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A GROUND LARVICIDING CAMPAIGN FOR ONCHOCERCIASIS CONTROL IN THE POLI AREA (FARO RIVER BASIN, NORTH CAMEROON) (1).
2. Two years of vector control

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by

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Summary

Based on the results of field studies undertaken from 1981 in a Cameroon savanna area, near a Tchadian refugee camp, it was concluded that the most suitable means of controlling onchocerciasis transmission was a ground larviciding pilot campaign directed at the Simulium damnosum breeding sites located in the tributaries of the Faro river close to the camp.

At a dosage of 0.1 mg per litre per 10 mn, under an average discharge of 3 m3 per sec., téméphos (Abate 200 CE) interrupted breeding for distances exceeding 15 km downstream of the spraying point. For a whole rainy season period of larviciding (mid-July to end of October), the value of the ATP decreased significantly to an hypoendemicity level resulting in 80 % reduction in onchocerciasis transmission.

Given the success and the low cost of this campaign, ground larviciding seems to be the most suitable means of controlling onchocerciasis in the Poli area until a new microfilaricide, Ivermectin, becomes available for mass apllication against this disease.

Résumé

Suite à des enquêtes parasitologiques, ophtalmologiques et entomologiques réalisées depuis 1981 aux alentours d'un camp de réfugiés tchadiens situé dans la région de Poli (Nord-Cameroun), une campagne de lutte antilarvaire contre l'onchocercose de savane a été entreprise durant deux années consécutives pendant la période de transmission, de la mi-juillet à la fin du mois d'octobre.

Les gîtes larvaires à Simulium damnosum s.l. sont situés non pas sur le fleuve principal, le Faro, mais sur ses affluents saisonniers. Les épandages hebdomadaires ont été réalisés par voie terrestre sur les trois affluents avoisinant la camp. A 0.1 mg par litre pendant 10 mn, pour un débit moyen de 3 m3 par sec., le téméphos (Abate 200 CE) a une portée efficace supérieure à 15 km.

Le traitement de la zone d'étude pendant l'intégralité de la saison des pluies permet de réduire de 80 % la transmission de l'onchocercose et d'abaisser le potentiel annuel de transmission d'un niveau de mésoendémicité à un niveau d'hypoendémicité.

Compte-tenu des bons résultats obtenus lors de ces deux années et du faible prix de cette campagne (environ 1 Dollar E.U. par habitant de la zone d'étude), la lutte antivectorielle est actuellement la méthode la plus appropriée pour combattre l'onchocercose. Cependant, dans un proche avenir, un nouveau microfilaricide, l'Ivermectine, prendra probablement le relais des insecticides dès que ce médicament pourra être utilisé en campagne de masse.

1. INTRODUCTION

In 1985, the branch office of the U.N.H.C.R. in the Republic of Cameroon requested technical assistance for an entomological and epidemiological study in a savanna area, near Poli (North Cameroon), to determine the risk of onchocerciasis for the Tchadian refugees of the Poli/Faro camp (Fig. 1). Based on the results of field studies undertaken from 1981 in this area (Quillévéré et al., 1989), it was concluded that the most suitable means of control of onchocerciasis was a ground larviciding pilot campaign directed at the Simulium damnosum breeding sites located in the rivers adjacent to the Poli/Faro camp.

The Poli area offered good conditions for such a campaign :

- transmission occured solely during the wet season, from mid-July to the end of October ;
- S. damnosum larvae were not found in the main river, the Faro, but many breeding sites were found on its seasonal tributaries ("mayos") ;
- meso- and hyper-endemic onchocerciasis foci existed along these tributaries. The local population and the tchadian refugees who cultivated near the mayos risked eye lesions which might be result in blindness.

No drug was available at the time for mass application against onchocerciasis. However, a new microfilaricide, Ivermectin, has given promising results (Prod'hon et al., 1988) but further investigations are necessary before its operationnal use. Consequently, taking into account the restricted area to be treated and the short period of larviciding, such a campaign appeared to be cheap and effective in reducing not only the disease transmission but also the Annual Biting Rate (ABR), especially in the riverside lands settled by the villagers and the tchadian refugees.

The control operations were divided chronologically into two phases. The first one, carried out during the 1987 wet season, was designed to elaborate the larviciding protocol and to assess the efficacy of such a campaign. The second one, carried out during the whole of the 1988 wet season, involved the devolution of the operations by training of Tchadian refugees under the responsability of the U.N.H.C.R.

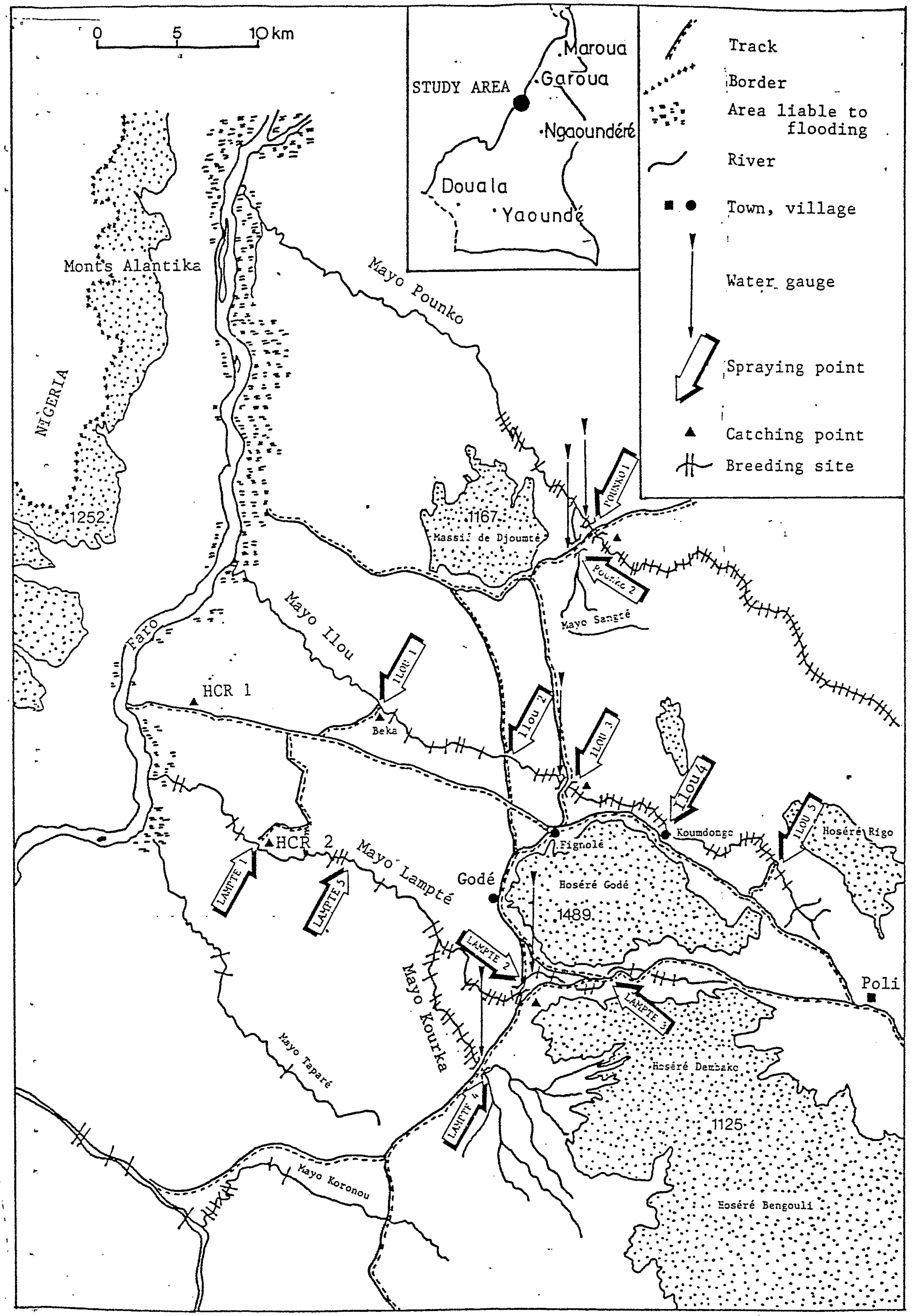

Figure 1 : The study area (Faro river basin - North Cameroon)

2. MATERIALS AND METHODS

Most of the techniques described in this section are those employed by the Onchocerciasis Control Programme (O.C.P.) in West Africa (Anonymous, 1985).

2.1. Aerial prospections

Ten hours of aerial helicopter prospections around the Poli/Faro camp allowed the author to complete the mapping of the *Simulium* breeding sites observed in the same area in 1986 (Quillévéré *et al.*, 1989).

2.2. Insecticide

Studies conducted by the O.C.P. have demonstrated the effectiveness of temephos (Abate· R), formulated as a 20% emulsifiable concentrate. At a dosage rate of 0.05 milligrammes per litres per 10 minutes at high water level and 0.1 mg/l/10 mn in the dry season, it produces 100% mortality of blackfly larvae. The "carry" of this formulation varies according to the river discharge but distances exceeding 40 km have been registred at high discharge rates. This organophosphate compound shows no toxic effect for mammals or fish and its impact on non-target invertebrate fauna is moderate.

Resistance of forest species appeared in Cameroon on the Sanaga river (Traoré-Lamizana *et al.*, 1985) but no decrease of susceptibility was observed with savanna species collected near the study area (Lochouarn *et al.*, 1987).

2.3. Larviciding operations

Temephos was applied by means of a single container which slowly released the formulation in the river and required preselection of the dosage of insecticide to be applied (Hougard *et al.*, 1987).
The quantity of insecticide formulation was calculated according to the discharge rates of the water course based on the water gauge readings. In the study area, the water gauges had been previously installed in the Faro tributaries during the dry season and standardized at the beginning of the wet season after several discharge measurements had been taken by means of an Ott current meter.

In view of the duration of the larval life, larviciding operations were based on a weekly treatment of the breeding sites.

2.4. Entomological and epidemiological surveillance

To keep a continuous check on the effectiveness of aerial operations, we established an entomological evaluation network in order to collect quantitative and qualitative informations on blackfly population and onchocerciasis transmission. These data were collected by catching men who were assigned to entomological checkpoints where biting rate were very high, particularly in the riverside agricultural lands and in the villages near the breeding sites.

As described in a previous paper (Quillévéré et al., 1989), the capture and dissection of biting females allowed the determination of entomological and epidemiological data and indices that could be related to the endemicity level and consequently to the efficacy of larviciding :

- the daily biting rate;
- the female parous rate ;
- the Monthly and Annual Transmission Potentials (MTP and ATP).

In savanna area, a good correlation exists between the ATP and the local epidemiological facies ranging from the hypoendemicity level (below 100 infective larvae per man per year) to mesoendemicity (100 to 1 000) and hyperendemicity level (above 1 000 infective larvae/man/year).

3. RESULTS

3.1. Larviciding operations

- Preliminary studies

The aerial prospections of the zone to be protected confirmed the 1986 results : the S. damnosum larvae colonized all the tributaries of the Faro river's right bank (Fig. 1). However, the "mayos" Koronou, Taparé and Pounko, far from the centre of the study area, were not concerned by the larviciding operations. Consequently, the assessment of the efficacy of temephos treatments which followed were carried out on the "mayos" Lampté, Yélé and Ilou.

The rainfall became intense from July to October. Discharge rates fluctuated during the wet season according to the rainfall frequency and varied also from stream to stream according to their size. In the "mayos" Lampté, Ilou and Pounko, they never exceeded 20 cubic meters per second (m3/sec.) even after a localized storm. The average discharge rate registered in 1987 and 1988 on these watercourses was about 3 m3/sec.

Taking into account the low discharge rate of the tributaries to be treated, temephos was used at its higher dosage (0.1 mg/1/10 mn). The preliminary studies conducted in these conditions showed that the carry of the insecticide could exceed 15 km from its point of application. At low discharge rates (below 0.5 m3/sec.) the carry sharply decreased .

- The weekly treatments

Each application had to be made every 15 km to obtain a complete "coverage" of the watercourse. A control of the efficacy of temephos after the first cyle of larviciding confirmed the preliminary data : 10 points of application (Lampté 1 to Lampté 5, Ilou 1 to Ilou 5) were sufficient to produce 100 % larval mortality from the upstream spraying points of the "mayos" Lampté, Kourka and Ilou (Fig. 1).

The larviciding operations required the treatment of about 90 km of watercourse during three months of the year, generally from the end of July (discharge rate above 0.5 m3/sec.) to October (discharge rate below 0.5 m3/sec.). Accordingly, the quantity of insecticide formulation used during the two years period of larviciding was approximately 200 litres a year.

3.2. Entomological evaluation

- the 1987 rainy season

Four vector collectors were assigned to four entomological checkpoints (Ilou 1, Ilou 3, Lampté 1, Lampté 2, Pounko 1) in the riverside agricultural lands, frequented from sunrise to sunset by the local population and the Tchadian refugees. A fifth vector collector was based at the Poli/Faro camp where the density of habitants was high (Fig. 1). In order to facilitate the explanation of the results, most of the informations presented are based on averages of the data collected by the five vector collectors.

In 1987, the larviciding operations started only at the begining of September in order to compare the entomological data before and after the treatment during the same rainy season (fig. 2).

. The biting rate declined slowly to remain stable at about ten bites/man/day only one month and half after the start of larviciding.
. The density of nulliparous females declined sharply as soon as the treatments began. 15 days after the first cycle of larviciding, the biting rate was under 5 bites/man/day.
. The mean parous rate was 57.3 % in August and increased after treatment to remain at a high level (about 80 %) until the end of the rainy season.

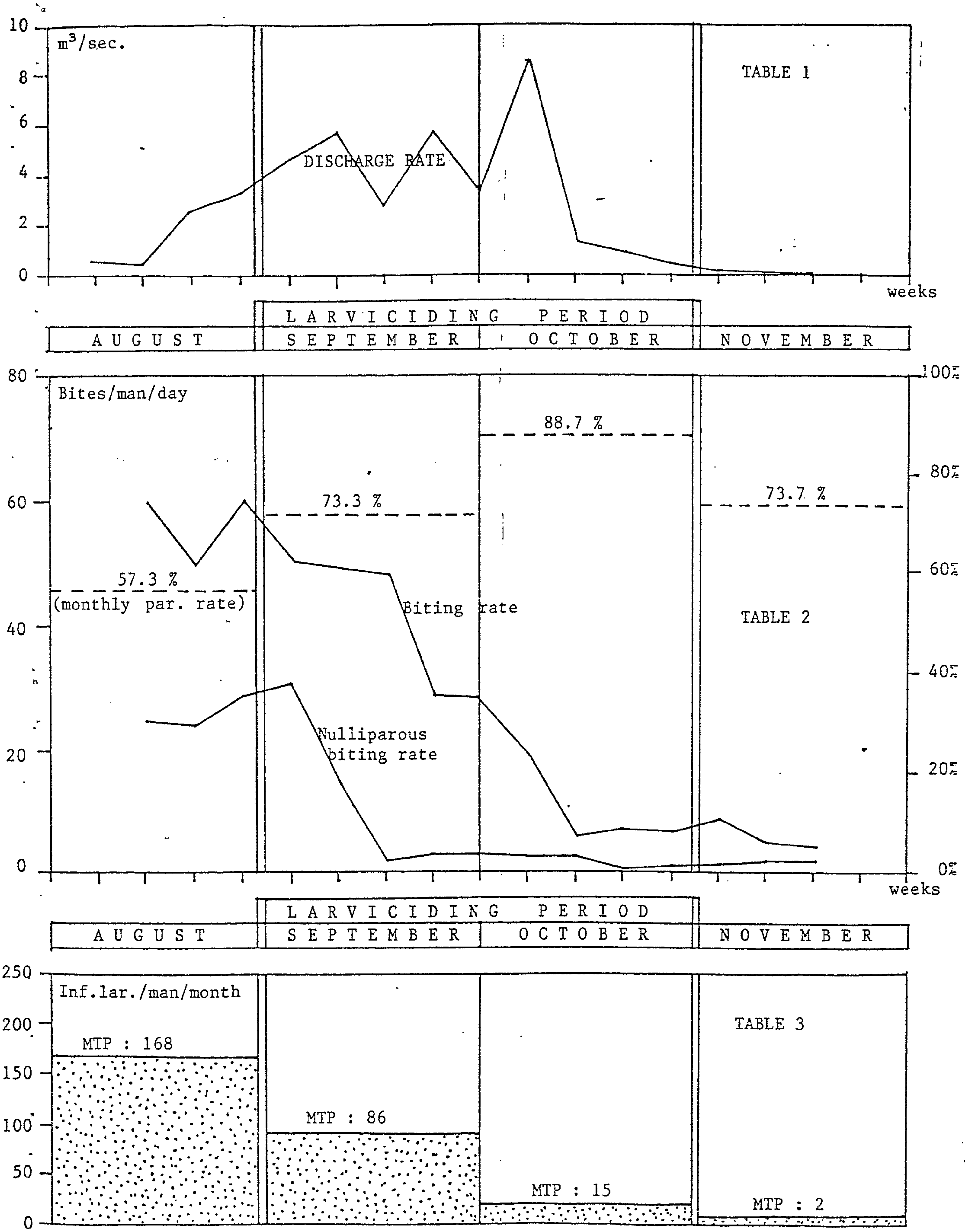

Figure 2 : Assessment of the effectiveness of the larviciding operations during the 1987 rainy season. Table 1 : weekly discharge rate ; Table 2 : mean biting rate, nulliparous biting rate and monthly parous rate in relation to control phases ; Table 3 : monthly transmission potential.

. The monhtly transmission potential (168 infective L3 larvae/man/month in August) decreased significantly in September to remain at a low level in October and November, respectively 19 and 2 infective L3 larvae/man/month.

.The graph of the average discharge rates registered every week during the reany season indicated that the modifications of the biting density and the M.T.P. were effectively due to the larviciding operations, and not to changing hydrological conditions.

It is interesting to note that the highest biting densities were registered at both checkpoints neighbouring the Poli/Faro camp (Ilou 1 and Lampté 1) while practically no blackflies were collected in the camp itself.

- The 1988 rainy season

The second phase of the programme involved the execution of control operations during the whole rainy season in order to quantify the entomological and epidemiological indices which allowed us to check the efficacy of such a vector control operation.

At this stage of the control phase, the evaluation network was simplified and confined to the two entomological checkpoints where the mean biting density was the highest (Ilou 1 and Lampté 1). The results presented here are the average of the data collected by both vector collectors.

The first cycle of larviciding started in July when the discharge rate reached 0.5 m3/sec. At this time, the biting density (107 bites/man/day) was high for three weeks before it declined gradually to remain stable one month later at a low level ; the average for October and September being 29 bites/man/day. The density of nulliparous females decreased just after the begining of larviciding, as in the 1987 pilot campaign, while the parous rate remained at a high level, ranging from 67 to 74 % all through the rainy season.

Both checkpoints previously mentionned were sufficient to follow the efficacy of the treatment throughout the rainy season. However, the level of endemicity of the disease in the study area had to be evaluated from the results of the complete entomological network. Thus the ATP obtained in 1988 have been extrapolated to the whole study area according to the previous 1987 results.

In 1988, the ATP was determinated in so far as it could be related to the onchocerciasis transmission level after a whole period of larviciding. Given the uncontrolled period which occured in 1987, its indice was not of great significance. Consequently, to know if we could expect promising results during the 1988 campaign, the value of the ATP was also calculated on the basis of the M.T.P obtained in October in the middle of the control period. These data, together with the ATP registred in 1986 during the precontrol phase (Quillévéré et al., 1989) are presented in Table 1.

	2 checkpoints (average)	whole study area (average 5 points)
A.T.P. 1986 uncontrolled phase	872 (Paksé * - Ilou 1)	478
A.T.P. 1987 partial cont. phase	731 (Lampté 1 - Ilou 1)	272
A.T.P. 1988 whole rainy season control	221 (Lampté 1 - Ilou 1)	82 (extrapolated results)
A.T.P. 1987 based on Oct. data	152 (Lampté 1 - Ilou 1)	62 (extrapolated results)

Table 1 : Comparison of the values of the annual transmission potential for the whole study area, in 1986, 1987 and 1988. * Paksé, near the Pounko river, presents the same epidemiological conditions as the Lampté 1 checkpoint only selected in 1987 and 1988 taking into account the extension of U.N.H.C.R. camp along the "mayo" Lampté.

4. DISCUSSION

At a high discharge rate (over 100 m3/sec.), Abate R 200 CE completely interrupted breeding for distances exceeding 50 km downstream the spraying point, while at low discharges (below 1 m3/sec.) sharply reduced carry of the formulation to less than several hundred meters was observed (Quillévéré <u>et al</u>., 1972 ; Kammura <u>et al</u>., 1985). Considering the average discharge of the "mayo" Lampté, Kourka and Ilou (3 m3/sec.), the 15 km observed in these watercourses confirmed the influence of hydrological conditions. However, from a logistic point of view, this "coverage" was convenient in so far as it allowed the whole cycle of larviciding to be completed in one day.

The larviciding operations had a major effect on adult blackfly populations, particularly in 1988 : the nulliparous females were directly affected by the treatments but the biting rate declined gradually, due to the remaining parous females invading the controlled area at the begining of the rainy season. In 1987, some blackflies bred locally during the untreated period (August) resulting in local parous females which were responsible for the higher level of the biting rate.

In comparison with the mesoendemicity level (478) observed in 1986 in the absence of treatment, the value of the ATP in the study area decreased significantly during the 1988 rainy season to a hypoendemicity level (82), resulting in 80 % reduction in onchocerciasis transmission. These results were not so important in 1987 (40 % reduction) given the presence of local parous females during the uncontrolled period.

In 1988, although the reduction in onchocerciasis transmission at the Lampté and Ilou 1 checkpoints was about the same as in the whole study area, these foci remained at the lower threshold of mesoendemicity. Reinvasions were mostly responsible for this situation but did not significantly influence the results at the end of the whole period of larviciding :

- the longevity of parous females did not exceed three weeks in savanna areas (Le Berre, 1966) ;
- the larviciding operations prevented the production of locally bred flies excepted for those breeding in the untreated intermittent tributaries of the "mayo" Lampté, Kourka and Ilou which may nevertheless be considered as negligible.

Over the whole period of larviciding, the value of the ATP of 1987, calculated on the basis of October data (62) was about the same as the value of the ATP of 1988 (82). These results confirm the effectiveness of the ground larviciding campaign and the commandable workmanship of the Tchadian trainees involved in this programme.

Local onchocerciasis vector control, by means of insecticides, has been carried out in many countries (in Anonymous, 1985 ; in Philippon and Le Berre, 1978) but the variety of logistic means, hydrological conditions and treated areas make the results difficult to compare. However, approximately similar vector control conditions as in the Poli area were reported in southwestern Sudan in the Bahr El Ghazal region where hyperendemic foci of onchocerciasis existed along the Bussere river (Baker and Abdelnur, 1985). As in the present study, a reduction of up to 80 % in transmission was achieved by controlling 41 km of the Bussere river where locally bred flies were found to be responsible for the majority of transmission.

5. CONCLUSIONS

This two-year research programme has shown that the control of the transmission of onchocerciasis in the study area could be achieved by ground larviciding of the tributaries (90 km of watercourses) neighbouring the Poli/Faro camp. Despite the residual transmission caused by reinvading blackflies, future vector control operations would suppress any risk of the development of ocular lesions for the Tchadian refugees and local population settling this area and would improve the ocular status of some subjects already affected and showing reversible lesions. For the next years, further parasitological and ophthamological studies would be neccessary to confirm these forecasts and consequently the value of such a vector control programme in geographical and hydrological conditions which offer, as in the Southwestern Sudan, the best chances of success.

Based on the 1988 rainy season results, the total cost of this campaign was estimated at about 12 000 U.S. Dollars (7 000 Dollars for insecticide, 2 500 Dollars for staff and 2 500 Dollars for logistic support). Taking into account the number of habitants in the study area, it cost about 1 Dollar per habitant per year, as in the O.C.P. area (Le Berre, comm.pers.), to protect the Tchadian refugees and the local population from onchocerciasis.

Given the success and the low cost of this campaign, ground larviciding seems to be the most suitable means of controlling onchocerciasis. However, a new microfilaricide, Ivermectin, has given promising results in the North Vina river basin, Cameroon (Prod'hon et al., 1988) and the strategy of onchocerciasis control in the Poli area could in a near future be based on the use of this drug, as indicated in the next paper (Quillévéré and Hougard, 1989) where strategy forecasts are also suggested for the whole of central Africa.

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