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# ANOPHELINE MOSQUITOES OF THE SOLOMON ISLANDS AND NEW HEBRIDES

JOHN N. BELKIN, Captain SnC, AUS, KENNETH L. KNIGHT, Lieutenant, H(S), USNR AND LLOYD E. ROZEBOOM, Lieutenant, H(S), USNR

## INTRODUCTION

Until less than three years ago, only two anopheline mosquitoes, *Anopheles punctulatus* and *A. punctulatus moluccensis,* had been reported as occurring in the Solomon Islands and New Hebrides. However, the presence of *A. punctulatus* was questionable as a state of confusion existed in regard to the exact taxonomic position of these species. Extensive collections during the past two years have revealed the existence of at least six species in this area. We feel that sufficient data have been accumulated to warrant a summary of the taxonomic status and the biology of these mosquitoes. Inasmuch as these species differ considerably in their habits, the presentation of this information should facilitate the determination of the relative importance of the disease transmitters as well as the formulation of control measures directed against the dangerous species.

The most intensive collections have been made on Espiritu Santo in the New Hebrides and on Guadalcanal in the lower Solomon Islands, and involved not only the rearing of adults from individual larvae taken from as many natural breeding places as possible, but also the rearing of progeny of isolated females, which had been captured in natural resting places and native dwellings. Such rearings enabled us to determine the extent of normal variation within "families," and to select the characters which remained constant and hence were of specific value. The distribution of the species in other islands of these groups is based upon material taken by a number of collectors.

## KEY TO SPECIES

### *Adult Females*

1. Costa without contrasting dark and light spots, palpi approximately one-third the length of the proboscis. ..... *Bironella hollandi*
   Costa with contrasting dark and light spots, palpi as long as the proboscis .... 2
2. Scutum with a vestiture of golden hairs, scales absent except on anterior promontory and near wing root; halteres white. ..... 3
   Scutum with a vestiture of yellowish-white, broad, recumbent scales throughout; halteres dark-scaled on apex. ..... 4
3. Apical third of labium yellow-scaled; fourth (morphological) segment of palpus with the basal dark ring covering approximately one-fifth of the segment *Anopheles lungae*
   Labium dark except for a small patch of bronzy yellow scales on the apical fifth or less; fourth segment of palpus with the basal dark ring covering approximately one-third of the segment. ..... *A. solomonis*
4. Labium dark-scaled except for an inconspicuous pale ring at extreme apex, rarely with a few ventral pale scales on basal half. ..... *A. farauti*

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Pale scales present on apical third to half of labium. ..... 5

5. Apical third to half of proboscis entirely pale except for a narrow subapical dark ring and scattered dark scales ventrally, subapical ring occasionally absent; usually a small dark sectoral spot on costa between the basal and median dark spots. ..... *A. punctulatus*

Apical third of proboscis with a ventral patch of pale scales which may be limited to a few scales or may be extended dorsally near apex to form an incomplete ring; usually no dark sectoral spot on costa between basal and median dark spots. ..... *A. koliensis*

### *Adult Males*

The characters used to separate the males of *Anopheles* are not entirely satisfactory; nevertheless, they will serve to distinguish the majority of specimens.

1. Costa without contrasting dark and light spots, palpi one-sixth of proboscis *Bironella hollandi*

Costa with contrasting dark and light spots, palpi as long as proboscis. ..... 2

2. Scutum with a vestiture of golden hairs; scales absent except on anterior promontory and near wing root; halteres white. ..... 3

Scutum with a vestiture of yellowish-white, broad, recumbent scales throughout; halteres black-scaled on apex. ..... 4

3. Labium all dark-scaled except for apical light ring. ..... *Anopheles lungae*

Apical sixth to fifth of labium with a dorsal patch or incomplete ring of bronzy yellowish scales. ..... *A. solomonis*

4. A small dark sectoral spot on costa between basal and median dark spots. ..... 5

No dark sectoral spot on costa between basal and medium dark spots. *A koliensis*

5. Labium with at least two or three ventral light spots, frequently large patches of light scales. ..... *A. punctulatus*

Labium all dark except for apical light ring. ..... *A. farauti*

### *Pupae*

1. Paddle with fringe hairs on external margin only (Fig. 19); hair 5 of abdominal segment VI external to hair 10 on the posterior margin of the segment (Fig. 16); no oblique lateral margin to abdominal sternites. *Bironella hollandi*

Paddle with at least some fringe hairs internal to the paddle hairs (Fig. 20); hair 5 of abdominal segment VI internal to hair 10 on the posterior margin of the segment; sternites of abdominal segments with distinct oblique lateral margins. ..... 2

2. Paddle with a series of strong denticles on the external margin (Fig. 20). ..... 3

Paddle without denticles, fringe consisting of fine hairs only (Fig. 19). ..... 4

3. Lateral spine (hair 1) of abdominal segment V approximately equal in length to that of segment III; lateral spine of segment VII extremely slender and pale, usually branched or apically frayed (Fig. 26, B and C). *Anopheles lungae*

Lateral spine of abdominal segment V approximately two to three times the length of that of segment III; lateral spine of segment VII stouter, darker, unbranched (Fig. 26, A). ..... *A. solomonis*

4. Trumpet pale, at most contrasting but little with the cephalothorax; hair 8 of the cephalothorax over 105 microns in length; hair 10 of abdominal segment II with 12 or more branches; lateral spine of segment VII elongate, slender, rarely showing any fraying (Fig. 26, H). ..... *A. punctulatus*

   Trumpet brightly pigmented from apex to basal notch; hair 8 of cephalothorax under 100 microns in length; hair 10 of abdominal segment II with fewer than 12 branches; lateral spine of segment VII, shorter, stout. ..... 5

5. Lateral spine of abdominal segment VII nearly always frayed or branched, shaped as shown in Fig. 26, D and E; apex of male genitalia as in Fig. 17. ..... *A. farauti*

   Lateral spine of abdominal segment VII rarely branched or frayed (Fig. 26, G, shows the type of branching which occurs occasionally), shaped as illustrated in Fig. 26, F; apex of male genitalia as shown in Fig. 18. *A. koliensis*

*Fourth Instar Larvae*

1. Hair 1 of mesothorax with stout shaft and many lateral branches; inner clypeals widely spaced, closer to outer clypeals than to each other; antennal hair minute. ..... 2

   Hair 1 of mesothorax with the structure of a small palmate tuft; inner clypeals closely approximated, with contiguous tubercles; antennal hair large, plumose. ..... *Bironella hollandi*

2. Prothoracic pleural group with one long hair branched; outer clypeals short, scarcely projecting beyond the clypeus or, if longer, then posterior clypeals 2–5-branched. ..... 3

   Prothoracic pleural group with all long hairs single; outer clypeals extending at least half their length beyond the clypeus, posterior clypeals single, rarely double. ..... 4

3. Outer clypeals extremely short, scarcely projecting beyond the clypeus; posterior clypeals extremely short, not reaching the tubercles of the anterior clypeals, usually single, rarely double; hair 1 of abdominal segment II with long, slender, unnotched leaflets; long metathoracic pleural hairs usually single, rarely one split into 2 branches. ..... *Anopheles lungae*

   Outer clypeals a third to a half as long as the inner; posterior clypeals extending to or beyond the tubercles of the anterior clypeals, with 2–5 branches; hair 1 of abdominal segment II almost as large as those of segment III, with broad notched leaflets; metathoracic pleural group with one of the long hairs usually split into 2–3 branches. ..... *A. solomonis*

4. Hair 1 of abdominal segment I a true palmate tuft, with broad, flattened leaflets; tubercles of prothoracic hairs 1 and 2 fused. ..... *A. farauti*

   Hair 1 of abdominal segment I not resembling a palmate hair, but with narrow, hair-like branches; tubercles of prothoracic hairs 1 and 2 separate. ..... 5

5. Outer occipitals usually with five or more branches (occasionally three to four); posterior clypeals short, not reaching the tubercles of the anterior clypeals; hair 2 of abdominal segments IV and V usually single or double; hair 6 of these segments usually double. ..... *A. koliensis*

   Outer occipitals usually with 1–3 branches (rarely four); posterior clypeals usually extending to, or beyond, the bases of the anterior clypeals; hair 2

of abdominal segments IV and V usually triple; hair 6 of these segments usually triple. ..... *A. punctulatus*

CONSIDERATION OF SPECIES

## *Bironella (Brugella) hollandi* Taylor

1934. *Bironella (Brugella) hollandi,* Taylor, Proc. Linn. Soc. N. S. W. **59:** 229 (♂ and ♀). **Type locality:** Kavieng, New Ireland. **Types:** Univ. of Sydney, Australia.

1944. *Bironella (walchi?).* Belkin and Schlosser, Jour. Wash. Acad. Sci. **34:** 268–273.

ADULT FEMALE.—A small, dark anopheline with unspotted wings and tarsi; palpi short. Length of wing 3–3.5 mm.

*Head:* White frontal tuft shorter than normal, lower setae barely reaching clypeus; vertical setae and long, erect, narrow, curved vertical scales white; erect occipital scales black, deeply forked and exceptionally long and slender, almost as long as frontal tuft setae. Antennae approximately two-thirds as long as proboscis; segments black except at base; torus dark brown; no scales on torus or first flagellar segment. Palpi usually slightly more than one-quarter length of proboscis, black-scaled. Labium black-scaled, slightly shorter than front femur. Labella light to dark brown. Buccopharynx without teeth.

*Thorax:* Scutal integument chocolate-brown; fossae, posterior extensions, and scutellum lighter; under proper illumination these areas, together with prescutellar space, and narrow median longitudinal scutal line, gray pollinose; scutellar disc usually dark, or entire scutellum often dark; scales entirely absent; very sparse vestiture of golden hairs; bristles dark. Halteres light basally, upper two-thirds of stem and knob dark; knob and part of stem with very short dark scales. Pleural integument variable in color, usually dark with lower mesepimera and lower sternopleura pale; scales entirely absent. Propleurals absent; spiraculars absent; lower sternopleurals 4–6 light hairs; upper sternopleurals 2 long dark bristles; prealars 3–5 light bristles; lower mesepimerals absent; subalar 1 dark bristle.

*Wing:* Vein scales, except on costal border, light gray, appearing white under proper illumination; fringe a slightly darker shade of gray; entire length of costa and vein 1 to slightly beyond middle of wing with scales much darker and denser giving appearance of black costal border in sharp contrast to rest of wing which appears light gray. Vein 2 approximately one and one-quarter times length of vein 2.1; vein 3 extending basad from cross-veins as a line of scales usually one-third of distance to wing base, just distad of cross-vein, usually a slight upward curvature; petiole of second posterior cell (vein 4 distad of cross-veins) approximately as long as vein 4.2, a downward curvature near its middle; vein 5.1 with downward curvature just distad of cross-vein; vein 6 with slight curvature in middle and at base; base of second posterior cell distinctly basad of second marginal cell; cross-vein at base of vein 2 clouded; cross-veins 2–3 and 3–4 in line; cross-vein 4–5 usually just basad of 2–3 and 3–4 and parallel to them.

*Legs:* Front femora slightly swollen, dark except for narrow central pale line on posterior surface from near base to apex, connected at base with a dorsal pale line which extends dorsally for approximately half the length of femur, anterior surface with a few scattered pale scales; front tibiae dark except for a narrow line of pale scales ventrally on posterior surface. Middle femora dark except for narrow pale line from base to within tenth of apex; middle tibiae dark except for narrow pale line from base to apex. Hind femora with entire anterior surface pale-scaled from base to apical fifth, posterior surface mottled with pale scales from base to apical fifth, narrow line of pale scales dorso-posteriorly extending halfway to apex; hind tibiae with narrow line of pale scales on anterior surface from basal sixth to apical fifth, posterior surface dark. Coxae and trochanters pale. All tarsi dark dorsally, lighter ventrally. Claws small, simple, and equal on all legs.

*Abdomen:* Dark brown, covered with moderately dense brown hairs on sternites and tergites, hairs more numerous and lighter on distal segments; no scales; cerci without scales, densely covered with light hairs.

ADULT MALE.—In general as in the female. White scaling on head more restricted; occipital scales fewer in number. Palpi usually slightly less than one-sixth the length of proboscis. Proboscis almost one-fifth longer than front femur. Thoracic vestiture even more restricted. Fifth segment of front tarsus shorter than fourth, cylindrical; claw simple. Sidepieces with very narrow dark scales.

*Genitalia* (Figs. 3 and 4) : Sidepiece short, stout, about twice as long as broad; outer surface clothed with rather short hairs; a patch of long, narrow scales basally on dorsal surface. Basal lobe prominent, with a group of 9–15 stout spines at apex, 8 spines according to Taylor. A dense clump of long hairs arising proximally from ventral surface of basal lobe. Clasper long.

slender, bulbous at base and narrowing abruptly distally, sharply curved before apex; terminal spine short, rounded, and only slightly projecting beyond tip of clasper. Mesosome very long, slender; at the apex a pair of long, downwardly and laterally curving forked appendages, the branches of which are coarsely serrate. Claspette long, erect, the dorsal surface strongly convex medially, this convexity clothed with a dense patch of short, appressed, curved spines; apex with a stout digit-like process and two membranous appendages with expanded tips.

PUPA.—*Cephalothorax:* Trumpet (Fig. 23) darkly pigmented, scoop-shaped. Head shield distinctively shaped (Fig. 27), index of width to length 1:1.16 (range 1.00 to 1.35). External margin of palpal case evenly rounded (Fig. 27). Internal margin of median keel indistinct. Metanotal bar with a series of longitudinal wrinkles of which the median is heaviest, no definite lateral margins (Fig. 16).

*Abdomen* (Fig. 16): Hair 5 of segment VI external to hair 10.[1] Lateral spine (hair 1) of segment V five to ten times the length of that on III, generally twice the length of that of IV, and one-half to three-fourths the length of the lateral spines of VI and VII; lateral spines of segments IV–VII gradually tapered, with rounded apices, never branched or frayed (Fig. 25). Table 3 summarizes the number of branches possessed by the more important hairs.

*Paddle* (Fig. 19): Buttress only slightly developed. External border of midrib distinct to posterior one-fourth, internal border indistinct; no granulation of midrib or buttress. Fringe on external margin only, extending from upper one-fourth posteriorly to hair 12, consisting of long fine hairs. Hair 12 short, stout, straight, dark and sharply tapered. Hair 13 fine, approximately equal in length to 12, and pale.

*Genitalia:* Figs. 22 and 24 illustrate the male and female pupal genitalia.

LARVA.—*Head* (Fig. 8): Inner anterior clypeals long, single, closely approximated, the tubercles contiguous; outer clypeals single, one-third to one-half the length of the inner; posterior clypeals very small, single or double. Frontal and subantennal hairs long, plumose. Occipital hairs short; inner 2–4-, outer 2–5-branched. Terminal hair of antenna long, plumose. Antennal hair 5–13-branched, situated one-third from base and reaching almost to or beyond apex of antenna.

*Thorax:* Prothoracic hair 1 without tubercle; stem short, slender, with 8–16 long, radiating branches; hair 2 with small tubercle, about twice the length of hair 1, with 12–15 branches (Fig. 9). Prothoracic pleural hair 9 long, split distally into 2–4 branches; hair 10 long, single; hair 11 small, 2–4-branched; hair 12 long, single (Fig. 10). Anterior mesothoracic pleural hairs (Fig. 11) long; hair 11 very small, single; hair 12 single, about one-fourth to one-third the length of the anterior pair. Anterior metathoracic pleural hairs (Fig. 12) long, single; hair 11 very small, single; hair 12 short, 2–4 branched. Hair 1 of meso- and metathorax with the structure of a small palmate tuft.

*Abdomen:* Palmate hairs present on segments I–VII; those on segment I somewhat reduced; leaflets long, narrow, edges smooth. Anterior tergal plates large, in width about two-thirds the distance between the palmate hairs; dorsum of segment VII almost entirely covered by tergal plate. Small posterior tergal plate present on segments III–VII. Hairs 6 and 7 of segments I and II long, plumose; hair 6 of segment III long, but with fewer branches; hair 6 of segments IV and V long, single. Postspiracular hair long, with about 5 branches; saddle hair long, single. Pecten with 6–8 short and 6–9 long spines.

EGG (Fig. 7). Broad anteriorly, tapering posteriorly; color black; approximately 0.55 mm. in length by 0.2 mm. in width (including floats). Floats large, almost as long as the egg; 15–20 float ridges. Frill with the shape of a broad collar at anterior end. Exochorion with fine reticulations forming an irregular, polygonal pattern.

*Taxonomic Discussion.*—The subgenus *Brugella* to which this species is assigned is characterized by short palpi, simple antennae in the male as well as the female, and by the absence of the basal arm and the presence of a clump of stout spines at the base of the sidepiece in the male genitalia. *B. hollandi* Taylor and *B. travestitus* (Brug) are the only species of the subgenus known in the adult stage at the present time. The original and subsequent descriptions of *B. travestitus* are too brief in their treatment of adult morphology and ornamentation to permit the separation of the two species in the female. The characters of the darker pleurae

[1] The position of hair 5 of abdominal segment VI in *Bironella* seems to offer excellent evidence that hair 9 of the genus *Anopheles* is actually hair 5, but shifted just internal to 10. Because of this, the nomenclature system for pupal hairs proposed by Rozeboom and Knight (1945, m. s.) and utilized here is being modified by changing hair 9 of segment VI to hair 5.

and differences in the curvature of veins used by Taylor to distinguish *B. hollandi* from *travestitus* are variable in the former species. *B. hollandi* and *travestitus* can be differentiated by the details in the structure of the claspette, and by the prominent basal lobe with its patch of long hairs and 8–15 stout apical spines in the former species. In *travestitus* there are only 4 long spines at the base of the sidepiece, and they apparently are not situated on a prominent lobe; furthermore, the group of long hairs seems to be absent (Swellengrebel and Rodenwaldt, 1932).

The larvae of *B. hollandi, travestitus, gracilis,* and *walchi* are characterized by the large plumose antennal hair and by the long external clypeals, which are at least a third as long as the inner clypeals. The known larvae of the other species of *Bironella* have a small antennal hair and very short outer clypeals, which are less than a fourth the length of the inner clypeals. Van Hell (1938) describes the long pleural hairs of *travestitus, gracilis,* and *walchi* as being single; in *hollandi* hair 9 of the prothoracic pleural group is split into 2–4 branches (Fig. 10). The outer clypeals of *walchi* are as long as the inner, while in *hollandi* they are one-third to one-half the inner. Prothoracic hair 1 of *walchi* is only 4–5-branched; in *hollandi* it is 8–16-branched. Taylor suggests the possibility that *hollandi* is the same as *walchi,* but this is not supported by the differences between the larvae. In *gracilis* the outer clypeals are 2–5-branched or even plumose; in *hollandi* they are single. The larva of *travestitus* seems to be very similar to that of *hollandi,* except for the outer anterior pleural hair (hair 9).

*Distribution.*—GUADALCANAL. Northwest and north central coast: Marovovo, Visale, Tenamba, Aruligo, Doma Cove, Segilau, Bunina, Tassafaronga, Bonegi, Mamara, Poha, Kokumbona, Matanikau, Kukum, Lunga, Teneru, Koli; southwest coast: West Cape. RUSSELL ISLANDS. Banika (W. G. Downs). NEW GEORGIA GROUP. Munda (J. G. Franclemont). BOUGAINVILLE. Empress Augusta Bay (A. B. Gurney).

*Biology.*—On the northwest coast of Guadalcanal *Bironella hollandi* is the commonest anopheline breeding in undisturbed, natural, permanent or semi-permanent bodies of water, such as streams, swamps, and dense coastal lagoons at the mouths of rivers. Bomb craters, "fox holes," road ruts, hog wallows, and even artificial containers in at least partial shade are sometimes utilized as breeding places. The larvae occur most frequently in shaded situations, and have been taken in places so dark that they could not be seen in a white dipper. Although they have been collected in very exposed situations, such as small canebrake swamps in grasslands, even here they are usually found deep in the vegetation where there is very little light. The dry season of the year forces the species into quite open situations such as pools in beds of dry streams. During the rainy season, the streams are flushed, the swamps expand and larvae are more difficult to find, although the species continues to breed in large numbers, as collections through every month of the year indicate. The larvae tolerate water with a high organic content such as is found in dense canebrake swamps, but occur more frequently in cool, clear water in vegetation or flotage.

The anophelines most frequently associated with this species are *A. lungae* and *solomonis.* In more exposed situations it is frequently associated with *farauti* and very rarely with *punctulatus.* A species of *Dixa,* several species of *Culex* (*Lophoceratomyia*), *Uranotaenia argyrotarsis* Leic. and *U. tibialis* Taylor are frequently found with *B. hollandi.*

There are two color phases of the larvae of this species, light yellowish-brown and black. Both phases may be recognized macroscopically from other local anophelines by the light coloration of the entire fourth abdominal segment which is in strong contrast with the uniformly darker coloration of the rest of the abdomen; the other anophelines may have light markings on the abdomen, but these are not restricted to the fourth segment. The pupae are smaller and wider than those of the other anophelines and have shorter and more widely-flared trumpets. The eggs float on the surface of the water like those of other anophelines, but can be distinguished from local species by the meniscus they form on the surface, which is straight instead of being cross-shaped.

Larvae brought from the field are rather difficult to rear and take approximately ten days to two weeks from the first instar to pupation; the pupal stage lasts two to three days. The adults are very fragile and are difficult to keep alive in captivity. They exhibit the normal anopheline resting position, but because of their extremely thin bodies and excessively elongate legs, they resemble small crane flies. Nothing is known about their habits beyond the fact that the females do not feed on man. All the adults in collections have been reared. Searches for resting places have been made without success in the vicinity of breeding places.

### *Anopheles* (*Myzomyia*) *solomonis*, n. sp.

ADULT FEMALE.—A medium-sized, yellowish-gray, speckled anopheline; apical sixth to fifth of labium with dorsal patch or ring of yellow scales. Length of wing, 4 mm.

*Head:* Conspicuous white frontal tuft; vertical setae white, followed by one or two rows of white narrow hair-like scales; white scales in middle of vertex forming a wide spot narrowed in center; posteriorly the light scales with a yellow tinge; the rest of the vertical and all occipital scales dark. Antennae with a few minute white scales on torus, dense white scaling on first flagellar segment. Palpi as long as proboscis, ornamented as shown in Fig. 2; second morphological segment black with very narrow ring of white scales; third segment black with very narrow incomplete ring of white scales; fourth segment black-scaled basally for a third of its length, remainder white in center and yellowish basally and apically; fifth segment black-scaled for a third of its length, remainder yellowish. Ratio of fourth segment to third segment 1 : 1.7. Labium (Fig. 2) dark-scaled except for a dorsal patch of yellowish bronzy scales which may extend ventrally, and an apical light ring; differentiation between the coloration not distinct. Labella dull yellow. Buccopharyngeal armature (Fig. 6) of several broad central teeth forming a single row; teeth of similar character, separated by intervals; apices of teeth deeply serrated, bases without bullae or lateral spines.

*Thorax:* Scutal integument light yellow-brown with gray pollinose longitudinal lines; dark brown eye spots in front of and behind scutal angle; prescutellar space and disc of scutellum dark brown. White scales on anterior promontory rather short and sparse, central scales elongate, lateral broader; 15–25 black scales on humeral angles below lateral tufts. Rest of scutum devoid of scales; vestiture consisting of numerous golden hairs of varying length. Scutal and scutellar bristles light in color. Prothoracic lobes with a large patch of short black scales on upper part. Pleura without scales, integument dark gray with usual darker lines and spots. Spiracular bristles absent; propleurals 6 stout dark bristles; lower sternopleurals several golden hairs; upper sternopleurals 2–3 dark bristles and varying number of light hairs; prealars 4–8 golden hairs; subalars 5–10 golden hairs; lower mesepimerals absent. Halteres white with white scales on shaft and knob.

*Wing* (Fig. 1): On the costal border three dark and three light humeral spots, third light humeral spot sometimes obliterated; basal dark spot solid on costa, subcosta and vein 1, usually narrowed on 1; sectoral spot variable in size; accessory sectoral spot usually reaching costa; dark sectoral spot narrowed on subcosta, frequently absent on vein 1; median dark spot very large, wedge-shaped, extending to base of vein 2, on vein 1 dark scaling may be interrupted by light scales distally, small dark spot thus formed migrating occasionally into subcostal spot; subcostal spot large; preapical dark spot extremely variable, may be large and solid on both costa and vein 1 or on costa alone, or broken into two to four small spots on these veins, or represented by one very small spot on each one of these veins; preapical spot sometimes reduced;

apical dark spot solid, including veins 1 and 2.1; apical spot smaller than apical dark spot. Wing veins light-scaled with the following dark spots: vein 2 with large dark spot involved in median dark spot and one to two small dark spots distad; vein 2.1 with 2 to 3 basal small dark spots and one large spot involved in apical dark spot, apex of vein light-scaled; vein 2.2 with 5 to 7 small dark spots, evenly spaced, vein dark at apex; vein 3 with 5–8 small dark spots, apex of vein light; vein 4 with 3 to 7 dark spots, large one usually at bifurcation; veins 4.1 and 4.2 each with 2 to 4 dark spots, large one usually at base continuous with apical dark spot of vein 4; vein 5 with 3–6 rather evenly spaced small dark spots; vein 5.1 and 5.2 each with 3–5 small dark spots; vein 6 with 4 to 7 small dark spots. Fringe white except for the following dark spots: large spot between veins 2.1 and 2.2; small spots below apex of veins 3 (frequently absent), 4.1, 4.2, and 5.1; large spot at apex of vein 6. Light wing scales yellow, dark scales black. Venation and cross-veins normal.

*Legs:* Front femora swollen in basal half, speckled with light scales; middle and hind femora and all tibiae with numerous, rather evenly spaced pale spots. First segment of all tarsi with numerous light spots and light apex. Second, third, and fourth segments of front tarsi with broad basal and apical light bands; second and third segments often with additional light spots in center; fifth segment dark except at apex. Second, third, and fourth segments of middle tarsi with narrow apical light bands, occasionally with light spots centrally; fifth segment dark except at extreme apex. Second segment of hind tarsi with narrow apical light band and usually one to three small light spots centrally; third segment with narrow apical light band and occasionally a few light scales centrally; fourth segment with narrow apical light band; fifth segment all dark. A few light scales basally on middle and hind tarsal segments, visible under high magnification. Extent of light scaling on legs very variable. Light scales on legs yellowish.

*Abdomen:* Integument dark gray. Devoid of scales on tergites and sternites I–VII, instead vestiture of narrow golden hairs similar to those on scutum. Hairs more numerous on posterior segments, grading into very narrow curved scales on tergite and sternite VIII. Cerci with narrow black scales.

ADULT MALE.—In general as in the female. First flagellar segment with tuft of narrow white scales. Second palpal segment with light scales dorsally in center; articulation between second and third segments light-colored, third palpal segment with narrow apical ring of yellow scales and patch of yellow scales dorsally in center; fourth and fifth segments yellow with narrow basal dark rings which extend externally to near apex of segments. Labium dark except for dorsal patch on incomplete ring of bronzy yellowish scales on apical sixth to fifth. Abdomen as in female except for numerous yellow scales on eighth tergite. Sidepieces densely covered with yellow scales ventrally (morphologically) and black scales laterally and dorsally.

*Genitalia:* Indistinguishable from those of *A. lungae*.

PUPA. The pupa possesses a brownish-yellow color which persists to a distinctive degree even in specimens reared completely through in the laboratory. This is in marked contrast to the *punctulatus* series, the members of which become nearly devoid of pigment in material reared from eggs. Tables 2 and 3 summarize the data of diagnostic value for this species.

*Cephalothorax:* Trumpet dark brownish-yellow. Index of width to length of head shield 1:0.98 (range 0.93–1.06). External margin of palpal case rounded, sometimes with an angulate point at the center of the curve. Internal margin of median keel sharply outlined. Metanotum with a distinct, smooth median bar bounded laterally by a crease which is incomplete posteriorly. Chaetotaxy similar to that of *B. hollandi* except that hair 11 is generally slightly anterior to a line drawn between 10 and 12.

*Abdomen:* Chaetotaxy generally similar to that shown for *B. hollandi* (Fig. 16) except for the following: sternites with strong oblique lateral margins. On segment I, hair 6 generally external to hair 9, occasionally in line with it; on segment III, hair 6 well anterior to a transverse line through hair 4, hair 18 absent; on segment IV, hair 6 well anterior to a transverse line through hair 5, on segment V, hair 5 nearer to hair 4 than to 8, much shorter than 8 in length; on segment VI, hair 2 on or very near the posterior margin of the segment, hair 5 on the posterior margin internal to 10, shorter than 10; on segment VII, hair 2 on the posterior margin of the segment, hair 5 well anterior to a transverse line through hair 4; on segment VIII, hair 8 very near to a transverse line through the lateral spine (hair 1). Lateral spine of segment V approximately two to three times the length of that of segment III; lateral spines of segments VI–VII (Fig. 26, A) slender, elongate, acutely tapered and only very rarely with branches or fraying, pigmented to about the same extent as the segments.

*Paddle* (Fig. 20): External border with stout, bluntly tapered denticles, which are pigmented to the same degree as the paddles. These denticles begin at upper one-fourth as minute teeth internal to the border, increasing in size posteriorly and extending to and along the external margin to the postero-lateral corner, the last few denticles being more acutely pointed

than the others; a fringe of long, pale hairs begins where the denticles terminate and extends mesally and forward along the inner margin of the paddle to the anterior one-fourth. External border of midrib obscure, internal border absent or very faint, granulations scanty or absent. Buttress with minute, scattered denticles and generally with areas of granulations. Hair 12 slender, pale, straight or curved. This hair is much in contrast to that of the *punctulatus* series where it is noticeably stouter and longer.

*Genitalia:* In male (Fig. 17), more heavily pigmented than any other part of the abdomen; the lateral margins of the genital lobes are nearly parallel from base to apical one-fourth, apex of lobes shaped as figured. Female genitalia similar in form to that illustrated for *farauti* (Fig. 21).

LARVA.—*Head:* Inner clypeal hairs very long, with many minute lateral branches; outer clypeals a third to a half the length of the inner, sometimes single but usually frayed; the distance between the outer and inner hairs one-fourth to one-third that between the inner hairs; posterior clypeals 2–5-branched and long enough to reach the tubercles of the anterior clypeals. Frontal and subantennal hairs feathered. Antennae with long spines on inner surface; antennal hair minute, situated one-third the distance from the base; terminal hair longer than sabers, 4–8-branched. Occipital hairs short; inner 2–5-branched, outer 2–6-branched.

*Thorax:* Tubercles, of prothoracic hairs 1 and 2 large, heavy, separated from one another; hair 1 with heavy shaft and many long radiating branches; hair 2 about twice the length of hair 1. Prothoracic pleural hair 9 (Fig. 13) long, with 5–10 branches; hair 10 long, single; hair 11 about one-fourth the long hairs, single or double; hair 12 long, single. Anterior pair of mesothoracic pleural group long, single, occasionally one hair double; hair 11 minute, single; hair 12 short, 2–4-branched. Outer anterior metathoracic pleural hair (9) split into 2–3 branches, inner hair long, usually single, sometimes double; hair 11 minute; hair 12 short, 2–4-branched (Fig. 14).

*Abdomen:* Hair 1 on segment I very small, with narrow, hair-like branches. Hair 1 on segment II almost full-sized, with broad, notched leaflets. Palmate hairs large on segments III–VI, smaller on segment VII, heavily pigmented on segments II–VII; leaflets very broad, abruptly narrowed, with deep indentations, into a short terminal filament that is about one-fourth as long as the main shaft. Hair 6 of segments IV and V 2–4 branched. Tergal plates darkly pigmented, small, half or less the distance between the palmate hairs except on segment VIII where it is large. Hair 13 of Segment V very large, with 7–13 branches. Pecten with 4–5 long and 6–10 short spines. Saddle hair long, single.

TYPES.—**Holotype** ♀ with larval and pupil skins, Poha River tributary, 3 miles south of the coast, Guadalcanal, 10 Sept. 1944 (L. E. Rozeboom). **Allotype** ♂ with larval and pupal skins, Bonegi River tributary, 2½ miles south of the coast, elevation 1500 feet, Guadalcanal, 21 July 1944 (L. J. Lipovsky). **Paratypes** (29 ♂, 41 ♀): 1 ♂ with pupal skin, Matanikau River tributary, Guadalcanal, 27 Nov. 1943 (J. N. Belkin); 1 ♀ with larval and pupal skins, Matanikau River tributary, Guadalcanal, 8 Feb. 1944 (J. N. Belkin); 1 ♀, Burns Creek, Lunga District, Guadalcanal, 25 May 1944 (J. N. Belkin); 2 ♀, 1 ♂ with larval and pupal skins, Bonegi River tributary, 2½ miles south of the coast, elevation 1500 feet, Guadalcanal, 21 July 1944 (L. J. Lipovsky et al); 1 ♂ with larval and pupal skins, Matanikau River tributary, Guadalcanal, 6 Aug. 1944 (J. N. Belkin); 1 ♂, 2 ♀, Kokumbona River, 4 miles south of coast, Guadalcanal, 24 Aug. 1944 (M. Cohen, H. Sexauer, et al); 1 ♂, 2 ♀ with larval and pupal skins, 2 ♂, 3 ♀ reared from pupae, Poha River tributary, 3 miles south of coast, Guadalcanal, 9–26 Sept. 1944 (L. E. Rozeboom, J. N. Belkin, J. Laffoon, et al); 22 ♂, 30 ♀ with larval and pupal skins, progeny from gravid female collected resting on tree trunk, Sprague Swamp, Bunina, Guadalcanal, 13 Nov. 1944 (L. J. Lipovsky, M. Cohen, A. W. Barnes). **Holotype** and **allotype** to be deposited in U. S. National Museum. **Paratypes** to be deposited in the collections of the University of Sydney, Cornell University, Johns Hopkins School of Hygiene and Public Health.

*Taxonomic Discussion.* *A. solomonis* and *lungae* form a distinct complex and perhaps should be recognized as a separate series under the group *Neomyzomyia.* They fall into this group on the basis of buccopharyngeal armature (Figs. 5, 6), propleural hairs, presence of scaling on the pronotal lobes, and speckled legs in the adults. Other species of this group in the Oriental and Australasian regions having the scutal ornamentation restricted to the anterior promontory, entirely white halteres, speckled legs without a broad white band on the hind legs at the junction of the tibia and first tarsal segment are *A. tesselatus, longirostris, longirostris annulata,* and presumably *tesselatus orientalis.* *A. solomonis* and *lungae* differ from

all of these in having a very narrow ring of white scales at the apex of third palpal segment instead of a broad light band, covering usually about a half of this segment.

The larval pleural hairs show branching which is inconsistent with the definition of the group *Neomyzomyia,* but which is found in three other forms usually referred to this group: *A. amictus, amictus hilli,* and *novaguinensis.* The latter species all have one long hair of the mesopleural group at least two-branched, and one long hair of the metapleural group with five or more branches. In *A. solomonis* and *lungae,* the long mesopleurals are usually single, and both long metapleurals may be single (usually in *lungae,* rarely in *solomonis*), or at most with 2–3 branches (occasionally in *lungae,* usually in *solomonis*).

The adults of *A. novaguinensis, amictus* and *amictus hilli* possess conspicuous scales on the disc of the scutum which immediately separate them from *solomonis* and *lungae.*

Adult females of *A. solomonis* are separated from *lungae* by the restricted yellow coloration on the apical fifth or less of the labium, the proportionately shorter third palpal segment, the greater extent of the dark coloration on the base of this segment, the generally darker coloration of the legs, and differences in the buccopharyngeal armature. All males of *solomonis* examined showed some pale scales on the labium, a character which is very rarely present in *lungae.* The larvae of the two species are separated on the size of the outer clypeals, the size and branching of the posterior clypeals, and the structure of the palmate hair on abdominal segment II.

In a personal communication to one of the authors (JNB), J. G. Franclemont reports finding a form similar if not identical with *A. solomonis* on New Georgia Island. The only obvious difference noted in the brief description available is in the more extensive yellowish coloration of the proboscis which may cover the apical third.

*Distribution.*—GUADALCANAL. Northwest coast: Bunina, Tassafaronga, Bonegi, Poha, Kokumbona, Matanikau, Lunga. ? NEW GEORGIA. Munda (J. G. Franclemont).

*Biology.*—The larvae of *A. solomonis* have been collected most frequently in small tributary streams of the larger rivers at a distance of one to four miles into the coral foothills of the northwest coast of Guadalcanal at elevations to 1500 feet. They were found in pot holes in coral stream beds, in coral depressions above the stream beds, along the margins of the streams, and in the blocked mouths of the tributary streams where they are probably flushed from breeding places farther up the streams. One collection was made in a taro swamp with a depth of water of only one inch. The water in the breeding places may be clear and running, but is frequently stagnant, with a high organic content, and bluish in color. Practically all the collections have been made in deeply shaded areas in flotage of sticks or in leaves along the margins of the pools. The larvae are difficult to locate and are very scarce. They have the same habits as *lungae* of crawling up on leaves and banks out of the water. The pupae also work their way out of the water, as do those of *lungae.* The species may be collected throughout the year but is less difficult to collect during the dry months.

*A. solomonis* is frequently found where other anophelines are absent, but it has also been collected in association with *A. lungae, B. hollandi,* and once with *A. farauti* and *punctulatus.*

The larvae and pupae resemble macroscopically those of *A. lungae* in the shape of the body and coloration and cannot be separated from this species in the field.

From laboratory rearings, the length of life cycle appears to be the same as for *A. lungae*. All the eggs do not hatch at once and the larval stage lasts from 10 days to 2 weeks or longer, and the pupal stage from two to three days.

Little is known concerning the habits of the adults. Both males and females have been found in very small numbers resting in the daytime in the company of *A. lungae* on the buttresses and trunks of large trees in swampy jungle areas.

### *Anopheles* (*Myzomyia*) *lungae* Belkin and Schlosser

1944. *Anopheles* (*Myzomyia*) *lungae* Belkin and Schlosser, Jour. Wash. Acad. Sci. **34**: 268 (♂ and ♀). **Type locality:** Guadalcanal Island. **Types:** U. S. National Museum.
1944. *Anopheles* sp., Knight, Bohart and Bohart. Keys to the mosquitoes of the Australasian Region. Nat. Res. Council, Wash., p. 10.

ADULT FEMALE.—A medium-sized, yellowish, speckled anopheline; apical third of labium yellow-scaled. Length of wing 4–4.5 mm.

Palpi as long as proboscis; second and third morphological segments black with narrow ring of white scales apically, in 5 per cent of specimens studied (80), dorsocentral patch of dark bronzy scales also present on these segments; fourth segment black-scaled basally for approximately one-fifth its length, remainder white except frequently yellowish basally and apically; fifth segment black-scaled for approximately one-fifth of its length, remainder yellowish; ratio of fourth segment to third segment 1 : 1.35. Labium dark basally; apical third golden-yellow-scaled except usually a preapical dark ring; boundary between black and yellow sharply marked; in less than 5 per cent of specimens examined a few light scales basad of light apical area. Labella dull yellow. Buccopharyngeal armature (Fig. 5) of several teeth forming a single row; teeth of similar character, separated by intervals; apices of teeth serrated, bases with bullae but without lateral spines. Scutum without scales except on anterior promontory and in front of wing roots, vestiture of numerous golden hairs of varying length. Scutal integument light yellowish-brown; eye spots and dark areas as in *solomonis*. Prothoracic lobes with patch of black scales dorsally. Pleura without scales. Lower mesepimerals absent; propleurals 6 stout dark bristles; other pleural bristles and hairs as in *solomonis*. Halteres white with white scales on shaft and knob. Wing in general as described for *solomonis*. Legs as in *solomonis*, except that on front tarsi fifth segment usually with basal and apical light bands, fourth segment frequently with light spots in center dorsally; light coloration of front legs more extensive than in *solomonis*. Abdomen devoid of scales on tergites and sternites I–VII; vestiture of golden hairs of varying length; hairs more numerous on posterior segments, grading into narrow curved scales on apical border of segment VIII. Cerci with narrow yellow scales at apex, dark scales at base and sides.

ADULT MALE.—In general as in the female. Second morphological palpal segment usually with few white scales at apex and patch of yellow scales dorsocentrally; third segment with narrow apical yellow ring and patch of yellow scales dorsocentrally; fourth and fifth segments yellow with usually narrow basal dark rings; extent of light coloration variable. Abdomen and sidepieces as in *A. solomonis*. The male genitalia have been described and figured by Belkin and Schlosser. Some of the leaflets of the mesosome are serrate.

PUPA.—Very similar to the pupa of *A. solomonis* except for the following: lateral spines of abdominal segments IV–V each approximately equal in length to that of segment III; lateral spines of segments VI and VII (Fig. 26, B and C) extremely slender and pale, appearing to be less pigmented than the segments, frequently branched or apically frayed; the lateral spine of segment VII possessing one or more branches in over 80 per cent of the specimens examined. Tables 2 and 3 summarize the data of diagnostic value for the species.

LARVA.—Inner anterior clypeal hairs widely spaced, rather short, frayed; outer clypeals very short, extending at most only slightly beyond the clypeus; posterior clypeals single, rarely double, and very short, not reaching the tubercles of the anterior clypeals. Inner and outer occipitals short, 2–4-branched. Tubercles of prothoracic hairs 1 and 2 heavy, separated from one another; hair 1 with stout shaft and long radiating branches. Outer anterior hair (9) of prothoracic pleural group (Fig. 15) split into 3–6 (rarely 2) branches; anterior hairs of meso- and metathoracic pleural groups long, single.

Hair 1 of abdominal segment I with narrow, leaf-like branches. Hair 1 of abdominal segment 2 with long slender, unnotched leaflets. Palmate hairs large on segments III–VI, smaller on segment VII. Hair 6 of segments IV and V sometimes 1–2-, usually 3-branched.

*Distribution.*—GUADALCANAL. Northwest and north coast: Tenamba, Aruligo, Doma Cove, Segilau, Bunina, Umasami, Tassafaronga, Bonegi, Mamara, Poha, Kokumbona, Matanikau, Kukum, Lunga, Tenaru, Koli, Tetere. NEW GEORGIA. Munda (J. G. Franclemont). BOUGAINVILLE. Empress Augusta Bay (A. B. Gurney).

*Biology.*—"The larvae of this species are normally found in the jungle in seepage areas, along the margins of streams, pot holes in stream beds, rock holes, dense jungle swamps, and temporary pools. The species has a decided preference for shade in its breeding places" (Belkin and Schlosser, 1944). Other breeding places noted are "fox holes," hog wallows, old steel helmets, dense canebrake swamps, and coastal lagoons at mouths of streams. The water in some breeding places may have a very high organic content, but usually is clear and cool. The larvae at times become quite numerous, but are hard to collect because of their habit of resting in very shallow water on the margins of the breeding places. They have been observed to crawl out of water and rest on the bank or on dead leaves floating ing on the water. The pupae also leave the water and in the laboratory normally rest on the sides of the rearing vessels, sometimes half an inch or more above the surface film. A film of water completely surrounds them, but does not connect with the surface of the water in the container. Usually emergence takes place from pupae resting above the surface of the water.

*A. lungae* increases in numbers during the rainy season when the breeding places become more extensive. The aquatic stages are even flushed from the hills into breeding areas in the coastal plain. On two occasions larvae and pupae were observed floating in a strong current in a small stream draining a large canebrake swamp. Several hundred larvae and pupae were collected in an hour's time among the debris held in place in the middle of the creek by an obstruction.

*A. lungae* has been collected commonly in association with *B. hollandi* and *A. solomonis,* rarely with *farauti,* and only once with *punctulatus.*

The larvae of *A. lungae* are easily distinguished in the field, except from *solomonis,* by the relatively broader abdominal segments, the transparency of the body and clear yellow pigmentation. The pale larvae of the other species have a much more opaque coloration (*A. punctulatus* and *farauti*) or are very narrow (*B. hollandi*).

A large number of rearings from eggs have shown some unusual characteristics of this species. All eggs do not hatch at once, even though they may be floating on the surface of the water. Some hatch three to four days after oviposition, others may not hatch for two weeks or longer. We have obtained adults from a batch of eggs before all first instar larvae appeared. The eggs are also capable of withstanding a considerable amount of drying. This seems to be an adaptation to breeding places which are periodically flushed. The larval development, once started, takes about ten days; the pupal stage usually lasts two to three days.

The diurnal resting places of the adults are easily located in swampy jungle areas where the species breeds in abundance. Males and unfed, blooded or gravid females are found together resting on the trunks and buttresses of various species of large trees growing in such areas. On several occasions they have been observed to rest also at the bases of various herbaceous plants. In uncontrolled areas, two or three hundred adults have been occasionally collected from a single tree. They

usually rest a foot or less above the ground where the humidity is very high and where there is very little light, but they have also been frequently collected resting as high as six feet above the ground on well-illuminated portions of the trunks. In some areas a third or more of the blooded or gravid females have been caught with Heleids of the genus *Culicoides* attached to their abdomens. In the daytime this species exhibits very little activity, never attempting to bite the collector, even though the density of the mosquitoes may be very high. When disturbed they will fly out a few inches or feet and again come to rest. The resting position is at an angle of approximately 60 degrees to the surface.

Nocturnal activity during the rainy season usually starts around 6:30 PM and by 7:00 or 7:30 PM all the adults have left their resting places. In the morning they have been observed to return to their roosts between 6:00 and 6:30 AM. Biting records and collections have been made at night in areas with a very high density of this species and a rather low density of *A. farauti*. *A. lungae* formed only 2 per cent of the total anopheline catch, while *farauti* comprised the remaining 98 per cent. In routine night catches near human dwellings conducted for a period of over a year in the Lunga area of Guadalcanal where this species is common, *lungae* accounted for less than 2 per cent of the total anopheline collections. No specimens of this species have to date been taken in native villages. Microscopic examination of the blood from females collected on tree trunks within a half mile of human dwellings revealed that approximately 70 per cent of the blood meals are nonmammalian in origin, the red blood cells being nucleated. There is no conclusive evidence at the present time as to the origin of the mammalian blood found in the stomachs of these mosquitoes. Precipitin tests, made on a small number of stomach contents, were inconclusive. It is felt that probably the majority of such blood is not of human origin as in addition to a variety of birds, a number of species of bats, a marsupial, many pigs, and occasionally cattle are present in the areas where *lungae* is abundant, and, as pointed out above, even with a high density of this species, it is not attracted to humans. It is possible that during the rainy season when the species is flushed into the coastal plain, relatively more available human hosts and scarcer natural hosts may induce *lungae* to feed on man. The experience on Guadalcanal during the last rainy season would seem to indicate that this takes place only locally.

### *Anopheles* (*Myzomyia*) *punctulatus* Doenitz

1901. *Anopheles punctulatus* Doenitz, Insekten Boerse. **18:** 36 (♂ and ♀). **Type locality:** New Guinea; Bismarck Archipelago. **Types:** unknown.

ADULT FEMALE.—A medium-sized, speckled anopheline, scales present on scutum, apical half of labium light. Size medium, length of wing 3–4 mm.

*Head:* Usual ornamentation on front, vertex and occiput. Antennae normal, with minute white scales on torus; patch of light scales on first flagellar segment. Palpi as long as proboscis; second morphological segment with narrow apical light ring, remainder usually black; third segment usually with narrow apical light ring, a broad subapical light band, separated by narrow dark ring; occasionally pale markings fused to form a very broad apical pale area; fourth and fifth segments broadly light with narrow basal black rings. Apical third to half of labium entirely pale except for a narrow subapical dark ring and scattered dark scales ventrally; subapical ring occasionally absent. Labella light. Buccopharyngeal armature of several teeth forming a single row; teeth of similar character, separated by intervals; apices of teeth deeply serrated; base of each tooth with bulla and a stout spine on each side.

*Thorax:* Scutum light yellow-brown to dark brown, darker eye spots anterior to scutal angle and dark prescutellar space. Anterior promontory with sparse elongate erect white scales in center, somewhat shorter, broader scales in lateral tuft, light above, dark below. Remainder of scutum with vestiture of broad, recumbent, yellowish-white scales and golden hairs; scales

somewhat longer in front and above wing base. Scutellum with disc dark; a few whitish scales, smaller than on scutum. Scutal and scutellar bristles golden brown. Prothoracic lobes dark with broad erect black scales dorsally. Pleural integument dark brown with usual light areas. Spiracular bristles absent; propleurals 2–3, rarely 1 or 4–6; lower sternopleurals usually 4 light hairs; upper sternopleurals 5–7 hairs; prealars a group of 4–6 light hairs; subalars a group of 4–10 light hairs; lower mesepimerals absent. Patch of 6–7 broad recumbent light scales on upper sternopleura, similar patch of 5–6 scales on lower sternopleura; rest of pleura bare. Halteres light at base, dark-scaled on knob.

*Wing:* As figured for *A. p. punctulatus* by Ross and Roberts (1943) but extremely variable. Costal border with four large dark spots; small dark sectoral spot usually present on costa between basal and median dark spots; small dark spots on vein 1 below median dark spot may coalesce, also small dark spots on vein 1 below preapical dark spot, giving much darker appearance to wing. Veins 2–6 with numerous small dark spots. Light scales yellowish-white. Fringe dark, light spots usually at apices of all veins.

TABLE. 1.—*Summary of diagnostic measurement* data for pupae of* punctulatus *series*

| Species | Hair 8 of Cephalothorax Length | | | | Hair 5 of Ab.† II Length | | | |
|---|---|---|---|---|---|---|---|---|
| | Range | Ave. | % under 105 mic. | % 105 mic. or over | Range | Ave. | % under 159 mic. | % 159 mic. or over |
| *punctulatus* | 95–166 | 111 | 2.3 | 97.7 | 119–238 | 181 | 2.9 | 97.1 |
| *koliensis* | 51–88 | 69 | 100.0 | 0.0 | 74–153 | 124 | 100.0 | 0.0 |
| *farauti* | 68–116 | 82 | 97.4 | 2.6 | 98–164 | 150 | 99.4 | 0.6 |

| Species | Hair 1 of Ab. IV Length | | | | Hair 1 of Ab. VI Length | | | |
|---|---|---|---|---|---|---|---|---|
| | Range | Ave. | % under 27 mic. | % 27 mic. or over | Range | Ave. | % under 104 mic. | % 104 mic. or over |
| *punctulatus* | 10–34 | 17 | 99.5 | 0.5 | 102–194 | 145 | 1.7 | 98.3 |
| *koliensis* | 20–71 | 43 | 1.6 | 98.4 | 51–119 | 75 | 99.5 | 0.5 |
| *farauti* | 17–55 | 28 | 33.4 | 66.6 | 71–180 | 109 | 22.6 | 77.4 |

| Species | Hair 1 of Ab. VII Length | | | |
|---|---|---|---|---|
| | Range | Ave. | % under 111 mic. | % 111 mic. or over |
| *punctulatus* | 115–204 | 152 | 0.6 | 99.4 |
| *koliensis* | 64–112 | 85 | 99.5 | 0.5 |
| *farauti* | 78–170 | 118 | 38.0 | 62.0 |

* Measurements in microns.
† Ab. stands for abdominal segment.

*Legs:* Light brown to black with yellowish-white markings. Front femora swollen in basal half, light at base, speckled and blotched with light along anterior and posterior surfaces; dorsal surface of tibiae with evenly spaced small light spots, ventral surface light, anterior surface dark, posterior surface speckled with light areas the majority of which connect with the light ventral area; first tarsal segment with light apex and variable number of light spots which expand laterally and ventrally, reducing the dark areas on ventral surface; second and third segments light at base and apex, central dark area may be greatly reduced ventrally; fourth segment light at base and usually apex; fifth segment light or dark; segments two to four may have light spots in central dark area; ventral surfaces of all segments usually much lighter than dorsal. Middle and hind femora and tibiae speckled. First segment of middle and hind tarsi similar to corresponding segment of front tarsi; second, third, and fourth segments with narrow apical light bands; fifth usually all dark; second and third segments frequently with one or more light spots in central dark area; ventral and posterior surfaces of segments one and two usually lighter.

*Abdomen:* Integument dark brown; vestiture of golden hairs, denser on posterior segments. Scales absent on tergites I to V and sternites I–VI, a few scales on tergites VI and VII and sternite VII; rather dense scaling on tergite and sternite VIII. Cerci with dark scales at base, light on apex.

ADULT MALE.—Labium with at least two or three, usually numerous, ventral light spots, frequently with large patches of light scales. Second morphological segment of palpus with light patch dorsally in basal half; articulation between second and third segments without scales,

TABLE 2.—*Summary of diagnostic measurement data for pupae of* lungae *series*

| Species | Hair 1 of Ab. III Length | | | | Hair 1 of Ab. IV Length | | | |
|---|---|---|---|---|---|---|---|---|
| | Range | Ave. | % under 17 mic. | % 17 mic. or over | Range | Ave. | % under 17 mic. | % 17 mic. or over |
| *lungae* .... | 6–17 | 12 | 95.0 | 5.0 | 6–17 | 12 | 100.0 | 0.0 |
| *solomonis* . | 10–28 | 19 | 12.2 | 87.8 | 17–41 | 24 | 4.2 | 95.8 |

| Species | Hair 1 of Ab. V Length | | | |
|---|---|---|---|---|
| | Range | Ave. | % under 25 mic. | % 25 mic. or over |
| *lungae* .... | 10–24 | 14 | 100.0 | 0.0 |
| *solomonis* . | 27–75 | 58 | 0.0 | 100.0 |

light-colored; third segment dark on basal fifth, light-scaled to apical fourth, remainder dark except light preapical area extending laterally to apex or apex light; segments four and five narrowly dark at or near base, dark area extending on outer surface usually to apex of segments, remainder light. Claws normal.

*Genitalia:* As figured by Ross and Roberts (1943).

TABLE 3.—*Branches of diagnostic hairs of pupa*

| Species | Ab. I | | | | Ab. II | | | |
|---|---|---|---|---|---|---|---|---|
| | Hair 6 | | Hair 9 | | Hair 5 | | Hair 10 | |
| | Average | Range | Average | Range | Average | Range | Average | Range |
| *hollandi* ..... | 9 | 7–11 | 3 | 2–4 | 6 | 5–9 | 7 | 4–11 |
| *solomonis* ..... | 7 | 5–9 | 2 | 1–4 | 3 | 2–5 | 6 | 5–8 |
| *lungae* ..... | 6 | 5–7 | 1 | 1–2 | 3 | 1–4 | 7 | 5–10 |
| *punctulatus* .... | 5 | 3–8 | 1 | 1–1 | 1 | 1–2 | 18 | 7–38 |
| *koliensis* ..... | 5 | 4–6 | 1 | 1–1 | 1 | 1–1 | 5 | 2–9 |
| *farauti* ..... | 4 | 1–5 | 1 | 1–2 | 1 | 1–3 | 7 | 4–16 |

| Species | Ab. III | | | | Ab. IV | | | |
|---|---|---|---|---|---|---|---|---|
| | Hair 5 | | Hair 10 | | Hair 2 | | Hair 10 | |
| | Average | Range | Average | Range | Average | Range | Average | Range |
| *hollandi* ..... | 8 | 5–10 | 10 | 7–14 | 3 | 2–4 | 8 | 6–10 |
| *solomonis* ..... | 3 | 2–5 | 4 | 3–5 | 2 | 1–2 | 4 | 2–5 |
| *lungae* ..... | 2 | 1–2 | 4 | 3–6 | 2 | 1–3 | 3 | 2–5 |
| *punctulatus* .... | 1 | 1–3 | 10 | 4–16 | 1 | 1–2 | 6 | 4–8 |
| *koliensis* ..... | 1 | 1–2 | 10 | 7–13 | 1 | 1–2 | 7 | 5–9 |
| *farauti* ..... | 1 | 1–2 | 8 | 5–11 | 1 | 1–1 | 6 | 3–8 |

| Species | Ab. V | | | | Ab. VI | | | |
|---|---|---|---|---|---|---|---|---|
| | Hair 10 | | Hair 2 | | Hair 6 | | Hair 10 | |
| | Average | Range | Average | Range | Average | Range | Average | Range |
| *hollandi* ..... | 5 | 4–7 | 3 | 1–4 | 7 | 5–11 | 5 | 3–7 |
| *solomonis* ..... | 3 | 2–4 | 2 | 2–3 | 3 | 2–4 | 2 | 2–4 |
| *lungae* ..... | 3 | 2–4 | 2 | 1–3 | 4 | 3–5 | 2 | 1–4 |
| *punctulatus* .... | 3 | 2–4 | 2 | 1–3 | 4 | 3–5 | 1 | 1–3 |
| *koliensis* ..... | 4 | 3–6 | 1 | 1–1 | 4 | 2–5 | 2 | 1–3 |
| *farauti* ..... | 3 | 1–6 | 1 | 1–2 | 4 | 3–6 | 2 | 1–4 |

| Species | Ab. VII | | | | Ab. VIII | | | |
|---|---|---|---|---|---|---|---|---|
| | Hair 6 | | Hair 8 | | Hair 10 | | Hair 8 | |
| | Average | Range | Average | Range | Average | Range | Average | Range |
| *hollandi* ..... | 7 | 4–8 | 6 | 3–10 | 5 | 4–6 | 4 | 3–7 |
| *solomonis* ..... | 3 | 1–4 | 5 | 2–8 | 2 | 1–4 | 2 | 2–3 |
| *lungae* ..... | 4 | 2–6 | 4 | 3–6 | 1 | 1–2 | 2 | 2–3 |
| *punctulatus* .... | 4 | 3–5 | 4 | 2–5 | 1 | 1–2 | 2 | 1–3 |
| *koliensis* ..... | 4 | 3–5 | 3 | 2–4 | 1 | 1–2 | 3 | 2–4 |
| *farauti* ..... | 4 | 3–6 | 3 | 2–4 | 1 | 1–2 | 2 | 1–3 |

PUPA.—Tables 1 and 3 contain the data for the more important hair counts and measurements of this species.

*Cephalothorax:* Trumpet pale, with only slight pigmentation in the central area between the apex and the basal notch, offering little contrast to the cephalothorax. Index of width to length of head shield 1 : 0.90 (range 0.81–1.0). External margin of palpal case usually angulate. Internal margin of median keel sharply outlined. Metanotum with a distinct, smooth median bar, bounded laterally by a crease which is incomplete posteriorly. Details of chaetotaxy not noticeably different from those of *solomonis*.

*Abdomen:* On segment II, hair 2 on or very near to a longitudinal line through hair 3; on segment IV, hair 5 external to hair 8; on segments VI and VII, hair 2 distinctly anterior to the posterior margin of the segment. Lateral spine (hair 1) of segment IV approximately equal to the length of that of segment III; lateral spine of V several times the length of that on III, and two-thirds to three-fourths the length of that on VI; lateral spines of V–VII (Fig. 26, H) rarely branched, frayed or with irregular outline, extremely elongate and slender. Similar to *solomonis* in the remaining details of structure and chaetotaxy.

*Paddle:* Midrib with external margin distinct, completely without granulations in over 50 per cent of the specimens examined, when granulations present seldom completely filling the area of the midrib but arranged in slender skeins along its length. Buttress well developed. Fringe of fine pale hairs extending from center of external margin to a short distance internal to hair 12, longest just before this hair. Paddle hair (hair 12) straight or curved, rather stout, darkly pigmented.

*Genitalia:* Apex of lobes in male shaped as shown in Fig. 17. Female genitalia as in Fig. 21.

LARVA.—Anterior clypeal hairs unbranched, the outer half or less the length of the inner. Posterior clypeals single, usually long enough to reach the tubercles of the anterior clypeals. Occipitals long, inner single or double; outer 1–3 (rarely 4)-branched. Tubercles of prothoracic hairs 1 and 2 small, unpigmented, separated from one another; stem of hair 1 slender, at most slightly enlarged basally. Long thoracic pleural hairs all single. Hair 1 of abdominal segment I with short, hair-like branches. Palmate hairs present on segments II–VII, all small, especially on segment II; filament of leaflet almost as long as the shaft. Hairs 2 and 6 of abdominal segments IV and V usually 3-branched.

*Taxonomic Discussion.—A. punctulatus, farauti, koliensis,* and *moluccensis* form a closely related complex of species in the group *Neomyzomyia*. The combination of the presence of scales on the disc of the scutum, the absence of scales from all but the terminal abdominal segments, the speckling of the legs, and the broad apical light bands on the last two palpal segments (3rd palpal segment variable) separate the *punctulatus* series from all other *Neomyzomyia* in the Oriental and Australasian regions. The larvae can usually be recognized from other *Neomyzomyia* with unbranched pleural hairs by the single or frayed widely spaced inner clypeals, by the single, frayed, or occasionally branched outer clypeals, which are never minute, and by the posterior clypeals which at most barely project beyond the margin of the head. *A. watsoni* and *hackeri* exhibit similar characters but can be separated by the position of the clypeal hairs, the bases of the inner, outer, and posterior clypeals on one side forming an equilateral, scalene or isosceles triangle.

The larva of *moluccensis* from New Guinea appears to be similar in structure to that of *farauti,* in that the tubercles of the prothoracic submedian hairs are fused and hair 1 of abdominal segment I is distinctly palmate with flattened leaflets. However, according to Swellengrebel and Rodenwaldt (1932) the adults of this species have the small light ventral patch of the labium which is characteristic of *koliensis*. *A. koliensis* and *moluccensis* larvae are easily separated from one another. Until comparison can be made with the type of *moluccensis* and with reared material from New Guinea, the exact relationship of *moluccensis* to *farauti* and *koliensis* cannot be determined.

It has been suggested that hybridization occurs between various members of the *punctulatus* series. Although no conclusive cross-breeding experiments have been made, the fact that the progeny of all species except of one female *koliensis* bred

true indicates that hybridization in the area in question does not normally occur in nature even though the species exist side by side. *A punctulatus, farauti,* and *koliensis* can be separated from one another in the adult, pupal and larval stages. Therefore, we prefer to treat these forms as species, and not as subspecies of *punctulatus.*

*Distribution.*—GUADALCANAL. North coast: Tenamba, Umasami, Tassafaronga, Bonegi, Poha, Kokumbona, Matanikau, Lunga, Tenaru, Koli, Tetere; Southwest coast: West Cape. BOUGAINVILLE. Empress Augusta Bay (A. B. Gurney).

*Biology.*—On Guadalcanal, this species is restricted to the valleys of the larger streams and rivers, usually occurring in the vicinity of native villages away from the coast. Larvae have been collected most frequently exposed to sunlight in road ruts and other temporary pools such as depressions and footprints in native trails. The margins of streams and sloughs in exposed situations and pot holes in drying stream beds are also utilized occasionally, particularly during the dry season. The pools in which this species occurs may be entirely free of vegetation and flotage and frequently are very muddy, or may have marginal herbaceous vegetation and dense algal growth. *A. punctulatus* has a very decided preference for breeding in sunlight, but is also found in partial shade.

During periods of dry weather this species almost disappears as its chief breeding places are greatly reduced. At such times it resorts to breeding in streams. After an occasional heavy rain it appears in large numbers in temporary pools. During the rainy season *punctulatus* extends its range into the coastal plain near the mouths of the rivers and utilizes the same breeding places as *farauti.*

The larvae and pupae can usually be recognized in the field by the uniformly light opaque coloration of the body. They are extremely active, especially when crowded in small breeding places without vegetation and seem to spend a great deal of time under water in search of food.

Some information on the length of the aquatic cycle of *punctulatus* and *farauti* under natural conditions was obtained on Guadalcanal in early March 1944. With relatively low water temperature (70°–91° F.), high rainfall and unfavorable food supply (old oil film and euglenoid film), the larval stage was observed to last five days. Approximately one day was required for the completion of each of the first three instars, and two days for the fourth instar. As the eggs took slightly less than two days to hatch and the pupal stage lasted approximately 20 hours, the entire aquatic cycle from oviposition to emergence of the adults was accomplished in less than eight days. Under more favorable conditions it undoubtedly is reduced to less than a week. The possibility that eggs are laid in mud was indicated by the appearance of first instar larvae in isolated temporary pools less than a day after they had become filled with water. Puddles with larvae and pupae were observed to dry completely; when these were filled two days later fourth instar larvae and pupae appeared. It would appear from these observations that *punctulatus* and *farauti* are well adapted to breeding in temporary pools and may be able to survive at least short periods of dry weather in the egg and possibly also the larval and pupal stages. Further indications of the short aquatic cycle of *punctulatus* and its adaptation to breeding in temporary pools were obtained from observations on a colony of this species maintained for a period of three months during the dry season. Gravid females would not lay eggs in small water con-

tainers, but scattered them on the floor of the cages. Eggs were collected in large numbers on moist filter paper placed on the bottom of the cage. Hatching took place in less than two days after oviposition, all the first instar larvae appearing in less than one hour of each other. A strikingly uniform rate of development of the larvae was observed in this species and was different from all other local anophelines. At any one time in a batch of the same age, the larvae would be of the same instar and size, taking from six to seven days to pupation with adequate food supply.

The short time required for *punctulatus* and *farauti* to complete the aquatic cycle in nature is of considerable interest in relation to control operations directed against these species.

Although females of *punctulatus* feed readily in captivity, they do not appear to attack man often in nature on Guadalcanal. Less than one per cent of the total anophelines collected in routine night catches for a period of over a year have been *punctulatus*. Special efforts were made to collect adults in native villages and in the open in areas of high larval densities of this species on the northwest coast of Guadalcanal with the result that a single blooded female was obtained in a native hut, while *farauti* was collected at will in the open as well as in dwellings. On the northeast coast *punctulatus* has been collected in native camps and villages, but in smaller numbers than *koliensis* or *farauti*.

The diurnal resting places of the adults of this species are not known on Guadalcanal. They have been searched for on stream banks, in jungle areas near breeding places, and in the vicinity of native villages.

## *Anopheles* (*Myzomyia*) *farauti* Laveran

1902. *Anopheles Farauti* Laveran, C. R. Soc. Biol. Paris **54:** 908 (♀ ♀ only). **Type locality:** Faureville, Ile Vate, New Hebrides. **Types:** unknown.
1927. *Anopheles* (*Myzomyia*) *punctulatus* Doenitz. Buxton and Hopkins, Res. in Polynesia and Melanesia, p. 67.
1929. *Anopheles punctulatus* Doenitz. Paine and Edwards, Bull. Ent. Res. **20:** 304.
1931. *Anopheles punctulatus* Doenitz. Senevet, C. R. 2e Congr. Intern. Paludisme, Instit. Pasteur, Alger. **1:** 109.
1944. *Anopheles punctulatus farauti* Laveran. Knight and Farner, Proc. Ent. Soc. Wash. **46:** 132.
1944. *Anopheles farauti farauti* Laveran. Knight, Bohart and Bohart. Keys to the Mosquitoes of the Australasian Region. Nat. Res. Council, Wash., p. 11.

ADULT FEMALE.—In general as in *punctulatus*. Labium entirely dark-scaled except for narrow light ring at extreme apex; a few light scales rarely present on basal half. Third morphological palpal segment usually with narrow apical light ring separated from larger subapical light area by dark ring; these pale markings, especially the subapical spot, frequently reduced, sometimes subapical completely absent. Small dark sectoral spot usually present on costa between basal and median dark spots. Buccopharyngeal armature as in *punctulatus*.

ADULT MALE.—In general as in *punctulatus*. Labium entirely dark-scaled except for narrow light ring at extreme apex. Small dark sectoral spot usually present on costa between basal and median dark spots.

*Genitalia:* Similar to those of *punctulatus*.

PUPA.—The three terminal abdominal segments of this species were figured by Buxton and Hopkins (1927) from New Hebridean specimens. Senevet (1931) described and illustrated the dorsal and ventral chaetotaxy of an anopheline from Iles Salomon (Solomon Islands ?) which he identified as *punctulatus*. However, from the incomplete figure given by Senevet, it appears that his specimens were *farauti*. Tables 1 and 3 contain the data for the more important hair counts and measurements made for this species. Similar to the pupa of *punctulatus* except for the following:

*Cephalothorax:* Trumpet orange-brown, contrasting noticeably to cephalothorax, pigmented area extending basad from the apex at least to the basal notch. Index of width to length of head shield 1 : 0.88 (range 0.65–1.11).

*Abdomen:* On segment IV, hair 5 internal to or in line with hair 8. Lateral spine (hair 1) of segment IV approximately twice the length of that of III; lateral spines of segments V–VI may occasionally have one or more minute lateral branches, or even be terminally frayed; lateral spine of segment VII (Figs. 26, D and E) elongate, stout, acutely tapered, usually branched or frayed; frequently those without obvious branching give the impression of possessing branches that are not separated from the shaft.

*Paddle:* Midrib usually evenly granulated.

LARVA.—Anterior clypeal hairs usually frayed; outer at least half the length of the inner; posterior clypeals long, extending beyond the anterior tubercles, usually single, sometimes 2-branched. Occipital hairs short; inner 1–2 (rarely 3)-branched, outer 1–4 (rarely 5–6)-branched. Tubercles of prothoracic hairs 1 and 2 long, pigmented, and almost always fused; stem of hair 1 swollen basally. Hair I of abdominal segment I a definite palmate tuft, with flattened, notched leaflets. Palmate hairs also present on segments II–VII; those on segment II pigmented and only slightly smaller than those on segment III. Leaflets with long filaments, sometimes almost the length of the shaft. Hairs 2 and 6 of abdominal segments IV and V usually double.

*Variation.*—On Guadalcanal in areas where there is little chance for human contact such as near abandoned native villages or campsites and beyond the edge of the controlled territory, the larvae of *farauti* are somewhat different from those reared in the laboratory in that the outer clypeals and outer occipitals exhibit heavier branching. A similar condition exists in more darkly pigmented larvae collected in the control area. Adults bred from larvae collected in such areas do not feed readily on humans. This seems to indicate the presence on Guadalcanal of a "wild" strain of *farauti.*

*Taxonomic Discussion.*—See under *A. punctulatus.*

*Distribution.*—NEW HEBRIDES: EFATE. Faureville (Laveran, 1902), Teuma and Havannah Harbor (Buxton and Hopkins, 1927), generally distributed along the coastal areas. ESPIRITU SANTO. Big Bay (Buxton and Hopkins, 1927), generally distributed along the southeastern and southern coastal area. AORE. MALO. TANNA. Whitesands (Buxton and Hopkins, 1927). MAI. (Buxton and Hopkins, 1927). MALEKULA. Tisman (Buxton and Hopkins, 1927), Port Sandwich. SOLOMON ISLANDS: GUADALCANAL. Generally distributed along the entire coast, has been collected on the north coast from Marovovo to Aola Bay, and at West Cape on the southwest coast. MALAITA (S. M. Lambert, J. R. Douglas). TULAGI. FLORIDA. SAVO. RUSSELL ISLANDS (W. G. Downs). NEW GEORGIA GROUP (W. G. Downs, J. G. Franclemont). BOUGAINVILLE. Empress Augusta Bay (A. B. Gurney). TREASURY ISLANDS (J. H. Paullus).

*Biology.*—The natural breeding places of this species consist primarily of river and stream margins with vegetation, springs, wells, seepage areas, taro gardens, ponds, lagoons, and swamps, all in open coastal areas. Even when these breeding areas are greatly reduced *farauti* does not invade such habitats as undisturbed dense canebrake marshes, or large open sunlit swamps in the jungle filled with floating and emergent vegetation. Normally, the breeding does not extend far from settled areas, usually not more than a mile, unless the jungle is cleared. However, breeding will often persist in areas once occupied, but later abandoned. Following heavy rains any of the very numerous temporary pools formed in the open coastal areas are utilized by this species. These may be natural or man-made water-holding depressions such as puddles, hog wallows, ruts, holes, hoofprints, bases of uprooted trees, borrow pits, poorly graded ditches and occasionally holes in coral above high tide mark. Frequent floods of the larger streams and rivers eliminate them as important breeding places during periods of high rainfall. When the species is denied breeding areas on the ground or when it becomes extremely abundant, it

resorts to breeding in artificial containers to a limited degree. At such times it has been collected in boats, tanks, oil drums, water collections in canvas, and even small tin cans.

The aquatic stages of *farauti* have a definite preference for sunlight, but are very frequently collected in large numbers under partial shade, rarely being found in very dense shade. This species tolerates a wide range of conditions, utilizing all types of water from highly turbid to clear spring water, from stagnant, foul or brackish to fresh rain water. It is not found in water collections in plants, such as leaf or frond axils, cocoanut shells, cacao pods, or tree holes, nor does it occur in water with high organic content, such as is found in jungle swamps. In almost all cases, breeding in extensive water areas is associated with flotage and emergent or surface vegetation. However, in small confined places such as pools, puddles, and road ruts, larvae will commonly be found on the open surface.

*A. farauti* is frequently associated with *punctulatus* where the latter is present in temporary pools during the rainy season. In the dry season it is found together with *B. hollandi* and *A. lungae* along the more exposed stream margins. The culicines most frequently associated with *farauti* are *Culex annulirostris* Skuse, *C. basicinctus* Edw. (New Hebrides), *C. squamosus* (Taylor), (Solomons), *C. jepsoni* Theo., *C. pullus* Theo. (Solomons), and during the rainy season various species of flood-water *Aedes*.

Larvae collected in the field frequently have a dark pigmentation mottled with light areas, but they may be just as light as those of *punctulatus* or greenish depending on the type of breeding place. Usually the antennae are darkly pigmented.

The aquatic cycle appears to be very short. It has been discussed under *punctulatus*.

Adult females enter any type of shelter in search of human blood, and readily bite out of doors. Feeding takes place generally from dusk to dawn. However, a number of daytime biting records have been obtained. In most cases, these attacks were in covered or shaded areas, but a few were made directly in bright sunlight. The flight is relatively quiet and the females are shy and wary in their approach, easily frightened away by movements, but persistent in returning to attack. In houses or tents where lights were present, they will feed most readily in dark corners and on shaded portions of the body. Their bite is noticeably painless to many individuals. Throughout the area covered by this report, except for isolated areas in the Koli district on Guadalcanal, *farauti* is the principal anopheline attacking man. On the northwest coast of Guadalcanal, 98 per cent of anophelines in routine night catches conducted for a period of over a year were this species.

The diurnal resting places for males and females apparently consist of nearly any cool, moist and shaded spot. Adults of *farauti* have been collected on Guadalcanal resting on buttressed tree trunks and under logs in swampy jungle areas in association with *lungae* and *solomonis,* but never in large numbers. In the New Hebrides they have been found among roots of banyan trees, weeds and grass, in open barrels, tin cans and wooden boxes, on shaded, moist earthen walls of pits and holes, and in moist situations beneath large felled logs. Resting blooded females may be collected at will in occupied houses and native huts, the sites being generally dark and somewhat secluded, such as in the folds of clothing and mosquito nets, on the undersurface of furniture, rafters and hanging objects and upon walls and low ceilings. They are commonly found from the ground surface to a height

of seven feet. On Guadalcanal they have been collected in native huts and tents under extremely high temperature in the middle of the day.

No definite information is available on flight range. Our records show several instances of adults having been captured at least one mile from the nearest known breeding area. On Espiritu Santo a blooded female was found by R. H. Daggy on a boat 600 yards off shore in the channel. Adults are commonly taken up to 400 yards from breeding areas.

Although no comprehensive data are available on the longevity of *farauti,* several females were kept alive in a small laboratory cage for approximately 35 days. The males, which were introduced at the same time, survived less than two weeks. Both insectary and cage mating have been obtained with this species. Although on Espiritu Santo and Efate colonies were readily established, such attempts on Guadalcanal met with great difficulty. This may be due in part to that fact that larvae were collected along the margin of the control area in places where human blood was not available. Under the section on variation above, the differences in the morphology of larvae found in such areas are discussed and the possibility of the existence of a "wild" strain of *farauti* is suggested.

### *Anopheles* (*Myzomyia*) *koliensis* Owen

1945. *Anopheles punctulatus koliensis* Owen, 1945. **Type locality:** Koli area, Guadalcanal, **Types:** U. S. National Museum.

ADULT FEMALE.—In general as in *punctulatus.* Apical third of labium with ventral area of pale scales; usually a well-defined ventral patch, which may extend dorsally in form of pale band at its anterior extremity; rarely pale markings reduced to a few scales ventrally; very rarely apical third dark-scaled as in *farauti* or extensively pale-scaled as in *punctulatus;* dorsal pale area when present not as extensive as in *punctulatus;* a few pale scales in basal half of labium may be present. Usually no small dark sectoral spot on costa between basal and median dark spots. Dark coloration of legs usually more extensive than in *punctulatus,* extending to ventral surface of tarsal segments. Buccopharyngeal armature as in *punctulatus.*

ADULT MALE.—In general as in *punctulatus.* Labium usually entirely dark-scaled except for a narrow apical light ring at extreme apex. Wings and legs as in female *koliensis.*

*Genitalia:* similar to *punctulatus.*

PUPA.—The pupa of this species is quite similar to that of *farauti.* Tables 1 and 3 give the data for the hair counts and measurements that have diagnostic value.

*Cephalothorax:* Index of width to length of head shield 1 : 0.88 (range 0.76–1.0).

*Abdomen:* Hair 5 of segment IV is frequently (35 per cent) external to hair 8, whereas in *farauti* it is in line or internal to hair 8 (91 per cent). Lateral spine of segment 7 (Fig. 26, F) stout, acutely tapered from base, only rarely branched, but when so of a distinctive type (Fig. 26, G).

*Paddle:* Midrib incompletely granulated, or occasionally granules entirely missing.

*Genitalia:* Apices of lobes in male distinctively shaped (Fig. 18).

LARVA.—Anterior clypeal hairs either simple or slightly frayed; outer half or more the length of the inner; posterior clypeals single and very short, not extending to the tubercles of the anterior hairs. Occipital hairs short; inner 2–4-branched; outer usually 5–9-, occasionally 3–4-branched. Tubercles of prothoracic hairs 1 and 2 usually separated; stem of hair 1 swollen. All long hairs of thoracic pleural groups single. Hair 1 of abdominal segment I with long, narrow, hair-like branches. Palmate hairs present on segments II–VII, those on segment II only slightly smaller than those on segment III. Filament of leaflets almost as long as the shaft. Hairs 2 and 6 of abdominal segments IV and V usually 2, sometimes 3-branched.

*Taxonomic Discussion.*—See under *A. punctulatus.*

*Distribution.*—GUADALCANAL. North coast from Malimbu River east to Aola Bay (W. B. Owen); absent from the northwest coast.

*Biology.*—Owen collected the larvae of this species in water exposed to sunlight from temporary pools in grasslands and along the edge of the jungle in association with *farauti* and once in association with both *farauti* and *punctulatus.* They were scarce in comparison with the other anophelines collected. The adults are

strongly anthropophilic. Where blooded females have been collected in the daytime resting in native huts and tents they have formed 90 per cent of the anopheline population. During the dry season they become active about 9:00 PM, the greatest activity occurring after midnight and continuing until daylight (W. B. Owen).

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## Explanation of Plates

### Plate I—Egg and Adult

Fig. 1. *A. solomonis*—Wing.
Fig. 2. *A. solomonis*—Head, proboscis and palpus.
Fig. 3. *B. hollandi*—Male genitalia.
Fig. 4. *B. hollandi*—Lateral aspect of claspette.
Fig. 5. *A. lungae*—Buccopharyngeal armature.
Fig. 6. *A. solomonis*—Buccopharyngeal armature.
Fig. 7. *B. hollandi*—Egg.

### Plate II—Larva

Fig. 8. *B. hollandi*—Head of larva.
Fig. 9. *B. hollandi*—Prothoracic submedian group.
Fig. 10. *B. hollandi*—Ventral aspect of left prothoracic pleural group.
Fig. 11. *B. hollandi*—Ventral aspect of left mesothoracic pleural group.
Fig. 12. *B. hollandi*—Ventral aspect of left metathoracic pleural group.
Fig. 13. *A. solomonis*—Ventral aspect of left prothoracic pleural group.
Fig. 14. *A. solomonis*—Ventral aspect of left metathoracic pleural group.
Fig. 15. *A. lungae*—Ventral aspect of left prothoracic pleural group.

### Plate III—Pupa

Fig. 16. *B. hollandi*—Dorsal and ventral aspect of metanotum and abdomen.
Fig. 17. *A. solomonis*—Male genitalia.
Fig. 18. *A. koliensis*—Male genitalia.
Fig. 19. *B. hollandi*—Paddle.
Fig. 20. *A. solomonis*—Paddle.
Fig. 21. *A. farauti*—Female genitalia.
Fig. 22. *B. hollandi*—Male genitalia.
Fig. 23. *B. hollandi*—Trumpet.
Fig. 24. *B. hollandi*—Female genitalia.
Fig. 25. *B. hollandi*—Lateral spine (hair 1) of abdominal segment VII.
Fig. 26, A. *A. solomonis*—Lateral spine of abdominal segment VII.
Fig. 26, B and C. *A. lungae*—Lateral spine of abdominal segment VII.
Fig. 26, D and E. *A. farauti*—Lateral spine of abdominal segment VII.
Fig. 26, F and G. *A. koliensis*—Lateral spine of abdominal segment VII.
Fig. 26, H. *A. punctulatus*—Lateral spine of abdominal segment VII.
Fig. 27. *B. hollandi*—Anterior portion of cephalothorax.

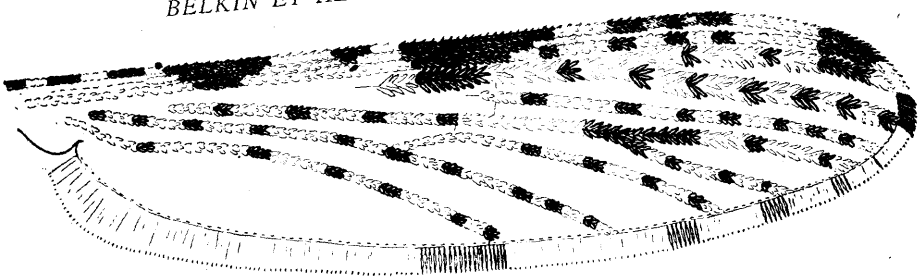

FIG. 1

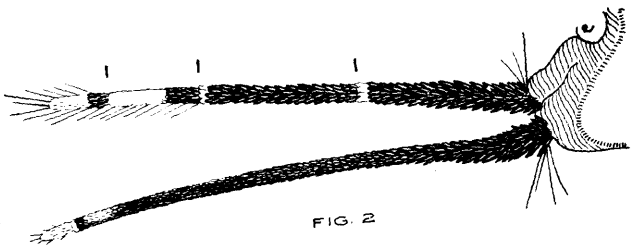

FIG. 2

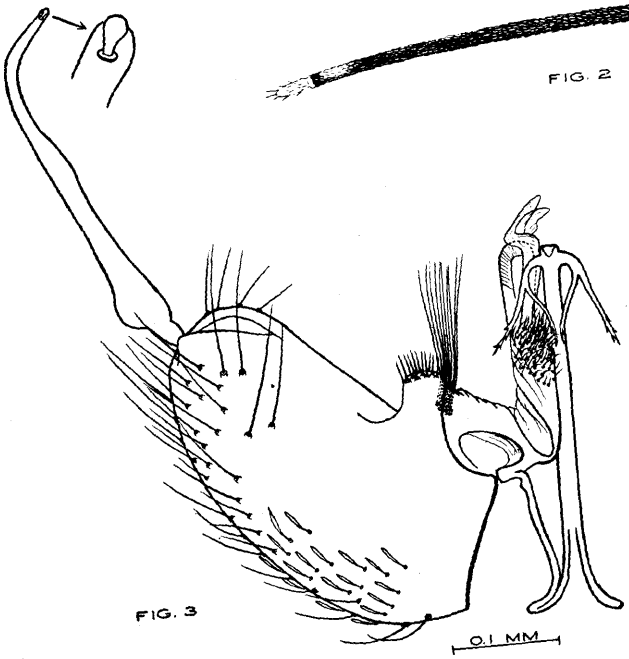


FIG. 3

FIG. 4

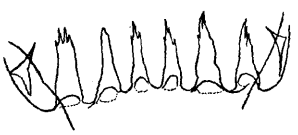

FIG. 5

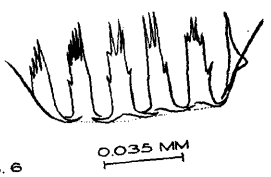


FIG. 6

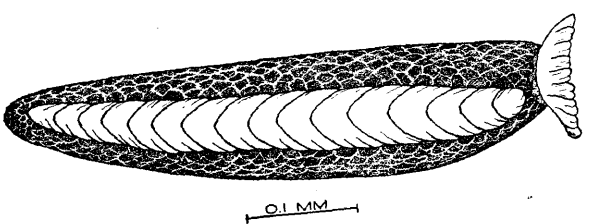


FIG. 7

PLATE I

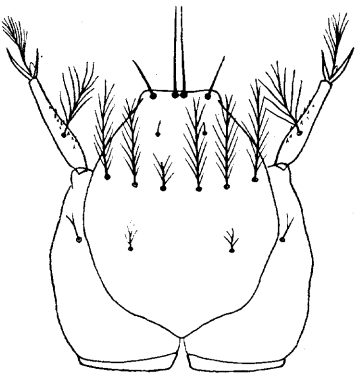

FIG. 8

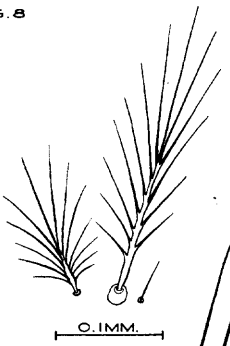


FIG. 9

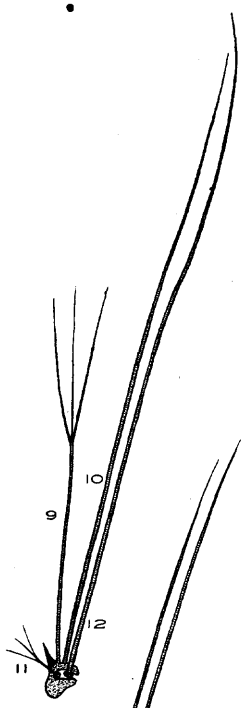


FIG. 10

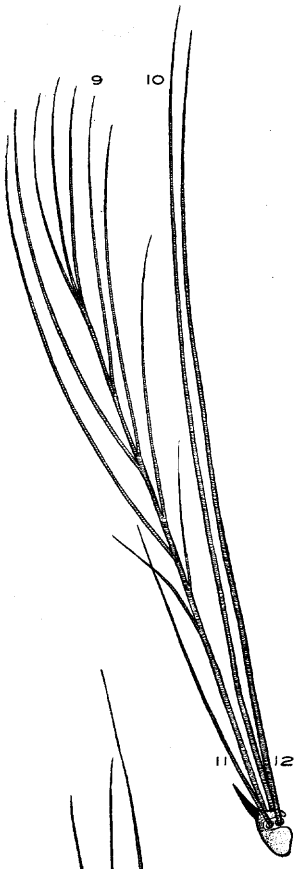


FIG. 13

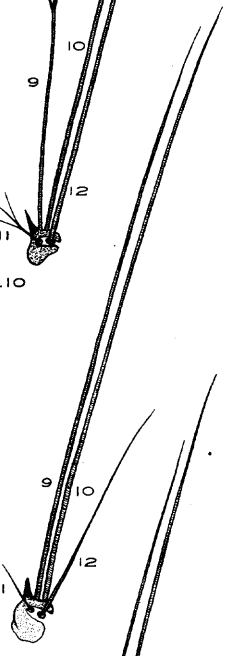


FIG. 11

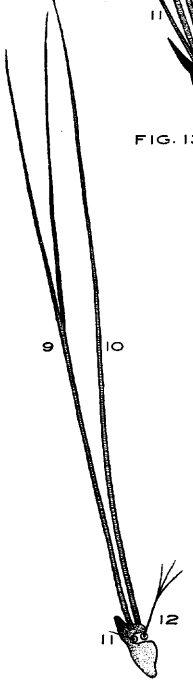


FIG. 14

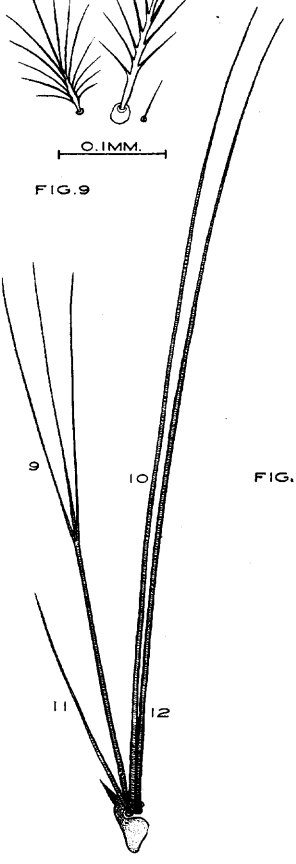


FIG. 15

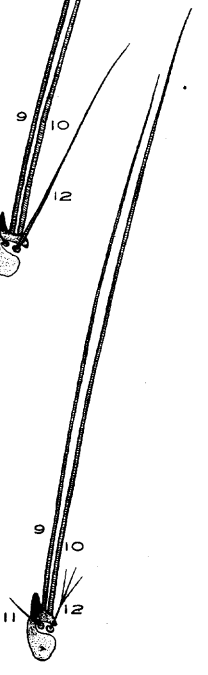


FIG. 12

PLATE II