International Journal of Biosciences (IJB)
ISSN: 2220-6655 (Print) 2222-5234 (Online)
Vol. 2, No. 3, p. 50-57, 2012
http://www.innspub.net

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RESEARCH PAPER OPEN ACCESS

Vectorial composition and dynamics transmission of malaria in Aguégués, A Fluvial, Lagoon, Coastal and Lacustrine commune of Benin

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Received: 24 February 2012
Revised: 02 March 2012
Accepted: 02 March 2012

Key words: *An. melas*, *An. gambiae*, Aguégués, malaria, transmission.

Abstract

Ecosystems characterized by brackish waters are favorable for the development of *An. melas* during dry season and of *An. gambiae* during the rainy season. A longitudinal entomological monitoring was conducted in Aguégués, a fluvial, lagoon, coastal and lacustrine commune of Benin from January to December 2010. It was to identify the vectors responsible for malaria and to study the vector transmission by the capture of mosquitoes on human volunteers inside and outside the rooms. 4 capture sessions were conducted each month by six internal catchers and six outside catchers, 48 men nights per month or 576 men nights during the whole study. About 10,800 mosquitoes captured, we counted 6734 *An. melas* and 4066 *An. gambiae*. The composition varies according to during flood periods or flood recession. *An. melas* represents 90.46% in flood recession and *An. gambiae* 8.54%. During flood periods, *An. melas* represents 7.02% and *An. gambiae* 92.98%. Gradually we leave the coast; the vectorial composition differs during times of flood or recession. The entomological inoculation rate is related to the flood periods or flood recession and the species of Anophele. It is 9.22 pi/h during the period from June to October for *An. gambiae* and 0.015 pi/h from January to May and 0.032 pi/h from November to December for *An. melas*. This study allowed us to know the malaria vector species and the transmission dynamics of malaria parasites in the commune in order to take the vector control measures in times of transmission.

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Introduction

Environments characterized by the presence of a complex of lakes and lagoons, most of which communicate with the sea ecosystems are favorable to malaria. These stretches of brackish water are favorable to the development of Anopheles melas in the dry season and of An. gambiae during the rainy season Malaria transmission in this environment depend on the population dynamics of these two species which the infectivity about the Plasmodium falciparum is not the same. (Akogbéto *et al.,* 1999; Coz *et al.,* 1966). Furthermore, epidemiologically, this apparently homogeneous environment shows different biotopes of transmission. One of the villages built on the lakes of brackish water has been recently described (Akogbéto, 1995). This is the case of Ganvié, a village built on stilts whose ecosystem offers to gambiae and melas species the adaptation options, the first can tolerate some freshwater gites and the second, the relatively high salinity rates (Akogbéto, 1995). Because of their ecological characteristics, other biotopes probably not yet described, affect malaria transmission in the lagoon environment. The commune of Aguégués located between Lake Nokoué, the river Ouémé and lagoon of Porto-Novo is subject to flooding in the least rainfall each year, encouraging the establishment of Anopheles gites and sustaining large populations of An. gambiae compared to what is reported in the cities of tropical Africa continental (Robert *et al.,* 1986; Trape *et al.,* 1987). In a longitudinal study, we observed the population dynamics of vector species that transmit malaria in different biotopes of the coastal lagoon areas, the variation in inoculation rates in these zones, the vector Anopheles gambiae competences, the influence of urbanization on malaria transmission, the action of the flood periods and flood recession and the changes in the salinity gites on the anopheline population.

Material and methods

The commune of Aguégués consists of three districts each of which is an island of alluvial accumulation accommodated in the low part of the river Ouémé. The sampling of anopheline populations was conducted from January 2010 to December 2010 by night captures on human subjects. The captures were conducted inside and outside of twelve houses four of which by district, from 6:00 p.m. to 6:00 in the morning to the rhythm of four consecutive days per month. These places of capture did not change throughout the study. They were selected according to their location (four houses in each of the three Borough of the municipality, the Borough of Zougamè surrounded by the lake Nokoué and the lagoon of Porto-Novo, the Borough of Houedomè surrounded by the lagoon of Porto-Novo and the river Ouémé, the Borough of Avagbodji surrounded by the river Ouémé and a tongue of land that connects it to the commune of Dangbo). The capture sessions were conducted with a team of 12 catchers who worked from 6:00 p.m. to 6:00. In each survey, there are six catchers inside the rooms and six catchers outside. Mosquitoes were captured when they settled on the legs of volunteers catchers (Le Goff et al., 1997). The mosquitoes captured were kept individually in hemolysis tubes plugged with cotton and arranged by dwelling (Gilles MT. *et al.,* 1987; Hervé JP. *et al.,* 1961). They were identified in the following morning according to the species key of EDWARDS (Edwards, 1941), of GILLIES and DE MEILLON (Gilles & De Meillon, 1968). The mosquitoes were counted per point of capture to determine the entomological parameters of transmission. Dissections of the ovaries and salivary glands were made the following morning on lots sampled by point of capture. The physiological age of females was determined on the aspect of ovarian tracheoles (Détinova, 1963). The sporozoites were investigated with an optical microscope in the salivary glands fresh between slide and coverslip in a drop of physiological water. Density aggressive (number of bites per man per night [p/h per night]), the infection rate (%) and parous (%) were calculated using standard methods previously described by Fontenille et al in 1997. The entomological inoculation rate (EIR) has been expressed in the number of bites per man per year, it has been calculated by making the product of the average annual infection rate (%) and average density aggressive (p / h per night) × 365 days. The determination of the index of the palps is based on the relationship between the length of the fourth and fifth segments of the palps and that of the third. This index is a character of distinction between An. melas and other fresh water species of the gambiae complex (Petrarca et al., 1983). The method is to enlighten the palps of mosquitoes in the chloral-lactophenol for 48 hours. These palps are then mounted between slide and coverslip in a drop of phenol-balsam. The measurements are conducted with an optical microscope with 10x objective with a 10x ocular micrometer. The value 0.81, for palpal index (PI) is the limit of separation between fresh water species and those of brackish water. The values of fresh water species have an index less or equal to 0.81. When the PI is higher than 0.81, it's An. melas. The thorax of the mosquito was used to search the positivity in circumsporozoite protein (CS) of P. falciparum. The detection of the CS antigen was carried out by conventional ELISA technique of Burkot et al in 1984 and Lombardi et al in 1987 with monoclonal antibodies. We used the monoclonal 2A10 conjugated to peroxidase and a chromogenic substrate ABTS to detect positive wells.

Results

Vector composition

In this study, 10,800 mosquitoes were collected from January 2010 to December 2010 for 48 nights capture (576 men-nights). The mosquito samples were mainly composed of two species of Anopheles: An. melas and An gambiae. The vector composition varied in time and in space. So from January to July, An. melas was the majority more than 95%. An. gambiae represented only 5% of accounts. From the month of August, we observed a dramatic drop of An. melas and an abundance of An. gambiae (Fig 1). It appears from this study, that the variation of anopheline species is related to the flood in the commune.

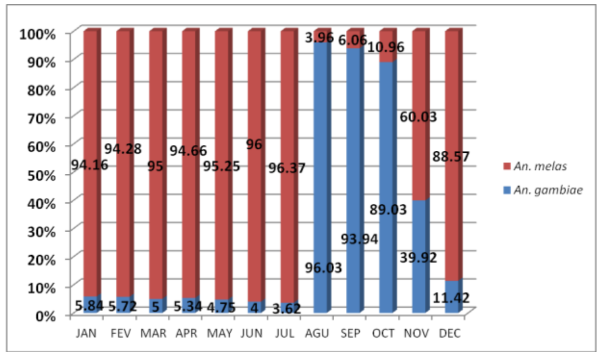

Fig. 1. Frequency of percentage of An. melas and An. gambiae species in the commune of Aguégués from January 2010 to December 2010.

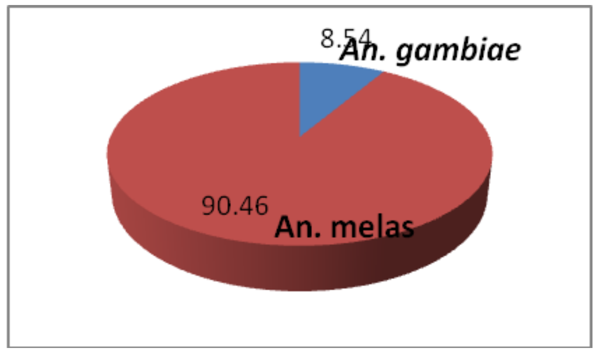

Fig. 2. Frequency of vector species in flood recession in the commune of Aguégués.

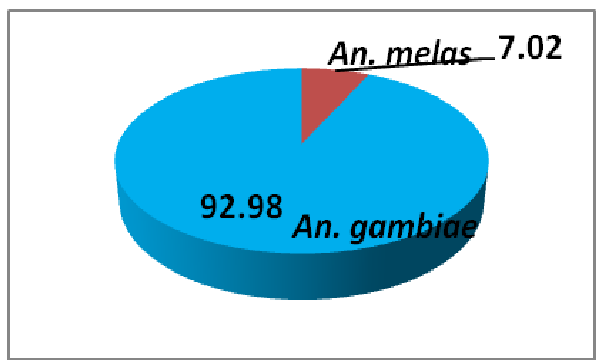

Fig. 3. Frequency of vector species in flood periods in the commune of Aguégués

Thus during the flood recession (January to July and November to December), about the 6734 Anopheles captured, An. melas represented 90.46% and An. gambiae represented 8.54% (Fig 2). Also, during the flood, there was the opposite of the phenomenon. About 4066 mosquitoes captured An. melas represented 7.02% and 92.98% An. gambiae represented 92.98% (Fig 3).

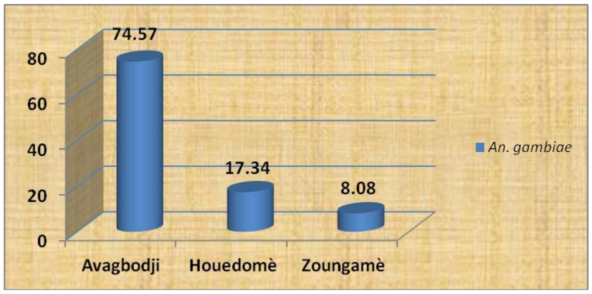

Fig. 4. Frequency of An. gambiae in flood recession in the commune of Aguégués.

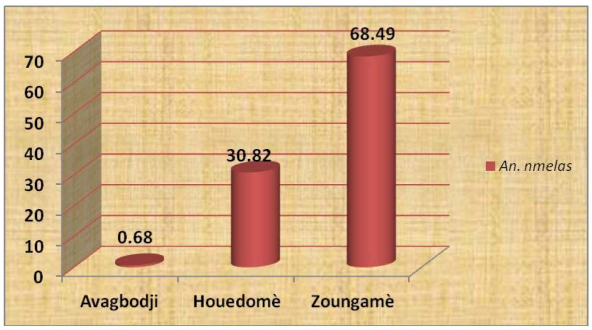

Fig. 5. Frequency of An. melas in flood periods in the commune of Aguégués.

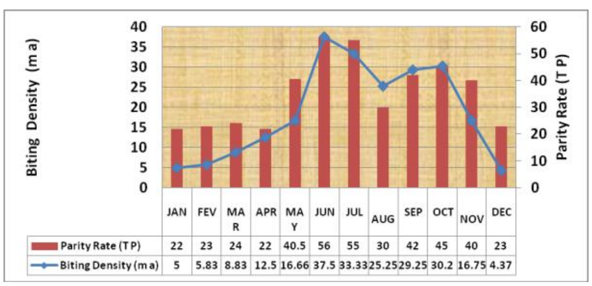

Fig. 6. Monthly trends in average bites and physiological age on Anopheles in the commune of Aguégués from January 2010 through December 2010

Further, the vector composition of the commune depends on the environment, that is to say the position of boroughs considering the flood periods or flood recession. Thus, about the 5943 An. gambiae captured during the flood recession, 74.57% were counted in Avagbodji, 17.34% in Houedomè and 8.08% in Zoungamè (Fig 4). During the flood, about 292 mosquitoes captured, 0.68% was enumerated in Avagbodji, 30.82% in Houedomè and 68.49% in Zoungamè (Fig 5).

Biting densité (m.a) and partus rate (TP)

The aggressive daily density was estimated of 18.74 p/h per night for all Anopheles. It was 7.58 p/h per night for An melas and 11.16 p/h per night An. gambiae. The highest aggressive density was observed in June and the lowest was observed in December. The average parity rate was estimated to 56.5% for An. gambiae.

The maximum parity rate was reached in June (TP = 56 %) and the minimum in January (TP = 22%) (Fig 6).

Monthly biting density of anopheles in the commune of Aguégués

It is low in December, 210 catches against 1800 in June table 1. The biting density is linked to rains. Monthly biting density of anopheles in indoor and outdoor in the commune of Aguégués. Throughout the study, the aggressive density is higher for the external capture than the internal capture. The lowest densities are recorded on both sides in December (1 mosquito is captured in internal and 3 are captured in external). They present a first peak in June (12 mosquitos are captured in internal and 26 are captured in external). They present a second peak in October (10 mosquitos are captured in internal and 19 are captured in external) (Fig. 7).

Variation of sporozoitic index (s)

About 910 thorax dissected during January-May, four of them carried sporozoites. So the sporozoitic index is 2.06%. Although An. melas is overlooking during this period in the commune, the sporozoite index recorded with An. gambiae is the highest 1.81% (2 positive thorax about 110 dissected). The sporozoitic index with An melas is low 0.25% (2 positive thorax about 800 dissected). X2 = 2.38, P = 0.12. During the rainy season from June to October, the sporozoite index was 0% with An. melas and 8.11% with An. gambiae. It is 0.31% with An. melas (1 positive thorax about 315 dissected) and 1.5% with An. gambiae (3 positive thorax about 200 dissected), X = 0.93, P = 0.355 (Table 2).

Overall, the sporozoitic index is high with An. gambiae during the flood periods and is low during the flood recession. It is low for An melas during the flood recession and canceled during the flood periods (Fig 7).

Table 1. Monthly variation of the number of Anopheles catched.

MOIS	JAN	FEV	MAR	AVR	MAI	JUN	JUI	AOÛ	SEP	OCT	NOV	DEC
NB An.	240	280	400	600	800	1800	1600	1212	1404	1450	804	210

Table 2. Variation of sporozoitic index (S) and positivity in circumsporozoitic antigen of *Plasmodium falciparum* (C.S) in the *An. gambiae* complex in the commune of Aguégués.

Period	NB of thorax	*An. melas*			*An. gambiae*			Total %
		NB of thorax	C S +	%	NB of thorax	C S +	%	
JAN-MAY	910	800	2	0.25	110	2	1.81	2.06
JUN-OCT	1025	125	0	0	900	73	8.11	8.11
NOV-DEC	515	315	1	0.31	200	3	1.5	1.81
Total	2450	1240	3	0.56	1210	78	11.42	11.98

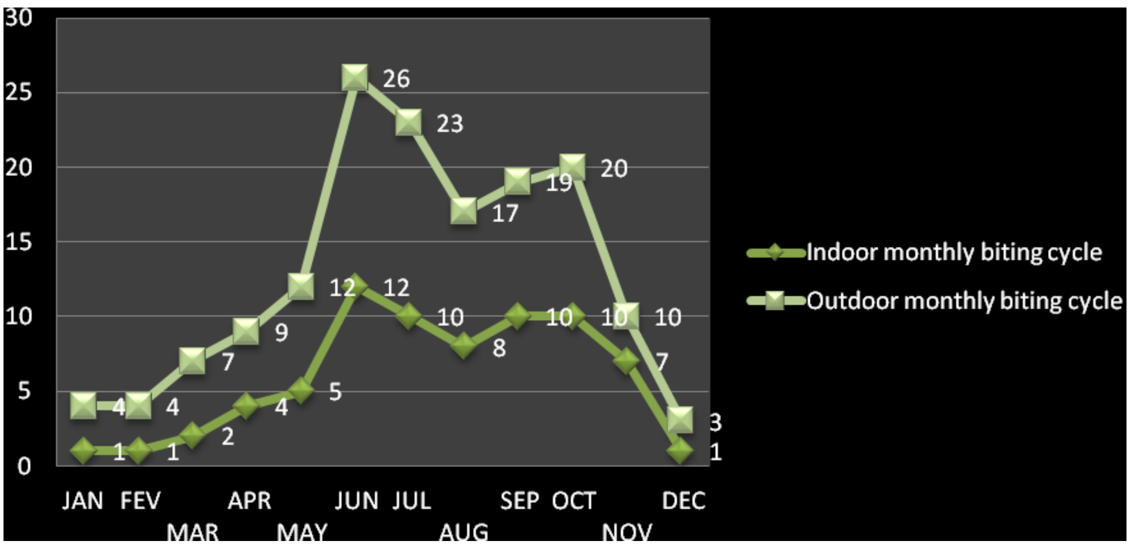

Fig. 7. Hourly biting cycle of Anopheles in indoor and outdoor dwelling in the commune of Aguégués

Entomological inoculation rate (TIE)

The entomological inoculation rate is related to the density aggressive "m.a" and the sporozoite index "s". The malaria transmission by An. melas is very low during the period from January to May and from November to December respectively 0015% and 0.032%. The transmission is null during the rainy season (June-October). As against the entomological inoculation rate during the rainy season (June-October) was 9.22 for An. gambiae. During the rainy season it recorded more than 9 infective bites in the Commune. It is 1.27 in the dry season for An. gambiae. During this period, is recorded more than one infective bite.

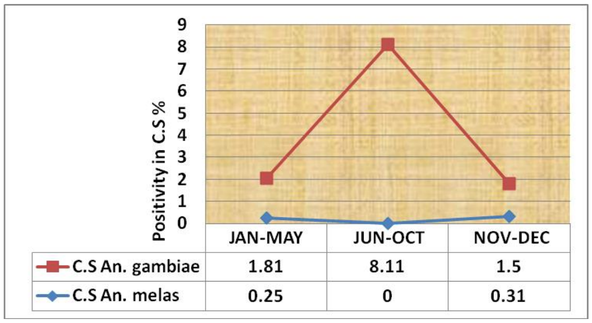

Fig. 8. Variation of infection rate of An. melas et d'An. gambiae in the commune of Aguégués.

Discussion

The knowledge of malaria vectors of a locality is essential for the study of the transmission and control of disease. Fontenille advanced the same idea in 2003. It is in this context that is part our study about the vector composition and transmission of malaria in the commune of Aguégués. The study was conducted on the twelve months of the year to assess the variation of the vector composition and transmission dynamics of vectors according to the flood period and flood recession. Two species cohabit all along the year but with variable geometry. An. melas is predominant during the dry season, more than 90% of the capture. An. gambiae in the dry season is low, less than 6%, but become predominant in rain season, especially during floods it is more than 92% of captures. These results reflect those of Akogbeto in Ganvié in 1992, an ecosystem similar to Aguégués. The agressive outdoor density is higher than that of indoor. This can be explained by the fact that the houses are closed at night and that protective measures are taken. As against, the infection rate is higher in inside than outside. This is due to the fact that people of Aguégués don't stay outside after nightfall (Konan *et al.,* 2009). The high level of aggressive rate of An. melas is accompanied by an absence of infection of the glands and a low sporozoitic index, 0.57% throughout the study while the entomological inoculation rate for An. gambiae is 9.22 only for the flood period and it is null for An. melas. This leads us to say that An. melas is a minor vector of malaria transmission in the commune of Aguégués. Malaria transmission is caused by An. gambiae. These results confirm the observations of Akogbéto in 1992. The research of sporozoites in the salivary glands by the microbiological conventional method appears to be negative. WHO / RBM confirmed these results. The sporozoite index obtained by ELISA is reliable. Microscopic observation reveals only 80% of glands positive in Elisa (Boudin *et al.,* 1988). The use of PCR as described by Scott *et al.,* (Scott *et al.,* 1993), could, in addition, identify sibling species of An. gambiae such as An. melas. In these coastal lagoon environments similar to our study medium (Coz *et al.,* 1966; Akogbeto *et al.,* 1982), it was shown the presence of a high proportion of An. melas with trends exophilic (Bryan, 1982; Akogbeto, 1995), with a very low potential for transmission An. gambiae vector and whose role is related to its behavior towards men. Whether it's during flood periods or flood recession, gradually and when you leave the coast, that is to say Zoungamè to Bemba, there is a reduction of An. melas for the benefit of An. gambiae. This could be caused by salinity, because during the flood period, salinity decreases significantly. We can say that the brackish water are favorable of An. melas development.

Acknowledgements

We thank the people of Aguégués for their participation in the study. Special thanks go to medical team of Aguégués. The study received financial support from the Ministry of Higher Education and Scientic Research of Bénin.

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