

determine transmission and pathogenicity. As next generation sequencing technologies become mainstream, this should be achievable in the near future.

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Biography

Dr David Williams is a Group Leader at the CSIRO Australian Animal Health Laboratory, Geelong, Victoria. His research and scientific interests are in the detection, diagnosis, and epidemiology of emerging and re-emerging viruses that affect humans and animals in Australia and overseas, including mosquito-borne viruses.

Protecting Australia from disease vectors: exotic mosquito management at the border



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Mosquitoes, through the diseases they transmit, are considered the deadliest animals in the world¹. While Australia is relatively free of many of the mosquito species capable of transmitting diseases such as dengue, yellow fever,

chikungunya, and Zika virus, Australia is not immune to the risk of these arboviruses becoming endemic through the introduction of exotic mosquito vectors. In 150 separate instances there were 525 individual exotic mosquitoes

detected at the Australian border between 2014 and 2017 (Department of Agriculture and Water Resources, unpublished data). Accordingly, there is a strong focus on surveillance and control activities to prevent exotic mosquito incursions and possible local establishment.

Aedes aegypti (Linnaeus) and *Aedes albopictus* (Skuse) are highly invasive mosquito species responsible for the transmission of diseases significant to public health across many parts of the world. *Aedes albopictus* is not yet established on mainland Australia and *Ae. aegypti* is confined to a limited distribution through eastern Queensland². As a result, diseases such as dengue, chikungunya, Zika virus, and yellow fever are relatively rare or non-existent in Australia. While Queensland continues to experience localised dengue outbreaks stemming from imported cases, the rest of Australia remains free from disease transmission.

The lack of a competent vector dramatically reduces the public health risk posed by arboviral diseases. For example, there were 1740 cases of dengue reported in Western Australia between 2014 and 2017³, predominantly associated with overseas travel. This is the highest recorded of any state or territory during this period, but in the absence of a competent vector no dengue outbreaks have occurred. The establishment of either *Ae. aegypti* or *Ae. albopictus* in this region of Australia would have significant public health consequences.

Australia's island geography aids in preventing the introduction of mosquito vectors, but a reliance on imports and increasing international passenger movements has provided a pathway for invasive mosquitoes via international conveyances and imported cargo. To prevent the establishment of vectors through import pathways and maintain a risk free environment with respect to the previously mentioned arboviruses, the Australian Government employs specific measures at the border, primarily: disinsection of all aircraft entering Australia, targeted inspections of international vessels and cargo, and vector surveillance at first points of entry (air and sea ports).

Exotic mosquito surveillance is legislated under the *Biosecurity Act 2015* and undertaken by the Australian Government Department of Agriculture and Water Resources. In line with the World Health Organization's *International Health Regulations 2005* surveillance is carried out to a minimum distance of 400 metres from facilities that are used for operations involving travellers, conveyances, cargo, and postal articles⁴.

The Department of Agriculture and Water Resources deploys a range of mosquito surveillance traps at first points of entry as part of its mosquito surveillance program. These traps are targeted at collecting different life stages of mosquitoes including Biogents

Sentinel traps and Encephalitis Vector Surveillance CO₂ traps for collecting adults, Sentinel tyre traps for collecting larvae, and ovitraps for collecting mosquito eggs (Figure 1). The vast majority of mosquitoes collected through this program are local species with 117 exotic mosquitoes (37 separate instances) identified from more than half a million mosquitoes collected at Australian first points of entry in 2016 (Department of Agriculture and Water Resources, unpublished data). The type and number of traps deployed at a first point of entry varies according to the size, the volume of arriving international conveyances and cargo, and local environmental conditions at the port. The larger the port or the higher the volume of international traffic arriving at a port, a greater number of traps and trap types are used. Surveillance activities are also escalated at times of heightened international traffic. For example, additional surveillance traps are deployed to cover increased international military arrivals during Australian Defence Force exercises.

The detection of a single exotic mosquito will trigger a rapid response involving Federal, State and, in some jurisdictions, Local Government. A typical response to an exotic mosquito detection will involve knockdown adulticide treatments (Figure 2), residual insecticide harbourage spraying, and treatments of potential mosquito breeding sites. Enhanced surveillance is undertaken to monitor the effectiveness of the treatments applied and to ensure no exotic mosquitoes remain. Site surveys around the detection point are undertaken to ensure that there is no localised breeding of exotic mosquitoes. To assist this cross government response, the Australian Government Department of Health has developed a set of guidelines to support decision making and describe the roles and responsibilities of the key stakeholders involved in the response activities⁵.

Pathway analysis is another important part of the response process. Determining the origin of an exotic mosquito and how it arrived



Figure 1. Cigar shaped *Aedes* mosquito eggs collected from an oviposition trap.



Figure 2. Thermal insecticide fogging treatment being conducted within a baggage unpack area at an International Airport. Image courtesy of Brisbane City Council.

allows for targeted control measures to be implemented. Genome-wide single nucleotide polymorphism (SNP) analysis is used as a population genetics tool to compare genetic similarities between exotic mosquitoes detected at the border and an established reference database in order to determine their origins⁶. This, as well as investigations into insecticide resistance profiles of exotic mosquitoes using genetic markers and biological assays, is helping to better understand new and emerging risk pathways.

To date, pathway controls, early detections of exotic mosquitoes at the border, and rapid response activities have helped prevent exotic mosquito vectors from establishing in Australia, however, exotic mosquitoes continue to probe our borders. Through continued efforts at the border, researchers are provided with more time to develop new and innovative ways to prevent and control these mosquito vectors, and the diseases they transmit ahead of their possible introduction to Australia.

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Biographies

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Short Lab Reports, Book Reviews and Hot Topics of interest to ASM members are invited at any time.