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**The ecology of *Aspergillus fumigatus* and  
implications for wildlife conservation in modified  
environments**

John K. Perrott

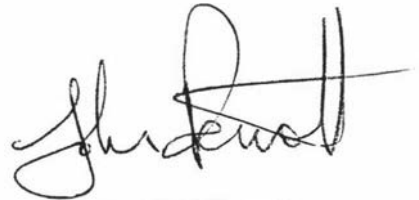
A thesis presented to Massey University  
in partial fulfilment of the requirements  
for the degree of

Ph.D.  
in  
Ecology

Institute of Natural Resources  
Massey University  
November 2001

## **Declaration of Originality**

This thesis represents the original work of the author, except where otherwise acknowledged. It has not been submitted previously for a degree at any university

A handwritten signature in black ink, appearing to read 'John Perrott', written in a cursive style.

**John Keith Perrott**

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## ACKNOWLEDGMENTS

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## Abstract

This thesis outlines my research since 1998 into inter-trophic interactions between pathogenic fungi, insects, birds, and the environment. Chapter One is a stand-alone investigation into fungal diseases associated with native cicadas on Mokoia Island (Lake Rotorua) and the Eastwoodhill Arboretum (Gisborne). Chapters Two through Four are specifically concerned with the natural occurrence of the pathogenic fungus *Aspergillus fumigatus* and its connection to hihi (or stitchbird) on Little Barrier Island (northern Hauraki Gulf), Mokoia Island, Tiritiri Matangi Island (Hauraki Gulf), and the Mt Bruce Wildlife Centre (near Masterton).

The hihi (*Notiomystis cincta*) is a small (i.e., starling sized) cavity-nesting honeyeater endemic to New Zealand. Following European colonisation, hihi became extinct everywhere except on Little Barrier Island, making the future of this species very uncertain. In response to this situation there have been several translocations of hihi to Hen, Cuvier, Kapiti, Mokoia and Tiritiri Matangi Islands from 1980 to 1996. While hihi on Tiritiri Matangi seem to be progressing well with intensive management, all previous translocations to other islands have failed to establish self-sustaining populations. The main hypotheses given to explain these failures are insufficient year-round supply of nectar and fruit, and lack of suitable nesting cavities.

Hihi were translocated to Mokoia Island in September 1994 with nest boxes provided. However, like past translocations, hihi have continued to decline on the island with high annual mortality rates above 50%. It is not clear what factors are contributing to this high mortality rate. My MSc studies carried out on Mokoia Island during 1994-1997 demonstrated that hihi had a good year-round supply of food, and were not dying as a result of starvation. Subsequent post-mortem examinations by Professor Alley of sick and dead hihi from Mokoia from 1995-1997 has revealed that the fungal disease aspergillosis, caused by *Aspergillus fumigatus*, is the most common cause of death among those birds. In addition, captive hihi at the Mt Bruce Wildlife Centre also suffer high rates of aspergillosis, and there is presently concern regarding the susceptibility of hihi to this fungal disease. This study suggests also that past hihi translocations have failed due, in part, to birds being exposed to elevated levels of disease-causing microorganisms.

*Aspergillus fumigatus* is an ubiquitous fungus, and common aspergillosis-causing pathogen in birds and mammals. Infection takes place following the aspiration of fungal spores, and is primarily a respiratory disease. *Aspergillus* infections are usually considered to be opportunist following other primary infections, immunosuppression or stressful environmental conditions. Small numbers of spores can usually be tolerated by the immune system, but large numbers can cause disease and death. At present, prevention is the only effective method of controlling aspergillosis in wild bird populations.

This project is concerned with studying the ecology of *A. fumigatus*, and identifying the most likely source/s of infection in hihi. Therefore, this project is directed towards identifying the most likely source/s of *A. fumigatus* rather than the most likely causes of aspergillosis in hihi. In doing so, the primary aim of this project is to investigate

whether previous hihi translocations from Little Barrier Island to young growth forests and forest edge habitats have been exposing birds to elevated levels of *A. fumigatus*, and therefore, whether *A. fumigatus* preventative management should be considered when planning future hihi translocations.

This project aimed to, A) determine whether habitat disturbance encourages the establishment of *A. fumigatus* in the environment B) measure and compare *A. fumigatus* densities from early growth regenerating forests (i.e., Mokoia and Tiritiri Matangi Islands), a pristine mature forest (i.e., Little Barrier Island), and two mainland forest locations (i.e., Mt Bruce Wildlife Centre, and the Massey University Campus) C) measure and compare *A. fumigatus* densities in forest edge habitats and inner forest locations. D) investigate whether hihi nest boxes on Mokoia Island and natural tree cavity-nests on Little Barrier Island are promoting the growth of *A. fumigatus* and, E) investigate various types of forest disturbance events that could account for the differences in *A. fumigatus* densities found between study sites.

Results from Chapter One describe a unique and previously unreported cicada disease caused by a *Conidiobolus* fungus on Mokoia Island. Results from Chapters Two and Three report elevated levels of *A. fumigatus* on Mokoia Island and at the Mt Bruce Wildlife Center. Low levels of *A. fumigatus* were recorded on Little Barrier Island, and moderate levels recorded for Tiritiri Matangi Island. Results indicate that forest disturbance promotes the abundance of *A. fumigatus* in the environment, and that forest edge habitats have significantly higher levels of *A. fumigatus* compared to inner forest locations. This suggests that forest disturbance alters natural disease dynamics, and increases bird's exposure to opportunistic disease-causing agents such as *A. fumigatus*. These results, in part, illustrate the functional significance of old growth forests in keeping weedy pest species like *A. fumigatus* in check. Results from Chapter Four report that hihi are exposed to elevated levels of airborne *A. fumigatus* spores while in the nest box. Additionally, results indicate that hihi re-using old nest sites would further suffer increased exposure to *A. fumigatus* spores.

Because hihi are a vulnerable species, and seem to be particularly susceptible to aspergillosis, the conservation value of this work is high. This study was made possible by grants from the J.S.Watson Conservation Trust, Massey University Graduate Research Fund, and the World Wide Fund for Nature, and furthers our understanding of mortality factors affecting free-living birds, and provides new information on the ecology of this common wildlife disease. The broader implications of this work for managing wildlife, particularly birds in New Zealand forests are also explored. The relationship between clear-felling forest regrowth, and the incidence of aspergillosis may be the key to understanding the fate of bird populations re-introduced into forests, and determine the viability of "mainland islands".

## Acknowledgements

I am indebted to many people for the assistance and advice, which helped make this thesis possible. Many thanks to my supervisor's Professor Brian Springett, who provided constructive criticism and direction throughout this study, and to Dr. Neil MacGregor who critically appraised my laboratory methods, and provided me with much needed advice and encouragement during problematic times.

I am particularly grateful to the late Dr Mike Baxter who helped with the design of field and laboratory methods and fungi identification during the early stages of the project. Dr Baxter played a major role in the construction of this study, and his selfless contribution will always be gratefully remembered.

This thesis would not have been possible without the assistance and direction provided by co-supervisor Dr Doug Armstrong. Doug's contribution to this project included helping out in the field, obtaining funding, obtaining equipment, endless hours editing drafts of this thesis, and providing me with confidence throughout the project. I also thank several other people who took time to criticise and/or proof read one or more chapters of this thesis: Dr Isabel Castro, Alan Perrott, Ian Watson, and Kimberley Perrott.

I would like to thank the Trust Board of the Eastwoodhill Arboretum, Gary Clapperton, Maurice and Lois Hall for their help and encouragement during my excursions to the arboretum. I very much enjoyed their company, and am grateful for the help and opportunities they provided me.

I have now spent over eight years studying the wildlife and vegetation on Mokoia Island. My time spent on Mokoia and the people I have encountered during these times have enriched my life and fortified my efforts to achieve my goals. I much appreciate the help and support willingly offered me by the Mokoia Island Trust Board, Mita Mohi, and the members of the many cultural groups I have shared the island with over the years. I am particularly grateful to John Marsh and his crew for their logistical help and friendship during my excursions to the island. Nau te rourou naku te rourou, ka ora te manuwhiri. John Marsh provided me transport to the island, use of his facilities and gave his time and advice without hesitation.

I would also like to thank the Rotorua DOC staff and Ngaroto cruises, especially Richard Griffiths, for help in the field and advice given during this study. Richard collected most of the hihi nesting data on Mokoia and helped to collect soil samples from Little Barrier Island (Hauturu).

I would like to thank Lance Te Hara and Tanya Munro from the Ngatiwai Kaitiaki for their assistance and contributions to my trips to Hauturu. I would particularly like to thank Lance for his help in the field and for refining my chess skills. He moana pukepuke e ekengia e te waka. I would also like to thank Sharina Taylor and crew aboard the Hauturu for helping me get to Little Barrier Island.

A number of other people assisted me directly during this study. Without their help this thesis would not have been possible, or as enjoyable. In no particular order I wish to thank Trent Barclay from Auckland Zoo, Prof. M. Alley, Gary Cross, Raewyn Bryn, Jay Jury, Robyn Leech, Dino and Helen, Deborah Anthony, Joanne Connolly, Brooklyn and Carolyn Povy, Ben Hagglund, Steven Huirama, Martin Aldridge, Edgardo Moreno, Hugh Neeilson, Paul Barrett, Babara Just, Chris Mercer, Dr Travice Glare, Aung Kyi, Max Moulds and Penny Aspen.

Thankyou to my wife (Kimberley) and two boys (Liam and Kelan) for their support and understanding throughout the project. There have been many difficult times for them during this project and they have reminded committed to the end. I am grateful to my mum & dad for their endless help and assistance during my time at university. I often take their support for granted because they are always there to give it. I would also like to thank the entire extended family whose strength and encouragement has kept me going. Finally, thankyou again to my wife Kimberley for the work you put into this thesis, and for what you had to endure while I writing it.