

I.

BRITISH MUSEUM.

1898.

Report of the Proceedings of the Expedition for the Study of the Causes of Malaria, Despatched to Sierra Leone, West Africa, under ... Major R. Ross ... 1898. By ... Austen. London, 1898.

II.

Report on the Collections of Mosquitoes (Culicidae) received at the British Museum (Natural History) from various parts of the World in connection with the investigation into the Causes of Malaria, conducted by the Colonial Office and the Royal Society. By F.V. Theobald.

London, 1900.



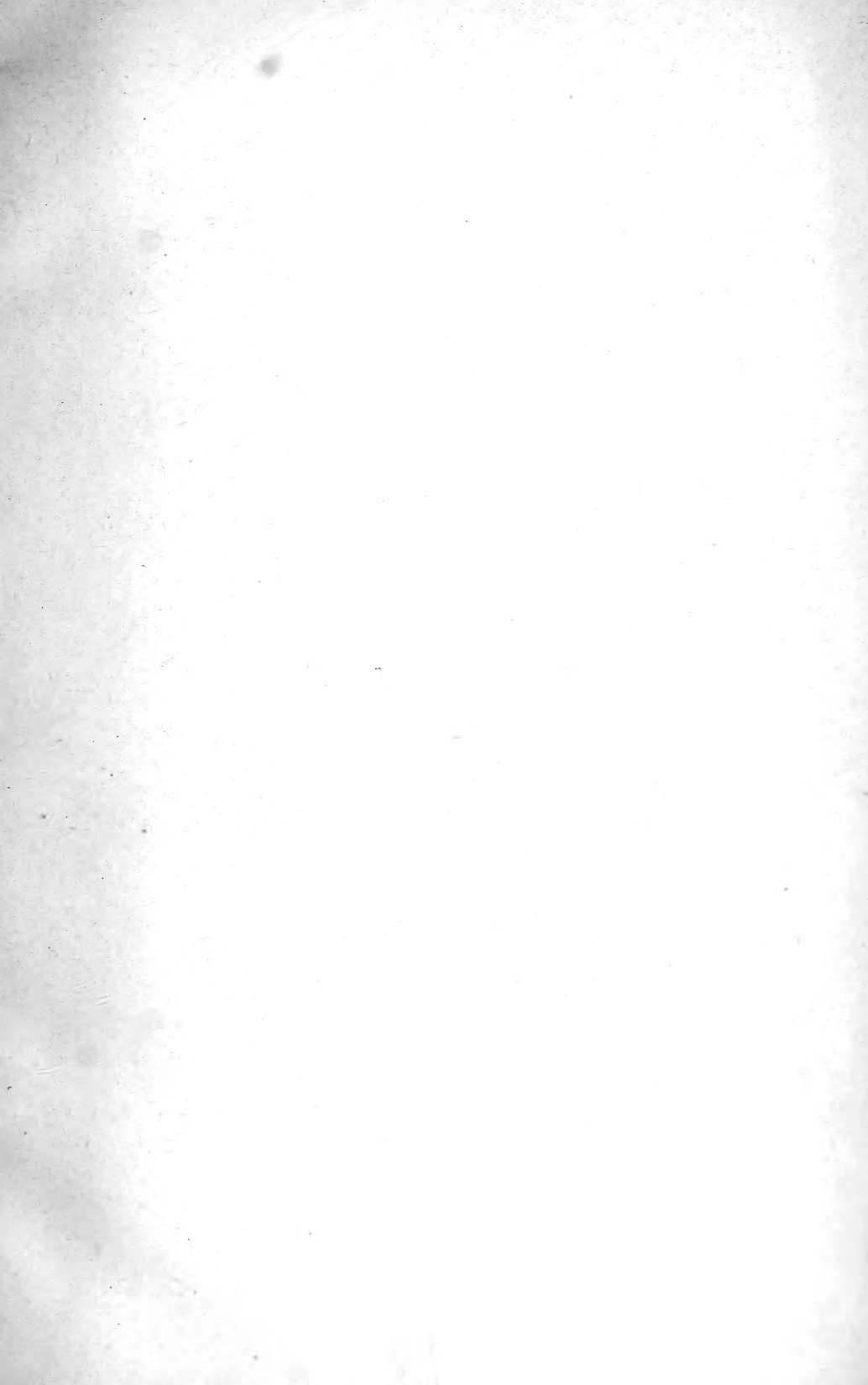
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BRITISH MUSEUM.

REPORT

OF THE

PROCEEDINGS OF THE EXPEDITION

FOR THE

STUDY OF THE CAUSES OF MALARIA,

DESPATCHED TO SIERRA LEONE, WEST AFRICA, UNDER THE
LEADERSHIP OF MAJOR RONALD ROSS (LATE INDIAN
MEDICAL SERVICE), BY THE LIVERPOOL SCHOOL
OF TROPICAL DISEASES, JULY 29TH, 1899.



BY

ERNEST E. AUSTEN,

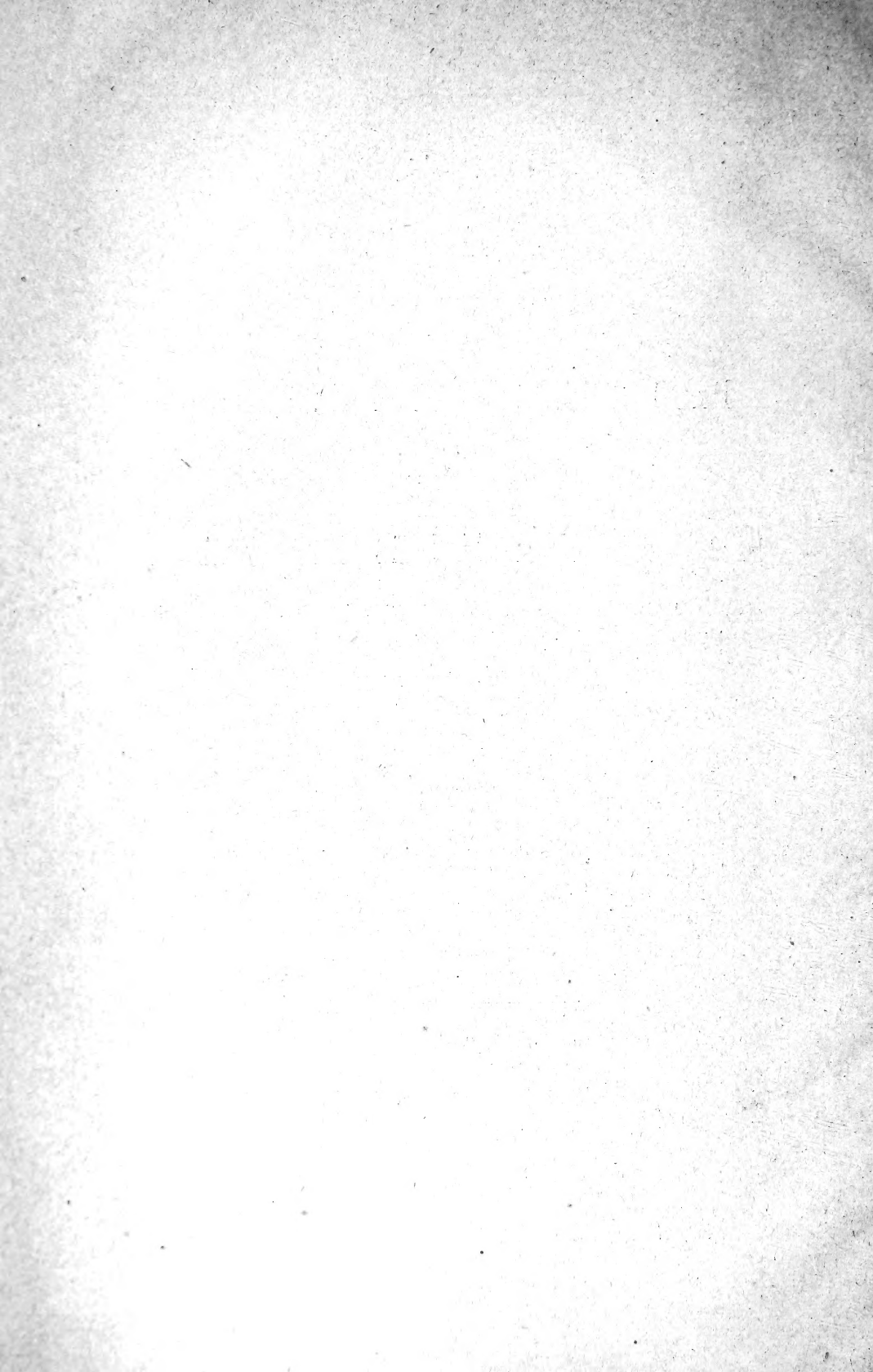
Zoological Department, British Museum (Natural History).

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1899

[April 1900]



BRITISH MUSEUM.

REPORT

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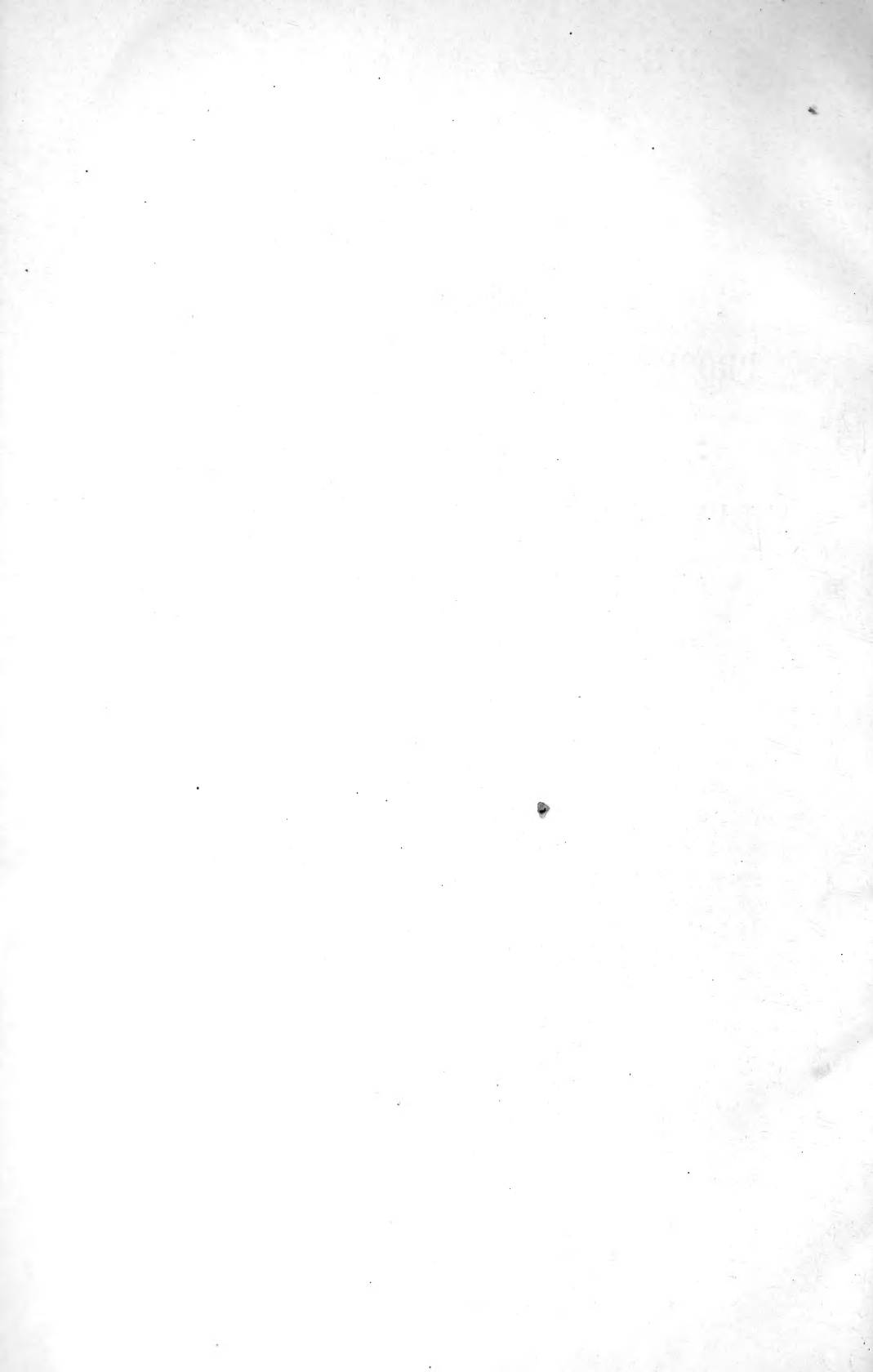
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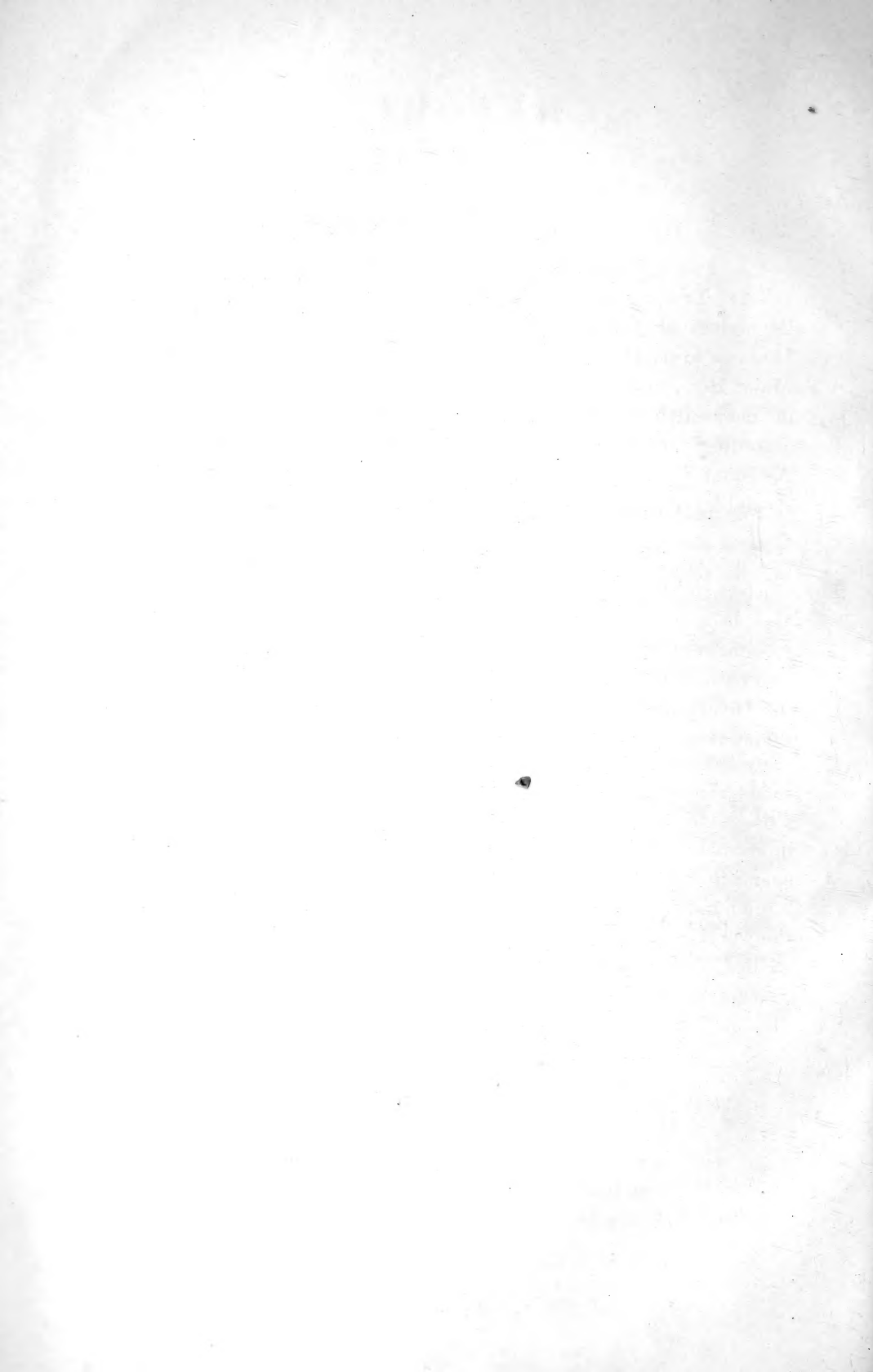
THE Trustees of the British Museum were glad to avail themselves of the offer of the Liverpool School of Tropical Diseases to send out to Sierra Leone one of their Assistants with Major Ross, to make a special study, on the spot, of mosquitoes in connection with the objects of the expedition. They accordingly, on my recommendation, allowed Mr. E. E. Austen, Assistant in charge of the Dipterous Insects, three months' special leave of absence for the purpose.

The expedition has resulted not only in the acquisition of much useful knowledge relative to the causes of malaria, but has also been the means of adding many interesting zoological specimens to the Museum. The National Collections have thus also been benefited, and the thanks of the Trustees are due to the Liverpool School of Tropical Diseases for their action in the matter.

Mr. Austen's report has been printed by order of the Trustees with a view to its distribution among institutions and persons interested in the subject. It may be of interest to state, in connection with the investigation of malarial diseases, that a large number of collections of mosquitoes from various parts of the world have been received in the Museum. These are being studied, and in due course a detailed report on them will be issued.

E. RAY LANKESTER,
Director of the Natural History Departments,
British Museum.

British Museum (Natural History),
Cromwell Road, London, S.W.



REPORT

OF THE

PROCEEDINGS OF THE EXPEDITION FOR THE STUDY OF THE CAUSES OF MALARIA.

FOR the purpose of accompanying this expedition, the Trustees granted me three months' special leave of absence from July 28th, 1899. Leave of
Absence and
Instructions.

The instructions I received before starting were to the effect that, in placing my services at the disposal of Major Ross for the special objects of the expedition, I should use my best endeavours to make my journey as useful as possible to the Museum.

At the end of this report will be found a summary of the results obtained in the collection of zoological specimens generally : the malaria investigations, being of greater practical importance and having occupied the larger portion of the time, are dealt with first.

The expedition consisted of Major Ronald Ross (late Indian Medical Service), Lecturer to the Liverpool School of Tropical Diseases ; Dr. H. E. Annett, Demonstrator to the School ; and myself. Dr. S. van Neck joined the expedition about a week after our arrival at Freetown as the Official Delegate of the Belgian Government, but took no active part in the operations. Members of
the Expedi-
tion.

The objects of the expedition were :—

Objects.

- (1.) To find the species of mosquito that carries the malaria parasites in Sierra Leone.
- (2.) To discover whether this mosquito breeds in sufficiently isolated puddles for its destruction to be possible, either by drainage or by the application of substances (such as kerosene) which suffocate the mosquito larvæ in the water.

It may here be remarked that we had not to deal with the question whether mosquitoes are or are not capable of carrying and transmitting from man to man the hæmatozoa, or blood-parasites, that give rise to the group of fevers known as *malaria*: for this question had already been decided in the affirmative by Major Ross's own researches in India and by those of the Italian school of investigators represented by Professors Grassi, Bignami, and Bastianelli, at Rome.

Reasons for selecting Sierra Leone.

Sierra Leone was selected as the scene of our investigations for the reason that (besides being likely to afford an abundance of cases of fever for study) it is within easy reach (only 12 days) of Liverpool.

Passages provided by Mr. A. L. Jones.

The members of the expedition were provided by Mr. A. L. Jones, of Messrs. Elder, Dempster, & Co., Liverpool, with free first-class passages to and from Sierra Leone; our passes were also made available to and from any other port or ports in British West Africa.

Departure and Arrival of the Expedition.

The expedition left Liverpool on July 29th, 1899, in the African Steam Ship Company's S.S. "Fantee," and reached Freetown, Sierra Leone, on August 10th. For the first four days after our arrival we were the guests of the Acting Governor, Major Nathan, C.M.G., R.E., at Government House. Afterwards we migrated to Tower Hill Barracks, occupied by the 1st Battalion West India Regiment, where Major Norris, D.S.O., the Officer Commanding, had very kindly placed quarters at our disposal, besides making us honorary members of the mess during our stay.

Freetown and Environs.

Since the work of the expedition was entirely devoted to Freetown and its immediate neighbourhood, it seems advisable to make a few remarks upon the place itself and its surroundings.

The town of Freetown (which contains over 30,000 inhabitants) is situated approximately in Lat. $8^{\circ} 30' N.$, Long. $13^{\circ} 15' W.$, on the shores of a fine bay on the northern side of a mountainous promontory. Behind the town runs a semicircle of wooded hills, rising to a height of some 3,000 feet in their highest peak (Sugar-Loaf Mountain). The town lies partly on the level ground at the foot of the hills, between them

and the sea, and partly on the lowest slopes of the hills themselves; it is disposed roughly from north-east to south-west.

The barracks for the main body of the garrison are on the hills rising behind and above the north-eastern end of the town. None of these barracks (of which there are three rising one above the other) are at a lower elevation than 400 feet, the lowest being those known as Tower Hill; consequently, as one would naturally expect, they are comparatively healthy, most of the cases of fever that occur in them being probably contracted in the town. The case, however, is very different in the village of Wilberforce, which is situated some two miles away on a spur of the hills to the south-west of Freetown, at an altitude of about 700 feet. Here are temporary barracks, tenanted at the time of our visit by four companies of the 3rd West India Regiment. In spite of the increased elevation, fever was rife in these barracks, and, as will be shown later on, practically the whole of the subjects we used for examination and feeding mosquitoes, besides an almost constant supply of mosquitoes of the genus *Anopheles*, were obtained here.

The village of Kissy, to be referred to almost immediately, is situated about three miles from Freetown, in the opposite direction to Wilberforce, on the lower slopes at the foot of the hills.

The soil of Freetown is derived from a red laterite rock which crops out everywhere, even in most of the streets, many of which may be said to be paved with it. Under the influence of the weather this rock readily wears into holes which become puddles in the rains.

Since the streets of Freetown are very imperfectly drained, during the rainy season (at its height at the time of our visit) a large amount of water is left standing in roadside puddles in most of the level parts of the town. In these localities, too, the streets are usually bordered on each side by a shallow, slowly flowing or nearly stagnant ditch. It is but fair to add that streets such as these are not inhabited by Europeans. In the parts of the town situated on the lowest flanks of the hills, where the streets have a considerable slope towards the sea, the bulk of the water runs swiftly off as soon as it falls, while the

hollows in the rocky soil, which are numerous in some sloping streets, are, during the wet season, violently scoured out almost every day—frequently more than once. The bearing of these facts will be seen later.

It is, perhaps, worth while to add that the rainfall at Freetown is exceedingly heavy, even for the West Coast of Africa. The rains last from May until October, and the wettest months are July and August. The fall for August, 1899, was 37.59 inches, and this was nearly 2 inches *under* the average for the last 13 years.

At the western end of the town there is a marshy tract of grass-grown land known as "Grass-Fields," and most of the numerous creeks which run in from the sea close to and within a few miles of Freetown are bordered with mangrove swamps. In spite, however, of the belief (which may almost be dignified by the name of a *creed*) to the contrary universally entertained by residents, we found nothing to justify the idea that, at Freetown, at any rate, malarial fevers are due to the proximity of swamps.

THE MALARIA INVESTIGATIONS.

Before we had been two days at Freetown we received intelligence of an outbreak of fever among the patients (natives) in the lunatic asylum at the village of Kissy. The news was accompanied by specimens of a species of mosquito belonging to the genus *Anopheles* that had been obtained in the asylum by Dr. Berkeley, Assistant Colonial Surgeon, and Physician to the asylum. As *Anopheles* was the genus implicated in connection with human malaria by the previous researches of Ross and the Italian school (all experiments performed by the Italian investigators with *Culex*—the genus to which the majority of species of gnats or mosquitoes belong—having proved negative), the find was very interesting, and we lost no time in visiting the scene of the outbreak. It was found that the fever had occurred in one of the male wards. Of the three patients attacked, one had died, another was still ill, and the third was convalescent.

A small species of *Anopheles*, most of the individuals being gorged with blood, was found resting on the walls in some

Outbreak of fever at Kissy.

Attitude of *Anopheles* when at rest.

numbers. It was noted that they always choose the darkest spots in which to rest, and sit in a highly characteristic attitude, their bodies being maintained at an angle of, at least, 45° to the surface. The elongated palpi (a diagnostic character of the female *Anopheles*, as distinguished from the female *Culex*) are carried pressed close to the proboscis, and stretched straight out in front of the body, thus giving the appearance of a thick *beak*. It frequently happens that the tips of the palpi are in contact with the wall on which the insect is resting, and the body is elevated so much that it is practically at right angles to the surface, so that the insect appears as if *standing on its head*.

Owing to this extremely characteristic resting attitude of *Anopheles*, it would be impossible for anyone who had once seen a specimen at rest to mistake it for a *Culex*, for the latter when at rest always allows its body to hang down vertically. Since, as already stated, so far as we know at present, *Anopheles* alone (and not *Culex*) carries the malaria parasite, the practical importance of this distinction is evident.

On this occasion we failed to find the breeding place of the *Anopheles*; indeed, it was not until nearly a fortnight later that we succeeded in discovering the origin of the fever-carrying mosquitoes.

On the other hand, although we had met with no specimens of *Culex* in the asylum, we found a large banded species of this genus breeding in numbers in three large tubs nearly full of rain-water, standing in the garden about 40 yards from the ward in which we had found the *Anopheles*, and separated from it by a stone wall some 15 feet high.

During our stay at Freetown we were much struck with the way in which *Culex* avails itself of even the smallest collection of stagnant rain-water for breeding purposes. Thus, the small quantities of water that collect in such discarded rubbish as old bottles, Swiss milk and sardine tins, and coconut husks frequently swarm with larvæ; while the water that accumulates in disused calabashes and other vessels, which the thoughtlessness of natives and even Europeans allows to lie about outside houses, is invariably turned to account by the insects. Although, so far

Breeding habits of *Culex* at Freetown.

as we were able to discover, *Anopheles* never breeds in such situations, this carelessness and apathy of the inhabitants of a mosquito-infested country towards a notorious enemy to comfort, though not perhaps to life, is really astonishing. Among the natives, indeed, this apparent carelessness is doubtless often due simply to ignorance ; but even Englishmen, who ought to know better, are, as a rule, equally apathetic.

Anopheles in
the Hospital
for
Incurables.

A few days after our first visit to Kissy, the same species of *Anopheles* that had been met with in the lunatic asylum was found by me in the Hospital for Incurables, which is situated near Kissy, about a mile away from the village and asylum. Here, again, the insects were always discovered at rest on the darkest part of the walls.

To reach the hospital one has to cross about half a mile of marshy ground, which is covered with grass and contains numerous small pools of stagnant water, besides streamlets ; but no sign of mosquito larvæ, either *Anopheles* or *Culex*, could be found.

Anopheles
and fever at
Wilberforce.

Our attention was next directed to the half-battalion of the 3rd West India Regiment at Wilberforce, which, in proportion to its strength, was suffering severely from fever. On August 17th we paid a visit to the barracks there, and caught a number of specimens of *Anopheles*, which we found resting on the walls of the hospital and several of the other huts. We endeavoured to find their breeding-place, but without success. The species (which has since proved to be *Anopheles costalis*, Lw.) was larger than that found at Kissy, but identical in habit, the insects adopting precisely similar resting postures, and always keeping to the darkest parts of the walls.

Except as the result of unsuccessful attempts to capture it, no *Anopheles* was ever seen on the wing in the day time, either on this occasion or subsequently, and there seems no reason to doubt the assertion of the men of the West India Regiment, that, as a rule, these mosquitoes bite only at night—an observation already confirmed by the published statement of a scientific observer. The female insects caught at rest during the day were in most cases found to be gorged with blood, but I never captured a male in

this condition, so that it is probable that the males, unlike those of certain species of *Culex*, are not blood-suckers.

On this our first visit to Wilberforce, Major Ross examined the blood of all the fever patients in hospital. We had brought with us a supply of live *Anopheles* from Kissy, each enclosed in a separate glass tube plugged with cotton wool, and a number of these were fed on certain patients, in whose blood fever parasites had been found in sufficient numbers.

Two days later (August 19th) Major Ross dissected some of the Kissy *Anopheles* fed at Wilberforce in the manner just described, and found attached to the stomach of one of them three quartan fever parasites in the *zygote* stage. From the appearance of these it was clear that the stage could not have endured more than two days, and must therefore be the result of the feeding experiments carried out on the 17th. Consequently the *Anopheles* from Kissy was proved to be a malaria-carrying species.

Parasite of quartan fever proved to develop in the *Anopheles* from Kissy

As a result of this discovery, Major Ross despatched the following cablegram to Mr. A. L. Jones, at Liverpool:—“Mosquito found. Ask Government to send at once man to continue work.” This led to the despatch by the Liverpool School of Dr. Fielding-Ould, who landed at Freetown on September 15th. On our departure it was arranged that Dr. Ould should proceed to Accra and Lagos, for the purpose of investigating the relations of *Anopheles* to malaria at those places.

During the next few days the rain-fall was exceedingly heavy, and greatly interfered with out-door work. Two more visits, however, were paid to Wilberforce, where further unsuccessful attempts were made to discover the breeding-place of the *Anopheles*. The appearance of the larvæ (which, as will be seen subsequently, are readily distinguishable from those of *Culex*) was described to men of the 3rd West India Regiment, who were encouraged to search for them by the offer of a reward of 10s. for the first specimens; this also produced no result. At this time the perfect insects appeared to be diminishing in number in the barrack huts, and the men told us that they were much more troublesome some three weeks previously. It therefore seemed possible that all the *Anopheles* we caught had hatched out a month earlier, and that breeding was no longer going on.

Further investigations at Wilberforce.

Although Major Ross was of the opinion that the breeding-place would eventually be found in close proximity to the barracks, since it was improbable that the female mosquitoes, which are not impregnated until they have enjoyed a meal of blood, would have to fly far in order to deposit their eggs, we made a search down the hill side in the direction of mangrove swamps fringing an arm of the sea known as Aberdeen Creek. The side of the hill below the barracks is covered with bush, and owing to the nature of the ground it was found impossible to get quite as far as the mangrove swamps by this route. At a distance of about a mile below the barracks, however, a level tract of marshy soil was met with. Here the ground was open and overgrown with grass; the soil was nearly everywhere covered with water, though seldom more than an inch in depth, stagnant or nearly so in some places, gently flowing in others. At intervals small pools were found, but a careful search by five people failed to disclose any mosquito larvæ whatever. A subsequent visit to the adjoining mangrove swamp itself produced a like result, which was not surprising, since the ground was alternately submerged and left nearly dry by every tide.

Failure to find the breeding-place of the *Anopheles* at Wilberforce: its probable situation.

Although the locality of the breeding-place of the Wilberforce *Anopheles* remained an enigma up to the time of our departure from Freetown, there is little doubt but that it will eventually be found, if at all, in or on the edge of the village itself. At the time of our visit the officers of the 3rd West India Regiment were quartered in houses in the village, where, in at least one case, they suffered from the attacks of *Anopheles* quite as much as did the men in barracks; it may be added that several of the officers were attacked with fever during our stay. It is probable that the trees clothing the sides of the hill on which Wilberforce stands would intercept any mosquitoes either flying or blown towards the village from a distance; and, as already hinted, a female mosquito must return to a suitable accumulation of water—probably to the place where she herself was hatched—in order to lay her eggs. The streets and roads in and about the village of Wilberforce, in striking contrast to so many of those in Freetown, are singularly free from puddles, and in the course of many visits I did not succeed in discovering more than four, all of which were tenanted by *Culex* larvæ alone. The precincts of the houses were also searched to no purpose. But it was

impossible thoroughly to search the thickets fringing the village, and it may be that these conceal small puddles in which the *Anopheles* breed.

On August 25th, to our great delight, we discovered a breeding-place of *Anopheles* in Freetown. This was a muddy puddle by the side of a street (Westmoreland Road) within a few hundred yards of the foot of Tower Hill. The road here being level and running parallel with the line of the hills, the puddle was not liable to be scoured out during heavy rain. Its dimensions were some 6 feet by 2 feet, and it contained about a score of larvæ; a few more were found in smaller road-side puddles close by.

Discovery of
Anopheles
larvæ in
Freetown.

The larvæ of *Anopheles* and *Culex*, though alike in shape, possess one striking difference in external structure. The respiratory apertures, which in both cases are placed just in front of the tail, on the dorsal side, in the *Anopheles* larvæ open flush with the surface of the body; in the larva of *Culex*, on the other hand, they are placed at the end of a projecting tube (varying in length and width according to the species), in which the terminal portion of the respiratory ducts is enclosed. The larvæ of both genera are aquatic, and are obliged constantly to come to the surface of the water in order to breathe. But owing to this difference in structure, their positions during the act of breathing present a striking contrast; for while *Culex* larvæ hang nearly vertically head downwards, suspended by the tip of their breathing tube from the surface film, those of *Anopheles* lie flat on the top of the water. The difference in this stage is therefore quite as remarkable as is that between the resting attitudes of the perfect insects.

Appearance
of *Anopheles*
larvæ.

The behaviour of the larvæ of the two genera when alarmed is also different. Those of *Culex* at once dart downwards, by alternately flexing and extending the body; *Anopheles* larvæ, on the other hand, shoot backwards along the surface of the water, with a rapid zig-zag motion, lashing their tails side-ways, the first stroke apparently being always made to the right; if much frightened, as by an attempt to catch them, they dart to the bottom of the puddle like *Culex* larvæ. When at the surface they appear fond of lying moored, with their tails in contact with a patch of green alga, on the margin of the puddle.

Anopheles
larvæ in a
tub.

On the following day (August 26th) the Colonial Surgeon (Dr. Prout) and Dr. Berkeley found *Anopheles* larvæ (mingled with those of *Culex*) in a tub of water standing in a yard at the Sanitary Office. With one exception, this was the only instance in the course of our investigations in which *Anopheles* was found breeding elsewhere than in a road-side puddle or ditch.

Further
discoveries
of *Anopheles*
larvæ.

From August 29th onwards, we made fresh discoveries of *Anopheles* larvæ almost every day in various parts of Freetown, where the ground is flat, but especially in the district known as Bambura Town, to the north-east, and in another to the south-west of Tower Hill. Others were found on the Kissy Road, while a pool of muddy water in an open drain outside the Post Office produced several batches of larvæ in succession. In most cases the larvæ were in stagnant puddles, varying in area from a foot to several feet, at the sides of the streets, but many were met with in the still water in little bays at the sides of slowly running shallow ditches. Whether the water was clear or muddy seemed to make no difference to the larvæ, but green algæ (on which they feed) were nearly always present. In some of the puddles tadpoles were numerous.

I kept a number of the larvæ for the purpose of obtaining the perfect insects, which proved to belong to the same species (*Anopheles costalis*, Lw.) as those found at Wilberforce.

Anopheles
breeding
under
similar
conditions at
Lagos.

It may be of interest to mention that shortly after our discovery of the breeding-places of *Anopheles* in the streets of Freetown, I received from Dr. H. Strachan, Colonial Surgeon at Lagos, specimens of the same species of *Anopheles* caught by him at that place, accompanied by the information that he had found the larvæ in puddles left in the streets after rain. Dr. Strachan had been a fellow passenger of ours on board the "Fantee," and had taken a great interest in our work and its possible results.

It thus appears that the conditions in Lagos are very similar to those in Freetown, but for further information on this point we must wait for Dr. Fielding-Ould's account of his investigations.

Dissections
of *Anopheles*
from
Wilberforce.

Concurrently with our search for breeding-places of *Anopheles*, Major Ross every day continued his dissections of the adult

insects, fresh supplies of which were constantly obtained by us from Wilberforce, where they were now to be found in greater numbers. Malaria parasites, in various stages, were detected in a fair proportion of those examined. In some specimens the salivary glands and ducts were found packed with *zygotezoids*—the young form of the parasite which is destined to pass into the blood of a human being when the mosquito takes its next meal.

That a small quantity of kerosene poured on to the surface of the water would kill mosquito larvæ was well known before the visit of our expedition to Freetown. The oil forms a film on the surface, which the larvæ are unable to penetrate when they come up to breathe; they are thus speedily suffocated, especially since the oil gets into and blocks their respiratory apertures. Major Ross found that a very young *Anopheles* larva in a watch-glass full of water with a trace of kerosene on the surface died in ten minutes, and that a half-grown larva under similar conditions perished in half an hour. Other substances (such as tar and creosote) have similar properties, and an extensive series of comparative experiments upon this subject have recently been made in Italy. Kerosene, however, was selected by us as being cheap, convenient to use, and readily obtainable.

Experiments
in destroying
Anopheles
larvæ by
means of
kerosene.

On September 7th an experiment in destroying *Anopheles* larvæ in a puddle by means of kerosene was performed in the presence of Drs. Prout and Berkeley, and was completely successful. The oil was applied in the morning, and most of the larvæ were apparently dead at the end of half an hour; the puddle was again visited about 5.0 p.m., when there was no doubt that not a single larva remained alive. On this occasion a small quantity of oil was poured on to the water from a bottle. It did not, however, spread over the surface as quickly and completely as was expected, and it was found necessary to stir the water with a stick before a film covering every portion of the surface was produced. It was subsequently discovered that a rag tied to the end of a stick affords the best means of applying the oil to puddles.

Our next task was to prepare a map, showing the situation of the breeding-places of *Anopheles* in Freetown. For this purpose, a street-plan of Freetown having been obtained, each street was carefully examined anew, and the position of every

Mapping-out
the breeding-
places of
Anopheles.

puddle and ditch containing an *Anopheles* larva was marked down on the plan in red ink. It is only fair to add that the bulk of this work fell upon Dr. Annett, Major Ross's time and my own being chiefly taken up with continuing the investigations at Wilberforce.

Report to
the Acting-
Governor.

As our work progressed, we took care, by means of informal communications, to keep the Acting-Governor constantly informed of the results that were being obtained. Shortly before the end of our stay the Acting-Governor, who evinced throughout a keen interest in our proceedings, asked us to furnish him with a formal statement, showing how, in our opinion, based upon our investigations, malarial fever in Freetown might be materially lessened—(a) at a minimum of cost, (β) without regard to expenditure. Accordingly we drew up and forwarded to his Excellency, a few days before our departure, a joint report, containing a detailed account of our proceedings, and embodying our recommendations as requested; this report was accompanied by a copy of the plan of the breeding-places of *Anopheles*, alluded to above.

It seems unnecessary for me to give here a statement of the conclusions and recommendations contained in this document, since it will practically be embodied in a joint report by the members of the expedition, which will shortly be furnished to the Committee of the Liverpool School of Tropical Diseases, with a view to publication. It is enough to say that we insisted chiefly upon the necessity for the universal use of mosquito-nets (and other simple appliances) in dwelling-places and hospitals, in order to prevent *Anopheles* from biting either healthy people or patients suffering from fever, and for the appointment by the Sanitary Authorities of responsible officials whose duty it would be to provide for the systematic and constant application of kerosene oil to the breeding-places.

Simple, and indeed, obvious, though these recommendations may seem at home, even a slight experience of life in the tropics will suggest more than one practical difficulty in the way of carrying them out. But it was the firm conviction of all the members of the expedition that the methods suggested, if only given a fair trial, would undoubtedly result in at any rate a

material diminution of malarial fevers in Freetown and its environs. It was, therefore, some satisfaction to us to learn before we left, that arrangements had been made, under the supervision of the Assistant Colonial Surgeon, to provide for the destruction of *Anopheles* larvæ in the manner indicated.

It is possible, although, as already pointed out, not probable, in the light of previous researches, that besides *Anopheles* species of *Culex* may also convey the parasites of malarial fevers in Freetown. Time, however, did not permit of our making investigations upon this point; and, moreover, it seemed to us that work of this character fell more properly within the province of a Laboratory of Preventive Medicine, which should certainly be established by Government in one of our West African Colonies.

Possibility that the parasites of malaria may be carried by *Culex* as well as by *Anopheles*.

During the progress of our work I carefully collected and preserved specimens of all the species of *Anopheles* and *Culex* that we came across, breeding many of them from the larvæ. In this way I obtained some 200 examples, representing some ten species of *Culex* and two of *Anopheles*. Many of these species will, doubtless, prove to be new, and of all of them I propose to publish careful descriptions in a scientific journal; these descriptions will afterwards be reproduced (if possible, accompanied by figures) in the form of an appendix to the report to be presented to the Liverpool School.

Collection of specimens of *Anopheles* and *Culex*.

THE COLLECTION OF ZOOLOGICAL SPECIMENS OTHER THAN MOSQUITOES.

Although our stay at Freetown lasted for nearly seven weeks, I was not able to devote very much time to the collection of zoological specimens generally. I endeavoured to make up for this, so far as possible, by engaging a native boy to collect for me daily. Unfortunately the season was very unfavourable for collecting, and, owing to the heavy rains, several days were practically wasted almost every week. However, I managed to bring home a fair number of specimens—chiefly insects: some 30 specimens of millipedes, scorpions, &c., were also obtained. Not much could be done among the vertebrates, as I had no chance of going up country, but a few small mammals, reptiles, &c., were secured.

Collection of zoological specimens other than mosquitoes.

Insects.

The total number of insects obtained (roughly counted) amounts to 1,527, distributed as follows :—

Lepidoptera	...	...	...	...	639
Hymenoptera	...	...	...	...	157
Diptera (including mosquitoes)	...	...	...	...	279
Coleoptera	...	...	...	...	92
Orthoptera	...	...	...	...	80
Neuroptera	...	...	...	...	216
Rhynchota	...	...	...	...	64
					<hr/>
					1,527
					<hr/> <hr/>

Species of particular interest.

Tsetse Fly.

Two or three species of particular interest may be noticed.

On August 16th, I had the good fortune to meet with a species of Tsetse fly, *Glossina longipalpis*, Wied., among mangrove bushes at the mouth of a river near Kissy. This species (which is distinct from the well-known South African form, *Glossina morsitans*, Westw.), appears to me to be identical with that obtained some years ago by Dr. W. H. Crosse, at Asaba, on the River Niger, specimens of which, presented by Dr. Crosse, are contained in the Museum collection.

Glossina longipalpis was originally discovered more than a century ago by Adam Afzelius, a Swedish botanist, who visited Free Town in 1792 and 1794, and made general collections of zoological and botanical specimens ; but its existence in Sierra Leone appears subsequently to have been overlooked. Whether the Tsetse fly is in any way responsible for the reported inability of horses to live at Free Town, however, seems to me to be doubtful, since, with the exception of a few small antelope (probably a species of *Oribia*), there is no big game in the vicinity of Free Town ; and, as shown by Major Bruce's account of his investigations in Zululand, before the fly can infect domestic animals with the disease, it must previously have obtained the parasite (*Trypanosoma*) which causes it, from the blood of some wild Ungulate. Moreover, I have recently been informed, on reliable authority, that horses will live well enough at Freetown, if properly looked after.

Be this as it may, the species of Tsetse fly in question is common enough in the vicinity of Freetown, and for some reason always seems to occur along the beds of streams, where it is fond of sitting on stones projecting from the water : it also abounds in mangrove thickets fringing the mouths of streams, close to the sea-shore. On one occasion I found it among bushes on the hill-side below Wilberforce, settling on stones in a small stream barely a yard in width. This fondness for running water is curious, and may possibly be due to the survival of an ancient habit by which the fly at one time obtained its food, as it probably does still in other parts of Africa. For instance, some twenty specimens of *Glossina morsitans*, presented to the Museum by Mr. Christopher Heseltine, were obtained by the donor on the Tzende River, North-East Transvaal. But near Freetown, since, as has just been pointed out, big game is practically non-existent, there would seem to be little encouragement for the fly to wait for animals coming down to drink.

The Tsetse fly is remarkably active and exceedingly difficult to catch, but persistently returns to the same spot ; it bites, and sucks human blood freely.

Residents in Freetown and the vicinity often suffer from a kind of painful boil, produced by a maggot which lives beneath the skin. I was informed that this was produced by the "sting" of an insect known as the "tumba" fly, but what the insect was like no one could tell me, although many had seen the grub after extraction. There was evidently much confusion on the subject, though some persons seemed to consider that the maggot was the offspring of a *horse-fly*, which, from what is known of the life-history of the Tabanidæ (the family to which horse-flies belong), was exceedingly improbable. It was said that dogs and pet monkeys are often afflicted in the same way, and I therefore expected that the mischief-maker would prove to be a warble-fly (Family Eëstridæ), allied to *Dermatobia cyaniventris*—a species with similar habits which occurs in Central and South America. In this, however, I was mistaken. A lady ("Sister Dorothy," of the Princess Christian Hospital, Freetown), finding that a small monkey belonging to her was infected with "tumba" fly maggots, kindly lent the animal to me, with the result that I obtained from it no less than 11 larvæ and pupæ, some of

"Tumba"
Fly.

which I preserved in spirit, leaving the remainder to mature. In about a fortnight's time five flies duly emerged, and proved to belong to a species of *Muscid* (nearly allied to the common European blow-fly, *Calliphora erythrocephala*, Mg.), probably new to science. This discovery was of great interest to the local medical men, who have frequently to deal with boils produced by the larvæ, and I therefore propose, as soon as I have determined the species to which the "tumba" fly belongs, to publish a description of it in the *British Medical Journal*, together with some valuable clinical notes on the effects occasioned by the grubs in human beings, which were most kindly drawn up for me by Major Blenkinsop, Royal Army Medical Corps.

Hemimerus
talpoides,
Walk.

In the year 1858 the Museum received from Sierra Leone some half a dozen specimens of a curious cockroach-like insect, about half an inch in length, which were described by the late Francis Walker under the name of *Hemimerus talpoides*. Some 20 years later considerable excitement was created among entomologists by the statement of M. Saussure that a new Order, if not a new Class, would have to be founded for the creature on account of certain alleged peculiarities of structure in its mouth-parts. This assertion proved to be unfounded, and *Hemimerus* was shown by Hansen to be a true Orthopterous insect.

It is parasitic in habit, occurring in numbers upon the Gambian pouched rat (*Cricetomyx gambianus*), a large rodent which burrows in cassava fields. From a living specimen of this rat (which I have since presented to the Zoological Society of London) I obtained more than a dozen specimens of the insect—a useful addition to the Museum collection, which had received no fresh specimens since the original acquisition in 1858.

Crypto-
stemma
afzelii.

Among the few Arachnida that I succeeded in obtaining, I was fortunate in securing a specimen of *Cryptostemma afzelii*, an archaic form of much interest. The species, of which only two specimens have been previously recorded, is new to the Museum, and belongs to a sub-order not previously represented in the collection.

His Excellency, the Acting-Governor of Sierra Leone, having kindly promised to endeavour to induce the District Commissioners in the Sierra Leone Protectorate to collect for the Museum if I would inform him what specimens were particularly required, a memorandum on the subject was drawn up and forwarded to his Excellency.

Memorandum on Collecting forwarded to the Acting-Governor.

At the very end of our stay I was incapacitated for some days by a slight attack of æstivo-autumnal fever. Though Major Ross was inclined to ascribe this to my having become infected through sleeping on one occasion without a mosquito net, I myself think it much more likely that I was bitten by *Anopheles* while dining in the town. During the whole of our stay in Tower Hill Barracks I never saw an *Anopheles* there alive, except those that we ourselves kept securely confined, and to discover even a *Culex* in my quarters was fortunately rare.

An attack of fever.

Major Ross having to resume his duties at Liverpool early in October, we left Freetown in the s.s. "Fantee" on September 27th, and reached Plymouth on October 9th. I proceeded in the ship to Liverpool with the boxes containing my collections, arrived there on the following day, and returned to duty on October 13th.

Departure for England and return to duty.

I cannot conclude this report without expressing my sincere thanks to his Excellency the Acting-Governor, and to Major Norris, D.S.O., and officers 1st and 3rd Battalions West India Regiment, as well as to the officers of the Royal Army Medical Corps at Tower Hill and Wilberforce, not only for their constant kindness, but also for much assistance in the acquisition of zoological specimens. It is also my pleasant duty to record my gratitude to Dr. H. E. Annett, who, in addition to frequently helping me in the pinning and labelling of specimens, most kindly relieved me of the whole of this work when I was attacked by fever, besides packing up my boxes and collections.

E. E. AUSTEN.

October 27th, 1899.





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