



Northern
Territory
Government

DEPARTMENT OF HEALTH

Mosquito investigation Wagait Beach 14 -15 January 2015

Medical Entomology
Centre for Disease Control
NT Department of Health
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1.0 Introduction

Medical Entomology received a mosquito enquiry from Wagait Shire Council on the 9th of January 2015. The complaint was received around the time of high salt marsh mosquito (*Aedes vigilax*) numbers in the Darwin Northern Suburbs, and when other areas of the Top End coastline were most likely also experiencing similar mosquito problems. *Aedes vigilax* has a very long flight range, and thus during major early wet season rainfall events, much of the NT coastline is likely to experience seasonal problems. However, in light of a lack of recent mosquito data from Wagait Beach, a mosquito investigation was carried out on the 14th-15th of January 2015, to determine which mosquito species was the causing the problem, the levels of mosquitoes compared to the most affected suburbs in Darwin, and the likely sources of the problem mosquitoes.

The investigation involved;

- The setting of five overnight adult mosquito monitoring traps (carbon dioxide baited EVS traps) within and nearby to the community of Wagait Beach.
- Mosquito larval surveys of nearby seasonally flooded areas, to determine the likely sources of mosquitoes.
- An examination of the mosquito data, and desktop examination of aerial photography, to determine potential mosquito breeding sites affecting Wagait Beach.
- Recommendations on mosquito mitigation measures that could be applied at Wagait Beach to reduce the potential for pest problems and mosquito borne disease transmission.

2.0 Methods

Five adult mosquito trap sites were chosen for this investigation (Figure 1). The sites were selected within close proximity to potential mosquito breeding areas and accessed by 4WD vehicle and on foot.

The traps used were carbon dioxide baited EVS (Encephalitis Vector Survey) traps. They consisted of a black insulated bucket, a suction fan powered by two 'D' cell batteries, a 'grain of wheat' light, and a rigid plastic collection container fitted with a muslin sleeve and very fine wire mesh vents. The traps were hung on trees around chest height and baited with approximately 1kg of dry ice. Traps were set in the late afternoon on the 14th of January and collected the following morning after 8am.

Once all the traps had been collected and returned to the laboratory, the mosquitoes were killed in the freezer to enable identification via a light microscope using various taxonomic keys. For catches less than 300 mosquitoes, each individual mosquito was identified. For catches over 300 mosquitoes, a sub sample of around 300 mosquitoes was obtained from the bulk sample, with all mosquitoes in the sub sample identified and the bulk scanned for species not present in the sub sample. A multiplication factor was calculated by dividing the weight of all mosquitoes by the weight of the sub sample, which was then applied to the sub sample results to get an overall count of each species. All species and totals for each individual collection were then entered into a database for evaluation.

Field surveys for mosquito larvae were also conducted at seven potential mosquito breeding sites on 14th January, with survey points shown in Figure 2. Surveys were carried out on foot using a 350ml ladle dipper to collect larvae which were then

stored in specimen jars. The larvae were later preserved in 70% alcohol to enable identification using a light microscope and various taxonomic keys. Notes and photos were also taken on the presence of aquatic/semi aquatic vegetation, the presence of mosquito larvae predators, and density and extent of mosquito breeding.

3.0 Results

3.1 Adult mosquito trapping

The results of the adult mosquito trapping are shown in Table 1. Trap locations are shown in Figure 1. There were a total of 1641 adult female mosquitoes collected from the 5 traps, representing a total of 14 different mosquito species.

The most common mosquito collected in all of the traps was the northern salt marsh mosquito *Aedes vigilax*, with a total of 1265 adult females collected in the 5 traps. The most productive trap site for this mosquito was Trap Site 3 at the eastern end of De Lissa Dve, adjacent to the mangrove swamp. A total of 366 adult female *Ae. vigilax* were collected at this sites. Trap Site 1 at Lot 133 Erickson Street was the second most productive trap site for *Ae. vigilax*, with 312 adult female *Ae. vigilax* collected, followed by Trap Site 4 (239), and Trap Sites 2 and 5 which both recorded 174 adult females.

The second most abundant mosquito was the common banded mosquito *Culex annulirostris*, with a total of 182 adult females collected in the 5 traps. The most productive trap site for this mosquito was Trap Site 5, set along Charles Point Road about 2.5km southwest of Wagait Beach with a total of 88 adult females collected. Trap Site 4, set about 5km south of Wagait Beach, was the second most productive trap site for this mosquito, with a total of 33 adult females collected, followed by Trap Site 1 (28), Trap Site 3 (21) and Trap Site 2 (12).

The third most common mosquito was the receptacle (or backyard) breeding mosquito *Aedes notoscriptus*. This mosquito was only recorded in the three traps set in Wagait Beach, with Trap Site 3 the most productive (41 adult females), followed by Trap Site 1 (15) and Trap Site 2 (13).

The fourth most common mosquito was the black jungle mosquito *Verrallina funerea*. This mosquito was only recorded in the three traps set at Wagait Beach, with Trap Site 3 the most productive with 37 adult females.

From the remaining mosquito species, *Culex sitiens* was an important mosquito collected, and was also the fifth most common mosquito recorded during trapping. There was a single male *Coquillettidia xanthogaster* mosquito collected. This species can be an important mosquito in areas of the Top End nearby to seasonally flooded areas. All other mosquitoes collected during trapping were considered of minor human significance.

3.2 Larval mosquito survey

The results of the larval mosquito survey are shown in Table 2, with survey points and potential mosquito breeding sites highlighted in Figure 2.

The most common mosquito collected during larval sampling was *Ae. vigilax*. This species was found in the beachfront grassy sand dune depressions at the NW corner of the township (Larval 05) and NE of De Lissa Drive (Larval 02), in moderate to high numbers.

The two other species found were *Cx. annulirostris* and *Cx. sitiens* at a separate grassy sand dune depression site NE of De Lissa Drive (Larval 01). These species were found in high numbers at the same location.

Four of the seven sites that were surveyed, did not have any mosquito breeding.

3.3 Mosquito breeding sites

The larval mosquito survey showed the dune depressions between the northern residents and the main beach front are significant breeding sites for *Ae. vigilax*. Sand dune depressions are usually the last habitat type for this mosquito to become seasonally flooded, and therefore it is expected that December to March would be the main months of breeding in this habitat at Wagait Beach.

The main breeding sites for *Ae. vigilax* from September to December/early January are likely to be the two large tidal swamps immediately to the east and west of Wagait Beach township. Productive breeding is expected to occur when monthly high tides flood the previously dry swamps, causing *Ae. vigilax* eggs to hatch. Numerous generations are expected to occur as the swamps dry and flood throughout the late dry-early wet season. Seasonal *Ae. vigilax* breeding usually ceases once the swamps remain flooded with water after consistent heavy rains during the monsoon season.

In Darwin, some tidal drains can be productive sources of *Ae. vigilax* during the late dry and early wet season. At Wagait Beach, *Aedes vigilax* is also likely to be breeding in the stormwater drains that convey stormwater from the roads to the beachline during the late dry and early wet season. In particular, the drain that runs between Lots 12 & 13 could be a productive breeding site for *Ae. vigilax* in the lower reaches towards the main beachline. If sand builds up at the mouth of the stormwater drains during the dry season, the extent of breeding could be exacerbated.

Wagait Beach is also likely to be subject to *Ae. vigilax* dispersal from swamps up to 5-10km away, due to the very long flight range of this mosquito. The numerous large tidal swamps associated with Two Fella Creek, starting about 1.6km to the west of Wagait Beach, are likely to contribute to the *Ae. vigilax* problem in Wagait Beach during September to December/early January. The numerous small tidal swamps associated with small mangrove creeks between Mandorah and Woods Inlet may also contribute to the Wagait Beach *Ae. vigilax* problem from September to early January, but are probably of minor significance compared to the other swamps.

The numerous paperbark swamps within Wagait Beach township (eg in Lot 133 and Lots 2 to 5) are not expected to be breeding sites for *Ae. vigilax*, as dense paperbark swamps are not typical breeding sites for this mosquito. The paperbark swamps however are likely to be major breeding sites for *Verrallina funerea*, particularly the paperbark swamp in Lots 2 to 4, which is likely to be brackish and most suitable for this species. The months of December to March are likely to be the peak months for

Ve. funerea breeding in brackish swamps. The dense paperbark swamps contained minimal semi-aquatic vegetation, suggesting they are not likely to be major breeding sites for freshwater mosquito species. However, they are still likely to produce low to moderate levels of *Cx. annulirostris*, *Cq. xanthogaster* and *Anopheles bancroftii* during the early to mid dry season, when water levels recede, leaving behind isolated shallow pools.

The small open freshwater swamp in Lot 76 is likely to be a localised breeding site for *Cx. annulirostris*, after ponding during the early wet season, before the swamp overflows Cox Drive, and during the early dry season when residual shallow ponding occurs as the swamp dries out. Low to moderate levels of *Anopheles* mosquitoes are also likely to breed in the open swamp.

During the early to mid dry season, the large tidal swamps immediately east and west of Wagait Beach are likely to be important sources of freshwater/brackish water mosquitoes such as *Cx. annulirostris* and *Cq. xanthogaster*, and probably also *An. bancroftii*, *An. farauti s.l.*, *An. hilli* and *Cx. sitiens*. The swamp to the east of Wagait Beach is probably more important for these species, as it appears to have a greater freshwater influence in its upper reaches and greater areas of semi-aquatic vegetation. Further trapping and larval sampling would be required in the early to mid dry season, to determine the importance of these swamps for these mosquitoes.

4.0 Discussion

4.1 Northern salt marsh mosquito *Aedes vigilax*

The high mosquito numbers at Wagait Beach in January 2015 were typical of coastal areas of the NT in early January, with appreciable salt marsh mosquito (*Aedes vigilax*) abundance. Due to its breeding habits, *Aedes vigilax* suddenly appears in high numbers starting 9 days after a flooding event, and relatively quickly declines a week or two later. Adult mosquito trapping at Wagait Beach occurred about a week after extreme pest levels were experienced (Pam Wanrooy pers. comm.), and whilst the traps recorded appreciable levels of this species, it is likely that traps would have collected much higher numbers if they were set a week earlier. For example, *Ae. vigilax* levels in bushland near the urban fringe of the Darwin suburb of Karama were very high on the 6th of January 2015 (1627 adult females), but were nearly 70% lower a week later on the 13th of January (518 adult females) due to natural die off. The authors experienced very high pest levels in the dune areas just behind the main beachline, most likely due to the proximity of breeding sites, and at Lot 133, most likely due to mosquitoes harbouring in the humid paperbark swamp during the daytime.

Aedes vigilax lays eggs at the edge of vegetation in damp or drying depressions in upper tidal areas (7.3m to 8.1m ACD), with the eggs hatching upon later inundation by high tides or rainfall. A drier than usual early wet season usually results in more generations of *Ae. vigilax* compared to wetter than average early wet seasons, as there are more wetting and drying cycles during a below average wet season that allows successful breeding. Also, fish cannot access the upper tidal depressions to provide natural control until the consistent heavy rains begin. As each female *Ae. vigilax* can lay up to 100 eggs, each generation is much larger than the previous one

until the breeding sites become unavailable. The 2014/15 early wet season rain was well below average, which resulted in higher than average *Ae. vigilax* numbers in the Darwin northern suburbs, and most likely higher than average *Ae. vigilax* numbers at Wagait Beach.

The presence of a wide range of potential *Ae. vigilax* habitat at Wagait Beach is most likely causing seasonal pest problems over many months of the year. Upper tidal swamps and drainage lines are likely to provide most of the *Ae. vigilax* problems from September to early January, while sand dune breeding sites would prolong the season into February or March. During some years, *Ae. vigilax* problems can appear in May after unseasonal rainfall or very high tides, however May peaks are usually much lower than September to January peaks, due to residual freshwater ponding restricting the size of available *Ae. vigilax* habitat.

The *Ae. vigilax* numbers recorded in the Wagait Beach trap were considered high for a residential area, with pest biting experienced by authors during the field visit attesting to the problem. As mentioned earlier in the report, it is likely that pest problems were much greater during the week before the trapping, and therefore pest problems affecting residents were most likely severe.

Aedes vigilax is the principal pest mosquito in coastal areas of the NT from September to January, as it is aggressive, and bites in shaded areas during the day as well as at night. *Aedes vigilax* is also a known vector of Ross River virus and Barmah Forest virus. Macropods such as wallabies are presumed to be the natural host for RRV, and in areas such as Wagait Beach, which is surrounded by relatively undeveloped land, wallaby hosts are likely to occur in greater numbers than in urban cities such as Darwin. Therefore, due to the likely higher numbers of reservoir host animals combined with the very high seasonal *Ae. vigilax* numbers, the RRV risk at Wagait Beach is likely to be higher compared to Darwin and Palmerston, and probably similar to mosquito prone areas in Litchfield Shire. The BFV risk is also likely to be similar to mosquito prone areas in Litchfield Shire.

4.2 Other mosquito species

The common banded mosquito *Culex annulirostris* is likely to be seasonally present in numbers sufficient to result in potential mosquito borne disease transmission. The mid wet season, and post wet season is likely to be the peak period for this mosquito. This mosquito is less of a pest species compared to *Ae. vigilax*, as it only bites at night time, and is more timid in the presence of lights and personal protection. It is unknown whether appreciable pest problems would affect Wagait Beach residents, with further trapping during the post wet season required to determine the seasonal peak in numbers. *Culex annulirostris* is considered the principal vector of arboviruses in the Northern Territory, and is a known vector of RRV, BFV, Murray Valley encephalitis virus, Kunjin virus and other viruses.

Anopheles species mosquitoes are likely to be seasonally present at Wagait Beach, with the late wet to mid dry season likely to be the peak period. It is unknown whether appreciable pest problems would affect Wagait Beach residents, with further trapping during the late wet to mid dry season required to determine the seasonal peak in numbers. However, due to the availability of potential breeding habitat, it is likely that this mosquito would at least be present in sufficient numbers to pose a potential risk of malaria transmission, if a person infected with malaria is bitten by *Anopheles* species mosquitoes at Wagait Beach. A trap catch of over 10 *Anopheles* species mosquitoes in bushland nearby to residents is considered the potential

malaria risk threshold. The adjacent swamp habitat is likely to provide seasonal levels of *Anopheles* species mosquitoes above this threshold. The malaria risk however is not likely to be any higher than other areas of the NT, and as the NT Department of Health has systems in place to minimise the potential for local malaria transmission.

The black jungle mosquito *Verrallina funerea* is likely to pose very high seasonal problems to residents living next to brackish water paperbark swamps and dune depressions, with January to March the likely peak season. This mosquito does not venture far from dense vegetation at their breeding sites, and is not thought to be involved in RRV transmission in the NT, therefore would be a localised pest mosquito only.

Freshwater pest mosquitoes such as *Coquillettidia xanthogaster* and *Mansonia uniformis* may occur in sufficient numbers to cause seasonal pest problems, most likely in the early to mid dry season. As they are not known to be involved in human virus transmission in Australia, they would only pose a pest problem to residents of Wagait Beach.

4.3 Mosquito mitigation measures

The best form of mosquito control is usually habitat modification to remove their breeding sites, or to shift the ecological balance in favour of mosquito larvae predators (fish, water bugs). Feasibility as well as environmental factors need to be considered prior to habitat modification measure being implemented. However, as the modification of swamps is generally not positively viewed, it is unlikely there would be support for such action at Wagait Beach due to the relatively low density living. Residents in rural residential areas of Darwin have relied on personal protection and avoidance.

Aerial control of the large tidal swamps within a few kilometres of Wagait Beach is an option that could be utilised to reduce *Ae. vigilax* pest problems affecting residents. When used in combination with localised ground control of drains and dune depressions, the seasonal *Ae. vigilax* populations would be greatly reduced. Tidal swamps and depressions within at least 2-3km of Wagait Beach township, and possibly up to 5km, would need to be targeted for control. The most effective and environmentally safe insecticides to use would be *Bacillus thuringiensis* var. *israelensis* and methoprene. It would be the requirement of local council/relevant authority to fund and carry out any mosquito control operation. A mosquito control program could also control other problem mosquito species such as *Cx. annulirostris*. However, it is likely that an intensive mosquito control program would not be economically feasible at Wagait Beach, due to the low density living.

The annual maintenance of stormwater drains could reduce *Ae. vigilax* numbers at Wagait Beach to some extent, by ensuring drains are clear of obstructions that could otherwise cause high tide/early wet season ponding and mosquito breeding. Shallow sand filling of the dune depressions could also be carried out, to fill the depressions to above the wet season water table, and thus prevent surface ponding and mosquito breeding from January to March. This could be carried out using local authority machinery, and may be a cost effective solution of reducing the impact of *Ae. vigilax*, particularly during the mid wet to late wet season.

The use of residual barrier insecticides, such as bifenthrin or alpha-cypermethrin, would reduce adult mosquito problems around residences when applied to mosquito harbourage areas (eg shrub vegetation, outdoor shaded areas etc). However, the

insecticide is very toxic to aquatic organisms, and affects other non target insects. Therefore if barrier spraying is to be considered by individual residents or for use at community areas, qualified pest controllers are recommended to apply the insecticide as per label instructions, and treatments should only be carried out occasionally to avoid issues with insecticide resistance and impact on non-target insects.

Personal protection, such as suitable screening on houses, the use of outdoor lanterns, coils and personal repellents, is likely to be the most effective long term measure for residents to reduce exposure to mosquitoes. Further information on personal protection can be found in Attachment 1. Medical Entomology also produces annual pest calendars for *Ae. vigilax* based on tide events, and issues media releases when significant pest mosquito problems are expected, or when there is an elevated risk of mosquito borne disease. These would all apply to Wagait Beach, and therefore can be published in the local paper and printed and displayed on community notice boards, and conveyed by any other means.

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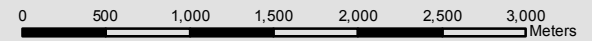
Figures

Figure 1 : Wagait Beach overnight mosquito trapping 14 -15 January 2015



Datum: GCS GDA 94

Absolute scale 1:45,000



Legend ● Adult biting insect trap locations (CO2 baited EVS traps)

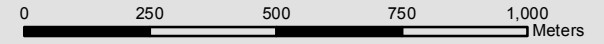
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Figure 2 : Wagait Beach larval mosquito survey 14 January 2015



Datum: GCS GDA 94

Absolute scale 1:15,000



Legend ● Larval mosquito sampling locations

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Data provided by Geoscience Australia
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Tables

Table 1 : Wagait Beach adult mosquito trapping results 15 January 2015

| Date collected | 15-Jan-2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|----------------------------------|--------------|-----------------------------|--------------|---------------------------|--------------|------------------------|--------------|-------------------------------|--------------|---------------------------|--------------|-----------------------------|--------------|--------------------------------|--------------|--------------------------|--------------|-------------------------------|--------------|-------------------------|--------------|--------------------------------|--------------|--------------------------|--------------|--------------------------|--------------|----------------------|--------------------|---|
| Trap location | <i>Ae. (Adm) alboscute/latus</i> | | <i>Ae. (Cha) elchoensis</i> | | <i>Ae. (Fin) britteni</i> | | <i>Ae. (Fin) kochi</i> | | <i>Ae. (Fin) notoscriptus</i> | | <i>Ae. (Mac) tremulus</i> | | <i>Ae. (Mol) pecuniosus</i> | | <i>Ae. (Och) phaeocastatus</i> | | <i>Ae. (Och) vigilax</i> | | <i>Cq. (Coq) xanthogaster</i> | | <i>Cx. (Cui) pullus</i> | | <i>Cx. (Cux) annulirostris</i> | | <i>Cx. (Cux) sitiens</i> | | <i>Ve. (Ver) funerea</i> | | TOTALS | | |
| | No. of females | No. of males | No. of females | No. of males | No. of females | No. of males | No. of females | No. of males | No. of females | No. of males | No. of females | No. of males | No. of females | No. of males | No. of females | No. of males | No. of females | No. of males | No. of females | No. of males | No. of females | No. of males | No. of females | No. of males | No. of females | No. of males | No. of females | No. of males | Total No. of females | Total No. of males | |
| Wagait Beach Site 1- Lot 133 Erickson Cres adjacent to paperback swamp at back of lot | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 312 | 0 | 0 | 0 | 0 | 0 | 28 | 0 | 1 | 0 | 12 | 0 | 369 | 0 |
| Wagait Beach Site 2 - Lot 227 in creekline vegetation at end of Vangemann Rd | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 174 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 1 | 0 | 1 | 0 | 208 | 0 | |
| Wagait Beach Site 3 - east end of De Lissa Rd in monsoon vegetation adjacent to mangrove swamp | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 366 | 0 | 0 | 1 | 3 | 0 | 21 | 0 | 31 | 0 | 37 | 0 | 500 | 1 | |
| Wagait Beach Site 4 - Cox Peninsula Rd approx 5km south along road from Charles Point rd | 0 | 0 | 1 | 5 | 0 | 0 | 5 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 239 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 280 | 7 | | |
| Wagait Beach Site 5 - Charles Point Rd in bush opposite Power Pole 35 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 8 | 2 | 0 | 0 | 0 | 0 | 174 | 0 | 0 | 0 | 0 | 0 | 88 | 0 | 13 | 0 | 0 | 284 | 2 | | |
| TOTALS | 1 | 0 | 1 | 5 | 1 | 0 | 12 | 0 | 69 | 0 | 9 | 4 | 1 | 0 | 1 | 0 | 1265 | 0 | 0 | 1 | 3 | 0 | 182 | 0 | 46 | 0 | 50 | 0 | 1641 | 10 | |

Please note: When "Trap failure mosquitoes" and "Not collected" = "1" in the insect species columns, this means that the corresponding trap site was a trap failure or the trap was not set/collected.

| Table 2 : Summary of larval mosquito survey, Wagait Beach, 14 January 2015. | | | | | | | | | | | | | | | | |
|---|----------------|--|-------------------------------|----------------|----------|-----------------|--------------------|-------------|--------------------|--------------------------------|--------------------|------------|------------|------------|------------|-------|
| Record no | Date collected | Trap Location | Specific conductivity (uS/cm) | Water presence | Breeding | Water area (m2) | Breeding area (m2) | No. of dips | Average no per dip | Species | Total no in sample | 1st instar | 2nd instar | 3rd instar | 4th instar | Pupae |
| LN02670 | 14-Jan-2015 | Lot 133 Erickson Cres, Wagait Beach. Swamp at rear of lot. | N/C | Flooded | FALSE | N/C | 0 | 10 | 0 | <i>Nil mosquitoes</i> | 0 | 0 | 0 | 0 | 0 | 0 |
| LN02671 | 14-Jan-2015 | Lot 227 Vangemann St, Wagait Beach. E edge of swamp on lot. | N/C | Flooded | FALSE | N/C | 0 | 10 | 0 | <i>Nil mosquitoes</i> | 0 | 0 | 0 | 0 | 0 | 0 |
| LN02674 | 14-Jan-2015 | Lot 3 Cox Drive, Wagait Beach. Swamp on N boundry. | N/C | Pooling | FALSE | N/C | 0 | 15 | 0 | <i>Nil mosquitoes</i> | 0 | 0 | 0 | 0 | 0 | 0 |
| LN02673 | 14-Jan-2015 | Lot 76 Cox Drive, Cox Country Club, Wagait Beach. Swamp NE corner. | N/C | Flowing | FALSE | N/C | 0 | 6 | 0 | <i>Nil mosquitoes</i> | 0 | 0 | 0 | 0 | 0 | 0 |
| LN02675 | 14-Jan-2015 | NE of lot 10 De Lissa Drive, Wagait Beach. Interdunal beachfront. | N/C | Pooling | TRUE | N/C | 5 | 2 | 50 | <i>Ae. (Och) vigilax</i> | 15 | 0 | 0 | 0 | 15 | 0 |
| LN02676 | 14-Jan-2015 | NE of lot 8 De Lissa Drive, Wagait Beach. Interdunal beachfront. | N/C | Pooling | TRUE | N/C | 40 | 1 | 100 | <i>Cx. (Cux) annulirostris</i> | 3 | 1 | 2 | 0 | 0 | 0 |
| LN02676 | 14-Jan-2015 | NE of lot 8 De Lissa Drive, Wagait Beach. Interdunal beachfront. | N/C | Pooling | TRUE | N/C | 40 | 1 | 100 | <i>Cx. (Cux) sitiens</i> | 16 | 16 | 0 | 0 | 0 | 0 |
| LN02672 | 14-Jan-2015 | NW corner of Wagait township, interdunal area on beach front. | N/C | Pooling | TRUE | N/C | N/C | 10 | 4 | <i>Ae. (Och) vigilax</i> | 16 | 0 | 0 | 1 | 5 | 10 |

**Attachment 1 – Personal protection from mosquitoes
and biting midges in the Northern Territory.**



Personal protection from mosquitoes & biting midges in the NT

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25 October 2011.

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Personal protection from mosquitoes & biting midges in the NT

1 MOSQUITOES AND BITING MIDGE BITES

Mosquitoes and biting midges (genus *Culicoides* and sometimes erroneously called sand flies) can reach sufficient numbers in various localities to be considered serious pests. The bites themselves can be painful and extremely annoying, and people suffer varying degrees of reaction to bites (Lee 1975). However the possibility of the spread of various diseases by their blood sucking habits to either humans or animals is a more serious outcome. Mosquitoes can carry viruses such as Murray Valley encephalitis, Kunjin, Ross River, and Barmah Forest virus, which cause human disease (Russell 1995). Biting midges do not carry any pathogens in Australia that cause human disease.

Female mosquitoes or biting midges bite to take blood from their hosts, which is necessary for the development of eggs.

Mosquitoes and biting midges show considerable variation in their preference for hosts. Some species feed selectively on cattle, horses, marsupials, amphibians, birds or humans, while other species are relatively indiscriminate feeders.

The time of feeding varies for different species. Many mosquitoes feed just after sunset while others are more active at other times including late in the night, in the late afternoon, or in the early morning. Biting midges are most active in the evening and early morning.

The place of feeding by mosquitoes or biting midges is varied. Some species, such as the brown house mosquito, readily enter houses to feed on people, while others will only bite people outdoors.

When a mosquito or biting midge bites, fine stylets sheathed in the proboscis are inserted into small capillaries in the skin. Blood is sucked up through one of the channels in the stylets, while saliva is injected down an adjacent channel. This saliva contains histamine like substances that the human body recognises as foreign and often stimulates a bite reaction. Sometimes the saliva can contain viruses or other pathogens that can cause disease.

Some people can become very sensitive after being bitten and suffer a general reaction from further bites. The bites may itch for days, producing restlessness, loss of sleep and nervous irritation. Scratched bites can lead to secondary infections and result in ugly scars. On the other hand, some people become tolerant to particular species and suffer little after-effects from repeated bites.

Biting insects create problems in the enjoyment of outdoor activities, causing a reluctance to enter certain areas after sundown or forcing people to be confined to insect-proof areas at certain times of the year. Personal protection and avoidance measures can offer considerable protection from bites, as well as offering protection against mosquito-borne disease.

2 MOSQUITO & BITING MIDGE AVOIDANCE

A sensible precaution to prevent biting insect attack is to avoid areas that are known to have high biting insect activity.

The upper high tide areas near creeks or low-lying areas, particularly near salt marsh habitats, can be significant sources of northern salt marsh mosquitoes *Aedes vigilax* and various other pest mosquitoes. The period of high salt marsh mosquito activity is usually during the late dry season and early wet season in tropical latitudes. Generally they are prevalent for one to two weeks after the highest tides of the month or appreciable rain. Salt marsh mosquito and midge pest calendars are available from the health website http://www.health.nt.gov.au/Medical_Entomology/index.aspx

Dense vegetation near the breeding sites should be avoided during the day over this period. Pest problems during the evening and night can occur within 3 km of productive breeding sites (Whelan et al., 1997).

Other areas of high mosquito activity are the large seasonally flooded areas associated with rivers or drainage lines, flooded coastal swamps, extensive reed swamps and lagoons, ill defined or poorly draining creeks, extensive irrigation areas, and wastewater disposal facilities. Densely shaded areas near these habitats should be avoided during the day, and accommodation areas should be at least 3 km from extensive areas of these habitats.

Extensive areas of mangroves with small dendritic creeks or estuarine areas with muddy banks are potential sources of mangrove biting midges. These midges have seasonal and monthly population peaks with the monthly peaks usually associated with the tidal regime. When camping or choosing a permanent living site, a separation distance of at least 2 km from these areas is recommended unless specific biting insect investigations indicate there are no seasonal pest problems (Whelan 1990, Whelan et al., 1997).

If camping or selecting house sites near creeks, rivers or lagoons, choose localities of the water body which have steep margins or little marginal emergent vegetation, have swiftly running water with little marginal pooling or vegetation, or do not arise from or empty into a nearby swamp area. Exposed beaches or cliffs away from mangrove or estuary areas are preferred sites to avoid both mosquitoes and biting midges. In more inland areas, locations on hills or rises at least 3 km from ill defined drainage lines, poorly flowing creeks and seasonally flooded areas should avoid the worst mosquito problems.

In residential areas, a local source of mosquitoes may be the cause of the problem. Check nearby potential artificial sources of mosquitoes such as disused swimming pools, receptacles such as tyres, drums, fallen palm fronds, pot plant drip trays, plant striking buckets, animal water, garden equipment, plastic sheeting, blocked roof gutters, old fishponds, or localised ponding of drains. Sites with mosquitoes breeding can be rectified by physically removing the source or through the use of insecticides. Fish ponds or ponds used for frogs can be rectified by the addition of a few fish.

3 SCREENING

The best method of avoiding attack at night is to stay inside insect-screened houses. Screens can be made of galvanised iron, copper, bronze, aluminium or plastic. Near the coast, iron or copper screens are not recommended because of the corrosive action of salt sprays. Homes near biting midge breeding sites require either fine mesh screens or lightproof curtains.

Screens should be of the correct mesh, fit tightly and be in good repair. Biting insects frequently follow people into buildings and for this reason, screen doors should open outward and have automatic closing devices. Insecticides such as permethrin, deltamethrin, bifenthrin, or alpha-cypermethrin sprayed on or around screens may give added protection against mosquitoes or biting midges, but care is needed as some insecticides affect screens.

It is advisable to use an insect proof tent when camping near potential biting insect areas. Coastal areas subject to attack by biting midges require tents to be fitted with a finer mesh screening. Tents can be made more mosquito effective by spraying them inside and out with bifenthrin or alpha-cypermethrin.

4 MOSQUITO NETS

Mosquito nets are useful in temporary camps or in unscreened houses near biting insect breeding areas. Generally standard mosquito nets are not sufficient to prevent biting midge attack. White netting is best as mosquitoes accidentally admitted into the net are easily seen and killed. The net is suspended over the bed and tucked under the mattress. An aerosol pyrethrin spray can be used to kill mosquitoes that enter the net. Care is needed not to leave exposed parts of the body in contact with the net, as mosquitoes will bite through the net. Nets can be made more effective by dipping impregnation with permethrin (Lines et al. 1985) or by spraying them inside and out with bifenthrin, lambda-cyhalothrin or alpha-cypermethrin.

5 INSECT PROOF CLOTHING

Head nets, gloves and boots can protect parts of the body, which are not covered by other clothing. Head nets with 1-1.5 meshes to the centimetre are recommended for good visibility and comfort, and additional treatment of the net with a repellent will discourage insect attack. Thick clothing or tightly woven material offers protection against bites. Light coloured, loose fitting long sleeved shirts and full-length trousers are recommended. Dark clothing such as dark blue denim or black clothing is much more attractive to salt marsh mosquitoes than white clothing. Many mosquitoes including salt marsh mosquitoes or *Anopheles bancroftii* will bite through tight fitting shirts or pants. For particular risk areas or occupations, protective clothing can be impregnated with permethrin or other synthetic pyrethroid insecticides such as bifenthrin to give added protection (Burgess et al. 1988). Some work wear clothing outlets and camping stores stock a range of clothing that has been impregnated with permethrin insecticide during manufacture. Sleeves and collars should be kept buttoned and trousers tucked in socks during biting insect risk periods. Protection is very necessary near areas of salt marsh, mangroves, or large fresh water swamps where the various species of mosquitoes may be very abundant during the day in shaded situations, as well as at night.

6 REPELLENTS

Relief from biting insect attack may be obtained by applying repellents to the skin and clothing (Schreck et al. 1984). Many repellents affect plastics and care is needed when applying them near mucous membranes such as the eyes and lips.

Repellents with the chemical diethyl-toluamide (DEET) or picaridin give good protection, with DEET based repellents the best. Many botanical based products do not offer sufficient protection. Some specific repellent products, such as standard Aerogard, which are formulated to repel flies, are generally not efficient against mosquitoes or biting midges. Brands with DEET such as Rid, Tropical Strength Aerogard, Bushman's, and Muskol, or products with picaridin such as Repel include specific products that are effective. Those products with higher amounts of DEET or picaridin are usually the most efficient.

Application of repellents over large areas of the body or on extensive areas of children is not recommended particularly those repellents with concentrations of DEET greater than 20%. Protection from mosquito penetration through open weave or close fitting clothes can be obtained by applying a light application of aerosol repellent to the exterior of clothing. Repellents should be supplementary to protective clothing and should not be regarded as substitutes.

Personal repellents are available as sprays, creams or gels. The gels are best and creams usually last longer than the aerosol formulations. Repellents can prevent bites from 1 to 4 hours, depending on the repellents, the species of biting insect, or the physical activity of the wearer. In general aerosol alcohol based repellents will only give one hour protection in the tropics so reapplication is necessary. Products labelled low irritant generally mean less active ingredient.

Insecticide impregnated mosquito coils offer good protection in relatively wind protected areas, while candle powered mosquito lanterns (Mortein, Raid and Hovex) or gas powered repellent dispensers (ThermaCELL) offer excellent protection in patio or veranda or other outdoor situations in still or very light breeze conditions. Mosquito lanterns and gas powered repellent dispensers utilise allethrin impregnated pads and are cost effective for events such as barbeques or congregations of people, with two or more dispersed around the group to cater for breeze direction. Candle and gas powered devices need to be used with care in the vicinity of flammable liquids and fumes as they include a naked flame. Automatic outdoor aerosol dispensers that release regular short bursts of allethrin and tetramethrin from canisters can be used in similar outdoor situations as for mosquito lanterns, and can be more safely used in the vicinity of flammable liquid storage (such as small boats).

Electronic insect repellents that emit ultrasonic or audible sounds do not offer any protection against mosquitoes or biting midges. They are based on a false premise and have been found to have no repellent effect under scientific testing (Curtis 1986). Electronic ultrasonic repellents do not repel mosquitoes or biting midges and should not be relied upon for personal protection (Mitchell 1992).

Plants with reported insecticidal properties such as neem trees and the citrus plant have not been shown to act as mosquito repellents just by growing in the vicinity of people (Mitchell 1992, Matsuda et al. 1996). Growing or positioning these plants near evening activity areas will not prevent mosquito attack. However some plants have some repellency effects as smoke or liniments (see section 12, emergency biting insect protection)

7 ANIMAL DIVERSION

Camping upwind near congregations of stock or domestic animals will serve to divert mosquitoes or biting midges to alternative hosts. Similar considerations can be made when planning residential sites and animal holding areas in a rural situation. Dogs of darker colour tend to attract some species of mosquitoes more than lighter colours and can divert some pest problems from people in close vicinity in outdoor situations in the evening.

8 LIGHTING DIVERSION

Many mosquito and biting midge species are attracted to white light. This can cause pest problems in unscreened houses or when camping. The use of yellow or even better red incandescent bulbs or fluorescent tubes rather than white light will reduce the attractiveness of lights to insects. An incandescent or ultra violet light placed at a distance from a house or camp can serve to attract insects to an alternative area. This is more effective if the light is close to the breeding site, or between the breeding site and the accommodation area. The attractive lights should not be close to accommodation or directly down wind of accommodation areas. Light proof curtains or similar screening can be very effective in reducing the attraction of biting insects to areas that are illuminated at night.

9 ADULT INSECT CONTROL

If mosquitoes or biting midges have entered a screened area or house or premises they can be knocked down with hand held pyrethrin aerosols. Care should be taken by reading the label to ensure only knockdown aerosols suitable for spraying in the air are used in proximity to people or food.

Automatic aerosol dispensers for repelling and/or killing adult mosquitoes or flies are available in both outdoor and indoor models. These generally dispense pyrethroid insecticide aerosol in short bursts every 20 to 40 seconds and can last up to 40 hours before refilling. Outdoors devices need to be in wind protected areas such as verandas and patios.

Other devices that can be effective at repelling and/or killing biting insects include mosquito lanterns and gas powered repellent dispensers (Collier 2006), mosquito coils (Charlwood & Jolley 1984) and electric plug-in insecticide pads. The plug-in pad devices are very effective inside buildings but care is needed in reading the labels. These devices are only effective in relatively protected or closed areas such as patios, inside buildings or where there are only slight breezes. Use of coils and other mosquito repellent devices in outdoor or unscreened areas should be backed up with other measures such as suitable protective clothing or repellents.

Large scale adult biting insect control can be achieved for short terms (hours) by using portable or industrial fog generators, backpack misters, or heavy duty ultra-low-volume aerosol generators to knock down active adult insects. The insecticides of choice in these machines are maldison, bioresmethrin or pyrethrum. Control relies on good access, open vegetation, and light breezes in the direction of the breeding or harbouring sites. Application should only be during the peak biting insect activity period of those insects actually causing the problem, which is usually the late evening and early night.

There are some synthetic pyrethroid aerosol products available as outdoor yard or patio repellents. Control may only be temporary (hours) and re-invasion will usually occur within hours or from one to a few days, depending on the species, nearby vegetation, proximity to breeding sites, environmental conditions and times of activity of the pest species.

Application of the older residual insecticides such as malathion, or permethrin sprayed as a mist spray to point of run off on building surfaces or nearby vegetation can sometimes give short term (a few days to a few weeks) relief. This method is useful as a barrier protection when large numbers of mosquitoes or biting midges are present near accommodation or outdoor use areas (Helson & Surgeoner 1985).

There are some longer term residual synthetic pyrethroids such as bifenthrin, lambda-cyhalothrin and alpha-cypermethrin that can be used as barrier sprays and provide excellent (up to 6 weeks) protection (Standfast et al 2003, Li et al 2010). These residual insecticides can be applied according to label recommendations with the aid of a garden sprayer for dark coloured walls, fences and solid surfaces on the outside of houses or back pack mechanical misters in a band 1-2 m high on low thick vegetation and shrubbery areas around houses. If there is no vegetation screen, black weed matting or shade cloth 1-2 m high all around fence lines in urban settings can substitute for vegetation as the application surface. Application should be at label rates and made to the point of just before runoff. For vegetation care is needed to apply under leaves as well as on leaves and surfaces. Use of these insecticides can give immediate relief from salt marsh mosquito plagues on a house block scale and the effect should last up to 4 weeks.

Application can be done by householders with appropriate equipment and familiarisation with the chemical and provisions and safeguards for use, although generally it is advisable for applications to be done by a licensed pesticide company.

Care must be taken with all synthetic pyrethroids around fishponds, fish tanks and other nearby fish habitats to avoid spray drift or run off, as these insecticides are efficient fish poisons.

10 INSECTOCUTORS AND INSECT TRAPS

Electric insect insectocutors and other trap or killing devices utilising an attracting light or carbon dioxide have been claimed to clear areas of biting insects and thus protect people. These claims have not been substantiated in outdoor situations with people nearby. While trap devices can attract biting insects, as well as a range of other insects, these devices can not be relied on for protection from biting insect attack (Mitchell 1992). When used in outdoor situations it is possible that they can increase local problems by attracting insects to the vicinity of people. Attractive odours and carbon dioxide emitted by humans then divert the insects from the trap device to the people.

11 TREATMENT OF BITES

Relief from bites and prevention of secondary infection can be obtained by the application of various products, either to the skin or internally. The effectiveness of various products is variable, depending on individual reaction. Skin application products include proprietary products such as Eurax, Stingose, Medicreme, Katers lotion, Dermocaine and Paraderm crème and topical antihistamine products, and non-proprietary products such as paw paw ointment, tea tree oil, eucalyptus oil, aloe vera gel, ice, or methylated spirits.

Ice packs to the general bite site will usually give immediate relief for painful and itchy bites and swelling or blisters from mosquitoes and biting midges in particular. The sooner the ice pack is applied after bites or reactions, the better the relief, and can often avoid more intense reactions. Some people have had good results from the application of paw paw ointment following bite reactions in the reducing the itching and aiding the healing process.

Other products for internal application for more general symptoms include oral antihistamine products such as Phenergan, Telfast and Vallergran. Check with your doctor or pharmacist for any products for the latest product and safety information.

12 EMERGENCY BITING INSECT PROTECTION

There are a number of emergency measures that can be taken when exposed to biting insects with no protection. Sheltering downwind next to smoky fires can offer considerable protection. Burning dung or aromatic and oil producing foliage from plants such as *Hyptis* (horehound), *Vitex* (black plum), *Calytrix* (Turkey bush), *Melaleuca* species (Paper bark) and *Eucalyptus* species (gum trees) can make the smoke more effective. A small native plant *Pterocaulon serrulatum* (warnulpu) has sticky strongly aromatic leaves, and branches are burnt or the moist leaves are rubbed on the skin by Aborigines in the Katherine district to repel mosquitoes (Aborigines of the NT 1988). Climbing relatively high trees or choosing locations exposed to the wind can also offer protection from some species.

Some protection can be obtained by rubbing exposed skin areas with the leaves of certain plants such as eucalypts, turkey bush, warnulpu, paperbarks or tea-trees that contain volatile oils. However these are not as efficient as proprietary repellents containing DEET or picaridin. Other emergency protection measures include coating the skin with mud, or burying yourself in shallow sand with some form of head protection. If all else fails, keep running. The best form of protection and the most comfortable require an awareness of the potential problems and adequate preparation.

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