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Characterization of mosquito fauna in the sanitary district Ouidah-Kpomasse-Tori Bossito in Benin

Sahabi Bio-Bangana[1,2*], Christophe Houssou[3], Razaki Ossé[1], Patrick Edorh[2], Luc Djogbénou[1], Claude C.A. Ahouangninou[1], Michel Boko[2,3], Martin Akogbéto[1]

[1]*Centre de Recherche Entomologique de Cotonou, 06 BP 2604 Cotonou Rép. du Bénin. Téléphone (229) 21330825*

[2]*Centre Interfacultaire de Formation et de Recherche en Environnement pour le Développement Durable. 03 BP 1463 Jéricho-03 Rép.du Bénin. Téléphone (229) 97 08 11 06 Téléscopie (229) 21305550*

[3]*Laboratoire Pierre PAGNEY "Climat, Eau, Ecosystème et Développement" (Laceede) 03 BP 1122 Jéricho Cotonou Rép. du Bénin*

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Abstract

The characterization of culicidy fauna in 28 villages of the health district Ouidah Kpomassè and Tori-Bossito was carried out during five months (October and December 2007, January, March and May 2008)., Adults mosquitoes were collected by human landing caught from 22:00 PM to 06:00 AM. 44693 adult mosquitoes were caught. 29 species were identified in the 28 hamlets by taxonomic studies. The specific richness varies between 8 species (Agokon) and 19 species (Agadon), while abundance vary between 688 individuals (Hèkandji) and 4577 individuals (Kindjitokpa). Five species are common on the whole of the 28 sites: *Aedes aegypti*, *Culex annulioris*, *Culex gr. decens*, *Culex quinquefasciatus* and *Mansonia africana*. The maximal index of equitability was 0, 47 in Dokanmey showing a large spatial heterogeneity in the 28 localities. The differences noted between the 28 communities would be related to differences in the biotic and abiotic conditions in the area.

*Corresponding Author: Sahabi Bio-Bangana ✉ biobanganaa@yahoo.fr

Introduction

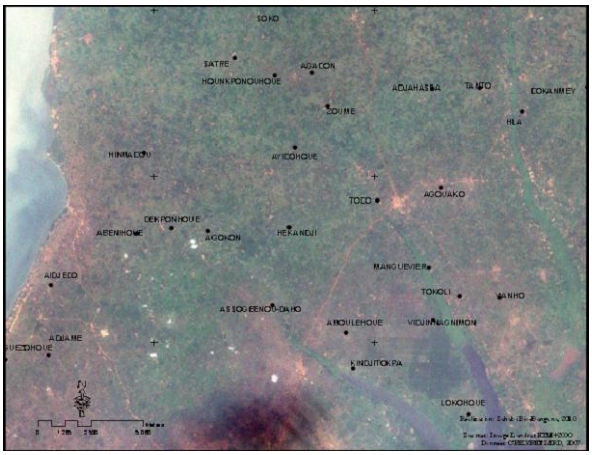
Studies from Hamon and et *al.*, (1954) as well as the exhaustive revision of the African species by Gilles & De Meillon (1968) and Gilles & Coetzee, (1987) remain until now the relevant base of documentation on taxonomy, the biology and the distribution of Culicidae in Africa. (Diagne, 1994).

The transmission of malaria and the filarioses is not homogeneous in intertropical Africa because of the éco-climatic variations. Many species of anopheles allow the transmission of malaria between human in a permanent, temporary or occasional way (Diagne, 1994). These anopheles occur in different ecological areas and have contracted trophic behaviours (Mouchet *et al.,* 2004).

Anopheles gambiae is the disease vector frequently studied in Africa. However, knowing the biogeography of these mosquitoes can provide us useful information for better understanding of their diversities, interactions etc.). Furthermore on their viability or not of their settlements (individual number and genetic diversities); their evolution (progression, regression).

In the district of Ouidah-Kpomassè-Tori Bossito (OKT) in Benin, there is no recent data on biogeography of mosquitoes since these insects are the vectors of many diseases such as malaria which kills every 30 seconds a child in Africa and which represent in Benin the main cause of morbidity and hospitalization of children less than 5 years (Kindé, 2011). Due to the consequence of malaria and filarioses disease, many strategies are developed and implemented against vectors to better control these diseases. However, based on the plasticity of the genome of the mosquitoes and their capacity to adapt to the several modifications of their environment resistance to one or more insecticides has been reported in several species of the *Anopheles gambiae* complex, the main malaria vector in these regions (OMS, 2006) and this may impair vector control strategies. This situation is occurring in the district Ouidah-Kpomassè-Tori Bossito, where the climatic and ecological conditions are favourable to the proliferation of these mosquitoes.

Rural character of this area in addition to the abundance of many dregs, made of this medium a framework favourable to the development of Anophelinae, Culicinae and Aedinae. In addition, the aspect of the dwellings and the worship lifestyle of the population could support the development of the mosquitoes.



Map. 1. Sanitary district Ouidah- Kpomasse-Tori Bossito showing the prospected localities.

Many entomological studies were carried out these last years by the Entomological Research centre of Cotonou, for the majority in little before prospected areas or not, in particular the area of Grand Popo, Malanville and Ketonou, within the framework of epidemiological studies on malaria and the filarioses (Djènontin, 2009). Within the framework of the Research project in Entomology, Formation and Strategies of preventions (REFS), entomological and epidemiologic studies were led in 28 hamlets of the health district Ouidah- Kpomassè- Tori Bossito from October to December 2007 and January to May 2008.

Within the framework of this project, it is question of using the indices of diversity, abundance and the equal distribution with other parameters to gather the 28 hamlets in 4 categories of 07 hamlets. Each category will receive a specific intervention to create anthropic disturbances being able to lead to the fall of specific

diversity and the abundance of the mosquitoes with an ultimate aim of carrying out interventions targeted against the vectorial diseases.

Materials and methods

Site of study

The present study was done from October 2007 to May 2008 in the district of Ouidah-Kpomassè and Tori Bossito (3°87' N and 11°52' E), located at the south-west of Benin (Map 1). This area is largely cleared and the original Equatorial forest does not exist anymore but in small islands of negligible extension. Currently, the vegetation is characterized by a shrubby bush, associated with more or less dense settlements of palm trees with oil, which one finds on the plates either in a natural state, or in industrial plantations (District of Gakpé). However, one can distinguish a certain number of quite distinct vegetable formations: coconuts; a bush pre-littoral consisted of tufts of rhyzophora on the current cord which finishes with the coastal lagoon; the marshy savanna more or less formed of loudetia and various cyperaceous in the low area; the shrubby thicket with prevalence of *Eleasis guineensis* ; classified plantations and forests. Apart from the hydromorphe grounds located in bottoms marshy dregs, the health district of Ouidah-Kpomassè and Tori Bossito is dominated by the ferralitics grounds. The hydrographic network is dense, made of many marshy dregs and river among which the Toho lake, the Couffo river which is thrown in the Aheme lake. The health district of Ouidah-Kpomassè and Tori Bossito belongs to the subequatorial field and its climate of the subequatorial type, shows two seasons of rains (September-November and March-June) which alternate with two dry seasons (February December and July-August). This climate is characterized by the abundance of the rains (1200 mm/year); such precipitations are very favourable to the existence of mosquitoes. They indeed represent the independent factor of immersion of the breeding sites with mosquitoes and they are mainly responsible for the main part of the surfaces of hatching (Kermogant, 1906). An annual average temperature contrasted between 27 and 31°C according to the seasons and annual thermal amplitude of 3, 5°C.

Sampling of the hamlets.

The hamlets of intervention were selected from March to June 2007, following a census of 850 hamlets covering the whole area of Ouidah-Kpomassè and Tori Bossito. These hamlets were selected according to well defined criteria (hamlet not having health centre, population considered ranging between 350 at 400 inhabitants, variation of at least 2 km between two hamlets, grouped dwellings and geographically accessible).

Larval prospection

Every 6 weeks, a larval prospection campaign was organized in a radius of 500 meters of each of the 28 hamlets of studies. The larval density of each breeding sites was measured using Bruce-Chwatt (1985) method.

Capture and Identification of anthropophiles mosquitoes

Research method consists in mosquito capturing during the months of October 2007, December 2007 and January 2008 on voluntary individuals using Human Landing Catch (HLC). Adults mosquitoes were collected during 2 nights consecutive in each of the 28 selected hamlets. The collection of the mosquitoes was made by waked up volunteers placed outside and inside 4 dwellings chosen by hamlet from 22:00 to 6:00 of following day (Djènontin and Al, 2010). The captured mosquitoes were identified by using the taxonomic key of determination of Gilles & De Meillon (1968) and Gilles & Coetzee (1987).

Data analysis

The simplest index to measure the biodiversity is the number S of categories decreases by 01 so that a collection including/understanding only one category

has a null biodiversity. This index is written: $Hr = S - 1$ and is called richness (Pavoine, 2005).

The relative abundance $P_K = \frac{nk}{N}$ or (nk = effectif of the species of row k, N=total effectif) of each species as defined by Barbault (1992) was calculated;

The index of diversity of Gini Simpson: $H_{G-S}(p) = 1 - \sum_{k=1}^{S} p_k^2$. allowed us to express the diversity (Simpson, 1949).

The equitability $Es = Is - \frac{1}{(S-1)}$ enabled us to define the equal distribution of effectives between the present species. Just like the index of diversity of Gini Simpson, Es lies between 0 and 1 (Barbault, 1992). Software PASW version 18.0 enabled us to test with the test of correlation of Pearson the relations between precipitations and the number of adults of mosquitoes on one hand and the relations between the number of adults and the number of larval breeding sites on the other hand.

Results

Specific richness of culicidienne in the health district of Ouidah, Kpomasse and Tori-Bossito

From October 2007 to May 2008, we recorded 29 species of Culicidae in the 28 hamlets (Table 1). All species belong to two sub families (Culicinae and Anophelinae) and to seven genus (Aedes, Anopheles, Coquilletidia, Culex, Erecmapodites, Mansonia and Uranotenia). The sub family of Culicinae (22 species) is approximately three times richer in species than that of Anophelinae (7 species). The Culex genus is richer in species (11 species) than the Anopheles genus (7 species); Aedes (6 species); Mansonia (2 species); Coquilletidia (1 specie); Erecmapodites (1 specie) and Uranotenia (1 specie) (Table 1). From these species of mosquitoes, 05 (belonging to the subfamily of Culicinae) were captured in all 28 hamlets. It is about: *Aedes aegypti*, *Culex annulioris*, *Culex gr. decens*, *Culex quinquefasciatus* and *Mansonia africana*.

Evolution of the specific richness according to the biotope

The specific richness or number of species varies from one village to another. The strongest specific richness was recorded in Agadon (19 species) follow-up of: Hla (18 species); Adjahassa and Soko (17 species) follow-up of Manguévier (16 species); Satré and Wanho (15 species); Agouako, Ayidohoué, Kindjitokpa, Guézohoué, Hounkponouhoué and Tanto (14 species); Adjamè and Dokanmey (13 species); Zoumè, Assogbénou Daho, Hékandji and Hinmadou (12 species); Aidjèdo, Amouléhoué, Abénihoué, Dékponhoué, Lokohoué and Tokoli (11 species). The lowest specific richness were observed in Tokoli Vidjinnagnimon (10 species); Agokon and Todo (8 species). This variation of the richness in the 28 hamlets would be related to the diversity of the larval breeding sites in the area.

Relative abundance of culicidienne fauna in the health district of Ouidah, Kpomasse and Tori-Bossito

During the study, 44693 mosquitoes were captured. The Culex and the mansonia represent the abundant genus (49. 29% of Culex and 44. 87% of mansonia of the whole of the captured mosquitoes), Aedes and Anopheles are minority (3. 25% for Aedes and 2. 55% for Anopheles). The genus Coquilletidia (0. 01%), Erecmapodites (0. 01%) and Uranotenia (0. 00%) are the genus the least met in the area. The relative abundance of culicidienne fauna by species arise as follows: *Ae. aegypti* Linné (1.58%), *Aedes gr. Palpalis* (0,09%), *Aedes gr. Tarsalis* (0.02%), *Aedes luteocephalus* (0.14%), *Aedes sp* (0.09%), *Aedes vittatus* (1.33%), *Anopheles brohieri* (0.002%), *Anopheles coustani* (0.02%), *Anopheles funestus* Gilles (1.30%), *Anopheles gambiae* Gilles (0.72%), *Anopheles nili* Théobald (0.004%), *Anopheles pharoensis* (0.44%), *Anopheles ziemanni* Gruenberg (0.07%), *Culex annulioris* (1.37%), *Culex gr. decens* (29.91%),

Culex nebulosis (6.22%), *Culex quinquefasciatus* (9.81%), *Culex tigripes* Charmoy (0.12%), *Cx sp* (0.06%), *Cx thalassius* (0.06%), *Culex duttoni* Théobald (0.12%), *Culex poicilipes* Théobald (0.04%), *Culex perfuscus* Edwards (0.004%), *Culex fatigans* (1.58%), *Erecmapodites gr. Quinquevittatus* (0.01%), *Mansonia africana* (44.84%), *Mansonia uniformis* (0.02%), *Coquilletidia aurites* (0.01%) and *Uranotenia gr. billinéata* (0.002%).

Evolution of the relative abundance of culicidienne fauna according to the biotope

Table 1. Distribution of mosquitoes abundance, Specific richness, Simpson Indice of diversity and Equal distribution Indice in the health district Ouidah Kpomassè and Tori Bossito from October 2007 to May 2008.

Hamlet	Abundance	Relative abundance	Specific richness	Simpson Indice of diversity	Equal distribution Indice
ADJAME	2446	5.5%	13	0.44	0.36
AGOUAKO	471	1.1%	14	0.53	0.45
AIDJEDO	1471	3.3%	11	0.52	0.42
AMOULEHOUE	3059	6.8%	11	0.53	0.43
ASSOGBENOU	1675	3.7%	12	0.52	0.42
AYIDOHOUE	813	1.8%	14	0.47	0.39
ADJAHASSA	1286	2.9%	17	0.49	0.43
DOKANMEY	786	1.8%	13	0.56	0.47
KINDJITOKPA	4577	10.2%	14	0.35	0.28
VIDJINNAGNIMON	2320	5.2%	10	0.55	0.44
GUEZOHOUE	1718	3.8%	14	0.38	0.30
HEKANDJI	688	1.5%	12	0.35	0.26
HINMADOU	3282	7.3%	12	0.33	0.24
HLA	2290	5.1%	18	0.24	0.18
AGOKON	795	1.8%	8	0.48	0.33
HOUNKPONOUHOUE	1006	2.3%	14	0.35	0.27
ABENIHOUE	3015	6.7%	11	0.32	0.22
DEKPONHOUE	1550	3.5%	11	0.39	0.29
MANGUEVIER	2315	5.2%	16	0.21	0.14
SATRE	882	2.0%	15	0.38	0.31
SOKO	1329	3.0%	17	0.39	0.32
TANTO	975	2.2%	14	0.56	0.48
LOKOHOUE	2456	5.5%	11	0.46	0.36
TODO	325	0.7%	8	0.51	0.37
TOKOLI	658	1.5%	11	0.46	0.36
WANHO	890	2.0%	15	0.46	0.39
AGADON	1376	3.1%	19	0.46	0.40
ZOUME	239	0.5%	12	0.35	0.26
	44693	100.0%	29		

Relative abundance vary from one hamlet to another. The higher abundance was recorded in Kindjitokpa (10. 2%) while the lowest one was noted in Zoumè (0. 5%). Table 1 in appendix indicates the distribution of this relative abundance in the other hamlets.

Evolution of diversity according to the biotope

It can be interpreted as the probability that two drawn individuals randomly in the sample be different species. It is included/understood in the interval [0; 1 [. Its value decreases with the regularity of the distribution. $H_{G-S}=0$ if only one species has a frequency of 1, $H_{G-S} = 1-1/k$ if k present species have the same $Pk=1/k$ frequency. 01 Value is reached for a number k infinite of species, of null frequencies. For an identical regularity, the index of diversity of Gini-Simpson increases with the number of species, Simpson, (1949). Index of Simpson calculated starting from the data

recorded on each locality (H_{G-S} ranging between 0. 21 and 0. 56) show that diversity in this area is very variable; the distribution of the index of diversity of Gini-Simpson per hamlet is consigned in Table 1.

Evolution of the equal distribution according to the biotope

The informations obtained with the richness and the indices of diversity are supplemented by the variations of the equal distribution of taxon within the hamlets. The values of equitability and the difference in equitability also make it possible to apprehend seasonal dynamics (Bernez, 2000). The equitability (Es) lies between 0 (only one species at a frequency of 1) and 1 (all the species have the same frequency). An expression of the equitability is often given starting from the index of diversity of Gini-Simpson (Es=Is-1/S-1) (Pavoine, 2005). The settlement of the mosquitoes of the 28 prospected sites appears heterogeneous in comparison with the value of the indices of equitability which exceeded 0. 47 forever (in Dokanmey). Nevertheless, heterogeneity is more remarkable in Manguévier (Es= 0. 14). The distribution of the index of equitability per hamlet is consigned in Table 1.

Table 2. Temporal variation of culicidienne abundance according to rain and the larval breeding sites in the health district Ouidah, Kpomassè and Tori Bossito.

Month	Abundance culicidienne	Rain	Number of Breeding sites
October _2007	18145	125.7	465
December_2007	9133	14.2	309
January_2008	2048	9.9	310
March_2008	2920	80.3	250
May_2008	13230	165.8	530

Relation between precipitation and abundance of the mosquitoes

The test of correlation of Pearson shows that the monthly variations of the adults of Culicidæ are strongly correlated with pluviometry in all the 28 hamlets (r = 0.45). The Fig. 1 and Table. 2 indicates that the abundance of the culicidae decreases systematically from October to January. It is weak between January and December. It increases in March (a few weeks after the first rains of the year), to reach a second peak in May.

Linear relation between larval breeding sites and abundance of the mosquitoes

The test of correlation of Pearson shows that the monthly variations of the adults of Culicidae are strongly correlated with the frequency of the larval breeding site in all 28 hamlets (r= 0. 68). Indeed, Fig. 2 and table. 2 indicates that the abundance of the culicidae decreases systematically from October 2007 to January 2008. It is weak between January and December. It increases in March (a few weeks after the filling of the larval breeding sites by the first rains of the year), to reach a second peak in May.

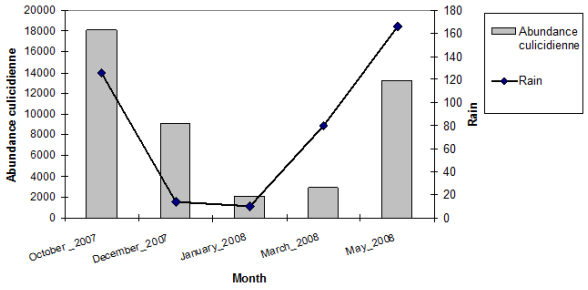


Fig. 1. Temporal variation of culicidienne abundance according to rain.

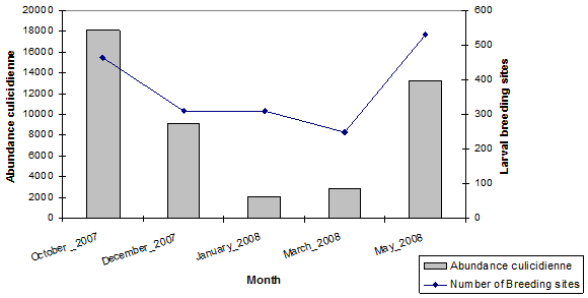


Fig. 2. Temporal variation of culicidienne abundance according to larval breeding sites.

Discussion

The study shows that the mosquito fauna in the 28 hamlets is rich and is diversified. These results

corroborate those of Djènontin et al, (2010) which working in the same site had obtained *Culex gr. decens*, *Mansonia africana*, likes the most abundant species. The weak correlation (0. 45) between pluviometry and abundance culicidienne explains a weak link between these two parameters. This correlation does not explain it only the determinants of abundance, since the test of Fisher of the linear model gives a probability of 0. 213. Pluviometry explains only 45% of the variation of abundance culicidienne. The strong correlation (r = 0. 68) between the abundance culicidienne and larval breeding sites explains a strong link between these two parameters. The larval breeding sites explain 68% of abundance culicidienne. The larval breeding sites and pluviometry do not explain alone abundance culicidienne in the area of Ouidah Kpomassè and Tori Bossito. The high abundance of the culicidae in this area would be as related to the favourable conditions as offered the anthropic activities (production of alcohol, water provision in the marshes, instrument of conservation of water not closed) and natural (proliferation of the marshes, depth of the ground water).

The strong specific richness observed in the hamlets of Hla, Adjahassa, Agadon and Soko (between 16 and 19 species) would be related on the depth of the ground water on one hand and the traditional manufacture of alcohol on the other hand. Indeed in this area, the ground water is very deep (65 meters of altitude in Agadon). This situation obliges the populations to preserve water in the barrels, the earthenware jars, basins... etc. To this comes to be added the artisanal manufacture of alcohol which accentuates the requirement of water and thus the stressing of the instruments of conservation of water in these localities and it costs the proliferation of various species of mosquitoes. These results corroborate those of Tsila, 2003 and Patrick, 2010 who working on a lake in Cameroon had noticed that the specific richness and the high abundance of the mosquitoes could be related to the favourable conditions which offered the anthropic activities (the exploitation of sand on the edges of the domestic Nkolbisson Lake and the excessive deposit of refuse by the bordering populations create favourable conditions with the development of many species of mosquitoes).

A comparative study of the recorded data shows the significant differences in indices of diversity from one site to another. Several biotic and abiotic factors would explain the strong density of mosquitoes observed during the rainy season (n= 18145 in October and n=13230 in May) compared to the dry season (n= 9133 in December; n=2048 in January and n=2920 in March). Indeed, during May and October, the repeated rains contribute to maintain a ground gorged with water. Such a ground is very favourable to the production of the larval breeding sites, since without hydrous contribution, the mosquitoes cannot develop. This situation added to the argillaceous texture of the ground of this medical area would limit the infiltration of rainwater by places, and maintains for a good period of the rainy season the temporary breeding sites of mosquitoes. Let us also underline that during this period; the sunning is moderated, which would limit the evaporation of water and the evapotranspiration by the plants. After emergence of the larvae and because of the shade of bulky vegetation, the young mosquitoes exophiles do not find any difficulty to colonize their places of rest. These factors are very favourable to the nesting and the proliferation of the mosquitoes in rainy season in opposition to the dry season.

The weak proliferation of the mosquitoes of the Aedes genus (n= 3. 25%) in a medium however favourable to their development (existence of many larval breeding sites consisted earthenware jars) was confirmed by other researchers. Indeed our results are similar to those of Karch obtained on culicidienne fauna and its harmful effect in Kinshasa in 1990. This situation would be explained by the fact that the captures started as from 10 p.m., hour in which the Aedes do not bite any more, their activities being diurnal. (Karch, 1990).

In the same time, the weak proliferation of the anopheles mosquitoes (n=2.55%) would be related to the fact that our research tasks on the capture of the mosquitoes started from October, at which time the temporary and semi permanent breeding sites of these dipterous rarefy.

The Culex and Mansonia represent the genus the most present in the health district Ouidah- Kpomassè- Tori Bossito. They pose an enormous problem of harmful effect in particular in the majority of the localities. This strong proliferation would be related to the natural factors and anthropic (retaining tanks of rainwater, water resulting from the drainage for the gardening but also to the many hollows and marsh) which maintain a permanent humidity in certain localities of this health district (Bio-Bangana, 2012).

The entomological study undertaken in the health district Ouidah Kpomassè and Tori Bossito in October and December 2007 then in January, March and May 2008 permitted to know specific diversity, the abundance and the equal distribution of the anthropophiles mosquitoes in this area of Benin. These various indices enabled us to obtain several ecological information on the viability or not of the settlements, their distribution. The fight against the mosquitoes in the health district Ouidah Kpomassè and Tori Bossito requires the taking into account of all these elements for the regrouping of the 28 hamlets in 04 groups of 07 hamlets. Anthropic disturbances or unusual factors (various strategies) in the various groups of hamlets will make it possible to make decrease the diversity and the abundance of the mosquitoes in the area. Taking into account all these geographical, cultural and entomological data about culicidian fauna in Tori-Bossito area is important to implement integrated fight method against disease vectors.

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