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

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
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<tbody>
<tr>
<td>1885</td>
<td>Introduced to east coast USA</td>
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<tr>
<td>1900</td>
<td>California, Canada, Mexico, Hawaii</td>
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<tr>
<td>1937</td>
<td>Columbia, Venezuela, Ecuador</td>
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<td>1956</td>
<td>Northern Brazil (Roraima)</td>
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<tr>
<td>1980</td>
<td>South of Amazon (Goias)</td>
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<tr>
<td>1991</td>
<td>Paraguay, Uruguay, Argentina</td>
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<td>1993</td>
<td>1993 – Chile, southern Argentina</td>
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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 Ecoclimatic 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
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

![Diagram showing Wolbachia and its effects on mosquito reproduction](image)

- 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)
  - Embryonic death
- Viability/pathology of filarial nematodes

(McGraw and Oneill 2013)
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

Dung beetles  Strategic chemical use  Traps
In conclusion

- Buffalo flies have extended their range southward by more than 1000 km in the last 40 years 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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