PLANTS AND ENVIRONMENT

HIGH-RISK EXOTIC MOSQUITOES OF INTEREST TO NEW ZEALAND

As of early 2011, New Zealand remains free of any locally transmitted mosquito-borne diseases of medical and veterinary importance. However, this status is constantly challenged by the threat of accidentally imported high-risk exotic mosquitoes. The risk status of individual species is evaluated from their importance as vectors of disease and the likelihood of their successfully establishing and spreading here.

In 2007 the mosquito species of high risk (as determined by likelihood of entry and establishment and potential to vector disease here) were listed in a MAF report (Mackereth *et al.*, 2007). The species with their common name/s and status include:

Culex (Culex) quinquefasciatus (southern house or brown mosquito). Introduced.

Aedes (Finlaya) notoscriptus (domestic container, or striped, or ankle-biting mosquito). Introduced.

Aedes (Ochlerotatus) camptorhynchus (southern saltmarsh mosquito). Introduced but declared eradicated in 2010.

Aedes (Stegomyia) albopictus (Asian tiger mosquito). Exotic.

Aedes (Finlaya) japonicus (Japanese rock pool or Asian bush mosquito). Exotic.

Aedes (Ochlerotatus) vigilax (saltmarsh mosquito). Exotic.

Culex (Culex) annulirostris (common banded mosquito). Exotic.

This list has since been extended (McGinn, 2008) to include:

Aedes (Ochlerotatus) procax and

Coquillettidia (Coquillettidia) linealis.

Exotic mosquitoes are of medical and veterinary importance to New Zealand owing to their potential to become established, act as vectors for disease and cause secondary health impacts. Here we highlight two quintessentially Australian species regarded as high risk to New Zealand. We provide background on the human and animal health importance of these insects.

Ae. camptorhynchus was detected in Napier in December 1998, and after nearly 11 years and at a cost of about $70 million, was declared eradicated from New Zealand in June 2010. However, it remains a high-risk species, especially given its demonstrated capacity to establish across much of the country's saltmarsh habitat.

Drivers for exotic mosquito surveillance

PUBLIC HEALTH

New Zealand is a signatory to the International Health Regulations 2005 (IHR 05), which set out obligations to control international movement of biological, chemical and radiological hazards to public health. Included among the biological hazards are vectors of human disease, such as mosquitoes. A recent review of vector surveillance in New Zealand (McKenzie *et al.*, 2009) identifies a number of exotic arboviruses of high to medium risk: West Nile virus (WNV), yellow fever virus (YFV), Murray Valley encephalitis virus (MVEV), Ross River virus (RRV), Sindbis virus (SV), and Barmah Forest virus (BFV). Four of these viruses occur in Australia. In terms of prevalence,

TABLE 1: ANNUAL NOTIFICATIONS OF SELECTED MOSQUITO-BORNE DISEASES IN QUEENSLAND, 2000–2009 (ANON., 2010)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BFV disease	345	601	387	869	583	680	955	826	1 245	797
Dengue fever	85	42	81	725	275	117	78	120	245	1 033
Japanese encephalitis	0	0	0	1	1	0	0	0	233	0
Kunjin virus disease	0	0	0	6	5	1	1	0	0	1
Murray Valley encephalitis	0	1	0	0	0	0	1	0	0	0
Ross River fever	1481	1568	885	2514	2005	1179	2611	2137	2846	2149
Yearly total	**1911**	**2212**	**1353**	**4115**	**2869**	**2253**	**3645**	**3083**	**4325**	**3981**

RRV and BFV are the most abundant across all Australian states and territories. As an example, Table 1 shows the yearly notifications to the Queensland Department of Health of some mosquito-borne diseases.

RRV and BFV are alphaviruses maintained in a zoonotic cycle between mosquito and vertebrate (usually macropod) host. Where environmental conditions encourage mosquito abundance and longevity, human populations are more exposed to the risk of virus transmission. Infection by RRV or BFV may result in no symptoms (in the majority of cases where they are endemic, and especially with children), but 10–20 percent of infected individuals exhibit mild to severe symptoms including mild fever and rash with a polyarthritis affecting the joints of the hands, feet and knees. Joint pain may last from several weeks to many months. People of working age suffer most with RRV and BFV. In areas where there is no RRV or BFV exposure, so-called "green field" epidemics may produce very high rates of clinical disease: for example, more than 90 percent of the population of Vanuatu developed clinical RRV in 1979–80 (60 000 cases).

Disease notifications listed in Table 1 represent only the reported clinical disease burden in the community. The incidence of infection is much greater but many cases are not reported because symptoms are unapparent or mild. The true activity of RRV and BFV in Australia therefore cannot be accurately described, but clearly they are highly prevalent and there is a very real threat of their being introduced to New Zealand by travellers who are viraemic (whether symptomatic or not). Only the absence of the mosquito vector breaks the potential cycle of disease transmission in New Zealand.

VETERINARY HEALTH

McKenzie *et al.* (2009) identify bovine ephemeral fever virus (BEFV) as having a medium risk of entry to New Zealand. While the arthropod vectors of BEFV are not well known, they are likely to belong to the mosquito species and possibly also include biting midge species of the genus *Culicoides*, that feed on cattle.

RRV infection also causes clinical disease in horses. Fever, polyarthralgia in leg joints, and lethargy are the common signs. Also of concern to New Zealand is the dog heartworm *Dirofilaria immitis*, vectored by mosquitoes including *Aedes (Ochlerotatus) vigilax* and possibly *Culex annulirostris*.

Even non-infectious mosquito bites can have a variety of effects. Allergens introduced to the host animal in mosquito saliva can produce a variety of reactions, for example even moderate numbers of bites can provoke porcine allergic dermatitis syndrome (PADS) in pigs. Figure 1 shows a living pig with numerous raised lesions associated with PADS at bite sites. Fair-skinned breeds are especially sensitive. Affected pigs show signs of this reaction at slaughter (Figure 2). Affected carcasses are highly devalued, not exportable, and generally only fit for rendering.

Figure 1: PADS-affected pig after mosquito attack

Figure 2: Mosquito-marked pig carcass after slaughter

Two high-risk exotic mosquitoes

Aedes (ochlerotatus) vigilax

Figure 3: *Ae. vigilax*

Ae. vigilax (Figure 3) includes at least two subspecies whose type localities are Gosford, New South Wales and Brisbane, Queensland. Overall, the species has a wide distribution within Asia and Australasia, including the Seychelle Islands, Taiwan, Philippine Islands, Ryukyu Islands, Vietnam, Thailand, Malaysia, Indonesia, East Timor, West Irian, Papua New Guinea, Australia, Solomon Islands, Vanuatu, New Caledonia (including the Ile des Pins and Loyalty Islands), and Fiji (Lee *et al*., 1984).

This species is essentially coastal and, like *Ae. camptorhynchus*, occupies saltmarsh in estuarine habitat flooded by spring tides, storm activity and wind-driven wave action. In Australia it also occurs inland where brackish-water habitats exist along river overflows and irrigation areas subject to salinisation. *Ae. vigilax* is found in all states or territories of Australia except Tasmania. In Victoria it occurs along the coast northeast of Gippsland, and in South Australia along the gulf regions. *Ae. vigilax* occurs in Australia at least as far south as 38°, which corresponds in New Zealand to near Gisborne. It is therefore highly likely that if *Ae. vigilax* were to penetrate New Zealand border security, it could find suitable habitat to establish itself.

Ae. vigilax is a competent vector of several important arboviruses and parasites of both medical and veterinary importance including RRV, BFV, dog heartworm and potentially also Chikungunya virus.

Culex (Culex) annulirostris

Figure 3: *Ae. vigilax*

C. annulirostris is a species complex that likely consists of several similar species and has a wide Australasian distribution (type locality: Blue Mountains, New South Wales, Australia). Within Australia it is found in every state or territory, although only once recorded in Tasmania, and is commonly found in fresh or brackish ground pools filled by rainwater runoff. These groundwater pools commonly include emergent vegetation, especially grasses. This species breeds in very high numbers in pools in pastures where animal manure increases nutrient loads, and is also found in oxidation ponds. It also sometimes colonises relatively small containers such as drinking troughs and barrels.

An extract from The Culicidae of the Australasian Region volume 7 (Lee *et al*., 1989) reads:

"With regard to New Zealand, D.H. Graham (1339) records that on 10.vi.1929 the s.s. "Tofua" from Fiji, berthed in Auckland, was inspected and a half-barrel containing several thousand larvae and pupae of *Cx. annulirostris*, from which adults were continually emerging, was found. Two months later a barrel containing many larvae of this species was found on the waterfront, about 300 yds (275m) from the berthing-place on the waterfront. They were all destroyed, and a search in nearby water receptacles proved fruitless."

The presence of *C. annulirostris* in the southern states of Australia suggests it could probably establish in some parts of New Zealand. It can live in a wider range of habitats than the saltmarsh mosquito, and potential habitats near ports of entry would be most likely to become colonised first.

C. annulirostris is a highly competent vector of several arboviruses, including Murray Valley encephalitis virus, Kunjin virus (closely related to West Nile virus), Ross River virus and Barmah Forest virus. It is also likely to play a role in the transmission of dog heartworm.

Present surveillance

Surveillance for exotic mosquitoes is jointly managed by the Ministry of Health (MoH) and MAF. Under the IHR 05, MoH has lead-agency responsibility for responding to port detections, while post-border responses are the sole responsibility of MAF. Port surveillance consists of routine monitoring to detect exotic mosquitoes at all developmental stages. Ovitraps and light traps are maintained at ports year-round to attract and capture mosquitoes, while MAF inspects vessels and goods for the presence of mosquito larvae and adults. Detections of suspected exotic mosquitoes are responded to under a memorandum of understanding between MoH and MAF.

A major surveillance programme of all saltmarsh habitats within New Zealand was developed during the southern saltmarsh mosquito eradication programme. This programe was originally developed and administered by the MoH in 2005, but responsibility for the National Saltmarsh Surveillance Programme (NSP) was transferred to MAF Biosecurity New Zealand in June 2010. The NSP is a risk-management programme of field inspections within saltmarsh habitat, which aims at early detection of exotic saltmarsh mosquitoes (both larvae and adults). The recent review of surveillance of vectors and vector-borne disease in New Zealand (McKenzie *et al.*, 2009) has identified an additional need to include suitable receptor habitat for *C. annulirostris* in post-border inspections.

Continual improvement and development of border and post-border surveillance for exotic mosquito surveillance is essential. Early detection of the southern saltmarsh mosquito (which had apparently been present for years before it was discovered in 1998) would likely have saved the country many millions of dollars in eradication costs. Accordingly, the current investment in early detection should pay dividends in the future.

References

Anonymous. Queensland Joint Strategic Framework for Mosquito Management 2010–2015. Queensland Government and Queensland Local Government Association, July 2010.

Lee DJ, Hicks MM, Griffiths M, Russell RC, Marks EN. The Culicidae of the Australasian Region. Volume 3. Aust. Govt. Pub. Service. Canberra, 1984.

Lee DJ *et.al.* The Culicidae of the Australasian Region. Volume 7. Aust. Govt. Pub. Service. Canberra, 1989.

McGinn D. Mosquito Surveillance Review. Report commissioned by the Ministry of Agriculture & Forestry and Ministry of Health, 2008.

McKenzie J *et.al.* Development of Surveillance for Vectors and Vector-Borne Diseases in New Zealand – Surveillance systems design. MAF Report, 2009.

Mackereth G *et.al.* Vectors and vector borne diseases: Ecological research and surveillance development in New Zealand. Risk Assessment. Ministry of Agriculture and Forestry, Wellington, 2007.

Darryl McGinn
Mark Disbury
Noelle Fynmore
Mosquito Consulting Services (NZ)
2–4 Bell Road South, Gracefield
Lower Hutt 5010
PO Box 38-328, Wellington Mail Centre 5045

Rachel Cane
Mosquito Consulting Services (NZ)
2 Marion Place, Lincoln,
Christchurch 7608
PO Box 69-198, Lincoln
Christchurch 7640