Techniques employed during the Aedes *Aegypti* eradication program in Tennant Creek

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Overview

This is an overview of what we'll be talking about today. First, a bit about Tennant Creek and this history of *Ae. aegypti* incursions. Then a bit about the eradication program and the methods that were undertaken to remove the breeding populations from the Tennant Creek area. This will be an overview of more of the practical things in the eradication program and the ongoing work that is being undertaken to monitor the populations and ensure that any populations that establish are found as soon as possible.

Tennant Creek

Tennant Creek is a small town about 4.5 hours north of Alice Springs along the Stuart Highway, and about a 10 minute drive south of the Barkly Highway which leads straight into Queensland. Being on a three-way junction, Tennant Creek gets a lot of traffic coming from all directions.

Tennant Creek is the largest town centre in the Barkly, and Barkly is the second largest local government area in Australia. Our population in town is approximately 3,600, with the rest of the Barkly population living in remote areas. The area of the Barkly region is about 322,000 km^2, which is 42% larger than Victoria and translates to about 39 km^2 per person.

Almost two-thirds of the Barkly population are Indigenous; within the town area, we have seven town camps (Karguru, Tingkarli, Wuppa, Marla Marla, Village Camp, Munji-Marla, and Ngalpa Ngalpa), which originally were the campsites for the numerous language groups of the Barkly region when they came into town. Some of the language groups are Warumungu, Warlmanpa, Warlpiri, Jingili, Garawa, Mudburra, Kaytetye, Alyawarr and Anmatyerre. Barkly has seven remote communities and 70 family outstations. The town of Tennant Creek resides in the Warumungu nation, whose borders go as far north as Renner Springs, and as far south as the Devils Marbles. Bit of trivia: the Warramunga people have a battle ship named after them.

Before 1950

From the 1950s, there hasn't been an endemic population of the dengue mosquito in the NT. *Ae. aegypti* seemed to die out before the 1950s. No one can really say why this may have happened; however, there are several things that may have had an impact:

- Removal of the railway
- Reticulation of town water supplies
- Removal of septics
- Removal of rainwater tanks

It is also interesting to note that the NT is one of the few tropical jurisdictions in the world that are dengue mosquito free.

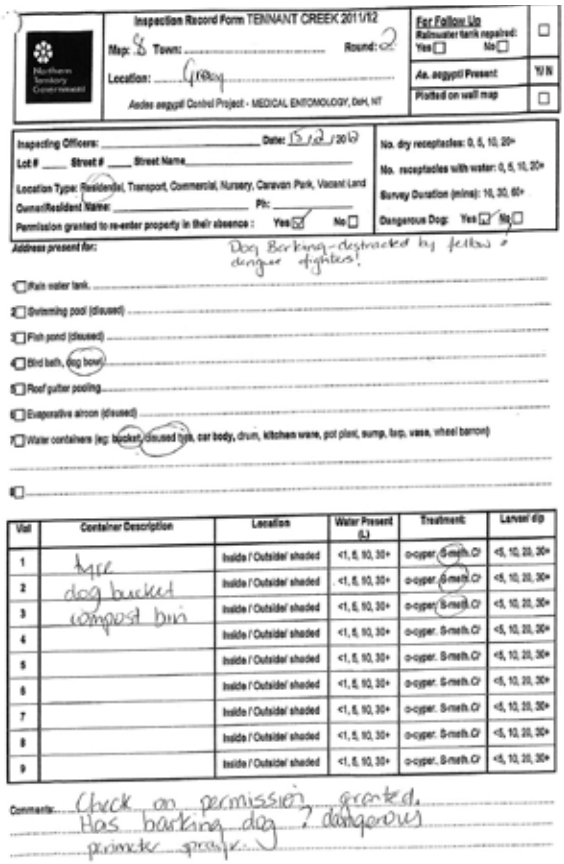
Surveys

Surveys and trapping for exotic mosquitoes have been taking place regularly since 1975.

Incursions

In 2004, *Ae. aegypti* was found in Tennant Creek, and a program was instigated to eradicate this mosquito over the next two years.The one that we'll be talking about today is the eradication program of 2011. A larva was initially found in an ovitrap, which is used as part of the routine surveillance. What happened over the next two years, and since, is what we'll be talking about today.

When conducting an inspection on a property, both treatment and data collection are done simultaneously. Each inspection team is equipped with GPS to record the lot number of a property and a survey form is completed, as follows:


Inspection Record Form TENNANT CREEK 2011/12

Aedes aegypti Control Project - MEDICAL ENTOMOLOGY, DoH, NT

Map: 8 Town: Round: 2

Location: Gray

For Follow Up

Ae. aegypti Present: Y/N

Plotted on wall map

Inspecting Officers: Date: 15/12/2012

Lot # Street # Street Name

Location Type: Residential, Transport, Commercial, Nursery, Caravan Park, Vacant Land

Owner/Resident Name: Ph:

Permission granted to re-enter property in their absence : Yes No

No. dry receptacles: 0, 5, 10, 20+

No. receptacles with water: 0, 5, 10, 20+

Survey Duration (mins): 10, 30, 60+

Dangerous Dog: Yes No

Address present for:

Dog Barking-distracted by fellas a dengue fighters!

Rain water tank

Swimming pool (disused)

Fish pond (disused)

Bird bath, dog bowl

Roof gutter pooling

Evaporative aircon (disused)

Water containers (eg: bucket, disused tyre, car body, drum, kitchen ware, pot plant, sump, tarp, vase, wheel barrow)

Visit	Container Description	Location	Water Present (L)	Treatment	Larvae/ dip
1	tyre	Inside / Outside/ shaded	<1, 5, 10, 30+	a-cyper, S-meth.Cl	<5, 10, 20, 30+
2	dog bucket	Inside / Outside/ shaded	<1, 5, 10, 30+	a-cyper, S-meth.Cl	<5, 10, 20, 30+
3	compost bin	Inside / Outside/ shaded	<1, 5, 10, 30+	a-cyper, S-meth.Cl	<5, 10, 20, 30+
4		Inside / Outside/ shaded	<1, 5, 10, 30+	a-cyper, S-meth.Cl	<5, 10, 20, 30+
5		Inside / Outside/ shaded	<1, 5, 10, 30+	a-cyper, S-meth.Cl	<5, 10, 20, 30+
6		Inside / Outside/ shaded	<1, 5, 10, 30+	a-cyper, S-meth.Cl	<5, 10, 20, 30+
7		Inside / Outside/ shaded	<1, 5, 10, 30+	a-cyper, S-meth.Cl	<5, 10, 20, 30+
8		Inside / Outside/ shaded	<1, 5, 10, 30+	a-cyper, S-meth.Cl	<5, 10, 20, 30+
9		Inside / Outside/ shaded	<1, 5, 10, 30+	a-cyper, S-meth.Cl	<5, 10, 20, 30+

Comments: Check on permission, granted. Has barking dog, dangerous private property.

Figure 1. Inspection Form

Property details: name and phone number of property owner/ tenant. What kind of property/is it a vacant lot, residential, industrial? Is there a dangerous dog? Permission for re-entry granted? Has the property owner given permission for technical officers to gain entry in any follow-up rounds?

Water tank: is there a rain water tank on the property and has it been sealed or does it need to be sealed?

Receptacles: approximate number of wet and dry receptacles in the property.

Survey duration: how long did it take to conduct the survey? When it's near the end of the day and you have time for a short inspection, you want to choose a property that would take 10 minutes, not 30.

List of receptacles: all receptacles, swimming pools, evaporative air cons, birdbaths, and fish ponds on the property, both wet and dry, are recorded. This helps with the data collection to indicate which type of receptacles are more prone to breeding. Also what to expect on a property; sometimes containers and wheelbarrows get moved around and you might otherwise miss it on a follow-up inspection without a list to remind you. Roof gutters are an easy one to miss without a list to remind you.

Larvae: for any larvae that are found on the property, data that is recorded is a description of the receptacle they were found in, and whether the breeding site was indoors or outdoors. Was the receptacle shaded or non-shaded? What water levels;

approximately how many litres? Treatment: how did you treat the breeding site - I.e. pellets, or spray? How many larvae per dip(10, 20, 30)?

The majority of larvae were found during the first round in containers (shell baths, plastic containers, bins, eskies, etc) and ornaments (bird baths, plant pots). The larvae were found throughout the town. Being a container breeder, it breeds in small amounts of water and these containers can typically be found in backyards, whether the containers are garden ornaments, dog bowls, baths, pools, rubbish or any number of other types of container.

Figure 2. Dipper

Figure 2 shows the kind of dipper that was generally used. It's like a soup ladle on a stick. Please note that this photograph is not *Ae. aegypti* but a sample from the local sewage ponds. These ones shown are most likely *Cx. annulirostris*.

Trapping and monitoring

The mosquito traps are a vital tool for the monitoring of vector carrying insects and pinpointing possible breeding sites.

Having traps spread out in evenly spaced intervals throughout the town, helps to give a wide reading, and indicate which properties to focus on.

Carbon dioxide EVS; The EVS traps are primarily used for monitoring the sewage ponds, with water all year round, and all sewage pipes leading to the one area. The sewage ponds are a great spot for a complete overview of the town. The trap consists of a billy can, PVC pipe, a fan (powered by D-sized batteries), and a catch container. It is used with either dry-ice or a CO_2 bottle.

Figure 3. EVS Trap

BG Sentinel: This is one of the better all-round mosquito traps. Designed to mimic convection currents created by the human body, it also employs visual cues that attract mosquitoes that breed in receptacles and tree hollows (white cover and black cone, meant to replicate dark holes and receptacles). The fan which holds the mosquitoes in the catch container is either powered by a 12 volt battery or connected directly into a power supply.

Figure 4. Sentinel Trap

Figure 5. Lethal Fly Trap

Lethal trap: These are usually set in a fixed position. A bunch of rimless car tyres are chained together to a tree and filled with water to attract breeding adults, but they are all chemically treated with surface spray and pellet's which regulate the larval growth.

Any present samples are taken for identification and the water levels are replenished and sprayed again with surface/knockdown spray.

Figure 6. Ovitrap

Ovitraps, also known as egg traps are designed to attract container breeding mosquitoes. This is pretty much a jar filled with water and an object in it for adults to lay their eggs along.

Sample preparation

Larvae samples are collected and then prepared for identification by removing the water and placing the sample in 70% ethanol. Once the larvae have stopped wriggling, they it can easily be moved to see the features of the larvae.

Adults are collected through traps. The catch containers are then placed in a freezer to kill them prior to identification.

Identification method

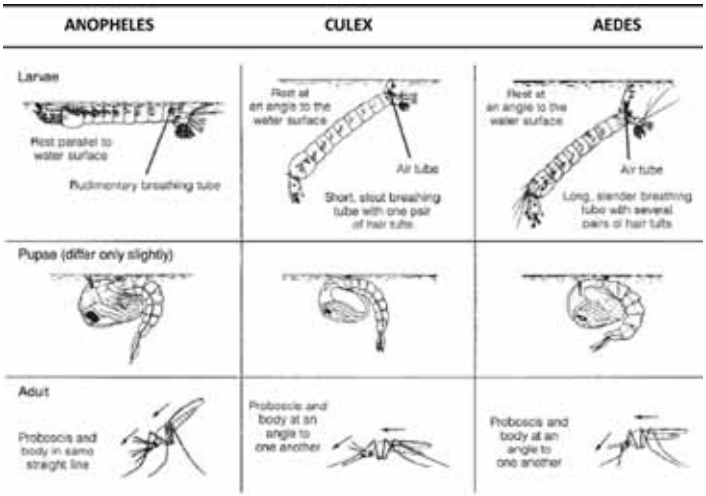


Figure 7. Identification of Genus Table

Genus identification can be done immediately by an experienced technical officer through the general look of the larvae or how the larvae sits in the water, while species identification is generally done through the use of a dissection microscope. Of course, it must be said that under a microscope is the best way to identify the species, and all samples were checked under a microscope to ensure the identification was correct.

Reasons for identification

By identifying certain species in certain areas, it can benefit the program. For example, if a certain type of mosquito is located in a specific area, then the further investigation can be targeted searching for breeding sites or locations where adults are harbouring to ensure that the treatment can be provided to best effect.

Identifying features

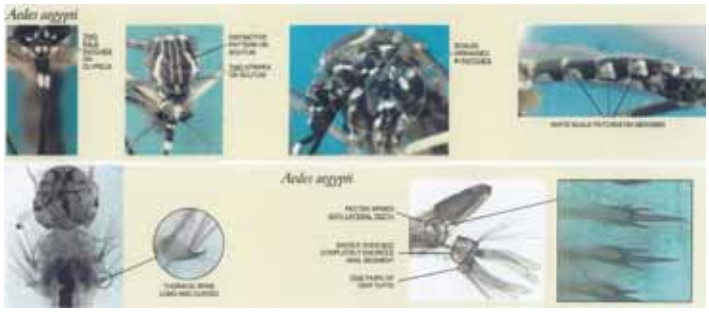


Figure 8. Aedes aegypti Identification Table

The species in question, *Ae. aegypti,* has several identifying features that assist in its identification under the microscope. For the larva, the hair tufts and pecten spines are looked at, as well as the throacic spine. For adults, you look for the lyre pattern on the thorax as well as patches on the abdomen.

Using a key

A key can also be used to find out what mosquito it is. The key can cover all the types of mosquitoes in an area. Using the key, you look at features which the particular mosquito has. Slowly you rule some out and others in. At the end of the key, if followed correctly, it will show you the type of mosquito that you have in front of you. While keys were used, an experienced person was always available to assist with or check the identification.

Damage and storage of specimens

Ensuring the specimen being identified is not damaged and in good condition can assist greatly with the identification. If some scales are missing or part of the sample is damaged, then a misidentification may occur. Therefore, it is important to ensure that samples are adequately looked after and protected. Generally this is done with the adults by providing padding in the container, such as a tissue. It's surprising how fragile samples can be.

Tipping out water

Overall, the physical treatments were the ones that were most used. Habitat modification is generally the most effective way to prevent mosquito breeding. This includes removing areas where mosquitoes can breed. For the dengue mosquito, as it is a container breeder, this included the removal of items that can hold water - such as tarpaulins, buckets, frying pans, tyres and any other water-holding containers from yards. Assistance was also provided in some cases to remove rubbish and other items from yards in order to cut down on possible breeding sites.

Educating home owners

There was also a lot of discussion with community members and home owners. We spoke with them regarding how they could remove potential breeding areas from their yards, workplaces and other areas. Once you started to speak to the home owners about why you were there, they were generally happy to get involved. By the end of the program, there was a good amount of knowledge throughout the community across all levels regarding mosquito breeding and prevention. People knew the 'Mozzie Mob' and knew what we were doing. They would come up to us and talk about what they were doing to stop mozzie breeding in their yards.

There were several different chemicals used throughout the eradication program. Each one used was dependent on many factors.

Bestox

The main chemical that was used was Bestox. Bestox is also good at killing pests such as cockroaches, flies and spiders, and of course mosquitoes on contact, so households were also getting a pest treatment around their house.

The active ingredient in this, alpha-cypermethrin, is highly toxic to fish and other aquatic life. Therefore, we had to ensure that this chemical was not sprayed anywhere near fish tanks, ponds or any other area or pet that may potentially assist in the spread of this chemical. In these areas, other chemicals or treatments were used. If the water could be removed, then this was always the preferred option, along with habitat modification (such as turning over the container so that it couldn't collect water).

Egg killing

Bleach with detergent were used to clean out dog bowls, shell baths or other items that are used for pets or wildlife. This killed any mosquito eggs that were present so when it was filled up with water again, any eggs present would not hatch.

Methoprene

Methoprene was used in areas such as ponds, bird baths, plant pots and other areas that may come into contact with wildlife. Methoprene has been shown to be safe to use around birds, reptiles and other animals, and even humans where it was also used in rainwater tanks. Methoprene is a growth regulator that can stop the larvae becoming adults. Using methoprene pellets or briquettes also provided a residual effect meaning the product would keep having an effect on any mosquito larvae for up to a month with the pellets and three months using the briquettes.

Aquatain

The water surface treatment was used in areas such as disused swimming pools. This disrupts the surface tension of the water and does not allow the larvae to put their breathing siphons through to the air outside. This can be quite effective for treating larger areas.

With treatment and community education, the mosquito numbers, especially *Ae. aegypti*, started to decrease significantly.

Steps to eradication

Figure 9. Positive Identifications in Town

These images of the town show how the numbers of positive properties for *Ae. aegypti* larvae decreased.

The initial survey of Tennant Creek from 23 to 26 November 2011 found *Ae. aegypti* infestation to be widespread, with approximately 160 premises positive. The intensive control program commenced in early December 2011 to mid-March 2012, utilising existing Department of Health staff and some volunteers. There were two rounds of survey and insecticide treatment in 13 weeks of visits.

As shown after the first round the number of premises where *Ae. aegypti* larvae were found decreased. By the third round, only one location was positive for *Ae. aegypti* larvae. After the first treatment, the populations were shown to be significantly reduced, with a marked decrease until only irregular samples were found.

The eradication treatments were done over a two-year period. It needed to go across a second wet season to make sure there were no dormant eggs hatching.

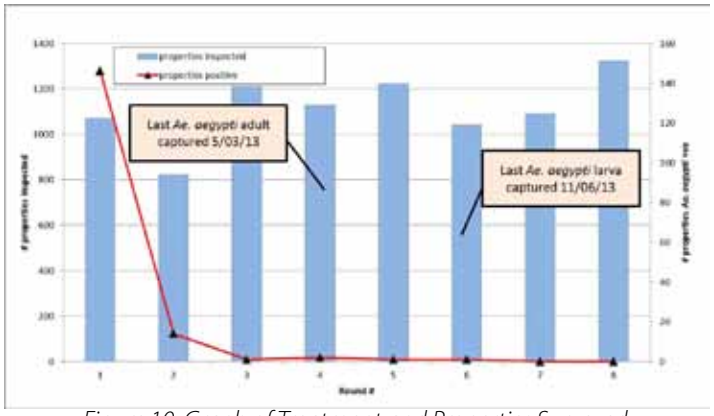


Figure 10. Graph of Treatment and Properties Surveyed

After the first two rounds of treatment, the numbers of *Ae. aegypti* dropped dramatically until it was only one or two premises with larvae detected. The last *Ae. aegypti* larva was found in round 6 and in rounds 7 and 8 no properties were found positive with *Ae. aegypti* larvae.

Weekly monitoring

Weekly monitoring of the mosquito populations in Tennant Creek is conducted using ovitraps, BG traps and EVS traps. The various locations cover from the south to the north and bits in-between.

Yearly survey

Once a year, a property survey is conducted on the ground, with officers visually inspecting and sampling the mosquitoes that are found in the town, with the assistance of both home and business owners for access to their properties. The collected samples are then identified to determine the types of mosquitoes that are in the town.

Positive working relationship

Ensuring a positive relationship with the community is essential in getting their support to carry out this kind of program. Every business, home, park and other place in the town was inspected and treated. Yearly surveys are also conducted to ensure that there are no further incursions of exotic mosquitoes.

This type of program could not have been successful without buy-in from the community of Tennant Creek. Through the adverts in the local papers, posters and information provided, as well as the staff themselves and their interaction with the community, the program was able to present a friendly and dedicated service to the town. The Barkly Regional Council, Power and Water and other stakeholders were involved with improving some of the infrastructure around the town to remove mosquito breeding areas, such as around properties that have many outside storage containers, the town's drains and sewage ponds.

Since that initial program, each year exotic mosquito surveys have been conducted throughout the town, and people still remember the Mozzie Mob. In speaking to those in the town, many still understand how to stop mozzies breeding in their backyard. Continuing that relationship with the community is an important way to keep mosquitos on the agenda and ensure that people are aware of where they breed and how to stop them.

With ongoing surveillance now taking place, and looking back at the program, what can be concluded from this program?

First of all, *Ae. aegypti* was successfully eradicated from Tennant Creek. This was done through targeted insecticide treatment

combined with habitat modifications. Therefore, the current NT surveillance program for exotic *Aedes* sp. can be seen as effective in detecting introductions.

Finally, during an elimination program, every property needs to be deliberately and systematically targeted for larval survey and insecticide treatment in every round of inspection. Here, having a positive relationship with the community and other stakeholders is invaluable in ensuring that each property is fully inspected and treated.

For more information

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Glossary

EVS	encephalitis virus surveillance
CO_2	carbon dioxide