BITTEN BIRDS

Piecing together the avian malaria puzzle

*All but one of a population of yellowheads, or mohua (*Mohoua ochrocephala*) at a Christchurch wildlife park were killed by avian malaria. Photographer: Ian Southy. Crown copyright: Department of Conservation*

Humans are not the only animals to suffer from malaria courtesy of mosquitoes. Avian malaria is an arthropod-borne disease where protozoan blood parasites (*Plasmodium* spp.) are transmitted to birds by mosquitoes. Though several native New Zealand birds are known to be affected by avian malaria, its overall significance to our native birdlife is not yet known. Biosecurity New Zealand Technical Adviser **José Derraik** backgrounds a research programme aiming to fill in the knowledge blanks about this potentially serious threat to New Zealand's native birds.

In 1996, a simultaneous outbreak of avian malaria and avian pox occurred among New Zealand dotterel chicks (*Charadrius obscurus*) in two captive-rearing institutions in northern New Zealand. This led to the death of 10 out of 16 birds – a significant loss for this endangered species (Richard Jakob-Hoff *et al.* unpublished data).

More recently, an outbreak of avian malaria amongst yellowheads (*Mohoua ochrocephala*) at a Christchurch wildlife park killed the entire population with the exception of one bird. There is also the suggestion that avian malaria may be a cause of deaths among endangered yellow-eyed penguins (*Megadyptes antipodes*) in the South Island (Graczyk *et al.* 1995), with at least one confirmed case of clinical infection (Alley 2001).

Non-natives may be carriers

Host susceptibility to avian malaria varies, and some widespread species, such as the exotic sparrow (*Passer domesticus*), song thrush (*Turdus philomelos*) and blackbird (*T. merula*) may be asymptomatic carriers (Laird 1950). This is a significant problem as birds not killed by the disease become carriers of the parasite for life (reservoir hosts), and will therefore be able to infect mosquitoes that feed on them.

The threat posed by avian malaria to New Zealand's unique avian fauna may be serious. The introduction of the *Plasmodium* parasite and the vector *Culex quinquefasciatus* to Hawaii, where no mosquitoes were present before its arrival in 1826 (Laird 1984), had disastrous consequences (van Riper III *et al.* 1986). It is estimated that the *Plasmodium* parasite played a key role in the extinction of about half of Hawaii's endemic bird species (van Riper III *et al.* 1986; Tompkins 2005). It is feared that New Zealand's avian fauna could suffer a similar fate.

New Zealand vectors to be identified

The mosquito species that are acting as vectors of the parasite in New Zealand are not yet confirmed. The exotic *Culex quinquefasciatus* is most likely to be the main culprit due to its worldwide role in the cycle of the disease, particularly in Hawaii. This species seems to have been spreading southwards in the past two decades or so (Laird 1995). Recent work conducted at seven sites around the country has detected the avian malaria parasite in exotic birds at all sites (Tompkins 2005). There was a north-to-south gradient in detection rates (48% of birds tested in the north compared to 6% in the far south).

While the results closely match the New Zealand distribution of *Culex quinquefasciatus*, there are some anomalies, suggesting the possible involvement of other mosquito species – most likely the native *Culex pervigilans*. Apart from *Culex quinquefasciatus*, another potential vector of *Plasmodium* spp.,

Top: José Derraik (Biosecurity New Zealand) collecting mosquito larvae from one of the numerous artificial habitats encountered in the Gisborne field site.

Above: Avian malaria contributed to the deaths of 10 New Zealand dotterel chicks like this one. Photographer: Dave Wills. Crown copyright: Department of Conservation

Below: Culex quinquefasciatus*: experience in Hawaii suggests it is a prime suspect as an avian malaria vector in New Zealand. Photo: Mark Disbury, Biosecure New Zealand.*

the introduced *Ochlerotatus australis* is present in New Zealand, but it is mostly confined to the southeastern coast of the South Island (Snell 2005).

The vector competence for avian malaria of all other mosquitoes in New Zealand, and their potential role in the cycle of the disease, is unknown.

Research under way

A Ministry of Research, Science and Technology (MoRST)-funded research project led by Landcare Research in collaboration with ESR and MAF, aims to answer as-yet unresolved pieces of the avian malaria cycle in New Zealand. The project is being led by Landcare's Daniel Tompkins and supported by José Derraik (Biosecurity New Zealand), Dave Slaney (ESR) and Rachel Paterson (Landcare Research). The investigation is concentrating on two sites: Gisborne where a high incidence of *Plasmodium* infection (~50%) has been detected amongst exotic birds, and Orana Park near Christchurch, the site of a previous avian malaria outbreak amongst native birds.

The main challenge facing the project team is to identify the mosquito species vectoring the avian malaria parasite. This requires the collection of blood-engorged females. These will be tested using molecular techniques to identify the presence (or absence) of the avian malaria parasite and the host on which the females fed.

Although such work has been carried out overseas, it is novel for New Zealand. Different types of traps are being tested to identify the best sampling technique(s). Preliminary work carried out in early December 2005 obtained promising results, with a number of blood-engorged females being trapped in resting boxes and pipe traps in Gisborne. To our knowledge, all previous collections in New Zealand were rare, and obtained using animals or humans as baits (e.g. Bullians & Cowley 2001), or via non-targeted traps such as CO_2-baited traps used to capture host-seeking mosquitoes.

Public health relevance

This project is also of public health relevance. PCR techniques will be used to identify the hosts on which the mosquitoes fed, which will provide an insight into this rather unknown aspect of mosquito ecology in New Zealand. The importance of such data is that there has never been a confirmed case of mosquito-borne disease in humans acquired in New Zealand (Derraik & Maguire 2005). However, this blissful state is likely to change in the future (Derraik & Calisher 2004), especially under a global warming scenario that will extend the areas of suitable climate for vector species in New Zealand, and increase the rate of pathogen/parasite transmission (de Wet *et al.* 2001; Weinstein *et al.* 1995; Woodward et al. 2001). Understanding the blood-feeding habits of mosquitoes in New Zealand will help us better evaluate the potential risk posed to human health.

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