Sampling mosquitoes with CDC light trap in rice field and plantation communities in Ogun State, Nigeria

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Abstract: Mosquito species were sampled to determine the mosquito composition and abundance in rice field and plantation communities in Ogun State Nigeria. Mosquitoes were caught once weekly from four selected houses in each of the two communities by means of CDC light traps. A total of 47,501 mosquitoes representing fifteen species were caught in the two communities of which the rice field community accounted for 63.8% of the total catch. *Mansonia africana* constituted the most important biting mosquito in the two communities representing 62.1% and 39.1% in rice field and plantation communities, respectively. Other species in decreasing order of abundance were *M. uniformis, Anopheles gambiae, Coquilletidia fuscopennata, An. moucheti, An. funestus, An. nili, Culex quinquefasciatus, Eretmapodites chrysogaster, Coq.metallica, Cx annulioris, An. rhodesiensis, Aedes aegypti, An. squamosus* and *An. maculipennis.* Seven mosquito species were caught throughout the year but mostly in the months of May to October. Abundance varied significantly between the study sites and between the months ($F,_{1.11}$ =241.9 P<0.05) Most of the mosquitoes collected were unfed and nulliparous (87.1%). In spite of the high proportion of *M. africana,* its parous rate was low 0.53 and 0.59 in rice fileld and plantation, respectively. The highest parity was seen in *Ae. aegypti* (0.81-0.86) and *An. gambiae,* (0.69-0.68).

Key words: light trap, mosquitoes, rice field, plantation, sampling, Nigeria

Introduction

Due to demographic pressure, there have been more and more large-scale environmental modifications for agricultural purposes such as rice cultivation or fish farming (Carnevale *et al.,* 1999). However, according to Robert *et al.* (1992) what may appear as the same modification such as rice fields could lead in different areas to quite different entomological and hence epidemiological consequences. For example, Anopheles mosquitoes are well known to be very adaptable to increasing ecological and environmental changes because of their high level of genetic diversity and plasticity (Coluzzi, 1994).

Anopheles species have been reported to be able to adapt themselves to the various ecological circumstances provided by all stages of rice culture (nursery, watering, planting, growing, tilering, maturation, harvesting, land fallow, etc.) (Carnevale *et al.,* 1999). Also irrigated rice fields represent ideal breeding sites for mosquitoes and they can generate large number of individuals. Depending on the number of cropping cycles, irrigated rice cultivation may also extend the breeding season of mosquitoes and hence increase the annual duration of transmission (Ijumba & Lindsay, 2001).

Before using any vector control measure, it is necessary to obtain as much knowledge as possible of the target vector. Sampling mosquitoes is a prerequisite to most vector population studies and depending on the objective of the exercise a variety of sampling methods can be used (Githeko *et al.,* 1994). Resting behaviour of many anophelines and some culicines is often assessed using Pyrethrum Spray-sheet collections (PSC) in houses, while biting behaviour is determined by carrying out human or animal bait collections. Service (1977, 1993) and Coluzzi & Collins, (1986) have pointed out the logistical problems involved in carrying out reliable human-bait collections. For example, a large number of field staff are required and hence this makes the exercise labour intensive and usually expensive (Chandler *et al.,* 1975). For this and other reasons entomologists have tried to develop alternative methods to human-bait collections.

Of the several tools used for sampling indoor host-seeking Afro-tropical mosquitoes, the CDC light trap has been mostly employed with varying degrees of success (Garrett-Jones & Magayuka,

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1975; Maxwell *et al.,* 1990; Lines *et al.,* (1991; Mboera *et al.,* 1998). The usefulness of CDC light trap in mosquito sampling has been reviewed in detail by Service (1977, 1993) and recently by Mboera (2005).

In the present study mosquitoes were collected indoors with CDC light-traps to determine the species composition and abundance of nocturnal host-seeking mosquitoes in Ajana-Liyebi, a rice growing village in Obafemi-Owode Local Government area and Ikenne farm settlement in Ikenne Local Government area of Ogun, State Nigeria.

Materials and Methods

Study area

The study was carried out in Ajana-Liyebi, a village in the rice belt and Ikenne farm settlement in Ogun State, South Western Nigeria. Ajana-Liyebi is 40km south of Abeokuta, the Ogun State capital. Most of the buildings consisted of mud walls, thatched or iron roofs with open eaves that could allow easy access to mosquitoes. To the east of the town is a very large expanse of land separated from the village by a tributary of Ogun River, which is usually flooded during the rain season. The flooded water is diverted and used for rice irrigation during the dry season. The inhabitants are mainly farmers and fishermen. They grow lowland and upland rice as well as maize and cassava.

Ikenne farm settlement is located within the Ogun State Ministry of Agriculture Rubber and Oil palm plantation located along Ikenne-Sagamu road. The oil palm plantation is about 6km off Lagos-Benin express road and lies on the margin of the lowland rainforest. Moist forest of several types covers the remainder of the reserve except for the areas of plantation.

Construction of CDC light traps

All light traps were constructed at the workshop of Electrical Engineering Department, University of Ibadan, Nigeria. The body of the trap consisted of a 9.8cm diameter and 14.8cm long plastic drainage pipe. A 6.0 volt motor from a radio cassette (tape recorder) was fitted inside halfway up the pipe with a 2.2cm wide iron bracket. A 0.4mm gauge aluminium sheet was shaped into a 4.2cm radius fan blade and soldered on to the axle of the motor. At the top of the trap a 6.0volt rechargeable lamp bulb was fitted in a 1.4cm iron blade. A 6 volt rechargeable battery was connected to the trap. All plugs were made of stainless steel to prevent rusting, which causes low conductivity and consequently reduces power input to the motor and the bulb. The voltage of the battery was maintained at 6.0 volt by recharging after every use. Each trap was fitted with a handle for suspending the trap with string to a convenient part of the roof of a house. Mosquito collecting bags were made from white mosquito netting material attached to the bases of the trap with the aid of an elastic rubber.

Collection of mosquitoes

CDC light-trap collections were carried out in a homestead at Ajana and Ikenne communities and were placed in 4 houses where untreated bed nets were provided. Only one trap was used in each house on each night of trapping. In each house the trap was suspended from the roof near a bed net and about 25cm above the ground. The bases of the traps were wetted with water while the strings suspending the traps were greased with Vaseline to prevent ants getting into the catching bags and eating the mosquitoes. Cotton wool soaked with sugar solution was placed in the trap collection bag under a small sheet made of perforated and inverted paper cup to provide food for the mosquitoes so as to minimize deaths from starvation. The traps were operated once weekly between July 2001 and June 2002. Traps were switched on at 21:00 hour local time and sleepers were instructed to switch them off at 05:00 hour after having tied the neck of the collection bag.

All mosquitoes collected in the traps were removed from the catching bags and placed in 10ml EDTA bottles and labeled according to where and when they were collected. Both live and dead male and female mosquitoes were counted and identified morphologically to species using Gillet's (1972) keys, and their gonotrophic stages recorded. The female mosquitoes were dissected to determine parity by observing the degree of coiling of tracheoles (Detinova, 1962). Only females whose ovaries were in stages I and II of Christophers (1911) were considered for parity determinations.

Table 1: Species composition and relative abundance of mosquitoes trapped in Ajana and Ikenne

Species	Ajana		Ikene		Total
	No. of adult mosquitoes	% Catch	No. adult mosquitoes	% Catch	% Catch
Mansonia africana	18,803	62.0	6,719	39.1	53.7
Mansonia uniformis	3,594	11.9	1,789	10.4	11.3
Coquilletidia fuscopennata	2,646	8.7	1,670	9.7	9.1
Anopheles gambiae	2,115	7.0	1,554	9.0	7.7
Anopheles moucheti	1,628	5.4	1,900	11.0	7.4
Anopheles funestus	633	2.1	1,556	9.1	4.6
Anopheles nili	433	1.4	804	4.7	2.7
Culex quinquefasciatus	395	1.3	823	4.8	2.6
Others	1,778	5.9	381	2.2	0.9

Data analysis

Correlation between abundance of mosquitoes in night catches and months were analysed by Spearman's rank order coefficient (Siegel, 1956). ANOVA test was used to compare the frequency of parous female mosquitoes in the two study sites.

Results

A total of 47,501 mosquitoes belonging to fifteen species were caught in the two communities (Table 1). *Mansonia africana* constituted the most important house entering mosquito in the two communities representing 62.1 and 31.1% in rice field and plantation communities, respectively. This was followed by *M. uniformis* (11.3%), *Coquilletidia fuscopennata* (9.1%), *Anopheles gambiae* (7.7%), *An. moucheti* (7.4%), *An. funestus* (4.6%), *An. nili* (2.7%) *and Culex quinquefasciatus* (2.6%). Other species, accounting 0.9% of the total catch included *An. maculipennis*, *Ae. eagypti, An. rhodesiensis, An. moucheti, Cx annulioris, Coq. fuscopennate, Eretmapodites chrysogaster* and *An. squamosus.*

The species compositions found at Ajana and Ikenne were similar. However, *An. maculipennis* was absent in Ajana but present in Ikenne. *An. rhodesienses* and *Coq. metallicus* were present in Ajana but absent in Ikenne. When the species were pooled there was a correlation between abundance of mosquitoes and months ($r = 0.938$ $P<0.01$). However, abundance of mosquitoes varied significantly between the study sites and between the months ($F_{1, 11} = 241$; $P< 0.05$).

Table 2: Gonotrophic stages (%) of mosquitoes collected in light traps at Ajana and Ikenne

Species	Unfed	Blood fed	Half gravid	Gravid	No. of mosquitoes caught
Anopheles gambiae	87.1	11.0	0.1	1.9	3,669
An. maculipennis	97.7	0.2	0.3	1.8	52
An. nili	89.6	10.0	0.2	0.2	1257
An. funestus	98.6	0.3	0.2	0.9	2189
An. moucheti	98.8	0.4	0.1	0.7	3528
Co. fuscopennata	73.4	20.6	3.8	2.2	4316
Mansonia africana	59.9	24.3	11.6	4.2	25522
M. uniformis	58.8	29.8	10.2	1.2	5383
Culex quiquefasciatus	84.8	13.1	0.4	1.7	1218

Mosquitoes were collected throughout the year in the two study sites but in larger numbers from May through September. Mosquitoes were abundant in the moderately raining periods and less abundant in the heavy raining and hot periods. Mosquito abundance diminished in October coinciding with a decrease in rainfall.

Table 3: Parity of mosquito species caught in light traps

Species	Ajana			Ikenne		
	No. dissected	No. parous	Parity rate (%)	No. dissected	No. parous	Parity rate (%)
Anopheles gambiae	2115	1,459	69	1,554	1056	68
An. maculipennis	00	-	0	52	36	69
An. nili	45.3	312	69	804	547	68
An. funestus	633	468	74	1556	1136	73
An. moucheti	1628	1221	75	1900	1368	72
Coquilletidia fuscopennata	2646	1825	69	1670	1219	73
Mansonia africana	18803	9966	53	6,719	3964	59
M. uniformis	3594	1509	42	1,789	823	46
Culex quinquefasciatus	395	241	61	23	477	51

The great majority of Anopheles species encountered were unfed *(An. moucheti* = 98.8%*, An. maculipennis* = 97.7%*, An. funestus* =98.5% *and An. gambiae,* = 87.1% (Table 2). The highest percentage of blood fed mosquito was found in *Coq. metallicus* (31.6%) followed by *M. uniformis* (29.8%)*, Eretmapodites chrysogaster* (26.4%), *Coq. fuscopennata* 20.6% and *Ae. aegypti* (19.9%). A high parous level was observed in *Anopheles* species in both study sites (Table 3). Using t-test, the parous rate of mosquitoes in both study sites was significantly different (t-critical = 1.223, $P< 0.05$). However, comparing the parity rates of mosquito in the two study sites ANOVA test revealed a non-significant difference ($F1, 13 = 135.470$ $P> 0.05$).

Discussion

A high proportion of culicine mosquitoes namely *Mansonia* and *Aedes* spp were encountered in the two study sites. Generally mosquitoes were abundant in the wet and moderately wet seasons. *Anopheles* mosquitoes were more abundant after the rains or during the moderately rainy periods (May to October) than during the dry season. Heavy rainfall is very likely to flush breeding sites, strand larvae and pupae, cause egg mortality and therefore reduce the abundance of adult mosquitoes. This may possibly account for the fact that the population of mosquitoes in August and September was higher than in June and July when the rains were very heavy. By contrast moderate rains sustain the breeding places and facilitate their connections to waters. *Anopheles* species are known to be ground pool breeders. It is therefore noteworthy that *An. gambiae, An. nili, An. funestus, An. maculipennis* and *An. moucheti* are abundant in the study sites during the rainy seasons when ground pools are available. More ground pools were encountered in rice fields hence more *Anopheles* mosquitoes were found in the rice growing community than in the plantation. This is in line with Carnevale *et al.* (1999) observations that *Anopheles* mosquitoes are able to adapt to the various ecological circumstances provided by all stages of rice culture.

According to TDR (1994) in much of Africa the pattern of malaria transmission is dictated by rainfall patterns and altitude. For instance, in the West African Sahel region, high malaria transmission is at its peak during the period corresponding to the annual rains which provide habitats for the primary vector of malaria *An. gambiae*. Hence the abundance of *Anopheles* mosquitoes in the study sites calls for concern. *An. gambiae* and *An. funestus* are generally associated with rice fields hence a moderate proportion of both were encountered in the rice field community. Ijumba & Lindsay (2001) made a similar observation in Tanzania. *An. gambiae* and *An. funestus* are the most important malaria vectors in Sub-Saharan Africa (White, 1974) and their abundance in the area means that they are likely to play a major role in malaria transmission among the communities. The two study communities are surrounded by forest; this could account for the high proportion of *Mansonia* species encountered in the present studies.

Most of the mosquitoes collected in the two sites were unfed and nulliparous. The larger proportions of blood fed, half and full gravid female mosquitoes of *Mansonia* species in the trap collection is a reflection that most of the mosquitoes were not host-searching. It is likely that they were caught either searching for a place to rest or randomly flying around. This is important to support the fact that the mosquitoes are zoophilic and therefore of little public health importance. The majority of the anthropophilic *An. gambiae,* and *An. funestus* were caught unfed indicating that they were trapped while host-seeking.

The number of females caught in the traps in different stages of the gonotrophic cycle will depend on their population size, which will be affected by both the proportion of females that obtain blood meals and the mortalities of females in different gonotrophic stages. There is probably little flight activity of blood-fed and grand females; this will diminish the size of the aerial population sampled by light traps.

Although a high proportion of *M. africana* was encountered the parous rate was low. However, in spite of the low proportion of Anopheles mosquitoes in the 2 sites the parity rate was high for Ajana and Ikenne. The highest parity was also observed among the *Ae. aegypti* in Ajana (0.81) and Ikenne (0.80). The parity of mosquitoes in the two study sites was not significantly different. This could be so as there were no observable differences in mosquito population in the two sites. Our results show that *An. gambiae, An. funestus, Ae. aegypti* and *Cx quinquefasciatus* are present in the study sites. This is a cause for public health concern despite the small numbers because these species are proven vectors of malaria and/or bancroftian filariasis in Africa.

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