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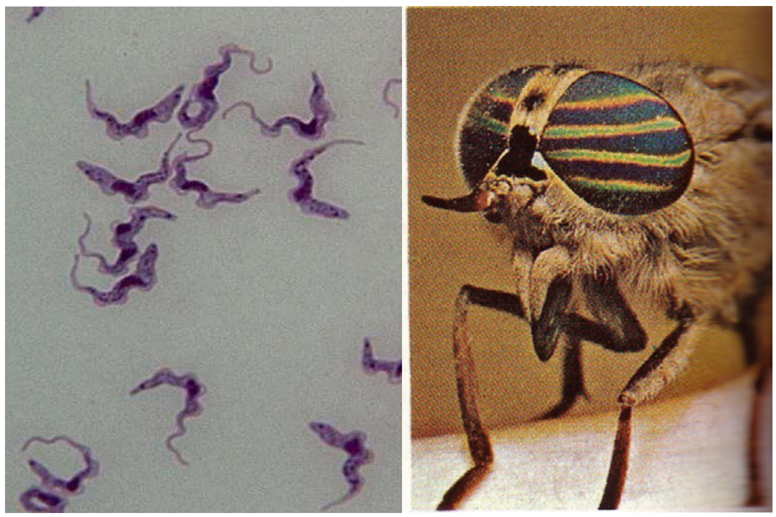
ASPECTS OF THE ECOLOGY OF TABANID FLIES (FAMILY: TABANIDAE) IN NORTH QUEENSLAND AND THEIR POTENTIAL TO TRANSMIT *TRYPANOSOMA EVANSI*



A thesis submitted by
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in August 2007

For the degree of Doctor of Philosophy
in the discipline of
Microbiology and Immunology,
School of Veterinary and Biomedical Sciences,
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I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references given.

Kirsty van Hennekeler
August 2007

STATEMENT ON THE CONTRIBUTION OF OTHERS

Financial support for this project in the form of scholarships was provided by The School of Veterinary and Biomedical Sciences (Gluyas Fellowship), Biosecurity CRC and Graduate Research School (James Cook University Doctoral Completion Award). Project funding was obtained from the AB-CRC. The work was completed under the supervision of Dr Lee Skerratt, A/Prof Lee Fitzpatrick and Prof Rhondda Jones. The AB-CRC project was in collaboration with researchers at Murdoch University, Queensland Health (Brisbane), Department of Agriculture Fisheries and Forestry and School of Tropical Environmental Sciences and Geography, James Cook University.

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Kirsty van Hennekeler
August 2007

DECLARATION OF ETHICS

Relevant research reported in this thesis received approval from the James Cook University Ethics Review Committee (approval numbers A991, A1059 and A1060) and National Parks and Wildlife (Scientific Purposes Permit: WISP03550006).

Kirsty van Hennekeler
August 2007

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The reason I became involved in this project was that it posed a great challenge: a cross-disciplinary project that was heavily oriented towards being a useful tool for key stakeholders. Being a "big picture" person, the only reason I managed to sustain interest in this PhD was that for me it fulfilled several criteria: it was original, I had a significant role in the process of defining its direction and scope and I would learn new skills and synthesise information in a way that would help me pursue an abiding interest in biosecurity issues. But great ideas cannot reach fruition without a lot of hard work and a good team. I was lucky that some wonderful, kind and knowledgeable people believed in the project and were patient enough to teach me aspects I was largely ignorant of. The inspiration for this project came from Bruce Copeman, who suggested the topic and told me that very little was known about possible tabanid vectors of surra in Australia. He also warned me that it would be difficult- very prophetic! In addition, Simon Reid offered his ideas and expertise during early discussions about which aspects I would explore and would have played a much larger role, except for the tyranny of distance. I am also grateful to Dick Copland for his encouragement and early involvement.

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ABSTRACT

Surra, the disease caused by the protozoal parasite, *Trypanosoma evansi*, is characterised by weight loss, anaemia, dependent oedema and death in susceptible animals. It affects all mammalian species tested, and is known to cause acute disease with high mortalities in wallabies and kangaroos (Reid *et al*., 2001). There is no evidence of presence of *T. evansi* in Australia, however it is considered a high biosecurity risk as it has the potential to cause significant economic loss due to livestock death and weight loss, as well as a possibly devastating effect on native wildlife (Reid, 2002; AFFA, 2003).

Tabanid flies (also called march flies or horse flies), especially the genus *Tabanus*, are considered the primary vectors of surra (Nieshulz, reviewed by Krinsky 1979). The distribution, abundance and population dynamics of insect vectors all influence the risk of *T. evansi* transmission. The risk of incursion is considered to be greatest in the northern-most parts of Queensland, Australia (Reid, 2002; Thompson *et al*., 2003a). Disease surveillance is expensive and logistically difficult in this region due to the low population density and remote location. Little historical information was available on the ecology of tabanid flies in Australia, so the main aim of this study was to seek ecological data on tabanids that would promote understanding of the times and places that tabanid abundance occurred in northern Queensland. This information would then be extrapolated over the northern Australian region and used in the production of risk maps for surra in Australia.

In this study, data on tabanid flies was collected in north Queensland over 21 months, and the weather and other environmental factors that were significantly related to their abundance was determined. This information was then applied to a GIS and the annual and spatial abundance of likely vector species was mapped. These maps will be used in conjunction with additional data on host animal density and distribution and disease spread between animals to provide risk maps that will help focus disease surveillance activities in areas of highest risk.

The yearly abundance of *Tabanus spp.* was greatest in the most northern part of Cape York Peninsula, and was related to average annual minimum temperature and solar radiation values. This area of northern Queensland corresponds to a high geographical risk of surra incursion associated with the proximity to West Irian (Indonesia) and Papua New Guinea, which is thought to be the likely route of entry for surra into Australia. In addition, species of *Tabanus* are present for an average of 11 months of the year in this region, as a result of a wide variety of species present in this area, including the presence of *T. ceylonicus*, which is active during the dry season. This indicates that there is a confluence of risk factors in the most northern part of Cape York, which increases the risk of incursion and establishment of surra in this region.

Other aspects of tabanid behaviour and ecology were also studied. It was established that the Nzi trap was the most efficient means of trapping tabanids in Australia, and that attractants greatly improved capture rates. Also the times of greatest daily activity, and activity between days, differed among various tabanid species and this was related to variation in response to meteorological variables.

This study has established relationships among tabanid numbers and weather and environmental factors. This has elucidated the annual temporal and spatial abundance patterns of tabanids in the north Queensland region. This information will provide the basis for further studies that further establish the links between vector intensity and disease incidence in surra endemic countries, which will in turn allow a greater understanding of the epidemiology of this disease.

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COMMONLY USED ABBREVIATIONS

AGID	Agar Gel Immuno-diffusion Assay
ANOVA	Analysis of Variance
AQIS	Australian Quarantine and Inspection Service
AVHRR	Advanced Very High Resolution Radiometer
BOM	Bureau of Meteorology
CART	Classification and Regression Tree Analysis
CCD	Cold Cloud Duration
CO_2	Carbon Dioxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Department of Agriculture Fisheries and Forestry
ELISA	Enzyme-Linked Immuno-Sorbent Assay
EIAV	Equine Infectious Anaemia Virus
EPA	Environmental Protection Agency
GIS	Geographic Information Systems
JCU	James Cook University
LST	Land Surface Temperature
NAQS	Northern Australian Quarantine Strategy
NASA	National Aeronautics and Space Administration (USA)
NDVI	Normalised Difference Vegetation Index
NOAA	National Oceanic and Atmospheric Agency
Meteosat	Meteorological Satellite
OIE	Office International des Epizooties
PCR	Polymerase Chain Reaction
s	Seconds