

Report on the Transmission of Nagana in the Ntabanana and Mhlatuze Settlements, Zululand.

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INTRODUCTION.

THE present report is based upon a survey of the blood-sucking insects to be found in the western section of the Lower Umfolosi Division of Zululand. The observations were made during the period October, 1922, to May, 1923.

The area in question may be described as that strip of country which extends from the Mhlatuze River on the south to the White Mfolosi River on the north; it lies immediately east of the open highlands of the District of Melmoth and west of the equally open sugarcane belt, a coastal zone some 15 to 20 miles across. Incidentally it is bounded on the west by Native Reserve No. XI, and on the south by Reserves Nos. VII and IX, and to the east by Reserve No. V. These reserves are for the greater part hilly open country, only the fringes that abut upon the area they enclose on three sides are comparable with it. This area, roughly 300 square miles in extent, comprises about 100 farms, of which a few, less than twenty in the south-east corner, were allotted in 1912; whilst the remainder were allotted in 1918-1920.

The settled portion is bounded on the north by a strip of Crown land some 10 miles in depth, which extends along the south bank of the White Mfolosi River. This strip is known as "Shooting Area No. 11"; it is one of the buffers or extensions of the immense game reserve that lies in the angle formed by the White and Black branches of the Mfolosi.

The greater portion of the now settled area, farms 236 to 320, was opened up to "returned" soldiers who had served in the Great War. Six of the farms were allotted in 1910, and nearly all the rest in 1919-1920. Prior to this, the Ntabanana section was practically unoccupied, being sparsely settled by natives only.

When the area under discussion was thrown open for settlement, it had come to be accepted that it was free from tsetse and nagana, or, at least, had become so in the course of time. This state of affairs was somewhat confirmed by the apparent, if not real, absence of nagana amongst the herds of the earlier settlers along the Mhlatuze; more apparent than real, because there is now little doubt that sporadic outbreaks did occur, if not at once, at least three years after the farms were occupied.

However, with the settlement of the Ntabanana section in 1919 a very serious state of affairs rapidly developed and, since 1920 onwards, most of the cattle introduced have gradually succumbed to nagana.

The whole area then, from the Mhlatuze northwards, became nagana affected. Notwithstanding the common occurrence of *Glossina pallidipes* in the Game Reserve and in Shooting Area No. 11, between the Mfolosi and the Emseleni Rivers, the fact that tsetse flies were not observed further to the south led to the suspicion that the disease was being conveyed by some other blood-sucking insect, possibly a Tabanid or a *Stomoxys*. Further support was lent to this suspicion by the pronouncement that a survey for tsetse conducted by Mr. R. H. Harris, of the Division of Entomology, had failed to disclose the presence of *Glossina* and had inculcated other species of biting flies. As against this was to be set the record of tsetse at the south-western extremity of the area by Fuller in 1904.

Sir Arnold Theiler instructed the writer to proceed to the Ntabanana Settlement in October, 1922, so as to clear up the point and ascertain what, in the absence of tsetse, was the casual agent transmitting the disease.

Briefly, it may be stated that *Glossina pallidipes* was found at each point at which systematic collecting was undertaken all the way from the White Mfolosi to the Mhlatuze River, or from end to end of the settlement area. Further, it was found that the coastal zone on the east and the high grasslands on the west and south were both unsuited to tsetse fly, but not to Tabanids and *Stomoxys*. The trypanosomiasis area therefore coincides with the distribution of *Glossina pallidipes*.

CHARACTERISTICS OF AREA SURVEYED.

The whole of the infected area may be described as composed of numerous hills and valleys, the floors of the latter ranging from 300 to 500 feet, the tops of the former up to 700 to 900 feet, with perhaps a point here and there of 1,000 feet above sea-level. The general aspect of the country is that of doornveld (or thorn country) interspersed with large or small patches of grasveld (or grasslands), the open areas more general on the hills, the valleys almost always carrying bush, either in patches or sprung out along the banks of numerous dongas or streams as dense strips of vegetation or sparse avenues. Much of the country is not only admirably suited to *Glossina*, but also to Tabanids and other blood-sucking flies.

It is almost impossible to travel any appreciable distance in any direction through the infected area without meeting with various species of Tabanids, *Stomoxys*, etc. On one occasion *T. gratus* was captured close to a donga on the top of a high hill about 800 feet above sea-level.

The water of the majority of the streams is brackish, but appears to be suitable for many species of Tabanidae and Culicidae, whilst *Simulium* was also captured along the banks of brackish streams in isolated localities.

METHOD EMPLOYED IN CATCHING FLIES.

As it was realized that, if present, tsetse could not be abundant, it was decided to employ sets of animals as bait. These animals were tethered at selected spots on farms where animals were known to have died of nagana. As a rule, three sets were employed. One set either in or against thick bush near water, one set on a hill or hillside about 500 yards from bush, and the third set intermediate of these two.

The collecting, which was undertaken by natives, was carried out every day, except Sundays and when the weather was wet and totally unsuitable. Three natives were employed to collect at a time, and after collecting for about two months their place was taken by others that were drafted from the laboratory. Some of the natives were, of course, much better at this work than others; but as I always seemed to get one boy that was excellent, one that was medium, and one that was of little use, the standard of collecting was the same throughout the season. The hours of collecting were from 7 a.m. to 8 a.m., and from 2 p.m. to 5 p.m. One native was detailed to collect on one of the animals at site No. 1, another to collect on one of the animals at site No. 2, and the third to collect on one of the animals stationed on the hill. Each boy was provided with a net and a killing-bottle.

In the cases, of which full details are given, it was found that ultimately tsetse would be taken upon the set against the bush, but not on those away from it.

On the Emseleni River a month elapsed before a tsetse was found, and then one was taken six days later and another fourteen days later.

On the Ntabanana twenty-three days elapsed before a single tsetse was taken, and no more were captured up to the thirty-third day, when the experiment was closed.

On the Mhlatuze no tsetse were taken until three weeks after collecting was started, when a male and a female were captured; after an interval of a week three more were taken, and for three weeks afterwards none were taken.

The results of the collecting prove conclusively that it is absolutely essential that systematic collecting must be undertaken in a trypanosomiasis area suspected to be free of tsetse fly for at least a month or two before it can be definitely asserted that *Glossina* are not present in such areas.

THE GAME FACTOR.

Game, as Swynnerton has stated, not only (a) helps to feed the fly, (b) provides the trypanosome, but also (c) distributes the fly, carrying it back each summer into the areas from which the fall of leaf has driven it.

The nagana-infected area was at one time overrun with game, but since it has become populated the game has gradually decreased, and the migration to and from the Game Reserve, especially of the larger animals, has gradually diminished to such an extent that to-day the migration of game from the nucleus of the infected area to the Mhlatuze, the southern boundary of the infected area, is, one might say, practically nil. In the more northern part of the settled area, however, noticeably beyond the Emseleni towards the Game Reserve, there is still some migration, or wandering out, especially of zebra.

There can be no doubt that game has been almost entirely responsible for the distribution of the tsetse fly in the nagana-infected area, and before settlement formed the main, if not the only, food supply for the fly. Since then, however, the country has gradually become more and more populated each year, with the result that the game has in consequence been gradually shot or driven back to the Crown lands and reserve to the north, and as the game has gradually diminished in numbers, so did domestic animals gradually increase and take their place, not only as food for the fly, but also as

distributing agents for the pest, enabling it to migrate from unsuitable to suitable localities between the seasons, and acting as reservoirs for the trypanosome.

In 1920, when game drives in the Ntabanana were instituted, there was a hue and cry throughout South Africa that attempts were being made to stamp out the game in that part of the country. Nobody, it is true, desires to kill off all the game in a country, but it must not be forgotten that man and game cannot live together in a fly area. Either one or the other must go, unless man is content to go in entirely for either agriculture or horticulture and to do all his work and transport with mechanical appliances.

THE TRANSMISSION OF NAGANA BY OTHER AGENTS THAN TSETSE.

Although the distribution of *Glossina pallidipes* coincides with that of trypanosomiasis, there is much to be said in favour of the view that tsetse alone are not wholly responsible for the general outbreaks of the disease in the area under discussion. For instance, the cases of nagana are out of proportion to the number of tsetse that seem to be present. Moreover, it is probably only a small percentage of tsetse that are (a) suitable hosts for the trypanosomes and (b) that acquire infection through feeding on infected animals.

The majority of the seventeen specimens of *Glossina pallidipes* that were collected on bait animals, used in the course of this investigation, were allowed to feed before they were captured. These particular animals were kept for months afterwards at the nagana research station, but none subsequently developed trypanosomiasis. In the circumstances under which the flies were captured it is not possible to state whether they could have previously become pathogenic; they may have been young flies taking a first meal, or may not previously have fed on an infected animal. These facts, therefore, serve to inculcate other biting flies, i.e. Tabanids and *Stomoxys*, but against them is to be set the fact that where, on farm No. 316, tsetse appeared the more abundant, there nagana was the worst, and, as a rule, the nearer we approach the game reserve the more abundant we find tsetse and the more prevalent the disease. Furthermore, Tabanids and *Stomoxys* are both widespread, whereas the distribution of both nagana and *Glossina pallidipes* is not only limited, but also appears to coincide.

Should there be a case of mechanical transmission by a Tabanid or *Stomoxys*, as between an infected and non-infected beast, it is only reasonable to suppose that the casual agent is a fly which has failed to get its fill of blood upon an infected beast. Disturbed, it flies off and rapidly settles upon a non-infected animal. It is hardly conceivable that a biting fly, other than a *Glossina*, which has fed to repletion on an infected animal is capable of transmitting the disease after it has digested its meal. Mechanical transmission would, therefore, be one over short distances and would depend upon the want of complacency of the infected animals and the flies they are capable of dislodging. Thus, from an animal far gone and lethargic with nagana one would not expect much mechanical transmission. With an active animal, however, trypanosomes would the more likely be carried by such biting flies that were readily dislodged. That is to say, those which could be dislodged either by the tail or by stamping. Hence one would lean towards inculcating *Stomoxys* and those Tabanids that for the main part confine their attacks to the legs and

not to such species as *Chrysozona (Haematopota) mastans*, *Tabanus biguttatus*, which normally settle on the bodies where they are not readily dislodged.

Unfortunately the occurrence of nagana in Zululand does not throw any light as to how the animals acquire the disease. *Glossina pallidipes* occurs in Zululand throughout the year, but is more numerous during the summer than during the winter months, when the flies are forced to confine themselves to small areas in order to obtain shade. Likewise, *Stomoxys* and *Bdellolaryna* are probably also found throughout the year, but the species of Tabanidae are only present during the summer months. On the other hand, nagana is much more prevalent among animals during the winter months than during the hot season. As this is to be accounted for by the fact that the animals usually only commence to show symptoms of the disease when the veld is dry and they are unable to obtain adequate nourishment, it is usually impossible to state when the animals became infected with the disease. Furthermore, it is frequently impossible to ascertain whether animals suffering from the disease have recently acquired the infection or whether they are suffering from a relapse, unless they have recently been imported from a non-infected area or their history is known.

TABANIDS IN ZULULAND.

As I did not arrive in Zululand until towards the end of October, it is not possible to state definitely when Tabanids first make their appearance here, but presumably some of the species are on the wing towards the end of August or beginning of September. In the Transvaal both *Chrysops stigmaticalis* and *T. nagamiensis* usually appear either the first or second week in September, and other species soon follow. The majority of the species found here occur throughout the summer until the end of April or the beginning of May. In Zululand, therefore, where the wet and dry seasons are the same, they probably appear a week or two sooner and they disappear a week or two later than they do in the Transvaal.

On examining the charts showing the rainfall, mean maximum and minimum temperatures and the prevalence of the commonest species of Tabanids found in the settlements during the months of October to May, it will be observed that there is no analogy between the rainfall and temperature curves and the curves of the various species of Tabanids. In early summer the rainfall was high and some of the Tabanids were prevalent, but late in the summer the rainfall was exceptionally low and one or two of the species of Tabanidae were very prevalent, much more so than in early summer when the rainfall was high. With *Chrysozona mactans* on the other hand, the reverse was the case.

With some species of Tabanidae, such as *Tabanus ustus* and *Buplex brunnipennis*, there is only one brood a year. The former species was found from the end of October to the beginning of November, and the latter from the beginning of November to the beginning of December, but both species probably make their first appearance either at the end of August or beginning of September.

Corzoneura pallidipennis, Ric. was found to have two broods in the season, the first brood being found from the end of October to the 1st December, and the second from the end of March to the second

week in May. The late summer brood, which was much more prevalent than the early summer brood, is probably the progeny of the first brood. This being the case, the prevalence of the second brood may be explained on the grounds that the larvae (which are aquatic) live under more favourable conditions than do those of the first brood, which live in the dry season. Furthermore, the duration of the immature stages of the flies of the late summer brood would be slightly shorter than that of the early summer brood, and this would also partly account for the prevalence of the flies of the second brood, because the shorter the life of the immature stages the less risk the insects run of being parasitized by parasitic insects and being devoured in their larval stage by either their companions or other predaceous aquatic insects.

The climatic conditions under which the adults live are probably, therefore, not responsible for the prevalence of the flies to the same extent as are:—

- (1) The prevalence of parasitic insects at the time the eggs are laid.
- (2) The climatic conditions during the time the insects are in their egg, larval, and pupal stages.
- (3) The amount of food available for the larvae, which in turn may vary according to the climatic conditions and the breeding grounds selected.
- (4) The number of predaceous insects present, which may also vary according to the climatic conditions and the breeding grounds selected.
- (5) The number of fossorial wasps belonging to the genus *Bembea* that are present when the adults make their appearance. These insects are predaceous upon the adult flies.

The majority of the commonest species of Tabanidae that were found were caught throughout the summer, and in so far as these species are concerned it is impossible to state how many broods they have in a season. No information can be gained in this respect by examining specimens as soon as they are captured to ascertain whether they appear to be fresh, because very rarely does one find specimens with torn wings, or that are in any way damaged. With Lepidoptera, however, which are covered with delicate scales on their wings and bodies, it is often an easy matter, by capturing a large number and examining them to see to what extent they are denuded of scales or their wings are torn, and so ascertain whether the insects on the wing are a fresh brood, an old brood, or whether there are two broods present at the same time.

If the species that are present throughout the summer are single brooded as in the case of *T. ustus* and *B. brunnipennis*, then the flies would take a year to complete their life cycles, in which case those that were on the wing, let us say in October, will be the parents of those that will appear about the same time the following season. If, on the other hand, they are double brooded, then it is likely that the first brood will be on the wing between August and October to about December, and the second brood from about January to April or May. This being the case, the second brood will be the progeny of the early summer brood, and its life cycle will be shorter than that of the first brood.

Owing to the life of the adults of Tabanidae being probably of very short duration, and as old flies on the wing are continually dying and fresh ones hatching out, the number present in any locality probably varies from day to day. It is, therefore, very difficult to gauge the influencing effect climatic conditions have in controlling the activities of these insects and impelling them to feed on vertebrate blood, and the fact that the flies do not require a daily feed of blood during their existence makes it still more difficult.

The flies are usually more numerous on calm, fine days than at other times, and on several occasions were exceptionally numerous either immediately before or after rains, also when the air was close and oppressive, due to a storm threatening in the distance.

The ideal climatic conditions for the flies are also the most suitable conditions for the diurnal Lepidoptera. On some fine, calm days, both Tabanids and butterflies were observed in large numbers, on others butterflies were numerous, but Tabanids scarce, and on some fine days the reverse was the case. As the scarcity of butterflies was due to there being very few in existence, the period being when the majority of these insects were living either in their egg, larval, or pupal stage, we must conclude that when the adults of Tabanids were scarce during ideal climatic conditions it was also because the majority were living in one or more of their immature stages.

On the 9th January insects belonging to various orders were exceptionally numerous in the Ntabanana Valley. Butterflies and wasps were seen in thousands flying around and settling on flowers, and drinking at pools, yet it proved to be one of the worst days for collecting Tabanids. Only three specimens were captured by two natives collecting with animals between 9 a.m. and 1 p.m., and although I spent the whole day searching for the insects on flowers and at pools, the only specimen I saw was a male of *T. biguttatus*, settling on damp sand at the edge of a pool, and sucking up moisture. The day was fine and bright, and the maximum temperature in the shade was 105° F. In the afternoon the air was very oppressive, there being a thunderstorm raging in the distance.

From October to about the middle of March, Tabanids are most numerous between the hours of 9 a.m. and 4 to 5 p.m., and from the middle of March to May from 9 a.m. to 2 or 3 p.m. *Chrysozona mactans* was the only species captured on animals from sunrise to sunset, and the only one that was ever prevalent between 7 and 8 a.m. On several occasions it was observed to be more numerous from 7 to 8 a.m., and late in the evening, than during the day when other species were numerous. It was also the only species that was found to be common on dull, cool days. On one occasion a female was caught biting an animal during a shower of rain.

COLLECTING BLOOD-SUCKING FLIES IN THE SETTLEMENTS.

1.—At the Emseleni River.

Collecting was first commenced on 26th October, on farm No. 311. The reason for selecting this locality was not only because a number of cattle had recently died of nagana on the farm, but also because it was thought that if *Glossina* was present in the Ntabanana Settlement it would prove to be a suitable place in which to find them.

Running along the southern boundary of the farm is the Emseleni River, and it was in the vicinity of this river that sites were chosen for collecting. Three sites were selected, and at each of these places a horse, a cow, and a goat were kept, those in each set being tethered to poles about 15 yards apart from one another.

One set of animals was kept in a small wood in which the undergrowth was very dense. This wood was 140 yards north of the river, and between it and the river there was a strip of flat cultivated land. Growing along the northern bank of the river were a few tall fig trees, and on the opposite bank there was a dense thicket extending in parts almost to the edge of the water.

Another batch of animals was kept on the fringe of dense bush 550 yards north of where batch No. 1 was kept, and 310 yards from the river. The land between this and site No. 1 was flat bushveld.

The third set of animals was kept on a hill 500 yards north of the second batch and 460 yards from a stream, a tributary of the Emseleni River. Between these two sites was open grasveld, but growing on the hill close to where the animals were stationed were a few trees, mostly acacia.

The animals that were kept in the wood were sheltered from the sun all day, but those kept at sites Nos. 2 and 3 were only protected part of the day-time by some bush-wood that was placed round them.

Horses and cattle appear to be equally attractive to blood-sucking flies; but as a rule the natives were employed to collect the flies that settled on the horses as the cattle were most of the time too wild to permit one to catch more than a small percentage of the flies that settled on them. The goats were also not used to any extent because it was soon found that very few blood-sucking flies were attracted to them. As these animals were by no means of a restless disposition, and their hair was not exceptionally long, it can only be concluded that their strong odour is objectionable to the flies. In one instance no flies were caught on a goat that was kept under observation for four hours, although numerous specimens were captured on a horse close by. With the exception of one *Chrysozona mactans*, *Stomoxys* and *Bdellolarynx* were the only flies caught on these animals, and they were never common on them.

When collecting was first begun the boys were instructed to catch the flies directly they settled on the animals, but later it was considered advisable to allow the flies to feed before they were captured in order to give them every opportunity of transmitting trypanosomiasis, so that in the event of any of the animals contracting the disease some light might be thrown on the casual agent. However, only one animal, the cow that was kept in the wood, became infected. The horse that was kept at site No. 2 died of horse-sickness on the 10th November, but was replaced by another horse on the 13th, and the horse that was kept at site No. 1 also showed marked symptoms of horse-sickness on the 17th November, although it eventually recovered.

In addition to the animals kept for collecting there were 15 head of cattle grazing on the farm in the neighbourhood of the animals stationed on the hill and also five cattle on the south bank of the river. Of these, two of the former developed nagana, one on the 16th January, and the other, which had previously had the disease, showed trypanosomes in its blood on the 30th January.

The temperatures of all animals that were kept for collecting were taken daily every morning, and blood-smears were also taken once a week of all animals on the farm.

Prior to the game drives that took place in 1920 game was plentiful on the farm, but the only game animals seen were bushbuck, duiker, and reedbuck, which were by no means common, especially the last named. In addition to these, a small troop of zebra which live in the neighbourhood occasionally trespass on to the farm.

Vervet monkeys were frequently seen, and crocodiles inhabit the river, but they are very rarely seen, especially during the summer months.

The wood and the fringe of bush where the animals of sets Nos. 1 and 2 were kept appeared to be equally favourable grounds for Tabanids. Some days, however, more specimens were collected in the wood than on the fringe of the bush, and on other days the reverse was the case. As was to be expected, considerably less specimens were seen and caught on the animals kept on the hill, and although this was the case and the worst native was employed to collect on the animals here, on one or two occasions the numbers collected exceeded those collected either on the animals in the wood or at site No. 2.

On the 28th November, a month after collecting was commenced, one *G. pallidipes*, a male, was captured on the cow at site No. 2, and two more, a male and a female, were also taken on the horse at the same place, one on the 4th and the other on the 12th December.

A list of the species of Tabanidae and blood-sucking *Muscidae* collected on the farm will be found on page 286, and charts showing the rainfall, temperature and prevalence of the commoner species of Tabanidae are appended at the end of the paper.

Collecting was discontinued on the 14th December, when the animals were sent to the laboratory to be kept under observation.

2.—In the Ntabanana Valley.

Collecting was commenced on the 28th December, and the site selected for collecting was the west bank of the Ntabanana River.

The animals used for collecting were divided up into three sets, each set consisting of a horse and a cow. Set No. 1 was tethered to trees within a few yards of the river, set No. 2 was kept at the foot of a hill about 200 yards west of set No. 1, and set No. 3 was stationed on the top of the hill 230 yards west of set No. 2.

Growing along the west bank of the river bed were a few tall trees, mostly fig, and a narrow strip of dense undergrowth. On the opposite bank the ground was flat and under cultivation. Between set No. 1 and set No. 2 the land was flat grass veld, and on the hill where set No. 3 was kept, there was a number of trees, mostly mimosa, dotted about. When collecting was started the river bed was dry except for one or two very small pools and a large pool about 400 to 500 yards from where the animals in set No. 1 were stationed, but on the 11th and 12th January heavy rain fell, and after that the river, which at this place is only a large stream, was comparatively full of water. It was found impossible to use the animals stationed on the top of the hill for collecting, as they were too wild to permit one to approach them with a net or bottle. The only blood-sucking flies observed to settle on them were a few *Stomoxys* and one *Chrysozona mactans*.

Game was by no means common in this locality. A few buck and vervet monkeys were the only animals to be found. Zebra had not been seen here for two or three years.

Collecting was discontinued on the 29th January. Only one *G. pallidipes*, a male, was captured. It was caught on the cow kept near the river on the 19th January. A list of the flies captured will be found on page 286, and charts giving meteorological data and showing the prevalence of various species of Tabanidae collected are appended at the end of the paper.

None of the animals kept for collecting contracted nagana.

3.—Collecting on the Mhlatuze River.

The site selected for collecting was in very bushy flat country on the left bank of the Mhlatuze River on farm No. 233. The river at this part is very wide but shallow, being only about 4 to 5 feet deep in the middle. The bed of the river is very sandy and growing along its banks are dense patches of reeds.

The animals used for collecting were divided up in three sets, each set consisting of a horse and a cow.

Set No. 1 was tethered to trees close to a small open patch of ground 45 yards north of the bed of the river, and 90 yards from the water.

Set No. 2 was kept in a similar situation 90 yards north of set No. 1, and set No. 3 was tethered to trees in dense bush 80 yards north of set No. 2.

Collecting was commenced on the 14th February, and was undertaken by three natives in charge of Mr. Vinnicombe. On the 9th March, three weeks after collecting was started, 2 *G. pallidipes*, a female and a male, were captured on horse No. 2, and three more, two females and one male, were taken between 15th and 17th March on cow No. 3. Although collecting was continued until the 7th April, no further specimens were captured, except one which was caught on the night of the 12th April with a lamp.

A search was made to find pupae of *Glossina* in the vicinity of where the flies were caught, but without success. This, however, was only to be expected since the flies were not numerous and a considerable area formed a suitable breeding locality for the flies, it not being necessary for them to select isolated breeding places in which to deposit their larvae.

No doubt it would have been possible for the tsetse flies that were captured in this locality to have migrated from the Game Reserve, without crossing stretches of open country by following the course of streams, along the banks of which dense vegetation grows, in the intervening country, but probably all the flies had bred in the vicinity of where they were caught, especially as three of them proved to be females, which are known not to migrate to the same extent as the males.

Fossorial wasps belonging to the genus *Bembex* were, as was only to be expected owing to the sandy bed of the river, very plentiful in this locality, and were frequently observed flying round animals in considerable numbers waiting to pounce upon any *Stomoxys*, Tabanid, or other fly that happened to settle upon the animals. Although these wasps were numerous, there was no appreciable difference between the numbers of Tabanids seen in this locality and in the vicinity of the Emseleni River, where *Bembex* were by no means common.

The farm had been in occupation for ten years, during which time the owner had specialized in dairy farming. Prior to then native cattle occasionally grazed on the farm. When the farm was first occupied it was mainly open grass veld, there being no dense bush growing as is to be seen at the present day. Not only has the country in the Mhlatuze Settlement become more wooded since it has been taken over by the white man, but the same thing is also taking place in the Ntabanana Settlement, where stumping has not been carried out or the ground cultivated.

Nagana apparently first broke out on the farm in 1915 or 1916, when several cattle died of the disease. It again broke out in 1920, when several cases occurred from May onwards and again in 1921. The last case of nagana occurred on the farm on the 8th July, 1922. Nagana also occurs on neighbouring farms, but the owners of these farms refuse to believe that they have the disease on their properties, and diagnose the disease as munga, which, at least in this locality, is synonymous with nagana. Bushbuck and duiker are the only buck one is likely to come across on the farm at the present time. Reedbuck were common when the farm was first occupied, but have since become extremely rare. Waterbuck and kudu have occasionally been seen on the farm. Three of the former were observed in January, 1923. Zebra have been observed in the neighbourhood, but not on the farm. They were last seen in 1920 or 1921. Bushpig were occasionally met with when the farm was first taken over, but now they are only found on neighbouring farms. Cape hunting dogs have occasionally been seen in the neighbourhood, and the manhaar jackal occurs on the farm but is not common. Monkeys have never been seen here. Crocodiles are seen occasionally on the banks of the river, but they are more numerous at the mouth of the Ntabanana River, which flows into the Mhlatuze about a mile from the farm.

4.—Collecting on Farm No. 316.

This farm is situated on the northern boundary of the Ntabanana Settlement, and is therefore the last farm one comes to before entering the Crown lands adjoining the Game Reserve.

The site selected for collecting was on the fringe of dense bush close to a small stream in a deep valley. Collecting was undertaken by Mr. L. Davies and a native, and the animals used for attracting flies were a horse and two mules.

One mule was kept under bush a few yards from the stream, and the other (No. 2) was also kept in bush about 20 yards from the water. The horse was stationed in the open 30 yards from the water. Collecting was commenced on 3rd April, and four days later one *G. pallidipes* was taken on mule No. 2. On the 11th April, two more specimens were captured, one on the same mule and the other on the horse. A further specimen was also captured on the same mule on the 25th April.

On the 26th April, the animals were removed to another valley and stationed near the Imfasi River. Here two *G. pallidipes* were captured, one on the 27th April, and the other on the 28th. Owing to the scarcity of flies very little collecting was done during May, and was finally discontinued on the 15th.

The reason for this farm being the most infected area in the Settlements was probably due in a greater measure to the higher percentage of wild animals acting as reservoirs of the disease on this farm than on the other farms, where game was not so numerous, and where less migration of game from the reserve takes place, than to the prevalence of *Glossina*.

LIST OF TABANIDAE AND BLOOD-SUCKING MUSCIDAE CAUGHT IN THE NTABANANA AND MHLATUZE SETTLEMENT.

Species.	Emseleni River.	Ntabanana Valley.	Mhlatuze	Farm No.
<i>Chrysozona decora</i> , Walk.....	+	+	+	
<i>C. mactans</i> , Austen.....	+	+	+	+
<i>C. vittata</i> , Loew.....	+		+	
<i>C. vittata</i> , var.....	+			
<i>Tabanus africanus</i> , Gray.....	+	+	+	+
<i>T. biguttatus</i> , Wied.....	+	+	+	
<i>T. par</i> , Walk.....	+	+	+	+
<i>T. taeniola</i> , Pal. de Beau.....	+	+	+	
<i>T. fraternus</i> , Macq.....	+	*	*	*
<i>T. ustus</i> , Walk.....	+	*	*	*
<i>T. atrimanus</i> , Loew.....	+	+	+	
<i>T. nagamiensis</i> , Car.....	+		*	*
<i>T. insignis</i> , Loew.....	+		+	
<i>T. gratus</i> , Loew.....	+	+	+	+
<i>T. pertinens</i> , Aust.....	+		+	
<i>T. leucostomus</i> , Loew.....	+		+	+
<i>T. ditaeiniatus</i> , Macq.....	+			
<i>T. fuscipes</i> , Ric.....	+	+	+	+
<i>T. maculatissimus</i> , Macq.....	+	+	+	+
<i>T. sp.</i>	+		+	
<i>Corzoneura pallidipennis</i> , Ric.....	+	*	+	+
<i>Buplex brunnipennis</i> , Loew.....	+	*	*	*
<i>Chrysops stigmatalis</i> , Loew.....	+		-	
<i>C. woodi</i> , Neave.....	+			
<i>C. sp.</i>	+			
<i>Stomoxys calcitrans</i> , L.....	+	+	+	+
<i>S. nigra</i> , Macq.....	+	+	+	+
<i>S. brunripes</i> , Grunb.....	+			
<i>S. taeniata</i> , Big.....	+			
<i>Bdellolarynx</i> , nov. sp.....	+			
<i>Glossina pallidipes</i> , Aus.....	1 ♀, 2 ♂♂	1 ♂	3 ♀♀, 3 ♂♂	7, mostly ♀♀

* Species not on the wing when collecting was undertaken at these localities.

LIST OF THE BLOOD-SUCKING DIPTERA COLLECTED IN THE NTABANANA AND MHLATUZE SETTLEMENTS.

FAMILY CHIRONOMIDAE.

Genus *CULICOIDES*.

Culicoides bedfordi, Ingram and Macfie.—This species was common on horses and cattle during the day-time in the neighbourhood of both the Emseleni and Mhlatuze Rivers from the 5th February, 1923, to the 6th April, 1923. They attacked animals kept both in the sun and in the shade. They were only found on the bellies of the animals, with the exception of one or two

specimens, which were caught on the front legs. This species is apparently entirely diurnal in the settlements, as no specimens were ever obtained after dark. The earliest time a specimen was caught was at 7 a.m. This species was described from one female and two males captured at Onderstepoort on the 22nd September, 1914.

Culicoides pallidipennis, Carter, Ingram, and Macfie.—This species was common in a house near the Emseleni River from the 10th February, 1923, to the 12th April, 1923, when I left for Pretoria. They were caught on windows from about 15 minutes before sunset to late in the evenings, and again about 8 a.m. in the mornings. Those caught in the morning were sometimes observed to be gorged with blood. Two specimens were also taken in a tent near the Mhlatuze River on the 5th April, 1923, at 9.30 p.m. Specimens have also been captured at Onderstepoort, near Pretoria, in the laboratory and on the backs of horses at night. It was described from specimens collected on the windows of a laboratory at Accra, Gold Coast, in the evening during the months of December, 1919, to April, 1920.

Culicoides sp. nov. (?).—This species is allied to *C. citroneus*, Carter, Ingram, and Macfie.—Two specimens were taken in a house near the Emseleni River, one at 7 a.m. on the 25th March, and the other at 8 a.m. on the 26th.

Culicoides brucei, Austen.—One specimen collected at night in a house near the Emseleni River on the 3rd February, 1923.

Culicoides schultzei, Enderl.—Two specimens were taken. One was caught at 7 a.m. in a room at Ntabanana on the 25th March, and the other in a tent at Mhlatuze at 8.45 p.m. on the 6th April. One specimen has also been taken in the laboratory at Onderstepoort at 11 a.m. on the 27th January, 1914. This species was described from specimens collected in South-West Africa, and Carter, Ingram, and Macfie have also recorded it from the Gold Coast.

Culicoides sp. nov. (?).—One specimen collected in a tent at Mhlatuze about 8.45 p.m. on the 6th April, and one caught on a horse at Ntabanana on the 7th April, 1923.

Genus FORCIPOMYIA.

Forcipomyia nov. sp. (?).—Only a single specimen was procured; it was caught in a tent near the Mhlatuze River at 9.30 p.m. on the 5th April, 1923.

FAMILY CULICIDAE.

Thirty species of mosquitoes were procured in the settlement, six of which belong to the genus *Anopheles*.

Quite a large percentage (about 50 per cent.) of the species collected were taken on animals either tethered to trees in thick bush or standing in the shade under trees during the day-time, including a few species which were previously thought to be entirely nocturnal in habits.

Speaking generally, it may be stated that the species of *Anopheles* and *Culex* found in South Africa are mainly nocturnal, and *Eretmopodites* spp. are entirely diurnal, whereas the species

belonging to the *Aedes* group, i.e. *Stegomyia*, *Aedimorphus*, *Banksinella*, and *Ochlerotatus* may be either nocturnal or diurnal in habits.

It may be argued that the reason for the large percentage of mosquitoes that are diurnal in the settlements, may be explained by the fact that the country is very thickly wooded in parts, much more so than the localities in the Transvaal, Orange Free State, and the Cape where we have collected.

It is only to be expected that mosquitoes living in dark, shady places, and sheltered from wind should feed during the day when opportunities offer. However, this is not always the case. For instance, *B. lineatopennis* is invariably nocturnal in habits in the Pretoria District, which is by no means destitute of trees, whereas in the Christiana District, Transvaal, a variety of this species was taken in large numbers in May, 1913, biting horses and myself during the hottest hours of the day in the open veld, where there was not a tree to be seen. *A. caballus* is another species which is mainly nocturnal in the Pretoria District, and diurnal in habits in the open veld in the Christiana District and the Vryburg District, Cape Province.

The only *Anopheles* caught feeding in the settlement during the day-time was *A. mauritanus*, but it was mainly nocturnal. Previously we had only taken it at night in other parts of South Africa. The only other species we have found biting during the day in South Africa are *A. squamosus* and *A. argenteolobata*. Both these species are mainly nocturnal in the Pretoria District, but they have been taken on one or two occasions biting horses standing in bright sunshine during the day.

Genus ANOPHELES, Meigen.

Anopheles funestus, Giles.—Specimens were occasionally caught in the evenings in a house near the Emseleni River from 20th January, 1923, to the 31st March, 1923. The Durban Museum possesses specimens collected at Ngxwala Hill, Zululand, by F. Toppin.

Anopheles nili, Theobald.—Several specimens were collected at night near the Mhlatuze River in April. This species has previously only been recorded from the Sudan, Togo, and Northern and Southern Nigeria.

Anopheles cinereus, Theo.—I caught a single female of this species in a house at Empangeni in October, 1924.

Anopheles costalis, Theobald.—This species was by no means common in the settlements, although both of them are bad malarial districts. Two females were taken in a tent near the Mhlatuze River in February, and one was collected on a cow at night on the 4th April, 1923. Three specimens were also taken in a house near the Emseleni River in March. The first specimen procured here I collected in my room early in the morning on the day I developed symptoms of malarial fever. The species may, therefore, have been present before, or I may have become infected through having been bitten by *A. funestus*. The larvae of these two malarial carriers were not obtained, but they probably bred in brackish water pools in a donga close to the house.

Anopheles theileri, Edwards.—A single specimen, a female, of this rare species, which had hitherto only been recorded from Onderstepoort, near Pretoria, was collected in a house near the Emseleli River at 8 a.m. on the 26th March, 1923.

Anopheles pretoriensis, Theobald.—A female was taken on a cow on the night of the 4th April, 1923, near the Mhlatuze River.

Anopheles mauritianus, Grandpré.—This species was fairly common in houses at Ntabanana from 19th October, 1922, to the 1st April, 1923, and two or three females were also taken in thick bush during the day-time, also one female was caught immediately after it had bitten a child in a room early one afternoon. It was also fairly common at the Mhlatuze during the months of February to April.

Anopheles marshalli, Theo.—Two females were procured, one was caught at Ntabanana on the 25th February, 1923, and the other was caught near the Mhlatuze River on the 5th April, 1923.

Genus MUCIDUS, Theobald.

Mucidus scatophagoides, Theo.—A single female of this species was collected near a muddy pool, three miles from the Umfolosi River, about 5 a.m. on the 8th February, 1923.

Genus AËDES, Meigen.

Sub-genus BANKSINELLA, Theobald.

Banksinella lineatopennis, Ludlow.—This species was usually to be found in thick bush near the Emseleli and Mhlatuze Rivers from the beginning of February to the 5th April. It was frequently very common during the day-time, but was never prevalent at night. At Onderstepoort it is mainly nocturnal in habits, only one or two females having ever been taken on animals during the day-time. It was exceptionally numerous at a certain spot in thick bush near the Emseleli River, throughout the day on the 5th February, 1923. Numerous specimens, along with *A. dentatus*, *A. sp. nov.*, and *A. simpsoni*, were observed biting the fore legs and belly, and occasionally also the hind legs of a horse tethered to a post, but only one or two attempted to bite me, although I was standing close to the animal. Numerous specimens were also seen flying round the base of a tree close by and settling on the bark. Others were observed settling on the foliage of the undergrowth.

As the mosquitoes were viciously attacking the horse, the opportunity was taken to ascertain how far they would follow the animal. The horse was, therefore, led away from the place very slowly for a distance of twelve yards. At this spot not a single specimen came to attack the horse, and the only mosquitoes observed were three engorged females that had remained on the belly of the animal to feed when it was led away. It may be mentioned that the place where the horse was halted was close to the fringe of the bush, but here the animal was still sheltered from both the wind and the sun. Outside the bush were tethered two other horses, but neither of these were observed to be attacked by mosquitoes. The spot where the mosquitoes were so prevalent was visited again that same evening at 8.15 p.m., and although it was a favourable evening

for mosquitoes, and I remained here until 9.30 p.m., I did not see a single specimen, and the only evidence of mosquito life was the sound of two mosquitoes buzzing round me.

Sub-genus *ARMIGERES*, Theobald.

Aedes (Armigeres) argenteoventralis, Theo.—A single female was captured in a house near the Emseleni River at 4 p.m. on the 27th March, 1923.

Sub-genus *STEGOMYIA*, Theobald.

Aedes (Stegomyia) argenteus, Poiret.—This species was found from the 24th January, 1923, to the 26th March, 1923, but it was not very common. Specimens were occasionally collected at night in a house near the Emseleni River, and larvae were found on one or two occasions breeding in a water-jug in a room. Females were also occasionally caught feeding on horses and cattle during the day-time in bushy localities near the Emseleni and Mhlatuze Rivers. One female was observed at 3.15 p.m. on the 15th February, 1923, laying eggs on the sides of a tin containing water in a wood. The eggs were deposited about 4-5 mm. above the surface of the water.

Aedes (Stegomyia) vittatus, Bigot.—Larvae were collected in a rock-pool near the Emseleni River in December.

Aedes (Stegomyia) simpsoni, Theo.—This species was fairly common in the settlements during the months of January to April. Specimens were taken in houses at night, and were also caught on animals at night and during the day-time in shady places, such as under a tree or in thick bush. On one or two occasions they were taken biting animals standing in the sun.

Aedes (Stegomyia) metallicus, Edwards.—Three females of this species, which had previously only been recorded from the Sudan, were collected in the settlements. One was taken on a cow during the day in thick bush near the Mhlatuze River on the 20th February, 1923, and two were captured on a horse standing in thick bush near the Emseleni River between 4 and 5 p.m. on the 26th March, 1923.

Sub-genus *AEDIMORPHUS*, Theo.

Aedes (Aedimorphus) durbanensis, Theo.—Three females were taken feeding on a horse in a wood near the Emseleni River between 3.30 p.m. and 6 p.m. on the 24th January, 1923.

Aedes (Aedimorphus) hirsutus, Theo.*—This species was very common in November, and numerous larvae were found breeding in a large pool in the bed of the Ntabanana River during the first and second weeks of January, and also in pools in dongas near the Research Camp at Ntabanana. Three specimens were caught in a house near the Emseleni River at night in January, and one was taken on the 31st March.

Aedes (Aedimorphus) bevisi, Edwards.—This species was fairly common in thick bush near the Emseleni and Mhlatuze Rivers from the 22nd January, 1923, to the 4th April, 1923. All the specimens collected were taken on horses and cattle during the day-time, with the exception of one or two, which were caught

* Mr. F. W. Edwards informs me that the specimens are probably *A. (A.) sudanensis*, * Theo. Unfortunately only female specimens were collected, so it is impossible to be certain.

- at night. It was described by Edwards from four females collected at Umbilo, near Durban, in May and September, 1914.
- Aedes (Aëdimorphus) punctothoracis*, Theo.—Specimens were occasionally met with near the Emseleni and Mhlatuze Rivers from the 24th January, 1923, to the 6th April, 1923. They were collected on animals tethered to poles in thick bush during the day-time, and were also taken on one or two occasions at night, and between 6 and 6.30 a.m.
- Aedes (Aëdimorphus) albocephalus*, Theo.—This species was fairly common in thick bush near the Emseleni River during the day-time from the 24th January, 1923, to 14th February, 1923.
- Aedes (Aëdimorphus) tarsalis*, Newst.—One female was taken near the Mhlatuze River on the 21st February, and one near the Emseleni on the 16th March. This species has previously only been recorded from the Congo Free State.
- Aedes (Aëdimorphus) quasiunivittatus*, Theo.—Several specimens were taken near the Emseleni River on animals in thick bush during the day-time in January, and one female was collected between 6 and 6.50 a.m. on a cow near the Mhlatuze on the 6th April, 1923.
- Aedes (Aëdimorphus) cumminsi*, Theo.—One female was caught on the bark of a tree in thick bush near the Emseleni River between the hours of 3 and 5 p.m. on the 5th February, 1923.

Genus TAENIORHYNCHUS, Arribalaza.

- Taeniorhynchus fuscopennatus*, Theo.—Three females were collected in the act of biting animals in thick bush near the Mhlatuze River between the hours of 7 and 9 p.m.; two were taken on the 4th, and one on the 14th April, 1923.

Sub-genus MANSONIOIDES, Theobald.

- Taeniorhynchus (Mansonioides) africanus*, Theo.—I caught one female attempting to bite me whilst sitting under a tree on the road between Empangeni and Ntabanana at 1.30 p.m. on the 23rd February, 1923.

Genus CULEX, Linnaeus.

- Culex annulioris*, Theo.—One female was taken near the Mhlatuze River at 7 a.m. on the 6th April, 1923.
- Culex univittatus*, Theo.—This specimen was common at the Mhlatuze from the 4th to the 14th April. They were caught on animals in thick bush at night and also early in the mornings between 6 and 6.50 a.m.
- Culex fatigans*, Wied.—One female was caught at Mhlatuze on the 5th April, 1923.
- Culex rima*, Theo.—One female was collected in a tent near the Mhlatuze River on the 21st February, 1923, one on the 22nd, and a male on the 23rd. The previous records for this species are: Ashanti, S. Nigeria, Congo Free State, and Uganda.

Sub-genus CULICIOMYIA.

- Culex (Culiciomyia) nebulosus*, Theo.—This species was common practically throughout the summer in a house near the Emseleni River. Larvae were found breeding in large numbers in a latrine.

Genus ERETMOPODITES, Theobald.

Eretmopodites chrysogaster, Gr.—This species was not common in the settlements. Females were occasionally taken on animals in thick bush near the Emseleni and Mhlatuze Rivers from the 24th January, 1923, to the 22nd February, 1923. On one occasion a female was observed laying eggs with a female of *A. fasciata*, Fabr., on the sides of a tin containing water at 3.15 p.m. on the 15th February, 1923. The eggs were attached to the sides of the tin about 1 to 2 mm. above the surface of the water.

FAMILY SIMULŪDAE.

Genus SIMULIUM.

Simulium sp. nov.—Several specimens were caught on animals standing in thick bush near the Emseleni River during the months of February and March, and numerous specimens were collected near the Mhlatuze River on animals standing in thick bush and also in the sun in open ground during April. These small flies, which were also present in the Ntabanana settlement during November to January, were only seen during the daytime, and were only observed to feed on the bellies of horses and cattle.

FAMILY PSYCHODIDAE.

Genus PHLEBOTOMUS, Rond.

Phlebotomus minutus bedfordi, Newst.—Specimens were collected in a house near the Emseleni River during the months of December to April. They were taken on windows and walls from about twenty minutes before sunset to late at night, and also occasionally in the mornings up to about 8 a.m. They were by no means common in December and January, but several specimens could usually be obtained any evening during February to April. Two specimens were also taken in a tent at night near the Mhlatuze River on the 5th April, 1923. This species also occurs in the Pretoria District, Transvaal. I have never known *Phlebotomus* to bite in South Africa, nor do I ever remember seeing any specimens gorged with blood.

FAMILY TABANIDAE.

The total number of species captured was twenty-four. The majority of specimens collected were caught on animals. Attempts were also made to obtain specimens, especially the males, by sweeping grass with a net, placing a wet white sheet on the ground in suitable places, looking for them on rocks and damp sand along the beds of rivers, and also on flowers and trunks of trees. The only Tabanid I remember capturing by sweeping with a net was a specimen I took to be a male of *Chrysops stigmatalis*, Loew, but unfortunately it escaped before I could get it into the bottle. I must admit I have rarely had good results with this method, except on one occasion in 1917, when I obtained a few species, including several males and females of *Tabanus taeniatus*, Macq., by sweeping in a marshy locality at Carolina, Transvaal.

Neave (*) states that canvas, either in the form of a tent or

* Bull. Ent. Res., Vol. III, Pt. 3, p. 281, 1912.

stretched on the ground, in the latter case particularly if damp, is peculiarly attractive to females of many Tabanidae and some *Haematopota*. All attempts on my part to attract females with a wet canvas sheet stretched on the ground failed. Females of *Tabanus ustus* were occasionally seen in a tent near the Emseleni River on hot days in early summer, and females of *Tabanus africanus* flew into a tent near the Mhlatuze River on two or three occasions. I did not find a single specimen on rocks, and I fared no better by searching for them on trunks of trees. The only Tabanid I saw settling on damp sand was a specimen of *T. biguttatus*, Wied., which I took to be a male, but failed to catch it. Likewise, with the exception of *Corizoneura pallidipennis*, Ric., few specimens were obtained on flowers.

It may be interesting to record that at Onderstepoort I have often caught males and females of *T. nagamiensis*, Carter, basking in the sun on rocks in the bed of the Aapies River in the spring, but have not taken them in any other situation, except, of course, the females on animals. This is the only species I remember having seen on rocks. Males and females of *Chrysops stigmatalis*, Loew. I have captured in the spring settling on a road. The males of *Rhinomyza denticornis*, Wied. I have occasionally taken on flowers, also the males of *T. ditaeniatus*, Macq. The males, and occasionally the females, of *Chrysozona mactans*, Austen, and also both sexes of *T. gratus*, Loew, I have taken on the bark of trees. Both these species appear to have their favourite trees. I have frequently taken males of *C. mactans* on certain mimosa trees, and on one occasion I counted no less than seventeen on one tree, yet on other mimosa trees close by I have never succeeded in finding a single specimen. *T. gratus* I have invariably been successful in finding on about half-a-dozen willow trees growing close together, but have never seen them on any other tree, although this is a common species here. They are usually found on the bark of trunks, about four to five feet from the ground, and usually facing the sun. The males of *C. mactans* I have found from four to about fifteen feet from the ground.

The explanation why different Tabanidae select various sites for resting is probably because some species require more heat than others. Rocks exposed to the sun get very hot, and this is probably the reason why they are chosen for resting sites by *T. nagamiensis*, Carter.

Genus CHRYSOZONA, Meizen, 1800.

According to Surcouf, *Chrysozona* has priority over the well-known name *Haematopota*, which was erected by Meigen a year later.

Chrysozona decora, Walker.—This well-marked species was found at Ntabanana along the Emseleni River from the 30th October to the 31st March, and in the Ntabanana Valley during December and January. Specimens were also captured near the Mhlatuze River in February and March, but it was never common.

They were taken on the sides of the bodies of horses and cattle, and also occasionally on their necks.

In the laboratory collection there are four females collected by D. T. Mitchell on Mkusi River, Zululand, in 1916. This species is widely distributed in Africa, and has previously been recorded from the Cape Province and Natal in the Union.

Chrysozona mactans, Austen.—As will be seen from the chart, this species was one of the commonest Tabanids occurring in the settlements. Specimens were caught from the 26th October to the 27th April. They were most numerous from 9 a.m. to about 3 p.m. or 4 p.m., but were also occasionally taken on animals from sunrise to sunset. On one occasion thirteen females were caught on a horse between 7 and 8 a.m. They attacked horses and cattle freely, but only one specimen was taken on a goat, and only on one occasion did a female attempt to bite the writer. They usually settle on the sides of the body, back, or neck of the animals to feed, but were often seen settling on the tails of horses or cattle either standing still or walking about.

Chrysozona vittata, Loew.—This species was by no means common, only eleven females being captured. Six were taken near the Emseleni River from the 27th November to the 13th December, and five at the Mhlatuze in February.

Chrysozona vittata, var.—A single specimen, a female, was procured near the Ntabanana River on the 8th December, 1922.

Genus TABANUS, Linné.

The following fifteen species were procured:—

Tabanus africanus, Gray.—This species was found from the 13th November to the 28th April. It was more numerous near the Mhlatuze River than at Ntabanana. Three females were observed feeding on the nectar of flowers of a small shrub (a species of *Cissus*) near the Emseleni River, and females were also taken in a tent near the Mhlatuze River on two or three occasions. This species usually settles on the sides of the body of animals to feed. In the laboratory collection there are several females that were collected in the Intambonani Valley, Zululand, by D. T. Mitchell in December, 1915, and January, 1916. It has been recorded from the whole of East Africa, from the Sudan in the north to Natal in the south. It also occurs in parts of the Cape Province, and has been found in Angola.

Tabanus biguttatus, Wied; and the var. *croceus*, Surc.—This large, dark species was never prevalent in the settlements, only about thirty specimens were captured. They were caught from the 2nd November to 31st March. The var. *croceus* was much more common than the typical form. This species is very widely distributed in Africa, and has also been recorded from the Cape Province and Natal in the Union. It is very rare in the Transvaal; we have only succeeded in capturing one female in the Pretoria District. The females always settle on the backs and sides of the bodies of their hosts to bite.

Tabanus par, Walker.—This species is also widely distributed throughout Africa, and its range in the Union appears to be the same as that of the foregoing species, except that it has never been found in the Transvaal. It was one of the commonest species of *Tabanus* found in the settlements, and specimens were captured from the 26th October to the 25th April. They were all

taken between 9 a.m. and 6 p.m., except one female which was caught biting an animal between 7 a.m. and 8 a.m. The laboratory collection contains several females collected in the Intambonani Valley, Zululand, in December, 1915 (D. T. Mitchell).

The females invariably settle on the legs or bellies of their hosts to feed.

Tabanus taeniola, Pal. de Beau., and the *var variatus*, Walker.—Specimens were caught from the 27th October to the 14th March. It was, however, never common, except from the 1st to the 14th March, when fifty-three females were captured near the Mhlatuze River. Four females were taken from the 27th to the 31st October, one in November, ten in December, nineteen in January, and fifteen in February. In the Pretoria District this species has in some seasons been one of the commonest species of *Tabanus* found here, and in others it has proved to be one of the rarest. It is very widely distributed throughout the African continent, and has been taken in all the Provinces of the Union. In South Africa the variety *variatus* appears to be far more common than the type. The females usually settle on the legs of their hosts to feed.

Tabanus fraternus, Macq.—Only two females of this species were taken. They were both caught on animals near the Emseleni River on the 26th October, 1922. It has also been recorded from the Cape Province and Natal in the Union, Portuguese East Africa, Nyasaland, East Africa, and Zanzibar.

Tabanus ustus, Walker.—This species was only found in early summer from the 26th October to the 9th November. Altogether twenty females were procured on animals, between the hours of 9 a.m. and 5 p.m., except one female, which was caught between 7 a.m. and 8 a.m., and in addition to these one or two were captured in a tent. It also occurs in the Union in the Cape Province and Natal.

Neave (*) states: "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."

Tabanus atrimanus, Loew.—This species was common in the settlements, and was found practically throughout the summer from the 25th October to the 15th April (see chart). The fly was most prevalent between the hours of 9 a.m. and 5 p.m., except towards the middle of March onwards, when they were not caught later than 2 p.m. Only two females were caught on animals between the hours of 7 a.m. and 8 a.m. They were both taken in early summer. Mr. D. T. Mitchell also took specimens in Zululand on the banks of the Mkusi River in 1916. Its range appears to be confined to the eastern portion of Africa and the Cape Province. The fly usually settles on the belly or legs of its host. On one occasion a specimen settled on the writer's hand to feed.

Tabanus nagamiensis, Carter.—Thirty-four specimens of this species were captured on animals in the settlements. One was taken on the 30th October, nineteen in November, eight during the first

* Bull. Ent. Res., Vol. III, Pt. 3, p. 294, 1912.

two weeks of December, and two were caught on the 6th February. It also occurs in the Pretoria District from about the middle of September to the end of March, and is usually common here in the spring and early summer. In this locality I have frequently taken both males and females settling in the sun on rocks in the bed of the Aapias River. This species was described by Carter from fourteen females collected by Mr. James in Ngamiland, South Africa, in 1910.

Tabanus insignis, Loew.—Only seven specimens of this well-marked species were obtained. The first was caught on the 28th October, four were taken in November, one in December, and one on the 10th March. The last was captured near the Mhlatuze River and the remainder near the Emseleni. In the laboratory collection there are two females collected by the writer at Pietermaritzburg, Natal, in November, 1913, and one male taken at Karkloof, Natal, on the 23rd February, 1917, by Professor A. J. T. Janse. It has also been recorded from the Cape Province, and we have taken it in the Pretoria District, but it is an extremely rare insect here. This and the foregoing species settle either beneath the abdomen or on the legs of their hosts to feed.

Tabanus gratus, Loew.—The fly, as will be seen from the chart, was one of the commonest species of *Tabanus* found in the settlements. It was prevalent practically throughout the summer between the hours of 9 a.m. and 6 p.m. from the 27th October to the 15th May, when collecting was abandoned. No specimens were caught between the hours of 7 a.m. and 8 a.m. The flies were mainly taken beneath the abdomen and on the legs of their hosts. This insect is also usually common in the Pretoria District from the end of September or beginning of October to April. It is widely distributed throughout the greater part of Africa.

Tabanus pertinens, Austen.—This species was rare in the settlements, only two females were caught. They were both taken on animals; one near the Emseleni River on the 30th September, 1922, and the other at the Mhlatuze on the 17th February, 1923. It was described by Austen in 1912 from numerous specimens collected in various parts of Africa.

Tabanus leucostomus, Loew.—This species has not previously been recorded from the Union. It was by no means common in the settlements. One female was caught on an animal on a hill near the Emseleni River on the 10th November, two were captured in March near the Mhlatuze River, and two on farm No. 316 in April, one on the 5th and the other on the 28th. In the laboratory collection there are three females collected on the Mkusi River in 1916 (D. T. Mitchell). Neave records finding this species abundant in Northern Rhodesia and Nyasaland, especially in low country, and he also took a few specimens along the coast-belt of Kenya Colony.

Tabanus ditaeniatus, Macq.—Two specimens, both females, were collected near the Emseleni River.

Tabanus fuscipes, Ricardo.—This species was rare in the settlements, only nine females were captured. Seven were caught near the Emseleni River; one on the 30th October, four in November, and two in December, and two were taken in the Ntabanana Valley in January, the last being caught on the 19th. This fly is also

found in the Pretoria District, but it is never common here. It has also been recorded from Natal, Northern and Southern Rhodesia, and Nyasaland.

Tabanus maculatissimus, Macq.—As will be seen from the chart, this fly, which is a very striking insect, was found in the settlements practically throughout the summer from the 25th October to the 11th May, but was never very prevalent. The females usually settle on the sides of the bodies of animals to feed. They were mostly found between the hours of 9 a.m. and 6 p.m., only one specimen being caught between 7 a.m. and 8 a.m. On one occasion only was a specimen observed on a flower, but as the writer failed to catch it, it was not ascertained whether the specimen was a male or female. This species has also been recorded from the Cape Province, Natal, Northern Rhodesia, Nyasaland, Tanganyika Territory, and the Congo Free State.

Tabanus sp.—Two females of a small, undetermined species were caught, one on the 6th February near the Emseleni River and one near the Mhlataze River on the 8th March.

Genus CADICERA, Macq.

No specimens of this genus were seen, but the following species has been found in Zululand:—

Cadicera quinquemaculata, Austen.—In the laboratory collection there is a female without data, collected by D. T. Mitchell. This fly has previously only been known to occur at Kingwilliamstown, Cape Province.

Genus CORIZONEURA, Rondani.

Corizoneura pallidipennis, Ric.—There are two broods of this species in the season. The first brood was found from the 26th October to the 1st December, when 107 females were caught attacking animals, and the second brood was very common from towards the end of March to the 11th May (see chart). They were collected between the hours of 9 a.m. and 6 p.m., the second brood being only prevalent, as a rule, up to 2 p.m. or 3 p.m. When feeding on an animal the female does not settle on its host, but hovers in the air with its long proboscis sticking out straight in front of its head. They invariably attack the sides of the bodies of their hosts, and also occasionally their legs. Although a diligent search was made to find both females and males on flowers in November, not a single specimen was seen, but both sexes of the second brood could nearly always be found between the hours of 8.30 a.m. and 2 p.m. or 3 p.m. hovering in front of and sucking the nectar of the flowers of *Barleria ovata*, E. Mey, and *B. elegans*, S. Moore. The probable reason why no individuals of the first brood were seen on flowers was because the countryside was one mass of bloom in early summer, whereas in April and May the two species of *Barleria* were practically the only plants flowering and the only ones that attracted the flies, and as they were not very common and were only found growing in isolated patches, it was necessary for the flies, in order to obtain nectar, to concentrate in the small areas where either the one or the other plant was growing. All the males captured, and also all the females, with the exception of one specimen,

including those of the first brood, were observed to have grains of pollen attached to the hairs of their thoraces, thereby indicating that the female of this species is largely a feeder of nectar as well as being a blood-sucker.

Genus BUPLEX, Austen.

This genus was erected by Austen in 1920 for a few species which were formally included in the genus *Pangonia*.

Buplex brunnipennis, Loew.—There is only one brood of this species in a year. Sixty-five females were captured on animals near the Emseleni River between the 2nd November and the 4th December. They were all caught between the hours of 9 a.m. and 6 p.m., except three specimens which were taken between 7 and 8 a.m. They attack animals in a similar manner to those of *Corizoneura pallidipennis*. No specimens were observed to be attracted by flowers, and no pollen grains were seen on the thoraces of any of the specimens caught. However, the absence of pollen on the thoraces was probably no indication that these flies do not feed on the nectar of plants, since the writer has taken other species of *Pangoninae* that frequent flowers in the neighbourhood of Capetown without finding grains of pollen on them. Mr. D. T. Mitchell took two females of this species at Nongoma, Zululand, in December, 1915. The only previous records of this fly are Kaffraria, Cape Province, and Durban.

Genus CHRYSOPS, Meigen.

Chrysops stigmatalis, Loew.—Eleven females were caught at Ntabanana and near the Mhlatuze River between the 16th November and the 6th April. In the Pretoria District it is found from about the middle of September to the end of March, but it is never a common insect here. The females usually settle either on the backs or the sides of the bodies of animals to feed. This species appears to be confined to South Africa. It has not been recorded further north than Southern Rhodesia.

Chrysops woodei, Neave.—A single specimen, a female, of this beautiful species I caught on a flower on the fringe of thick bush near the Emseleni river on the 14th December, 1922. It was the only specimen seen. This insect was described and figured by Neave in 1915 from specimens collected in Portuguese East Africa and N. W. Rhodesia.

Chrysops sp.—A single female was collected on an animal near the Emseleni River on the 15th November, 1922.

FAMILY MUSCIDAE.

Genus GLOSSINA, Wied.

Glossina pallidipes, Austen.—Seventeen specimens were caught in the settlements. Two males and one female were captured near the Emseleni River, one was taken between 4.30 and 5 p.m. on the 28th November, and two between 9 and 12 a.m. on the 4th and 12th December. The writer also succeeded in finding one empty pupa case close to the place where the flies were collected. Only one specimen, a male, was taken in the Ntabanana Valley, it was caught on a cow between 9 and 10 a.m. on the 19th January. Three females and two males were caught on animals in the

vicinity of the Mhlatuze River about 4 p.m., and one between 9 and 12 a.m. between the 9th and 17th March, and one specimen was also taken at night with a lamp in April. On farm No. 316, specimens, mostly females, were captured between the 7th and 27th April. Four were caught between 4.15 and 5.15 p.m. and two between 9 a.m. and 11 a.m. Of the above flies four were caught on mules, five on cattle, and seven on horses.

Genus STOMOXYS, Geoffroy.

Flies belonging to this genus were found in large numbers practically everywhere the writer went, although some species were very much more numerous than others. All the species found have similar habits. They usually settle on the legs of animals to feed, but may also be found beneath the abdomen, sides of the body, back, and neck of their hosts. They were, with the exception of one *Chrysozona mactans*, the only blood-sucking Diptera observed on goats, but they prefer the blood of horses and cattle to these animals. They seldom attack man. The only times the writer has been bitten by these flies, both in Zululand and in the Pretoria District, have occurred when he has been sitting down in the open, either in the sun or in the shade, and the only places they have attacked have been the ankles and just above them. All the species listed were usually to be found from shortly after sunrise to about sunset, but they were always very much more numerous during the heat of the day than either early morning or late in the evening.

Stomoxys calcitrans, Linné.—This fly, which is almost cosmopolitan in its range, was by far the commonest species found in the settlements. In the Pretoria District we have taken it throughout the year, but it does not occur here during severe winters.

Stomoxys nigra, Macq.—This species was also very common in the settlements, although not as numerous as the foregoing species, except on one or two occasions when it was observed to be more prevalent. It is widely distributed in Africa, but very rare in the Pretoria District. We have only succeeded in capturing a single specimen here.

In addition to the above two other species were found, namely, *Stomoxys brunnipes*, Grunt, and *Stomoxys taeniata*, Big. They were, however, not very common.

Genus BDELLOLARYNX.

One species, not yet described, was found in the settlements. It was very common and similar in its habits to *Stomoxys*. The flies usually settled on the legs of their hosts, but were also occasionally taken either beneath or on the sides of their bodies.

Genus CORDYLOBLIA, Grün.

Cordylobia anthropophaga, Grünberg.—Two specimens of this species, commonly known as the Tumbu-fly, were caught in the settlements, and a number were caught in warthog and ant-bear burrows in the Mfolosi Game Reserve and at the Mhlatuze.

Genus CHAEROMYIA, Roub.

Chaeromyia praegrandis, Austen.—Several specimens of this species I captured at the entrance of warthog holes in the Mfolosi Game

Reserve in October, 1924. I also took a single male at the entrance of a warthog hole in the Northern Transvaal in July, 1924.

Genus *AUCHMERO MYIA*, Br. & Berg.

Auchmeromyia luteola, Fabr.—Larvae of this species were obtained at the NKwaleni Cotton Estates near Eshowe, and adult flies at Umzinduzi, Northern Zululand, where they breed in native huts, in October, 1924.

FAMILY HIPPOBOSCIDAE.

Genus *HIPPOBOSCA*, Linné.

Hippobosca rufipes, Van Olfers.—This fly was by no means common in the settlements. Specimens were occasionally observed on horses and cattle. It is very common in some parts of South Africa, especially at Vryburg, where it is found throughout the year. In the Pretoria District it also occurs throughout the year, except during severe winters. It is, however, always more numerous during the summer months. Both sexes are blood-suckers, and attack horses, donkeys, mules, cattle, and on rare occasions settle on man. They usually settle beneath the tail or on the scrotum of animals, but may be found on any part of the animal except the head.

Genus *ECHESTYPUS*, Speiser.

Echestypus paradoxus, Newst.—Specimens of this species were collected at Ntabanana and in the Game Reserve on bushbuck (*Cervicapra arundinum*); it has also been taken in Zululand by Mr. D. T. Mitchell on kudu (*Strepsiceros kudu*) and on inyala (*Tragelaphus angasi*) on the Ubombo Flats. We have also received specimens collected on a kudu at Pietersburg, Transvaal, and on a bushbuck in Sukukuniland. This fly possesses wings when it first hatches out of the pupa case, but almost as soon as it finds a suitable host it breaks them off at the bases and then resembles *Melophagus ovinus*, L., the well-known sheep ked, in general appearance, except that it is much smaller.

In conclusion I wish to express my sincere thanks to both Major Austen and Mr. F. W. Edwards for their kind help in identifying some of the Diptera recorded in this paper.