

MOSQUITOES (DIPTERA: CULICIDAE) OF CITY OF RYDE, NEW SOUTH WALES

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Summary

The City of Ryde local government conducted field collections of larval and adult mosquito populations between the seasons 1992-93 and 2007-08 to assist mosquito management strategies. A total of 25 species was recorded. The two most commonly occurring and abundant species in the area were the saltmarsh mosquito *Aedes vigilax* (Skuse) and freshwater mosquito *Aedes notoscriptus* (Skuse). Both species have the potential to cause nuisance-biting and public health impacts but differ substantially in their ecology and management response requirements.

Keywords: Culicidae, mosquito, *Aedes vigilax*, *Aedes notoscriptus*

INTRODUCTION

Mosquitoes have the potential to be serious nuisance-biting pests and vectors of disease-causing pathogens such as Ross River virus (RRV) and Barmah Forest virus (BFV) (Russell and Kay 2004). While public health risks in metropolitan areas are relatively low, there have been instances of locally acquired mosquito-borne disease in major Australian cities including western and southern areas of Sydney (Brokenshire *et al.* 2000).

There are over 50 species of mosquito in the Sydney basin (Webb *et al.* 2001) with the local abundance and diversity of the mosquito fauna highly variable and dependent on the availability of suitable larval mosquito habitats. Populations are generally low but in some regions, abundant pest species have been recorded (Webb and Russell 1999). Monitoring of mosquito populations is the only reliable method to identify the major pest and vector species and is essential for the development of informed management strategies.

The pest impacts of mosquitoes have been a concern for the community in the Ryde local government area for some time with extensive estuarine wetlands along the Parramatta River, bushland and urban waterways and more than 30000 suburban gardens all potential sources of nuisance-biting mosquitoes. In response to this concern, the City of Ryde Council established a monitoring program in 1992 that runs between December and April each year as part of the NSW Health Arbovirus Surveillance and Mosquito Monitoring Program.

The aim of this paper is to present a summary of the mosquito species collected through trapping of adults during the annual monitoring program from 1992 until 2008.

MATERIALS AND METHODS

Study area

The City of Ryde is situated in the central northern part of the Sydney Metropolitan area and covers a total area of 40.651 km². The climate is temperate with an average annual rainfall of 863.3 mm and with average summer (December - February) temperatures ranging from 16.8°C to 27.2°C (Australian Bureau of Meteorology, 2004). The region is primarily residential and supports a population of almost 100000.

The City contains seven main Lane Cove River sub-catchments draining to the north and east, and five main Parramatta River sub-catchments draining to the south. Extensive bushland areas are contained in 207 parks and reserves within the City. Additional bushland in the Lane Cove National Park to the north-east contains significant mangrove river foreshores.

Approximately one third of the City's 39.3 km borders contain estuarine wetlands with a significant mangrove component. However, on the opposite, southern side of the Parramatta River there are extensive areas of saltmarsh and mangrove areas known to produce unusually large mosquito populations (Webb and Russell 1999). These are currently the focus of a mosquito management program designed to minimise population increases of pest mosquitoes (Webb and Russell 2001).

Larval mosquito population sampling

Immature mosquitoes (larvae and pupae) were collected from local watercourses, larger water bodies, and domestic vessels using a conventional 300 mL dipper, as part of regular or temporary monitoring on community land and also during *ad hoc* residential inspections. Where possible, specimens were bred through to adult stage in the laboratory for species identification.

Adult mosquito sampling

Adult mosquitoes were sampled using dry-ice (frozen carbon dioxide) baited encephalitis vector surveillance (EVS) traps (Rohe and Fall 1979). Host seeking female mosquitoes attracted to the dry ice are drawn into a small container via a battery-operated fan. Traps were placed in leafy and sheltered locations to protect them from wind and rain, and to give relative security from interference.

Six permanent trap sites were routinely used during each monitoring period in the western sector of the City. Traps were located near watercourses from the mangrove forest on the Parramatta River foreshore up to approximately 2.3 km inland. On each sampling occasion, traps were set from approximately 1700 h and collected at approximately 0800 h the following day. Specimens were returned to the laboratories of the Department of Medical Entomology, Westmead Hospital and identified to species using the keys of Russell (1993).

The monitoring data contributed to the NSW Arbovirus Surveillance and Mosquito Monitoring Program (<http://www.arbovirus.health.nsw.gov.au/>).

RESULTS

A total of 24 mosquito species belonging to seven genera was recorded over the 16 years of sampling between 1992 and 2008 through adult trapping. Another species was found through larval sampling only, adding one genus (Table 1). The total number of mosquitoes collected each season ranged from 588 (1992-93) to 9851 (2006-07). The first three years of the monitoring program were of shorter duration and yielded lower numbers than subsequent years. In the second season, data on only four species were recorded.

The most commonly collected species seasonally over the 16 years were: *Aedes notoscriptus*, *Aedes vigilax*, and *Culex annulirostris* Skuse, with another 11 species *Anopheles annulipes* Walker s.l., *Aedes alboannulatus* (Macquart), *Aedes alternans* (Westwood), *Aedes procax* (Skuse), *Aedes rubrithorax* (Macquart), *Coquillettidia linealis* (Skuse), *Culex australicus* Dobrotworsky & Drummond, *Culex molestus* Forskal, *Culex orbostiensis* Dobrotworsky, *Culex quinquefasciatus* Say and *Culex sitiens* Wiedemann regularly collected. The other ten less commonly occurring species are: *Aedes camptorhynchus* (Thomson), *Aedes flavifrons* (Skuse), *Aedes* species Marks 51, *Aedes multiplex* (Theobald), *Aedes quasirubithorax* Theobald, *Aedes vittiger* (Skuse), *Culex bitaeniorhynchus* Giles, *Lutzia halifaxii* (Theobald), *Mansonia uniformis* (Theobald), and *Verrallina* species Marks 52 (Table 1). The most important species from a pest and public health perspective are *Ae. notoscriptus* and *Ae. vigilax*.

Ae. notoscriptus was the most commonly collected species across the region, through trapping of adults as well as larval surveys. Immature stages of the two estuarine mosquitoes, *Ae. vigilax* and *Cx. sitiens*, were rarely found and at one site only. The majority, if not all, adults of these species disperse to the City of Ryde from the estuarine wetlands south of the Parramatta River where more suitable larval habitats are found (Cameron Webb, personal communication). Adults of *Ae. vigilax* were, however, found throughout the region, dispersing from the opposite shores of Parramatta River and at smaller sites along the City's shore, but outside the Ryde local government area (Cameron Webb, personal communication).

Sampling of watercourses on community land was most frequent between seasons 1998-99 and 2004-05, with known sites visited regularly and others subsequently found to complaints by residents. The most commonly found species in creeks and drains as well as in domestic containers were *Cx. quinquefasciatus* and *Ae. notoscriptus* with *Ae. alboannulatus*, *Ae. camptorhynchus*, *An. annulipes* and *Cx. australicus* found in creeks. *Lt. halifaxii* was found in watercourses and on occasion also entered traps as adults. *Toxorhynchites speciosus* larvae were found in discarded tyres, but no adults were trapped.

It is important to note that some misidentification of specimens occurred over the monitoring period prior to season 2003-04 with *Ae. quasirubithorax* misidentified as *Ae. nr. monocellatus*. Both species have limited distributions in Sydney. Specimens of *Ae. species* Marks 51 may have been misidentified with the closely related *Ae. procax*, which is more common within the Sydney Metropolitan area (John Clancy, personal communication).

DISCUSSION

The mosquito fauna of the region is primarily influenced by the availability of estuarine, bushland and urban habitats and results in a relatively diverse mosquito fauna for a metropolitan area. While there are only small areas of estuarine wetland in the local area, the extensive saltmarsh and mangrove habitats of Sydney Olympic Park to the south provide suitable conditions for *Ae. alternans*, *Ae. camptorhynchus*, *Ae. vigilax* and *Cx. sitiens*. Of these four species, *Ae. vigilax* is most abundant and can disperse many kilometers from larval habitat (Russell 1993, Webb and Russell 1999) and, although large numbers of this mosquito may be present within the City of Ryde area, almost all mosquitoes disperse into the region. This is evident from foreshore surveys carried from season 1995-96 to season 2007-08 showing insignificant and infrequent mosquito breeding in one small saltmarsh in Melrose Park only (Gith Strid-Nwulaekwe unpublished

Table 1. Total number of adult mosquito species collected at regular sites within City of Ryde, 1992 - 2008.

Species / Season	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
<i>Aedes alboannulatus</i>																
<i>Aedes alternans</i>																
<i>Aedes camptorhynchus</i>																
<i>Aedes flavifrons</i>																
<i>Aedes multiplex</i>																
<i>Aedes notoscriptus</i>																
<i>Aedes procax</i>																
<i>Aedes quasirubithorax</i> *																
<i>Aedes rubrithorax</i>																
<i>Aedes</i> sp. Marks 51																
<i>Aedes vigilax</i>																
<i>Aedes vittiger</i>																
<i>Anopheles annulipes</i> s.l.																
<i>Coquillettidia linealis</i>																
<i>Culex annulirostris</i>																
<i>Culex australicus</i>																
<i>Culex bitaeniorhynchus</i>																
<i>Culex molestus</i>																
<i>Culex orbostensis</i>																
<i>Culex quinquefasciatus</i>																
<i>Culex sitiens</i>																
<i>Lutzia halifaxii</i>																
<i>Mansonia uniformis</i>																
<i>Toxorhynchites speciosus</i> **																
<i>Verrallina</i> sp. Marks 52																
Total mosquito species	10	4	15	16	15	16	17	17	19	15	19	18	19	19	19	20

* *Aedes quasirubithorax* misidentified as *Aedes monocyellatus* prior to season 2003-04 within Sydney Metropolitan

** Not collected as adults but found as larvae only

observation and Cameron Webb, personal communication). *Ae. vigilax* is known to disperse over 10 km from larval habitats (Lee *et al.* 1989) and mark-release-recapture studies have shown that *Ae. vigilax* disperses over 5 km from larval habitats in Sydney Olympic Park (Cameron Webb, personal communication). As a result of seasonal fluctuations in tidal and rainfall inundation of estuarine wetlands, the Sydney Olympic Park Authority manages populations of *Ae. vigilax* through habitat modification (e.g. dredging to improve tidal flushing) and larvicide applications (Webb and Russell 2001) and, as a result, populations can fluctuate greatly between seasons.

Urban habitats such as stormwater structures (e.g. smaller drains and stormwater detention pits and ponds) and backyard habitats (e.g. water holding containers, bird baths, rainwater tanks, unkept swimming pools) provide suitable conditions for mosquitoes including *Ae. notoscriptus*, *Cx. quinquefasciatus*, *Lt. halifaxii* and *Tx. speciosus*. The two most common species, and potential pests, are *Ae. notoscriptus* and *Cx. quinquefasciatus*. *Ae. notoscriptus* is a serious nuisance-biting pest and across the Ryde area as a whole, and is likely to be a more substantial pest than *Ae. vigilax* due to this species' close association with residential dwellings.

Ae. vigilax is exclusively a saline water breeder, and it is of great importance along the eastern and south-eastern Australian coasts for several reasons: it is a major vector of RRV, it is able to breed in very high numbers in untreated areas, it has a dispersal range of up to 10 km, and it is a voracious day-time biter (Russell 1993). It was found during all of the 16 trapping seasons to be the most commonly trapped saltwater species, and was collected at sites furthest from the Parramatta River. Its fluctuating population numbers have been positively related to the numbers of resident complaints to Council about mosquito biting.

Ae. notoscriptus is one of the most common container-breeding species in Australia and was present in most of the weekly collections. The species is likely to play a role in the transmission of RRV and BFV (Russell and Kay 2004) and it is the most important vector of Dog Heart Worm (Russell 1993). The species represented approximately one third of all mosquitoes trapped in the City of Ryde and based on *ad hoc* backyard trapping by Council, is implicated in a significant proportion of resident complaints.

Cx. quinquefasciatus is a common species breeding in containers and watercourses in association with *Ae. notoscriptus* and other freshwater species. These two species constitute a significant proportion of the domestic suburban mosquito fauna. Not surprisingly, the

most frequently found immature mosquitoes were *Cx. quinquefasciatus* and *Ae. notoscriptus* on residential property, sampled from various containers (e.g. tyres, gutters, dirty swimming pools and water features).

Cx. annulirostris is one of the most important arbovirus vectors in Australia. It breeds in a variety of inland and coastal environments, including rainwater-diluted saline and brackish marshes, irrigation channels, creeks, and ground pools (Russell 1993). Although it was found in a relatively small proportion of the total catch, it occurred regularly, particularly later in the season. In the absence of extensive freshwater wetlands, populations of species such as *Cx. annulirostris* and another species closely associated with well vegetated freshwater wetlands, *Cq. linealis*, were generally low but occasionally abundant as a result of suitable environmental conditions.

Ephemeral ground pools occurring after rainfall, particularly within bushland areas, provide suitable habitats for species including *Ae. flavifrons*, *Ae. multiplex*, *Ae. vittiger*, and *Ae. Marks* species 51. However the abundance of these species was generally low and only small numbers of specimens of some species were collected. *Ae. procax* is a freshwater species that was found in relatively low and fluctuating numbers in forested sites in the City.

There is a diverse mosquito fauna present in the City of Ryde area reflecting the variety of available habitats. However, the fauna is dominated by two species, *Ae. notoscriptus* and *Ae. vigilax*. While both species are known to transmit disease-causing pathogens such as RRV and BFV, the public health risks posed by these two species are relatively low in metropolitan areas (Russell and Kay 2004). Far more important is the potential nuisance-biting impacts and while populations of *Ae. vigilax* are currently managed by nearby authorities, an important component of the community awareness program by the City of Ryde is to ensure that potential habitats for *Ae. notoscriptus* (e.g. water pooling in household containers and rubbish) are removed, swimming pools are kept at full level and disinfected, and large structures such as rainwater tanks are covered or appropriately screened to prevent access by mosquitoes.

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