# NOTES ON THE BLOOD-SUCKING INSECTS OF EASTERN TROPICAL AFRICA.

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# (PLATES X. and XI.)

Owing to the very limited time available during my stay in England, it has not seemed advisable to attempt any general account of so extensive a region as that covered by my recent journey through Tropical East Africa. This region extends practically from the Zambesi River to the Upper Nile, and is included in 12 degrees of longitude and no less than 22 parallels of latitude. It comprises all types of country from open plains to dense forests, and elevations from sealevel to 10,000 feet. This area includes, in addition to a large portion of the Eastern Tropical subregion, a small portion of the South African subregion and. in Uganda, of the Western Tropical subregion. The entomological study of so large an area involves a great variety of interesting questions and an even more bewildering diversity of insect life. The economic relations of these numerous species with man and his domestic animals present a large number of problems, in regard to many of which much additional evidence is required.

One of the most urgent of these problems at the present time in Eastern Africa, or indeed in any part of the continent, viz.: the occurrence of human trypanosomiasis in Nyasaland and Northern Rhodesia, outside the distribution of *Glossina palpalis*—is already being studied by two Commissions on the spot.

Apart from this important question, all the countries under discussion have to contend with other diseases borne by blood-sucking organisms, and it is clear that all the local Governments, especially in Nyasaland and on the coast belt of British East Africa, will find it imperative during the next few years to spend large sums in combating these serious hindrances to human progress in Tropical Africa.

From the entomological standpoint it is of the utmost importance that too fine a line should not be drawn between the insects which, in the present very limited state of our knowledge, we believe to be noxious and those which are considered to be innocuous. If entomological workers are to be of the greatest possible assistance to medical science, it is their duty to collect all available data about *all* blood-sucking organisms. They will thus be fore-armed with knowledge of inestimable value should any species, at the moment believed innocuous or only under suspicion, become incriminated as a disease-carrier.

The following paper will therefore be confined to the blood-sucking arthropods, mainly Diptera, collected during the tour, with the exception of a few records of biting flies taken on previous journeys in Northern Rhodesia, in 1904, 1905 and 1908. The great bulk of the collection was made during the writer's recent tour on behalf of the Entomological Research Committee in 1910 and 1911. During this period the greater portion of the three British Protectorates, Nyasaland, British East Africa and Uganda, were visited, and portions of Northern Rhodesia and German East Africa were traversed.

In the course of this survey over 5,000 miles were covered with native porters, exclusive of railway or steamer journeys. A very large collection of all forms

of insect life was made, comprising about 100,000 specimens, of which about 15,000 were blood-sucking arthropods.

I am glad to be able to take this opportunity of expressing my best thanks for the unvarying assistance and hospitality I everywhere received during the course of my tour. My especial thanks are due to the Principal Medical Officers of the three Protectorates, viz. :--Dr. H. Hearsey at Zomba, Dr. A. D. Milne at Nairobi, and Dr. A. P. D. Hodges, C.M.G., at Entebbe, who rendered me every possible assistance.

In addition to somewhat detailed records of my collection, I have endeavoured to bring up to date lists of the known species of biting arthropods from each of the countries under discussion. These lists must not be regarded as by any means complete, but if they be compared with those given in Mr. E. E. Austen's "Illustrations of African Blood-sucking Flies" (1909), some idea will be gained of the great increase in our knowledge of these insects that has been effected in the last few years.

I have also added, as an appendix, a provisional list of the native names of the principal blood-sucking insects and ticks in Eastern Tropical Africa.

The identification of so large a number of species as those recorded in this paper has been a most laborious task, and the writer's best thanks are due to those who have done a large part of this work, particularly Mr. E. E. Austen, Mr. F. W. Edwards, Professor R. Newstead, F.R.S., Professor G. F. Nuttall, F.R.S., and Mr. C. Warburton. Finally the writer is most deeply indebted to Mr. Guy A. K. Marshall who, in spite of a great press of work, has found time not only to help much in identification but to assist in a great variety of ways throughout the production of this paper.

Before giving particulars of the insect themselves a few notes on general methods of collecting may perhaps be of interest. It is not necessary to lay down any special instructions for collecting such insects as biting flies, since, to a large extent, they come to the collector instead of having to be searched for. Special methods have however to be adopted in collecting the males of those groups in which only the female sex bites, as in the TABANIDAE, but these will be discussed under that family.

Given the time to train them, I have always found native collectors to be invaluable. Young boys of from 12 to 15 years of age usually seem to be the most satisfactory. If older than this, they are slower to learn, take less interest in their work, and are not so energetic or active. Personally, I have always found a system of partial payment by results most satisfactory. My collectors have usually been paid the lowest local monthly rate of wages, but in addition often earn 25–50 per cent., or even more, per month according to their success. This system not only encourages them to work hard but gives them a definite interest in the insects themselves, as the additional pay is given for special insects, such as, in the case of biting flies, male Tabanids or individuals of species not at all, or very little represented in the collection.

The different tribes of East African natives seem to differ to a remarkable extent in their capacity for this kind of work. Though some of the North East Rhodesian tribes are good, particularly the Awemba, by far the best come from Nyasaland, notably those of Yao stock. The natives of British East Africa developed only exceptionally into really useful collectors, while those of Uganda, of whom I had expected much, seemed altogether to lack the necessary energy and enterprise.

The secret of successful insect collecting in Africa lies largely in the careful organisation of equipment and native assistants. As soon as a competent staff has been got together the amount of work which can be got through is almost unlimited. This, of course, necessarily takes time. It is always well worth while to expend time and trouble in teaching each new collector, since the native learns to do his work in the right way just as easily as in the wrong. He is, however, such a creature of habit, that having once learned wrong methods it becomes extraordinarily difficult to get incorrect ideas out of his head.

So far as equipment for native collectors is concerned, the writer always armed half his staff with large kite nets having long handles, a box of papers for Lepidoptera, Neuroptera, &c., a tube charged with chloroform on cotton wool, and one or two pill-boxes. In addition to biting flies these boys chiefly collected insects suitable for papering. The long nets were found very necessary for many biting flies, especially TABANIDAE drinking at damp sand or attacking domestic animals, occasions when they are usually very wary. A very useful adjunct to the equipment is a satchel or some form of haversack, since it must be remembered that natives seldom possess pockets!

The other half of the staff were supplied with small, short-handled, round nets, about a foot to fifteen inches in diameter, cyanide bottles, and small tubes and pill-boxes for Diptera or other delicate insects. These boys, in addition to biting flies, collected principally Coleoptera, Hymenoptera, Hemiptera, etc. They were usually instructed to work in couples, one of each class, so that they might be of mutual assistance and between them prepared for all emergencies.

When not on the march the boys usually worked from about 9 a.m. to 3 or 4 p.m. Special work, such as searching for the species of *Glossina* with crepuscular habits, was of course also done when necessary. These native collectors are easily taught to keep separate, predaceous ASILIDAE or other insects taken with prey, or two individuals taken "in coitu." It is however unfortunately most inadvisable to give rewards for specimens of this kind, as by so doing a doubt at once arises as to the facts.

With the more intelligent boys I found it of great value to stimulate their interest by showing them pictures, coloured if possible, of biting flies or any specially wanted insect.

# Order DIPTERA.

#### Family Chironomidae.

The bulk of the midges and other small biting insects in my collection have not yet been fully worked out systematically. It is therefore not possible to give more than a general account of each genus.

#### Genus CULICOIDES, Latr.

These small midges are far better represented in Uganda and the Nyanza Province of British East Africa than in any of the other countries under discussion. No less than five species are known from that region, and there are probably more to be discovered. The most abundant of these species is C. grahami, Aust., which I found in vast numbers in the forests of the Semliki Valley, in November 1911. It was there a most terrible pest, and made life almost unbearable. The hours when it was worst were between 8 and 10 a.m., and from about 4 p.m. until sunset. It did not bite after dark.

One species, which appears to be new to science, was taken near the sea-shore at Lamu, British East Africa, and presumably breeds in salt or brackish water. It is said to be a great pest at certain seasons.

#### Genus JOHANNSENIELLA, Will.

This genus is only known from Africa, up to the present, by two females of the recently described *Johannseniella fulvithorax*, Aust., which I took in May 1911, on the Yala River, in North Kavirondo, British East Africa. They were taken at night, shortly after sunset.

#### Genus CERATOPOGON, Mg.

A few insects of this genus were taken on the southern slopes of Mount Elgon, in June 1911. The Research Committee have also received it from Nyasaland from Sir David Bruce, on whose authority it is stated to attack man. Dr. Spurrier, of Zanzibar, also states that insects of this genus are a serious pest there.

### Family Culicidae.

It is not possible for lack of time to give a detailed account of the mosquitos collected, though the records of all the species obtained are included in the general list. Apart from this, the collection made was by no means a representative one, it being very difficult to collect these insects at all exclusively when constantly on the move. Among the more interesting species taken was Shusea pembaensis, Theo., of which a few specimens were obtained in March 1912 near Lamu, British East Africa. It attacks man readily, but was only really troublesome for an hour about sunset and again at sunrise. It seems to occur only on the sea-shore, often great distances from fresh water, and presumably breeds in the sea. The most interesting mosquitos from an economic standpoint are of course the ANOPHELINAE, the carriers of malaria. They are widely distributed in all the countries under consideration, but certainly seem scarcer in individuals, if not in species, in the damper parts of Western Uganda than, for instance, in the drier and more open country to the north or in the Nyanza Province on the eastern side of the Lake. In this latter region several species, particularly Anopheles (Myzomyia) costalis, are extraordinarily abundant, and malaria is consequently very prevalent.

#### Family Simuliidae.

#### Genus SIMULIUM, Latr.

The species of this genus, of which several were taken over a large area, have not yet been systematically studied. They seem to be chiefly numerous in wellwooded, damp localities, often at considerable elevations, as on the slopes of Mt. Kenya.

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#### Family Psychodidae.

# Genus PHLEBOTOMUS, Rond.

Representatives of this genus were taken in Northern Rhodesia and Nyasaland, which will shortly be described by Professor Newstead as a new variety of *P. minutus*, Rond. They were mostly taken at light, immediately after sunset, in damp localities, and seemed but little inclined to bite.

#### Family Tabanidae.

This family includes by far the greatest number of African biting flies. These insects are often exceedingly numerous, and during my last tour, 9,591 specimens were collected, of which 3,649 were males. The period, however, when these flies are on the wing is often a very short one, and in regions with well marked wet and dry seasons, is usually confined to the former.

TABANIDAE generally become noticeable in large numbers at the beginning of the rains, though, as I shall explain later, many species probably emerge from the pupa some time before the first rains fall. In some species at any rate there appears to be a second brood about the end of the rainy season, and in certain *Haematopota* and *Chrysops* there would seem to be several broods in the year.

In East Africa, in the country south of about 9° S. Lat., there is normally only one wet season, which lasts from about November to April, May to October being dry. The best months therefore for TABANIDAE in Nyasaland and Northern Rhodesia are November to January. A limited number also occur throughout the rainy season up to the end of April or beginning of May. During the cool dry weather of June, July and August practically no TABANIDAE are to be found, and they probably spend this period in their larval stages.

In the Luangwa Valley, North-Eastern Rhodesia, judging by my experience there in 1910, many species, especially of *Tabanus*, begin to emerge from the pupa during September and October. They are, however, during this time but little in evidence until the first rains fall at the end of October or beginning of November. During this period, immediately before the rains, more particularly in the genus *Tabanus*, the males were at least as numerous as the females, and the latter seemed not to be much in search of vertebrate blood. They might therefore be overlooked at this time, unless specially sought for.

Like nearly all biting Diptera, these insects appear to be peculiarly sensitive to climatic conditions. Different genera vary in the conditions of sunshine, amount of humidity, etc., which influence the times at which they are inclined to feed. A certain degree of humidity of the atmosphere, even if only temporary, would seem to be an essential factor in impelling the females to seek for vertebrate blood. During the extremely dry hot weather which is usual before the rains break, it is remarkable how little inclined to bite the females of most species seem to be. Thus during September and October 1910, in Northern Rhodesia and Nyasaland, over two thousand individuals of some twenty-five species were collected. These were almost entirely taken in the immediate vicinity of water, either drinking at wet sand or mud, or resting on the reeds and grasses near by; a few of the males were also frequenting flowers. There can be no doubt that in very hot and dry weather, such as at the time mentioned, hoth sexes absorb considerable quantities of water. During this period the females very rarely attacked animals or man, the natives alone appearing to be bitten, and then only occasionally, when actually at the water-holes where the flies were swarming.

As I have already pointed out,<sup>\*</sup> some of the more fragile and slender species of *Tabanas* appear to be able to drink by alighting on the surface of the water and passing the proboscis through the surface film. Though I have never actually seen it happen, I am inclined to think from their behaviour that some species of *Haematopota* and *Chrysops* do the same, since I have once or twice seen the males skimming to and fro over the surface of the water, apparently wishing to alight upon it.

In British East Africa the conditions in respect of TABANIDAE are somewhat different and more complicated, since there are two fairly well marked rainy The most important of these is that from the end of March to about seasons. the end of May, there being another short rainy period about November. In this region therefore most species will probably be found to have at least two broods during the year. The hottest and driest months are from the beginning of January to the middle of March, and at this period few if any TABANIDAE are to be found, at least in the lower-lying parts of the country. When however I was in the hot dry country near Voi, in March 1911, I found some evidence that several species emerge from the pupa a week or two before the rains break in the low ground, as in Nyasaland and Rhodesia. On the other hand, in the much cooler and less dry highlands, especially in the more forested parts, as on the slopes of Mt. Kenya and on the Aberdare range, many species of Haematopota were on the wing during the driest season and therefore probably all the year.

In Uganda the conditions are again somewhat different. There, though there are nominally two wet and two dry seasons, they are very ill-defined, except in the Nile valley and parts of Ankole. The natural consequence of this is that, owing to the more or less humid conditions all the year, many species of TABANIDAE, especially the forest-loving ones, seem to be on the wing throughout the cycle of the seasons.

Thus it will be seen that the best time for collecting TABANIDAE in Eastern Tropical Africa, especially the males, is immediately before and after the beginning of the rains. Since the males appear seldom to stray very far from their breeding-places, they should, particularly in the case of *Tabanus* and many species of *Haematopota*, be searched for in the immediate vicinity of water, on the damp mud or sand in river beds or on the vegetation bordering it. The drier the country is, and particularly if the river is reduced to isolated pools, the better the chance of success, since the drinking places are thus much more easily located. In a running stream in such a season I have taken some numbers of both sexes basking in the sun on branches of trees and shrubs overhanging the water. A rock or log of wood just above the surface of the water is also a very attractive spot, and I have often seen my collectors attracting many TABANIDAE and other Diptera by scattering water on such surfaces.

<sup>\*</sup> Bull. Ent. Res. I, p. 311.

In the case of some species of *Haematopota* and *Chrysops* which frequent open short-grass country, both sexes, but more especially the males, may be found in enormous numbers on the grassy land near the water in which they would appear to have bred. In such species large broods of apparently freshly emerged individuals are as likely to be found in the middle or even at the end of the wet season as at the beginning.

Many species of TABANIDAE are certainly attracted by sweet substances, whether honey or the "honey-dew" secreted on plants by such insects as COCCIDAE and APHIDAE, this being especially true of the males. When near Lake Kioga, in August 1911, I captured very large numbers of many specimens of *Tabanus*, males being in the majority, apparently feeding on some sweet substance on the cotton plants of which there were fairly extensive plantations. The flowers of many flowering shrubs are very attractive to these insects, particularly those of the subfamily PANGONIINAE.

With reference to the interesting note from Dr. J. W. Scott Macfie, published in the last part of this Bulletin (p. 223), regarding his capture of TABANIDAE on a tree infested by Coccids, attention should be called to two points. Firstly, the predominance of the males, there being 34 out of 60 individuals; and secondly, his statement, "It is noteworthy that my pony, tethered not 20 yards away, was quite unmolested by flies at the very times when I was catching considerable numbers on this tree."

This is precisely in accordance with my own experience, which is that whenever the males are at all numerous both sexes will be found either feeding on sweet substances or drinking at damp sand, and the females do not show any desire for vertebrate blood. Though further evidence and more systematic observations are required, I think it is very probable that female TABANIDAE will be found to feed on blood only during a certain period of their imago state. This period seems to be subsequent to pairing and to the death of the male individuals, and most probably (though I have no actual evidence of this) before oviposition.

Since this period when the females, at least in the case of *Tabanus*, are in search of vertebrate blood appears also connected with some degree of atmospheric humidity, it would be interesting to know exactly when, in relation to the seasons, Dr. Macfie made his observations. From my own experience I should expect it to have been shortly before the onset of the rains or, less probably, during a dry interval in the rainy season.

The males of those species which frequent forests are usually extremely difficult to obtain, since the general conditions of humidity make it improbable that the insects will be found drinking, even if the favoured spots could be located. Though occasional individuals are to be found sheltering on the underside of leaves of shrubs, flowers which are attractive to them offer the only reasonable prospect of success.

For some reason, which is not quite clear, canvas, either in the form of a tent or stretched on the ground, in the latter case particularly if damp, is peculiarly attractive to many TABANIDAE and some *Haematopota*. I have observed only females to be thus attracted, and what the object of their visits may be is not obvious, since they seldom bite. I am inclined to think that the tent is attractive as affording shade. Species of *Tabanus*, at least, seldom enter a tent except in bright sunshine, and though always more vigorous in the sun, I should doubt if they can stand very long exposure to its direct rays. Damp cloth stretched on the ground would appear to provide a suitable medium for absorbing moisture, but it also seems to afford *some* attraction even when dry.

With regard to the insect enemies of TABANIDAE in the imago state, there can be little doubt, I think, that they are preved upon to a considerable extent by both predaceous Hymenoptera and Diptera. Though there has not been time to work out the details, the collections made on my last tour include two examples of Asilid flies preving upon Tabanus and no less than nineteen on Haematopota, these Asilids Several of the Haematopota were males. representing some eight or nine species. The most important Hymenopterous foes of TABANIDAE in Africa, as elsewhere, are probably the fossorial wasps of the genus *Bembex*, though my collection contains only a single example of an attack by these insects, viz. :- Bember capensis, Lep., preying on Holcoceria nobilis, Grünb. I have very little doubt that prolonged observation in suitable localities and at the right season would produce numerous instances. The attacks of the *Bembex* would seem to be most usually made when the Tabanid is itself attacking domestic animals, and from the nature of the circumstances only females would be carried off on such The Tabanids seem to be aware of the presence of these wasps occasions. and of the risks they run, for I have noticed in these circumstances that they will settle on cattle only under the belly or between the fore-legs, where it is difficult for the wasps to seize them.

This family is divided into two subfamilies. The first of these the PANGO-NIINAE is distinguished from the TABANINAE by the presence of spurs on the tip of the hind tibia, and contains a number of rather heterogeneous genera. Two of these, *Chrysops* and *Rhinomyza*, resemble the TABANINAE in their appearance and largely in their habits. The males of these two genera also resemble those of the TABANINAE in having in their eyes two distinct areas of large and small facets. The other genera of the PANGONIINAE, such as *Pangonia* (sens. lat.), *Silvius, Aegophagamyia*, etc., have unicolorous eyes, with the facets all of one size in both sexes and (except *Silvius*) the head is not completely holoptic, the eyes only meeting in the middle line on the vertex.

The TABANINAE include the two larger genera Tabanus and Haematopota, as well as Holcoceria, Grünb., represented, so far as our present knowledge goes, by a single species. One species of the West African genus Hippocentrum, Aust., also comes into the region under discussion, a few specimens of H. versicolor, Aust., having been recorded from the forested areas in Western Uganda.

#### Genus CADICERA, Macq.

### Cadicera speciosa, Aust.

My experience of flies belonging to this genus is confined to the above species of which I took four females in rather densely wooded country at the foot of Mt. Kifulufulu on the Iringa-Kilossa road, German East Africa, in December 1910. They were all taken biting native cattle, except one, which entered my tent, but did not attempt to bite. This capture extends the hitherto known range of the genus very much further north.

# Genus PANGONIA, Latr. (sens. lat.)

The flies of this genus are well represented in Eastern Africa, particularly to the south. Though usually to be found only in well wooded areas in the eastern region, they seem to disappear as one approaches the more densely forested western districts and no species has as yet been recorded from Uganda.

The bite of the female is severe, but they do not, I think, very readily attack man, at least in the case of species of the subgenus *Diatomineura*. Those that do suck blood also differ somewhat from the TABANINAE in their method of attack, since they usually seem to insert the proboscis without settling, instead of walking over the body of their victim seeking for a suitable spot to bite.

# Pangonia elongata, Ric.

Two males and three females of this striking species were captured in the valley of the Chambezi, Northern Rhodesia, during April 1908.

#### Pangonia comata, Aust.

I was fortunate enough during a single day's collecting at Rabai, near Mombasa, British East Africa, on 15th March 1912, to obtain three individuals, all males, of this recently described species.\* They were taken in some patches of timber on the side of a wooded hill. All three individuals were captured within a few yards of each other, two at about 10 a.m. and one about 2 p.m. Though the whole neighbourhood was carefully searched, no others could be found.

#### Pangonia bubsequa, Aust.

This species is represented in my collection by a single Q (a paratype) taken near Petauke, in the Luangwa Valley, Northern Rhodesia, 8th April 1905.

#### Diatomineura sp.

Nine females were taken at the beginning of March on the south-east slopes of Mt. Kenya, British East Africa. They were all captured in more or less dense forests and at elevations varying from 6,000 to 7,000 feet. One or two individuals came into the tent, but they were mostly taken at flowers.

#### Dorcaloemus compactus, Aust., and var. centralis, Aust.

This species was taken in some numbers in the Luangwa Valley, Northern Rhodesia, in March 1908; in the Ruo Valley, Nyasaland, in April 1910; and also at Voi, British East Africa, in February and March 1911, 1912. In my experience, it mainly frequents the banks of rivers in rather heavily wooded, low-lying country. It does not seem to bite man very readily, but when it does so, the bite is a severe one. In a native, the shin is generally attacked. One of the Voi specimens appears to be intermediate between D. compactus and the recently described D. woosnami, Aust.

# Dorcaloemus sp. nov.

Two males and nine females of this species were captured in the Upper Luangwa Valley, North-Eastern Rhodesia, during March, 1908.

# Genus SILVIUS, Mg.

#### Silvius fallax, Aust.

This interesting, recently described species was taken in very large numbers during September and the beginning of October in the lower Luangwa Valley, North-Eastern Rhodesia. The numbers in which it occurred may be realised by the fact that 78 males and 298 females were captured during this period. In spite, however, of these large numbers it was not much in evidence, unless specially looked for in the neighbourhood of water-holes, and nearly all the above specimens were taken under these conditions. The females were very ready to bite natives drawing water at these places, but did not seem to be troublesome at any appreciable distance from the water. At the same time the conditions were somewhat exceptional, there being an average shade temperature at midday of over  $110^{\circ}$  Fahr., and an intensely dry atmosphere.

# Genus AEGOPHAGAMYIA, Aust.

# Aegophagamyia pungens, Aust. (Pl. XI, fig. 10.)

I originally took a single female of this interesting and recently described insect on some mangroves on the beach at Lamu, British East Africa, in February 1912. Subsequently I found it abundant on the shores of the mainland close by. On 21st February 1912, 38 males and 6 females were collected at Wangi, and on the following day 129 males and 8 females on another part of the shore near by. The whole of these were taken on the actual shore, the vast majority of them drinking at damp sand between tide-marks. Thev were most abundant where there were mangroves, and it seems almost certain that this species must breed in salt water, since the only fresh water in the neighbourhood was in deep artificial wells. I am not aware of an instance of anyone having been bitten by one of these flies on this occasion, but it will be seen that the females were relatively very scarce, and as I have explained elsewhere, in other TABANIDAE under similar conditions the females are very little inclined to bite.

The eyes of both sexes are of a rather translucent greyish-green colour, and the male eye has *no* area of large facets above.

#### Genus RHINOMYZA, Wied.

The flies of this genus seem to be seldom found in very large numbers. They usually frequent damp, well-wooded localities near water. From a limited experience, they certainly appear to be largely crepuscular in their habits, especially as regards their time of feeding.

So far as I am aware, the eyes are always unicolorous, and in the male the head is holoptic, the eyes being large, unbanded, and with clearly marked upper and lower portions of large and small facets respectively.

#### Rhinomyza perpulcra, Aust.

This species is represented in my own collection only by a single female taken on the Yala River, South Kavirondo, British East Africa, in May 1911, but it appears to be not uncommon at certain seasons in Uganda, in well forested localities. The above-mentioned specimen was biting a native soon after sunrise.

## Rhinomyza umbraticola, Aust.

I found this species not uncommon in the higher ground of the northern portion of North Eastern Rhodesia during a tour there in 1908. It seemed to be a forest species.

#### Rhinomyza innotata, Karsch.

Five females of this species were captured in October 1908, in the lower portion of the Chambezi valley, North East Rhodesia; and two females were taken at Nkata Bay, Lake Nyasa, in November 1910. The two latter specimens were biting a native sitting on the beach, shortly after sunset.

#### Rhinomyza concinna, Aust.

This species is represented by a single male taken in March 1908, in the Upper Luangwa Valley, North East Rhodesia.

#### Genus CHRYSOPS, Mg.

This genus is represented in Eastern Africa by nine species or subspecies. The flies occur for the most part in well-wooded districts, and occasionally, e.g., *C. funcbris*, they are typically forest insects. They are usually rather local, and do not, so far as my experience goes, attack man so readily as, for instance, *Haematopota*. The bite is said, however, to be far more painful than that of species of that genus, though I do not remember ever having personally experienced it. They would appear to bite chiefly under the same conditions as those which favour *Haematopota*.

The eyes of these flies in the female sex exhibit very beautiful and complicated patterns of green, gold and purple. The male eye, as in other TABANIDAE, resembles that of the female in the lower small-facetted area, but is usually, if not always, different in the upper large-facetted portion.

Different species of *Chrysops* exhibit very different types of eye in the male sex. Thus the eyes of the male of *C. centurionis*, Aust., are relatively very large, the head being holoptic. In other species, such as *C. funebris*, Aust., or *C. distinctipennis*, Aust., the eyes of the male are small, and only partially meet in the middle line.

#### Chrysops funebris, Aust.

This is a characteristically forest species, which is not uncommon in the heavily timbered parts of Uganda. It also occurs sparingly in Northern Kavirondo, British East Africa. As in other forest-haunting species of TABANIDAE, the males are not easy to find in numbers. They do not differ from the females in colour. Insects of this species are very fond of sitting on the underside of the leaves of large-leaved shrubs in the forest. In the neighbourhood of Entebbe, where the insect is a common one, I have seen as many as 10 or 15 individuals resting on half-a-dozen adjoining leaves.

# Chrysops longicornis, Macq.

This appears to be an insect of wide distribution, but I have not seen it anywhere in particularly large numbers. Specimens of my own collecting are limited to three females taken in the lower Luangwa Valley, North East Rhodesia, September 1910, and two females at Simba, on the Uganda Railway, British East Africa, in April 1911. It seems to bite with some freedom, perhaps more so than most species of *Chrysops*.

# Chrysops fuscipennis, Ric.

I found this insect not uncommon on and near the south-west shores of Lake Nyasa, in March 1910. Several individuals were taken biting natives. The male is not yet known.

# Chrysops distinctipennis, Aust. (Pl. XI, fig. 8.)

This is a very common species in the more open parts of the country in Uganda and the Nyanza Province of British East Africa. Very large numbers of both sexes may sometimes be found in open short-grass country near water; thus in two days at Mumias, N. Kavirondo, my collectors brought me 65  $\mathcal{S}$   $\mathcal{S}$  and 16  $\mathcal{Q}$  all from a very small patch of ground. The insects were taken sitting on the grasses, the males being more sluggish than the females.

# Chrysops brucei, Aust. (Pl. XI, fig. 9.)

# Chrysops wellmanii, Aust.

This species is represented by a single female taken near Luwingu, N.E. of Lake Bangweolo, Northern Rhodesia, in September 1908.

#### Chrysops cana, Aust.

The only specimens of this remarkable little species, in my collection, are the two males already referred to by Mr. Austen.\* They were taken on the river at Masongaleni during the heat of the day, and I fancy had only just emerged. The Research Committee have also received a single female of this species from Mr. C. M. Dobbs, District Commissioner at Kericho, British East Africa, taken near that place. This specimen appears to bear out Mr. Austen's view that *C. cana* is allied to, but distinct from, *C. wellmanii*.

The eyes of this species, in the  $\circ$  at least, are unusually coloured for a member of this genus. They are of a deep blue-green, with three small white spots arranged in a triangle, near the outer margin of each eye.

### Chrysops magnifica, Aust.

The few individuals of this remarkably handsome species recorded by Mr. Austen<sup>†</sup> were the only ones seen by me. They were nearly all taken in woodland country, biting natives during the heat of the day, in damp weather.

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<sup>\*</sup> Bull. Ent. Res. II, p. 166. † Bull. Ent. Res. II, p. 161.

#### Chrysops centurionis, Aust. (Pl. XI, fig. 6.)

This would appear to be a fairly common forest species in Uganda, though it has probably a very short season and is therefore frequently overlooked. During a few days collecting at Entebbe, between the 1st and 12th September 1911, with the assistance of my collectors, 128  $\mathcal{J} \mathcal{J}$  and 17  $\mathcal{Q} \mathcal{Q}$  were obtained. The vast majority of these, females as well as males, were taken on the flowers of shrubs on the outskirts of the forest, in company with a few individuals of *C. funebris*, Aust. The eyes of the  $\mathcal{J}$  of this species are somewhat remarkable for one of its genus, being very large, so that the head is truly holoptic. They are of a golden yellow colour, with a semi-circular transverse black streak, below which are two black spots, one on each eye.

#### Genus HOLCOCERIA, Grünb.

# Holcoceria nobilis, Grünb. (Pl. X, fig. 10.)

I was fortunate in obtaining a small series of  $16 \circ 9 \circ 9$  of this striking species on the banks of a heavily wooded stream at the foot of Kifulufulu Mountain, Iringa-Kilossa Road, German East Africa. The species is also known from the northern shores of Lake Nyasa both on the German and British sides, and the Research Committee have also a male of this insect from Chirinda Forest in S. Rhodesia, collected by Mr. C. F. M. Swynnerton. It would therefore appear to have a wide distribution over the more densely wooded parts of Eastern Tropical Africa. The eyes of the female are of a reddish bronze colour with numerous black spots and markings.

#### Genus Наематорота, Mg.

The insects of this genus are extremely numerous both in species and individuals in Eastern Tropical Africa. They occur practically everywhere in the wet season and are perhaps more abundant at the higher elevations than in the lower-lying country, in contradistinction to the majority of species of *Tabanus*. The number of species of this genus already known is very large and doubtless many more remain to be discovered, probably more than in the case of *Tabanus*, since they are more local in their habits, and the season when any given species is much in evidence is often a very short one. The range of the genus is, however, very wide, and it is represented in all types of country and at all elevations from sea-level to at least 10,000 feet.

Different types of Haematopota seem to frequent rather different types of country. The lighter coloured species such as H. unicolor, H. denshami, H. copemani and their allies are characteristic of rather open short-grass country. The more strikingly marked species, on the other hand, as H. distincta, H. alluaudi and H. brucei, or those of dull but dark coloration, as H. fusca or H. inornata are principally forest species or at least frequent streams with well wooded banks.

Nothing, at present, is known as to the breeding habits of the African species of this genus. Until some careful work is done by an observer stationed in one spot for an entire cycle of the seasons it is unlikely that our knowledge on this point will be much advanced. It would seem probable that the majority of the species have two broods at least in the single long wet season of a country like Nyasaland and possibly more in British East Africa, which has two rainy seasons in the year. The tendency of these flies to emerge from the pupa before the advent of the rains is not nearly so marked as in the genus Tabanus. This is probably connected with the fact that they require a more humid atmosphere than the insects of that genus. The females usually bite, in Africa at least, in rather dull damp weather and rarely in the heat of the sun, as is the usual habit of Tabanus. In very sunny weather they are most in evidence from about 8-10 a.m. and again from 4 p.m to sunset. In exceptional localities, such as cool and shady, damp forests, they may be troublesome all day. The males are usually very sluggish and easily captured if they can be located. They sometimes occur in enormous numbers in one spot, and in Northern Kavirondo, in June, the writer has seen hundreds of these insects crowded together on the short grasses near water. The males of the forest species, however, are extremely hard to locate and are therefore only procurable with difficulty.

The eyes of the female insects of this genus are remarkable objects in life, exhibiting a complicated pattern of iridescent colours which could only be satisfactorily denoted by a coloured drawing. As the colours and patterns are of diagnostic value it is to be hoped that some of the collectors who are kindly assisting the work of the Committee will, if time avails, endeavour to send coloured sketches of the eyes of these insects with their specimens. The relation of the male eye to that of the female is similar to that in *Tabanus*. The male eye exhibits a narrow, lower, small-facetted portion bearing the same complicated pattern as in the eye of the female. The broad, upper, largefacetted portion is usually unicolorous and never banded. This area of the eye is usually of a shining grey or greyish bronze colour, occasionally, e.g., *H. mactans*, with a number of irregularly placed minute dusky spots.

#### Haematopota denshami, Aust. (Pl. XI, fig. 1.)

An abundant species in open grass country in Northern Kavirondo, British East Africa, and in the less forested parts of Uganda. It occurs side by side with *H. similis*, Ric., and *H. unicolor*, Ric. Very large numbers of both sexes of all three species were taken and in spite of the fact that the females all closely resemble one another, the males, as will be seen from the figures (Pl. XI, figs. 1, 2, 3), differ from one another in a remarkable and interesting manner. The  $\mathcal{J}$  of *H. denshami* is an insect with small dark eyes, a dark thorax, the anterior segments of the abdomen bright ochreous and the posterior ones dusky. The  $\mathcal{J}$  of *H. similis* is a nearly black insect, with small eyes; while the  $\mathcal{J}$  of *H. unicolor* is an altogether pale insect with *large* pale eyes.

# Haematopota similis, Ric. (Pl. XI, fig. 2.)

Like *H. denshami*, this is a very abundant species in open short-grass country in Uganda and the Nyanza Province of British East Africa.

# Haematopota unicolor, Ric. (Pl. XI, fig. 3.)

The same remarks as regards habits and distribution apply to this species as to *H. similis*, Ric., and *H. denshami*, Aust.

# Haematopota pertinens, Aust.

A fairly common Nyasaland and Northern Rhodesian species, which occurs principally in short-grass woodland country.

#### Haematopota copemani, Aust.

This species is common in open short-grass country in the Serenje district of Northern Rhodesia, in December.

# Haematopota masseyi, Aust.

Represented by a single female taken on the Mchinga escarpment, near Mirongo, Upper Luangwa Valley, Northern Rhodesia, in April 1908.

# Haematopota taciturna, Aust.

Of this northern species I captured two females at Petauke in the Luangwa Valley, Northern Rhodesia, in January 1908. The only other localities from which it has been recorded are Abyssinia and the Anglo-Egyptian Sudan.

## Haematopota fusca, Aust.

This is a common and widely distributed forest species in Uganda, though I never met with it in very large numbers in any one spot. It also occurs in the forests of the northern portion of the Nyanza Province of British East Africa. Only a single male was captured.

# Haematopota abyssinica, Sure.

This fly was taken in some numbers in German East Africa, in December, near Iringa and between Iringa and Kilossa. I also captured a single female in British East Africa, near Simba.

#### Haematopota tenuis, Aust.

This small species seems to occur sparingly in the open country of Northern Kavirondo, British East Africa, and of Northern Uganda. There are only two females in my collection, one taken near Mumias, in June, and the other near the north-east shore of Lake Kioga, in August.

#### Haematopota nociva, Aust.

A few individuals of this species were taken on the Upper Shire and near the southern shores of Lake Nyasa in February 1910.

# Haematopota insidiatrix, Aust.

A small series of this insect was taken on the Upper Shire and on the southern shores of Lake Nyasa in February 1910, and a single Q in the lower Luangwa Valley in January 1905.

# Haematopota noxialis, Aust.

This species is represented by a single specimen from the Upper Shire River, Nyasaland, taken in February, and by a large series, including a few males, from North and South Kavirondo, British East Africa. It seems to frequent mostly rather open country.

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# Haematopota stimulans, Aust.

This species is represented in my collection only by a single Q from the Serenje district of Northern Rhodesia, taken in December. It appears however, judging by the material received by the Research Committee, to be not uncommon to the west and north-west of Lake Nyasa.

# Haematopota mactans, Aust.

This is a common and widely distributed insect, occurring chiefly in the low ground and main river valleys of Northern Rhodesia, Nyasaland, German East Africa and the coast belt of British East Africa. I managed to capture a number of males in various localities; they were mostly taken drinking at damp sand during the heat of the day.

# Haematopota inornata, Aust.

A few individuals of this little known species were taken in the Mpanga Forest, Toro, Western Uganda, in November 1911.

# Haematopota alluaudi, Surc.

Very large numbers of this fly, including what appears to be a great range of colour variations, were swarming in the forests on Mt. Kenya and the Aberdare range in February and March 1911.

# Haematopota distincta, Ric.

This species, which has hitherto been recorded only from Nyasaland, was taken in several localities in German East Africa and also on the top of the Aberdare range in British East Africa, at an elevation of nearly 10,000 ft. It is worthy of note that it occurred in rather open moorland country at the top of the mountain, whilst *H. alluaudi* swarmed near by in the forest, but not outside it. A single  $\Im$  of this species was taken.

# Haematopota hirta, Ric. (Pl. XI, fig. 4.)

Though not strictly a forest species, this insect occurs chiefly in grassy clearings, papyrus swamps, etc., in the neighbourhood of forest. It is common both in British East Africa and Uganda. The males, which are remarkably hairy little insects, occasionally occur in very large numbers. Thus, on a small marsh on the Kikuyu Escarpment in two days 91 males, besides a few females, were taken.

# Haematopota furva, Aust.\* (Pl. XI, fig. 7.)

This species swarms all over the forested areas in Uganda and British East Africa, coming nearly as far east as Nairobi. The males are not easy to locate and only a few were obtained.

# Haematopota ugandae, Ric.

This is a common forest species throughout Southern Uganda and the Nyanza Province of British East Africa.

<sup>\*</sup> See below, p. 334.

### Haematopota vittata, Lw.

Though never very abundant and often extremely local, this species appears to have a very wide distribution over Eastern Africa, particularly in the more well wooded valleys.

#### Haematopota neavei, Aust.\* (Pl. X, fig. 9.)

No less than 67 Q and 1  $\sigma$  of this striking species were taken in the Tero Forest, South-East Buddu, Uganda, between 26th and 30th September 1911. Though so abundant in this spot, it was local even there and I never met with it elsewhere.

# Haematopota decora, Walk.

Widely distributed over Eastern Africa. It seems to occur principally in lowlying river valleys in moderately well wooded country. A few males were taken during the month of September at damp sand in dried-up river beds in the Luangwa Valley, Northern Rhodesia, and near the west shores of Lake Nyasa, in October.

#### Haematopota brucei, Aust.

Of this striking species, hitherto known only from the unique type, I was fortunate in obtaining two females in the Mabira Forest, Uganda, in July 1911. I have however no reason to suppose that it is really scarce, though its season is probably a very short one.

# Haematopota brunnescens, Ric.

This is a common insect all over Uganda and the Nyanza Province of British East Africa. There is also a single specimen in the National Collection taken by Captain R. Crawshay and labelled Nyasaland, but until this is confirmed by further specimens it would seem best to omit this from the list of Nyasaland species. *H. brunnescens* occurs in some variety of country. It is often abundant in the papyrus swamps in Uganda, especially those bordered by patches of forest.

#### Genus TABANUS, L.

I have already given some account of the seasonal prevalence of the flies of this Their range is very wide, and it is not very easy to generalise about their genus. habitats, but they are on the whole decidedly more abundant in river valleys, particularly at low elevations, than elsewhere. In British East Africa they are the dominant representatives of the family on the low ground, while Haematopota are more dominant at the higher levels. Many species of *Tabanus* also occur in plateau country of moderate elevation, at about 4,000 feet, notably in Northern Rhodesia. At greater elevations, especially in heavily forested country, the flies of this genus are poorly represented, though a few species are peculiar to such localities, such as T. ruwenzorii, Ric., from the Ruwenzori range, and the recently described T. canofasciatus, Aust., from Mt. Kenya and the neighbouring Aberdare range. These two species occur in dense forest up to at least 6,000 feet above sea-level. Tabanus africanus, T. fasciatus, and their

\* See below, p. 336.

allies seem to be most usually found in the neighbourhood of large bodies of water, on the larger rivers, the shores of lakes, etc.

The male *Tabanus* is not nearly such a sluggish insect as that of *Haematopota* or *Chrysops*. They are usually very wary, especially when drinking at damp sand in hot sun, and it requires a sharp eye and a long-handled net to capture them.

The eyes of the majority of species are very striking objects in life. Those of the male consist of two portions, as described already in many other genera of TABANIDAE:—(1) a lower portion, composed of small facets, which also extends as a very narrow line round the whole upper margin of the eye, this small-facetted area being, in my experience, invariably of the same colour as the whole eye in the female<sup>2</sup> of the same species; (2) an upper portion, formed of large facets, which is usually of a different colour or pattern.

The African species of the genus Tabanus may be roughly classified by their eyes. Thus, there are two groups with translucent spotted eyes. The first of these comprises only T. maculatissimus and T. irroratus. The second includes T. ditaeniatus and its allies. These groups both exhibit the exceptional conditions in which there is no difference in colour (at least, in the males of those species which are known) between the upper and lower portions of the male eye, though there is sometimes a difference in the size of the spots in the two areas. It should be noted that the translucent eyes of these insects nearly always turn to a more or less opaque dusky colour immediately after death.

The species which have unicolorous green or bluish-green eyes in the female, such as T. africanus, T. thoracinus, T. par, etc., have also the upper part of the male eye unbanded and usually of a bronze or golden colour. Other species which have a dusky unicolorous eye in the female, such as T. coniformis, T. crocodilinus, T. sandersoni and T. leucostomus, have the upper part of the male eye of various shades of shining grey or greyish bronze.

A very important group, including *T. taeniola* and the many species allied to it, have a unicolorous dark eye in the female, while the upper portion of the male eye is grey or sometimes nearly white, with a distinct dusky band across both eyes, which in some species is much broader at the junction of the eyes than at the outer margins, and has the form of a somewhat elongate lozenge. The shape or development of this band is of no diagnostic value, as it varies a good deal in individuals of the same species, and is occasionally evanescent.

Another group of rather small, black and white species, such as T. gratus, T. sharpei, T. velutinus, etc., have the eyes brilliantly banded with crimson and green or blue in both sexes. In these cases, in the upper portion of the male eye the bands are represented, but are much less brilliant and less clearly defined than in the lower portion or in the whole of the female eye.

A smaller group of rather similar black and white insects, including T. atrimanus and T. variabilis, or species nearly allied to them, have dusky, unbanded eyes in both sexes, the two portions of the male eye being of the same colour. In the case of these species also the male eyes are relatively smaller than in the foregoing group.

The recently described T. pertinens, Aust., stands by itself, in my experience, in having a combination of bands and spots in its eyes.

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# Tabanus fasciatus niloticus, Aust.

Fairly common throughout Uganda and the Nyanza Province of British East Africa. Some of the individuals from Lake Edward and the Semliki Valley seem to be somewhat intermediate between *T. fasciatus niloticus* and the western type-form. This species has a powerful flight, and I once took a specimen on board-ship in the middle of the Kavirondo Gulf, some miles from land. The eyes of the female are a beautiful deep green colour. In the males, of which I obtained a small series, the lower small-facetted portion of the eyes resembles that of the female, while the upper large-facetted area is a greyish bronze.

#### Tabanus brucei, Ric.

This fine species is represented in the collection from the region under discussion by a single female from the valley of the Chambezi River, Northern Rhodesia, April 1908. This insect is common in the principal river valleys of Katanga, in the southern Congo Free State, where it has apparently at least two broods during the year: one in October, at the beginning of the rains, and another about April, at the end of the wet season. The eyes of the female are of a deep green colour. The male is not known.

#### Tabanus africanus, Gray.

This species occurs over a very wide area in Eastern Africa, but I have never seen it remarkably abundant in any one place. It is usually found on fairly low ground and particularly in the neighbourhood of large rivers or lakes. I do not recollect ever seeing it near small bodies of water. The males are very scarce; I captured only five individuals, three on the Chitala stream, near Domira Bay, Nyasaland, in October 1910, and two near Lake Kioga, Uganda, in August 1911. The female cye is green, and the male eye green below and golden bronze above.

# Tabanus maculatissimus, Macq.

This very striking fly is widely distributed in Northern Rhodesia, Nyasaland and German East Africa, but is never plentiful in any one place. In the lower Luangwa Valley, Northern Rhodesia, in September 1910, I captured four males and two females, and the following month in Nyasaland, near Domira Bay. two males and one female; in German Territory, to the north of Lake Nyasa, in November and December, five more females. The male is strikingly different in colouring from the female as may be seen from a comparison of the figure (Pl. X, fig. 1) with that of the female in Mr. Austen's book.<sup>\*</sup> The eyes of both sexes are vitreous, with numerous small black spots.

# Tabanus biguttatus, Wied.

This striking species occurs all over Eastern Tropical Africa, chiefly on low ground and in the neighbourhood of large bodies of water. The sexes seem to occur in about equal numbers, 76 males and 71 females having been taken during the tour. When on the shores of Lake Mpeketoni, near Kipini, at the mouth of the Tana River, British East Africa, in March 1912, I found a number of these flies laying their eggs on the grasses and reeds at the water's edge. The females were very abundant, the few males seen on this occasion being taken on some small trees about 100 yards from the water. The Q eye is black; the d' eye black below and silvery grey above.

#### Tabanus grandissimus, Ric.

This species is only represented in my collection by two QQ from the Kalungwisi Valley, Northern Rhodesia, taken in September 1908. It seems to be not uncommon in places on the west shore of Lake Nyasa.

# Tabanus secedens, Walk.

This is a common fly in Uganda and the Upper Nile Valley, especially in the neighbourhood of forests. The female eye is dark purplish.

# Tabanus socialis, Walk.

A small series of this characteristically West African species was taken in the Tero Forest, South-East Buddu, Uganda, in September 1911. It was not met with elsewhere. The female eye is dark purplish.

## Tabanus taeniola, P. de B., and var. variatus, Walk.

This is the most abundant and widely distributed species of the genus in Eastern Africa, especially on the lower ground. In all, about 700 males and 670 females were taken of this species and its variety during the tour. In Eastern Africa the var. variatus very much out-numbers the typical form. It would appear, however, that on Mombasa Island, judging from specimens collected by Dr. Haran and Dr. W. J. Radford, and at Voi, typical taeniola is the common form, but this is quite exceptional for East Africa as a whole.

The eyes of T. taeniola and those of the many other species belonging to this group are all very similar. The female eye is usually of a dull purplish colour. In the male eye this colour is replaced in the upper large-facetted portion by a pale greyish ground with a median dusky band. This band varies in width to some extent even in individuals and is occasionally evanescent. In typical specimens it is narrow, though somewhat broader at the junction of the eyes than at the ends. In species such as T. nyasae, Ric., and T. ustus, Walk., this character is much more pronounced, the band being very broad in the middle and shaped somewhat like an elongate lozenge.

# Tabanus ustus, Walk.

This insect is a common one before and during the first rains in Northern Rhodesia, Nyasaland and the southern part of German East Africa. The females sometimes occur in very large numbers after the rains have commenced. Between mid-September and the beginning of November in 1910, 221 males and 49 females were collected. The eyes resemble those of T. taeniola.

# Tabanus denshami, Aust.

Both sexes of this species were taken in the Luangwa Valley, N. Rhodesia, in September. Also a single  $\varphi$  from near Fort Hall, British East Africa, in February. The eyes resemble those of *T. taeniola*.

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#### Tabanus nyasae, Ric.

This seems to be a common insect over a great part of Northern Rhodesia and Western Nyasaland, and my collection contains a very large number of both sexes. Some individuals seem to be scarcely distinguishable from forms of T. denshami, Aust. The eyes of both sexes resemble those of T. taeniola.

#### Tabanus fraternus, Macq.

A widely distributed species, though nowhere particularly common, so far as my experience goes. Dr. Aders reports, however, that it is plentiful in Zanzibar. It seems to resemble T. taeniola in its habits, and the colours of the eyes of both sexes are the same as in that species.

#### Tabanus trianguliger, Aust.

A series of this newly described fly, comprising about 20 females, was taken in the Uhehe and Usangu districts of German East Africa, in November 1910. The female eye is dusky like that of T. taeniola.

#### Tabanus quadrisignatus, Ric.

A small series of both sexes of this species was taken in Northern Rhodesia and Nyasaland. The eyes in both sexes resemble those of *T. taeniola*.

# Tabanus distinctus, Ricardo.

This seems to be a fairly common species throughout North-Eastern Rhodesia, the northern portion of Nyasaland and the part of German East Africa near the northern shore of Lake Nyasa. The eyes of both sexes resemble those of T. taeniola, but in the  $\mathcal{S}$  the ground-colour of the large-facetted area is paler and the dark markings are more distinct.

# Tabanus coniformis, Ric.

This rather obscure looking insect has a wide distribution in Northern Rhodesia, Nyasaland and German East Africa. The eye of the Q is dusky, that of the  $\overline{O}$  dusky below and shining grey above.

# Tabanus sandersoni, Aust.

Two females were taken in the Ruo Valley, near Chiromo, Nyasaland, in April 1910. The female eyes are dark purplish. I have not seen a living male, but judging by males received by the Entomological Research Committee from Dr. Meredith Sanderson, the large-facetted portion of the male eye would appear to be unbanded and of a purplish bronze colour.

# Tabanus pallidifacies, Surc.

A small series of eight females of this species was taken on the Tsavo River, British East Africa, in March 1911. They were all captured on the reeds, etc., on the river bank, except one or two which were biting natives bathing in the river. The eyes of the female are dark purplish.

# Tabanus barclayi, Aust.

Only a single female of this recently described species occurs in my collection, taken in February 1910, in the Upper Shire Valley, Nyasaland. A few specimens were taken in Central Angoniland and South Nyasa districts about the same time by Drs. A. H. Barclay and J. B. Davey, but the species does not seem to be a common one.

# Tabanus unitaeniatus, Ric.

A single female was taken on the Lower Zambesi, in February 1904; others in the Luangwa Valley, in January 1905, and on the Upper Shire and the south-west shores of Lake Nyasa, in February and March 1910.

## Tabanus variabilis, Lw. (Pl. X, fig. 7.)

Fair numbers of this species were captured in various localities. It seems to frequent woodland or moderately open country, not forest. The eyes in both sexes are dusky.

# Tabanus atrimanus, Lw.

This fly seems to be common and widely distributed all over Eastern Tropical Africa, except Uganda. In my experience, it chiefly frequents well wooded streams. The  $\mathcal{J}\mathcal{J}$  seem nearly as common as the  $\mathcal{Q}\mathcal{Q}$ , my collection containing 38  $\mathcal{J}\mathcal{J}$  and 46  $\mathcal{Q}\mathcal{Q}$ . The eyes of both sexes in life are a dusky purplish.

# Tabanus velutinus, Sure. (Pl. X, fig. 6.)

A good series of 32 males and 38 females was taken in British East Africa at Masongaleni, Kibwezi, and Makindu, on the Uganda Railway, in April 1911. The insect was evidently just hatching out at that time. The eyes are banded with crimson and green like those of T. sharpei.

# Tabanus neavei, Aust. (Pl. X, fig. 5.)

This is a fairly common forest-haunting species in Uganda, and it also occurs in the forests of North Kavirondo, in the Nyanza Province of British East Africa. My collection contains in all 34 males and 15 females.

#### Tabanus sharpei, Aust.

Though nowhere abundant this species seems to have an extensive range in Northern Rhodesia, Nyasaland and German East Africa, and small numbers of both sexes were taken in various localities in those countries. The female eye is of a deep claret colour, with a median green band. On the male eye the same colouring is reproduced below, but above in the large-facetted area is replaced by an iridescent mauve ground with a dusky band.

#### Tabanus wellmanii, Aust.

Three females were captured on the high plateau south of Lake Tanganyika, Northern Rhodesia, at 4,500 ft., in August 1908, and three more on the Chisinga Plateau, in the Kalungwisi district, in September 1908.

#### Tabanus pertinens, Aust.

This recently described species is a common one in Eastern Africa, chiefly in low-lying river valleys, and fair numbers, in some cases large numbers, were taken in Northern Rhodesia, German and British East Africa. In all, 58 males

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and 274 females were obtained. The eyes of this species are remarkably brilliant. The female eye has a ground colour of a clear shining green with a broad transverse crimson band. In the lower part of each eye are two crimson spots. In the male eye the above pattern is reproduced in the lower smallfacetted area; the upper portion is also banded with the same colours, but they are much less brilliant and less clearly defined.

#### Tabanus diversus, Ric.

Examples of this species were taken sparingly from various localities in Northern Rhodesia, Nyasaland and German East Africa. Two males captured at the end of September near Fort Jameson, Northern Rhodesia, would seem to be correctly assigned to the females of this species, and this is borne out by the character of the eyes, which in the female are dusky purple. In the case of these males, the small-facetted area has the same dusky purple colour, the large-facetted area being greyish white with a central band of greyish dusky. The absence of green and crimson bands in the lower portion distinguishes these males at once from those of T. gratus, which they otherwise somewhat resemble.

# Tabanus gratus, Lw. (Pl. X, fig. 8.)

This species occurs in river valleys over a very wide area in Eastern Africa, but nowhere in very great abundance. My collection contains 48 males and 17 females in all. The eyes in life are exceedingly beautiful objects. That of the Q has a shining green ground-colour, with a border and a central band of shining crimson. The  $\mathcal{J}$  eye has the lower small-facetted position banded and coloured like the female eye, the large-facetted upper portion being dull greenish grey with a central band of dull crimson.

# Tabanus leucostomus, Lw. (Pl. X, figs. 3, 4.)

I found this interesting and little known species abundant in Northern Rhodesia and Nyasaland, especially in the low country. I also took a few individuals in similar localities in the coast belt in British East Africa. In this species the males would seem to be more common or at least more easily taken than the females, my collection containing from all sources 144  $\sigma \sigma$  to 46 QQ. It does not seem to bite man very readily. The female eye is black; the male shining black below and dark bluish grey above.

# Tabanus crocodilinus, Aust.

Represented by a single male taken on a patch of swamp, in October 1910, near Domira Bay, Nyasaland. The  $\mathcal{J}$  eye has the large facets shining grey and the small facets iridescent greenish. From this it may be inferred with a reasonable degree of probability that the  $\mathcal{Q}$ , which I have not myself seen in nature, has eyes of the same iridescent greenish colour.

# Tabanus claritibialis, Ric.

This appears to be a not uncommon species in the wet season in the Upper Shire Valley and round the southern shores of Lake Nyasa. It has also been received from the mid-Luangwa Valley. The female eyes are dusky and unbanded.

#### Tabanus pullulus, Aust.

Two females of this recently described species were taken on the Upper Shire and on the southern shores of Lake Nyasa, in February and March 1910. It much resembles T. claritibialis, to which it is closely allied, both in habits and distribution. The female eyes are dusky and unicolorous.

# Tabanus thoracinus, P. de B.

A very widely distributed species, occurring in high ground as well as low, and in forest as well as in open country. It is especially abundant in Uganda. The series I obtained comprised 128 males and 202 females. The female eye is a brilliant green (a slightly deeper colour than that of T. par); the largefacetted area of the male eye is "old gold," with a greyish iridescence in some lights.

# Tabanus obscuripes, Ric.

Of this somewhat scarce species I captured 2 males and 2 females near the north-east shore of Lake Bangweolo, between Luwingu and the mouth of the Chambezi River, in October 1908. In November 1910, I took some 10 females in German East Africa, in the Usangu and Usagara districts. The female has dark purplish eyes, not green like those of T. thoracinus, but the upper area of the male eye is of a golden bronze colour, as in that species.

#### Tabanus par, Walk.

This small species has a wide distribution throughout Tropical Africa. My collection, from all sources, contains 82 males and 48 females. The eye of the Q is brilliant emerald green, somewhat paler than that of T. thoracinus when compared in life. The upper large-facetted portion of the male cye is of a shining golden colour.

#### Tabanus medionotatus, Aust.

This new species is represented by  $6 \bigcirc \bigcirc$ , taken between Luwingu and the mouth of the Chambezi River, near the north-east shores of Lake Bangweolo, Northern Rhodesia, October 1908. Also by a single  $\bigcirc$  from the Upper Kalungwisi Valley, September 1908.

# Tabanus liventipes, Sure.

This seems to be an uncommon species. It is only represented in my collection by a female collected near Petauke, in the Luangwa Valley, Northern Rhodesia, in January 1905, and by another from the Upper Shire Valley, taken in February 1910. The eyes of the female are green; the male is unknown.

# Tabanus ditaeniatus, Macq.

Although this species ranges practically throughout Africa, and even as far as India, it seems to be nowhere very abundant in East Africa. It is more common in low country and near the larger rivers or lakes than elsewhere. The Q eye is a pale vitreous yellow, with dark spots. In the  $\mathcal{S}$  the large-facetted area is paler, of a more silvery colour and seems to lack the spots.

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#### Tabanus fuscipes, Ric.

This is a common species in the middle of the rainy season in the Shire Valley, Nyasaland, and also in the Luangwa Valley, Northern Rhodesia. The eyes resemble those of *T. ditaeniatus*, Macq.

#### Tabanus albipalpus, Walk.

A few females were taken in the valley of the Kuja River, South Kavirondo, in April 1911, and a single female on the southern slopes of Mount Elgon, in June 1911. The eyes are of the same character as those of T. ditacniatus.

#### Tabanus canofasciatus, Aust.

This interesting species seems to be confined to forestal areas in the neighbourhood of Mount Kenya and the Aberdare Mountains in British East Africa. It occurs up to at least 7,500 feet, in localities where no other species of *Tabanus* are to be found, though certain species of *Haematopota* are plentiful. It bites both man and domestic animals readily. The eyes are dusky.

#### Tabanus ruwenzorii, Ric.

Four females were taken in the Mpanga Forest, Toro, some 15 miles east of the Ruwenzori Range, in November 1911. It is a typically forest species and bites by day, closely resembling T. canofasciatus in its habits. The eyes of the female are dusky.

# Tabanus producticornis, Aust. (Pl. XI, fig. 5.)

A single male and 38 females of this species were captured at Lamu, or on the sea-shore near by, and also on the small Lake Mpeketoni, a short distance inland. This insect would thus appear to breed in salt, or at least brackish, water, as well as in fresh. The female eye is iridescent and of a dark greenish-grey colour. The male eye resembles that of the female below, while the large-facetted area above is of a deep bronze colour.

#### Family Muscidae.

#### Genus GLOSSINA, Wied.

This genus contains the most important, in an economic sense, of the African biting flies, on account of their relation with trypanosomiasis in man and other animals. It becomes necessary therefore to discuss the habits and distribution of each species more fully than in the case of the TABANIDAE.

Seven species are at present known from the regions of East Africa under discussion, exclusive of the races or varieties of G. palpalis and G. morsitans which have been described.

#### Glossina morsitans, Westw.

Before giving an account of the experience of the writer with regard to this important species, reference must first be made to the answers which have been given to a series of questions on the habits of this insect, issued by the Entomological Research Committee in 1910 and 1911. The majority of the answers come from Government officials, Medical Officers, settlers and others long resident in Nyasaland and Northern Rhodesia. G. morsitans is not known to occur in British East Africa and in Uganda appears to be confined to a comparatively limited and little traversed area. But little information is therefore available from this region and, in the case of Uganda, the area of distribution is closely adjacent to, if not actually intermingled with, that of G. pallidipes, Aust. It has not, therefore, seemed advisable to refer to the few reports from those regions, owing to the possibility of these two species having been confused.

A large number of gentlemen have been so good as to respond to the series of questions issued by the Committee. Amongst those who have answered at all fully are the following :---

NYASALAND.

Mr. Henry Brown.	Dr. W. A. Murray.
Mr. C. A. Cardew.	Dr. J. E. S. Old.
The Rev. H. A. M. Cox.	Dr. E. H. Allon Pask.
Mr. William Edwards.	Mr. J. Percival.
Mr. D. Fraser.	Dr. G. Prentice.
Mr. R. S. Hynde.	Sir Alfred Sharpe, K.C.M.G.
Mr. G. F. Manning.	Dr. H. S. Stannus.
Mr. L. Murray.	

NORTHERN RHODESIA.

Mr. A. L. Barnshaw.	Mr. W. A. Rowell.
Dr. W. Fisher.	The Rev. J. van Schalkwijk.
Mr. H. Forsyth.	Mr. H. S. Thornicroft.
Mr. H. T. Harrington.	Mr. R. A. Young.
Mr. H. C. Marshall.	

Although there is considerable conflict of evidence on some points in these answers, some interesting data arise out of them.

There would appear to be a fairly general consensus of opinion that, though it is difficult to define with certainty the limits or character of a fly-area, it is usually a region covered with fairly thin scrub or bush and at a moderately low level. One observer however, Dr. Prentice, says "I have found *morsitans* in the open country, in sparse bush, in dense jungle and in deep dark shade (such as *palpalis* likes) by the water's edge." Others, such as Mr. Barnshaw, state that it never occurs in "msitu," by which he means the patches of dense forest which occur particularly over the Nyasa-Tanganyika plateau and the Awemba country.

Most observers appear to be doubtful whether there is any marked seasonal fluctuation of numbers of the fly. A large majority agree that the presence of water is not essential to the well-being of this insect, whilst three gentlemen, Drs. Pask and Murray and Mr. G. F. Manning, refer to the absence of this species from a belt about half a mile wide along the south-west shore of Lake Nyasa, a fact which had already been noticed by several other observers, including the writer.

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On the vexed question of the relations of G. morsitans with game, there is, as might be expected, much conflict of evidence, more particularly as on this subject opinions are very apt to be somewhat biassed. Six gentlemen are of the opinion that this species is entirely dependent upon the presence of big game. The view of eight others however is precisely the opposite, whilst three are of opinion that the fly is only partially dependent upon the larger mammals. It must be admitted that the majority of the more experienced observers group themselves amongst those who believe that G. morsitans can, and indeed does, exist in the absence of the larger mammalia. The importance of this point is increased by the fact that it agrees with the recently published views of men of such great practical experience as Major J. Stevenson Hamilton and Mr. R. B. Woosnam.

There is however a remarkable unanimity of opinion in the answers as to the spread of *G. morsitans* in recent years in Northern Rhodesia and Nyasaland, practically all observers, with the important exception of Sir Alfred Sharpe, agreeing that this has been the case. Some gentlemen associate this spread with the increase and scattering of big game; others, Messrs. Fraser, Manning and van Schalkwijk, with the movements of natives. Mr. Thornicroft notes a special increase along main roads. Amongst the few people who were in the country when the rinderpest swept through it, there is an agreement that the fly disappeared to a large extent about this time. This is an important point in respect of the above-mentioned spread of the insect, since only one observer, Dr. Prentice, even suggests that the fly has now spread to an area where it did not occur previous to the rinderpest. Five gentlemen, Messrs. Brown, Edwards, Barrington, Manning and Young, refer to the disappearance or reduction in numbers of the insect with the advent of natives and the consequent clearings in the neighbourhood of villages.

In respect of my own personal experience and observations of *Glossina morsitans*, I am of opinion that among the essential factors which determine the distribution of this species, are a combination of the presence of such vegetation as will provide moderate but not excessive cover, coupled with a hot and moderately or even very dry climate. This, it is true, does not explain the sometimes marked definition of a fly-area without apparent change in the conditions, a point on which we still appear to be as much in the dark as ever. It does however explain to some extent the difficulty of defining the character of the country in which the fly occurs, when extensive regions are considered, since a considerable variation in the two factors of vegetation and climate might produce the required medium. In many parts of Southern Africa the actual amount of cover required is not excessive, though probably a limited amount of trees, bush or at least thin scrub is necessary. Personally, I am of opinion that, at least for the adult fly, long grass itself would provide sufficient cover, but for the fact that this type of country is burnt clear during the dry season practically every year. That G. morsitans inhabits open grass country has been denied by many observers, but it must be remembered that the great majority of Europeans do most of their travelling in the bush during the dry season when the grass is burnt. I have on several occasions, particularly in Northern Rhodesia, noted that when the grass is long (not less than four feet) G. morsitans is inclined to be more numerous in grassy areas of limited size than in the woodland or bush-covered country

surrounding them. I have more than once seen this species swarming in long grass on plains of some size, from a half to a mile or more from the line of bush at the edge. In such a locality there would probably be a few isolated trees or bush-covered termite mounds, and in some cases these would probably be the sites for the deposition of pupae. When such a locality is burnt clear, especially if there is a high wind and the grass burns fiercely, large numbers of flies are undoubtedly destroyed. The survivors will generally be found on the outskirts of the surrounding timber. Whether this species could exist on plains of great size covered only with long grass is impossible to say, since, so far as I am aware, this type of country does not occur in Tropical Africa. It must be remembered that the presence of long and rank species of grass denote a soil of at least moderate fertility, and long grass would therefore be almost certainly accompanied by more or less timber. In large short-grass plains, such as those to the east of Lake Bangweolo, this fly does not occur, nor from the paucity of the cover would it be expected to do so. G. morsitans also appears to avoid the other extreme, viz :-- dense forests where the atmosphere is cool and damp.

My experience of this species in the northern part of its distribution, in the upper Nile Valley, has been very limited, but I obtained a few specimens near Masindi Port on the Victoria Nile in December 1911 and also in the valley of the Kafu River near by. It is perhaps of some significance that this is a decidedly drier area than all the southern part of the Uganda Protectorate and it is also about that point that one begins to enter a rather thin bush and woodland country, presenting a great general resemblance to that of Northern Rhodesia and Nyasaland.

G. morsitans would appear to have a rather less marked seasonal variation in numbers than some other species of Glossina, being usually fairly numerous throughout the year where it does occur. Some observers have considered that the range of this species is much more restricted in the dry season than in the wet. I have not personally noticed this to be very marked in Nyasaland or Northern Rhodesia, except that, as explained above, the fly is driven out of more open areas into shadier bush by the grass fires.

Reference has been made in a recent paper by Dr. Sanderson to the "migratory" habits of this species. The actual evidence on this point however seems to be almost nil, but it is certainly an important question about which we shall know little of value until some definite flight experiments with marked. individuals are carried out. There is no doubt that the distance to which this species will follow its victims is much greater than that of G. palpalis. Considerable allowance in studying the range of this species must be made for the state of the weather, to which it is very sensitive. It must be remembered that in dull rainy weather, it would be quite easy to go through a patch of country where this fly was numerous and see scarcely a single individual. In this way a quite erroneous impression of its abundance or otherwise might be G. morsitans delights in hot sunny weather and is particularly noticeable gained. under such conditions. In the rainy season it seldom bites unless the sun is shining, but given suitable conditions, such as occur for instance in the Luangwa Valley during the last three months of the dry season, this species will be ready to bite from an hour after sunrise until midnight or even later, especially if

there is a moon and little or no wind. When it is most active it would certainly seem to be more attracted by moving men or animals than by stationary ones, as other observers have already pointed out.

The limit of elevation at which *G. morsitans* occurs in Nyasaland would appear to be about 3,000 feet. In Northern Rhodesia I have never met with it myself at over about 4,200 feet, though it is said to have been taken at somewhat greater elevations. This difference may perhaps be accounted for by the fact that Northern Rhodesia has on the whole a somewhat drier climate than Nyasaland.

Compared with most species of *Glossina*, the complete independence of water exhibited by this species is remarkable. In the Luangwa Valley I have seen it swarming, in intensely hot weather, at least five miles from any known water. Indeed, the driver the atmosphere, the greater seems to be the activity of this fly.

With regard to the relations of G. morsitans with game I must unhesitatingly group myself with those who consider that the presence or absence of big game is not the primary factor in determining the distribution of the fly. That the presence of a large quantity of big game within a morsitans area might influence the numbers of the fly by increasing the food supply is probably true, but that the game materially affects the distribution of the insect I do not for one The majority of those who hold the opposite view have moment believe. acquired their experience in Northern Rhodesia and Nyasaland and, as I shall endeavour to show, have probably been misled by peculiar and abnormal circum-It is now I think, pretty generally admitted that, north of the Zambezi stances. at any rate, there is no special relation between G. morsitans and buffalo. Certainly in this part of Africa their distribution by no means coincides. Where it does so, these animals are certainly very attractive to the fly, probably because they are slow-moving and are usually in herds of some size.

Perhaps the most important point in connection with this insect is the extension in its distribution which is believed to have taken place in Northern Rhodesia and Nyasaland within recent years. There is now a considerable accumulation of evidence, and my own experience is certainly in accordance with it, that a well-marked spreading into apparently new areas has really taken place. I say apparently new because, as I have already pointed out,\* I believe that the fly is really recovering the ground lost at the time of the rinderpest. By what means the death of large quantities of game could have caused the disappearance of the insect is now impossible to say positively. I think however the suggestion which has been put forward that the blood of the infected animals was in some way noxious to the fly is at least worthy of consideration. It is certainly not easy to understand how the fly could have died of starvation during the rinderpest epidemic since no actual extermination of the game as a whole seems to have taken place. The zebra, for instance, which swarm in the Luangwa Valley, were unaffected, and it is very doubtful if antelopes such as impala, waterbuck, puku and roan, all of which are very common there, were much reduced in numbers. It will also be seen from Major Stevenson Hamilton's interesting account<sup>†</sup> that a similar disappearance of the fly, which cannot be explained on the ground of

\* Bull. Ent. Res. I, p. 306.

<sup>+</sup> Bull. Ent. Res. II, p. 114.

starvation, took place in the Transvaal. I have been personally acquainted with the Luangwa Valley from time to time during nearly nine years and the one animal which shows an undoubted increase is the greater kudu, which, as is well known, suffered severely from rinderpest.

Under these abnormal conditions G. morsitans seems to have extended its range during recent years to areas suitable to its existence and in which it formerly occurred. In these special circumstances I am somewhat inclined to think that the game has been a factor of some importance. It is not unreasonable to conclude that the general scattering of game at the beginning of the rains. from the limited area near water which they have frequented during the drv season, has somewhat accelerated this spread of the fly during recent years. This could not probably have happened but for these special circumstances, in which there were adjacent areas suitable to the fly and unoccupied by it-a state of affairs which would be very improbable under normal conditions. The fly has apparently now nearly, if not quite, recovered all its lost ground, i.e., its present distribution is approximately the same as before the advent of the rinderpest. It will be of extreme importance to note whether G. morsitans now spreads into areas which it did not occupy before the rinderpest, e.g., parts of Angoniland where the natives have kept large herds of cattle for several generations; but it seems to me that this is very unlikely. It will thus be seen that it is possible that some of the observers in Nyasaland and Rhodesia have been unintentionally led to exaggerate somewhat the importance of game as a factor in the distribution of G. morsitans by the above mentioned circumstances.

With regard to the relations of this species with man, though, as is well known, it bites man readily, I think it is doubtful whether it has any preference for him as compared with other mammals. Indeed it is questionable whether this is true of any species of *Glossina*, with the possible exception of *G. palpalis*. It has often been stated that *G. morsitans* avoids human habitations, though many observations as to the fly entering native villages have been made. This insect, without question, frequently follows bands of natives traversing main roads into the heart of villages, but it is doubtful if any but an occasional individual remains there any length of time. I am in complete agreement with the views expressed by Sir Alfred Sharpe and others that it is the cleared and cultivated area that usually surrounds native villages which is the deterrent and not the actual human habitations or their accompaniments.

It would therefore seem that this species is only to be exterminated by extensive occupation and cultivation by human beings of the area it occupies. This area must be *kept* cultivated, as it seems probable that not only G. morsitans but G. pallidipes will return to land where the bush has been allowed to grow up again. Measures for clearing the bush and thus removing the natural cover, as is being done in the case of G. palpalis, would seem impracticable. The habitat of the insect is so different and its range usually so much wider, that a road, for instance, through a fly-belt, to be efficiently cleared, would have to be perhaps as much as a mile wide. Possibly something might be done in this direction by imitating the condition surrounding native villages and planting extensive strips of crops, such as sweet potatoes or ground-nuts, by the road-side. It would seem probable that such low-growing crops would be a greater

deterrent than maize or millet, but, so far as I am aware, there is no evidence on this point.

In view of the strong probability that this species can feed on a great variety of vertebrate life, the mere destruction of the large game would seem at first sight absurd, unless the said game can be proved to be the *sole* reservoir of a noxious trypanosome. If a serious attempt is to be made to starve out the insect, the only logical step would involve the removal or destruction of *all* such classes of animal life, including man and his domestic animals.

#### Glossina pallidipes, Aust.

This species somewhat resembles G. morsitans in its habits, at least as regards the type of country in which it occurs and the conditions under which it feeds, but it would appear not to be so completely independent of water. So far as my experience goes, though not at all confined to river banks, it is always associated with a fairly considerable amount of bush in rather low-lying river valleys; but given sufficient cover, it would no doubt be found a mile or so from water. There would appear to be some ground for thinking that, in British South Africa at any rate, this tsetse has a more marked seasonal prevalence than G. morsitans, being much more numerous at the end of the wet season and the months immediately following it than during the dry. It also seems often to occur in far fewer numbers in any one spot than does G. morsitans, which, when the conditions are favourable for seeing it, is usually fairly abundant.

As regards distribution, this species occurs mainly in the coast belt, from which it extends up the principal river valleys, especially near the Equator. An important exception to this is its occurrence in some numbers in western and north-western Uganda, particularly in the Semliki Valley, where, considering the essentially Western character of the fauna generally, *G. longipalpis*, Wied., might have been expected to replace it. When on the Victoria Nile, near Masindi Port, in December 1911, I was fortunate in obtaining both *G. pallidipes* and *G. morsitans* in the same locality, which is of some interest, as authentic records of this seem to be very few. Dr. van Someren's statement that both species occur together as far south as Toro would appear to be mistaken, only specimens of *G. pallidipes* having as yet been received by the Entomological Research Committee from that district.

The records of the distribution of this species in Nyasaland are in a very unsatisfactory state, there being apparently no recent data available and no very accurate localities are known for the very few specimens which are said to have been taken in that country. It is, however, not improbable that this species does occur in Southern Nyasaland, particularly near Lake Shirwa and perhaps on the lower Shire.

Authentic records of *G. pallidipes* occurring at over 4,000 feet do not seem to be available. Reports of what may, perhaps, be this species from near Fort Hall, British East Africa, if confirmed, would, however, show that it can exist at considerably greater elevations.

There would seem to be some evidence that this species, like G. morsitans, is kept at bay by cultivation.

In many places along the coast belt of British East Africa the natural bush is now overwhelming the many large native plantations which have been deserted, and this species, and also G. *brevipalpis*, are almost certainly increasing and extending their range. I am informed that, in consequence of this, it is now no longer possible to keep cattle in many places where they flourished a generation ago.

# Glossina austeni, Newst.

I was fortunate in capturing a few specimens of this recently described and remarkable little species. I first took a single female at Voi, British East Africa, on 9th February 1912, and subsequently two individuals of each sex in the Uchweni forest, near Witu, February 25th-27th, in the same Protectorate.

The Entomological Research Committee have also received a single female from the Juba River from Dr. C. L. Chevallier, from whence came the type, and a male, taken on Mombasa Island on November 22nd, 1911, by Dr. W. J. Radford, Senior Medical Officer at Mombasa.

In spite of its small size this species is readily recognisable in life by the bright rufous colour of the upper surface of the abdomen. So marked is this colour, that from a short distance I mistook the first specimen I saw for a small individual of *Tabanus par*.

I have necessarily had only a very limited experience of this species. It occurs in company with *G. pallidipes* and *G. brevipalpis*, though it seems to require more heavily forested country than that in which those species sometimes are found. It would appear to be confined to the coast belt in British East Africa, where it evidently has a fairly wide distribution. It would not be surprising, however, to hear of its existence in the coast belt in German East Africa also. Up to the present it has not been captured at a greater elevation than about 1,500 feet above sea-level.

#### Glossina palpalis, Rob. Desv.

The habits of this species are now so widely known that it is perhaps not necessary to consider them at any length. As I have pointed out before,<sup>\*</sup> the distribution of this tsetse in the main coincides with that of other insects of the tropical West Coast, and it is therefore strictly not an East African species. Since however political boundaries do not concern themselves with faunistic ones, *G. palpalis* occurs in several of the East African countries under consideration, viz.:—part of N.E. Rhodesia within the Congo basin, the basin of Lake Tanganyika, and of the great lakes of Uganda and of the Upper Nile. Everywhere in this region *G. palpalis* is confined to the shadier portions of lake shores or river banks at elevations under 4,000 feet. In other words, the climate is nowhere sufficiently humid to enable it to exist at any appreciable distance from a permanent body of water. I do not know of any authentic record of its occurring at over 4,000 feet, even at the equator, and the further from the equator, the lower the limit seems to be, as might be expected.

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<sup>\*</sup> Journ. of Econ. Biol. IV, pp. 109-114 (1909).

The distribution of this species on the eastern side of the Victoria Nyanza and in the basin of the Upper Nile is interesting, since there would appear to be some evidence that a climatic change, perhaps a change in the water-level, is taking place in these regions with a consequent effect upon the fauna. This is especially noticeable in the region draining into Lake Kioga. Over this area, with the exception of the banks of the main stream of the Nile connecting the Victoria Nyanza and Lake Kioga, the distribution of G. palpalis is remarkably discontinuous. The whole of the Kioga basin proper including Mpologoma, Salisbury, Kwania, &c., is now flat country with swampy watercourses, quite unsuitable for this species. Consequently it is confined at the present day to small patches near the low watershed between the Victoria Nyanza and the streams which flow into the Mpologoma swamp, and again at the foot of Mount Elgon. It also occurs in one or two small patches on the north shore of Lake Kioga itself. The extremely sporadic character of this distribution appears to point to a former time when the nature of the water system was different and the insect occurred almost continuously throughout it.

On the Victoria Nile itself, below Lake Kioga, the fly ceases approximately at a point a little above the marked right-angled bend near Masindi Port. The banks of the river near this point are of great interest as the cover is limited and the climate relatively dry. *G. palpalis* does not occur here in any great numbers and certainly gives the impression of only surviving under difficulties. It is under such conditions as this that the extensive clearing operations which are there being carried out by the Uganda Government would seem to give exceptional promise of success.

The case with regard to the eastern shores and islands of the Victoria Nyanza. which are in the British East Africa Protectorate, is somewhat different. Here again the climate is rather drier than that of Uganda proper, and the amount of forest and bush on the lake shore and on the banks of many of the rivers is comparatively scanty. G. palpalis is present for the most part only in small numbers and usually in very limited patches, except on some of the larger rivers such as the Kuja. This region has no doubt always been considerably drier than Uganda proper, on account of the high ground of the Kisii and Sotik countries, immediately to the east of it, intercepting most of the rain. This drvness appears however to have been increased by the action of man within the last few generations. Since the Nilotic Jaluo or Kavirondo invaded the lower part of the country near the Lake shore, the indigenous agricultural Bantu races were driven on to higher ground to the east, chiefly to what is now the Kisii country. This region exhibits evident signs of fairly recent deforestation, which is now practically complete. This condition of affairs has had a considerable effect upon the rainfall of the lower-lying country immediately to the west.

The conditions in Northern Kavirondo are somewhat different, since there the high ground to the east is populated by the Nandi, who are mainly a pastoral people, and much of the primeval forest still exists there in consequence. Such deforestation as has occurred has principally been on the lower ground, in the valleys of the Nzoia and Yala rivers. The insect fauna of this district exhibits evident traces of more or less continuous forest having existed at some former time across Usoga into Uganda proper. It would then appear that the conditions in North and South Kavirondo, but especially the latter, are not too well suited to G. *palpalis* at the present time. There is a reasonable probability therefore that extensive clearing operations in this region would result in the extinction of the insect.

One point in respect of clearing operations is of interest, namely, that this and probably all other species of *Glossina* habitually *live very near the ground* and probably never settle more than a few feet above it. Hodges and others have demonstrated that clearing operations need not involve the removal of large trees with clean trunks free from low-growing branches. It seems to be the low growth of shrubs, etc., which provides the necessary cover for *G. palpalis*, and this will probably be found true for all species of *Glossina*.

#### Glossina brevipalpis, Newst.

This species seems to be, partially at least, dependent on the presence of water or a moderate degree of atmospheric humidity. It is therefore only found in river valleys and amongst a considerable amount of cover and shade, much more than would be necessary for *G. pallidipes*, but less than for *G. palpalis*. In the height of the dry season it seems to be found only in the immediate proximity of water or cool and damp river beds. It prefers comparatively low country, and I do not know any record of its occurrence at much over 3,000 feet.\*

This tsetse feeds for the most part in the early morning and late evening and has, I think, a decided preference for animals as against man. Dr. Sanderson informs me that in the Wankonde country, Northern Nyasaland, he has seen *G. brevipalpis* in native huts. This is however explained by the fact that in that country the natives keep their cattle in their living houses.

The evidence as to whether this species is a carrier of trypanosomiasis is at present very conflicting. It must be remembered that it frequently occurs in company with G. pallidipes on the east coast of Africa or with G. morsitans in Nyasaland and Northern Rhodesia. On the other hand where it is the only known species of *Glossina*, as in the country to the north and north-west of Lake Nyasa, which is full of cattle, there is no definite evidence of trypanosomiasis among the stock.

# Glossina longipennis, Corti.

This is a desert-haunting species, confined, so far as at present known, to North-Eastern Africa. It is widely spread over the lower-lying and drier regions to the east and north in the British East Africa Protectorate and will very probably be found extending into the Uganda Protectorate in the country to the south-west and west of Lake Rudolph. It appears to be absent from the sea-coast, where the climate is probably too humid for it. It would seem to be entirely independent of water, and indeed rather to avoid it. I found it most striking, when travelling from station to station on the railway between Voi and Makindu, to find numbers of this species in the dry, semi-desert, thorn-scrub

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<sup>\*</sup> In Austen's "Handbook of the Tsetse-flies," p. 104, the elevation of the Tsavo R. on the Uganda Railway (where this species and G. longipennes occur) is given in error as 6,000 feet; this should be about 1,500 feet.

country between the rivers, while on the river banks it was replaced by G. brevipalpis.

Like the other large species of *Glossina* it is chiefly on the wing and inclined to feed in the early morning and late evening. It is probably the species which most frequently enters the railway carriages on the Uganda Railway at night, that being the time when the principal trains traverse the region between Voi and Makindu.

# Glossina fusca, Walk.

This West African species of tsetse enters the region under discussion only on the western boundaries of Uganda. It is not uncommon in the forests of Toro and the Semliki Valley, and is also reported from the Budongo forest, Unyoro, though I did not meet with it there myself. From a limited experience of this insect it would appear to be essentially a dense forest, rather than a riverine, species, and evidently delights in very deep shade. Though occurring in many places with *Glossina palpalis*, the distribution of the two species is by no means coincident, since *G. fusca* seems to be able to exist at considerably greater elevations and in much cooler localities. In Uganda the limit for this species seems to be about 4,500 feet, as compared with rather under 4,000 feet for *G. palpalis* in the same region. It is of course also numerous at much lower elevations, *e.g.*, the forested portions of the Semliki Valley at under 2,500 feet.

It seems to feed principally in the early morning and late evening and shows a decided preference for animals, as compared with man.

The above notes on the habits of the East African species of *Glossina* may perhaps best be summarised by the following classification according to environment :---

- A. Requiring a great degree of atmospheric humidity :--
  - A. 1. Requiring a high temperature. G. palpalis, R. D.
  - A. 2. Not requiring a high temperature. G. fusca, Walk.
- - B. 1. Requiring comparatively little cover. G. pallidipes, Aust.
  - B. 2. Requiring fairly heavy timber and bush. G. brevipalpis, Newst.
  - B. 3. Requiring more or less dense forest. G. austeni, Newst.
- C. Independent of water and most active in a dry atmosphere. G. morsitans, Westw., and G. longipennis, Corti.

The three large species, G. brevipalpis, G. longipennis and G. fusca, may also be separated from the others by their being mainly crepuscular or nocturnal in their habits, instead of being most active in sunshine.

#### Genus STOMOXYS, Geoffr.

The flies of this genus are, after *Glossina*, the principal biting flies in Africa belonging to the MUSCIDAE. In my experience, they only exceptionally bite man, exhibiting a marked preference for other animals, particularly domestic ones. They are common nearly all over Eastern Africa in the neighbourhood of townships and human habitations where any appreciable number of domestic animals are kept. Though I have exceptionally taken the flies of this genus in large numbers on freshly killed game, they are not much in evidence out in the bush. They seem most active in bright sunlight.

#### Genus LYPEROSIA, Rond.

I only met with these insects in Western Uganda. They were seen in large numbers on freshly killed eland, waterbuck, kob and wart-hog in various localities in Ankole and the valley of the Semliki. They would appear rarely, if ever, to attack man.

#### Genus AUCHMEROMYIA, Br. and Berg.

These flies attack man only in their larval state. They are widely known as "floor maggots" and *A. luteola*, F., (and perhaps other species) occurs in the more neglected huts in native villages throughout Tropical Africa. The adult flies are sometimes to be seen on the walls of native huts, and frequently enter a tent when it is pitched near a village.

#### Genus CORDYLOBIA, Grünb.

The flies of this genus also attack man in the larval state by burrowing into the skin and producing a painful boil. Dogs also suffer very badly in some places from this cause, and I have seen one instance in the case of a rat, probably some species of *Tatera*. Many instances in human beings would seem to preclude the possibility of the eggs having been laid direct on the skin by the parent fly, and in these cases they have probably been deposited on clothing when put out to dry.

The commonest species is *C. anthropophaga*, Grünb, and this seems to be more abundant in Northern Rhodesia and Nyasaland than to the north. A few adults of the recently described *C. praegrandis*, Aust., were taken in Northern Rhodesia, Nyasaland and German East Africa, in the same circumstances as *Auchmeromyia luteola*.

#### Family Hippoboscidae.

The curious flies of this family are widely distributed in Tropical Africa. They are not very easy to collect in any number, at least in the case of the winged forms, on account of their habit of leaving the body of their host immediately after death. If a large animal, such as an antelope, suspected of having these parasites, be shot, the body should be approached quietly, and if no disturbance is made, several of the flies can usually be netted; but they will be driven off at once if numbers of natives are allowed to rush up to the carcase and stand round it, as is their usual habit. The species that frequent birds are often very difficult to capture, as the flies are extremely active, and seldom seen until in the act of flying away. I have often noticed that the best chance of taking the flies arises when the carcase of the shot bird has fallen into water, and the insects then become entangled in the wet feathers.

The following is a brief list of the species taken on my last tour, not including two or three not yet identified.

#### Genus HIPPOBOSCA, L.

# Hippobosca hirsuta, Aust.

Two males from the plains north-east of Lake Edward, Uganda, 16th October 1911, on a waterbuck (*Cobus defassa*). One of these was biting a native after having escaped.

#### Hippobosca hirsuta var. neavei, Aust.

Eight males and four females were taken in the upper and mid Luangwa Valley, North Eastern Rhodesia, in August 1911, all on waterbuck (*Cobus ellipsiprymnus*). Two males were also obtained on the Lofu River, south of Lake Tanganyika, in August 1908, on a puku (*Cobus vardoni*).

#### Hippobosca capensis, Olf.

A few individuals of this species were taken on natives in the valley of the Ruaha River, German East Africa, in December 1910, and also on dogs at Voi, British East Africa, in February 1912. It is specially associated with CANIDAE and FELIDAE.

#### Hippobosca struthionis, Jans.

A good series of this species was taken on a wild ostrich, which was shot for the purpose, near Gimba, British East Africa, in April 1911. A single specimen was also captured on a native in the same neighbourhood.

# Genus ECHESTYPUS, Speiser.

# Echestypus paradoxus, Newst.

This species seems to be a common parasite on Tragelaphine antelopes over a wide area. I found it on a bushbuck at Msoro's, 50 miles west of Fort Jameson, and also on greater kudu, 35 miles east of Fort Jameson, North East Rhodesia, in September 1910; in Nyasaland, on bushbuck, near Kota Kota, in November 1910; in British East Africa, on lesser kudu, near Makindu, in April 1911.

#### Genus OLFERSIA, Leach.

#### Olfersia ardeae, Macq.

Two individuals of this species were taken on the Goliath Heron (Ardea goliath), near Kota Kota, Nyasaland; in October 1910.

#### Genus LYNCHIA, Weyenb.

# Lynchia maura, Big.

A common and almost cosmopolitan parasite of domestic pigeons. I have personally taken it on these birds in Northern Rhodesia, Nyasaland and German East Africa; but it probably occurs all over Eastern Africa.

# Ornithoctona platycera, Macq.

This is not an uncommon species on Passerine birds over a very wide area. It occurs in my collection from a thrush, *Turdus stormsi*, Hartl., north of Lake Bangweolo, North Eastern Rhodesia, in June 1908, and from a stonechat, *Pratincola torquata*, L.

	N. Rhodesia and Nyasaland.			Uganda.			
	Chichawa (Yao).	Chimanganja.	Chiwemba.	Chisenga.	Lusoga.	Luganda.	Lunyoro.
Tsetse	Maguo	Maguo	Kasyembe	Kamzembe	Binsukuma	Bivu	Viju <b>j</b> i.
Tabanus, large	Vipanga	Zipanga		Vipanga	Bilumambogo	Bilumambogo	Vilumambogo
Tabanus, small	$\mathbf{v}_{\mathrm{ipanga}}$	Zipanga	-	Vipanga	Binsukuma		Vivara.
Haematopota	Vipanga	Zipanga	-	Vipanga	Binsukuma		Mbara.
Simulium	-	_		_	Mbwa	Mbwa	Kachururu.
Culicoides	-		- 1		Bujusiyi	Butugu	
Mosquitos	Uzuzu		Imbu	Imbu	Nsiri	Nsiri	Mivu.
Larva of Cordylobia or Auchme-	Mbisu	·	_	Vikusi	Nyengere	Nyengere	Kihengere.
romyia. Bed-bug	Gunguni	Msikizi	-	Sania	Biku	Biku	Visuzi.
Flea	Utitiri		-	_	_	Nkukunyi	Nkukunyi.
Ornithodorus	Ngufu	Nkufu or	Nkufu	Nkufu	Bibo	Bibo	_
Ticks in general.		Nkufi.	_	-	Nkodo	Nkwa	_

# Native Names for Blood-sucking Arthropods.

	British East Africa.					
	Kiswahili.	Kikuyu.	Kikamba.	Nandi.	Jaluo (Nilotic Kavirondo).	Jamwa (Bantu Kavirondo).
Tsetse	_		Chitangua	Kibjagara (?)	Maugo	Ruuko.
Tabanus, large		Igi or	Nju	Kiptololet.		—
Tabanus, small	-	Mbogo or	Madzunzuma	Kiptololet.	—	
Haematopota	-	Zigayi. Mbogo or	Madzunzuma	Sogoriet.	-	—
Simulium		Zigayi,	-			-
Culicoides		-	—			- 1
Mosquitos	Imbu	Lubuyu	Մամ	Sogoniat	Suna	Tisuna.
Larva of Cordylobia or Auchme-	Funsa	Ngagi or Kigago.		-		-
romyia. Bed-bug	Kunguni	Gunguni	-		-	-
Flea	Kiroboto	_	-		-	-
Ornithodorus	Papasi	Ngoha	-	-	-	
Ticks in general.	-	_		Karabasiet	Kulundeng	

\* Signifies " biter of buffalos."

# LOCAL LISTS OF BLOOD-SUCKING ARTHROPODS.

# Northern Rhodesia.

Order DIPTERA.

Family CULICIDAE.

Anopheles (Myzomyia) costalis, Lw.	Stegomyia poweri, Theo.
" " funesta, Giles.	Mansonioides uniformis, Theo.
" (Myzorhyncus) mauritianus, Grp.	Culex pipiens, var. zombaensis, Theo.
Stegomyia africana, Theo.	" tigripes, Grp.
" fasciata, F.	" univittatus, Theo.

Phlebotomus minutus, Rond.

# Family PSYCHODIDAE.

#### Family TABANIDAE.

Pangonia bubsequa, Aust.	Tabanus claritibialis, Ric.
" elongata, Ric.	", coniformis, Ric.
" oldii, Aust.	., copemani, Aust.
Dorcaloemus compactus, Aust.	denshami, Aust.
" silverlocki, Aust.	" distinctus, Ric.
Rhinomyza concinna, Aust.	., disjunctus, Ric.
" innotata, Karsch.	., ditaeniatus, Macq.
,, umbraticola, Aust.	., diversus, Ric.
Silvius fallax, Aust.	,, fraternus, Macq.
Chrysops fuscipennis, Ric.	,, fuscipes, Ric.
,, longicornis, Macq.	,, grandissimus, Ric.
" wellmanii, Aust.	,, gratus, Lw.
Haematopota copemani, Aust.	,, leucostomus, Lw.
" divisapex, Aust.	,, liventipes, Surc.
,, decora, Walk.	" maculatissimus, Macq.
,, furtiva, Aust.	,, medionotatus, Aust.
,, hirsutitarsis, Aust.	,, nyasae, Ric.
., insidiatrix, Aust.	,, obscuripes, Ric.
,, mactans, Aust.	,, par, Walk.
,, masseyi, Aust.	,, pertinens, Aust.
,, nociva, Aust.	,, pullulus, Aust.
" pertinens, Aust.	,, quadrisignatus, Ric.
" sanguinaria, Aust.	,, sharpei, Aust.
" stimulans, Aust.	,, septempunctatus, Ric.
" taciturna, Aust.	,, tueniola, P. de B.
" vittata, Lw.	,, thoracinus, P. de B.
Tabanus africanus, Gray.	,, unitaeniatus, Ric.
" atrimanus, Lw.	,, ustus, Walk.
" barclayi, Aust.	,, variabilis, Lw.
" biguttatus, Wied.	,, wellmanii, Aust.
,, brucei, Ric.	,, xanthomelas, Aust.

Family MUSCIDAE.

Glossina brevipalpis, Newst	Stomoxys nigra, Macq.
,, morsitans, Westw.	" brunnipes, Grünb.
,, pallidipes, Aust.	Auchmeromyia luteola, F.
,, palpalis, R.D.	Cordylobia anthropophaga, Grünb.
Stomoxys calcitrans, L.	" praegrandis, Aust.

#### S. A. NEAVE-NOTES ON THE BLOOD-SUCKING

Family HIPPOBOSCIDAE.

Hippobosca hirsuta, Aust. var. neavei, Aust. Ornithoctonus platycera, Macq. Echestypus paradoxus, Newst Lynchia maura, Bigot.

Order SIPHONAPTERA.

Family SARCOPSYLLIDAE.

Echidnophaga gallinacca, Westw.

Ctenocephalus canis, Curtis.

Family PULICIDAE.

# Order RHYNCHOTA. Family CIMICIDAE.

Cimex rotundatus, Sign.

Order ANOPLURA.

Family PEDICULIDAE.

Family HAEMATOPINIDAE.

Haematopinus latus, Neum.

Phthirius pubis, L.

Order ACARI.

Family ARGASIDAE.

Ornithodorus moubata, Murray.

#### Family IXODIDAE.

Amblyomma marmoreum, Koch. ,, petersi, Karsch. ,, variegatum, F. Boophilus decoloratus, Koch. Haemaphysalis leachi, Aud. Hyalomma aegyptium, L. Rhipicephalus appendiculatus, Neum. ,, capensis, Koch. ,, evertsi, Neum. ,, neuvei, Warb. ,, nitens, Neum. ,, sanguineus, Latr. ,, simus, Koch.

| Haematopinus aulacodi, Neum.

# Nyasaland.

#### Order DIPTERA. Family CHIRONOMIDAE.

Ceratopogon sp.

#### Family CULICIDAE.

Ingramia uniformis, Theo.
Mansonioides mediolineata, Theo.
" uniformis, Theo.
Mucidus mucidus, Karsch.
Ochlerotatus argenteopunctatus, Theo.
" cumminsi, Theo.
", marshalli, Theo.
,, nigeriensis, Theo.
,, quasiunivittatus, Theo.
Taeniorhynchus metallicus, Theo.
Toxorhynchites brevipalpis, Theo.
Stegomyia fasciata, F.
" simpsoni, Theo.

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Phlebotomus minutus, Ro	ond.	
Simuli <b>um d</b> amnosum, <b>T</b> h	Family ieo.	SIMULIIDAE.   Simulium neireti, Roub.
	Family	TABANIDAE.
Cadicera flavicoma, Aus	t.	Tabanus atrimanus, Lw.
" nigrescens, Ric	•	, barclayi, Aust.
" obscura, Ric.		, biguttatus, Wied.
Pangonia bubsequa, Aus	st.	, claritibialis, Ric.
" fodiens, Aust.		" coniformis, Ric.
" oldii, Aust.		" copemani, Aust.
Dorcalocmus compactus,	Aust.	" crocodilinus, Aust.
,, bicolor, Au	st.	,, denshami, Aust.
Rhinomyza concinna, Av	ist.	" distinctus, Ric.
" innotata, Ka	rsch.	,, ditaeniatus, Macq.
Chrysops distinctipennis,	Aust.	,, diversus, Ric.
,, fuscipennis, Ri	c.	,, fraternus, Macq.
" longicornis, Ma	icy.	,, fuscipes, Ric.
,, magnifica, Aus	st. var. inornata, Aust	. , grandissimus, <b>R</b> ic.
Holcoceria nobilis, Grün	ıb.	,, gratus, Lw.
Haematopota abyssinica.	, Sure.	" laverani, Surc.
", decora, Wa	alk.	,, leucostomus, Lw.
" distincta, I	Ric.	" liventipes, Surc.
" furtiva, A	ust.	, maculatissimus, Macq.
" insatiabili	3, Aust.	" nigrostriatus, Ric.
" insidiatrix	, Aust.	,, nyasae, Ric.
" longa, Ric	•	,, obscuripes, Ric.
", mactans, 1	Aust.	,, par, Walk.
,, malefica, 1	Aust.	,, pertinens, Aust.
,, nocens, Au	ıst.	,, <i>pullulus</i> , Aust.
" nociva, Aı	ıst.	,, quadrisignatus, Ric.
" noxialis, A	Lust.	,, ruficrus, P. de B.
" pellucida,	Surc.	" sandersoni, Aust.
" pertinens,	Aust.	" sharpei, Aust.
,, sanguinari	ia, Aust.	" taeniola, P. de B.
,, stimulans,	Aust.	" unitaeniatus, Ric.
" vittata, Ly	۷.	" ustus, Walk.
Tabanus africanus, Gray	۶.	,, xanthomelas, Aust.

#### Family PSYCHODIDAE.

Family MUSCIDAE.

Glossina brevipalpis, Newst.	Stomoxys taeniata, Big.
" morsitans, West.	Stygeromyia sanguinaria, Aust.
" pallidipes, Aust.	Auchmeromyia luteola, F.
Stomoxys brunnipes, Grünb.	Cordylobia anthrophaga, Grünb.
" calcitrans, L.	" praegrandis, Aust.
" nigra, Macq.	

#### Family HIPPOBOSCIDAE.

Hippobosca hirsuta, Aust. var. neavei, Aust. Echestypus paradoxus, Newst. Lynchia maura, Bigot. Olfersia ardeae, Macq.

#### Order SIPHONAPTERA.

#### Family SARCOPSYLLIDAE.

Echidnophaga gallinacea, Westw. ,, larina, Roths. Dermatophilus penetrans, L.

Family PULICIDAE.

Chimaeropsylla potis, Roths. Ctenocephalus canis, Curtis. felis, Bouché. ...

Moeopsylla sjoestedti, Roths. Xenopsylla aequisetosus, Endl. brasiliensis, Baker. ••

Order RHYNCHOTA.

Family CIMICIDAE.

Pediculus humanus, L. Phthirius pubis, L.

Cimex rotundatus, Sign.

Pedicinus longiceps, Piag.

#### Family HAEMATOPINIDAE.

Haematopinus bufali, de G.

- eurysternus, Nitzsch. .,
  - latus, Neum. ,,

Haematopinus peristictus, Kell. & Paine Linognathus forficula, Kell. & Paine. vituli, L. ,,

#### Order ACARI.

#### Family ARGASIDAE.

Ornithodorus moubata, Murray.

#### Family IXODIDAE.

Amblyomma marmoreum, Koch.	Rhipicephalus appendiculatus, Warb
" <i>petersi</i> , Karsch.	,, bursa, Can. and Fan
" tholloni, Neum.	,, capensis, Koch.
" variegatum, F.	" coriaceus, Nutt. and Warb
Aponomma exornatum, Koch.	" evertsi, Neum,
Boophilus australis, Fuller.	,, falcatus, Neum.
" decoloratus, Koch.	" lunulatus, Neum.
Dermacentor rhinocerotis, De Geer.	,, maculatus, Neum.
Haemaphysalis hoodi, Nutt. and Warb.	, neavei, Warb.
" leachi, Aud.	,. neavei, var. punctatus, War
Hyalomma aegyptium, L.	,, sanguineus, Latr.
Ixodes brunneus, Koch.	" sculptus, Warb.
" pilosus, Koch.	" simus, Koch.
, tenuirostris, Neum.	,, sulcatus, Neum.
Rhipicentor bicornis, Nutt. and Warb.	,, supertritus, Neum.

# German East Africa.

#### Order DIPTERA.

Family CULICIDAE.

Anopheles (Myzomyia) costalis, Lw. funesta, Giles. ,, (Myzorhynchus) mauritianus, Grp. ,, (Nyssorhynchus) pharoensis, Theo. Toxorhynchites brevipalpis, Theo. Stegomyia fasciata,  $\hat{\mathbf{F}}$ . simpsoni, Theo. ,,

Ochlerotatus fascipalpis, Edw. leucarthrius, Speiser. Tueniorhynchus fuscopennatus, Theo. Mansonioides uniformis, Theo. Culex pipiens, L. var. zombaensis, Theo tigripes, Grp. ,, Eretmopodites chrysogaster, Graham. quinquevittatus, Theo. • •

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Order ANOPLURA. Family PEDICULIDAE.

Cadicera speciosa, Aust.	Tabanus	amblychromus, Speiser.
Pangonia elongata, Ric.	,,	atrimanus, Lw.
" mesembrinoides, Surc.	••	biguttatus, Wied.
, zonata, Walk.	,,	conifornis, Ric.
Diatomineura aethiopica, Thunb.	••	distinctus, Ric.
" distincta, Ric.	11	ditaeniatus, Macq.
Rhinomyza innotata, Karsch.	·,,	diversus, Ric.
Adersia oestroides, Karsch.	1,	fraternus, Macq.
Chrysops bicolor, Cordier.	,,	gratus, Lw.
" longicornis, Macq.	,,	imbecillus, Karsch.
" magnifica, Aust.	,,	impurus, Karsch.
Holcoceria nobilis, Grünb.	,,	latipes, Macq.
Haematopota abyssinica, Surc.	,,	maculatissimus, Macq.
" albohirta, Karsch.	,,	obscuripes, Ric.
" alluaudi, Surc.	,,	par, Walk.
avida, Speiser.	,,	pertinens, Aust.
., decora, Walk.	••	pullulus, Aust.
,, distincta, Ric.	,,	quadriguttatus, Ric.
,. hieroglyphica, Gerst.	,,	quadrisignatus, Ric
,, hirta, Ric.	,,	sharpei, Aust.
" imbrium, Wied.	**	taeniola, P. de B.
" <i>mactans</i> , Aust.	,,	thoracinus, P. de B.
" maculiplena, Karsch.	,,	trianguliger, Aust.
,, vittata, Lw.	,,	ustus, Walk.
Parhaematopota cognata, Grünb.	,,	variabilis, Lw.
Tabanus africanus, Gray.		

#### Family TABANIDAE.

Family MUSCIDAE.

Glossina brevipalpis, Newst.	Stomoxys nigra, Macq.
" morsitans, Westw.	" ochrosoma, Speiser.
,, pallidipes, Aust.	" tueniata, Big.
,, palpalis, R.D.	" varipes, Bezzi.
" tachinoides, Westw. (?)"	Lyperosia schillingsi, Grünb.
Stomoxys bilineata, Grünb.	Auchmeromyia luteola, F.
" brunnipes, Grünb.	Cordylobia anthropophaga, Grünb.
" calcitrans, L.	" praegrandis, Aust.
" korogwensis, Grünb.	

#### Family HIPPOBOSCIDAE.

Hippobosca capensis, Olf. ,, struthionis, Janson. Echestypus parvipalpis, Speiser. Lynchia maura, Bigot. Ornithoctona platycera, Macq. Olfersia ardeae, Macq. ,, pilosa, Macq.

#### Order SIPHONAPTERA.

#### Family SARCOPSYLLIDAE.

Dermatophilus penetrans, L.

| Echidnophaga gallinacea, Westw.

\* The record of this species from German East Africa needs confirmation. It is not impossible that the specimens which were identified as G. tachinoides may prove to have been really G. austeni, Newst.

Family PULICIDAE.

Ctenocephalus canis, Curt. Moeopsylla sjoestedti, Roths. Ceratophyllus infestus, Roths. Ctenopsyllus aethiopicus, Roths.

Order ANOPLURA.

Family PEDICULIDAE.

Pediculus capitis, de G.

#### Family HAEMATOPINIDAE.

Haematopinus eurysternus, Nitzsch.

| Haematopinus phacochaeri, End.

# Order ACARI.

Family IXODIDAE.

Amblyomma petersi, Karsch. variegatum, F. Boophilus australis, Fuller. " decoloratus, Koch.

Haemaphysalis leachi, Aud. Rhipicephalus capensis, Koch. evertsi, Neum. ,, maculatus, Neum.

# Zanzibar.

Order DIPTERA.

Family CHIRONOMIDAE.

Ceratopogon sp.

#### Family CULICIDAE.

Anopheles (Myzomyia) costalis, Lw. Stegomyia fasciata, F. Skusea pembaensis, Theo.

Adersia oestroides, Aust.

Aegophagamyia pungens, Aust.

Parhaematopota cognata, Grünb.

biguttatus, Wied.

Chrysops longicornis, Macq.

Haematopota decora, Walk.

Tabanus africanus, Gray.

Stomoxys calcitrans, L

,,

"

# Iaeniorhynchus fuscopennatus, Theo.

Mansonioides uniformis, Theo. Culex tigripes, Grp.

# Family TABANIDAE.

Tabanus ditaeniatus, Macq. " fraternus, Macq.

- gratus, Lw.
- "
- par, Walk. "
- taeniola, P. de B. "
- thoracinus, P. de B.

#### Family MUSCIDAE.

Lyperosia minuta, Bezzi Cordylobia anthropophaga, Grünb.

#### Family HIPPOBOSCIDAE.

Ornithoeca podicipis, Röd.

Hippobosca capensis, Olf.

maculata, Leach. ,,

nigra, Macq.

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#### Order SIPHONAPTERA.

Family PULICIDAE.

Xenopsylla cheopis, Roths.

#### Order ANOPLURA.

Family PEDICULIDAE.

| Pediculus humanus, L.

Pediculus capitis, de G.

# Order ACARI.

#### Family IXODIDAE.

Amblyomma hebraeum, Koch. ,, variegatum, F. Boophilus decoloratus, Koch. Haemaphysalis leachi, Aud. Hyalomma aegyptium, L.

Rhipicephalus	appendiculatus, Neum.
	evertsi, Neum.
17	pulchellus, Gerst.
,,	sanguineus, Latr
	· TZ 1

" simus, Koch.

# British East Africa.

Order DIPTERA.

Family CHIRONOMIDAE.

Culicoides milnei, Aust. Johannseniella fulvithorax, Aust. Ceratopogon sp.

#### Family CULICIDAE.

Anopheles	(Myzomyia) cinerea, Theo.	Ochlerotatus wellmani, Theo.
,,	" costalis, Lw.	Skusea pembaensis, Theo.
,,	" funesta, Giles.	Taeniorhynclus cristatus, Theo.
,,	" longipalpis, Theo.	" fuscopennatus, Theo.
,,	,, marshalli, Theo.	,, metallicus, Theo.
,,	" rhodesiensis, Theo.	Mansonioides uniformis, Theo.
,,	" transvaalensis, Carter.	Culex annulioris, Theo.
,,	(Myzorhynchus) mauritianus, Grp.	" consimilis, Newst.
,,	(Nyssorhynchus) christyi, Theo.	" decens, Theo.
,,	" natalensis, H. & H.	" duttoni, Theo.
**	" squamosus, Theo.	" insignis, Carter.
Banksinel	ba luteolateralis, Theo.	" invidiosus, Theo.
Stegomyia	fasciata, F.	" ornatothoracis, Theo.
,,	poweri, Theo.	" pipiens, L. var. zombaensis, Theo.
,,	unilineata, Theo.	" rima, Theo.
Ochlerotai	tus cumminsi, Theo.	", salisburiensis, Theo.
**	dentatus, Theo.	" simpsoni, Theo.
,,	durbanensis, Theo.	" stoehri, Theo.
,,	hirsutus, Theo.	" tigripes, Grp.
,,	nigeriensis, Theo.	" tipuliformis, Theo.
,,	ochraceus, Theo.	" univittatus, Theo.
,,	quasiunivittatus, Theo.	Uranotaenia alba, Theo.

#### Family SIMULIIDAE.

Simulium damnosum, Theo.

| Simulium neireti, Roub.

Family TABANIDAE.

Pangonia comata, Aust.	Haematopota tumidicornis, Aust.		
" beckeri, Bezzi.	ugandae. Ric.		
" magrettii, Bezzi.	, unicolor, Ric.		
" rüpellii, Jaen.	., vittata, Lw.		
" elongata, Ric.	Tabanus africanus, Gray.		
Diatomineura distincta, Ric.	albipalpus, Walk.		
Dorcaloemus compactus, Aust.	"atrimanus, Lw.		
" woosnami, Aust.	" biguttatus, Wied.		
Rhinomyza perpulcra, Aust.	,, canofasciatus, Aust.		
Aegophagamyia pungens, Aust.	., conspicuus, Ric.		
Chrysops cana, Aust.	,, denshami, Aust.		
" ciliaris, Lw. (?)	, ditaeniatus, Macq.		
" distinctipennis, Aust.	, fasciatus niloticus, Aust.		
" funebris, Aust.	,, gratus, Lw.		
" longicornis, Macq.	,, kingi, Aust. var. nigrifeminibus, Aust.		
Haematopota abyssinica, Surc.	,, leucostomus, Lw.		
" alluaudi, Surc.	" morsitans, Ric.		
" brunnescens, Ric.	, neavei, Aust.		
" denshami, Aust.	,, pallidifacies, Surc.		
" distincta, Ric.	,, par, Walk.		
" <i>furtiva</i> , Aust.	" pertinens, Aust.		
,, furva, Aust.	" producticornis, Aust.		
" <i>fusca</i> , Aust.	,, rothschildi, Surc.		
" hirta, Ric.	,, sufis, Jaen.		
" insidiatrix, Aust.	" taeniola, P. de B.		
" longa, Ric.	" thoracinus, P. de B		
" <i>mactans</i> , Aust.	" unitaeniatus, Ric.		
" noxialis, Aust.	" variabilis, Lw.		
" similis, Ric.	" velutinus, Surc.		
" tenuis, Aust.	" xanthomelas, Aust.		
Fam	JT MILCIDAR		

#### Glossina austeni, Newst.

- " brevipalpis, Newst.
- " longipennis, Corti.
- " pallidipes, Aust.
- " palpalis, R.D.
- Stomoxys varipes, Bezzi.
  - " calcitrans, L.

#### Hippobosca struthionis, Janson.

- " maculata, Leach.
- " camelina, Leach.
- " capensis, Olf.

# Echestypus sepiaceus, Speiser. "paradoxus, Newst. Olfersia pilosa, Macq.

#### Order SIPHONAPTERA.

Family HIPPOBOSCIDAE.

#### Family SARCOPSYLLIDAE.

Echidnophaga gallinacea, Westw.

#### Family PULICIDAE.

Ctenocephalus canis, Curtis. Ctenopsylla ellobius, Roths. Pulex irritans, L. Xenopsylla brasiliensis, Baker

Echidnophaga larina, Roths.

#### Family MUSCIDAE.

Stomoxys nigra, Macq. ,, taeniata, Big. ,, brunnipes, Grünb. Lyperosia minuta, Bezzi. Stygeromyia woosnami, Aust. Auchmeromyia luteola, F. Order ACARI.

#### Family ARGASIDAE.

) Ornithodorus savignyi, Aud.

#### Family IXODIDAE.

Amblyomma gemma, Dön.	Rhipicephalus appendiculatus, Neum.
", marmoreum, Koch.	,, armatus, Poc.
" petersi, Karsch.	" evertsi, Neum.
" variegatum, F.	,, falcatus, Neum.
Boophilus decoloratus, Koch.	,, maculatus, Neum.
Dermacentor rhinocerotis, De Geer.	,, neavei, Warb.
Haemaphysalis leachi, Aud.	,, pravus, Dön.
" parmata, Neum.	,, pulchellus, Gerst.
Hyalomma aegyptium, L.	,, sanguineus, Latr.
Ixodes pilosus, Koch.	" simus, Koch.
" rasus, Neum.	

# Uganda.

Order DIPTERA.

#### Family CHIRONOMIDAE.

Culicoides grahami, Aust.

Argas brumpti, Neum.

Ornithodorus moubata, Murray.

" brucei, Aust.

" milnei, Aust.

,, .........., ...........

Anopheles (Myzomyia) costalis, Lw. funesta, Giles. ,, ,, marshalli, Theo. •• (Christya) implexus, Theo. •• (Myzorhynchus) mauritianus, Grp. •• (Nyssorhynchus) pharoensis, Theo. Toxorhynchites brevipalpis, Theo. Mucidus scatophagoides, Theo. Banksinella luteolateralis, Theo. Stegomyna africana, Theo. apicoargentea, Theo. •• fasciata, F. •• fraseri, Edw. ,, luteocephala, Newst. •• simpsoni, Theo. •• sugens, Wied. Ochlerotatus argenteopunctatus, Theo. cumminsi, Theo. •• domesticus, Theo. ,, hirsutus, Theo. ,, minutus, Theo. ,, nigeriensis, Theo. ,, quasiunivittatus, Theo. Taeniorhynchus annettii, Theo. aurites, Theo. ,, fuscopennatus, Theo. ,, metallicus, Theo. ,, microannulatus, Theo ••

Mansonioides uniformis, Theo

Culicoides distinctipennis, Aust.

,, nearei, Aust.

#### Family CULICIDAE.

Culex consimilis, Newst. decens, Theo. .. duttoni, Theo. ,, grahami, Theo. ,, guiarti, Blanch. ٠, insignis, Carter. •• inridiosus, Theo. •• pipiens, L. var. zombaensis, Theo. ,, quasigelidus, Theo. ,, rima, Theo. ,, tigripes, Grp. Culiciomyia nebulosa, Theo. Micraëdes inconspicuosus, Theo. Hodgesia sanguinis, Theo. Uranotaenia alboabdominalis, Theo. bilineata, Theo. ,, coeruleocephala, Theo. ,, fusca, Theo. ,, mashonaensis, Theo. ,, ornata, Theo. •• pallidocephala, Theo. Mimomyia hispida, Theo. plumosa, Theo. ,, splendens, Theo. ,, Ingramia nigra, Theo. uniformis, Theo. •• Harpagomyia taeniarostris, Theo. Eretmopodites chrysogaster, Graham.

oedipodius, Graham.

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Family SIMULIIDAE.

Simulium damnosum, Theo.

Phlebotomus sp.

Family PSYCHODIDAE.

#### Family TABANIDAE.

Rhinomyza perpulcra, Aust.	Tabanus biguttatus, Wied.
Chrysops brucei, Aust.	,, brucei, Aust.
" centurionis, Aust.	" brumpti, Surc.
" distinctipennis, Aust.	" crocodilinus, Aust.
,, funebris, Aust.	,, denshami, Aust.
Hippocentrum versicolor, Aust.	" ditaeniatus, Macq.
Haematopota abyssinica, Surc.	" fasciatus niloticus, Aust.
,, brucei, Aust.	,, fuscipes, Ric.
,, brunnescens, Ric.	,, gratus, Lw.
,, decora, Walk.	,, irroratus, Surc.
" denshami, Aust.	" latipes, Macq.
" fusca, Aust.	" neavei, Aust.
" <i>furva</i> , Aust.	" obscurior, Ric.
,, hirta, Ric.	" par, Walk.
" inornata, Aust.	,, quadrisignatus, Ric.
,, mactans, Aust.	,, ruficrus, P. de B.
,, neavei, Aust.	,, ruwenzorii, Ric.
" similis, Ric.	", secedens, Walk.
,, tenuis, Aust.	" socialis, Walk.
,, ugandae, Aust.	,, taeniola, P. de B.
" unicolor, Ric.	,, thoracinus, P. de B.
" vittata, Lw.	" variabilis, Lw.
Tabanus africanus, Gray.	" xanthomelas, Aust.
" albipalpus, Walk.	

# Family MUSCIDAE.

Stomorys ochrosoma, Speiser. ,, omega, Newst. Lyperosia minuta, Bezzi. ,, punctigera, Aust. ,, thirouxi, Roub. Auchmeromyia luteola, F. Cordylobia anthropophaga, Grünb.

#### Family HIPPOBOSCIDAE.

Hippobosca hirsuta, Aust. ,, maculata, Leach. Ornithoctonus platycera, Macq.

Glossina fusca, Walk.

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morsitans, West.

pallidipes, Aust.

Stomoxys brunnipes, Grünb.

calcitrans, L.

nigra, Macq.

palpalis, R.D. (fuscipes, Newst.).

Olfersia pilosa, Macq. ,, dukei, Aust. Echestypus paradoxus, Newst.

#### Order SIPHONAPTERA.

Family SARCOPSYLLIDAE.

#### Family PULICIDAE.

Ctenocephalus canis, Curtis. ,, felis, Bouché. Ctenopsylla ellobius, Roths.

Echidnophaga larina, Roths.

Xenopsylla brasiliensis, Baker. ,, cheopis, Roths.

#### Order ANOPLURA.

Family PEDICULIDAE.

Pediculus capitis, de G.

#### Family HAEMATOPINIDAE.

Haematopinus eurysternus, Nitzsch. latus, Neum. ,,

Haematopinus peristictus, Kell. & Paine. Linognathus vituli, L.

#### Order ACARL

#### Family ARGASIDAE.

Ornithodorus moubata, Murray.

### Family IXODIDAE.

Amblyomma cohaerens, Dön. petersi, Karsch. ,, tholloni, Neum. ,, variegatum, F. ,, Aponomma exornatum, Koch. Boophilus australis, Fuller. decoloratus, Koch. ,, Dermacentor circumguttatus, Neum. rhinocerotis, De Geer. •• Haemaphysalis hoodi, Nutt. and Warb. leachi, Aud. ,,

Rhipicephalus appendiculatus, Neum.

- capensis, Koch. ,,
- dux, Dön. ,,
- evertsi, Neum. ,,
- falcatus, Neum. ,,
- lunulatus, Neum. "
- neavei, Warb.
- ,, sanguineus, Latr.
- ,, simus, Koch.
- ,,
- sulcatus, Neum. ,,

# EXPLANATION OF PLATE X.

Fig.	1.	Tubanus	maculatissimus, 1	Macq., J.
	2.	,,	irroratus, Surc.,	<b>ç</b> .
	3.	"	leucostomus, Lw.,	8.
	4.	,,	"	ę.
	5.	"	neavei, Aust., &.	
	6.	"	velutinus, Surc.,	đ.
	7.	,,	variabilis, Lw.,	ð •
	8.	"	gratus, Lw., S.	
	9.	Haemato	pota neavei, Aust	., ð.
]	10.	Holcocer	<i>ia nobilis</i> , Grünb	., <b>ç</b> .

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Plate X.



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EAST AFRICAN TABANIDÆ.

# EXPLANATION OF PLATE XI.

Fig. 1.	Haematopota	denshami,	Aust.,	8.
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- 2. ,. similis, Ric., 3.
- 3. ,, unicolor, Ric., 3.
- 4. " hirta, Ric., 3.
- 5. Tabanus producticornis, Aust., &.
- 6. Chrysops centurionis, Aust., 3.
- 7. Haematopota furva, Aust., 3.
- 8. Chrysops distinctipennis, Aust., &.
- 9. ,, brucei, Aust., 5.
- 10. Aegophagamyia pungens, Aust., &.



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