Anopheline Mosquitoes of Myanmar. II.

Anopheles (Cellia) minimus Theobald, 1901

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Anopheles minimus together with Anopheles dirus constitute the primary vectors of malaria in Myanmar. The former has a wider distribution and occurs in higher densities with longer seasonal prevalence and is therefore considered to be the most important malaria vector in the country. Previous studies showed that An. minimus breeds in grassy edges of perennial hill streams, in slow running irrigation channels and terraced rice fields while DMR teams, in addition, found it breeding in small puddles in stream beds together with An. maculatus. At Phado, An. minimus was found to constitute 26.2%, 50.5% and 44.1% in monsoon, cool/dry and hot/dry seasons respectively. Prevalence of An. minimus in relation to distance from forest was presented. Biting, resting behaviour and host preference studies were carried out and the results presented. Man-biting rate and vectorial capacities in relation to rainfall for each month over a year are also presented.

INTRODUCTION

Anopheles minimus and Anopheles dirus are considered to be the two primary vectors of malaria in Myanmar. Of the two primary vectors, An. minimus has a wider distribution in the country as well as higher densities and a longer season of prevalence. Thus, An. minimus could be considered more important as a vector than An. dirus. This species has been studied in Myanmar many years ago by Weeks (1) & Khin Maung Kyi (2) and in the neighbouring countries by Ismail et al (3,4) and by Chow (5). Recently, Myo Paing et al(6) presented the results obtained from a longitudinal study of An. minimus in a forested foot-hill area. The Department of Medical Research (DMR) survey teams have visited many parts of the country for the study of anopheline vectors. During these surveys, facts about An. minimus have been obtained. This paper presents data on An. minimus recorded by DMR teams as compared to previous data available.

MATERIALS AND METHODS

Distribution

Khin Maung Kyi (2) presented the distribution of An. minimus as recorded by his survey teams (Fig 1). It was collected from States & Divisions from all over the country. The location where An. minimus was recorded by DMR teams was presented in (Fig 2) & (Table 1). Anopheles minimus was collected from different ecological situations like (a) plateau areas at Wetwun, Maymyo Township, (b) foot-hill areas like Phado & Tha-bye-wa and Se-daw-gyi (c) deep forest areas like Nam-Tun Camp, Kawthaung Township.

Breeding Habitat

Khin Maung Kyi (2), quoting previous workers, stated that An. minimus larvae were found most frequently breeding in the grassy edges of bags and back waters of parennial hill streams, either unshaded or partially shaded. Other

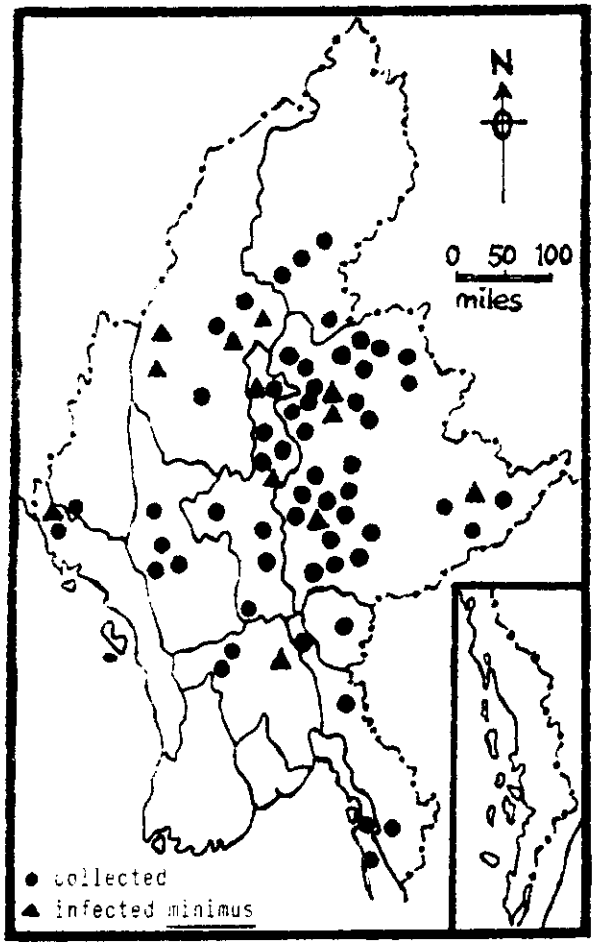

Fig1. An. minimus collected by Khin Maung Kyi

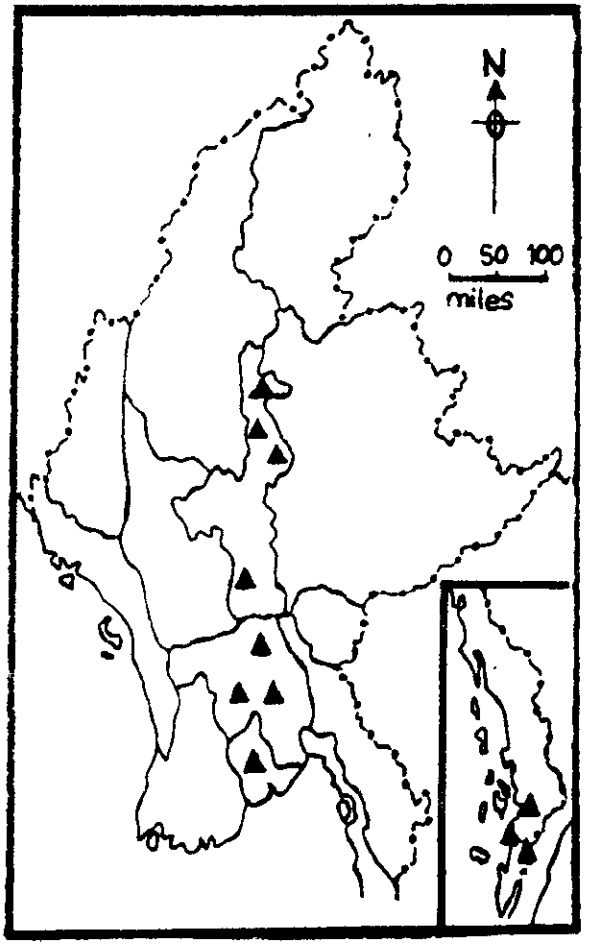

Fig.2. An. minimus collected by DMR teams

breeding places recorded by Khin Maung Kyi were grassy edges of slow-running irrigation channels and terraced rice-fields.

DMR survey teams found An. minimus breeding in the following type of places.

(a) At Phado, Kyauk-ta-gar Township :
  i- edges of slow-running clear streams(together with An. maculatus)
  ii- in small water collections and puddle in the stream bed formed when water flow stopped during the dry season (also together with An. maculatus).
  iii- edges of paddy fields at the end of monsoon
  iv- seepage water collections near paddy fields.

(b) At Wetwun, Maymyo Township, Se-daw-gyi, Madaya Township and Ka-baing, Mogok Township.
  i- Small running streams (sometimes located on the roadside) at points where water flow was extremely sluggish and edges of stream covered with vegetation.

(c) At Ye-net-gyi Road construction Camp, Hle-gu Township.
  i- a stagnent pool contained fairly clear water.

(d) At Tha-bye-wa, Oktwin Township and Shwe-du, Mergui Township.

Table 1. Locations where An. minimus was collected by DMR teams

Locality	Township	Season/Time	Remarks about locality
YANGON DIVISION			
Ye-sit-kan	Taik-kyi	June-July	Near Yangon Water Reservoir with forests.
BAGO DIVISION			
Phado	Kyauk-ta-gar	Dec	Villages within 1½ mile of forested foot-hills near drying stream beds
Tha-bye-wa	Oktwin		
Ye-bya Camp	Okpo	Sept/Oct	Timber extraction camp near Bago Yoma range
MANDALAY DIVISION			
Moe-Swe Camp	Pyinmana	May/June	Adjacent to a thick forest. Timber extraction camp.
Ka-baing	Mogok	Aug/Sept	A hilly area 4000 feet above sea level.
Wet-wun	Maymyo	June/July	Plateau area (3000 feet altitude) with perenial streams
Se-daw-gyi	Mandalay	Sept/Oct	Adjacent to foot-hills & forest. A slow running stream nearby.
Nyaung Thar Yar (larval survey)	Maymyo	Dec	In a plateau area about 3 miles from forested foot-hill. Found in a stream with grassy edges.
TANINTHARYI DIVISION			
Nam Tun Camp	Kawthaung	Jan	Deep forest timber extraction camp
Han-ga-daing camp (larval survey)	Bok-pyin	Jan	Deep forest timber extraction camp near sea
Mon-Su Chaung (larval survey)	Myaik	Jan	Small stream from forested foot-hills flowing through Mon-Su village

i- along grassy edges of small streams in the forest under partial shade. The breeding sources were either inside or very close to deep forest.

(e) Nun-Tun Forest Camp, Kaw-Thaung Township and Han-ga-daing camp, Bok-pyin Township, both situated in deep forest extraction area.

i- small clear-water streams with rocks and grassy edges (together with An. maculatus).

ii- small pools on road side created when building timber extraction trails.

Adult Bionomics

Seasonal prevalence :

Khin Maung Kyi (2) stated that the *maximum prevalence of this species in* all areas was found to be in the post monsoonmonths of October to December, during which the condition of the hill streams were most favourable for breeidng of An. minimus. Khin Maung Kyi also observed that in many areas *this species is abundant from April to* December, although during the monsoon period the larvae were flushed out by rain in many locations.

DMR survey teams found that An. minimus prevalence was throughout the whole year at many locations, although in different densities seasonally.

In Tha-bye-wa, An. minimus was collected in very low numbers during July & August. However, in January and February, hundred of An. minimus could be collected in a single night from one big bed-net (11 x 11 x 6) using a cattle

Table 2. Man-biting rate and vectorial capacities of An.minimus in the forested foot-hill villages of Phado in relation to rainfall

MONTH	Man-biting rate (mbr) Per man night	Vectorial capacity	Rainfall (mm)
1984			
Sept	9.08	4.19	346
Oct	8.69	4.57	112
Nov	9.95	1.65	-
Dec	7.44	1.34	-
1985			
Jan	1.00	0.02	-
Feb	1.61	0.26	-
Mar	3.30	10.42	-
Apr	4.90	1.01	14
May	4.70	14.85	392
Jun	0.36	1.14	871
Jul	2.30	3.99	637
Aug	3.82	0.02	1039
Sep	2.73	8.00	176

as bait. In the deep forest timber Camp of Nun-Tun, Kawthaung Township, An. minimus was collected by human baited nets in middle of January. At Phado, the monthly man-biting rate(mbr) and vectorial capacity of An. minimus in relation to rainfall was presented for 13 consecutive months in Table(2). During the survey at Phado, An. minimus was found to be the predominant anopheline mosquito, especially in the non-monsoon months. During monsoon out of the 17 species of anophelines recorded, 26.2% (321/1226) were An. minimus. In the cool/dry season out of 10 species of anophelines collected, 50.5% (205/406) were An. minimus. In the hot/dry season, An.minimus comprised 44.1% (142/322) out of 11 species of anophelines recorded. From Table 2 it can be observed that An. minimus was collected throughout the year, although peak densities were obtained from September to December. Also, An. minimus density was found to have no relationship to rainfall. Fig.1 shows An.minimus reported by Khin Maung Kyi(2) and Fig 2 shows locations where it was recorded by DMR teams.

Prevalence of An. minimus in relation to distance from forest:

An. minimus is mainly associated with deep forest and forested foot-hill areas. Myo Paing et al (6) showed out of a total of 699 An. minimus collected in the Phado area. 71.4% of (499/699) was collected at Kyar-kyaung-thaik Temporary settlement located at the forest edge,26.2% (183/699) from Ngok-to village situated 0.33 miles from forested foot-hills and only 1.3% (9/699) from Gwe-gon village which is about 1.5 miles from the forest.

Biting behaviour & host preference

Myo Paing et al(6) found An. minimus to be predominantly exophilic, the out-door biting rate being about 3 times that of the indoor biting rate. Host preference studies at Phado also showed that An. minimus was more attracted to humans. Khin Maung Kyi(2) also reported that An.minimus have a high preference for human blood.

Resting habits

Weeks(1) reported from work done at Lashio, North-Eastern Shan States, that An. minimus constituted 90% of the total day-time indoor resting mosquitoes caught. Chow(5) at Yunnan-Myanmar Road found that An.minimus prefers to rest by day-time in human dwellings. Muirhead-Thomson (7) reported from his work at tea garden districts of Assam, that An. minimus was evidently a domestic species sheltering in dark house and coolie houses by day. DMR survey teams, however, failed to collect any An. minimus resting indoors during the daytime.

Gonotrophic cycle

To determine the vectorial capacity, one of its parameters, the gonotrophic cycle was determined under field conditions seasonally at Phado by the authors. During the cool/dry & monsoon seasons the gonotrophic cycle was found to be

on a average of 2.5 days and in the hot/dry season, it was found to average 2.25 days. Field collected An. minimus adult females were used to conduct the test and the mosquitoes were given blood meals from the local volunteers.

Relationship to malaria

Khin Maung Kyi (2) presented an extensive list of An. minimus dissection results carried out by various workers in Myanmar. On the basis of available information, Khin Maung Kyi considered An. minimus as chiefly responsible for intense post-monsoon transmission and in areas where breeding extended throughout the pre-monsoon periods, An. minimus was responsible for pre-monsoon as well as post-monsoon transmission. Myo Paing et al reported that during Phado longitudinal study, the sporozoite rate of An. minimus was found to be 0.43% (3/699). From Table(2) it can be observed that the vectorial capacity of An. minimus in the area was, except for two months, always above the critical level (0.03) required for transmission.

DMR survey teams also found epidemiological evidence to incriminate An. minimus as a major vector of malaria. During February 1989 survey to Tha-bye-wa, An. minimus was collected in large numbers and at the same time the slide positivity rate of villages was found to be 40% and the villagers infant parasite rate 75%. Thus, An. minimus could be considered an important vector in Tha-bye wa. During DMR survey at Tha-bye-wa in July 1987, out of 16 An. minimus caught biting man, one was found to have oocysts.

Some aspects of An. minimus biology under laboratory conditions :

Myo Paing et al (8) observed some aspects of An. minimus biology under laboratory conditions.

(a) Fecundity of An. minimus females was on an average 80, the range observed being 58-102 eggs per female.

(b) The hatching rate of An. minimus eggs was found to be 86.7%.

(c) The peak mating potential of An. minimus, both males & females, was observed on the 3rd day, after which there was a marked reduction on the 4th day. By 5th day successful mating was very difficult to obtain.

(d) Anopheles minimus was found to start taking blood meals on the 2nd day and reached peak biting potential on the 3rd day.

(e) Gonotrophic cycle of An. minimus was studied seasonally in the laboratory under natural conditions after taking human blood meal.
During the cool/dry season the average duration of gonotrophic cycle was found to be 65 hours, while the duration for monsoon and hot/dry seasons were found to be 58 hours and 51-53 hours respectively.

Morphological variations

During the course of this study, the morphology of An. minimus was observed to be very variable. Even off-springs from the same iso-female lines were found to have much morphological differences which could lead to errors in identification. A detailed study is being reported in a separate paper.

DMR Collection

Anopheles minimus adult specimens, morphological variations mounted on slides, pupal & larval skins slides are being preserved as DMR Collections.

REFERENCES

1. E. B.Weeks: Experience in the control of malaria carried by Anopheles minimus in Burma. World Health Organization Malaria Conference for Western Pacific and South East Asia Regions, Taipei, 15-27 November 1954, WHO/MAL/112; 1-10.

2. Khin-Maung-Kyi. Malaria vectors in Burma 1. Anopheles minimus Theobald, 1901. Union of Burma Journal of Life Sciences, 1970: 3: 205-216.

3. I.A.H. Ismail, V. Notananda and J. Schepens. Studies on Malaria and Responses of An. balabacensis and An. minimus to DDT Resident spraying in Thailand. Part I. Pre-spraying observations. Acta Tropica 1974, XXXI, 2: 129-163.

4. I.A.H. Ismail, V. Notananda and J. Schepens. Studies on Malaria and Responses of An. balabacensis balabacensis and An. minimus to DDT Residual spray in Thailand part II Post-spraying observations. Acta Tropica 1975, XXXII, 3: 206-231.

5. C.Y. Chow. The bionomics of two important malaria vectors in China. Proceedings of 4th International Congress on Tropical Medicine and Malaria, Washington D.C, 1948; Vol 1: 681-685.

6. Myo-Paing, W. Tun-Lin and A.A. Sebastian. Behaviour of An. minimus in relationship to its role as vector of malaria in a forested foothill area of Burma. Tropical Biomedicine 1988, 5: 161-166.

7. R.C. Muirhead-Thomson. Studies on the behaviour of Anopheles minimus. Part V the behaviour of adults in relation to feeding and resting in houses. Journal of Malaria Institute of India 1941, 4, 2: 217-245.

8. Myo-Paing, W. Tun-Lin and A.A. Sebastian: Observation on the bionomics and transmission potentials of An. minimus. Paper presented at Paper Reading Session, Medical Sciences Division, December 1985-January 1986.