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Original article

Onchocerca ochengi transmission dynamics and the correlation of *O. ochengi* microfilaria density in cattle with the transmission potential

Mbunkah Daniel ACHUKWI[a,b], William HARNETT[b], Alfons RENZ[c]*

[a] Institute of Agricultural Research for Development, Wakwa Centre, PO Box 65 Ngaoundere, Cameroon
[b] Strathclyde University, Department of Immunology, 31 Taylor street, Glasgow, G4 0NR, UK
[c] Zoophysiologisches Institut, Universität of Tübingen, 72076 Tübingen, Germany

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Abstract – The intensity of natural transmission of *Onchocerca ochengi* and *Onchocerca volvulus* by anthropo-boophilic *Simulium damnosum s.l.* was studied longitudinally in two cattle watering sites of a cattle ranch within a predominantly cattle populated area of the Guinea savanna of Cameroon and related to cattle *O. ochengi* skin microfilaria abundance. During the 12 months study period, a total of 4 696 flies was individually dissected to examine the monthly transmission potential (MTP) of *O. ochengi* and *O. volvulus.* The estimated *Simulium damnosum s.l.* annual biting rates (ABR) on human baits were 47 529 flies at the bank of the Vina "du sud" river. The ABR at the lake, which was situated at about 2 km upland from the perennial river, was 8 579. The monthly parous rate was highly correlated with monthly biting rate. The annual transmission potentials (ATP) of *O. ochengi* were calculated to be 7 732 and 1 669 at the riverbank and the lake, respectively. Transmission occurred mainly in the dry season, peaking in the months of January to mid-March when dermal microfilaria density in the animals was also the highest. The *O. ochengi* microfilaria uptake by the fly vectors was host microfilaria density-dependent. The MTP of *O. ochengi* was positively correlated with dermal microfilaria density. The mean number of microfilariae per fly taken up during a blood meal was high during the dry season as was the mean number of infective larvae per fly but declined significantly with the onset of the early rains. A similar seasonality of transmission was also observed for *O. volvulus* that was concurrently transmitted by the same vector flies, but its ATP was comparatively much lower: 1 332 infective larvae per man per year at the riverbank and 107 around the lake. The population dynamics of cattle microfilariae therefore plays an important role in the regulation of *O. ochengi* transmission.

transmission / ***Onchocerca ochengi*** / ***Onchocerca volvulus*** / **microfilariae density** / ***Simulium damnosum s.l.***

* Correspondence and reprints
Fax: (49) 7071 83801; e-mail: Alfonsrenz@cs.com

Résumé – Dynamique de la transmission de *Onchocerca ochengi* et corrélation entre la densité de leurs microfilaires chez les bovins et le potentiel de transmission. L'intensité de la transmission naturelle de *Onchocerca ochengi* et *Onchocerca volvulus* par l'anthropo-boophile *Simulium damnosum s.I.* a été étudiée longitudinalement à deux points d'eau d'un élevage de bovins, situé dans une région de savane guinéenne du Cameroun comportant une population principalement bovine, et a été corrélée à l'abondance en microfilaires de *O. ochengi* dans la peau des bovins. Au cours des 12 mois de l'étude, un total de 4 696 mouches a été disséqué individuellement, afin d'examiner le potentiel de transmission mensuel (PTM) de *O. ochengi* et *O. volvulus*. Les taux annuels de morsures (TAM) estimés de *Simulium damnosum s.I.* sur des proies humaines étaient de 47 529 mouches sur les berges de la rivière Vina du Sud. Les TAM autour du lac, situé à environ 2 km sur les plateaux dominant la rivière permanente, était de 8 579. Le taux de parité mensuelle était fortement corrélé au taux mensuel de morsures. Les potentiels de transmission annuels (PTA) de *O. ochengi* ont été de 7 732 et 1 669 au niveau de la rivière et du lac, respectivement. La transmission s'est produite principalement pendant la saison sèche, avec un pic pendant les mois de janvier à mi-mars, lorsque la densité de microfilaires dans le derme des animaux était également la plus forte. Le captage des microfilaires de *O. ochengi* par les mouches vecteurs était dépendant de la densité en microfilaires dans le derme de l'hôte. Le PTM de *O. ochengi* était positivement corrélé à la densité en microfilaires du derme. Le nombre moyen de microfilaires capté par mouche durant un repas sanguin était élevé durant la saison sèche, comme l'était le nombre moyen de larves infestantes par mouche, mais déclinait significativement avec le début des premières pluies. Un phénomène saisonnier similaire a été également observé pour la transmission de *O. volvulus*, qui était simultanément transmis par les mêmes mouches vecteurs, mais son PTA était comparativement beaucoup plus faible : 1 332 larves infestantes par humain et par an au bord de la rivière, et 107 autour du lac. La dynamique de population des microfilaires des bovins joue donc un rôle important dans la régulation de la transmission de *O. ochengi*.

transmission / *Onchocerca ochengi* / *Onchocerca volvulus* / densité microfilarienne / *Simulium damnosum s.I.*

1. INTRODUCTION

In recent years animal filarial parasites infecting cattle in savanna areas of Africa have attracted research interest [1, 16, 18, 20–22]. This trend has been largely attributed to the demonstration that the bovine *Onchocerca* species, *O. ochengi* Bwangamoi, 1969 is so far the best animal model available for studies on drug screens against human onchocerciasis [16]. *O. ochengi* has also been reported to be phylogenetically related to *O. volvulus* [2] and actually resembles *O. volvulus* in several aspects [20]. In the African savanna, *Simulium damnosum* Theobald *sensu lato*, which transmits *O. volvulus* is also known to naturally transmit other species of *Onchocerca* from animals [7, 15] including *O. ochengi* from cattle [6, 12, 24] and *O. ramachandrini* [7, 25] from the wart hog, *Phacochoerus aethiopicus*. The animal filariae detected in these vectors are indicators of a high degree of zoophily of the onchocerciasis vectors. It is not certain whether different seasonal transmission potentials of bovine and human onchocerciasis in the Guinea savanna region of Cameroon are due to seasonal fluctuations in definitive host microfilaria densities [29].

This paper reports the results of a one-year longitudinal monitoring of the quantitative levels of vector-parasite transmission rates with respect to definitive host parasite population in an area where prevalence of bovine onchocerciasis is very high. The study was part of an experiment designed to investigate the build up pattern of the *O. ochengi* parasite burden in the definitive host (Achukwi, unpublished data).

2. MATERIALS AND METHODS

2.1. The study site and fly catching

The study was carried out on a cattle ranch situated at the banks of the Vina "du sud" river on the Adamaoua plateau of Cameroon. The cattle population in the area was estimated to be higher than that of humans by a factor of about 15. Two fly catching sites located at watering points for the cattle were chosen: one at the river bank and the other near a man-made lake located about 2 km uphill from the river. At each catching site, *Simulium* flies were caught on men once a week, from March 1995 to February 1996, from 07:00 hours to 18:00 hours throughout this period. A set of three experienced fly collectors followed a rotation protocol ensuring that no collector caught flies in the same site for two consecutive weeks. Sampling consisted of catching all flies, which landed on the fly collector's exposed legs before they had a blood meal, with a sucking tube. The flies caught were stored at –20 °C within a maximum period of two hours after fly catching stopped.

2.2. Identification of *Simulium* species

The *S. damnosum s.l.* populations at the study site were identified by cytotaxonomy (using the chromosome banding pattern) of the larvae [23] in the nearest breeding site, Vina "du sud" river, and by the colour (first 3 segments) and compression (segments 4 + 5) of the antennae of adult flies [8]. From the larval chromosome banding pattern, 95% of the *Simulium* flies larvae were identified to be *S. squamosum* characterized by a high frequency of heterologous II L/18 inversions but some larvae (about 5%) were *S. damnosum*. Larvae of *S. bovis* and *S. hargreavesi* were very rare. All adult biting flies with pale and compressed antennae were therefore considered as "*S. damnosum s.str*." while those with dark and uncompressed antennae were "*S. squamosum*".

2.3. Dissection of flies and infection assessment

One hundred flies from each day's catch for each site were individually dissected, each in a drop of normal saline, under a stereomicroscope. When less than 100 flies were caught the whole catch was dissected. Single flies were dissected to describe parity, number and location of L_1, L_2, L_3 larvae (head, thorax, abdomen). Individual larvae were identified as *O. ochengi* or *O. volvulus* following morphological differences adopted from Wahl and Schibel [26]. Briefly, the total body length of larvae was measured directly on the dissecting slide using an ocular scale in a stereomicroscope (50× magnification). The larvae were then covered with a glass cover slip and examined under a compound microscope at 400× magnification. The differences in the following morphometric parameters were described: body length (µm), width at the thickest part of the body (maximal diameter (µm)), the maximal diameter expressed as a percentage of the body length of the same larva (relative diameter), distance between the anal pore and posterior end (relative length of the tail), relative length of the muscular oesophagus (including the buccal cavity) and the relative length of the glandular oesophagus, all expressed as a percentage of the body length of the same larva. Besides their greater length (745 ± 47 µm), the larvae of *O. ochengi* differ from those of *O. volvulus* (638 ± 46 µm) by their blunt tail and their thinner anterior end. This morphological classification was facilitated when several infective larvae were found in the same fly. Only flies of the *S. damnosum* complex (*S. squamosum* and *S. damnosum*) were dissected while the other species (*S. bovis* and *S. hargreavesi*), which occurred very occasionally, were just counted. Transmission indices calculated

from 4 696 *S. damnosum s.l.* flies dissected during the 12 months included: monthly biting rate (MBR) on man, annual biting rate (ABR), monthly transmission potential (MTP), annual transmission potential (ATP), parous rate, infected and infective parous rate, and arithmetic mean of the number of L_3 per infective fly. The MTPs and the ATP were derived from dissection data of flies caught on human baits. All L_3 emerging from the flies' head, thorax and abdomen were included in the calculation of MTP. The MTP was calculated as the arithmetic mean of the number of L_3 per fly dissected multiplied by the MBR. The sum of the MTPs for the 12 months of the year gave the ATP. All these estimates were calculated following the procedures described by Walsh et al. [30] and Renz [13].

2.4. Cattle skin microfilariae

Cattle exposed to natural vector transmission in the ranch with regularly characterised parasite burden were used for evaluation of the dynamics of dermal microfilaria density (Achukwi, unpublished data). Eleven three-year old cattle (5 males and 6 females) were chosen randomly from two stationary herds in the ranch. Repeated evaluation of dermal microfilaria density was undertaken on these animals every other month for one year. For studies involving the natural uptake of microfilariae from the bait bull, microfilaria density was assessed during selected days in December, January, February and March (dry season) and April, May and June (rainy season). From the shaved skin, three superficial skin biopsies were taken with a scalpel from along the *linea alba*, one just posterior to the umbilicus, one mid-way between the umbilicus and udder and one just anterior to the udder/scrotum. All other data on microfilaria density not related to microfilaria uptake from the animal bait was derived from cattle skin biopsies collected on the fifth day after the animals had been treated against ticks. It has been previously suspected [1] that treatment of the animal bait with an acaricide, alphacypermethrin, led to the reduced recovery of infective larvae from the flies fed on the treated bait. Further investigation (Achukwi, unpublished data) however showed that following treatment of the animal bait with the acaricide, microfilaria density was not significantly affected. The three skin biopsies were incubated in polystyrene tubes at 37 °C in 1mL RPMI 1640 medium supplemented with 2 mM glutamine, 100 IU·mL^{-1} Penicillin (Gibco, Ltd. Paisley, Scotland), 100 µg·mL^{-1} streptomycin (Gibco), 1% (w/v) glucose, 0.5 µg·mL^{-1} amphotericin B and 2% FCS. After 6 and 24 hours of incubation (the medium was recovered and replenished once in between), the biopsies were blotted dry and weighed (the range was 20–50 mg for all three skin snips). Thereafter, to recover the microfilariae that had not emerged from the biopsies during incubation, the skin biopsies were digested with 0.5% (w/v) Type VII collagenase (Sigma, St. Louis, USA) at 32 °C. The microfilariae were morphologically identified and distinguished using the procedure of Wahl et al. [27] with respect to their species and counted under a dissecting microscope at 50× magnification. A compound microscope was used for confirmation of identification when necessary. Microfilariae of *O. gutturosa*, which occurred as a concurrent infection in the vectors, and other filarial species such as the occasionally detected *Onchocerca dukei*, *Onchocerca armillata* and *Setaria* spp. were also counted. Microfilaria density was obtained from the total number of microfilariae of each species counted divided by the skin biopsy weight.

2.5. *O. ochengi* microfilaria uptake by *Simulium damnosum s.l.* flies

A bait bull highly infected with *O. ochengi* and lightly infected with *O. gutturosa* was exposed to *S. damnosum s.l.* flies

at the banks of the Vina "du sud" river. The bait bull used in this experiment was never treated with any acaricide. The figures for *O. gutturosa* microfilaria density in the bull during the study period ranged between 0.33 to 1.59 mf·mg^{-1}. This part of the experiment was undertaken during the dry season (December to March) and the rainy season (April to June) of 1995 and repeated in 1996. Flies landing on the bull at the ventroposterior regions, including the scrotal sac skin were allowed to be fully engorged with blood before they were individually caught using 5 mL polystyrene tubes. The polystyrene tubes were locally adapted to suit the purpose by putting a net on the open end. The flies were kept at –20 °C within 2 hours of collection. At dissection, all microfilariae were counted and identified with respect to species. The blood meal taken by each fly was graded according to size as 1, 2, or 3, where 1 was the least (about 0.1 µL), 3 the largest (about 1 µL) and 2 an intermediate amount of blood ingested. For the particular purpose of this experiment, only flies with a blood meal size of 2 or 3 were used.

The chi-squared (χ^2) test was used to compare the seasonal variations in microfilaria uptake by the flies. The relationship between microfilaria density of naturally infected cattle and the MTP as well as between MBR and parous rate were studied by analysis of correlation.

3. RESULTS

3.1. Vector population dynamics and transmission rates

During 51 days of fly catching (between March 1995 and February 1996) in each of the two catching sites, a total of 6 672 *Simulium damnosum s.l.* flies was caught at the banks of the Vina "du sud" river (3 771 dissected) and 1 164 (925 dissected) at the lake. Of the dissected flies, 393 were infected with filarial larvae (L_1 sausage

Table I. MBRs proportion of parous infected *Simulium damnosum s.l.*, *O. ochengi* microfilaria density and mean L3 of *O. ochengi* and *O. volvulus* at the Vina "du sud" river bank and the ranch lake.

Month 1995 to 1996	Vina river bank				Ranch lake				Cattle (O.o) *Mf density
	MBR	Parous flies (%)	Parous flies infected (%)	m_a L_3/ infective fly O.o/O.v	MBR	Parous flies (%)	Parous flies infected (%)	m_a L_3/ infective fly O.o/O.v	
March	5 572	75.0	18.3	2.9/1	1 837	55.9	18.2	7.3/0	2.98
April	2 604	58.2	17.1	3.4/0	248	57.1	0	0	–
May	2 519	63.2	6.96	1/0	295	40.0	0	0	1.32
June	2 760	63.6	10.3	2/9	217	15.4	0	0	–
July	955	54.5	11.9	11/0	85	–	–	–	1.21
Aug.	3 759	64.5	11.8	2.5/1	1 217	14.9	13.0	1/4	–
Sept.	2 982	78.3	7.7	2.6/2	1 428	25.6	9.8	0	1.81
Oct.	488	44.6	4.0	1.0/0	391	33.3	9.1	0	–
Nov.	1 808	54.4	9.2	1.3/3	420	21.4	8.3	0	3.14
Dec.	4 600	75.4	19.3	2.7/1.7	403	72.3	19.1	4.8/0	–
Jan.	4 859	91.2	24.5	4.4/2.7	1 062	88.3	14.0	4.1/1.5	4.66
Feb.	14 623	75.7	18.3	3.4/5.5	976	67.3	23.5	3.0/1.5	–

MBR: monthly biting rate, O.o: *O. ochengi*; O.v: *O. volvulus*; * geometric mean of microfilariae·mg^{-1} of skin; m_a: arithmetic mean; L_3 = infective larvae; early dry season (November, December); late dry season (January, February, March); early rainy season (April, May, June); late rainy season (July, August, September, October).

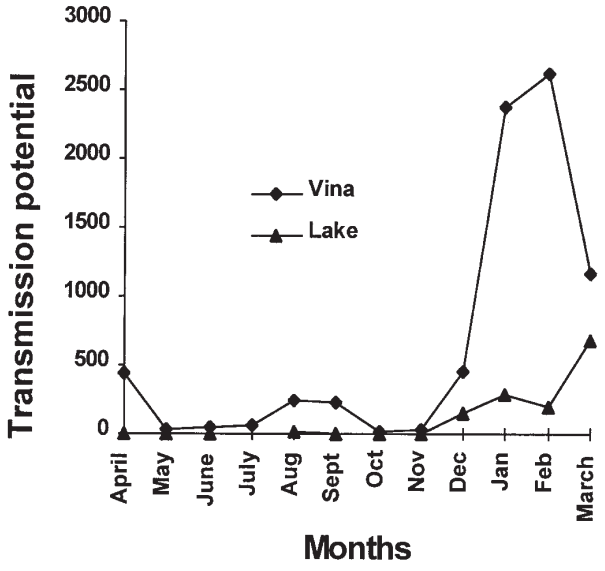

Figure 1. Monthly transmission potential (MTP) of *Onchocerca ochengi* at the banks of the Vina "du sud" river and the ranch lake. MTP = arithmetic mean of infective larvae per dissected fly multiplied by the monthly biting rate. The experiments were undertaken on man as the bait for catching *Simulium damnosum s.l.* The flies were not allowed to feed before catching.

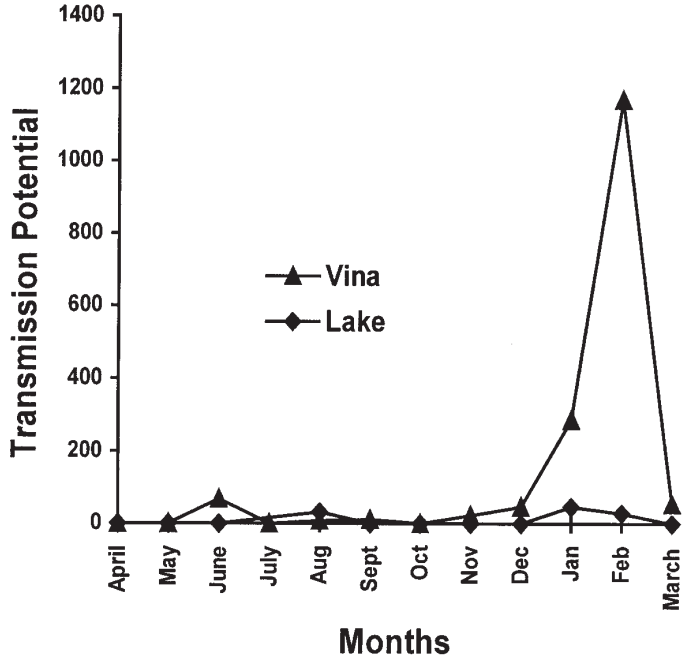

Figure 2. Monthly transmission potential (MTP) of *Onchocerca volvulus* at the banks of the Vina "du sud" river and the ranch lake. MTP = arithmetic mean of infective larvae per dissected fly multiplied by the monthly biting rate. The experiments were undertaken with man as the bait in order to catch *Simulium damnosum s.l.* The flies were not allowed to feed before catching.

stage, L_2 or L_3) at the riverbank but only 66 at the lake. The ABR on man for the riverbank was 47 529 flies per man per year while that at the lake was 8 579. The ATP of *O. ochengi*, measured from human bait catches, was calculated to be 7 732 and 1 669 at the riverbank and the lake, respectively. The ATP of *O. volvulus* was 1 332 and 107 at the riverbank and the lake, respectively. Details of the MBR are shown in Table I, while those for MTPs are shown in Figure 1 (*O. ochengi*) and Figure 2 (*O. volvulus*). The highest transmission occurred in the dry season, peaking in the months of January to mid March (Figs. 1 and 2). A period of moderate MBR occurred between April and November with the lowest MBRs recorded in July and October (Tab. I). MTPs variation tended to resemble that of the MBR and for *O. ochengi*, there was a high positive correlation ($P < 0.05$) between them. The proportion of parous flies, parous flies infected, and mean L_3 loads of *O. ochengi* and *O. volvulus* at the two sites are also shown in Table I. The proportion of parous flies was quite high, almost throughout the year, the highest being in January while the lowest was recorded in October (Tab. I). Correlation analysis also showed a significant positive correlation ($P < 0.05$) between MBR and parous rate. Inspection of *Simulium* breeding sites in the Vina "du sud" river revealed that no important breeding took place with the onset of heavy rains, that is from April on, but this activity resumed when the volume of water in the river fell at the beginning of the dry season (November).

During the 12 months study period, *O. ochengi* microfilaria density of naturally infected cattle that grazed within and around transmission measurement sites are shown in Table I. When microfilaria density of naturally infected cattle was compared with the MTP measurement, a significant positive correlation ($P < 0.05$) between microfilaria load and the MTP was obtained.

3.2. Uptake of *O. ochengi* microfilariae during natural blood meals by *S. damnosum s.l.* flies

For experiments destined to study microfilaria uptake from a bait bull, the microfilaria density (after digestion with collagenase) in the animal bait varied as follows: 25.5, 38.1, 51.3 and 15.1 *O. ochengi* microfilariae per milligram of skin tissue in the months of December, February, March and April 1996, respectively. The microfilaria densities of *O. ochengi* for the months of February, March, and June 1995 were 48.1, 53.2 and 14.8, respectively.

Table II. Uptake of *O. ochengi* microfilariae during natural blood meals by *S. damnosum s.l.* during the dry season as opposed to the rainy season.

Period	No. of microfilariae/No. of flies dissected (microfilaria range indicated)			No. of microfilariae	
	0	1 to 10	11 to 229	per dissected fly[a]	per infected fly[a]
Dry season	0/63 (36.6%)[b]	198/44 (25.6%)	3 050/65 (37.8%)	18.9 ± 33.2	29.8 ± 37.5
Rainy season	0/31 (45.6%)	115/30 (44.1%)	248/7 (10.3%)	5.3 ± 13.0	9.8 ± 16.4

[a] Arithmetic mean.
[b] Percentage of flies carrying microfilariae in the range indicated. A total of 240 *S. damnosum s.l.* flies were dissected during the two seasons. Background infection rates in non-engorged flies were 1.5% and 0.6% for the dry and rainy season, respectively. Microfilaria uptake was significantly higher in the dry than the rainy season (Chi-square value: 36.93; $P < 0.01$).

Microfilaria uptake by *Simulium damnosum s.l.* at the banks of the Vina "du sud" river varied with the month and particularly with the change in season. Microfilaria uptake was significantly higher (at least three times more, Chi-square value: 36.93; $P < 0.01$) in the dry season (November to March) than during the early rainy season (April to June). This lower microfilaria uptake coincided with a drop in dermal microfilaria density of the animal bait during the same period (Tab. II). As many as 229 *O. ochengi* microfilariae were identified in a single fly during the dry season and there were 13 other dissected flies carrying between 60–135 microfilariae.

4. DISCUSSION

The vector population dynamics and transmission rates reported in this study indicate that in this area *O. ochengi* is predominantly transmitted by *S. damnosum s.l.* (mainly *S. squamosum* in the local population) while the transmission of *O. volvulus* by the same vector is much lower. The ATP of *O. ochengi* at the river was 5 times higher than that of *O. volvulus* in this study area. Following previous observations [24, 29], that the *Simulium damnosum s.l.* biting density on cattle was about twice that of a human bait, the likely real ATP for *O. ochengi* on cattle would be about 15 464 and 3 338 at the river bank and lake, respectively. Transmission was much higher at the banks of the river than at the lake (located about 2 km uphill and away from the river) within the ranch. The cattle population in the study area was estimated to be higher than that of humans in the locality by a factor of about 15. The higher infection of the flies with *O. ochengi* as compared to *O. volvulus* may be due to the fact that most of the cattle carry *O. ochengi* infections as described earlier by Wahl et al. [27], providing the more accessible and main source of blood meals for the vectors. Low *O. volvulus* infection rates (17%) in humans in the locality [28] may also be a contributing factor to the low transmission rates of human onchocerciasis. In this area, the flies will have a low human reservoir pool (*O. volvulus)* from which to draw infections while a large reservoir of cattle (*O. ochengi)* parasites is readily available. Wahl et al. [29] attributed the low endemicity of human onchocerciasis in the same area to the high ATP of *O. ochengi* which they called "natural heterologous" vaccination.

The polymerase chain reaction (PCR) technology was thought to be more sensitive as a diagnostic tool [19] than the morphological classification used for the identification of the larvae in the fly. The proportion of misidentified larvae is certainly quite low since verification of our method by Wahl and Schibel [26] using DNA probes, which reacted exclusively with *O. volvulus* and *O. ochengi*, has shown that the morphological identification was up to 91% correct.

The seasonal fluctuations of the vector population and infection rates observed in this study are similar to those observed in Togo [5], where it was reported that the transmission of *O. volvulus* by *S. squamosum* at Amou-Oblo was maximal in the dry season. In the study by Cheke et al. [5] mean monthly transmission potentials ranged from 10.4 in August to 520 in February. Infectivity in terms of L_3 in the head per 1 000 parous flies was highest in March and significantly higher L_1, L_2 larvae loads occurred in the dry season. However, in absolute terms, the MTP for *O. volvulus* in February and the MTP for *O. ochengi* in January, February and March in the present study are all superior to those reported in Togo [5] by at least a factor of 2. The results of this study also have some similarities with those of another study carried out in Sierra Leone in West Africa [4] where the highest proportion of parous black flies occurred in the dry season. Chavasse et al. [4] however reported that the highest MBR occurred in February and the lowest in October. In a savanna area of Mali, with

S. sirbanum as the main vector, a high proportion of *O. ochengi* (39% of ATP) was calculated by Séchan [17]. The present results and those of Séchan suggest that the ratio of *O. ochengi* to *O. volvulus* ATP in those savanna areas in West and Central Africa where concurrent transmission of the two parasites by the same vector occurs, varies greatly and probably depends on specific microecological conditions.

In the present study, a significant correlation ($P < 0.05$) between MBR and parous rate was observed. Nulliparous flies tend to bite during the early morning and late afternoon. The time at which the flies are collected could therefore influence the results of the infection survey [11]. During our fly catching sessions, flies tended to be abundant during the morning (8–11 hours) and afternoon (14–18 hours); both periods fell within the catching times instituted. Le Berre [10] studied this phenomenon in various parts of West Africa and found high parous rates in some savanna areas.

In the neighbouring Sudan savanna area of Cameroon, lower proportions of animal filariae have been described in black flies. Duke [7] found 30–40% at the Mayo Boki while Renz [13] reported 33 to 51% of non-*O. volvulus* infections. In South West Ethiopia [9] and West Africa [19] the prevalence of *O. ochengi* infective larvae in the local black flies has also been reported to be higher with respect to those of *O. volvulus*. The present results highlight the need to study the immune responses invoked in man or cattle following inoculation (by *S. damnosum s.l.*) of man with *O. ochengi* and cattle with *O. volvulus* infective larvae.

Means of 3.3 *O. volvulus* L_3/wild caught infective *S. squamosum* and 3.0 *O. volvulus* for wild caught *S. damnosum s.str*. have been reported by Renz et al. [14] in the Guinea Savanna and Sudan Savanna area of Cameroon, respectively. In the present study area, a much higher fly infection rate of wild caught flies during the dry season than the rainy season has been reported previously [1]. In an analysis of data on the relationship between microfilaria uptake by the vectors and the density of microfilariae in the skin in human onchocerciasis from Guatemala (*S. ochraceum s.l.*), West and Central Africa (Savanna members of the *S. damnosum* complex), and South Venezuela (*S. guianense*), it was concluded that microfilaria uptake by the vector hosts was not strongly density-dependent in the three geographical areas and the ranges of dermal microfilaria load examined [3]. Our results in the cattle/*O. ochengi* system show a high correlation between microfilaria densities and L_3 infection rates in parous flies. Dermal microfilaria density in the present study dropped at the onset of the rainy season. It could be that more than one factor is responsible for the observed low vector infection rates. Some of such factors may be inherent vector strategies to limit larval development. In blood-fed flies dissected a few hours after being caught on *O. ochengi* infected cattle, we noted the ingestion of a high number of microfilariae by the flies at catching time but many of the microfilariae were trapped within the peritrophic membrane.

In the cattle/*O. ochengi* system definitive host microfilaria density correlates strongly with MTP in wild caught black flies in the study site and this could have important implications for the epizootiology of the parasite in the area. Microfilariae appear to congregate in the ventral skin when biting rates are highest and this correlation is likely to be, as is the prepatency period of about 10 to 12 months, an adaptation to the seasonal vector abundance in the savanna environment.

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