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Full Length Research Paper

Contribution of mosquito vectors in malaria transmission in an urban district of Southern Cameroon

Eric Moise Bakwo Fils[1,2]*, Patrick Akono Ntonga[2,3], Philippe Belong[4] and Jean Messi[2]

[1]Département des Sciences de la vie et de la Terre, Ecole Normale Supérieure, Université de Maroua. P. O. Box 55, Maroua, Cameroun.
[2]Laboratoire de Zoologie, Département de Biologie et Physiologie Animale, Faculté des Sciences, Université de Yaoundé I, P. O. Box 812 Yaoundé, Cameroun.
[3]Laboratoire de Biologie des Organismes Animaux, Département de Biologie des Organismes Animaux, Faculté des Sciences, Université de Douala, P. O. Box 2701, Douala, Cameroun.
[4]Département des Sciences Biologiques, Ecole Normale Supérieure, Université de Yaoundé I, Cameroun.

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In order to observe the role of vectors in malaria transmission in an urban area, a 12-month longitudinal entomological survey was conducted from January to December 2007 at Ekombitié, a central district of Ebolowa, south Cameroon. Mosquitoes captured indoors by human volunteers were identified morphologically. Among the 14.468 mosquitoes captured, three vectors were identified: *Anopheles gambiae s.l.*, *Anopheles moucheti* and *Anopheles funestus*. *A. gambiae* was the most aggressive species with 38.72 bites per human per night. *A. gambiae s.l.* was the main malaria vector at Ekombitié with 86.72% of total transmission, followed by *A. moucheti* (12.38%) *A. funestus* (0.9%). Malaria transmission occurred throughout the year and was due each month to at least two vector species, *A. gambiae s.l.* (98 infective bites/human/year) and *A. moucheti* (14 infective bite/human/year) being always involved.

Key words: Malaria, transmission, *Anopheles gambiae*, Ekombitié, Cameroon.

INTRODUCTION

Known for over a hundred years, malaria remains nowadays a major public health problem in tropical countries. Over two billion people are exposed worldwide, and about 300 - 500 million are infected each year (OMS, 2008). The annual mortality is estimated between 1.5 and 2.7 million individuals, in particular children of less than five years old. Sub-Saharan Africa recorded the highest prevalence (Malvy et al., 2000; OMS, 1998, 2000). This is also an obstacle to the development of sub-saharan Africa because of its consequences on human health and its considerable impact on livestock production. Thus the annual loss of growth due to malaria accounts for 1.3% per year in Africa (OMS, 2000). In Cameroon, malaria is by far the leading cause of morbidity (15.6%) and mortality (13%).

The most common malaria vectors in this country are *Anopheles gambiae s.l.*, *Anopheles nili, Anopheles arabiensis*, *Anopheles funestus*, and *Anopheles moucheti* (Fontenille and Simard; 2004). Recent studies in Cameroon have shown that the presence and the role of a vector species in malaria transmission vary spatially and temporally across the country (Antonio et al., 2006; Fondjo et al., 1992; Manga et al., 1992, 1997). Climate diversity and the strong pressure exerted by men on the environment through various development projects accounts for the heterogeneity of malaria transmission. Indeed, such modifications affect the distribution and the density of malaria vectors and can affect malaria transmission. According to the heterogeneity of the transmission, successful implementation of effective vector control program requires detailed knowledge of vectors species present and the dynamics of malaria transmission in each locality. Thus, this paper describes the anopheline species composition and malaria transmission dynamics in Ekombitié a district of Ebolowa,

*Corresponding author. E-mail: bakwoeric@yahoo.fr. Tel: 237 22 03 76 27.

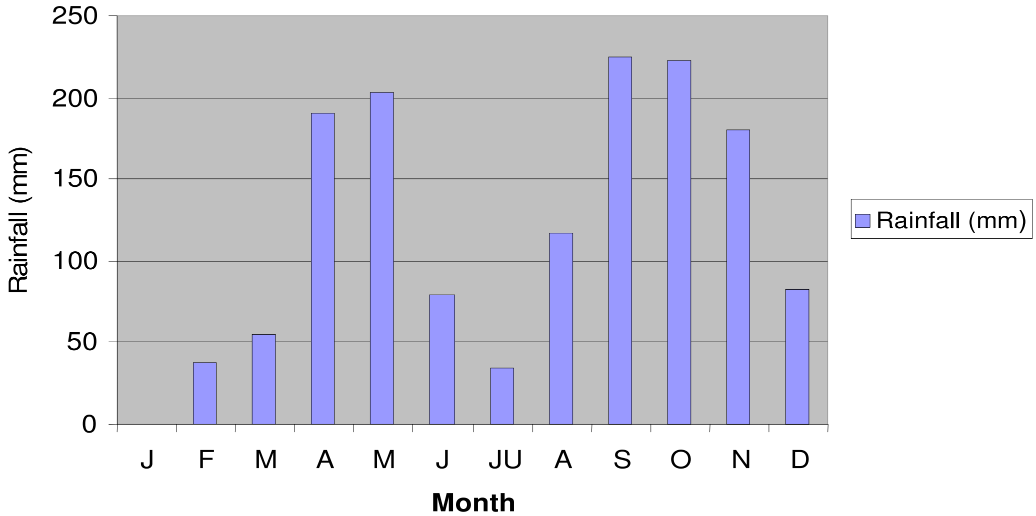

Figure 1. Monthly variation of rainfall (average) at Ekombitié in 2007. (Data obtained from the National Weather Agency).

Table 1. Density of different Culicidae caught at Ekombitié from January to December, 2007 on 192 men night.

Species	Number of individuals
Anopheles gambiae	7473
Anopheles moucheti	831
Anopheles funestus	121
Culex sp.	5218
Mansonia sp.	825
Total	14468

a locality where despite urbanization and the increase in population, few studies have been carried out.

MATERIALS AND METHODS

Study site

The region of Ebolowa (2°54' N, 11°9' E), in South Cameroon, is a lowland area where the annual rainfall average is about 1400 to 2500 mm. Usually, it rains throughout the year, with a maximum in September and a minimum in December-January. In 2007, the precipitation totaled 1425 mm with maxima in May and September (Figure 1). The annual average temperature was 24.99°C.

The town of Ebolowa is located in the department Mvila. It has a population of about 79,500 inhabitants distributed in numerous districts. Our study focuses on one district: Ekombitié. It is a central district of Ebolowa town. Urbanization is disorganized; the housing is heterogeneous and densely populated. There are lowland swamps and also a council lake which is not well taken care of in this district.

Sampling

Adult mosquitoes were collected from January to December, 2007 using human landing catches method. Samplings were performed monthly for two consecutive nights, from 18:00 to 6:00 h, indoors in four randomly selected houses. Four teams of 4 catchers each worked inside houses, every night. The first team worked from 9 pm to 1 am and the second from 1 am to 6 am. Upon collection, Anophelinae were sorted from other mosquitoes and identified to species according to the morphological identification keys (Gillies and De Meillon, 1968; Gillies and Coetzee, 1987). Anophelinae were dissected using the Detinova's method (Detinova, 1963) to determine their physiological state and to microscopically detect sporozoites in the salivary glands.

RESULTS

Mosquitoes captures

At Ekombitié a total of 14.468 mosquitoes were caught during 24 nights (192 men nights). The sample was composed of *A. moucheti, A. gambiae s.l., A. funestus, Mansonia* sp and *Culex sp* (Table 1). Anopheles mosquitoes represented 58.23% (n = 8425) of the sample and Culicinae represented 41.77%. Among the Anopheles captured, *A. gambiae s.l.*, *A. moucheti* and *A. funestus* accounted for 88.70; 09.86% and 1.44%.

The overall mean aggressivity of Anopheles species

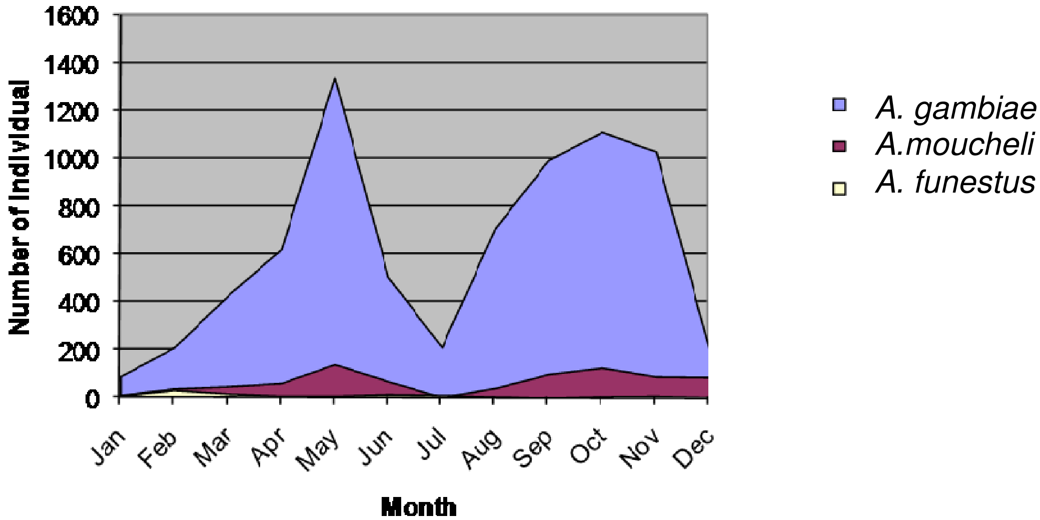

Figure 2. Monthly variation of biting rate on human for the 3 anopheline species involved in malaria transmission at Ekombitié (January – December, 2007).

was 43.88 bites per human per night (b/h/n), consisting of 38.72 b/h/n for *A. gambiae s.l.*, 4.58 b/h/n for *A. moucheti* and 0.64 b/h/n for *A .funestus*.

At Ekombitié, Anophelinae were caught throughout the year and the densities of the three species varied with rainfall. Seasonal variations of *A. gambiae s.l.* and *A. moucheti* was significantly correlated with rainfall (r = 0.908; ddl = 12; p = 0.0001 and r = 0.8270; ddl = 12; p = 0.0009) while there is no significant correlation between density and rainfall for *A. funestus* (Figure 2).

A. gambiae s.l. was the most abundant species from January to December (Figure 2). The highest densities for *A. gambiae s.l.* were recorded in May (83.81 b/h/n) and October (69.62 b/h/n) and the highest densities of *A. moucheti* in May (8.93 b/h/n) and October (8 b/h/n) (Figure 2). The two peaks of densities were observed simultaneously for both species (Figure 2). The highest density for *A. funestus* (1.93 b/h/n) was recorded in February (Table 2).

Parity rate of vectors

During the study period, the parity rate of *A. gambiae s.l.; A. moucheti* and *A. funestus* were respectively 67.17% (n = 5208); 71.95% (n = 589) and 63.85% (n = 68). The monthly parity rate for *A. gambiae s.l.* significantly correlated with density (r = 0.4727; ddl = 12; p = 0.1207), while those of *A. moucheti* (r = - 0.0005; ddl = 12; p = 0.9987) and *A. funestus* (r = 0.1206; ddl = 12; p = 0.7090) did not significantly correlate with the density (Table 2). There was a significant correlation between the parity rate and rainfall for *A. gambiae s.l.* (r = 0.5870; ddl = 12; p = 0.0448) and *A. moucheti* (r = 0.779; ddl = 12; p = 0.8098) while this correlation was negative for *A. funestus* (r = -0, 1065; ddl = 12; p = 0.7417).

Infectivity of vectors

The overall infectivity rate for the three vectors was 1.33%, consisting of 3.54% (n = 3065) for *A. gambiae s.l.*; 0.44% (n = 453) for *A. moucheti* and 0.02% (n = 20) for *A. funestus*. Infections are recorded for *A. gambiae s.l.* and *A. moucheti* throughout the year with two peaks in May and October (end of the rainy seasons), while there was no transmission for *A. funestus* in April, August and October (Figure 3). There was a positive correlation between infection rate and density in *A. gambiae s.l.* (r = 0.4727; ddl = 12; p = 0.1207) and *A. funestus* (r = 0.1206; ddl = 12; p = 0.7090), whereas this correlation was negative for *A. moucheti* (r = - 0.005; ddl = 12; p = 0.9987).

Malaria transmission

The annual average of the entomological inoculation rate (EIR) was evaluated to 3.11 bites of mosquitoes (*A. gambiae s.l., A. funestus, A. moucheti*) infected/man/ night). Throughout year, each man at Ekombitié had received at least 113 infected bites (ib/h/y), or 98 ib/h/y for *A gambiae s.l.*; 14ib/h/y for *A. moucheti* and 1 ib/h/y for *A. funestus*. Malaria transmission occurred throughout year and was due each month to at least two vector species, *A. gambiae s.l.* and *A. moucheti* being always involved. The peak of transmission was in October with 19.66 infected anophelines/man/month (Figure 3). *A. gambiae s.l.* was the main malaria vector at Ekombitié with 86.72% of total transmission, followed by *A. moucheti*

Table 2. Monthly variation of density and parity of anopheline species caught at Ekombitié from January to December, 2007.

Months	*Anopheles gambiae*		*Anopheles funestus*		*Anopheles moucheti*	
	Density	Parity (%)	Density	Parity (%)	Density	Parity (%)
January	91	61.54	9	55.56	12	75.00
February	211	57.35	31	38.71	40	57.50
March	428	79.67	17	76.47	49	75.51
April	623	80.26	8	25.00	63	69.84
May	1341	65.92	8	100	143	74.83
June	507	58.78	14	64.29	71	80.28
July	212	65.57	11	45.45	3	100
August	711	74.82	5	40.00	42	45.24
September	997	64.89	1	100	101	69.31
October	1114	71.99	6	83.33	128	68.75
November	1032	76.26	8	37.50	91	80.22
December	206	49.03	3	100	88	67.05
Total	7473		121		831	

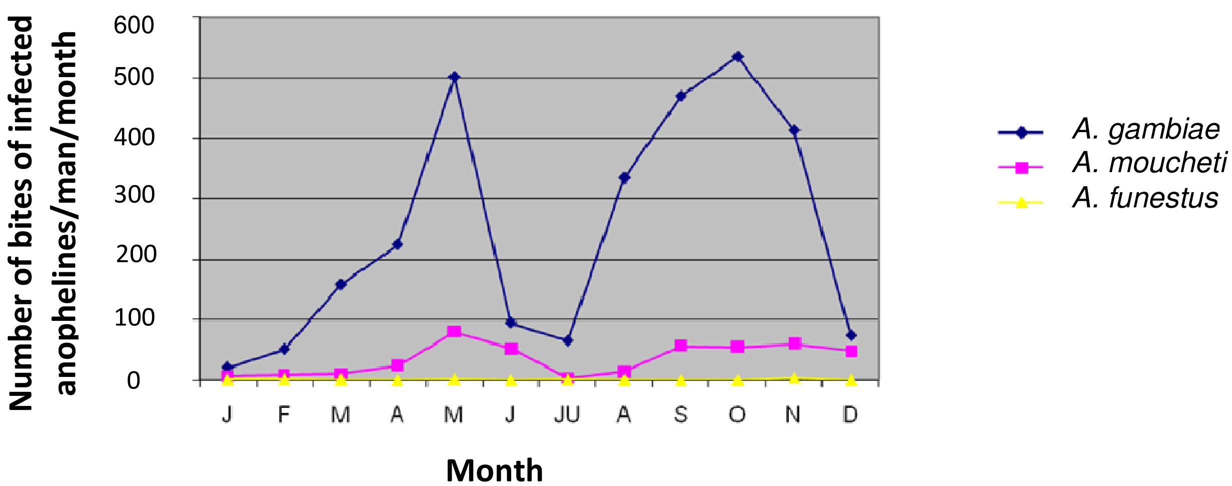

Figure 3. Monthly variation of malaria transmission of the 3 vectors at Ekombitié in 2007.

(12.38%) *A. funestus* (0.9%).

DISCUSSION

The present study revealed that three anopheline species are involved in malaria transmission in Ekombitié. Vectorial fauna at Ekombitié is composed of *A. gambiae s.l.*. (88.70%), *A. moucheti* (09.86%) and *A. funestus* (1.14%). The monthly average density of vector species is 7.39% (n = 623) for *A. gambiae s.l.*; 0.81% (n = 69) for *A. moucheti* and 0.11% (n = 10.83) for *A. funestus*. The frequency of *A. gambiae s.l.* increased from the first rains (February), reaching to its peak in May (n = 1484) and October (n = 1242). The highest frequency of *A. funestus* was observed in February (n = 31), and the lowest was observed in September (n = 1). These results are similar to those observed by Sangare (2000) and Touré (1983). They found that the frequency of *A. gambiae s.l.* and *A. funestus* varied inversely.

Despite the presence of the Council Lake in this district, malaria transmission at Ekombitié is permanent and correlates with rainfall patterns. This observation is consistent with observations in tropical regions (Mouchet et al., 1993). *A. gambiae s.l.* is the main malaria vector in the study site. This species is responsible for about 86.72% of the transmission recorded during the study period. This result is similar to those observed in most African cities (Coene, 1993; Lindsay et al., 1991; Robert et al., 1988; Rossi et al., 1986; Vercruysse and Jancloes, 1981).

The seasonal distribution of frequencies of the three species could be explained by differences in adaptation to environmental conditions (temperature and humidity). The same observation was made by Toure et al. (1983); Coulibaly (1985) and Traoré (1989).

Previous studies conducted on urban malaria in tropical Africa cities showed that seasonal variations among vectors in the same area are explained by an adaptation to the temperature and humidity (Coulibaly, 1985; Traoré, 1989; Touré et al., 1983). Our observation in the town of Ebolowa confirmed this view.

In conclusion, the contribution of *A. gambiae s.l.* in the transmission of malaria at Ekombitié is higher than those of the other two vector species. The results arrived at show that the contribution of anophelinae species in malaria transmission depends more on changes in their densities than on the susceptibility of infection of the different species.

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