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# Impact of integrated fight against vectors of arboviruses on the epidemic risk indices in six communities of abidjan, Cote d'ivoire

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**Abstract**
The aim of this study was to conduct an inventory and characterize the breeding sites of Aedes in the district of Abidjan as well as to estimate the epidemic risk of arboviruses. The entomological prospections were conducted in six communities of Abidjan. It was observed that *Aedes aegypti* mosquito was most dominant and its breeding predilection sites in each of the surveyed communities consisted of water storage containers. The Stegomyian indices showed a moderate epidemic risk in all communities. Surveillance programs must be developed to prevent and effectively fight against these diseases in the city of Abidjan.

**Keywords:** Arboviruses, *Aedes aegypti*, risk indices, abidjan, Côte d'Ivoire

## Introduction
Arboviruses are experiencing in recent years, an upsurge that upsets the scientific world. These diseases, most of which are prevalent in the tropics, are among the leading causes of mortality and morbidity in both humans and animals [1]. The World Health Organization (WHO) estimates that 200,000 people suffer from yellow fever each year, while dengue strikes over 50 million people per year [2]. Arboviruses represent a scourge for African nations in general and for those in sub-Saharan Africa in particular. They also represent a significant risk for travelers to endemic areas. Ecosystem diversity and climate change, as well as human activities, are among the causes of the proliferation of these diseases [3, 4]. The main vectors of arboviruses are mosquitoes of the *Aedes* genera (*Aedes aegypti*, *Aedes albopictus*) as well as *Culex*, major vectors of arboviruses in Africa, Asia, and elsewhere [5, 6, 7, 8, 9, 10, 4].
In Côte d'Ivoire, epidemics of arboviruses are common [11]. The recent outbreak of yellow fever was reported in the Autonomous District of Abidjan in 2008, while dengue fever was recently reported in the Cocody-Bingerville Health District in 2017 [11, 12]. Following the dengue epidemic, vector control campaigns (fumigation, elimination and/or treatment of breeding sites), sensitization and communication were carried out in the Autonomous District of Abidjan. Given the abundance of the vector, could we say that the vector control actions have met the expectations of the populations? Are breeding sites favorable for vector development still abundant at homesteads?
This study was carried out in six communities of the district of Abidjan, namely Abobo, Attécoubé, Cocody, Koumassi, Port-Bouët and Yopougon, with the objective to evaluate the impact of integrated pest management on vectors of arboviruses. Specifically, the aim was to carry out an inventory and characterize the breeding sites of arbovirus vectors in the Abidjan district, while determining epidemic risk indices.

## Materials and Method
### Study area
The city of Abidjan is located in the south of Côte d'Ivoire, on the shores of the Gulf of Guinea. Abidjan is located between latitudes 5° 00' and 5° 30' N and longitudes 3° 50' and 4° 10' W and extends over an area of 57735 ha. Since 1979, Abidjan is divided into ten communities whose position in relation to the lagoon Ebrié, can distinguish two major parts "Abidjan North" and "Abidjan South". Abidjan North includes the following communities Cocody, Plateau, Abobo, Adjamé, Attécoubé and Yopougon and is located on the mainland. South Abidjan includes all the communities located on the lagoon namely Port-Bouet, Koumassi, Marcory and Treichville (Figure 1).

Abidjan has a subequatorial, warm and humid climate, two rainy seasons (May to July and October to November) and two dry seasons (December, April and July to September).

**Entomological prospection**

The entomological survey was carried out in different communities of the Abidjan district Abobo, Attécoubé, Cocody, Koumassi, Port-Bouët and Yopougon. These activities took place in two stages: before and after mosquitoes control operation. Before vector control, a situational analysis was carried out from 07th to 22nd February 2018 in the communities mentioned. During this step, larval surveys were conducted throughout the day. They consisted of searching for potential breeding sites of mosquitoes around the homesteads of the populations, to collect larvae or nymphs of mosquitoes in order to identify them in the laboratory after emergence. The second step of the study (after vector control), took place from 20th to 28th August 2018 and consisted of monitoring and evaluation of the control activities carried out during the first step of the study.

**Statistical analysis**

Data was analysed using the STATA Version 5 statistical sofware. The Kruskal Wallis test was used to compare proportions at different potential breeding sites before and after mosquito control. The Student's T test was used to compare the positivity of the different preferred breeding sites before and after the mosquito control.

**Results**

**Characterization of larval breeding sites**

Before vector control, 2106 breeding sites were identified in all communities. Water deposits, dry spots and positive spots were estimated at 1098, 646 and 362 respectively. After vector control, 1475 breeding sites were identified, of which 966 are water deposits, 323 are dry, and 186 are positive. Larval breeding site density analysis revealed a significant difference (Kruskal Wallis (KW) = 22.467, p= 0.000) at the community level before vector control. And significant difference (KW= 18.657, p= 0.001) after vector control (Fig. 2).

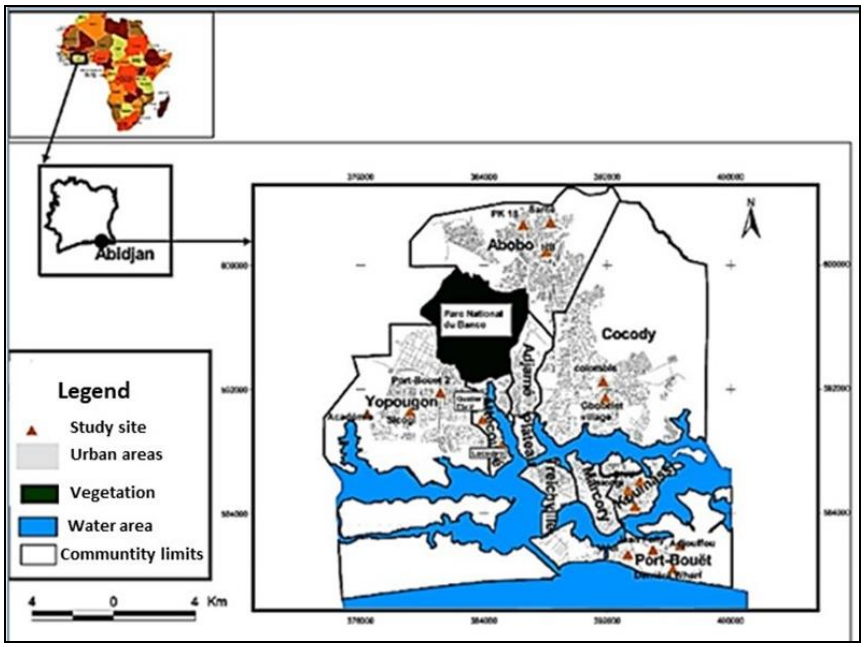


**Fig 1:** Map of the town of Abidjan showing sampled sites (orange triangles)

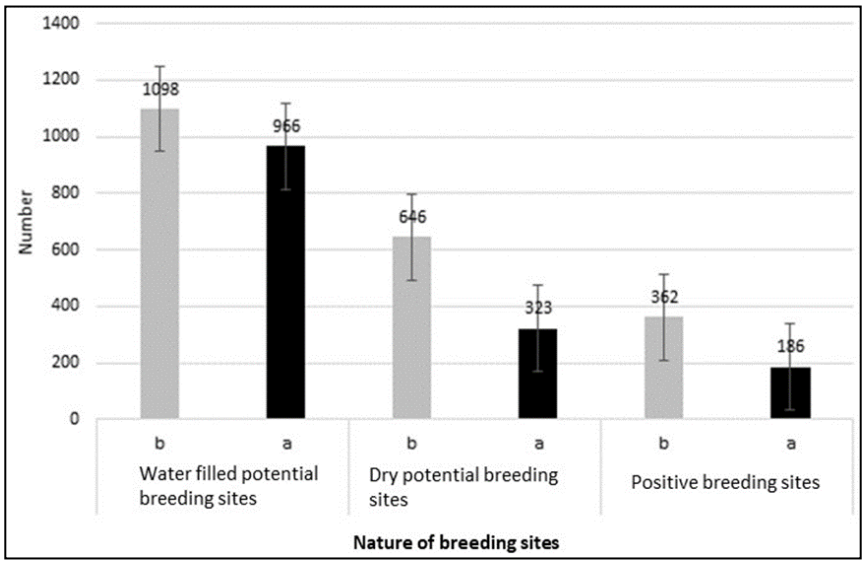


**Fig 2:** Number of breedings sites based on their nature, before (b) and after (a) control

**Inventory of breeding predilection sites**

During the situational analysis (before the fight), water storage containers were predominant (200 potential deposits or 55.24%) followed by abandoned containers (73 potential deposits or 20.16%). These water storage containers accounted for 49% to 70% (Table 1) of deposits harboring *Aedes* larvae in the

communities of Abobo, Yopougon, Cocody, Port-Bouët and Koumassi. In the case of Attécoubé, this type of deposit represented 38.33%. After vector control, the predominance of water storage containers (104 potential positive deposits or 55.91%) was observed followed by other deposits (34 potential deposits or 18.27%). The water storage containers accounted for 45% and 80% of the deposits harboring *Aedes aegypti* larvae (Table 2) in the Attécoubé, Cocody, Koumassi, Port-Bouët and Yopougon communities. In the case of the Abobo community, this type of deposit represented 41.02%. The analysis of the positivity of breeding predilection sites showed different results *w.r.t.* communities. In the Abobo community, the comparison of the positivities of the breeding sites before and after the vector control showed no significant difference (Test T, p = 0.999) between the proportions. In Attécoubé, the comparison of positivity breeding sites of Aedes showed no significant difference (Test T, p = 1.000). A similar non-statisitcally significant difference was made in the other communities of Cocody, Koumassi, Port-Bouet and Yopougon.

**Larval epidemic risk indices**

A total of 627 homesteads (104, 106, 103, 100, 103 and 111 in Abobo, Attécoubé, Cocody, Koumassi, Port-Bouët and Yopougon respectively) were identified in all the communities before vector control. In the community of Abobo, the Habitat (HI), Container (CI), and Breteau (BI) indices were estimated at 38.46; 17.73; and 66.34 respectively, reflecting a high epidemic risk (ER) of 6 on the WHO population density scale. In the Attécoubé community, the HI, CI and BI was 38.67; 17.24 and 56.60 respectively, representing a high ER of 6 on the WHO density scale. In Cocody, a high epidemic risk (ER) was determined (6-7 on the density scale) with HI, CI and BI indices estimated at 47.57; 29.28 and 67.96 respectively. At Koumassi, the HI; CI and BI were estimated at 49, 31.54 and 82 with a high ER between 7-8 on the WHO density scale. In the community of Port-Bouët, the HI, CI and BI was 31.06, 12.59 and 50.48 respectively and represented a high ER (5-6). Finally, in the Yopougon community recorded a moderate epidemic risk (ER=4 on the WHO density scale) with HI, CI and BI indices estimated at 20.72; 6.34 and 26.12 respectively (Table 3). After vector control, a total of 600 housing units were recorded in all the communities visited, with 100 habitats per community. In the community of Abobo, the epidemic risk indices were estimated at 25, 14.88 and 39 respectively for the HI, CI and BI indices, reflecting a moderate ER (4-5 on the density scale). In Attécoubé, the HI (12); CI (5.39) and BI (15) represented a moderate epidemic risk of 2-3 (Table 3). In the town of Cocody, the HI, CI and BI were estimated at 28, 16 and 40 respectively, reflecting a moderate ER (5 on the scale). In Koumassi, the HI, CI and BI estimated at 20, 10.63 and 25 respectively, reflecting a moderate ER (4 on the WHO density scale). In Port-Bouët, the HI, CI and BI indices determined during the investigations were estimated at 25, 13.83 and 40 respectively and stood for a moderate ER ranging between 4-5 on the WHO density scale. Finally, in the Yopougon community, the ER indices determined were estimated at 22 (HI), 16.77 (CI) and 27 (BI), reflecting a moderate ER between 4-5 on the WHO population density scale.

**Discussion**

The water storage containers were the most frequent and preferred *Aedes* breeding sites during the survey, followed by abandoned containers, other deposits and tires. This finding was similar to that reported by other authors from Côte d'Ivoire [11, 12] but contrary to that published by authors elsewhere who rather reported that the most preferred breeding site for *Aedes* mosquitoes was tire [13, 14]. The differences in the preferred breeding site could be linked to the differences in the ecology of the sampled sites in the different studies. Positive breeding sites were more prevalent before vector control than after vector control. The problems linked to drinking water and the lack of sanitation in the different districts of the communities visited are factors that could explain this increase in the density of breeding sites. The role of the human population in this increase in density is not to be neglected given the lack of application of hygiene and vector control measures by them. This observation was made by Degallier *et al*. [15] who indicated that the human population is responsible for the proliferation of larval breeding sites. Also, the low maintenance of the water storage containers could justify why they are mostly preferred for breeding by mosquitoes in the prospected sites. The neglect of populations in the maintenance and cleaning of barrels and basins can be the cause of vector proliferation, in the sense that these deposits become the preferred targets of female mosquitoes that use them to lay their eggs. This clain is in line with findings already documented for Côte d'Ivoire and showed a strong colonization of the storage containers by *Aedes* larvae in the city of Abidjan [16, 11, 12]. However, Kamgang [17] found that *Aedes* larvae rarely colonized water storage containers. In addition, the observed presence of mosquito larvae in abandoned containers may be explained by the fact that they are rarely or not covered and therefore are good breeding and egg laying sites by female mosquitoes. In addition, these water storage containers containing *Aedes* larvae were most common in the communities of Koumassi, Port-Bouët and Yopougon (70.73%, 80% and 59.61% respectively). Indeed, these three communities are known to shelter many precarious neighborhoods with high population density that are conducive environments for the development of vectors because hygiene is really lacking there. The lack of hygiene could result in an increase in the prevalence of vector-borne diseases in the population. These observations corroborate those made by Zézé [18] that water storage containers are abundant in neighborhoods where modern infrastructures are inadequate (drinking water supply, sewerage system) or non-existent (precarious neighborhoods).

**Table 1:** Positivity of the different breeding sites in sampled communities before vector control in the long dry season

| Positivity of larval breeding sites of Aedes with nature of its environment | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Communities** | **Total breeding sites** | **Positive breeding sites** | **Water storage containers** | **Abandonned containers** | **Tires** | **Natural breeding sites** | **Other breeding sites** |
| Abobo | 389 | 69 | 34 (49.27 %) | 18 (26.06 %) | 10 (14.49 %) | 1 (1.44 %) | 6 (8.69 %) |
| Attécoubé | 348 | 60 | 23 (38.33 %) | 12 (20.00 %) | 10 (16.66 %) | 2 (3.33 %) | 13 (21.66 %) |
| Cocody | 239 | 70 | 39 (55.71 %) | 8 (11.42 %) | 11 (15.71 %) | 4 (5.71 %) | 8 (11.42 %) |
| Koumassi | 260 | 82 | 58 (70.73 %) | 14 (17.07 %) | 3 (3.65 %) | 0 (0.00 %) | 8 (9.75 %) |
| Port-Bouët | 413 | 52 | 31 (59.61 %) | 15 (28.84 %) | 1 (1.92 %) | 1 (1.92 %) | 1 (1.92 %) |
| Yopougon | 457 | 29 | 15 (51.72 %) | 6 (20.68 %) | 3 (10.34 %) | 1 (3.44 %) | 4 (13.79 %) |
| Total | 2106 | 362 | 200 (55.24 %) | 73 (20.16 %) | 38 (10.49 %) | 9 (2.48 %) | 40 (11.04 %) |

Regarding epidemic risk indices, it appears from the present investigations that in the communities of Abobo, Attécoubé, Cocody, Koumassi and Port-Bouët, the ER was high during the long dry season (before vector control) compared to a moderate scenario in the short dry season. In Yopougon, the ER which was moderate before vector control (4 on the WHO density scale), did not change after control (4-5 on the scale). This shows the importance of vector control operations carried out after the first phase of the study. This vector control has made it possible to reduce the density of the

vectors and, in turn, the stegomyian indices in certain communities visited. These results are in agreement with those obtained by Diakarida *et al*. [12] and Coulibaly [19] who obtained a high ER (6-9 and 5-6 respectively) in the community of Cocody. However, Konan *et al*. [20] reported a close to zero ER in the northern part of the country during the dry season. These results clearly show that the epidemic risk of arboviruses is real in the city of Abidjan.

**Table 2:** Positivity of the various breeding sites prospected sites after vector control in short dry season

| Positivity of larval breeding sites of Aedes with nature of its environment | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Communities** | **Total breeding sites** | **Positive breeding sites** | **Water storage containers** | **Abandonned containers** | **Tires** | **Natural breading sites** | **Other breeding sites** |
| Abobo | 262 | 39 | 39 | 5 (12.82 %) | 6 (15.38 %) | 3 (7.69 %) | 9 (23.07 %) |
| Attécoubé | 278 | 15 | 15 | 2 (13.33 %) | 1 (6.66 %) | 0 (0.00 %) | 4 (26.66 %) |
| Cocody | 250 | 40 | 40 | 10 (25.00 %) | 3 (7.50 %) | 3 (7.50 %) | 5 (12.50 %) |
| Koumassi | 235 | 25 | 25 | 2 (8.00 %) | 0 (0.00 %) | 0 (0.00 %) | 3 (12.00 %) |
| Port-Bouët | 289 | 40 | 40 | 6 (15.00 %) | 2 (5.00 %) | 3 (7.50 %) | 9 (22.50 %) |
| Yopougon | 161 | 27 | 27 | 1 (3.70 %) | 1 (3.70 %) | 0 (0.00 %) | 4 (14.81 %) |
| Total | 1475 | 186 | 186 | 26 (13.97 %) | 13 (6.98 %) | 9 (4.83 %) | 34 (18.27 %) |

**Table 3:** Epidemic risk indices before and after vector control in the six communities of Abidjan

| | **Homesteads visited** | | **Positive homesteads** | | **Total breeding sites** | | **Positive breeding sites** | | **Habitat Index (HI)** | | **Container Index (CI)** | | **Breteau Index (BI)** | | **WHO scale** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Communes** | **b** | **a** | **b** | **a** | **b** | **a** | **b** | **a** | **b** | **a** | **b** | **a** | **b** | **a** | **b** | **a** |
| Abobo | 104 | 100 | 40 | 25 | 389 | 262 | 69 | 39 | 38.46 | 25 | 17.73 | 14.88 | 66.34 | 39 | **6** | **4-5** |
| Attécoubé | 106 | 100 | 41 | 12 | 348 | 278 | 60 | 15 | 38.67 | 12 | 17.24 | 5.39 | 56.6 | 15 | **6** | **2-3** |
| Cocody | 103 | 100 | 49 | 28 | 239 | 250 | 70 | 40 | 47.57 | 28 | 29.28 | 16 | 67.96 | 40 | **6-7** | **5*** |
| Koumassi | 100 | 100 | 49 | 20 | 260 | 235 | 82 | 25 | 49 | 20 | 31.54 | 10.63 | 82 | 25 | **7-8** | **4** |
| Port-Bouët | 103 | 100 | 32 | 25 | 413 | 289 | 52 | 40 | 31.06 | 25 | 12.59 | 13.84 | 50.48 | 40 | **5-6** | **4-5** |
| Yopougon | 111 | 100 | 23 | 22 | 437 | 161 | 29 | 27 | 20.72 | 22 | 6.34 | 16.77 | 26.12 | 27 | **4** | **4-5** |

b: before antivectoral fight
a: after antivectoral fight
*: With vector infestation notified in 2017

## Conclusion

Investigations revealed that *Aedes aegypti* was the main vector of arboviruses in the country and is still very abundant in the city of Abidjan. The diversity of breeding sites observed could favor not only the contact between humans and this vector, but also the occurrence of outbreak and spillover of arboviruses. Integrated pest management is therefore an important alternative in the fight against vectors of arboviruses.

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## References

1. Failoux AB, Vazeille- Falcoz M, Mousson L, Rodhain F. Genetic control of vectorial competence in *Aedes* mosquitoes. Bulletin de la Société de pathologie exotique. 1999; 92:66-73.
2. WHO (World Health Organisation). Maladies infectieuses et parasitaires. Rapport publié sous le lien (http://destinationsante.com/quelles-sont-les-maladies-vehiculees-par-les-moustiques.html) 2018.
3. Wilson ME. Travel and the Emergence of Infectious Diseases, Emergency and Infectious Diseases. 1995; 1:39-46.
4. Esser HJ, Ramona M, Natalie BC, Henk J, Hein S *et al*. Risk factors associated with sustained circulation of six zoonotic arboviruses: a systematic review for selection of surveillance sites in non-endemic areas. Parasit & Vectors. 2019; 12:265. https://doi.org/10.1186/s13071-019-3515-7.
5. Gubler DJ. Dengue and dengue hemorrhagic fever: its history and resurgence as a global public health problem. In ed. Gubler, DJ & Kuno G. Dengue and Dengue Hemorrhagic Fever, Wallingford, UK: CAB International, 1997, 1-22.
6. Reiter P, Fontenille D, Paupy C. Aedes albopictus as an epidemic vector of Chikungunya virus: another emerging problem? Lancet Infectious Disease. 2006; 6:463-464.
7. Raharimalala FN. Rôle des moustiques Culicidae, de leurs communautés microbiennes, et des réservoirs vertébrés, dans la transmission d'arbovirus à Madagascar. Thèse de Doctorat, Université Claude Bernard, Lyon (France) et l'Université d'Antananarivo (Madagascar), 2011, 186.
8. Koumba AA, Zinga-Koumba CR, Nguema RM, Djogbenou LS, Ondo PO *et al*. Distribution spatiale et saisonnière des gîtes larvaires des moustiques dans les espaces agricoles de la zone de Mouila, Gabon. International Journal of Biological and Chemical Science. 2018; 12(4):1754-1769.
9. Braack L, Paulo AGA, Anthony JC, Robert S, de Jager C. Mosquito-borne arboviruses of African origin: review of key viruses and vectors. Parasit & Vectors. 2018; 11:29.
10. Lwande OW, Obanda V, Lindstrom A, Ahlm C, Magnus E *et al*. Globe-Trotting Aedes aegypti and Aedes albopictus: Risk Factors for Arbovirus Pandemics. Vector-Borne and Zoonotic Diseases, 2019, 1-11.
11. Kone BA, Konan LK, Diakaridia F, Koffi AF, Coulibaly D *et al*. Entomological evaluation of the risk of spread of the dengue 3 epidemic in the health district of Cocody (Abidjan, Côte d'Ivoire). International Journal of Mosquito Research. 2018; 5(5):19-24.
12. Diakarida F, Jean MVB, Yao-Acapovi GL, Sevidzem SL. Risk of Dengue Transmission in Cocody (Abidjan, Ivory Coast). Journal of Parasitology Research. 2019; 1:1-7.
13. Ferede G, Moges T, Ebba A, Wondmeneh JK, Yitayih W *et al*. Distribution and larval breeding habitats of Aedes mosquito species in residential areas of northwest Ethiopia. Epidemiology and Health. 2018; 40:7.
14. Abılio AP, Abudasse G, Kampango A, Candrinho B, Sitoi S *et al*. Distribution and breeding sites of *Aedes aegypti* and Aedes albopictus in 32 urban/peri-urban districts of Mozambique: implication for assessing the risk of arbovirus outbreaks. PLoS Neglected Tropical Disease, 2018, 12(9).
15. Degallier N, De Andrade TRAP, De Tarso RVP, Hervé JP, Mondet B *et al*. Arboviroses émergentes au Brésil. Convention CNPQ/IRD, 1998, 102-104.
16. Koné AB, Konan YL, Coulibaly ZI, Fofana D, Guindo-Coulibaly N *et al*. Évaluation entomologique du risque d'épidémie urbaine de fièvre jaune survenue en 2008 dans le district d'Abidjan, Côte d'Ivoire. Médecine et Santé Tropicales. 2013; 23:66-71.
17. Kamgang MDB. Bio-écologie et génétique des populations d'Aedes aegypti et d'Aedes albopictus vecteurs potentiels d'arboviroses au Cameroun. Thèse de Doctorat de l'Université de Yaoundé, 2011, 1-214.
18. Zézé GD. Moustiques anthropophiles de la ville d'Abidjan. Doctorat 3ème cycle de l'Université d'Abidjan, 1991, 96.
19. Coulibaly ZI. Evaluation du risque entomologique d'émergence du virus Chikungunya dans le district d'Abidjan (Côte d'Ivoire) de 2008 à 2010. Thèse de Doctorat, Université Nangui Abrogoua, Côte d'Ivoire, 2015, 217.
20. Konan YL, Fofana D, Coulibaly ZI, Diallo A, Koné AB *et al*. Investigations entomologiques menées autour de dix cas de fièvre jaune survenus en 2009 dans la région sanitaire du Denguélé, Côte-d'Ivoire. Bulletin de la Société de pathologie exotique. 2010; 10:57-64.