Observations relating to the transmission of sleeping sickness in Uganda, the distribution and bionomics of Glossina palpalis, and to clearing measures / by Aubrey D.P. Hodges.

Observations

RELATING TO

The Transmission of Sleeping Sickness in Uganda;

The Distribution and Bionomics of Glossina Palpalis;

AND TO

Clearing Measures.

BY

AUBREY D. P. HODGES, M.D.Lond.

Principal Medical Officer, Uganda Protectorate.

London:
Sleeping Sickness Bureau,
Royal Society, Burlington House, W.

1909.

Issued under the direction of the

HONORARY MANAGING COMMITTEE of the SLEEPING SICKNESS BUREAU;

EDITED WITH NOTES BY THE DIRECTOR.

Application for Copies should be made to the

DIRECTOR, SLEEPING SICKNESS BUREAU,
Royal Society, Burlington House,
London, W.

CONTENTS.

NOTE ON THE QUESTION OF SLEEPING SICKNESS CARRIED BY TSETSE FLIES OTHER THAN *GLOSSINA PALPALIS*?

The postponement of research on this point is to be regretted because it is by means of *G. morsitans* and *pallidipes* that Sleeping Sickness would spread northwards, along the east bank of the Nile, into the Sudan, if unfortunately it should ever do so. It is also through species of tsetse other than *palpalis* that Sleeping Sickness might spread to East and to South Africa.

There is no evidence, however, that Sleeping Sickness spreads in regions where other species of tsetse exist apart from *G. palpalis*, nor that it spreads otherwise than in the usual manner or than in the usual localities or with more than ordinary rapidity where other species co-exist with *G. palpalis*.

In a district of this kind which is known to me personally, viz., that comprising North Unyoro and the eastern half of the Nile valley as far north as the northern limit of *G. palpalis*, the process of the extension of the epidemic does not appear to point to the presence of any distinctive factor nor does it present any special characteristic.

Except in the Magungu district of Northern Unyoro, which is almost the only part of it where *G. palpalis* is the single species hitherto found, the spread of infection has been remarkably slow in the Lake Albert epidemic area, whilst between it and the Wadelai epidemic the cases are reported by the late Dr. Densham to be scattered, isolated and probably "imported." The distribution of the disease, though clearly connected with that of *G. palpalis*, shows no relation to that of other species of tsetse. The same observations apply to the Wadelai epidemic, though *G. pallidipes* and *morsitans* are common within its area. Extension in both areas has been slow, compared with that in the Lake Victoria epidemic area, where *G. palpalis* only is found. Other factors, such as greater population and more frequent intercommunication, no doubt account for a good deal, but each of the above epidemics (Lake Albert and Wadelai) has, according to native report, existed for at least five years, and there is no traditional or demonstrable connection directly between these two or between them and the one on Lake Victoria.

In the south part of the Lake Albert epidemic area and beyond it *G. fusca* is found, but neither does this species appear to influence the rapidity or the direction of the spread of infection.

G. morsitans and *pallidipes* are found in increasing numbers northwards to the Sudan border and no doubt beyond this. They are found at many points along the Fajao-Gondokoro Road and even in the near vicinity of Gondokoro station, but no case of infection has been known to have occurred there from the imported cases which have from time to time found their way there along this road, nor has Sleeping Sickness become endemic anywhere beyond the limit of distribution of *G. palpalis*.

[Note.]—Having some familiarity with the subjects of these papers I have added footnotes freely. I have not altered the extracts from my own Reports more than seemed necessary, but have given explanations or more detail in the notes.

Arthur G. Bagshawe.
January 9th, 1909.

Personally, therefore, I remain of the opinion that the species *morsitans*, *pallidipes* and *fusca* are not likely to carry infection, unless occasionally and by chance, as a needle or a thorn might, and under specially favourable conditions such as interrupted feeding. It does not seem probable that their presence would cause or seriously influence an epidemic; nor do I see any need to suppose the existence of any other means of spreading infection among human beings than the bite of *G. palpalis*.*

(Signed) A. D. P. Hodges.

NOTE ON THE DISTRIBUTION OF *GLOSSINA PALPALIS*.

The mapping of the general distribution of *G. palpalis* in the Uganda Protectorate may be said, broadly speaking, to be complete. The examination of minuter details in special localities will still from time to time be required for special purposes, but the main facts, with a very large amount of local detail, have been ascertained and recorded.

The general distribution may be taken as practically constant, but the local distribution varies within certain limits, and the conditions governing local variations require further investigation.

We know now the distribution as described by a single observer in each region in one set of conditions or season of the year. What is now required for complete detailed knowledge is a re-examination under different conditions by the same or other observers. In this way comparison could be made which would give us the variations in seasonal prevalence and under improved conditions of clearing etc.

The seasonal variation of *G. palpalis* in numbers and distribution is as yet little known, but in some localities it is probably considerable, chiefly so along the banks of rivers and water-courses. †Along the shores of lakes the physical conditions affecting the fly are much less subject to change with the seasons, whereas water-courses may be full or dry, at low water or in flood—the conditions, especially at the water's edge, varying much with the height of the water-level and the width of the contained stream.

---

* At a place near the Victoria Nile I met with *G. morsitans* and *pallidipes* for the first time. I made the following note:—"I was struck by the way in which the flies pestered us. I was bitten several times, three times in the palm. These flies settled quickly and settled to bite, whereas *G. palpalis* often alights on a clothed part of the body and even when it settles on skin is in no hurry to puncture and often seems to be merely resting. I was bitten more in three hours than by *G. palpalis* in the whole course of these investigations." I cannot say which was the species which attacked us so pertinaciously, as I did not at the time recognise that there was more than one. The observation supports Dr. Hodges' argument that these species do not spread the disease.

† Along the shores of lakes such as the Albert, where there is a well-defined dry season, the leaves of many shrubs become wilted or are dropped when the hot weather has set in. The amount of shade afforded becomes less and probably the conditions for breeding are not so favourable as in the rains. On the north west shore of the Victoria Nyanza, including the islands, there is no definite dry season and the shade conditions remain unchanged throughout the year.

In former reports it has been mentioned that *G. palpalis* is not found along the banks of swamp-choked rivers or channels and that gaps in its distribution occur along lake-shores or river-banks clothed with wide belts of swamp; also that, on both lakes and rivers, where the waterside is naturally free from scrub-vegetation or other forms of shade, or where the bank has been artificially cleared, fly is not present. These conditions, especially those of swamp, appear to form effectual blocks to the distribution and migration of *G. palpalis*.

It is important, therefore, for practical purposes, to ascertain, with respect to swamp-choked sections of rivers, channels and inlets and also shadeless stretches of lake-shore or river bank, the extent or area which is necessary to constitute an effectual barrier to the migrations of the fly, and whether existing barriers are likely to be permanent or only temporary.

The great rivers Katonga and Kafu are, for miles of the lower part of their course, choked with sudd, except for one or more narrow and tortuous channels. Fly is absent from these parts of the rivers, and also from their tributaries, head-waters and the whole of their inland course, although there may exist, in places, conditions apparently most favourable to its presence and although it is found on the estuary of the former river and quite near to the mouth of the latter.

Again, the channel between the mainland and the islands south of Entebbe is blocked with sudd for 20 miles or so. On their lakeward side these islands are fly-infested, but on their landward side there are no fly except at the extremities of the channel, along the margins of the sudd, near the open lake, while the corresponding mainland is fly-free.

In the Lake Victoria region practically all the rivers are swamp-choked and fly-free, and *G. palpalis* is therefore almost entirely confined to the near vicinity of the lake-shore. Thus there is fortunately little variation in its local distribution, which remains, as a whole, confined to fairly definite and circumscribed areas, the greater part of the interior being fly-free and, so far as we can tell, permanently so. It is to this comparatively favourable condition of things that such a measure as deportation of the lake-shore population inland owes its chances of success.

The potential extent of the fly's migration, which must not be confused with its feeding-range, is probably without limit along open rivers and streams with shaded banks, so that in a system of water courses such as exists in the Nile or Congo basin the seasonal variation in its distribution might be very wide indeed, while on the shores of a lake like Victoria Nyanza, where the conditions at the waterside remain at all times much the same, and most of the tributary rivers are blocked by sudd, the variation would be small.

Further, movements of sudd, which are comparatively rare in great lakes, may at any time block or unblock a moderate-sized stream and cause, eventually, a change in the distribution of *G. palpalis* with regard to its banks. Both Dr. Bagshawe and Dr. Densham, and I myself also, have noticed, when investigating districts in which practically all the streams are open, with more or less shaded banks, and so carry fly, that here and there a stream is encountered on which, although all the physical conditions favourable to *G. palpalis* seem to exist, it has not been found even after careful search. In such cases it is at least possible that these streams have been blocked with sudd or swamp, either at their estuaries or at some point below the point of observation, and so shut off, as regards

the fly's migration, from the lake or river into which they flow. It would be advisable that, in future investigations, the course of such a stream should be followed to its mouth, in order to ascertain the existing conditions. It is not always possible to predicate with certainty the presence or absence of fly on the banks of a running stream from its physical characteristics at one spot. The conditions obtaining between this point and the lake or river it feeds must also be known.

The feeding-range is increased in *dull, still weather and where there are wide belts of scrub or forest at the waterside. It is also certain that the existence of constant and extensive human or animal traffic, and especially the former, across fly-areas or to and fro between them, is the most potent factor in influencing local migration and distribution and also in extending the feeding-range under conditions favourable to the fly.

The facilities for migration, as well as the feeding-range, are doubtless on the whole increased in the wet season by the increase in the size and number of watercourses and by the increase of shade-vegetation along their banks, and perhaps also by the movements of sudd during floods. But it is quite possible that in certain cases the conditions may be more favourable to the presence of fly in the dry season than in the wet. For example, what is a narrow stream with steep or scrub-shaded banks in the dry season may become during the rains a wide sheet of water or swamp with unshaded banks, in which case the fly would migrate up or down stream to more favourable haunts, to return with the fall of the flood.

It may be useful at the present stage to give a brief survey of the general distribution of *G. palpalis* over the Uganda Protectorate as a whole.

This would be represented on a map, with the nearest approach to accuracy, by a thin, more or less interrupted, line drawn along the shores of the great lakes and the islands contained in them, along the banks of the river Nile and for a few miles up-stream from the mouths of most of those rivers which flow into the Nile below Foweira, into Lake Albert or into Lake Albert Edward.

It is absent from the great rivers entering Lake Victoria and from most of the small streams except in Usoga. It is very plentiful along the northern shores of Lake Victoria but decreases in abundance and continuity of distribution on the western shore towards the south. It is very abundant in the Sesse Islands and on part of the mainland opposite them. South of this it is much less plentiful, and apparently does not occur south of Duma, some twenty miles from the Anglo-German boundary.

It is found in abundance along the banks of the Victoria Nile as far north as Kibuye, a short distance from Lake Kioga. It exists in patches on parts of the Mpologoma River and some of its tributaries, but has not been observed on Lake Kioga itself. Below this it is found again on the Victoria Nile near Mruli and the mouth of the Kafu River. Between Mruli and Foweira it is found in comparatively few places, but occurs on both banks. From Foweira to Lake Albert it is again very abundant on the Nile banks and is also present on the tributary streams.

Along the Eastern shore of Lake Albert the fly is plentiful north of Butiaba and occurs on practically all the rivers and streams as far as, and sometimes even beyond, the escarpment, which, in the neighbourhood

---

* My experience was perhaps exceptional; in dull weather, I saw few flies and those were sluggish and disinclined to bite. When, in the course of flight experiments, it was necessary for me to catch large numbers of flies I looked upon a dull day as one lost.

Wide belts of scrub reaching the water side greatly increase the feeding range.

of Butiaba, becomes less abrupt and, inclining to the N.E., passes some distance inland from the lake. South of Butiaba the distribution is patchy and comparatively scanty. Fly is present on practically all the streams, but only for about three miles inland, as far as the escarpment, which is here very steep and runs parallel to the lake shore. This three mile limit along the streams was discovered by Dr. Bagshawe. The only exceptions to it which he found were the Ngussi and the Waki Rivers, along which the fly is found for 12 and 6 miles respectively. Of these the Waki enters Lake Albert near Butiaba, where the escarpment begins to curve inland. On the Ngussi Dr. Bagshawe found that the inland limit of the fly's distribution along its banks coincided with the point at which the river leaves the Bugoma Forest. This led him to believe that wide belts of dense forest on both banks of a river are inimical to the presence of *G. palpalis*.*

On the †Semliki River fly is found at the northern and southern ends of its course, with patches here and there midway; but the greater part of it, including the main ferry, is fly-free.

On Lake Dweru or Ruisamba, which is the northern portion of Lake Albert Edward, the conditions as regards *G. palpalis* are similar to those existing on Lake Albert, the fly being distributed in strips or patches along the shores and for three miles or so inland along most of the streams; but it is most abundant at the southern part, towards Katwe.

No sign of Sleeping Sickness infection has yet been discovered south of Butiaba on Lake Albert.

Along the east bank of the White Nile, from Lake Albert northwards, *G. palpalis* is found at intervals as far as Nimule, its distribution being influenced by the presence or absence of large masses of sudd. At Nimule, where the rapids begin, it is again abundant, and extends, with the rapids, intermittently as far as the Koro River, which appears to form its northern limit in this Protectorate some 30 miles south of Gondokoro.

Between the Koro River and Lake Albert fly is present on practically all the tributary streams but, so far as is known, its distribution nowhere extends along their banks for more than 15 miles inland from the Nile.

The conditions prevailing east of this limit and north of the Victoria Nile are not well known; but there is no reason to suppose that Sleeping Sickness exists there in epidemic or endemic form.

The following instances of exceptional distribution of *G. palpalis* may also be recorded here:—

(1) In a wooded gully with a dry water course connected with the Mzizi River Dr. Bagshawe found not only *G. palpalis* but also pupal deposits along the banks above the water line. Nearly all the pupae were empty and might have been deposited a long time previously. The gully was 150 or 200 yards from any water existing at the time.

(2) On the Hoima River, which is not the river on which Hoima Station stands, the same observer found *G. palpalis* in a similar dry gully or stream-bed half a mile from existing water.

---

* The late Dr. Densham and I were unable to find *G. palpalis* in the Budongo forest, though we concurred in thinking that all the conditions were favourable.

† Dr. Hodges is speaking of the Semliki in what is, pending the settlement of the Uganda-Congo boundary, British territory. By "southern end" I suppose him to mean a point not far within the great forest. I do not know whether that part of the river which lies in the Congo State has been examined for fly.

(3) He also found the fly in a similar situation in N. W. Unyoro 200 yards from existing water.

(4) The late Dr. Densham and I, on separate occasions, each saw *G. palpalis* on a dry watercourse in the Nile Province. In these cases also there was no visible water within several hundred yards.

Dr. Bagshawe at first thought, on finding *G. palpalis* along a dry water-course, that he might have frequently overlooked it in similar conditions; but, after having searched many other such places and found the fly to be present in but two more instances, he came to the same conclusion that I had formed, namely, that such cases are quite exceptional, at all events in the Uganda Protectorate.

Dr. Bagshawe mentions that, in the neighbourhood of the Mzizi River, where he first found *G. palpalis* haunting a dry gully, he saw more game than at any other place during his tour. One would suppose that there must exist, in such places, some source of more or less constant food-supply which is absent from the many similar dry gullies which do not harbour fly. It may be that there are sometimes game-tracks along them leading to the rivers or other water with which they eventually connect; or they may contain water near the surface which game or other land animals can obtain by scratching or digging. Water animals, such as hippopotami or crocodiles, might occasionally visit such places, by night, but would not be found there by day and certainly could not form the source of food-supply for the fly.

*None of the gullies in question were in the near vicinity of human habitations or traffic; all of them were examined during the dry season of the year and all of them were situated in the eastern part of the Protectorate, where there are more pronounced dry seasons than in the western or Lake Victoria region.

(Signed) A. D. P. Hodges.

NOTE ON CLEARINGS AT LANDINGS, FERRIES, FORDS, ETC.

In my letter No. 164/SSE of March 21st, 1907, I proposed that preventive clearing should be carried out after some definite plan, and I described, with a diagram, a scheme of clearing for a section of lake shore which I hoped might serve as a useful type and which could be modified to meet special conditions. I consider that this scheme, with modifications adapted to local necessities, is suitable for adoption on river banks and foreshores in or near to settlements or townships. A copy is attached hereto (*vide* page 11).

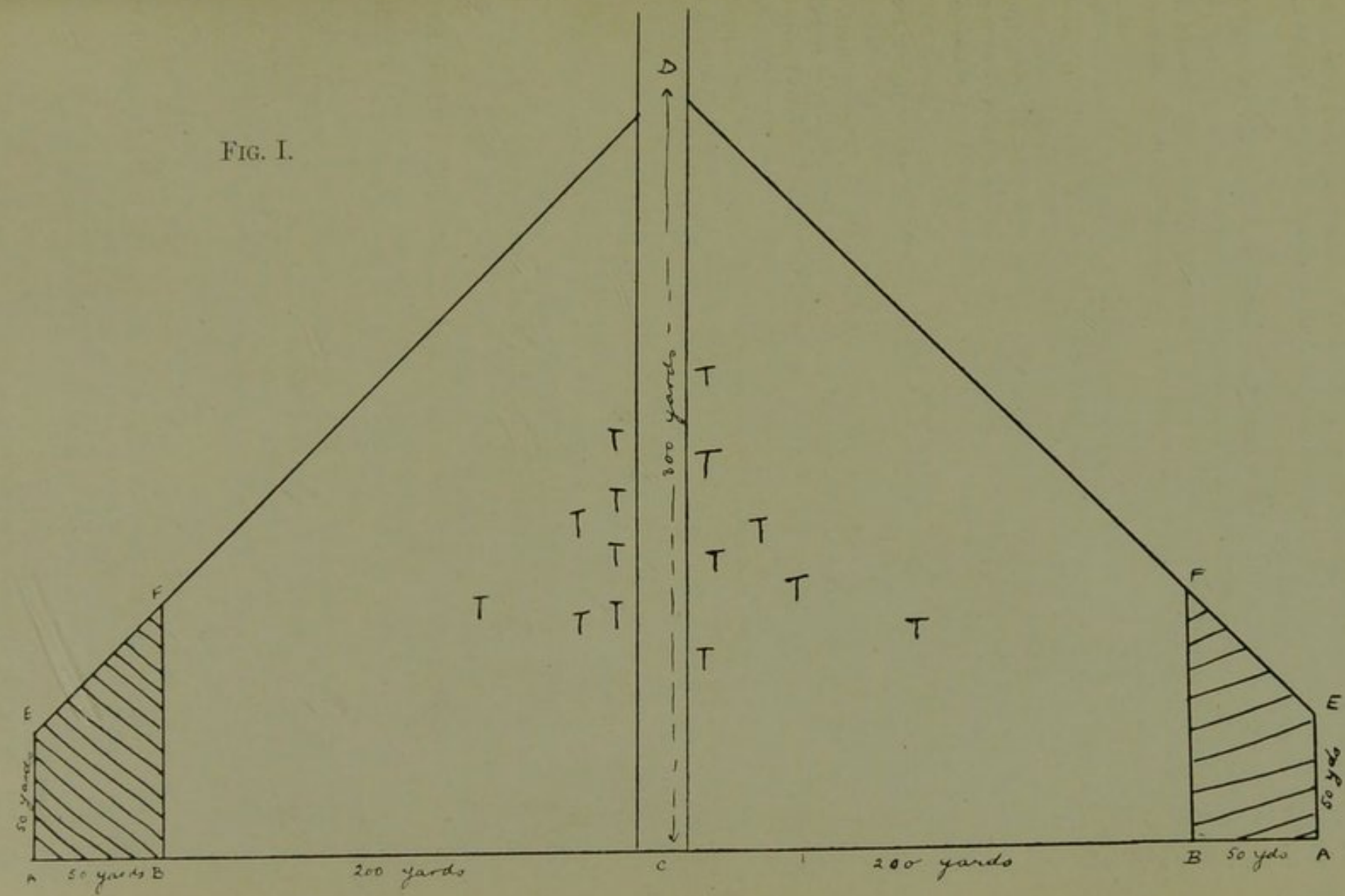
I would now add a further note on the scheme of clearing which I think most suitable for landings, fords and ferries, and which also will be illustrated by diagrams.

The measurements on the diagrams represent the minimum that I would recommend in any case.

---

* This is only correct as regards human habitations. In case (1) a native path crossed the gully, and was used by many persons as it formed the most direct route between Unyoro and a station in the Congo state. Cattle are driven along this path. There was no village nor inhabited hut within many miles. In (2) also there was a native path, connecting two villages.

FIG. I.


D
300 yards
F
F
E
E
50 yards
50 yds
A
50 yards B
200 yards
C
200 yards
B
50 yds
A

The landing or ferry should be as nearly as possible in the centre of the cleared shore-line, which should extend for at least 250 yards in a direct line, AA, on either side of the central point C.* The road from the shore should pass inland from C at right angles to line AA and should approximately bisect the cleared area.

From each of the points AA a perpendicular line AE should be drawn inland for 50 yards and the inland extremities of these lines should be joined with a point D at least 300 yards along the central road CD. The whole space thus enclosed should be cleared except for a few shade trees in its central position.

There should be no roads or paths connecting with the cleared areas but the road CD, and no communication with it except by this road.

At points 50 yards distant from AA and 200 yards from C perpendicular lines should be drawn to meet the lines DE. The spaces AEFB should be railed off and should be taboo to all but those actually engaged in the upkeep of clearing or planting, they should be kept absolutely clear or planted with citronella grass.

No canoe or other vessel should be allowed to pass within 50 yards of the shore outside the point B.

A certain number of shade-trees, but no bush, scrub or long grass, should be left in the central part of the clearing, near the road. If there are no suitable trees, shelters, preferably open sheds at least six feet high at the eaves, may be erected. In the absence of shade natives cannot be prevented from eating, sleeping, etc., in the surrounding jungle.

It will be best, where there is considerable traffic, to provide some sort of latrine accommodation in the cleared area. Where fly are very numerous it will be well to carry the taboo strip along the sides of the clearing to meet the central road at a point 50 yards from D.

Figure I represents the scheme in its simplest form, where the shore-line is more or less rectilinear. Figures II and III show the adaptation of the scheme to shore-lines which are much curved or irregular.

Diagram IV illustrates a case in which special modification is required, on account of the curved course which must be followed by ferry boats in crossing a river having a considerable current.

The lines RR represent the river bank, and the dotted line GH shows the curved course between the points C followed by the ferry boats, which start against the current and afterwards drop down in the slack water near the banks.

Clearing must be extended upstream on either bank as far as that point where boats are in the habit of approaching to within 50 yards of the land. It will probably be sufficient in most cases to extend the taboo area, 50 yards deep, to that point. The area of extension is shown by the figures. FAXZ in the diagram.

(Signed) A. D. P. Hodges.

[Note.]—I think that when our knowledge of breeding grounds becomes systematised much less clearing will be needed. When the breeding grounds are at a distance from the ford or ferry to be rendered fly-free quite a small amount of clearing may get rid of the fly; when they are at the spot to be cleared, the destruction of the shade on the bank alone will suffice.

It must, however, be remembered that inadequate clearing gives a false sense of security, and brings discredit on a measure of proved value, and that to allow a cleared area to relapse into jungle is many times worse than never to have touched it.—A.G.B.

---

* *Vide* diagrams.

FIG. II.

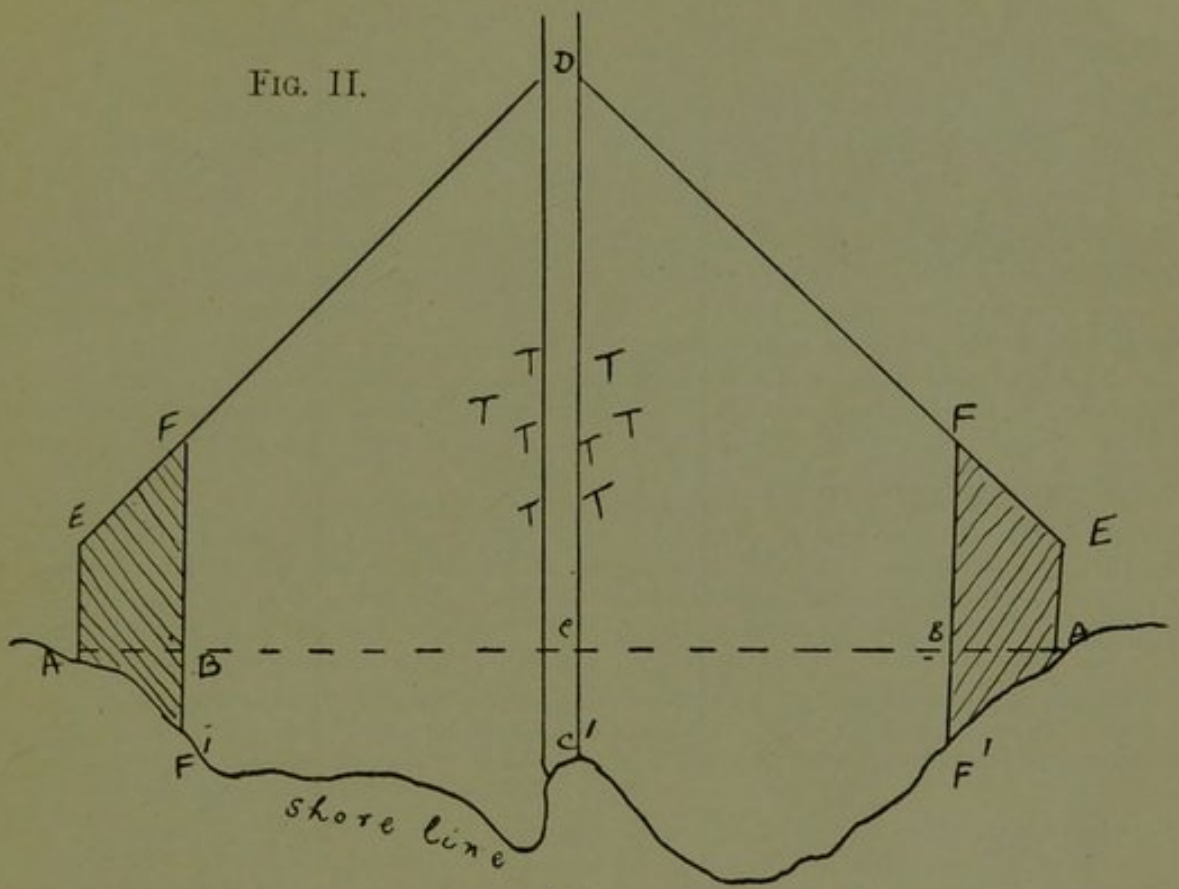
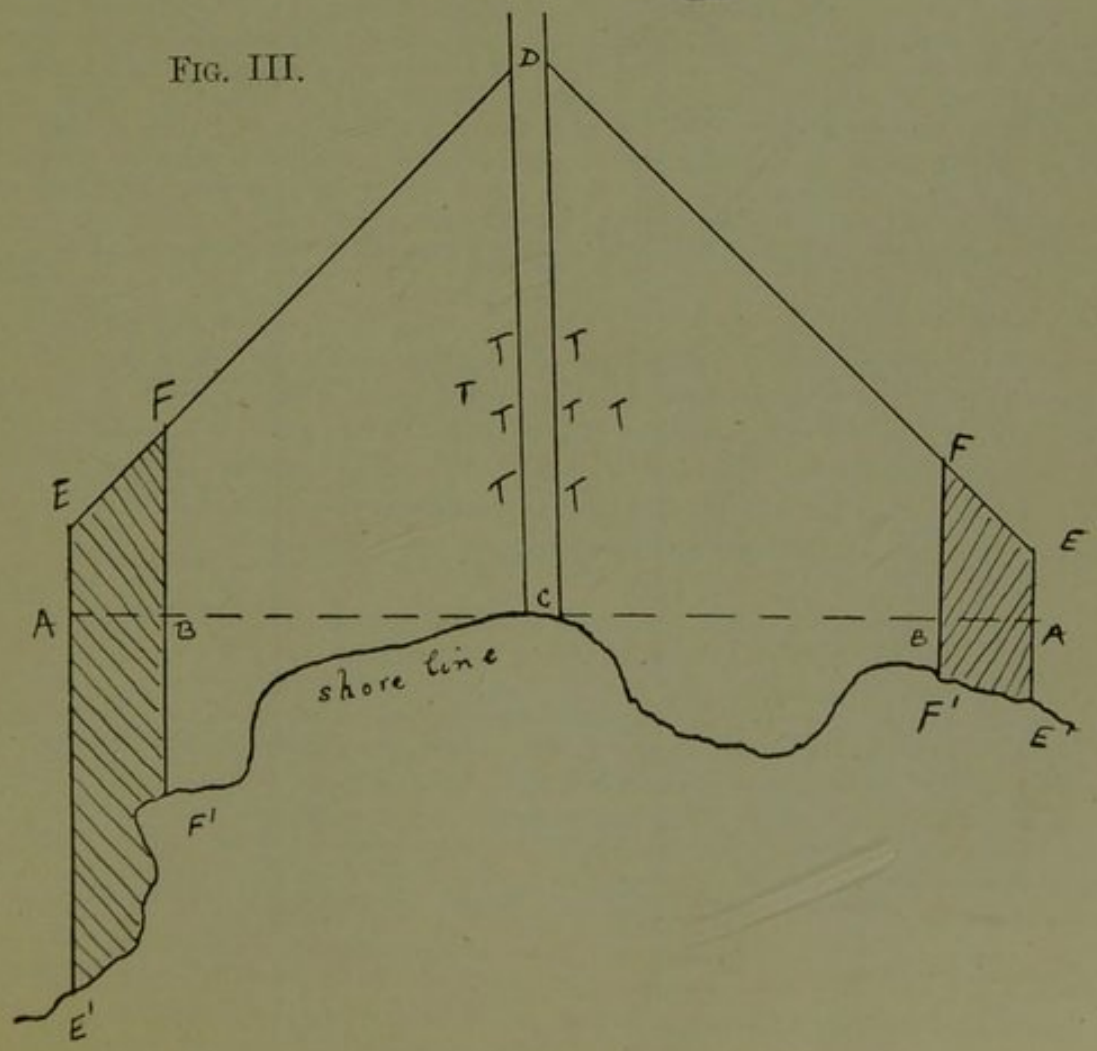


FIG. III.



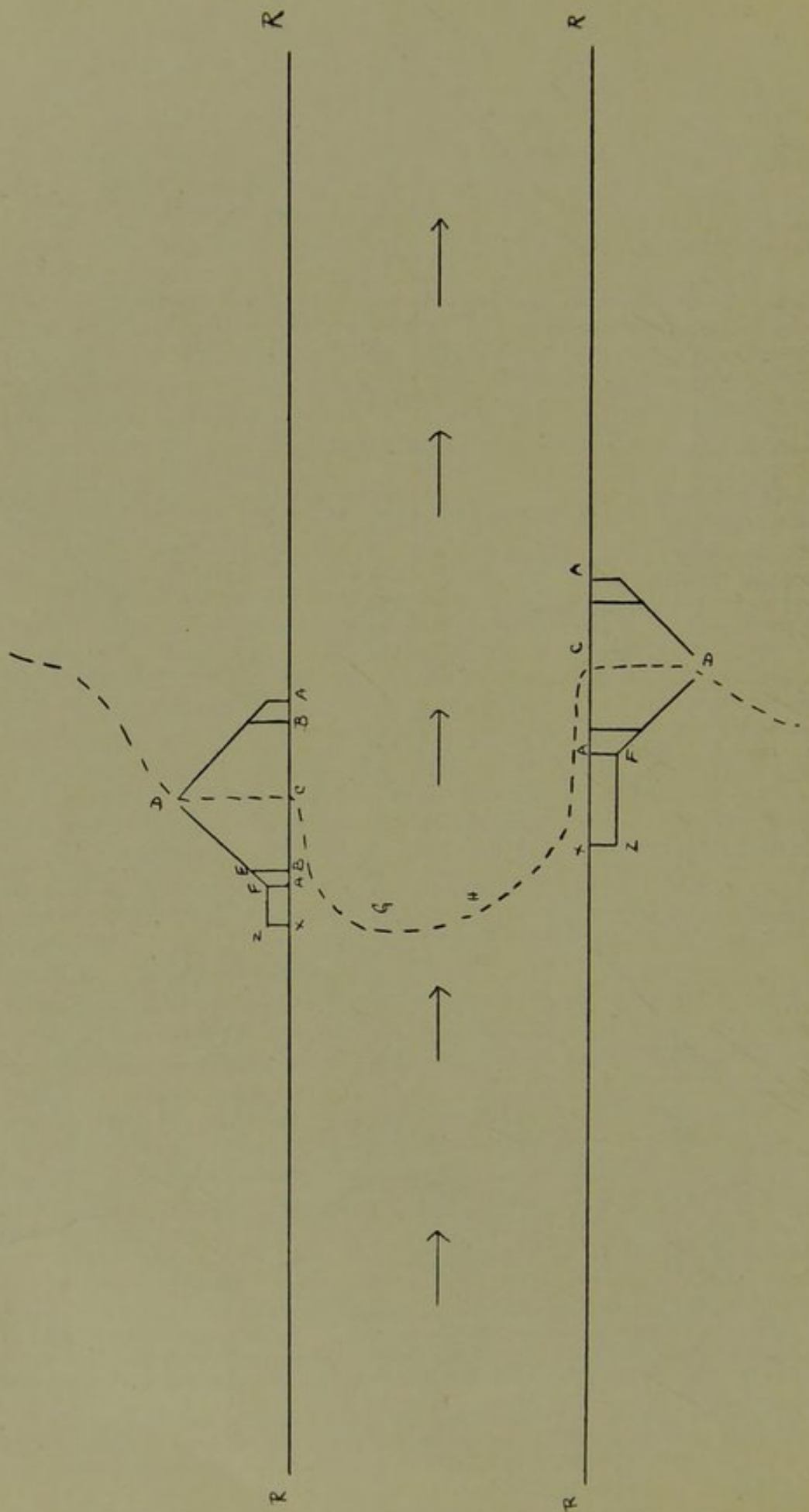


FIG. IV.

S.S.E.I.'s Office,
Entebbe,
21st March, 1907.

It is most important from a practical and economical point of view that those officials who may be detailed to carry out or superintend preventive clearing directed against *Glossina palpalis* should thoroughly understand the kind of clearing which is required for this purpose.

It does not seem to have been fully grasped yet that the undergrowth is the true resort and refuge of the fly and that trees, especially tall or large trees, matter very little in this connection.

All shrubs, bushes, vines, creepers, tall grass or cane-break, with all the tangle of herbaceous plants which go to constitute what is called scrub, bush or jungle, it is essential to remove completely. But a certain number of timber trees can always be spared if so desired, and it will be rarely that any particular tree cannot be preserved with safety. Trees need not necessarily be cut down unless they overhang the water; or their foliage reaches, or nearly reaches, the ground so as to mix with the undergrowth, or unless they stand very close together. In the second case it will be sufficient to lop the lower branches of those trees which it is wished to preserve. Clean-stemmed trees and saplings, unless crowded together, are harmless as regards cover for the fly, even near to the water. All trees must be cleared as far as possible of vines and creepers.

It appears to me that preventive clearing would be much more scientific and economical, and much more certain and satisfactory in its results, if it were carried out according to a definite plan, in all cases and as a routine, unless special instructions were given to vary or depart from this.

I have therefore prepared and beg to propose, as the type most generally applicable, the following scheme, a copy of which could be supplied for guidance to every official to whom the conduct of this important work may be entrusted. It is based on a strip of clearing 100 yards in width from the waterside, because that is the average width which will commonly be required; because practically all variations which may be needed will be within that width and most within the first 50 yards of it; and because in any clearing which may be required of greater width, either clearing as in the outer strip (No. 3) may be extended, or as is generally sufficient beyond 100 yards, the undergrowth only would be removed and the trees dealt with as convenient. As here stated this scheme represents the average minimum clearing required, and nearly all variations will be in the direction of more complete or wider clearing.

It is as follows:—

1. Inner belt 20 yards wide from the waterside. To be absolutely cleared of all save clean-stemmed trees, their branches lopped, when necessary, to 15 feet from the ground, not to overhang the water, and not more than 5 per acre.

2. Middle belt 30 yards wide. Ditto except trees or saplings, lopped where necessary to 10 feet from the ground, and not more than 15 per acre.

3. Outer belt, 50 yards wide. All undergrowth removed. Trees may be left up to 50 per acre.

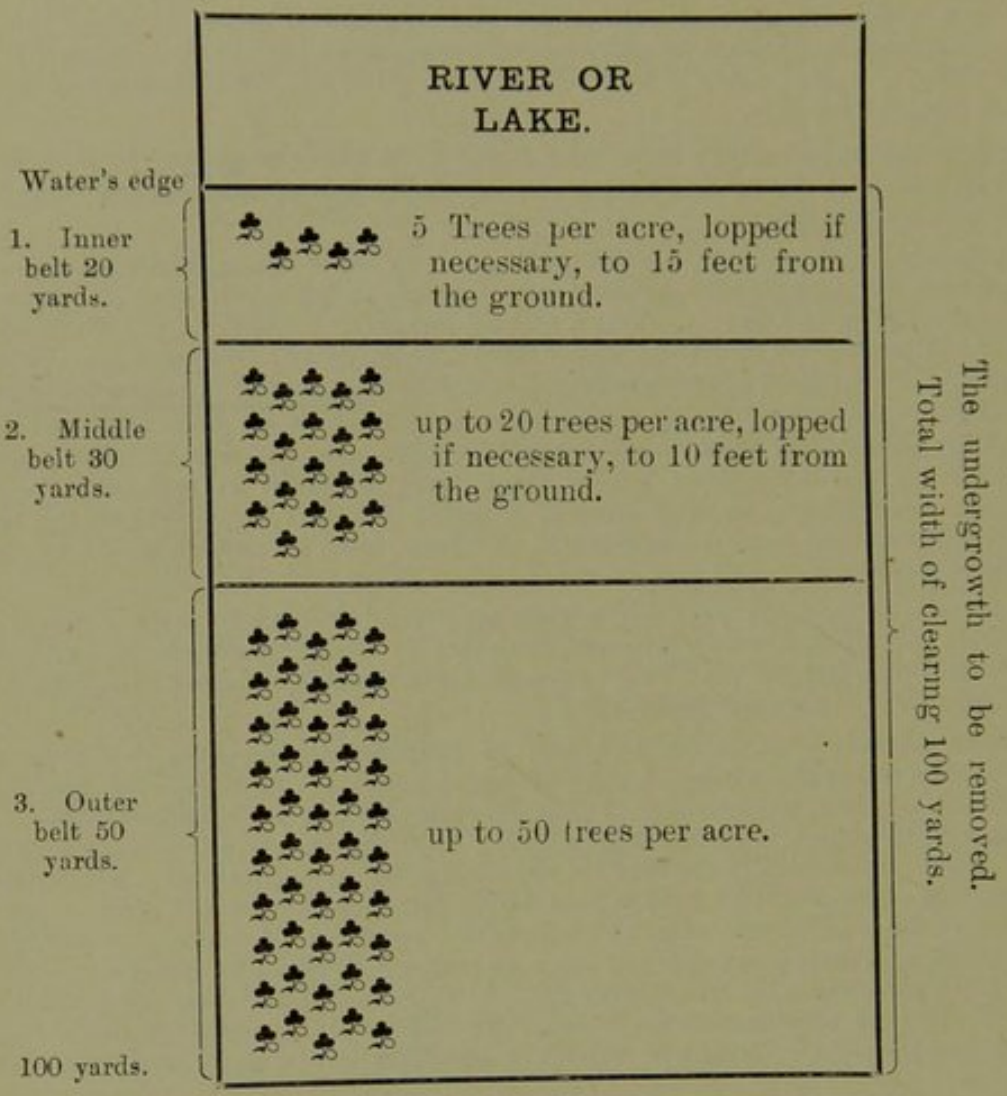
Trees which are left should be well cleared of vines and creepers. Trees which are felled should not be left lying, but the tops which afford cover like undergrowth should be at once cut up. If at the waterside there is a cliff or a sheer or very steep bank, the width of the inner belt should be measured from the top of this and not from the actual water's edge. Beyond 100 yards, if clearing is carried beyond this width, it will be sufficient, as a rule, to remove the undergrowth and leave the trees.

To meet local wishes or requirements many variations of the typical scheme are possible, as *e.g.*, the inner belt could be cleared bare and the trees left on the middle one reduced to 5 per acre, or the 3 belts could be made 50 yards wide each, or the two inner ones 50 yards each and the outer 100 yards, and so on.

It is to be taken for granted that trees and bushes in the water itself, such as ambatch, must be removed in all cases.

The following diagram is intended to illustrate the above scheme and I hope that it will be easy to see from it what is intended.

Section of Clearing, 100 Yards Width.



Beyond this, clearing can be made as in No. 3 but it is usually sufficient to clear the undergrowth only.

(*Signed*) A. D. P. HODGES,
Medical Officer-in-Charge,
S.S. Extended Investigations.

NOTE ON DR. BAGSHAWE'S DISCOVERIES OF PUPAE AND BREEDING-PLACES.

Those passages in Dr. Bagshawe's reports which describe his further* observations and discoveries in connection with the breeding-places of *G. palpalis*, the deposit of pupae and his method of finding them, are quoted in full and attached hereto; and also those relating to his discovery of the pupae of a larger species of *Glossina*, which he thought to be *fusca*.

An insect which had hatched out from one of these large pupae was sent in for identification and, though it had not arrived at maturity, it was sufficiently developed to enable me to decide that the surmise as to its species was correct.

The pupae of *G. fusca* were first discovered by Dr. Bagshawe on December 5th, 1906, and they were found on several occasions in the same localities with those of *G. palpalis*.

One of the most interesting observations with regard to pupal deposits was made on the left bank of the Nile between Mruli and Foweira, where the pupae of *G. palpalis* were found in loose earth round the bases of stems of the wild date-palm. The previous discoveries had been made in the western borders of the Protectorate, a country of rock, scrub and open rivers, whereas in the present case the conditions resembled those more generally found in the eastern or Lake Victoria region, namely, luxuriant jungle-vegetation bordering on stretches of reed-fringed or swamped-fringed lake or river.

It will be remembered that the first pupae discovered were found by Dr. Bagshawe deposited around the bases of the stems of banana-plants. I pointed out at the time that it would be premature to suppose any more than an occasional connection between the banana and the breeding-grounds, and this precaution has been justified by the fact that the breeding-grounds since discovered have had no connection with banana-plants. In the region of Lake Albert which was investigated by Dr. Bagshawe bananas are not cultivated, and he saw only four plants there, though he found numerous fly-areas and many pupal deposits. Since his first discovery he has found pupae under shrubs of species of *Allophyllus*, under a species of wild fig-tree, under the wild date-palm, under other species of shrubs and under tangled masses of creepers.†

It seems to me unlikely that either these or any other species of trees or shrubs are indispensable for the deposit of pupae, but no doubt some species more than others provide, or assist in providing, the necessary conditions. It would be of great use, however, to determine what these species are, and it would be of still greater use if we could discover trees or shrubs which, being antagonistic to the fly as regards its haunts and breeding-places, would flourish at the water-side.

It would appear that among the chief conditions required for the deposit of pupae are patches of dry, loose, friable earth and vegetable debris, which are protected from sun and from rain by shade, and where, from lack of moisture or other reasons, grass and such like small vegetation grows sparsely or not at all.

---

* For the original observations *vide Reports of the Sleeping Sickness Commission of the Royal Society*, 1908, *IX*, *p.* 48.

† *i.e.* creepers supported by trees and shrubs.

Such conditions are most often realised around the bases of comparatively clean-stemmed shrubs and trees, and under tangled masses of shrub and creeper overhanging the crevices among rocks. The requisite shade may be afforded by the shrub or tree itself, or, as must happen, for example, in the case of the wild date-palm, by shrub or under-growth surrounding its base. In the case of banana plants additional shade, either from surrounding under-growth or from overhanging trees, would probably always be necessary. Pupae have not been found under clean-stemmed trees where undergrowth is absent.

In all probability the larvae are placed close to the stems of trees or shrubs or in the interstices of basal or buttress roots or of rocks in order to guard them from injury and to prevent them from being washed away by rain. It seems possible that they also may be deposited in such earth-filled hollows or crevices in *tree-trunks and branches as exist at no great distance from the ground and are not liable to be flooded by rain. This might happen especially where there was not sufficient bank at the water-side to form a safe deposit and where the other conditions were favourable to the fly's existence.

Apart from such a possibility it is apparently an essential condition for breeding-places that there should be a well-defined upward slope of the ground from the water's edge, while steep banks or cliffs seem to be exceptionally favourable for pupal deposits.

The pupae hitherto found have been placed on scrub-covered banks or shelving ground at a sufficient distance above high water-mark to avoid the probability of their being washed away or destroyed by floods, and also near enough to water-ways to protect them from being, in ordinary seasons, destroyed by bush or forest fires. It is unusual, according to Dr. Bagshawe, to find them more than twenty yards beyond high water-mark.

It is unlikely, therefore, that much can be done, under natural conditions, towards the destruction of pupae by means of fire; but, by cutting down the scrub along fly-infested banks, allowing it to dry, and then burning it *in situ*, it is probable that a great many pupae would be destroyed at the same time that the banks were rendered unsuitable for further deposits.†

Dr. Bagshawe is of opinion that natives could, with practice and training, discover pupal deposits fairly easily and thus destroy them in large numbers. Unfortunately such a procedure would involve considerable danger to the natives so employed, in any region where Sleeping Sickness is present; but experiments in this direction could be undertaken without danger in our non-infected fly-areas and might lead to most valuable results.‡

Dr. Bagshawe frequently found pupae deposited in considerable

---

* Zupitza has found them in these situations at Duala in the Cameroons. (*Beiheft 2 zum Archiv f. Schiffs- und Tropen Hyg.* 1908. *April, Vol. XII.*)

I think it probable that they would be found in trees in Uganda also at times or places where rainfall is frequent.

† This should be tried after the commencement of the dry season. If it were done in the wet, fresh vegetation would spring up before the scrub was dry enough to burn, and the fly would flourish more than ever. I have seen an instance of this.

‡ Dr. Hodges has lost sight of the fact that the search is made at dawn and in the late afternoon when the flies do not show themselves and are disinclined to feed. Neither my natives nor I were ever bitten, to my remembrance.

numbers within a circumscribed area. *In such an area they were sometimes found in batches or pockets of five or six together, at other times in twos or threes, and frequently they were single. No doubt the varying conditions at the waterside govern the manner of deposit, and some breeding-grounds would be much more difficult to deal with than others. A large area of potential breeding-ground might entail a sparse deposit of pupae and *vice versâ*, and the wider the breeding-ground and the sparser the deposit the more difficult it would be to destroy the pupae.

It is evident that it will be important, in choosing situations for landings ferries, fords, etc., to take into careful consideration the knowledge we have gained both as to the conditions in which pupae are deposited and as to the flight and range of *G. palpalis*.

For example, localities, where the conditions are such that the whole bank or shore, or a large part of it, may form a potential breeding-ground, must be avoided. Localities should be selected where the places likely to be used for pupal deposit are few and circumscribed and can be suitably dealt with by clearing. Also, the position of probable breeding-grounds should always be noted in relation to clearings and the maintenance of cleared areas.

Dr. Bagshawe made the very interesting observation that certain empty pupal shells of *G. palpalis* presented a small aperture through which on one occasion minute winged insects were seen to emerge. Unfortunately he did not succeed in preserving specimens of these insects, which he thought might be the imagos of an ichneumon fly.† It is to be hoped that opportunities may be afforded for further investigation on this point.

Most of Dr. Bagshawe's observations were made during the dry season and the great majority of the pupae found were empty. The empty cases were nearer to the surface than the full ones, showing that the pupae probably rise to the surface when they become mature. Dr. Bagshawe remarks that the pupal cases, or shells, appear to be extremely resistant to decay and that some of the deposits which he found might represent the accumulation of several seasons.

It is probable that a larger proportion of living pupae would be found during or immediately after the wet season.

(Signed) A. D. P. Hodges.

---

* The "batches" or "pockets" were exceptional. Far more frequently the pupae were single. As a rule, as Dr. Hodges remarks, the area available for pupal deposit is large.

† More probably, I am informed by Mr. Austen, they belonged to a species of *Chalcididae*.

EXTRACTS FROM DR. A. G. BAGSHAWE'S REPORTS.

NOVEMBER, 1906.

Where fly are very scarce it is obviously of little use to search for pupae I have therefore not paid much attention to the search for pupae this month. I sought them without success on the *Rugeye. On the river at Nyamasenzi I noticed ten feet above the water at the top of a steep bank the multiple buttress roots of a fig tree clasping a †" nsambya." The conditions below were almost those of a large hollow trunk. The soil was quite dry and crumbly. Here I went to search and found pupae at once. Eleven occupied and seventy-six empty cases were obtained.

DECEMBER, 1906.

It was noted in my November report that of 94 pupal cases found by the river Mizizi only 3 had occupants.

On the 4th December on the top of a high steep bank above the lesser branch of the Mizizi in the shade of various shrubs 130 small and 14 large (*? fusca*) empty cases were found but only one occupied pupa. Some of these shells may have been there for a long time, some were full of earth. They are probably resistant to decay. I noted that two pupal cases were entire but for a minute hole in the side and on another occasion from such a pupa many small winged insects emerged: they were unfortunately lost. They may have been the imagos of an ichneumon fly which had devoured the developing insect. If this should prove to be so and we could encourage the enemy it is conceivable we might lessen the number of tsetse that would hatch out. The larger pupal cases might I thought be those of *G. fusca*. Later I found a full one and kept it, it was not tightly packed for a march and the insect came out prematurely: it appears to be *G. fusca* (specimen forwarded).‡

On the 5th, of 135 small pupae—3 were occupied.
of 17 large pupae—1 was occupied.

These were found on the §" island " all within ten yards of the water on a shaded dry bank.

On the 6th at the spot 200–250 yards from the water (the dry gully) 86 small pupal cases of which 3 were occupied, and 8 large empty ones were found. The bank was steep above the channel where water would flow. There was scrubby shade and many dead leaves.

On the 7th on the same spot were found 111 small pupae of which 2 were occupied and 17 large empty pupae.

On the 10th at the head of the bay near "Manara's boma" 102 pupae were found and of these 22 were intact. They were on a fairly steep slope

---

* The places mentioned in my November, December and January Reports are on the south-west and south-east shores of Lake Albert or within a few miles of that lake.

† Native name of *Dolichandrone platycalyx*, Baker, a well-known timber tree.

‡ The specimen is at the Natural History Museum; it has been identified by Mr. Austen as *G. fusca*.

Though large puparia, presumably of *G. fusca*, were found in many places along the south-eastern shore of Lake Albert, the fly was never seen. *Palpalis* was the only species caught. The large pupal cases were of such a size that the small fitted loosely inside them.

§ At this point the river Mzizi divided, the branches joining again below; the small wooded tract enclosed would be nearly submerged at times of spate.

within 7 yards of water (the lake) in the shade of *Allophyllus* and other shrubs and creepers.

On the 12th at Kitebere of 44 pupal cases only one was occupied. At the Ngusi-Mpamba confluence one empty pupa was found in debris in the shelter of a large overhanging rock. Omitting the pupae found near "Manara's boma," of 557 pupal cases only 14 had occupants, a percentage of little over two and a half.

It is noteworthy that at Kitebere where only one female fly was taken 44 pupae were found in an hour at the first spot searched. Of course they may have been accumulating, only one was occupied. On the other hand the native statement that the fly are now scarce may be worthy of credence. (Where "small pupae" or "pupae" are mentioned it is presumed that they are those of *G. palpalis*: these however are not uniform in size).

I have nothing to add to what I have written about the breeding places except that pupae as well as fly may be found in dry shaded gullies. When fly have been found at any spot it is best usually to search close to the trunks of trees and shrubs.

When asked about *mbara* (tsetse) the natives all along the lake shore say—Now they are very few because it is the *kyanda* (dry season) when the *mugusa* (millet) comes again they will increase.—The millet comes up I believe in April. This would mean that the fly breed chiefly at the end of the dry season or more probably at the beginning of the rains. If this is true and it is certainly generally believed it would account for the small number of intact pupae. The dry season set in early in November in the Semiliki valley; since then I have been close to or within ten miles of the Lake Albert. Rain has fallen only on November 21st, December 14th and 17th.*

JANUARY, 1907.

Pupae were sought in the dry gully near Kaiso but without success. Below the Wambabya Falls 30 full and 17 empty pupae were found all in one spot—in the shade of a large *Allophyllus* shrub near its trunk where much loose debris had collected 25 yards from water and 10 feet or more above it.

At the mouth of the Hoima river a few empty shells were found. Here the search was difficult because the area of ground suitable for breeding was large, there being woody shade a steep bank and loose mould in abundance.

Below the Waki fall there were found 90 small empty shells, 1 large (? *Gl. fusca*) and 5 small pupae. They were scattered on the rather steep wooded hill-side about 20 yards from the water.

Below the Wambabya Falls 63% of the pupae found were full. Below the Waki Falls 5·2% of the pupae found were full. Referring again to my notes I find that omitting my original discovery of pupae when the empty shells were not counted and many were seen but not picked up, in three places only has the proportion of full to empty pupae been much over 5%.

At "Manara's boma" (Tonya),	of	102	pupae	22 were full,	21·5%.
„ Harubale, in one spot	„	145	„	39 „	26·8%.
„ Wambabya falls	„	47	„	30 „	63%.

* This was written on January 3rd.

In each case the pupae were aggregated under an **Allophyllus* shrub. It may be that when this shrub occurs near water where *G. palpalis* exist the physical conditions occasioned by it are eminently favourable for breeding. Should this be so the extermination of *Allophyllus* in fly areas might have the same effect as an extensive clearing. †More observations are, of course, needed. The shrub is well known to the Banyoro and Batoro as *mutete*, and I am informed by my interpreter that the Luganda name is the same, It is used everywhere for making fire by friction and for walking sticks. There is more than one species. All have leaves of three leaflets, minute white flowers and globular seed-vessels smaller than peas and usually in pairs. Some dried leaves are enclosed. The Officer in charge of the Botanical Department would point out living shrubs in or near Entebbe.

MARCH, 1907.

I landed to-day on the Unyoro side of the Victoria Nile at a point below Kijumbura where was a small patch of jungle at the river's edge. It consisted of two clumps of wild date palm, with shrubs and creepers. *Glossina palpalis* was seen very soon, and in the course of an hour (9.30–10.30 a.m.) there were caught 9 male and 2 female; no other species of *Glossina* was taken. I searched for pupae around the palm stems where the soil was heaped-up dry and crumbly, and mixed with debris of fronds and leaf bases. There were found thirty empty and one full pupa.

This observation is perhaps of importance for the wild-date palm, "Makindu" (*Phoenix reclinata*) is common round the Victoria Lake.

APRIL, 1907.

PUPAE.—I had meant to work on this subject at Foweira in the intervals of flight experiments but the weather was too unfavourable. When the ground is wet the earth sticks to the fingers and the search becomes difficult as well as unpleasant.

Near the ‡Karuma falls pupae were found chiefly in two situations:—

(a) There were found about and within the buttress and flying buttress roots of a large fig, eight yards from the river and ten feet above it nineteen shells—on the surface a *Glossina palpalis* just hatched out, its proboscis still folded beneath it.

(b) Among rocks close to water and three feet above it in the dense shade of a fig covered with creepers were found twenty-two shells. Another day many shells and three full pupae were found on a steep wooded bank much above the water, twenty feet or more.

---

* A genus of N. O. *Sapindaceae* widely distributed in Africa. Mr. Edmund Baker of the Natural History Museum informs me that at least thirty-seven species from Tropical Africa have been described.

† Another possible explanation occurs to me. At the time of my visit many shrubs had shed their leaves, thereby avoiding the loss of water by evaporation due to the great sun-heat in the rainless season. On others the leaves hung down, shrivelled and to all appearance lifeless. *Allophyllus* seemed unaffected by the seasonal conditions and gave much denser shade than other shrubs. This being so, pregnant females might choose the shade of *Allophyllus* for the deposit of their larvae *during the dry season*. Observations in the wet season would decide this point.

‡ It was here that Speke crossed the Victoria Nile. The falls are figured in his book, *Journal of the Discovery of the Source of the Nile*, 1863, *p.* 568.

In my opinion the time is now ripe for a concerted attack on the breeding grounds of *Gl. palpalis* in limited areas. The search for pupae is tedious but it is well suited to the native and under direction he will do much useful work. Had I a staff of intelligent natives and six weeks at my disposal I would engage to add much to our knowledge of breeding grounds and the natives who had learnt would teach others. If as I suspect certain trees and shrubs produce conditions specially suitable for the harbouring of pupae these could be extirpated and much clearing could be done at small expenditure of time, money or labour. Intelligent Baganda would not be slow to appreciate this.

For the present I would inculpate the following plants :—

Bananas (with scrub and water in the immediate neighbourhood).
Allophyllus (mutete) a widely spread shrub.
Large figs with their intricate root arrangements.
The wild date palm.

It is not uncommon to find a few pupae in dry earth sheltered by overhanging rocks on wooded banks; I have never found a large collection.

NOTE ON DR. BAGSHAWE'S REPORT ON FLIGHT EXPERIMENTS.

This report contains observations which are both interesting and important and I am sorry that I did not see it until after I returned to Uganda from leave in March last.

Dr. Bagshawe was requested to continue the experiments which he had already undertaken in Toro and Unyoro, an account of which was included in the First Half Yearly Report, but he found no favourable opportunity for doing so until he arrived, in the course of his investigations, at Foweira, on the Victoria Nile.

His main object was to test by experiment the range of flight of *G. palpalis* :—

(1) Along the course of rivers.
(2) Across broad rivers.

He was instructed to make comparative studies of the range of flight in the following conditions :—

(a) Along banks affording continuous or practically continuous shade. In the case of narrow streams both banks to count as one.

(b) Along banks with scattered or decidedly intermittent shade, with the same proviso for narrow streams.

(c) Along unshaded banks of narrow and broad rivers, the banks themselves not to afford shade.

(d) Along margins of rivers or lakes to study the influence, on limitation or interruption of flight, of blocks of sudd and of clear or artificially cleared spaces.

He was also asked to study the range of flight along and across rivers under conditions of :—

(e) Habitual human traffic.
(f) Intermittent human traffic.
(g) Absence or impossibility of human traffic.

Attention was also to be given to the influence of the traffic along or across rivers of land and water animals, such as game, hippo and crocodiles.

It was pointed out in Dr. Bagshawe's instructions that the distance to which *G. palpalis* may be carried on boats, provided that shade is available and that it can rest free from constant interruption, is apparently unlimited. It was also pointed out that the influence of conditions, such as cleared spaces, causing blocks or limitations to the flight of *G. palpalis* along watersides would be most important to ascertain in relation to preventive clearing, and he was asked to determine, if possible, the degree or extent of such blocks sufficient to bar the progress of the fly. The influence on the range of flight across open spaces of the existence of breeding grounds in their vicinity was also to be enquired into.

It was hoped that a series of experiments of this kind would throw considerable light on the conditions determining the migration and distribution of *G. palpalis* and also the extent of its feeding range from the breeding places.

The series of experiments described in the attached report deals mainly with the flight of *G. palpalis* along and across a broad river where there exists habitual human traffic and also continuous shade along the banks. Unhappily Dr. Bagshawe was not able, owing to pressure of time and scarcity of food, to finish his experiments, and he considered that at least three months would be required by a qualified observer for the completion of the series.

It will be seen, therefore, that much important investigation remains to be done on the lines indicated above and including the suggestion made by Dr. Bagshawe at the end of his report.

It is most unfortunate that there has never since been a Medical Officer available for this class of work. After Dr. Bagshawe left, the services of Dr. van Someren, who was detailed to continue the research, were almost immediately required in connection with the segregation camps.

The attached report emphasises the importance of human traffic as a factor in influencing the range of flight and local distribution of the fly; it shows the wide range of individual flies under favourable conditions and it also shows how considerable stretches of even broad rivers may become infested with flies from a few breeding grounds on either bank by means of boat traffic; in the same way that, as I have previously pointed out, the forest fringes along watersides sometimes become infested throughout their extent by means of land-traffic.

Dr. Bagshawe remarks, in making his suggestions for further experiments, that wherever there are rapids the river is considerably narrower. I would point out there are many parts in the Victoria Nile where there are rapids, owing to which human traffic from bank to bank is infrequent or impossible, and where the river has a breadth equal to, or even greater

than its breadth at the scene of his experiments, which he gives at about 300 yards. Comparative experiments on navigable and unnavigable sections of river would of course need to be carried out at points where the breadth was approximately the same.

In conclusion I venture to hope that opportunities may be given for the continuance of experiments such as those recorded above, a course which has hitherto been impossible owing to lack of staff.

The knowledge to be gained from such experiments is likely, in my opinion, to be of great value in guiding, strengthening and elaborating our measures for the prevention of Sleeping Sickness and should also enable us to apply them with greater economy.

The present uncertain position held by Atoxyl and allied drugs, as curative and preventive agents, is far from warranting any relaxation in the search for and application of general preventive measures, which still remain, to my mind, of the first importance in dealing with the disease.

(Signed) A. D. P. Hodges.

Report on Flight Experiments by Dr. Bagshawe. April, 1907.

*In marking flies for subsequent identification I followed the method adopted on the Mpanga river last August, in which a leg was snipped off with scissors at or just above the tibio-femoral joint. I have considered other ways but I do not think it is possible to better this. The flies are readily identified when re-caught. I have shown that though the legs of *Gl. palpalis* are sometimes found to be deficient (tarsi torn off or one limb wholly missing), flies are not maimed in the way described. That flies survive the operation in considerable numbers is shown by the fact that of 480 flies marked at A (*vide* sketch) 53 were re-caught, that is more than 11% and of those marked and released at A, 17·7% were re-caught. The marking was done on April 10th, 14th, 15th, 16th, and 17th and the flies were retaken from the 13th to the 26th. Had I been able to remain longer I should doubtless have re-caught more for on the 26th three flies marked at A were taken. I do not think it is material which pair of legs is chosen: one can therefore do six series of experiments at one place.

Detailed Account of Experiments.

On April 10th a boat landing place A was selected as the upper limit of abundant fly on this part of the Nile, about a mile above the camp C. A fly was caught by the fly boys, taken out of the net by my dresser and held in a suitable position. Having examined its legs and noted its sex I seized its *right fore leg* with forceps and snipped it off at the femoro-tibial joint. The fly was put into a cage. The process was gone through with each fly till 100 had been treated. All my assistants were then sent away and the flies liberated at the same spot.

To determine readily the incidence of males and females the sexes were

* Vide *Reports of the Sleeping Sickness Commission of the Royal Society*, 1908, *No. IX.* *p.* 45.

put down in parallel columns and a fresh line was started at the end of each series of 10 male or female. In point of fact when the male line reached 10 the female almost invariably at Foweira showed a lower number. Notes of weather were taken. Opportunity too was afforded of noting the sex of gorged flies, *i.e.* flies with visible blood in the abdomen.*

On April 11th and 13th the same procedure was followed at B, half a mile below, the *left fore leg* being selected and the flies released at the same spot. A watch was kept for flies marked at A. If such were identified the fact and the sex were noted and the fly killed.

On the 14th more flies were marked at A, the *left hind leg* being snipped. These were taken across to the opposite shore a little lower down where was a landing place used by fishermen (WA): this spot was swampy and without woody vegetation; it was free from fly. It was in a small bay to which the fishermen who embarked at A were in the habit of going to catch fish. Here the flies were released. The boat was delayed at that bank of the river for some time and was not taken back to A but to C. A fly was noted in the boat in midstream and doubtless got across. I wished to find out how many of these would be re-caught at A and elsewhere. Should they have any homing instinct more should be caught at A than at other places. In point of fact, of the 14 re-caught 10 were taken at A, but A was one of the nearest points on the opposite shore and that to which most of the fishing canoes went.

On the 15th more flies were treated in the same way and liberated at WA: none of the flies of the 14th were seen there.

On the 16th flies were treated at A as on the 10th and at B as on the 11th.

On the 17th flies were marked at A by snipping the *right posterior leg*; these were taken away from the bank into the grass jungle for a distance of 500 yards in a direct line from the river and there set free (LA). It was sought to find the relative proportion of LA and WA flies retaken.

On the 18th and 19th flies were caught at A and C (camp) and examined afterwards.

On the 21st I crossed to D, a landing place on the Bukedi side where fly were plentiful. Flies were caught and marked (*right mid leg*) and released at the same spot. On the 22nd flies were marked (*left mid leg*) at a landing place on that side three quarters of a mile lower down (F), just above the rapids.

On the 23rd, 24th, 25th and 26th flies were caught at various points including two other landing places on the Chope side (E and G) and afterwards examined.

Results.

The results are shown on the accompanying tables. I wished to remain a week longer to get more complete figures but was prevented by famine and by the necessity of leaving for Fajao. As it was I was handicapped much by bad weather, and had to waste two mornings hunting game for the porters.

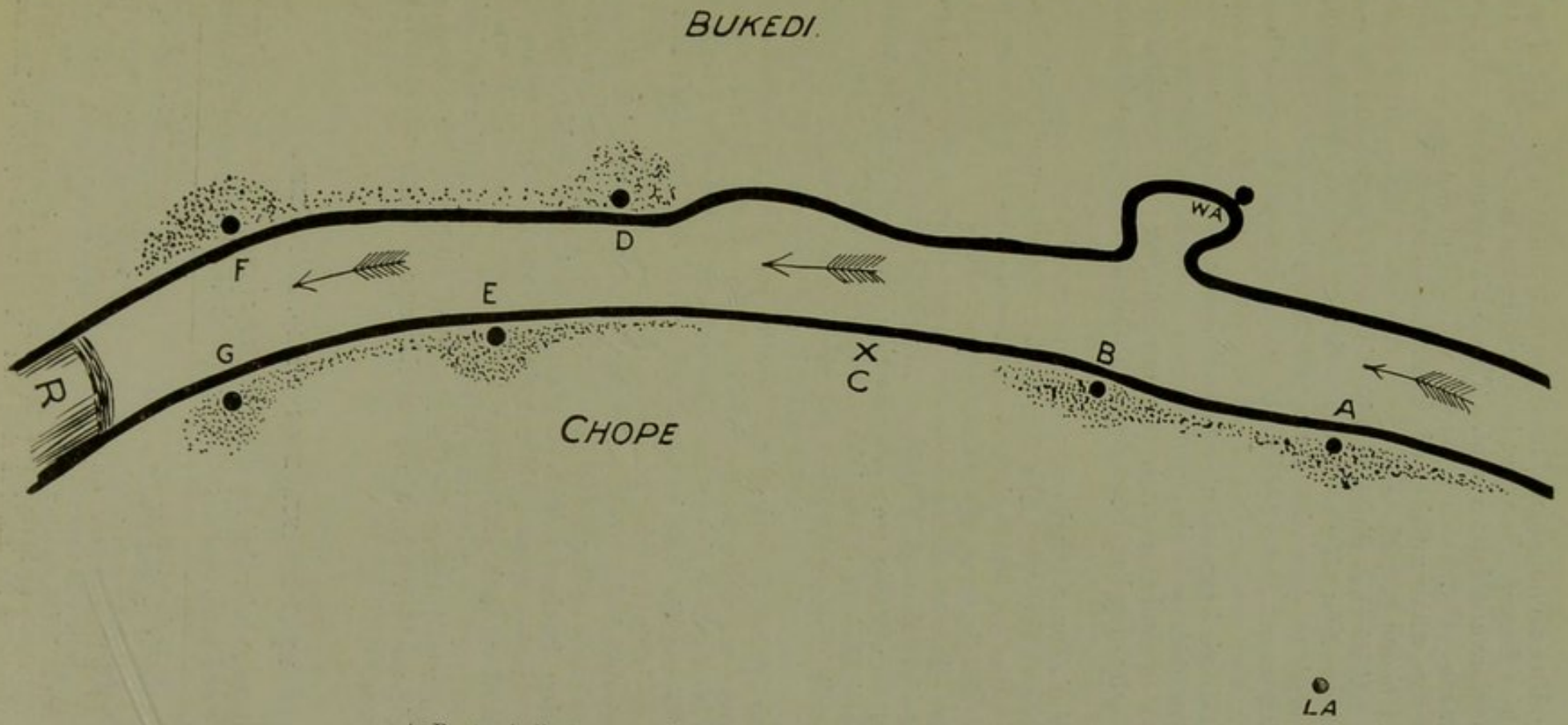
†Table I shows the number of flies that were marked at each spot, and

---

* Of these flies 32 were male and 20 female, figures which almost correspond to the proportion of each sex caught.

† *Vide* page 27.

Sketch of Nile at Foweira to illustrate flight experiments.



A, B, etc., indicate spots where fly were caught or released.
C shows the site of the camp.
A–B = ½ mile, B–C = ½ mile, C–D = ½ mile, D–F = ¾ mile. Total 2¼ miles.
The continuous line is the river bank.
The dots show fly areas.
At R the rapids commence.
Average width of river at Foweira 300 yards.

the number and percentages of those re-taken elsewhere. The small number of D and F flies re-taken may be attributed to the shortness of the period in which they could be caught. The table shows that male and female flies travel equally.

Table II shows what number of flies marked at each place were retaken at other places and where.

It will be noticed that while 10 WA flies were recaught at A, only 3 LA flies were recaught there. A proportion of 5 to 3. The numbers are small but tend to show the great part taken by boats in carrying *Gl. palpalis*. There was much traffic of small dug-out canoes between WA and A.

The same thing is brought out by the C figures. Not only were flies caught here identified as having come from 5 out of 6 possible places but the proportion of marked flies caught was much higher than anywhere else. C was not in a fly area but boats came to this, the camp landing place from all parts.

At D and F flies were caught on one occasion only.

The table shows that two flies travelled two and a quarter miles, one one and three quarters, two one and a half, one one and a quarter and eight one mile (the distances are not overestimated).

Of these long-distance flies nine were male and five female.

It will be noticed that while thirteen travelled down stream only one travelled up stream. This fact loses its significance when it is observed that on the five occasions on which upstream flies could be caught 552 were examined whereas on the three occasions on which down-stream flies could be caught only 145 were examined and also that 635 flies were marked above (at A and B) and only 258 below (D and F). None the less one would expect a greater number of flies to be conveyed down stream than up for boats make quicker passages with the current and therefore carry flies twice the distance in the same or less time, and such flies as alight on floating islands are invariably taken down stream.

I have underlined the bank to bank flights to distinguish them at a glance from the along-bank flights. Leaving out of account WA to A where a homing instinct might play a part it is noticeable that the majority of flies which crossed did not do so between the nearest points on opposite banks; thus there were no flights between WA and B, none between D and C, nor between D and E. This is additional evidence that flies are conveyed across for the most part by boats, for if they got across by their unaided efforts one would expect them to choose the shortest passages.*

Conditions Influencing Flight of Flies.

Boats.—In my opinion by far the most important.

I have watched a *Gl. palpalis* settled on a small dug-out canoe remaining

* It also goes far to show that *G. palpalis* does not make such long flights as would be necessary to cross this river, and therefore that such a river is an efficient barrier in the absence of boats. An observation which I made on the Semliki at the edge of the great forest is of interest in this connection. On one side of the river were three native huts close to the bank. Fly was scarce, 18 were caught in three hours; on the other bank, uninhabited, 48 were caught in two hours, weather conditions being the same. The stream was 70–80 yards wide. If *G. palpalis* could cover this distance in a single flight the flies should have been at least as numerous on the inhabited side, where blood was always to be had during the hours of activity of the fly.

with occasional shifts of position for half an hour. There is no limit to the distance flies may be carried if undisturbed. There is much fishing in this part of the river and natives pass freely between the Bukedi and Chope shores. At A there were at times five small canoes: none would hold more than three persons.

Floating Papyrus Islands.—These are common phenomena and doubtless often afford the tsetse a rest. Flies may be carried long distances down stream. One such island I estimated to be fifty yards long. Crocodiles and birds take passage on them.

Water and Land Animals.—In this part of the river their share if any is insignificant. Only crocodile and hippopotamus need be considered. Crocodiles are not often visible except on the bank and do not swim long distances above water. Hippos are few and nearly always to be found near or in the papyrus belts where fly are few or absent.

Paths along banks.—There are none: all the paths lead away from the water.

Conclusions.

Pending further experiments we may I think say:—On broad navigable rivers where fly-areas exist on both sides, where fishermen ply their trade and ferries exist, *Gl. palpalis* may and probably do visit the landing places on either bank along a stretch of river two miles in length and flights of one mile are fairly common.*

In such cases the chief means of transport is by boat and possibly by floating islands if such exist.

In these experiments the range of flight on a broad river where there is "habitual human traffic" has been dealt with both in the course of and across the stream.

It is difficult to keep the two inquiries apart. The banks at Foweira afford "continuous or practically continuous †shade." The width of the river is perhaps three hundred yards.

I have not had time to investigate the range of flight where there is "impossibility for human traffic" nor the "influence of cleared or naturally clear places."

With regard to the former wherever there are rapids the river is considerably narrower and there are usually islands or rocks on which the fly might rest. In such parts of the river there would usually be fly areas opposite.

In this case experiments should be carried out (a) where there are native watering places on each side, (b) where they exist on one side only, (c) where there are none.

In case (b) flies should be marked on each bank differently to decide if in the event of their crossing more flies go from uninhabited to inhabited bank or *vice versâ*.

With regard to the latter I think that in experimenting at cleared places it is essential to find out the distance and direction of flight before

---

* I did not mean uninterrupted flights, *vide* previous note.

† Shade was not continuous from A to G; about C there was perhaps half a mile of shade-free bank.

interfering with the vegetation and afterwards to determine the influence of various degrees of clearing. Such a procedure would take time but is calculated to lead to that precise knowledge which we at present lack.

(Signed) A. G. Bagshawe.

[Note.]—It is worth noting that while of 1,521 flies caught at A, B, D, E, F and G only 478 were female, of 129 caught at C 66 were of that sex. These figures and others in my possession lead me to suspect that as a rule where female flies are found in excess the breeding grounds must be looked for at a distance. Thus at Harubale (Lake Ruisamba) females were on every occasion in excess: of 1,420 flies caught in the first series of flight experiments 827 were female. When, however, I found the chief breeding ground, some hundred yards from the scene of previous captures, I caught very quickly 61 male and 45 female flies. At a bridge over the Mpanga river, much used by caravans, fly were scarce but females relatively numerous, 59 to 16 male. It is certain that this spot was far from a breeding ground, perhaps three miles.

Referring to my notes of the flies caught at the spots where pupae were found I find that, in every case but one, males were in excess and as a rule were as two to one. Probably the female must be well supplied with blood to enable her to nourish her larva; if there is scarcity she must go far afield to procure it. The male could exist with less food and need not range so widely.

This is not so unimportant as at first appears for in clearing it should be our aim to attack the breeding grounds; the sex proportion, if it has the significance which I suggest, will assist us to find them. My figures are too small, my data too few, to prove anything; other observers will, it is to be hoped, follow up these suggestions.—A.G.B.

TABLE I.

												per cent
Of	115 M	flies caught marked and released at						A	6	were retaken elsewhere		5·2
	65 F								2			3·07
Of	111 M							B	11			9·9
	44 F	,,	,,	,,	,,	,,	,,		5	,,	,,	11·3
Of	117 M							D	0			0
	35 F	,,	,,	,,	,,	,,	,,		1	,,	,,	2·8
Of	70 M							F	0			0
	36 F	,,	,,	,,	,,	,,	,,		2	,,	,,	2·7
Of	70 M	caught and marked at A released at						LA	4			5·7
	30 F								3	,,	,,	10
Of	134 M							WA	11			8·2
	66 F	,,	,,	,,	,,	,,	,,		3	,,	,,	4·5

i.e.—Of 617 M flies marked 32 were retaken elsewhere = 5·18 per cent.
276 F ,, ,, 16 ,, ,, ,, = 5·79 ,,

(Signed) A. G. Bagshawe.

TABLE II.

Flies caught at A which had been released elsewhere—

from B 10 M, 3 F
from WA 8 M, 2 F
from LA 2 M, 1 F
} = 26 = 3·25 per cent. of those examined (798).

Flies caught at B which had been released elsewhere—

from A 3 M, 1 F = 4 = 2·58 per cent. of those examined (155).

Flies caught at C which had been released elsewhere—

from WA 2 M, 1 F
from A 1 M, 1 F
from LA 1 M, 1 F
from B 0 M, 2 F
from F 0 M, 1 F
} = 10 = 7·75 per cent. of those examined (129).

Flies caught at D which had been released elsewhere—

from LA 1 M, 0 F
from A 1 M, 0 F
from B 1 M, 0 F
} = 3 = 1·9 per cent. of those examined (152).

Flies caught at E which had been released elsewhere—

from LA 0 M, 1 F = 1·06 per cent. of those examined (94).

Flies caught at F which had been released elsewhere—

from WA 1 M, 0 F = ·94 of those examined (106).

Flies caught at G which had been released elsewhere—

from F 0 M, 1 F
from A 1 M, 0 F
from D 0 M, 1 F
} = 3 = 1·3 per cent. of those examined (216).

Bank to bank flights underlined.

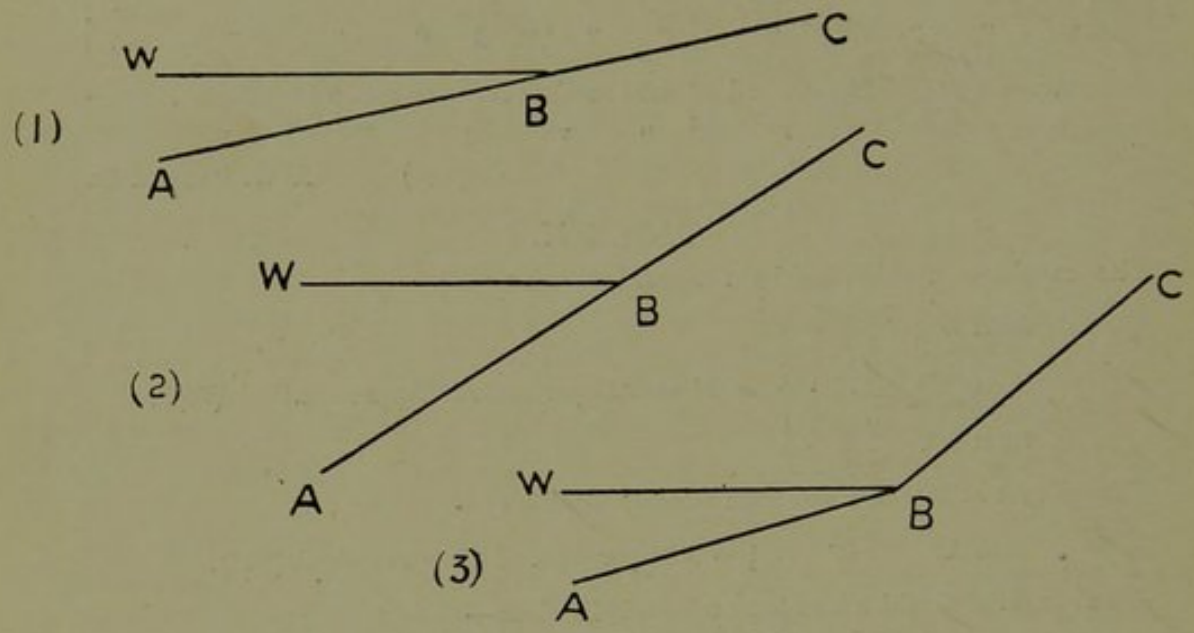
(Signed) A. G. Bagshawe.

FROM DR. BAGSHAWE'S REPORT FOR APRIL, 1907.

Influence of Papyrus on the Distribution of *G. Palpalis.*

For some time I was uncertain what was the nature of the influence of papyrus on *Glossina palpalis.* It is well known that fly are not usually found behind a wide belt.

The reason can be shown by diagrams.



WB = water level. AB = submerged bank.
BC = bank above water.

The normal relations between A and C are shown in (1) and (2) where AC includes no angle.

In (1), the water is shallow at A and the papyrus belt may be wide while BC is swampy and there are few or no bushes.*

In (2), BC is suitable for the growth of woody scrub but the rapidly deepening water prevents the extension of papyrus.

When one meets with conditions represented in (3), *e.g.* at a point on the Semiliki river where it reaches a steep hill, both scrub and papyrus flourish and fly may be present in large numbers.

In the voyage down the river from Mruli to Foweira only samples of bank could be tested but it is fairly certain that fly are absent behind the very wide belts of papyrus which exist for a large proportion of the way on each bank.

Fly certainly rest on the waterside of wide strips of papyrus whence they descend on occupants of boats.

* There may of course be bushes; a soil that is always wet is suited for the growth of certain shrubs, but not for the deposit of larvae.

Harrison & Sons, Printers in Ordinary to His Majesty, St. Martin's Lane, London, W.C.