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Projet de recherche : Mapping of insecticide resistance of the dengue vector *Aedes aegypti* in Cape Verde

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To my parents and brothers…

…For all!

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ABBREVIATIONS

ARS – Agence Regionale de Santé, Martinique

BI - Breteau Index

Bti – Bacillus thuringiensis israelensis

BIW - Breteau Index Weighted

CI – Container (Receptacle) Index

DHF - Dengue Hemorrhagic Fever

DSS - Dengue Shock Syndrome

EC - Emulsifiable Concentrate

HI – House Index

IMCM – Integrated Mosquitoes Control Management

IVM - Integrated Vector Management

Life + - *L'Instrument Financier pour l'Environnement* de l'Union européenne

WHO – World Health Organization

ULV – Ultra Low Volume

ABSTRACT

In the absence of vaccine and chemoprophylaxis, vector control is the only effective way to fight against dengue. In this context, knowledge of vector populations is essential, and sampling the populations of Aedes aegypti give additional information of the vector and are useful to evaluate vector control activities and transmission risk.

Our investigations about **sampling the populations of Aedes aegypti** was performed in four villages of Martinique. We used the classical methods of larval indexes (House index, Container index, Breteau index), the Productivity index (Yébakima), ovitraps to collect the eggs and BG-Sentinel mosquito traps to catch adults. Although it is not shown a direct correlation between the density estimation, the vector population and the incidence of dengue, our results show that the methods used are effective and functional. Allowing calculating the different indexes in all villages of study, the recollection of 5146 eggs in total and the capture of 1948 Aedes aegypti adults. That permits conclude no systematic correlation between different kinds of indicators.

Keywords: Aedes aegypti ; Martinique ; Dengue ; Larval indexes ; ovitraps ; BG-Sentinel;

RÉSUMÈ

A ce jour, en l'absence de vaccin et de chimioprophylaxie, la lutte contre la dengue passe uniquement par la lutte contre le moustique vecteur. De ce fait, il est essentiel de bien connaître ce vecteur. L'échantillonnage des populations d'Aedes aegypti apporte des informations complémentaires sur le niveau d'infestation et utiles pour l'évaluation des activités de lutte ainsi que pour l'appréciation du risque de transmission.

Notre travail a été conduit dans 4 zones de la Martinique; dans chacune des zones, nous avons eu recours à l'évaluation des indices larvaires classiques (indice Habitation ou Maison; indice Récipient ou Gîte et indice de Breteau), l'indice de Productivité (Yébakima), l'utilisation des pondoirs-pièges et des pièges BG-Sentinel. Bien qu'il n´y ait pas une corrélation directe entre l'estimation de la densité, la population de vecteurs et l´incidence de la dengue, nos résultats montrent que les méthodes utilisées sont efficaces. Elles ont permis le calcul des différents indices dans chacun des quartiers, la collecte de 5146 œufs au total et la capture de 1948 Aedes aegypti adultes. Nous constatons qu'il n'y a pas de corrélation systématique entre les différents indicateurs appréciés.

Mots-clés: Aedes aegypti ; Martinique; Dengue; Indices larvaires; Pondoirs pièges; BG-Sentine

INTRODUCTION

Aedes (Stegomyia) aegypti Linnaeus, 1762 (Diptera: Culicidae), is the major vector of dengue and the yellow fever virus, and also vector of chikungunya and others arbovirus. This mosquito has a cosmotropical distribution between 20° S and 30° N latitudes. Originating in Africa, Ae. aegypti is now present globally in tropical and sub-tropical regions, white preference for human habitats (Zettel et Kauffman, 2009; Clemonts et al., 2010).

Dengue is the most rapidly spreading mosquito-borne viral disease in the world. In the last 50 years, incidence has increased 30-fold with increasing geographic expansion to new countries and, in the present decade from urban to rural settings resulting in approximately 2.5 billion people living in dengue endemic countries. It is estimated that 50 million dengue infections occur annually and 500,000 cases of Dengue Hemorrhagic Fever (DHF) /Dengue Shock Syndrome (DSS), resulting in 24,000 deaths annually (WHO, 2009).

In absence of vaccines against dengue and frequent dengue epidemics, the vector monitoring and control are options to preventions of outbreaks. Actuality, chemical treatment is one of most important components in integrated campaign and several studies have been developed in this matter (Lloyd, 2003; WHO, 2009). These control measures involve antivectorial and entomological surveillance, as measures to prevent epidemics of dengue and carried out with urgency in order to limit an epidemic. Interruption of dengue transmission in WHO Region of the Americas resulted from the Ae. aegypti eradication campaign, during 1960 and early 1970. However, vector surveillance and control measures were not sustained and there were subsequent reinfestations of the mosquito, followed by outbreaks of dengue in the Caribbean, Central and South America. Dengue fever has since spread with cyclical outbreaks occurring every 3-5 years (Shepard et al., 2011), and African region is now also concerned.

Control of Ae. aegypti is mainly achieved by eliminating container habitats that are favorable oviposition sites and which permit the development of the aquatic stages. Through preventing access of mosquitoes to these containers or frequently, emptying and cleaning them, killing the adult mosquitoes using insecticides or biological control agents, or combinations of these methods. According WHO, 2009, Integrated Vector Management (IVM) is the strategic approach to vector control promoted and includes control of the vectors of dengue, defined as a rational decision-making process for the optimal use of resources for vector control.

In Martinique several studies over the years compiled in Yébakima 1991, allow enumerating 21 species of Culicidae, of these, only six are anthropophilic and have role vector. Ae. aegypti, the principal vector of dengue virus currently circulating in Martinique; Culex pipiens quinquefasciatus Say, 1823 having in the past played the role of vector of Bancroft filariasis; Anopheles albimanus Wiedemann, 1820, and Anopheles aquasalis Curry, 1932, the two main local vectors of malaria (eradicated on the island after 1947). Ochlerotatus taeniorhynchus Wiedemann, 1821, capable to transmit encephalitis and Aedes busckii Coquillett, 1762, with ubiquitous distribution and which is essentially savage means may also colonize peridomestic areas. Of these, which play the role of dengue transmission, and being sort of greatest concern of public health in Martinique, actually is Aedes aegypti.

Currently the four dengue serotypes are circulating in the Caribbean, in different degrees of infectivity. In Martinique, have been recorded in recent years 5 major dengue outbreaks, in 1997, 2001, 2005 with 17000, 27000 and 14000 reported cases, respectively. In 2007, 18000 reported cases, and in 2010, the largest epidemic dengue recorded on the island, with a total of 41 970 reported cases, 644 hospitalized, 17 deaths, serotypes DEN1 (67%) and DEN4 (33%) (Yébakima, personal communication).

As the other countries where there are Ae. aegypti presence, also in Martinique, most larval breeding sites are domestic and peridomestic nature. “Démoustication” has been responsible for the work of fighting, vector control interventions and all types of activities that aims to elimination / eradication of the disease on the island, focuses on three different lines of action complementary: The Surveillance of dengue, Entomological Surveillance, and the Health Education (Etienne, 2006).

In Latin America and Caribbean, several Ae. aegypti populations show strong resistance to pyrethroids, carbamates and organophosphate insecticides correlated with elevated activities of a least one detoxification enzyme family (Marcombe et al., 2009a). In the past to control this vector, organophosphates (malathion, fenitrothion) have been used for space treatments for more than 20 years, but there is now a trend to switch to pyrethroids that has high insecticidal properties at low application rates, relatively short persistence in the environment, no bioaccumulation and low mammalian toxicity. Actually, deltamethrin, (ultra-low volume–ULV and emulsifiable concentrate EC formulations), is the main stay of adult control program. In Martinique, where dengue occurs in an endemo-epidemic pattern, larval source reduction is done by cleaning of water-holding containers, that serve as the larval habitats for Aedes mosquitoes in the domestic environment, and by using larvicide (Bti - Vectobac ®) in permanent water containers, implemented routinely. Other mechanism in

use is the space spraying, used when source reduction has failed to limit the density of adult mosquitoes (i.e., high entomological indices) or when the risk of dengue transmission is high (Macombe et al., 2009b).

High level of Ae aegypti resistance to temephos and deltamethrin was reported in Martinique. Studies recent (Macombe et al., 2009a; Macombe et al., 2009b) shown the resistance of field mosquitoes to pyrethroids associate with Kdr mutation, that reduce the efficacy of delthamethrin and synergized pyrethrins. These metabolic resistances play a key role in both pyrethroids and organophosphates resistance.

Within the Project Life + supported by the European Union, called "**Fight against nuisance mosquitoes and vectors of disease: Proposal of an integrated management compatible with sustainable development Integrated Mosquitoes Control Management"** (IMCM), that involve seven French Public Mosquito Control Operator partners, with the aims principal is to implement and/or adapt innovate approaches and better integrated to optimize mosquito control in accordance with requirements of sustainable development. The project has seven tasks, and the first – "Veille Entomologique" – has as aim principal, increased knowledge of target species and non-target species as indicators of biodiversity. Here included our work with the aim of study is sampling the populations Ae. aegypti in Martinique, using methods of density estimation of Ae aegypti in four zones of the island, by determination of larval Index, the use of ovitraps to collect eggs and utilization of BG-Sentinel traps to capture adults.

MATERIALS AND METHODS

Study areas

Sited in the Eastern Caribbean Sea at 14°40′N and 61°00′W (fig. 1), **Martinique** is an island with 400 000 habitants and a land area of 1128 km^2, is an overseas region of France, consisting of a single overseas department. This study was developed in four communities where high numbers of case was recorded during the last outbreaks of dengue in 2010.

Bélème an area of Lamentin, located in the center of Martinique in the south-west of bay from Fort-de-France (Fig. 1-A); **Tartane**, a village located on the peninsula of the Caravel in the north-east of the island (Atlantic coast) in the territory of the Commune of Trinité (Fig. 1-B); **Canal Cocotte**, located in a zone of mangrove, a small village of Ducos, (Fig. 1-C) and the last **Trois Rivières** sited in Sainte-Luce, on the south coast of Martinique, (Fig 1-D).

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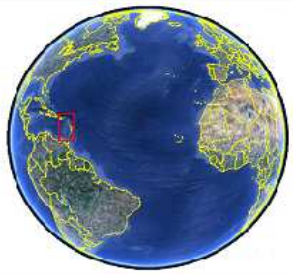
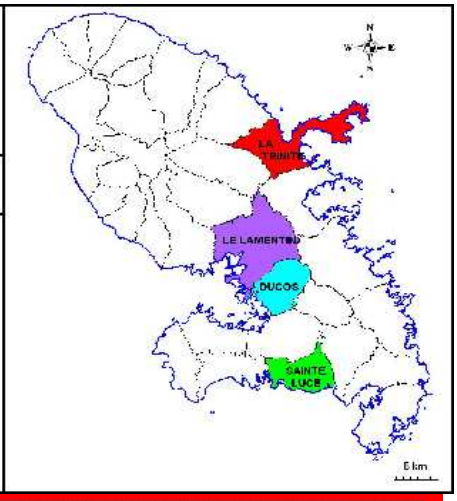
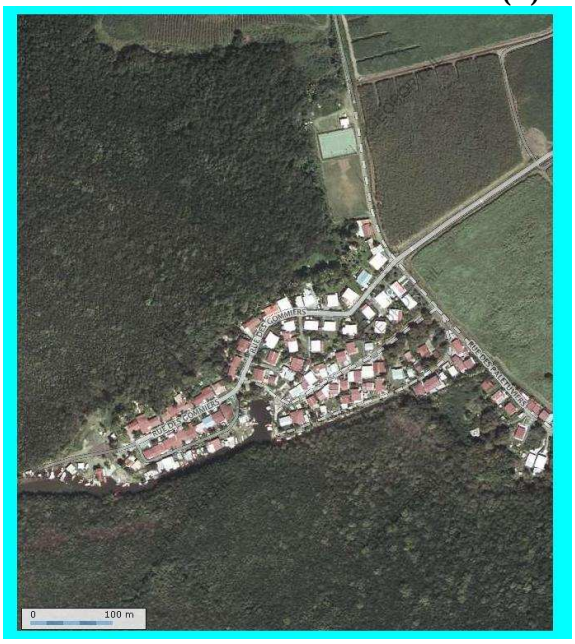
CARTE DE LA MARTINIQUE





(A)

(B)



(C)

(D)

Fig. 1 – Localization of Martinique and the four communities and respective areas of study A – Bélème, B – Tartane, C – Canal Cocotte and D – Trois Rivières. Adapted from Glogle Earth, Google Maq, Geoportial and Service Demoustication / Lutte Antivectorielle, Martinique.

Estimation of density Ae aegypti in the area of studies

Entomological larval indexes

In this study was used different Index to evaluate the domestic/peridomestic breeding sites of Ae. aegypti in Martinique. The **House Index (HI)** – percentage of positive houses; The **Container** (=Receptacle) **Index (CI)** – percentage of water holding containers that contain Ae. aegypti; The **Breteau Index (BI)** – Number of positive containers per 100 houses (Tun-Lin et al., 1996; Aburas, 2007); and the **Productivity Index**, developed by Yébakima (1991) that is a weighted Index Breteau. Each cottage is thus factor affecting productivity biting females, which makes the BI more representative. This weighted index is a tool for decisions support those actions of field interventions (Etienne, 2001).

In the 4 different areas of exploration breeding domestic and peridomestic survey was made one time per month during 3 months. The data were recorded in a form appropriate with the location of deposits in water, the type and condition (positive or negative). All cottages listed positive was physically removed, and the data was analyzed with a software appropriate used in the Center to calculate the different Indexes.

Ovitraps

Designated to collect mosquito's eggs, the first ovitraps has been made from bamboo stems severed (McCelland, 1956, in Corriveau et al., 2003). Adapted by Fay and Eliasson (1966) to characterize the adult populations of Ae. aegypti, in USA, changing the material composition, currently consists of a dark water container and paper with support nesting that is support ideal for depositing Ae. aegypti eggs. Ovitraps were deposited in ten houses per neighborhood, with two traps per house, one inside and other outside. They were placed on the ground or overhead, away from the solar ray and were collected every week and brought to the laboratory for egg counts.

BG-Sentinel mosquito trap

Developed by scientists from the Department of Zoology, University of Regensburg, in Germany, in partnership with the Laboratory of Chemical Ecology Insect Vectors –

UFMG, BG - Sentinel has been scientifically proven as best commercially available trap to catch mosquitoes, mainly of the genus Aedes. It consists of a collapsible white bucket with white gauze covering its opening. In the middle of the gauze cover, there is a black tube through which a down flow created by 12V DC (Fig. 2-A) fan that causes any mosquito in the vicinity of the opening to be sucked into a catch bag. The catch bag is located before the suction fan, therefore avoiding damage to specimens passing through the fan. The air then exits the trap through the large surface of white gauze, the design therefore generates ascending currents (Fig. 2-B). These are similar to convection currents produced by a human host, both in its direction, its geometrical structure, and, due to the addition of attractants, also in its composition. The attractants is a defined combination of lactic acid, ammonia, and caproic acid, substances that are found on human skin (Bioagents, Manual for the BG-Sentinel).

A) **B)**

Fig. 2 - The BG-Sentinel trap. **A-** Assembling the trap in Trois Rivières, Martinique, and B) Mosquitoes flying in trap vicinity are attracted by a dispenser which releases a combination of components found in human skin and are captured in the black centered catch bag (yellow arrows) and the air exits the trap through the large surface of white gauze (red arrows), generating ascending currents. Adapted by DePINA and www.bg-sentinel.com

Some independent scientific studies (Maciel-de-Freitas et al., 2006; Willians et al., 2007) demonstrate that the BG-Sentinel is an effective Ae. aegypti and Ae. albopictus trap. BG-Sentinel traps were installed indoors (inside house) and outdoors (in the peridomestic area), operated for a period ± 24 h a day. Captures were carried out weekly by each 2 zones

(total 3 experiences by each zone), and captured mosquitoes were taken to laboratory, where species identification was performed and the count of sex ratio for Ae. aegypti.

RESULTS

Our results are preliminaries because this work will be continue at least until June 2013 (the end of Life+ Project).

Starting in February until April, all experiences was repeated 3 times by each district, accompanied by entomological survey did before the project begins, in February, during the time of realization of experiences in March, and in the end of our work in the field, in April. So, with this we could calculate the different indexes that permit evaluate the density of mosquitoes in the areas of study.

Entomological larval indexes

With three experiences by each zone of studies, we could calculate the value of different indexes, that permit estimate the density of mosquito's adults in each village. In the first experience, Bélème was where the value of House Index was highest (fig.3), with 56.5%, decreased to 20.3% and in the end to 20.0%. In Tartane in the first experience was registered a value of 54.9% with a decrease in the second experience to 33.9% and in the last experience the value increased to 52.7%. The same tendency was verified in Trois Rivières, where the initial value of House index, was 39.1% in the first experience, decreasing to 27.6% in the second experience and in the last increased to 53.3% too. In Canal Cocotte, the value initial was 50.0% with a slight decrease in the second experience to 47.3% and a high decrease in the end of our work in this village, recorded a value of 15.4%.

Calculating the value of Container Index (fig. 4) to all villages of studies, Bélème is again the zone where the value in the first experience was highest, being 68.1%, decreasing to 16.3% during the work on the field and increasing to 24.8% in the last experience. Tartane with the same trend, the value initial was 56.1%, decreasing to 38.5% and a rise to 54.2% in the last experience. In Canal Cocotte, the value in the first experience was 42.1%, decreased to 34.0%, and to 13.6 in the last experience. Trois Rivières, the value initial was 26.4% in the first experience, increased to 39.0% and 44.1% in the second and third experience respectively.

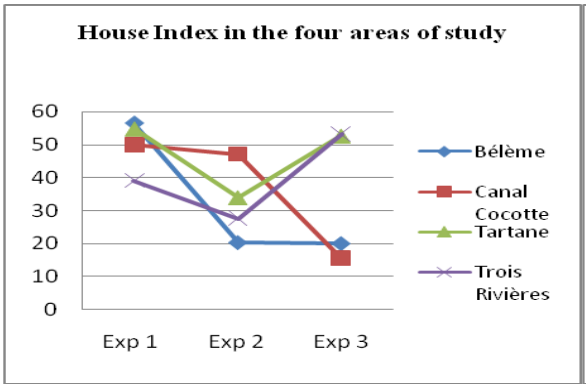


Fig. 3 – Results of House indexes in the four areas of study.

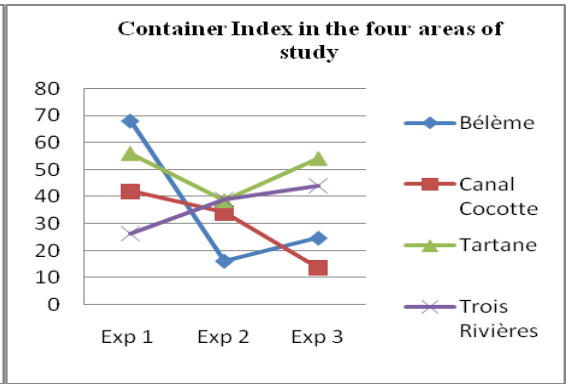


Fig. 4 – Results of Container Indexes in four areas of study.

Looking to the results of Breteau and Productivity Indexes (fig. 5 and 6) Bélème, and Tartane was where observed similar tendencies but with different values. The Breteau Indexes for these two villages were 182.8, 28.8 and 45.0 in Bélème for the three experiences and 134.1, 62.7, and 103 in Tartane, respectively. To Canal Cocotte the value of Breteau Index (fig. 5), in the first experience was 107.1 raised to 150.0 and a high reduction to 23.1 in the last experience. In Trois Rivières there was an increased the value of Breteau Indexes during our study, starting in 60.9 and increasing to 103.4 and 142.2 in the last experience.

The Productivity Index (fig. 6), in Bélème was 636.0, in the first experience, decreased to 128.8 and 146.7 in the last experience. In Tartane these value was 495.1 changing to 249.2 and 350.5 in the last experience. To Canal Cocotte, the value initial was 328.8, a slight rise to 332.4 and a significant reduction to 73.1 in the end. Trois Rivières, where the value initial recorded was 139.1 in the first experience increased to 154.3 and 286.7 in the last experience.

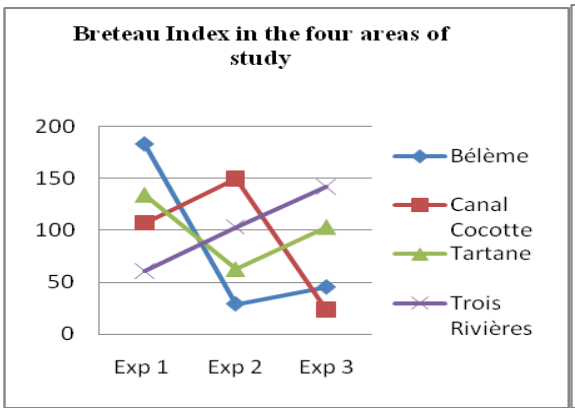


Fig. 5 – Results of Breteau Indexes in the four areas of study.

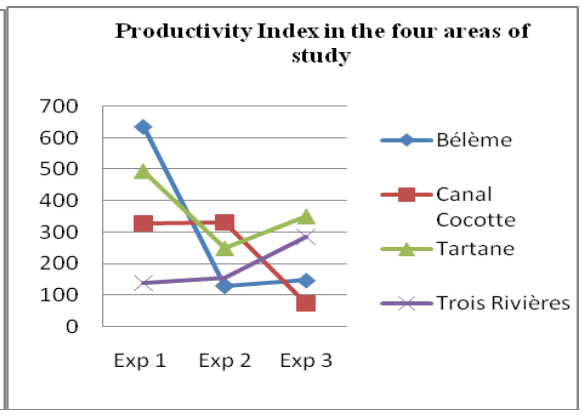


Fig. 6 – Results of Productivity Indexes in the four areas of study

Ovitraps:

Aedes aegypti has as favorable breeding conditions include dark, water holding containers in close proximity to human population which the mosquitoes can feed, and prefer to lay their eggs on rough, moist surfaces, just above the water line (Goma, 1964; Lenhart et al., 2005). So, to our three experiences ovitraps was placed inside and outside of inhabitant's houses of each village to collect eggs of Aedes. The result is plotted in following figure (fig. 7). Was collected 639 eggs in Bélème, 355 inside and 284 outside, in Canal Cocotte, 93 eggs inside and 267 outside, totaling 360 eggs collected during our experiences. Tartane, was noted a considerable number of eggs, 764 in totality, of these 358 and 406 eggs, inside and outside, respectively. And finally in Trois Rivières, was founded a higher number of eggs than the other three villages, a total of 810 eggs, being 403 inside and 407 outside.

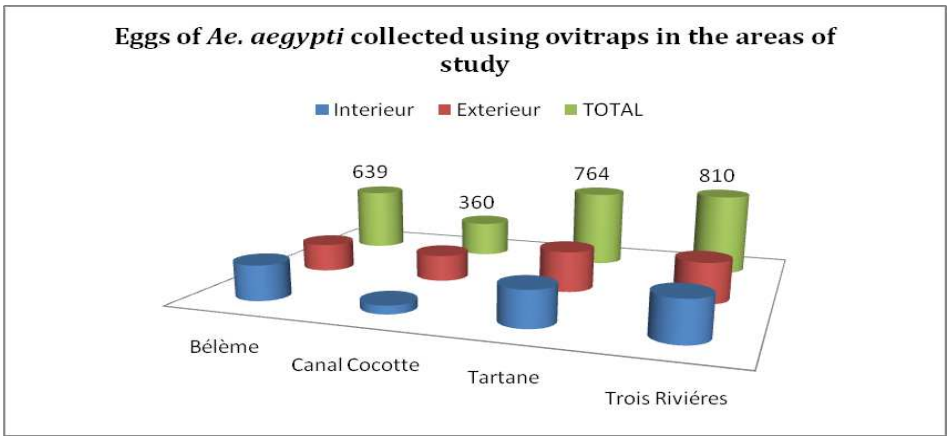


Fig. 7 - Results of Ae. aegypti eggs collected with ovitraps in the four areas of study.

BG-Sentinel mosquito trap

The BG-Sentinel trap uses visual and olfactory cues as well as convection currents to attract Ae. aegypti. It dispenses the use of CO^2 as attractive and do not use pesticides which cause harm to the environment and human health, being 100% safe for use in domestic, commercial or in animal breeding. The traps was placed one inside and other outside to the house of residents of each village of study, what allow to catch mosquitoes in the different points of the house and permitted the calculation of sample size.

Table 2 – Total of number of mosquitoes from different species and its genders of Aedes aegypti captured during the study, (3 experiences) with BG-Sentinel Trap in four different zones of Martinique, French West Indies.

Zone / Species	Aedes aegypti			Culex	Ocherotatus	Anopheles	Deinocerites	Others
	♂	♀	Total	sp.	taeniorhynchus	sp.	sp.	
Bélème	332	183	515	521	-	-	-	**4 ***
Canal Cocotte	189	152	341	1296	11	12	68	**1 #**
Tartane	315	197	512	282	4	-	15	
Trois Rivières	332	249	580	143	3	-	46	
Total	1168	780	1948	2242	18	12	129	**5**

Note: * : Aedes busckii # : Psorophora sp - : species not observed in the area of study.

Species of Ae. aegypti, Culex sp., Anopheles sp., Ochlerotatus taeniorhynchus, Deinocerites sp., Aedes busckii, and Psorophora sp. were captured with BG-Sentinel traps in a total of 4354 mosquitoes. In general the trap was more efficient to Culex sp., than to Ae. aegypti, catching more specimens of Culex sp. (2242 specimens) than Ae. aegypti (1 948 = 1168 males + 780 females). This result was observed in two areas of studies, Bélème, with a total of 515 Ae. aegypti value below the 521 Culex sp., and in Canal Cocotte, where the difference is higher, 1296 specimens of Culex sp., and 341 specimens of Ae. aegypti. In contrast, the two others zones of studies, the number of Ae. aegypti was higher than Culex sp., in Tartane was observed a total of 512 Ae. aegypti against 282 Culex sp., and in Trois Rivières, with a total of 580 and 143 specimens, respectively. Other specie with a representation in our results is Deinocerites sp., with 129 samples, with different values in Canal Cocotte, Trois Rivières and Tartane, being 68, 46 and 15 specimens respectively. Anopheles sp., was founded only in the commune of Ducos, 12 specimens in Canal Cocotte, and in the same zone, was observed one exemplar of Psorophora sp.. Another species recorded was Aedes busckii, 2 specimens founded in Bélème.

With the results obtained we can do a comparison between the sex ratio and numbers of total of Ae. aegypti captured inside and outside the home, of inhabitants to each area zone of study. In total were captured 1948 Ae. aegypti mosquitoes, of these the majority are male, 1168 in comparison with 780 females. There was greater number of males inside and outside in relation to female, in this case, 644 and 524 males to 350 and 430 females respectively. In general, were captured more Ae. aegypti inside than outside, 994 and 954 specimens, respectively (Fig. 8).

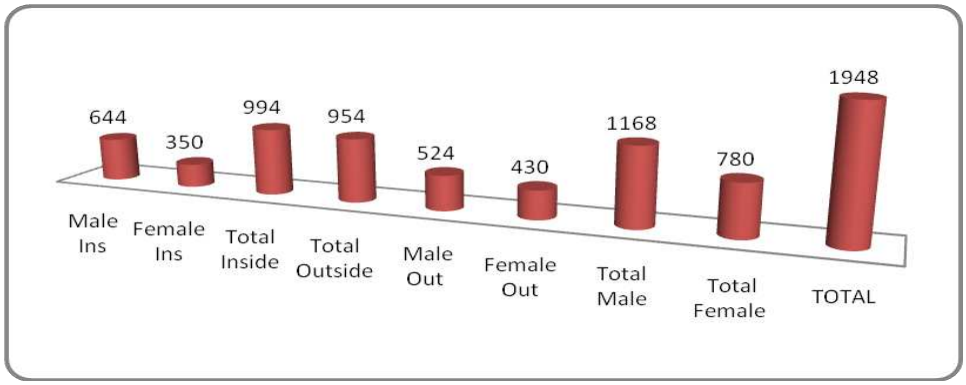


Fig. 8 – Number total of Ae. aegypti captured in the four areas of study using BG-Sentinel trap.
Note: Ins – Inside and Out – outside.

In all areas of study, was recorded more number of male than female, with exception the first experience in Canal Cocotte (Fig. 8-B), where was observed more females inside and outside, namely 28 females inside against the 27 males, and outside, 24 females and 19 males, respectively. The same situation was occurred in Tartane (Fig. 8-C) in the two first experiences, was observed more females than males in the traps placed outside of home. A total of 40 specimens females and 35 males in the first experience and 30 to 24 in the second. In Trois Rivières (Fig 8-D) too, during the first experience, we found more female outside that males, a total of 50 against the 38 samplings collected. As well in Bélème (Fig. 8-A), in the first experience, was collected more females inside that males, being the difference minimum, 30 and 29 specimens, respectively. Comparing the results total of for each experience, there is two experiences where was recorded more females. The first experience in Canal Cocotte (Fig. 8-B) resulting in 52 females and 46 males, and in Tartane, with the second experience, 64 females and 59 males (Fig. 8-C). In all others experiences realized in all zone, was founded more males than females, as observed in Tartane (Fig. 8-C), with the third experience was recorded 127 males against the 42 females, inside, or with the second experience in Trois Rivières (Fig. 8-D) was founded 58 males and 28 females.

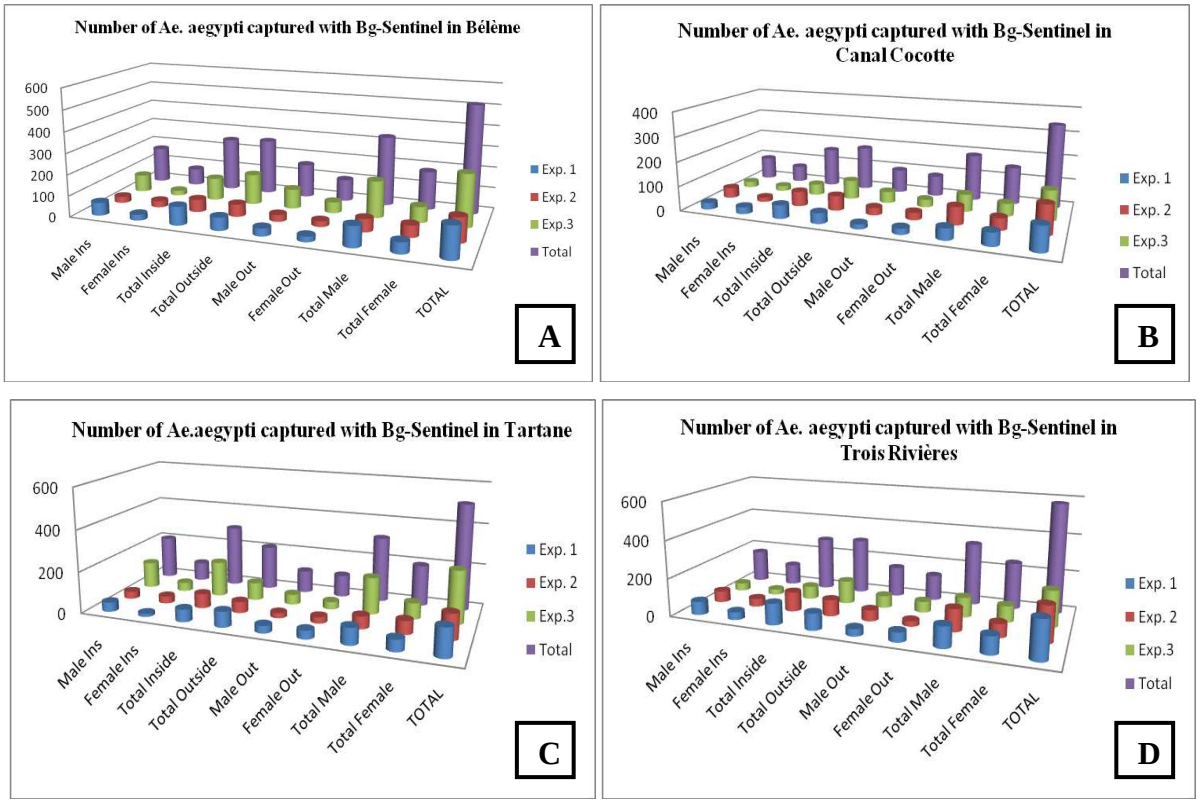


Fig. 9 - Results of sampling of Aedes aegypti populations captured in the four areas of study by using Bg-Sentinel, during 24h. Exp. 1 - experience 1; Exp. 2 - experience 2; Exp.3 - experience 3 and Total - result total of all experiences. A - Bélème in La Lamentin; B - Canal Cocotte in Ducos; C - Tartane in La Trinité and D – Trois Rivières in Sainte Luce.

DISCUSSION

Entomological larval indexes

A number of indexes have been described and are currently used to monitor Ae. aegypti population in terms of dengue transmission risk. Since this vector is a domestic/peridomestic breeder, most attention has been paid to larvae. The House Index has been used for many years and was considered the most valuable; however, since 1954, the Breteau Index (Breteau, 1954) aided by the single larvae per container are identified on the basis of the species identification of one specimens from the container (Tun-Lin, 1996).

The surveys home performed monthly, before, during and in the end of the realization of work in the field, demonstrated a reliable density of mosquitoes in the four areas of study, with values of Breteau Index between 23.1 in the last experience in Canal Cocotte and 182.6, the first

visit to Bélème (Fig. 4). The value of Breteau Index decrease from the first to the second surveys in zones as Bélème and Tartane, it could be explained by the presence of technicians of service during this period to realization of others experience in the same time, recollection of eggs using ovitraps and capture of adults with BG-Sentinel. The reason why the first values of Breteau Index being high, 182.6 and 134.1 in Bélème and Tartane, compared to the two others zones, Canal Cocotte in Ducos and Trois Rivières in Sainte Luce, could be, firstly, the long time without surveys in this two first village, especially in Bélème where the last surveys performed was done in September 2009. Secondly, despite of the constant circulation of information in the media, in general, the population of Martinique, especially in these four areas of study, pays little attention and few attitudes in the mosquitoes control. So the presence of Mosquito Control technicians on the field has a good impact in dengue vector control. And the third explanation is that in Municipal Services of Ducos and Sainte Luce have volunteer youths that work as civic service in these two villages, doing work in health educational, visiting constantly the inhabitants of these two zones, what does not happen in Bélème and Tartane. Another reality is that Bélème and Tartane are village with individual houses, the majority with large outdoor spaces, gardens and many large reservoirs to collect rainwater and utilization to irrigation. These reservoirs are in the majority drums, cans and others containers that are preferable breeding sites of Ae. aegypti.

In Trois Rivières there was an increase constantly of all indices in all experiences, with exception of the House Index that passed from 39.1 in the first survey to 27.6% in the second (Fig. 2). Being a village where the principal activity is fishing, was noted some inoperable boats, abandoned houses, and in the same time is sited in touristic commune where is there some many houses of vacation. So, some empty houses or with few human activities but with containers associated to the constant rainfall occurred during the time of our experiences and, ideal temperature in Martinique are favorable conditions and consequently prosperous to development of Ae. aegypti. This is confirmed by some studies (Costero et al., 1997; Barbosa et Lourenço, 2010) that demonstrate the impact of rainfall in the ecology of dengue vectors and consequently the increase of vectors density.

In Martinique, the different types of deposits have been grouped into categories according to their productivity – Breteau Index weighted (BIW) developed by Yébakima, 1991, where each cottage is affected by a coefficient according to its nature and provides information on the risk of dengue epidemic (Etienne, 2001). This conventional index is used as part of an

operational perspective, as a tool for decision support for prioritizing interventions (Etienne, 2006). Looking to our results, Bélème was the zone where initially was found highest value of productivity and was decreased with the time and a high increase. In Canal Cocotte our presence constant and the work in the field namely the reverse of potential containers and health education causing the inhabitants to become used to cover water tanks with large capacity, resulted in the decrease of the value of BIW. In the other two villages, Trois Rivières and Tartane, despite of reduction of small containers, the reason to the increase of BIW values consists in the presence of containers with large capacity, as large recipients (50-100L), barrels and tires that have a big coefficient and consequently high values of BIW. Especially in Tartane where according with Etienne 2006, is a village where frequently most productivity in Aedes vector, namely, metal drums. The epidemic threat weighing on the human population of this area was more important that it was impossible to control the density by the elimination of vector potential breeding sites or positive.

The all others indexes have the same tendencies when compared between them by each area of study namely, the decrease in the first to the second surveys in Bélème and Tartane and a slight increase to the third survey. Canal Cocotte was the unique zone where there was a reduced values of indexes, except the Breteau Index that increased from 107.1 in the first survey to 150 in the second (Fig. 4), in March its due to the fact of an increase of breeding sites positives by house, namely the barrels, small containers, and others containers. In general was observed a reduction of all indices in this village, which could be explained too by our presence constant in this small village with about 100 homes, where the same number of traps was placed in a reduced area, comparing with others zones of study.

Ovitraps

Preferred breeding sites of Ae. aegypti tend to be in clean water, possibly with a small amount of organic matter as larval food supply. In dengue epidemic countries, ovitraps are useful in assessing the impact of dispersal of Ae. aegypti mosquitoes populations. It can also be used to determinate the presence or absence of breeding sites of Ae. aegypti in locations where control measures are being considered (Chadee, 1986) and, is a simple way to obtain substantial quantities of eggs to use in laboratory tests (Lenhart, 2005). Our results of ovitraps confirmed the

reliability to survey and study Ae. aegypti populations. With the utilization of ovitraps in the four areas of study we confirmed the presence of Ae. aegypti and provide indicators of dispersion and laying behavior.

In our experience the ovitraps proved to be excellent tool to evaluate the presence of Aedes population. In all three experiences by each village, none were totally negative and the number of eggs collected lies between 8, in the total of ovitraps inside in the third experience in Canal Cocotte and 291 eggs, in the first experience in Trois Rivières with ovitraps placed Inside of the house.

In canal Cocotte and Tartane was observed more eggs outside than inside. In contrast, in Bélème was record more quantity of eggs inside than outside, it confirms the preference of Ae. aegypti females by shadow zones located inside the home. In Trois Rivières, the difference is minimal, 4 eggs unless inside than outside its was caused by some inconveniencies encountered during the completion of field work, namely, the localization of ovitraps that consequently dried or returned resulting in negative results (two ovitraps outsides) and absence of residents in the house in the moment of recollection, causing a slight delay in the recuperation of ovitraps.

BG-Sentinel mosquito trap

The BG-Sentinel mosquito trap is a highly effective Ae. aegypti sampling device, capturing both males and females in similar quantities and is a good tool to obtain abundance and frequency data that could be useful for both rapid assessment and routine monitoring of local Ae. aegypti populations (Williams et al., 2007). In our experiences using BG-Sentinel traps resulted in the capture of Ae. aegypti males and females, a significant number of Culex sp., and others more species of mosquitoes. The major number of mosquitoes was captured in Canal Cocotte and Bélème, with 1729 and 1040 specimens, respectively. Culex sp., was the species with more representatively in all villages except in Trois Rivières where was recorded more Ae. aegypti. BG-Sentinel was developed to catch Ae aegypti, but in some studies (Maciel-de-Freitas et al., 2006; Williams et al., 2007) was confirmed the good functionality of this trap to Culex sp., males and females, simultaneous, namely Culex quinquefasciatus. This high number of Culex sp., when compared with the others former species, means that BG-Sentinel can also be used to monitor Culex quinquefasciatus, principal vector of filariasis and West Nile. The high number of Culex sp., in theses area is explained by the types of breeding site of this genre of mosquitoes, that

basically use all domestics and peridomestic containers, with freshwater. In Canal Cocotte where was observed highest number of Culex sp., its due to the existence of a septic tank cracked at the beginning of our activities and later with the cut of sugar cane in a large surface of production, resulting in a large breeding sites temporary to Culex sp.. Still, the cut of sugar cane was the cause of emergence of Psorophora sp.. Specie with breeding sites temporary, exposed to the sun, in low altitudes in Martinique (Fize, 1976).

In the same time was caught more Ae. aegypti males than females in all villages, except in Canal Cocotte. The high number of male caught by BG-Sentinel traps which use host outdoors as attractants that combine substances that are found in human skin to stimulating host-seek female behavior is surprising. It is known that males occur around human host practically in the same time as the females, where they can interrupt the females probably by sound and mate (Hartberg, 1971). According to Maciel-de-Freitas, 2006, it is likely that BG-Sentinel have visual or/and olfactory stimuli that attract males of Ae. aegypti towards humans.

Species of the genus Deinocerites are crabhole specialists. Adult of this genres use the upper portions of burrows of land crabs as daytime resting sites, whereas the immature stages of these mosquitoes develop in water accumulations at the bottom of these burrows. The distribution of Deinocerites is confined primarily to Central America, West Indies and nearby parts of North and South America (Adames, 1971). In Martinique the unique specie marked is Deinocerites magnus (Theobald, 1901) (Fize, 1976) and are normally founded in crabhole at 300 or 400 m to the sea or mangrove, this is why was verified this species in Canal Cocotte, Tartane and Trois Rivières, zones of mangrove.

Adults of Ochlerotatus taeniorhynchus rest in the vegetation during the daytime. The females are persistent biters and attack anytime during the day or night (Edman, 1971). In Martinique the habitat normal to this specie lays are area of mangrove swamps or brackish water collections close to mangrove (Fize, 1976). The presence of Ochlerotatus taeniorhynchus and Deinocerites magnus in the three zones (Canal Cocotte, Tartane and Trois Rivières) is explained by the facts that are coastal areas, where there are rivers and mangroves that are environment favorable to these species.

On the other hand, Aedes (Howardina) busckii (Coquillett, 1906), specie no anthropophilic but very ubiquitous, is found essentially in moist forest and naturals containers as cut bamboo, heliconias, or others epiphytes, that seem to be usual site, it is also found in artificial

deposits (Fize, 1976). Never occurs in altitude below to 100m, what explain the observation of this specie in Bélème, village sited at an altitude above 100m and with rainforest vegetation.

Anopheles sp., the major malaria vector is present virtually everywhere, specially Saharan Africa. In Martinique the two species presents prefers stagnant water to shade, with a little sun and vegetation and small ponds, often in the mouths of rivers, standing water or with a low current. In generally in full sun or shade with a minimal in according with Fize, 1976. That explains the presence of this species in Canal Cocotte where environmental and ecological conditions are favorable.

CONCLUSION

To better understand the ecology of Aedes aegypti and evaluate vector control program, the entomological surveillance should include two components:

Firstly, the rapid assessment of abundance to allow for targeting of particular areas for vector control operations and evaluations, and with our studies we demonstrate that the utilization of ovitraps and Entomological Larval Indexes are good ways to estimate and to study the presence of mosquitoes vector in a certain area. Although the inexistence of a direct correlation between the two methods of density estimation of Aedes population, they are effective and functional. Their utilization is integral part of monitoring the density of Ae. aegypti populations and the effectiveness of vector control interventions.

Secondly is necessary a routine collection over several months to provide measures of populations dynamics, the density and if possible the relation to dengue virus activity, in the case of virus circulations. To this the BG-Sentinel traps has been a good tool to caught mosquitoes adults.

Entomological field investigations steel need a lot of various tools. However the relation between collections adults and the amount of disease transmission remains unknown, the determination of this correlation between BG-Sentinel collections and dengue infection risk will be a parameter in utilization of control of dengue vector.

The results we observed in Martinique during our study will be integrated with the next others and would be analyzed at the end of the Project Life+.

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RESEARCH PROJECT

Mapping of insecticide resistance of the dengue vector Aedes aegypti in Cape Verde

Introduction

Aedes aegypti is the primary vector of dengue and yellow fever virus (DEN, YFV). Vaccines are not yet available against DEN and in the last 50 years its incidence has increased 30-fold with increasing geographic expansion to new countries (Reiter, 2010) and from urban to rural settings resulting in approximately 2.5 billion people living in dengue endemic countries. It is estimated 50 million dengue infections annually and 500 000 cases of Dengue Hemorrhagic Fever (DHF) /Dengue Shock Syndrome (DSS) resulting in 24,000 deaths annually (WHO, 2009).

Currently, the only method of prevention or reduction DF and DHF is through control or eradication of Ae. aegypti populations. In the past eradication campaigns combined reduction of breeding-sites with use of dichloro-diphenyl-trichloroethane (DDT) was successful. Actually, pyrethroid insecticides, that retard the activation and inactivation potential of voltage-gated sodium (Nav) channels resulting in paralysis - knock-down (Kdr) and death (Narahashi, 1992), have played a major global role in the control of Ae. aegypti adults, in combination with the organophosphate insecticide, temephos, to immature. However different mutations correlated with Kdr resistance are known in Ae. aegypti what represents a threat for efficacy of control programs (Brengues et al., 2003; Chen et al., 2008). So, Kdr genotyping is a good predictor of susceptibility to pyrethroid, and considered efficacy of these compounds in the field (Donnelly et al., 2009).

Located at 14°55′N 23°31′W and 570 km off the coast of Senegal, West Africa, Cape Verde is composed by 10 islands. Medical entomology surveys were initiated in the year 1920 in the country (Sant´Anna, 1920) and, since then, a total of teen mosquito species have been annotated, being five the major vectors of human diseases (Alves et al., 2010). Of these, Aedes (Stegomyia) aegypti Linnaeus, 1762, the most competent dengue vector was reported for the first time in Cape Verde by Sant'Anna in 1931 (in Ribeiro et al., 1980). Despite the presence of Aedes

in Cape Verde, in the past there had been no case of dengue until in 2008, there were the first dengue cases and in September 2009, the country was ravaged by an epidemic of dengue. Were registered 25071 suspected cases nationwide, 6747 confirmed cases, of which 174 fitted the WHO definition of DHF/DSS and four were fatal, with higher incidence in city of Praia, São Filipe in Fogo and Maio with 20542, 3007 and 568 cases, respectively. The epidemic was caused by serotype DEN-3, peaked in September with rapid decline after the rainy season (MOH, unpublished data).

During this epidemic dengue were used temephos and deltamethrin to treatment and the results of first tests of resistance/sensibility show a high level of sensibility for Aedes populations in Cape Verde, between 95% and 100% (Yébakima, unpublished data). The aim of this project is Mapping the insecticide resistance of the dengue vector Aedes aegypti in Cape Verde to better understand the situation in all islands.

Materials and Methods

Cape Verde is composed by 9 inhabited islands, so, sampling of Ae. aegypti will be collected in all island, in pre-defined areas. Specially in Santiago, the largest island with more cases reported, and Fogo with more incidence during the first outbreaks of dengue in 2009, will be defined 5 areas of studies, each, and one or two zone in others island. Immatures samples will be collected using oviposition traps (ovitraps), (Lenhart et al., 2005) and populations of mosquitoes will be keeping under controlled conditions in insectarium, in order to be used in biological, biochemical and molecular experiments.

Temephos (Abate) is used to treatment larvicide and deltamethrin as adulticide, in Cape Verde so tests with dose-response bioassays will be undertaken according with the methodology proposed by WHO to evaluate larval and adulticide susceptibility/resistance insecticides (WHO, 1981a). Larvae will be exposed to 10 different concentrations of temephos and deltamethrin, for the estimation of lethal concentrations (50% and 95%) and estimation of resistance ratio (RR) for population of each island. Testes using the technical of WHO tube test will be performed, using impregnated papers, to evaluate and follow resistance level of mosquito adults strains against deltamethrin. The number of immobilized, knocked-down test mosquitoes will be documented one hour after the exposition and the mortality rate 24 hours after (WHO, 1981b; WHO, 1996).

Biochemical tests will assayed in order to verify the activity and following insecticide detoxification enzymes, to esterases, mixed function oxidases (MFO), glutathione S transferases (GSTs), and acetylcholinesterase (AChE; the target of temephos). Microplate assays will be adapted and performed to these experiences (Rodríguez et al., 2007; Lima et al., 2011).

In cooperation with international Organizations (IRD, Pasteur Institute, …), studies of Molecular Biology/PCR will be used to Kdr screening. In this case mosquitoes will be separated according to the resistance phenotype, resistant mosquitoes and susceptible (dead mosquitoes) will be used for DNA extraction that will be available in according to the manufacturer's instructions and processed in order to analyze mutations using primers designed based on the region of mutation, (Mazzarri et al., 1995; Martins et al., 2009).

Expected Results

With the increasing incidence of dengue, yellow fever and Chikungunya worldwide, especially in tropical countries, it is crucial to develop studies on ecology, mapping of insecticides susceptibility/resistance, vectorial competence and genetic populations of Ae. aegypti in Cape Verde Islands. So, with this study, we will map the insecticide resistance of the dengue vector Aedes aegypti in Cape Verde, the first to be performed in the country, where the vector of dengue and the virus are present.

With this mapping insecticide resistance of the dengue vector Aedes aegypti in all islands of Cape Verde will facilitate the management of insecticides in the Control of vector to Aedes in Cape Verde that in according with Reiter and Diallo (2010) is more vulnerable than in many countries where dengue is endemic. Priority and special attention will taken to Santiago, Fogo and Maio islands, where was recorded high numbers of cases and founded greater number of breeding sites. Especially in city of Praia in Santiago, where the principal larval breeding sites founded are associated with activity human as storage containers of water (Diallo 2010) caused by several factors, with emphasis on the rapid and disorganized urban growth and consequent negative impact on sanitation, coupled with a relatively long rainy season with rainfall, the multiplication of air links with regions of the world where presence dengue is high. In Fogo the incidence was highest and until now, no study was done in order to assess the viability of the chemicals used in treat and combat Ae. aegypti in Cape Verde.

Perspectives

At the same times studies of ecology of Aedes aegypti and vectorial competency in the different island will be developed, and will be created partnerships between local Institutions (MOH, Universities, etc) and International Agencies (WHO, Institutes Pasteur and others). All results will contribute to better understand certain parameters that are involved in the transmission of dengue in Cape Verde to better study and work in the control of vector in Cape Verde, and all entomological data will be associated with epidemiological, social and environmental data in order to reinforce the national program activities and to develop some new approaches in vector control.

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Annex I

Entomological data of Aedes aegypti sheet

Projet LIFE+
Tâche 1.2
Centre de Démoustication/Lutte antivectorielle
Martinique (FWI)

FICHE DE RELEVE ENTOMOLOGIQUE AEDES AEGYPTI

(Appréciation de la typologie des gîtes et des indices larvaires)

Commune :
Quartier :

Date :
Relevé effectué par:

Fût = F ; Citerne = C ; Pot à fleurs = PF ; Pneu = P ; Carcasse = Ca ; Gouttière = G ; Petit Récipient = PR (-50 l) ; Grand Récipient = GR (+ de 50l)
Grand Déchet = GD ; Petit Déchet = PD ; Bassin = B ; Dessous de Pot = DP ; Autres = A

MAISONS VISITEES	GÎTES DOMESTIQUES				GÎTES PERIDOMESTIQUES			
	En eau	Avec larves	Positifs	Nature et richesse	En eau	Avec larves	Positifs	Nature et richesse

Observations :

Annexes II

Results of Entomological larval Indexes in the four zones of study

II.1 - Bélème

CENTRE DE DEMOUSTICATION MARTINIQUE

SURVEILLANCE D'AEDES AEGYPTI

Valeurs des indices larvaires et Productivité

Secteur : CENTRE - NORD CARAÏBE
Commune : LAMENTIN
Quartier : BELEME
Date de relevé : 16/02/2011

Indice Habitation	56,5%
Indice Gîte	68,1%
Indice de Breteau	**182,6**

Maisons inspectées : 69
Maisons fermées : 58
Maisons positives : 39
Gîtes en eau : 185
Gîtes positifs : 126
Gîtes domestiques (+): 0,5%
Gîtes péridomestiques (+): 67,6%

Répartition des gîtes positifs :
Gîtes domestiques : 0,8%
Gîtes péridomestiques : 99,2%

Nature	I.B.P. Yeb.*
PF	1,4
P	4,3
F	405,8
GR	142,0
PR	73,9
DP	4,3
D	1,4
A	2,9

Productivité totale : 636,2

Nature	En Eau	%	Positifs	%
PF	6	3,2%	1	16,7%
P	3	1,6%	1	33,3%
F	75	40,5%	56	74,7%
GR	32	17,3%	28	87,5%
PR	52	28,1%	34	65,4%
DP	3	1,6%	3	100,0%
D	1	0,5%	1	100,0%
A	13	7,0%	2	15,4%

Impression du 06/05/2011

* : I.B.P. Yeb. : Indice Breteau Pondéré Yébakima
PF : Pot à Fleurs, P : Pneu, F : Fût, GR : Grand Récipient, PR : Petit Récipient, DP : Dessous de Pot, D : Déchet, A : Autre

CENTRE DE DEMOUSTICATION MARTINIQUE

SURVEILLANCE D'AEDES AEGYPTI

Valeurs des indices larvaires et Productivité

Secteur : CENTRE - NORD CARAÏBE
Commune : LAMENTIN
Quartier : BELEME
Date de relevé : 29/03/2011

Indice Habitation	20,3%
Indice Gîte	16,3%
Indice de Breteau	28,8

Maisons inspectées : 59
Maisons fermées : 52
Maisons positives : 12
Gîtes en eau : 104
Gîtes positifs : 17
Gîtes domestiques (+): 0,0%
Gîtes péridomestiques (+): 16,3%

Répartition des gîtes positifs :
Gîtes domestiques : 0,0%
Gîtes péridomestiques : 100,0%

Nature	I.B.P. Yeb.*
PF	0,0
P	0,0
F	118,6
GR	5,9
PR	2,5
DP	0,0
D	1,7
A	0,0

Productivité totale : 128,8

Nature	En Eau	%	Positifs	%
PF	0	0,0%	0	0,0%
P	0	0,0%	0	0,0%
F	60	57,7%	14	23,3%
GR	8	7,7%	1	12,5%
PR	12	11,5%	1	8,3%
DP	5	4,8%	0	0,0%
D	2	1,9%	1	50.0%
A	17	16,3%	0	0,0%

Impression du 06/05/2011

* : I.B.P. Yeb. : Indice Breteau Pondéré Yébakima
PF : Pot à Fleurs, P : Pneu, F : Fût, GR : Grand Récipient, PR : Petit Récipient, DP : Dessous de Pot, D : Déchet, A : Autre

CENTRE DE DEMOUSTICATION MARTINIQUE

SURVEILLANCE D'AEDES AEGYPTI

Valeurs des indices larvaires et Productivité

Secteur : CENTRE - NORD CARAÏBE
Commune : LAMENTIN
Quartier : BELEME
Date de relevé : 26/04/2011

Maisons inspectées :	60
Maisons fermées :	51
Maisons positives :	12
Gîtes en eau :	109
Gîtes positifs :	27
Gîtes domestiques (+):	0,0%
Gîtes péridomestiques (+):	24,8%

Répartition des gîtes positifs :

Gîtes domestiques :	0,0%
Gîtes péridomestiques :	100,0%

Indice Habitation	20,0%
Indice Gîte	24,8%
Indice de Breteau	**45.0**

Nature	I.B.P. Yeb.*
PF	0,0
P	0,0
F	100,0
GR	17,5
PR	27,5
DP	0,0
D	0,0
A	1,7

Productivité totale : **146,7**

Nature	En Eau	%	Positifs	%
PF	9	8,3%	0	0,0%
P	0	0,0%	0	0,0%
F	53	48,6%	12	22,6%
GR	14	12,8%	3	21,4%
PR	20	18,3%	11	55,0%
DP	0	0,0%	0	0,0%
D	1	0,9%	0	0,0%
A	12	11,0%	1	8,3%

Impression du 06/05/2011

* : I.B.P. Yeb. : Indice Breteau Pondéré Yébakima
PF : Pot à Fleurs, P : Pneu, F : Fût, GR : Grand Récipient, PR : Petit Récipient, DP : Dessous de Pot, D : Déchet, A : Autre

II.2 – Canal Cocotte

CENTRE DE DEMOUSTICATION MARTINIQUE

SURVEILLANCE D'AEDES AEGYPTI

Valeurs des indices larvaires et Productivité

Secteur : SUD
Commune : DUCOS
Quartier : CANAL
Date de relevé : 29/03/2011

Indice Habitation	47,1%
Indice Gîte	34,0%
Indice de Breteau	150,0

Maisons inspectées : 34
Maisons fermées : 37
Maisons positives : 16
Gîtes en eau : 150
Gîtes positifs : 51
Gîtes domestiques (+): 0,0%
Gîtes péridomestiques (+): 34,0%

Répartition des gîtes positifs :
Gîtes domestiques : 0,0%
Gîtes péridomestiques : 100,0%

Nature	I.B.P. Yeb.*
PF	35,3
P	0,0
F	102,9
GR	123,5
PR	35,3
DP	8,8
D	11,8
A	14,7

Productivité totale : 332,4

Nature	En Eau	%	Positifs	%
PF	17	11,3%	12	70,6%
P	1	0,7%	0	0,0%
F	10	6,7%	7	70,0%
GR	24	16,0%	12	50,0%
PR	24	16,0%	8	33,3%
DP	23	15,3%	3	13,0%
D	21	14,0%	4	19,0%
A	30	20,0%	5	16,7%

Impression du 06/05/2011

* : I.B.P. Yeb. : Indice Breteau Pondéré Yébakima
PF : Pot à Fleurs, P : Pneu, F : Fût, GR : Grand Récipient, PR : Petit Récipient, DP : Dessous de Pot, D : Déchet, A : Autre

CENTRE DE DEMOUSTICATION MARTINIQUE

SURVEILLANCE D'AEDES AEGYPTI

Valeurs des indices larvaires et Productivité

Secteur : SUD
Commune : DUCOS
Quartier : CANAL
Date de relevé : 26/04/2011

Maisons inspectées :	39
Maisons fermées :	33
Maisons positives :	6
Gîtes en eau :	66
Gîtes positifs :	9
Gîtes domestiques (+):	0,0%
Gîtes péridomestiques (+):	13,6%

Répartition des gîtes positifs :

Gîtes domestiques :	0,0%
Gîtes péridomestiques :	100,0%

Indice Habitation	15,4%
Indice Gîte	13,6%
Indice de Breteau	**23,1**

Nature	I.B.P. Yeb.*
PF	2,6
P	0,0
F	38,5
GR	26,9
PR	0,0
DP	0,0
D	0,0
A	5,1

Productivité totale : **73,1**

Nature	En Eau	%	Positifs	%
PF	3	4,5%	1	33,3%
P	1	1,5%	0	0,0%
F	19	28,8%	3	15,8%
GR	5	7,6%	3	60,0%
PR	6	9,1%	0	0,0%
DP	13	19,7%	0	0,0%
D	2	3,0%	0	0,0%
A	17	25,8%	2	11,8%

Impression du 06/05/2011

* : I.B.P. Yeb. : Indice Breteau Pondéré Yébakima
PF : Pot à Fleurs, P : Pneu, F : Fût, GR : Grand Récipient, PR : Petit Récipient, DP : Dessous de Pot, D : Déchet, A : Autre

II.3 – Tartane

CENTRE DE DEMOUSTICATION MARTINIQUE

SURVEILLANCE D'AEDES AEGYPTI

Valeurs des indices larvaires et Productivité

Secteur : NORD ATLANTIQUE
Commune : TRINITE
Quartier : TARTANE
Date de relevé : 15/02/2011

Indice Habitation	54,9%
Indice Gîte	56,1%
Indice de Breteau	**134.1**

Maisons inspectées : 82
Maisons fermées : 58
Maisons positives : 45
Gîtes en eau : 196
Gîtes positifs : 110
Gîtes domestiques (+): 3,1%
Gîtes péridomestiques (+): 53,1%

Répartition des gîtes positifs :
Gîtes domestiques : 5,5%
Gîtes péridomestiques : 94,5%

Nature	I.B.P. Yeb.*
PF	7,3
P	3,7
F	378,0
GR	64,0
PR	31,1
DP	7,3
D	1,2
A	2,4

Productivité totale : 495,1

Nature	En Eau	%	Positifs	%
PF	10	5,1%	6	60,0%
P	3	1,5%	1	33,3%
F	96	49,0%	62	64,6%
GR	22	11,2%	15	68,2%
PR	38	19,4%	17	44,7%
DP	11	5,6%	6	54,5%
D	5	2.6%	1	20.0%
A	11	5,6%	2	18,2%

Impression du 06/05/2011

* : I.B.P. Yeb. : Indice Breteau Pondéré Yébakima
PF : Pot à Fleurs, P : Pneu, F : Fût, GR : Grand Récipient, PR : Petit Récipient, DP : Dessous de Pot, D : Déchet, A : Autre

CENTRE DE DEMOUSTICATION MARTINIQUE

SURVEILLANCE D'AEDES AEGYPTI

Valeurs des indices larvaires et Productivité

Secteur : NORD ATLANTIQUE
Commune : TRINITE
Quartier : TARTANE/BOURG
Date de relevé : 29/03/2011

Maisons inspectées :	59
Maisons fermées :	48
Maisons positives :	20
Gîtes en eau :	96
Gîtes positifs :	37
Gîtes domestiques (+):	0,0%
Gîtes péridomestiques (+):	38,5%

Répartition des gîtes positifs :

Gîtes domestiques :	0,0%
Gîtes péridomestiques :	100,0%

Indice Habitation	33,9%
Indice Gîte	38,5%
Indice de Breteau	**62,7**

Nature	I.B.P. Yeb.*
PF	0,0
P	5,1
F	194,9
GR	35,6
PR	5,1
DP	5,1
D	3,4
A	0,0

Productivité totale :	**249,2**

Nature	En Eau	%	Positifs	%
PF	2	2,1%	0	0,0%
P	1	1,0%	1	100,0%
F	48	50,0%	23	47,9%
GR	10	10,4%	6	60,0%
PR	7	7,3%	2	28,6%
DP	14	14,6%	3	21,4%
D	2	2,1%	2	100,0%
A	12	12,5%	0	0,0%

Impression du 06/05/2011

* : I.B.P. Yeb. : Indice Breteau Pondéré Yébakima
PF : Pot à Fleurs, P : Pneu, F : Fût, GR : Grand Récipient, PR : Petit Récipient, DP : Dessous de Pot, D : Déchet, A : Autre

CENTRE DE DEMOUSTICATION MARTINIQUE

SURVEILLANCE D'AEDES AEGYPTI

Valeurs des indices larvaires et Productivité

Secteur : NORD ATLANTIQUE
Commune : TRINITE
Quartier : TARTANE
Date de relevé : 26/04/2011

Maisons inspectées :	93
Maisons fermées :	38
Maisons positives :	49
Gîtes en eau :	177
Gîtes positifs :	96
Gîtes domestiques (+):	1,7%
Gîtes péridomestiques (+):	52,5%

Répartition des gîtes positifs :

Gîtes domestiques :	3,1%
Gîtes péridomestiques :	96,9%

Indice Habitation	52,7%
Indice Gîte	54,2%
Indice de Breteau	103,2

Nature	I.B.P. Yeb.*
PF	3,2
P	6,5
F	279,6
GR	11,3
PR	33,9
DP	4,3
D	6,5
A	5,4

Productivité totale :	350,5

Nature	En Eau	%	Positifs	%
PF	9	5,1%	3	33,3%
P	2	1,1%	2	100,0%
F	62	35,0%	52	83,9%
GR	8	4,5%	3	37,5%
PR	36	20,3%	21	58,3%
DP	22	12,4%	4	18,2%
D	17	9,6%	6	35,3%
A	21	11,9%	5	23,8%

Impression du 06/05/2011

* : I.B.P. Yeb. : Indice Breteau Pondéré Yébakima
PF : Pot à Fleurs, P : Pneu, F : Fût, GR : Grand Récipient, PR : Petit Récipient, DP : Dessous de Pot, D : Déchet, A : Autre

II.4 – Trois Rivières

CENTRE DE DEMOUSTICATION MARTINIQUE

SURVEILLANCE D'AEDES AEGYPTI

Valeurs des indices larvaires et Productivité

Secteur : SUD
Commune : SAINTE LUCE
Quartier : TROIS RIVIERES
Date de relevé : 29/03/2011

Indice Habitation	27,6%
Indice Gîte	39,0%
Indice de Breteau	103,4

Maisons inspectées : 58
Maisons fermées : 45
Maisons positives : 16
Gîtes en eau : 154
Gîtes positifs : 60
Gîtes domestiques (+): 0,0%
Gîtes péridomestiques (+): 39,0%

Répartition des gîtes positifs :
Gîtes domestiques : 0,0%
Gîtes péridomestiques : 100,0%

Nature	I.B.P. Yeb.*
PF	0,0
P	15,5
F	43,1
GR	0,0
PR	18,1
DP	31,0
D	41,4
A	5,2

Productivité totale : 154,3

Nature	En Eau	%	Positifs	%
PF	3	1,9%	0	0,0%
P	3	1,9%	3	100,0%
F	23	14,9%	5	21,7%
GR	2	1,3%	0	0,0%
PR	18	11,7%	7	38,9%
DP	53	34,4%	18	34,0%
D	34	22,1%	24	70,6%
A	18	11,7%	3	16,7%

Impression du 06/05/2011

* : I.B.P. Yeb. : Indice Breteau Pondéré Yébakima
PF : Pot à Fleurs, P : Pneu, F : Fût, GR : Grand Récipient, PR : Petit Récipient, DP : Dessous de Pot, D : Déchet, A : Autre

CENTRE DE DEMOUSTICATION MARTINIQUE

SURVEILLANCE D'AEDES AEGYPTI

Valeurs des indices larvaires et Productivité

Secteur : SUD
Commune : SAINTE LUCE
Quartier : TROIS RIVIERES
Date de relevé : 26/04/2011

Maisons inspectées :	45
Maisons fermées :	40
Maisons positives :	24
Gîtes en eau :	145
Gîtes positifs :	64
Gîtes domestiques (+):	1,4%
Gîtes péridomestiques (+):	42,8%

Répartition des gîtes positifs :

Gîtes domestiques :	3,1%
Gîtes péridomestiques :	96,9%

Indice Habitation	53,3%
Indice Gîte	44,1%
Indice de Breteau	142,2

Nature	I.B.P. Yeb.*
PF	48,9
P	0,0
F	100,0
GR	77,8
PR	26,7
DP	28,9
D	0,0
A	4,4

Productivité totale : 286,7

Nature	En Eau	%	Positifs	%
PF	31	21,4%	22	71,0%
P	0	0,0%	0	0,0%
F	20	13,8%	9	45,0%
GR	25	17,2%	10	40,0%
PR	27	18,6%	8	29,6%
DP	34	23,4%	13	38,2%
D	1	0,7%	0	0,0%
A	7	4,8%	2	28,6%

Impression du 06/05/2011

* : I.B.P. Yeb. : Indice Breteau Pondéré Yébakima
PF : Pot à Fleurs, P : Pneu, F : Fût, GR : Grand Récipient, PR : Petit Récipient, DP : Dessous de Pot, D : Déchet, A : Autre

Annex III

Identification Form

Centre de Démoustication
Lutte-Antivectorielle Martinique (FWI)

FICHE D´IDENTIFICATION

Project Life + **Commune:** **Date de récolte:**

Tâche 1.2 **Quartier:** **Opérateur:**

Numéros maison	*Aedes aegypti*		*Culex sp.*	*Oc. taeniorhynchus*	*Anophèles sp .*	*Deinocerites sp.*	Autres espècies	Autres insectes
	Males	Femelles						
Int								
Ext								
Int								
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