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Behaviour Of Anopheles Gambiae S.L. To Different Concentrations Of Insecticide, Kingasani District, Kimbanseke Commune, City Of Kinshasa, DR Congo

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Abstract – The results of these investigations reveal that the waste management and environmental sanitation system in place in the Commune of Kimbanseke and specifically in the Quartier Kingasani is inefficient and consequently has health and environmental weaknesses, which would mean it is not environmentally friendly.

This is due to a number of variables, including poor use of LLINs and insecticides, insalubrity, the absence of a genuine environmental management policy, mesological education, entomological surveillance and ongoing public awareness-raising.

The study of the resistance of Anopheles vectors of malaria subjected to different concentrations of insecticides in the Quartier de Kingasani, Commune de Kimbanseke, city of Kinshasa in DR Congo consisted firstly of a larval prospection and localization of larval sites, obtaining adults after rearing in the insectarium, which allowed the realization of sensitivity tests in order to observe the behavior of Anopheles facing different concentrations of insecticides and to highlight the rate of resistance.

Among the five insecticides exposed to Anopheles, these mosquitoes were highly sensitive to three insecticides (Alpha cypermethrin 0.5%, bendiocarb 0.1% and deltamethrin 0.05%), but showed resistance to two insecticides (Permethrin 0.75% and pirimiphos methyl 0.1%).

Thus, it is clear that the misuse of LLINs and a variety of insecticides from unknown sources, sold to markets could be the main cause of the increased resistance of Culicidae and sometimes other arthropods of medical interest in the Kingasani micro ecosystem.

Keywords – Anopheles Gambiae, Insecticide, Kingasani District,

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I. Introduction

According to the Programme National de Lutte contre le Paludisme (PNLP, 2016), malaria is a major public health problem in Africa, Asia in general and the Democratic Republic of Congo in particular, as it is the leading cause of infant (under 5) and pregnant women's mortality worldwide. It is a factor in the reduction of socio-economic well-being, due to the high morbidity of the active Congolese population.

Malaria is endemic in 106 countries and territories, including 45 in Africa. Africa is the region where malaria is most prevalent (234 million cases), with an estimated 593,000 deaths in 2021 (WHO, 2021).

Before the Covid 19 pandemic swept the world, the number of malaria deaths was estimated at 568,000 cases in 2019. This estimate rose to 625,000 cases in the first year of the pandemic in 2020, before falling back to 619,000 cases in 2021. The number of malaria cases continued to rise between 2020 and 2021, but at a much slower rate than from 2019 to 2020, when the number of cases was estimated at 247 million worldwide in 2021, 245 million in 2020 and 232 million in 2019 (WHO, 2022).

However, several insects provide enormous services to mankind and the environment, such as the palmetto beetle, the cockchafer and the honeybee. Others, on the other hand, represent potential risks for mankind, due to the pathogens they carry and the diseases they cause.

These include mosquitoes, tsetse flies, simulids, sandflies and fleas, which are responsible for many parasitic diseases. Mosquitoes account for 17% of infectious diseases and cause over 700,000 deaths a year (WHO, 2020). Although present in all regions of the world, these diseases are particularly prevalent in the Afro-tropical region, which remains the hardest hit, including DR Congo.

The role of mosquitoes in nature is not obvious, as we tend to think only of all the inconveniences they are synonymous with: biting, itching, roaring in flight, considerable nuisance and can transmit to man various infectious agents, many of which can prove pathogenic. They are essential to biodiversity as we know it. The malaria pathogen is transmitted by the female Anopheles mosquito. It is one of the most widespread and deadly diseases in the world, particularly in Africa (WHO, 2022).

Anopheles is a genus of mosquitoes in the order Diptera, family Culicidae, subfamily Anophelinae. This subfamily also includes two other genera: Bironella and Chagasia, which are numerically much less numerous.

464 species of Anopheles have currently been identified, but only 68 of them transmit the famous parasite, the etiological agent of the Plasmodium genus, to humans.

This article shows how anthropogenic activities (use of LLINs and insecticides sold in markets) carried out by the population of this district, have caused the pullulation of anopheles vectors resistant to different concentrations of insecticides, a consequence of the endemicity of malaria in this environment.

From an entomological point of view, major discrepancies were observed between achievements and projections. There is a serious lack of field entomologists to generate the basic data required for an appropriate vector control strategy in DR Congo, and in particular in the Kingasani district (WHO, 2010; RTI, 2012; Abt, 2013, 2014, 2015).

The aim of this study is to determine the sensitivity rate of anopheline vectors to different insecticide concentrations tested in the Kingasani district, Commune of Kimbanseke, City of Kinshasa in DR Congo.

II. Study Area

The Kingasani district covers an area of around 1 km² and is bordered by other districts as follows:

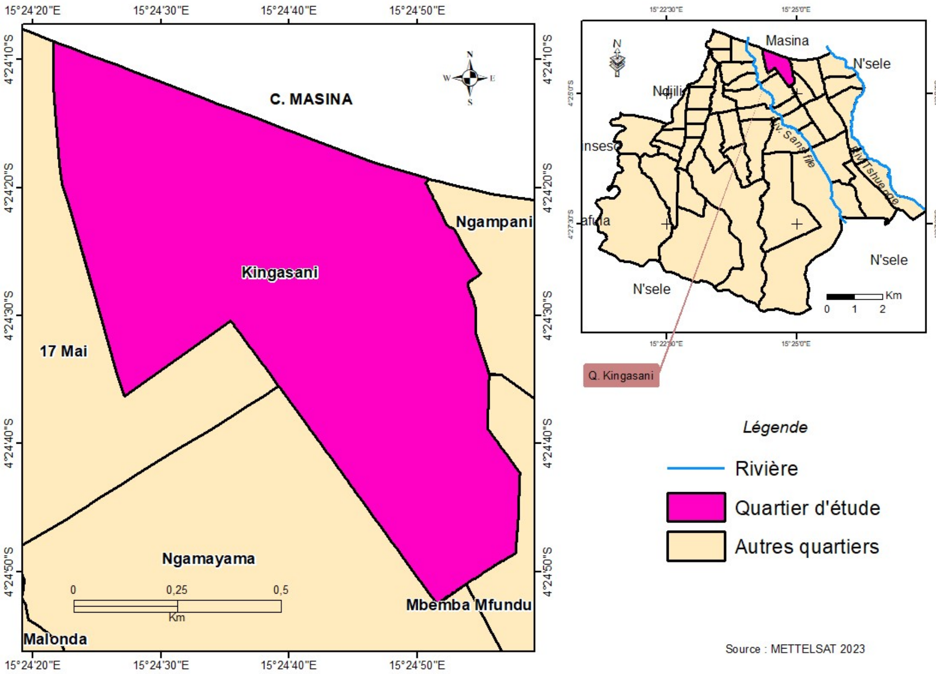

Figure 1: Quartier Kingasani in the Commune of Kimbanseke, Kinshasa/DRC

III. Materials and methods

1. Materials

The material used in this study is complex, in accordance with WHO protocol. The number of 844 larvae collected by larval prospection enabled the sensitivity test to be carried out.

2. Methods

The survey was carried out in sunny mosquito breeding sites: puddles, ponds, abandoned water wells, irrigation channels, river coves, etc.

The larvae collected were placed in small plastic buckets and sent to the INRB insectarium for rearing. 844 mosquitoes from the rearing were subjected to sensitivity testing using the WHO tube.

Figure 2: Ladle containing Anopheles larvae collected from a puddle in 2021.

3. Sensitivity testing

When mosquitoes are exposed to a given concentration of insecticide, anopheles undergo an aggression reaction to this concentration. This technique consists of placing Anopheles in contact with a paper impregnated with a concentration of insecticide in an insect-passing tube or WHO tube. Contact lasts 60 minutes, during which time every 5 minutes the number of stunned or dead mosquitoes is recorded in a bench notebook or data sheet.

Mosquitoes that have fallen and not fallen after 60 minutes of exposure are recovered from the WHO tube and placed in another WHO tube containing no insecticide, on the "roof" of which is placed a absorbent cotton pad soaked in a 10% glucose solution for the survivors' food requirements.

During the 60-minute mosquito/insecticide contact, three different mosquito behaviors were observed :

- ✓ mosquitoes were insensitive, and therefore resistant, to the insecticide ;
- ✓ mosquitoes stunned slightly by the insecticide, but were not killed 24 hours after contact with the insecticide: they were resistant to the insecticide ;
- ✓ the insecticide stuns them (causes a strong shock) and kills them immediately or 24 hours after contact with the insecticide: they were sensitive to the dose of insecticide.

IV. RESULTS

4.1 Distribution of species bred at the insectarium

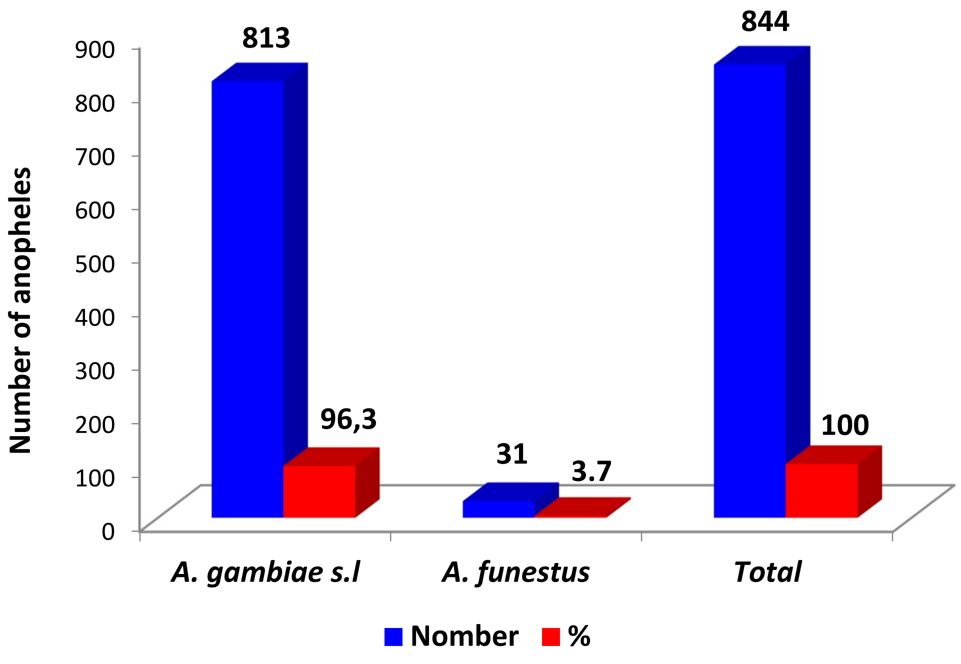

Figure 3: Distribution of Anopheles species bred at the insectarium.

Figure 3 shows that 844 adult Anopheles specimens were identified, divided into 813 A. gambiae s.l individuals representing 96.3% and 31 Anopheles funestus individuals accounting for 3.7% of total abundance.

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4.2 Status of A. gambiae s.l exposed to different insecticide concentrations

The behavior of Anopheles gambiae s.l vis-à-vis different insecticide concentrations, the sensitivity test was carried out at the INRB entomology laboratory according to the procedure recommended by WHO (2018).

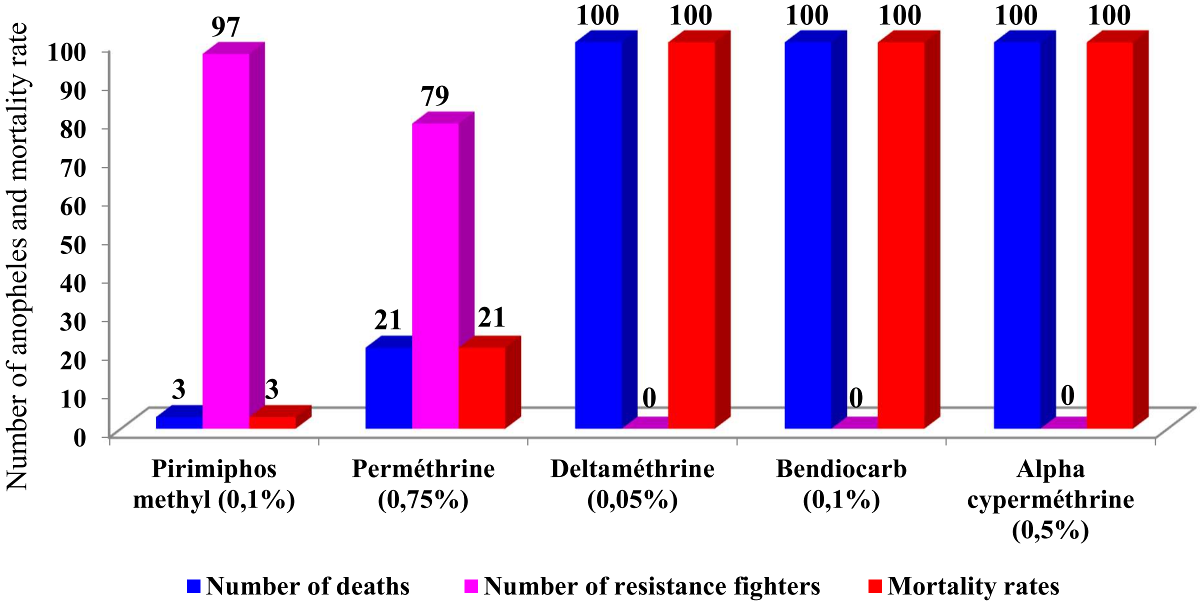

Figure 4: Status of Anopheles gambiae s.l. exposed to different insecticide concentrations

Figure 4 shows that mosquitoes exposed for 60 minutes were highly sensitive to all three insecticides (Alpha cypermethrin (0.5%), bendiocarb (0.1%) and deltamethrin (0.05%)).

In contrast, A. gambiae s.l. exposed to Permethrin (0.75%) and Pirimiphos methyl (0.1%) for 60 minutes, 24 hours later, were resistant. Resistance was highest with Pirimiphos methyl (0.1%).

Discussion

Improving environmental conditions in a community should certainly have a positive impact on public health, but it is difficult to determine whether this impact will be direct or indirect.

Often, improving environmental conditions is part of a wider set of development activities within the community, and even independently of improving drinking water supplies and waste management. It is usually accompanied by other factors that have an impact on public health, such as hygiene training and health education, to name but a few (Blum and Feachem, 1983).

However, it is not easy to identify or assess the effect of environmental factors such as hand-washing, changing attitudes towards children's faeces and community involvement (Franceys, Pickford and Reed, WHO, 1995).

The results of this study showed that Anopheles gambiae s.l vis-à-vis different insecticide concentrations during laboratory sensitivity testing according to the procedure recommended by WHO (2018) was exceptional.

Anopheles gambiae s.l. individuals were highly sensitive to the three insecticides (Alpha cypermethrin 0.5%, bendiocarb 0.1% and deltamethrin 0.05%), in contrast to the less effective insecticides (Permethrin 0.75% and pirimiphos methyl 0.1%), whose mosquitoes were resistant.

Mosquitoes were exposed in 4 tubes containing 25 individuals (female Anopheles gambiae) to insecticide-impregnated paper and 2 tubes containing 25 individuals (Anopheles gambiae s.l.) to non-impregnated paper (control). A total of 150 Anopheles gambiae s.l. were used to evaluate the efficacy of an insecticide against this species of malaria mosquito.

After 60 minutes' exposure of A. gambiae individuals to a given concentration of insecticide, Anopheles gambiae s.l. showed a behavioural response to this concentration. Contact of mosquitoes with different insecticide concentrations for 60 minutes highlighted three different behaviors (WHO, 2017) :

- ✓ Mosquitoes were sensitive to insecticides (≥ 98%);
- ✓ Mosquitoes were resistant to insecticides after 24 hours (< 98%);
- ✓ Low mortality (21%) was observed with both insecticides (Pirimiphos methyl 0.1% and Permethrin 0.75%).

Conclusion

It was a right of privilege and a matter of curiosity for us to approach this study in Kingasani to analyze the behavior of mosquitoes to different insecticide concentrations after several years of distribution and use of long-lasting insecticide-treated nets, as well as the multiplicity of various insecticide uses sold in the markets of Kinshasa and elsewhere.

Anopheles gambiae s.l. individuals were highly sensitive to the three insecticides (Alpha cypermethrin 0.5%, bendiocarb 0.1% and deltamethrin 0.05%) and resistant to the two insecticides (Permethrin 0.75% and pirimiphos methyl 0.1%) which were less effective.

In view of these results, larval control could be a palliative solution for interrupting malaria transmission, since the latter is a simple function of Anopheles density.

In this respect, it is reassuring to know that reducing the number of Anopheles bites effectively contributes to reducing the incidence of the disease.

So, to remedy this highly lethal parasite, it seems sensible to reconcile integrated control for economic, social, cultural and environmental interests, in order to build coherence and harmony in sustainable vector control.

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