



Buffalo flies (*Haematobia exigua*): expanding their range in Australia: The opportunity for area wide controls

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Buffalo flies (BF) and horn flies (HF): close cousins and invasive pests



- Obligate blood feeding parasites
- Larval stage in cattle dung
- Can reach numbers of > 1000 per animal
- Feeding 20-40 x daily,
- Pool feeders, highly irritating
- Production effects
- Animal welfare

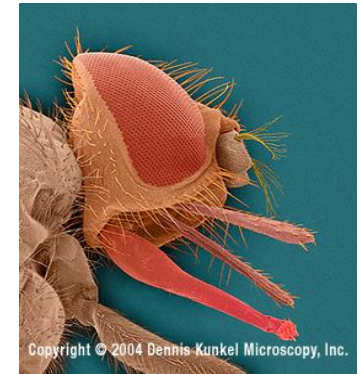


H. exigua, *H. irritans* - subspecies?

- *H. exigua* 4-6 long hairs on second segment of male hind tarsi

Molecular studies

- 1.8% -1.9% divergence in MtDNA Mt-CO1 MT-CO2
(Iwasa and Ishiguru 2010)
- ND5 demonstrated highest resolution power 3.6-4.1% interspecific p distance
- Use of COI, CytB and ND5 genes proposed
(Low et al. 2014)



Buffalo fly- Horn fly differences

Lesions

BF *Stephanofilaria* sp.

Lesions can be large, suppurating, widely spread

HF *Stephanofilaria stilesi*

Dry crusty abdominal lesions

Overwintering

HF pupal 'diapause'

BF 'overwinter' at edge of their range as low slowly cycling populations

Wolbachia

HF – *Wolbachia* ubiquitous

BF – No *Wolbachia*



Horn fly distribution

History of horn fly spread

Origins in Europe, N Africa

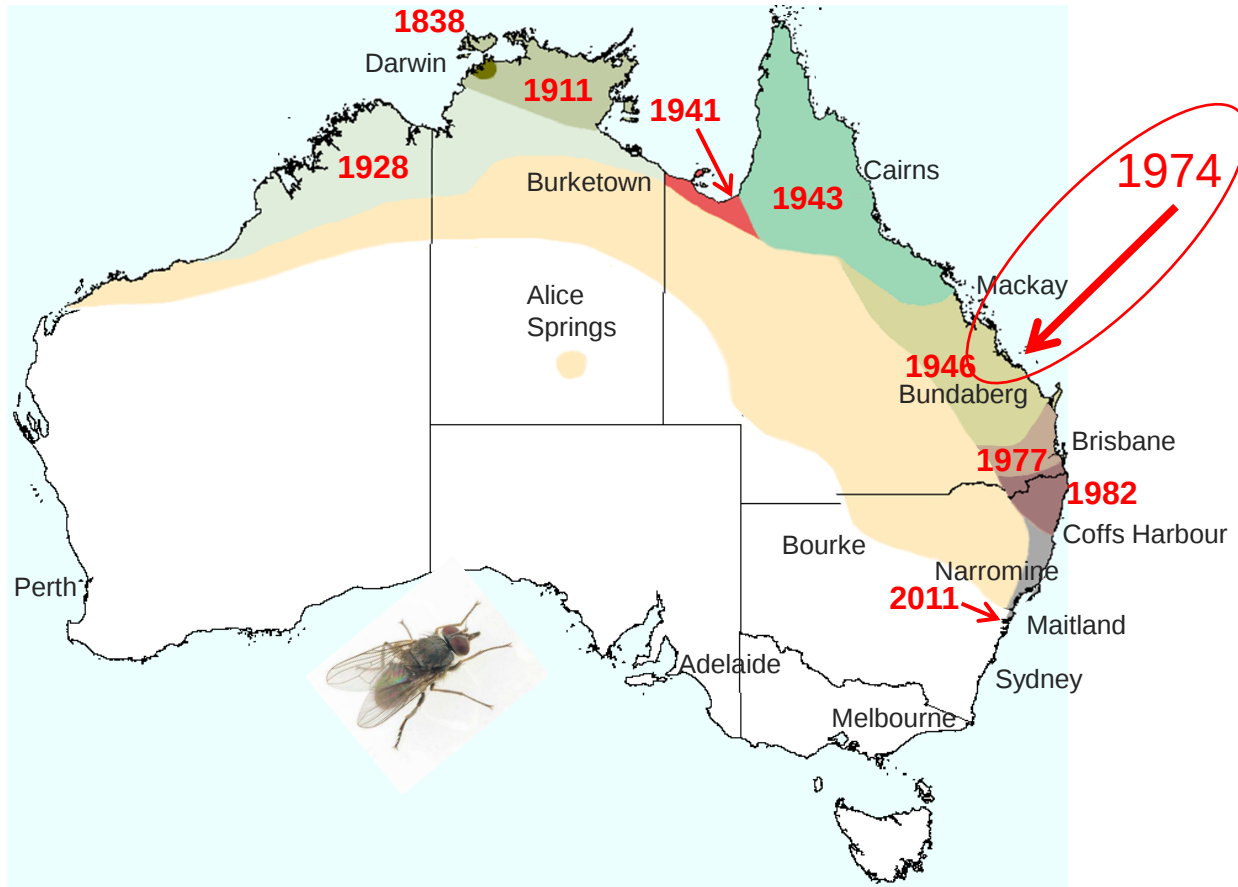
1885	Introduced to east coast USA
1900	California, Canada, Mexico, Hawaii
1937	Columbia, Venezuela, Ecuador
1956	Northern Brazil (Roraima)
1980	South of Amazon (Goias)
1991	Paraguay, Uruguay, Argentina
1993	1993 – Chile, southern Argentina



Buffalo flies - tropical and subtropical Asia, Australia and parts of Oceania

(India, Nepal, Thailand Taiwan, Indonesia, Malaysia, New Guinea, Fiji, Australia)

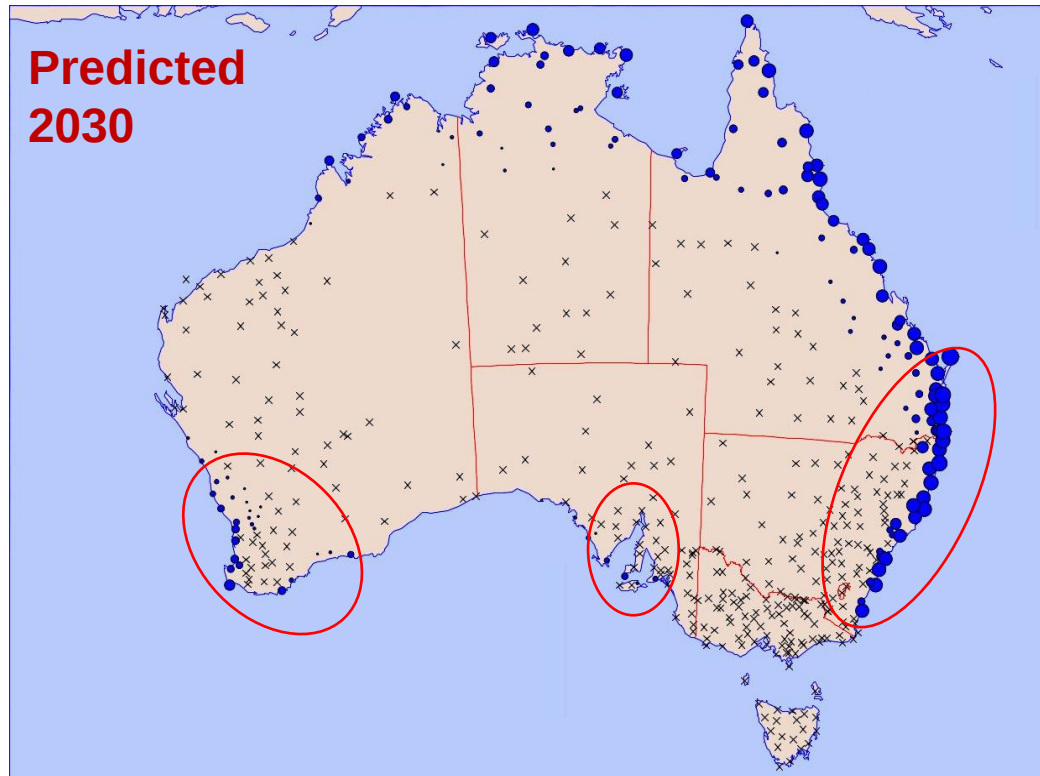
BF spread in Australia



- Introduced on water buffalos
- Early spread followed buffalo range expansion
- Wet years from 1939 -1941 enabled spread across dry area below Gulf
- East spread across Cape York followed rivers, cattle transport
- Rapid spread down east coast. to Bundaberg by 1946
- Further spread paused until 1974

- 1974 - recommenced southerly spread,
 - series of mild winters
 - use of amitraz for tick control
 - abandoned policy of treating all cattle for ticks prior to movement
- 2010, 2011 – 3rd and 2nd wettest years on record for Australia
 - BF found south to Maitland, west to Narromine and Bourke
 - Alice Springs in Northern Territory

CLIMEX modelling of BF distribution with climate change



CLIMEX modelling:

Crosses/blue circles = sites of weather measurements

Area of blue circles proportional to Ecoclimate Index,

Indicate favourability for **sustaining** populations of BF

Crosses indicate unsuitability

- Increased extreme weather events
- Micro climate effects



- Spread across dry areas facilitated by wet events
- Periodic widespread incursions from foci of fly persistence

Other factors

- Resource availability/favourability (*Bos indicus* v *Bos taurus* cattle, off host resources)
- Management (e.g. other parasite treatments)
- Microclimate effects
- Genetic plasticity (ability to adapt at the edge of their range)
- Species interactions (competing dung fauna, predators, parasitoids)
- 'Human factors' - management responses, regulatory controls
- Dispersal – autonomous, stock movements

Bos indicus



Bos taurus



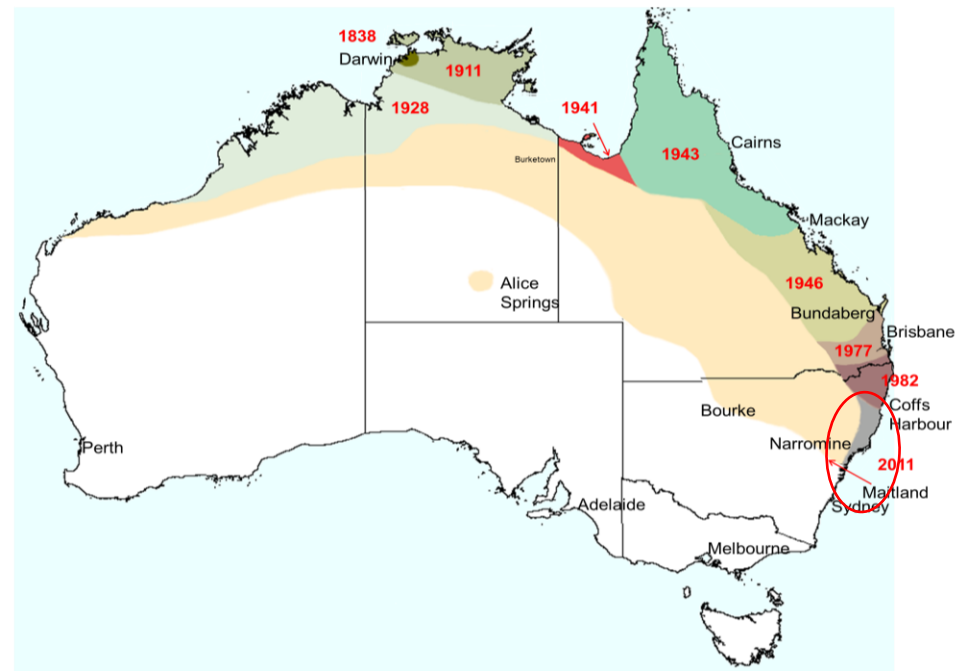
Area wide controls for buffalo flies?

- Effectiveness and cost benefit favourability
- Potentially little ongoing producer input/cost
- Reduce welfare impacts
- Reduced chemical use
 - Low residue / organic market access
 - Reduce resistance selection
 - Environment
 - OH&S benefits



Area wide controls and buffalo flies?

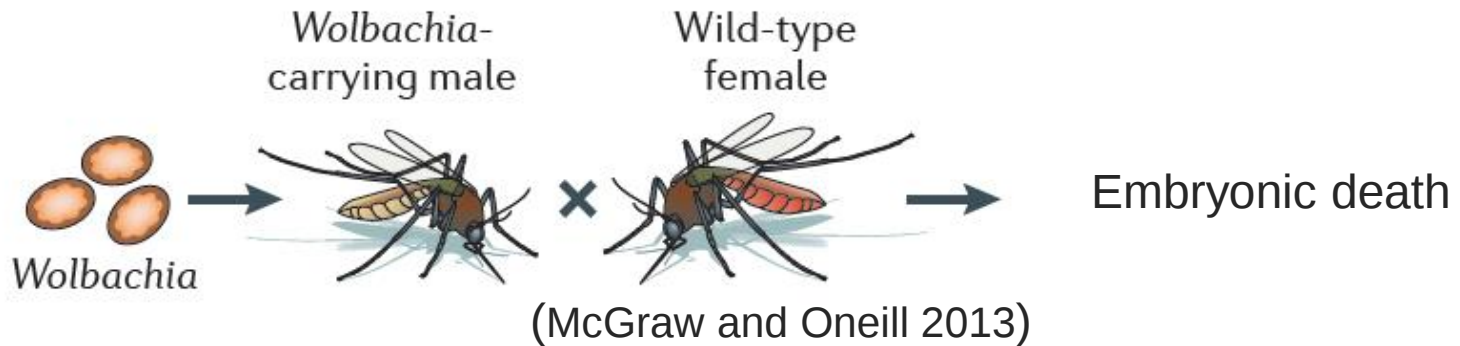
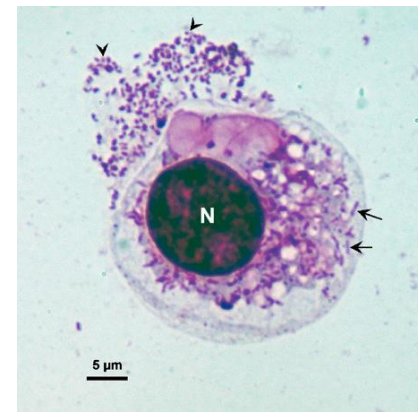
- Area of permanent colonisation limited
- Obligate parasites on cattle or buffalo
- Thin band of survival on east coast at edge of range
- Overwintering foci of low numbers of adults (survival limited by cold, dry)



Wolbachia

- Maternally transmitted (transovarial), intracellular bacterium
- “Reproductive parasite”- able to drive itself through a population by manipulating host reproduction

e.g. cytoplasmic incompatibility



- Various fitness effects – e.g. reduced life span, reduced size, egg mortality, increased larval development time, inhibited feeding,
- Inhibition of replication/blocking of transmission of pathogens, (including filarial nematodes)
- Viability/pathology of filarial nematodes

Is *Wolbachia* already present in buffalo flies?

- Buffalo flies were collected from cattle herds around Australia and from Indonesia
- Assayed by standard PCR for the *Wolbachia* wsp gene
- Horn flies from Lethbridge in Canada as +ve control
- Reciprocal testing in Ag Canada lab
- *Wolbachia* ubiquitous in horn fly but not currently present in buffalo flies (Oz or Bali)
- Suggests BF would be a competent host (Zhang et al. 2009)



How could we use *Wolbachia*?

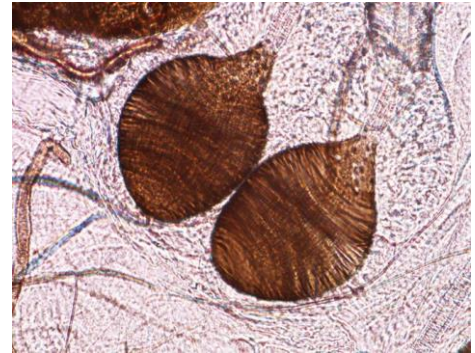
- Cytoplasmic incompatibility
- Fitness effects
 - e.g. Reduced lifespan and survival (wMelPop), length of life stages, blood feeding efficiency, locomotion, egg production and viability
- Pathogen blocking – transmission of *Stephanofilaria* sp. to reduce BF lesions?
- Use at edge of the range to eradicate advancing foci?
- Release to collapse overwintering populations?
- Drive other genes into the population

What are the effects of different strains of *Wolbachia* transinfected into BF?

So where are we up to?

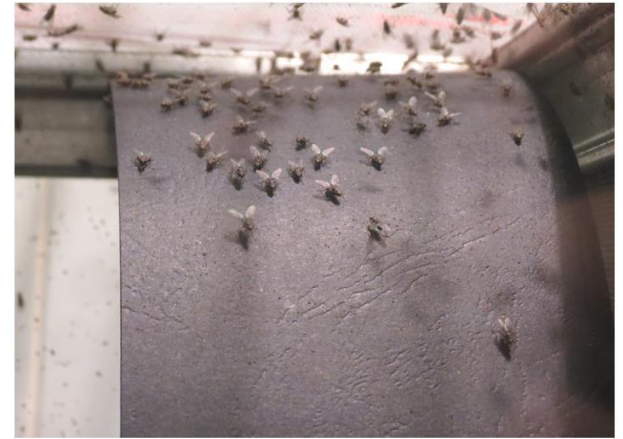
Buffalo fly colony

- Availability of a BF colony critical for this work (cf. cages attached to cattle)
- Low egg fertility was the main factor preventing establishment
- Mating only seen at dusk and dawn
- Was preceded by an uncharacteristic 'milling' behaviour of flies



Buffalo fly colony

Now maintained in the laboratory for more than 60 generations



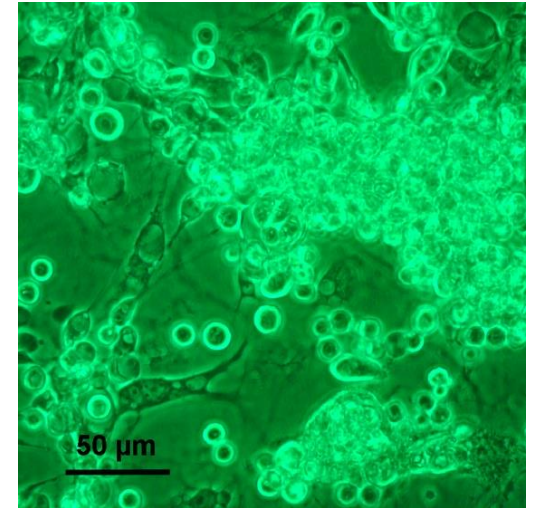
Membrane blood feeder and buffalo flies on a mating platform used in rearing



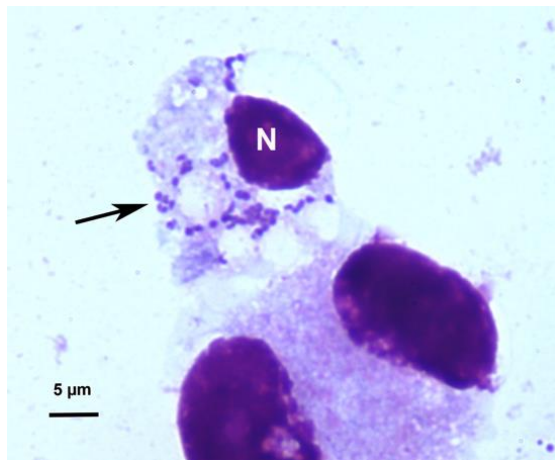
Rearing cages with daytime and dusk lighting regime

Cell lines

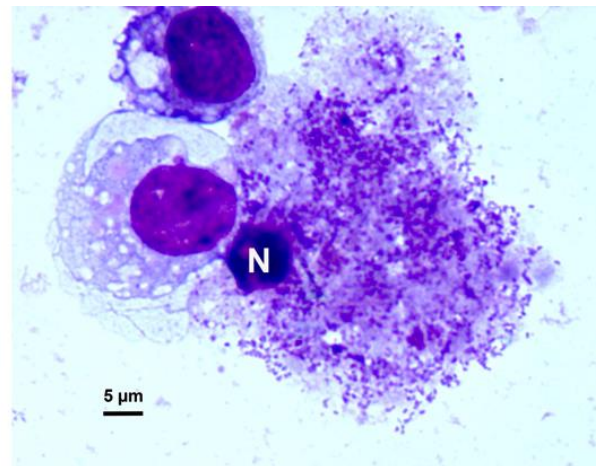
- Cell lines used to adapt *Wolbachia* prior to transfection to a new host
- HF and BF cell lines developed
- Non infected *Haematobia* cells successfully transfected with mosquito (*WAlbB*) and brown plant hopper strains (*WStr*) of *Wolbachia* (Kurtti et al. 2015)
- Embryonic microinjection has commenced



Lightly infected cells 3 days post inoculation



Heavily infected cells 10 days post inoculation



Integrated control of buffalo flies

- Resistant cattle genotypes
- Buffalo fly traps
- (Dung beetles)
- Chemical treatment according to economic thresholds
- Resistance management



Genetics



Dung beetles



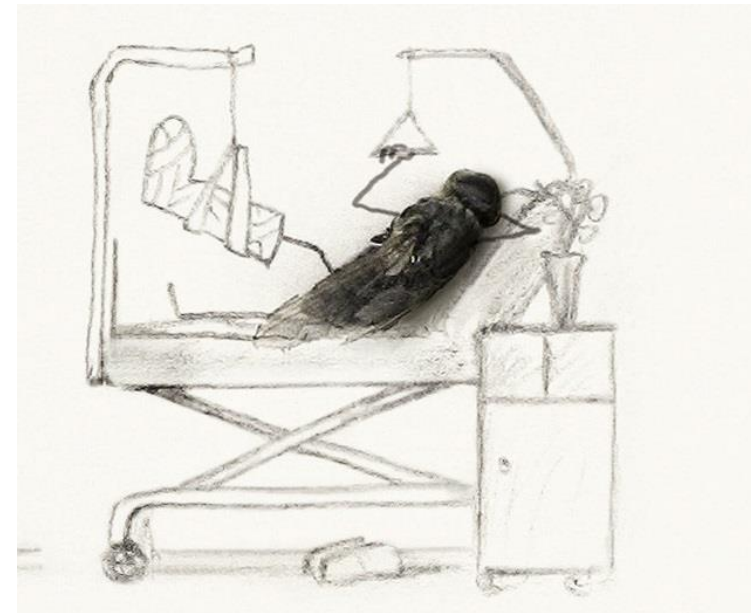
Strategic chemical
use



Traps

In conclusion

- Buffalo flies have extended their range southward by more than 1000 km in the last 40y in Australia and climate change will further increase their range and impact
- Area wide controls may provide particular opportunities to arrest this expansion and offer potentially large economic benefits (compared to controlling them after they establish)
- Directly targeting parasite populations has many potential advantages for beef and dairy producers (and consumers)
- New technologies provide exciting opportunities for an area wide approach



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