Mosquito-borne diseases in the Northern Territory: an historical overview

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The importance of mosquito control for a reduction in mosquito-borne disease is locally and globally valid. The most important mosquito-borne diseases in Australia’s history are malaria, dengue and the endemic arboviruses. These are outlined briefly below.

**Malaria---no longer acquired in Australia**

Malaria, causes substantial morbidity and mortality globally, each year. The World Health Organisation (WHO) estimates that malaria causes over 780 000 deaths and more than 200 million clinical cases annually.\textsuperscript{1} Malaria was historically endemic in Australia. It was eradicated from the Northern Territory (NT) in 1962\textsuperscript{2} and WHO declared Australia “malaria-free” in 1981.\textsuperscript{1} Each year, Australia receives numerous imported cases, with occasional local transmission occurring in far north Queensland\textsuperscript{3,4}; however, due to public health measures and vigilant mosquito control, malaria has failed to re-establish in the NT. The NT and Queensland are however particularly receptive to re-introduction, as many competent vector Anopheline mosquito species breed near urban residential areas above latitude 19° S, suggesting that in the absence of adequate border surveillance and control and/or health regulations, malaria could indeed become endemic in northern Australia once again.\textsuperscript{5}

**Dengue---NT is free of the dengue mosquito**

Dengue virus infection is increasingly recognized as the world's most important emerging tropical disease.\textsuperscript{6} Already it is the leading arboviral infection in the world, causing higher rates of morbidity and mortality than any other mosquito-borne virus. The WHO currently estimates 50 million dengue infections occur worldwide every year, with a further 2 billion people at risk.\textsuperscript{1} Dengue disease reappeared in Australia in north Queensland during 1981-2, after an absence of more than 28 years.\textsuperscript{7} Since then, north Queensland has annually faced cases of people presenting with dengue infection acquired overseas, but leading to outbreaks of local dengue and each year Queensland struggles to prevent dengue from becoming an endemic disease. Presently the primary vector mosquito *Aedes aegypti* exists in Australia only in the state of Queensland (Figure 1), however, another dengue vector *Aedes albopictus*, the Asian tiger mosquito, is considered endemic on Christmas Island and in the Torres Strait.\textsuperscript{8}

**Figure 1, Aedes aegypti range, Australia (Source- Queensland Health)\textsuperscript{9}**
Dengue virus and its primary vector, *Ae. aegypti*, have been endemic in the NT in the past. There are historical records documenting infection in Australian Aborigines\(^{10}\) and documented outbreaks in troops during WWII.\(^{11}\) The eradication process of dengue virus in the NT differed from that of malaria, as the mosquito vector was targeted, rather than the infecting organism. *Aedes aegypti* was eradicated from the NT during the 1950s and 1960s, with the last record of local breeding in 1956\(^{12}\), and by 1969 Darwin was considered *Ae. aegypti* free.\(^ {13}\)

Since eradication, this species has been regularly imported into the NT, as larvae or eggs in water containers on board boats visiting from dengue endemic countries to the north, but it has yet to re-establish. This lack of establishment is largely due to the activities of Medical Entomology (ME), as part of the Centre for Disease Control (CDC), NT Department of Health (DoH), in conducting surveillance and eradication programs. Recent incursions in 2004 into Tennant Creek and 2006 on Groote Eylandt resulted in expensive eradication programs, each continuing for over 2 years.\(^ {14-17}\)

Recently, a lone *Ae. aegypti*, possibly arriving via an airplane flight from a dengue endemic country, is thought to be responsible for a single case of local transmission in Darwin, in August 2010.\(^ {18}\)

To maintain dengue-free status, the NT DoH commits appreciable resources into border control and surveillance of exotic mosquito species.

Murray Valley encephalitis

Murray Valley encephalitis virus (MVEV) is a mosquito-borne arbovirus in the flavivirus family and the human disease is commonly referred to simply as ‘Murray Valley encephalitis’ (MVE). Infection in humans can result in severe disease with symptoms including quadriplegia, and death.\(^ {19, 20}\) From 1974 to 2010, 30 cases have been recorded in the NT and 4 of these were fatal.\(^ {31}\) Waterbirds such as herons and egrets are the most probable vertebrate hosts involved in the MVEV cycle\(^ {22}\), while the implicated vector in the NT is the common banded mosquito *Culex annulirostris* (Skuse)\(^ {22, 23}\), which is abundant after seasonal heavy rainfall. The virus is considered to be enzootic in the Top End of the NT and the Barkly region (including Tennant Creek) and epizootic in the Alice Springs region, where it occurs seasonally after widespread heavy wet season rainfall.

In Alice Springs, high summer rainfall (December – February) and relatively high mosquito vector numbers have been found to be significantly associated with sentinel chicken MVEV seroconversions.\(^ {24}\) Summer rainfall >100 mm and vector numbers of *Cx. annulirostris* >300 per battery operated carbon dioxide baited EVS trap per night can indicate a high risk of MVE disease.\(^ {24}\) The presence of MVEV activity in the Alice Springs region has been associated with monsoonal weather conditions in the north in the NT and northwest in Western Australia, possibly assisting infected bird and wind-blown mosquito dispersal into the region.

Kunjin

Kunjin virus (KUNV), also a flavivirus, is a subtype of West Nile virus found in the Oceania region. The disease it causes has a much lower mortality rate compared to MVE, with initial presenting symptoms similar but usually milder.\(^ {25}\) As with MVEV, KUNV is considered endemic in the Top End, Katherine and Barkly region of the NT and until 2000, KUNV disease had not been recorded in Central Australia.\(^ {26}\) However in 2001, 2 cases of KUNV disease were notified from the Alice Springs urban locality without preceding human cases in known endemic areas.\(^ {26}\) Following a major mosquito control drainage intervention in the Alice Springs area, cases have not occurred in the region. Two further cases were reported from the endemic Top End, 1 in 2009 and the other in 2010.\(^ {27}\) The NT sentinel chicken program conducted by ME, volunteers and the NT Department of Resources investigates KUNV as well as MVEV activity in the major townships around the NT and serves as an early warning system for seasonal risk of both diseases.\(^ {28}\)
Ross River and Barmah Forest

Ross River virus (RRV) and Barmah Forest virus (BFV) are alphaviruses endemic to the Australian mainland, with RRV also endemic in Tasmania and Papua New Guinea (Figure 2). These 2 viruses constitute the majority of arbovirus infections in Australia with the NT reporting the highest incidence of these diseases, with averages for 1995-2010, for BFV 23/100 000 and RRV 109/100 000 population. The main presenting symptoms for these diseases are joint pains, fever and rash; while not life threatening, the symptoms are debilitating enough to be of economic concern, as some people suffer myalgia and fatigue for up to 6 months. Harley et al estimated the cost to Australia of between US$2.0 and US$4.6 million annually. The primary vectors in the NT are the northern salt-marsh mosquito *Aedes vigilax* (Skuse) and the common banded mosquito *Cx. annulirostris*. RRV is thought to be maintained primarily by enzootic cycles between reservoir hosts and the primary vectors. Marsupials are implicated as the most likely RRV reservoir hosts as they provide the best disease amplification, with humans considered poor amplifiers; and usually regarded as dead-end hosts in the cycle.

NT medical entomology (ME) activities

In addition to the surveillance of mosquito-borne virus activity in the NT, the ME unit conducts weekly adult mosquito trapping to monitor mosquito species and their populations; larval surveillance to inform of impending populations and control needs, ovi-trapping for exotic species detection, strategic larval spraying operations throughout the year, and ongoing maintenance of artificial drainage channels. Furthermore, understanding the many facets of mosquito ecology is vital to identifying vulnerable locations and periods in its lifecycle to better target effective mosquito control. There is much to be learned about the various mosquito breeding habitats and habitat dynamics such as flooding and vegetation change, which subsequently relate to fluctuations or trends in mosquito numbers and diversity. Investigating ecological habitats will further elucidate mechanisms to facilitate vector control efforts and therefore reduce potential disease.

Figure 2, RRV and BFV endemic regions
transmission. The ecology and biology of mosquito pest and vector species in the NT continues to be studied by staff at the NT ME unit, with the aim to publish and share this information.

References


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**Centre for Disease Control website**

The Northern Territory Centre for Disease Control (CDC) website has a wide range of useful resources, including: communicable disease information for visitors to the Territory, CDC fact sheets, CDC Protocols, NT Disease Control Bulletin and the NT Sexual Health and Blood Borne Virus Unit Surveillance. The CDC website address is:


**Centre for Disease Control contact details**

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