

THE ANOPHELINE MOSQUITOES OF AUSTRALASIA.

By I. M. Mackerras.

These notes are a revised edition of those issued previously, corrected up to April, 1943. Only those species which have been recorded from Australia, New Guinea, and the islands to the eastward will be noted. The more extensive fauna of the Netherlands East Indies has been well treated by Swellengrebel and Rodenwaldt (1932), and will not be mentioned in these notes, which are designed merely to enable the worker in the field to make preliminary identifications.

Genus BIRONELLA.

Small, obscure brown species, some of which have remarkably short palpi in the female. Adult: stem of vein M_{1+2} and Cu_1 sinuous. Larva: both meso- and meta-thoracic palmate hairs present. The genus is only known from New Guinea, where 7 species have been recorded. * All appear to be rare, and none has any known relationship to malaria.

<u>Bironella</u> (<u>Bironella</u>)	<u>gracilis</u>	Theo. (= <u>bironelli</u> Chris.)
"	"	<u>de rooki</u> S. & S.
"	"	<u>papuae</u> Sw.
"	"	<u>papuae</u> var <u>brugi</u> S. & S.
"	"	<u>socsiloi</u> Str. & Ch.
"	(<u>Brugella</u>)	<u>travestitus</u> Brug
"	"	<u>walchi</u> Soes.
"	"	<u>hollandi</u> Tayl.

Genus ANOPHELES.

More typical Anophelines, with long palpi in the females. Adult: stem of vein M_{1+2} and Cu_1 straight. Larva: with only meta-thoracic palmate hairs or none on thorax. Two distinct sub-genera are recognized.

Subgenus ANOPHELES

Adult: Brown or blackish species; costa with at most one or two small pale spots; wing veins not conspicuously marked with white; legs with few or no white rings or spots.

Larva: inner anterior clypeal hairs close together, much closer to each other than to the outer anterior clypeals.

An. (An.) stigmaticus Sk.

A small, brown, obscure species, which has a resting attitude like a Culex. Wings, legs, and palpi entirely concolorous, except that the wing membrane frequently has a brown patch covering the forking of R & R_s , and the basal four-fifths of the anterior surface of the hind femora is pale yellow. Larva: head concolorous; inner and outer anterior clypeal hairs single, slender; posterior clypeals bifid; antennal plume a little proximal to the middle, small, and finely branched.

An. stigmaticus has been taken, but rather uncommonly, from National Park, S. of Sydney, in N.S.W. to Burpengary in S. Queensland, and has recently been found by Atherton at Cairns and Youngaburra, N. Queensland. It is not known to bite man, and has no relation to malaria.

* An unidentified species of the subgenus Bironella has recently been found at Cairns (Simmonds).

An. (An.) aitkeni James.

Very similar to An. stigmaticus, from which the adults may be distinguished by the absence of a dark patch on the wing membrane, or of a pale area on the outer surface of the hind femora. The larvae are extremely variable, and a number of varieties and races have been described on larval character. The var. insulae-florum Sw. has been recorded from Dutch New Guinea, and a race rather similar to it has recently been found at Darwin, Adelaide R., and Pine Ck., N.T., (Powell) and Cape York (Mackerras). It is to be distinguished from An. stigmaticus by the extremely stout outer anterior clypeal hairs, by the position of the antennal plume very close to the base of the antenna, and, at any rate in the Darwin specimens, by the bifurcate inner anterior clypeal hairs, which cross over one another in a very curious manner.

It attacks man, but has no known relationship to malaria.

An. (An.) atratipes Sk.

A medium-sized, blackish species, with dark scale-patches on wings, fringe at wing-tip white, moderately slender proboscis and palpi, and no white rings on tarsi. The larva differs from that of An. stigmaticus in its larger size, darker colour, and much larger, bushy, antennal plume, and the apparent absence of palmate hairs.

This species bites vigorously, and stands vertically like An. bancrofti; but it is too uncommon, and its distribution is too scattered, for it to have any practical relationship to malaria. It is on the wing in spring from Sydney, N.S.W., to Stradbroke Is., S. Queensland, and has recently been taken at Cairns, N.Q. (Atherton) and Perth, W.A. (Ratcliffe).

An. (An.) bancrofti Giles.

This species is regarded by Swellengrebel and Rodenwaldt as a subspecies of An. barbirostris Wulp, but it is convenient here to treat it as distinct, although the differences are slight. It is a large, black, species, with black and white scale markings on the wings (the black predominating), a small white spot beyond the middle of the costa, white patches on the wing-fringe at the apices of the medial and cubital veins; small patches of white scales on the ventral surface of the abdomen; thick bushy palpi with conspicuously outstanding scales; legs with narrow white rings at the tarsal joints, and femora with some scattered pale scales anteriorly. The larva is robust, dark, without pigment pattern on head; it is distinguished by the very dark, heavily branched outer anterior clypeal hairs, which can easily be seen with a hand lens, by the strongly branched antennal plume, and by the dark, very conspicuous palmate hairs.

An. bancrofti is widespread in coastal Queensland, from Brisbane northward; throughout the N.T., at least as far inland as the 30 in. rainfall line, being especially abundant near the coast; and widely distributed in New Guinea. It bites in the shade by day, as well as at night, but is especially active about dusk. Its biting habits, however, seem to vary with locality; for it is quite the most vicious biter and worst pest species in parts of the N.T. (e.g. the Mary R. swamps), whereas at Cairns it will scarcely attack man at all. An investigation into the possible occurrence of varietal forms similar to those of the European An. maculipennis is being undertaken.

The larvae are found in fresh water in shaded situations, generally in clear water, though sometimes in muddy pools, and especially in sedgy swamps and those heavily overgrown with vegetation. They were very numerous in the extensive freshwater swamps at Cairns, although the adults were difficult to find (Roberts). Generally, they would be difficult to control, for the simplest method of treatment, namely clearing the breeding grounds of shade, would only make conditions favourable for An. punctulatus var. moluccensis, a far more dangerous species.

The relationship of An. bancrofti to malaria is obscure. Parasites will develop very readily in it under experimental conditions (Heydon), and de Rook, at Tanah Meroh in Dutch New Guinea, found a natural infection rate of 4.3% though he did not consider it as important as An. punctulatus var. moluccensis, which showed an infection rate of 12.7% at the same time. On the other hand, its distribution in the N.T. does not really agree very well with that of malaria, while it was certainly not implicated in the Cairns outbreak. On the whole, it seems likely to be important only in a relatively few localities where it is particularly abundant and vicious. The study of races may clear away these obscurities.

An (An.) barbirostris v.d. Wulp.

To be separated from An. bancrofti only by the entirely dark-scaled femora, and the absence of white patches on the wing fringe opposite the ends of veins M_1 , M_2 , and Cu_{1A} . Widespread in the N.E.I., but known in our area only from a few localities in Dutch New Guinea. It seems to be of negligible importance as a malaria carrier, Swellengrebel and Rodenwaldt recording an infection rate of 0.18% in 1340 specimens dissected by various workers in the island.

Subgenus MYZOMYIA.

Adult: wings with conspicuous black and white spots along the costa, wing veins with many white spots; palpi ringed with white; legs with at least some white rings or spots.

Larva: Inner anterior clypeal hairs widely separated, nearer to the outer anterior clypeals than to each other.

Many species of this subgenus are closely related, and difficult to distinguish, except by careful examination of apparently minor characters. They are treated here not in order of importance nor of relationship, but of convenience in identification; and varieties are recognized which may well have no zoological validity, but which must be considered until we know more about their relative importance as vectors of malaria.

An (Myz.) Melanotarsis (W. & L. MS.).

A remarkable Anopheline, so far known only from a single female bred by Capt. Simmonds from mixed larvae collected at Charters Towers. The palpi have only a narrow white ring in the distal half of the third segment and a pale tip to the second segment; proboscis almost uniformly dark; abdomen with only a few scales posteriorly; legs with a row of white spots on femora and tibiae, but no pale rings on tarsi.

An (Myz.) subpictus Grassi.

The only Myzomyia in this part of the region, which has legs with white rings only on the tarsal joints and none on the shaft of the segments (all others have pale rings or spots at least on the femora and tibiae). Palpi with the fifth (apical) segment all white, making with the white apical part of the fourth segment a broad white end to the palp; bases of fourth and third segments also narrowly white. Larva similar to that of An. amictus, but separated by the

very distinctive abdominal palmate hairs.

An. subpictus usually breeds in salt to brackish water, and is widespread in coastal districts of the N.E.I., where it is of some local importance as a malaria carrier, although the natural infection rate is usually low (0.46%, Swellengrebel and Rodenwaldt.). Hill (1925) recorded it from the Moresby and Mekeo districts of New Guinea, breeding in beached native canoes; he suspected it of causing an attack of B.T. from which he suffered. It also occurs at Milne Bay (Allman) and Buna (Rees).

An. (Myz.) longirostris Brug.

Immediately distinguished by the long proboscis, which is markedly (about one-fourth) longer than the normal palpi, and is brown on its apical half or more, black basally. The palpi are rather similar to those of An. annulipes, but the white bands are yellow towards the base. The larvae are apparently very similar to those of An. punctulatus, of which Swellengrebel and Rodenwaldt record longirostris as a subspecies.

An. longirostris is known from the Moluccas and Dutch New Guinea; Taylor (1934) records it from New Ireland; while Roberts and Allman have recently found it at Milne Bay, where it was for a little while sufficiently abundant to come under suspicion as a possible transmitter of malaria. Nothing, however, is known of its actual capacity as a vector.

An. (Myz.) amictus Edw.

The distinctive feature of this species is the presence of numerous conspicuous yellowish scales on the abdominal tergites. (An. punctulatus var. moluccensis and An. annulipes may have some scales on the last two or three segments, and rarely in the latter they may be more numerous and extend onto the basal segments; but in both these species they are narrower, more creamy in colour, and much less conspicuous than in An. amictus). Shaft of the proboscis entirely black; palpi with apical white rings on the 5th, 4th, and 3rd. segments; antennae with white scales on the first eight flagellar segments; abdominal sternites with irregularly scattered pale scales. Larva with inner and outer anterior clypeal hairs single; posterior clypeals single or bifurcate, almost as long as the inner anterior hairs and projecting well beyond the anterior margin of the head. Occipital hairs relatively long, inner single, outer three-branched.

Two varieties of the species are recognised:-

var. typicus Edw. - Tarsi with narrow white rings at the apices of the segments only; white rings on palpi generally narrow; middle dark patch on costa (opposite R₅) subdivided into two by a small median white spot; larva usually with the posterior clypeals closer together than the inner anterior, i.e. projecting between the two inner anterior hairs. The larvae are found in clear, fresh, running water, associated with Spirogyra and other green algae. This variety is known from Queensland (Eidsvold, Townsville, Ingham, Mareeba, and near Burketown) and the N.T. (Adelaide R. to Larrimah).

var. hilli (W. & L.ms) - Generally known as the "Var. C" of Hill, this form warrants a definite varietal name. Tarsi with broader white rings, covering both the apices and bases of adjacent segments; palpi with broad white rings, like An. annulipes; middle dark spot on costa broad and continuous; larva usually with the posterior clypeals wider apart than the inner anterior, i.e. projecting between the inner and outer anterior hairs

on each side. This variety usually breeds in open sunlit brackish pools in coastal districts. It is widely distributed in coastal Queensland from Brisbane to Cairns, at Normanton and Lawn Hill in the Gulf of Carpentaria, from Darwin to Larrimah in the N.T., and in Dutch New Guinea. (Swellengröbel and Rodonwaldt record as the larva a form with plumose anterior clypeal hairs; it may be a distinct species.)

The only known relationship of An. amictus to malaria is the discovery of one infected individual of var. hilli out of 79 collected in houses toward the end of the Cairns epidemic (Roberts).

An. (Myz.) meraukensis Vonn.

Resembles An. amictus closely, particularly in having the dorsum of the abdomen clothed with yellow scales; but distinguished by the flagellar segments of the antennae having white scales easily detected on the first segment only; abdominal sternites with the pale scales in a series of definite rounded patches towards the lateral margins, with very few in the centre; tarsal marking like var. typicus, but wing like var. hilli. The larva is generally similar to An. punctulatus, but has dark, strongly branched, very conspicuous outer anterior clypeal hairs, almost like those of An. bancrofti. Dutch New Guinea: Morauke. Northern Territory: Darwin to Larrimah (Woodhill).

An. (Myz.) annulipes Walk.

The most widespread and best known Anopheline on the mainland of Australia. The adults are to be recognised by the following characters; palpi with 5th. (apical), 4th, and 3rd segments broadly white (the white usually covering the distal three-fourths or more of the 5th and 4th segments, and the distal half of the 3rd.), basal portion of palpi with some variable white markings; abdominal tergites with few or no scales (Note: if many scales are present, the proboscis is always pale distally, an easy distinction from An. amictus). Larva with inner anterior clypeal hairs single, outer anterior clypeals distinctly plumose or branched, posterior clypeals of moderate size, but not projecting beyond head, four or five-branched; occipitals also fairly conspicuous, inner three-branched, outer six or seven branched.

An. annulipes is variable, both in adult and larval characters. The almost universal adult form has the apical half of the proboscis creamy or yellowish, which immediately separates it from all its allies except An. punctulatus var. typicus. In southern N.S.W. and Victoria, a few specimens have an entirely dark proboscis, but these should cause no confusion, as they are not known to occur anywhere near the limits of the northern complex of species.* All stages linking the two forms may be found in single series of southern specimens taken in the same locality at the same time.

The two larval forms differ in the outer anterior clypeals, one having these hairs plumose and the other branched. The form with plumose outer anterior clypeals may be difficult to distinguish from An. punctulatus var. moluccensis, though the plumosity is rarely as marked in that species as it is in An. annulipes. The form with branched outer anterior clypeals will not be confused with An. meraukensis, as the hairs are paler and the branching more delicate and antler-like. Both forms apparently give rise to adults

* In the earlier notes, these two forms were tentatively recognised as var. mastersi Sk. and var. typicus respectively.

of the common ("mastersi") type.

The range of An. annulipes is from Tasmania to Darwin, from Sydney to Perth, and New Guinea (Moresby district). On the mainland, it is found from the coast up to an elevation of 5000 feet, and inland at least as far as the 15 in. rainfall line; in some areas it is distinctly abundant, especially in the north. It bites chiefly at dusk and during the night, but also freely in shady situations during the day. It breeds in a considerable variety of situations; generally in clear sunlit pools containing green algae or other aquatic vegetation; often in the backwaters, at the edges of running streams; in rock pools; at the margins of muddy waterholes; and sometimes in brackish or strongly saline water; it has recently been collected among the gravel at the edges of swiftly running streams (Johnston), a habitat which is reminiscent of the Palestinian An. superpictus.

Roberts has shown that An. annulipes is, under experimental conditions, as hospitable to P. falciparum and P. vivax as is An. punctulatus var. moluccensis. Nevertheless, although it is the only species which could have transmitted the occasional locally acquired infections that have occurred in N.S.W., it has never been found infected in nature, and it appears to be a decidedly poor natural vector over the greater part of its range.

An. (Myz.) punctulatus Don.

Very closely related to An. annulipes, from which it is only to be distinguished by the following; adult - either the shaft of the proboscis is entirely dark, or the white apical portion of the third (antepenultimate) segment of the palpi is divided into two by dark ring, or at least extensively interrupted by dark scales (no useful distinctions have been found in other characters, including the male genitalia); larva - outer anterior clypeal hairs single or at most finely plumose, posterior clypeals normally very short, usually single or bifid; occipital hairs much shorter than in An. annulipes, inner single or bifid, outer 3-5 branched.

Three varieties are recognised:-

var. moluccensis Sw. - Shaft of proboscis entirely dark; larva with thoracic pleural hairs as in Fig. 13, antennae entirely pigmented. This is the common and widespread variety, occurring throughout the coastal districts of New Guinea and all the associated islands, as far east as the New Hebrides; and on the mainland of Australia in North Queensland - Ingham, Cardwell, Tully, Innisfail, Kuranda, Mareeba (Roberts), Burdakin R. (Camel Ck. Stn., Maxwell), Cairns (Woodhill), Mossman (Simmonds), Leckhart R. (Taylor), Cape York (Mackerras); and in the N.T. - Darwin to Adelaide R. (Powell, Woodhill), Katherine (Hill). It has not yet been found at Townsville, nor above 2,000 ft. on the Atherton Tableland. The adults bite almost exclusively at night, and readily enter houses. This variety is the dominant malaria transmitter of the region, having been proved to be an effective vector at Rabaul (Heydon), Dutch New Guinea (de Rook et al.), and Cairns (Heydon). Infection rates found have varied up to the 12.7% recorded by de Rook at Tanah Merah..

var. typicus Don. - The apical half of the proboscis is pale-scaled, otherwise similar to the above. Larva with pleural hairs as above, but antennae pigmented only on distal third. According to Taylor (1934), this variety prefers more elevated localities, from a few

hundred to 3,500 feet high, in New Guinea, although it also occurs on the coast. It breeds very freely in small soakages, and in wheel ruts and hoof marks; it has not been found in brackish water. On the mainland of Australia it has only been recorded from Boroloola, N.T. (Hill). It is a proven vector of malaria in New Guinea (de Rook, Heydon, the former recording sporozoite rates from 1.5-5%).

var. novaguinensis Venh. -- The shaft of the proboscis is entirely dark, as in var. moluccensis, but the palpi are similar to An. annulipes (Fig. 8, right hand side); the wings are darker than in both species, with the dark costal markings tending to become confluent, and the pale markings more creamy white than creamy yellow. The larvae differ from all related forms in having a plumose metathoracic pleural hair (Fig. 14). New Guinea: Merauke; N.T.: Darwin to Katherine (Woodhill). It is not known whether this variety transmits malaria.

An. (Myz.) incognitus Brug.

Known only from the larva, which is remarkable in having the inner anterior clypeal hairs finely plumose, the outer anteriors strongly branched on the distal half, and the posteriors extremely long, projecting far beyond the head, and strongly branched on the distal half. Dutch New Guinea (Merauke).

An. (Myz.) sp. Hill.

This species was known only from the larva, which had plumose inner and outer anterior clypeal hairs; but the posterior clypeals were not figured, and it is not now possible to identify it. New Britain.

An. (Subgen?) sp? (N.T.).

A most curious and variable species, like the ghost of a Myzomyia. The palpi are entirely pale scaled; the proboscis is pale or yellowish; the wings with a vague, inconstant costal spot, but usually with dark specklings on the veins; and the legs with vague and inconstant paler rings and spots. In the absence of males and larvae, this species cannot be identified more accurately, but it may be related to An. (Myz.) immaculatus James; it is not included in the key to the species. N.T.: Adelaide R., Katherine (Powell), and Mataranka (Johnston).

KEY TO AUSTRALASIAN ANOPHELINI

A d u l t s

1. Stem of veins M_{1+2} and Cu_{1A} distinctly sinuous..Gen. BIRONELLA
These veins perfectly straight Gen. ANOPHELES..2
2. Brown or black spp.; costa with at most one or two white spotsSubgen. Anopheles..3
Brightly marked spp.; costa with at least four conspicuous white patchesSubgen. Myzomyia..7
3. Small, brown, concolorous spp.; wing scales uniform4
Larger, blackish spp.; wings with patches of dark scales ...5
4. Basal four-fifths of hind femora creamy to yellow anteriorly stigmaticus Sk.
Hind femora uniformly brown anteriorlyaitkeni Giles
5. Palpi normal; costa without a white spot beyond middle; hind tarsi entirely darkatratispes Sk.
Palpi with bushy outstanding scales; wing with a white spot beyond the middle of the costa; hind tarsi with narrow white rings6
6. Hind femora with scattered pale scales; fringe scales of wing with white patches at the end of the medial and cubital branchesbancrofti Giles
Hind femora entirely dark; fringe scales of wing with white patches only at the apices of the radial field and Cu_{1B}barbirostris Wulp
7. Legs without white tarsal rings, only with a row of pale spots on femora and tibiae; palpi entirely dark except for two narrow pale rings ...melanotarsis (W.&L. ms.)
Legs with distinct pale rings at tarsal joints; palpi not as above8
8. Legs with narrow white tarsal rings only, shafts of femora and tibiae without rings or spots; palpi with apical segment and apical part of fourth segment entirely white, forming a broad white tip to the palp subpictus Grassi
Femora and tibiae conspicuously ringed or spotted with pale scales; palpi not as above9
9. Proboscis one-fourth longer than the normal palpi, black on basal half, brown to golden on distal half; palpi with three broad pale bands on distal half ..longirostris Brug
Proboscis but little longer than the palpi10
10. All abdominal tergites with numerous conspicuous yellow scales; sternites with patches of white scales11
Abdominal tergites with at most scattered creamy scales, increasing posteriorly; sternites bare13

4. Inner anterior clypeal hairs bifurcate and crossing over one another; outer very stout and spine-like aitkeni Giles var.
Inner anterior clypeal hairs single; outer normal.....5
5. Larger, black larvae, with the antennal plume large and strongly branched atratypes Sk.
Smaller, brown larvae, with the antennal plume very small and finely branched stigmaticus Sk.
6. Posterior clypeal hairs very long, and projecting well beyond the head.....7
Posterior clypeal hairs short, never reaching to the anterior margin of the head10
7. Outer anterior and posterior clypeal hairs strongly branched incognitus Brug
Outer anterior clypeal hairs single, or with few and inconspicuous branches; posterior clypeal hairs single or bifid8
8. Abdominal palmate hairs with shoulder marked, and filament tapering abruptly to a very slender tip, which is nearly as long as the blade subpictus Grassi
Abdominal palmate hairs with shoulder narrower, and filament tapering more evenly9
9. Posterior clypeal hairs often closer together than the inner anterior and projecting inside them.....
..... amictus var. typicus Edw.
Posterior clypeal hairs often wider apart than the inner anterior, and projecting between them and the outer anteriors amictus var. hilli (W. & L. ms.)
10. Outer anterior clypeal hairs dark and strongly branched, almost like An. bancrofti meraukensis Venh.
Outer anterior clypeal hairs pale, with more slender branches, plumose, or bare11
11. Meta-thoracic pleural tuft with a long branched hair
..... punctulatus var. novaguinensis Venh.
Meta-thoracic pleural hairs all single12
12. Posterior clypeal hairs longer, more conspicuous, with several definite branches; outer anterior clypeals definitely plumose or branched, annulipes Walk.
Posterior clypeal hairs usually very short and inconspicuous, single or at most trifid; outer anterior clypeals usually bare or very finely plumose13
13. Antennae pigmented throughout length
..... punctulatus var. moluccensis Sw. & Sw. de G.
Antennae pigmented on distal third only, remainder pale punctulatus var. typicus Don.



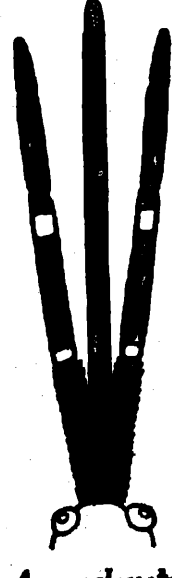
An. aitkeni
FIG. 3



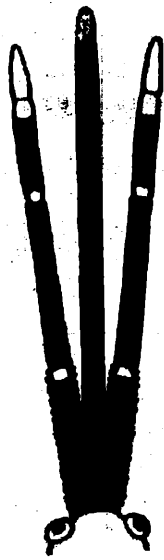
An. atralipes
FIG. 4



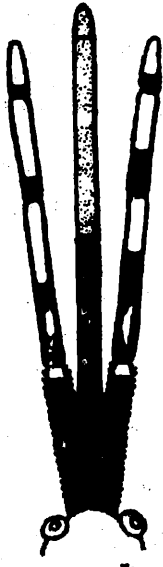
An. bancrofti
FIG. 5



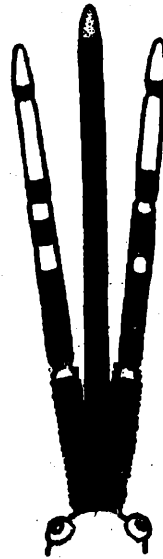
An. melanotarsis
FIG. 6



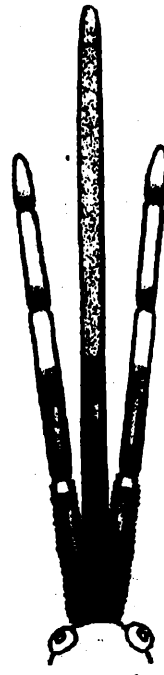
An. subpictus
FIG. 7



An. annulipes
FIG. 8



An. punctulatus
FIG. 9



An. longirostris
FIG. 10

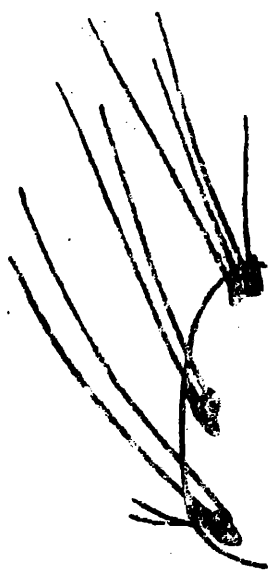


FIG. 13



FIG. 14

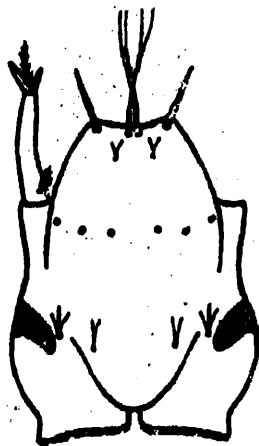


FIG. 15

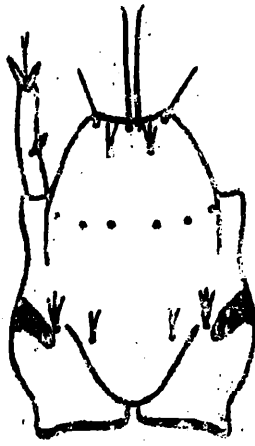
Figs. 13-15.-- Pleural thoracic hairs of Anopheles larvae.

13: An. annulipes, An. meraukensis, An. punctulatus var. typicus, An. punctulatus var. moluccensis, An. longirostris;

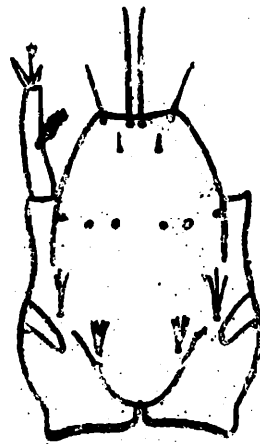
14: An. punctulatus var. novaguinensis; 15: An. amictus.



An. aitkeni var.
FIG. 16



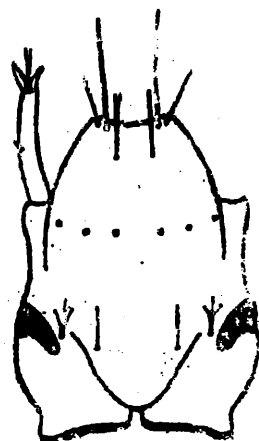
An. stigmaticus
FIG. 17



An. atratipes
FIG. 18



An. bancrofti
FIG. 19



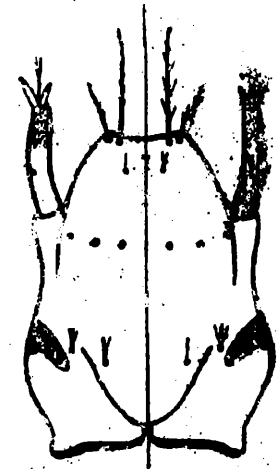
An. amictus
FIG. 20



An. meraukensis
FIG. 21



An. annulipes
FIG. 22



An. punctulatus
FIG. 23