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**Behavioural Ecology and Management of Hihi (*Notiomystis cincta*), an
endemic New Zealand honeyeater.**

A Thesis presented in partial fulfilment of the requirements for the degree of PhD in
Ecology at Massey University

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To
Isabella, who first entered
the house and into our hearts.
Randy, who hid from me, but not
from any of the other females.
Tongue face, who showed me
how strong a hihi can be.
Mañeña, who taught me that hihi
are born to be free.
Baby, who bred with another
male and two females, and
Geegee, who is a real character.



Abstract

This thesis is concerned with the release techniques, post-release survival and behavioural ecology of hihi (*Notiomystis cincta*), a rare New Zealand honeyeater. It aims at offering management strategies for translocated populations. The only self-sustaining population of hihi exists on Little Barrier Island. The New Zealand Department of Conservation is trying to establish self-sustaining populations elsewhere.

In 1991 and 1992 hihi transfers to Kapiti Island were approached in an experimental way. Experiments provided four main conclusions: (1) immediate-release birds survived better than delayed-release birds; (2) there was no difference between the survival of birds released in pairs or in a group; (3) hihi released in the absence of resident conspecifics survived better than those released in their presence; and (4) birds released in the absence of resident conspecifics moved to an area with residents in three days.

The breeding system of hihi is highly variable, including monogamy, polyandry, polygyny and polygynandry. Males have physical features found in other species with highly variable mating systems. Male and female hihi benefit from a mixed reproductive strategy where a female hihi can solicit copulations from males other than her partner and male hihi can perform extra-pair copulations both with willing females or by forced copulation. Field tests aimed at determining the influence of the distribution of food and nest sites on the choice of mating system by hihi are proposed.

The phenology of a selected group of plants, important as honeyeater food, was followed from 1992 to 1994. The onset and length of the flowering and fruiting periods for particular plant species varied between the years. The number of fruits and flowers per tree also varied. Hihi egg laying periods coincided with the period of greatest flowering. Hihi breeding success was low every year. In 1993-94 there was great competition for nest sites with kakariki *Cyanoramphus novaezelandiae*. It is suggested that hihi failure to establish self-sustaining populations on Kapiti Island is mainly the result of competition for nest sites and food limitation. It is recommended that feeding stations and nesting boxes are established in three different areas of the island. Food should be provided during the breeding season.

The quality of nectar in some small flowers, and the rate of flower visitation by hihi, tui *Prosthemadera novaezelandiae* and bellbirds *Anthornis melanura* to those flowers were measured. The estimated nectar consumption rate for all flowers was enough to sustain hihi and bellbirds' energetic requirements. It is suggested that honeyeaters might play a previously unrecognised but important role in pollination. Forest regeneration on the New Zealand mainland could be hampered by the loss of hihi and serious reduction in the abundance of tui and bellbirds. Necessary studies to elucidate the role of honeyeaters in pollination are offered.

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It was Ed Minot, my "chief" supervisor, who is mostly responsible for me taking over the study of hihi. I did not want to work with such small bird, but he pointed out to me that after having experience with large birds, the best thing in my C.V. would be to have experience also with small ones. I am very thankful to him because this project is one of the best things that have ever happened in my life. Not only Ed started the whole process, but he has been a major support all the way through. Ed, Robin Fordham, my second supervisor, and Brian Springett, my third supervisor, have helped me with advice, interesting discussions, and enticing questions about my research. They have spent long hours making sure my English is right in my papers and my thesis, and I can only say *mil gracias*. I wish all students could have such a great team as advisers for their thesis.

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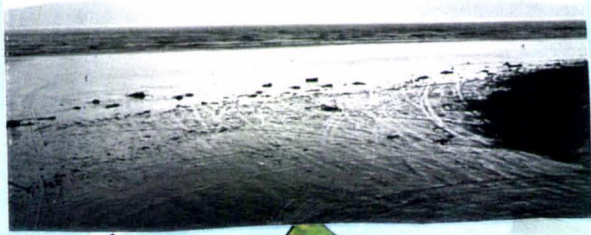
Thank you to Liz Grant and Keith Woodley for making all the drawings of hihi in this thesis. Particularly thanks to Liz for drawing hihi mating postures from my excited descriptions. I would have never been able to do it myself!

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This thesis no sooner will go to the binders than I will probably remember several other people who made important contributions. I apologise for any such omissions.

P.S. Despite the length of the list of those who assisted my efforts, I managed to make all mistakes completely on my own.



PREFACE

Hihi is the name given by Maori to *Notiomystis cincta*. I use this in preference to the more usual common name, stitchbird. Hihi in Maori has several meanings all related to *N. cincta*. The word means "ray of sun", which refers to the yellow shoulders of the male hihi. It also means a head decoration used by Maori warriors which had white feathers on the sides of a black helmet, representing the white ear tufts of the male hihi. There are some derivative words such as *whahihi* which means "cheeky" in relation to the active curious behaviour of the species. As a Maori noun it keeps the same form in both the singular and the plural. Hence "many hihi" (also tui, kiwi, kakariki, kaka).

Each chapter of this thesis has been written in the form of a paper. Several of the chapters have already been published or have been submitted for publication. The objective of this preface is:

- to give the full references for those chapters already published,
- whenever the papers have more than one author to explain the role of each author in the making of the paper and
- to give information about the chapters submitted or to be submitted for publication.

Chapter 1 and **Chapter 2** were presented at the Conference on Reintroduction Biology of Australasian Fauna held in Healesville, Victoria, Australia in April 1993. Papers published from the Conference were refereed by two people chosen by the Editor from those scientists attending the Conference. The full references for those papers are:

- Castro, I., Alley, J.C., Empson, R.A. & Minot, E.O. 1994. Translocation of hihi or stitchbird (*Notiomystis cincta*) to Kapiti Island, New Zealand: transfer techniques and comparison of release strategies. Pp. 113-120 *In* Reintroduction Biology of Australasian Fauna. Surrey, Beatty and Sons. Australia.
- Castro, I., Minot, E.O. & Alley, J.C. 1994. Feeding and breeding behaviour of hihi or stitchbirds (*Notiomystis cincta*) recently transferred to Kapiti Island, New Zealand, and possible management alternatives. Pp. 121-128 *In* Reintroduction Biology of Australasian Fauna. Surrey, Beatty and Sons, Healesville, Australia.

I presented the second paper in the spoken session of the Conference and Julie Alley presented the first one. Julie Alley was my field assistant during the first release of hihi and later from March 1992 to April 1993. She helped me with data collection. Ed Minot, as my supervisor, was involved in the design of the experimental releases and later helped tracking hihi during the first week of each release. Raewyn Empson,

from the Department of Conservation, was in charge of the logistics of the translocation, capture of hihi on Little Barrier Island, and she also helped tracking the birds once released on Kapiti Island. The manuscript gained from conversation with all of them as well as from their editing.

Chapter 1, has not been changed from the published form. Chapter 2 has been changed considerably particularly the information about feeding. I have added the information I collected from 1992-94 to that published from 1991-92.

Chapter 3 has been accepted for publication in *Ibis*. The full reference is:

Castro, I., Minot, E.O., Fordham, R.A., and Birkhead, T.R. *In press*. Polygynandry, face-to-face copulation and sperm competition in the hihi *Notiomystis cincta* (Aves: Meliphagidae). *Ibis*.

Ed Minot and Robin Fordham have both supervised my work on Kapiti Island, helped with mistnetting the birds, and in Ed's case watching and finding nests. Tim Birkhead kindly dissected and described the male hihi cloacal protuberance and counted the sperm in the seminal glomera. He also applied Møller's formula to my testes measurements and drew the cloacal protuberance and its parts. The three of them also contributed to the manuscript with editing and valuable discussions both in person and via e-mail. I have included more theoretical information in the Discussion section of the Chapter than that allowed in the publication.

Chapter 4 has been recently submitted to Functional Ecology. The reference for this paper is:

Castro, I. & Robertson A.W. (*Submitted*). Honeyeaters and the New Zealand forest flora: The utilisation and profitability of small flowers.

Alastair Robertson taught me the techniques to collect nectar from the flowers and the processing of the samples in the laboratory. He was also helpful in providing references on the subject of pollination ecology and evolution, and advice on statistics. The paper gained from valuable discussions with him. He also helped to edit it.

Chapter 5 will be submitted to the New Zealand Journal of Ecology.

Chapter 6 was written as a report to the Department of Conservation.

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