First record of the mosquito species *Aedes (Aedimorphus) nocturnus* (Theobald) (Diptera: Culicidae) in Australia.

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**Introduction**

*Aedes (Aedimorphus) nocturnus* (Theobald) is a mosquito species widely distributed in many islands of Indonesia, the Philippines, New Guinea, the Central Pacific and Hawaii. Although one report of the distribution of *Ae. nocturnus* included Australia, its occurrence in this country had not been authenticated. This paper describes the first confirmed report of *Ae. nocturnus* in Australia.

**Methods**

Adult mosquitoes were collected using modified Encephalitis Vector Surveillance (EVS) carbon dioxide-baited traps2,3 at up to 30 collection sites around Kununurra in northern Western Australia (WA) A during the latter part of the wet season (March and April) each year from 1989 (Fig. 1). Mosquitoes were frozen and stored on dry ice until returned to the Arbovirus Surveillance and Research Laboratory at The University of Western Australia (UWA) in Perth, where they were stored at -70°C. *Aedes nocturnus* specimens were identified to species using keys to mosquitoes in the Australasian Region,1,5 and confirmed using descriptions by Belkin.5

**Results**

A total of 45 *Ae. nocturnus* adults were collected around Kununurra since it was initially detected in 1996 (Table 1). Low numbers (5,19,5,16) of *Ae. nocturnus* were collected in 1996, 2001, 2002 and 2003 respectively. Overall, *Ae. nocturnus* was a minor component of the mosquito populations, comprising <0.1 % of the total number of mosquitoes collected each year. Most (84%) were collected at trap sites close to or in the Ord Stage I Irrigation area (Figure 1). The remaining *Ae. nocturnus* were collected in the Packsaddle Plains Irrigation area in April 2001 (4) and in the vicinity of Kununurra townsite (3) in March 2003. In the EVS traps in which *Ae. nocturnus* was collected, the mean number per trap ranged from 3.0 to 6.5.

**Table 1. Abundance of Aedes (Aedimorphus) nocturnus collected by EVS- dry ice-baited traps at Kununurra, Western Australia, 1996-2003.**

<table>
<thead>
<tr>
<th>Date of collection</th>
<th>No. traps</th>
<th>Total mosquitoes collected</th>
<th>No. Aedes nocturnus</th>
<th>No. % Aedes nocturnus (%)</th>
<th>Mean No. mosquitoes per trap</th>
<th>Total mosquitoes collected</th>
<th>No. % Aedes nocturnus</th>
<th>Mean No. mosquitoes per trap</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/9, 10, 13 April 1996</td>
<td>13</td>
<td>5790</td>
<td>1</td>
<td>5</td>
<td>(0.1)</td>
<td>5.0</td>
<td>17</td>
<td>12897</td>
</tr>
<tr>
<td>21, 23 March 1997</td>
<td>9</td>
<td>5760</td>
<td>0</td>
<td>0</td>
<td>(0.0)</td>
<td>0.0</td>
<td>9</td>
<td>7543</td>
</tr>
<tr>
<td>21, 23 March 1998</td>
<td>9</td>
<td>4249</td>
<td>0</td>
<td>0</td>
<td>(0.0)</td>
<td>0.0</td>
<td>9</td>
<td>3845</td>
</tr>
<tr>
<td>3, 6 April 1999</td>
<td>14</td>
<td>11735</td>
<td>0</td>
<td>0</td>
<td>(0.0)</td>
<td>0.0</td>
<td>10</td>
<td>11488</td>
</tr>
<tr>
<td>25, 26, 27 March 2000</td>
<td>14</td>
<td>20003</td>
<td>0</td>
<td>0</td>
<td>(0.0)</td>
<td>0.0</td>
<td>11</td>
<td>11556</td>
</tr>
<tr>
<td>24, 25 April 2001</td>
<td>15</td>
<td>28181</td>
<td>3</td>
<td>15</td>
<td>(0.1)</td>
<td>5.0</td>
<td>13</td>
<td>16113</td>
</tr>
<tr>
<td>30 March, 1 April 2002</td>
<td>14</td>
<td>7111</td>
<td>2</td>
<td>5</td>
<td>(0.1)</td>
<td>2.5</td>
<td>11</td>
<td>5147</td>
</tr>
<tr>
<td>17,18, 20 March 2003</td>
<td>18</td>
<td>29870</td>
<td>2</td>
<td>13</td>
<td>(0.1)</td>
<td>6.5</td>
<td>11</td>
<td>14160</td>
</tr>
<tr>
<td>Total</td>
<td>106</td>
<td>112699</td>
<td>8</td>
<td>38</td>
<td>(0.1)</td>
<td>4.8</td>
<td>91</td>
<td>82749</td>
</tr>
</tbody>
</table>

EVS- Encephalitis Vector Surveillance traps. In traps where >500 mosquitoes were collected, a subsample of approximately 500 mosquitoes was identified to species and the species composition of the remainder of the sample was estimated by weight and extrapolation. *C. relictus* was the only species collected in all traps. - mean No. of *Ae. nocturnus* in traps in which it was collected. Initially misidentified as *Ochlerotatus* sp. (Diptera: Culicidae).
Figure 1. Locations where *Aedes nocturnus* was collected around Kununurra in northern Western Australia between 1996 and 2003.

Discussion

The first *Ae. nocturnus* specimens were collected in the Ord Stage I Irrigation area during the wet season of 1996, even though regular wet season collections had been undertaken since 1989 and there have been irregular collections in the area since 1972. One explanation for the new record is that the species may be a recent arrival to the area.

*Aedes nocturnus* superficially closely resembles the major pest saltmarsh species *Ochlerotatus vigilax* (Skuse) that is occasionally detected in the area, and the original specimens were misidentified as the less common *Ochlerotatus phaecasiatus* (Marks) that is also very similar to *Oc. Vigilax*. *Aedes nocturnus* was not collected again until 2001, however it has since been collected in EVS traps in the late wet season around Kununurra each year. Given that both *Oc. vigilax* and *Ae. nocturnus* have been collected in the Kununurra environs, the possibility exists that specimens of *Ae. nocturnus* may have been confused with *Oc. vigilax* in collections prior to 1996.

In other countries, *Ae. nocturnus* larvae are predominately found breeding in shallow, temporary pools, marshes, road-side ditches and grassy pools, so it is not surprising that the majority of adult *Ae. nocturnus* were collected in the vicinity of the irrigated areas of Kununurra where there is extensive breeding habitat suitable for *Ae. nocturnus*. Additionally, it appears that the distribution of *Ae. nocturnus* may be increasing in the locality, as evidenced by the collection of specimens from the Packsaddle Plains Irrigation area in April 2001, and from the eastern edge of the Kununurra townsite in March 2003 (Figure 1).

Large populations of adult *Ae. nocturnus* have been reported following heavy rain in Fiji and the populations are usually short-lived. The low numbers of *Ae. nocturnus* collected in EVS traps during mosquito collection trips around Kununurra may be attributed to the fact that the annual collection trips were timed to occur during the latter part of the wet season, several weeks after the last heavy rains, and may have been too late for *Ae. nocturnus*. It is notable that large numbers of adult *Ae. nocturnus* were collected during the 2003 dry season in Kununurra, and one pupa collected in the area at the same time was reared through to an adult specimen of *Ae. nocturnus* (A. Jardine, UW A, 2003, personal communication). This finding, coupled with the observation that *Ae. nocturnus* has been collected in EVS traps each year at Kununurra since 2001, provides circumstantial evidence that it has become established in the area.

The mechanism by which *Ae. nocturnus* was introduced into the northeast Kimberley region is unknown, but the apparent absence of *Ae. nocturnus* in collections prior to 1996 suggests that it was first introduced around this time. The introduction of *Ae. nocturnus* into Hawaii has been linked to movement of airplanes. Similarly the introduction of *Culex gelidus* Theobald, a confirmed vector of Japanese encephalitis virus (JEV), to southeast Queensland is thought to be aircraft related. The nearest international airport
is located at Darwin in the Northern Territory (NT), approximately 500 km northeast of Kununurra, and thus is an unlikely point of entry for *Ae. nocturnus* to northern W A. However, Kununurra is occasionally used by light aircraft arriving from Timor and other close overseas islands (G. Tucker, Australian Quarantine Inspection Service, personal communication), and it is possible that *Ae. nocturnus* may have been introduced via these aircraft. It is of interest that *Ae. nocturnus* has never been collected at Wyndham, approximately 100 km West of Kununurra, where the nearest shipping port is located. As an alternative explanation, the introduction of JEV into northern Queensland has been linked to the carriage of infected mosquitoes by cyclonic winds, and it is also possible that *Ae. nocturnus* was introduced into the northeast Kimberley from islands of the Indonesian archipelago during similar meteorological events.

The role of the large irrigation area and associated infrastructure around Kununurra in facilitating establishment of *Ae. nocturnus* in the region is not clear. However, it is of note that *Ae. nocturnus* has not been collected during similar surveillance of mosquito fauna at numerous other towns and communities across the Kimberley, where no irrigation infrastructure exists. Similarly, an examination of mosquito reference specimens collected from many localities in the NT over many years, including the locality of Port Keats (close to the W A/NT border) has failed to find any evidence of *Ae. nocturnus* in the NT.

The encephalitogenic flavivirus JEV has been isolated from this species in Taiwan, and *Ae. nocturnus* readily takes bloodmeals from humans. These associations are cause for concern, given that the flaviviruses Murray Valley encephalitis virus and Kunjin virus are enzootic in the Kimberley region of W A. Accordingly, the vector competence of *Ae. nocturnus* for these viruses needs to be investigated for public health reasons. This species is also recorded as an annoying biter and an important human pest species capable of entering houses. If this species spreads, it would add a new dimension to the range of human pest species across northern Australia. Thus the activity and distribution of this species must continue to be monitored in both the north west.

Acknowledgements

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References