Photo by David Wiltshire

NZASE research resource

Feather lice and allopatric speciation

Authors

Professors Steve Trewick and Mary Morgan-Richards, above, of Massey University, Palmerston North, study evolution with a focus on New Zealand endemic insects, birds and snails.

Key points

- Parasites can be inherited from your parents, just like genes
- When hosts speciate, their parasites diverge in allopatry
- Feather lice are parasites of birds
- The research illustrates New Zealand examples of host-parasite coevolution.

Link to the curriculum

Level 8 Biology
Scholarship Biology

Abstract

Feather lice are completely dependent on their bird hosts. They move from one host to the next during close physical contact, usually when parents are brooding their chicks. Speciation of the host can lead to allopatric speciation of the feather lice, because they are isolated on their lineage of bird. This particular type of coevolution is called cospeciation, when the speciation of the host lineage leads to a barrier between parasites and potential for divergence via genetic drift. For every host generation there can be 10 or more generations of feather lice. Molecular genetic evolution therefore looks faster in the parasite lineage measured in years compared with their host. New Zealand examples of cospeciation are described in <u>*Wild life New Zealand*</u>.

Feather lice and allopatric speciation

We might think of parasites as plaguing their defenceless hosts, but most parasites are at the mercy of their host's evolutionary future. If a host goes extinct, so too does its parasite. When huia were driven to extinction after Europeans arrived in New Zealand (~1910), the huia's unique feather louse (*Rallicola extinctus)* also went extinct (Mey 1990; Palma 1999).

Feather lice are small insects that live their whole life on a bird, and usually only move from one bird to another when parents are brooding their chicks in the nest. Lice are wingless and need the close physical contact of birds to move from one host to another. Thus, feather lice are passed through the generations from parents to offspring much like the inheritance of alleles (Trewick & Morgan-Richards, 2019). When the adult bird dies, its population of feather lice cannot survive the cold, and without wings their destiny is linked to their host (Figure 1).

__Figure 1__. Feather lice are insects without wings. Ectoparasites go wherever their hosts (birds) go. Pūkeko (page 3) can travel long distances with their hitchhikers - two species of feather lice.

When a host flies off to a new island, so too do their feather lice. Over time, mutations accumulate in the louse population, are passed to their offspring and allele frequencies change from one generation to the next due to genetic drift. While their host is isolated, the lice are also isolated and there is no gene flow between these louse populations. Thus, isolation of the host (bird) results in isolation of the parasite lineage. And if this isolation is extended for long enough before extinction, then we will recognise a distinct species (allopatric speciation).

Whether the host is geographically isolated on an island, or reproductively isolated due to mate choice behaviours, their lice populations are allopatric. For example, parea (*Hemiphaga chathamensis*), the pigeon endemic to the Chatham Islands, is closely related to kererū (*Hemiphaga novaeseelandiae*); each pigeon species is host to its own feather louse species that is closely related yet genetically distinct.

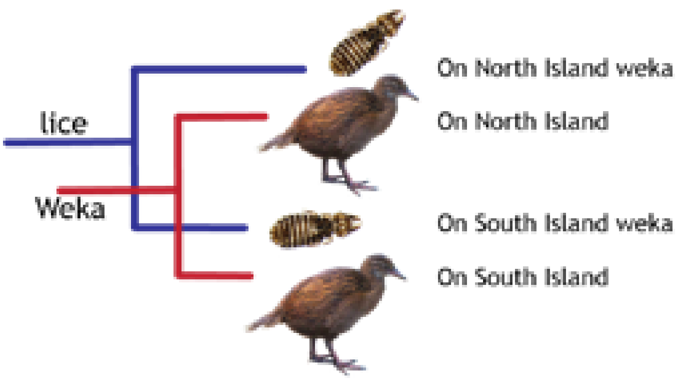


***Figure 2**. Flightless weka on either side of the Cook Strait are allopatric (isolated from one another) and genetically distinct. Their feather lice are therefore also allopatric and show the same pattern of divergence as their hosts.*

Flightless weka (*Gallirallus australis*) populations either side of the Cook Strait have their own feather lice. Each weka can be host to two distinct types of lice, from different suborders, and the same patterns are seen in these two independent parasites (Trewick et al. 2017). Isolation of the bird populations by the Cook Strait has prevented gene flow between the lice populations, north and south, and they too have diverged (Figure 2).

When host speciation leads to parasite speciation we call this co-speciation (a special kind of coevolution). If splitting of the host's evolutionary lineage results in allopatric speciation of its feather lice, the evolutionary trees of the host and parasite will match one another (figure 3). Biologists who study parasite evolutionary history find similarities with host history that is not the result of chance. Co-speciation is an important driver of parasite diversity. In New Zealand pūkeko (*Porphyrio melanotus*) and takahē (*Porphyrio hochstetteri*) share the same habitats but each is host to its own unique feather lice species. Looking at diagrams of the evolutionary relationships among New Zealand's rail birds, it is clear that their lineage splitting is matched by their parasitic lice (Figure 3).

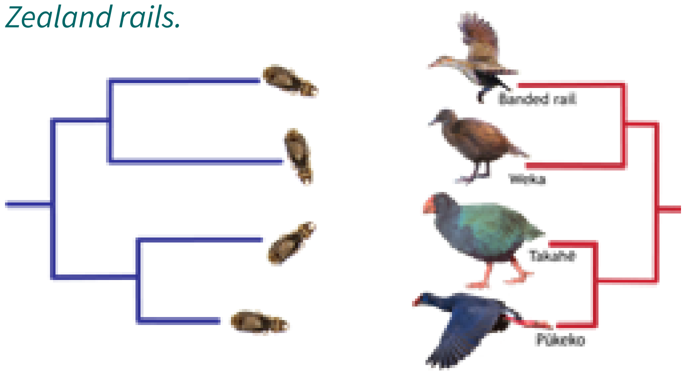
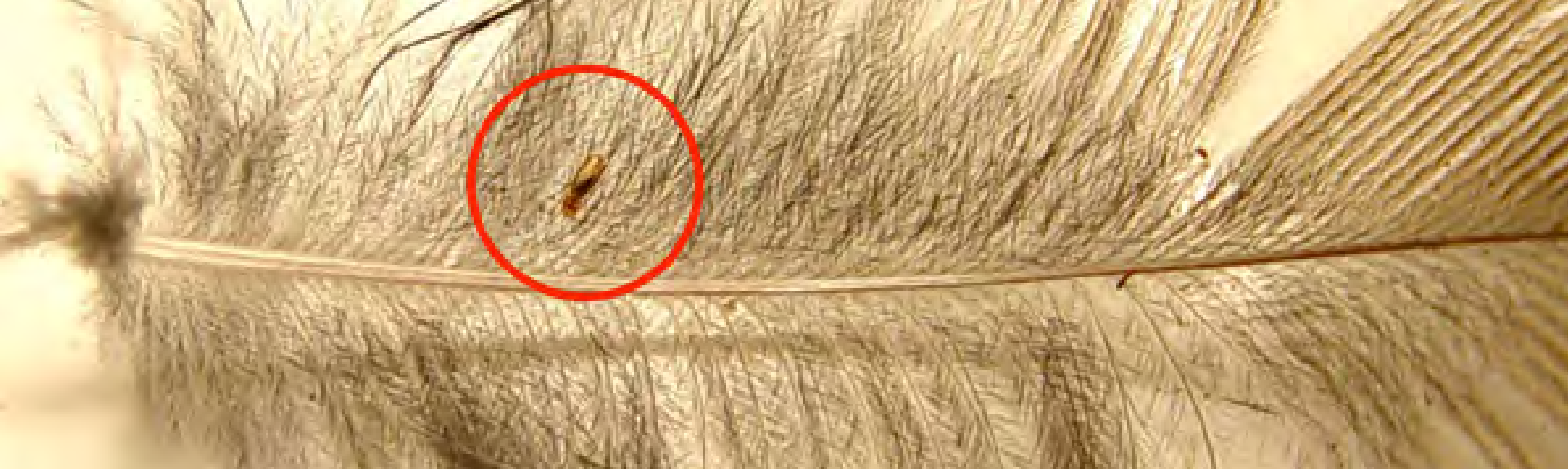


***Figure 3**. The evolutionary relationships of feather lice match the evolutionary relations of the New Zealand rails.*

In the lifetime (generation) of a bird host, lice go through many generations. Some feather lice go from egg to adult in less than a month, and human head lice have a similar generation time. If measured in years, isolated louse populations will accumulate genetic differences more rapidly than their hosts, because the fundamental rate of mutation per generation is similar in louse and host. For example, the pigeon lineage on the Chatham Islands has been isolated there for as long as their feather lice have been there (about two million years), but if we measure the genetic difference between the host species (parea and kererū; Goldberg et al. 2011) we see it is smaller (1.3%) than the genetic difference between their respective parasite species (6.2% between *Coloceras harrisoni* and *C. novaeseelandiae*).



However, the environment that lice occupy differs little, whatever their host is doing or wherever it is. The lice have a ready supply of skin and feathers to eat, and a constant temperature supplied by their host. The only hazard is the bird's beak – used to preen feathers and remove lice. So, although lice have a faster pace of life than their hosts, they show little morphological divergence; while their environment remains the same, natural selection constrains them to a conserved shape that fits their feathery home.

Links

Parasites

Definition and examples
Definition and different types of parasites

Speciation

Brittanica - Types and definitions
Short, simple definitions of the process
Khan Academy - Definitions and examples

Genetic diversity

Edugreen - Short definition
2008 academic article about genetic diversity in threatened species in New Zealand (PDF)

Ngā Kupu

Huru Feather
Iranga tuku iho Genetic inheritance
Kukuwhatanga Evolution
Kutu Louse, lice
Mātai iranga Genetics (subject)
Momo Species
Pirinoa Parasite, parasitic.

From Paekupu and Te Aka Maori Dictionaries

Above: Feather louse on a feather. Below: Pūkeko. All photos by Steve Trewick except where stated.

References

Goldberg J, Trewick SA, & Powlesland RG. (2011). Population structure and biogeography of Hemiphaga pigeons (Aves: Columbidae) on islands in the New Zealand region. *Journal of Biogeography.* 38: 285–298.

Mey, E. (1990). Eine neue ausgestorbene Vogel-Ischnozere von Neuseeland, Huiacola extinctus (Insecta, Phthiraptera). *Zoologischer Anzeiger* 224: 49–73

Palma, RL. (1999). Amendments and additions to the 1982 list of chewing lice (Insecta: Phthiraptera) from birds in New Zealand. *Notornis.* 46 (3): 373–87.

Trewick SA, Pilkington S, Shepherd L, Gibb GC, & Morgan-Richards M. (2017). Closing the gap: avian lineage splits at a young, narrow seaway imply a protracted history of mixed population response. *Molecular Ecology* 26(20): 5752–5772.

Trewick SA, & Morgan-Richards M. 2019. *Wild life New Zealand*. Hand-in-Hand Press, New Zealand. ISBN 978-0-473-48320-3. [*This book includes this and other stories about the evolution of New Zealand's flora and fauna.*]