Exotic *Aedes* Mosquitoes : Onshore detection and elimination in Darwin, Northern Territory

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Introduction

The Medical Entomology Branch (MEB) of the Territory Health Services (THS) and the Australian Quarantine Inspection Service (AQIS) have coordinated and separate programs to detect and eliminate exotic mosquitoes imported into Darwin. AQIS searches all overseas vessels and cargo for exotic mosquitoes and conducts elimination procedures on positive or potential receptacles on vessels or within 400m of a port area. Both AQIS and MEB operate egg traps (ovitrap) detection programs continuously in the Darwin Port area. The ovitraps are checked weekly (AQIS) or fortnightly (MEB) for eggs and larvae, and eggs are reared to late instar larvae for identification. The AQIS onshore program is inside a 400m area of port facilities while the MEB programs are within port areas, in nearby suburban and industrial areas, as well as in other vulnerable sites for importation or establishment throughout Darwin.[1,2]

The Northern Territory is free of the 2 principal vectors of dengue, although there have been numerous instances of both *Aedes aegypti* and *Aedes albopictus* imported into Darwin.[2,3] On each occasion the importations have been quickly detected and eliminated by established procedures.[4] The most recent detections have been in cargo on or recently offloaded from overseas vessels.[2] On only two previous occasions since 1978 have exotic *Aedes* eggs or larvae been detected in onshore ovitraps and none have been detected in other onshore receptacles. This paper describes the most recent onshore detection of an exotic *Aedes* species, and discusses the identity of the species, the elimination procedures taken and future precautions and procedures.

Detection

On the afternoon of the 14 June 2001 an AQIS officer notified MEB of the detection of possible exotic *Aedes* mosquito larvae reared from an ovitrap in the Fort Hill wharf area of Darwin. Three third instar larvae were submitted to the MEB on 14 June 2001 and subsequently one fourth instar larvae on 18 June 2001. The larvae had been reared from egg paddles from two separate ovitraps within 100m of each other in the Fort Hill Wharf industrial area close to a forested escarpment below the city area of Darwin.

The first larvae were initially identified by the MEB as probably *Aedes scutellaris,* an exotic New Guinea and Torres Strait species, but they were possibly *Ae. albopictus,* which is exotic to Australia and a potential vector of dengue and other arboviruses.[5] There was uncertainty with the identification because the larvae were at an earlier growth stage than normally required for positive identification and differed from a key identification character in a published description.[6] Although *Ae. scutellaris* larvae cannot be distinguished from *Aedes katherinensis*, a tropical north Australian species, this species is absent from the Darwin locality and thus was ruled out of contention because of the location and other circumstances surrounding the ovitrap recoveries. The importation was treated as *Ae. albopictus* until the identity could be resolved.

Surveillance and eradication measures

The importation of adult exotic mosquitoes and subsequent detection of eggs in onshore egg traps raised the possibility of the establishment of an exotic *Aedes* mosquito species in the Darwin port area. It was decided that immediate surveys and precautionary elimination measures were required to determine the current situation and ensure the importation was eliminated.

It was agreed that AQIS would have principal responsibility in this situation, with responsibility for larval survey and control, public advice and landholder liaison. AQIS is nominally responsible for surveys and elimination of exotic mosquitoes within a 400m quarantine zone around port facilities. The MEB was to provide scientific advice, assist with larval surveys and increased surveillance, and carry out adult mosquito control.

The target and risk area was assessed as the area between Stokes Hill and Fort Hill wharves. This included various industrial and port facilities adjacent to the shoreline, a steep forested escarpment fronting the wharf area, and the grounds of Government House at the top of the escarpment overlooking Fort Hill wharf.

AQIS notified nearby premises and the public of the detection and planned control measures. A quarantine hold was placed over movement of all potential water holding receptacles such as tyres, in the target area. Further advice was given to various premises during a search for any water containing receptacles. The MEB carried out adult mosquito control by fogging bioresmethrin throughout the target area between 5.30pm and 6.30pm on the 15 June 2001.

The receptacle survey was carried out within a 400m zone around the positive ovitraps over 2 days after the fogging,

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including a survey of vessels in the port area, the Port Authority premises, and Government House. The survey located all receptacles holding or with evidence of recently containing water.

All water-holding receptacles were sampled for larvae. Sixteen separate premises were surveyed and 42 receptacles with water were located. Eleven of these receptacles contained mosquito larvae. Receptacles with water and larvae were found primarily adjacent to the positive ovitrap location in the Port facilities area and at Government House. One receptacle without larvae included an underground concrete section of a conveyor belt facility containing several thousand litres of rainwater. All larvae were collected alive and reared to fourth instar larvae in the MEB facilities. All larvae recovered were native species with four of the receptacles containing *Aedes notoscriptus* alone, while the remaining seven contained either alone or in combination, *Culex annulirostris*, *Culex quinquefasciatus* and *Culex halifaxii*.

All receptacles with water or evidence of recent flooding were sprayed with the insecticide deltamethrin to the point of run off, with no spraying carried out until the initial receptacle survey was completed. A follow up receptacle survey will be carried out 3 days after the first rains of the wet season (possibly in October or November 2001).

Over 2 days during the receptacle survey, carbon dioxide-baited light traps were set on the Dilia floating hotel (Olympia) recently transferred from East Arm port, in the grounds of Government House, in the inner city area adjacent to the escarpment overlooking the port, and near each ovitrap positive position. The MEB set 6 additional ovitraps within and outside the port area. AQIS set an additional 6 ovitraps within the port area. The increased ovitrap surveillance was maintained for 2 months. There was no further detection of exotic *Aedes* in this period.

Discussion

The ovitraps were set three weeks prior to the notification and collected 2 weeks prior to the notification, indicating that the eggs were laid between this period. A Papuan vessel moored at Darwin about three weeks prior to the detection had pooling in a canvas tarpaulin on board but no larvae were detected in the water. However, inspection was delayed for a number of days after mooring. The water was dark and hindered inspection for larvae in the water. The water was discarded and the tarpaulin was treated with insecticide.

The Olympia was moored nearby at Fort Hill wharf and was considered a potential, although unlikely, source of the mosquitoes. This vessel had numerous *Cx. quinquefasciatus* larvae detected, and one *Ae. aegypti* adult was found flying on board when it first arrived in Darwin from Dili, East Timor, in early January. While no *Aedes* larvae were detected then, the *Culex* breeding site was below floorboards decking and there was the possibility that *Aedes* larvae were present prior to treatment in early January. On 5 January 2001, while moored at East Arm port, this vessel was treated with adulticides (with chlorine and the residual insecticide deltamethrin) to destroy potential breeding sites.

The larvae from the ovitraps were examined further (by RCR) and it was concluded that the larvae could have been either *Ae. scutellaris* or *Ae. albopictus*, but did not fully conform to published keys or descriptions of either species although they were more consistent with the former.

There is a slight possibility that the larvae were *Ae. katherinensis*. However, its absence from the greater Darwin area, the failure to detect this species in ovitraps in Darwin for over 25 years, and the occurrence of this species only in very low numbers in remote localities away from potential importation routes, indicates that the larvae were unlikely to have been this species.

There is also a possibility that the larvae were an undescribed species of the *Aedes scutellaris* taxomomic group from East Timor. *Aedes scutellaris* itself has a Papuan distribution and has not been recorded from Timor, although *Ae. albopictus* has been collected there,[6,7] but there are many members of the group from a wide area of the islands of South East Asia and the Pacific. It is possible that a member of the group does exist on Timor, and suspect *Ae. albopictus,* particularly from Timor, should be scrutinised carefully.

Following this episode, an adult male mosquito of the *Aedes scutellaris* group collected in Timor (D McGinn and H Standfast, personal communication) has been determined (by author RCR) on its genitalia characters, to be *Aedes alorensis* (previously known only from Alor to the north of Timor) or a local Timor species of the group very similar to *Ae. alorensis*. Adult females of *Ae. alorensis* are very similar to *Ae. katherinensis,* and *Ae. alorensis* larvae have never been described, but the male genitalia are quite distinctive and readily distinguished from those of *Ae. katherinensis* and *Ae. scutellaris*.

This is the third record of an ovitrap positive for exotic mosquitoes in Darwin. The previous records include one of *Ae. albopictus* in January 1989 in the wharf area at Frances Bay, which is approximately one kilometre east of Fort Hill wharf, and one of *Ae. aegypti* in May 2000 at the Hudson Creek wharf area approximately 9 kilometres east of Fort Hill wharf. On each occasion adult fogging and increased ovitrap surveillance and receptacle survey and treatment were carried out and no evidence of establishment was found.

The last importation of *Ae. albopictus* occurred on 31 January 2001 at Frances Bay, associated with the tray of a damaged vehicle offloaded from a vessel that had recently arrived from Dili, East Timor. Live adults were observed flying from the vehicle. Immediate adult fogging operations and receptacle insecticide treatments were carried out. Increased ovitrap surveillance and receptacle surveys failed to detect any establishment. This importation was unlikely to have been a source of the current detection.

This is the second record of ?*Ae. scutellaris* importation into Darwin. The previous importation was in vehicle tyres on board a general cargo vessel from Jakarta on 25 May 2000. On that occasion the larvae were examined (by authors PIW and RCR) who concluded that they were probably *Ae. scutellaris* although the identification could not be confirmed with certainty and there was some possibility that the larvae could have been the related species *Ae. malayensis* which occurs on Java and nearby areas. *Aedes scutellaris* has not been recorded from Jakarta, the vessel's last port of call, but the ship stops regularly at Dili, East Timor, most recently in March 2000. It is possible that the larvae found 2 months later in May 2000 were from eggs laid during a stop at Dili. *Aedes alorensis* was not considered at that time as the

larvae are not described and there were no records from Timor.

The conclusion is that the eggs in the ovitraps probably originated from one or two females flying from the Papuan vessel which was in port around the time of probable egg laying. The identity of the larvae remains undecided but is ?*Ae. scutellaris*. However, because of the minor differences in described larval morphological characters and the variability of some of these determining characteristics, there is a possibility that the larvae were *Ae. albopictus,* another of the *Aedes scutellaris* group such as *Ae. malayensis, Ae. katherinensis*, *Ae. alorensis* or an undescribed similar member of the *Aedes scutellaris* group from Timor. Adults (females and males) are required for a determination of species.

It is recommended that quarantine procedures be modified to collect larvae or pupae alive from receptacles on vessels from Timor arriving in Darwin, and that the larvae and pupae be link reared to adults in secure premises to confirm any identification. It is also recommended that a critical review be undertaken of the larval descriptions of *Ae. albopictus* and relevant members of the *Aedes scutellaris* group, particularly with respect to early as well as fourth instars.

The interception of this importation is evidence that the ovitrap surveillance procedures to detect exotic mosquitoes are working well in Darwin. Although there have been a few risk situations with cargo, in general the vessel and cargo inspections do detect importations, and their detection has allowed timely eradication procedures.[2] This detection and eradication is at odds from instances in other parts of the world.[8] A considerable amount of the success of these procedures is due to the good cooperation and liaison between AQIS and the MEB/THS. However, some of these arrangements have not been formalised, particularly in regards to requirements for countering the establishment of an exotic species after importation, and the responsibilities and methodologies for large-scale eradication measures. It is strongly recommended that protocols and procedures for such arrangements should be discussed, agreed and formalised as soon as possible, for Darwin and other 'at-risk' international ports in Australia.

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References

1. Whelan PI and Tucker G. Exotic *Aedes* surveillance and exclusion from the Northern Territory of Australia. Proc Third Nat Con Mosq Con Assoc Aust. Supp *Bull Mosq Cont Assoc of Aust* 1998;10:85-99.
2. Whelan PI, Hayes G, Tucker G, Carter J, Wilson A, Haigh B. The detection of exotic mosquitoes in the Northern Territory of Australia. Arbovirus Research in Australia 2001;8:405-416.
3. Whelan PI. The Northern Territory Remains free of dengue fever vectors. *Bull Mos Cont Assoc of Aust* 1999;3:1;7-9.
4. Whelan PI. Exotic mosquitoes arriving on seagoing vessels; recommended inspection and eradication procedures. *Bull Mosq Cont Assoc of Aust* 1998;10:14-23.
5. Lee DJ, Hicks MM, Griffiths M, Debenham ML, Bryan JH, Russell RC et al. Commonwealth Department of Health, School of Public Health and Tropical Medicine. Entomology Monograph 1987;2:volume 4.
6. Huang Yiau-Min. Contrib Mos Fauna South East Asia XIV; The subgenus *Stegomyia* of *Aedes* in South East Asia, *Cont Am Ent Ins* 1972;9:1.
7. Whelan PI and Hapgood G. A mosquito survey of Dili East Timor, and implications for disease control. Arbovirus Research in Australia 2001;8:395-404.
8. Kay BH, Ives WA, Whelan PI, Barker-Hudson P, Fanning ID and Marks ENM. Is *Aedes albopictus* in Australia? *Med J Aust* 1990;153:31-34.