

A PRELIMINARY REPORT ON THE PROBLEM OF CONTROLLING GLOSSINA IN NYASALAND.

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On initiating this investigation my first aim was to discover a small isolated fly area, such as those described as "primary fly centres" by Dr. Shircore (Bull. Ent. Res., v., pt. 1, p. 87), with a view to carrying out experiments in the clearing of bush and endeavouring to reduce the numbers of the fly by systematic capture on a large scale.

With these objects in view I decided that I could not do better than proceed to the sleeping sickness area discussed in the paper referred to; but owing to much delay in the course of my voyage out, I did not arrive until almost the end of the dry season, so that it was only possible for me to examine two of the "primary fly centres" before the rains, though the remaining two were examined subsequently.

On examination of the Nyansato district (see Dr. Shircore's map facing p. 90), in late October and early November, before any rain had fallen at all, the fly was found over a very large area, which commenced about 2 miles from Domira Bay and extended nearly to Matumba's villages, a distance of about 8 miles in a direct line from east to west. Detours were then made so as to enter the district directly both from the south and from the north, the result being that in a direct line from south to north the fly was found over an area of 10 miles, extending right up to the edge of the clearing made round Mtalamanga's chain of villages. The observations made in this locality were confirmed subsequently in the course of frequent visits for the purpose of studying the fly.

The Lingadzi district was then examined, also before the rains. The fly was found sparingly a mile to the north of Mtalamanga's, at no great distance from the edge of the clearing, and a little further to the north it was obtained in numbers over a distance of approximately 10 miles in a direct line as far as the Chitua River, far beyond the Lingadzi. From east to west fly extended in this region from a point 2 miles west of the dambo at Makko, along the course of the Lingadzi for 10 miles in a westerly direction.

The examination of the Kuti marsh district and of the Patsanjoka marsh district was only completed after the onset of the rains. The fly distribution in these areas was then found to be continuous, extending from east to west for 15 miles, and from the Lintipi River in the south right up to Nyansato in the north, approximately 15 miles in a direct line.

To summarise my observations:—No evidence of the natural splitting of the northern portion of the fly area in the dry season into two *small* localised patches was found, though two large areas do certainly exist as a result of the subdivision of one larger one by native clearings; and in the southern portion, examined after a few scanty rains, the two so-called "primary centres" were certainly continuous with each other and with the northern portion of the area, the fly extending over so large a region as to make one sceptical in regard to the possibility of their limitation to within narrow patches so short a time before.

Fly is undoubtedly more concentrated in this district in the dry season than in the wet, coincident with the greater concentration of the game which then takes place, as I have been informed by several professional hunters and others, the reason for which is not far to seek. Over the greater part of the country in the dry season rivers and water-holes dry up, all shady verdure disappears, and the grass is burnt off, leaving a blackened wilderness which then compels the game to seek certain localities, such as are included in the area under consideration, where they can obtain shade and the necessities of life. This district, partly woodland and partly plain and all lowlying ground, is situated between Lake Nyasa to the east and tiers upon tiers of mountains to the west, and is in the wet season, as I am informed, permeated by numerous rivers and streams, when large areas often remain under water for weeks. Its soil is composed of rich black humus and, unlike that in other parts, contains little sand, which with the constant presence of subsoil water renders it extraordinarily fertile. Even in the dry season over the greater part of the area water is only surface deep and is always obtainable in the extensive marshes and elsewhere in hollows ; as a consequence grass is to be found here when no vestige can be seen elsewhere, and large forest trees, such as are found nowhere else at the same elevation, occur abundantly and always afford a certain amount of shade. In this district in the late dry season the grass was ankle-high when not a single blade could be seen in other parts, and as further evidence of the fertility of the soil it may be added that the native farmer can grow as many as two or three crops of maize on it in a favourable season, when elsewhere only one can be raised, though comparatively very little is under cultivation. Certain districts are well populated, but the habitations are all arranged along three definite narrow lines, so that the greater part is rarely traversed by human beings. The reasons for the concentration of the game are therefore obvious, and it seems a natural corollary that the fly, which, so far as has been ascertained at present, is entirely dependent on the game, should concentrate at the same time.

Though the fly does occupy certain definite regions in the dry season from which, as I quite agree, they radiate out farther afield when the grass springs up everywhere and the game spreads abroad, the foci, in this district at all events, are in my opinion far too extensive to make any experimental attempt at clearing and reducing their number by systematic capture practicable. I have not been able to discover that the "primary centres" form localised breeding grounds, so that this very attractive hypothesis is up to the present unsupported by a shred of evidence.

The whole question will be more fully studied in another district at a later date.

Flight Experiments with *Glossina morsitans*.

Preliminary experiments have been conducted with a view to determining the range of flight of *Glossina morsitans*.

Between 4th and 22nd December, 1,810 males and 312 females were captured in the Lingadzi district, where the elevation is about 1,700 feet, and between 4th and 17th December 854 males and 66 females had been marked and released at two different points—at Chunzi, at an elevation of 2,420 feet, 10 miles due south of the Lingadzi fly area ; and at a spot which has an elevation of 1,950 feet and is situated 2 miles south of the Lipimbi River and 5 miles south of the same fly area.

The flies released at Chunzi were marked by snipping off the first right foot through the middle of the metatarsus, an injury unlikely to occur in nature, and those released at the second spot were marked by snipping through the second foot on the same side. Their fitness seemed to be little impaired by the operation, for test specimens fed on a goat with avidity a few minutes after it, and it is usual to be much assailed by such flies immediately they are released.

By 7th December, 270 males and 29 females had been released at Chunzi, and on this date on proceeding in the direction of Lingadzi I recaptured one, a male, half a mile away. Two days later 379 males and 57 females had been released at the same place, and two males were then recaptured 2 miles to the south in the direction of the same fly area.

TABLE I.
Showing Numbers of Tsetses released and recaptured later.

Releases.					Recaptures.			
Date.	Locality.	♂	♀	Total.	Place of recapture.	♂	♀	Where released.
4 Dec.	Chunzi	73	11	84				
5 "	"	76	6	82				
7 "	"	121	12	133	½ mile S. of Chunzi	1		Chunzi.
8 "	"	47	13	60				
9 "	"	62	15	77	2 miles S. of Chunzi.	2		Chunzi.
10 "	Lipimbi	38	9	47				
11 "	"	97	—	97				
12 "	"	126	—	126	Lingadzi ..	2		One at Chunzi, the other near Lipimbi R.
14 "	"	76	—	76	Lingadzi ..	1		Near Lipimbi R.
15 "	"	138	—	138	Lingadzi ..	3		" "
16 "	"	—	—	—	Lingadzi ..	2		" "
17 "	"	—	—	—	Lingadzi ..	1		" "
22 "	"	—	—	—	Lingadzi ..	2		" "
Totals		854	66	920		14		

On 10th December I commenced to release flies at the second spot south of the Lipimbi, where by 12th December 261 male and 9 female flies had been set free. On this date one of the males was retaken at Lingadzi at the same time with another male which had been set free at Chunzi on a date between the 4th and 9th. By the 14th, 337 males and 9 females had been released at this place, and another male originally released here was on this date taken at Lingadzi. On 15th December, 138 additional males were released and 3 more were retaken at Lingadzi, where also on the 16th 2 more males, on the 17th 1 more male, and on the 22nd 2 more males, were recaptured. Evidence has therefore been obtained of ten flights of 5 miles and of one flight of no less than 10 miles back to the locality from which the flies were

originally taken, and in the case of three other flies, of flights tending to show that they were on their way back also. The flies recaptured were all taken at the fringe of the fly area, where, on account of the greater probability of meeting with them, the collectors had instructions to work. The country which they necessarily traversed is all well-wooded and without open spaces, and though careful search was made for released flies in directions away from the main fly area, none were obtained. No flies were fed previous to release. The results are appended in tabular form (Table I). I propose to continue experiments on these lines, using also flies which have been well fed before release.

The Proportion of the Sexes.

Record has been kept of the numbers of tsetse-flies captured and the proportion of the sexes, the results of which are appended (Table II). The number of fly boys engaged in the work of collecting has not been constant, neither has the work been uniform, so that no just deductions can be drawn from the figures as to the numerical prevalence of the flies.

TABLE II.
Showing captures of G. morsitans.

Locality.	Date.	Males.	Females.	Total.
Matumbas	20th Nov. ..	15	8	23
"	21st " ..	51	24	75
"	24th " ..	38	6	44
"	25th " ..	51	31	82
"	26th " ..	43	18	61
"	28th " ..	42	24	66
"	30th " ..	94	19	113
"	1st Dec. ..	12	5	17
Lingadzi	5th " ..	119	23	142
"	7th " ..	104	14	118
"	8th " ..	114	38	152
"	9th " ..	117	24	141
"	10th " ..	130	40	170
"	11th " ..	167	18	185
"	12th " ..	133	14	147
"	14th " ..	115	10	125
"	15th " ..	175	12	187
"	16th " ..	84	15	99
"	17th " ..	159	27	186
"	21st " ..	93	33	126
"	22nd " ..	184	27	211
Totals		2,040	420	2,460

Trapping Experiments.

In accordance with Sir Patrick Manson's suggestion, a cage of wire mosquito-proof netting was constructed in a part of the Lingadzi district where tsetses are especially numerous, and in this a goat was incarcerated, the outer side of the cage and the undersides of branches of trees near by being smeared with bird-lime in the hope

of catching the flies attracted by the animal. The results were by no means satisfactory, for no more than eight flies were taken, though the goat remained there for 7 days, a failure possibly to be explained by its not being called upon to move about with any degree of activity, and by the inability of the fly to see such movements as occurred, my experience in this connexion confirming that of other observers, namely, that the flies are attracted especially by moving objects.

Why, however, the odour of the goat, which was especially strong, the animal being a male, should have failed to attract them it is difficult to understand, seeing that, like some TABANIDAE, *G. morsitans* will after a little time discover a freshly killed animal and settle to feed, in which case the fly can only have been drawn to the scene by the sense of smell. When this particular goat was removed and paraded up and down in the vicinity it was much assailed by the flies.

A series of experiments was made in the use of English bird-lime spread on various materials carried on the backs of natives, in the hopes of catching *morsitans* in the same way as *palpalis* is caught in the Island of Principe. The results are tabulated below :—

Date.	Material used.	Boys.	Duration of experiment.	Tsetses captured.
8 Dec.	Deal board, 3 ft. by 3 ft.	a	6 hours	18
9 "	Green cardboard, 3 ft. by 3 ft.	a	"	23
" "	" " " " " " " "	b	"	15
" "	Tarred waterproof paper, 3 ft. by 3 ft.	c	"	39
10 "	" " " " " " " "	a	"	17
11 "	" " " " " " " "	a	"	29
12 "	Board made of dried bamboos laced together, 3 ft. by 3 ft.	a	"	12
" "	" " " " " " " "	b	"	7
15 "	Light brown paper, 3 ft. by 3 ft.	a	"	53
" "	" " " " " " " "	b	"	59
16 "	" " " " " " " "	a	"	58
" "	" " " " " " " "	b	"	67
17 "	" " " " " " " "	a	"	31
" "	" " " " " " " "	b	"	54
18 "	" " " " " " " "	a	"	51
" "	" " " " " " " "	b	"	47

As *morsitans* is so frequently observed to settle on the underside of loads carried on the heads of natives, experiments were also made in the use of material lined on the underside carried in a horizontal position, but the results were not so satisfactory as when the material was carried in a vertical position.

Natural Enemies.

Considerable attention has been devoted to the fossorial wasps of the genus *Bembex* as being possibly natural enemies of *morsitans*, one species in particular being especially numerous in the fly area. A long series of specimens, each taken on the wing carrying its prey, shows that this species attacks in particular flies of the families ASILIDAE and BOMBYLIIDAE. Several other species taking various MOSCADA and Orthoptera have also been secured.

In mid-December, however, a *Bembex* was actually seen to seize a tsetse-fly and to carry it away. The particular species had been repeatedly observed buzzing round as I walked, but little attention was paid to it at first, seeing that an inquisitive disposition seems to characterise many Sphegid wasps. Then one of the insects was seen to make a rush at a tsetse-fly on my leg, which it failed to secure. When a goat was led through the district three more were seen in the course of half an hour, after flying round and round the animal and hovering a few feet away, to rush at tsetses on it, two unsuccessfully, but the third was captured on the wing having seized one of the flies. So far, all attempts to find out the other habits of the insect have failed, though the matter is receiving attention.

Flies of the family BOMBYLIIDAE, some small species of which exist in great numbers in the Lingadzi district, have also been under consideration as potential enemies of the fly, in view of Mr. Lloyd's discovery of one as a parasite of a tsetse pupa, but little advance has been made, beyond the discovery that three of the species, after careful selection of a site, oviposit in irregular fissures in the ground frequently under trees, though what influence induces them to do so has not been determined.

Tsetses and Caterpillars.

An endeavour was made to ascertain whether the fly will ever feed on Invertebrates by caging them with the caterpillars of a large Saturniid moth, such as were to be found recently in enormous numbers in the Rifu district, where large trees had been entirely defoliated by them. The results were negative.

Spread of the Fly in Marimba District.

When on my arrival in late October I had an interview with H.E. The Governor, he informed me that disquieting reports had been received from members of the Livingstonia Mission to the effect that tsetse-fly had recently spread in from North-Eastern Rhodesia and was within measurable distance of one of their principal stations at Kasungu in the Marimba district, and he asked me if I could make it convenient to look into the matter. I was unable to do so until late December, when I travelled to the district and found *Glossina morsitans* existing over a wide area in small numbers and more abundantly as one approached the border.

The district is hilly and covered with stunted trees, which nowhere approach the size of so many found in the sleeping sickness fly area, and the soil differs in being mostly very sandy, producing small fine grass, growing in many places in tufts only, instead of spreading uniformly. It is very arid also, stretches of 18 miles without a trace of water being several times met with, and as a consequence the district is very thinly populated.

This new fly area is situated in the Marimba district of Nyasaland just north of the Duangwa River, where it crosses into Rhodesia.

I am informed by Dr. J. B. Davey, one of the Medical Officers, that he has also found the fly extending well into Nyasaland south of the Duangwa River, also over a wide area.

General Observations.

As has already been remarked, tsetses are especially attracted by moving objects, and it has been my frequent experience that the faster one moves the more one is

beset, for which reason I now invariably walk rather than cycle in a fly area. If one stands still, such flies as may have been hovering around come to rest on objects near by, frequently on a blade of grass, or they settle on the ground, resuming their attentions immediately one is in motion again; though if one remains still long enough, as I have often found during a rest for lunch in the open; the majority gradually fly away. It is frequent, especially in the early evening, for flies to dog one's footsteps, often for several miles, settling at intervals on the ground behind and again and again catching up, an occurrence I have noticed repeatedly in respect of men walking ahead of me and which I have then been able to verify in my own case.

The interpretation of these facts, and that several flies will often travel on a person for considerable distances without attempting to bite, is not yet clear, but an examination of 43 individuals taken off the ground on various occasions as they followed showed that all were males, and it seems a reasonable supposition that such flies may be lurking in anticipation of the advent of a female. No courtship takes place, several males often making a simultaneous rush at the female on sight, and one seizing her, pairing takes place in the air, the couple then settling. It is by no means uncommon to take off natives in one's company a couple which have been seen to pair, and several times paired couples have been taken by means of bird-lime smeared on material borne on a native's back.

With regard to the distance a fly will travel in pursuit of human beings, it has been a frequent experience when crossing the open plain between the edge of the bush and the lake to find fly with one all the way, a distance of $2\frac{1}{2}$ miles, and in passing up in the dry season from Matumba's villages to Chunzi, a distance of 5 miles, the path being rather devious, one was invariably accompanied by flies all the way.

The distribution and numbers in a given locality undoubtedly vary from day to day, few being sometimes found where previous experiences have led one to expect many, and *vice versa*.

It has been a matter of surprise to find that *G. morsitans* heeds so little the heat of the day, seeing that in my experience other species on the West Coast, *palpalis* in particular, never expose themselves to the rays of the overhead sun, unless compelled to do so.