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Autor: Morris, K.R.S.
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Formerly of the American Foundation for Tropical Medicine,
now at the Department of Pathology, Makerere University College,
Kampala, Uganda.

A Study of African Tabanids Made by Trapping.

By K. R. S. MORRIS, D.Sc.

In the course of investigations on sleeping sickness in Liberia it was found that the "Morris" trap used for sampling the tsetse fly vectors was effective also in sampling a number of species of Tabanids (MORRIS 1961 b). The African staff were therefore taught the recognition of the Tabanidae, so that these flies could be collected from the traps and by men catching with nets during their routine sampling of *Glossina*. The sampling work lasted just 12 months, from the end of May 1959 to May 1960. The resulting collection of Tabanidae, which amounted to several hundred specimens with 36 different species so far identified, served not only as an indication of the Tabanid fauna of the areas studied, but gave a measure of the seasonal occurrence of all but the rarest of the species and, with the more abundant ones, enabled some notes on their biology to be accumulated.

Terrain and Methods of Study.

The investigation was centered on the village of Voinjama, in the extreme north of Liberia close to the Guinea border. The area lies within the Zone of Guinea Rain Forest, but in the well populated northern strip of the country the system of shifting cultivation practiced by the natives has left little of the original forest intact. It is replaced by farms and secondary forest, the latter in all stages of regeneration, from low open bush with few tall trees to high forest with almost closed canopy. The various stages of regeneration occur in an intricate mosaic, in which the more open bush predominates in the north, where the population is heaviest, but southwards, with decreasing population, the proportion of well grown secondary and true rain forest increases, until at the Lofa river, 18 miles south of Voinjama, the latter is predominant. Southward of this river the only breaks in otherwise uninterrupted rain forest are around the few small villages, 10 or more miles apart, mostly situated along a newly constructed main road serving this northern area.

The terrain is hilly, and since the towns and villages are invariably placed on a crest and erosion of the hill slopes is common, the pattern of the mosaic tends to be open country on the higher ground and forest, with frequent marshes, streams or rivers in the valleys.

The area investigated is drained by three main rivers, the Zeliba,

1½ miles south of Voinjama, the Lofa, 18 miles south and the Lawa, 30 miles south. Each has a general ENE to WSW flow, has permanent water, and is joined by numerous side streams, most of which flow during the rains only.

No meteorological data were available for this region, so only the general trend of the climate can be given. A dry season, with only very occasional light rainfall, lasts from the end of October to February or March; intermittent heavy storms mark the onset of the rainy season in April and May; rain falls almost daily in June, less frequently in July, but increases again in August and September. Intermittent storms in October mark the end of the rains.

Continuous routine observations on the tsetse fly, *Glossina palpalis* R.D., were maintained on these three rivers, and shorter term observations or surveys were made in much of the intervening country. In this way the Tabanid flies were being sampled over a variety of habitats ranging from uninhabited rain forest to quite open country of existing or recent cultivation around settlements. It was found that the 28 species regularly encountered could be placed in three groups, those found in all types of habitat, those caught in closed forest only, and those occurring in the secondary forest of a predominantly open nature. Forest species were caught regularly from the Lawa to the Lofa river but never north of here, open country species came mainly from along the Zeliba river and nearby villages, with occasional captures made as far south as the Lofa river, but never in the true forest beyond this. From the point of view of the Tabanidae, then, the area of observations fell naturally into two broad types of habitat, those of the forest, represented from the Lofa river southwards, and those of the open, occurring from this point northwards and most fully represented in the well populated country along the course of the Zeliba river.

Standardised routine observations, with traps and hand catching by men, were maintained on the Zeliba river close to Voinjama and in a marsh just north of the town from June 1959 to May 1960. Similar observations of two to four months duration were made at several other points on the Zeliba as far as Bolahun, 30 miles westwards, and a number of short surveys (five to ten days at each place) were made throughout this well-populated northern belt. Thus a fairly wide cover of the distribution of the Tabanids of the open type habitats was obtained, and since all but one or two of the rarest appeared with regularity at one or other of the Voinjama observation stations, quite a reliable picture of their seasonal appearance and relative abundance can be given. In the forest, after some preliminary visits in June and July 1959, continuous

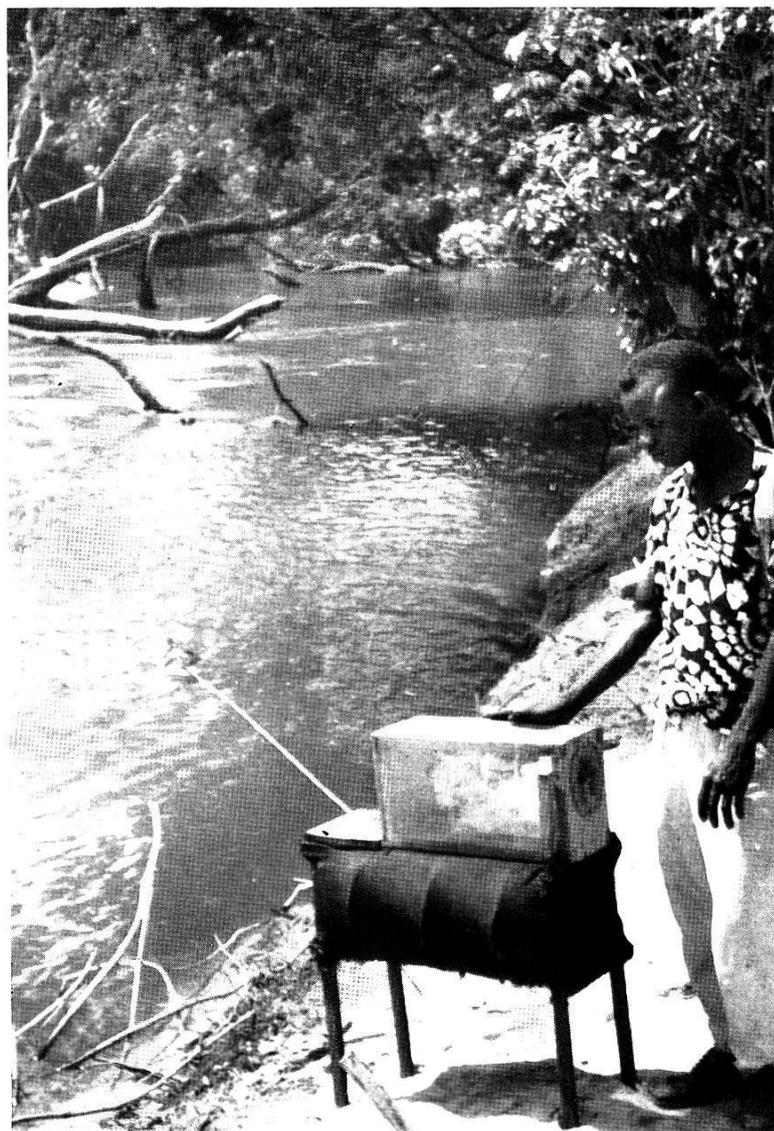


Fig. 1. The standard-sized "Morris" trap used for sampling Tsetse-flies, which was effective in sampling also many species of Tabanids (Horse-flies etc.). On the Lofa river, Liberia.

observations were maintained for the next 10 months, that is to May 1960. It was found that the commoner species, which were prevalent here at the beginning of routine observations in August but which disappeared in the dry season, were beginning to appear again in the following May, and from these facts their continual presence for the next two months can reasonably be deduced. Several of the forest species had quite short times of abundance, which fell within the period of continuous routine observation, and for these the picture of seasonal appearance and frequency is complete.

The routine tsetse fly observations were made by means of simple, unbaited traps (Figs. 1 to 4) which have proved effective and reliable for sampling a number of species of *Glossina* (MORRIS 1960, 1961a). Hand catching by teams of fly-collectors with nets

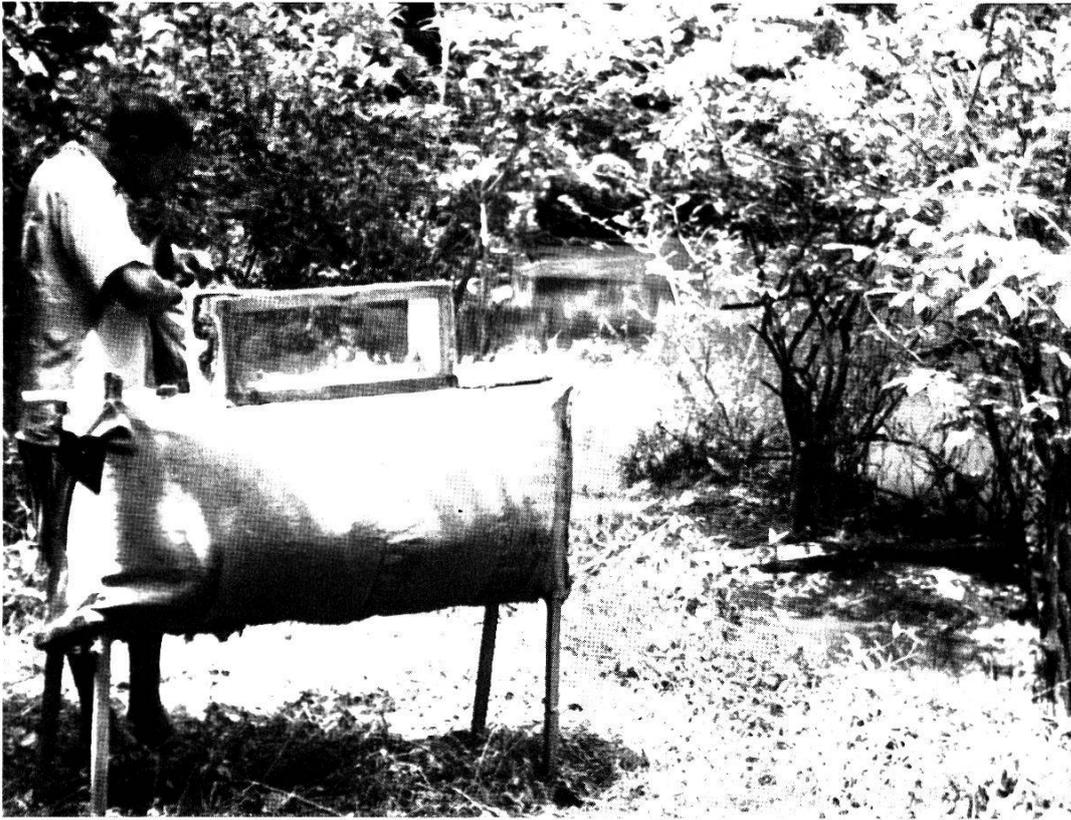


Fig. 2. A double-sized trap, 4' high by 4' long, at a game drinking place on the Lawa river, Liberia. This trap was more effective for some species of *Tabanus* and *Tabanocella* than the smaller, standard-sized traps. In Uganda it caught *Haematopota* when small traps failed.

was carried out simultaneously in most of the localities, so that comparisons could be made between these two methods in the studies on *G. palpalis*. In this way parallel series of observations with traps and hand catching were obtained for the Tabanids also. The necessity to concentrate on the main object of tsetse studies did not allow the men to pay particular attention to other genera, and although many Tabanidae were caught this was incidental to the main work. Traps, on the other hand, caught both groups with equal facility. For the Tabanids, then, accurate assessments of the relative efficiencies of traps and men cannot be given on the data obtained, but it was sufficient for rough comparisons to be made for most of the species. The comparison was decisive when a species was taken exclusively by one method, either by traps or by men, when both were in operation simultaneously.

Although the traps, working without interruption or variation in performance for 24 hours a day and seven days a week, provide a more reliable and efficient means of sampling than does hand catching, it must be borne in mind that their design was developed after a long series of trials, specifically for the capture of tsetse flies (MORRIS & MORRIS, 1949). There can be no doubt that similar

attention to their performance with the Tabanidae might result in improvements in the design or manipulation of the traps for these flies also. Different sizes and colours of trap were being tried experimentally for *G. palpalis* and some of these modifications were found more effective for certain of the Tabanids. A large size (4' long and 4' high body, compared with the standard 2' by 2' model), dark grey trap (Fig. 2) was found particularly attractive to *Tabanocella* and some species of *Tabanus* in the forest, as will be mentioned in the next section of this paper. As in the case of trap-man comparisons, the possibilities of variations in trap design could not be fully explored, and this is a field which would certainly be rewarding.

Species Captured.

As already mentioned, the demands of the main project did not allow a special study being made of the Tabanidae. However, a large number of observations were made on these interesting flies, particularly as the writer's work took him much into the forest and along the rivers. Full records were kept of the captures by traps and by men and although these did not have the high statistical value which could be accorded to the data on *Glossina*, yet the methods of capture were uniform and regular, so that it is possible to give a fair approximation of the abundance and seasonal periodicity of the species which were encountered. The definitions of abundance are given in the next section when this aspect is considered.

The following species were caught during the 12 months:

<i>Family</i>	TABANIDAE
<i>Sub-family</i>	TABANINAE
<i>Tribe</i>	Haematopotini

Haematopota grahami Aust.

Forest only. Very abundant for a short period, from middle of March to beginning of May. Showed marked early morning activity, small swarms surrounding a grey Land Rover car on its arrival on the open Lawa river banks, from 6.30 to 7.30 (together with *Tabanus secedens kingsleyi*), possibly taking the car for an elephant or hippo. In April and May frequently 9 or 10 specimens would be caught around the car in the first five minutes, they then appeared to retire into the adjacent forest, where they continued to appear in one's or two's up to midday. Not so pestilential in its attacks as *H. torquens*.

H. guineensis Bigot.

Very occasional, only two specimens having been taken, in March and April 1960, in the open country round Voinjama.



Fig. 3. A pool on the Lawa river, Liberia, visited by pigmy hippo and occasionally elephants. High catches of *Haematopota torquens* and of several species of *Tabanus* were made here. — This is deep in tropical Rain Forest. A trap can be seen on the bank at the left of the picture.



Fig. 4. A washing place on the Zeliba river in the well populated country close to Voinjama, Northern Liberia. Many species of *Tabanus* and occasionally *Chrysops longicornis* were caught here. At this place 12 months continuous sampling was carried out by traps and by fly-collectors (seen at right of picture).

H. torquens Aust.

Forest only. It appeared in great abundance, but only during February 1960. It always occurred deep in the forest and was definitely associated with the presence of elephant, although buffalo and pigmy hippo were also present and could have been additional hosts. From February 1st to 7th a bull, cow and calf elephant were present in the same patch of forest along the Lawa river. We approached them closely on three occasions, and on each of these we were set upon by many *H. torquens*, very hungry and feeding ravenously, so much so as to be a most uncomfortable pest. The following week, 7th to 14th February, the elephants had moved away. *H. torquens* was still present in numbers, but decidedly less abundant than in the previous week. On February 20th, after rain, this fly was present in great abundance during the whole morning. Buffalo and pigmy hippo were around, but not the elephant. By the end of February this species had disappeared, and no more specimens were caught after this date, it apparently being replaced by *H. grahami*. The greatest activity of *H. torquens* was early in the morning, but it continued all the forenoon.

H. maculata Oldroyd.

Forest only. A few of this species were present in the swarms of *H. torquens*, showing the same activity and habits, and appearing in February only. One isolated example was caught at Voinjama, but this might have followed the car from the forest.

Hippocentrum murphyi Aust.

Forest only. Caught in fair numbers, 1 to 5 a day, but for a short period only, end of August to mid September, on the Lofa River. It was caught at once when regular observations started here, 18th August, 1959, so it may well have been present for a longer period. By the following May (1960) it had not reappeared however. It was first taken in traps, and these continued to catch it as well as did men.

*Tribe: Tabanini.**Ancala fasciata* Fab.

This was one of the commonest species, appearing in great numbers over a wide area, from deep forest to open country and in towns and villages themselves, frequently inside the houses. It appeared first in May, by June it was appearing regularly in the writer's house and laboratory at Voinjama, three or four or more specimens being caught daily, and this continued until October, after which it became less obvious in the open country, and disappeared between December and May. In the forest it was regularly abundant from June until November, and here much greater catches, 20-100 per day, could be made. During October and November it was so numerous as to be described in field notes as pestilential. None was caught from December to March.

Euancala maculatissima irrorata Sourc.

A single specimen was caught by a fly collector on the Lofa Ferry (Forest) at the end of September 1959.

Tabanus chevalieri Sourc.

A single specimen was caught in a trap on the Zeliba river near Voinjama (open country) in February 1960.

T. marmorosus Sourc.

High forest only. Appeared with the first rains, at the beginning of May, and continued to be caught in small numbers, 1-3 per week, until the end of September, when there was an exceptional catch of 11 in one week. After 10th October no more were caught until the following May. Active during the middle of the day and caught equally well by traps and men.

T. obscurifumatus Sourc.

Found at the edge of true forest only (Lofa river). Appeared with great regularity from mid-August to mid-October, with catches from 1-9 per day, usually 3-5 a day. Caught equally by traps and men.

T. tenuipalpis Aust.

Forest only, with only occasional appearances from August to November always singly with the exception of a batch of 5 caught on 20th November, after which no more were seen.

T. pertinens Aust.

True forest only. A batch of 8 specimens were taken, mostly in traps and one or two by men, on the Lawa river, deep in the forest, in the second week of February 1960, and a single specimen was caught in a trap on the Lofa river, at the edge of the forest, a week later. No other examples were seen, although observations were being made over a wide area at this time. OLDROYD (1956) considered this to be a savanna species, but the present observations could only be explained by the sudden emergence of locally bred flies deep in the forest.

T. gratus Loew.

A single specimen was caught in a trap on the Zeliba river (open country) in July 1959.

T. argenteus Sourc.

Forest only. Short appearance April to June. Only single specimens met in April, but by May it was sufficiently numerous for a dozen specimens to be taken in a short time. By the end of June it had disappeared. Active only in the heat of the day, from about 10 a.m. onwards, when it attacked man readily and was attracted round a grey Land Rover, but was quick and alert and difficult to catch. Taken by hand-catching only.

T. variabilis Loew.

Only three specimens seen, on the Zeliba river near Voinjama (open), but as these were caught within a few days, 17th-20th February 1960, it is possible that special search might have revealed it to be commoner at this time.

T. insignis Loew.

Open country only, where it is widely found, especially close to villages, at washing places on streams and in marshes. Only two specimens were caught at the edge of the forest, at the Lofa Ferry where people were frequent. None were caught within the forest. Appeared with great regularity from July to mid-November. Although never numerous, with maximum catches of two and three a day, yet a single trap at a much frequented washing place in a marsh, 500 yards north of Voinjama, regularly took 6-12 flies per month from July to September 1959. Despite an evident association with people it was taken

far more frequently by traps than by men. All the first examples taken, during July, had wings frayed and broken, but later, from August on, perfect (? younger) specimens became common and damaged specimens fewer.

T. pluto Walker.

Open country only, although a few specimens were caught as far south as the Lofa river at the edge of forest, but none in the forest itself. This handsome and obvious species, despite its preference for open country, avoided towns, was never caught in or around the house or laboratory, but most often taken on roads, coming into a car. A few appeared in May, it was more frequent in June and July, was occasionally caught in August and September, but not seen after this. None were caught in traps, but this might be because trapping was not practiced in the places where it was usually found.

T. ruficrus Pal de Beauv.

Abundant and widespread from forest to open country, where it was frequently caught in and among houses, although its greatest abundance was reached in forest. First appearance was in May, by June and July it was common everywhere. In August and September it was the most numerous species in the forest; 3-4 could be caught in five minutes and 100 a day could easily be taken. This status prevailed up to the end of November, when it was pestilential. After this it disappeared. It entered traps freely, but the greatest catches were made by men.

T. par Walk.

Widespread distribution, primary and secondary forest, farms and among houses. Although not quite reaching the abundance of *A. fasciata* or *T. ruficrus* it was at times extremely plentiful, particularly around houses. It appeared almost throughout the year, but was not recorded in December and January. The greatest abundance was reached in August and September, at the height of the rains when six or seven specimens were caught in the house every day. It was caught in traps with great regularity, as well as by men.

T. boueti Sourc.

Forest only. Although never numerous, it appeared with great regularity from the beginning of the rains in April until the middle of October. Usually only one or two per day were caught, but up to 4 per day were occasionally taken. This species was readily attracted by traps, which first showed its presence, and less frequently taken by men.

T. besti Sourc.

Widespread, reaching greatest abundance in open country around villages, although quite often met in high forest. First seen in May, but not appearing in numbers until end of the rains, September–October, when it was plentiful, especially around villages, catches up to seven per day often being made, and 3-4 specimens being caught in the Laboratory or house every day during these months. Less frequent in November and disappeared by the end of that month. With the exception of September and October only small numbers were caught, 1-3 specimens at a time. Caught equally well by traps and men.

T. besti arbucklei Aust.

Widespread from high forest to open country, where it occurred in great abundance. A few specimens were caught in forest in February, and it continued to appear here in one's and two's, rather irregularly, until September.

In open country it appeared first at the beginning of May, and within a week, by 10th May, had reached such an abundance as to be a nuisance in the house and laboratory. This continued through June into July, five or six being caught in the house alone every day. It was common in any village visited in the open country. In August it was only occasionally caught, and disappeared at the end of September. Caught much less readily by traps than by men.

T. secedens Walk.

Open country only. This species appeared at a number of separate localities on the Zeliba river between 14th October and 6th November, 1959, none being caught before or after those dates despite the routine observations in progress. From one to four examples were taken at a time, traps and men being equally effective.

T. secedens regnaulti Sourc.

In high forest on the Lawa river, a batch of over a dozen specimens were caught by men and traps at the end of January 1960.

T. secedens kingsleyi Ric.

Widespread and reaching great abundance in forest. This species was first caught in the forest at the end of February, and by mid-March it was abundant in the forest and being caught over a wide area in the open country. From the middle of April to the beginning of May it became the most abundant species on the Lawa river in the forest, but by the middle of May this abundance was over. It had a marked early morning activity. On many occasions a swarm of these flies (together with *Haematopota grahmi*) attacked a grey Land Rover car immediately on its arrival in the early morning in an opening in the forest on the river bank, but within 5-7 minutes the swarm retired again into the forest. During this time 15-20 specimens could be caught by one man, the limit to the catch being the catcher's ability, not the number of flies present. Inside the forest we were still vigorously attacked during the whole morning, but not by such swarms as appeared during the first hours of daylight. This species was caught also in traps, the larger sized trap being the most effective. This fly's behaviour suggests large game, particularly elephants or hippos, being a favoured food host.

T. quadrisignatus Ric.

Open country only. For a short period, from the end of February to the end of April 1960, this species appeared with fair regularity in traps, but never more than one to two specimens per week. During this period however it was caught from several places over a wide area, usually in well grown secondary forest. Not taken by men.

T. postacutus Old.

Forest only. During February and March 1960 this species was being caught occasionally by men on the Lawa river, not more than one per week being recorded.

T. congoiensis Ric.

Forest only. In November 1959 a batch of eight was caught by men on the Lawa river. It was not seen again, despite continuous observations, until the end of January, after which it was met with in some abundance until March 19th, 6-12 specimens being caught in a day by traps and men. It was not seen in April, but reappeared in May at the same rate of abundance, but none was caught from June to October.

T. flavicoxa Old.

Forest only. For a short period, from end of January to end of March, this species was caught regularly in small numbers, mostly one or two, but up to four being taken at a time. Traps and men were equally effective.

T. laverani Sourc.

Open country only, most frequently in marshes and farmed land around villages. First seen in February, and from then until May it appeared regularly in traps, from one to four being caught almost every day. A single specimen was caught in June and none after that. Never taken by men, despite the apparent association with the presence of humans.

Sub-family PANGONIINAE.*Tribe:* Chrysopini.*Chrysops longicornis* Macq.

Widely distributed in open country, down to edge of forest, but not within the forest. Always found in contact with people, i.e. around villages or at well frequented river crossings and water holes. Seen from August to November, a total of only eight specimens being caught in traps, always singly. Never taken by men.

Thaumastocera aqua Grunberg.

A single specimen was taken in May 1960, in a car in secondary forest near Bolahun, 30 miles west of Voinjama.

Tabanocella stimulans Aust.

Open country to forest. Most frequently met with around Voinjama, in the town and at water holes nearby. First appearance here was on 17th September, and from then was caught regularly until the end of October, occasionally two specimens taken in a day, more usually one every second or third day. In the forest two were taken in April, all others were caught between early September and the end of November, usually as single specimens at intervals of about a week, but during the third week in November eight were taken in five days by a large, grey coloured trap on the Lawa river. The majority of the captures in both forest and open were by traps, although there was a definite association of this species with people. In the open country, however, where the main catches were made around villages, it was active only late in the evenings, just at dusk, at a time when fly-collectors were no longer working. In the forest it was active by day also, and it was here that captures by men were made. In September, around Voinjama houses, it would attack fiercely after rain, with complete disregard of being caught. If not caught its bite was very painful and drew blood.

Tabanocella purpulera Aust.

A single specimen was caught in a trap on the Lofa river (forest) in May 1960.

Tabanocella ? sp. nov. cf. *umbraticola* Aust.

A species with lightly marked tergites was caught in the open country around Voinjama in places where *T. stimulans* was being regularly captured. Half a dozen specimens were taken in traps during October 1959.

Mesomyia cincta Enderlein.

A single specimen was taken on the Lofa river (forest) by men in October 1959.

Abundance.

Table 1 gives an approximation of the frequency with which the various species were encountered during the 12 months in this part of Liberia.

TABLE 1.

The species of Tabanidae caught in Northern Liberia in 1959/60 arranged in order of abundance.

	Time of Appearance	Habitat	Method of Capture
<i>Very Abundant</i>			
<i>Tabanus ruficrus</i>	May-Nov.	FO	T < M
<i>T. par</i>	Feb.-Nov.	FO	TM
<i>T. besti arbucklei</i>	May-Sept.	FO	T < M
<i>T. secedens kingsleyi</i>	Feb.-May	F > O	TM
<i>Ancala fasciata</i>	May-Nov.	FO	TM
<i>Haematopota grahami</i>	Mar.-May	F	M
<i>H. torquens</i>	Feb.	F	M
<i>Abundant</i>			
<i>T. congoiensis</i>	Nov.-May	F	TM
<i>T. argenteus</i>	Apr.-June	F	M
<i>T. besti</i>	May-Nov.	FO	TM
<i>T. obscurifumatus</i>	Aug.-Oct.	F	TM
<i>Regular</i>			
<i>T. insignis</i>	July-Nov.	O	T > M
<i>T. marmorosus</i>	May-Oct.	F	TM
<i>T. boueti</i>	April-Oct.	F	T > M
<i>T. pluto</i>	May-Sept.	O	M
<i>T. flavicoxa</i>	Jan.-Mar.	F	TM
<i>T. laverani</i>	Apr.-May	O	T
<i>T. quadrisignatus</i>	Feb.-Apr.	O	T
<i>Tabanocella stimulans</i>	Sep.-Nov.	F < O	T > M
<i>Occasional</i>			
<i>T. tenuipalpis</i>	Aug.-Nov.	F	M
<i>T. postacutus</i>	Feb.-Mar.	F	M
<i>Chrysops longicornis</i>	Aug.-Nov.	O	T
<i>Sporadic</i>			
<i>Hippocentrum murphyi</i>	Aug.-Sep.	F	TM
<i>T. pertinens</i>	Feb.	F	TM
<i>T. secedens</i>	Oct.-Nov.	O	TM
<i>T. secedens regnaulti</i>	Jan.	F	TM
<i>Haematopota maculata</i>	Feb.	F	M
<i>Tabanocella? sp. nov</i>	Oct.	O	T

(see over)

TABLE 1 (continued).

	Time of Appearance	Habitat	Method of Capture
<i>Very Occasional</i>			
<i>Haematopota guineensis</i>	Mar.-Apr.	O	M
<i>T. variabilis</i>	Feb.	O	TM
<i>T. chevalieri</i>	Feb.	O	M
<i>T. gratus</i>	July	O	T
<i>Euancala maculatissima irroxata</i>	Sept.	F	M
<i>Thaumastocera aqua</i>	May	O	M
<i>Tabanocella purpuler</i>	May	F	T
<i>Mesomyia cincta</i>	Oct.	F	M

The definitions of abundance are as follows:

- VA Very Abundant—very common for a month or more, in such numbers that captures of more than 10 per day were usual, up to 100 per day being caught in some cases.
- A Abundant—consistently common for a month or more, but captures usually between five and ten per day, rarely above ten.
- R Regular—appearing regularly for longer than a month, but rarely as many as five per day caught, more usually taken singly, not less than five per month.
- O Occasional—appearing occasionally over a period longer than a month, rarely more than one at a time or more than four in a month, but with sufficient frequency to indicate a seasonal rhythm.
- S Sporadic—appearing in batches of several at a time, from two or three to over a dozen, but for short periods only, less than four weeks, more usually one to two weeks in duration. At the time of its appearance it gives an impression of abundance not encountered among R and O.
- VO Very Occasional—only an odd one or two specimens taken during the 12 months, with no relation to season. Could never be confused with any other group.

In the third and fourth columns of this table, the initials indicating habitat and method of capture are as follows:

- F Forest only
 O Open country only
 FO Forest and open equally
 F > O Commoner in forest than in open
 T Traps only
 M Men only
 TM, T > M and T < M = traps equal to, better than and inferior to men.

Seasonal Appearance.

An assessment of the seasonal abundance of such active insects as the *Tabanidae* must be made with due regard to the restricted periods of activity in some species, which can make the same insect painfully obvious at one time of day, and so inconspicuous

as to be completely missed, despite search, at another. The traps, operating all round the clock for as long as they are left in position, overcome the difficulties of adequately sampling such species, and the data thus obtained will bear some relation to the presence or absence of imagines and to their density at the time of observation, provided they are attracted by traps at all. It might be considered that for the half dozen species taken by men only the data would lack this assurance. However, among those species of any abundance which were taken by men and traps, the fluctuations in the captures by the two methods followed similar trends, and the dates for first and last appearance agreed well, so it is a reasonable supposition that this will hold good for those species caught

TABLE 2.

Seasonal appearance of the Tabanids caught in true Rain Forest in Northern Liberia. Definitions of abundance are those given on page 28. A stop line indicates the beginning or end of the period of appearance when this does not correspond with the beginning or end of a month.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
<i>Haematopota grahami</i>			/VA	VA	A/							
<i>H. torquens</i>		VA										
<i>H. maculata</i>		/S										
<i>Hippocentrum murphyi</i>								/S	S/			
<i>Ancala fasciata</i>						A	A	A	VA	VA	VA	
<i>Tabanus marmorosus</i>					R	R	R	R	R	R/		
<i>T. obscurifumatus</i>								/A	A	A/		
<i>T. tenuipalpis</i>								/O	O	O	O	
<i>T. pertinens</i>		/S/										
<i>T. argenteus</i>				R	A	O/						
<i>T. ruficrus</i>					O	A	A	VA	VA	VA	VA	
<i>T. par</i>								R	A	A	O	
<i>T. boueti</i>				/R	R	R	R	R	R	R/		
<i>T. besti</i>							O	O	A	A	O	
<i>T. b. arbucklei</i>		O			O	O	O	O	O			
<i>T. secedens kingsleyi</i>		/	A	A VA	VA/							
<i>T. s. regnaulti</i>	S											
<i>T. postacutus</i>		O	O									
<i>T. congoiensis</i>	/	A	A/		A						/S	
<i>T. flavicoxa</i>	/	R	R									
<i>Tabanocella stimulans</i>				/S/					R	R	R	

TABLE 3.

Seasonal appearance of the Tabanids caught in open country, either farms, villages or secondary forest, in Northern Liberia. Notations are the same as in Table 2.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
<i>Ancala fasciata</i>					/R	R	A	A	A	A	
<i>Tabanus insignis</i>							R	R	R	R	R/
<i>T. pluto</i>					O	R	R	O	O		
<i>T. ruficrus</i>					O	A	A	A	A	A	VA
<i>T. par</i>		O		R	R	A	A	VA	VA		
<i>T. besti</i>					O	O	O	O	A	A	
<i>T. b. arbucklei</i>					VA	VA	VA	R	O		
<i>T. secedens</i>										/S	S/
<i>T. s. kingsleyi</i>				R	R						
<i>T. quadrisignatus</i>		/R	R	R							
<i>T. laverani</i>		/R	R	R	R	R/					
<i>Chrysops longicornis</i>								O	O	O	O
<i>Tabanocella stimulans</i>									/R	R	
<i>T. sp. nov.</i>										/S/	

by men only, giving their data also some measure of validity. With the reservation that it was in no way possible to make the full-time study of the Tabanidae necessary for accurate sampling work, the information obtained is presented in Tables 2 and 3, giving their seasonal abundance over 12 months of observation. The tables indicate the periodicity more fully than could be given in the preceding notes on species, and also bring out the differences obtaining in forest and in open country among those species common to both groups of habitat. In compiling the tables, naturally those flies very rarely observed were not included. It follows that the more abundant the species, the more valid is the information concerning it, which holds for habitat as well as for periodicity and methods of capture.

Discussion.

Considering the importance of the Tabanidae in the transmission and spread of a number of diseases, surprisingly little research had been done on the African members of this family, with the exception of the genus *Chrysops*. Since *Chrysops* has been known as the cyclical vector of *Loa loa* (Calabar Swelling) since 1912, it has received its share of attention, but not so the various species

of *Tabanus*, *Haematopota* and allied genera. Yet LEWIS (1953), has pointed out that Tabanids play such an important role, by their nuisance value and as mechanical vectors of diseases of cattle, horses and camels, that this family of insects has probably been decisive in governing the distribution and annual movements of the cattle and camel owning tribes of the Sudan. As vectors of animal trypanosomiasis (nagana), they assumed a tremendous importance by 1946-47, when an area of the White Nile and its tributaries covering 100,000 square miles and holding one and half million cattle was severely affected. Most herds were infected, many lost half their beasts, and at one time over 10,000 cattle died per month. Tsetse flies (*Glossina*) were entirely absent from this area.

At least eight other diseases, mainly of cattle, horses and camels, have now been proved to be transmitted mechanically by Tabanids, in Africa, the United States, Russia and the Far East. The evidence is well surveyed by ZUMPT (1949) and by CHANDLER (1950), and only one more example will be mentioned here—Anthrax. In this disease the very important role played by the Tabanids as vectors has been confirmed by several workers. The interesting fact is that infection is spread both directly, through the contaminated proboscis during interrupted feeds, and indirectly through infected faeces, in which the bacteria remain virulent for two days, thus allowing one infected fly, which may defaecate 15-20 times a day, to give rise to a large number of new foci. In certain parts of Russia, Tabanids were responsible for 80% of the cases of anthrax among horses and cattle during summer.

Despite this evidence the amount of research devoted to the sub-family *Tabanidae* in Africa had been negligible compared with that lavished for example on *Glossina* and *Anopheles*. The only good studies of life histories recorded are those published over 40 years ago by NEAVE (1915) and KING (1910 and 1926). It is not surprising that ZUMPT (loc. cit.) is led to remark how greatly the importance of the *Tabanidae* is underestimated.

The role played by Tabanids as vectors is nearly always mechanical, as direct transmitters of disease, the causal organism being carried on the proboscis when the fly is interrupted in its feeding and passes quickly from one animal to another. From this it follows that the factors deciding the importance of a species as a vector are its size (governing the size of the labellae), its numbers, and above all its behaviour. In their varied and complex behaviour patterns lies one of the most fascinating, as well as the most important characters of this attractive family.

The work described in this paper has contributed a few facts

on frequencies and behaviour, it has suggested many aspects which would respond, without undue efforts, to further study. There is the suggestion, from the difference in the seasonal prevalence of *T. besti* and *T. besti arbucklei*, that closely related species have slightly different ecological requirements which do not throw them into competition (or account for their divergence!). In *Haematopota grahami* and *H. torquens* this non-overlapping is even more clearly marked. There is the apparent anomaly that species such as *T. insignis*, *T. laverani* and *Chrysops longicornis*, whose distribution indicated association with man, were rarely or never taken by men. One obvious answer, that their activity time fell outside the men's time of searching, is only partly convincing. The first specimens of *Tabanocella*, which has a very limited, crepuscular activity in open country, were brought to me by one of my staff and were caught by myself when the insect literally gave itself up during vigorous attacks upon us in the evenings. One is left with a suspicion that those other species, caught so regularly by traps at water holes and washing places with abundant human hosts, had, through this association, developed an alertness and skill in avoiding capture. Such a character would favour the insect's potentialities in the mechanical transmission of disease, by causing it to move quickly from host to host with little chance of being killed.

The whole question of the food and feeding habits of the *Tabanidae* is one demanding much further study. Again the present work gave most interesting suggestions, but could not, for lack of facilities, be pushed further. There was the obvious attachment of swarms of *Haematopota* to elephants, possibly also pigmy hippo and buffalo. There was the attraction exerted by a grey Land Rover car to *H. grahami*, *T. s. kingsleyi* and *T. argenteus*, suggesting that they took it for an elephant or hippo, which would reveal quite unexpected feeding habits. This is not an improbable suggestion. In Uganda the game-feeding *Glossina pallidipes* and *G. fuscipleuris* were strongly attracted to grey Land Rovers and were known to feed readily on elephants and hippos (MORRIS 1960a). The trap which is so effective in capturing the Tabanids is itself a very simplified model of a food host. In the original experiments with *Glossina* in the Gold Coast traps were covered with goat, sheep or antelope skins, but it was soon found that a covering of ordinary hessian was just as effective, provided the shape and size of the original traps was preserved (MORRIS & MORRIS 1949). There is no doubt that experimental modifications of these traps, involving size, colour, shape and possibly the use of attractant scents, might provide models more efficient in capturing some of the *Tabanidae*.

In the process further light on their feeding habits would assuredly be gained.

The Uganda research just mentioned (MORRIS 1960a), demonstrated the great value of traps in the study of a fly, such as *G. pallidipes*, which is shy of man and feeds mainly on game animals. Sampling by means of an inanimate, mechanical trap did not alter the fly's environment by disturbing its natural hosts, or introducing unnatural ones (fly-collectors with bait animals). During these operations information on several of the East African *Tabanidae* was obtained. The present studies have not only provided a little additional knowledge on the members of this family met with in Northern Liberia, they have demonstrated the undoubted value of trapping in acquiring this knowledge.

It is important to remember that these results were obtained because it was possible to sample these insects continuously for long periods at a number of different points in their environment. Over 50 traps were eventually in operation during these investigations, with 6-14 traps covering from half to a mile of river at each of several widely spaced localities. It is in this context that the value of a simple, unbaited trap, independent of light or power, is fully realised.

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Zusammenfassung

Bei Untersuchungen über Tsetsefliegen (*Glossina*) in Nordliberia wurden auch 36 verschiedene Arten aus der Familie der Tabanidae (Bremsen) gefangen.

Fallen eigneten sich zum Fangen der meisten dieser Arten. Das routinemäßige Sammeln mit Hilfe von Fallen und durch Fangen von Hand wurde während 12 Monaten (Mai 1959 bis Mai 1960) durchgeführt und erstreckte sich über die verschiedenartigsten Vegetationsregionen, vom primären Regenwald bis zum offenen Land rund um die Siedlungen. So wurde ein zuverlässiges Bild von der Verbreitung und vom saisonbedingten Auftreten für die 28 Arten, die mehr oder weniger regelmäßig gefunden wurden, gewonnen.

Die Untersuchungen über die Tabaniden wurden beiläufig neben der Hauptaufgabe, der Erforschung der Tsetsefliegen, unternommen, und nur ein Bruchteil der Arbeitszeit wurde darauf verwendet. Dies war nur möglich, weil sich einfache und billige Fallen zum Fangen von Tabaniden sehr wirksam erwiesen.

Die Bedeutung der Tabaniden als Krankheitsüberträger und die durch die wirksamen Fallen gegebenen Möglichkeiten, sie zu erforschen, werden besprochen.

Résumé.

Au cours de recherches sur des mouches tsétsés (*Glossina*) dans le nord du Libéria, on a aussi capturé 36 différentes espèces de la famille des Tabanides (taons).

Les pièges se sont révélés efficaces pour capturer la plupart de ces espèces. Pendant 12 mois (mai 1959 à mai 1960) on a régulièrement collectionné des espèces au moyen de pièges ou à la main, dans les régions les plus variées, allant de la forêt primaire jusqu'aux savanes ouvertes aux alentours des villages. Ainsi, on a obtenu une image exacte et sûre de la répartition et de l'apparition saisonnière des 28 espèces rencontrées plus ou moins régulièrement.

Les recherches sur les Tabanides ont été faites incidemment, à côté du travail principal sur les tsétsés, et une partie du temps seulement a été consacrée à cette étude. Cela n'a été possible que grâce à l'efficacité de ces pièges simples et de prix modique.

La discussion porte sur le rôle joué par les Tabanides comme vecteurs de maladies et sur l'efficacité des pièges pour de telles études.