Northern Territory Government DEPARTMENT OF HEALTH AND FAMILIES

Biting Insects in the Proposed Newtown (Weddell) Development, Darwin

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May 1988 Revised February 2009

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1.0 Introduction

Biting insects may have a major influence on the viability of residential and other developments through their obvious effect on the quality of life, in limiting outdoor activities, and because of the disease they transmit. The importance of these pests in determining the attractiveness of an area can be gauged by their effect on land values – which have increased four-fold in some instances, when the biting insect problem had been removed (Reye, 1981).

The worst effects of biting insects can frequently be mitigated by appropriate steps in the planning stage. Attention to sound construction practices can further ensure there is no increase in breeding areas, and no need for costly rectification procedures.

There are many examples of development in the Darwin region that have led to enormous populations of a range of mosquito species, severely effecting residents in nearby areas and requiring costly rectification. The siting of the Leanyer Sewerage Treatment Works and associated embankments resulted in severe disruption of mangrove drainage patterns. Thus a mud flat was transformed in to a dense brackish water reed swamp. In another case, a stormwater drain in Tiwi transformed a seasonal drainage line into a permanently flowing creek, which caused ecological changes at the salt-water interface and resulted In the creation of a range of mosquito breeding habitats and serious mosquito pest problem.

In contrast, the Palmerston development plans incorporated carious features designed to minimise the effect of biting insects already present and avoid the creation of new pest breeding areas.

To aid planners in their design of the proposed Newton development, the Medical Entomology section of the department of Health and Families has made collections of biting midges and mosquitoes form March 1984 to April 1985 in and around the proposed development area between the Elizabeth and Blackmore Rivers, south-west of Palmerston. Additional surveys of biting midge breeding areas were made in late 1987.

This report analyses the result and suggest methods of minimising the adverse effects of the biting insect present in the proposed development area, and outlines some construction guidelines to avoid exacerbating the problem.

2.0 The Biting Midge

2.1 Biology

Biting midges are small blood-sucking flies commonly, but inaccurately, known as ‘sandflies’. In the coastal areas on the N.T. the biting midges of the family *Ceratopogonidae* causes the major biting midge problems. The most common members of this family that bite man are *Culicoides Immaculatus,* found near sandy foreshores (not a pest in the Newtown area), and *C. ornatus,* which breads in the neap tide zone and may occur in very large numbers in parts of Newtown.

C. ornatus are about 1mm long, and thus visible to the naked eye. They pose problems due to their extremely annoying and painful bites, and to the discomforting after-effects of these bites. In tropical areas where evening outdoor recreation is an important aspect of the quality of life, these insects can impose serious restrictions on such activities.

It breeds in the muddy shoreline, where there is shelter from wave-action. It is usually associated with the mangrove species, *Aegiceras corniculatum* and *Rhysophora stylosa*. The eggs are laid in the neap tide zone. The larvae are small worm-like creatures confined to the mud in this zone. They take six weeks to develop to the relatively inactive air-breathing pupa. This stage lasts several days. The adults emerge about the time of the neap tides.

The adult female bites mainly during the period of sunrise and sunset (crepuscular), but may continue to bite throughout the day and night. They rarely fly in windy conditions. Appendix 2 contains a summary of the biology of Newtown biting midges.

2.2 Biting Midge in Newtown

Biting midges were trapped using EVS carbon dioxide baited light traps. Collections were timed to catch maximum numbers of biting midges (ie traps were run shortly after neap tides). The location of the traps are shown on Map1. Results are shown in Tables 1 and 2. Traps 5,7,8,9,10,14 and15 all caught low numbers of *C. ornatus* indicating the southern and southeastern ends of the area have acceptable numbers of the pest.

However the areas of Newtown that abut Elizabeth River or are within 2km of Blackmore or Elizabeth Rivers have considerable numbers of the pest, as indicated by catches from traps 1,1A, 2,12,13 and 16. These regularly produced >1000/trap night. Traps 3,4 and 11 also collected pest levels of *C. ornauts.*

Of the other biting midge species collected, *C. marski, C. pallidothorax and C. Hewitti* were the only ones to occur in high numbers. The first two rarely bite man. *C. Hewitti*, which was abundant in traps on the Blackmore riverside of Newtown, may present a problem, but only where *C. ornatus* is also present, and the same buffer zone and wind belt control methods apply for both.

The high trap catches of *C. ornauts* in and around Newtown are greater than those from traps in the worst part of Stuart Park and The Narrows, from where complaints are regularly received. However, areas of Palmerston have similar or greater numbers of biting midges than Newtown.

C. ornatus is a competent flier and can be collected many kilometres from its breeding area (eg site 11, 3kms from any mangroves, had appreciable numbers of this species, reaching up to 530 in one trap night). Leihne (1985) studied biting midge dispersal though a range of conditions at Palmerston and found that highest numbers were usually collected in the kilometre nearest the mangroves, and that a decrease occurred somewhere between 1 and 1.5 kilometres, depending on local conditions.

A transect of traps were operated in Newtown to study the dispersal characteristics in the local conditions (map 1, Table 4). The traps were placed 500m apart, from the mangrove edge, up a slight ridge, through open forest, to a distance of 2.5km. No other mangrove area was likely to affect the biting midge population size. The forest was typical of the Newtown district, and the number of biting midges trapped at the mangrove edge of the same order of magnitude as along the Elizabeth River. Wind, rainfall and temperature were all not likely to inhibit flight over the trapping period.

Numbers trapped fluctuated greatly, both temporally and spatially. There was a general increase after the neap tide, and a slight decrease in the days after it. This is consistent with neap tide emergence and subsequent minor daily mortality. More than 85% of biting midges were trapped in the first 1.5km, with the maximum number trapped at the 1.0km mark. However, more than a 1000/trap night were collected 5 days after the neap 2km from the mangroves.

This is similar to the results obtained by Liehne, and confirms that a minimum buffer of 1.5km is needed, and that occasionally pest levels will still occur in the area beyond the buffer. Notably a trap in the mangrove side of the residential area of Palmerston, 2.1km from the mangroves, run over the same four nights as the Newtown transect traps, collected from 16 to 975/trap night (the level at the mangrove edge was higher than anywhere in Newtown).

To confirm that biting midges are breeding in the neap tide zones of the Elizabeth River, adult and larval surveys were conducted in late 1987. Larvae were collected from the neap tide zones of all samples (table 3). The neap tide zone is approximately equivalent to the area dominated by the mangrove species *Rhizophora stylosa.* This mangrove species is present in extensive stands approximately a kilometre up Bennetts Creek and most of Creeks 1&2 in Newtown (map1). Trap sites 1 and 1A, near creek 1, trapped up to 1000 *C. ornatus* per trap night.

Due to the access limitations, no adult traps were set in the areas of Creek 2 and Bennetts Creek in the yearlong monitoring program. However, adult traps operated along the river system in October 1987 indicate the comparative *C. ornatus* populations at the upper reaches of the river are at least as high as those near trap sites 1 and 1A (map2). As the breeding areas are extensive for this pest, it can be expected that anyone living within 1-2 kilometres of the Elizabeth River in the Newtown area will be exposed to significant pest levels of biting midges.

2.3 Biting Midge Control

The breeding areas are too extensive for insecticidal control to be practical or cost-effective. Similarly, selective removal of the breeding areas would be enormously expensive and ecologically disruptive. Buffer zones have been used in other Top End localities, and may be effective here.

As *C. ornatus* has a pest range of 1.5km it is necessary to have a buffer of at least this distance. However, much of the proposed Newtown district is within 1.5km of biting midge breeding areas. If the mangrove arms (i.e. the tributaries of both Elizabeth and Blackmore Rivers) are engineered out a 1.5km buffer zone would be as marked on map 1.

A second option is to install a wind belt. This is a belt of land, at least 500m wide, between the mangroves and the development. This strip must be kept free of any vegetation build-up, in the manner of a fires-break, for the life of the development. Evidence suggests biting midges avoid areas of low humidity or high wind and thus few would be expected to cross such a barrier.

A possible wind belt is shown on map 1. The belt is measured from the current biting midge breeding areas along the Elizabeth River, and from the western boundary on the Blackmore River side of Newtown. The extremities of Creeks 1 and 2 and Bennetts Creek have been left in the belt as they are expected to have only small neap tide areas. The effective biting midge breeding area at these tips should be further reduced by the increased freshwater input from the developed suburbs. Naturally, if the mangrove arms are engineered out the wind belt can be moved closer to the mangroves.

It is emphasised that experimental work is needed to confirm the effectiveness of the wind belt. Trials by Liehne (1985) have shown that up to an 80% reduction in biting midge numbers may occur. By combining the wind belt and buffer zone concepts a number of variations are possible (Figure 1). The comparative effectiveness if each of these methods will vary according to local circumstances. This would need to be investigated before any buffer zone/wind belt mix was to be used.

C. ornatus is mainly active at crepuscular hours (dawn and dusk), and thus industrial areas could be sited closer to the midge breeding areas than residential areas. However, some diurnal biting can be expected to occur.

The extensive area required for an effective buffer zone, with no infilling of mangrove arms, will leave little land suitable for urban development. A managed buffer zone, with or without wind belt, with infilling of mangrove arms, is likely to be very expensive to install and maintain. The option of no biting midge control will also be very expensive in terms of the lowered value of the land.

A dam has been mooted for the Elizabeth River. A fresh or saltwater dam would destroy the mangroves and the *C. Ornatus* breeding areas above the dam site. A dam and its associated urban development could also remove many of the mosquito breeding areas. This can only be effective, however, if the sides of the dam are steep to precent vegetation becoming established on the edges, and the mangroves are killed and removed rather than allowed to die. If they are left to die the dead leaves and trunks will lead to nutrient rich wave protected areas, which will allow substantial mosquito breeding. The same applies for any proposed dam on Blackmore River, or any engineering works on the mangrove creeks.

3.0 Mosquitoes

3.1 Mosquito Breeding in Newtown

Mosquito breeding in the area is not large and probably limited to cut-off pools along the creek lines, temporary pools in depressions in the general terrain, and brackish water breeding sites at the freshwater/saltwater interface.

The most abundant species were *Culex annulirostris*, the common banded mosquito, and *Conquillettidia xanthogaster*, the golden mosquito (tables 5 and 6). The first is the major Australian arbovirus disease (including epidemic polyarthritis and Australian encephalitis) vector, and the second a major nuisance species (i.e. it bites man but is not know as a disease vector).

Cx annulirostris breeds in grassy areas after rain; in freshwater swamps edges, in storm drain and sewage pond edges. Catches of 100/trap night are considered the equivalent of 1 mosquito bite/ minute, a level considered beyond the comfort level of most people. This level was reached at a number if sites from May to September, but the maximum catch was only 179/trap night (site 4, May). It was common throughout the Newtown area, but not in very large numbers at any particular site. Although no specific control procedures need be implemented for the current breeding sites, this species is the one most likely to breed in artificially created or altered breeding sites.

Cq xanthogaster was more common, reaching 540/trap night (site 3, June). This species breeds in permanent and semi-permanent swamps and waterholes and is closely associated with aquatic vegetation, such as Eleocharis and Typha reeds. It is abundant from May to August. It was also ubiquitous throughout Newtown, but no site produced continuously large numbers, suggesting conditions were only sporadically suitable for large-scale breeding. This species will probably become less common following development if the basic guidelines are followed.

Eight Anopheles species were collected in the area, including the primary Australian malaria vector, *An farauti s.l*. This species was only present in low densities in the Newtown district, but is capable of exploiting any new brackish or freshwater breeding areas. It was most common along the upper reaches of the Elizabeth River (site 7), along the old railway line (site 8), and at the gauging station on the Blackmore River (site 13).

An bancrofti, *An annulipes s.l.* and *An meraukensis* were also most abundant at site 7. These are all freshwater species, and it is probable that the *An farauti* species trapped was *An farauti* No.3, rather than the more widely occurring *An farauti* No. 1, which is usually found in brackish water breeding sites. *An meraukensis* was also quite common near Berry Springs (site 14 and 15), along the old railway line (site 8), near the quarry (site 10) and on Bennetts Creek (site 5).

However, one species, *An novaguinesis*, occurred at very high levels at site 9 (the old railway line), 10 (near the quarry) and 11 (along the main ridge line). The highest number trapped was 440/trap night at site 10 in March. It breeds in freshwater seepage and is an unknown quantity in respect of malaria transmission.

3.2 Mosquito Control

Mosquito control can be achieved in a number of ways: filling of breeding areas, drainage of breeding areas, destruction of adult harbouring areas, management of water retention areas, or through use of insecticides (Whelan 1984).

Filling permanently removes mosquito-breeding sites if done correctly. Sand or earth can be used to fill many small depressions which hold water eg sand or gravel borrow pits, depressions resulting from uneven land clearing, uneven settling, sanitary land fills, or water scouring. Attention to the final slope is most important.

Naturally fills can be facilitated by redirecting silt laden streams to depressions, using retention dams to trap silt, or using sand trapping vegetation to create a wind fill. Hydraulic fills, where silt-laden water is pumped into swampy or low-lying areas to be reclaimed, may be used in conjunction with dredging of harbours and rivers and disposal of mining wastes. Landfills can also be achieved using urban garbage (sanitary land fills). Consideration must be given to final slope, vegetation cover, and site selection.

Drainage and management of retention waters require proper construction of appropriate facilities and are discussed in appendix 1. Stormwater drains have a great capacity to cause mosquito breeding in both tidal and freshwater influenced areas (Whelan, 1988). However it should be noted that the amounts of water to be removed when draining areas for mosquito control may be small and often not significant to the civil engineer or farmer, but may be of great significance as a mosquito-breeding site. Drainage can often be simple and less expensive than filling. Further, whereas urban drains are usually designed to drain water over a few hours, drains for mosquito control can take up to five days to drain and operate effectively.

Adult mosquito numbers can sometimes be reduced by burning off or otherwise removing harbouring areas. This method produces only minor or temporary reduction, particularly if a major breeding area nearby continues to produce new adults. However, if the removal of harbouring areas reduces the age of the mosquito population by increasing their daily mortality rate, it can have a large effect on the transmission of disease.

Insecticides are a last resort in mosquito control. They can provide good short-term control – but problems of insecticide resistance, damage to non-target organisms and the environment, high continuing costs in their use, and public hostility to their use mean they are only useful when the other methods are inapplicable.

4. The Effect of Previous Development in Newtown

Past human activity has produced mosquito-breeding areas in the region. The old railway line, although coverts were located in the appropriate position, impeded natural drainage at several points and the resultant pooling has caused the formation of swamps suitable for mosquito breeding and possibly responsible for the high numbers of *An novaguinensis*. There are some quarries on the edge of the development, which may also be responsible for the large numbers of *An novaguinensis* – but these are on private land and have not been checked.

5. Conclusions

- Data from one years' collection of biting insects from the Newtown region are presented and discussed in this report.

- This data indicates that biting midges were at very high levels at sites within 2 kilometres of mangrove areas. To mitigate the effect of these biting midges either the environment must be physically modified, eg by damming the Elizabeth River, or by establishment of a 1.5km buffer zone, or by a combination of the three. The alternative is that future residents or workers in the area will have to tolerate very high numbers of biting midges. This is also an expensive option, since for example; the value of the land would be much lower.

- Mosquito species capable of transmitting various diseases were present. *Culex annulirostris*, a vector of Ross River virus, and Murray Valley encephalitis virus, occasionally reached nuisance levels. This species will rapidly colonise freshwater pooling generated by interruptions to natural drainage.

- Malaria vectors were collected in the area, including the main potential vector of this disease in Australia, *Anopheles faruti s.l.*, which was collected at relatively high numbers in some localities and is cause for concern. However, only *Anopheles novaguinensis* was abundant in the trapping area. Its potential as a malaria vector is unknown, but it's occurrence at up to 400/trap night in the Newtown region is cause for concern.

- Pest mosquito species were also collected in Newtown, but only *Coquellittidia xanthogaster* was collected at greater than 100/trap night. The likely breeding areas for this species were along the more permanent semi-aquatically vegetated drainage lines into Elizabeth River.

- Although mosquito-breeding areas in the Newtown area are not large, any major construction practices can generate such areas. Guidelines for construction practices are outlined in the enclosed appendix.

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Tables, Maps & figures

Appendix