: 1550
Munoz, R. A.: 708
Murata, S.: 872
Murati, K.: 291, 292, 1040, 1212
Murphy, W. E.: 1426, 1427
Murphy, W. W.: 1402
Murray, A., III.: 423, 432
Murray, D. H.: 586
Murray, G. S.: 1538
Myers, R. F.: 1573, 1574, 1575
Myser, W. C.: 281
Nabours, R. K.: 1041
Nagel, R. H.: 64, 70, 354
Nakagawa, S.: 96
Nakagawa, Y.: 184
Nakanishi, Y. H.: 871
Nakajima, M.: 291, 292, 392, 1147, 1148
Nakao, Y.: 1042, 1043, 1044, 1213, 1403
Nandi, A. K.: 1227
Narayanan, E. S.: 133, 134, 1214
Narraway, C. A.: 1365, 1366
Naruse, H.: 527
Naville, B.: 1045
Nawa, S.: 1330
Nehemias, J. V.: 1508, 1528, 1529, 1530, 1531, 1536
Neubert, J.: 1183
Neuenschwander, J. T.: 1453
Neurath, H.: 525
New, W. D.: 1466, 1467, 1469
Newman, J. F.: 440
Newsom, L. D.: 630, 732
Nichev, L.: 18
Nicholas, R. C.: 1515
Nichols, R. E.: 571
Nicholson, J. F.: 1550, 1551, 1552
Nickerson, J. T. R.: 1516
Niedermeyer, R. P.: 514, 596, 746
Nield, P.: 440
Niini, R.: 376
Niles, W. J.: 258, 345, 404
Nishiwaki, Y.: 872
Nishiyama, H.: 262, 263, 264, 265
Nishizawa, T.: 527
Nix, M.: 828, 1385, 1386
Nixon, H. L.: 21, 22, 31, 46
Nordback, K.: 1046
Nourteva, P.: 35
Novotný, I.: 142
Nueslein, R. M.: 489
O'Brien, R. D.: 509, 510, 541, 551, 564, 565, 566, 568, 569
Oertle, E.: 47
Oftedal, P.: 394, 395, 396, 397, 398, 791, 792, 842
Ohnuki, Y.: 1215, 1216
Ohta, N.: 1231
Oi, H.: 1556
Olenov, Yu. M.: 873
Olson, N. A.: 319
Omura, H.: 315, 316
Onimaru, K.: 1072, 1073
Onuchin, A. N.: 85
Oosterbaan, R. A.: 523, 532, 533, 534
Oratz, M.: 197
Ossiannilsson, F.: 407
Oster, I. I.: 919, 954, 1038, 1047, 1049, 1217, 1218, 1219, 1220, 1221, 1222, 1404
Oteifa, B. A.: 1568
Ott, A. H.: 1223
Otter, I. K. H.: 621, 762
Oughton, J.: 339
Pace, A.: 1554'
Paget, O. E.: 1445
Pal, R.: 1050
Palin, D.: 450, 454
Panigel, M.: 283
Pant, C. P.: 515
Pardue, M. L.: 979, 980
Park, P. O.: 620, 621
Park, T.: 1151
Parker, D. R.: 955, 1224, 1225, 1226
Parrish, M. E.: 852
Pashinsky, S. Z.: 1238, 1555
Passonneau, J. V.: 198, 929, 1321, 1326
Pate, B. D.: 793
Patel, N. G.: 468
Paton, J. M.: 1561
Patterson, J. T.: 1108
Paul, W.: 831, 989, 1051
Pavan, C.: 215, 216, 375, 1439, 1440, 1441
Pearce, G. W.: 435, 455, 473, 481, 483, 484, 485, 577, 578, 738
Pedersen, J. R.: 1553
Peel, R.: 89

Pelc, S. R. : 225, 324, 405
Pellegrini, J. P, Jr. : 675
Pelling, G. : 226
Pendleton, R. C. : 19, 30
Peng, C. T. : 367
Percovskii, E. S. : 1517
Peredelsky, A. A. : 893, 937, 1517
Perlowagora-Szumlewicz, A. : 456
Perry, A. S. : 430, 431, 485, 486, 723, 790
Pertsovsky, E. S. : 1518, 1527
Peter, T. , Jr. : 428
Piechowska, M. J. : 275
Pietri-Tonelli, P. , de: 626
Pimentel, D. : 94
Pires des Camargo, M. L. : 1439, 1440, 1441
Plaine, H. L. : 1307, 1308, 1346, 1348, 1349, 1405
Plapp, F. W. : 521, 563, 601
Plaut, W. S. : 772
Plichet, A. : 20
Plotnikova, E. D. : 897
Plus, N. : 1314
Pohley, H. -J. : 1000, 1052, 1053, 1054
Pomerantz, R. : 1519
Porretta, A. : 1520
Posthumus, C. H. : 529, 530
Potekhina : 853, 1176
Potts, W. H. : 874, 1152, 1494
Poulsen, D. F. : 298, 299, 300
Pound, D. W. : 615
Prince, F. M. : 406
Proctor, B. E. : 1521, 1522, 1525
Prout, T. : 1447
Provost, M. W. : 111, 112
Pryor, M. E. : 252
Purohit, S. N. : 1531
Pushnitsya, A. D. : 873
Putnam, L. G. : 103
Pyle, W. B. : 1548
Pyne, C. K. : 1059
Quan, S. F. : 71, 367, 406
Quarterman, K. D. : 78, 79, 114
Quastler, H. : 870, 1303, 1398
Quednau, W. : 135
Radeleff, R. D. : 340, 516, 758
Radhakrishna Murty, R. : 304
Rahalkar, G. W. : 134, 1214
Ramel, C. : 1433, 1434, 1435, 1448
Rancien, P. : 741, 742
Randolph, M. L. : 819
Ratan Lal : 134, 1214
Ratanova, V. F. : 1123
Raudszuz, I. O. : 368
Ray, D. T. : 875, 876, 1055, 1056, 1057
Ray, J. : 1495
Ray, J. W. : 277
Ray-Chaudhuri, S. P. : 399, 1058, 1059, 1227, 1406
Read, J. : 1407
Redemann, C. T. : 781
Reeve, E. C. R. : 1060
Regehr, H. : 1061
Reinius, L. : 35
Rekemeyer, M. L. : 982
Rempel, J. G. : 334
Reynolds, H. T. : 559, 560, 595, 625
Ribbands, C. R. : 46
Richardson, H. H. : 1523
Richman, M. W. : 1143
Riegert, P. W. : 103, 261
Ringler, R. L. : 686
Rings, R. W. : 65, 369, 370
Riordan, D. F. : 102
Ripper, W. E. : 414
Risø Research Establishment, Risø, Denmark,: 1506
Roan, C. C. : 95, 241, 351, 542, 653, 667, 733, 734
Robbins, W. E. : 238, 239, 242, 243, 244, 245, 487, 517, 518, 543, 553, 602, 672, 743
Roberts, R. : 1563
Robertson, A. : 987
Robinson, J. R. : 598, 654
Rodionova, L. Z. : 1341, 1517, 1518
Rodriguez, J. G. : 301
Rogers, R. W. : 906, 920, 921, 922
Rogers, W. I. : 1342, 1343
Rohde, C. J. : 894, 895
Ronzio, A. R. : 423
Rossi, C. : 499
Roth, A. R. : 341, 469, 470, 478, 479, 488
Rothe, C. F. : 489
Rothfels, K. H. : 1062
Rotterdam, J. van : 533, 534
Roussel, J. S. : 630, 732
Rubin, M. A. : 986
Rubinson, A. C. : 290, 300
Rudkin, G. T. : 227
Rudnicki, T. : 844
Rumyantsev, P. D. : 1123, 1517, 1518
Rusakova, N. S. : 254, 255, 256
Russel, S. R. : 11
Russell, W. L. : 845, 1063, 1237
Sacks, J. : 709
Saeki, R. : 203
Saenger, E. L. : 363
Saha, A. K. : 1406
Saito, T. : 527
Sakurai, Y. : 1524
Salthouse, T. N. : 1300, 1301, 1302, 1368, 1369
Sandermann, W. : 1562
Sarkar, I. : 399, 1058
Sarma, P. S. : 304
Sasaki, R. : 302
Sato, J. : 203, 205
Sato, T. : 570, 587, 588
Saul, G. B. , II. : 1064
Saunders, B. C. : 535
Sävhagen, R. : 877
Saxena, P. N. : 134, 1214
Schacht, L. E. : 1065

Schaffer, N. K.: 536, 537, 538, 539, 540
Schalet, A.: 1198
Schinz, H. R.: 896, 1228
Schlinger, E. L.: 127
Schmid, W.: 846, 957
Schmidt, C. H.: 66, 462, 490, 491, 492, 676, 677, 713, 715, 737
Schneiderman, H. A.: 1294
Schonbrod, R. D.: 728
Schoof, H. F.: 69, 80, 81, 82, 83, 84, 89, 108
Schrader, G.: 508
Schubert, G.: 834, 989, 1051, 1182, 1371
Schulz, K. R.: 476
Schuwert, B.: 1289
Scossiroli, R. E.: 1437, 1449, 1450, 1451
Scott, K. G.: 71, 367
Seecof, R. L.: 1453
Selff, R. E.: 427
Semenova, L. M.: 303
Séréno, C.: 878
Sethi, G. R.: 134, 1214
Seto, F.: 1262
Seume, F. W.: 569
Sgourakis, E.: 1358, 1359
Shafkov, A. D.: 85, 87
Shapiro, N. I.: 897
Sharpless, R. V.: 675
Shaw, E. L.: 1066, 1408
Shchenkov, S. N.: 1238, 1555
Shellenberger, J. A.: 1554
Shemanchuk, J. A.: 115, 348
Shenfield, A. J.: 847
Sheppard, C. W.: 775, 1067
Siverly, R. E.: 69, 80, 82, 83
Shigematsu, A.: 200, 224, 228
Shigematsu, H.: 150, 201, 202
Shimura, K.: 203, 204, 205, 208, 209, 210
Shinozaki, K.: 872
Shiroisi, M.: 1524
Shortino, T. J.: 246
Shura-Bura, B. L.: 85, 86, 87, 116
Shvetsova-Shilovskaya, K. D.: 572, 573
Siedek, K.: 747
Siegfried, K. J.: 699
Sigmund, R.: 1337
Silva, G. M.: 151
Simet, L.: 539, 540
Simpson, H. R.: 1496
Sinclair, W. K.: 379
Singleton, W. R.: 1499
Sirlin, J. L.: 360, 773
Sisakyan, N. M.: 206
Sisken, J. E.: 220
Siu, R. G. H.: 1539
Sivarama Sastry, K.: 304
Skipper, C. C.: 1467, 1469
Skraba, W. J.: 706
Slater, M.: 1067
Slipka, J.: 305
Slobodian, E.: 195, 207
Smales, A. A.: 793
Smetana, O.: 803
Smith, A. H.: 88
Smith, A. J.: 646, 647
Smith, C. L.: 1489
Smith, C. N.: 1116, 1296
Smith, J. N.: 457, 458, 459
Smith, R. W.: 102
Smith, W.: 114
Sobels, F. H.: 1409, 1410, 1411, 1412, 1413, 1414, 1415, 1416, 1417, 1418
Söderström, J.: 1287
Solomon, F.: 141
Solt, M. L.: 689, 690
Sommer, K.: 1256
Sorokin, Yu. L.: 45
Souza, H. L. de: 1439, 1440, 1441
Sparrow, A. H.: 1572
Speers, C. F.: 371
Spencer, E. Y.: 598, 748
Spencer, H. C.: 744
Spencer, W. P.: 1453
Sperandio, G. J.: 717
Spindler, M.: 511
Spindler, M. W.: 1563
Spinks, J. W. T.: 12, 14, 261, 282, 334, 348, 350, 358, 377, 586, 788, 789
Stadler, J.: 1309, 1310
Stafford, E. M.: 642, 644
St. Amand, W.: 923, 924, 925, 926, 1229, 1322, 1334
Stahler, N.: 1153
Standen, H.: 441, 442, 443, 444, 445
Stark, H. E.: 406
Stebbins, F. M.: 1041
Steiner, L. F.: 1491
Steffensen, D.: 400
Steger, R.: 1263
Stein, L. H.: 627, 646, 647
Steiner, L. F.: 96, 1493
Stephens, S.: 1129
Stern, C.: 1452
Stern, V. M.: 127
Stich, H.: 306
Stone, W. S.: 927, 938, 946, 1068, 1108, 1156, 1388, 1453, 1454, 1455
Stone, W. E.: 1491
Strangio, V. A.: 958
Strittmatter, C.: 428
Strashnenkov, S. L.: 897
Strømnaes, Ø.: 898, 899
Struckmann, R.: 1389
Strunnikov, V. A.: 900, 959, 960, 1557, 1558
Sudo, M.: 188
Sugahara, T.: 913, 914, 1264
Sugimura, T.: 1043
Sullivan, C. R.: 101, 123
Sullivan, R. L.: 132, 269, 382, 383, 830, 1117, 1295

Sullivan, W. N.: 1296
Sumarokov, G. V.: 1265
Summerson, W. H.: 141, 536, 537
Studier, H.: 1565
Studier, R.: 1565
Sundby, R.: 372
Suomalainen, E.: 376
Surendrana-Than, R.: 258
Suslikova, V. L.: 897
Suto, M.: 184
Suto, S.: 204
Suzuka, I.: 208, 209, 210
Svetovidov, A. Kh.: 345
Tabau, R. L.: 544, 545, 546, 547, 548, 549, 741, 742
Taboada, O.: 1239, 1240, 1242, 1243, 1419
Tabor, L. A.: 239, 242, 245
Tahmisian, T. N.: 848, 928, 929, 1323, 1324, 1325, 1326, 1327, 1328, 1329, 1350, 1420, 1421
Taimr, L.: 412, 415
Taira, T.: 1330, 1351
Takahashi, J.: 332
Takasaki, T.: 1070
Takeyama, S.: 229
Tamagusuku, S.: 872
Tanaka, K.: 1119
Tanaka, M.: 219, 1279
Tanaka, S.: 196, 210
Tanaka, T.: 1119
Tanaka, Y.: 939
Taylor, J. H.: 223, 230
Tazima, Y.: 901, 961, 1043, 1071, 1072, 1073, 1230, 1231, 1232, 1233, 1234, 1235, 1236, 1331, 1332
Tedeschi, R. E.: 681
Telfer, J. D.: 211, 1154, 1157, 1266
Templeton, W. H.: 760
Terriere, L. C.: 728
Terzian, L. A.: 1153, 1333
Theisen, P.: 705
Thélin, L.: 995, 996
Thomas, W. D. E.: 416, 605, 606, 607, 608, 613, 614, 628, 648, 649, 752
Thornburg, W. W.: 424
Thurman, D. C.: 118
Tietz, H.: 561, 562, 645, 650, 651, 652
Timofeeva-Resovskaya, E. A.: 268
Timofeev-Resovsky, N. V.: 268
Tipton, S. R.: 1334
Tkhelidze, L. M.: 1555, 1559
Tobari, I.: 1292, 1293
Toczko, K.: 701
Tolbert, B. M.: 427
Toledo, J. S. de: 1439, 1440, 1441
Tomisek, A. J.: 429
Tomizawa, C.: 307, 570, 587, 588
Totter, J. R.: 1306, 1322
Tracey, Sr. K. M.: 1297
Traut, H.: 1074, 1422
Treherne, J. E.: 143, 144, 145, 146, 147, 148, 213, 308
Treiber, G. H.: 513, 553
Tripp, G. E.: 1522
Troshin, A. S.: 347, 349
Trump, J. G.: 1525
Tsetskhaldze, T. V.: 1555, 1559
Tsujii, T.: 291
Tsukada, M.: 262
Tultseva, N. M.: 879
Turpeinen, O.: 376
Turrell, F. M.: 710, 711
Tuttle, L. W.: 1270, 1339
Tyron, P. F.: 778
Ulrich, H.: 880, 881, 882, 883, 884, 885, 1075, 1077
Umaerus, M.: 945
United States Department of Agriculture (U. S. D. A.): 603
U. S. D. A. (see: United States Department of Agriculture)
Usubillaga, A.: 673, 674
Valencia, J. I.: 1036, 1078, 1079, 1080, 1211
Valencia, R. M.: 1080, 1211
Vande Hey, R. C.: 1081
Vanderplank, F. L.: 373
Van Emden, H. F.: 1543
Vasileva, N. V.: 168, 257
Vasilyan, V. V.: 1124
Vasterling, H. W.: 1423
Verly, W. G.: 158, 160, 161, 162, 164, 165, 280
Viadō, G. B.: 551
Vickery, D. S.: 519
Vigne, J. P.: 544, 545, 546, 547, 548, 549, 741, 742
Virk, D. S.: 1083, 1084
Vogel, H. H., Jr.: 848, 849
Voight, G. K.: 757
Volgina, K. P.: 121
Voronin, M. V.: 342
Vladimirova, I. L.: 585
Vyskrebentseva, E. I.: 152, 153, 154
Waldrop, R. H.: 89
Waldschmidt, M.: 231
Walker, D.: 128
Walker, R. L.: 351
Wallace, B.: 1085, 1086, 1456, 1457, 1458, 1459, 1460, 1461, 1462, 1463, 1464
Wallace, L.: 93
Walz, D. E.: 465
Wang, C. H.: 151, 463, 464
Ward, A. A.: 106, 1087
Ward, C. L.: 1453
Warne, R. J.: 422
Warner, R. M.: 97
Warringa, M. G. P. J.: 522, 523, 524
Washburn, G. E.: 119
Wasserman, M.: 1121
Watanabe, K.: 316

Watanabe, Y.: 1524
Watson, M. A.: 31
Weatherley, A.: 727
Weber Kaye, N.: 1014
Wedding, R. T.: 629, 756
Weed, R. M.: 33, 34, 278
Weidhaas, D. E.: 490, 491, 492, 737, 1116
Weinstein, J.: 1294
Weischer, B.: 1576
Weiss, G. J.: 1533
Weiss, U.: 689
Welch, H. E.: 120, 129
Welshons, W. J.: 1237
Werum, L. N.: 424
West, A. S.: 39, 40
West Africa Cacao Research Institute: 37, 38
Weygand, E.: 581
Weygand, F.: 231
Wharton, D. R. A.: 887, 1335
Wharton, M. L.: 887, 1335
Wheeler, B.: 309
Wheeler, H. E.: 47
Wheeler, M. R.: 1453
Whitaker, W. O.: 446
Whiting, A. R.: 930, 931, 962, 967, 978, 1093, 1267, 1336, 1424, 1425, 1426, 1427
Whiting, P. W.: 1056, 1089, 1090, 1091, 1092, 1094
Whittacker, M.: 615
Whittinghill, M.: 1095, 1096, 1097
Wiant, D.: 1239, 1240, 1242, 1243, 1361
Wilcox, A.: 384
Williams, C. M.: 198, 211, 212
Williams, D. L.: 432
Wilson, E. O.: 48, 56
Wilson, F. D.: 1453, 1454, 1455
Wilson, L. P.: 289, 391, 712, 1319
Wing, R. E.: 684
Winterfeld, G.: 1271
Winteringham, F. P. W.: 155, 156, 310, 311, 312, 417, 418, 433, 436, 437, 493, 494, 495, 678, 679, 724, 725, 727, 729, 730, 760, 761, 764, 767, 782, 783, 784, 785, 786, 787
Winton, M.: 559, 560
Witt, J. M.: 471
Witte, E.: 850, 1337
Woestijne, N. van de: 1298
Wolf, A. P.: 690
Wolf, J. P., III.: 636, 754
Wolfe, R. A.: 1528
Wolff, S.: 1428
Wood, E. M.: 1011, 1012
Wood, F. C.: 1577
Wood, P. S.: 227
Wood, T. H.: 1130
Worthy, T. S.: 535
Wright, B. J.: 1329, 1350
Wyatt, G. R.: 313
Yagi, N.: 1299
Yamafuji, K.: 315, 316
Yanagizawa, T.: 262
Yanders, A. F.: 840, 1098, 1099, 1100, 1101, 1102, 1103, 1104, 1268, 1338
Yates, W. W.: 74, 90, 374, 479
Yeomans, A. H.: 1131
Yoshida, R.: 292
Yoshida, Y.: 1105, 1106, 1212, 1293
Yost, H. T., Jr.: 1003, 1429
Young, F. G.: 706
Yu-Ying Fu: 820
Zeid, M. M. L.: 680
Zhadin, V. I.: 349
Zeumer, H.: 759
Zimmering, S.: 1049
Zirkle, R. E.: 851, 852
Zunick, M. J.: 1554

# SUBJECT INDEX


| | | |
|---|---|---|
| Acanthoscelides obtectus | β, x | 1419 |
| | β, x | 1357 |
| | β | 1243 |
| | β | 1242 |
| | | 893 |
| Acarus siro | β | 1515 |
| Acethion | $P^{32}$ | 541 |
| | $P^{32}$ | 563 |
| Acyrthosiphum onobrychidis see Aphid | | |
| Adalia bipunctata | $Ta^{182}$ | 60 |
| Aëdes spp. see Mosquito | | |
| Aeschna spp. | $I^{131}$ | 293 |
| Agriotes obscurus (see also Wireworm) | | 121 |
| Agrotis orthogonia (see also Cutworm) | $Co^{60}$ | 358 |
| Aldrin | $C^{14}$ | 436 |
| | $C^{14}$ | 435 |
| Allethrin | $C^{14}$ | 666 |
| | $C^{14}$ | 667 |
| | $C^{14}$ | 668 |
| | $C^{14}$ | 670 |
| | $C^{14}$ | 672 |
| | $C^{14}$ | 723 |
| Alpha particles | | |
| Dosimetry | | 920 |
| | | 921 |
| Effects | | 986 |
| | | 922 |
| | | 906 |
| | | 851 |
| Amblyomma | | |
| - americanum | $P^{32}$ | 363 |
| - maculatum | $P^{32}$ | 519 |
| American Cyanamid 12880 | $P^{32}$ | 737 |
| Amiton | $P^{32}$ | 644 |
| | $P^{32}$ | 512 |
| Anagasta kühniella see Ephestia kühniella | | |
| Anasa tristis (squash bug) | $P^{32}$ | 319 |
| | $I^{131}$ | 293 |
| Angumois grain moth see Sitotroga cerealella | | |
| Anobium punctatum (common furniture beetle) | γ | 1246 |
| | γ | 1245 |
| Anopheles spp. see Mosquito | | |
| Ant | | |
| Camponotus ligniperda | $P^{32}$ | 49 |
| Crematogaster lineolata | $I^{131}$ | 48 |
| Formica spp. | $P^{32}$ | 49 |
| | $P^{32}$ | 50 |
| Formica spp. | $I^{131}$ | 48 |
| | $P^{32}$ | 51 |
| | $P^{32}$ | 317 |
| | $P^{32}$ | 54 |
| | $P^{32}$ | 55 |
| Ant | | |
| Lasius | | |
| - niger | | 21 |
| - minutus | $P^{32}$ | 62 |
| Monomorium pharaonis | γ | 888 |
| Pogonomyrmex badius | $I^{131}$ | 48 |
| Review | | 53 |
| General | $P^{32}$ | 32 |
| Anthonomus grandis (boll weevil) | $Co^{60}$ | 351 |
| | γ | 1115 |
| Aphid | $P^{32}$ | 135 |
| Acyrthosiphum onobrychidis | $P^{32}$ | 609 |
| Anuraphis sp. | $P^{32}$ | 30 |
| Aphis fabae | $P^{32}$ | 609 |
| | $P^{32}$ | 750 |
| | $P^{32}$ | 407 |
| | $P^{32}$ | 751 |
| | $P^{32}$ | 649 |
| | $P^{32}$ | 753 |
| | $P^{32}$ | 25 |
| | $P^{32}$ | 632 |
| | $P^{32}$ | 21 |
| | $P^{32}$ | 22 |
| | $P^{32}$ | 24 |
| - gossypii | $S^{35}$ | 630 |
| - medicaginis | $P^{32}$ | 626 |
| - leguminosae | $P^{32}$ | 366 |
| Brevicoryne brassicae | $P^{32}$ | 23 |
| | | 131 |
| | | 657 |
| Liosomaphis abietina | $P^{32}$ | 26 |
| Myzus | | |
| - ascalonicus | $P^{32}$ | 27 |
| | $P^{32}$ | 28 |
| - persicae | $P^{32}$ | 108 |
| | $P^{32}$ | 609 |
| | $P^{32}$ | 23 |
| | $P^{32}$ | 31 |
| | $P^{32}$ | 29 |
| | $P^{32}$ | 27 |
| | $P^{32}$ | 28 |
| Predators | $S^{35}$ | 732 |
| | $Ta^{182}$ | 60 |
| Apis mellifera: see Bee | | |
| Apotettix eurycephalus see also Grasshopper | x | 1041 |
| Arctia caja | $S^{35}$ | 124 |
| Arsenic, radioisotope of | $As^{76}$ | 793 |
| Attagenus piceus | γ | 1252 |
| | γ | 1253 |

| | | |
|---|---|---|
| Bacillus Rossii | β, γ, x | 838 |
| Barium, radioisotope of | $Ba^{140}$ | |
| Blattella germanica | | 337 |
| Drosophila | | 249 |
| | | 299 |
| Musca domestica | | 337 |
| Bayer L 13/59 | | |
| see Dipterex | | |
| Bayer 21/199 | | |
| see Co-Ral | | |
| Bayer 19639 | | |
| see Di-Syston | | |
| Bayer 22408 | $P^{32}$ | 726 |
| Bayer 25141 | $P^{32}$ | 656 |
| | $P^{32}$ | 657 |
| Bee | | |
| Contamination (nectar) | $P^{32}$ | 613 |
| | $P^{32}$ | 614 |
| Labelling | $P^{32}$ | 368 |
| queens | | 368 |
| workers | $Au^{198}$ | 353 |
| Metabolism | | 214 |
| Radiation effects | β | 777 |
| | γ | 1258 |
| | γ | 1019 |
| | γ | 1020 |
| | x | 1021 |
| | x | 1135 |
| | x | 1248 |
| disease, on | β | 1564 |
| | γ | 1565 |
| Beta-rays | | |
| Bees | | |
| contaminated combs | | 1564 |
| Cockroach | | |
| longevity | | 887 |
| sex-attractant | | 1335 |
| Drosophila | | |
| chromosome breaks | | 817 |
| comparison of radiations | | 851 |
| | | 1186 |
| dosimetry | | 1169 |
| | | 1170 |
| eclosion decay | | 1268 |
| general radiation effects | | |
| eggs or larvae | | 1182 |
| | | 573 |
| | | 1051 |
| | | 821 |
| | | 1228 |
| pupae | | 822 |
| mutagenesis | | |
| ingested radioisotopes | $P^{32}$ | 397 |
| | $P^{32}$ | 398 |
| | $P^{32}$ | 393 |
| | $P^{32}$ | 396 |
| external sources | | 989 |
| | | 1372 |
| external sources | | 815 |
| | * | 816 |
| | * | 834 |
| | | 1010 |
| | * | 824 |
| | * | 847 |
| | | 814 |
| | * | 825 |
| | * | 826 |
| | | 842 |
| | | 395 |
| | * | 846 |
| | | 1202 |
| | | 1104 |
| Flies | | 305 |
| | | 844 |
| Grain and food pests | | 1525 |
| | | 1357 |
| | | 1239 |
| | | 1243 |
| | | 1241 |
| | | 1240 |
| | | 1419 |
| | | 1242 |
| | | 1522 |
| | | 1342 |
| | | 1343 |
| | | 1340 |
| | | 1517 |
| | | 1214 |
| | | 1515 |
| | | 776 |
| Grasshopper | | 1325 |
| | * | 828 |
| | * | 827 |
| | | 775 |
| | | 837 |
| | | 1204 |
| | | 871 |
| Habrobracon | | |
| Development | | 1276 |
| | | 811 |
| egg production and hatchability | | 383 |
| | | 1137 |
| | | 1138 |
| morphology | | 1032 |
| relative effects (different radiations) | * | 1117 |
| | * | 810 |
| | * | 811 |
| | * | 383 |
| | * | 830 |
| | * | 1137 |
| | * | 1138 |
| radioisotopes (ingested) | $P^{32}$ | 1033 |
| | $P^{32}$, $Sr^{89}$ | 830 |
| sterilizing effects | | 1117 |
| | | 830 |
| Mite | | 1515 |


*) Some comparison with other ionizing radiation(s)

Silk worm
effect on germ cells 1233
recovery 838
virus multiplication 314
BHC and isomers 723
$C^{14}$ 440
$C^{14}$ 450
$C^{14}$ 454
$C^{14}$ 441
$C^{14}$ 442
$C^{14}$ 443
$C^{14}$ 446
$C^{14}$ 439
$C^{14}$ 444
$C^{14}$ 447
$C^{14}$ 445
$C^{14}$ 448
$C^{14}$ 449
$Cl^{36}$ 778
$Cl^{36}$ 451
$Cl^{36}$ 779
$Cl^{36}$ 452
$Cl^{36}$ 439
$Cl^{36}$ 453
$Cl^{36}$ 455
$Cl^{36}$ 780
$Cl^{36}$ 431
Th 456
438
Application to
houseflies 441
443
444
440
439
445
mosquitoes 442
Triatoma infestans 456
Analytical studies 455
454
449
779
780
1533
450
451
452
453
Residue analysis 447
Synthesis 1563
Systemic action in plants 446
Blabera fusca x 1320
Blaberus craniifer x 1284
Blatta orientalis $P^{32}$ 297
$P^{32}$ 296
Blattella germanica $Ba^{140}$ 337
$C^{14}$ 236
$C^{14}$ 242
$C^{14}$ 633
$C^{14}$ 704
Blattella germanica $Ca^{45}$ 337
$Cd^{115}$ 337
$Ce^{144}$ 367
$Fe^{59}$ 337
$H^{3}$ 243
$I^{131}$ 293
$I^{131}$ 337
$P^{32}$ 246
$P^{32}$ 509
$P^{32}$ 566
$P^{32}$ 541
$S^{35}$ 247
$S^{35}$ 278
$S^{35}$ 276
$Sr^{89}$ 402
$Zn^{65}$ 337
insecticide metabolism
Malathion 566
509
OP-insecticides 541
Sevin 704
Systox 633
Labelling $Ce^{144}$ 367
Metabolism 247
278
246
293
236
242
243
Radiation effects 1291
$\gamma$ 888
ingested radioisotopes $Sr^{89}$ 402
Blow flies
see Calliphora
Boll weevil
see Anthonomus grandis
Bombyx mori
Genetics 934
1082
1083
1084
959
960
Metabolism and biochemistry 292
392
158
174
175
206
152
157
201
160
162
188
154
171
199
163

Metabolism and biochemistry 164
177
178
179
187
170
169
150
202
200
Silk protein (particular emphasis on) 207
203
172
173
229
204
176
165
180
181
182
183
184
187
186
224
228
205
210
209
208
192
Radiation effects 903
959
904
960
900
β 838
γ 1559
γ 1148
γ 1147
x 1282
x 1283
x 1136
x 1247
x 1279
x 1082
x 1083
x 1084
$Ca^{45}$ 302
$Ca^{45}$ 263
$Ca^{45}$ 264
$Ca^{45}$ 265
Review 328
Virus 314
315
1317

Book lice
see Psocoptera
Bracon gelechiae $P^{32}$ 134
Brachycentrus (caddis fly) $P^{32}$ 42
Brevicoryne brassicae
see Aphid
Bromine, radioisotope of $Br^{82}$
DDT analogues 784
760
761
493
494
786
787
432
ethylene dibromide 766
Periplaneta americana 294

C.

Cabbage moth
see Hylemyia brassicae
Cabinet beetle
see Trogoderma versicolor
Caddis fly
see Halesus interpunctatus
Cadelle beetle
see Tenebriodes mauritanicus
Cadmium, radioisotope of $Cd^{115}$ 337
Caesium, radioisotope of $Cs^{137}$
grasshopper 252
mosquito, caddis fly 267
268
266
grain disinfestation 1518
1538
Calandra (Sitophilus)
- granaria
radiation effects 893
β 1340
γ 1144
γ 1304
γ 889
γ 890
γ 891
x 1341
x 1260
x 1122
- oryzae
radiation effects 893
γ 1518
γ 1304
γ 889
γ 890
γ 891
x 1518
x 1541
Calcium, radioisotopes of $Ca^{45}$
Bombyx mori 302
263
264
265
Conotrachelus nenuphar 370
369

Drosophila 299
290
Flies 78
347
337
Habrobracon 383
400
Pieris rapae 1299
Roaches 337
Trees 352
Calliphora (blow flies) $P^{32}$ 347
$P^{32}$ 76
- erythrocephala $P^{32}$ 77
- vomitoria $P^{32}$ 349
$P^{32}$ 77
Callitroga
- americana x 1110
labelling $P^{32}$ 340
- erythrocephala
metabolism $C^{14}$ 240
- hominivorax
mass rearing 1478
1489
radiation effects x, γ 1111
γ 1471
γ 1466
γ 1472
1467
1121
1481
1109
1469
1483
1488
1484
1436
(cf. Part II, II A: 1)
review articles (sterile male technique) 1482
1475
1476
1477
1470
1485
- macellaria
tagging $P^{32}$ 336
dispersal $P^{32}$ 79
$P^{32}$ 78
$P^{32}$ 84
Callosobruchus chinensis (weevil) 588
Caloglyphus mycophagus
see Mite
Calotermes flavicollis
see Termites
Camnula pellucida
see Grasshopper
Camponotus ligniperda
see Ants
Carabus
- auratus $P^{32}$ 297
- hortensis $P^{32}$ 297
- ullrichi $P^{32}$ 297
Carbon, radioisotope of $C^{14}$
Aldrin 436
435
Allethrin 667
668
666
672
670
BHC
Analytical studies 450
454
449
Metabolism 446
439
447
448
Synthesis 450
Bromacetic acids 499
500
Carbamate 702
Chlorobenzene 459
457
458
DDT
Analysis 738
Grain pests 477
468
Musca domestica 469
478
479
488
474
475
485
728
471
Mosquitoes 466
737
490
491
492
Pediculus humanus humanus 486
Persistence in soils 472
Physical properties 460
462
461
Plants, translocation in 476
Roaches 464
487
477
471
Synthesis 465
480
483
484
463
432
Dieldrin 435
Dimethyl phthalate 716

Dimethyl phthalate 717
Dolycoris baccarum 35
Endrin 497
498
Fumigants
Cyanides
$HC^{14}N$ 427
421
$KC^{14}N$ 426
419
$NaC^{14}N$ 420
Methyl bromide 423
761
764
765
767
Ethylene dioxide 429
422
424
Carbon tetrachloride 744
Isodrin 496
Nicotine
Analysis 683
685
692
Metabolism 995
684
681
696
(Bio)synthesis 694
682
687
693
697
686
698
688
689
700
691
690
701
Piperonyl butoxide 671
676
677
Pyrethrins 675
678
680
673
674
Pyrethroids 679
Repellent 717
714
715
Rotenone 708
Sevin 706
703
704
Systox 633
Thiodan 501
Carbon tetrachloride $C^{14}$ 744
Carbophos $P^{32}$ 574
Celerio euphorbiae (hawk moth) $P^{32}$ 274
275
Ceratitis capitata $P^{32}$ 96
$\gamma$ 1493
92
see also Fruit flies
Cerium $Ce^{144}$
Labelling
(fleas, mosquitoes, roaches) 367
(flies, mosquitoes) 267
268
266
Lygus oblineatus 36
Chilo suppressalis $C^{14}$ 191
588
Chipman R-6200 $P^{32}$ 658
Chironomus
- tentans $H^3, S^{35}, C^{14}$ 226
- thummi thummi x 948
see also Metriocnemus hygropetricus
Chloealtis conspersa
see Grasshopper
Chlorine, radioisotope of $Cl^{36}$
BHC
Analysis 778
779
455
780
Insect resistance 431
Metabolism 439
Conotrachelus nenuphar 369
Lindane 431
Chlorobenzene $C^{14}$ 459
$C^{14}$ 457
$C^{14}$ 458
Chlorothion $P^{32}$ 665
Chortophaga viridifasciata
see Grasshopper
Chrysopa oculata $S^{32}$ 732
Cicada
see Tibicen spp
Cigarette beetle
see Lasioderma serricorne
Cimex lectularius $\gamma$ 888
$P^{32}$ 519
Cinerins $C^{14}$ 671
$C^{14}$ 680
Cobalt, radioisotope of $Co^{60}$
Anthonomus grandis 351
Bombyx mori 332
Conotrachelus nenuphar 370
369
Pissodes strobi 101
Rhyazionia buoliana 123
Wire- and cutworms 350
125
358
788

| | | |
|---|---|---|
| Wire- and cutworms | | 357 |
| | | 63 |
| Coccinella septempunctata | $Ta^{182}$ | 59 |
| | | 60 |
| Coccinellidae | $S^{35}$ | 732 |
| | $Ra^{226}$ | 58 |
| | $Ta^{182}$ | 59 |
| | $Ta^{182}$ | 60 |
| Cockroach | | |
| see Blaberus craniifer | | |
| Blattella germanica | | |
| Leucophaea maderae | | |
| Periplaneta americana | | |
| | $P^{32}$ | 808 |
| | $P^{32}$ | 140 |
| | $S^{35}$ | 270 |
| Collembola | γ | 1432 |
| | γ | 2 |
| Compound 2046 | $P^{32}$ | 659 |
| | $P^{32}$ | 660 |
| Confused flour beetle | | |
| see Tribolium confusum | | |
| Conotrachelus nenuphar (plum curculio) | $P^{32}$ | 65 |
| | $P^{32}$, $S^{35}$, $Cl^{36}$, $Ca^{45}$, $Co^{60}$, $Zn^{65}$, $Sr^{89}$, $I^{131}$ | 369 |
| | various | 370 |
| Copper, radioisotope of | $Cu^{64}$ | |
| Drosophila, metabolism | | 298 |
| | | 299 |
| | | 300 |
| Co-Ral (Bayer 21/199) | $P^{32}$ | 515 |
| | $P^{32}$ | 737 |
| | $P^{32}$ | 513 |
| | $P^{32}$ | 514 |
| | $P^{32}$ | 517 |
| | $P^{32}$ | 518 |
| | $P^{32}$ | 516 |
| | $P^{32}$ | 758 |
| | $P^{32}$ | 519 |
| Corcyra cephalonica (rice moth) | | |
| Toxicity | $Zn^{65}$ | 304 |
| Radiation effects | β | 1214 |
| Cotton moth | | |
| see Pectinophora malvella | | |
| Crane fly | | |
| see Tipula paludosa | | |
| Ctenicera aeripennis destructor | | |
| see Wireworm | | |
| Culex | | |
| see Mosquito | | |
| Cutworm | | |
| Agriotes orthogonia | $Co^{60}$ | 358 |
| Euxoa ochrogaster | $Co^{60}$ | 358 |

D.

| | | |
|---|---|---|
| Dacus | | |
| - cucurbitae | γ | 1493 |
| | $P^{32}$ | 96 |
| - dorsalis | $P^{32}$ | 95 |
| - dorsalis | γ | 1171 |
| | γ | 1493 |
| - orientalis | $P^{32}$ | 96 |
| - tryoni | γ | 1492 |
| see also Fruit flies | | |
| Dahlbominus fuscipennis | | |
| Radiation effects | x | 1244 |
| | x | 1365 |
| | x | 1366 |
| | x | 1367 |
| Radiographic technique | x | 1560 |
| DDT | | |
| $C^{14}$, see under $C^{14}$ | | |
| DDT analogues | $I^{131}$ | 473 |
| | $Br^{82}$ | 784 |
| | $Br^{82}$ | 760 |
| | $Br^{82}$ | 761 |
| | $Br^{82}$ | 493 |
| | $Br^{82}$ | 494 |
| | $Br^{82}$ | 786 |
| | $Br^{82}$ | 787 |
| Effects on insect metabolism | | 307 |
| (labelled pool technique, $P^{32}$) | | 277 |
| | | 138 |
| | | 495 |
| DDVP | $P^{32}$ | 554 |
| | $P^{32}$ | 557 |
| | $P^{32}$ | 723 |
| Death watch beetle | | |
| see Xestobium rufovillosum | | |
| Deilephila euphorbiae | $P^{32}$ | 297 |
| Delnav (Hercules AC-528) | $P^{32}$ | 520 |
| | $P^{32}$ | 749 |
| | $P^{32}$ | 739 |
| | $P^{32}$ | 758 |
| | $P^{32}$ | 521 |
| | $P^{32}$ | 723 |
| Demeton | $P^{32}$ | 639 |
| | $P^{32}$ | 641 |
| | $P^{32}$ | 648 |
| | $P^{32}$ | 628 |
| | $P^{32}$ | 649 |
| | $P^{32}$ | 636 |
| | $P^{32}$ | 632 |
| | $P^{32}$ | 754 |
| | $P^{32}$ | 595 |
| Dendroctonus | | |
| - engelmanni | $I^{131}$ | 64 |
| | $Sc^{46}$, $Rb^{86}$, $Ag^{110}$, $Ir^{192}$, $I^{131}$ | 354 |
| | | 98 |
| - frontalis | $Ir^{192}$ | 371 |
| - pseudotsugae | $P^{32}$ | 260 |
| Dermacentor variabilis (Tick) | $C^{14}$ | 190 |
| Dermestes | | |
| - ater | γ | 1252 |
| | γ | 1253 |
| - vulpinus | $C^{14}$ | 233 |
| DFP | $P^{32}$ | 740 |
| | $P^{32}$ | 535 |

DFP — $P^{32}$ 531; $P^{32}$ 528; $P^{32}$ 522; $P^{32}$ 536; $P^{32}$ 537; $P^{32}$ 523; $P^{32}$ 538; $P^{32}$ 532; $P^{32}$ 534; $P^{32}$ 525; $P^{32}$ 526; $P^{32}$ 524; $P^{32}$ 527; $P^{32}$ 539; 727; $P^{32}$ 533; $P^{32}$ 540; $P^{32}$ 529; $P^{32}$ 530

Diazinon
- Analysis — $P^{32}$ 544; $P^{32}$ 545
- Metabolism — $P^{32}$ 543; $P^{32}$ 741; $P^{32}$ 742; $P^{32}$ 568; $P^{32}$ 736; $P^{32}$ 541
- Synthesis — $P^{32}$ 545; $P^{32}$ 547; $P^{32}$ 542; $P^{32}$ 546; $P^{32}$ 548; $P^{32}$ 549

Dicapthon — $P^{32}$ 665

Dieldrin — 434; $Br^{82}$, $S^{35}$ 437; $C^{14}$ 435; $Br^{82}$, $Cl^{36}$, $S^{35}$, $C^{14}$ 723; 495

Diethyltoluamide — 812; $C^{14}$ 715

Diisopropylphosphorofluoridate
see DFP

Dimefox — $P^{32}$ 762; $P^{32}$ 604

Dimethoate — $P^{32}$ 552; $P^{32}$ 553; $P^{32}$ 763; $P^{32}$ 551; $P^{32}$ 541

Dimethylphthalate — $C^{14}$ 716; $C^{14}$ 717

Dinitrophenol (DNP) — $P^{32}$ 709; $P^{32}$ 712; $P^{32}$ 707; 142

Dipterex
- Metabolism, toxicity — $P^{32}$ 743; $P^{32}$ 555
- Metabolism, toxicity — $P^{32}$ 556; 66; $P^{32}$ 557; $P^{32}$ 723
- Synthesis — $P^{32}$ 554

Di-Syston (Bayer 19639) — $P^{32}$ 560; $P^{32}$ 595; $S^{35}$ 558; $P^{32}$ 559

DNP: see Dinitrophenol

Dolycoris baccarum (wheat bug) — $C^{14}$ 35; $C^{14}$ 356

Dow ET-57 — $P^{32}$ 602; $P^{32}$ 603; $P^{32}$ 665

Dragon fly
see Aeschna sp

Drosophila
Work on radiation effects from normal external sources has not been indexed separately. (See Part II, particularly under I. A:1, B, C:1-4 and D.) Radioisotope studies (labelling, distribution and metabolism) and genetic effects from attached or ingested radioisotopes are cited under Fruit flies.

Dytiscid larvae — $P^{32}$ 61

## E.

E 605 — $P^{32}$ 584

E 1059
see Systox, active substance of

Endrin — $C^{14}$ 497; $C^{14}$ 498

Ephestia kühniella — 1515; x 1336; x 962; x 1000; x 1052; x 1053; x 1280; x 1054; x 1376; x 1025; (ingested) $P^{32}$ 132; γ 1026; γ 1298
- appraisal of sterile male technique 1114

EPTC — $S^{35}$ 705

Ethylene dioxide — $C^{14}$ 429; $C^{14}$ 422; $C^{14}$ 424

Euchaetias egle — $I^{131}$ 293

European corn borer
see Pyrausta nubilalis

Eurygaster integriceps (grain bug) — $P^{32}$ 694; $P^{32}$ 664

| | | |
|---|---|---|
| Euxoa ochrogaster | | |
| see Cutworm | | |
| Exenterus candensis | x | 1560 |

F.

| | | |
|---|---|---|
| Fannia | | |
| - canicularis | $P^{32}$ | 338 |
| - pusio | $P^{32}$ | 84 |
| Firebrat | | |
| see Thermobia domestica | | |
| Fleas | | |
| Hystrichopsylla sp | $Ce^{144}$ | 367 |
| Malaraeus telchinum | $Ce^{144}$ | 71 |
| | $Ce^{144}$ | 406 |
| Xenopsylla cheopis | $Ce^{144}$ | 367 |
| | various | 1296 |
| Flies | | |
| see under | | |
| Calliphora | | |
| Callitroga | | |
| Fannia | | |
| Fruit fly | | |
| Glossina | | |
| Hexagonia | | |
| Hylemyia | | |
| Hypoderma | | |
| Lucilia | | |
| Musca domestica | | |
| Phoenicia | | |
| Phormia | | |
| Flour mite | | |
| see Acarus siro | | |
| Tyroglyphus farinae | | |
| Formica spp | $I^{131}$ | 56 |
| | $P^{32}$ | 48 |
| | $P^{32}$ | 51 |
| | $P^{32}$ | 55 |
| - rufopratensis minor | $P^{32}$ | 49 |
| - pratensis | $P^{32}$ | 49 |
| - rufa | $P^{32}$ | 50 |
| - polyctena | $P^{32}$ | 317 |
| | $P^{32}$ | 54 |
| Fruit fly | | |
| Ceratitis capitata (Mediterranean fruit fly) | $\gamma$ | 1493 |
| | $P^{32}$ | 96 |
| | | 92 |
| Dacus | | |
| - cucurbitae (melon fruit fly) | $\gamma$ | 1493 |
| | $P^{32}$ | 96 |
| - dorsalis (oriental fruit fly) | $P^{32}$ | 95 |
| | $\gamma$ | 1171 |
| | $\gamma$ | 1493 |
| | $P^{32}$ | 96 |
| - orientalis | $P^{32}$ | 96 |
| - tryoni | $\gamma$ | 1492 |
| Drosophila | $\gamma$ | 1493 |
| | | 1490 |
| | | 1491 |
| | $\beta$ | 844 |
| | $P^{32}$ | 379 |
| Drosophila | $P^{32}$ | 282 |
| | $P^{32}$ | 95 |
| | $P^{32}$ | 378 |
| | $P^{32}$ | 94 |
| | $P^{32}$ | 390 |
| | $C^{14}$ | 360 |
| | $P^{32}$ | 96 |
| - ananassae | $Cu^{64}$ | 298 |
| | | 299 |
| - funebris | $Fe^{59}$ | 300 |
| - gibberosa | $I^{131}$ | 309 |
| - melanogaster | | |
| genetic effects of | $P^{32}$ | 380 |
| radioisotopes | $P^{32}$ | 385 |
| | $P^{32}$ | 377 |
| | $P^{32}$ | 386 |
| | $P^{32}$ | 387 |
| | $P^{32}$ | 389 |
| | $P^{32}$ | 388 |
| | $C^{14}$ | 376 |
| | $P^{32}$ | 390 |
| labelling | $P^{32}$ | 95 |
| | $P^{32}$ | 94 |
| | $C^{14}$ | 360 |
| | $P^{32}$ | 96 |
| metabolism | $Cu^{64}$ | 298 |
| | $Fe^{59}$ | 299 |
| | $Cu^{64}$ | 300 |
| | $C^{14}$ | 141 |
| | $P^{32}$ | 284 |
| | $P^{32}$ | 285 |
| | $P^{32}$ | 286 |
| | $P^{32}$ | 287 |
| | $P^{32}$ | 288 |
| | $P^{32}$ | 283 |
| | $C^{14}$ | 324 |
| | $Ca^{45}$ | 290 |
| | $H^{3}$ | 220 |
| Dinitrophenol | $P^{32}$ | 712 |
| Parathion | $P^{32}$ | 581 |
| - pseudoobscura | $P^{32}$ | 707 |
| - robusta | $Cu^{64}$ | 298 |
| | $Fe^{59}$, $Cu^{64}$ | 299 |
| | $Cu^{64}$ | 300 |
| | $Ba^{14}$ | 249 |
| - simulans | $P^{32}$ | 284 |
| | $P^{32}$ | 286 |
| | $P^{32}$ | 287 |
| | $P^{32}$ | 288 |
| -virilis | $Cu^{64}$ | 298 |
| | $Fe^{59}$ | 299 |
| | $P^{32}$ | 380 |
| Rhagoletis | | |
| - cingulata (cherry fruit fly) | $P^{32}$ | 93 |
| - completa | $P^{32}$ | 91 |

G.

| | | |
|---|---|---|
| Galleria mellonella (greater wax moth) | $I^{131}$ | 293 |
| Gay harlequin caterpillar | | |
| see Euchaetias egle | | |

"Gammexane"
see BHC
Glossina sp. 1495
- morsitans γ 1152
γ 874
- palpalis γ 1494
Gnat
see Hippelatus
Gold, radioisotope of $Au^{198}$
Spray 794
Bees 353
Gonepterix rhamni $C^{14}$ 231
Grain and grain products
Detection of infestation of - x 1545
x 1547
x 1540
x 1544
x 1546
x 1550
x 1551
x 1552
1554'
Evaluation of infestation of - $P^{32}$ 1554
Insecticide residues in - $Br^{82}$ 760
$Br^{82}$ 761
$C^{14}$ 702
$C^{14}$ 767
$C^{14}$ 764
$C^{14}$ 765
$Br^{82}$ 766
$C^{14}$ 421
Irradiation of 1521
1533
1535
1528
1536
1529
1532
1530
1524
1527
1508
1531
1113
1537
1501
1517
1509
1510
1518
1511
1512
See also under beta-rays
Pests of -
For individual pests, see
Acanthoscelides obtectus
Acarus siro
Calandra
Corcyra cephalonica
Dolycoris baccarum
Ephestia kühniella
Eurygaster integriceps
Lygus rugulipennis
Oryzaephilus surinamensis
Plodia interpunetella
Pyrausta nubilalis
Rhyzopertha dominica
Sitophilus
Sitotroga cerealella
Tenebrio molitor
Tenebriodes mauritanicus
Tribolium confusum
Tyroglyphus farinae
Tyrophagus noxius
Radioisotopes used on pests of -
$P^{32}$ 319
$C^{14}$ 35
$P^{32}$ 128
$Zn^{65}$ 304
$C^{14}$ 232
$C^{14}$ 468
Radiosensitivity of pests of -
x 1336
β, x 1357
β 1239
β 1240
x 1052
x 1419
β 1243
β 1242
x 855
x 1053
x 1554'
x 856
γ 1524
γ 1275
γ 1253
β 1342
1304
γ 1144
γ 1150
x 1054
x 1341
x 1123
γ 1265
x 1025
x 1260
x 1122
x 1515
x 1516
x 1297
γ 889
γ 890
γ 891
1114
x 665
γ 1298
γ 886
Grain bug
see Eurygaster integriceps

Grain mite
see Tyrophagus noxius
Grasshopper α 920
α 921
$P^{32}$ 341
$P^{32}$ 103
x 1125
x 915
x 1353
x 1421
x 965
x 1215
x 1216
Apotettix eurycephalus x 1041
Camnula pellucida $P^{32}$ 261
$P^{32}$ 102
Chloealtis conspersa x 1062
Chortophaga viridifasciata β 1385
β 828
β 827
β 775
β 837
γ 907
γ 908
x 907
x 1385
x 912
x 828
x 827
x 775
x 1386
x 923
x 1306
x 1322
x 924
x 1334
x 916
x 942
x 925
x 909
x 217
x 926
x 1408
x 910
x 1259
x 1066
902
Melanoplus
- bilaturatus $P^{32}$ 102
- femur-rubrum x 916
- differentialis β 1325
γ 848
γ 849
n 848
n 849
n 820
x 1323
x 1324
x 928
x 929
- differentialis x 848
x 1326
x 1327
x 1328
x 820
x 1329
x 1350
x 955
Podisma sapporense β 1204
γ 871
Romalea microptera $Cs^{137}$ 252
Trimerotropis maritima x 916
Gypsy moth
see Porthetria dispar
Gryllotalpa gryllotalpa $P^{32}$ 297
$P^{32}$ 296
Gryllus
- bimaculatus $C^{14}$ 321
$C^{14}$ 189
$C^{14}$ 322
- domesticus $P^{32}$ 283
x 878
Gusathion $P^{32}$ 562
$P^{32}$ 561


## H.


$H^3$
see Tritium
Habrobracon
Radiation effects 1313
1179
1130
1436
983
1336
962
α 986
α 922
α 906
β 1276
β 1117
β 810
β 811
β 1138
γ 810
γ 811
γ 1137
γ 1138
ingested radioisotopes $P^{32}$ 1032
$P^{32}$ 1033
$P^{32}$ 382
$P^{32}$ 1295
$P^{32}$ 269
$P^{32}$ 132
$P^{32}$ 830
$S^{35}$ 393
$Ca^{45}$ 393
$Ca^{45}$ 400
$Sr^{89}$ 383
$Sr^{89}$ 401

ingested radioisotopes — $Sr^{89}$ 830
$Sr^{90}$ 400
x 863
x 930
x 1336
x 864
x 1254
x 1089
x 865
x 998
x 858
x 999
x 1392
x 1295
x 1424
x 859
x 832
x 1393
x 1402
x 1177
x 978
x 1374
x 1375
x 833
x 1149
x 931
x 1093
x 1426
x 967
x 979
x 1311
x 1277
x 1394
x 1427
x 980
x 861
x 830
x 981
x 1273
x 1395
x 1281
x 1267
x 1396
x 1397
x 862
x 1274
x 867
x 868
x 1139
x 1191
x 1017

Halesus interpunctatus (caddis fly)
$Sr^{90}$, $Ru^{106}$, $Cs^{137}$, $Ce^{144}$ 266
$Sr^{90}$, $Ru^{106}$, $Cs^{137}$, $Ce^{144}$ 267

Harlequin cabbage bug
see Murgantia histrionica

Hawk moth
see Celerio euphorbiae

Heliothrips haemorrhoidalis
see Thrips

Hercules AC-528
see Delnav

Hexagenia — $P^{32}$ 42

Hippelatus pusio (eye gnat)
see Gnat

House longhorn beetle
see Hylotrupes bajulus

Hydrogen cyanide (HCN) — $C^{14}$ 427
$C^{14}$ 426
$C^{14}$ 421

Hylemyia spp
Anthomyidae — $P^{32}$ 339
- brassicae — $P^{32}$ 355

Hylotrupes bajulus (house longhorn beetle) — γ 1126

Hypoderma bovis — $P^{32}$ 743

I.

Indian meal moth
see Plodia interpunctella

Iodine, radioisotope of — $I^{131}$
Ant 56
48
Bombyx mori 195
207
Conotrachelus nenuphar 370
369
DDT-analogue 473
432
Dendroctonus engelmanni 64
354
Flies and roaches 309
78
305
293
294
337

Iridium — $Ir^{192}$ 354
371

Iron, radioisotope of — $Fe^{59}$ 299
337

Isodrin — $C^{14}$ 496
$C^{14}$ 498
$C^{14}$ 723

J.

Japanese beetle: see Popillia japonica

K.

KCN: see Potassium cyanide

L.

Lasioderma serricorne (cigarette beetle) — γ 1252
γ 1253
γ 893
664

Lasius niger
see Ant

Leptohylemyia coarctata (wheat bulb fly) — $P^{32}$ 75

Lesser grain borer
see Rhizopertha domestica
Leucophaea maderae (Madeira roach)
DDT $C^{14}$ 477
Piperonyl butoxide $C^{14}$ 676
$C^{14}$ 677
$Sr^{89}$ 281
Ronnel $P^{32}$ 599
Lindane $C^{14}$ 454
$Cl^{36}$ 431
Liosomaphis abietina (Sitka spruce louse) $P^{32}$ 26
Locusts
Locusta
- migratoria $P^{32}$ 362
x 1315
- pardalina $P^{32}$ 362
Schistocerca gregaria
Labelling $P^{32}$ 361
Metabolism $C^{14}$ 144
$C^{14}$ 145
$C^{14}$ 146
$C^{14}$ 213
$C^{14}$ 137
$C^{14}$ 237
Chlorobenzene metabolism $C^{14}$ 459
$C^{14}$ 457
$C^{14}$ 458
Locust borer
see Megacyllene robinae
Lone star tick
see Amblyomma americanum
Lucanus cervus (stag beetle) $P^{32}$ 295
$P^{32}$ 296
Lucilia spp $P^{32}$ 77
- cuprina cuprina $P^{32}$ 336
$I^{131}$, ($Ca^{45}$), $P^{32}$ 78
$P^{32}$ 84
$\gamma$ 1470
- sericata $P^{32}$ 74
$P^{32}$ 335
$I^{131}$, ($Ca^{45}$), $P^{32}$ 78
$\gamma$ 1500
$P^{32}$ 259
$P^{32}$ 84
Louse (human body-)
see Pediculus humanus humanus
Lyctus
- brunneus $\gamma$ 1245
$\gamma$ 1246
$\gamma$ 1126
$\gamma$ 1507
- planicollis $\gamma$ 1252
Lygus
- oblineatus $P^{32}$ 33
$P^{32}$ 34
$Ce^{144}$, $Ag^{110}$, $P^{32}$ 36
- rugulipennis (wheat bug) $C^{14}$ 35
$C^{14}$ 356


M.


Madeira roach
see Leucophaea maderae
Malaraeus telchinum
see Flea
Malathion
Labelled bait 66
Metabolism $P^{32}$ 574
$P^{32}$ 567
$P^{32}$ 745
$P^{32}$ 565
$P^{32}$ 566
$P^{32}$ 568
$P^{32}$ 509
$P^{32}$ 768
$P^{32}$ 736
$P^{32}$ 723
$P^{32}$ 570
$P^{32}$ 569
$P^{32}$ 563
$P^{32}$ 564
Manganese, radioisotopes of
$Mn^{52, 54, 56}$ 248
Mass rearing or tagging
Bees $P^{32}$ 365
Flies (Simulium spp) $P^{32}$ 334
(Calliphora) 347
(Callitroga) 1489
Mosquitoes $P^{32}$ 346
$P^{32}$ 112
$P^{32}$ 110
Mealworm (yellow)
see Tenebrio molitor
Mealybug
see Pseudococcus njalensis
Megacyllene robinae (locust borer) $I^{131}$ 293
Melanoplus
see Grasshopper
Melanotus $Co^{60}$ 357
- communis $Co^{60}$ 63
Meloidogyne
see Nematode, root-knot -
Melolontha vulgaris $P^{32}$ 297
$P^{32}$ 296
Metasystox $P^{32}$ 650
Methylisosystox $P^{32}$ 645
see also Systox
Metriocnemus hygropetricus $P^{32}$ 218
Milkweed bug
see Oncopeltus fasciatus
Mites
Acarus siro (flour mite) $\beta$ 1515
Caloglyphus mycophagus $\gamma$ 894
$\gamma$ 895
Fuscuropoda marginata $\gamma$ 895
Metatetranychus citri $P^{32}$ 641
$P^{32}$ 657
Parasite (mite-cockroach) $P^{32}$ 808
$P^{32}$ 130
Pimeliaphilus podapoliphagus $P^{32}$ 130
Predator-prey (Mite-mite) $\gamma$ 2

Predator-prey (mite-mite) γ 895
Rhizoglyphus sp. γ 2
Tetranychus
- bimaculatus $P^{32}$ 301
- urticae (spider mite) $P^{32}$ 408
Monomorium pharaonis
see Ants
Mormoniella vitripennis
x 1089
x 1090
x 1091
x 1055
x 835
x 1056
x 1092
x 1057
x 1064
x 836
x 1094
x 1184
x 875
x 1294
x 985
x 876
n 836
$n_{th}$ 835
$n_{th}$ 836
Review (general) 932
Mosquitoes
Aëdes
- aegypti $P^{32}$ 272
Disease vector $P^{32}$ 384
$S^{35}$, $P^{32}$ 405
x 1333
$Sr^{89}$, $P^{32}$ 345
Metabolism $P^{32}$ 271
$P^{32}$ 250
$I^{131}$ 293
$P^{32}$ 136
$P^{32}$ 138
Radiation effects x 1333
x 1081
384
Radioisotopes (ingested) $Na^{24}$ 308
$P^{32}$ 405
$P^{32}$ 109
$P^{32}$ 250
$P^{32}$ 345
$P^{32}$ 713
$S^{35}$ 405
$Sr^{89}$ 109
$Sr^{89}$ 345
$I^{131}$ 293
$Ce^{144}$ 367
Review 109
723
Toxicity $C^{14}$ 735
$C^{14}$ 491
$C^{14}$ 492
- campestris $P^{32}$ 348
- communis $P^{32}$ 61
$P^{32}$ 110
$P^{32}$ 39
$P^{32}$ 40
DDT $C^{14}$ 466
- dorsalis $P^{32}$ 348
- excrucians $P^{32}$ 61
- flavescens $P^{32}$ 348
$P^{32}$ 115
- nigromaculis $P^{32}$ 118
$P^{32}$ 119
Paraxon $P^{32}$ 731
- pullatus $P^{32}$ 61
- sollicitans $P^{32}$ 108
- spencerii $P^{32}$ 348
- sticticus $P^{32}$ 374
DDT $C^{14}$ 466
- taeniorhynchus
dispersal $P^{32}$ 111
$P^{32}$ 108
$P^{32}$ 113
toxicity $P^{32}$, $C^{14}$ 737
$C^{14}$ 490
$C^{14}$ 491
723
- togoi x 872
- trichurus $P^{32}$ 129
$P^{32}$ 120
Anopheles
- gambiae
Aldrin $C^{14}$ 436
BHC $C^{14}$ 442
double-labelling $S^{35}$, $P^{32}$ 771
- Kerteszia spp Th 343
Th 107
Th 344
- quadrimaculatus $P^{32}$ 272
1116
toxicology $P^{32}$, $C^{14}$ 737
$C^{14}$ 490
$C^{14}$ 491
$C^{14}$ 492
Armigeres obturans $P^{32}$ 258
Culex $P^{32}$ 349
- molestus $P^{32}$ 253
- pipiens $P^{32}$ 306
$P^{32}$ 272
x 1018
x 949
- (pipiens) fatigans $P^{32}$ 626
Disease vector $P^{32}$ 404
$Sr^{89}$, $P^{32}$ 345
$P^{32}$ 258
x 1016
x 1050
723
- pipiens pallens x 872
- pipiens pipiens
$Sr^{90}$, $Ru^{106}$, $Cs^{137}$, $Ce^{144}$ 267
$Sr^{90}$, $Ru^{106}$, $Cs^{137}$, $Ce^{144}$ 266

- pipiens pipiens
$Sr^{90}$, $Ru^{106}$, $Cs^{137}$, $Ge^{144}$ 268
- quinquefasciatus $P^{32}$ 374
$P^{32}$ 563
Psorophora
- confinnis $P^{32}$ 114
- discolor $P^{32}$ 114
Radiation effects $\gamma$ 1116
$\gamma$ 1153
$\gamma$ 1081
x 872
x 1333
x 1018
x 1016
x 949
x 1050
Mud dauber
see Sceliphron cementarium
Murgantia histrionica (squash bug) $P^{32}$ 319
Musca domestica (housefly)
Aspetic conditions and tagging 323
Bait $P^{32}$ 66
Disease vector $P^{32}$ 86
Dispersal $P^{32}$ 74
$P^{32}$ 90
$P^{32}$ 80
$P^{32}$ 116
$I^{131}$, $Ca^{45}$, $P^{32}$ 78
$P^{32}$ 79
$P^{32}$ 83
$P^{32}$ 82
$P^{32}$ 72
$P^{32}$ 85
$P^{32}$ 87
$P^{32}$ 89
$P^{32}$ 84
Tagging techniques $Ca^{45}$, $P^{32}$ 347
$P^{32}$ 349
Insect biochemistry and insecticide metabolism $P^{32}$ 310
$P^{32}$ 734
$P^{32}$ 311
$P^{32}$, $C^{14}$ 783
$S^{35}$ 279
$I^{131}$ 293
$C^{14}$ 727
$C^{14}$ 467
$S^{35}$ 251
$S^{35}$, $C^{14}$ 167
$C^{14}$ 193
$C^{14}$ 232
$C^{14}$ 657
$P^{32}$ 156
$H^3$ 238
$C^{14}$ 239
$C^{14}$ 244
$C^{14}$ 245
$P^{32}$ 312
$P^{32}$ 495
Resistance $Cl^{36}$ 431
$P^{32}$ 734
Resistance $Br^{82}$ 493
$Cl^{36}$ 494
$S^{35}$ 437
Insecticides, effects of -
Acethion $P^{32}$ 541
BHC $C^{14}$ 440
$C^{14}$ 441
$C^{14}$ 443
$Cl^{36}$, $C^{14}$ 439
$C^{14}$ 444
$C^{14}$ 448
Co-Ral $P^{32}$ 519
Diazinon $P^{32}$ 736
$P^{32}$ 568
$P^{32}$ 541
DDT $C^{14}$ 479
$C^{14}$ 469
$C^{14}$ 478
$Br^{82}$ 493
$C^{14}$ 470
$C^{14}$ 488
$C^{14}$ 474
$C^{14}$ 475
$C^{14}$ 485
$C^{14}$ 728
$C^{14}$ 467
$C^{14}$ 471
DDVP $P^{32}$ 557
Dieldrin 434
$S^{35}$ 437
$C^{14}$, $S^{35}$, $Cl^{36}$, $Br^{82}$ 723
Dimethoate $P^{32}$ 541
$P^{32}$ 566
Dipterex $P^{32}$ 556
$P^{32}$ 557
Endrin $C^{14}$ 498
Isodrin $C^{14}$ 498
Lindane $Cl^{36}$ 665
Malathion $P^{32}$ 568
$P^{32}$ 734
Parathion $P^{32}$ 541
methyl - $P^{32}$ 568
methyl - $P^{32}$ 734
Pyrethrins and related compounds $C^{14}$ 671
$C^{14}$ 675
$C^{14}$ 679
$C^{14}$ 670
$C^{14}$ 672
Sevin $C^{14}$ 703
$C^{14}$ 704
Radiation effects $P^{32}$ 335
$P^{32}$ 246
$Sr^{89}$ 402
1069
$\gamma$ 888
1296
Tagging $P^{32}$ 336
$P^{32}$ 341
$P^{32}$ 347
Muscina stabulans $P^{32}$ 85

Myzus
see Aphid

## N.

Nematodes — 1569
γ — 1574
Ditylenchus destructor — γ — 1577
Golden nematode, see below
Heterodera
- rostochiensis — x — 1572
$P^{32}$ — 1556
β, γ — 1576
γ — 1570
γ — 1571
- schachtii — β, γ — 1576
Meloidogyne incognito acrita — $P^{32}$ — 1556
$P^{32}$ — 1557
- javanica — $P^{32}$ — 1568
Panagrellus silusiae — x — 1575
Rhabditis spp — 1577
Root-knot nematode
see Meloidogyne
Tylenchorhynchus claytoni — γ, x — 1573
γ, x — 1575
Neodiprion sertifer — x — 1560
Neoparasitidae — γ — 2
Nicotine — $C^{14}$
Analytical studies — 683
685
692
Biogenesis and synthesis — 694
682
687
686
693
697
688
689
698
699
700
691
690
701
Metabolism — 995
684
681
696
NIUIF-101 — $S^{35}$, $P^{32}$ — 585
$S^{35}$, $P^{32}$ — 574

## O.

Oncopeltus fasciatus (milk weed bug)
DDT — $C^{14}$ — 471
Sevin — $C^{14}$ — 704
Onthophagus texanus — γ — 1141
Ophyra
- aenescens — $P^{32}$ — 84
- leucostoma — $P^{32}$ — 84

Organophosphorus insecticides
For individual insecticides, see
Amiton
Co-Ral
Delnav
Diazinon
Dimethoate
Dipterex
Di-Syston
Guthion (Gusathion)
Malathion
Parathion
Phorate (Thimet)
Phosdrin
Ronnel
Schradan
Systox (Demeton)
TEPP
Thiodan
(See also Part I, II. D.)
Orosius argentatus (leaf hopper) — $P^{32}$ — 32
Oryzaephilus surinamensis (saw-toothed grain beetle)
893
664
β — 1515

## P.

Pachycrepoides dubius — x — 1090
x — 1092
Panagrellus silusiae
see Nematodes
Panaxia dominula — $S^{35}$ — 124
Paraoxon — $P^{32}$ — 733
$P^{32}$ — 571
$P^{32}$ — 731
Parathion
Application and metabolism — $P^{32}$ — 581
$P^{32}$ — 733
$S^{35}$ — 577
$P^{32}$ — 583
$P^{32}$ — 582
$P^{32}$ — 576
$S^{35}$, $P^{32}$ — 805
$S^{35}$, $P^{32}$ — 572
$P^{32}$ — 573
$P^{32}$ — 584
$S^{35}$, $P^{32}$ — 574
$P^{32}$ — 580
$P^{32}$ — 665
$P^{32}$ — 571
$S^{35}$ — 412
$P^{32}$ — 541
$P^{32}$ — 568
Synthesis — $S^{35}$, $P^{32}$ — 384
$S^{35}$, $P^{32}$ — 575
$S^{35}$ — 578

Synthesis — $P^{32}$ 586
$S^{35}$, $P^{32}$ 585
$P^{32}$ 665
- methyl — $S^{35}$, $P^{32}$ 574
$P^{32}$ 665
$P^{32}$ 588
$P^{32}$ 570
$P^{32}$ 665
307
$P^{32}$ 736
587
Pectinora malvella (cotton moth) — x 1124
Pediculus humanus humanus (human body louse) — $C^{14}$ 486
γ 888
Periplaneta americana — $P^{32}$ 733
Biochemistry and metabolism — $P^{32}$ 273
$P^{32}$ 142
$P^{32}$ 307
$I^{131}$ 293
$Br^{82}$, $I^{131}$ 294
$C^{14}$ 330
$C^{14}$ 234
$C^{14}$ 143
$P^{32}$ 331
$C^{14}$ 151
$C^{14}$ 147
$C^{14}$ 232
$P^{32}$ 166
$C^{14}$ 241
$S^{35}$ 276
$P^{32}$ 148
$P^{32}$ 149
Dispersal — $P^{32}$ 69
$P^{32}$ 68
Insecticides
Acethion — $P^{32}$ 541
Bayer 25141 — $P^{32}$ 656
$P^{32}$ 657
Compound 2046 — $P^{32}$ 659
DDT — $C^{14}$ 464
$C^{14}$ 487
$C^{14}$ 471
DDVP — $P^{32}$ 554
Delnav — $P^{32}$ 520
(DFP) — $P^{32}$ 527
Diazinon — $P^{32}$ 541
Dimethoate — $P^{32}$ 541
Dipterex — $P^{32}$ 554
Malathion — $P^{32}$ 567
$P^{32}$ 566
$P^{32}$ 509
Parathion — $P^{32}$ 581
$P^{32}$ 582
$P^{32}$ 733
$S^{35}$, $P^{32}$ 805
$P^{32}$ 541
- methyl — $P^{32}$ 588
Pyrethrins and related compounds — $C^{14}$ 671
$C^{14}$ 680
$C^{14}$ 668
$C^{14}$ 669
Systox — $P^{32}$ 640
TEPP — $P^{32}$ 653
$P^{32}$ 733
Toxicity studies
$C^{14}$ 464
$C^{14}$ 499
$P^{32}$ 307
$P^{32}$ 277
$C^{14}$ 500
$C^{14}$ 166
Phaenicia spp
see Lucilia
Phorate — $P^{32}$ 593
$P^{32}$ 594
$P^{32}$ 592
(Earlier work, listed under "Thimet") — $P^{32}$ 589
$P^{32}$ 595
$P^{32}$ 590
$P^{32}$ 755
Phormia — $P^{32}$ 90
- regina — $P^{32}$ 74
$P^{32}$ 81
$C^{14}$ 193
$P^{32}$ 84
$C^{14}$ 194
- terraenovae — $P^{32}$ 85
Phosdrin — $P^{32}$ 596
$P^{32}$ 746
$P^{32}$ 597
$P^{32}$ 598
Phosphoric esters — $P^{32}$ 508
Phosphorus, radioisotope of — $P^{32}$
Due to the very extensive use which has been made of $P^{32}$, relevant papers have been classed according to subject
Phyllocnistis labyrinthella — $P^{32}$ 372
Phyllodromia germanica — $P^{32}$ 297
$P^{32}$ 296
Pieris
- brassicae — $C^{14}$ 231
- napi — $C^{14}$ 231
- rapae — $C^{14}$ 231
γ 1299
$Ca^{45}$ 1299
Pimeliaphilus podapolipopagus 130
Pinus radiata — $P^{32}$ 757
Piperonyl butoxide 671
$C^{14}$ 676
$C^{14}$ 677
Pissodes strobi — $Co^{60}$ 101
$Sc^{46}$ 99
110
γ 39
$P^{32}$ 39
Plasmodium gallinaceum — $P^{32}$ 384
$S^{35}$, $P^{32}$ 405
$P^{32}$ 403
Plodia interpunctella (Indian meal moth) — β 1515

Plum curculio
see Conotrachelus nenuphar
Podisma sapporense
see Grasshopper
Polonium $Po^{210}$ 920
Grasshopper 921
Habrobracon 922
Popillia japonica $S^{35}$ 270
Porthetria dispar (gypsy moth) 944
Potassium, radioisotope of $K^{42}$ 303
Potassium cyanide (KCN) $C^{14}$ 419
Praesiodimium $Pr^{144}$
see Cerium
Prodenia eridania (Southern armyworm) 1291
$P^{32}$ 590
$C^{14}$ 326
Proisomota minuta γ 1432
Propylea quatuordecempunctata $Ta^{182}$ 60
Pteronarcys (stone fly) $P^{32}$ 42
Ptinus hirtellus $C^{14}$ 360
Pseudococcus
- brevipes $C^{14}$ 139
- njalensis $P^{32}$ 37
$P^{32}$ 104
$Sr^{90}$, $P^{32}$ 106
$P^{32}$ 38
$P^{32}$ 105
Psocoptera (bock lice) β 1515
Puffs $H^3$ 215
$P^{32}$ 218
$H^3$, $C^{14}$ 216
$H^3$ 227
$H^3$, $C^{14}$, $S^{35}$ 226
$H^3$ 375
x 375
Pyrausta nubilalis $C^{14}$ 477
Pyrazoxon $P^{32}$ 511
Pyrethrins $C^{14}$ 675
$C^{14}$ 671
$C^{14}$ 678
$C^{14}$ 673
$C^{14}$ 674
Pyrethroids $C^{14}$ 679
Pyrethrum 671
$C^{14}$ 669

R.

Radium $Ra^{226}$
Labelling 58
59
Resistance (insecticide-) to
BHC 439
440
441
442
443
444
445
448
DDT 466
474
486
493
494
Endrin 498
Malathion 563
568
Review 718
721
736
568
413
430
431
Rhagoletis
see Fruit Fly
Rhizoglyphus sp
see Mites
Rhyzopertha dominica (lesser grain borer) γ 1252
γ 1253
x 1541
1128
Rhodnius prolixus $P^{32}$ 296
x 1300
x 1301
x 1302
x 1368
x 1369
Rhyazionia buoliana $Co^{60}$ 123
Rhynchosciara angelae $H^3$ 215
$C^{14}$, $H^3$ 216
$H^3$ 375
Rice moth
see Corcyra cephalonica
Romalea microptera
see Grasshopper
Ronnel $P^{32}$ 601
$P^{32}$ 599
Root-knot nematode
see Nematode
Root maggot fly
see Hylemyia spp
Rotenone 307
$C^{14}$ 708
Rubidium $Rb^{86}$ 352
$Rb^{86}$ 354
Ruthenium $Ru^{106}$ 266
$Ru^{106}$ 268

S.

Sarcophaga
- bullata $P^{32}$ 84
- crassipallus $C^{14}$ 671
- sueta $I^{131}$, $Ca^{45}$, $P^{32}$ 78
$P^{32}$ 84
Sarin $P^{32}$ 540
Sawflies
see Tenthredinidae

Saw-toothed grain beetle
see Oryzaephilus surinamensis
Sceliphron cementarium — $I^{131}$ — 293
Scandium — $Sc^{46}$
Dendroctonus engelmanni — 354
Pissodes strobi — 99
Schistocerca gregaria
see Locusts
Schradan
Analytical studies — $P^{32}$ — 615
$P^{32}$ — 613
$P^{32}$ — 614
$P^{32}$ — 619
$P^{32}$ — 639
$P^{32}$ — 625
$P^{32}$ — 628
$P^{32}$ — 621
Biochemistry and metabolism — $P^{32}$ — 623
$P^{32}$ — 609
$P^{32}$ — 610
$P^{32}$ — 750
$P^{32}$ — 616
$P^{32}$ — 606
$P^{32}$ — 612
$P^{32}$ — 617
Schradan analogue — $P^{32}$ — 751
Synthesis — $P^{32}$ — 611
Toxicity studies — $P^{32}$ — 609
$P^{32}$ — 750
$P^{32}$ — 626
Sciara coprophila — x — 1181
x — 1392
Screwworm
see Callitroga
Setaria digitata — $P^{32}$ — 258
Sevin
Metabolism — $C^{14}$ — 703
$C^{14}$ — 704
Synthesis — $C^{14}$ — 706
Silkworm — x — 1042
364
Genetics — 939
961
x — 1043
x — 1044
x — 1403
x — 997
γ — 1556
x — 1213
x — 1236
x — 1073
Killing (cocoon stage) — 1255
1238
1555
Metabolism — $C^{14}$ — 229
$S^{35}$ — 197
Radiosensitivity — 1230
1231
1232
901
Radiosensitivity — 1233
1234
1235
1331
1072
1332
Reviews — 328
939
Attacus ricini — $C^{14}$ — 209
Antheraea pernyi (Chinese oak silkworm) — $S^{35}$ — 168
$P^{32}$ — 254
$P^{32}$ — 255
$P^{32}$ — 256
$P^{32}$ — 257
$C^{14}$ — 206
Bombyx mori
see under B.
Cecropia — $C^{14}$ — 211
$C^{14}$ — 198
$P^{32}$ — 313
$C^{14}$ — 212
SANIISh* No. 111
(*) Central Asian Sericulture Institute — 1558
1557
Silver, radioisotope of — $Ag^{110}$
Dendroctonus engelmanni — 354
Lygus oblineatus — 36
Simulium spp — $P^{32}$ — 334
$P^{32}$ — 42
Sitka spruce louse
see Liosomaphis abietina
Sitophilus (see also Calandra)
- granarius
Insecticides
DDT — $C^{14}$ — 468
HCN — $C^{14}$ — 421
Radiation effects — β — 1525
β — 1357
β — 1239
β — 1241
β — 1240
β — 1242
β — 1340
β — 1515
γ — 1530
γ — 1517
γ — 1518
γ — 886
x — 1357
x — 1419
1521
- oryza — β — 1515
γ — 1252
γ — 1253
γ — 1517
γ — 886
x — 1553
Sitotroga cerealella — β — 1340
β — 1515
x — 1541

Sodium, radioisotope of $Na^{24}$
Aëdes 308
Southern armyworm
see Prodenia eridania
Spices γ 1513
γ 1128
Squash bug
see Anasa tristis
Stag beetle
see Lucanus cervus
Stem borer x 1543
Sterile male technique
see part II, II. A
Strontium, radioisotopes of
$Sr^{89}$
Conotrachelus nenuphar 370
369
Flies 337
Habrobracon 401
383
830
Mosquitoes 109
345
268
Roaches 402
281
337
$Sr^{90}$
Habrobracon 400
Mosquitoes 266
267
Pseudococcus njalensis 106
Termites (protection against) 1562
Wireworms
Sulphur, radioisotope of $S^{35}$
Insecticides
Elemental sulphur 710
711
$CS_2^{35}$ 428
$S^{35}O_2$ 425
Dieldrin 437
Di-Syston (Bayer 19639) 558
EPTC-$S^{35}$ 705
NIUIF-101 585
574
Parathion 575
805
578
577
572
585
574
412
Systox 631
756
732
630
639
Tedion 702
503
Thiodan 655
Insect metabolism
Roaches 247
278
276
Silkworm 168
257
197
Various 124
405
369
383
225
279
251
167
373
226
437
270
Techniques 329
773
Double labelling 771
Systox
Analysis $P^{32}$ 638
$P^{32}$ 637
$P^{32}$ 634
$P^{32}$ 643
$P^{32}$ 636
$P^{32}$ 645
$P^{32}$ 650
$P^{32}$ 754
Biochemistry and metabolism $S^{35}$, $P^{32}$ 631
$S^{35}$ 756
$S^{35}$ 630
$P^{32}$ 623
$P^{32}$ 507
$P^{32}$ 641
$P^{32}$ 646
$P^{32}$ 651
$P^{32}$ 635
$P^{32}$ 640
$P^{32}$ 645
$P^{32}$ 755
$C^{14}$ 633
Toxicity $S^{35}$, $P^{32}$ 631
$S^{35}$ 732
$P^{32}$ 753
$P^{32}$ 632


## T.


Tabanidae $P^{32}$ 342
Tantalum, radioisotope of $Ta^{182}$ 59
371
60
Tedion $S^{35}$ 502
$S^{35}$ 503
Tendipes plumosus $C^{14}$ 45
see also Chironomus x 948

TEPP (tetraethyl pyrophosphate) $P^{32}$ 653
$P^{32}$ 733
$P^{32}$ 654
Tenebriodes mauritanicus (cadelle beetle) 1515
Tenebrio molitor (yellow meal worm)
Labelling $P^{32}$ 319
$P^{32}$ 280
Radiation effects β 1515
x 855
x 856
x 1376
x 1297
893
Tenthridinidae (saw fly) x 1560
Termites
Wood protection $Sr^{90}$ 1562
Labelling $P^{32}$ 57
$P^{32}$ 359
$P^{32}$ 51
Tetranychus
see Mites
Thermobia domestica γ 888
Thimet
see Phorate
Thiodan $C^{14}$ 501
$S^{35}$ 655
Thiophos $P^{32}$ 579
see Parathion
Thorium Th
BHC 438
456
Mosquitoes 343
107
344
Thrips
Heliothrips haemorrhoidalis $P^{32}$ 624
$P^{32}$ 641
Thrips tabaci $C^{14}$ 320
$P^{32}$ 41
Tibicen spp (cicada) $I^{131}$ 293
Tipula
- maxima γ 305
- paludosa (crane fly) $K^{42}$ 303
Triatoma spp $P^{32}$ 296
- infestans Th 456
- protracta $Ce^{144}$ 367
Tribolium spp β 1342
γ 615
γ 1253
- castaneum β 1343
β 776
x 1151
- confusum
β 1419
β 1357
β 1240
β 1239
β 1242
β 1340
- confusum
β 1515
γ 1252
γ 1530
γ 1524
γ 1275
893
x 1357
x 1419
x 1151
1521
1291
1128
Labelling $P^{32}$ 128
$C^{14}$ 232
$P^{32}$ 657
Radiation effects β 1525
Trichogramma spp $P^{32}$ 135
- fasciatum $P^{32}$ 127
Trimerotropis maritima
see Grasshopper
Tritium $H^3$
Blattella germanica 243
Bombyx mori 221
Chironomids 215
226
375
216
Drosophila 227
220
222
Musca domestica 238
Spider mite 318
Trogoderma
- granarium γ 1112
- sternale γ 1278
- versicolor γ 293
Tsetse fly 1495
see also Glossina γ 1496
Trolene $P^{32}$ 600
Tylenchorhynchus claytoni
see Nematodes
Tyroglyphus farinae γ 1150
Tyrophagus noxius (grain mite) x 1123


V.


Vanessa io $P^{32}$ 297
$P^{32}$ 296
Vespidae spp $Mn^{52, 54, 56}$ 248
Virus
Insect - 314
1314
1317
315
316
Insect vector of - 407
320
32

Walnut husk fly
see Rhagoletis suavis completa
Wax moth (greater)
see Galleria mellonella
Wheat bulb fly
see Leptohylemyia coarctata
Wheat bug
see Dolycoris baccarum
Lygus rugulipennis
Wireworm — $Co^{60}$ 350; $Co^{60}$ 125; $Co^{60}$ 358; 121; $Co^{60}$ 357; $Co^{60}$ 788; $Co^{60}$ 789; $Co^{60}$ 63
Wood
Protection problems — $Sr^{90}$ 1562; 1561; $\gamma$ 1126
Infestation — $\gamma$ 1126; $\gamma$ 1246; $\gamma$ 1507; $\gamma$ 1245
Wuchereria bancrofti — $P^{32}$ 404; $Sr^{89}$, $P^{32}$ 345; $P^{32}$ 258

## X.

Xestobium rufovillosum (death watch beetle) — $\gamma$ 1126; $\gamma$ 1246; $\gamma$ 1245

## Y.

Yttrium — $Y^{91}$ 395; 337

## Z.

Zinc, radioisotope of — $Zn^{65}$ 337
Blattella germanica, Musca domestica 337
Conotrachelus nenuphar 370; 369
Corcyra cephalonica 304
Zirconium — $Zr^{95}$ 808

ANOTHER IAEA PUBLICATION IN THIS FIELD

RADIOISOTOPES AND RADIATION IN ENTOMOLOGY

The Symposium proceedings cover the use of radioisotope-labelling in work on insect eradication, insect physiology and biochemistry, ecological studies on insect migration and dispersal, habits, mating and longevity in a large variety of insects; progress in the self-eradication of insect populations by the sterile-male technique, where sterility is induced by radiation; the effects of continuous and fractionated radiation doses on the control of infested grain and other commodities; and research projects in France, Pakistan and the Philippines which indicate the future needs and possible applications of these techniques. Twenty-eight papers were presented and discussed at this Symposium organized by the IAEA in Bombay in December, 1960.

Papers in the original languages (English, French or Russian); abstracts in English, French, Russian and Spanish.

307 p. (16 × 24 cm) — STI/PUB/38

Retail price: US$ 6.50; 39s. stg; NF 26, -; DM 22, 80; Sch 136, -

OTHER IAEA PUBLICATIONS

IN THE BIBLIOGRAPHICAL SERIES

No. 1: Application of High Energy Radiations in Therapy
STI/PUB/21/1, 88 p. US$ 1.00; 6s. stg; NF 4, -; DM 3, 20; Sch 21, -

No. 2: Nuclear Reactors
STI/PUB/21/2, 728 p. US$ 5.00; 30s. stg; NF 20, -; DM 17, 50; Sch 105, -

No. 3: Nuclear Propulsion
STI/PUB/21/3, 240 p. US$ 2.00; 12s-stg; NF 8, -; DM 6, 40; Sch 42, -

No. 4: Geology of Uranium and Thorium
STI/PUB/21/4, 130 p. US$ 1.50; 9s. stg; NF 6, -; DM 4, 80; Sch 31, 50

No. 5: Disposal of Radioactive Wastes into Marine and Fresh Water
STI/PUB/21/5, 365 p. US$ 3.00; 18s. stg; NF 12, -; DM 10, 50; Sch 63, -

No. 6: Effects of Neutron Irradiation in Non-Fissionable Metals and Alloys
STI/PUB/21/6, 171 p. US$ 1.50; 9s. stg; NF 6, -; DM 4, 80; Sch 31, 50

No. 7: Research on Controlled Thermonuclear Fusion
STI/PUB/21/7, 582 p. US$ 4.00; 24s. stg; NF 16, -; DM 14, -; Sch 84, -

No. 8: Semiconductor Nuclear Particle Detectors
STI/PUB/21/8, 100 p. US$ 1.50; 9s. stg; NF 6, -; DM 4, 80; Sch 31, 50

All the above publications are obtainable from the Sales Agents listed overleaf.

A complete Catalogue of all Agency Publications will be gladly supplied by any of the Sales Agents or directly by the Editorial and Publications Section, International Atomic Energy Agency, Kärntner Ring, Vienna I, Austria.

# IAEA SALES AGENTS

ARGENTINA
Editorial Sudamericana, S.A.
Alsina 500
Buenos Aires

AUSTRALIA
Melbourne University Press
369, Lonsdale Street
Melbourne, C.1

AUSTRIA
Georg Fromme & Co.
Spengergasse 39
Vienna V

BELGIUM
Office International de Librairie
30, avenue Mamix
Brussels 5

BRAZIL
Livraria Kosmos Editora
Rua do Rosario, 135-137
Rio de Janeiro
Agencia Expoente Oscar M. Silva
Rua Xavier de Toledo, 140-1° Andar
(Caixa Postal N° 5.614)
São Paulo

BURMA
See under India

BYELORUSSIAN SOVIET SOCIALIST REPUBLIC
See under USSR

CANADA
The Queen's Printer
Ottawa

CEYLON
See under India

CHINA (Taiwan)
Books and Scientific Supplies
Service, Ltd.,
P.O. Box 83
Taipei

DENMARK
Ejnar Munksgaard Ltd.
6 Nörregade
Copenhagen K

ETHIOPIA
G.P. Giannopoulos
International Press Agency
P.O. Box 120
Addis Ababa

FINLAND
Akateeminen Kirjakauppa
Keskuskatu 2
Helsinki

FRANCE and FRENCH UNION
Office International de
Documentation et Librairie
48, Rue Gay-Lussac
Paris, 5e

GERMANY, Federal Republic of
R. Oldenbourg
Rosenheimer Strasse 145
Munich 8

ICELAND
Halldór Jónsson
Mjóstræti 2
Reykjavík

INDIA
Orient Longmans Ltd.
17, Chittaranjan Ave.
Calcutta 13

ISRAEL
Heiliger and Co.
3 Nathan Strauss Street
Jerusalem

ITALY
Agenzia Editoriale Internazionale
Organizzazioni Universali
(A.E.I.O.U.)
Via Meravigli 16
Milan

JAPAN
Maruzen Company Ltd.
6, Tori Nichome
Nihonbashi
P.O. Box 605
Tokyo Central

KOREA, Republic of
The Eul-Yoo Publishing Co.
5, 2-ka Chong-ro
Seoul

MEXICO
Librería Internacional
Av. Sonora 206
Mexico 11, D.F.

MONACO
The British Library
30, bd des Moulins
Monte Carlo

MOROCCO
Centre de diffusion documentaire
du B.E.P.I.
8, rue Michaux-Bellaire
(B.P. N° 211)
Rabat

NEPAL
See under India

NETHERLANDS
N.V. Martinus Nijhoff
Lange Voorhout 9
The Hague

NEW ZEALAND
Whitcombe & Tombs, Ltd.
G.P.O. Box 1894
Wellington, C.1

NORWAY
Johan Grundt Tanum
Karl Johans gate 43
Oslo

PAKISTAN
Karachi Education Society
Haroon Chambers
South Napier Road
P.O. Box No.4866
Karachi, 2

PARAGUAY
Agencia de Librerías
de Salvador Nizza
Calle Pte. Franco No. 39-43
Asunción

PERU
Librería Internacional del Perú S.A.
Boza 879
(Casilla 1417)
Lima

PHILIPPINES
The Modern Book Company
508 Rizal Avenue
Manila

POLAND
Ośrodek Rozpowszechniana
Wydawnistw Naukowych
Polska Akademia Nauk
Palac Kultury i Nauki
Warsaw

PORTUGAL
Livraria Rodrigues
186, Rua do Ouro, 188
Lisbon 2

SOUTH AFRICA
Van Schaik's Bookstore (Pty) Ltd.
Libri Building
Church St.
(P.O. Box 724)
Pretoria

SPAIN
Librería Bosch
Ronda Universidad, 11
Barcelona

SWEDEN
C.E. Fritzes Kungl. Hovbokhandel
Fredsgatan 2
Stockholm 16

SWITZERLAND
Librairie Payot
40, rue du Marché
Geneva

SYRIA
Georges N. Coussa
Imm. Chanan
rue Khan el-Harir
(B.P. 779)
Aleppo

TURKEY
Librairie Hachette
469, Istiklâl Caddesi
Beyoğlu, Istanbul

UKRAINIAN SOVIET SOCIALIST REPUBLIC
See under USSR

UNION OF SOVIET SOCIALIST REPUBLICS
Mezhdunarodnaya Kniga
Kuznetsky Most, 18
Moscow G-200

UNITED KINGDOM OF GREAT BRITAIN
AND NORTHERN IRELAND
Her Majesty's Stationery Office
P.O. Box 569
London, S.E.1

UNITED STATES OF AMERICA
National Agency for
International Publications, Inc.
801 Third Avenue
New York 22, N.Y.

YUGOSLAVIA
Jugoslovenska Knjiga
Terazije 27
Belgrade

IAEA publications can also be purchased retail at the United Nations Bookshop at United Nations Headquarters, New York, at the news-stand at the Agency's Headquarters, Vienna, and at most conferences, symposia and seminars organized by the Agency.

Orders and inquiries from countries where sales agents have not yet been appointed may be sent to:

Distribution and Sales Unit, International Atomic Energy Agency,
Kärntner Ring, Vienna I, Austria

INTERNATIONAL
ATOMIC ENERGY AGENCY
VIENNA 1963

PRICE: North America: US $8.00
Elsewhere: Sch 168,-
(48s. stg; NF 32,-; DM 28,-)