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Twenty-five years of blackfly control in a localized moist forest area of Cameroon: a review

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Abstract

The high number of blackfly bites in a moist forest area of Cameroon, around the Sanaga river, was causing considerable nuisance and had led to a local ground-based larval control campaign. We have reviewed the 25 years of almost uninterrupted weekly larvicide applications in this area and emphasized the problems related to application difficulties, environmental pollution and blackfly resistance to the insecticides. Although the number of larvicidal compounds readily available is now limited, the future of blackfly control at this site does not seem to pose real technical difficulties because of its economic importance (hydroelectric dam) and the progress made in the fields of resistance management, search for new insecticide molecules and development of new control methods.

Introduction

When blackfly bites are many they cause a real nuisance to humans and animals and sometimes constitute a serious obstacle to economic activities in a region, both in temperate (NOIRTIN *et al.*, 1981; CHARNETSKI & HAUFE, 1981) and tropical (PHILIPPON *et al.*, 1970) countries. In tropical Africa, the blackflies of the *Simulium damnosum* complex are vectors of onchocerciasis. A high biting rate alone may sometimes lead to blackfly control campaigns as at Edea and Song Loulou (Fig. 1), at the sites of 2 hydroelectric dams in southern Cameroon, where the number of bites exceeds 8000 per man per day (G. Chauvet, personal communication). This nuisance is at the root of the ground-based blackfly control campaigns directed against the rheophilic larval stages of the only cytospecies encountered, *S. squamosum*, which breeds in the Sanaga river and not in the little tributaries of the study area. In these moist forest zones, the economic stakes outweigh the cost of the control operations because the nuisance which the riverine populations find difficult to bear is an obstacle to the region's agro-industrial development.

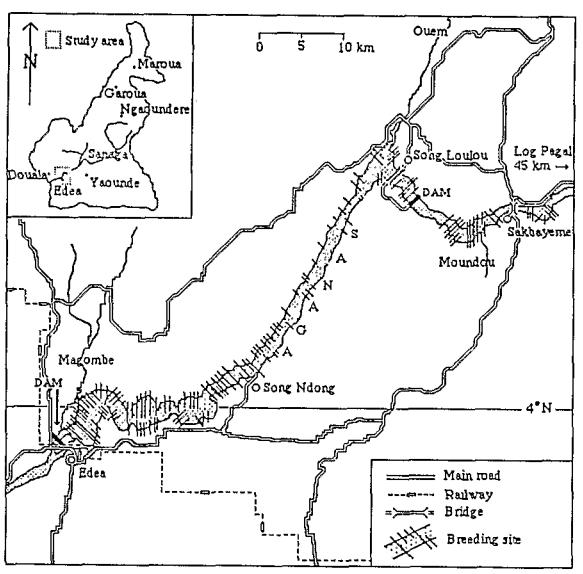

Fig. 1. Map of the study area in Cameroon.

Larviciding was started in this region in 1965 and is being continued successfully at present. It has, however, always posed serious difficulties because of the unfavourable hydrological conditions as well as the problems of resistance of the blackflies to the insecticides and environmental pollution. More than a quarter of a century of intervention has led to a successive use of insecticides sometimes having very unequal performances. The history of these larvicidal treatments over such a long period constitutes a unique source of information whose synthesis will certainly facilitate the selection of a strategy to adopt in future years both in this region and at other sites having similar trial conditions.

History of the larvicidal treatments and present status

The first larval control operations were carried out under the supervision of the Helminthiasis Research Unit of Kumba (DUKE, 1966, 1967) and started in 1965 when the Edea hydroelectric dam was constructed. The weekly treatments were firstly made at the Song Ndong rapids and, from 1967, were combined with treatments at Sakbayeme (Fig. 1), in the form of spraying a wettable DDT powder at concentrations varying, according to the discharge, between 0·0125 and 0·05 mg/litre for 10 min. The treatments led to a decrease in biting female density at Edea to 13% of its initial level but in 1977, following the expert appraisal by PHILIPPON (1977), DDT was abandoned despite its great efficacy and low cost price.

The main reasons for the renunciation of DDT were its too-great persistence and the accumulation in the environment of its decomposition products which still remain toxic. It was therefore replaced in 1977 with an emulsifiable concentrate of temephos, a very active product that is not very toxic, biodegrades rapidly and could, under favourable hydrological conditions and at a concentration of 0·05 mg/litre/10 min, be 100% effective more than 50 km downstream from the application point. Thus, the residual adult blackfly population practically disappeared but at the beginning of 1980 blackfly recrudescence was observed at the site of the Song Loulou dam, which was then under construction, and susceptibility trials with this organophosphorus compound revealed a high level of resistance (TRAORE-LAMIZANA *et al.*, 1985).

After a period of trials during which several compounds were tested, the treatments were continued in 1982 with an emulsifiable concentrate of chlorphoxim, another organophosphorus compound that is slightly less efficacious than the previous one but adequate, at the same concentration as temephos, for effective protection of the Song Loulou dam area, a site that had become a priority for blackfly control. After 3 years of uninterrupted weekly larvicidal treatments at only one spraying point, resistance to this compound was also observed and it was therefore abandoned and replaced with permethrin, a pyrethroid which is moderately toxic to non-target fauna if used at a high discharge (ANONYMOUS, 1990).

The first cycles of larviciding started in 1986, a few months after the completion of work on the dam, and are still continuing. At the concentration of 0·02 mg/litre/10 min, river trials showed that an emulsifiable concentrate of this insecticide caused 100% larval

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mortality more than 33 km from its application point with a river discharge of 520 m^3/sec. After 5 years of uninterrupted treatment, a slight decrease in susceptibility to this compound was detected but an unintentional interruption of treatment for more than 6 months led to a return of the susceptibility to its initial level. This compound is at present used for the protection of the Song Loulou dam site at one spraying point in the rainy season and at 2 points during the low discharge period.

Future of anti-blackfly control at Song Loulou

The performance required for anti-blackfly larvicides (efficacy, range, low toxicity, selectivity, good physical characteristics) already limits the choice of available compounds. The multi-resistance phenomena recorded in the study zone and the high discharges considerably reduce the number of alternatives to permethrin (Discussion, below). Although at that time no decrease had been observed in the efficacy of DDT, this organochlorine compound could no longer be used for safety reasons. Furthermore, susceptibility tests carried out by LOCHOUARN *et al.* (1987) have shown that temephos resistance has not decreased and that the return of susceptibility to chlorphoxim was only partial (Fig. 2). In order to reduce the chances of resistance developing to permethrin, and relying on the experience gained in the vector control programme in West Africa concerning resistance management (KURTAK, 1986), the use of 2 additional insecticides should be considered immediately, i.e., one chemical insecticide, pyraclofos, and one biological insecticide, *Bacillus thuringiensis* H-14.

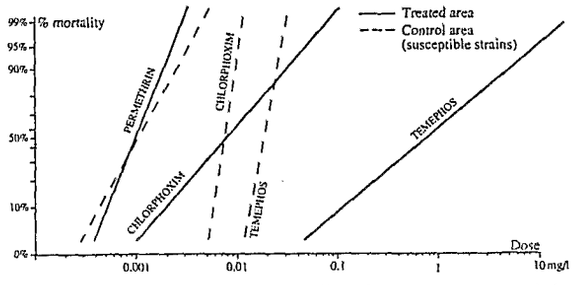

Fig. 2. Present status of the susceptibility of blackflies to permethrin, chlorphoxim and temephos after 25 years of larviciding in Cameroon.

Pyraclofos is an organophosphorus compound which has appeared recently on the market as an anti-blackfly larvicide. Its characteristics are at least equal to those of temephos and, because of its particular mode of action, the possibility of cross-resistance between it and compounds of the same family (temephos and chlorphoxim) is low. Pyraclofos can now be used in rotation with permethrin, or alone in case of resistance to this pyrethroid. Its use is, however, limited by its cost, which is far higher than that of permethrin.

The endotoxin of serotype H-14 of *B. thuringiensis* has been used for many years in blackfly control in temperate (MOLLOY, 1990) and tropical (GUILLET *et al.*, 1990) countries. Trials on the Sanaga with a liquid concentrate gave a range ('carry') greater than 20 km for a discharge of 565 m^3/sec. This insecticide has many advantages but the operational dose is unfortunately high (0·72 litre/m^3), limiting its use, for mainly logistic reasons, to discharges less than 400 m^3/sec and therefore to periods restricted to 3 or 4 months per year. It can therefore be used only in rotation with another insecticide, permethrin, or, in cases of resistance to this compound, pyraclofos.

Discussion

It is difficult to draw specific lessons from these 25 years of anti-blackfly treatments because the information is fragmentary and the study techniques vary according to the authors. However, these results have to be considered carefully because they emphasize the importance of the treatment protocol as well as the hydrological conditions of the river, both of which are of great significance in the future of larval control operations.

The treatment protocol is responsible to a large extent for the appearance of multiresistant strains because the stretch treated (some 50 km) has been constantly subjected to reinvasion by blackflies from sites upstream (Log Pagal) or, in the case of insufficient 'carry', downstream from Song Ndong to Edea (*S. squamosum* is practically absent from the tributaries of the river). The consequence of this reinvasion has been the need to maintain the weekly periodicity of the treatments while, downstream of the spraying point, the insufficient 'carry' and the resultant under-dosage have favoured the appearance of resistant strains. This phenomenon has forced the adoption of compounds which, though acceptable from the environmental point of view, are sometimes more toxic for the non-target fauna while being more expensive and often less effective (needing 2 spraying points instead of one).

The hydrological conditions of the river considerably reduce the choice of compound. The Sanaga is the most important river in Cameroon and its discharge, which ranges between 400 m^3/sec during the low water period and more than 8000 m^3/sec during the high water period, permits it to be classified among the biggest rivers in tropical Africa. In addition to this characteristic, there is, on a great part of its course, particularly between Sakbayeme and Song Loulou, a fast current due to a series of rapids covering some 100 m in a length of 18 km (DUBREUIL *et al.*, 1975). These hydrological conditions favour insecticide 'carry' and therefore limit the number of spraying points needed but, on the other hand, the high discharge necessitates weekly spraying of great quantities of insecticide, particularly during the rainy season which, in these latitudes, lasts more than 9 months.

The treatment protocol and the hydrological conditions are therefore the 2 factors which, indirectly, increased the cost of larviciding at the site. At the height of the rainy season, up to 400 litres of permethrin can be sprayed in a single weekly spraying, should the discharge reach 6000 m^3/sec. However, compared to the quantities of insecticides required by the Onchocerciasis Control Programme in West Africa, where several thousand kilometres of river have been treated each week for more than 15 years (ANONYMOUS, 1990), this control campaign does not represent a significant market to the insecticide suppliers who, under these conditions, are not always prepared to reduce their profit margin.

Conclusions

The blackfly nuisance control campaign on the lower course of the Sanaga river is being continued at the rate of one weekly treatment throughout the year. The results can be considered as satisfactory since the residual biting rate is, if not close to zero, at least at a level bearable to the local populations and the personnel working at the Song Loulou dam site. It is therefore to be noted that, despite the difficulties encountered during these 25 years of larviciding, it has been possible to prevent blackfly nuisance locally and that very probably there will always be replacement insecticides or new control methods to be made available to the users. However, it should be born in mind that these good results have been obtained only at a considerable cost, estimated at about US$ 200 000 per year, and that the maintenance of these operations is due only to the returns expected (blackfly control would not have been undertaken had it not been for the great importance that the country attaches to hydroelectric production). Fortunately, such operations are not always costly and the conditions under which treatments are carried out can sometimes considerably reduce their cost. Thus, in a savanna area in northern Cameroon, an on-

chocerciasis vector control campaign, which is also of local importance, has made it possible to reduce the blackfly biting rate by 60% at a cost of about US$ 12 000 per year (HOUGARD *et al.*, 1990).

S. squamosum is a vector of onchocerciasis in southern Cameroon, but this is not considered a serious problem at Song Loulou, compared to other areas of the Sanaga basin where the skin lesions are serious and many of the patients are blind (J. P. Chippaux, personal communication). Nevertheless, the high population density at this site has led the health service to distribute ivermectin, a new microfilaricide used in onchocerciasis control (PROD'HON *et al.*, 1991). Therefore the larval control carried out in this region directed against insect bites and the operations undertaken at the Song Loulou dam site can rightly be considered as a model for blackfly nuisance control in areas subjected to reinvasion.

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