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Relaxing inside one of the cages of the new Mosquito Research Facility, James Cook University, Cairns. Helen Cook

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Western Gulf of Carpentaria - Exotic Vector Surveillance, April-May 2006

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Introduction

From April - May 2006 the Northern Territory (NT) Medical Entomology unit (ME) and the Australian Quarantine Inspection Service (AQIS), in association with the Royal Australian Navy (RAN) embarked on a quarantine surveillance operation along the western coastline of the Gulf of Carpentaria and the northern NT coast (Fig. 1). The operation was to extend from Mornington Island in Queensland (Qld) to Darwin. However, due to a redeployment of the HMAS Tarakan (Fig. 2a) from the operation to other duties, the survey was limited to the coastline between Mornington Is. and the Wessel Is., NT.

The operational objectives were to:

- Investigate and report on the logistical difficulties encountered during the survey with a view to future operations.
- Establish links with local outstations and communities, and to educate communities on the importance of recognising and reporting a quarantine risk.
- Survey and collect samples (termites, ants, mosquitoes etc.) from any potential landing sites of international foreign fishing vessels (IFFV).
- Engage with local indigenous ranger groups.

Prior to the survey, there had been reports of an increase in the activity of IFFVs in the Gulf region by Coastwatch and local indigenous communities and ranger groups. These reported not only IFFVs coming close to land (Fig. 2b), but the crew landing (Fig. 2c) and bringing material onto shore.

Previously, ME has conducted a number of quarantine surveys along the northern (Kelton and Whelan 1983, Smith and Whelan 1985) and eastern coasts (Kelton 1986, Dobson 1990) of the NT. None of these surveys included Mornington Is. in Qld, or the Sir Edward Pellew Group in the NT. One of the aims of this survey was to establish the susceptibilities and receptiveness of the communities and outstations to an exotic vector incursion.

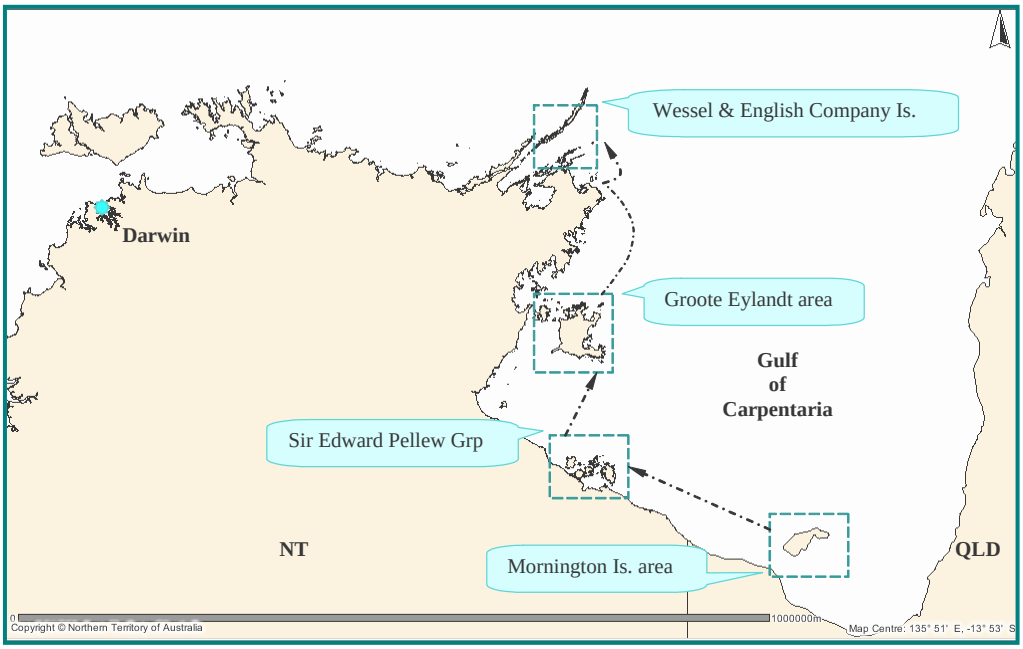

Figure 1: Voyage of HMAS Tarakan, Gulf of Carpentaria, 2006.

In July 2006, an ME internal report (Shortus et al. 2006) briefly outlined the results of an exotic vector survey along the western Gulf of Carpentaria, giving indications that the coastal communities were receptive to an exotic mosquito incursion. The report indicated that the Groote Eylandt area was most vulnerable to an *Ae. aegypti* introduction from IFFVs. Three months later, *Ae. aegypti* was detected in a routine ovitrap collection located at Alyangula Port, Groote Eylandt (Kulbac and Whelan 2007). This article presents the complete results and assessment of the previous survey prior to the exotic detection on Groote, and discusses the implication of the survey for the later detection of *Ae. aegypti* on Groote Eylandt.

Figure 2a: HMAS Tarakan

Methods

Location Selection

Twelve coastal locations were targeted between Mornington Is. and the Wessel Is. from surveillance supplied by Coastwatch, the Australian Defence Forces, Customs, and indigenous ranger groups that indicated IFFV activity and possible shore landings in those areas. The locations visited, including specific communities and outstations, are listed in Table 1 and Figure 1.

Receptacle Breeding Survey

The selected localities were surveyed for evidence of IFFV visitation and the presence of any exotic animal and plant species. Receptacle breeding mosquito surveys were conducted at all sites. All potential mosquito-breeding receptacles at each survey location were recorded, including those that contained water and those with no water. Water-filled receptacles were sampled for mosquito larvae using a standard 270ml ladle and a turkey baster or pipette. The larvae were preserved in 70% ethanol in labelled vials. When only pupae were present in a collection, they were reared on wet tissue paper in a sample vial. Adults that emerged were frozen after ~24 hours. All samples were later identified at the ME lab in Darwin.

Adult Mosquito Trapping

Adult mosquito collections were more opportunistic, with person landing catches and commercial trapping methods employed.

Figure 2b: Sheltering IFFV, Groote Eylandt Nth.

Figure 2c: Lane Is. IFFV landing apparent.

Adult mosquito traps were set at potential IFFV landing locations, but deployment of these were subject to weather and time constraints. Trapping was restricted to where HMAS Tarakan could anchor close to the trap site, and where there was sufficient time to remain at the anchorage overnight so that traps could be collected in the morning before departure to another location. All adult specimens were frozen in labelled sample jars in the freezer store onboard HMAS Tarakan for later identification by ME in Darwin.

Two types of adult mosquito traps were used during the survey, 1) the BG Sentinel trap and 2) the Counter Flow Geometry (CFG) or 'pickle jar' trap.

The BG Sentinel trap uses a synthetic odour and visual cues as a lure. The odours include a combination of fatty acids, lactic acid and ammonia. The trap is specifically designed to attract *Ae. aegypti*, and is also

effective in collecting *Aedes albopictus* (Meeraus et al. 2008).

The CFG trap uses CO_2 bottled gas as a lure, which is released at 500ml per minute through a calibrated regulator that is incorporated into the trap. A rechargeable 12V gel cell battery powered each trap.

Where adult mosquito trapping was possible, both traps were used in tandem, targeting the two exotic *Aedes* vector species that pose the highest potential for importation by IFFVs. The BG Sentinel trap was positioned in a sheltered site at a residence, usually on a veranda, to target *Ae. aegypti*. *Aedes aegypti* is highly anthropophilic, and if present, will harbour and breed at locations very close to human habitation.

The CFG trap was positioned at least 50m away from the BG trap at a location close to vegetation where it was more likely to detect the presence of *Ae. albopictus*.

Person-Landing Catches

Person-landing catches of adult mosquitoes were conducted at sunset and opportunistically during daylight hours at three locations. Both species of exotic *Aedes* that were targeted during these collections are usually daytime feeders. However, they do display differences in their harbourage preferences and times of peak biting activity.

Aedes aegypti are generally active biters throughout the day and prefer to harbour on walls and under tables (Reiter and Gubler 1997). *Aedes albopictus* are also active daytime biters, however they exhibit more crepuscular host-seeking behaviour and prefer to harbour on low vegetation (Hawley 1988).

Results

Receptacle-Breeding Summary

Overall, 109 potential receptacles were located in all the communities and outstations visited. Amongst these receptacles, 60 contained water and 25 of these were found with mosquito larvae (Table 1). The container-breeding index (% of receptacles with water that were breeding) was 41.7%. The most commonly detected species during the receptacle survey was *Aedes katherinensis* (52%), followed by *Aedes notoscriptus* (32%) and *Aedes tremulus* (16%). The locations with the highest percentage of receptacles with water that were breeding (where there was more than one receptacle) were house 1 at the Wigram Is. Outstation (77.8%), Clarkson Pt. outstation (66.7%), Vincents Bay outstation (57.1%), and Base Bay outstation (50.0%) (Table 1).

A range of receptacle types were detected during the survey. The most common breeding receptacles were tyres (8), drums (8) and buckets (2) (Table 2).

Adult Mosquito Trapping

Adult mosquito collections were limited to Bartalumba Bay outstation (Groote Eylandt), and Clarkson Pt. and Base Bay outstation (Vanderlin Is.). Fifteen species were detected using the BG sentinel and CFG traps, and includes 265 female adults and 11 male adults (Table 3). The most commonly detected species (female only) of receptacle-breeding *Aedes* from adult trapping operations were *Ae. tremulus* (7), *Ae. katherinensis* (5) and *Aedes (Mac) sp. 125* (2).

Person-Landing Catches

Person-landing catches collected 5 adult mosquitoes. These included *Ae. katherinensis* at Wigram Is. (2) and at Clarkson Pt. outstation (1), and *Ae. tremulus* at Base Bay outstation (1).

Discussion

No exotic *Aedes* were detected during the survey. However, the survey was limited, due to time and resource constraints, to a relatively small number of sites in the Gulf of Carpentaria and the islands along the north east coast of the NT.

Vulnerability and Receptiveness to Exotic Vector Incursions

Movements of IFFVs close to Australian islands and the mainland presents increased vulnerabilities for exotic vector incursions. In the NT, there have been reports by indigenous ranger groups of equipment being cached by IFFVs and the crews camping and collecting freshwater at remote areas, such as the Sir Edward Pellew Group and the Groote Eylandt area. One report even suggested that bartering between IFFV crew and indigenous community members had taken place (Anindilyakwa Ranger group, pers. comm.).

During these landings it is possible that the drought resistant eggs of either *Ae. albopictus, Ae. aegypti* or other *Aedes* species were imported in subsequently abandoned receptacles and were later found and relocated. However, the risks of an introduction and successful establishment for each of these species, via these activities, differ according to the presence of nearby established communities, and the activities or habits of the residents.

Table 1. Gulf of Carpentaria survey 2006: Receptacle breeding summary – by location.

Table 1. Gulf of Carpentaria survey 2006: Receptacle Breeding Summary - By Location

Location and Receptacle Breeding Summary							No. of Receptacles Positive for Each Species					
Island/ Is. Group (Fig. 1)	**Location**	**Community/ Outstation**	**Survey Date**	**Total No. of receptacles with water**	**Total No. of receptacles with water breeding**	**% of receptacles with water breeding (receptacle breeding index)**	***Ae. (Fin) notoscriptus***	***Ae. (Stg) katherinensis***	***Ae. (Mac) tremulus***	***An. (Cel) annulipes s.l.***	***Cx. (Cux) quinquefasciatus***	***Cx. (Cui) pullus***
Mornington Is. area	Gununa	Council storage yard	27-Apr-06	1	1	100.0	1					
		Social Club		1	1	100.0					1	1
		Council workshop		10	2	20.0					2	
Sir Edward Pellew Group	Vanderlin Is.	Base Bay	29-Apr-06	6	3	50.0	1		1	1		
		Vincents Bay		7	4	57.1	1	4				
		Clarkson Point		6	4	66.7	4	4				
	Craggy Islet	Craggy Is.	30-Apr-06	2								
Groote Eylandt area	Groote Eylandt	Bartalumba Bay	3-May-06	Unable to Survey								
		Makbumarja	5-May-06	6								
		Thompson Bay	6-May-06	3	1	33.3			1			
		Dalumbu Bay	7-May-06	4	1	25.0	1	1	1			
	Hawksnest Is.		3-May-06	Nil Receptacles								
	North East Isles	Lane Is.	6-May-06	4								
English Company Is. & Wessel Is.	Wigram Is.	House 1	11-May-06	9	7*	77.8		3	1			
		House 2		1	1	100.0		1				
	Raragala Is.		12-May-06	Nil Receptacles								
			Totals	**60**	**25**		**8**	**13**	**4**	**1**	**3**	**1**
			% of Totals	**98.4**	**41.0**		**32**	**52**	**16**	**4**	**12**	**4**
			Receptacle Breeding Index			**41.7**						

* Larvae were not collected from all breeding receptacles

Aedes aegypti is the most commonly encountered exotic vector species on board IFFVs in the NT (Whelan and Tucker 1998, AQIS unpublished data (2002-2009)). With vessels reportedly landing closer to the larger permanent communities, there is an increasing risk of introductions and establishments of this species. However, the sites where IFFVs tend to land are usually remote, making it less probable for imported *Ae. aegypti* eggs in receptacles to be relocated to outstations and communities. The very low human population bases or periodic absence of humans, and the relative lack of water holding receptacles at some outstations on these islands would also be a prohibiting factor for *Ae. aegypti* establishment.

Populations of domestic receptacle-breeding mosquito species such as *Ae. aegypti* could potentially be sustained on Mornington Is., which has a large population base, and includes the major community of Gununa and the smaller permanent outstations. Limited time was allocated for surveys in Gununa, which focused on areas with potentially high receptacle breeding presence. No other sites on Mornington Is. were able to be surveyed due to challenging sea conditions.

Unfortunately, rainfall was limited in the weeks before the surveys were conducted on Mornington Is., which resulted in collections of mainly *Culex* species. It appears that *Ae. aegypti* maybe absent from Mornington Is. However, as the survey was very limited, the possible absence cannot be determined with any certainty. It would be desirable to carry out surveys for *Ae. aegypti* in Karumba and repeat the survey on Mornington Is. in Qld, as it was last detected at these locations in 1983 (Sinclair 1992, Beebe et al. 2009).

Table 2: Gulf of Carpentaria survey 2006: Receptacle-breeding summary - by receptacle type.

Receptacle Summary				No. of Times Receptacles Positive for Each Species					
Receptacle Type	No. of potential receptacles	No. of receptacles with water	No. of receptacles breeding	*Ae. (Fin) notoscriptus*	*Ae. (Stg) katherinensis*	*Ae. (Mac) tremulus*	*An. (Cel) annulipes s.l.*	*Cx. (Cux) quinquefasciatus*	*Cx. (Cui) pullus*
Beer can	25	6	-						
Beer keg	1	1	1	1	1				
Bottle (glass)	1	1	-						
Bucket (metal)	1	1	1		1				
Bucket (mop)	1	1	-						
Bucket (plastic)	1	1	1		1				
Car body	2	2	-						
Drum (1/2 44 gal)	10	7	5		1				
Drum (200 L)	4	3	1	1	1				
Drum (Unspecified)	4	2	1				1		
Drum 20L	4	4	1			1			
Fridge (disused)	1	1	-						
Plastic casing	1	1	1	1	1				
Plastic container	10	1	1	1					
Plastic wrap	1	1	1		1				
Rainwater tank	6	1	1	1	1	1			
Saucepan	1	1	-						
Styrofoam box	1	1	1		1	1			
Toilet bowl	1	1	1			1			
Tyre (car)	12	6	4	2	2			1	1
Tyre (tractor)	1	1	1		1				
Tyre (truck)	12	11	3	1	1			1	
Water cooler	2	2	-						
Water tank	4	3	-						
Well	2	-	-						
Totals	**109**	**60**	**25**						

There is a routine barge service from Karumba via Mornington Is. to Nhulunbuy and this mode represents a potential vulnerability for the importation of *Ae. aegypti* into the NT.

All outstations surveyed in the Sir Edward Pellew Group contained very small human populations. Resident families often travel, leaving the outstations uninhabited for long periods. Although there has been a lack of evidence of any IFFV landings, the large number of sightings of IFFVs by local outstation residents would indicate that the Sir Edward Pellew Group is a low - medium risk for an *Ae. aegypti* introduction and establishment.

Although the detection of *Ae. albopictus* eggs or adults on IFFVs in the NT are not as common as *Ae. aegypti,* an incursion by *Ae. albopictus* into remote islands off the NT coast should be considered an appreciable risk. This risk is greater than that for *Ae. aegypti,* as *Ae. albopictus* has the potential to become established in areas with no human presence (Hawley 1988).

The areas that appeared to have the highest potential for an incursion from IFFVs or small vessel inter-island travel are the coastal communities and outstations on Groote Eylandt and the other nearby inhabited islands. These include Alyangula and Umbakumba (Groote Eylandt), Milyakburra (Bickerton Is.), Lane Is. (North East Isles), and the other outstations on the Groote Eylandt coast.

The higher risk associated with these sites is due to the five main factors; 1) high levels of IFFV activity in the area; 2) evidence of IFFVs landing and camping at sites near the area; 3) natural and artificial receptacles to provide breeding sites; 4) permanent human settlements to support *Ae. aegypti*, and 5) communities relatively close to potential landing sites, which increases the possibilities of residents finding and relocating abandoned imported receptacles.

Based on 2007/08 figures, the number of apprehensions of IFFVs brought into NT ports has been reduced by more than half of that apprehended in 2005/06 (Australian Fisheries Management Authority, unconsolidated data). This is presumably due to the injection of Commonwealth funds into enhanced border patrol and protection strategies announced from May 2007, and the relocation of IFFVs to Christmas Island. Although the perceived risks of incursions may have been reduced via this mode, remote NT coastal communities still remain receptive to exotic *Aedes* introductions.

Aedes aegypti on Groote Eylandt: Detection, Eradication and Confirmation of Absence.

On the 31 October 2006, five months after the completion of this survey, *Ae. aegypti* larvae were collected in an ovitrap at the Alyangula seaport, Groote Eylandt (Kulbac and Whelan, 2007).

The detection of the *Ae. aegypti* establishment instigated a 2-year eradication program on Groote Eylandt, which was declared eradicated on 8 May 2008. Routine ovitrap and adult monitoring programs have since continued on Groote with no further detection of *Ae. aegypti* eggs or larvae (Nguyen et al. 2009).

Table 3: Gulf of Carpentaria survey 2006: Adult mosquito trap collection summary.

Collection Details			Mosquito Species																					
			Ae. (Stg) katherinensis		*Ae. (Mac) species*		*Ae. (Mac) species 125*	*Ae. (Mac) tremulus*	*Ae. (Och) vigilax*	*An. (Cel) amictus*		*An. (Ano) bancroftii*	*An. (Cel) hilli*	*An. (Cel) meraukensis*	*Cx. (Cux) annulirostris*	*Cx. (Cui) pullus*	*Cx. (Cux) sitiens*	*Cx. (Cux) squamosus*	*Tp. (Trp) magnesianus*	*Tp. (Pol) punctolateralis*	Nil mosquitoes	Trap failure mosquitoes	Total No. of Females	Total No. of Males
Trap Location	**Date of Collection**	**Trap Type**	**F**	**M**	**F**	**M**	**F**	**F**	**F**	**F**	**M**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**				
Vanderlin Island - Clarkson Point	30-Apr-06	BG						2															2	
		CFG																				1		
Vanderlin Island - Base Bay	1-May-06	BG								11	8						4						15	8
		CFG					2	5	24	16		1	12	5	159	2	12	2	1	1			242	
Groote Eylandt - Bartalumba Bay	3-May-06	BG																			1			
		CFG	5	1		2											1						6	3
		Totals	5	1		2	2	7	24	27	8	1	12	5	159	2	17	2	1	1	1	1	265	11

F = Number of Females, M = Number of Males

Between the 19 – 22 January 2009, ME conducted a wet season receptacle-breeding survey on Groote (Nguyen et al. 2009). The survey focused on Alyangula and the nearby communities, and again found that *Ae. aegypti* was absent.

It is possible that *Aedes aegypti* was present in Alyangula in May 2006 during the Gulf survey. However, Alyangula Township, the site of the infestation, was not surveyed during the Gulf survey, since existing exotic *Aedes* monitoring programs were in place. The detection at Alyangula in October 2006 and the subsequent surveys showed that there were areas of the town that were not infested, indicating that the establishment was relatively recent and probably occurred during the latter part or just after the wet season of 05/06. The previous ME survey for exotic receptacle-breeding *Aedes* in Alyangula was February 2004.

Based on all the available information including shipping records, no further *Ae. aegypti* detections within the port area, and DNA analysis (Whelan et al. 2009), it is plausible that an egg infested receptacle from an IFFV could have been relocated via inter-island travel (including from communities anywhere along the nearby coast) to Alyangula, the major community hub of the Groote Eylandt group. Recreation fishing boats are a common feature in Alyangula and the other island communities. Residents often travel widely during fishing expeditions (Whelan et al. 2009) and often camp on various nearby islands or the mainland. These boats are stored at dwellings and are often relocated, together with any receptacles on board, between communities.

On one occasion, during the 2006 eradication program, *Aedes aegypti* was detected in Angurugu. The receptacle, a vehicle tyre, was linked to a relocated boat that originated from Alyangula (Nguyen et al. 2009).

Conclusions

- During the April – May 2006 western Gulf of Carpentaria survey, no exotic mosquitoes were detected.

- Locations assessed as vulnerable included:
  - Groote Eylandt area (high)
  - Sir Edward Pellew Group (low - medium)

- The October 2006 detection of the establishment of *Ae. aegypti* on Groote was probably from IFFV receptacle(s) relocated to Alyangula.

- Recent January 2009 surveys detected no *Ae. aegypti* or *Ae. albopictus* on Groote Eylandt.

- Ongoing surveillance recommendations:
  - Maintain current ovitrap and adult trapping programs in Alyangula and conduct regular (annual) receptacle breeding surveys in Alyangula and the nearby communities on Groote, with periodic surveys of outstations and other nearby islands.
  - An immediate and every few years survey in Karumba and on Mornington Is. Qld.

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