

EXOTIC MOSQUITOES POST BORDER SURVEILLANCE

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ABSTRACT

There are over 3500 mosquito species worldwide and many are disease vectors. Exotic mosquito species are routinely discovered at the New Zealand border. The Ministry of Health (MoH) has developed and implemented systems to detect these. There are two border health protection programmes currently in place which target exotic mosquitoes; ports of entry surveillance and the National Saltmarsh Surveillance Mosquito Programme (NSP). Ports of entry are monitored by Public Health Units for the MoH, and utilise a range of surveillance methodologies. Since July 2001, exotic mosquitoes have been regularly intercepted predominantly associated with known risk goods. The NSP was initiated in 2005 to establish standardised surveillance methodologies nationally for surveying saltmarsh habitat. The programme has been developed and implemented by New Zealand BioSecure (NZB) and has successfully detected a new population of *Aedes camptorhynchus* (the southern saltmarsh mosquito) as well as an as yet undescribed species from the Chatham Islands.

Keywords: border health, mosquito surveillance, early detection, interception

INTRODUCTION

There are in excess of 3500 mosquito species worldwide and a large number of these are known disease vectors of humans and animals. With only 16 species of mosquito (including one newly discovered undescribed species and not including *Aedes camptorhynchus* presently subject to eradication – refer below), New Zealand is believed to contain a large proportion of underutilised mosquito breeding habitat which could easily be exploited by invasive exotic species.

Three of New Zealand's mosquito species are established exotics which have some disease association, although none are considered to be of major importance for transmitting diseases of risk within New Zealand. New Zealand is presently free of mosquito-borne diseases of public health significance. If exotic mosquito species capable of vectoring human diseases are allowed to establish here, the risk of their associated mosquito-borne diseases also becoming established, increases considerably.

The recent rise in global transportation of humans and cargo has increased the opportunities for exotic mosquito species to spread (Morse 1995). Container breeding mosquito species in particular, have been extremely successful at invading new geographic areas (Lounibos 2002). Larvae of species such as *Aedes aegypti*, *Ae. albopictus* and *Ae. japonicus* are commonly imported within cargo on shipping vessels, in a variety of receptacles, e.g. used tyres (Laird et al. 1994), used machinery (Derraik 2004) and vehicles with water-holding containers. The importation of live plant material has also been shown to be an effective import pathway, e.g. 'lucky

bamboo' (*Dracaena* spp.) transported as stalks in water has facilitated the spread of *Ae. albopictus* within the United States (Madon et al. 2003).

On 24th December 1998, *Aedes (Ochlerotatus) camptorhynchus* (Thomson) an Australian mosquito commonly known as the southern saltmarsh mosquito (SSM), was discovered breeding in habitat around Napier (Hearnden 1999). This species is a competent vector of Ross River virus (Ballard & Marshall 1986), a debilitating disease of humans and wildlife. The incursion triggered a series of eradication programmes to remove this species from New Zealand and highlighted the importance of preventing the establishment of exotic mosquito species (Weinstein 1995; Hearnden 1999), as well as the need for robust surveillance to be maintained in New Zealand.

At that time, existing mosquito surveillance in New Zealand focussed on ports of entry, predominantly targeting container breeding species via detection of immature stages in ovitraps (traps which attract gravid female mosquitoes and provide a suitable habitat in which to lay their eggs), as well as trapping adult mosquitoes in purpose-built light traps. Saltmarsh mosquitoes are predominantly groundwater breeders and are not generally found associated with artificial or natural containers and therefore were not really accommodated for, by the ports of entry surveillance methods. Saltmarsh mosquitoes were identified as posing a significant threat for establishment in New Zealand.

From 1999, surveillance of saltmarsh habitat outside the SSM eradication zones was carried out on a regional basis by Public Health Unit (PHU) staff. In 2002, a review of the New Zealand mosquito surveillance programme was commissioned by the Ministry of Health (MoH) and the resulting report by Ritchie & Russell (2002), recommended that saltmarsh surveillance be undertaken 'towards a national uniformity of approach'. Following this, the MoH decided to have the National Exotic Saltmarsh Mosquito Surveillance Programme (NSP) developed and implemented.

Since July 2001, the SMS New Zealand BioSecure Entomology Laboratory (NZBEL) has been contracted by the MoH to identify all mosquitoes collected as part of the two border health surveillance programmes, including suspected interception specimens. Data collected through this work is presented in this report.

The MoH have compiled a list of unwanted organisms currently containing 14 exotic mosquito species, the establishment of which is to be actively prevented.

PROGRAMMES

The Ministry of Health manages border health surveillance with three key objectives; to intercept exotic mosquitoes on arrival in New Zealand and prevent their establishment, to detect any exotic mosquito incursions at an early stage to allow for a greater chance of eradication and to prevent the export of any mosquito species out of New Zealand.

The surveillance is currently divided between two programmes, one concentrating on first ports of entry into New Zealand, i.e. air and sea ports and transitional facilities, and the other (the NSP), focuses on saltmarsh habitat throughout New Zealand. These programmes also monitor changes in the numbers and distribution of already

established mosquito species and generate additional information of potential public health significance, such as changes in habitat, which is incorporated into a comprehensive database of saltmarsh habitat and MoH report requirements.

Ports of Entry surveillance

Regional Public Health Units carry out ongoing border health surveillance work at all New Zealand international first ports of entry. It comprises part of a secondary line of defence aimed at detecting exotic mosquitoes entering the country through aircraft, shipping or associated with risk goods. Primary biosecurity inspections of vessels, aircraft and risk goods, both offshore and at the border, is undertaken by MAFBNZ Cargo Clearance Services.

The surveillance in and around sea and air ports is comprised of ongoing trapping regimes targeting host-seeking adult female mosquitoes in need of a blood feed utilising carbon dioxide-baited light traps and using ovitraps and tyre traps to attract gravid container-breeding females looking to oviposit. These trapping regimes are run in conjunction with habitat surveys. The extent and frequency of the trapping and surveys considers matters such as the risk posed by each individual port, assessed on volume and frequency of traffic, risk good importation, ports or origin, and time in transit.

An interception event occurs when specimens are discovered which are believed likely to be of exotic origin, e.g. mosquito larvae found breeding on goods just arrived in New Zealand. The discoverer, usually a MAFBNZ Cargo Clearance Services border inspector contacts the local PHU on-call officer who initiates an urgent response. All relevant stakeholders, including MoH, MAFBNZ, Port Authorities and NZBEL are informed. Specimens are collected and where possible same day couriered to the NZBEL for identification. PHS staff initiate a delimiting survey and additional light traps frequently deployed in the area. This is followed by an enhanced surveillance programme in response to each interception event. Enhanced surveillance is maintained for a variable period of time, dependent on the life stages and species type involved. If there was evidence of any establishment of an exotic mosquito population, the response would be transferred to MAFBNZ.

In addition to this active surveillance, passive surveillance systems where the public are encouraged to report any unusual mosquitoes or mosquito activity such as increased biting or changes to times of biting, also exist.

National Exotic Saltmarsh Mosquito Surveillance Programme (NSP)

The NSP programme operates through the NZB Control Centre now located in Silverdale, Auckland. New Zealand was divided into five operational management zones (Fig. 1) and the entire coastline as well as many offshore islands was aerially surveyed, digital images taken and GPS data collected for all potential saltmarsh habitat observed. This data, along with previously identified saltmarsh habitat data collected during the SSM eradication programmes as well as historical PHU saltmarsh sampling data was combined to produce a new record of potential saltmarsh habitat for the entire country.

The programme design allows for specific site habitat data collected and recorded at the time of each site visit, to be made available for immediate assessment as well as

historical review. It provides statistical guidance for the amount of surveillance effort individual saltmarsh habitat sites require, based on parameters most likely to influence the habitat quality, and associated risks of incursion (paper in prep.). All saltmarsh habitat sites were categorised and the surveillance hours required for the given calendar year, calculated for each.

All ground surveillance activities are recorded using GPS units equipped with specialised GPS tracking software as well as digital cameras which record voice annotations with each image. The field track data is uploaded and the digital photographs and voice annotations are linked to the track using viewing software. These provide a historical archive of each site which is added to over time.

Each year the data is reviewed and the habitat categories are revised and updated as required. Any sites containing poor or non-saltmarsh habitat are 'Archived'. These will still be visited periodically to monitor any changes to the habitat.

RESULTS

Programme Results – Port of Entry Surveillance

From July 2001-June 2008, the NZBEL has responded to 124 suspected exotic mosquito interception events. 30 of these involved non-mosquito specimens and 56 involved mosquito species endemic to New Zealand. 38 interceptions involved exotic mosquitoes, a total of 16 different species (Table 1) and on several occasions more than one exotic mosquito species were intercepted at the same time. The majority of these were species on the MoH's unwanted organisms list.

TABLE 1: Exotic mosquitoes intercepted July 2001-June 2008

| Species | Number of interceptions |
|--------------------------------|-------------------------|
| <i>Aedes albopictus</i> * | 13 |
| <i>Aedes japonicus</i> * | 5 |
| <i>Aedes aegypti</i> * | 4 |
| <i>Culex sitiens</i> * | 3 |
| <i>Culex australicus</i> | 2 |
| <i>Aedes vigilax</i> * | 2 |
| <i>Aedes polynesiensis</i> * | 2 |
| <i>Aedes alternans</i> | 2 |
| <i>Uranotaenia novobscura</i> | 1 |
| <i>Tripteroides bambusa</i> | 1 |
| <i>Culex pipiens pallens</i> * | 1 |
| <i>Culex gelidus</i> * | 1 |
| <i>Culex fusocephala</i> | 1 |
| <i>Aedes sierriensis</i> * | 1 |
| <i>Aedes togoi</i> | 1 |
| <i>Aedes camptorhynchus</i> * | 1 |

*Unwanted organism

The exotic mosquito species most commonly intercepted in New Zealand is *Aedes albopictus*, the Asian Tiger mosquito, having been intercepted on 13 occasions in the last seven years. This species has been intercepted at the Ports of Auckland on a

number of occasions and the frequency appears to be increasing. *Ae. albopictus* is a vector of a number of diseases including Dengue, Chikungunya, Yellow fever and various encephalitises and is the only mosquito listed among the worlds top 100 invasive species.

It should be noted that in several interception events, *Aedes notoscriptus* and *Culex quinquefasciatus*, two species established throughout much of New Zealand, were identified in the samples. In these situations, they have not been recorded as exotics, but as each is also found in other countries, specimens found in interception scenarios may actually be of exotic origin.

Most interceptions involve mosquito larvae found in small pools of water on imported risk goods such as used cars and trucks, although a few cases of live adults being imported in shipping containers have occurred. There have also been two incidences of adult exotic mosquitoes being caught on the wing within the port environment. The first involved an *Aedes aegypti* female which flew into a vehicle being driven through the port by a MAFBNZ Cargo Clearance Services (then MAF Quarantine Service) officer and the second, an adult *Ae. albopictus* male was captured in a PHU light trap positioned near a site for unloading risk goods.

Both cases occurred at the Ports of Auckland, where the majority of exotic mosquito interceptions occur. This is to be expected, as this port is responsible for processing the largest quantity of imported risk goods.

Programme Results - NSP

Two complete years of data have been collected so far - 2006 and 2007. During 2006, over 7000 larvae and almost 3000 adults were collected. One exotic incursion was detected in the Coromandel in May 2006, with 117 *Aedes camptorhynchus* larvae identified from several small sites in the area. A new eradication programme was established to remove the population from the area. All other specimens collected and identified by the NZBEL entomologists, were not exotic saltmarsh species.

Following the find in Coromandel, the results of the eradication programme delimiting survey indicated that the population numbers within the sites were relatively low compared to previous SSM eradication programme population numbers at the time the incursions were detected.

During 2007, in excess of 13000 larvae and 3000 adults were captured and identified. There were no exotic saltmarsh mosquito species collected, however three unusual larvae were collected in from swampland on the Chatham Islands in August. They were identified as an *Aedes* species within the subgenus *Ochlerotatus*, but don't match any of the currently described species. Australian experts were consulted and agreed the larvae appeared different. In response to this light traps were deployed during two separate trips to the Islands and adult specimens also not fitting any described species have been collected. Taxonomic descriptions of both life stages are now underway.

DISCUSSION

The continuing discoveries of exotic mosquitoes at New Zealand ports of entry in combination with the absence of exotic mosquito populations breeding in or around the port environments suggests that the port of entry border health surveillance programme, in conjunction with the biosecurity measures in place is effective in detecting exotic mosquito importations and preventing their establishment in New Zealand.

While the trapping of the adult male combined with the intercepted immature specimens of *Ae. albopictus* at Ports of Auckland indicates that the ports of entry surveillance programme is effective, this species continues to be arguably the most significant threat to New Zealand. The indication that the frequency of interceptions of this species are possibly on the increase only emphasises the need to continue to operate stringent border health surveillance at the country's first ports of entry.

The finding of the low density *Aedes camptorhynchus* population in Coromandel, supports the success of the NSP objective for 'early detection' of exotic saltmarsh mosquito. The discovery of a previously unknown mosquito species in the Chatham Islands further demonstrates the effectiveness of the surveillance programme within the saltmarsh environment.

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FIGURE 1: Map showing the five NSP Zones