

THE CULICID FAUNA OF THE ADEN HINTERLAND, THEIR HAUNTS AND HABITS.

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(WITH PLATES A, B, C, D, AND A MAP.)

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The following paper is the outcome of a year's study of the Culicidæ of the Aden Hinterland, the notes for which were made when serving with a Native Field Hospital.

One could not help being struck with the large number of men who suffered from a very severe type of malaria, and yet nothing was known about the species of Anopheles that was carrying the malaria parasite. It was this that led me to investigate the matter, studying, more particularly, the Anopheles mosquitoes that are to be found in the District.

As an introduction a short description of the journey from Aden to D'thala, the furthest British Post in the Hinterland, is given, as a very vague idea exists as to where the Hinterland is, judging from the addresses of many letters received there.

The Hinterland can be roughly described as that part of Southern Arabia, outside Aden, under British Protection, stretching from Point Murad, on the Gulf of Aden, inland in a north-easterly direction passing Kataba, the Turkish frontier town, 9 miles from D'thala, to the Great Arabian Desert.

This boundary has already been delimited and is roughly about 300 miles long; from here the boundary, yet to be mapped out, stretches in an easterly direction reaching the coast north-east of Aden.

After leaving Aden, the first halt is made at Sheik Othaman, where there is a rest camp on the further side of the town. Sheik, 9 miles from Aden, has a population of about 7,000. The country house of the Resident is here, situated in a thickly wooded garden.

The road from Sheik to Bir Said Ali, the next post about 12 miles from Sheik, crosses a sandy desert. It is a very tedious and trying march in the hot weather.

There is a Standing Camp at Bir Said Ali and good drinking water can be obtained from the wells close by.

Salim, 11 miles further, the next halting place, is situated about 200 yards from the Wady es Saghir. It is a most undesirable spot, exceedingly hot and sandy, and is infested with camel ticks, mosquitoes and sand flies.

Next morning, trekking almost due north, the Wady Tiban is met at Silula, after leaving it on the left, the villages of Zaida, Shaka, and Al Anad are passed, from which last, Nobat Dakin, the next post, comes into view.

Nobat, 1,100 feet up, is situated on a spur, about $\frac{1}{4}$ mile above the Wady Tiban. It is the head-quarters of the lines of communication, consisting of a large Supply and Transport Depôt with a detachment of Native Infantry under a British Officer.

The next march to El Milleh, 14 miles from Nobat, is up the dry bed of the Sailah Bileh for 7 miles, then the track leaves the bed and passes over the hills to El Mil'eh.

El Milleh, where there is a small blockhouse, is situated on a plain, just above a dry river bed. There is a legend attached to some graves, within a few hundred yards of the camp, that they belong to some sailors who were shipwrecked close by.

El Milleh to Hardeba, is a stage of 12 miles over a good track ; about 8 miles from El Milleh, looking due east, two miles from the path, one sees the Fort of Sulek, the centre of the late Kotaibi Operations.

Hardeba is situated on the Saileh Hardeba, and has a good water-supply from a perennial spring below the Fort. The path onwards to Rhado, the next halt, a nine-mile march, is along a dry bed, which in parts is thickly wooded and rather picturesque for this part of Arabia. It is exceedingly unwise to encamp in the river bed during the rainy season, as mountain torrents swelled by the storms in the mountains above make their appearance without much warning and wash everything before them.

Rhado brings one on the 7th evening to the foot of the D'thala hills and the last march is accomplished by ascending either the Kuraba or the Robart Pass.

D'thala, a plateau 5,000 feet, named after the village, is situated at the foot of the Jehaf Range. The climate is salubrious and compares favourably with Indian stations such as Poona. The weather is bracing from December to March. The rainy season consisting of June, July, and August are delightful months. They are characterized by frequent afternoon thunderstorms, seldom raining continuously but lasting for about two hours. The average rainfall is moderate, amounting to about 20 inches.

After this short introduction, I will take up the detailed description of the various mosquitoes, starting with the Anopheles. The accompanying skeleton map of the Hinterland has the names of the different species marked on it. It is especially intended to show the distribution of the various Anopheles Mosquitoes that are found in the country.

After examining some hundreds of specimens of the five Arabian Anopheles, I came to the conclusion they were distinct species for the following reasons:—

- (1) The adult females differ from the descriptions of all the known Anopheles.
- (2) The eggs and larvæ are distinct from any that have yet been described.

Thanks to the excellent works of Captain James, I.M.S., Dr. J. W. W. Stephens and Lieut. S. R. Christophers, I.M.S., on the eggs and larvæ of most of the Indian Anopheles, one is able to say a species of Anopheles is a distinct one, if a definite difference between the eggs and the larvæ of any two species can be shown to exist.

It will be noted the five Anopheles are named after different parts of the country, thus enabling anyone to locate these species.



MAP OF THE ADEN HINTERLAND,
TO ILLUSTRATE THE DISTRIBUTION OF THE
ANOPHELES,

- A.A ANOPHELES ARABIANENSIS.
- A.D .. DHALI.
- A.T .. TIBANI.
- A.J .. JEHAFI
- A.Z .. AZRIKI

Scale 1" = 8 Miles
Lahej is approx. 44° 52' E.
x 13° 4' N.

ANOPHELES ARABIENSIS n. sp.

Palpi, three white bands, remainder brown, thorax mouldy with silvery hair-like curved scales. Abdomen brown, covered with dark hairs. Legs banded at all joints.

Female.—Head black, occiput and nape covered with brown upright forked scales. Long curved silvery hairs project over the eyes and clypeus. Scattered over the back of the head there are a few narrow curved and spindle-shaped scales.

Palpi (Fig. 1) are not densely scaled and show three white bands including the apices. The lowest band is about a third of the way up the palpus and is intermediate in size. The central band is the smallest and the apical the broadest. Proboscis brown with yellow apex. Clypeus dark-brown, antennæ are dark with silvery hairs, the basal joint being large and globular.

Thorax light brown, anteriorly there are a few dark, forked and spindle-shaped scales. Scattered over the dorsum there are long and short hair-like curved scales. Prothoracic lobes have a few hairs on them.

Abdomen has no scales on either surface, but long brown hairs.

Wing (Fig. 2) is spotted, with costa showing 7 dark spots, four long and three short. Subcostal vein has two dark spots below the fifth and sixth costal spots. The 1st longitudinal has four black spots, the second is divided into two, sometimes three. The 2nd vein has two black spots on main stem, two on upper and three on lower stem of each branch—often one spot is wanting on each. The 3rd vein has two small patches near its origin and one near its termination—this is most constant. The 4th long vein has two long black spots on the main stem and two on each branch. The 5th has one small spot on the main stem, two on the upper and one on the lower branch. The 6th vein has three spots, one near its origin, one in the centre and one at its termination. The wing fringe is dark with white areas at the junction of all the veins and with a white spot between the junction of the 6th vein and the base of the wing. This spot is sometimes absent.

Legs dark brown with yellowish bands at all the joints. The femur and tibia of the hind leg are speckled, the latter often has a well marked band at its lower end, ungues are simple and equal.

Male.—The upright forked scales are better marked, otherwise the cephalic ornamentation is the same as in the female.

Palpi (Fig. 1) are lightly scaled, the lowest band is the same as in the female, though less distinct. The next band is situated at the junction of the club-shaped apical segment with the lower end, then follows a long white band, then a small black patch, which is sometimes wanting, and lastly the apex is white.

The thorax and abdomen are the same as in the female, sometimes a few spindle-shaped scales are seen on the last abdominal segment.

Genitalia.—Basal segment is curved and globular, covered with brown hairs, apical segment is long and narrow terminating in a point.

Wing ornamentation is the same as in the female. The legs are faintly banded at all the joints. Fore unguis are unequal and uniserrated.

Larva.—Head is black, thorax dark, brown in centre, paler at the sides, abdomen is dark brown. The antennæ have no spine on outer side. Frontal hairs simple and unbranched.

Palmate hairs are present on 2-7th segment inclusive; there are undeveloped hairs on the 1st segment. The blade is long and dark, the shoulder serrated and the filament long and pointed.

Egg (Fig. 3) is boat-shaped, with a narrow striated frill extending all round the margin of the upper surface. The float is lateral, extending nearly to each end, but nearer the narrower. It does not encroach on the frill. The ova are as a rule laid in the early morning on the surface of some floating object. They are laid in irregular groups and only display star-shaped and other patterns when disturbed by the wind or current.

Habitat and Observations.—*A. arabiensis* has been found from Sheik Othaman to D'thala. It is the common anopheles of the district and is the chief and, as far as the writer can say, the only certain malaria transmitter in nature. It loves breeding in running water and is found in all the small streams and irrigation channels round about Lahej. It has also been found breeding in wells. In most parts of the country water is obtained from deep wells, 40-50 feet below the surface.

Adult females were found in the tents of the rest camp at Sheik Othaman in February 1904 and in January 1905 larvæ were found breeding in the irrigation channels in the garden of the Resident's bungalow. A careful search was made for larvæ in June to September, but neither adult imagines nor larvæ were found. It is most probable that it comes into season early in November and remains till April or May. This almost exactly corresponds with the fever season at Sheik.

The same can be said about Bir Said Ali, where it breeds in the local wells. Many adult females were caught in the tents in February 1905.

It abounds in all the pools and streams around Lahej and Salim, where there is much cultivation. The tents occupied by the sepoy's at Salim contained large numbers of this mosquito in September, January and February. Nobat has long been famous for its fever and it was found that this anopheles, though present in the Wady Tiban practically all the year round, is most numerous from March to November. It breeds in the wells at El Milleh during the hot weather. It was found in the wells around Sulek and Ulub; it was at the latter place in May 1904 that this anopheles was found for the first time breeding in the well near Ulub. The water was stored in tanks in the camp and all precautions were taken from preventing any larvæ from Hardeba being brought to the camp and placed in the tanks. I personally inspected the tanks immediately after the water was brought. Adult females were caught every morning in a tent nearest to the Ulub well (900 yds.). One morning the sepoy in charge informed me some larvæ were brought in the



FIG. 1 PALPI

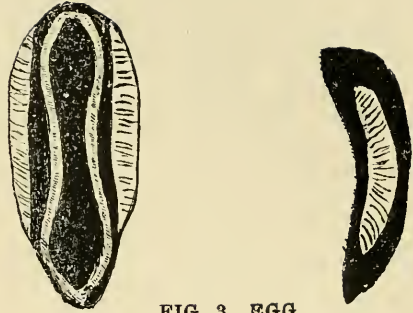
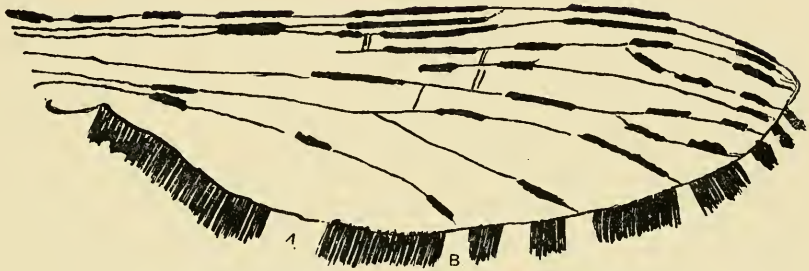


FIG. 2 WING

FIG. 3 EGG



DIAGRAMS OF ANOPHELES ARABIENSIS N. SP.

FIG. 5 WING

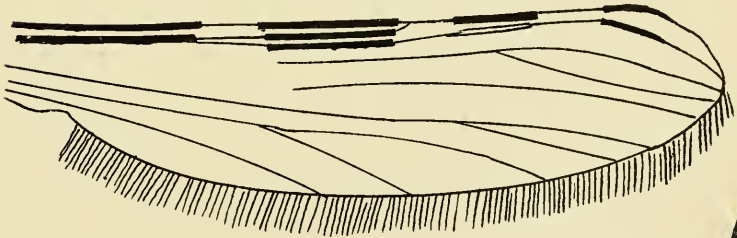
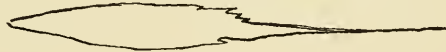


FIG. 6

LEAF OF PALMATE HAIR



DIAGRAMS OF ANOPHELES DTHALI N. SP.

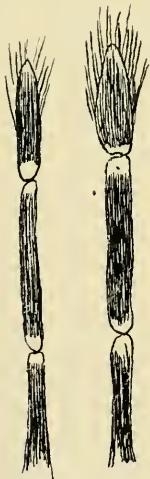


FIG. 4 PALPI

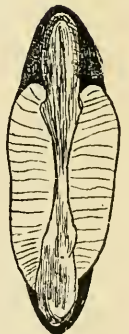


FIG. 7 EGG

water from the well. The Hardeba water was kept quite separate. This then explained the presence of the few females which were caught every morning.

At Hardeba it breeds in the spring water and many pools which collect in the river bed, chiefly from March to November.

It breeds in all the wells around D'thala from May to the end of October. It was also found in two springs near D'thala. Towards the middle of October at D'thala most of the adults bred out of larvæ were very miniature and I feel certain that if these specimens had been sent to the British Museum for identification they would have been labelled differently. They had hardly any palpal markings and the wing fields were quite pale. This seasonal variation was observed in the earlier part of the year when this anopheles begins to come into season.

It was at D'thala that this mosquito was dissected and sporozoits were found.

When on a short visit to *Am Riga* in the Subahai country this anopheles was found breeding with *Culex pipiens* in brackish water.

This anopheles was never found by me in Aden, but Dr. Young of Sheik Othaman informed me that he once observed an anopheles mosquito at Steamer Point, which was most probably, he thought, *arabiensis*. I am certain this mosquito will be found in the wells both at the Crater and Steamer Point and that it has made its way into Aden from Sheik Othaman. When stationed in Aden a short time I undertook to estimate the endemic index and soon found malaria parasites in children who were born in Aden and who had never been out if it.

This anopheles is closely related to *A. rossii* and *A. ludlowi*, but there are some important differences, which will be seen on comparing them. Specimens of this mosquito were sent to Mr. Theobald in May 1904 and they were said to be *A. wellcomei*, Theobald. Since then I have read the description of *A. wellcomei* in the First Report of the Gordon Memorial College and it is obvious to me that they are not the same. I sent some specimens to Dr. Stephens, saying Mr. Theobald thought they were *A. wellcomei*. He compared them with the type in the British Museum and he informed me they were quite distinct.

Curiously enough though Mr. Theobald informed me that this mosquito was, in his opinion, *A. wellcomei*, yet in a note on *A. pharæusis* he says, "it also extends into Arabia, having recently been sent me from the Aden Hinterland." This note is obviously meant for *A. wellcomei* as up to that time (September 1904), when the report first appeared, this was the only anopheles I sent to Mr. Theobald. It is hardly necessary to say not a single specimen of *A. pharæusis* was found by me anywhere in the Hinterland.

ANOPHELES DTHALI n.sp.

Palpi pale with two white bands, thorax light brown covered with curved scales.

Abdomen greenish with darker patches in parts. Legs brown with yellowish bands at the joints.

Female.—Head light brown with many long light brown upright forked scales ; clypeus grey, antennæ light brown with light and dark hairs. Palpi (Fig. 4) lightly scaled with two white bands, one at the junction of the middle with the upper third and the second at the junction of the middle and lower third. The apex is dark.

Thorax yellowish brown covered with pale curved hairs and scales. The sides of the meso-thorax are greenish in some lights ; scutellum is brown with a few curved scales.

Abdomen, greenish with darker patches, is covered with light brown hairs.

Legs are brown with faint yellow bands at all the joints.

Wing (Fig. 5), the costa has four black spots, the basal spot being the longest. The sub-costal has one black spot near its termination.

The 1st long vein has four black spots corresponding to the four on costa. The remainder of the wing field is pale. The wing fringe is dark. There are no pale patches.

Male is much paler than the female, the upright forked scales on head are more prominent. The palpi are exceedingly pale, there are practically no bands ; thorax and abdomen same as in female.

Legs are brown with yellow areas at the joints ; fore unguis unequal and uniserrated.

The wing has the same markings as in the female.

Genitalia.—Basal segment medium sized covered with light brown hairs, apical segment narrow, much curved and terminating in a point.

Larva.—Head brown, thorax dark, body almost black with some light mottling.

Frontal hairs are simple and unbranched. Antennæ have a spine on the outer border about midway.

Cephalic ornamentation same as that of *Anopheles tibani* (below). Palmate hairs extend from 1st to 7th segment inclusive with modified hairs on the thorax. The blade is long with no definite shoulders (Fig. 6) and is serrated more on one side than on the other. The filament is as long as the blade.

Egg (Fig. 7) is boat shaped with a narrow striated frill, it is encroached upon by the floats, which are well marked almost meeting in the middle line.

Habitat and Observations.—This anopheles was first found breeding in a spring near D'thala. It was never found in any of the wells around D'thala. At Hardeba it breeds in the spring from October to April. It was found in the tents at Sulek in January 1905 and was breeding in the well 50 yards below the Camp.

This anopheles was also found at the new camp at Nobat, which is $1\frac{1}{4}$ miles from the river. It was then biting freely and was, I am sure, carrying the malaria parasite, though this was not definitely settled. Specimens of this anopheles were sent to Mr. Theobald, who informed me it was undoubtedly a new species, but related to *Anopheles nili* described in the First Report of



FIG. 12

LEAF OF
PALMATE HAIR

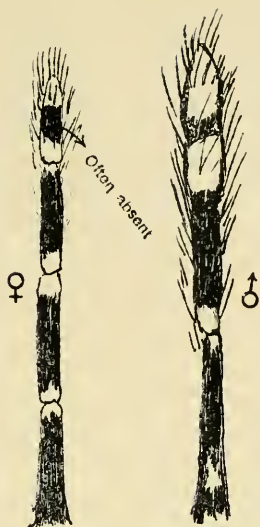


FIG. 8 PALPI



FIG. 10
HIND LEG

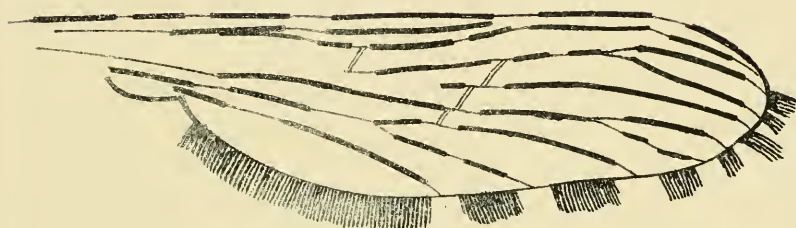


FIG. 9 WING

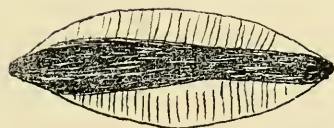


FIG. 13 EGG

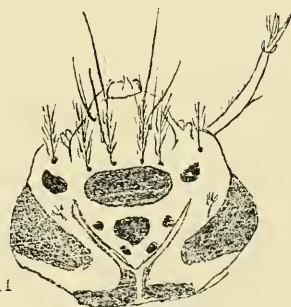


FIG. 11

LARVAL HEAD

the Gordon Memorial College Laboratory. It can be at once distinguished from *A. nili* by the apical segment of the palpus being black, also by the two white palpal bands.

ANOPHELES (Nessorhynchus) TIBANI n. sp.

Palpi three white bands, sometimes four, remainder black. Thorax black with silvery mottling with many light curved scales. Legs banded, hind leg has $2\frac{1}{2}$ - $2\frac{3}{4}$ segments pure white.

Female.—Head black with silvery dots here and there; occiput and nape are covered with black, upright forked scales, scattered about are many white spindle-shaped scales. A tuft of light hairs spread over the clypeus. Palpi (Fig. 8) are black with three white bands including the apex, the bands are arranged as follows:—A narrow white band is situated towards the base, a broader band about the centre and an equally broad band at apex. There is sometimes a narrow black band dividing the apical band into two. Proboscis dark brown and longer than the palpi, clypeus is black. Antennæ dark with light and dark hairs, basal segments are globular and have a few white scales on its inner side.

Thorax.—Prothoracic lobes are black with long light curved hairs, dorsum of thorax is covered with light and dark scales, with many spindle-shaped scales. The dorsum has a general silvery appearance. Scutellum is dark with a row of black bristles and scales. Metanotum is dark, halteres dark with a few minute flat scales.

Abdomen is covered with black hairs, there are a few scales on the last abdominal segment.

Wing (Fig. 9) is much spotted, costa has six dark spots and sub-costal two. The first longitudinal has six spots, the central spot being divided into three. The second vein has two dark spots on main stem, sometimes three and two long ones on each branch. There is sometimes a second spot on lower branch. The third longitudinal has a small basal spot and a long apical one, this latter is occasionally divided into two unequal black spots. The fourth vein has two spots on the main stems with two on the upper and two on the lower branch. The fifth vein has two on the main stem, with two, often three on upper and two on the lower branch. The sixth longitudinal vein has three dark spots. The fringe is dark with light areas opposite the terminations of the veins and their branches.

Legs are black with many white spots; hind leg (Fig. 10) has $2\frac{1}{2}$ - $2\frac{3}{4}$ white tarsi, the first tarsus has its lower third covered with white scales, the remainder is black. The metatarsus has a distinct white band at its lower end, this band is most constant, the remainder is speckled. The tibia is spotted and has a distinct black band at its lower end. The femur is black with many white spots. Mid-leg all the tarsi are black, the joints are white metatarsus, tibia and femur black with many white spots. Fore-leg, the two lowest tarsi are black, the second has a well marked and constant white band, the first also has a pale band at its distal end.

Male.—There are many broad upright forked scales on the head, otherwise the cephalic ornamentation is the same as in the female. Palpi (Fig 8) have three, often four white bands, the basal, the smallest is often very indistinct, the central is longer, and the apical the same as in the female, is often divided into two. These are not complete bands as in the female; antennæ have marked club-shaped ends, which are covered with dark bristles.

Thorax is black with a frosty appearance. The scales are the same as in the female.

Abdomen is black, the last segment alone has a few flat scales on its sides.

Genitalia, medium sized basal segment, apical segment is dark tapering to a fine point.

Wing same as in female, legs also the same, unguis unequal and uniserrated.

Larva.—Head dark brown to black, thorax and abdomen also dark brown. Cephalic ornamentation is shown in Fig. 11. The antennæ have a small spine situated on the outer border; frontal hairs are simple and unbranched. Palmate hairs are present from 2nd to 7th segment inclusive. Blade (Fig. 12) is long with marked serrations on one of the shoulders, the other has generally one notch. The filament is long and pointed.

Egg (Fig. 13) boat-shaped with long narrow floats which extend almost to both ends. They extend up to the frill which is narrow and not marked. The floats do not approach each other in the middle line.

Habitat and Observations.—This anopheles is found in all the rivers and springs in the Hinterland as far up as Jehaf (6,800 ft.). It only breeds in running water and pools connected with it. It was never once found breeding in any of the wells. It is a wild species and does not come to human habitations. Experiments were made at D'thala to see if the malaria parasite (Benign Tertian) would develop in this species, but a negative result was obtained. Mr. Theobald agreed with me that though it is closely related to *A. theobaldi*, it is a distinct species.

The main differences are as follows: $2\frac{1}{2}$ - $2\frac{3}{4}$ hind tarsi are white, while only the last two are white in *A. theobaldi*, the frontal hairs are unbranched and the palmate hairs are only found 2-7th segments, the terminal filament of each blade being long and pointed.

ANOPHELES (MYZOMYIA) JEHAFI n. sp.

Palpi, dark with four bands, thorax brown with many curved hair like scales; abdomen dark brown, legs brown, pale at all the joints.

Female.—Head dark, occiput and nape covered with broad upright forked scales, on each side of vertex, there are a group of silvery upright forked scales and scattered all over, there are many narrow curved scales. There are a tuft of dark bristles spreading over the clypeus on each side. Antennæ dark, clypeus black. Palpi (Fig. 14) are densely scaled with four white bands, basal band narrowest, central the broadest, the other two are small. The apical band is often very small.

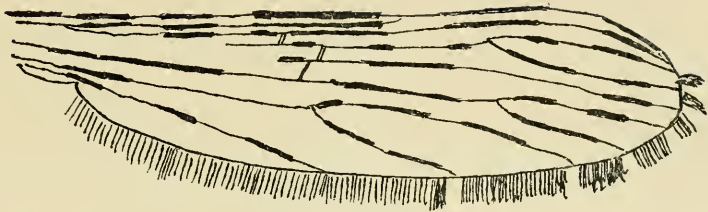


FIG. 15 WING



FIG. 14

PALPI

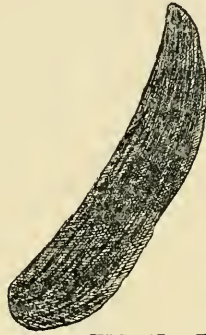


FIG. 17 EGG



FIG. 16

LEAF OF PALMATE HAIR

DIAGRAMS OF ANOPHELES JEHAFI N. SP.

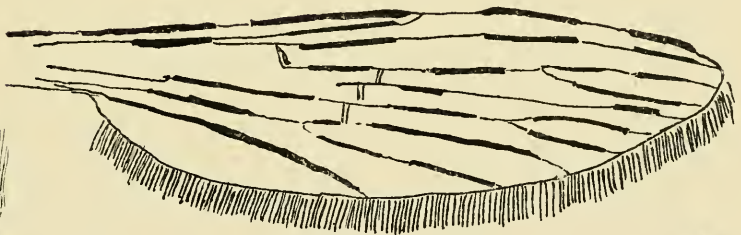


FIG. 19 WING



FIG. 18 PALPI

DIAGRAMS OF ANOPHELES AZRIKI N. SP.



FIG. 20

LEAF OF PALMATE HAIR

Thorax dark brown and when denuded of its scales there are three black lines, one central and two lateral. It is covered with brown curved scales with many bristles. Prothoracic lobes are dark with bristles and narrow curved scales. Scutellum has a row of black bristles on upper surface with a few light curved scales scattered about. Metanotum dark with a black line down the centre.

Abdomen is brown with some light patches, there are no scales but many long dark bristles.

Legs are brown with pale areas at all the joints. Fore-legs, the femur are lightly scaled at upper end, the remaining segments are densely scaled.

Wing.—Costa (Fig. 15) has six black spots and three subcostal. The 1st long vein has five spots, sometimes the small central spot is absent. The 2nd vein has three spots on the main stem, two on the upper and two on the lower branch. The 3rd vein has three, sometimes two spots. The 4th has two long black spots on the stem, two on the upper and one on the lower branch. The 5th vein has one spot on its main stem, three on the upper and two on the lower branch. The 6th vein has three black spots. The wing fringe is dark with pale areas at the termination of all the veins except the 6th.

Male.—The cephalic ornamentation is the same as in the female; antennæ dark and plumose. Palpi (Fig. 14) have four white bands as in the female, the basal band is sometimes absent.

Thorax lighter brown, but has the same scale ornamentation as in the female. Legs are marked the same as in the female.

Abdomen light brown and is covered with light brown hairs. The wing has the same markings as in the female.

Larva is a large one, the head is black and much ornamented. Thorax dark brown, abdomen greenish, fading away to a light brown. Antennæ have no spine on the outer side. Frontal hairs are single and unbranched. Palmate hairs present on the 3rd to 7th segments, inclusive with modified hairs on the 2nd segment. Blade (Fig. 16) long and almost black with light patches at sides, shoulder on both sides has many serrations, the filament is long and pointed.

Egg.—52 mm. in length and 15 mm. There is no distinct upper surface, no floats and no frill (Fig. 17). The only resemblance that it has to an anopheles egg is, that it is boat-shaped. Each egg is covered with a thin pellicle which easily breaks off. These eggs were found in a spring near D'thala where the larvæ of this mosquito were breeding. They were found on some green matter and were all in a little heap. There was no difficulty in hatching out the larvæ, even though many of the eggs sank.

I instructed my Hospital Assistant, who was on duty at Hardeba, when I first found these eggs to try and obtain some eggs of *Taniorhynchus tenax* from the spring. I gave him a careful description of the eggs and he sent up what he thought was an egg raft of *T. tenax*. They, however, turned out to be those of this anopheles, they were packed on moist wool and weeds. Most of the eggs sank on attempting to float them. I was surprised after 2½ days to find that most had hatched out. The larvæ were reared and developed into the

above anopheles. This egg is the most aberrant type of anopheles egg yet described.

Habitat and Observations.—This anopheles was found in two springs near D'thala, also on Jehaf, hence its name. It was caught in the Hospital tents at D'thala and was breeding in the wells. In December and January it was found breeding in the spring at Hardeba. Some specimens were caught in the tents at Sulek in January. This anopheles has not been found anywhere else. It is a large anopheles and is easily recognised from the other Arabian varieties by the four palpal bands.

Some specimens were sent to Mr. Theobald, who suggested it might possibly be *A. cinereus*, Theobald. *A. cinereus* has been placed by Mr. Theobald in his new genus *Pyretophorus* but this anopheles undoubtedly falls in the genus *Myzomyia*. The wing markings will at once separate it from *A. cinereus*. I would like to throw out the suggestion that this mosquito is possibly a malaria transmitter in nature. It was caught in tents and was biting freely. This, however, needs further investigation.

ANOPHELES (MYZOMYIA) AZRIKI n. sp.

Palpi, three bands, apex black; thorax light brown, abdomen brown, legs dark, no bands.

Female.—Head covered with brown upright forked scales, scattered among these are many brown curved scales. A tuft of light hairs is seen extending over the clypeus on both sides; antennæ are dark, clypeus is light. Palpi (Fig. 18) are lightly scaled, with three white bands, apex is black.

Thorax is brown and covered with brown curved scales and hairs, scutellum is dark, with bristles along its border, metanotum is almost black.

Abdomen is brown covered with light hairs, there are no scales on the abdomen. Legs are brown with pale spots at the joints.

Wing.—(Fig. 19) Costa has five black spots and subcostal two. 1st longitudinal has four spots. The 2nd vein has two on its main stem with two on the upper and two on the lower branch. The 3rd has two spots, one near the base the other at the apical end. The 4th vein has two black spots on the main stems, one on the upper and one on the lower branch. The 5th vein has one black spot on the stem, one short and one long on the upper and two long spots on the lower branch. The 6th vein has one long spot extending almost up to the fringe.

The fringe is dark with no light areas opposite the terminations of the oculus.

Male.—It is much lighter than the female. The palpi often have four pale areas, the apex often being pale. The wing is much lighter than the female, many of the spots are wanting. The legs are brown, fore ungues unequal and uniserrated.

Larva.—A light green larva with amber coloured head. Frontal hairs are simple and unbranched.

Palmate hairs are present on 4th to 6th abdominal segments. Each blade is broad and stumpy (Fig. 20) with serrated shoulders and the filament is a mere spike; the antennæ have a small spine on the outer side.

The feeding brushes are placed laterally. This larva is exceedingly characteristic. It suspends itself in the water like a culex larva. From the head up to the 2nd segment are submerged.

The egg was not found.

Habitat and Observations.—This species was only found in one spring, the Aziriki spring, near D'thala, where it was breeding in the pools with *Anopheles tibani*. It is a wild species. Mr. Theobald agreed with me that it was closely related to *A. turklandi* Liston. The main differences are as follows:—The costa has five white scaled portions, the 3rd long vein has black spots and the wing fringe has no light areas, but is dark throughout. There is no long branched hair at the end of the antennæ which is well marked in the larva of *A. turklandi*.

I came across this species quite by accident, when studying *A. tibani* a large number of larvæ were collected and examined, this larva was found among them. It is difficult to find if scarce, as it lies up, among green weeds, etc., and seems to have the capacity of remaining a longer time below the surface than the larvæ of the other four species. It is easily frightened. Many attempts were made to procure its eggs, but all failed.

CULEX ARABIENSIS n. sp.

Thorax straw coloured with brown curved scales, with a dark line down the centre and two at the sides. Abdomen brown with apical black bands. Tarsi banded at all the joints, fore ungues unequal and unserrated.

Female.—Head brown covered with brown upright forked scales, some darker than others, with many narrow brown curved scales; along the eyes there are black bristles projecting forward and two marked tufts spreading over the clypeus. Antennæ pale in centre and darker at all joints. Palpi dark brown with a small apical white spot, proboscis and clypeus are both dark brown.

Thorax, prothoracic lobes simple with a few dark bristles. Dorsum of thorax is straw coloured, covered with brown curved scales. There are black bristles at the sides; scutellum is dark with a few narrow curved scales on each lobe.

There are from 7 to 9 bristles on the mid-lobe and four on each lateral lobe; metanotum is brown.

Abdomen apical black bands consisting of brown broad tile-like scales. Each segment has a large number of brown bristles at the sides and on the dorsum. There are cream coloured tile-like scales on the central surface.

Legs coxæ brown, femora brown but not densely scaled, pale at the tibio-femoral joint. Tibiæ brown with well marked pale band at the tibio-metatarsal joint. Metatarsi densely scaled with a band at both ends. Tarsi are densely scaled with pale bands at all the joints. Fore ungues unequal and unserrated.

Wing.—Veins have brown scales. Costal, sub-costal and 1st longitudinal are darker than the remainder. 1st sub-marginal cell is nearly twice as long as the 2nd posterior cell.

Male.—Head dark brown with many almost black upright forked scales. The upright forked scales cease at the vertex and are replaced by brown curved scales. Antennæ dark and light with many dark, long plumes, proboscis is dark brown. Palpi (Fig. 21) are brown with a pale band about the centre of the 2nd joint; there is also a pale area at the basal joint. The hair tufts are brown.

Thorax.—Scale ornamentation is the same as in the female, scutellum is brown with a variable number of bristles.

Abdomen is banded the same as in the female. Male genitalia, basal lobes narrow (Fig. 22), covered with dark hairs, apical segment thin and somewhat club shaped. The wings are paler than those of the female, the legs have the same scale ornamentation.

Larva.—Head globular, with a few branched hairs on dorsum. The antennæ are short with a tuft of hairs on the inner side. The larva is like that of *C. fatigans* Wiedemann. The syphon tube is somewhat narrower.

The eggs and egg-raft are the same as those of *C. fatigans*.

Habitat.—This banded culex was first found in a tank on the plain near Ulub Camp in May 1904. It was breeding in the rain water, that had collected in this tank, with *Stegomyia sugens*. This species was also found in the Crater, Aden. Specimens were sent to Mr. Theobald, who informed me it was a new species of culex.

STEGOMYIA SUGENS Wiedemann (1828).

Auss. Tweiflug. Mxc. p. 545 (1828) Wied. Ann. Soc. Ent. d Fr. S. 4. t. 1 (1863). Rigot (billatus), Bull. Soc. Ent. Ital. p. 257 (1886). Ficalbi (billatus), Mono. Culicid. 1. 300, Theobald (1901).

This mosquito varies a little from the descriptions of the type. After examining some hundreds of specimens it was found that there were always three large white spots on the thorax with a few smaller ones between. Scutellum has three white spots on each lobe.

Male Genitalia (Fig. 23) are exceedingly characteristic and as far as I know have not been described. The basal segment is long and covered with dark hairs, on its inner surface there is a knob-like projection covered with minute hairs.

The apical segment is thin and terminates in a flattened boss. From its outer and upper end there projects a long curved hair-like process, which has a blunt termination.

Larva.—Head (Fig. 24) small and black with long curved antennæ. The syphon tube is short.

Egg (Fig. 25) is the same as that of *S. fasciata* described by Daniels.

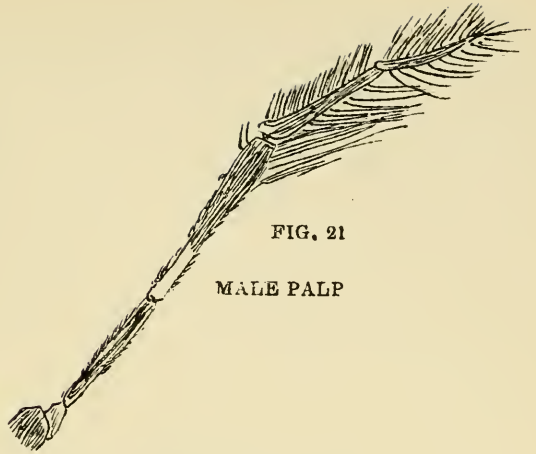
Habitat and Observations.—This mosquito was first found in the tank near Ulub where it was breeding with *C. fatigans*. It was found breeding on the barrels of water at Nobat. Strange to say it has never been found further up than Ulub. In Sheik Othaman and Aden it is the common mosquito and is a great pest. It breeds in the wells, and wherever water is stored in barrels,

FIG. 22



MALE CLASPER

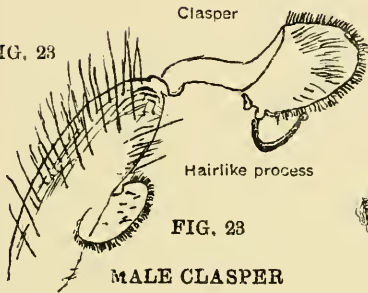
FIG. 21



MALE PALP

DIAGRAMS OF CULEX ARABIENSIS N. SP.

FIG. 23



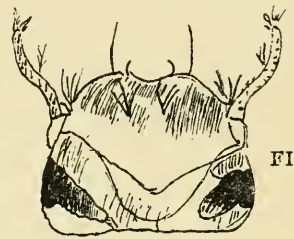
MALE CLASPER

FIG 25



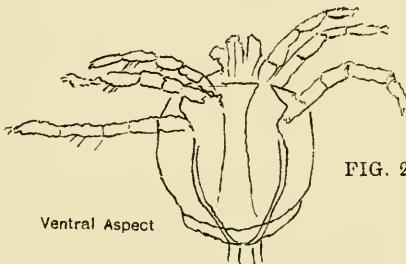
EGG

FIG. 24



HEAD OF LARVA

DIAGRAMS OF STEGOMYIA SUGENS WIEDEMANN



Ventral Aspect

FIG. 26.



5 Joints

Dorsal Aspect

CULICID ACARID

buckets, etc. An attempt was made to try and exterminate this pest in Aden, and what was at first thought to be a simple matter turned out to be most difficult. The eggs are capable of hatching after sinking and it was thus not easy to be sure when emptying a barrel of removing all the eggs. The only sure method was constantly oiling the water, which destroyed the larvæ when they hatched. The bite of this mosquito is most irritating, a large lump being raised in a short time where the mosquito inserted its proboscis. The male of this species does not bite like that of *S. fuscata*. It invariably accompanies the female and will alight on one's body but never bite. It is troublesome in the early morning and at mid-day.

The larvæ are exceedingly active and are able to remain a long time below the surface. It was never found breeding in running water.

TENIORHYNCHUS TENAX Theobald.

Banded Arabian variety.

MACULIPES ARABIENSIS. Mono Culicid II, 198 (1901), and III, 258 (1903); First Report Wellcome Research Laboratories, Gordon Wellcome College, p. 78 (1904).

This species is closely related to the type except that the abdomen is very distinctly banded and all the femora have pale basal band. The joints are all banded. The male palpi have four white bands. In all other respects it corresponds with the type.

Larva.—This larva is exceedingly characteristic, it is green and has a long thin syphon tube. It is always found in pools where there is much spirogyra. It rests below the surface among the green strands and is thus most difficult to find. It can remain a long time below the surface only very occasionally coming up for air.

Habitat and Observations.—It was found in the springs at D'thala, and at Hardeba and in the river at Nobat. It is curious that the male of the type was only recently described in the Report of the Gordon College Laboratories. Mr. Theobald agreed with me it was a banded variety of *Teniorhynchus tenax*, Theobald.

CULEX PIPIENS Linneus.

For Suca (1758) Linneus; Mono Culicid II, 132 (1901) and III, 224 (1913), Theobald; First Report Wellcome Research Laboratories, Gordon Memorial College, p. 76 (1904).

This mosquito was in all the springs and wells about D'thala, also up at Jehaf. It was found at the highest point 7,000 odd feet breeding in pools of rain water that collected in holes in rocks. It is abundant at Hardeba and Nobat.

CULEX FATIGANS Wiedemann.

Auss. Liver. Insect p. 10 (1828) Wied., Mono Culicid II, p. 151 (1901), Theobald, and III, p. 225 (1903).

This is the most common mosquito in the district and is practically found everywhere, breeding in springs, wells and puddles. It was found on Jehaf.

CULEX CONCOLOR Robineau Desboidy.

Memo, d. l. Soc. d'Hist. Nat. de Paris, IV. 403.

Mono, Culicid II., p. 107, 1901; III., p. 230, 1923.

This mosquito is the same as *Culex tigripes* Grandpool, (1900). *Tigripes* is a spotted legged variety of *C. concolor*.

It was found only once breeding in an old tank at D'thala containing rain water. It was feeding on *C. fatigans*.

This completes the detailed notes on all the species of Culicidæ found by me in the district. It only remains for me to mention a Culicid acarid which I found parasitic on two species of Anopheles, (*Anopheles jehafi*). Mr. Theobald mentions it occurring on the Egyptian Anopheles. He says "Many of the specimens showed the presence of a parasitic tick attached to them. When alive the parasite resembles a minute preserved cherry. As a rule this parasite is attached to the undersurface of the thorax and abdomen, but it was once found on the wing of an Anopheles." This acarid was also found on *A. arabiensis*. This tiny insect (Fig. 26) measures 25 millimeters and is of a lemon yellow colour. It has six legs and the claws are unequal and uniserrated. I was at first puzzled as to how it attached itself to its host. It struck me it might possibly be on the larvæ and after some hundreds were examined I found one attached to a larvæ just on the outer side of the 1st abdominal segment. I later found two attached to pupa. The specimen on the larva transferred itself from the pupa to the adult mosquito when it hatched out. It was most frequently found on the under surface of the adults close to the head, but I have seen it on the dorsum. On the pupa it fixes itself in the concavity between the abdomen and thorax. I kept many for days in water, but never observed any further development.

I would like to say a few words on the maximum flight of the Arabian Anopheles and also on malaria prophylaxis which may be useful to others.

Since starting the study of the mosquitoes I was constantly making observation on the maximum flight of anopheles. At Nobat in May, 1904, I lived in a Staff Sergeant's tent on the ridge, the river was directly below about 450 yards. The wind at night was always fairly strong and from the S.E. Every morning I was able to capture from 6 to 10 female anopheles, (*A. arabiensis*) in my tent and in the tents on the further side about 800 yards from the river, I caught from 50 to 60 every morning. At that time there were many cases of malaria in hospital. The camp at Nobat has now been moved $1\frac{1}{4}$ miles from the river, there is no water of any description lying between the camp and the river and yet in January 1905 I caught a large number of *A. dhali*. This anopheles was undoubtedly flying this distance to obtain its food, though there was a large Arab village close by. The only explanation I can offer is that as the Arab tents and houses were constantly full of smoke, the mosquito preferred to travel further, where they would not be put to this inconvenience. I need hardly say that though some water was obtained from the river, every precaution was taken to prevent larvæ from being

brought into the camp and I could not find a single specimen in any of the barrels. The drinking water was obtained from a pool about 2 miles to the north of the camp. This pool was connected with a spring which here came to the surface when the sand was removed. There were no larvæ here of any description. When at Ulub in May I found *A. arabiensis* always in two or three E. P. tents facing the Ulub well, which was 900 yards away. About 100 yards above the well were two Arab huts, yet this mosquito preferred to come to the tents. I am certain it was the smoke in the tents that kept them away. The Arabs are in the habit of driving the mosquitoes away by a smoking fire.

Now with regard to malaria prophylaxis in the Hinterland. Though I stayed in many of the places where I knew malaria was being contracted, viz. Nobat, Old and New Camps, Ulub and Sheik Othaman, I never contracted malaria, because I used my mosquito curtain with extreme care, invariably fixing it up early and never going to bed without seeing that there were no mosquitoes inside. I only once took three grains of quinine and can only recollect finding *A. arabiensis* four times in my curtains in the morning. I would recommend any one going to the Hinterland to provide himself with a good mosquito curtain fitted on to a camp bed and to use this curtain from Sheik Othaman onwards. He should also observe the following points:—

- (1) See that there are no holes.
- (2) Have the curtain put up early and be most particular to have all mosquitoes driven out that may have settled on the inside when the curtains were turned up.
- (3) To see that there is no entrance left after he has got into bed.
- (4) To have a piece of cloth 'let in' (about 8 inches broad), where his arms or legs are likely to touch the curtains when asleep. This is so often forgotten. Camp beds are often cramped for various reasons. It is a good plan to have the rods fixed to the legs and diverging so that the curtain falls away from the bed and allows more space.
- (5) Wear putties when sitting out at night. I have seen anopheles (*A. dthali*) at Nobat come into the mess tent at dinner time and fly round the lamp.
- (6) Not to hang up dark clothes, as mosquitoes prefer dark objects to rest on.
- (7) Keep all trunks and boxes closed as they are often means of conveying mosquitoes from one place to another.

Some one will say, this is so troublesome; but I think it is worth the trouble. Officers often leave their servants to fix up their curtains and I am sorry to say they are then not of much use. A native does not understand why the sahib takes all the trouble, so it is left till late and by that time mosquitoes are already on the wing and easily enter the net and so escape notice.

In conclusion, I wish to record here my grateful thanks to Mr. Fred. V. Theobald, of the British Museum, for his kind help.

I trust this paper will be of some use to those serving in the Aden Hinterland and that some will be able to fill up the many gaps.