New Zealand Entomologist 31: 31-34 (February 2008)

Effect of height on the use of artificial larval container habitats by *Aedes notoscriptus* in native forest and zoo in Wellington, New Zealand

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Abstract

An experiment was carried out in Wellington to assess the level of infestation by the exotic mosquito *Aedes notoscriptus* and to assess whether its oviposition in artificial containers would be vertically stratified. The study was done at an urban patch of native forest and the Wellington Zoo. No mosquito larvae were recorded in any ovitraps within the native forest site during the experiment, in contrast to 386 *A. notoscriptus* larvae recorded at the Wellington Zoo. There was an indication that *A. notoscriptus* at the latter site preferred to oviposit at ground level in comparison to 6 m height. In addition, the difference in ovitrap use between the two sites suggested that larval mosquito habitats in native ecosystems in the Wellington region may be somewhat under-used.

Keywords: mosquito, ovitraps, New Zealand, containers, *Aedes notoscriptus*

Introduction

New Zealand has a relatively species-poor mosquito fauna, but little is known of the ecology of culicids in native ecosystems. A recent study in the Wellington region showed that the leaf axils of the abundant and widespread native epiphyte *Collospermum hastatum* (Colenso) (Liliaceae) are the main phytotelmata in local native forests (Derraik 2005a). Although these phytotelmata are the main breeding habitat for the native *Culex (Culex) asteliae* Belkin in the Auckland region, they are not used by culicids in the Wellington region (Derraik 2005a), although larvae of other Diptera are present (Derraik & Heath 2005).

Field work at a native forest fragment in Wellington found that the exotic *Aedes (Finlaya) notoscriptus* Skuse was the only culicid species occupying tree holes as larvae (Derraik 2005a) and recorded in CO_2-baited light traps as adults (Derraik et al. 2003). Although the natural habitats of *A. notoscriptus* in Australia are believed to be tree holes (Russell 1986), this species is the predominant peridomestic mosquito in Australia (Foley et al. 2004), and a similar pattern is being observed in northern New Zealand (e.g., Derraik 2005c).

Oviposition height preferences vary considerably between mosquito species (Schreiber et al. 1988). While some species may be active over extensive vertical strata (Corbet 1964), other culicids have strong height-related oviposition preferences (Jones & Schreiber 1994). The absence of mosquitoes from *C. hastatum* plants may be a consequence of the plants occurring primarily in the tree canopy and *A. notoscriptus* and other resident culicids preferring to oviposit near ground level.

An experiment was set up to assess whether *A. notoscriptus* would oviposit in artificial containers within a native forest fragment in Wellington and at the Wellington Zoo, and whether the species' oviposition would be vertically stratified.

Materials and Methods

This study was carried out at Otari-Wilton's Bush (41° 16' S; 174° 45' E), in Wellington City, a 90 ha urban native forest dominated by broadleaved trees, with emerging podocarp trees. Ovitraps consisted of plastic containers of three different aperture sizes (4.9, 35.3 and 103.9 cm^2) and similar depths (6-8

Table 1. Number of *Aedes notoscriptus* larvae collected from ovitraps at the Wellington Zoo.

	Ground Level			6m		
Date	**Tree 1**	**Tree 2**	**Tree 3**	**Tree 1**	**Tree 2**	**Tree 3**
20 Feb	12	0	76	0	0	0
07 Mar	4	24	35	0	0	56
22 Mar	4	0	146	0	0	29
05 Apr	0	0	0	0	0	0
Total		301			85	

cm), prepared according to Derraik and Slaney (2005). Each container was filled to within 1 cm of the rim with a sheep manure solution prepared with tap water at 5.0 g/L (dry weight), in which nutrient concentrations of nitrogen, phosphorus and potassium were approximately 0.15, 0.10 and 0.20 g/L. This solution was used in other studies in Wellington, and found to yield large numbers of culicids (Leisnham et al. 2004).

To offer similar visual attractiveness as the main phytotelm habitat in the forest (*C. hastatum*), ovitraps were painted with Japanese laurel-green (Resene Paints Ltd., New Zealand). Three native rimu trees (*Dacrydium cupressinum*) were chosen for placement of traps, and at each tree, sets of three different sized ovitraps were placed at ground level, 6 m and 12 m heights (total of 27 ovitraps). Although trees were randomly selected using the walking tracks as centrelines, only large trees were chosen to allow for safe climbing, all of which were no less than 100 m apart. All sets of ovitraps were fixed against the trunks to favour oviposition by container breeding species, as the presence of tree trunks adjacent to the ovitraps seems to increase the chances of a gravid female finding them (Jordan 1991, Jordan & Hubbard 1991). Ovitraps were monitored fortnightly from January to May 2002. Each time a container was checked for mosquito larvae, it was emptied and the manure solution replaced. Larval counts were carried out as per Derraik and Slaney (2005).

A concurrent study was set up at the Wellington Zoo to replicate the experiment due to the site's comparatively high density of mosquitoes, more specifically of the endemic *Culex (Culex) pervigilans* Bergroth and *A. notoscriptus* (Derraik 2004a, Derraik et al. 2003). At the Zoo, three native trees were selected for sampling, with identical sets of ovitraps placed at ground level and at 6 m. No traps were set at 12 m (as in the Otari investigation) due to the absence of tall native trees with branches strong enough to allow for safe placement and monitoring of ovitraps. These were checked fortnightly between February and April 2002.

Results and Discussion

The 27 ovitraps monitored over 8 fortnights at Otari-Wilton's Bush, equated to 216 container inspections. No mosquito larvae were recorded in any of the ovitraps.

In contrast, 386 *A. notoscriptus* larvae were recorded in the concurrent investigation at the Wellington Zoo (Table 1). Larvae were recorded during the first three fortnights, but were absent from the final five fortnights. In relation to height distribution, 85 *A. notoscriptus* were collected at 6 m, and 301 at ground level (Table 1). However, the occupancy rate of ovitraps varied considerably between the different locations within the Zoo (Table 1). One particular tree stood out with a relatively large number of *A. notoscriptus* larvae (85% total), being also the only location where larvae were present in ovitraps at 6 m (Table 1).

Although there was evidence that *A. notoscriptus* preferred to oviposit at ground level, these results must be interpreted with caution. One location appeared to be comparatively more sheltered than the other two with a relatively higher degree of shade (Tree 3, Table 1). The latter factors may have provided positive stimuli for the search behaviour of *A. notoscriptus* females, as these are characteristics that more closely resemble its original habitat preferences as a tree hole breeder. Nevertheless, Foot (1970) for example, collected four times more larvae of *A. notoscriptus* in stagnant water in glass jars at 4.6 m high than at ground level, while also recording larvae in ovitraps at 7.6 m. Williams et al. (1999) also recorded large numbers of larvae in ovitraps hung in trees 3-4 m above ground. Adults of *A. notoscriptus* have been shown to be active over a relatively wide vertical stratum in New Zealand, and were recorded biting from ground level to 18 m (Derraik 2005b). Similar behaviour may also apply to its oviposition, but further research is needed to clarify this issue.

The results of this investigation and the findings of a phytotelmata study (Derraik 2005a) suggest that larval mosquito habitats in native forests in the Wellington region appear to be somewhat under-used, as suggested by Laird (1990). *Aedes notoscriptus* has become the main container breeding mosquito species in many urban areas and fragmented native forest habitats in the Auckland region (e.g., Derraik 2005c). However, *A. notoscriptus* has not occupied these modified native ecosystems in the Wellington region to the same extent, as for example, similar ovitraps placed in fragmented patches of native forest in Auckland were highly exploited by this species (Derraik & Slaney 2005).

Aedes notoscriptus was recorded in tree holes in the Wellington forest investigated in this study, but it seems that this species' invasion of native habitats in the region may be at an early stage (Derraik 2005a). Furthermore, the cooler climate of the Wellington region (located 4° further South) may be a limiting factor hindering its establishment in native forest habitats, in comparison to the Auckland area. Interestingly, in regards to *C. hastatum*, a recent extensive investigation in the Auckland region showed that *A. notoscriptus* does not use these plants in native forest habitats (Derraik 2006), but do so in urban settings (Derraik 2004b).

Acknowledgements

We would like to thank the staff of Otari-Wilton's Bush (in particular Jane Wright, Eleanor Burton and John Dawson) and of the Wellington Zoo (especially Mauritz Basson) for their great support. Thanks also to Phil Lester (Victoria University of Wellington) for his very valuable input, and to John Charles (HortResearch) and two anonymous reviewers for feedback on previous versions of this manuscript. The University of Otago provided funding support.

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