ONCHOCERCIASIS CONTROL PROGRAMME
IN THE VOLTA RIVER BASIN AREA

OCP/SAP/77/WP. 6

SCIENTIFIC ADVISORY PANEL

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WORKING GROUP ON CRITERIA FOR
RESETTLEMENT IN THE OCP AREA

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Agenda item 2.1.2

LEVELS OF ATP*) IN A SAVANNA AREA OF NORTHERN CAMEROON

by

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*) ATP: Adenosine triphosphate

Summary

1) From a preliminary analysis of mainly monthly or bi-monthly Simulium catches during 13 months in and around 10 villages in the Tcholliré-Touboro focus in the Sudan-savanna of North Cameroon, the following three patterns of onchocerciasis transmission have emerged:

a) year-long transmission near S. damnosum breeding sites in perennial rivers, with particulary high transmission in May-August and December-January (peak transmission potentials of 1000 and 800 respectively) at the breeding site.

b) high rainy season transmission (August-September) from seasonally running streams, with a peak monthly transmission of 350 in a nearby village.

c) short moderately high transmission (monthly tp 50-100) in the early dry season (December) due to an unexplained spreading of numerous parous flies far from possible breeding sites.

2) An estimated annual transmission potential of less than 100 in a village was associated with an acceptably low intensity of O. volvulus infection that produced no serious eye lesions. A high intensity of infection probably depends on a high amount of man-fly contact, and this can take place near breeding sites away from the village environment, even when the transmission potential within the village is negible or even absent.

3) These fly catching data are probably representative for the area, but annual variations in meteorological conditions must influence the transmission pattern, especially that close to rainy season streams.

4) Rapid re-appearance of many S. damnosum adults at the start of the rainy season is explicable by the presence of scattered

dry season breeding sites, but the trigger mechanisms for large scale S. damnosum movements require further studies. The influence of meteorological variations might be particulary important.

5) Other filarial parasites were found in birds and cattle, and their larvae have been seen in S. damnosum, as well as in other Simulium sp., as yet unidentified.

6) Different cytotypes of S. damnosum may be the reason for differences in zoophilie, mean parasitic load (i.e. arithmetic mean of infective O. volvulus larvae per infective fly), and behaviour of the fly populations at Toubourou, Tcholliré and Benoué, Pont de Boukma.

7) Several factors seem to limit the fly populations: first of all the presence of suitable breeding sites and substrates, than the hydro-chemical conditions and parasites of the S. damnosum larvae, and, less important, the presence of blood hosts for adult flies.

8) The continuation of this entomological survey shall be concentrated from the beginning of the rainy season in May 77 upon three villages: Mayo Galké village, Douffing, Rey Manga. Around each village, four catching stations shall be used.

Introduction

This work represents the entomological part of a study of a focus of onchocerciasis in the Sudan-savanna of Northern Cameroon. Clinical and parasitological data are provided by the team Drs. Anderson and Fuglsang, and this study aims to evaluate the dynamics of transmission of onchocerciasis in order to determine the annual transmission potentials (atp's) at certain key-places in or around villages with different endemicity and different relation to their respective Simulium damnosum breeding place.

Area and villages, selected for this study

During the time from February 76 to March 77 continuous fly data were collected in two areas at the following points:

Region of Tcholliré ($8^{o}25'N x 14^{o}10'E$; Fig.1)
Almost perennial breeding site at the river Mayo Galké ford
Villages Douffing (9^{+}), Tcholliré (8), Nonozé (7), Gandi (3), Mayo Galké village (0,3), Larki (5) and Rey Manga (10)

Region of Toubourou ($7^{o}50'N$ x $15^{o}20'E$)
Perennial breeding site at the Vina river bridge
Villages Toubourou (3), Bonandiga (4)

+ In brackets: distance in km to the next perennial breeding site

The positions of the fly-catching places are:

- at perennial rivers (Vina bridge, Mayo Galké ford)
- at the village well, about 150 m from the village itself (Douffing, Tcholliré, Gandi, Nonozé, Larki)
- in the village (Toubourou, Tcholliré, Bonandiga, Mayo Galké village)
- at the river Mayo Galké, about 10 km from the next breeding site (Rey Manga)

Material and Methods

The evaluation of the transmission potential is based on the results from fly-catching by human baits (vector collectors). At each catching station, 2 vector collectors worked from 6 am till 12 o'clock, a second team of 2 vector collectors from 12 to 6.30 pm. The flies caught were dissected to establish parous and infection rates. All developed III stage larvae were classified as infective, irrespective to their position in the fly body. From the results of dissecting, the monthly parous percentage (p %), the daily biting density (dbd = flies per man/day) during this time and the monthly transmission potential (mtp = infective larvae O.v. per man/month) were calculated. For to get a ~~previous~~ preliminary evaluation of the transmission potential, the infective biting density (= infective flies per man/month) was multiplied with the arithmetric mean of infective O.v. larvae in one infective lfy (i.e. 2.7 infective larvae per fly).+

+ In time it became clear, that there exists a marked difference in the mean parasitic load of an infective fly from the Toubourou region (M_A = 3.03 iL/fly) and the region of Tcholliré (M_A = 2.14 iL/fly).

Results

On 17 March 1977, a total of 13 months catching activities had taken place at most of the catching points. The total for the entire catching period (7 Feb. - 17 March 1977) was as follows: -

Number of flies caught	36,538	
" " flies dissected	30,924	
" " nulliparous flies	10,774	
" " parous flies	20,150	
" " flies preserved	3,423	
" " flies not dissected and not preserved	2,191	
Overall parous percentage	65.12 %	
Number of infected flies^{+} (L_2 and L_3)$^{+}$	1,838 ≙ 9.12 % of parous fl.	
" " flies with developing stages	1,346 ≙ 6.85 % " " "	
containing	3,846 developing stages	
arithmetic mean number of develop. stages	2.86/infected fly	
Number of infective flies (O. volvulus)	591 ≙ 2.93 % of parous fl.	
" " infective O. volvulus larvae	1,487	
arithmetic mean number of infective O.v.	2.52/infective fly	
Number of flies with double infections (L_2^{+}, L_3)	99 ≙ 5.49 % infected fl.	

$^{+}$No attempt was made to distinguish between different types of second stage larvae (L_2), which included other filariae as well as O. volvulus.

Monthly fly data

Table 1 gives, for each catching point, the daily biting density (dbd, i.e. number of flies/man/day), parous percentage (p%), and the monthly transmission potential, together with an estimated annual transmission potential (mtp and atp). From this table the following situations can be seen: -

A. Breeding sites in perennial rivers

1) Vina bridge and Mayo Galké ford. At both places there was a peak in July-August, and a second peak at the end of the year, particularly marked at Mayo Galké ford. Daily variations were marked, particularly at Mayo Galké.

2) Boukma bridge, on the Benoué river, where many S. damnosum larvae were found, showed a surprisingly low biting density, but at the same time there was a relatively high biting density at Larki, at a distance of 5 km from the nearest Benoué breeding site.

B. Villages near perennial breeding sites

1) At the center of Mayo Galké village, 500 m from the ford, the biting density followed the same pattern as at Mayo Galké ford, but at a much reduced level (5-10 %).

2) At Gandi, 3 km from Mayo Galké ford, a similar pattern of biting density was seen, but with a reduced parous percentage in May-September, followed by an end-of-year high parous percentage, which was similar, though less pronounced, to that seen at Larki and Rey Manga. However, the relatively high number of flies in August, which corresponded to the rise seen at purely seasonal transmission sites such as Tcholliré East, Campement (Nonoze), Douffing, and Bonandiga, suggests an additional source of flies, which could be breeding sites in nearby seasonal streams.

C. Villages with seasonal transmission

The most pronounced seasonal transmission was found at Bonandiga, where the sudden rise in the biting density in August-September did not parallel the situation at the Vina bridge. This, together with the high parous percentage, suggested a breeding site in the local seasonal stream.

Correlation between tp and intensity of onchocerciasis

Table 2 lists the main parasitological and ophthalmological data from the 10 villages surveyed, together with the estimated annual tp (atp) at the villages, and at the nearest breeding site (Vina bridge, Mayo Galké ford). The village data have not been age adjusted.

Table 3 demonstrates graphically the correlation between the annual transmission potentials (log atp) and the prevalence of + skin snips as well as the percentage of eye lesions and oncho-blind eyes. Arrows indicate the three villages, where the entomological survey is continued in 1977 (Rey Mango, Douffing, Mayo Galké village).

There is an obvious correlation between the atp and the prevalence of + skin snips and/or onchocercal eye lesions, a correlation, that will be more pronounced when the population parameters are standardized for age and sex. The populations of Mayo Galké and M.G./Gandi were previously all settled near Mayo Galké ford, but approximately 9 years ago the latter population moved towards Gandi away from the breeding site, but obviously took its eye lesions and blind eyes along. Nonoze (Campement) is an artificial village near the protestant Mission at Tcholliré, and the onchocerciasis status does not necessarily reflect local transmission. The same hold for Toubourou, where the tp at the popular Vina bridge washing

place probably accounts for the high intensity of infection among many of the Toubourou inhabitants.

Fly behaviour

From the fly catches and dissections, the following preliminary observations have been made: -

1) In the rainy season the fly biting density was most intense between 10.00 and 16.00 hrs.

2) In the dry season the biting density was most intense between 07.00 - 11.00 hrs, and again between 15.00 - 18.00 hrs, with 1/3 of the flies biting in the morning and 2/3 during the afternoon and early evening.

3) At the start of the rainy season there was an immediate appearance of large numbers of mainly nulliparous flies at the Mayo Galké ford - as soon as the river started to flow after having been stagnant for 2 months. This repopulation probably came from the breeding site at the Mayo Oldiri, or from the Benoué or Vina rivers.

4) In the early dry season there were large numbers of mainly parous flies at Larki and Rey Manga.

5) In the seasonally flowing tributaries of the Mayo Rey near Tcholliré, as well as in those of the Vina at Toubourou (e.g. near Bonandiga), larvae of Simulium sp. were present during the whole rainy season, but those of S. damnosum were not found. The fly numbers, however, suggest that S. damnosum breeding must have taken place near Bonandiga, and also near Gandi and Douffing.

6) The fly biting density was high at the Vina bridge, and at

Mayo Galké ford, but diminished away from these breeding sites. By contrast, it was low at the Boukma bridge breeding site, but higher far away from it at Larki.

7) A marked difference in the mean parasitic load of infective larvae per infective fly seems to exist between the flies of the region of Toubourou, where 244 infective Simulium damnosum flies carried 739 infective Onchocerca volvulus larvae (M_A = 3.03 infective larvae per fly) and flies of the region of Tcholliré, where 357 flies carried 764 infective larvae (M_A = 2.14 infective larvae per fly). Larvae of Simulium damnosum were collected at both places to determine different cytotypes.

Factors, limiting the Simulium damnosum fly population

Important seasonal changes in the population of Simulium damnosum as they are measured by the seasonal variations of the daily biting density, are related with the water level of the breeding rivers and indicate, that, whenever favourable breeding conditions occur, the daily biting density can be as high as 800 flies per Man/day.

In the large perennial rivers, where only a few or no submerged water plants seem to exist, clumbs of Simulium damnosum larvae and pupae can be found on the few leaves and sticks that hang into the fast running water, and, without no doubt, more larvae would be there, if they could find a suitable support.

The lack of Simulium damnosum larvae and pupae in most of the seasonal tributaries, where other species of Simulium flies (S. unicornutum, cervicornutum, medusaeforme, bovis) are commonly found, probably results from unfavourable chemical constitution of the water.

At one occasion, dissecting of larvae of Simulium spec., collected in a seasonal tributary without Simulium damnosum pupae, revealed a high prevalence of mermithidae parasites in these larvae; about 80 % of all old larvae were infested.

There seems to be no evidence, that the presence (or absence) of blood hosts for the flies might be a major factor for the survival rate of the adult female flies, at least not at the river Mayo Galké (bridge) where several villages are within the flight-range of Simulium damnosum. Furthermore, zoophilie may provide other possibilities of blood meals, at least at the river Mayo Galké, where zoophilie is confirmed by a high percentage of non-Onchocerca volvulus infective larvae in these flies.

Discussion

The 3 different patterns of transmission, and the estimated annual tp which emerged from the 13 months catches are probably typical for the area, but variations no doubt occur from year to year, depending on meteorological changes. However, in this study, a correlation between the intensity of infection of the villages and their tps, or those at nearby breeding sites, is still obvious. The fact that the tps were usually low at village centres, e.g. Mayo Galké, Toubourou, Tcholliré, emphazises that the intensity of infection depends on the actual man-fly contact, which does not usually occur in the village itself, but during the numerous activities which take place near S. damnosum breeding sites. Onchocerciasis is therefore to a great extent an occupational disease.

Where the annual tp was low at villages without nearby perennial breeding sites, e.g. Douffing, Larki, Rey Manga, and to some extend Gandi, the people were not aware of having onchocerciasis. Their few onchocercal eye lesions were mild and probably acquired elsewhere.

The choice of catching points, whether in the village or its surrounds, is crucial for the calculations of the transmission potentials. This probably explains the generally low tps in this study, when compared with previous studies by Duke in the same area, since Duke tends to choose catching points at places to which Simulium were thought to be attracted, and never at the village centre. Thus, in the present study, the tps at Bonandiga and Mayo Galké village would have been much higher had the catching point situated rather away from the village, and not at its centre.

The high transmission which occurred at Bonandiga when its local watercourse began to flow rapidly during the rainy season was expected at other similarly placed villages, but it was not so marked in the Tcholliré area. The absence of S. damnosum larvae and pupae was unexpected, and there is no obvious explanation for this phenomenon. Further studies on the breeding conditions in the seasonal tributaries are therefore necessary.

Fig 1
Bassari
Babbabla
Natdjari
Anina
REY BOUBA
Sultanat
Godji
Rodier
Rey Manga
Boromi
Mbila
Gatougel
Mayo Kalardja
Landou
Ngao Nan
Ouafango
Larki
Pani
Maradi
Tapare
Mayo Rey
H. Balinga
Hosére Gingri
H. Ribao
Nonozé
Mayo Dazdai
H. Djindjing
H. Nanga
H. Dog
Mayo Galke
TCHOLLIRÉ
Siège de la Subd
Gandi
Rodier
Laboun
Reyna
Kali
Kourouk
H. Toumbé
Doulling
Mayo Doudja
Dougon
Homé Garal
Ndoukla
H. Djapa
Mbip
Youkout
Yet
Hosére Mbip
Taboun
Hosére Gaonomé
ou
Hosére Djamji
H. Gadapela
Rodier
Campement de Chasse
H. Mano
H. Goulooukè
Réserve de Faune de la Bénoué
BÉNOUÉ
8° 40'
8° 30'
8° 20'
960
950
930
920
910

Table 1
Daily biting density (dbd=flies/man/day), parous percentage (p%), monthly and annual transmission potentials (mtp, atp)

place		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	atp
R Vina bridge	dbd	181	69	138	-	33	18	143	89	13	12	23	51	
	p %	66	78	86	-	48	71	68	77	47	51	46	63	
	mtp	293	81	210	-	103	60	810	241	38	0	19	40	2,000
AQ Bonandiga	dbd	16	-	3	-	1	3	1	148	71	6	0	0	
center	p %	12	-	40	-	50	53	100	85	80	80	-	-	
	mtp	0	-	0	-	0	0	0	345	253	10	0	0	610
AM Toubourou	dbd	0	-	5	-	0	0	0	0,2	0	0,3	0,5	0	
Mayo	p %	-	-	53	-	-	-	-	-	-	-	-	-	0
	mtp	0	-	0	-	0	0	0	0	0	0	0	0	
BM Mayo Galké	dbd	593	303	157	1	124	214	468	250	143	80	209	288	
Ford	p %	80	67	29	40	65	82	82	84	53	42	64	74	
	mtp	784	264	0	0	500	513	980	670	111	79	137	184	4,222
BK Mayo Galké	dbd	26	24	8	-	19	29	26	15	6	5	6	37	
Vil.Centre	p %	53	27	6	-	52	63	61	59	60	11	51	36	
	mtp	0	0	0	0	0	41	21	42	27	0	19	63	213
BG Gandi well	dbd	8	12	9	-	2	18	13	33	15	4	27	13	
	p %	37	21	20	-	33	50	29	32	42	53	42	58	
	mtp	0	0	0	-	0	0	0	0	10	0	15	0	25
BD Nonozé	dbd	0,4	0,5	-	-	-	6	21	15	3	4	11	2	
Campement	p %	50	0	-	-	-	40	60	44	46	25	31	20	
	mtp	0	0	-	-	-	0	56	33	0	0	0	0	89
BC Tcholliré	dbd	0	0	0,5	0	1	2	2	15	3	4	3	0	
East	p %	-	-	0	-	0	25	50	32	22	10	35	-	
	mtp	0	0	0	0	0	0	0	8	0	0	0	0	8
BF Douffing	dbd	1,3	0	0,5	0	2	5	3	23	9	12	25	1	
well	p %	67	-	100	-	0	64	67	44	29	18	27	0	
	mtp	0	0	0	0	0	8	42	17	0	0	14	0	81
BP Larki well	dbd	9	0,5	0	0	54	73	9	25	12	15	50	102	
	p %	29	0	-	-	14	29	22	26	26	10	22	69	
	mtp	0	0	0	0	0	0	0	0	0	0	0	95	95
BG Rey Manga	dbd	16	6	0,5	-	-	-	5	-	0	1	15	54	
	p %	35	33	100	-	-	-	70	-	-	0	18	58	
	mtp	21	0	0	-	-	-	0	-	0	0	0	40	61

T A B L E 2

No	Village census	Total seen	Number of persons with skin +	+++	++	MFAC	MFC	Oncho oncho eye lesion	blind eye no. of
01	145	114	103	24	42	39	63	16	5 = 4.4 %
02	72	53	48	16	19	20	33	11	10 = 19 %
03	157	124	109	12	43	28	44	8	5 = 4 %
04	112	93	65	2	14	24	34	4	2 = 2.2 %
05	108	88	70	13	30	25	42	15	9 = 10 %
06	51	42	32	0	2	6	14	2	1 = 7.4 %
07	94	88	56	4	8	11	14	2	0 = 0 %
08	79	68	47	6	12	12	30	7	6 = 8.8 %
09	48	48	33	0	2	6	9	1	0 = 2.1 %
10	?	158	113	20	28	34	54	14	1 = 0.6 %

Percentages

									annual transmission potential
01	Mayo Galké	79	90	21	37	34	55	14	213
02	MG/Gandi	74	91	30	36	38	62	21	(4.222)
03	Gandi	79	88	10	35	23	36	6	25
04	Douffing	83	70	2	15	26	37	4	81
05	Bonandiga	82	80	15	34	28	48	17	610
06	Larki	82	76	0	5	14	33	5	95
07	Rey Manga	94	64	5	9	13	16	2	61
08	Nonozé	86	69	9	18	18	44	10	89
09	Tcholliré	100	69	0	4	13	19	2	0 - 8
10	Toubourou	?	72	13	18	22	34	9	0(2.000)

+++: 15 or more microfilariae per snip at the outer canthus (right)
++: 100 or more microfilariae per snip at the iliac crest (right)
MFAC:microfilariae in the anterior chamber of the eye
MFC: microfilariae in the cornea
(results from Drs. Anderson and Fuglsang, data not yet age-adjusted)

Table 3: Correlation between % + skin snips, % eye lesions, % blind eyes and atp