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In the Asia Pacific Region

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The web of Death. Photo Darryl McGinn

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Mosquito Bites
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Malaria Vectors in West Timor, Indonesia – An Overview

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Introduction

Malaria is a life-threatening disease in Indonesia. Around 50% of Indonesian people live in malaria endemic areas with an estimated 30 million cases occurring annually with 30,000 deaths (Laihad (2000). Baird *et al.* (1993) reported that in malaria infested villages, the prevalence rate of malaria ranges between 25%-75% during the year (Laihad 2000).

There are around 20 *Anopheles* species in Indonesia (MoH. RI-CDC, 2005). The most extensively occurring species are *An. sundaicus, An. subpictus, An. barbirostirs, An. maculates, An. aconitus, An. balabacensis* (Harijanto, 2000). The mosquitoes transmit the malaria parasite and all four species of those parasites (*Plasmodium falciparum, vivax, malarie and ovale*) are found in Indonesia.

This article describes the malaria vectors, their habitats and biting habits in West Timor, an area of high malaria incidence.

Material and Methods

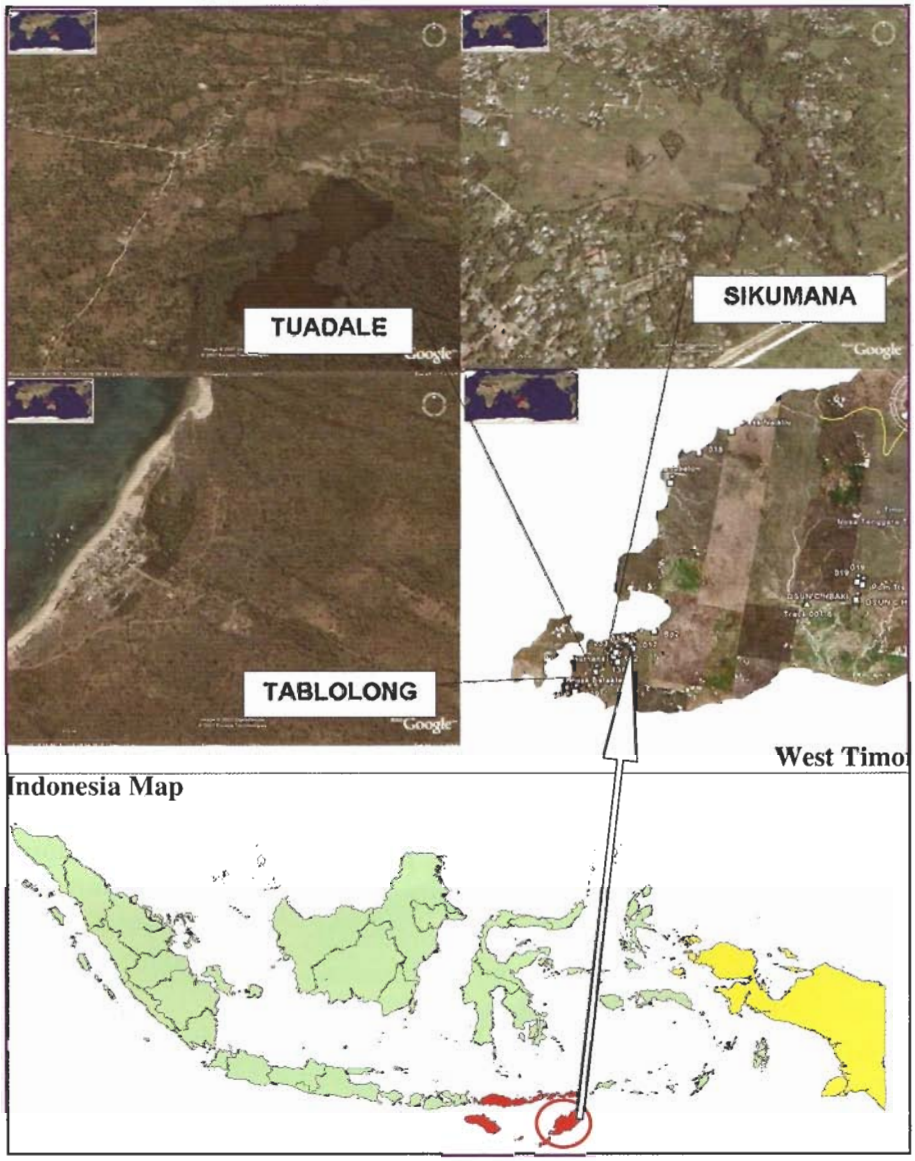
Study area

West Timor is located in Nusa Tenggara Timur (NTT) province of Indonesia, between 8°-12° S and 118°- 125° E. The province consists of 566 islands, which cover an area of 47,349.90 km^2. Figure 1 shows the location of the 3 of the 5 study villages within the area.

Entomological Survey

An entomological survey was conducted in the 5 villages based on the method recommended by WHO (WHO, 2003a, 2003b). Mosquitoes were collected fortnightly on 25 occasions between June 2006 and January 2007, using volunteer human collectors. Mosquitoes were caught when landing on the volunteers' bare legs or hands during the night. Four to six people (depending on the location, see Table 1) were employed to catch the host-seeking mosquitoes. The collectors were

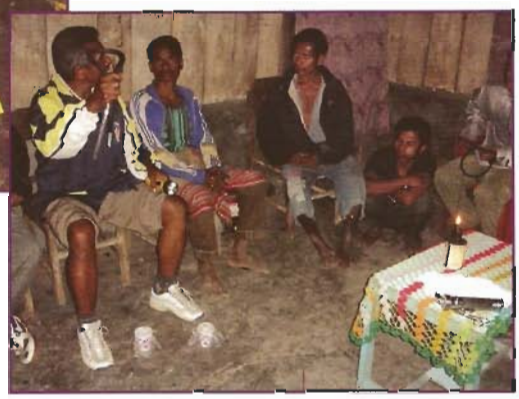
Figure 1: Maps of Study Areas (Modified from Indonesian Ministry of Health and Google Earth).



divided into two groups, indoor and outdoor groups. Both indoor and outdoor catches were carried out throughout the night from 6 PM to 6 AM at 1 hour intervals. The human landing collection was done for forty minutes followed by ten minutes collecting on-the-wall for resting mosquitoes in the house and also outdoors – in the animal shelters. To avoid bias, collectors were rotated. The collectors were equipped with torches, aspirators and paper cups (Figure 2). Data were recorded as counts and later converted into Man Hour Density (MHD).

Results

The results for all the villages are summarised in Table 1.



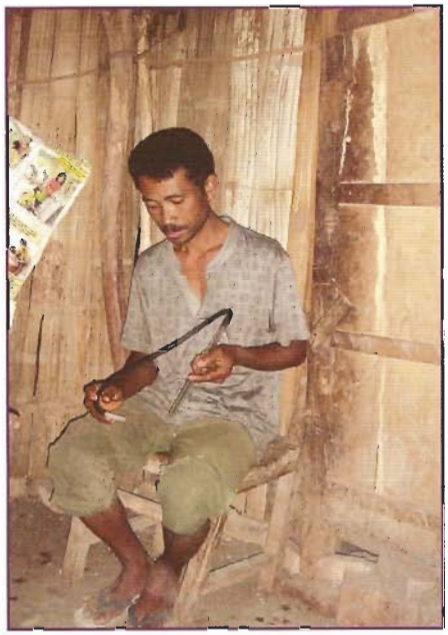


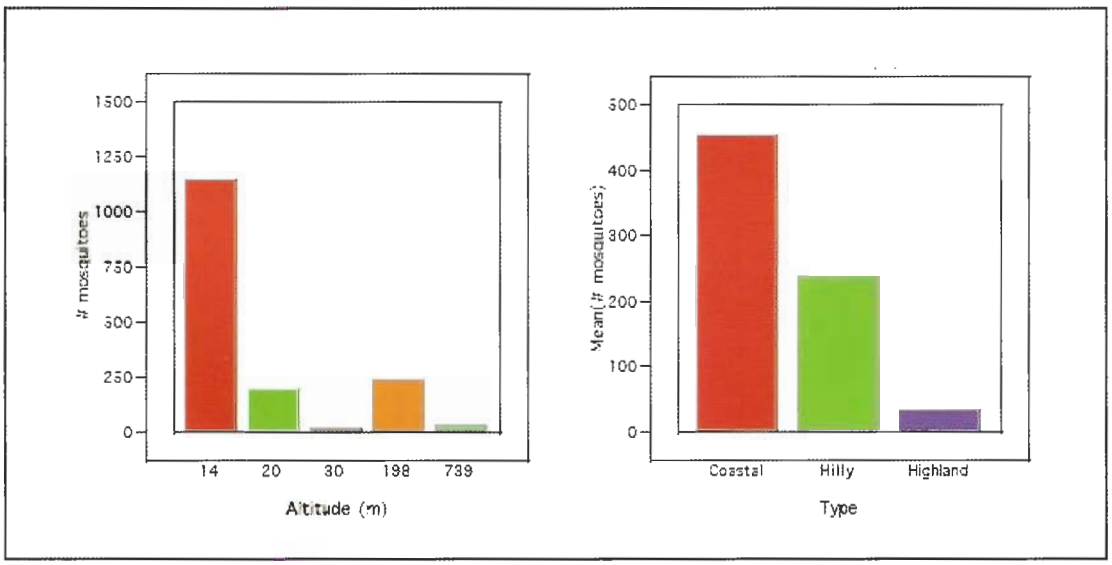
Figure 2: The entomologist was training the collectors, while other staff prepared the equipment (left). A collector inside a typical house in West Timor was waiting for a mosquito to land on his bare legs (right).

Table 1: Summary of results of the entomology surveys in West Timor

NO	Selected Variable	LOCATIONS AND TOPOGRAPHY SETTINGS		
		WEST TIMOR - COASTAL	WEST TIMOR - HILLY RICE FIELD	WEST TIMOR - HIGHLAND
1	Number of villages	3	1	1
2	Altitude (m)	14 - 30	198	739
3	Local weather condition (Range)			
	a. Temperature (^{0}C) - Indoor	21.0 - 28.1	20.9 - 28.2	21.3 - 24.3
	- Outdoor	19.2 - 27.7	26.7 - 27.3	19.6 - 22.8
	b. Relative Humidity (%) - Indoor	61.0 - 79.7	59.8 - 82.8	76.0 - 80.7
	- Outdoor	61.0 - 85.7	61.7 - 86.4	75.3 - 82.1
	c. Wind speed (m/s)	0 - 1.8	0.1 - 2.0	NA
4	Number of surveys	7	6	12
5	Number of Collectors	6	6	4
6	*Anopheles* Species	*An subpictus* *An vagus* *An annularis* *An barbirostris*	*An aconitus* *An vagus* *An annularis* *An maculatus* *An barbirostris*	*An vagus* *An maculatus* *An barbirostris*
7	Average no of mosquitoes per survey	193.71	39.67	2.67
8	The dominant species by blood feeding places			
	- Indoor	*An subpictus*	*An vagus*	*An vagus*
	- Outdoor	*An subpictus*	*An vagus*	*An vagus*
9	The dominant species by Resting Places			
	- Human Shelters	*An subpictus*	*An annularis*	*An barbirostris*
	- Animal Shelters	*An subpictus*	*An annularis*	*An vagus*
10	Peak biting hour of the dominant species			
	- Indoor	9-10 PM, 12PM - 3 AM	9-11 PM	no clear pattern
	- Outdoor	10-11 PM	8-11 PM, 1-2 AM	no clear pattern

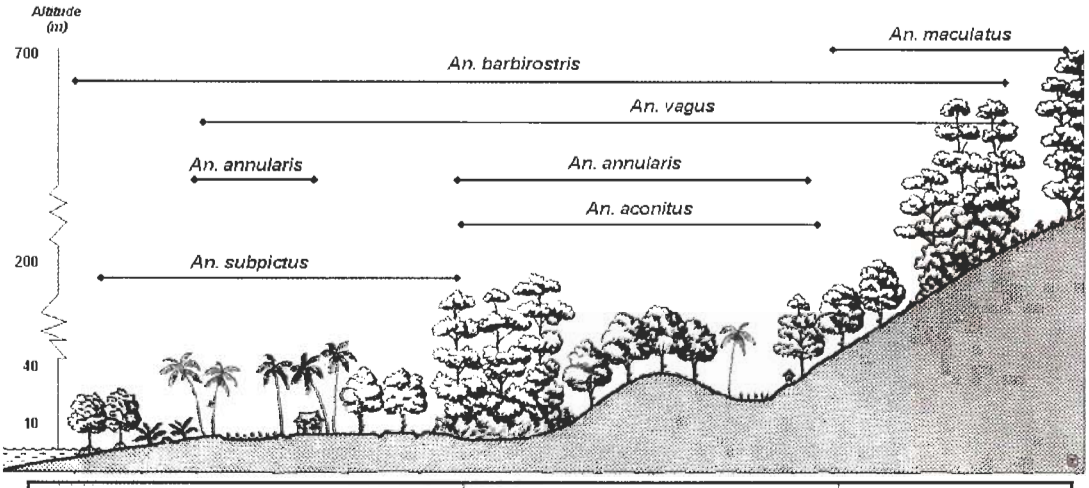
The results show that *Anopheles* mosquito species and their numbers varied across the areas (Figure 3) A total of over 1600 mosquitoes were collected in the 5 villages and the average MHD ranged from 1.33 to 63.44 per night. On average there were more mosquitoes in coastal areas than in hilly and highland areas. The distribution by altitude and location type is shown in Figure 3.

Figure 3: Malaria Vectors in NTT Province



Six *Anopheles* species were recorded during the survey: *An. subpictus* (65.50%), *An. vagus* (17.34%), *An. barbirostris* (15.19%), *An. aconitus* (0.62%), *An. annularis* (0.98) and *An. maculatus* (0.37%). *An. subpictus* was the most common, but only in coastal locations. Two species, *An. vagus* and *An. barbirostris*, appeared to be widespread over the area in all locations. In contrast, *An. maculatus* and *An. annularis* were less common and were restricted to the hilly and highland areas. Figure 4 summarises the distribution of the main species by location type, land use and altitude.

Figure 4: A schematic of malaria vector distribution based on West Timor Surveys, 2007



Coastal Plains			Hilly	Highland
Tuadale (14 m)	Nostbaki (20 m)	Tablolong (30 m)	(Sikumana 198 m)	Haumenbaki (739 m)
Village, coastal plain, rice field, bush	Village, coastal plain, rice field, coconuts, mixed plants	Village, coastal plain, rice field, coconuts, mixed plants	Semi urban, hilly, rice field, coconuts, mixed plants	Village, highland, rice field, coconuts, mixed plants

Anopheles feeding habits in West Timor

Feeding habit describes *Anopheles'* preference for feeding indoors (endophagy) or outdoors (exophagy) along with the times of feeding during the night. This is measured here as Man Hour Density (the number of landings per man/hour, assuming that a landing mosquito is there for the meal). The overall pattern is shown in Table 2

Table 2: The overall indoor and outdoor man hour density in West Timor

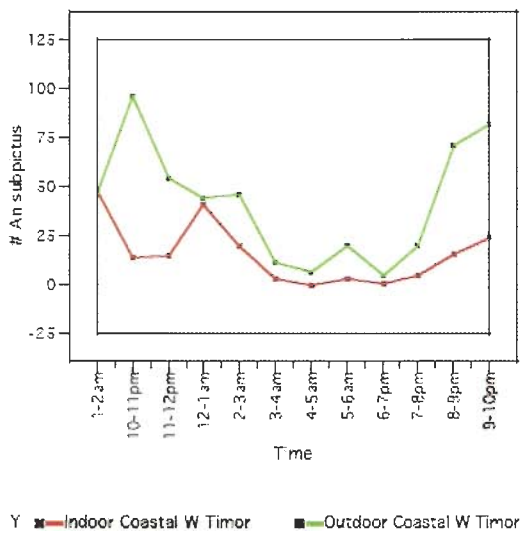
NO	Anopheles species	Total Mosquitoes Collected			Man Hour Density		
		Indoor	Outdoor	Total	Indoor	Outdoor	Average
1	*An.subpictus*	190	503	693	0.61	1.61	1.11
2	*An. vagus*	26	72	98	0.08	0.23	0.16
3	*An. barbirostris*	76	97	173	0.24	0.31	0.28
4	*An. aconitus*	1	3	4	0.00	0.01	0.01
5	*An. annularis*	1	2	3	0.00	0.01	0.00
6	*An. maculatus*	0	1	1	-	0.00	0.00
Total		294	678	972	0.94	2.17	1.56

Note: Where numbers are <2 the MHD was not calculated

The Man Hour Density (MHD) reflects the abundance of mosquitoes. Table 2 shows the number mosquitoes collected, overall *An. subpictus* was the most abundant species with an average MHD of 1.11. *An. barbirostris* (MHD = 0.28) and *An. vagus* (MHD = 0.16), both widespread species, were also important.

For the diurnal pattern we report the landing rates of *An. subpictus*, the most common species. Data are from the coastal area, which has most malaria.

Figure 5: Number of *An. subpictus* landing on volunteers.



For indoor nocturnal activities, *An. subpictus* started its biting activities around 6-7 PM. It had two landing (biting) peaks at around 9-10 PM and 12 PM – 2 AM. When the morning approached, *An. subpictus* stopped its biting activity inside the house.

The peak hour of biting activities in the outdoor environment of *An. subpictus* started from dusk and reached its peak at 10-11 PM. The biting activities tended to decrease around 3-6 am, but the mosquitoes remained active until dawn.

Anopheles resting habits in West Timor

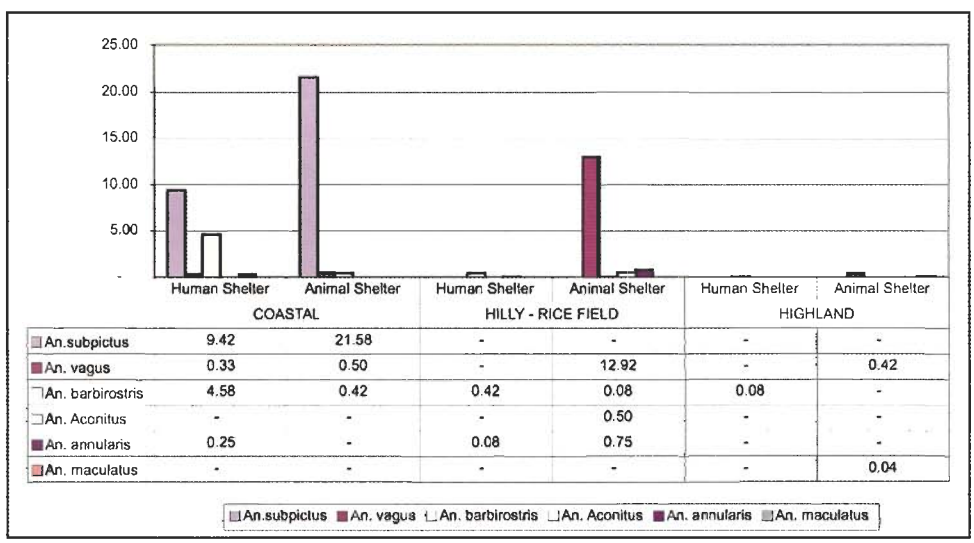
Most mosquitoes, when they have taken a blood meal, will rest for a while. During this study, mosquitoes' preferences for resting places in human or animal shelters were observed all night long. The results are shown in Figure 6.

Figure 6 shows that four species: *An. subpictus*, *An. vagus*, *An. barbirostris* and *An. annularis* were found in human shelters, as well as in animal shelter. In contrast, the other two species, *An. aconitus* and *An. maculatus*, were found only in animal shelters. *An. subpictus*, *An. vagus* and *An. annularis* were more prevalent in animal shelters than human shelters. *An. subpictus* tended to remain inside human shelters until 2-3 AM in the morning and were most abundant around 7-10 PM in animal shelters.

Discussion

Malaria incidence is associated with many factors. One of these is the distribution of the mosquito vectors. Among the 20 vectors in Indonesia, species such as *An. subpictus*, *An. barbirostris* and *An. vagus* are considered to be the most extensively occurring species in

Figure 6: *Anopheles* density (MHD) in resting places in West Timor



West Timor (CDC-NTT, 2005). In the present study, *An. subpictus* was the dominant vector in the coastal area and *An. vagus* was dominant in rice fields and highland areas. The mosquitoes were more active outdoors than indoors and so being outdoors, especially at times of high biting activity is likely to be a malaria risk factor. Other data from the project suggest that occupation is also a factor. For example fishers are at risk when fish have to be brought to market around 3-4 am in the morning, a time when *An. subpictus* are active.

The findings from this study can be used to assist decisions about types of mosquito control activities. Since mosquitoes in the study area were more active outdoors than indoors, indoor residual spraying might not be the top priority for managers. The less costly use of bed nets and malaria education promotion might have a better outcome for reducing malaria incidences.

Conclusion

Malaria is a serious health concern in West Timor. The dominant vector in the coastal areas is *An. subpictus*, whilst *An. vagus* is the main vector in the hilly rice field and highland areas. More mosquitoes were active outdoors than inside the house. Since the risk of being bitten by mosquitoes is greatest outdoors, people should be advised to wear long clothing when working at night outside. To reduce malaria incidence, malaria control programs should protect people from mosquito bites, especially in the dry season, when the mosquitoes seem to more numerous (unpublished data).

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