Abstract

This article reviews the past establishment of the dengue mosquito Aedes aegypti in the Northern Territory, provides an update on the current elimination program in place in Tennant Creek and explores local and national implications of the incursion.

Key words: dengue; mosquito; eradication

Background

The dengue mosquito Aedes aegypti was present in the Northern Territory (NT) from early settlement up until the 1950’s and was responsible for large outbreaks of dengue fever.1 Dengue, a viral disease of humans, is an appreciable and increasing public health problem in tropical regions, with many thousands of cases and many deaths in countries to the north of Australia.2 Dengue is not endemic in Australia, although the principal vector of this disease, the dengue mosquito Ae. aegypti, is established in north and western Queensland, where importation of the virus in infected travelers from overseas leads to regular outbreaks of dengue disease from Townsville to Cape York.3 Ae. aegypti was previously widely established in the NT where it was recorded from many towns in the northern half of the NT, including Darwin, Pine Creek, Katherine, Mataranka and Larrimah, with the most southern extension at Anthony’s Lagoon and Newcastle Waters and it was never recorded in Tennant Creek.4,5 There was a decrease in distribution after 1946, with a probable absence from Darwin in 19531, but it remained established in some locations until at least 1956.5,6

Figure. Tennant Creek round 1, Week 2 team
Ae. aegypti disappeared in the NT some time between 1956 and 1974, with the date of disappearance unable to be verified as there were very few mosquito surveys in the intervening years. The decline and disappearance is thought to be due to the result of widespread reticulation of water during and soon after World War 2 and the coincidental removal of rainwater tanks.1,4,6

Medical Entomology (ME) of the NT Department Health (DoH) has a surveillance program to detect the possible importation or establishment of exotic mosquitoes in the NT, particularly the Aedes vectors of dengue.7 In 1974 regular mosquito larval surveys, human biting collections, and light trapping were started in Darwin by ME. These surveys and collections were extended and intensified over the following years to include ovi-traps (special egg traps) around overseas arrival seaports and airports, regular CO2 baited light-trapping (EVS traps) in principal towns and widespread larval surveys of most towns and communities.7 While many exotic mosquito importations were recorded from port areas around Darwin, all these importations were subject to elimination measures and none became established until 2004.8,9,10

In 2004 an incursion of Ae. aegypti was detected in Tennant Creek and although it was well established was subsequently eliminated after an intensive campaign,11,12,13,7,5 DNA analysis of these mosquitoes indicated the incursion was imported from North Queensland, probably as eggs in dry receptacles from Cairns by vehicle transport.14

In October 2006 another incursion and establishment of Ae. aegypti was detected on Groote Eylandt by the ovitrap surveillance method. The subsequent elimination of this species from Groote Eylandt was declared in April 2008.5 It has not been subsequently detected on Groote Eylandt or established elsewhere in the NT.

The NT remains very receptive to receptacle breeding mosquitoes. There are relatively high populations of receptacle breeding species such as Aedes notoscriptus and Aedes tremulus detected by regular adult mosquito trapping in various towns and communities in the NT.15 Ovitrap results from residential and industrial areas in the major towns indicate year round breeding, with seasonal peaks in the wet season.15 Receptacle surveys of various towns and communities indicate a relatively high number of receptacles per property that can breed endemic mosquitoes.15

The recent detection

The dengue mosquito was discovered again in Tennant Creek in 2011. It was first detected in an ovitrap. A preliminary larval and adult survey in late October 2011 followed early wet season rains and found the mosquito widely established in the town. It was possibly imported from north Queensland as adults in vehicles such as coach buses, or in receptacles as drought resistant eggs. Specimens have been sent for DNA analysis to see if a possible origin can be determined.

The elimination program

ME started a coordinated and intensive program to eliminate this incursion as soon as it was clear an establishment was present. The program plan includes a media program to encourage public cooperation and a property by property survey and treatment of all receptacles. The proposed 18-month program will involve 2 components, with 1 centered on Tennant Creek town, with the other focused on nearby towns and communities to determine if this mosquito has spread.

The program in Tennant Creek will involve both dry and wet season property by property larval surveys, and applying the pyrethroid residual insecticide alpha-cypermethrin, liquid chlorine or pellets of a mosquito hormone insecticide, methoprene, to all appropriate receptacles in all 1100 odd properties. Additionally a barrier spray of alpha–cypermethrin will be applied to appropriate areas around premises to provide residual control of adult mosquitoes. Piles of internally sprayed tyres with water and pellets of methoprene have been established near the transport hubs of all bus and road transport companies to lure, trap and kill any adults about to harbour or lay eggs. Other treatments will concentrate on roadside drains and rehabilitation of the municipal dump in cooperation with the local Barkly Shire council. Elimination will rely on treatment of all receptacles capable of holding water and clean up programs with the
residents and the local Shire participation. Surveys will need to be negative for a complete wet season after the last detection for elimination to be declared successful.

The cycle of survey and treatment of all properties will need to be repeated every 6 to 8 weeks in the wet season, with some relaxation of inspections in Tennant Creek over the dry season from May to November. A team of at least 6 new full time staff will be required to do the surveys and treatments, adult trapping, larval and adult identifications, data recording, organisation, logistics, project management, field supervision, analysis, communications, rectifications, procurement and other town and community surveys and treatments. Project staff will be supported by ME staff. The evaluation of the ongoing progress of the elimination project will be evaluated by larval survey results and adult traps.

**Progress to date**

The initial surveys and treatments have been carried out by ME staff from Darwin, with assistance from Environmental Health staff, other CDC staff and volunteers from DOH and other government organisations. Local based project staff are being recruited. The potential threat of this incursion and the national implications have been highlighted.

The Department is seeking the cooperation of residents to help stop the spread of these mosquitoes. A post office box drop has been carried out to alert residents of the measures they can take to assist the program. The local newspaper has run stories and there have been full-page ads in the paper illustrating potential breeding places and measures that can be taken by residents. Posters have been put up at public points.

The first complete round of property inspections and treatment was started on 23 November 2011 and completed on the week ending 10 February 2012. In this round there were 1070 properties inspected in Tennant Creek, with 146 properties positive for *Ae. aegypti* and 195 receptacles positive, representing 13.6 % properties positive for the mosquito (Table). The number of properties positive for *Ae. aegypti* per week declined from a high of 45 in week 4 to 1 in week 9. The number of positive receptacles declined from 64 in week 4 to 1 in week 9. This is an apparent rapid decline in infestation. However, due to the below average rain in Tennant Creek in January and February, many potential receptacles were dry and this rate of detection represents a probable under estimate of properties initially infested. During some weeks in January after rain, the rate of detection of positive properties was up to 20%. Despite this aspect there was undoubtedly a real and very appreciable reduction in the number of receptacles with larvae and possibly with eggs. By the end of Round 1 a very large majority of the receptacles in Tennant Creek had residual insecticide applied to them and will not be able to successfully produce larvae or adult mosquitoes when rain reoccurs.

Dengue mosquito positive receptacles have included tyres, pot plant drip trays, bird baths, drums, frog breeding drums, disused fish ponds, poorly maintained swimming or wading pools and spas, take away meal containers, canoes and boats, sheets of plastic and canvas, old machinery, car bodies, discarded construction materials, animal water receptacles, garden items such as wheel barrows and watering cans, mower catchers, rainwater tanks and buckets used for striking plant cuttings. There have been a few properties where owners have been reluctant for project staff to inspect or treat and a very few where residents have been non cooperative. Each of these problem properties will eventually be required to be inspected to confirm all breeding places have been eliminated. In the last week of Round 1, in the middle of a dry period, there was still 1 receptacle positive in 1 property in the last of the properties to be inspected, illustrating that a single property can continue to supply dengue mosquitoes for nearby properties and thus reinforcing the need for every property to be inspected and free of this mosquito.

Round 2 has now begun, and by the end of week 3 of this round on 24 February, 534 properties had been reinspected and retreated. On day 1 during week 4 of Round 2 starting on 27 February, there were 2 properties detected with *Ae. aegypti* larvae, while all other properties had water in receptacles with no larvae. These positive detections were in receptacles used for pet water, where treatments were non insecticidal, with either chlorine or methoprene pellets applications, which are usually short term
treatments. These detections followed rain the previous week and demonstrates that the program will take a number of rounds to achieve elimination while all the negative receptacles so far in Round 2 demonstrates our treatments to date are generally working very well.

Discussion

The rapid reduction of properties infested is urgently required in order to prevent the spread of this species to other towns in the NT and beyond. If it spreads north, it could become established in Darwin urban and rural properties and other higher rainfall towns, where it would be extremely hard to control or eliminate. This could lead to the re-establishment of dengue endemicity in the NT and periodic outbreaks of dengue.

The elimination of *Ae. aegypti* is a national public health matter and has been recognised as such by the expert committee of the National Arbovirus and Malaria Advisory Committee (NAMAC) advising the Commonwealth Department of Health. The infestation is likely to be the result of the mosquito being transferred from one jurisdiction to another. It also has the potential to spread to other jurisdictions such as Western Australia, where environmental conditions and history suggest spread is likely. This will be a serious threat to NT public health, but also to national public health. It will be extremely detrimental to the Queensland public health effort to control periodic dengue outbreaks, as the interstate spread of dengue cases will open another front in their dengue battle and threaten the current strategy to contain dengue outbreaks from overseas case importations.

Large outbreaks of dengue in northern Australia would have a negative impact on both national and international tourism and workforce mobility, with potentially serious impacts on industry.

The continued widespread occurrence of *Ae. aegypti* in coastal and western Queensland, means that the NT will be continually vulnerable to the transport of this species by vessels or roads to towns and communities not covered by overseas arrival port surveillance. This latest incursion is another reminder of this vulnerability and strengthens the case for a reduction in the footprint of this species in north and western Queensland.

There have been very few reported successful attempts to eradicate established populations of *Ae. aegypti* in any area of the world. One of these was the highly successful, vertically structured paramilitary eradication campaign directed by the Pan American Sanitary Board from 1946 to 1970 which resulted in the elimination of *Ae. aegypti* from a number of countries in South America. However in the years after this elimination there was a relaxation of survey and control and many of these countries have been re-infested and are now facing very large dengue outbreaks.

The progress in achieving near complete coverage of every property in Tennant Creek before further wet season rains is very encouraging. It is probable that the population of this mosquito is quite low in Tennant Creek at present. The current risk of dengue transmission in Tennant Creek is now extremely remote. It would require someone with overseas acquired dengue fever going there and being bitten by one of these mosquitoes. This infected mosquito would then have to live at least 8-12 days to bite another person to transmit the dengue virus. With the amount of residual insecticide barrier spraying in many properties, this survivor now becomes a very low probability. However complete elimination will require many more rounds of property surveys and treatment and then repeated surveys until we can be sure this mosquito has been eliminated.

The NT exotic vector program is an example of one of the very few successful programs in the world able to detect and maintain an *Ae. aegypti* free status in a demonstrated vulnerable and receptive geographic area for over 35 years. The NT program has demonstrated that elimination can be sustained over the long term and is an effective approach.

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Abbreviations

(ME) Medical Entomology Darwin, (NCCTRC) National Critical Care Trauma Response Centre Darwin, (EHO) Environmental Health Officer, (CDC) Centre for Disease Control, (RDH) Royal Darwin Hospital, (VOL) Volunteer.

References

5. Whelan PI, Kulbac M, Bowbridge D, and Krause...
The Australasian Society for Infectious Diseases, with support from the Australian Veterinary Association, is holding a 2 day meeting Friday-Saturday July 27/28 2012. The venue is the Eastern Avenue Complex at the University of Sydney.