FIRST REPORT

# WELLCOME RESEARCH LABORATORIES

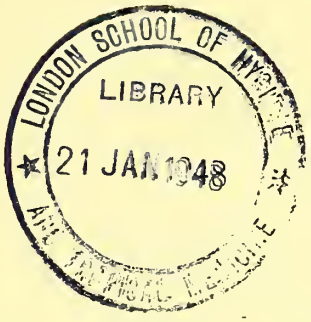
AT THE

GORDON MEMORIAL COLLEGE

KHARTOUM

ANDREW BALFOUR, M.D.

*DIRECTOR*




The Gordon Memorial College, Khartoum

# FIRST REPORT

OF THE

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# KHARTOUM

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BY

THE DIRECTOR

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Department of Education, Sudan Government,

Khartoum,

1904

# THE GORDON MEMORIAL COLLEGE KHARTOUM

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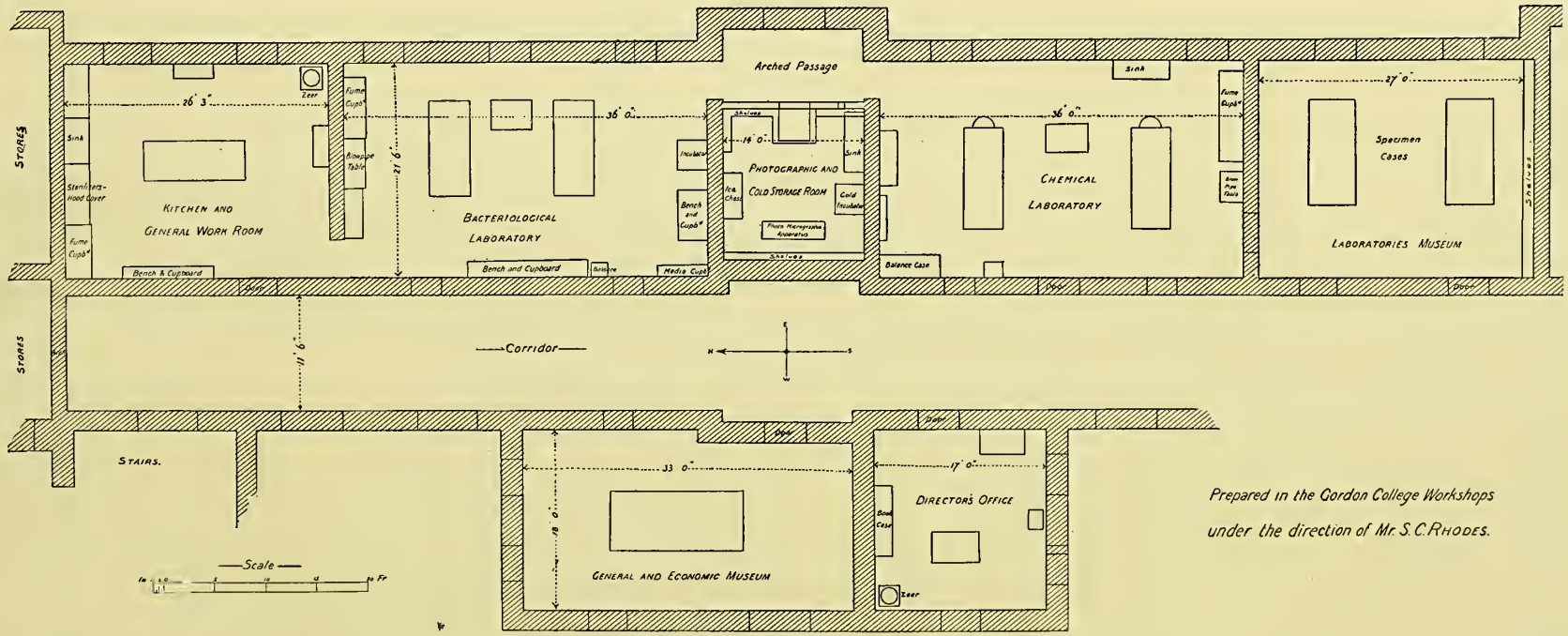
1st Floor Plan

'WELLCOME' RESEARCH LABORATORIES, KHARTOUM.




Prepared in the Gordon College Workshops under the direction of Mr. S. C. Rhodes.

The Wellcome Research Laboratories, Gordon Memorial College, Khartoum

## Introduction

The Research Laboratories of the Gordon College, the equipment of which formed the generous gift of Mr. Henry S. Wellcome to the Sudan Government, are intended to serve the following purposes:—

*a.* To promote technical education.

*b.* To promote the study, bacteriologically and physiologically, of tropical disorders, especially the infective diseases of both man and beast peculiar to the Sudan, and to render assistance to the officers of health, and to the clinics of the civil and military hospitals. Functions of the Laboratories

*c.* To aid experimental investigations in poisoning cases by the detection and experimental determination of toxic agents, particularly the obscure potent substances employed by the natives.

*d.* To carry out such chemical and bacteriological tests in connection with water, food stuffs, and health and sanitary matters as may be found desirable.

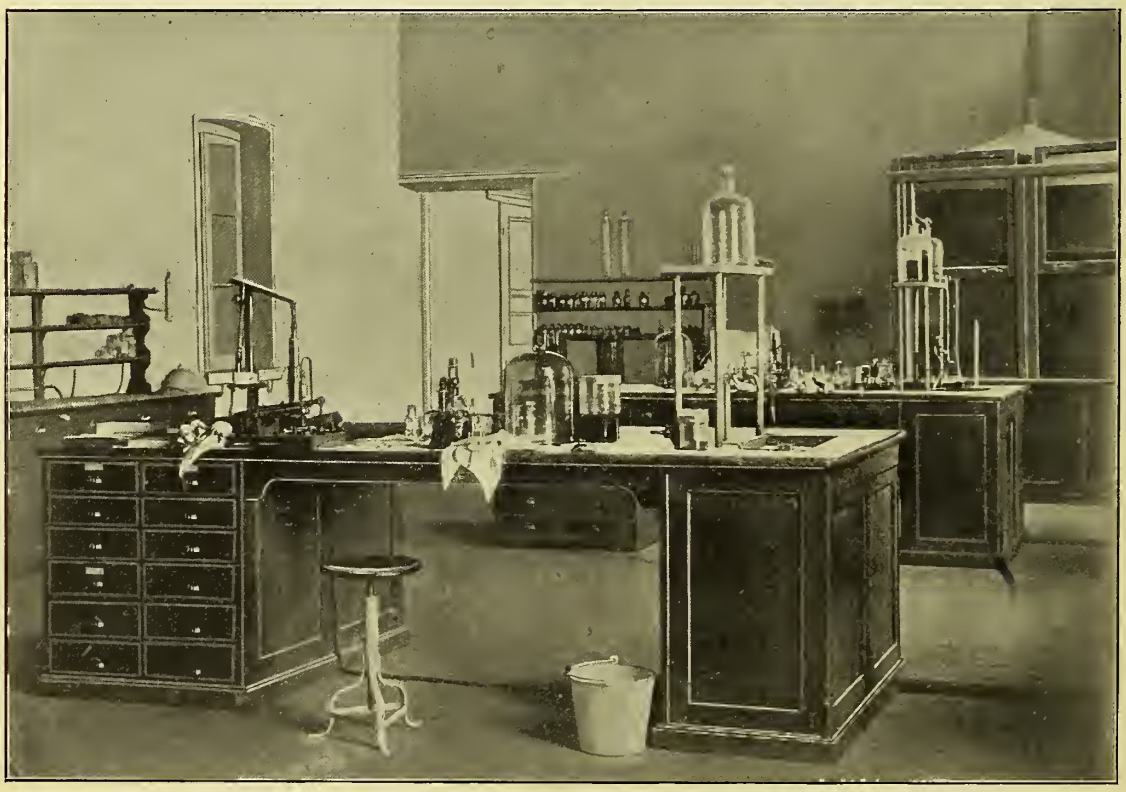
*e.* To undertake the testing and assaying of agricultural, mineral and other substances of practical interest in the industrial development of the Sudan.

The following report, embracing the period between Feb. 1st, 1903, and Feb. 1st, 1904, will indicate in what measure and with what success the laboratories have been concerned with these divers subjects during the first few months of their existence, and it may be said at once that practically every branch of them has claimed attention to a greater or less extent.

Having been appointed Director, and having spent some time in London discussing matters with Mr. Wellcome, and inspecting the equipment provided, which was in every way excellent, I finally arrived in Cairo on Dec. 24th, 1902, where acting on advice received from Mr. Currie, Director of Education for the Sudan and Principal of the Gordon College, I remained for a period of nearly three weeks, during which time I had an opportunity of visiting the laboratories and hospitals and making myself acquainted with the prevalent types of disease and the special laboratory methods employed in hot climates. I was given every facility and help by members of the staff of the Kasr-El-Aini School of Medicine and the Egyptian Sanitary Department. Opportunity was also afforded one to become acquainted with the future basis of supplies for the laboratories and to make enquiries about an assistant. Mr. John Newlove was subsequently appointed to the post. Khartoum was reached on Jan. 22nd, 1903, and it was found that everything connected with the laboratories was in a very backward condition. The rooms were not nearly ready, much of the equipment had yet to arrive, and some of the furniture and fittings had been damaged in transit. It had been considered better to do very little until the Director was on the spot, probably the wisest course under the circumstances, though it rendered delay inevitable. Through the courtesy of Mr. Currie a room was provided for work while the laboratories were being got

Laboratory assistant

Kitchen and General Work Room, Wellcome Research Laboratories, Khartoum



Bacteriological Laboratory, Wellcome Research Laboratories, Khartoum

ready, and considering everything it was not so very long before they were completed. Material for examination in the shape of diseased dura plants and pathological specimens were sent in thus early, and the laboratory work may be said to date from February 1st, 1903. Mr. Newlove arrived and took up his duties on April 1st, by which time the rooms were nearing completion and the nucleus of a museum had been formed.

The laboratories, as at present constituted, consist of a suite of five rooms, *i.e.*, a kitchen for the preparation of culture media and for the general rough work, separate bacteriological and chemical rooms, a chamber specially prepared as a photographic dark room and cold storage room, and a museum room. Adjoining these are the Director's office and the Economic and General Museum, with which the laboratories are associated.

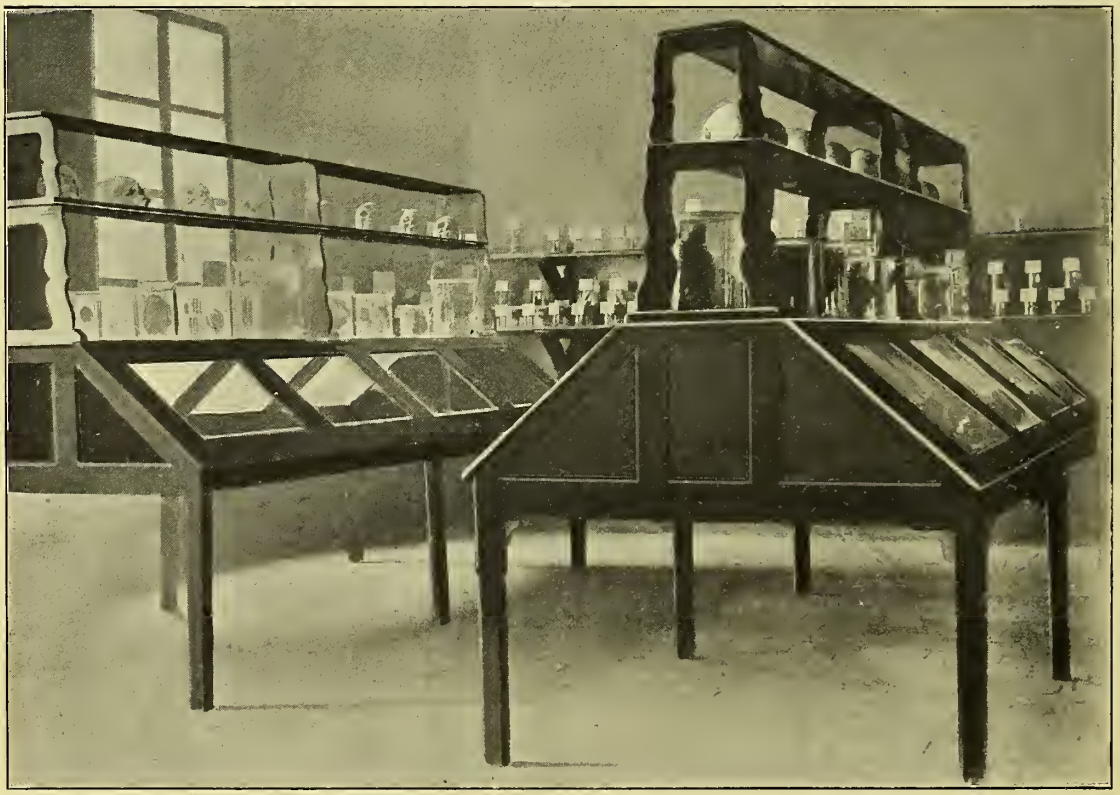
The whole department is situated on the second floor in the east wing of the Gordon College. The rooms, though they unfortunately face the east, are large and commodious, well lighted, and supplied with water from a special well, and with gas generated from an acetylene plant. The woodwork and fittings are executed in English oak and Indian teak, which had been previously baked at a high temperature for several months to season them suitably for the Sudan climate. It is gratifying to be able to report that all the wood thus treated has passed through the ordeal of a Khartoum summer very satisfactorily. The state of the walls, especially those of the bacteriological room, leaves something to be desired, and there has been considerable delay and annoyance owing to the lack of skilled labour, the distance from supplies, and the difficulties of transport; but when all is said and done the laboratories have fared none so badly and have received much kind aid from many government officials, both in Khartoum and Cairo.

Museum of the laboratories

The museum of the laboratories has progressed steadily since its formation. It is primarily devoted to the collection and exhibition of specimens and photographs shewing the diseases of man and animals met with in the Sudan, and maps indicating their respective distribution. It now contains over a score of mounted specimens illustrative of human pathology and tropical diseases—those of mycetoma, so prevalent in the Sudan, may be specially mentioned, several of veterinary interest, a small collection of skulls, and what promises to be a very fine and complete set of photographs illustrative of the native diseases of the Sudan, taken by Mr. Türstig, Omdurman, for Dr. J. B. Christopherson and kindly presented by the latter. Mr. Newlove, who is responsible for most of the photographs illustrating the Report, has also secured similar records as opportunity offered. In addition to these exhibits a collection has been made of the remedies indigenous to, or used in, the Sudan by the native races. Over a hundred different drugs have been obtained from various parts, some of considerable interest, and to facilitate the study of those of vegetable origin and of poisonous plants employed in the Sudan a plot of ground has been enclosed and what may be called a "therapeutic garden" has been started. This garden is fed from the laboratory well and contains a water-tight cement tank into which the laboratories' waste-water is conducted. Thus, if necessary, the latter can be

Formation of a "therapeutic garden"

Chemical Laboratory. Wellcome Research Laboratories. Khartoum



Museum of the Wellcome Research Laboratories, Khartoum

disinfected and so all danger of fouling the soil, and through it the waters of the Blue Nile obviated.

Museum of the laboratories

The laboratories' museum is much indebted to those who have been good enough to send it specimens. The chief contributors have been Dr. Christopherson of the Civil Hospital, Omdurman, Lt.-Colonel Griffith, P.V.O., Major Bray, the late Captain McArdle, who took much interest in the work, and whose untimely death is greatly to be deplored, Captains Rivers, Cummins, and Ensor of the Egyptian Medical Corps, and Sadek Effendi and Nagib Shedid Effendi, of the same service. Mr. and Mrs. Broun, members of the Museum Board, have also from time to time presented specimens of drugs and poisonous plants.

Principal donors

It is a great pleasure to be able to report that in several instances the medical officers in Khartoum have availed themselves of the facilities presented by the laboratories, and have worked in them to some extent. Captain Ensor, especially, has devoted much of his spare time to blood examinations and other research. One is only too pleased to welcome such visitors, and place the laboratory resources at their disposal; and they have responded by permitting one access to clinical material under their charge, and furnishing notes and general information of great value.

Having been appointed a member of the Museum Board, it devolved on me to get the General and Economic Museum room ready for occupation, and the first specimens collected and mounted. To this work Mr. Newlove devoted himself with his accustomed energy. In this museum, but associated with the laboratories' work, are various specimens of diseased dura, a collection of mosquitoes including microscopical preparations of the three genera most common in Khartoum, examples of injurious insects such as those which destroy the melon plant, and the aphides, so destructive to the dura crop. In contrast to these latter are the beneficial lady-birds (Coccinellidæ), found along with the Aphides. Specimens of two species of tse-tse fly, one of which occurs in the Sudan, are also exhibited, as are a few snakes, scorpions, locusts, and samples of ore.

General and Economic Museum

The year's work, of which a record is here given, has conclusively proved that it would be a great advantage to increase the small staff by the appointment of a chemist. At present the staff consists only of the Director, a laboratory assistant, and two Sudanese, one a small boy. Considering the work which has to be done, and might be done, and the size of the country which these laboratories serve, it is essential that such an addition should be made. His Excellency the Governor-General, who has taken a deep interest in the laboratories and all that pertains to them, has been approached upon this subject, and, thanks to his prompt recognition of the need for such an official, permission has now been obtained and a chemist well versed in agricultural, economic and toxicological work will shortly be appointed. Another post which might well be filled is that of collector, a trained observer whose duty it would be to traverse the country and collect blood films, biting and injurious insects, parasites, photographs of pathological conditions amongst the natives, drugs, poisons, and

Staff

Necessity for increase of staff

General and Economic Museum, looking North

General and Economic Museum, looking South

indeed anything having a bearing on tropical medicine in the Sudan. Such work, properly conducted, might be invaluable and lead to many interesting discoveries. Although a museum memorandum has been freely circulated throughout the Sudan, it has met with little response, save from Suakin, which, thanks to Major Borton, has responded nobly. For all that, if officials were made to realise the value of such a collection there is reason to believe they would be able and willing to aid in the scheme. It is, perhaps, too much to expect that a collector will be found, but it is well to draw attention to the great services such a member of the staff might perform, and how he might aid in the pursuit of knowledge.[1]

Value of a collector

The laboratories are in communication with the London and Liverpool Schools of Tropical Medicine, and one of their functions should be, as far as possible, to provide these great centres with material for teaching purposes. They have also been asked to aid the Cancer Research Fund in its enquiries, and have already done so to the best of their ability. The United States Department of Agriculture has been approached and has most kindly consented to send its valuable publications for the use of the library, a gift of great importance considering the prevalence of fungus diseases and insect pests in the Sudan, and the vast experience that Department has in combating such conditions. The library itself is well stocked and is supplied with a selection of necessary scientific journals and periodicals. The authorities of the Natural History Department of the British Museum have been good enough to present it with several of their valuable publications.

Correspondence

Foreign aid

Library

To Mr. James Currie, Director of Education and Principal of the College, and to the members of his staff, I would express my indebtedness for much kind aid, advice and encouragement, freely rendered me on all occasions.

Thanks to Mr. Wellcome's munificence the laboratories are admirably equipped. That they filled a want has, I think, been demonstrated by what they have been called upon to do in the past year, and there is every reason to expect that their sphere of usefulness will steadily increase. That they may be fully equipped to undertake all that is demanded of them, and at the same time endeavour to justify their title, must be the aim and object of those responsible for the work.

[1] Mr. Wellcome has recently intimated his willingness to provide a collector.

## Mosquito Work in Khartoum and in the Anglo-Egyptian Sudan generally

Before reaching Khartoum one had been informed by certain residents that the town contained very few mosquitoes, that those of the malaria-carrying genera grouped under the sub-family Anophelina were unknown and that malaria did not occur. It was speedily apparent that such was not the case. Before any measures were taken against them, mosquitoes bred in their tens of thousands in Khartoum, the family Anophelina was represented by one genus and species to a considerable extent, though limited as to locality, and malaria was and is present, though whether it is frequently acquired in Khartoum itself is another question and one more difficult to answer.

Prevalence of Mosquitoes in Khartoum

By far the commonest mosquito in the town and neighbourhood is the *Culex fatigans* (Wied.), so widely distributed throughout the tropics. The female of this insect has for some time been known to be capable of conveying the parasite of the disease, filariasis, from the sick to the sound. Of this disease elephantiasis is a form and elephantiasis occurs in the Sudan. Further, the recent laborious researches of Dr. Graham, of Beyrout,[1] seem to have conclusively proved that this mosquito is the transgressor in the case of dengue or dandy fever, forming the intermediate host for the protozoon of that disease. One first encountered the *Culex fatigans* in the Grand Hotel, where this species was very numerous and annoying, and the cause of many complaints by residents. The reason of its presence was not far to seek. The hotel possessed a well, the well water possessed egg-boats, larvæ, and pupæ in abundance and those in charge possessed no knowledge of the life-history of the mosquito. This well was in no way peculiar, for subsequent researches showed that more than half the wells throughout the length and breadth of Khartoum, and there are in the town over 600 wells, formed breeding places for the ubiquitous Culex.

Culex fatigans, a filaria-carrier

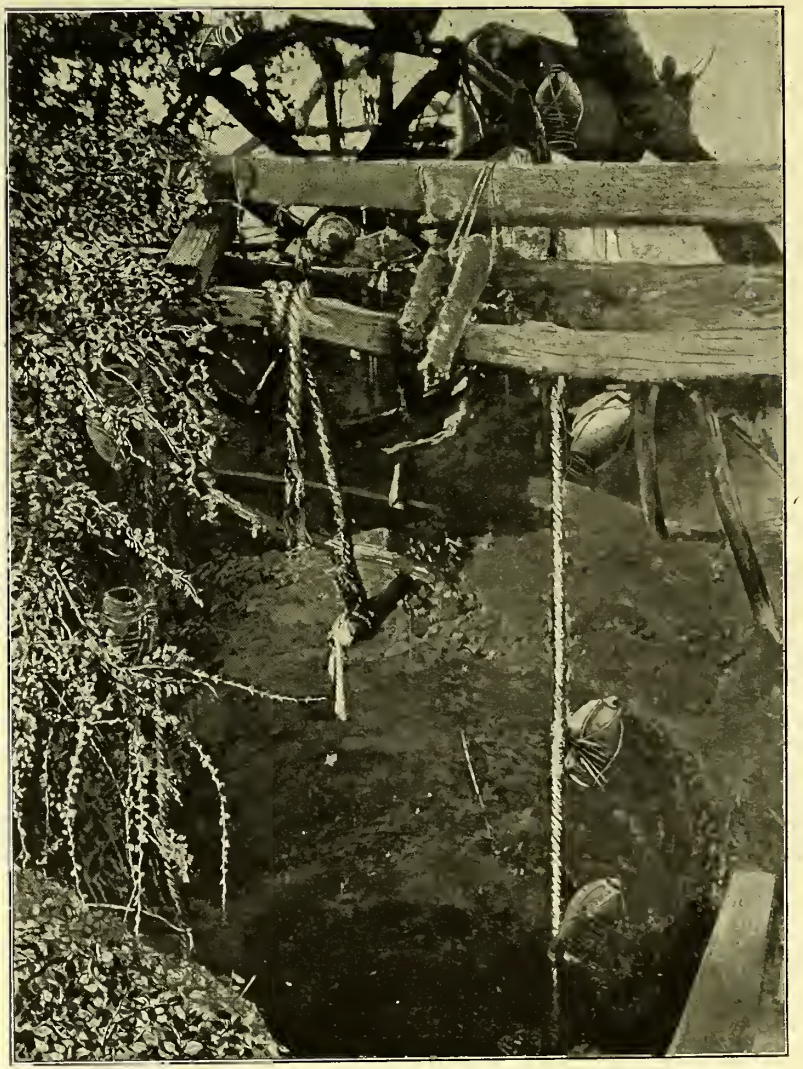
This mosquito is voracious, nocturnal in its habits, and distinctly annoying, but in a place like Khartoum is unlikely to be the cause of much transference of disease, save in the presence of an epidemic of dengue, which, if Dr. Graham be correct, it would spread wholesale. The dry climate of Khartoum is scarcely suited for filariasis, nor if Bastian's hypothesis[2] be correct, and the *Filaria perstans* be proved to be a Tylenchus and associated with the cultivation of the banana, is that parasite likely to occur to any extent, for banana plants are few and far between, and the fruit is not used in these parts. But, then again, Khartoum is a centre, and natives are continually coming and going and passing through it, while steamers constantly reach it from the humid and typically tropical regions of the Southern Sudan. Herein lies a danger, and, as a matter of fact, Dr. Christopherson has reported one case of elephantiasis from Omdurman and I have seen a second under the care of Major Bray in Khartoum.

Mosquitoes and disease

[1] *Journal of Tropical Medicine*, 1/2/03

[2] *Lancet*, 30/1/04

Zeer. Native earthenware water filter. A favourite breeding place for Stegomyia fasciata and one frequently overlooked by householders.



Sakia pit. A not infrequent breeding place for Culex fatigans.

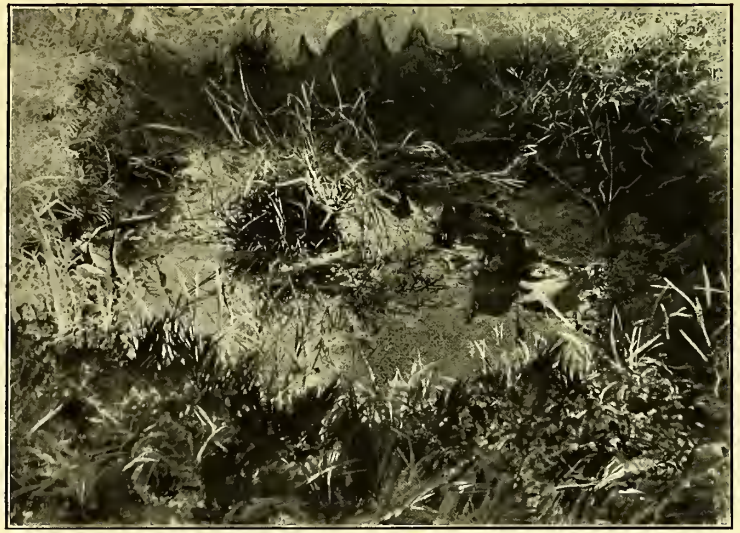
For all that, the presence of *Culex fatigans* was not felt to be very alarming, but it was a different matter when *Pyretophorus costalis* was encountered. This species of the Anophelina has been proved to be both a filaria and malaria carrier, and though it did not exist in great numbers had yet to be seriously reckoned with, even although Khartoum and its neighbourhood cannot be called a malarious district. This is simply because the Anophelines cannot find many suitable spots wherein to breed—the result of a small and limited rainfall, the comparative absence of vegetation and the power of the sun's rays as an evaporating agent. Still, as long as *Pyretophorus costalis* persists in Khartoum there will be a risk of malaria being spread from person to person. As already stated birds of passage are common in the town, and many of these come directly from the malaria-ridden reaches of the Blue and White Niles, while a greater number hail from Egypt, where malaria certainly occurs. In the bloods of different patients in Khartoum I have found all three forms of the malaria parasite, *i.e.*, quartan, benign tertian, and sub-tertian or malignant. The two latter forms are the most common, and the small ringed form and crescent forms are frequent in patients coming from up the White Nile. Now Khartoum is a garrison town, and probably the majority of the Sudanese soldiers at least have served or lived in malarious districts and have acquired the parasite. The same is true of their Egyptian comrades-in-arms, who are exceedingly susceptible to infection and suffer severely. I believe that one reason why there has not been more malaria in Khartoum is to be found in the fact that the military hospital is at present situated far from the breeding grounds of the Anopheline, which would have to cross a bare stretch of wind-swept desert, over a quarter of a mile in breadth, to reach those who might transfer to it the protozoon.

Pyretophorus costalis, a malaria carrier

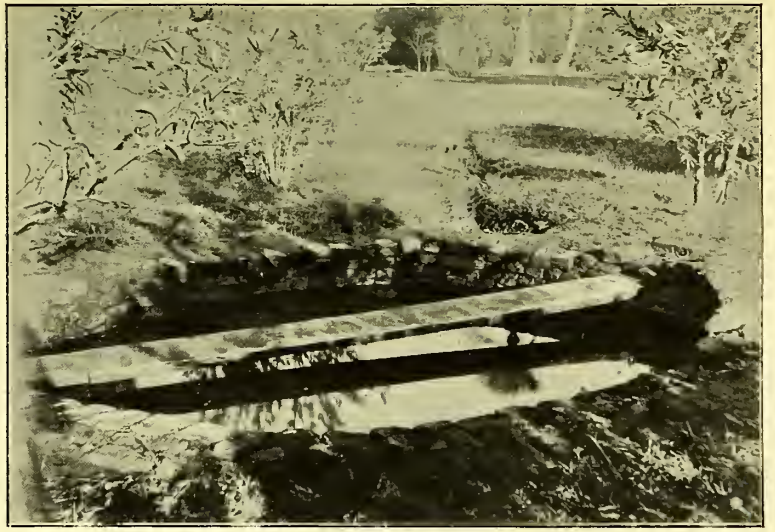
Nor must it be forgotten that many members of the crews of the steamers plying on both Niles harbour crescents in their bloods, and are constantly exposed to infection during their journeys in the south. It is not infrequent for several members of a steamer's company to arrive in Khartoum prostrated by fever, and such patients may well prove centres of distribution.

*Pyretophorus costalis* is the only representative of the Anophelina which has been discovered in Khartoum, but a third genus of mosquito occurs which in point of numbers comes midway between *Culex fatigans* and *Pyretophorus costalis*, being nothing like so common as the former but considerably in excess of the latter. This is a *Stegomyia*, species *fasciata*, which in the western hemisphere has been proved beyond all doubt to be the active agent in the dissemination of yellow fever. Here the germ of that disease does not, so far, exist to be transferred by it, but the Stegomyia is the most troublesome insect of the three, being exceedingly lively and biting viciously even in the heat of the day. As will be shewn Stegomyia also breeds in Khartoum, though not to any great extent. Its prevalence is, I believe, to be attributed to the presence of so many steamers on the Blue Nile for *Stegomyia fasciata*, as has often been pointed out, is an excellent traveller. Along with *Culex fatigans* it has been found breeding in large numbers in the bilge-water, tank-water, and engine-room-water of the river steamers.

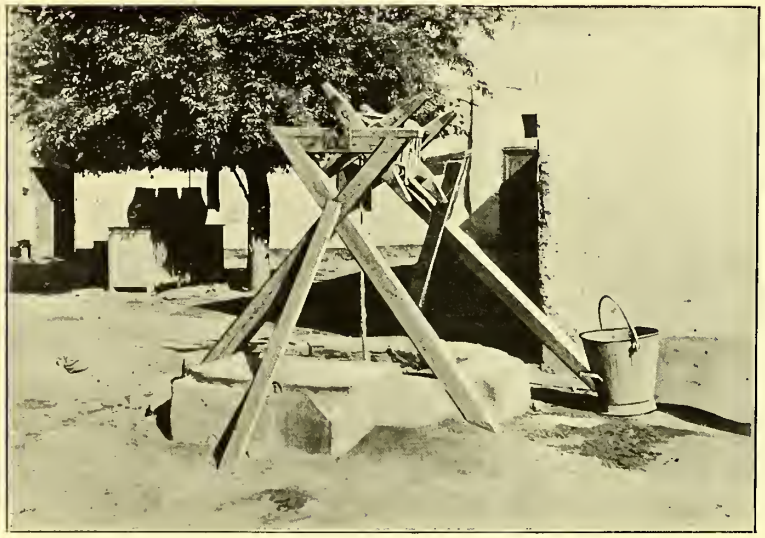
Stegomyia fasciata, the yellow fever mosquito



Permanent reedy pool in the Palace Gardens, Khartoum. A favourite breeding place for Pyretophorus costalis.



Type of irrigation pool in the Palace Gardens, Khartoum. A breeding place for Pyretophorus costalis and Culex fatigans.



Type of Khartoum well. The commonest breeding place of Culex fatigans.

Garden tank, Khartoum, in which were found the larvæ of Pyretophorus costalis and Culex fatigans.

These are not the only varieties of mosquito to be encountered in Khartoum. A large species of Culex closely resembling, if not identical with *Culex concolor* (probably *C. tigripes*) exists, but it is rare. At least one other species of Stegomyia is to be found besides *Stegomyia fasciata* and its variety form "*mosquito*," while Colonel Stanton, the Mudir, sent me a very large female mosquito which I found to belong to the genus Mucidus, and which Mr. Theobald, to whom I am much indebted for help freely rendered, declared to be a variety of his *Mucidus africanus*.[1] I have recently found *Theobaldia spathipalpis* breeding in barrel water at Khartoum North. Sufficient has been said to show that it was necessary to take steps for destroying these insects, and especially the Anophelines. Colonel Talbot, R.E., being much interested in the matter it was not long before one was asked to send to the Senior Medical Officer, Khartoum, a statement regarding the formation of a mosquito brigade, and one was subsequently requested to take complete charge of the work. I was very glad to do so, as it gave me an opportunity of studying the mosquitoes and their breeding places, of collecting specimens and of carrying out a few experiments. A small mosquito brigade was therefore formed on the lines suggested by Major Ronald Ross.[2] Two intelligent natives were obtained from Colonel Stanton, the Mudir, and quickly trained to recognise mosquitoes, their eggs, larvæ and pupæ, and to distinguish the culicidæ from other insects. Mr. Newlove, the laboratory assistant, who by this time had also become familiar with all the stages of the mosquito, was placed in charge of these men, his knowledge of Arabic being most useful, and here I would pay a well deserved tribute to the energy and zeal he displayed in what was often hot and tiresome work. The necessary equipment was provided by Captain Rivers, E.M.C., the acting S.M.O. at that time, and it was decided to attack the mosquitoes chiefly in the larval stage. This was the more easily accomplished owing to the nature of their breeding places.

Rarer forms

Formation of Mosquito Brigade

These may be classed as follows:—

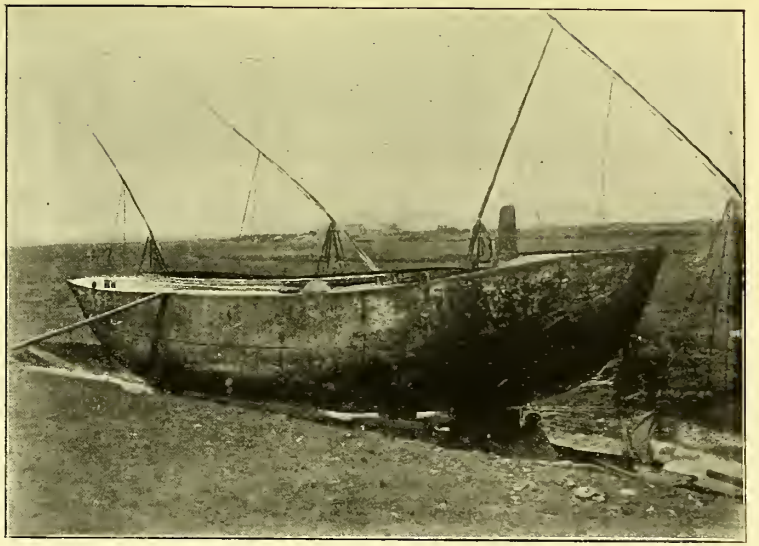
1. Wells; by far the most numerous and most largely infected (see page 17).
2. Sakia pits, both along the river bank and in certain gardens (see page 15).
3. Garden tanks, practically confined to the river front (see page 17).
4. Bath-waste pits.
5. Permanent garden pools, practically only found in the Palace Gardens (see page 17).
6. Zeers (native water filters) (see page 15).
7. River pools, *i.e.*, pools left in the banks by the falling Nile (see page 19).
8. Steamer holds, tanks, water-closet cisterns and engine rooms, also the holds of wood and other barges (see page 19).
9. Chance water collections as in old "sandals" or barges drawn up on the river bank, and from which speedy evaporation was prevented (see page 19).

Breeding places

[1] Theobald, "Monograph of the Culicidæ" [2] Ross. "Mosquito Brigades"

*Photo by Venieris*

River front, Khartoum, shewing the steep nature of the bank in which pools are often left by the falling Nile. The proximity of the Post Office to the steamers is also indicated, *vide* p. 11.



Sandal on bank of Nile. A curious breeding place of Pyretophorus costalis.

Pools left by the falling Blue Nile.
These constitute favourite breeding places for Pyretophorus costalis and Culex fatigans, especially the former.

Type of Upper Nile steamer. Common breeding ground for Stegomyia fasciata and Culex fatigans.

Fortunately, in Khartoum we have not to deal with any swamps, ditches, permanent pools in the streets or near the houses, empty cans, old bottles, broken crockery or other receptacles containing water for any length of time; at least, there were none such last year. It is possible that they might have to be considered during a very wet summer, but the rainfall of 1903 was trifling. As a result the labours of the brigade have been limited, and the small staff has so far sufficed. Major Ross [1] recommends refined petroleum or eucalyptus oil for the "training" of well waters, but, after careful enquiry it was deemed better to employ crude petroleum, not only because it was cheaper, but because comparatively little of the well water is used for drinking purposes, the native portion of the population preferring to use water direct from the Blue Nile.

Use of petroleum

Latterly, as a considerable quantity of the refined petroleum had been stocked, a mixture of crude and refined has been employed. The former appears to be the more efficacious, as it forms a denser film and one which lasts longer. The well water in Khartoum is for the most part reserved for washing, cooking, and the use of animals. It was evident that the oiling of the wells would entail some hardship on their owners, but the above fact shows, what indeed proved to be the case, that it could be done without producing any great outcry. The user of an infected and oiled well generally managed to easily satisfy his wants from a neighbouring uninfected and untreated water supply.

Crude petroleum, as stated, is very effectual if properly applied, and, moreover, makes the water so unsightly that none would touch it, and thus there was little risk of any poisoning from water so treated. As a matter of fact, no such accident has been reported, and the plan adopted was as follows:—

Mosquito Brigade work

The men constituting the brigade began every morning to visit systematically all the water collections in the town, beginning on the river front and working backwards day by day till the whole town had been explored. They were provided with wide-mouthed bottles for taking samples, and instructed how best to proceed. A cup-shaped apparatus of fine wire gauze was also employed, but the bottles were found quite as efficient, especially when the men were made to take three or four samples from different parts of the surface of every well water where the first dip proved negative. In the case of other water collections Durham's larva collecting spoon and tin,[2] recently introduced, have been found to answer admirably. In the afternoons, under the charge of Mr. Newlove, the men again went their rounds, the water collections were re-inspected, and any found to be infected were thoroughly oiled. In the case of wells, observations showed that in the great majority we had to deal with a surface area of from 12 to 13 square feet. Roughly speaking, about one pint of the crude petroleum was employed per well. This amount was probably in excess of that actually required, but by using it a reliable film was obtained. Syringes, though good in the case of pools, were no use for wells, and it was found best to simply pour the oil straight down upon the water, which, as a rule, was found at a

[1] Ross. "Mosquito Brigades" [2] *Journal of Tropical Medicine*, 1/10/03

depth of from 25 to 30 feet. The Sheiks of the various districts had orders to see that such "trained" water was not disturbed for forty-eight hours, after which time the users were allowed to remove the oil and take the water. This length of time amply sufficed, all the larvæ and pupæ present being killed as shown by repeated investigations.

As a matter of fact the real lethal period was probably from about four to six hours, or even less, but it was deemed advisable to let the oil remain for a time as it has been shown that although mosquito eggs may be laid on such oiled waters they will not undergo further development.[1] It was of course impossible to make absolutely certain that these instructions were always faithfully obeyed, but in the great majority of cases the people did as they were told, and any that were refractory were at once reported to the S.M.O., Captain Cummins, who straightway informed the Mudir, and the offenders were promptly brought to their senses. Captain Cummins, indeed, rendered great assistance in the work from an administrative standpoint, and was at all times ready to aid and advise. More recently efforts have been directed to the closing of all unused wells, while, wherever possible, covers have been fixed on those in use and pumps introduced. Special methods were required in special places. In the Palace Gardens pools had to be cleared of reeds and water-weeds, and in some instances were abolished; Mr. Sillitoe, the head gardener, very kindly assisting the brigade as much as possible.

Co-operation of military and town authorities

Fish taken from the Blue Nile were tried both in wells and pools. In the former they speedily died, the water being too hard for them, but in pools containing river water they proved a success, though after causing the larvæ to disappear they too often disappeared themselves, owing to the depredations of natives or aquatic birds. Wherever possible zeers (native water filters) were inspected, and a notice both in English and Arabic was posted in the *Sudan Gazette*, the official government organ, drawing attention to the rôle of these earthenware jars as breeding places, and emphasizing the importance of having them emptied and cleaned at least twice in the week. At an early period the steamers were found to be largely infected, especially with the larvæ of *Stegomyia fasciata*, and to a less extent by those of *Culex fatigans*. Anophelines, either as larvæ or imagines, have never been met with; but up-country, as will be noted later, the adults are frequently to be seen on board, and may remain as passengers for a considerable period. At first it was decided to use lime for the steamer bilges, but this was said, erroneously I believe, to act upon iron and to be unsuitable. Consequently crude petroleum was recommended, though not so good nor so easily applied. Along with this the periodical emptying of the bilge and fumigation with the sulphur squibs described by Colonel Giles[2] were advised, the latter to get rid of the adult insects. Unfortunately in the case of the steamers familiarity had evidently bred contempt, for, at first, despite the co-operation of the Director of the Steamers and Boats Department, little energy was displayed by the engineers in charge, and the preventive measures were largely ignored, and in some instances even

Closing and covering of wells

Treatment of Steamers

[1] St. George Gray. *Journal of Tropical Medicine*, 15/10/03

[2] Giles. "Handbook of Gnats or Mosquitoes"

ridiculed. This was the more to be regretted as there is no doubt that mosquitoes can be banished from all the steamers if a little care and trouble were taken. Mr. Beadnell, of the Geological Survey, carried out these simple methods on the s.s. "Nubia," and practically cleared her of mosquitoes, so that for the first time he was able to sleep below in comfort. A great improvement also resulted in the case of the gunboat "Zafir," in which I went to Dueim and found to be simply swarming with adult Culices and their larvæ, while these measures absolutely prevented any mosquitoes breeding out on board the s.s. "Amka" during a period of nearly two months, the greater part of which was passed in regions swarming with these winged pests. Latterly, I am glad to say, the engineers have been impressed with the necessity of doing all in their power to aid the brigade. This is the more necessary as it is easy for the steamers to infect the town and thus spoil much of the work done and render it futile. I am certain that this has occurred in many instances for reasons which will be stated.

Improvement in the state of the steamers

The men of the brigade also paid some attention to the killing and capturing of adult mosquitoes, but without much success, as most of the Culices live in the wells and are not easily obtained, while it was impossible for the men to go round and catch mosquitoes in Mohammedan households. A good many Anophelines and Stegomyia were, however, captured, and in the case of the former I made an effort by dissecting the females to determine the proportion harbouring the zygotes of the malarial parasite. As Daniels [1] has pointed out, this method is only of value when the mosquitoes are selected from different houses and places in equal proportion owing to the great variations which occur in this proportion in adjoining houses and at different times. As he says, the number of infected mosquitoes is the real test, and the number of Anophelines that bite a man per hour is also required. Consequently, such examinations as were performed possessed little value, and, indeed, it soon became difficult to secure material, chiefly because, as the result of the brigade work, Anophelines became a rarity. It was a case of killing the geese which laid the necessary, if not the golden, eggs. Of greater importance was the preservation of specimens of captured eggs, larvæ, and pupæ of all the genera found, as these proved valuable object lessons to officers and others proceeding up-country. Several have thus learned for the first time to recognise the appearance of the water-stages of the mosquito. Mr. Cross, of the s.s. "Gordon Pasha," made a point of bringing back specimens from his trips up the White Nile.

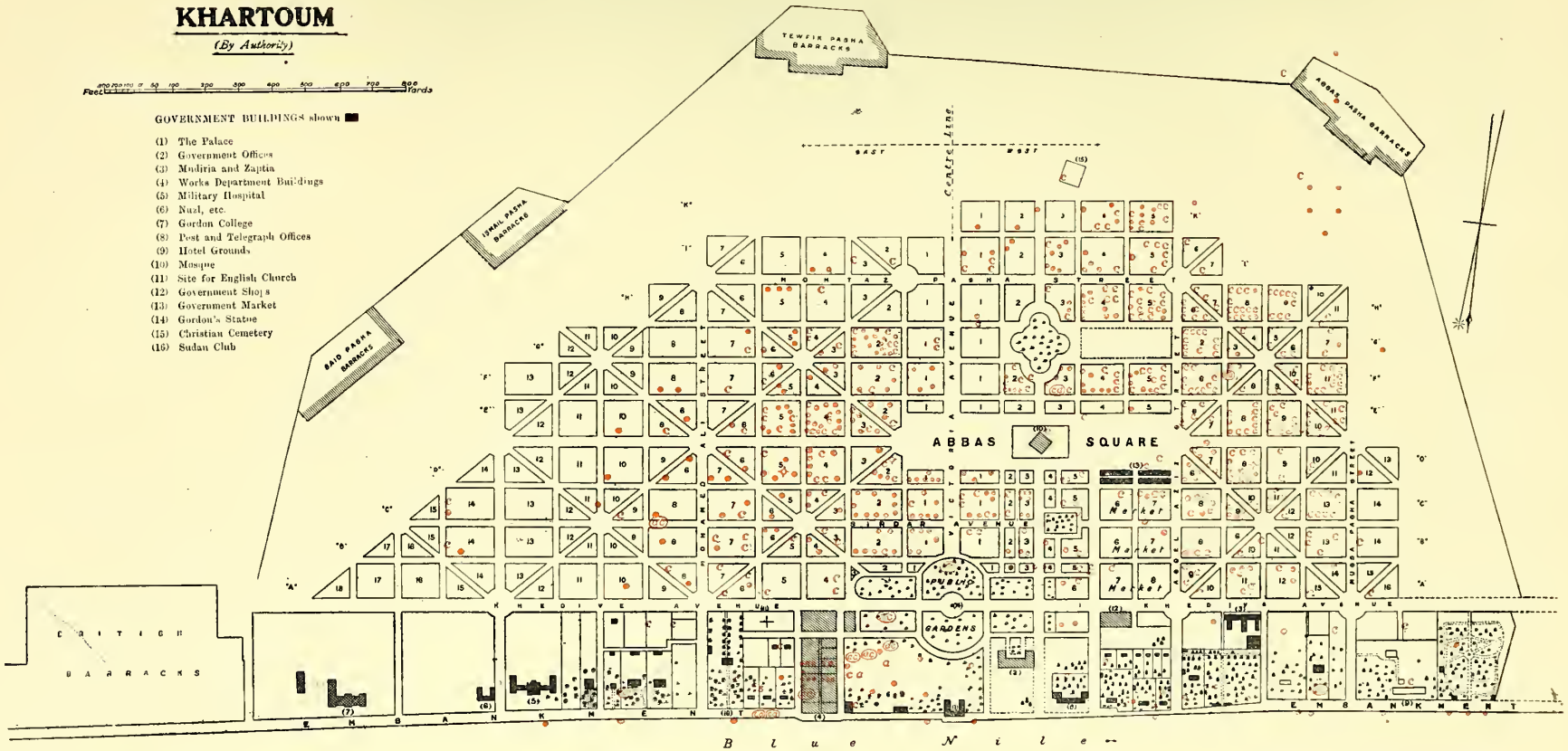
Examination of Anophelines

On the whole, Khartoum may be said to have had a moderate "endemic index." There were not a vast number of malaria-carrying mosquitoes, but there were many people who harboured the malarial parasite and many more susceptible to infection.

Khartoum's "endemic index"

The results of the work of the brigade are interesting and instructive in several directions. In the first place they have shown the distribution of each of the three main genera.

[1] Daniels. "Laboratory Studies in Tropical Medicine"




MAP No. 1

Shewing the condition of Khartoum as regards the distribution and breeding places of mosquitoes during part of August and the month of September, 1903, before treatment and prior to the advent of the cool weather.

. signifies an unaffected water collection.
c ,, a water collection infected by Culex.
a ,, ,, ,, ,, ,, Anophelina.
s ,, ,, ,, ,, ,, Stegomyia.
◇ ,, a place capable of holding water, but destroyed and empty or merely empty.

*Culex fatigans* is ubiquitous, but is chiefly, as has long been known, a domestic variety. It is the well mosquito *par excellence*, and consequently is found all over Khartoum, from the steamers back to the cemetery and Gordon's old ramparts, and from the British barracks in the east to the Zoological Gardens in the west. It also loves river pools, garden tanks, and bath-waste pits, and will breed in almost any kind of dirty water, even in that streaked with oil, as found in steamer engine rooms.

Distribution of genera in Khartoum

*Pyretophorus costalis*, on the other hand, is not domestic, and its range was found to be limited. It chiefly occurred in the various water collections rendered necessary by the irrigation of the Palace Gardens. It was found in those which were not stocked with fish, and especially in valve pits and shallow, reedy pools. It seemed indifferent to the presence of frogs. This mosquito has also been found in garden tanks along the river front, in the pools left by the falling Nile, in the sakia pits of the Gordon Gardens, and in a few, a very few, wells. It was present in considerable numbers in the Palace Gardens, and infested the neighbouring houses, but it does not appear to fly far from the shelter of vegetation, nor has it ever been found breeding on board steamers at Khartoum, partly because it is somewhat fastidious in its tastes, and prefers natural collections, and partly because the larvæ require plenty of light.

*Stegomyia fasciata* again, is the great steamer mosquito, and has not been found to breed much in Khartoum itself. It is to be remembered, however, that the larvæ of this genus differ somewhat in habits from those of the other genera. They are more worm-like, hug the bottom and come only infrequently to the surface, consequently they may have been more often missed. It has been found breeding in the zeers and a few other water collections, but very rarely in the wells. Further, and this is interesting, it seemed to be almost wholly confined to what may be called the front belt of the town, the river zone, and hence my belief that it was very largely an unwelcome gift from the steamers. Certain wells, opposite which steamers were accustomed to lie up, for example at the post office, (see page 19) constantly became reinfected with Culex after they had been treated and freed, and these also I believe came from the boats. Indeed it has been found much easier to keep the south part of the town free than that which borders the Blue Nile.

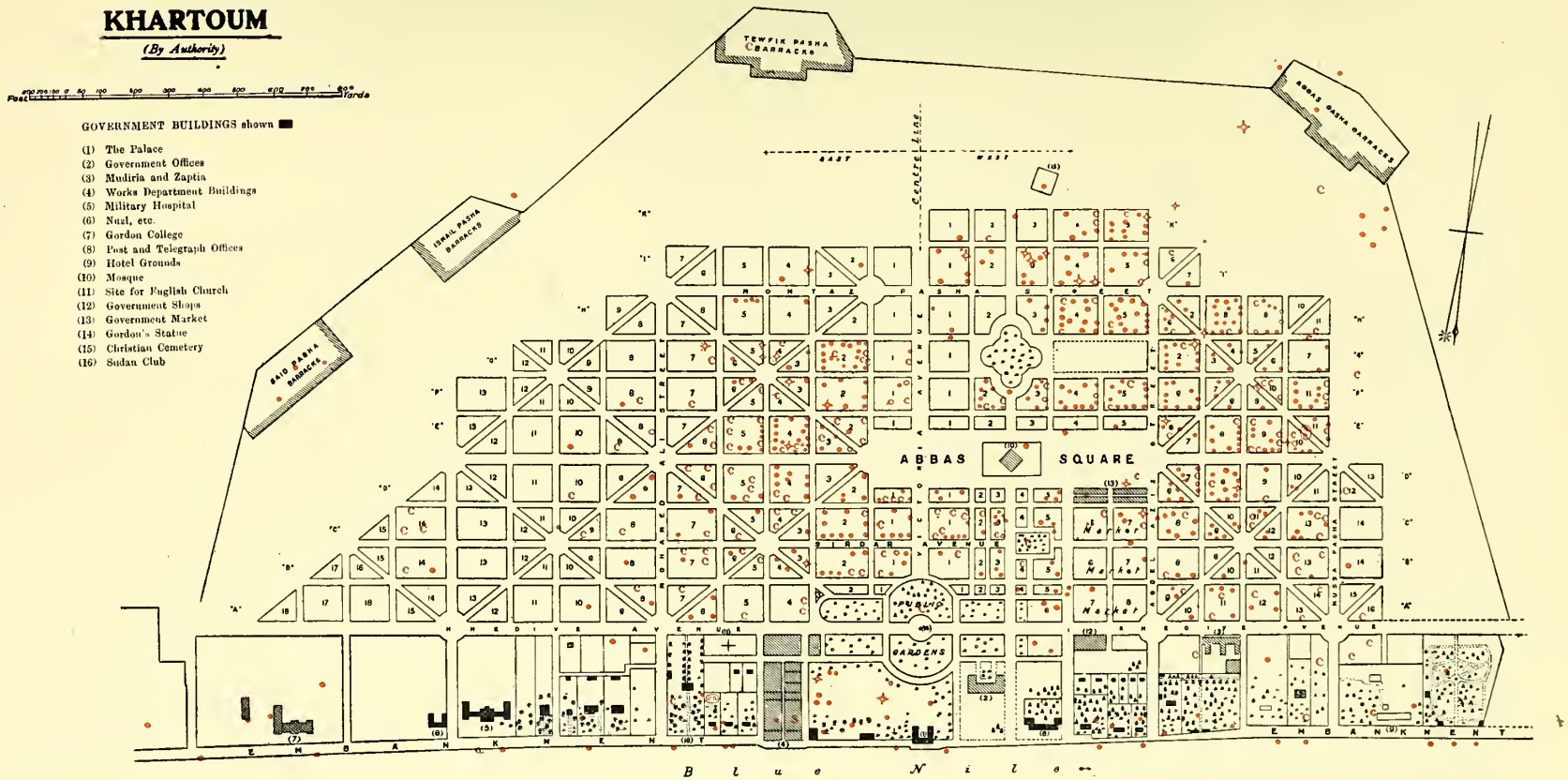
Reinfection by steamer bred mosquitoes

The accompanying maps show the respective distribution, and also exhibit another point, the effect of the treatment.

Map No. 1 represents the condition of the various water collections as found during the first complete round of the town made in August and the first part of September, 1903.

Mosquito Maps

Map No. 2 shews the same collections and any new ones which may have been discovered or been formed (for new wells are constantly being sunk), after the necessary oilings. Different marks have been devised to explain different conditions so that the improvement which has resulted may be seen at a glance. The second map brings us down to the end of the summer (October 31st) and the summer work, thus excluding any fallacies which might arise from altered climatic




MAP No. 2.

Shewing the condition of Khartoum as regards the distribution and breeding places of mosquitoes during October, 1903, after treatment of the whole town, and prior to the advent of the cool weather.

· signifies an unaffected water collection.
c ,, a water collection infected by Culex.
a ,, ,, ,, ,, ,, Anophelina.
s ,, ,, ,, ,, ,, Stegomyia.
◇ ,, a place capable of holding water, but destroyed and empty or merely empty.
o ,, a water collection to which access could not be obtained.

conditions. I append the average maximum and minimum temperatures, and the average wind velocity recorded during August, September and October, these being the meteorological factors likely to affect the mosquitoes in the work of propagating themselves.

Influence of meteorological conditions

| 1903. | Average maximum in °C. | Average minimum in °C. | Wind velocity in miles per hour. |
|---|---|---|---|
| August | 37·45 | 24·25 | 2·7 |
| September | 38·5 | 20·88 | 2·10 |
| October | 38·51 | 22·82 | 1·98 |

It will be seen that the weather conditions differed very slightly in September and October.

The work was steadily continued during November and December, and a record of the conditions found during January is exhibited in Map No. 3. This map is drawn up on slightly different lines, as it was deemed inadvisable to repeatedly spot all the uninfected water collections previously shown. Only new water collections and infected places are marked. It will be noticed that during this month pools began to make their appearance on the river's bank and on a sandbank which had formed and stretched out into the main stream. Such pools, provided they were large enough, were speedily occupied, despite the fact that they were often exposed to the strong north wind.

The meteorological conditions prevalent during the last two months of 1903 and the first month of 1904 are here stated:—

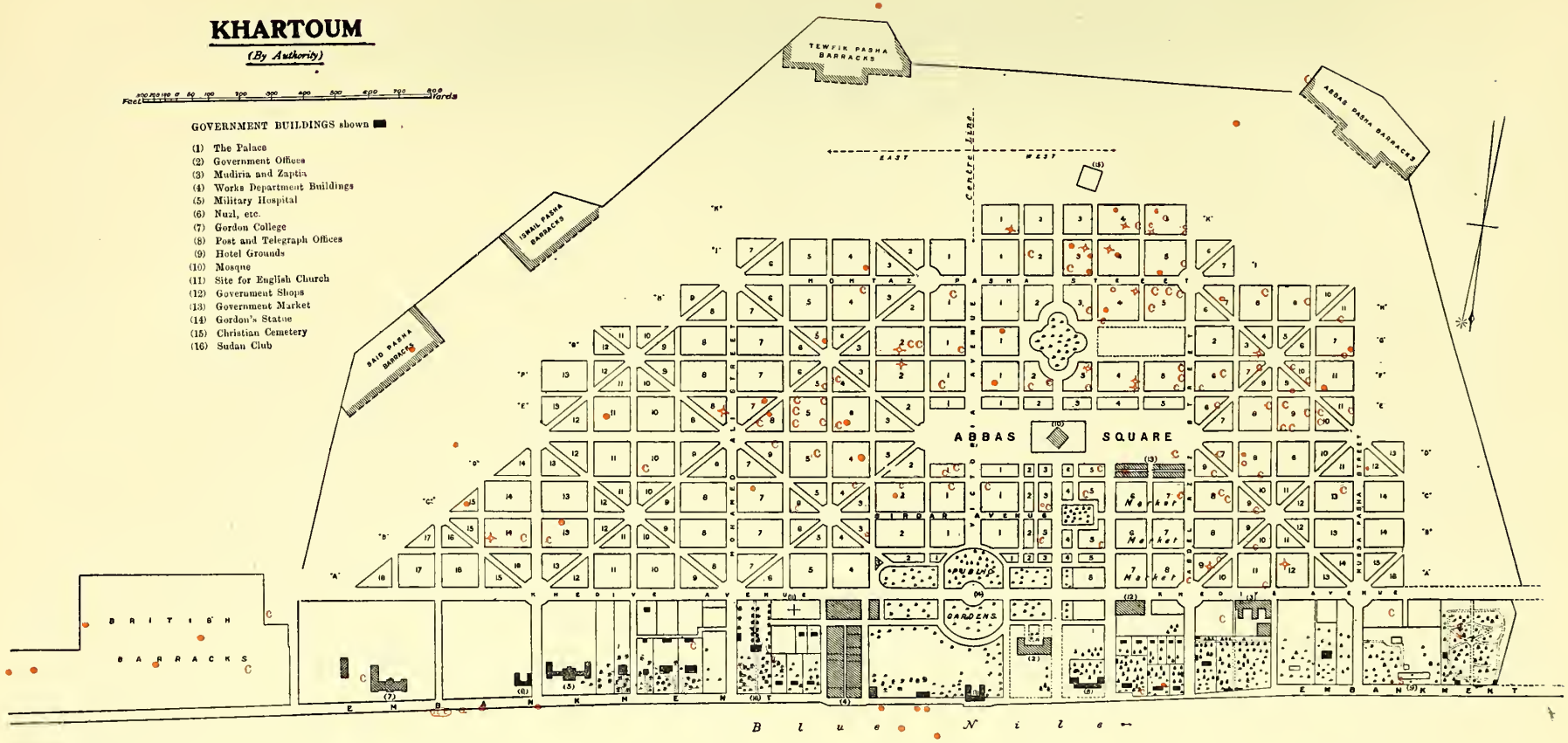
| 1903 | Average maximum in °C. | Average minimum in °C. | Wind velocity in miles per hour |
|---|---|---|---|
| November | 37·28 | 20·89 | 1·48 |
| December | 35 | 18·01 | 1·75 |
| 1904 | | | |
| January | 31·5 | 16·3 | 1·82 |

I do not think these conditions influenced the mosquitoes to any marked extent.

Statistics

The general figures work out as follows:—

| | During Aug. and part of Sept. before treatment | During Oct. after treatment. Several destroyed | During Jan. after treatment |
|---|---|---|---|
| Total water collections | 670 | 664 | 689 |
| Total infected | 324 | 163 | 102 |
| Percentage infected | 50 | 24·5 | 14·8 |
| Harbouring Culex (total Culex) | 321 | 161 | 100 |
| „ Culex and Anophelina | 12 | 2 | 1 |
| „ Anophelina alone | 2 | 1 | 1 |
| „ Culex and Stegomyia | 1 | 0 | 0 |
| „ Stegomyia alone | 1 | 1 | 1 |
| Total Anophelina | 14 | 3 | 2 |
| Total Stegomyia | 2 | 1 | 1 |




MAP No. 3.

Shewing the condition of Khartoum as regards the distribution and breeding places of mosquitoes during the month of January, 1904, after treatment of the whole town, and in the middle of the cool weather.

• signifies a new and unaffected water collection.
C ,, a water collection infected by Culex.
a ,, ,, ,, ,, ,, Anophelina.
s ,, ,, ,, ,, ,, Stegomyia.
✧ ,, a place capable of holding water, but destroyed and empty or merely empty.
o ,, a water collection to which access could not be obtained.

NOTE.—Unaffected water collections other than new are not charted.

As regards the second table it is to be noted that it was found impossible, despite every endeavour, to visit eleven water collections by the time the statistics were made up, owing to the fact that the houses containing them were closed, and the owners absent. There were over thirty such cases, but by the kind help of the Mudir, to whom also my thanks are due for supplying the blank plans, the difficulty was overcome save in these eleven instances. In order to complete the table I have counted six of them as harbouring Culex, which is certainly a very fair proportion, judging from what was found elsewhere under parallel conditions. All these houses were in what may be called the "Culex" part of the town. Similarly, in Map No. 3, six unvisited wells are charted, and three of these were considered as being infected. The above figures can only be regarded as being approximately correct, and as only applying to the special times at which the examinations were made. The conditions were constantly altering, as the mosquitoes were driven from well to well, and at the time of writing the state of the town is better than the last figures indicate.[1] Still, these statistics serve to show that very considerable progress has been made. For the sake of argument, let us suppose that the average number of larvæ and pupæ in an infected water was one thousand. This is by no means an absurd figure, indeed, I believe it to err on the small side, but even so, taking the first and third tables, a total destruction of 222,000 mosquitoes is indicated, granting that, if left alone, all the larvæ and pupæ would have reached maturity. Nor does this represent in any way the eggs which were checked in their development.

Extent of mosquito destruction

Again, say half of the above were females capable of laying from 200 to 400 eggs apiece, a moderate computation, and it will be apparent that the ranks of the winged host have undergone enormous depletion. This is further evidenced by the fact that latterly the infected wells have been found to harbour much smaller numbers of larvæ than was the case at first, and by the experiences of residents and visitors. I admit that such statistics as the above savour of guess work, but they approach the truth, and that truth is instructive and encouraging. I should think that there are few mosquito-ridden towns which could be so completely cleared as Khartoum, where, as will be evident, the conditions are somewhat specialised. Such a happy result could, however, only be obtained by increasing the staff of workers, by constant vigilance, more frequent inspections, and bringing Khartoum North into the field of operations. Colonel Penton, the P.M.O. of the Sudan, has now agreed to this being done, so even better results may be looked for in the immediate future, especially as the steamers are to receive special attention. The Manager of the Sudan Development and Exploration Company has signified his willingness to co-operate in the work of clearing the steamers. Of course if the old type of well were abolished and driven or tube wells substituted, the mosquito would find it very difficult to thrive at all in Khartoum, but such a radical and expensive cure would be neither necessary nor justifiable.

Future operations

At the time when the Blue Nile was at its highest a considerable tract of land to the south-west of the town was submerged by the dammed up waters of the

[1] In February the percentage infected was 10·4, in March only 9·5. Anophelina had disappeared

White Nile. The pools so formed, were however shallow, soon dried up, and at no time were mosquitoes found breeding in them.

A point worth mentioning is that the labours of the brigade have served to locate every well in Khartoum, a matter of great importance in the event of any extensive outbreak of cholera or enteric fever. The original number of wells sent me by the Mudir, and obtained from information furnished by the local sheiks, fell far short of the actual count. Value of localising wells

Certain water insects which prey on the larvæ have been found, but none are so voracious as to yield hopes that they may be turned to practical account.

More may possibly be expected from the discovery in the United States of a new sporozoon parasite[1] of the Anophelina, and of a larval round worm, *Agamomermis culicis* (Stiles)[2] which is said to render the female mosquito barren and induce disease in the insect. As has often been said, what is wanted is a thoroughly good larvicide, non-volatile, harmless to vegetation, non-poisonous, simple in application, easily soluble, readily diffusible, not obnoxious to the eyes or nose and at the same time cheap. The nearest approach to this is a well-known proprietary preparation made from anilin dyes and used successfully in the case of rice fields. Parasites of the mosquito

Having at one time found that chrysoidine, the hydrochloride of di-amido-azo-benzene ($C_{12}$ $H_{12}$ $N_4$ HCl), a yellow anilin colour, was most deadly to fish in very dilute solutions, it seemed worth while to experiment with it upon larvæ and pupæ. It was found that a solution of 1 in 30,000 was efficient both as regards Anopheles and Culex larvæ, the former being the less resistant. The amount, however, required for practical purposes would be too expensive, and the solution has rather a strong yellow colour. Action of chrysoidine, an anilin dye

The following are the details of the few experiments performed. As far as possible the water in which the larvæ and pupæ were found was employed:—

| No. | Strength of Solution. | Result. | Temp. of Water. |
|---|---|---|---|
| 1 | 1 in 1,000,000 | Some advanced larvæ of *Culex fatigans* dead within 72 hours. Pupæ formed and hatched out. Some alive after 4 days. All dead in 5 days. | 28·5°C |
| 2 | 1 in 100,000 | Half the larvæ of *Culex fatigans* dead within 48 hours. Several living after 72 hours. | Do. |
| 3 | 1 in 75,000 | Some larvæ of *Culex fatigans* alive after 72 hours. Discontinued. | Do. |
| 4 | 1 in 50,000 | Half the larvæ (young) dead in 24 hours, not in 10 hours. All dead within 31 hours. | Do. |
| 5a | 1 in 50,000 | Killed the larvæ of *Pyretophorus costalis* within 24 hours, but not those of *Culex fatigans*. | Do. |

[1] Johnson. *Journal of Medical Research.* Vol. vii., 1902. No. 2, p. 213. [2] *Lancet*, 1/8/03

| No. | Strength of Solution. | Result. | Temp. of Water. |
|---|---|---|---|
| 5b | 1 in 50,000 | Larvæ of *Pyretophorus costalis* all alive after 48 hours. A few alive after 72 hours and after 96 hours. Pupæ formed. Discontinued. | 28·5°C |
| 6a | 1 in 30,000 | *Culex fatigans*. Nearly all the larvæ dead within 40 hours. Some alive after 72 hours. All dead within 4 days. | Do. |
| 6b | 1 in 30,000 | Larvæ and pupæ of *Culex fatigans* and *Pyretophorus costalis*. Very sluggish in 20 hours. Some dead. Some alive at the end of 24 hours. All dead except one larva and one pupa of *Culex fatigans* within 44 hours. All dead in about 50 hours. | Do. |
| 7 | 1 in 10,000 ? some suspended matter. | Killed larvæ of *Culex fatigans* within 18 hours, not in 5 hours. | Do. |
| 8 | 1 in 1,000 ? much deposit. | Killed advanced larvæ of *Culex fatigans* in 25 minutes. | Do. |

All the larvæ and pupæ killed were stained a bright yellow. The solutions soon altered a little in strength owing to evaporation, and, as will be seen, the results were somewhat indefinite.

Regulations for the prevention of malaria generally

Mosquito work has not, however, been confined to Khartoum. At the request of the S.M.O. Khartoum one drew up a set of simple regulations, with reference to the prevention of malaria, for the use of outlying stations. It was on the lines of Major Ross's recommendations, and in addition, care was taken to include those measures rendered necessary by the discovery, made by those [1] who have worked with forest mosquitoes, of breeding places in pitcher plants and hollow trees holding water.

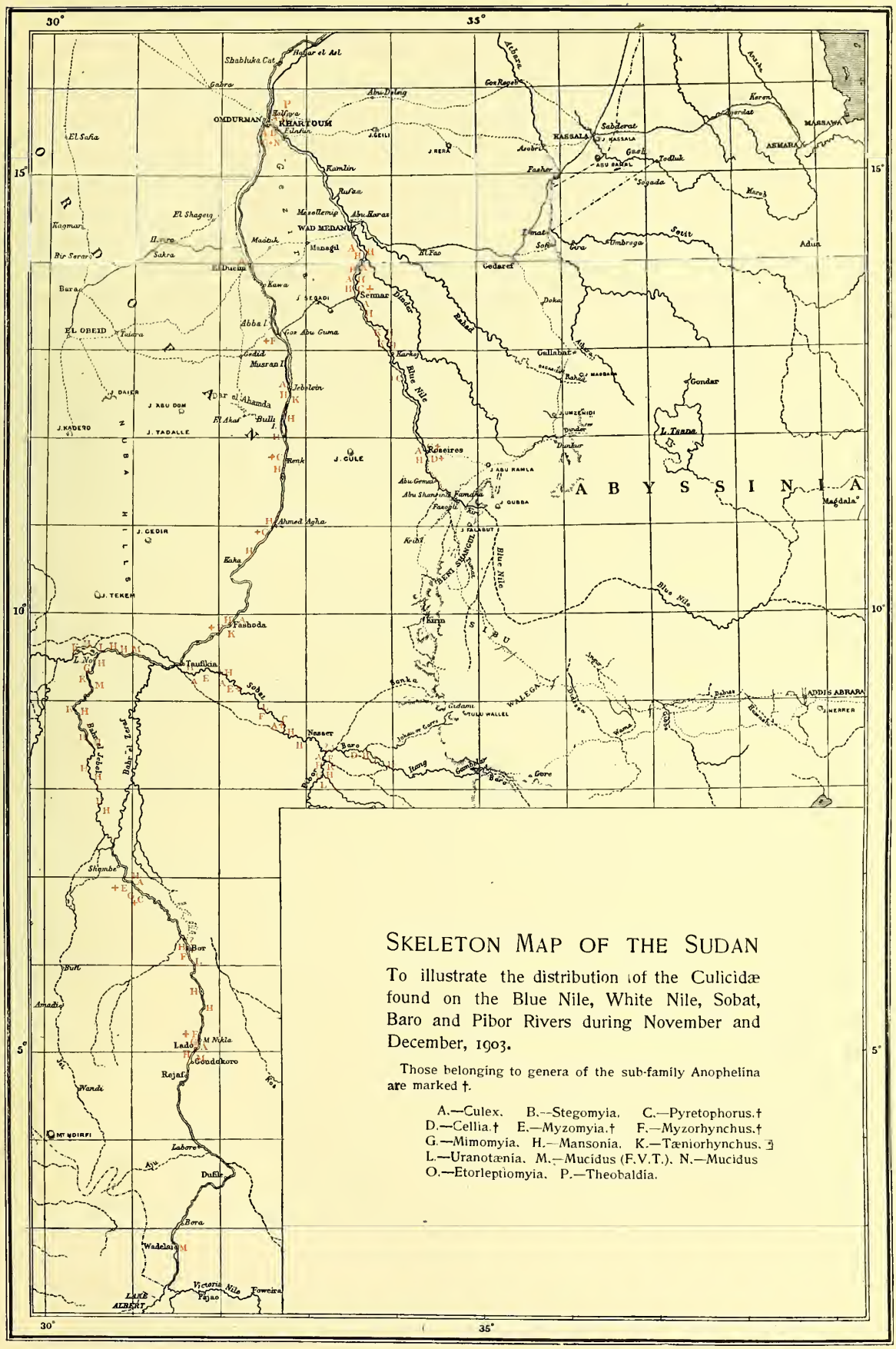
From Kassala, Captain Ensor reports a great improvement both as regards mosquitoes and other noxious and annoying insects which pass their larval stages in water. In this connection, it is interesting to note that the Shilluks have a so-called "mosquito plant." They dry the leaves and lay them inside the roofs of their huts. The myth of the basil,[2] if not that of the neem, has been exploded, so that probably this precautionary measure is of no value. I have not been able to obtain a specimen of the plant.

A "mosquito plant"

Mr. Cross brought the laboratories specimens of Mansonia uniformis from Renk, and Dr. Christopherson sent certain mosquitoes he collected up the Blue Nile. Unfortunately, these had not been mounted and were much damaged. The fact

[1] Lutz. Cent. f. Bakt., &c. Bd. xxxiii., No. 4, Jan. 1903. Leicester. *Journal of Tropical Medicine*, 15/9/03

[2] Prout's Experiments. *The Times*, London, 27/7/03




# SKELETON MAP OF THE SUDAN

To illustrate the distribution of the Culicidæ found on the Blue Nile, White Nile, Sobat, Baro and Pibor Rivers during November and December, 1903.

Those belonging to genera of the sub-family Anophelina are marked †.

A.—Culex. B.—Stegomyia. C.—Pyretophorus.†
D.—Cellia.† E.—Myzomyia.† F.—Myzorhynchus.†
G.—Mimomyia. H.—Mansonia. K.—Tæniorhynchus.
L.—Uranotænia. M.—Mucidus (F.V.T.). N.—Mucidus
O.—Etorleptiomyia. P.—Theobaldia.

Mosquitoes of the Nile

that His Excellency the Governor-General kindly gave me permission to join a party proceeding up both the Blue Nile and the White Nile and its tributaries gave me an opportunity of collecting mosquitoes in these parts during the months of November and December. There was little opportunity of catching mosquitoes on shore save at certain places. This rather interfered with the work as far as the Blue Nile was concerned, but on the White Nile and tributaries where the steamer often tied up for the night and at times was stuck fast in the Sudd, the mosquitoes boarded her in hundreds, and collection was an easy, though not a comfortable, pursuit.[1]

The accompanying map, for which I am indebted to the Director of Intelligence, War Office, shows the places where observations were made, and has the names of the different genera met with recorded on it. It is intended specially to show where the sub-family Anophelina and its genera flourish in greatest abundance, but also exhibits the great prevalence of the filaria-carrier Mansonia uniformis. The accompanying tables contain the names of the different genera and species encountered[2].

BLUE NILE—*November*, 1903

| | |
|---|---|
| Khartoum | Culex fatigans. |
| No swamp. A few pools in river bank. | Culex tigripes. |
| | Stegomyia fasciata and var. mosquito. |
| | Pyretophorus costalis. |
| | Mucidus africanus. |
| Khartoum North | Culex fatigans. |
| | Stegomyia fasciata var. mosquito. |
| | Theobaldia spathipalpis. |
| Between Wad Medani and Sennar | Culex fatigans. |
| No swamps. Bush country. | Mansonia uniformis (dark variety). |
| | Tæniorhynchus tenax. |
| Sennar | Mansonia uniformis. |
| | Culex pallidocephala. |
| South of Sennar | Mansonia uniformis. |
| Forest country. Swampy in parts. | Culex fatigans. |
| | Tæniorhynchus aurites. |
| Senga | Culex viridis. |
| River pools. Swamps dried up. | Pyretophorus costalis. |
| | Mansonia uniformis. |
| Roseires | Culex fatigans. |
| River pools. Forest country. | Mansonia uniformis. |
| | Pyretophorus costalis. |
| | Cellia pharœnsis. |

[1] I would here express my thanks to Mr. and Lady Fitzgerald, Miss Leigh Hunt, and Mrs. Balfour, for their kind help in the collection of specimens.

[2] *Vide* special article by Mr. F. V. Theobald

WHITE NILE—*December*, 1903

| | |
|---|---|
| Dueim | Culex fatigans. |
| No swamps. | |
| South of Goz-abu-Guma | Myzorhynchus paludis. |
| Swamps. | |
| Jebelein | Tæniorhynchus tenax. |
| Swamps. | Mansonia uniformis. |
| | Culex fatigans. |
| Renk | Mansonia uniformis. |
| Much swampy land. | Pyretophorus costalis. |
| Jebel Akmet Aga | Mansonia uniformis. |
| Swamps along river bank. | Myzomyia nili. |
| Kodok, late Fashoda | Mansonia uniformis. |
| Much swampy land. | Myzorhynchus paludis. |
| | Tæniorhynchus tenax. |
| | Culex fatigans. |
| | Culex viridis. |

SOBAT

| | |
|---|---|
| Lower Sobat | Tæniorhynchus tenax. |
| Few swamps. Open grass country. | Uranotænia sp.? |
| | Culex viridis. |
| | Culex fatigans. |
| | Myzomyia funesta (subumbrosa). |
| | Mansonia uniformis. |
| Middle Sobat | Culex fatigans. |
| Bush country. River banks swampy. | Myzomyia nili. |
| | Uranotænia cæruleocephala. |
| | Myzorhynchus paludis. |
| | Tæniorhynchus tenax. |
| | Pyretophorus costalis. |
| | Anopheles wellcomei. |
| | Culex dentatus? |
| | Mansonia uniformis. |
| | Culex viridis. |

BARO (first 100 miles)

| | |
|---|---|
| River banks high. Grass and open country. Some river pools. | Anopheles wellcomei. |
| | Culex fatigans. |
| | Tæniorhynchus tenax. |
| | Mansonia uniformis. |
| | Cellia pharœnsis. |
| | Culex viridis. |

### Pibor (first 60 miles)

| | |
|---|---|
| The whole country full of swamps . . | Myzorhynchus paludis. |
| Much sudd in the river. | Mansonia uniformis. |
| | Culex viridis. |
| | Tæniorhynchus tenax. |
| | Uranotænia balfouri. |
| | Stegomyia fasciata. |
| | Myzomyia funesta. |
| | Tæniorhynchus cristatus. |
| | Uranotænia domestica ? |
| | Culex fatigans. |
| | Anopheles wellcomei. |
| | Etorleptiomyia mediolineata. |

### Bahr-el-Jebel

| | |
|---|---|
| Bahr-El-Jebel, North . . . . . | Mimomyia splendens. |
| Swamps and papyrus sudd. | Form with clubbed and peculiar palpi. (New genus ? and new species.) |
| | Mansonia uniformis. |
| | Uranotænia cæruleocephala. |
| | Mimomyia uniformis. |
| | Tæniorhynchus aurites. (New genus and new species.) |
| Lake No. . . . . | Mansonia uniformis. |
| Swamps on all sides. Sudd. | Tæniorhynchus annetii. |
| Bahr-El-Jebel, North . . . . . | Mansonia uniformis. |
| Swampy river banks. No real sudd. | Mimomyia uniformis. |
| | Uranotænia cæruleocephala. |
| Kenissa (south of Shambe) . . . . | Mansonia uniformis, 2 types. |
| River banks swampy. Forest land. | Culex fatigans. |
| | Tæniorhynchus tenax. |
| | Myzomyia funesta. |
| | Var. umbrosa. |
| | „ subumbrosa. |
| | Myzomyia nili. |
| | Culex viridis. |
| | Pyretophorus costalis. |
| Bor . . . . . | Mansonia uniformis. |
| River banks very swampy. Open country beyond. | Anopheles wellcomei. |
| | Myzorhynchus paludis. |
| | Myzomyia n. sp. ? |
| | Uranotænia cæruleocephala. |
| | Culex cumminsii ? |

| | |
|---|---|
| Lado . . . . . | Mansonia uniformis. |
| River banks high. Swampy island. Bush country beyond. | Culex viridis. |
| | Culex fatigans. |
| | Myzorhynchus paludis. |
| | Mimomyia uniformis. |
| | Myzomyia ? |

It will be seen that several genera previously unrecorded from this part of Africa have been found, such as Mucidus, Tæniorhynchus, Theobaldia, Uranotænia and Mimomyia,[1] while several entirely new genera and species have been secured.[2] New genera and species

The White Nile, as might have been expected, was found to harbour many more Anophelines, than the Blue Nile, though the Blue Nile furnishes a good many fever cases in the summer months. *Myzorhynchus paludis* was very common on the Pibor, where Uranotæniæ were also in large numbers, and were very vicious. On the Bahr-El-Jebel *Myzomyia funesta*, in both its varieties, was a frequent visitor in the evenings. This mosquito was found to remain on board for several days at a time, lying *perdu* in the folds of curtains and hangings, in mats and carpets bestowed in heaps, and finding special sanctuaries on the under surfaces of tables. Permanence of Anophelines on steamers

The steamer on which the captures were made was prevented becoming a breeding ground, and so any fallacy which might have arisen from this source of infection, was obviated. Mr. Young, the engineer, rendered every assistance in his power.

*Mansonia uniformis* is, however, *par excellence*, the mosquito of these parts of the Niles, *i.e.*, the Blue Nile from Wad Medani to Roseires, and the White Nile from Renk to Gondokoro, including the Sobat River and Lake No. In the light of this fact it would be well to ascertain if filariasis is common in these regions. It was on this blood-loving insect that a small red tick looking like a tiny preserved cherry was first found. This tick was afterwards discovered on *Myzorhynchus paludis*, and on several other species. It does not seem to affect the mosquito in any way, and was usually attached to the thorax or abdomen. I have also once seen what seems to be a green tick. So far, there has not been time to study these parasites more fully, but specimens have been sent to Mr. Theobald. The mosquito tick

In connection with preventive methods to be adopted at stations in the swamp regions of the White Nile, one would strongly advocate the introduction of sun-flower cultivation. Apart from its water-absorbing capacities the sun-flower is of great value as an economic product, the oil, seeds, and fibre all being useful. It has been successfully cultivated in the previously malarial stretches of the Mississipi valley, and is known to grow well and rapidly in the Sudan. Sun-flower cultivation advocated

As far as the application of culicifuges goes I have found a mixture of equal parts of citronella oil and absolute alcohol, the most effective preparation, and one pleasant to employ.

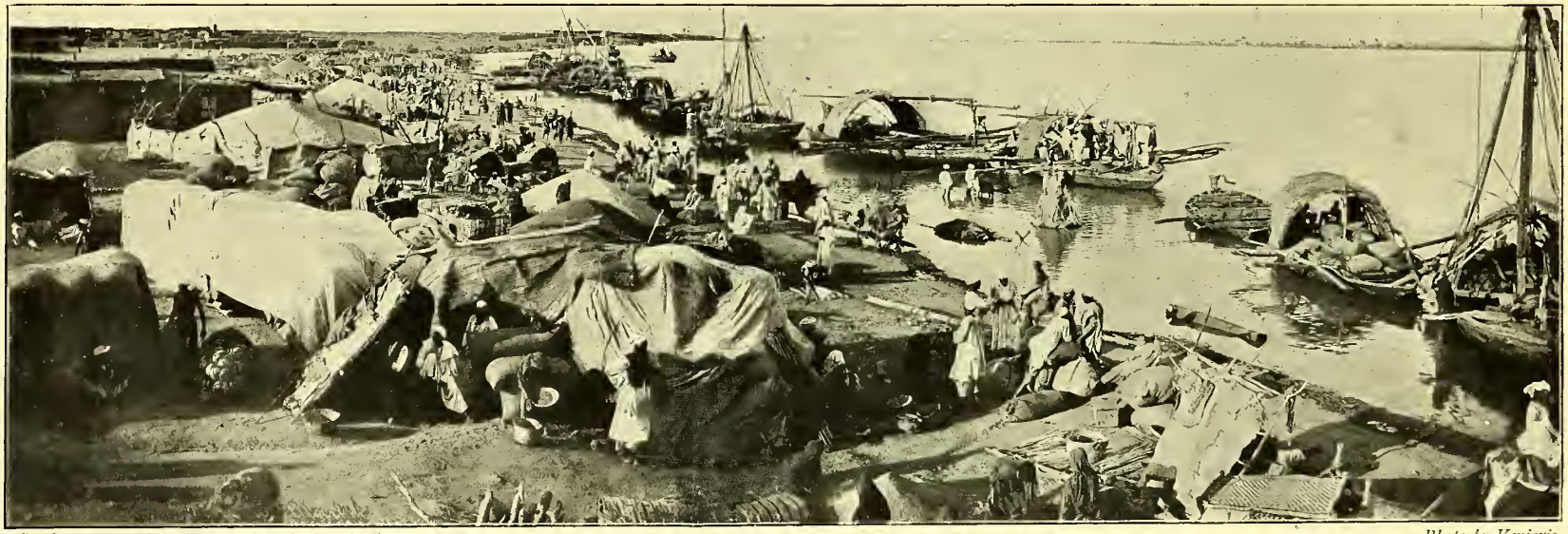
[1] Theobald. Monograph of the Culicidæ, Vol. iii.

[2] *Vide* special report by Mr. F. V. Theobald

The sudd as a factor in mosquito distribution

Daniels[1] has suggested that larvæ protected by floating sudd may be carried long distances, and that new genera and species may in this way reach Egypt. The first part of this hypothesis may well be true, but as regards the second, I would point out that little, if any, sudd finds its way even so far north as Khartoum. Floating islands of sudd are rarely encountered north of Dueim on the White Nile. They get caught by the reedy river banks and the low islands, and are at all times liable to be broken up and dispersed by the paddle floats of steamers. As a matter of fact, the distribution of mosquitoes indicated on the map is, on the whole, an argument adverse to the ingenious theory of this able observer.

[1] Laboratory Studies in Tropical Medicine, 1903



*By the courtesy of the Editor of "The Graphic."* *Photo by Venieris.*

FORESHORE AT OMDURMAN.

Note the sloping nature of the river bank in which mosquito pools are not left by the falling Nile. This is a point of some importance, as many native boats from malarial regions call here, and many people congregate at the market held on the shore.

## Biting and Noxious Insects other than Mosquitoes

In this connection one discovery has to be chronicled. It was made by Lt.-Colonel Griffith, D.S.O., to whom the laboratories supplied a small entomological outfit prior to his journey up the White Nile. He brought back specimens of various insects, and amongst them Glossina morsitans, a species of tse-tse fly, which he captured on the Pongo River, in the Bahr-El-Ghazal province, when marching from Wau to Dem Zobeir. He reported that the fly occurred in great numbers. This tse-tse is the carrier of the trypanosome of nagana so fatal to horses, donkeys, and certain other domestic animals, and had not previously been reported nearly so far north in these regions, having been encountered near Runbek by the Pethericks[1] in 1869. This has hitherto constituted its most northerly record. I looked for, and made careful enquiries about, the tse-tse flies throughout the Nile journey made on the "Amka," but I saw nothing either of Glossina morsitans or G. palpalis. The only information obtained was that a fly belt existed about 10 miles west of Shambe on the White Nile, and that horses and donkeys passing through it suffered from sickness. My authority was the very intelligent Egyptian officer in charge of the post. As it is very essential to define correctly the localities in the Sudan which are infested by the fly, and as Mr. Austen, the Dipterologist of the British Museum was anxious to obtain specimens and information, the laboratories forwarded an entomological outfit to the British Medical Officer in the Bahr-El-Ghazal Province with full instructions, a request for notes and specimens, and asking him to make enquiries amongst officials and natives. It is thus hoped to obtain reliable accounts and plenty of material. A complete collection of all the biting flies of the Sudan is much to be desired. Sand flies and owl midges are common in Khartoum and more annoying than mosquitoes, while specimens have been secured of the seroot flies of the Nile. These include species of the genera Tabanus and Pangonia, which are very numerous, and whose bites are severe. Mr. Theobald identified amongst the Tabanids, Glossina, etc., brought him by Lt.-Col. Griffith, D.S.O., *Tabanus dorsovittus* (Walker) from Kodok, a Stomoxys sp? and *Glossina morsitans* from the Pongo which were quite typical. *Vide* Second Report on Economic Zoology, p. 113 (Biting horse flies in Central Africa), F. V. Theobald.

The tse-tse fly

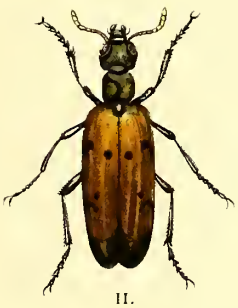
Biting Diptera

The Hippoboscidæ,[2] so annoying to horses and camels, are represented in Khartoum as are several other genera, specimens of which have been secured but not yet identified. Dr. Craig of the Egyptian Survey kindly presented a small insect collection made on the White Nile.

[1] "Travels in Central Africa," &c., quoted in Austen's Monograph of the tse-tse flies. (Nat. Hist. Brit. Mus.)

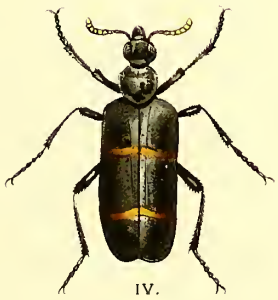
[2] The species on the camel is *Hippobosca camelina* L., that on the horse H. equina Linn. The dog in Egypt is attacked by *H. Canis* Leach. Probably *H. Maculata* L. also occurs on cattle and horses.

I.



II.

III.



IV.

*C. Beard*

PLATE A

BLISTER BEETLES OF THE SUDAN

I., II., III. Mylabris liquida Er.
IV. Mylabris ligata Chevr.

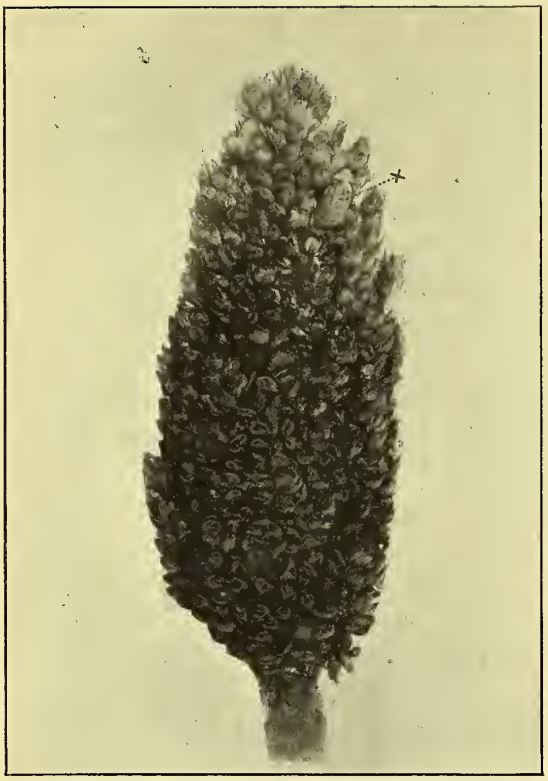
It appears as far as can be judged that the specimens figured at I., II., & III. are all merely varieties of the same species. The difference in shape is due to the specimens being somewhat damaged. (F.V.T.)

At Roseires, in November, I found numerous specimens of beetles belonging to the Cantharidæ, genus Mylabris. Captain Ensor reports them as being common in the Kassala district, where they are called "Fasseea." Captain Rivers states that they occur in great numbers in Kordofan. Probably several other species exist. Samples of similar vesicating insects from South Africa have appeared on the London market, and yielded from 1·09 to 1·02 per cent. of cantharidin.[1] Mylabris bifasciata of the Cape of Good Hope was found by Braithwaite[2] to be extremely rich in cantharidin. It is quite possible that these beetles may be of some economic value. The subject seems worthy of further investigation. Blister beetles

[These beetles are figured on Plate A, and a note regarding them is appended to the plate.—F. V. T.]

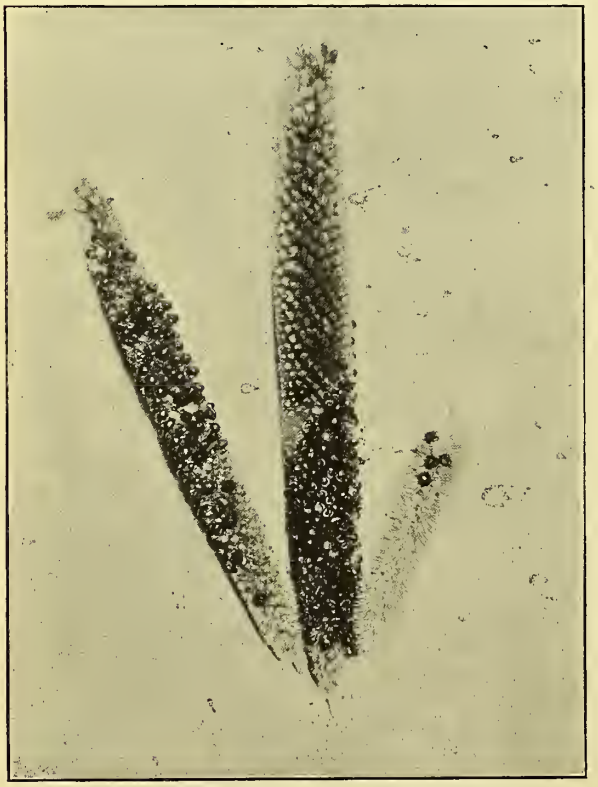
[1] Dispensatory of the United States

[2] P..J. Tr. xviii. 246



Smut of dura, probably Ustilago panici-frumentacei. Solitary seed grain infected.

Smut of dura. Ustilago Reiliana.



Smut of dukhn Pencillaria spicata (Swartz) from Sennar.

Smut of dura, probably Ustilago panici-miliacei. Head of grain wholly destroyed.

FUNGUS DISEASE IN SUDAN MILLET

## Insects and Vegetable Parasites Injurious to Crops

The first work undertaken in the laboratories related to this subject, a most important one in the Sudan, and was concerned with the damage done by the so-called "Asal" (Honey) fly, which has been found to be a large and new species of Aphis. In 1902 it was very destructive to the dura crop (*Sorghum vulgare*) in Kassala, Sennar and the Bahr-el-Ghazal. Last summer, (1903), it was not so much in evidence, but the infection of most of the dura grown in Khartoum gave one an opportunity of studying it on the spot, especially in the Zoological Gardens. I do not think that this latter Aphis is the same species as that found on samples sent from Kassala and Sennar. These were very dry and shrivelled, and only a few good specimens were secured. They seemed to be larger than the Khartoum Aphides and had red eyes, whereas those of the Khartoum species were black. The eggs were also different. In Khartoum there was not nearly so copious a secretion of honey-dew, though the leaves were rendered sticky. Differences were also noted in shape. The life history of the Aphides is very complicated, owing to the curious alternation of generations, and unless one be an economic entomologist it is not easy to trace out the various stages and recognise the sexes in the winged and wingless forms. Possibly one stage of the insect's life is spent on the melon plant. I have had melon plants sent from Rufaa on the Blue Nile with the leaves covered by the Aphis secretion, which often retained the shape of the excreting cornicles and presented a beautiful appearance when viewed through a magnifying lens. These leaves were completely blighted and the melon crop was ruined. It is, however, probable that this Aphis is yet another species, (for one thing the larvæ are very large), and that the others confine their attentions to the dura. They certainly do much damage, sucking out the sap

Aphides
The "Asal" fly

The melon aphis

Leaf of Sorghum vulgare, infested by the Aphis sorghi.

of the leaves, hindering the plant respirations by their secretion, and destroying the young ears of grain while they are yet soft. It is easy to recognise an infected plant from the shiny stickiness on the leaves, the deposit on the ground, sometimes very copious, and the vast number of pale larvæ and so-called plant-lice. The acacia arabica, (sant tree), is liable to be attacked by a scale insect which forms little white balls on the twigs. Specimens of this and of all the Aphides have been sent to Mr. Theobald. The acacia insects were given me by Mrs. Broun, the Honorary Secretary of the Museum Board. She had collected them on the White Nile.

Scale insects

The Aphis has formed the subject of several reports to the Secretary General, but it is evident that in a country like the Sudan it is very difficult to employ suitable preventive methods. No doubt petroleum, naphthalene and quassia washes and sprays are effective, but they have to be properly and judiciously applied, and in many cases spraying apparatus would be required. Burning of infected grain would be beneficial, the planting of the castor-oil plant round the fields is said to be useful, and something might be accomplished by merely squirting water through a hose on the plants and thus washing off the insects, but the outlook is scarcely hopeful in this direction. The question of the utility of lady-bird beetles, (Coccinellidæ), which along with their larvæ feed greedily on the Aphides, is an important one. Mr. Broun noticed a lady-bird busy on infected plants in the Bahr-El-Ghazal. I found fragments of lady-birds in the dura specimens from Kassala and Sennar, and discovered the following species present in large numbers on the "Asal" dura in Khartoum. Mr. Theobald kindly identified them for me as—

Difficulty of combating the aphides in the Sudan

*Chilomenes vicina*, Muls.
*Coccinella, 11-punctata.*

Specimens of these were secured and mounted and entomologists in South Africa were communicated with, as American lady-birds have been introduced there to combat Scale Insects and Aphides.

The information obtained has been sent to the Secretary General, and it is probable that in the Coccinellidæ, either those which are indigenous or species which may be imported, we have the best means of attacking the fly. At the same time it must be confessed that the reports received are none too encouraging. The Aphides are themselves liable at times to invasion by a fungus (*Entomophtora aphidis*), which destroys them wholesale. It seems worth while considering if this could not be utilised, but the whole question is really one for a skilled entomologist. It will no doubt receive due attention from the official recently appointed for the purpose by Lord Cromer. Meanwhile information has been furnished with regard to appropriate washes and how they are best employed, and here again I would express my indebtedness to Mr. Theobald, to the Agricultural Bureau at Washington, U.S.A., and to the South Eastern Agricultural College at Wye, Kent, England.

Value of lady Bird beetles

a

c

d

b

*C. Beard*

PLATE B

THE MELON BUG
(Aspongopus viduatus Fabr.)

a & b, Two forms of the adult; c & d, Two stages of the larvæ. Dried and old specimens are somewhat darker. The lines at the side show natural size. (F.V.T.)

Fungus diseases of dura

Dura has also been found to be the victim of numerous other diseases. Mr. and Mrs. Broun discovered the larvæ of a noctuid moth which bores up the stems, and a fungus, Helminthosporium sorghi which, however, only causes the leaves to wilt. One has met with four forms of Smut, (Ustilaginous fungus), a variety of Puccinia, and what is apparently a bacillary disease—at least a large bacillus was present in a grain head from Sennar, which presented quite a peculiar aspect and showed no sign of insect or fungus infection. Klein, Houston, Potter and others, have drawn attention to the presence and significance of the Schizomycetes in cereals and tubers.

The proper preventive measures for smut and other fungi have been detailed in several reports. The dura in the Dongola district is said to harbour some kind of wire-worm or slug, while that in Sennar is stated to be occasionally eaten by a large species of fly.[1]

The melon bug and its treatment

A plant bug or Hemipteron, *Aspongopus viduatus* (Fabricius), has caused much damage to the melon crop, and specimens of winged adults and wingless larvæ have been preserved and are figured in this Report. (Plate B, a to d.)

In this instance the preventive methods are simple and consist merely in shaking the bugs into pans of paraffin or tar early in the year when they first make their appearance. The gravid females that have wintered are thus destroyed, and so the hosts to which they give rise prevented from appearing. Land that has been infected with these bugs should have all the litter burned in the hibernating season, and all badly infected plants should be pulled up and burned (Theobald).[2] These precautionary measures, it seems to me, might very well be adopted and much loss averted.

## The 'Dura' Aphis or 'Asal Fly'

(*Aphis sorghi.* nov. sp.)

(Plate C.)

By Fred. V. Theobald, M.A.

The following are the structural details of the destructive Dura Aphis which is causing such havoc in the Sudan. The species is new, and I have named it after the plant it attacks. The details are shown on Plate C.

*Winged viviparous female.*

*Expanse of wings* 5·0 to 5·5 mm.
*Length of body* 1·5 to 1·8 mm.

Head (Fig. 4) brown, with a pale green line behind across its whole length, with three processes projecting forward, one median and one at the base of each antenna; antennæ brown, the two basal segments green, the third green basally, basal segment

[1] This probably does not refer to a true fly (Dipteron). F. V. T.
[2] Second Report on Economic Zoology, p. 117, 1904. F. V. Theobald.

dusky on the inside; not quite as long as the body, composed of 6 segments, the two basal ones thick and short, the three following of nearly equal length, the apical one as long as the two preceding, annulated and notched near its base (Fig. 5). Pronotum green; mesonotum green around the edges, brown in the middle; metanotum greenish-brown. Abdomen dark green above, pale at the sides and below, with two brown spots on the sides of each segment. Cornicles (Fig. 1) short, thick, almost uniformly cylindrical, truncated, the sides slightly crenulated. Legs greenish, thin, of moderate length, tibiæ especially hind pair with fine bristles arising from minute papillæ, edges of the tibiæ especially towards the apex crenulated. Venation typical (*vide* figure 13).

Aphis sorghi or Asal fly. Winged viviparous female. Posterior wings not shewn.

*Apterous viviparous female.*

*Length of body* 1·0 to 1·5 mm.
*Length of antennæ* 0·8 to 1·0 mm.

Antennæ (Fig. 11) with four or five segments, the two basal ones normal, the third long and with a constriction apically making the quasi-fifth segment; not quite as long as the body. Head (Fig. 10) showing the frontal lobes indistinctly, the central one with a median groove and a lateral curved bristle on each side. Legs short and thick, the hind tibiæ with prominent lateral bristles. Rostrum short and thick reaching to nearly halfway between the bases of the first and second pairs of legs; cornicles cylindrical, brown. Eyes black.

Aphis sorghi. Nearly mature apterous female.

*Pupa.* The three cephalic processes very small; the antennæ (Fig. 8) considerably shorter than the body, of five segments the two basal ones as in the winged female, the third rather long, the fourth about half the length of the third, the fifth as in winged viviparous female. Legs thick as in the apterous female, the hind tibiæ rather swollen apically and with pale bristles; cornicles (Fig. 3) as in the apterous female, rather shorter than in the winged female. Eyes black.

*Larva.* Cornicles shorter and more cone-shaped with truncated circular apex.


*C. Beard*

## PLATE C

### THE DURA APHIS OR ASAL FLY

(Aphis sorghi. nov. spec) and Lady-Bird Enemies

1, Cornicle of winged viviparous ♀ ; 2, Ovum; 3, Cornicle of pupa ♀ ; 4, Head of winged vivip. ♀ ; 5, Antenna of winged vivip. ♀ ; 6, Apex of leg of ♀ ; 7, Larval antenna (advanced) ; 8, Antenna of pupa ; 9, Head of larva ; 10, Head of apterous vivip. ♀ ; 11, Antennæ of apterous vivip. ♀ ; 12, Antenna of larva ; 13, Wing of viviparous ♀ ; 14, *Chilomenes vicina*. Muls ; 15, *Coccinella undecimpunctata*

*Ova.* Oblong oval, somewhat pointed at one end; yellow, with smooth shiny shell (Fig. 2).

*Length* 0·8 mm.

*Observations.* This species infests to a serious extent the 'dura' in the Sudan (*vide* Dr. Balfour's Report). It is also known as the 'Asal' Fly. It produces a copious flow of honey dew; this and the quantity of black excreta passed out by the aphides smother the leaves and heads to such an extent that the plants die off. I cannot detect any specimens that might be oviparous females or males. The descriptions are drawn up from spirit specimens. The general ground colour of the Aphis is green. Another species (sent me by Mrs. Broun), undoubtedly exists. It came from Kassala, but in too damaged a state to describe. My thanks are due to the U. S. Department of Agriculture for help in this matter.

Beneficial Lady Bird Beetles

*Natural Enemies.* Two Lady Bird Beetles feed both in their larval and adult stages on this pest namely *Coccinella undecimpunctata*, the 11-spotted Lady Bird and the Three-lined Lady Bird—*Chilomenes vicina* Muls.[1] (Plate C, Figs. 14 & 15.)

The 11-spotted Lady Bird (*Coccinella undecimpunctata*) has a black head with two yellow spots, the clypeus black with yellow hair; the prothorax black with a creamy area on each side, broadest in front; scutellum black. Elytra yellowish red with eleven black spots when closed, the first row of three spots, the large median one being half on each elytron and two curved rows of four spots. Pronotum and elytra densely, finely and closely punctate. The legs are black and hairy.

*Length* 4·5 to 5 mm.

The Three-lined Lady Bird (*Chilomenes vicina.* Muls) has a creamy yellow head and clypeus and black eyes, deeply indented in the prothorax. Prothorax creamy yellow with a black band behind and a black central area connected by a narrow stalk with it, a few dark converging streaks behind the black eyes. Scutellum small and black. Elytra pale ochreous-yellow with a thick black median line, formed by the junction of a black line on each edge of the elytra, and a black curved line on each elytron on its outer half, between which and the narrow black edge are numerous minute black specks. Legs pale yellowish to ochreous. The whole surface of the pronotum and elytra very faintly and minutely punctate.

*Length* 3·8 to 4·3 mm.

A species of *Bassus* has been sent with the material, the species of this genus live on Syrphus flies and are thus injurious as the Syrphus flies feed on Aphis during their larval stage, and help the Lady Birds to keep down these pests.

[1] Second Report on Economic Zoology, p. 121, 1904. F. V. Theobald

## Cyanogenesis in Sorghum vulgare

Reverting to the subject of dura, mention must be made of another matter relating to it which has claimed attention. This is the presence of hydrocyanic acid in dura used as fodder, and the fatality resulting amongst animals fed on such dura. Attention was directed to the subject by reading accounts of the discovery by Dunstan and Henry [1] of a glucoside, "dhurrin," contained in the young plants of the sorghum, which on decomposition in the presence of water yields free hydrocyanic acid. This is said to explain the numerous cases of sudden death occurring among cattle fed on immature sorghum. The analytical work of Brünnich [2] on the same subject, and the observations of Dr. Maxwell, and Veterinary-Inspector Quinnel [3] in Australia, show how important it is, and accordingly, through the medium of the Secretary General one collected as much information as could be gathered from various parts of the Sudan, and proceeded to examine some specimens of dura in which no difficulty was experienced in detecting the poisonous acid. The answers to the enquiries are interesting, and may with advantage be briefly stated here.

Hydrocyanic acid in dura

Sennar

Colonel Gorringe reported from Sennar that there had been no recent casualties among animals from this cause, but recalled a considerable loss in horses and cattle at Kerreri in 1898, from their having been fed on green dura about one foot high. He states that the natives in his district regard it as harmless when dry, and do not give it when green till the seed ears are well developed. Mr. Neville, from the Atbara district, furnished much important information, and recorded his opinion that dura of normal growth is absolutely innocuous to animals in the Sudan. He also stated that the variety known as Peterita is the most poisonous, and that more deaths result from animals eating "hantout" and other poisonous grasses than from dura. The most fatal condition, he says, and the most common in the Sudan, is produced when animals are fed on dura which has been stunted from lack of rainfall and has then grown rapidly when water was obtainable. Natives, he further states, are well aware of the danger, and believe that only ruminants suffer and that donkeys and horses may feed on such dura with impunity. Colonel Stanton, however, informed me that on one occasion his horse, although well and hungry, and though he expected it to feed greedily on some tempting green dura, refused to touch it. Possibly animals of a higher intelligence than cattle may recognise and avoid the danger. Mr. Neville also enters into a consideration of other ill-effects produced by dura such as colic and kidney troubles, due to the presence of large quantities of potassium nitrate in the plants.

Atbara

Reports on poisonous dura

Gezira

Major Dickinson, Gezira, gave evidence which coincides with that of Mr. Neville, and mentioned fatal cases occurring at Wad Ramleh in 1902. Some

[1] Phil. Trans. 1901 Series, B 515, and 1902 Series, A 399 [2] Journal Chemical Society, July, 1903
[3] Injurious effect of sorghum on stock. Paper Agric. Con., Queensland, June, 1902

poisoned animals were saved by the prompt exhibition of natron, followed by simsim (sesame) oil.

Viscount Frankfort, Inspector, Dongola, also spoke of the danger from giving immature dura, and cited the fact that at the end of 1901 and the beginning of 1902 there was a great mortality in cattle at Affat Dabbah. They had fed on dura affected by some species of rust. Dongola

Major Borton, from Súakin, had much the same to say as Mr. Neville, and in addition remarked that—

1. If rainfall suddenly ceases after a good start in growth has been made, plants have been known to have poisonous effects. Suakin
2. When eaten dry after failing to mature from want of rain the stalks are poisonous.
3. When the dura heads have been eaten by locusts the stalks are said to be poisonous, but animals will rarely touch them.

There seems to be some difference of opinion amongst the various observers as to whether dura, which has been poisonous, becomes harmless when thoroughly sun-dried or air-dried.

Brünnich[1] gives the following as precautionary measures :— Precautionary measures

1. All fodder plants related to sorghum must be used with discretion, in either the green or the dried state, and should not be given in large amounts to animals which have fasted for some time.
2. Sorghum should never be used in a very immature stage of growth, but only when the seed ears are well developed.

Mr. Neville, as stated, lays stress on the normality or otherwise of the crop, and seems to agree with the native opinion that in the Sudan thoroughly dried dura is innocuous. The latter statement is borne out by Professor Dunstan's experiments[2] at the Imperial Institute. Several samples of young green *sorghum vulgare* have been examined in the laboratories and the presence of hydrocyanic acid demonstrated. There is a belief in Australia that the plant is more poisonous when attacked by insects during a dry season, a statement elicited by Quinnel. I mentioned this to Mr. Sillitoe, the head gardener, when he was collecting aphis-infected dura for fodder. He lost one animal fed on it, and several others were seriously ill. Influence of insect infection on cyanogenesis

At the same time I made a comparison of two samples of dura of the same age; the one normal, the other harbouring aphides. As shown there was certainly more hydrocyanic acid present in the latter, but no conclusions can be based on

[1] Journal Chemical Society, July, 1903 [2] Technical Reports, &c., 1903

Laboratory experiments on cyanogenesis

a single experiment. Liebig's process was employed, and sulphuric acid was in each case added to the distillation flask as recommended by Brünnich.

1. Affected. Young dura about 16 inches high. No seed grains developed. Contained ·035 per cent. HCN.

2. Unaffected. Dura slightly younger than the above. No seed grains developed. Contained ·014 per cent. HCN.

The investigation of cyanogenesis in all the fodder plants used in the Sudan and in certain of the leguminosæ, is a piece of research a chemist might carry out with advantage.

## General Routine Work

The nature of this work may be classed under two main headings :—1. Pathological; 2. Chemical. It bulked so largely that little time was afforded for original investigations, but then again some of it was really more or less research work, and in any case the mere fact that so much had to be done thus early in the laboratories' career, seems to show that they have filled a felt want.

Under each of the above headings is placed a list of the examinations and analyses performed.

### 1. Pathological

| Nature | No. |
|---|---|
| (*a*) Morbid secretions and excretions | 16 |
| (*b*) Blood | 20 |
| (*c*) Bacteriological apart from (*a*) | 6 |
| (*d*) Parasites apart from (*a*) and (*b*) | 5 |
| (*e*) New growths | 4 |
| (*f*) Other pathological conditions | 3 |

It may be as well to indicate some of the forms of disease encountered and included under these figures, and also to deal briefly with the more common diseases found in the Sudan. The classification adopted by Wellman[1] for the diseases of Angola is here introduced for the sake of convenience[2].

The Anglo-Egyptian Sudan is a huge territory inhabited by many divers races of men, and possessing several types of climate. One could no more scientifically compare the diseases found in the neighbourhood of Suakin with those prevalent in the Khartoum district than one could compare the latter with those occurring in the Bahr-El-Ghazal. On the Red Sea coast the climate is that of a littoral; it is the Northern Sudan climate modified by proximity to the sea. Round about Khartoum there exists, roughly speaking, a desert climate, somewhat modified by the presence of the two mighty rivers which unite immediately to the south of Omdurman. In the Bahr-El-Ghazal we meet with typically tropical conditions —a moist, humid atmosphere, a heavy rainfall, an abundant vegetation, many rivers, and much insect life. Minor differences exist in different parts of the different districts. Elevation above sea-level, as in Kordofan, plays a part, so does the area of cultivated land, as in the Dongola district, so does the presence (Kassala district) or absence (Gezira) of much bush country, so does the proximity to the great water-ways of this part of Africa. The incidence of disease is also affected by the distribution of population. The Northern Sudan, in addition to its Arabic and mixed Arabic and negro population, is peopled by British, Greeks, Italians, Turks, Syrians, Armenians, Egyptians, Copts, Abyssinians, and several

[1] *Journal of Tropical Medicine*, 15/2/04

[2] The following notes appeared in the *Journal of Tropical Medicine*, 15/4/04, and are here reproduced by the kind permission of the Editors of that journal

other nationalities. Of these, the Egyptians, the majority of them engaged in military service, are the most numerous. The Southern Sudan is the home of the negro tribes—the Dinkas, Shilluks, Nuers, Nyuaks, Niam-niams, and many others. It is hopeless with our present knowledge to proceed to any kind of a classification, and none will be attempted.

## I.—Diseases Appearing from an Examination of the Blood

*Malaria* (native name, *humma*=fever).—All three forms of the malaria parasite have been seen. The most common have the benign tertian and the malignant tertian, the latter appearing as small ring forms and crescents. Quartan is rare and is probably acquired in Egypt or elsewhere, not in the Sudan. Cases from up the Niles, and especially from the White Nile, show the small ring and crescent forms most frequently. Typical ague attacks occur, but are not often seen. Remittent fevers seem to be the rule in the southern districts. Enlarged spleens due to malaria are numerous. Captain Cummins, E.M.C., found a large percentage of children in the Bahr-El-Ghazal affected in this way. A high percentage of large mononuclear leucocytes is frequently found in the blood of natives, or Egyptian soldiers who have served up country. Very few cases have been seen in which such white corpuscles contained pigment. Chronic splenitis sometimes leads to a very considerable enlargement of the spleen. It will be interesting to see if the new blood parasite, *Leishmania Donovani*, is to be found in cases of splenomegaly.[1] Professor Ross has suggested to me that it might be well to look for it in monkeys.

*Filariasis* seems to be rare in the Northern Sudan, although *Culex fatigans* abounded in Khartoum before preventive measures were adopted. I have only seen one case of elephantiasis (*da el feel*). It was in the leg of a Dinka, but his blood showed no filaria embryos.

As *Mansonia uniformis* exists in considerable numbers along the banks of the Blue Nile, south of Wad Medani; in veritable swarms on the White Nile, south of Abbas Island, and all along the Sobat, Baro and Pibor Rivers and the reedy shores of Lake No, one would expect to find abundant evidence of filarial infection. Gross lesions, such as lymph scrotum, chylocele, varicose groin glands, and elephantiasis of the legs are not visible to the passing traveller even if he looks out for them. I had no opportunity of examining the blood of natives, nor, so far as I know, has any work been done on this subject in these regions.

*Trypanosomiasis* has not been encountered. Trypanosomes possibly occur in the blood of natives living close to the more tropical parts of the White Nile. No trypanosomes were found in the blood of several siluroid fish examined. *Glossina palpalis* has not been found in the Sudan. *Glossina morsitans* occurs in the Bahr-El-Ghazal, and is numerous in some parts.

[1] It has now been discovered in a single case at Omdurman by Dr. Sheffield Neave, *vide* B.M.J. 28/5/04

## II.—Diseases Appearing from an Examination of the Fæces

*Dysentery* (*Dorontaria*) is not very frequently seen. It is probably most common in young British officers. Slight forms, the so-called dysenteric diarrhœas, occur. It seems to be more frequent in the hot weather, when there is a greater change between the day and night temperatures. It is probably amœbic in type, though it is likely that irritating sand particles and chill play a more important part in its production than does the *Amœba coli*.

*Ankylostomiasis* (*Ankylostoma*).—Common amongst the Egyptian soldiers, and often very severe. Does not seem to be indigenous in the Sudan.

*Ascaris lumbricoides* (*Tabaan el buttu*).—Common, especially amongst Egyptian soldiers. These fellaheen seem to be very favourite hosts for parasites of all kinds.

*Tænia* (*Dooda waheeda*).—I have only seen *T. saginata*. Multiple infection occurs.

*Oxyuris vermicularis* (*Wooda Khatya*).—Very common. Its ova are very liable to be confounded with those of the Ankylostomum. I have found the difference in the shape (the ova of Oxyuris being more curved on one side than the other) to be the best guide.

*Trichocephalus dispar* has not been met with.

*Schistosomum hæmatobium*.—Ova with laterally placed spines are common in the fæces of Egyptian soldiers.

*Chronic Diarrhœa*.—No opinion can be given.

*Sprue*.—Apparently unknown.

## III.—Diseases Appearing from an Examination of the Urine

*Hæmoglobinuric Fever (Hummet el mayiah el iswid)*.—I have only seen one case, and that was in a Greek at Gondokoro, in Uganda; but at Rejaf (Lado Enclave) I met a young Scotchman who had just recovered from a second attack. Although not charted in Scheube's map, blackwater fever does occur in the Sudan. Capt. Rivers, E.M.C., reports that no case has yet occurred north of 10° N. lat. The disease seems confined to the White Nile regions south of Fashoda, and to the Bahr-El-Ghazal province. British officers and Egyptians form the majority of the victims, and since the reopening of the country these have been few in number. It is, however, significant that the natives of the Golo tribe have a special remedy for this disease.

*Endemic Hæmaturia (Bilharzia)*.—Of frequent occurrence amongst the Egyptian soldiery. Was supposed not to exist in the Sudan, save such cases as had acquired infection in Egypt or elsewhere. Recently the urines of three Sudanese boys have been sent to the laboratories. All three showed blood, pus and the characteristic ova. Two were brothers. None of the three had ever been out of the Sudan. The chief point of significance lay in the fact that all three drank water from a school well in Khartoum. So far nothing suspicious has been

found in this water, though some of it has been centrifuged and examined. The only other water drank was that from the Blue Nile, the general source of supply for Khartoum. The urines of all the boys (73 in number) attending the school have been examined and 17 per cent. have been found to suffer in like manner. It is important to note that most of these boys were in the habit of bathing in the Blue Nile.

Captain Ensor reports cases from the Kassala district in Arabs who had presumably not been in Egypt. They may have visited Abyssinia.

*Calculus (Hagga misana)* is common. Soft uratic stones are the rule; but phosphatic and uric acid calculi occur. Much of the underlying strata in the Sudan consists of limestone, and the well waters are hard. Blue Nile water issues from amongst the granitic rocks of Abyssinia.

*Pyelitis.*—A form of pyelitis, due apparently to the irritation produced by concentrated urine, occurs. Captain Ensor tells me it is of common occurrence, and to be attributed to the above cause. The symptoms are slight fever, a general feeling of malaise, sharp pricking at the point of the penis, with some spasm towards the end of micturition, and a dull boring pain in the region of the affected kidney. Rest in bed, a milk diet, free flushing, and dry cupping in the lumbar region soon cause relief and cure.

## IV.—Diseases Appearing from an Examination of the Sputum

*Pulmonary Phthisis* (*Sil rheowé, durran*).[1]—Very common amongst the native Sudanese. No doubt due to the fact that they live in ill-ventilated mud dwellings, the main object of which is to exclude the powerful rays of the sun. Most frequent amongst women and children, as might be expected.

*Asthma.*—Bronchial asthma seems to be unknown in the Northern Sudan where the dry climate is good for catarrhal asthmatics. I have known two instances of British officials, previously martyrs to the disease, who have not had an attack since coming to the country, in which they have now been resident for a considerable time. In the damp regions to the south the disease is sometimes encountered.

*Gangrene of Lung.*—This seems rather common, as is cancrum oris. In one instance the pulmonary gangrene occurred in a case of mycetoma.

## V.—Diseases Appearing from an Examination of the Skin

*Leprosy (Goyam).*—Probably occurs all over the Sudan. There are a good many lepers in Omdurman and Kassala. The tuberculous variety seems to be the more common form to judge by the leper photographs sent me by Dr. Christopherson. Fish is largely eaten by dwellers on the Niles, and I understand that the natives are none too particular about its condition. There is said to be leprosy in waterless Kordofan. In this connection one may mention

[1] Where there is both an Egyptian and Sudanese name, the latter is put second

the siluroid fish, which appear there in the rain pools. At other times they lie *perdu* in the sun-baked mud. I do not know if they serve as food. Scarification is practised as a remedy. Very few attempts at segregation have been made, but lepers labour under certain restrictions.

*Yaws.*—Captain Ensor, who has had considerable experience of this disease in West Africa, tells me that he has seen one undoubted and one doubtful case at Kassala. In both instances children were affected. He suggests that the introduction of the disease into this part of the Sudan is due to the Hausa pilgrims on their way to Mecca.

*Dhobie Itch (Harrara).*—Quite common, especially in the Southern Sudan. Chrysarobin is found the most effective remedy.

*Keloids.*—Huge keloids occur as the result of syphilitic and other ulcerations. The Sudanese seem specially liable to such disfiguring overgrowths.

*Kordofan Sores (Kurrha).*—These are stated to be of the nature of veldt sores, and occur chiefly on the hands. It will be interesting, in view of Wright's discoveries in connection with Delhi boils, to see if *Leishmania Donovani* exists in the basis of these sores.

*Myiasis.*—The larvæ of flies are sometimes found subcutaneously in the Bahr-El-Ghazal. No specimens have been sent me. Myiasis is common in the domestic animals, especially the camel, mule and horse.

*Leucoderma.*—Seems to be rather frequent. May in some cases be the result of syphilitic infection.

### VI.—Diseases Detected by a General Examination of the Body

*Beri-Beri.*—Occurs. I saw a case in Omdurman which I suggested might be beri-beri. Dr. Christopherson was inclined to regard it as a neuritis dependent on diet. Captain Ensor tells me that he has seen two typical cases in the Sudan.

In Kordofan there is a peculiar disease, evidently a neuritis, known by the Arabic name for a haltered camel. Is this beri-beri, lathyrism, or the akatama described by Wellman[1] amongst the Bantus?

*Sleeping Sickness.*—So far unrecorded. As stated, *Glossina palpalis* has not yet been found in the Sudan.

*Low Fever.*—Occurs. A kind of simple continued fever which is not enteric. May be due to the *B. coli communis.* During the hot weather there is a so-called Khartoum fever, which is fairly sharp, but only lasts a week or ten days. It is not malarial, but it is amenable to quinine. Possibly exposure to the sun and fatigue are the predisposing, if not the exciting, causes.

*Malta Fever.*—Has been described, but is certainly very rare, at least in its typical form.

*Heat Stroke (Darbit harrarar).*—Not very common, but may be fatal, as in the case of a British soldier last summer. Red or rather orange covering

[1] *Journal of Tropical Medicine*, September 1st, 1903

for the head and spinal regions is effective. The small tight skull cap affected by the Arabs is said to be an excellent preventive when worn under the helmet.

*Poisoning.*—Infrequent. The blacks employ senna as a purge, followed by a large dose of a native salt called "gardugga." I have analysed this, and found it to consist of the carbonate, chloride, and sulphate of sodium. It caused the death of a Greek, a weakly man, to whom it had been given. The *post mortem* appearances were like those met with in poisoning from a corrosive alkali. I believe the large dose of sodium carbonate was what killed him. It is said that datura is frequently employed as a poison. I have not seen a single case of death resulting from this drug.

*Alcoholic Poisoning* from the drinking of excessive quantities of merissa, a beverage made from dura *(Sorghum vulgare)*, now and again occurs.

## VII.—Local Affections

*Liver Abscess (Khorag Kabid).*—Not uncommon. Apparently unassociated with dysentery. I have found the *Amœba coli* in the pus in one case—a European. Is it possible that liver abscess may be the forerunner and not the sequel of an acute dysentery[1]. Two out of four cases seen were multiple. In one a superficial abscess was successfully opened and drained, but the patient died from a deeply-seated abscess, which had apparently formed subsequent to operation, and was not detected during life.

*Ainhum.*—Is said to exist amongst the natives in the south. I have seen one case under the care of Dr. Christopherson.

*Goitre (Gwatre).*—Occurs. I have a photograph of one case (from Dr. Christopherson), associated with exophthalmos, in which the huge goitre has ulcerated and looks as though it were undergoing malignant changes. The patient was an Egyptian woman resident in the Sudan. (As regards water conditions, see under Calculus.)

*Hypertrophied Mammæ in Males.*—This curious condition exists, but I am told is not so common as in Central Africa. The possessor of these abnormalities has been known to excise them, being angered at the chaffing to which he had been subjected.

*Guinea Worm (Erk Medain, Farranteet).*—Fairly common, and not confined to natives. There are certain pools in both Niles (charted by Major Bray) whence infection may be obtained. It is most common in the foot, but I have seen a Sudanese with multiple infection in the arm.

*Cancrum Oris.*—Already mentioned. The disease occurred in a chimpanzee, *Anthropopithecus troglodytes* (Schweinfurth), confined in the Zoological Gardens in Khartoum.

*Mycetoma (Napt Hindi Nabit).*—Exceedingly common for such a rare disease. The form due to the black variety of Streptothrix is most frequently

[1] *Lancet, November* 21*st*, '03

encountered, but the yellow or white fungus is also to be seen. The pink variety has not come under my notice. The foot is the part principally affected, but the inguinal glands are often involved, pointing to a spread by the lymphatics. They may break down in the centre, and become what is practically a cyst with pigmented walls. The ankle- and knee-joints may become involved and disintegrated. The Laboratories' Museum possesses a fine specimen of mycetoma of the hand—a case of twenty years' duration in a Nile boatman, aged 65. The source of infection of the disease is unknown. It is worth noting that the Northern Sudan is largely a country of thorn bush.

*Jigger.*—I have no information as to this pest.

*Insect Bites.*—Those of sand-flies and owl-midges are often more severe and irritating than those of mosquitoes. Colonel Talbot has recently sent a new and very vicious species of *Simulium* from Abu-Hamed.

*Tick Fever* probably exists in the Bahr-El-Ghazal. It is not seen in Khartoum or Omdurman, nor are ticks a nuisance in these places save to cattle and sheep.

*Snake Bites.*—Rare, considering the large number of poisonous snakes in the country. On the Sobat there is a viperine snake which protects itself by spitting in one's eyes. The venom is very acid, and dries up into small white crusts when ejected on a glass surface.

*Leeches (Alak).*—Common in the swamps of the Southern Sudan. I have found them clinging in dozens to the under surface of a crocodile, and they have been discovered within the beak of a whale-headed stork *(Balinœceps rex)*. Those on the crocodile, when dislodged, fastened at once on the feet of the Egyptian who was skinning the reptile.

*Eye Troubles.*—I cannot say much about these. Cataract and corneal ulcer both occur. I have a specimen of Staphyloma sent by Dr. Christopherson. The Sudanese, as malingerers, sometimes put the milky juice obtained from the "Ushar" plant, *Calotropis procera*, into their eyes, in order to produce inflammation. I have seen women collecting this juice; but whether they employ it to destroy female infants, a use to which it is said to be put in India, I cannot tell. There is much blindness—the result of small-pox.

## Appendix

### (1) *Epidemics*

*Small-pox (Gidri).*—Is said to be endemic, and occurs in epidemics. May cause many deaths if unchecked. There was a small epidemic in Omdurman last year. A good many of the cases were confluent and severe. The natives recognise and appreciate the benefits conferred by vaccination.

*Cholera (Shota).*—Has reached Wady Halfa. Will probably visit the Sudan from Egypt. The completion of the Berber-Suakin Railway may be of grave significance as regards both cholera and plague.

*Enteric Fever.*—Natives apparently unaffected. The disease is rare.

*Chickenpox (Gidri Kasib. Borgool).*—Is occasionally seen.

*Dengue* (*Abul Rukub*).—Not recorded, with the exception of one epidemic at Wady Halfa. *Culex fatigans*, said by Dr. Graham[1] to be the intermediate host of the protozoon, is common.

*Plague (Tahun).*—No record of this disease.

*Cerebro-spinal Fever.*—Occurs sporadically and in epidemics. Some forty deaths in the last outbreak at Omdurman in 1899. I have seen one typical case along with Captain Ensor in a Sudanese. We isolated a small diplococcus from the cerebro-spinal fluid obtained by lumbar puncture during life. It was secured in pure culture, but efforts to inoculate rabbits and a monkey, *viâ* their nasal cavities, proved ineffectual. A rabbit received 1 cc. of a broth culture subcutaneously. Beyond slight fever no illness resulted. The cultural and staining characteristics, such as they are, were positive, and we have little doubt the organism was the *Diplococcus intracellularis meningitidis* of Weichselbaum. The disease did not spread, every precaution being taken.

*Typhus* (*Humma Typhusick*).—Was once supposed to be common. It is said the Mahdi died of it. His fatal disease was, however, probably cerebro-spinal fever, and typhus is only doubtfully present, if at all.

(2) *Other Diseases common to all climates which are frequent in the Sudan*

*Tuberculosis (sil, daran)* and *syphilis (zhurri, halug)* are common. Their ravages are terrible, especially on the integumentary and loco-motory systems of those affected. The reason for the tubercle bacillus system finding suitable pabulum has been mentioned, but it must not be supposed that the climate of the Sudan favours its existence. The reverse is true, at least during the winter months (November to March) when the air is very dry and pure, and the variations in temperature are not startling or excessive, although the nights are always cool. Occasional high winds and blowing sand form the only drawbacks.

Syphilis in the Sudan is a loathsome scourge. In the time of the Dervishes it was considered rather an honour to have acquired infection. A lad was not a man till he had developed a chancre. The results of this ignorant and pernicious *régime* are deplorable. Patients do not visit the hospitals till they are masses of ulceration and necrosis. True, they make use of tureba, a native preparation of mercury found locally, and they even fashion cones for fumigation with it, but their treatment is not conducted on sound principles and is probably more harmful than beneficial. Education, combined with proper sanitary measures, is the only remedy. The Sudanese are fond of their children, and if they could be made to understand how frequently they are themselves to blame for the pitiable condition of their offspring, be taught the dangers and crippling effects of the unchecked disease, and be instructed how to avoid acquiring it and how much can be done by

[1] *Journal of Tropical Medicine*, July 1st, 1903

proper treatment when it is acquired, a great step would have been taken to ameliorate their sad condition. Such methods of instruction are now being put in force, and I believe their value will ere long be apparent.

Gonorrhœa is common, and is called Salan in Egypt and Bagal in the Sudan.[1]

### (3) *Surgical Affections*

Concerning these I do not feel qualified to speak. All that one would say is that sarcoma and carcinoma both occur, and there have been some cases tending to prove that the native who has never lived in contact with the white man is not immune.

One may also note the frequency of both inguinal and umbilical herniæ.

### "*Veterinary Diseases*"

As regards veterinary diseases, parasitic worms are very prevalent in horses, and I have little doubt, account for a good deal of the mortality amongst these animals. The armed strongyles which produce thrombosis, aneurism, and death occur as does *Spiroptera microstoma* which causes curious cystic tumours in the walls of the stomach and occasionally peritonitis, the result of suppuration and rupture. The bot of the warble fly *Gastrophilus equi* is met with and so is a trematode, which I think is identical with *Gastrodiscus Sonsinoi.* There seems to be an idea prevalent that the so-called "star sickness" of horses, so named in reference to the astronomical conditions obtaining at the time of year it occurs, is dependent on parasitic infection. Lieut.-Colonel Griffith, however, assures me that it is the same as the South African form of horse sickness known as "big head," and he has sent the museum a typical specimen of a stomach from such a case. Texas fever probably occurs in a latent form amongst Sudanese cattle.

[1] For information regarding the drugs employed by the natives, see a paper on the subject in the *Journal of Tropical Medicine*, April 15th, 1904

# Eosinophilia in Bilharzia Disease and Dracontiasis[1]

In the *Lancet* of October 10th, 1903, p. 1009, there is an article by Captain S. R. Douglas, I.M.S., and Major F. W. Hardy, R.A.M.C., on 50 cases of Bilharzia Disease, in which they gave an account of the results obtained by them in the differential leucocyte counts. Their very complete and interesting investigation was apparently instigated by Coles's observations [2] on one case of bilharzia disease, in which he found an increase of coarse-grained eosinophile leucocytes. His case was that of a young Englishman in whose blood he discovered 20 per cent. of these cells instead of the normal 2 to 4 per cent. Hayem puts the normal at 7 per cent. With a view to confirming Coles's solitary observation I proceeded in my spare time to examine the blood of the few bilharzia cases I could obtain in Khartoum and Omdurman.

Previous observations

Bilharzia disease, so far as is known, is not common in the Egyptian Sudan, save amongst those who have acquired the infection in Egypt or elsewhere, and owing to this and other reasons I was only able to examine three cases. At the same time I thought it well to investigate the blood condition in dracontiasis. At the time I began to do so I believe no work had been accomplished on this subject, but while I was thus employed a paper [3] appeared by Dudgeon and Child recording their results in one case of guinea-worm disease in an Englishman infected in India and resident in London. They found from 13·0 to 18·4 per cent. of coarse-grained eosinophiles present, and suggest that in this respect dracontiasis may occupy a position midway between trichiniasis and infections with other internal parasites. I have notes on six cases of guinea-worm disease, and had intended collecting further statistics before publishing an account of them, but as I find my results confirm theirs in large measure I think it well to place them on record, especially as some time must needs elapse before I can add materially to my number of cases.

*Method.*—In each instance I counted 500 leucocytes, and in nearly every case made a double examination, one film being stained by Jenner's method and the other by the Leishman-Romanowsky. The counts were found to approximate very closely, and that obtained in the better-stained film was taken as correct. In several instances also other confirmatory counts were made. In differentiating large mononuclears from lymphocytes I followed the plan adopted by Captain Leonard Rogers and classed every single unlobed nucleated corpuscle as large as, or larger than, a polymorphonuclear as a large mononuclear. Like Captain Delany, I preferred to place transitional forms under the heading polymorphonuclears, but I see that Dudgeon and Child counted them as lymphocytes.

Methods of staining, counting, and classification

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[1] This paper originally appeared in the *Lancet*, 12/12/03. I am indebted to the Editor for kind permission to re-publish it here

[2] Diseases of the Blood, Coles.

[3] Eosinophilia associated with Dracontiasis.—*Journal of Tropical Medicine.* 15/8/03

*Table of Results.*—For convenience of reference I place the accepted normal percentages in the table (Table I.)

TABLE I.—CASES OF BILHARZIA DISEASE.

| No. | Cases | Remarks | Percentage of various Leucocytes | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Eosinophiles | Polymorphonuclears | Lymphocytes | Large mononuclears | Basophiles | |
| | | Normal . . . . . | 2 to 4 | 70·75 | 15·25 | 6·8 | 0·5 | |
| 1 | Bilharzia of the rectum | Egyptian soldier, Omdurman | 18·0 | 49·0 | 12·6 | 20·4 | — | Bilharzia cases |
| 2 | Bilharzia of the rectum | Egyptian soldier, Omdurman | 14·0 | 28·6 | 46·4 | 11·0 | 0·6 | |
| 3 | Bilharzia of the bladder | Egyptian soldier, Omdurman | 18·4 | 35·8 | 33·6 | 12·2 | 0·2 | |

It will be seen that there was a very decided increase of coarse-grained eosinophiles, and though the number of cases is very small, too small to furnish any definite conclusions, it is interesting to observe that the average percentage works out at 16·8, while in Captain Douglas's and Major Hardy's 50 cases it was 16·486. As is mentioned by them there is also a proportional diminution in the percentage of the polymorphonuclears, and curiously enough in the one case (No. 1) in which there is a marked increase of the large mononuclears there is a diminution of the lymphocytes, a point to which they also draw attention. In the remaining two cases there is an increase in the lymphocytes.

TABLE II.—GUINEA-WORM CASES.

| No. | Cases | Remarks | Percentage of various Leucocytes | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Eosinophiles | Polymorphonuclears | Lymphocytes | Large mononuclears | Basophiles | |
| 1 | Greek, Omdurman | In foot, much induration . . | 16·0 | 51·0 | 22·0 | 11·0 | — | |
| 1a | Same man, Khartoum | Worm had been wholly removed two weeks before this examination | 15·2 | 42·0 | 27·8 | 15·0 | — | |
| 2 | Egyptian soldier, Omdurman | Worm had been wholly removed two days before examination. Induration was still present in the foot | 13·4 | 52·8 | 24·4 | 9·4 | — | Guinea-worm cases |
| 3 | Sudanese, Khartoum | In foot; malaria, but no rise of temperature | 34·4 | 36·0 | 13·0 | 16·6 | — | |
| 4 | Sudanese, Khartoum | In foot; malaria, but no rise of temperature | 36·6 | 31·2 | 16·4 | 15·4 | 0·6 | |

| No. | Cases | Remarks | Percentage of various Leucocytes | | | | |
|---|---|---|---|---|---|---|---|
| | | | Eosinophiles | Polymorphonuclears | Lymphocytes | Large mononuclears | Basophiles |
| 5 | Sudanese soldier, Khartoum | Double infection in the arm. One worm wholly removed and a portion of the other three weeks before examination. Probably malaria present | 6·4 | 38·6 | 28·8 | 26·2 | — |
| 6 | Sudanese soldier, Khartoum | In foot. Worm supposed to have been removed, but ulcer and induration persisted. Probably malaria | 10·8 | 27·8 | 39·6 | 21·8 | 0·6 |

There being, so far as I am aware, no other statistics with which to compare these results it is hardly worth while, with so few cases, to express the average percentage of eosinophiles or to discuss the relative numbers of the other forms of leucocyte. One point may, however, be raised. It is often a difficult matter to say if the whole of a guinea-worm has been extracted. Might the percentage of eosinophiles be taken as a guide in such cases? I have not been able to follow out a case through all its stages, but the results obtained seem rather suggestive, and if this be so the differential leucocyte count would have a practical and useful bearing. It will be seen that Case 3 and Case 4 gave a much higher percentage of coarse-grained eosinophiles than did the case in London. Further observations are indicated to decide the usual amount of eosinophiles which one may expect to find in dracontiasis. I am much indebted to Dr. J. B. Christopherson, Omdurman, and to Captain Cummins and Sadek Effendi, E.M.S., for kindly placing suitable and uncomplicated cases at my disposal in the military hospitals at Omdurman and Khartoum, and in the Prison Hospital, Khartoum.

The blood count as an indication of successful operation

Chemical work

## 2. Chemical.

| Nature | No. |
|---|---|
| (*a*) Analysis of alcoholic liquors . . . . . | 6 |
| (*b*) Toxicological . . . . . | 3 |
| (*c*) Medical Jurisprudence apart from (*b*) . . . . | 1 |
| (*d*) Plant analysis (Economic) . . . . . | 1 |
| (*e*) Water analysis . . . . . | 1 |
| (*f*) Milk analysis . . . . . | 1 |
| (*g*) Soil analysis . . . . . | 2 |

Substitution of the Sudan

As regards (*a*) it has been shown that substitution is practised, cheap made-up spirits, so-called brandies and whiskies, being manufactured. The toxicological cases (*b*) were not of any special interest, though in one instance arsenic in the form of the yellow orpiment mixed with sulphur, was detected. At the same time these cases involved a great deal of labour. This will be apparent when it is stated

that two of them were associated with native vendors of drugs, and that the whole stock-in-trade of these worthies, varying from Galena to santal oil, was sent to the laboratories for analysis along with the organs of the deceased. Their drugs are, as a rule, harmless, but it is gratifying to know that the new sanitary regulations will deal with such gentry and so prevent much unnecessary work in the laboratories. Regulation of the sale of drugs

An opinion had to be given regarding blood stains (*c*) in a case of suspected murder, while the plant analysis mentioned (*d*) was that of "Kusub," the product left after the extraction of sim-sim (sesame) oil from the *sesame orientale*. The result obtained bore out Mr. Fitzgerald's [1] statement that it is an excellent food for working bullocks, being employed largely as such in India under the name of "gingelly-poonac." Value of "Kusub"

The sample was of the following composition :—

| | |
|---|---|
| Water | 7·70 |
| Ash | 8·80 |
| Fat | 11·07 |
| Starch as sugar | 11·97 |
| Total starch (by difference) | 26·43 |
| Albuminoids | 34·50 |
| Crude Fibre | 11·50 |
| | 111·97 |
| Less starch as sugar | 11·97 |
| | 100·00 |

The soil analyses were in connection with the disposal of sewage in Khartoum, and interesting from that standpoint. Thus virgin desert sand gave the following results :— Soil analyses

| | |
|---|---|
| Moisture | ·8 per cent. |
| Organic matter as Nitrogen | ·0329 grams per cent. |
| Free Ammonia | ·00085 „ „ „ |
| Fixed Ammonia | ·039 „ „ „ |

while soil from a sewage trench in the desert which had not been employed as such for a period of eight months, yielded these figures :—

| | |
|---|---|
| Moisture (air-dried sample) | 1·44 per cent. |
| Organic matter as Nitrogen | ·1916 grams per cent. |
| Free Ammonia | ·665 „ „ „ |
| Fixed Ammonia | ·232 „ „ „ |
| Composition (Sand | 91·15 per cent. |
| Composition (Clay | 1·85 „ „ |

[1] Report on the Improvement and Possible Development of the Cultivable Products of the Sudan.—W. W. A. Fitzgerald, 1902

# The Mosquitoes of Egypt, The Sudan and Abyssinia

BY

Fred. V. Theobald, M.A.,

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The following paper is mainly based on the material collected by Dr. Andrew Balfour, Director of the Wellcome Research Laboratories, Khartoum, and to some extent by Captain Lyle Cummins, R.A.M.C., Dr. Keatinge, Major Ronald Ross, C.B., late I.M.S., and others. Many of the notes are those sent me by Dr. Andrew Balfour.

The specimens collected by the Director were mostly taken during a trip up the Blue Nile to Roseires, up the White Nile to Regaf in the Lado Enclave and up the Sobat and its two branches the Baro and the Pibor in Abyssinian territory.

As one might expect the regions traversed by the Nile and its tributaries are very prolific in regards to this group of Diptera. This is especially noticeable along the course of the Blue and White Niles, where in many parts the number of these pests is enormous. Not many species are yet known from this region, but it is almost certain that very many more exist.

The chief pests seem to be in the genera Culex and Mansonia, and amongst the Anophelina we find abundance of a Cellia, *C. pharœnsis*, Theobald, and a Myzomyia, *M. funesta*, Giles. A new Anopheles *(A. wellcomei)* closely related to *Anopheles gigas*, Giles, from India is described and a new Myzomyia also some other Anophelines of considerable interest. The collection made by Dr. Balfour also contained a new Uranotaenia *(U. balfouri)* and at least one new genus *(Etorleptiomyia)*. Two strange males occurred in the collection, one undoubtedly the male of my genus Mimomyia. The other I cannot place in spite of its marked palpal character. I have merely described it without referring it to any definite position, as it was in too damaged a condition to show scale structure. The great number of *Mansonia uniformis*, Theobald, was the most noticeable feature during Dr. Balfour's trip. For other localities *vide* Dr. Balfour's list, which I have checked.

Many of the specimens showed the presence of a parasitic tick attached to them. When alive the parasite resembles a tiny preserved cherry, says Dr. Balfour. As a rule this parasite is attached to the under surface of the thorax and abdomen, but it was once found on the wing of an Anopheles. The colour varies in intensity.

# PLATE I.

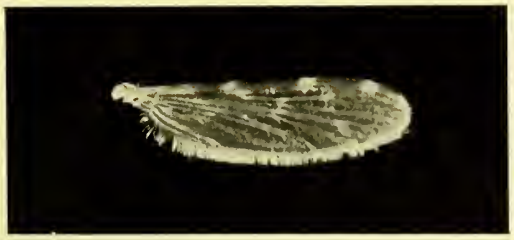


FIG. 1. Myzomyia funesta, Giles

FIG. 2. Myzomyia funesta, Giles

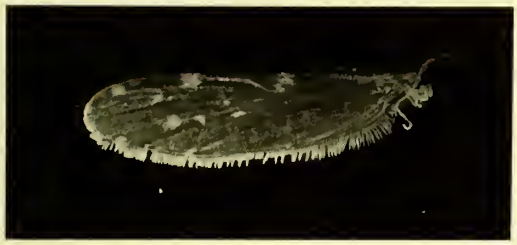


FIG. 3. Myzomyia nili, n. sp.

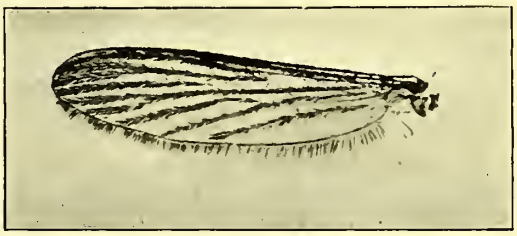


FIG. 4. Myzomyia nili, n. sp.

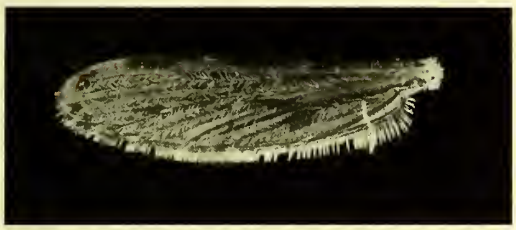


FIG. 5. Anopheles wellcomei, n. sp.

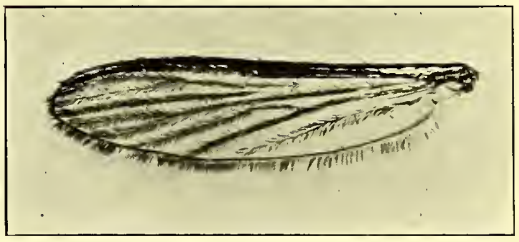


FIG. 6. Anopheles wellcomei, n. sp.

FIG. 7. Mimomyia unitormis, n. sp. ♀

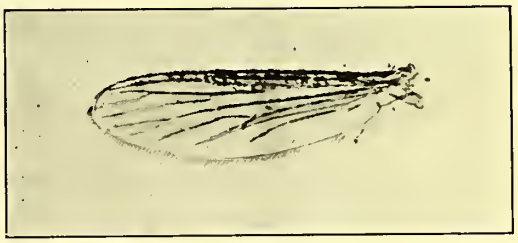


FIG. 8. Mimomyia uniformis, n. sp. ♀

FIG. 9. Etorleptiomyia mediolineata, n. sp.

FIG. 10. Mimomyia uniformis, n. sp. ♂

WINGS OF SUDANESE CULICIDÆ

Genus Anopheles, Meigen

Syst. Beschr. I, 10 (1818), Meigen; Mono. Culicid. I., p. 115 (1901), Theobald, and III., p. 17 (1903).

*Anopheles wellcomei*, n. sp.

(Plates I., Figs. 5 & 6; III., Fig. 4, & V., Fig. 5)

Head black with dense white, yellow and brown upright forked scales, the white ones in front and two long hair-like projecting white tufts; palpi yellow, black at the base with two white bands on the yellow area. Thorax ashy, chestnut-brown at the sides and with hair-like golden scales; abdomen brown, unbanded with brownish-golden hairs. Wings mostly yellow scaled, costa jet black with two yellow spots and three or four black spots on the wing field.

*Female.* Head black densely clothed with large upright forked scales giving it a ragged appearance, white in front, yellow in the middle, black behind and at the sides; projecting forwards are two prominent tufts of long white hair-like scales; antennæ brown with pale hairs and the basal six or seven joints with many white scales, basal segment bright reddish-brown; proboscis with basal half black, apical half ochreous; palpi not quite as long as the proboscis, basal third black scaled, apical two-thirds bright ochreous with an almost white apical band and a pure white band about one-fourth the way down.

Thorax ashy-grey with a broad dark median stripe and chestnut-brown laterally, two more or less yellowish lines on the grey median area seen only in certain lights and under $\frac{2}{3}$rd power, scales hair-like and pallid golden, except in front over the head, where there are grey and long narrow-curved scales; the hair-like scales form a prominent double row on each yellow line; scutellum and metanotum pale brown; pleuræ pale ochreous brown.

Abdomen brown, ochreous ventrally, with pale brown hairs, most dense on the venter.

Wings (Plate I., Figs. 5 & 6) with the costa jet black, with two prominent, rich yellow spots on the apical half; apex of wing yellow; first long vein yellow with a black spot near the apex under a small apical black costal spot, traces of two smaller ones nearer the base; subcostal black; second long vein yellow with a black spot on both branches of the fork-cell just under the black spot on the first long vein; third long vein all yellow, with a minute apical black spot and another minute one at its base just past the cross-veins; fourth long vein yellow with two dusky spots on the upper and one on the lower branches of the fork-cell, and a few on one side of its stem; fifth long vein yellow, a few black scales at the base of the upper branch, and a trace of an apical spot; sixth yellow with a black median spot; fringe black with yellow spots at the junction of all the veins, with the border and the greater part of the fringe from the sixth vein to the base yellow; first submarginal cell longer and narrower than the second posterior cell, its base nearer the base of the wing, its stem slightly more than half the length of the cell; stem of the second

# PLATE II.

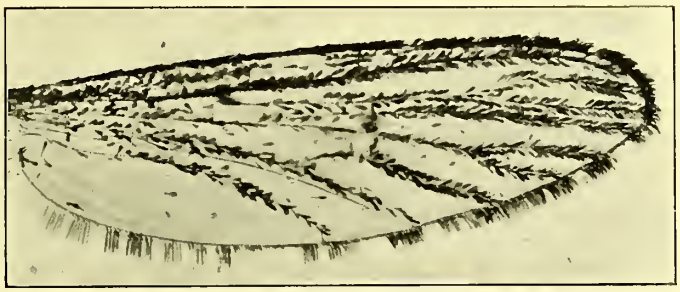


Fig. 1. Mucidus africanus, ♀ Theo.

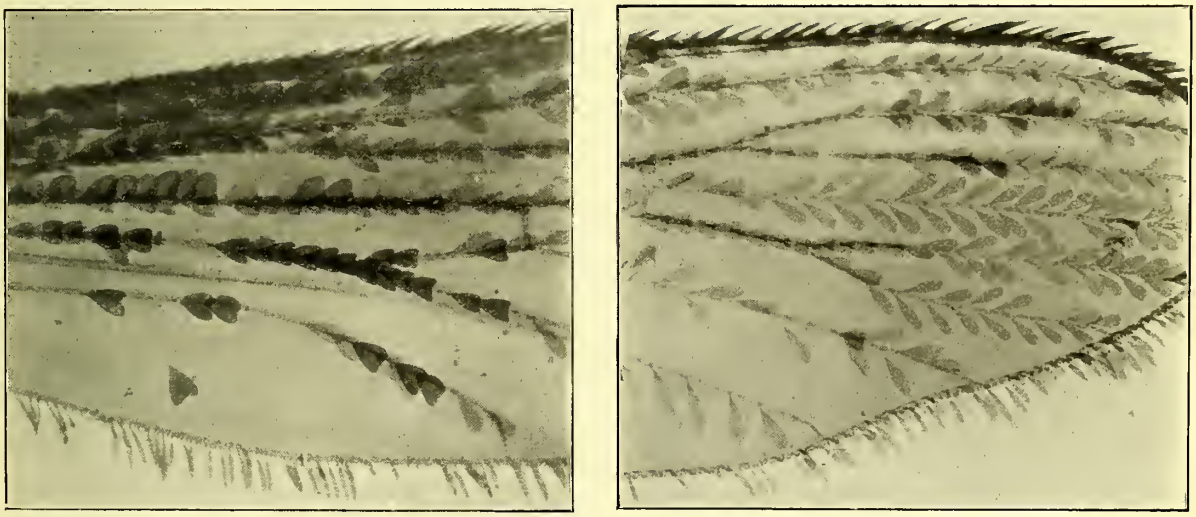


Fig. 2. Etorleptiomyia mediolineata, ♀ n. sp.

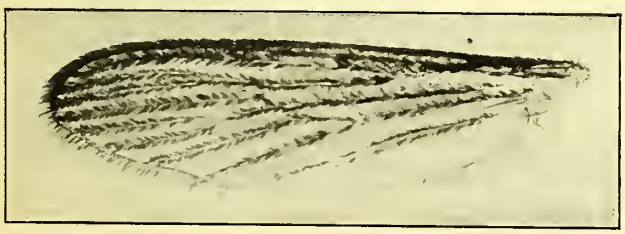


Fig. 3. Mansonia uniformis, ♀ Theo.

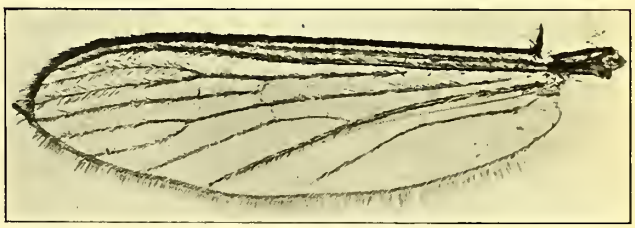


Fig. 4. Culex dentatus, ♀ n. sp.

WINGS OF SUDANESE CULICIDÆ

posterior cell nearly as long as the cell; supernumerary and mid cross-veins in one line, posterior cross-vein about its own length distant behind the mid. Halteres with pale stem and fuscous knob.

Legs brown with very narrow apical yellow bands.

*Length.* 4.5 to 5 mm.

*Habitat.* Baro and Pibor.

*Observations.* Described from several females, but all have been slightly damaged, the wings are very characteristic and approach nearest to Giles's *Anopheles gigas* from India. Dr. Balfour states that "it boarded the steamer in the evening at Baro and bit freely."

There is variation in the wing marking especially in the size of the black spots on the wing field. It is abundant on the Baro.

### Genus Myzomyia, Blanchard. (*Grassia*, Theobald.)

Comp. Rend Heb. Soc. Biolog. No. 23, p. 795, Blanchard (*Myzomyia*) 1902; Journ. Trop. Med. V., p. 181, Theobald (*Grassia*), 1902; Mono. Culicid. III., p. 24, Theobald, 1903; Mem. X, Liverpool School Trop. Med. App. p. 4, (Varieties *umbrosa* and *subumbrosa*), Theobald (1903).

### *Myzomyia nili*, n. sp.

(Plates I., Figs. 3 & 4; III., Fig. 2; V., Fig. 3)

Related to Myzomyia funesta, (Giles) but easily told by its much darker hue than in the dark varieties of funesta, by the palpi having one small apical pale band only and by the palpi and the proboscis being much shorter than the body.

*Female.* Head deep brown with grey upright forked-scales in the middle with a slight creamy hue, dusky ones at the sides, a creamy white tuft of hair and scales projecting forwards between the eyes; antennæ deep brown with brown hairs; palpi thin, as long as the proboscis covered with black scales, the apex only pale; clypeus black with a sulcus across the middle; proboscis thin and black, apex acuminate and testaceous with a few black hairs; proboscis and palpi not nearly as long as the body.

Thorax dull, pale fawn colour in the middle, dark brown at the sides, covered with scattered pale golden curved hair-like scales, a tuft of pale creamy narrow-curved ones in front projecting over the head; scutellum pale brown with many brown border-bristles; metanotum brown; pleuræ pale brown with a greenish tinge. Abdomen black with rich brown hairs.

Legs brown, unbanded, with small simple, equal ungues.

Wings (Plate I., Figs. 3 & 4) mainly black scaled, with three yellow costal spots spreading evenly on to the first long vein, all the veins dark scaled, except for a small yellow spot at the base of each of the two fork-cells, and at the cross-veins and another at the lower branch of the second fork-cell where it joins the costa and one on the costa where the lower branch of the

# PLATE III.

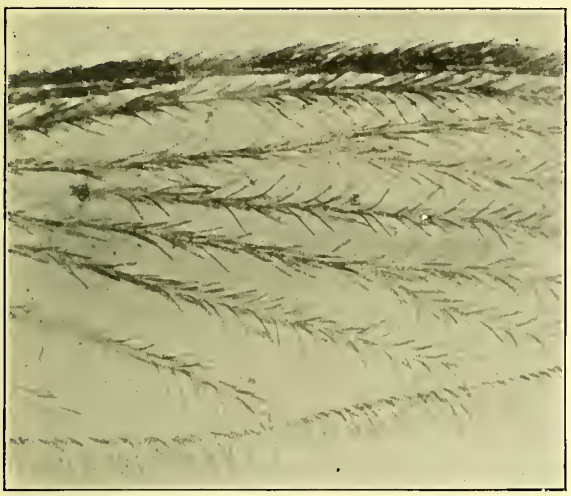


FIG. 1. Myzomyia funesta, Giles

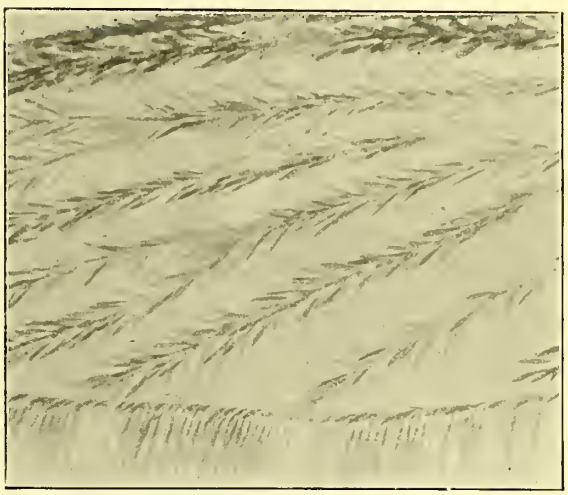


FIG. 2. Myzomyia nili, n. sp. ♀

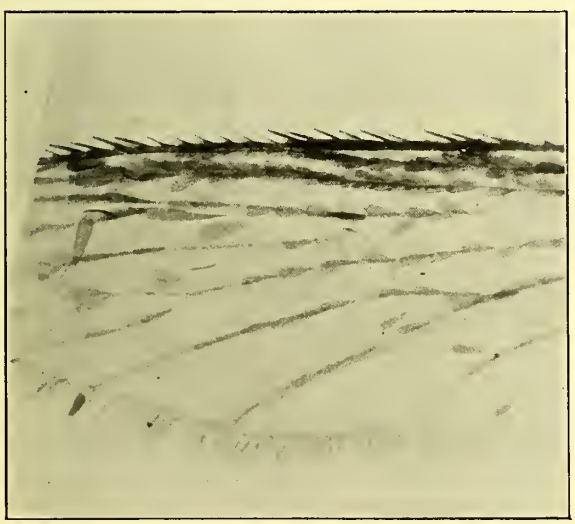


FIG. 3. Mimomyia uniformis, n. sp. ♀

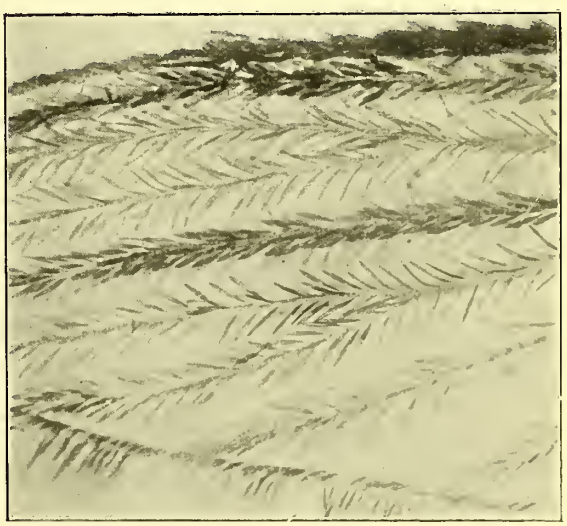


FIG. 4. Anopheles wellcomei, n. sp.

WING SCALES OF CULICIDÆ

fifth joins it; fringe dark except where the lower branch of the fourth and fifth veins join the border where creamy patches occur; fork-cells both short, the base of the second posterior the nearer the base of the wing, both nearly equal in length, the first submarginal narrower than the second posterior, its stem as long as the cell, stem of the second posterior as long as the cell: supernumerary cross-vein slightly in front of the mid, the posterior nearly twice its own length distant from the mid. Halteres pale with fuscous knob.

*Length.* 3 mm.

*Habitat.* Jebel Akmet-Aga on the White Nile, also on the Middle Sobat.

*Observations.*—Described from two perfect females taken by Dr. Balfour. They bear a very strong resemblance to *Myzomyia funesta*, Giles, variety *umbrosa*. Theobald (vide Rept. Malaria Exp. to Gambia, Mem. X, Liv. School Trop. Med. App. p. 4, 1903). The main differences are as follows: the palpi and the proboscis are relatively not so long as in *M. funesta*, and they are all black save for a minute pale apical band, whilst in funesta there are three pale bands; the wings are much more densely scaled than in funesta and the fork-cells shorter and with much longer stems than in funesta. I thus think it must be treated as a distinct species owing to the shorter palpi and not as a melanic variety.

### *Myzomyia funesta*, Giles

(Plates I., Figs. 1 & 2; III., Fig. 1, & V., Fig 2)

(Hand. Bk. Mosq., p. 162 (1902), Giles; Mono. Culicid. I., p. 178 (1901); III. p. 34 (1903).

This species has been sent by Dr. Balfour from the Sudan, and he states it is common on the Sobat, where he found it in numbers. The specimens sent were quite typical. I believe it occurs all over Central Africa down to Fashoda. The wing is figured on Plate I., Figs. 1 and 2.

### *Myzomyia* n. sp.

A single much damaged Myzomyia was taken at Bor by Dr. Balfour, but it is too imperfect to describe, I am sure it is a new species however. Its marked feature is the pale grey ventral surface; the wings have only two yellow costal spots and a yellow apical spot which extends on to the first long vein, another pale spot towards the base of the first long vein, not reaching the costa and the base of the vein yellowish; a pale spot at the base of each fork-cell, another at the cross-veins and another at the marginal cross-vein; on the lower branch of the fifth a long yellow area and another faint one on the stem; fringe unspotted.

*Length.* 3 mm.

### *Anopheles (Myzomyia?) impunctus*, Dönitz

(Beit. II., Kennt. d. Anop. (1902), p. 67; Mono. Culicid. III., p. 54 (1903).

This species is described by Dönitz from Lower Egypt (Wadi Natrun). I have not seen any species which answers to the figure of the wing which he gives.

# PLATE IV.

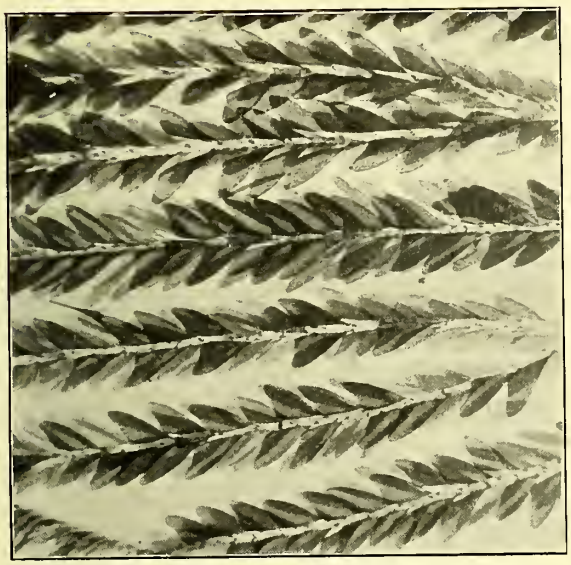


FIG. 1. Mansonia uniformis, Theo.

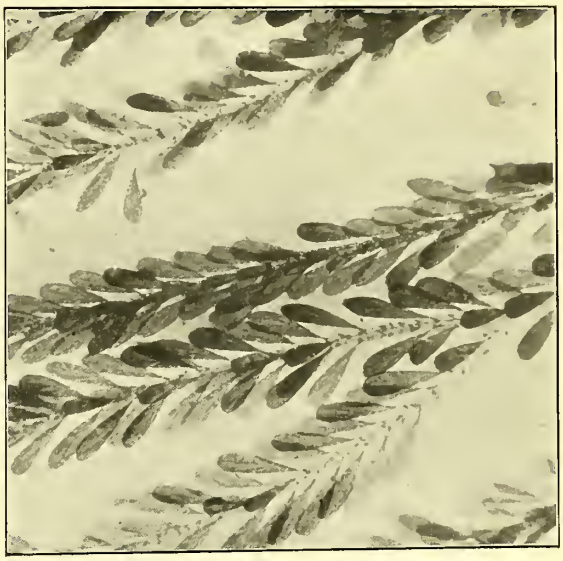


FIG. 2. Mucidus africanus, Theo.

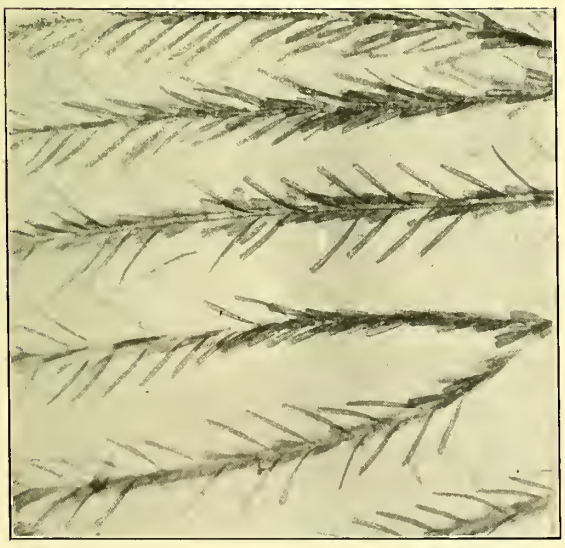


FIG. 3. Culex dentatus, n. sp.

FIG. 4. Tæniorhynchus tenax, Theo., var maculipes, n.v.

Genus Pyretophorus, Blanchard (*Howardia*, Theobald)

Compt. Rend. Hebdom. Soc. d. Biol. No. 23, p. 795, Blanchard; Journ. Trop. Med. V., p. 181 (1902) Theobald; Mono. Culicid. III., p. 66, Theobald (1903).

*Pyretophorus costalis*, Loew.

*Anopheles costalis*, Loew.
*Anopheles gambiæ*, Giles.
*Anopheles gracilis*, Dönitz. (?)

(Plate V., Fig. 4)

Ent. Zeit. Berlin, p. 55 (1866), Loew; Handbook Gnats, 2nd Edition, p. 511, Giles (1902); Mono. Culicid. I., p. 157 (1901); and III., p. 74, Theobald (1903); Beit. z. Kennt. d. Anoph., p. 76, Dönitz (1902).

Found by Dr. Balfour at Senga and at Roseires, on the Blue Nile. I have not seen any specimens myself from Egypt or the Sudan, but I have had specimens from Uganda. It also occurs in Khartoum. This is a malaria carrier.

Genus Myzorhynchus, Blanchard. (*Rossia*, Theobald).

Comp. Rend. Hebd. Soc. d. Biol. No. 23, p. 795 (1902). Journ. Trop. Med., p. 181 (1902), *Rossia*; Mono. Culicid. III., p. 84 (1903).

*Myzorhynchus paludis*, Theobald

Repts. Malarial. Comm. Royal Society England, p. 75 (1900); Mono. Culicid. I., p. 128 (1901), and III., p. 86 (1903).

Dr. Balfour obtained many on the Pibor (Bor and South of Goz-abu-Guma, White Nile) which showed no special peculiarities. He says they are very common there, but not very vicious. This species is much subject to the parasitic tick, often being covered with them. It is also probably a malaria bearer.

Previously, Captain Lyle Cummins obtained specimens from Bahr-El-Ghazal.

Genus Cellia, Theobald
Mono. Culicid. III., p. 107 (1903)
*Cellia pharœnsis*, Theobald.
*Anopheles pharœnsis*, Theobald.
(Plate V., Fig. 1)

Mono. Culicid. Vol. I., p. 169, (1901), & Vol. III., p. 109 (1903)

Found by Dr. Balfour at Baro, also at Roseires on the Blue Nile (W. L. S. Loat and Dr. Balfour); Cairo (Keatinge); Ismailia (Ross).

This seems to be an abundant North and Central African species, and is undoubtedly a malaria bearer. It also extends into Arabia, having recently been sent me from the Aden hinterland, and it also occurs in Palestine.

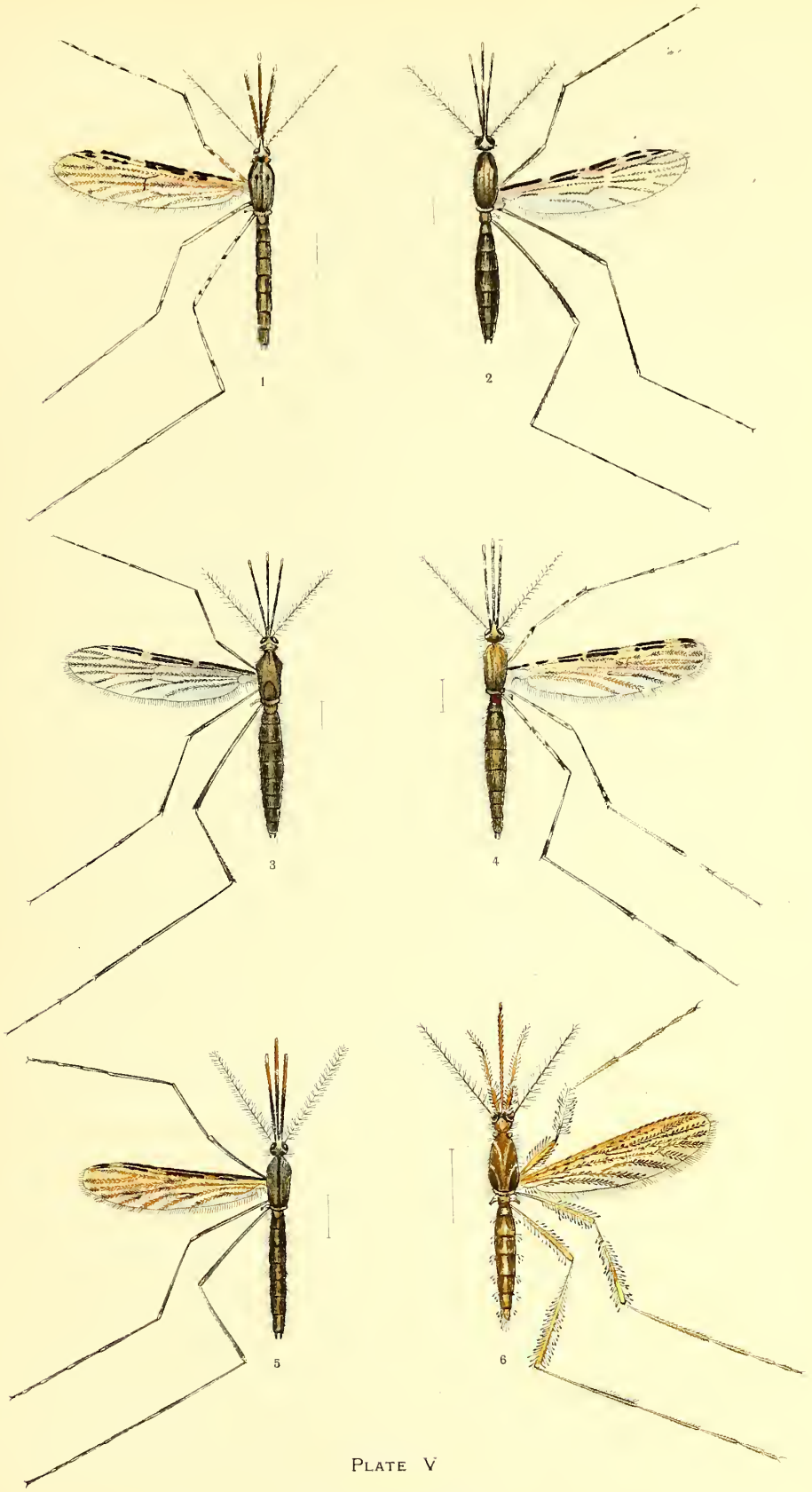



PLATE V

*C. Beard*

SUDANESE MOSQUITOES

1 Cellia pharœnsis, Theobald
2 Myzomyia funesta, Giles
3 Myzomyia nili. n. sp.
4 Pyretophorus costalis, Loew
5 Anopheles welleomei, n. sp.
6 Mucidus africanus, Theobald

Genus Mucidus, Theobald.
Mono. Culicid. I., p. 268 (1901)
*Mucidus africanus*, Theobald.
Mono. Culicid. I., p. 274, and III., p. 134 (1903).
(Plates II., Fig. 1; IV., Fig. 2; V., Fig. 6)

A single female was sent by Colonel Stanton to Dr. Balfour, taken in Khartoum. It is undoubtedly a variety of my *M. africanus*. Dr. Balfour describes in his notes the cross-veins as being like a Culex. I have mounted the wings of the specimen he sent, and find them quite normal. I may here point out a character I have missed in this genus, namely, that the third long vein is very near the second (*vide* photo of wing, Plate II., Fig. 1). It has also occurred in Uganda. (Wadelai, one female.)

Genus Stegomyia, Theobald
Mono. Culicid. I., p. 283 (1901)
*Stegomyia fasciata*, Fabricius.
(Plate VI., Fig. 2)

Syst. Antl. 36, 13 (1805) Fabr.; Mono. Culicid. I., p. 289 (1901) and III., p. 141 (1903).

This yellow fever carrier has been taken at Ismailia and Port Said by Major Ronald Ross, and it also occurs in Khartoum and on the river steamers. Other localities Pibor, Cairo.

Genus Etorleptiomyia, nov. gen.

Head clothed with a mixture of narrow-curved scales, upright forked ones and small loose flat scales all over; antennæ scaly on the basal joints. Thorax with scales of mesonotum narrow and curved, those of the scutellum flat and small. Abdomen clothed with flat scales. Wings with very marked heart-shaped scales (Plate II., Fig. 2), on the basal halves of the second, fourth, fifth and sixth veins; on the first long vein, base of second and fourth also with more or less Mansonia-like scales and along costal border also, scales on the apical halves of the veins pedunculated, clavate, peduncles very short; costa spiny; fork-cells moderately long.

This forms a very distinct genus, easily told by the curious heart-shaped scales on the wings. The proboscis seems very weak.

A single species only is so far known, which was taken by Dr. Balfour. The Mansonia-like scales are not exactly as in that genus, but approach them very closely.

*Etorleptiomyia mediolineata*, n. sp.

Head yellow with a black patch on each side; proboscis brown, unbanded. Thorax black with narrow-curved golden scales. Abdomen black with a median line of yellow scales. Legs brown, femora yellow beneath, tibiæ mottled with yellow, metatarsi and tarsi with yellow apical bands except the last. Wings with dark brown scales basally and along the costal area.

*Female.* Head brown, clothed with creamy yellow scales in the middle and around the eyes, black at the sides, the scales behind and in the middle are narrow-curved ones and they extend through to the front, and scattered between the loose flat paler yellow ones which form most of the median area; flat black scales at the sides, those round the eyes pale yellow, fork-scales black on the dark area, ochreous in the middle yellow area; the yellow fork-scales have three terminal spines, the black four or five. Palpi densely black scaled, short; proboscis weak and thin, clothed with small black scales, the yellowish ground color showing through; antennæ deep brown, basal joint and next two following with small flat creamy scales.

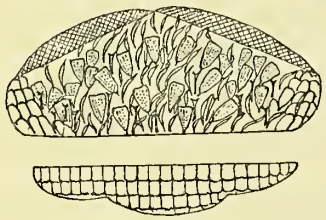


Fig. 1
Cephalic and scutellar ornamentation of *Etorleptiomyia mediolineata*

Thorax black with narrow-curved golden scales and a few bronzy ones behind; scutellum with small flat black scales, mid lobe with five posterior border-bristles; metanotum deep brown with a median paler line; pleuræ pale ochreous. Abdomen black with a median line of creamy yellow scales, rather broadest at the base.

Legs with yellow coxae, femora yellow with blackish scales above, and two pale spots, yellow below; the fore femora appear much paler than the mid and hind; tibiæ black with scattered yellow scales and small yellow apex; metatarsi yellow at the base, and apex, and with a more or less pronounced yellow median band; first two tarsi on all the legs with an apical yellow band, last two all brown; ungues small, equal and simple.

Wings (Plate I., Fig. 9 and Plate II., Fig. 2), with dark scales basally and some spread out towards the apex along the costal border and another slightly dark area on the first fork-cell; scales on the first long vein, upper branch of first fork-cell, and one side of the base of the fourth, of Mansonia type; the second, fourth, fifth and sixth with characteristic single line of heart-shaped scales on the major area, on most of the branches of the fourth and fifth are clavate scales, with very short peduncles; a few heart-shaped ones at the base of the cells; costa spiny; first submarginal cell longer and slightly narrower than the second posterior cell, its base nearer the base of the wing, its stem short, about one-fifth the length of the cell; stem of the second posterior not quite half the length of the cell; posterior cross-vein about twice its own length distant from the mid.

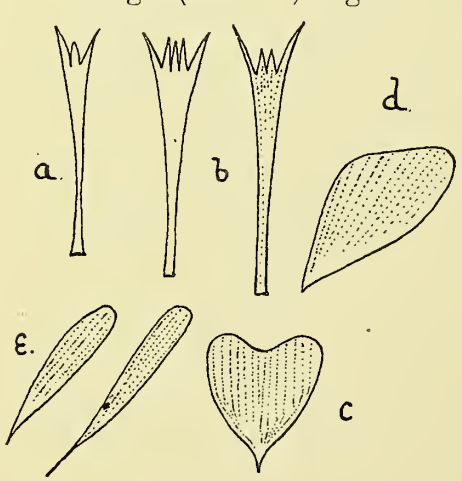



Fig. 2
Scales of *Etorleptiomyia mediolineata*
a & b Upright forked scales
c Heart-shaped wing scale
d Mansonia scales of costal border
e Other wing scales

*Length.* 3 mm.

*Habitat.* Pibor.

*Observations.* Described from a single perfect female. Dr. Balfour sends the following notes regarding it which show that differences of colour exist between fresh and dried specimens:—"proboscis brownish yellow with a purple or black band or tuft near the labellæ. Thorax, ground colour purple. Abdomen purple with median line of pale scales and two yellowish lateral patches on the last segment." There may be a minute tooth on each fore unguis, but I do not think so; the mid and hind are anyway equal and simple. The differences in color between the areas of the wing are very marked.

Genus Theobaldia, Neveu-Lemaire

Compt. Rendus. d. Seas. d. la. Soc. d. Biol., 29 Nov. (1902). (Neveu-Lemaire); Mono. Culicid. III., p. 148. Theobald (1903).

*Theobaldia spathipalpis*, Rondani

*Culex spathipalpis*, Rondani

(Plate VI., Fig. 1)

Dipt. Ital. Prodro. I. (1886), Rondani; Mono. Culicid I., p. 339 (1901), and III., p. 154 (1903), Theobald.

Adults, larvæ and pupæ of this species, have been sent me by Dr. Balfour from Khartoum North. Both male and female are somewhat pallid, but the thoracic ornamentation is very marked, the wing spots paler than in most specimens, almost absent.

Genus Culex, Linnaeus

Linn. Syst. Nat. (1735); Mono. Culicid. I., p. 326 (1901)

*Culex viridis*, Theobald

Mono. Culicid. III., p. 212 (1903)

This is apparently a widely distributed African species, being especially abundant in Central Africa. I originally described it from Uganda specimens. It varies much in size; some sent by Dr. Balfour being 3.5 mm. only, others 4.5 mm. Dr. Balfour collected it from the Sobat, Baro, Pibor, Lado.

The specimens show considerable variation in regards to the length of the fork-cells, position of the cross-veins and size.

Dr. Balfour mentions in regard to one specimen that the "legs were rich reddish-brown." They are dull brown in the dried specimens.

The lateral abdominal spots also vary, usually basal, but some are found to be central and others apical, yet others where the spot spreads all along the side of the segment. It is the only species so far found in Central and West Africa with an unbanded abdomen, otherwise it looks much like *C. fatigans*. The Sudanese specimens do not show so clearly the greenish pleuræ seen in Uganda specimens.

*Culex pallidocephala*, n. sp.

Somewhat like *C. fatigans* but the head with rather dense, pale, narrow-curved scales and numerous dark brown to black upright-forked ones. Palpi and

proboscis black. Thorax dark brown ornamented with brown and golden brown narrow-curved scales, the golden brown forming more or less distinct linear ornamentation and a curved line on each side in front of the wings, which surrounds a dark area in front of each wing. Abdomen black with basal creamy bands. Legs brown unbanded.

*Female.* Head brown, clothed with rather dense pale narrow-curved scales which lie uniformly pointing forwards, a few still paler very small flat scales laterally and long thin bifid upright forked-scales over the greater part, those placed laterally jet black, those in the median area dark brown to yellowish-brown according to the rays of light; palpi thick, three distinct small basal segments dull testaceous, the fat apical segment as long as the three basal ones and black scaled; there may be a minute nipple-like apical segment, but if so it is hidden in scales; proboscis and clypeus deep brown.

Thorax dark brown, ornamented with dull golden and deep rich brown narrow-curved scales; the dark scales form two prominent oval areas, one in front of the base of each wing, the dull golden scales bordering them; the latter are also more or less placed in lines along the middle of the thorax and others at the sides above the pleuræ, others, almost creamy, in front of the scutellum; scutellum paler brown than the mesonotum, with pale narrow-curved scales and black border-bristles, seven to the mid lobe; metanotum black; pleuræ black with three patches of white scales.

Abdomen black with black scales and creamy basal bands, the last two spreading out laterally; venter all creamy yellow.

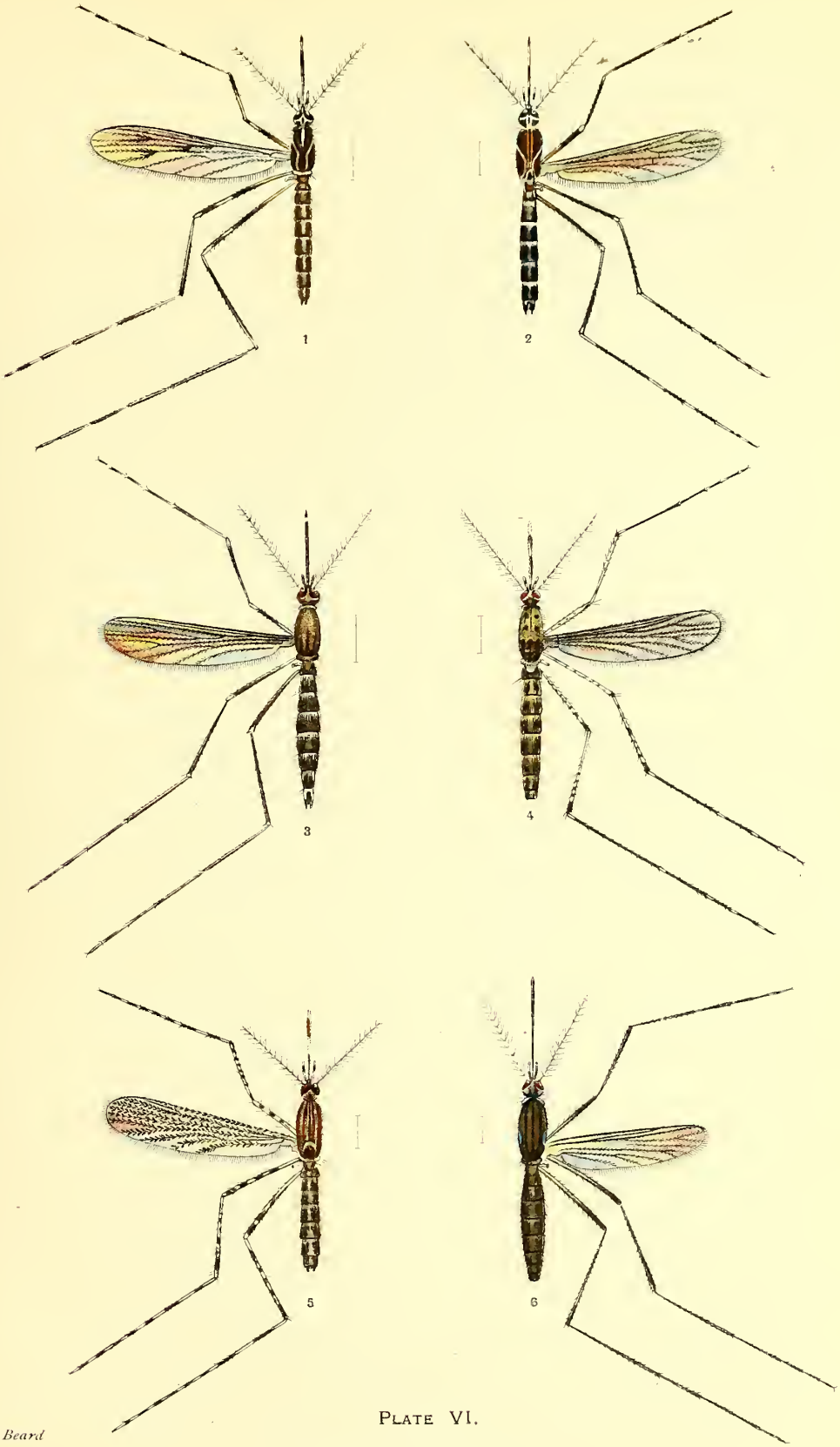
Legs deep brown, unbanded, traces of a pale knee spot and a creamy apical spot on the hind tibiæ.

Wings with typical brown Culex scales; the first sub-marginal cell considerably longer and slightly narrower than the second posterior cell, its base much nearer the base of the wing than that of the latter, its stem short, rather less than one-fourth the length of the cell; stem of the second posterior about two-thirds the length of the cell; posterior cross-vein rather more than its own length distant behind the mid cross-vein; halteres with reddish-brown stem, fuscous knob with a few grey scales.

*Length.* 4.5 mm.

*Habitat.* Sennar, Blue Nile.

*Observations.*—Described from a single female. It resembles at first sight *C. fatigans* but the paler scaled head and the numerous long upright forked-scales separate it, the thorax too is distinctly ornamented, the two dark ocellate areas being most noticeable. The palpi may be five-jointed, but are heavily scaled so that a small apical segment cannot be seen, the three small basal segments are very distinct. The last tarsals are gone so that the characters of the ungues cannot be given.




C. Beard

## PLATE VI.

### SUDANESE MOSQUITOES

1 Theobaldia spathipalpis, Rondani
2 Stegomyia fasciata, Fabricius
3 Culex dentatus, n. sp.
4 Tæniorhynchus tenax var. maculipes n. var.
5 Mansonia uniformis, Theobald
6 Uranotænia balfouri, n. sp.

*Culex cumminsii*, Theobald
Mono. Culicid. III., p. 214, (1903)

This large mosquito was taken first by Capt. Cummins in the Bahr-El-Ghazal and subsequently by Drs. Moffat and Low in Uganda. From a note sent me by Dr. Balfour I fancy it also occurs in Khartoum.

It is a large handsome gnat with deep brown thorax clothed with narrow hair-like golden scales and white scaled pleuræ; deep brown unbanded abdomen with prominent white lateral basal spots. Unbanded legs and brown palpi and proboscis. Length 7 mm.

*Culex dentatus*, n. sp.

(Plates II., Fig. 4; IV., Fig. 3; VI., Fig. 3)

Head dark brown with some narrow-curved golden scales, a golden yellow border around the eyes and a pale patch on each side. Thorax deep brown, ornamented with rich golden-brown and golden narrow-curved and hair-like scales showing more or less linear arrangement. Abdomen deep brown with basal pale bands and basal creamy lateral spots, venter creamy scaled. Palpi, proboscis and legs uniformly brown, except the venter of the femora which are pale, and there is a yellow apical tibial spot; ungues large, equal, uniserrated.

*Female.* Head dark brown, almost black, clothed behind and over most of the mid area with large narrow-curved pale golden scales, almost creamy yellow in some lights and with a frontal median patch of much smaller golden-brown ones, around the eyes thin narrow-curved pale creamy scales and flat pale creamy lateral ones; upright forked-scales not much expanded apically, scanty and dark brown; a pale yellow tuft projects beneath the eyes; palpi thick, deep brown or black, with long black bristles; proboscis deep black; antennæ deep brown, basal segment and base of the second segment testaceous, the former darker on the inner side with a few creamy scales. Thorax deep brown clothed with curved hair-like golden-brown and golden scales, the golden scales forming two rather indistinct median parallel lines and a curved lateral line on each side behind with a more or less darkened area outside it, before the scutellum the scales are paler and of normal curved form; scutellum brown with narrow-curved pale golden scales and brown border-bristles, seven to the mid lobe; metanotum brown; pleuræ black with patches of creamy scales.

Abdomen black with basal creamy scaled bands and lateral spots, venter mostly creamy scaled; on the apical segment the creamy lateral spots join the basal band and look like extensions of it down the sides.

Legs brown, unbanded, but the femora are pale ventrally, and there are yellow knee spots and traces of apical yellow tibial spots; ungues all equal, thick and with a thick tooth.

Wings (Plate II., Fig. 4) large and broad, scales of typical Culex form (Plate IV., Fig. 3); first submarginal cell longer and narrower than the second posterior cell, its base nearer the base of the wing than that of the second posterior cell, its stem a little more than one-third the length of the cell;

posterior cross-vein about half its length distant from the mid cross-vein; halteres with pale stem and creamy scaled knob.

*Length.* 5 to 5.5 mm.

*Habitat.* Abyssinia (Isana, through Damot).

*Observations.* Described from four females. It is a large heavy built Culex, very like a large *C. fatigans,* Wied., but can at once be told by the dentate ungues. The thoracic ornamentation is marked in some very clearly, in others not so much.

A specimen sent by Dr. Balfour from the Sobat in very damaged condition seemed to be this species.

*Culex fatigans*, Wiedemann

Auss. Zwei. Ins. p. 10 (1828), Wied. Mono. Culicid. II., p. 151 (1901), Theobald. Mono. Culicid. III., p. 225 (1903), Theobald

Apparently very abundant along the Nile and its tributaries as elsewhere. Dr. Balfour has taken it on the Baro and Pibor, and reports it as by far the commonest mosquito in Khartoum. I have also seen specimens from Suez, Ismailia, and Cairo.

*Culex pusillus*, Bigot

Dipt. Exot. 4th Supp., p. 9, Mono. Culicid. II., p. 166 (1901)

This small thick set Culex has not occurred since Bigot's specimens were taken. It is evidently distinct, and comes between Culex pipiens and C. fatigans.

*Culex pipiens,* Linnaeus

Fn. Suec. (1758), Linnaeus; Mono. Culicid. II., p. 132 (1901), and III., 224 (1903)

Recorded by Dr. Keatinge from Cairo, and from Suez by Col. Giles, late I.M.S. Also from Port Said and Ismailia (Major Ronald Ross, C.B.).

Genus Mansonia, Blanchard

*Panoplites*, Theobald

Comp. Rend. Hebd. Soc. d. Biol., No. 37, T. liii., p. 1046 (1901)
Mono. Culicid. II, p. 173 (1901)

*Mansonia uniformis*, Theobald.
{*Panoplites uniformis*, Theobald.
{*Panoplites africanus*, Theobald.

(Plates II., Fig. 3; IV., Fig. 1; VI., Fig. 5)

Mono. Culicid. II, p. 180 *(uniformis)*, p. 187 *(africanus)*, 1901; III, p. 273 (1903)

Specimens were taken at the following places:—Middle Sobat, Pibor River, Renk, and Kenissa by Dr. Balfour. Bahr-El-Ghazal (Cummins).

Probably occurs all over Egypt and the Sudan.

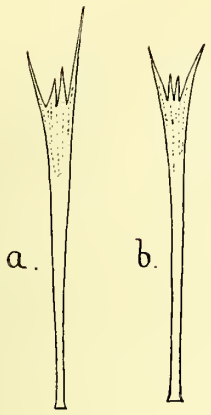



FIG. 3
Upright forked scales of
a *Mansonia major*
b *Mansonia uniformis*

The specimens show great variation in size. The large ones look very like *Mansonia major*, Theobald (Mono. Culicid. III, p. 270) but the forked cephalic scales have mostly only one median spine, but may have two as in *M. major*, but the lateral spines are equal not unequal. This character I neglected to point out before. For figures of wing, *vide* Plate II., Fig. 3, and Plate IV., Fig. 1.

Dr. Balfour writes that this species "becomes common and remains so shortly after passing Wad Medani on the way South."

It is widely distributed over Central, Northern, East and Western Africa, and also in India and the Philippine Islands. I have had none from the Transvaal, Orange River Colony or Cape Colony.

*Mansonia major*, Theobald
Mono. Culicid. III, p. 270 (1903)

No fresh specimens have been received since the one sent me by Capt. Cummins taken in the Bahr-El-Ghazal.

It is larger than the largest of the preceding species reaching 6.5mm. in length. It can be told by the upright forked cephalic scales having the thin lateral spines unequal and by their irregular form and the "border scales" on the wing being all dull yellow whilst in *M. uniformis* they are in alternating patches of dull yellow and black.

Genus TÆNIORHYNCHUS, Arribalzaga
Dipt. Argentina, p. 47 (1899); Mono. Culicid. II, p. 190 (1901)

*Tæniorhynchus aurites*, Theobald
Mono. Culicid. II, p. 209 (1901) and III, p. 269, (1903).

This species occurs in fair numbers on both the Blue and White Niles. Dr. Balfour took them between Roseires and Sennar on the Blue Nile, at Bahr-El-Jebel North Sudd country on the White Nile

It also occurs in Uganda and on the West Coast at Bonny and in the Federated Malay States.

*Tæniorhynchus annettii*, Theobald
Mono. Culicid. II, p. 205 (1901)

A single female with body gorged with blood and denuded of scales thus appearing black. The sixth dusky scaled long vein is prominent and clearly defines it from the former species.

Taken at Lake No, White Nile. Dr. Balfour adds a note "femora spotted black," I cannot detect the spotting in the specimen he sends. This beautiful species has also been taken in Old Calabar.

*Tæniorhynchus cristatus*, n. sp.

Thorax shiny black, with golden hair-like curved scales. Abdomen orange. Legs black and orange, with tufts of black scales especially on the middle of the hind tibiæ.

*Female.* Head brown, with pale yellow narrow-curved scales, and long, black, bifid, upright, forked-scales over the occiput, and a tuft of stout brown bristles projecting forwards; antennæ brown, the four basal segments reddish. Proboscis and palpi yellowish, with black apices.

Thorax black with narrow hair-like curved golden scales, pleuræ with a few white patches; on the mesonotum lateral rows of long stout black bristles; scutellum black, with hair-like golden scales and black border-bristles.

Abdomen entirely orange with orange-yellow scales, above and below. Legs yellow, with black tufts, very inconspicuous on the forelegs, more like banding at the femoro-tibial and tibio-metatarsal joints; the second pair the same, but more marked, femur spotted with black, the last segment of tarsus black; the hind legs similar to the mid, but with bright purple to black tufts in the middle of the tibiæ, consisting both of scales and bristles; apical half of the metatarsus black; nearly two-thirds of the apical half of the first tarsal and the second tarsal black, last tarsal black with yellow basal band at the joint; ungues of fore and mid legs long, equal and simple, of the hind small, equal, and simple.

Wings with yellow costa and veins, and yellow and dark scales, the yellow scales more rounded at the apex than the dark ones, some slightly expanded; most of the dusky scales are acutely truncated. First sub-marginal cell very long, longer than the second posterior cell; fringe dark. Halteres pale yellow, with pale knobs.

*Length.* 6 mm.

*Habitat.* Pibor.

*Observations.*—A single specimen only taken. The description is mainly that sent me by Dr. Balfour; the type was much damaged in transit, but I have added a few notes to those he has sent me. It is certainly a new species, easily identified by the tuft of purple-black scales and bristles on the hind legs.

*Tæniorhynchus tenax*, Theobald

Mono. Culicid. II., 198 (1901), and III., 258 (1903)

*Male.* Thorax as in the female; palpi black with five yellowish bands, one apical, the two apical segments of nearly equal length, with black hairs on both sides, the antipenultimate segment with black hairs on the outside, the fifth (basal band) is small; antennae banded black and white with blackish hairs. Abdomen with basal pale bands which spread out laterally on the basal segments. Wings with the fork-cells and their stems short; the first submarginal cell longer and narrower than the second posterior, its stem about half the length of the cell, stem of the second posterior less than half the length of the cell. Legs as

in the female; fore and mid ungues unequal, the larger uniserrated, the smaller also with a basal tooth, hind equal and simple.

*Length.* 5 mm.

*Habitat.* Middle and Lower Sobat; Sennar, Blue Nile; Jebelein, White Nile; Fashoda; Kenissa; Baro; Pibor. This species is very common on both Niles.

*Observations.* Dr. Balfour adds a note as follows:—"Band on the proboscis narrower and paler than in the female. There are marked white basal abdominal bands. The white scales on the second segment are arranged like the letter V: abdomen has also white lateral spots."

Besides the male, which has not been previously described, several females have been sent me by Dr. Balfour. The anterior thoracic ornamentation is not as pronounced as in the type, but where the pale scaled area joins the dark it is just the same; the abdomen is not so speckled on the posterior segments.

### *Tæniorhynchus tenax* Theobald
var *maculipes*, n. v.

(Plates IV., Fig. 4; VI., Fig. 4)

Very similar to the type, but with the femora and tibiæ of all three pairs of legs with a row of clear white spots on one side.

The banding of the legs passes slightly on to the apices of the preceding segments above, forming apical pale spots. The tibiæ and to some extent the femora have black bristles. The wings (Fig. 4) resemble the type, but there is some variation in the relative lengths of the fork-cells and their stems; in the type of this variety the first submarginal is considerably longer and narrower than the second posterior cell, its stem less than one half the length of the cell, its base nearer the base of the wing than that of the second posterior; stem of the second posterior half the length of the cell; posterior cross-vein about twice its own length distant from the mid. Scales shown in Fig. 4, Plate IV.

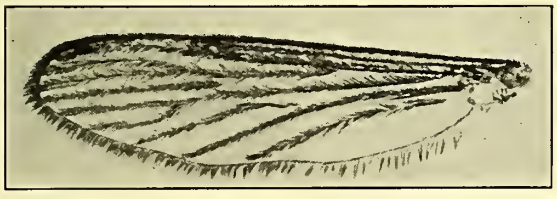


FIG. 4
Wing of *Tæniorhynchus tenax* Theo.
var *maculipes*, n. v.

*Length.* 6.5 mm.

*Habitat.* Kenissa, White Nile and Middle Sobat.

## Genus MIMOMYIA, Theobald.

Mono. Culicid. III., p. 304, 1903.

The female only has so far been described, and in general appearance it resembles a Uranotænia but the larger fork-cells and narrow-curved scutellar scales will at once separate it.

Dr. Balfour sends a male which is described here, I feel sure it is the male of the new species recorded. It is one of the most curious mosquitoes I have seen. The proboscis is much swollen for half its length, the labellæ small, leaf like and acuminate and the palpi long and thin and acuminate, about two-thirds the length of the proboscis. The structure of the palpi would thus place it between the Culicinæ and Aedinæ.

*Mimomyia uniformis*, n. sp.
(Plate I., Figs. 7, 8, & 10)

Head brown with yellowish scales, thorax testaceous with small black scales. Abdomen brown with blackish-brown scales, the apical segments with scattered creamy scales. Legs uniformly brown, venter of femora pale. Wings with a pale spot at their base.

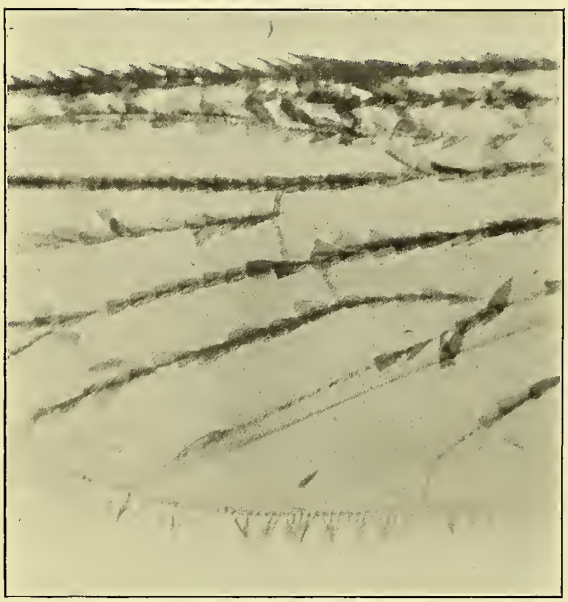


Fig. 5
*Mimomyia uniformis* ♂
Enlarged portion of wing to show scales

*Female.* Head brown, clothed with rather irregular flat creamy scales and some yellow and black upright-forked ones, the latter towards the nape; antennæ brown, basal joint testaceous darker on the inside, remainder deep brown; proboscis brown, swollen apically and the labellæ black; palpi small, testaceous, with black scales above.

Thorax shiny brown with scattered narrow-curved black scales; pleuræ testaceous; scutellum bright brown with black narrow-curved scales, four border-bristles to the mid lobe; metanotum chestnut-brown with brown scales and with basal bands of dull creamy scales, so dull that they are only noticeable in certain lights, apical segments with a few scattered creamy scales; border-bristles dull golden.

Legs uniformly brown, except the venter of the femora, which are pale; in certain lights the legs show ochreous reflections. Wings with brown scales and with a nude shiny white basal patch, lateral scales on the apical portions of the veins and on the major area of the second and on one side of the fourth elongate, clavate, those on the basal parts of the second and fourth longer than the others; median vein-scales short and spatulate a single row only, those on the sixth somewhat longer than the rest; first submarginal cell about the same length and scarcely narrower than the second posterior cell, its base nearer the apex of the wing, its stem longer than the cell; stem of the second posterior about the length of the cell; supernumerary cross-vein slightly nearer the base of the wing than the mid cross-vein; posterior

cross-vein longer than the mid and about its own length distant from it; halteres with grey stem and black scaled knob.

*Length.* 2 mm.

*Male.* Proboscis (Fig. 6) brown, swollen from a little past the middle ventrally, apex truncated, labellæ leaf-like and acuminate, clothed with small brown scales. Palpi very thin and needle-like, about two-thirds the length of the proboscis, swollen at the base and clothed with small brown scales. Antennæ densely plumose, plume-hairs brown.

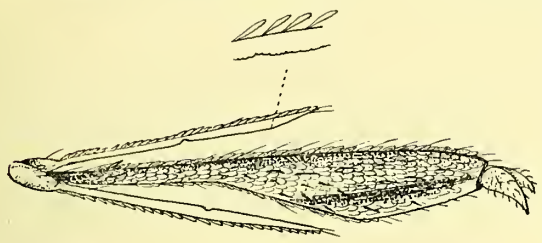


FIG. 6

*Mimomyia uniformis*, n. sp. ♂ proboscis

Legs brown, unbanded; fore and mid ungues simple, unequal; hind, small equal and simple. Wings (Plate I., Fig. 10), with similar scales to the female, but the lateral clavate ones rather shorter and broader (Fig. 5); the upper branch of the first submarginal cell rather close to the first long vein; first submarginal cell scarcely narrower but almost the same length as the second posterior cell, its stem as long as, or longer than, the cell, its base nearer the apex of the wing than that of the second posterior cell, stem of the latter as long as the cell; posterior cross-vein longer than the mid and about its own length distant from it, supernumerary and mid cross-veins united. Upper costal border with black spines.

*Length.* 2 mm.

*Habitat.* Lado (female); Bahr-El-Jebel (male).

*Observations.* Described from a single female and male. I feel almost sure the male belongs here as the general characters are so similar. It can at once be told from the two other African Mimomyias by the general brown hue. The female was partly denuded in transit, but some notes sent by Dr. Balfour complete the description.

### *Mimomyia splendens*, Theobald
Mono. Culicid. III., p. 304 (1903)

Dr. Balfour records this very marked species from the Sudd country, Bahr-El-Jebel; the specimen being captured on the steamer. He has not sent me the specimen, but says apart from the features mentioned below, it entirely agrees with the type having apple-green scales on the thorax, etc.

The following differences are pointed out.—"The halteres of a fine lemon yellow; there is a thick scaling, almost tufting, at the apices of the tibiæ with metallic violet scales and metallic violet scales are scattered over the tibiæ and some on the coxæ." These differences in colour are due probably to Dr. Balfour noting a fresh specimen, whilst mine was some months old. The only important character is the trace of tibial tufting, but if only slight it cannot be taken as a character sufficient to separate the specimen as a new species.

Genus Uranotænia, Arribalzaga.
Dipt. Argentina, p. 63 (1899); Mono. Culicid. II., p. 241 (1901)

*Uranotœnia balfouri,* n. sp.
(Plate VI., Fig. 6)

Head with a broad black median band, pale blue on each side. Thorax brown with pale blue pro-thoracic lobes and a pale blue area in front of the roots of the wings. Abdomen brown, unbanded. Legs brown unbanded. Wings with brown scales, except a short row at the base of the fifth long vein.

*Female.* Head black clothed in the middle with flat black scales forming a broad median area, sides clothed with flat pale blue scales; viewed in certain lights the back of the dark area of the head reflects deep rich blue colours; four prominent curved black bristles in front which project medianally and some short black ones between; antennæ deep brown with paler nodes, basal joint pale reddish-brown; clypeus pale reddish-brown; palpi black; proboscis black, nearly as long as the whole body.

Mesothorax brown with small narrow-curved brown scales, a short blue line on each side before the root of the wings; prothoracic lobes clothed with flat pale blue scales; scutellum brown, testaceous along the edge, lateral lobes with small flat black scales (mid lobe rubbed); four posterior border-bristles to the mid lobe; metanotum deep brown; pleuræ brown, with a small median patch of pale blue scales.

Abdomen deep brown with rich deep brown scales and pale golden border-bristles, on the sides of the last three or four apical segments are traces of basal brown scales; venter pale ochreous with brown border-bristles; legs deep brown, bases testaceous, venter of femora pale; ungues small equal, and simple; wings with brown scales except at the base of the fifth long vein where there is a row of broad flat white scales; costa and first long vein with very dark scales, long lanceolate and prominent lateral vein-scales on the second and third veins and a few on the fork of the fourth; the second long vein lying very close to the first, the upper branch of the small first submarginal cell being particularly closely applied; the stem of the first submarginal cell about two and a half times as long as the cell, that of the first posterior slightly longer; posterior cross-vein twice the length of the mid and about its own length distant from it; mid cross-vein much shorter than the supernumerary; the scales on the fifth (except base) are dark and also on the sixth except at the apex which is nude in the specimen examined; halteres with testaceous stem and black knob.

*Length.* 2 mm.

*Habitat.* Pibor.

*Observations.* Described from a nearly perfect female, the scutellum alone being damaged. Dr. Balfour states that it is "very common on the Pibor, and very annoying in the evening." It is a very small species that may easily get through ordinary mosquito netting.

It is closely related to *Uranotænia cæruleocephala*, Theobald (Mono. Culicid., Vol. II., p. 256), but can be told at once by the head having a broad area in the middle of flat black scales, and by the thoracic markings being blue instead of white.

*Uranotænia cæruleocephala*, Theobald

Mono. Culicid. II., p. 256, (1901), and III., p. 302 (1903)

A single female taken by Dr. Balfour on the Bahr-El-Jebel. It exactly resembles the type but small, lateral, white abdominal patches may be seen. It can at once be told from the former by the head being entirely pale blue. It has also been taken at Old Calabar, Gambia and Uganda.

## A New Genus and New Species.

The very curious male described here cannot be placed in any known genus, but without the female I prefer to leave it un-named.

*Male.* Proboscis black; labellæ paler; palpi brown (Fig. 7), a pale band on the lower side of centre; the apical joint, rather swollen and bent, covered with scales and a few bristles. Antennæ, plumose with a long terminal pilose segment. Head dark and small, eyes deep purplish-black; pale upright scales, not forked, over vertex and occiput; white flat scales on either side of a dark median line of scales, a few black scales on the nape. Thorax denuded, with traces of black and long golden hair-like scales; pleuræ brown with white patches.

Fig. 7
Male palp and labellæ of a new genus?

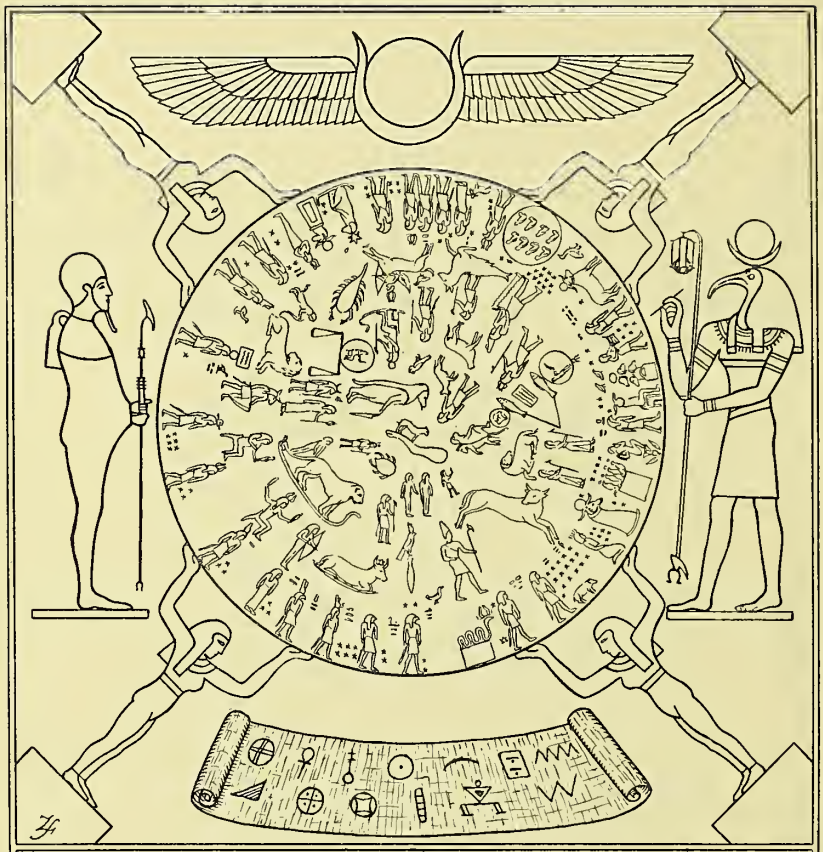
Abdomen purplish-black with basal yellowish white bands to the segments, which expand laterally and spread on to the venter.

Legs with knee spot and long tibial bristles, pale tibio-metatarsal tufts and the three last hind tarsals pale yellow; posterior ungues much smaller than the others, all apparently equal and simple.

*Length.* 4 mm.

*Habitat.* Bahr-El-Jebel, North Sudd Country.

*Observations.*—Described from a single damaged male which I have mounted in balsam. It is most marked owing to the curious form of the palpi which separate it from all other Culicids I have seen, or that have been described. It may be a male of some genus already named; hence, until more specimens are obtained, I leave it unclassified.




DESIGN FOR THE BOOKPLATE OF THE LIBRARY, WELLCOME RESEARCH LABORATORIES, GORDON COLLEGE, KHARTOUM

## KEY TO THE ABOVE DESIGN

In the centre is the famous Zodiac of Denderah depicting the various signs, planets, constellations and decani, together with the genii of the months and days.

Above is the winged disk, symbol of Horbehutet, a solar deity, which was believed to ward off evil and protect the buildings over which it was placed from destruction.

On the right is Thoth, one of the earliest known Egyptian deities associated with medicine. He was believed to be the inventor of all the sciences, letters and arts. He wrote the sacred books and was a great magician. In one hand he holds a stylus or pen, and in the other the notched palm branch.

On the left is Ptah, the most ancient of the gods, who is called the "Father of the mighty fathers," "Father of the beginnings," "He who created the Sun egg and the Moon egg." In his hands he holds a sceptre which terminates in the signs for power, life and stability.

Below is a roll of papyrus, on which are inscribed the ancient Egyptian symbols for the world, life, goodness, the sun, the moon, barley, water, fire, science, medicine, geometry, astronomy and magic.

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