

### Abstract

Insecticide resistance management (IRM) depends upon the availability of at least some effective insecticidal compounds. Four insecticides classes are available for malaria vectors control and resistance to pyrethroids and organochlorine classes is well known in African anopheles. Carbamate and organophosphate remain the alternatives and resistance to these classes is far less prevalent, and where each has been tested, all populations studied to date remain susceptible to at least one insecticide class. We tested *Anopheles gambiae* mosquitoes from Côte d'Ivoire for resistance. Here we report, the discovery of a population of *Anopheles gambiae* that is resistant to all available insecticides classes.



Only **pyrethroids** insecticides are approved for insecticide treated nets



**Organochlorine, carbamate and organophosphate** insecticides are approved for indoor residual spraying

Figure 1. Four classes of insecticides available for vector control

### Key message?

This represents an unprecedentedly extreme case of multiple resistance, which effectively nullifies Insecticide resistance management strategies and presents a severe threat to local vector-targeted malaria control.

## Research methods

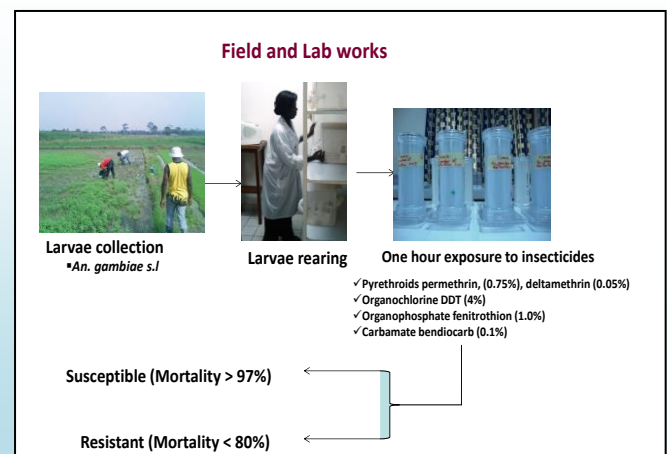
### 1-Larvae collection and insecticide susceptibility tests

We exposed adults (3-5 days old) *An. gambiae* s.s mosquitoes obtained from larvae collection in rice growing area of Tiassale, to technical doses of insecticides (below) during one hour, and we recorded the mortality rate 24 hours later. When mortality was under 80%, mosquitoes were considered resistant.

- Pyrethroids: permethrin and deltamethrin
- Organochlorine DDT
- Carbamate bendiocarb
- Organophosphate fenitrothion

### 2-Laboratory analysis of resistant mosquitoes

We used molecular techniques to investigate the genetic basis of such resistance.



## Results

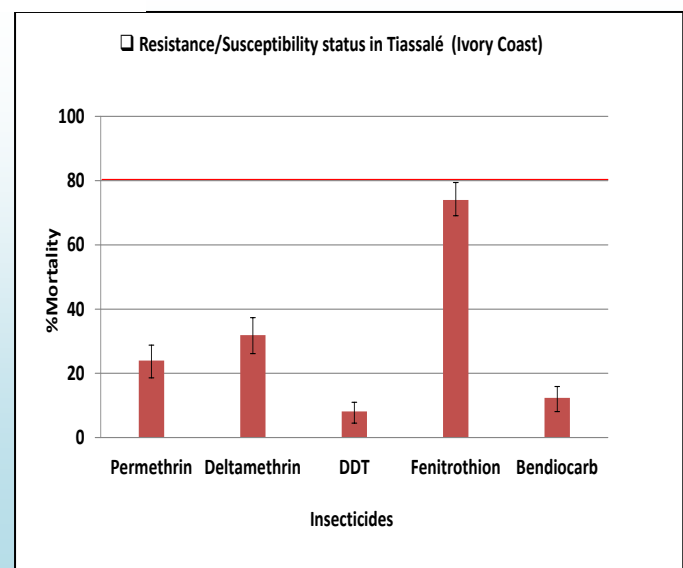
### 1- Insecticide resistance status

Mosquitoes were resistant to all insecticides available for insecticide treated nets and indoor residual spraying. The mortality rates were ranged from 12.4 to 74 % and were less than 80% according to WHO criteria.

### 2- Molecular analysis of resistance

Showed that:

- For DDT and pyrethroids, resistance is mainly due to overexpression of metabolic genes (metabolic resistance).
- For organophosphate and carbamate resistance, both metabolic resistance and change in acetylcholinesterase site (target site resistance) are implicated.



### What does this means?

Given the remarkable rates of spread of insecticide resistance, it is unlikely that this problem will remain confined to this geographical locale for long. Consequently the results should be made available simultaneously to malaria control programme officers and the research community.