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RESISTANCE OF *ANOPHELES GAMBIAE* S.S. TO PYRETHROIDS IN COTE D'IVOIRE

by

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Introduction

The extensive use of insecticides in agriculture, mainly directed against cotton and rice pests, led to the development of resistance in anophelines (1). Deltamethrin, a pyrethroid, is intensively used in ricefields in Côte d'Ivoire. In view of the increasing interest in pyrethroids for the impregnation of bed-nets in malaria control, we decided to study the susceptibility of *Anopheles gambiae* s.s., the main malaria vector, to this group of insecticides. This study was carried out at the Institut Pierre Richet, Organisation de Coordination et de Coopération pour la Lutte contre les Grandes Endémies (OCCGE) in Bouaké, Côte d'Ivoire.

Study areas

Three sites were considered:

1. the surroundings of Bouaké, where the rice fields are close to habitations;
2. the surroundings of Katiola, a non urbanized area;
3. the Vallée du Mbé, a rural area.

In the Vallée du Mbé (about 75 ha), which is under the direction of the West Africa Rice Development Association (WARDA), the only insecticide used is endosulfan, an organochlorine. In the other sites, the farmers, independent from any official organism, mainly use deltamethrin and Furadan® , a carbamate. In Bouaké, the population uses *larga manu* deltamethrin- and propoxur-based aerosol spray cans as well as bioresmethrin-based coils. The use of domestic insecticides is less spread in the rural areas.

Methods

In the different study sites, larvae of *A. gambiae* were collected and placed in cages where they were reared to adult stage. Adult females were fed on sugar-water and tested three days after emergence. The study included:

— 3 populations of *A. gambiae* from the surroundings of Bouaké (Tolakouadiokro: TOLA; Broukro: BR; Camp Pénal: CP);
— 1 population issued from Katiola (KAT);
— 1 population from Vallée du Mbé (ADRAO).

The control population consists of a colony originating from Bobo Dioulasso (BOBO) and maintained at the Institut Pierre Richet for several years. This strain is known to be resistant to DDT but susceptible to other groups of insecticides.

Four to five replicates of 25 specimens of each population were exposed to a concentration, imposed by the availability of impregnated papers, of three pyrethroids: permethrin (0.25 %), deltamethrin (0.025 %) and lambdacyhalothrin (0.1 %). We noted the knock-down (KD) effect after 15, 30, 45 and 60 minutes. After one hour of exposure, the surviving and the inert insects were placed under observation for 24 hours to determine the mortality rate.

Results

Permethrin

Mortality after 24 hours of observation is 18, 45 and 51 % respectively in the three populations (BR, CP, TOLA) of Bouaké. Mortality in the reference population (BOBO) is 90 %, in ADRAO it is 92 % and 83 % in KAT (figure 1). The KD effect is very different in the Bouaké populations where it does not exceed 21 % after one hour; in the three other populations it exceeds 85 % (figure 1).

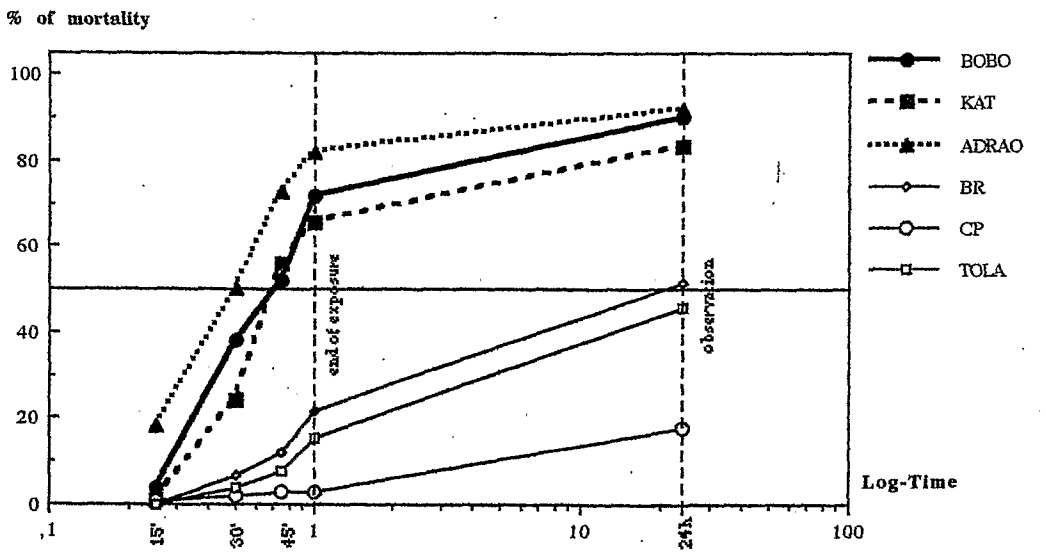

Figure 1.
Knock-down effects and mortality rate of *A. gambiae* adults after their exposure to permethrin (0.25 %)

Deltamethrin

Mortality after one hour of contact and 24 hours observation shows little difference in the six populations: it is around 95 % in Bouaké batches and 100 % in the other (figure 2). There is no KD effect after 15 minutes in the strains from Bouaké while it is about 75 % for BOBO, 59 % for ADRAO and 31 % for KAT. After 30 minutes, 28 to 55 % of Bouaké populations are KD

in comparison to 80 to 93 % in the other strains. After 45 minutes, 47 to 77 % of Bouaké are KD while 87 to 98 % of the others are KD. After one hour, only 83 to 90 % of Bouaké are KD as compared with 98 to 100 % in the other populations (figure 2).

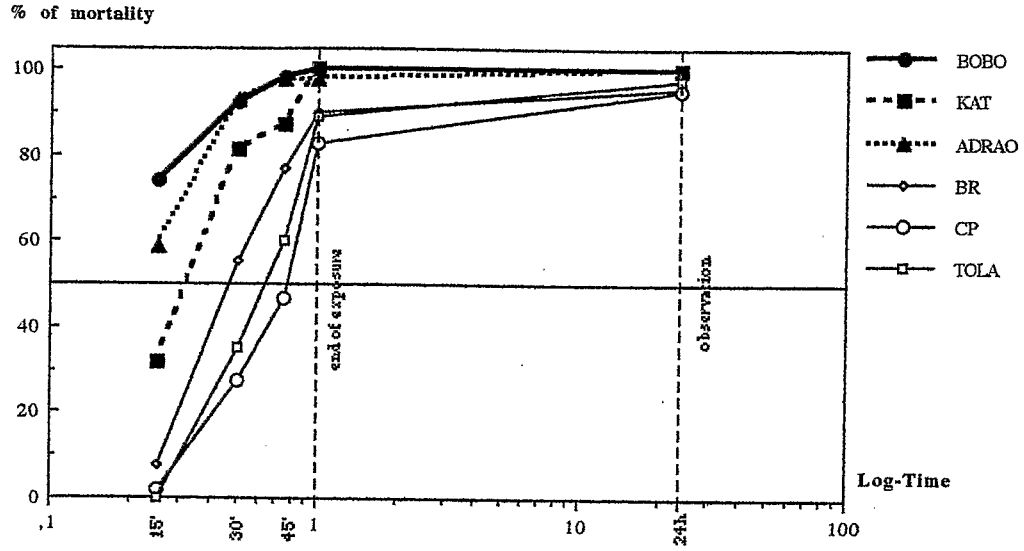

Figure 2
Knock-down effects and mortality rate of *A. gambiae* adults after their exposure to deltamethrin (0.025 %)

Lambdacyhalothrin

As with the last product, the mortality after one hour of contact and 24 hours of observation is between 94 to 100 % (figure 3). Concerning the KD effect, we distinguish clearly the three Bouaké strains from the others: the KD at 15 minutes is above 95 % in BOBO and ADRAO while it is below 15 % in Bouaké; at 30 minutes, the KD is above 98 % in BOBO and ADRAO and below 45 % in Bouaké (figure 3).

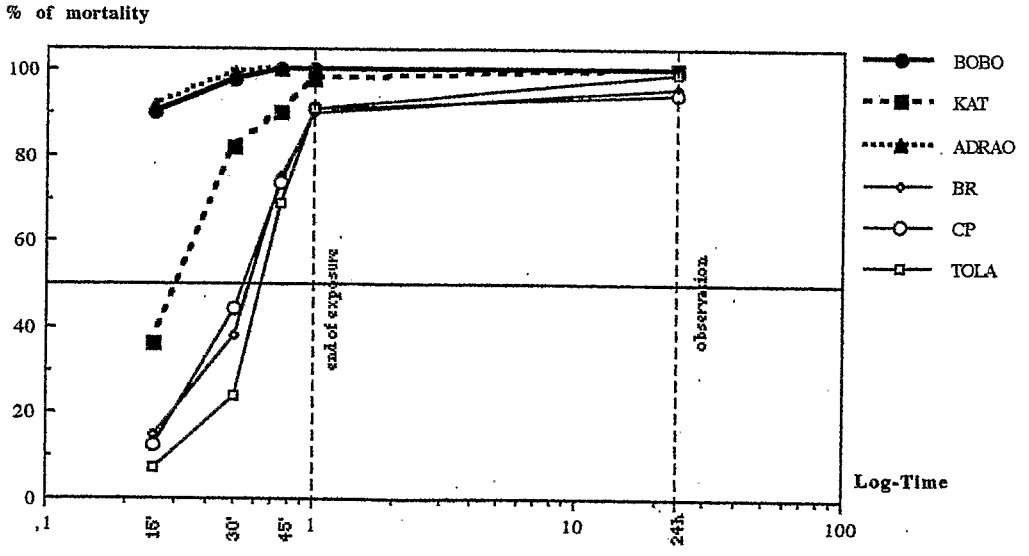

Figure 3
Knock-down effects and mortality rate of *A. gambiae* adults after their exposure to lambdacyhalothrin (0.1 %)

Discussion

In the surroundings of Bouaké more than 20 % females survived at the discriminative concentration of permethrin and according to the WHO criteria (2), there is no doubt about the resistance of *A. gambiae* s.s. to permethrin.

The resistance to deltamethrin and lambdacyhalothrin is a debatable matter: actually, at the exposure concentration after one hour of contact and 24 hours of observation, mortality reaches 95 % with the two compounds. Nevertheless, there is a significant drop in the KD effect of the two compounds. This drop does not necessarily imply a resistance according to WHO criteria, but shows a decrease in susceptibility which could be interpreted as a trend or a beginning of resistance to these insecticides. However, the suggested discriminative concentration of lambdacyhalothrin (0.0125 %) and deltamethrin (0.1 %) for *A. gambiae* s.s. (2) should be readjusted.

Origin and operational importance of resistance to pyrethroids

It seems that the resistance of *A. gambiae* s.s. to pyrethroids has not been induced by the chemicals used in agriculture. Indeed the population coming from Katiola, where deltamethrin has been used in ricefields, is still susceptible. However, it may not be excluded that resistance could have been selected by the domestic use of insecticides.

The operational importance of resistance to pyrethroids could be considerable as it might compromise the use of impregnated bed-nets, the only method of vectorial control considered effective in the areas of holoendemic malaria in Africa.

This pessimistic view should be tempered until answers will be given to two questions:

1. What is the geographic extension of resistance? If the origin is the use of domestic insecticides, it could easily be limited to the close surroundings of the cities.
2. In spite of the decreased knock-down effect, are deltamethrin and lambdacyhalothrin still able to provide good protection to people sleeping under impregnated nets?

The answer to these two questions is essential to establish malaria control strategies in Africa.

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