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**Avian Malaria (*Plasmodium* spp.) in the Auckland Region:
Host-Parasite Associations, Capture Technique Bias, and
Landscape Disease Dynamics**

A thesis submitted in partial fulfilment of the requirements for the degree of

Master of Science in Conservation Biology

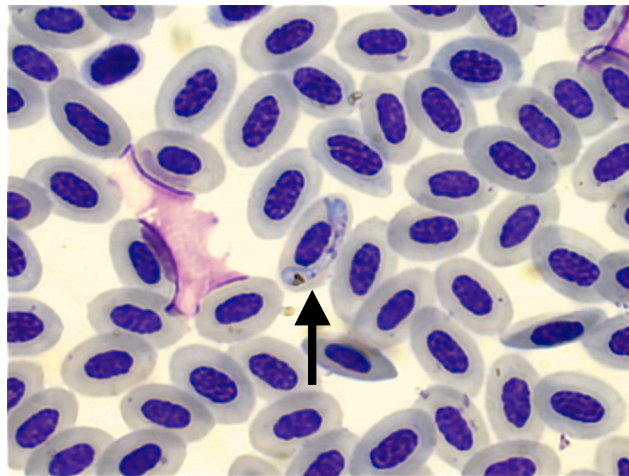
Massey University

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Bellbird (*Anthornis melanura*)



Plasmodium (Novyella) sp. found in bellbirds



Two avian malaria vectors in New Zealand
Culex pervigilans (dark) and *Culex quinquefasciatus* (light)
Photographs by D.J. Gudex-Cross

ABSTRACT

Avian malaria parasites (*Plasmodium* spp.) are distributed throughout the world and affect a vast range of bird species. However many aspects of avian malaria in New Zealand, such as the extent of parasite diversity, distribution and prevalence in host populations, are currently unknown. Thus, the first aim of this study was to examine these parameters in native and exotic bird species of the Auckland Region, North Island. A total of 21 species were sampled at two sites: Tiritiri Matangi Island and Waharau Regional Park. Of these, five native (bellbird *Anthornis melanura*, tui *Prosthemadera novaeseelandiae*, New Zealand fantail *Rhipidura fuliginosa placabilis*, North Island tomtit *Petroica macrocephala toitoi* and silvereye *Zosterops lateralis*) and three exotic (myna *Acridotheres tristis*, blackbird *Turdus merula* and song thrush *T. philomelos*) species were infected. This is the first reported incidence of avian malaria in the New Zealand fantail, and only the second record in tui. The parasite morphospecies identified in this survey were *P. (Haemamoeba) relictum*, *P. (Huffia) elongatum*, *P. (Novyella) rouxi* and two *P. (Novyella)* spp. not yet formally taxonomically described, one of which appears to be specific to the endemic bellbird. Parasite prevalence within the two most heavily sampled species varied strikingly: bellbird prevalence was estimated at 41.5% ($N = 51/123$) in the Tiritiri Matangi population and silvereye prevalence at 9.2% ($N = 22/240$) within the Waharau population.

The other two objectives of this study addressed: 1) the potential bias that choice of capture technique may have in avian malaria surveys and 2) the effects of forest fragmentation on avian malaria and vector distributions. The first objective was investigated by comparing prevalence and parasitaemia in adult male bellbirds on Tiritiri

Matangi Island caught *via* two live-capture techniques: mist netting and supplementary feeder trapping. In this instance it was found that the choice of capture method did influence results: mist netting of bellbirds yielded significantly higher parasitaemia than feeder trapping. The second objective was investigated through a comparison of mosquito species abundance, composition, and avian malaria prevalence in silvereyes at forest edge *versus* interior sites in Waharau Regional Park. A total of five mosquito species, three native (*Aedes antipodeus*, *Culex asteliae* and *Cx. pervigilans*) and two exotic (*Ae. notoscriptus* and *Cx. quinquefasciatus*), were trapped in this study. Significantly more exotic mosquitoes were trapped at the forest edge, with almost complete absence in the interior. Furthermore, analysis of the individual species showed a significant edge-association for *Cx. quinquefasciatus*. Although significantly more native mosquitoes were trapped in the forest interior *versus* the edge, this was due to high *Ae. antipodeus* abundance in one interior site. Consequently, no edge- or interior-associations were found for the individual native species. Finally, avian malaria prevalence in silvereyes did not significantly differ between forest edge and interior.

The outcomes of this study included: a) additional baseline prevalence data for New Zealand; b) records of two new parasite-native bird associations; c) a demonstration that different live-capture techniques can bias estimates of parasitaemia; d) confirmation that forest edge habitats are more prone to exotic mosquito invasions in New Zealand; and e) determination that avian malaria prevalence in the silvereye does not differ between birds caught at forest edge and interior and is thus not closely correlated to mosquito distribution at these sites. A discussion of the future avenues of avian malaria research in New Zealand is provided at the end of this study.

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The Real Work

It may be that when we no longer know what to do

we have come to our real work,

and that when we no longer know which way to go

we have come to our real journey.

The mind that is not baffled is not employed.

The impeded stream is the one that sings.

-Wendell Berry

(The Collected Poems of Wendell Berry ©1987, North Point Press)

PERMITTING AND BIRD NOMENCLATURE

This research was approved by the Massey university Animal Ethics Committee (AEC/13, amended 01/09) and Department of Conservation (permit AK-20666-FAU). Bird banding was carried out under Department of Conservation permit No. 2008/33. Massey University (Masterate Scholarship) and the Auckland Regional Council provided funding for this study.

The scientific names of New Zealand birds used in this study follow the nomenclature of:

Gill, B.J., B.D. Bell, G.K. Chambers, D.G. Medway, R.L. Palma, R.P. Scofield, A.J.D. Tennyson and T.H. Worthy. 2010. Checklist of the birds of New Zealand, Norfolk, Macquarie Islands, and the Ross dependency, Antarctica. Fourth Edition. Te Papa Press, Wellington, New Zealand, in association with the Ornithological Society of NZ Inc.

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