

Indoors man-biting mosquitoes and their implication on malaria transmission in Mpwapwa and Iringa Districts, Tanzania

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Abstract: Entomological surveys were carried out in six villages at different altitudes in Mpwapwa and Iringa Districts in central Tanzania in March 2002. A total of 1291 mosquitoes were collected. Of these, 887 mosquitoes were collected by light traps and 404 by indoor pyrethrum spray catch technique. Seventy-nine percent (1026) were *Anopheles gambiae* s.l., 0.2% (N= 3) were *An. funestus*, and 20.3% (N= 262) were *Culex quinquefasciatus*. Other species including *Cx cinereus*, *An. coustani* and *Aedes* spp accounted for 0.5% of the mosquito population. In Iringa, more mosquitoes were collected by pyrethrum spray catch than light trapping technique. The light trap catch: spray catch ratio in Iringa and Mpwapwa was 1:1.15 and 2.5:1, respectively. Indoor pyrethrum spray catch gave an overall estimate of *An. gambiae* density of 8 and 0.6 mosquitoes per room in Iringa and Mpwapwa, respectively, whereas light trap collections gave an overall respective density of *An. gambiae* of 63.9 and 2.9 mosquitoes per room. The densities of house entering mosquitoes were found to range from 0 to 135 in Iringa and from 2.6 to 3.5 per room in Mpwapwa. *An. funestus* mosquitoes were collected in Iringa only. None of the dissected *An. gambiae* collected in the two districts was infected with malaria sporozoites. Despite low mosquito densities and absence of infective mosquitoes in our study, the two districts are malaria epidemic prone, thus a continuous surveillance is critical for a prompt response to any impending outbreak. Further longitudinal studies are required to determine the transmission potential of the malaria mosquitoes in the two districts.

Key words: indoor resting, host-seeking, mosquitoes, malaria, Tanzania

Introduction

In recent years, a number of studies have shown that malaria is a public health problem in Iringa and Mpwapwa districts of Tanzania. The endemicity of the disease in the two districts varies with altitude, with some areas in Mpwapwa experiencing frequent malaria epidemics (Mboera *et al.*, 2006). In both districts, malaria parasitaemia, though at a lower rate, have been observed among individuals living in villages located at <800 m (Mboera *et al.*, 2002; Mboera *et al.*, 2006).

Despite a number of studies on the distribution of malaria vectors in Tanzania (Mnzava & Kilama, 1986; Mnzava *et al.*, 1989), those that looked at their transmission potential in Iringa or Mpwapwa districts are scarce. Few studies carried in the two districts have provided little information as to the malaria vector species and their transmission potential (Wakibara *et al.*, 1997; Maegga *et al.*, 2005; Mboera *et al.*, 2002, 2006). It was the objective of this study therefore, to determine the malaria vector species and their infectivity in Iringa and Mpwapwa districts of central Tanzania.

Materials and Methods

Study area

The study was carried out in Iringa Rural and Mpwapwa Districts of Tanzania in March 2002. Iringa (7°35'S, 35°30'E) comprises of 3 distinctive landscape

zones, namely: highlands, midlands and lowlands (lying between 700 and 2700 m). The mean annual rainfall is about 1000mm with most of the rains falling in January - May. The mean annual temperature ranges between 15°C and 30°C. The villages of Kilolo (highlands), Mangalali (midlands), and Idodi (lowlands) were selected for the studies.

Mpwapwa (6°00'S, 37°00'E) consists of spontaneous mountain chains rising to over 2400m especially in the southern and western parts. Otherwise the district mostly consists of flat scrubland, with a mountainous belt across the central part. Mpwapwa has a dry savannah type of climate receiving an average of 727 mm of rainfall per year, mainly from November-April. The climate is fairly arid and getting rains 2 years out of every 7 is not uncommon. Temperature ranges between 15.8°C and 27.7°C. Three villages were selected for the study, these included Mwanawota (highlands, >1600 m), Kibakwe (midlands, 1000-1600m) and Chogola (lowland, <1000 m).

Mosquito collection

Mosquito collections were made using pyrethrum spray catch and light trap techniques. For pyrethrum spray catch, indoor resting adult mosquitoes were sampled in 10 houses selected randomly. One room in each selected house was sprayed with pyrethrum insecticide during morning hours, and after 10 minutes, the mosquitoes knocked down on white

cotton sheets were picked up and preserved in petri dishes lined with moist cotton wool and filter papers. Three sentinel houses were selected in each study village for light trapping of house entering mosquitoes at night. Light traps were hung beside a sleeper who was provided with an untreated net as described by Mboera *et al.* (1998). The householder was instructed on how to set the trap at 18.00h in the evening and setting it off at 06:00h in the morning. As much as possible, the houses were of similar construction to avoid the effect of variability caused by differences in construction.

All mosquito collections were morphologically identified, sorted according to site of collection, house, date and species. The female *Anopheles gambiae* sensu lato were dissected to determine parity by observing the degree of coiling of ovarian tracheoles (Detinova, 1962). Salivary glands of parous mosquitoes were examined for malaria parasites using standard dissection techniques (WHO, 1975).

0.5% of the mosquitoes. In Iringa, more mosquitoes were collected by pyrethrum spray catch (PSC) than light trapping technique. The light trap catch: spray catch ratio in Iringa and Mpwapwa was 1:1.15 and 2.5:1, respectively. The ratio was higher in Idodi (8.1:1) than in Mangalali (1.3:1).

In Iringa, all *An. gambiae* were collected in Mangalali (51.5%) and Idodi (44.4%). In Mpwapwa, *An. gambiae* were collected in Chogola (31.7%) and Kibakwe (68.3%). No mosquito was collected in villages in the highlands.

The number and density (mosquito per room) collected in the two districts is summarised in Table 1 and 2. The overall indoor resting density of *An. gambiae* as determined by PSC in Iringa and Mpwapwa was 8 and 0.6 mosquitoes per room, respectively, whereas the overall density of the host-seeking *An. gambiae* in Iringa and Mpwapwa was 63.9 and 2.9 mosquitoes per room, respectively. Light trap

Table 1: Number and density of mosquitoes per room collected in Iringa using light trap and pyrethrum spray catch (PSC) techniques

Trapping technique	Village	<i>An. gambiae</i>		<i>An. funestus</i>		<i>Cx. quinquefasciatus</i>	
		Total	Density	Total	Density	Total	Density
Light trap	Idodi	406	135	2	0.7	71	23.7
	Mangalali	297	99	1	0.2	11	2.2
	Kilolo	0	0	0	0	1	0.3
	Total	703	63.9	3	0.3	83	7.5
PSC	Idodi	50	4	1	2	11	0.9
	Mangalali	232	21	0	1	8	0.7
	Kilolo	0	0	0	0	3	0.2
	Total	282	8	0	3	22	0.6

Results

A total of 1291 mosquitoes were collected, of which 887 were collected by light traps and 404 by indoor pyrethrum spray catch technique. Of the collected mosquitoes, 79% (N= 1026) were *An. gambiae* s.l., 0.2% (N= 3) *An. funestus*, and 20.3% (N= 262) *Culex quinquefasciatus*. Other species including *Cx. cinereus*, *An. coustani* and *Aedes* spp accounted for

collections gave an overall estimate of the density of *An. gambiae* of 63.9 and 2.9 mosquitoes per room in Iringa and Mpwapwa, respectively. Mosquito densities were found to range from 0 to 135 and 2.6 to 3.5 per room in Iringa and Mpwapwa, respectively. *An. funestus* mosquitoes were collected in Mangalali (N=1) and Idodi (2) villages only. None of the *An. gambiae* dissected in the two districts was infected with malaria sporozoites.

Table 2: Number and density of mosquitoes per room collected in Mpwapwa using light trap and pyrethrum spray catch (PSC) techniques

Trapping technique		Village	<i>An. gambiae</i>		<i>An. funestus</i>		<i>Cx. quinquefasciatus</i>	
			Total	Density	Total	Density	Total	Density
Light trap	Kibakwe	13	2.6	0	0	75	15	
	Chogola	7	3.5	0	0	3	1.5	
	Mwanawota	0	0	0	0	0	0	
	Total	20	2.9	0	0	78	11.1	
PSC	Kibakwe	15	1.66	0	0	67	7.4	
	Chogola	6	0.5	0	0	12	1.0	
	Mwanawota	0	0	0	0	0	0	
	Total	21	0.6	0	0	79	2.4	

Discussion

An. gambiae s.l. was the predominant malaria vector in the two districts. Larger numbers of *An. gambiae* were collected in villages at altitudes lower than 1600m. Although in this study, *An. gambiae* was not found in the highlands in both Iringa and Mpwapwa districts, in another study the species was the only indoor biting malaria vector collected and was found in villages both at lower and higher altitudes (Mboera *et al.*, 2002).

The malaria infectivity rates of the mosquito in the previous study were 5.3 and 4.2%, in Iringa and Mpwapwa, respectively (Mboera *et al.*, 2002; 2006). Like in our current study, an entomological survey carried out in villages of Mtera area, in the northern part of Iringa district in April and May 1994 showed variations in the densities of *An. gambiae* between the study villages (Njunwa & Msuya, 1994). The authors recorded an average density of 25.2 and 0.7 for *An. gambiae s.l.* and *An. funestus* females per room, respectively; with sporozoite infectivity rate of 3.4% in *An. gambiae s.l.*

A survey carried out during the rain season of 1973 in Mpwapwa found that mosquito numbers were low and no sporozoite-infected mosquitoes were recorded (Bushrod & Magayuka, 1973). With such low numbers of malaria vectors, a low to moderate malaria transmission is likely to be a common feature in the districts, making the districts malaria-epidemic prone. A number of malaria epidemics have been reported in Mpwapwa district in recent years (Mboera *et al.*, 2005) In 2001, Mboera *et al.* (2002) carried out an entomological study in the same villages and *An. gambiae s.l.* was the only malaria mosquito collected. *An. gambiae s.l.* was found in all villages, both at low and higher altitudes. On average, a density of 1.5 *An. gambiae s.l.* per room was found in the study villages. Higher sporozoite rates were found in Wangi, Kibakwe and Makose (Mboera *et al.*, 2002).

In the current study, a larger number of *An. gambiae* was collected when light traps were used indoors. It is likely that in this and most of the other studies, the low number of *An. gambiae* caught was

due to the trapping technique used. Already, Mnzava (1984) has shown that the majority of the *An. gambiae* complex species in Iringa composed of *An. arabiensis*, which is endophagic but exophilic. This means most of the mosquitoes will rest outdoors after a blood meal, hence only a few of them are likely to be caught by an indoor pyrethrum spray technique. On the other hand, the light trap catch: spray catch ratio in Mpwapwa was similar indicating most probably, the presence of an endophilic-endophagic mosquito.

Light traps have proved exceptionally useful for catching endophagic malaria vectors in Tanzania (Lines *et al.*, 1991; Mboera *et al.*, 1998). Light traps are useful as they provide more information on the specific composition of the *Anopheles* fauna during a period of high *Anopheles* density (Joshi *et al.*, 1975). Moreover, light trap may also attract and capture resting mosquitoes, which have been shown to have a higher sporozoite rate than host-seeking ones (Petarca *et al.*, 1991).

Some species of malaria vectors are known to rest in houses before and/or after feeding on man or other hosts. Although indoor spray collections give a good estimate of the mean house resting density in a given area, it may not necessarily give a good estimate of entomological inoculation rate. This is due to the fact that sampling indoor-resting mosquitoes tends to miss the mosquitoes that leave the house immediately after feeding, and may include those that enter after feeding outdoors on other hosts (Mboera, 2005). Studies to identify member of *An. gambiae* species complex are necessary to address this problem.

Despite the low number and absence of sporozoite infected *Anopheles* mosquitoes in the two districts, malaria prevalence in the area ranges from 0-78%, being higher in the lowlands and absent in the highlands (Mboera *et al.*, 2006). This indicates that malaria transmission is taking place, but most likely is seasonal in nature. This study represents a snapshot of a scenario in many highland areas of Tanzania where malaria epidemics have been reported in recent years but only very low numbers of malaria vectors have been identified (Mboera *et al.*, 2002, 2006;). Like in our previous studies (Mboera *et al.*, 2002), the

current study in Mpwapwa and Iringa were carried out during the rain season (potential high transmission season). The low mosquito densities observed in the two districts are likely to be due to several factors including trapping technique and mosquito behaviours. More intensive longitudinal studies are currently being planned to complement these results.

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