

ENTOMOLOGY.—*The mosquitoes of Ponape Island, eastern Carolines.*<sup>1</sup> KENNETH L. KNIGHT<sup>2</sup> and HERBERT S. HURLBUT,<sup>3</sup> Naval Medical Research Institute, Bethesda, Md.

This paper is based upon a collection of mosquitoes (Diptera-Culicidae) made by the junior author on Ponape Island early in 1948. Six species are treated, of which three are described as being new. Bohart and Ingram (1946), in a comprehensive treatment of the mosquitoes of the Caroline Islands, record 14 species as occurring in the whole island group. The three new species here described bring the total number known for the Carolines up to 17, of which 12 appear to be endemic. Farner (1944a and 1944b), in a review of the literature relating to the mosquitoes of the Caroline Islands, lists only three species for the island of Ponape: *Culex quinquefasciatus* Say, *Aedes aegypti* (Linnaeus), and an unidentified small dark mosquito species from Japuteick Island in Ponape harbor.

All holotypes are to be deposited in the U. S. National Museum; and the paratypes in the U. S. National Museum, the British Museum (Natural History), the Bishop Museum, Honolulu, and the California Academy of Sciences.

The help of John I. Thomas, HMC, U. S. Navy, in making this collection is gratefully acknowledged.

<sup>1</sup> Received September 27, 1948.

<sup>2</sup> Lieutenant Commander, MSC, U. S. Navy.

<sup>3</sup> Commander, MSC, U. S. Navy.

DESCRIPTION OF THE ISLAND

The island of Ponape is located in the eastern Carolines (lat. 6° 55' N., long. 158° 15' E). It has an area of approximately 145 square miles and is roughly circular in outline, with a diameter of about 13 miles. A coral reef surrounds the island, with an intervening shallow lagoon. The island is completely fringed by mangrove swamps which vary in width from a few yards to a mile. There is little or no coastal plain. A foothill belt of about 1 mile in width rises almost directly from the water's edge. There are extensive coconut groves in this zone, and cleared areas are found in the broader valleys on the north, west, and east. The remainder of the interior is mountainous and heavily wooded, with numerous peaks above 2,000 feet and a maximum elevation of 2,595 feet.

The annual rainfall is extremely heavy, probably averaging between 255 and 300 inches at Colonia on the north coast. There are about 300 rainy days per year. The wettest months are April through September, and the driest in January and February, which average about 10 inches each. The mean annual temperature is 83° F. There is little seasonal variation. The winds are south to southeast in August to October and northeast the rest of the year.

The strongest winds occur from December to March.

The island is divided into five civil districts: Not, U, Matalanim, Kiti, and Sokas, in a pie-like arrangement proceeding around the coast in a clockwise direction. The largest settlement is at Colonia on the north side, where the Civil Administration Unit is located. Other small settlements are located at Matalanim on the east coast and at Ronkiti and Wani Kiti on the west. The interior is uninhabited. The localities indicated on the sketch map (Fig. 1) are not villages in the usual sense but groups of widely separated dwellings scattered over areas of a square mile or more. The native population is Micronesian and totals about

5,000. There is little agriculture except for small patches of yams, taro, sugarcane, and bananas. Most of the coast is accessible only by trails and by boat. About ten miles of motor road exist on the north side. The interior has no roads and only a few trails.

KEY TO THE ADULTS

- 1. Tarsi dark..... 2  
Tarsi with definite pale markings..... 4
- 2. Pleuron prominently marked by 2 longitudinal broad dark integumental bands, the ventral one terminating medially on sternopleuron; no pleural scale patches.....  
*Culex (Culicomyia) pullus maplei*, n. subsp.
- Pleuron not marked by dark integumental bands; 3 or more pleural scale patches present..... 3

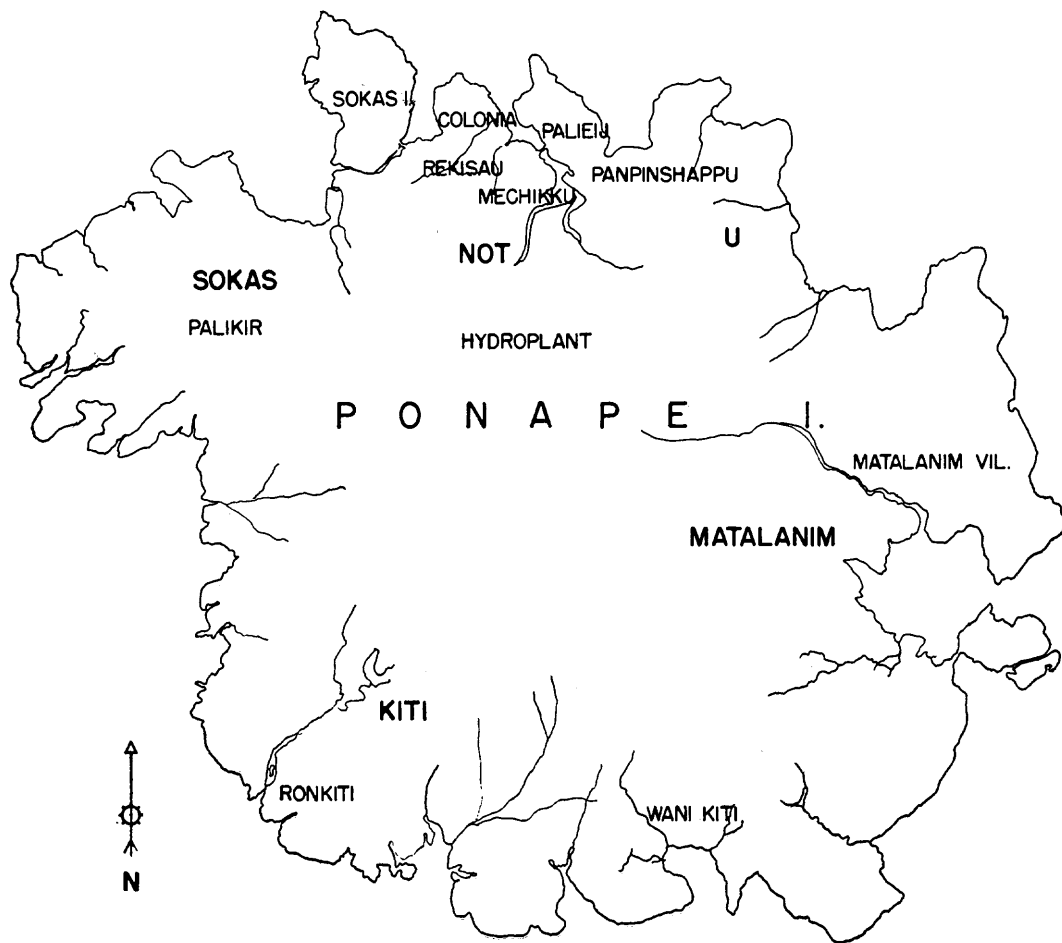


FIG. 1.—Map of Ponape Island. Specific localities labeled are those where collections were made.

3. Scutellum with narrow black scales (usually a variable number of narrow yellow scales present basally); postspiracular bristles present; scutum clothed with sparse hairlike black scales and marked with several rather indefinite patches of yellow scales.....  
*Aedes (Aedimorphus) senyavinensis*, n. sp.  
 Scutellum with narrow pale yellowish scales; no postspiracular bristles; scutum clothed with narrow brownish-yellow to brownish scales. *Culex (Culex) quinquefasciatus* Say
4. Proboscis banded; dorsal vertex scales narrow.....  
*Culex (Culex) annulirostris* Skuse  
 Proboscis dark; dorsal vertex scales nearly all broad..... 5
5. Fifth hind tarsal segment all white; scutum with a pair of thin admedian longitudinal pale lines and a rather broad crescent-shaped area of broad silvery scales on lateral margin over *ppn*.....  
*Aedes (Stegomyia) aegypti* (Linnaeus)  
 Fifth hind tarsal segment with at least apical half dark; scutum with a complete median longitudinal pale band that tapers posteriorly to prescutellar area and there forks to posterior scutal margin.....  
*Aedes (Stegomyia) hakanssoni*, n. sp.
3. Meso- and metathoracic pleural hair tufts each with a prominent basal spine; comb teeth with prominent lateral denticles (Fig. 20)..... 3  
*aegypti* (Linnaeus)  
 Meso- and metathoracic pleural hair tufts not bearing a prominent basal spine; comb teeth with only a very fine basolateral fringe (Fig. 21).....  
*hakanssoni*, n. sp.
4. Siphon with six pairs of hair tufts (Fig. 24).....  
*annulirostris* Skuse  
 Siphon with not more than four pairs of hair tufts..... 5
5. Siphon with 3 pairs of hair tufts, all in a line; siphon tapered from base (Fig. 23).....  
*pullus maplei*, n. subsp.  
 Siphon with 4 pairs of hair tufts, third pair dorsally out of line to others; siphon tapered from about basal two-fifths (Fig. 22).....  
*quinquefasciatus* Say

***Aedes (Stegomyia) aegypti* (Linnaeus)**

Figs. 2, 14, 20

A medium-sized brown, or black, and white species; with a dark proboscis, all hind tarsal segments basally banded (V all white), vertex scales nearly all broad, numerous white pleural scale patches (not forming definite bands), and pale dorsobasal bands and separate lateral white spots on the tergites. The scutum is distinctively marked as follows: Two thin admedian longitudinal lines of narrow pale scales from near anterior margin to shortly before the prescutellar space, a small anteromedian spot of narrow pale scales, a rather broad crescent-shaped area of broad curved silvery scales on the lateral margin over *ppn* and along the scutal angle, a thin line of narrow white scales extending to the posterior margin from the end of the scutal angle, a patch of broad curved white scales before the wing base with a thin posterior extension above the wing base, and a line of narrow pale scales around the prescutellar space.

In general, the Ponape material showed the same range of variation common to *aegypti* elsewhere in its geographic range.

*Bionomics*.—The adults were not observed in nature. The larvae, which were taken only once, were collected from steel rain barrels.

*Distribution*.—SPECIMENS EXAMINED (4 males, 5 females, 9 sets of adult-associated larval and pupal skins, 4 larvae): Greenwich Village, near Colonia.

LITERATURE RECORDS FOR THE CAROLINES: Ponape (Farner, 1944a). Kusaie, Truk Atoll: Moen I. (Bohart and Ingram, 1946).

KEY TO THE PUPAE

1. Only 1 terminal hair present on each paddle (*Aedes*)..... 2  
 Two terminal hairs present on each paddle, one dorsal and the other ventral (*Culex*)..... 4
2. Paddles with a prominent marginal fringe of long hairs (Fig. 11).....  
*hakanssoni*, n. sp.  
 Paddles not possessing a marginal fringe of hairs..... 3
3. Hair 8 on abdominal segments II-VI prominent and distinctly spinelike in form; posterior half of paddle margin distinctly denticulate (Fig. 14).....  
*aegypti* (Linnaeus)  
 Hair 8 on abdominal segments II-VI very small and not spinelike; posterior half of paddle margin smooth and rather indistinct (Fig. 15).....  
*senyavinensis*, n. sp.
4. Hair 5 on abdominal segments IV-VI double (rarely single) (dorsal paddle hair approximately twice length of ventral hair).....  
*quinquefasciatus* Say  
 Hair 5 on one or more of segments IV-VI with more than 2 branches..... 5
5. Hair 5 on abdominal segments V and VI with 2 or 3 branches; metathorax largely, or entirely, brown.....  
*annulirostris* Skuse  
 Hair 5 on abdominal segments V and VI nearly always with 5 or 6 branches; lateral half, or more, of the metathorax unpigmented (clear).....  
*pullus maplei*, n. subsp.

KEY TO THE LARVAE

1. Siphon with 1 pair of hair tufts (*Aedes*)..... 2  
 Siphon with 3 or more pairs of hair tufts (*Culex*)..... 4
2. Comb teeth scalelike and arranged in a patch (Fig. 19).....  
*senyavinensis*, n. sp.

*Systematics.*—This species of *Stegomyia* was placed by Edwards (1932) in group A (*Stegomyia* s. str., or *aegypti*-group), which is a group composed of African species (undoubtedly the original home of *aegypti* also). The members of this group are distinct from all the Pacific species of *Stegomyia* in details of the scutal scale pattern, and in the possession of a prominent mesoventral arm basally on the tenth sternite.

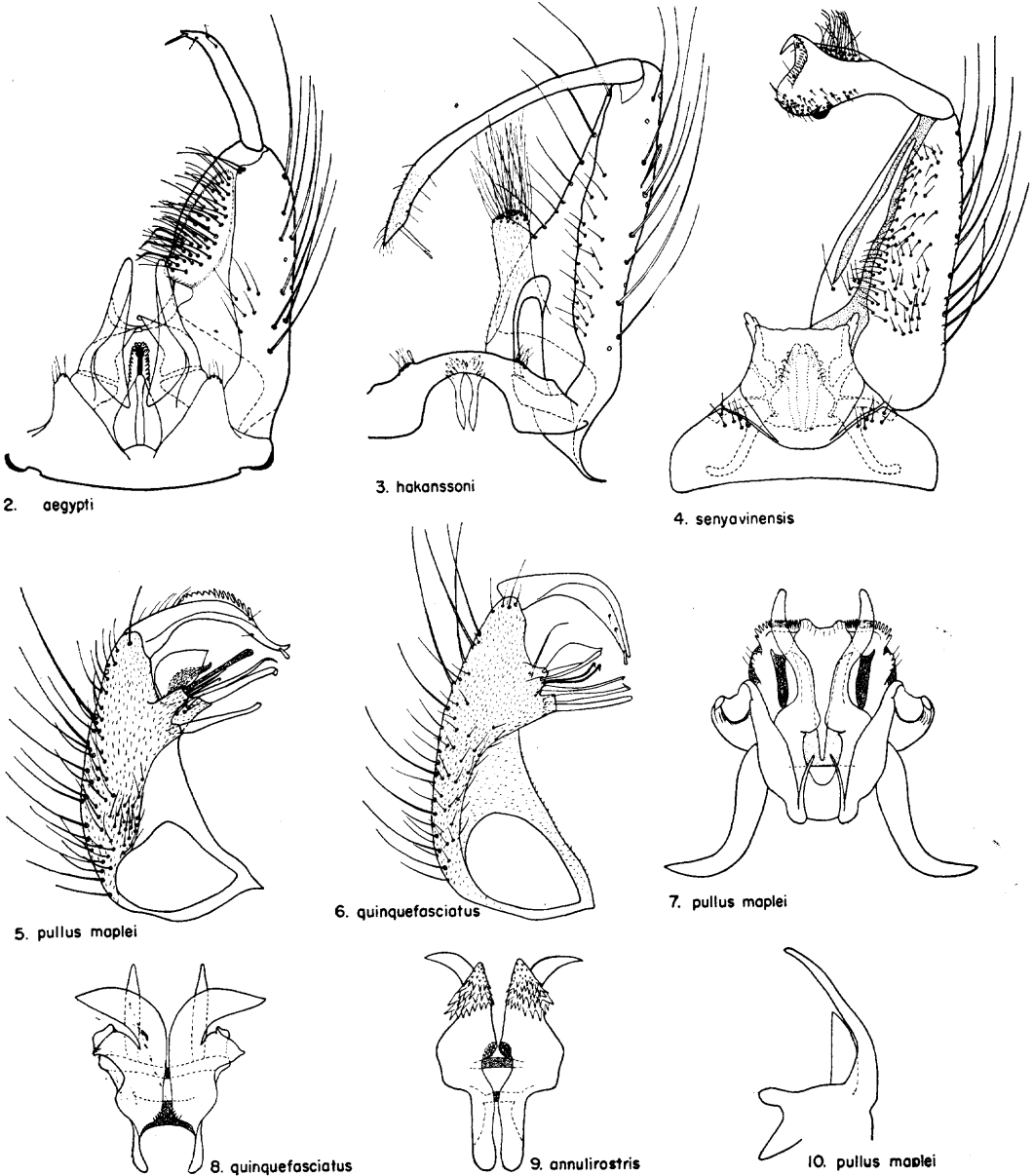
*Relation to disease.*—This species is a proven

vector of dengue elsewhere in the Pacific and is undoubtedly also the vector on Ponape. Epidemics of this disease occurred during the Japanese occupation of the Caroline Islands.

***Aedes (Stegomyia) hakanssoni*, n. sp.**

Figs. 3, 11, 13, 16, 21

*Adult.*—A small black-and-white (the scutal pale markings yellowish) species; with a dark



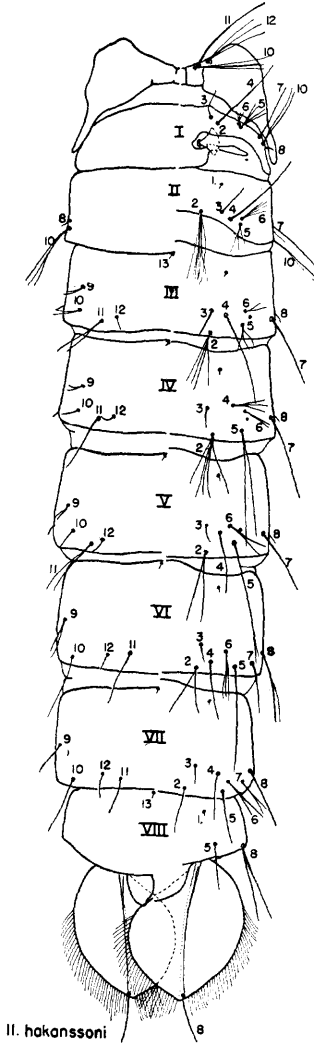
FIGS. 2-10.—Male genitalia: 2-4, Tergal aspect, left basistyle removed; 5, 6, mesal aspect of right basistyle; 7-9, sternal aspect of mesosome; 10, lateral aspect of right mesosomal lateral plate.

proboscis, all hind tarsal segments basally banded, vertex scales all broad, the white pleural scale patches forming two longitudinal bands across the pleuron, and prominent basolateral white spots on the tergites (becoming subbasal on the margins of the dorsum).

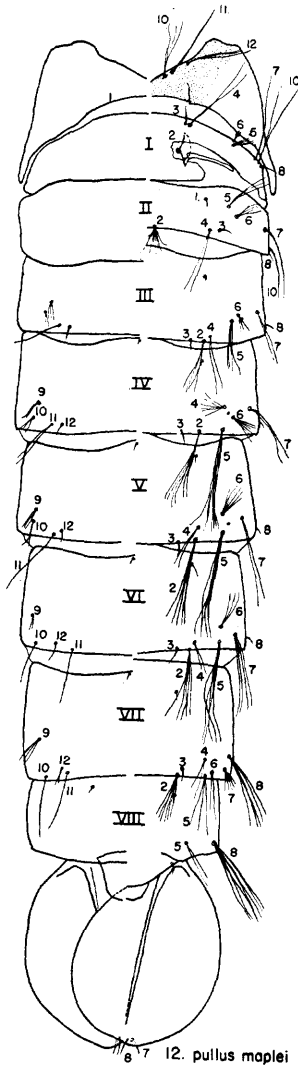
**MALE:** Length of wing about 2.0–2.5 mm. *Head:* Proboscis dark. Palpal length variable, ranging from somewhat shorter than proboscis to slightly longer; dark scaled, II with a white band just before the middle, III–V each with a basal white band, the bands on II–III incomplete ventrally, those on IV–V incomplete dorsally; IV and V somewhat upturned; a few stiff hairs apically on III–V. Torus partially clothed with broad white scales. Vertex with white or cream colored broad scales, broken on either side by two longitudinal bands of broad black scales, the alternating dark and pale bands being approximately equal in width; a line of pale scales extending along the eye margin from the subdorsal white area to the median line; some dark and pale upright forked scales on the nape. *Thorax:* Scutum with narrow black scales, prominently marked with whitish or yellowish-white scales as follows: A complete median longitudinal pale band that tapers posteriorly to the prescutellar area and there forks to the posterior margin of the scutum; a thin line of pale scales along the anterior scutal margin, over *ppn*, inward along the scutal angle and there extending posteriorly from the end of the scutal angle to the lateral scutellar lobe; and a patch of pale scales on the lateral margin just before the wing base with a thin posterior extension above the wing base; no acrostichal bristles. Scutellar lobes each with a patch of broad scales, those on the midlobe dark except for a few basal white scales (rarely no white scales), those on the lateral lobes all white. *Apn* with broad white scales; *ppn* with sparse narrow dark scales dorsally, broad white scales ventrally. Following pleural areas each with a patch of broad white scales: proepisternal, subspiracular (along the anterior margin of the sternopleuron), paratergite, dorsal sternopleural, medioposterior sternopleural, and mesepimeral (broadly V-shaped with apex directed anteriorly). The scale patches of *apn*, *ppn*, and the paratergite form an upper longitudinal pleural band and those of the proepisternum, dorsal sternopleuron, and the dorsal arm of the mesepimeral patch form a lower longitudinal pleural band. *Legs:* Forecoxa white scaled except for a median dark patch; mid coxa with white scales above

and dark below, a few separate white scales dorsoposteriorly; hind coxa with white scales anteriorly, a small detached spot of white scales dorsoposteriorly. Fore and mid femora dark anteriorly except that in some cases a thin edging of white is visible along portions of the margins, prominently marked with pale scaling posteriorly. Hind femur white, with a dorsal dark area beginning subbasally or medially and widening across the anterior and posterior surfaces to just before the apex. Each of the femora with an anterior white knee spot. Tibiae dark, fore and mid with pale scales posteriorly, hind sometimes with a ventrobasal pale scaled area. Fore and mid tarsi with basal white scales on I and II, the pale spot on II consisting of only a few scales. Hind tarsus with basal white bands on I–V, that on I occupying about one-fourth of the segment, on II about one-third, on III about two-fifths, on IV a lateral patch only and varying from two- to three-fifths of the segment length, and on V a lateral patch varying from just a few basal pale scales to extending along one-half of the segment, the bands on I–III incomplete mesally. Fore and mid tarsal claws unequal, the larger unidentate, the smaller simple; hind tarsal claws equal, simple. *Wings:* Wing dark scaled; bases of fork cells approximately even; anterior fork cell approximately equal to its stem (may be up to one-third longer). Halter pale, knob largely pale scaled. *Abdomen:* Tergite I dark except for a white lateral band; II–VII dark, each marked with a prominent laterobasal white patch which extends subbasally just onto the margins of the dorsum, frequently scattered subbasal white scales across the dorsum between these dorsal extensions. Sternites with basal white bands, white scales along the midline and the posterior margins of the more basal segments. *Genitalia* (Fig. 3): Dististyle appendage subapical. Basal lobe prominent, bearing a dense apical tuft of long setae. Mesosome with about 6–8 strong teeth apically on each plate. Ninth tergite medially convex, the lobes each with a sparse tuft of small setae.

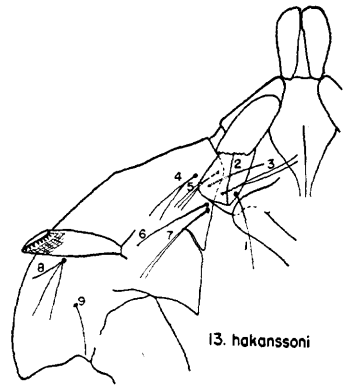
**FEMALE:** Length of wing about 2.7–2.9 mm. Palpus approximately one-fifth the length of the proboscis, broadly white at apex. Vertex as in male except that the median white band is only one-half as wide as the following black band. Portions of pale-scaled line over *ppn* and posteriorly from the scutal angle may be lacking. Scutellar lobes each with a patch of broad black scales, sometimes a few basal white scales present



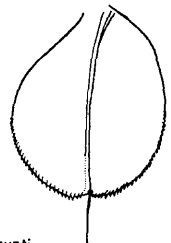
11. *hakanssoni*



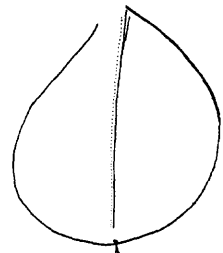
12. *pullus maplei*



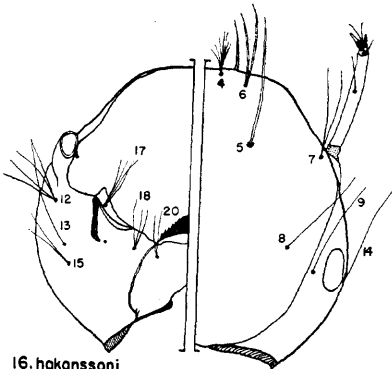
13. *hakanssoni*



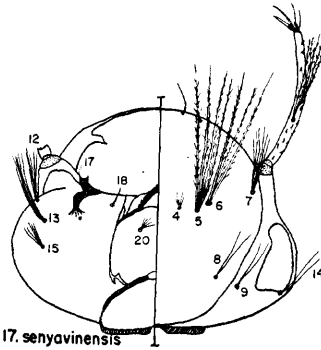
14. *aegypti*



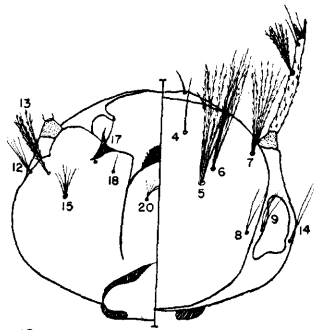
15. *senyavinensis*



16. *hakanssoni*



17. *senyavinensis*



18. *pullus maplei*

Figs. 11-18.—11, 12, Pupa: Metathorax and abdomen, left half ventral; 13, pupa: Cephalothorax; 14, 15, pupa: Dorsal aspect of the right paddle; 16-18, larva: Head, left half ventral.

on the midlobe. Hind tarsal basal bands of II–III may be basally complete on the mesal aspect. Tarsal claws equal, simple. Wing with a dorsal spot of white scales on the base of the costa. Sternite II white scaled except for a sub-apical or apical lateral black spot; III–VI white basally, dark apically; VII with a subbasal white band.

*Pupa*.—Figs. 11 and 13 completely illustrate the pupa of this species. It is easily recognized by the occurrence of a prominent fringe of long hairs along the greater portion of the paddle margins.

*Larva* (Figs. 16 and 21).—Description based on 10 adult-associated skins, from 6 collections. *Head*: Antennal shaft short, smooth, of approximately the same diameter throughout; antennal hair inserted about midway between base and apex, single, not reaching to apex. Hair 1, slender, pointed, single; 4 with 7–12 branches; 5 and 6 single, rarely double; 7 with 1–3; 8 and 9 single; 12 with 3–5; 13 with 1–2; 14 single; 15 with 1–3; 17 with 3–4; 18 and 20 with 2–4; ventral hairs well developed. Median mouthbrush hairs with comblike tips. Mentum with 9–13 lateral teeth. *Thorax*: Prothoracic hair 0 weak, thinly stellate; 1 slender, with 3–4 branches; 2 single; 3 double; 9, 10, and 12 slender, long, unbranched; 11 short, unbranched. Mesothoracic hair 9 large, greatly elongate, with 2–7 branches; 10 and 12 large, greatly elongate, single; 11 small, single. Metathoracic hairs 9, 10, and 11 as on mesothorax; hair 12 much reduced. *Abdomen*: Dorsolateral hair of I with 3–6 branches, lateral hair of I with 1–2; lateral hair of II with 2–6; of III with 2–4; of IV and V double; of VI single. Pentad hair 1 with 3–4 branches, 3 with 4–7, 5 with 3–4. Comb consisting of a curved row of 7–11 scales, these very finely fringed along basal half. Siphon dark, index 2.0–2.5; acus lacking; hair tuft at basal four-tenths, with 4–6 branches; 9–15 pecten teeth each usually with a single ventral denticle, the teeth evenly spaced from base to basal three-tenths, the line of pecten teeth curving dorsally from the base. Anal plate incomplete; *lh* large, with 2–3 branches; *isc* with 2–4; *osc* with 2–3. Ventral brush posterior to anal plate, composed of 6–8 tufts, each tuft with 1–3 branches, lateral portion of barred area lacking. Anal gills fingerlike, the dorsal pair slightly longer than the ventral pair and approximately 1.2–2.8 times as long as the anal plate.

*Types*.—HOLOTYPE: Male (5-1), with associ-

ated larval and pupal skins and mounted genitalia (U.S.N.M. no. 58806), Sokas Island, Ponape Island, Caroline Island Group, January 11, 1948 (H. S. Hurlbut), reared from a banana stump. PARATYPES (15 males, 31 females, 36 sets of adult-associated larval and pupal skins, 10 larval slides): Four males, 3 females, 7 sets of associated skins, 1 larval slide, same data as for holotype; 1 male, 5 females, 5 sets of adult-associated skins, 3 larval slides, same data as for holotype except that they were reared from glass bottles; 2 males, 7 females, 6 sets of adult-associated skins, 1 larval slide, Hydroplant, Not District, Ponape Island, January 15, 1948, reared from a tree hole; 2 males, 9 females, 8 sets of adult-associated skins, 4 larval slides, Paliej, Not District, Ponape Island, January 16, 1948, reared from a steel rain barrel; 5 males, 7 females, 10 sets of adult-associated skins, 1 larval slide, Matalanim Village, Ponape Island, January 21, 1948, reared from steel barrels; 1 male, 1 set adult-associated skins, Paliej, Not District, Ponape Island, January 16, 1948, reared from water in a canoe; all of the paratypes collected by H. S. Hurlbut.

*Bionomics*.—The females were not observed to bite man, either in nature or in the laboratory. A few specimens were seen resting in rain barrels in which larvae were living. The larvae were collected in tree holes, glass bottles, coconut shells, steel rain barrels, and a canoe. The larvae were quite common in the rain barrels around native dwellings.

*Systematics*.—This new species is a member of Edwards's (1932) group C (*scutellaris*-group) of the subgenus *Stegomyia*. That group was modified by Knight and Rozeboom (1946) by removing the *albolineatus* complex and raising it to the status of a full group. In keeping with Edward's nomenclature, this new group could be named as follows: Group E (*albolineatus*-group).

Group C, modified as mentioned above, can be subdivided into three rather distinct subgroups, which are tentatively defined as follows: *Subgroup I—scutellaris* s. str. Characterized by having the more mesal portions of the abdominal tergal markings subbasal. In addition, postspiracular scales are lacking, the scutal longitudinal median line is relatively slender, and the pleural scale patches are arranged in two rather well-defined longitudinal bands (not true of *gurneyi*, however). Included species: *alorensis* Bonne-Wepster and Brug, *andrewsi* Edwards,

*guamensis* Farner and Bohart, *gurneyi* Stone and Bohart, *hakanssoni*, n. sp., *hensilli* Farner, *horrescens* Edwards, *marshallensis* Stone and Bohart, *paullusi* Stone and Farner, *pernotatus* Farner and Bohart, *pseudoscutellaris* (Theobald), *quasiscutellaris* Farner and Bohart, *riversi* Bohart and Ingram, *scutellaris* (Walker), *scutoscriptus* Bohart and Ingram, and *tongae* Edwards. *Subgroup II—albopictus*. Characterized by the combination of the following: Abdominal tergal markings basal, no postspiracular scales, and the scutal longitudinal median line relatively slender. Included species: *albopictus* (Skuse), *cretinus* Edwards, *downsi* Bohart and Ingram, *flavopictus* Yamada, *galloisi* Yamada, *granti* Theobald, *novalbopictus* Barraud, *pseudalbopictus* Borel, *subalbopictus* Barraud, and (?) *unilineatus* (Theobald). *Subgroup III—mediopunctatus*. Characterized by the combination of the following: abdominal tergal markings basal, postspiracular scales present, and the scutal longitudinal median line quite broad. Included species: *mediopunctatus* Theobald, *m. var. submediopunctatus* Barraud, and *m. var. sureilensis* Barraud.

*Aedes hakanssoni* is most closely related to *scutoscriptus* Bohart and Ingram, a species that is known only from the Truk Atoll in the Caroline group. However, it is well distinct from *scutoscriptus* on both adult and larval characters. Both sexes of *scutoscriptus* have the scutellar lobes white scaled except for some apical black scales on the mid lobe, segment IV of the hind tarsus is all dark except for a few basal white scales, segment V of the hind tarsus is all white, and the basal bands of the hind tarsal segments are broadly interrupted mesally on I and V and narrowly so on III (complete on III in the male). Also, the lateral pale scaling that extends from the anterior margin to the scutal angle on the scutum is a solid, rather broad band in *scutoscriptus*. In *hakanssoni*, however, it is only a thin line of pale scales and with parts of it frequently obsolete altogether. The basal lobe of the male genitalia of *hakanssoni* differs distinctly from that of *scutoscriptus*, being quite similar to that of *riversi* and *hensilli*.

The larva of *scutoscriptus* is similar to that of *hakanssoni* except that head hair 6 is double, rarely single; the comb scales have a more developed lateral fringe, both dorsally and ventrally; *osc* is single (rarely divided, but not near the base); and the anal plate is more nearly complete.

*Aedes hakanssoni* is most easily distinguished

from all the other members of subgroup I by the scutellar scaling, since they all have the scutellar scales white except for a few apical black scales on the midlobe.

This new species is dedicated to Capt. E. G. Hakansson, MC, U. S. Navy, Retired, who, as the former Medical Officer in Command of the Naval Medical Research Institute, so ably promoted this and numerous other mosquito investigations.

***Aedes* (*Aedimorphus*) *senyavinensis*, n. sp.**

Figs. 4, 15, 17, 19

*Adult*.—A medium-sized dark brown species; with some pale scaling on the proboscis, dark tarsi, narrow dorsal vertex scales, 3 or 4 pleural patches of broad white scales, and basal pale bands on some tergites.

*MALE*: Length of wing about 2.6–2.9 mm. *Head*: Proboscis dark, frequently some ventral pale scaling at the medial joint. Palpus approximately equal in length to the proboscis, including the labella; dark scaled; apex of III slightly upturned, IV and V turned down; numerous long hairs ventrally on III, and ventrally and laterally along IV–V. Torus bare. Vertex dorsally with narrow scales, which are yellow except for a triangular median patch of dark scales just before the eye margin (the yellow scales extend to the midline along the eye margin), and dark upright forked scales; laterally with broad cream-colored scales, usually a patch of broad dark scales at the lateral margin of the dorsal narrow scaled area. *Thorax*: Scutal integument reddish brown; clothed with sparse hairlike black scales, a subdorsal patch of yellow scales extending posteriorly for a short distance from the anterior margin and a second patch on a longitudinal line with the first at the inner end of the scutal angle, also a few yellow scales medially on the anterior margin and a patch on the lateral margin just before the wing base. Each scutellar lobe with a patch of narrow black scales, usually a variable number of narrow yellow scales present basally. *Apn* with a few narrow yellow scales; *ppn* with sparse narrow dark scales, frequently a ventroposterior group of yellow scales present (may be some broadened scales in this group). Following pleural areas each with a small patch of broad white scales; dorsal sternopleural, medioposterior sternopleural, and dorsal mesepimeron. *Legs*: Forecoxa with dusky scales, mid and hind with some pale scales anteroventrally. Fore and mid femora dark scaled, prominently marked with



pale scaling posteriorly; hind femur anteriorly with a ventral white area beginning near apex and widening to base, posteriorly with ventral pale scaling. Tibiae with an apical pale patch, fore and mid tibiae paler posteriorly. Tarsi dark. Fore and mid tarsal claws unequal, all unidentate except the larger claw on the mid tarsus which is simple; hind tarsal claws equal, simple. *Wings*: Wing dark scaled; base of posterior fork cell nearer wing base than that of the anterior fork cell, anterior fork cell approximately equal to its stem in length. Halter knob with dusky scaling, paler apically. *Abdomen*: Tergite I dark scaled, a small pale scaled patch on the lateral margin; II with a few median pale scales, III-VI with pale basal bands that are widened laterally, VII with a pale vaso-lateral spot. Sternites with apical dark bands, VIII all pale scaled. *Genitalia* (fig. 4): Quite distinctive in the form of the dististyle and the mesosome.

**FEMALE**: Length of wing about 3.6-3.8 mm. Proboscis dark, a ventral and lateral paler area from near base to shortly beyond the middle. Palpus approximately one-sixth to one-seventh the length of the proboscis, dark scaled. Torus with a few dark scales mesally. Scutal scaling as in male except that sometimes a few yellow scales are present around the prescutellar space and rarely a thin line of pale scales posteriorly from the spot at the end of the scutal angle. Proepisternum with a patch of broad white scales. Tarsal claws equal; fore and mid claws each unidentate, hind simple. Anterior fork cell about one and one-half times its stem in length. Tergites dark dorsally, a rather indistinct basal pale band on IV and sometimes on V, sometimes also a variable number of basal pale scales on III and VI, a lateral pale band on I, and a basolateral pale patch on II-VII, VIII completely withdrawn, the cerci long and protruding.

*Pupa* (Fig. 15).—This pupa is rather similar to that of *hakanssoni*. However, it can be separated without trouble from either that species or *aegypti* by the poorly defined paddle margin.

*Larva* (Figs. 17 and 19).—Description based on 10 adult-associated skins, from one collection. *Head*: Antennal shaft long, curved, tapered uniformly from base, sparsely spiculate laterally; hair tuft inserted at basal two-fifths, with approximately 7-10 elongate frayed branches. Hair 1 long, slender, pointed, single; 4 with 4-7 branches; 5 with 3-6; 6 with 3; 7 with 5-9; 8 with 2-4; 9 with 2-3; 12 with 4-8; 13 with 4-6; 14 with 1-3;

15 with 4-9; 17 with 1-3; 18 with 1-2; 20 with 4-6; hairs 5, 6, and 7 long, well developed, frayed. Median mouthbrush hairs with comblike tips. Mentum with 14-17 lateral teeth. *Thorax*: Prothoracic hair 0 thinly stellate in form; 1 long, slender, single; 2 with 2 or 3 branches; 3 with 2-4; 9, 10, and 12 slender, single, rarely double; 11 small, with 2-6 branches. Mesothoracic hair 9 large, greatly elongate, with 3-7 branches; 10 and 12 large, greatly elongate, single; 11 minute, with 2-5 branches. Metathoracic hairs 9, 10, and 11 as on mesothorax; hair 12 much reduced. *Abdomen*: Dorso-lateral hair of I with 3-6 branches, lateral hair of I with 1-2; lateral hair of II with 1-7; of III-VI with 1-3. Pentad hair 1 with 5-8 branches, 3 with 8-14, 5 with 4-11. Comb consisting of a patch of 29-39 scales, each scale with lateral and apical fringe. Siphon light; maximum diameter at about the basal one-fourth, index about 3.2-3.3; acus present; hair tuft at distal one-third, with 3-5 branches; 16-20 pecten teeth, the distal tooth (and often the one just basal of it) more widely spaced and without denticles, remainder evenly spaced and each with a single ventral denticle, the pecten teeth extending from base to basal two-fifths. Anal plate incomplete; *lh* with 1-2 branches; *isc* with 8-13 branches; *osc* single. Ventral brush arising posterior and ventral to anal plate, composed of 12-13 tufts, each tuft with 6-12 branches. Anal gills tapered from near base, pointed, the dorsal pair slightly longer than the ventral and approximately 1.6-1.9 times as long as the anal plate.

*Types*.—**HOLOTYPE**: Male (19-10), with associated larval and pupal skins and mounted genitalia (U. S. N. M. no. 58807), Rekisau, Not District, Ponape Island, Caroline Island Group, January 20, 1948 (H. S. Hurlbut), reared from the axils of young palms. **PARATYPES**: Eight males, 10 females, 15 sets of adult-associated larval and pupal skins, 4 larval slides, same data as for holotype; 1 female, with associated larval and pupal skins, 1 larval slide, Matalanim Village, Ponape Island, January 21, 1948 (H. S. Hurlbut), reared from steel rain barrel.

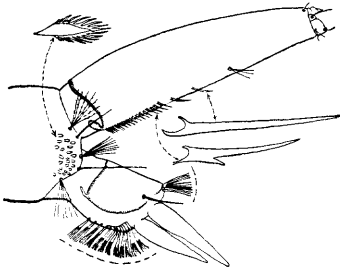
*Bionomics*.—The adults were not observed in nature except for one female taken in a trap baited with a live pig. The larvae were numerous in clear water collected in the axils of a group of young palms. In addition, one larval collection was made from a steel barrel containing rain-water.

*Systematics*.—This new species is most closely

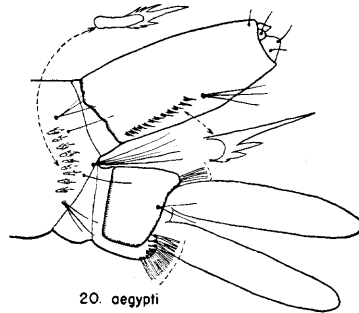
related to the species included in Edward's (1932) group C (*alboscuteclatus*-group: *Aedimorphus*) of the subgenus *Aedimorphus* but is excluded from the group by Edward's definition that the scutellar scales must be broad and silvery white. However, from the fact that *punctifemore* (Ludlow) and *oakleyi* Stone are also obviously related to the species included in group C and yet are excluded on the above scutellar scale character (in neither of these two species are the scutellar scales silvery white, although they are

broad), it is evident that the coloration, and probably also the shape, of the scutellar scales constitute a character of less than group value and accordingly should be omitted from the group definition.

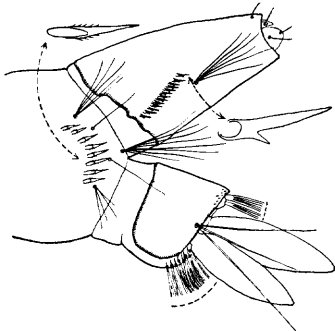
With the discard of the scutellar scale character, group D (*albocephalus*-group) is no longer sufficiently distinct from group C to justify its retention. Edwards (1932) supports this by saying that there is no sharp line of division between the two groups. Furthermore, in his 1941



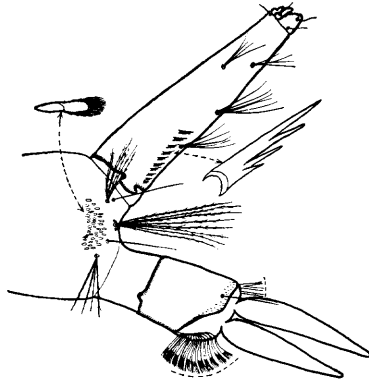
19. *senyavinensis*



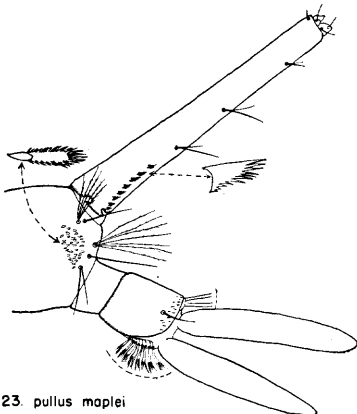
20. *aegypti*



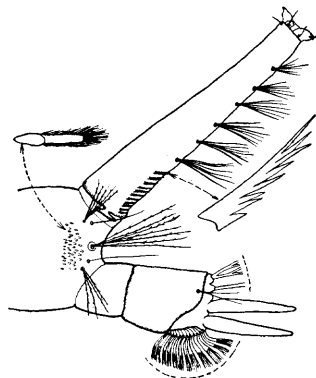
21. *hakanssoni*



22. *quinquefasciatus*



23. *pullus maplei*



24. *annulirostris*

FIGS. 19-24.—Larva: Terminal abdominal segments.

account of the Ethiopian members of the subgenus he goes so far as to redivide the African members of groups C and D into four divisions.

At any rate, until someone has an opportunity for making a new comparative study of all the species belonging to groups C and D, we prefer to treat them as a single group which we here tentatively designate as group C (*alboscuteclatus-albocephalus* group). This group is separable from the others as follows: (1) Palpi of male as long as the proboscis, the last two segments noticeably hairy, and the ultimate segment not very short; and (2) the basistyle with basal lobe small or absent. Included species: *alboscuteclatus* (Theobald), *culicinus* Edwards, *jamesi* (Edwards), *lowisi* (Theobald), *niveoscutella* (Theobald), *oakleyi* Stone, *orbitae* Edwards, *pampangensis* (Ludlow), *punctifemore* (Ludlow), and *senyavinensis*, n. sp. Unfortunately, the male of *ostentatio* (Leicester) is still unknown so that even its inclusion in the subgenus *Aedimorphus* is doubtful. Pending publication of a male description, the exact position of *wainwrighti* Baisas is also still uncertain but it is clearly not a member of group C.

*Aedes senyavinensis* is probably most closely related to *oakleyi* Stone, a species known only from Guam. In the adult, *oakleyi* is most distinct in having the scutellum covered with shining creamy broad scales. Also, *apn* possesses pale broad appressed scales, and the abdominal tergites of the female have prominent basal bands. In general, the adult of *oakleyi* is much paler than that of *senyavinensis*. The male genitalia of *oakleyi* is similar to that of *senyavinensis* except for the chaetotaxy of the dististyle, where some small differences occur. The larva of *oakleyi* has been described by Bohart and Ingram (1946) and from their description differs as follows from the larva of *senyavinensis*: head hair 6 double, the mentum with 18 or 19 lateral teeth, pentad hair 2 with about 3 branches, and the siphon index about 4.0-4.5.

This new species is most easily distinguished from all the other Australasian and Oriental members of group C, except *culicinus*, on the scutellar scaling, since all the others have the scutellar scales broad, or nearly all so. Although no specimens of *culicinus* were available for comparison, differences in the spines and hairs of the dististyle are evident from Barraud's (1934) figure. The larva of *culicinus* is undescribed.

This species is named after the Senyavin Islands, which is the eastern island group in the Carolines that includes the island of Ponape.

### *Culex (Culex) quinquefasciatus* Say

Figs. 6, 8, 22

A medium-sized brown species; with dark proboscis and tarsi, narrow dorsal vertex scales, several pleural patches of broad white scales, and prominent basal creamy bands on tergites II-VII.

Although all the Ponape specimens examined came from only three larval collections, all the commonly reported adult and larval variations of *quinquefasciatus* were represented. No significant differences were noted between the Ponape specimens of *quinquefasciatus* and those described from other portions of its range.

*Bionomics*.—The adults were observed biting man soon after sunset and their biting activity continued through the night and early morning before sunrise. They were rarely found resting in native houses during the day. A few were seen near the entrance of caves; and a few were caught in a light trap, in a trap baited with a live pig, and in small wooden kegs placed under native houses. They were never taken in numbers except while biting in the evening.

The larvae were collected in water receptacles such as steel barrels, cement tanks, tin cans, and coconut shells near dwellings. In depositing their eggs, the females showed a preference for polluted water.

*Distribution*.—SPECIMENS EXAMINED (3 males, 17 females, 20 sets of adult-associated larval and pupal skins, 3 larval slides): Colonia, Sokas Island, Palikir, and Matalanim Village.

LITERATURE RECORDS FOR THE CAROLINES: Kusaie, Ponape, Woleai, and Palau (Farner, 1944a). Truk Atoll, Ulithi Atoll, and the Palau Group (Bohart and Ingram, 1946).

*Relation to disease*.—Filariasis is common on Ponape and this mosquito is probably the vector. Under experimental conditions, *quinquefasciatus* is capable of transmitting Japanese encephalitis. However, this disease is now known to occur in Ponape.

### *Culex (Culex) annulirostris* Skuse

Figs. 9, 24

A medium-sized brown or blackish species; with white-banded proboscis and tarsi, narrow dorsal vertex scales, several pleural patches of broadened pale scales, and prominent basal creamy or yellowish bands on tergites II-VII.

The pupa of this species may be distinguished from that of either *quinquefasciatus* or *maplei* by

the number of branches possessed by hair 5 on abdominal segments IV–VI: hair 5 on segment IV with 5–8 branches (usually 5–6), on segment V with 2–3, and on VI double. The two terminal hairs on each paddle are approximately equal in length.

No significant differences were noted between the adults of *annulirostris* from Ponape and those described from other portions of its range, except, that, in general the scutal scaling (particularly of the female) is darker, the abdominal banding is yellower, and the pale spots of scales are largely lacking from the anterior aspect of the fore tibia.

Several minor differences in the larvae have been noted. Woodhill and Pasfield (1941) reported Australian material as having a siphon index of approximately 7.2, and the anal gills only 0.6–0.8 times the length of the anal plate. These observations are corroborated by Lee (1944), also from Australia. On the other hand, Cooling (1924) describes the siphon index of Australian material as about 5.0–5.5 (also described head hair 7 as having 11–12 branches); Buxton and Hopkins (1925) of Samoan material as about 5.1; and Bohart and Ingram (1946) of specimens from Truk as about 6. The siphon index of the Ponape material is 4.1–5.3 (head hair 7 with 6–9 branches). On the basis of these records, and from observations made by the senior author in the New Hebrides, it is apparent that there is a considerable range of natural variation in the siphon index of this species. From the literature records mentioned above it is also apparent that the anal gills are variable in length (1.5–2.0 times longer than the anal plate in Ponape material), but no correlation between this character and the geographical distribution of the species is possible at present.

*Bionomics.*—The females are commonly observed biting man soon after sunset, and their activity continued throughout the evening. They were captured in great numbers in a trap baited with a live pig, as many as 400 being taken in a single overnight catch.

The larvae were collected in clean water in ditches containing emergent vegetation, in small marshy areas containing algae and emergent vegetation, in shallow wells open to sunlight, in small cement tanks containing algae, and in a rock pool containing algae.

*Distribution.*—SPECIMENS EXAMINED (9 males, 16 females, 22 sets of adult-associated larval and pupal skins, 7 larvae): Colonia, Sokas Island, Matalanim Village, and Ronkiti.

LITERATURE RECORDS FOR THE CAROLINES: Truk Atoll and Ulithi Atoll (Bohart and Ingram, 1946).

*Systematics.*—Of the *Culex* (*Culex*) species with banded proboscis, *annulirostris* is probably most closely related to *sitiens* Wiedemann, from which it is distinct on characters of the male genitalia and of the larva. There are undoubtedly valid adult coloration differences, but since both species are subject to natural variations in the intensity of the color pattern (particularly of the scales of the vertex, scutum, and abdomen) these are rather unsafe for use until more comprehensive studies, covering all portions of the geographical range of the two species, are made.

*Culex annulirostris marianae* Bohart and Ingram, from the Marianas, is subspecifically distinct in possessing an apical line of pale scales on tergites II–IV, and sometimes also on V–VI. The anal gills are usually shorter, frequently much shorter, than the anal plate.

***Culex* (*Culiciomyia*) *pullus maplei*, n. subsp.**

Figs. 5, 7, 10, 12, 18, 23

*Adult.*—A medium-sized brown species; with dark proboscis and tarsi, some broad dorsal vertex scales, and prominent basal creamy bands on tergites III–VII; and without scales on the pleuron. Pleuron pale, prominently marked by two longitudinal broad dark bands (integumental), the ventral one terminating medially on the sternopleuron.

*MALE:* Length of wing about 3.0 mm. *Head:* Proboscis dark, a prominent ventral tuft of bristles medially (just before the labial joint), numerous short hairs all along the proboscis. Palpus longer than the proboscis, including labella, by approximately the length of the last segment; dark scaled; II–III straight, usually directed obliquely away from the proboscis and IV–V directed obliquely inward toward the proboscis; III with a rather sparse ventral row of long modified scales from near base to apex, these modified scales hairlike except for being broadened and flattened medially, numerous long hairs ventrolaterally and mesally along IV–V. Torus bare. Vertex covered with broad creamy scales, dorsum with dusky upright forked scales (the more anterior ones paler) and with a band of narrow creamy scales on the nape and more sparsely on the longitudinal midline. *Thorax:* Scutum with fine brownish narrow scales. Scutellar lobe with pale narrow scales. *Apn* bare of

scales; *ppn* with some narrow brownish scales dorsally. No pleural scale patches. Single lower mesepimeral bristle present. Pleural integument pale; marked with a prominent longitudinal dark brown band beginning on *ppn* and extending across the postspiracular, prealar (below the knob), and upper mesepimeral areas; and a second shorter one below, beginning on the proepisternum and extending about halfway across the medial portion of the sternopleuron. *Legs*: Forecoxa with dusky scales anteriorly; mid with a few dusky scales anteriorly; hind bare of scales. Fore and mid femora dark scaled, marked with pale scaling posteriorly; hind femur pale scaled, anteriorly with dark scaling dorsally from near base to apex, posteriorly the apical two-fifths is largely dusky. Tibiae and tarsi dark. Fore and mid tarsal claws unequal, each unidentate; hind tarsal claws equal, simple. *Wings*: Wing dark scaled; base of fork cells approximately even, anterior fork cell noticeably longer than stem. Halter knob with grayish scales. *Abdomen*: Tergite I with a median area of dark scales; II dark scaled; III-VII with broad basal creamy or yellowish bands, on the more posterior segments these bands are narrowed medially, all the bands extending onto the lateral aspect. Sternites II-III pale scaled, IV-VII with pale scales basally and dark scales apically. *Genitalia* (Figs. 5, 7, 10): Identical with that of *pullus*, the genitalia of which has been illustrated by King and Hoogstraal (1946). Their drawing of the basistyle of *pullus* is a lateral view and shows the distinctive hair tuft that is present at the level of the subapical lobes. This is also present in *maplei* but is not visible in the mesal view given in Fig. 5 of this paper. Their drawing of *pullus* fails to show one of the three appendages (the curled-tipped or shortest one) always possessed by the most distal-mesal lobe. This setalike appendage is difficult to locate unless stained. Also, the irregular subapical lateral lobe of the tenth sternite is omitted in their drawing.

**FEMALE**: Length of wing about 3.2-3.8 mm. Proboscis without a special hair tuft. Palpus approximately one-sixth the length of the proboscis, dark. Torus with dusky scales and hairs mesally. Vertex as in male except that the narrow scaled dorsal area is more extensive. Forked upright scales golden brown. Scutellar scales approximately the same shade of color as those of the scutum. Tarsal claws equal, simple. Stem of anterior fork cell only slightly more than one-half as long as the cell. Basal band on ter-

gite VII frequently broken medially; tergite VIII dark. Sternite scales may be nearly all pale. Occasionally a thin apical pale line of scales on some tergites. *Variations*: Two female specimens of the series studied completely lacked the basal band on tergite III.

*Pupa* (Fig. 12).—This pupa may be distinguished from that of the other two *Culex* species treated in this paper by the number of branches possessed by hair 5 on abdominal segments IV-VI: hair 5 on segment IV with 4 or 5 branches, on V with 3-6 (5-6 branched in 20 out of 22 examples), and on VI with 3-7 (usually 5-6, and with 3 branches only once out of 22 examples). It is also distinct in the lack of pigment on the lateral half, or more, of the metathorax. The two terminal hairs on each paddle are approximately equal in length.

*Larva* (Figs. 18, 23).—Description based on 10 adult-associated skins, from 4 collections. *Head*: Antennal shaft spiculate and somewhat broadened from base to level of hair tuft, slenderer and mostly free of spicules from there to apex; hair tuft inserted just before apical one-third, with approximately 15 elongate frayed branches; subapical bristles distinctly removed from apex. Hair 1 elongate, slender, single (once forked); 4 single; 5 with 4-7 branches; 6 with 3 or 4; 7 with 8-11; 8 with 2; 9 with 3-7; 12 with 3-5; 13 with 2-5; 14 with 1-3; 15 with 4-7; 17 and 18 single; 20 with 3-6; hairs 5, 6, and 7 prominently frayed. Median mouthbrush hairs with comblike tips. Mentum with 13-15 lateral teeth. *Thorax*: Prothoracic hair 0 thinly stellate in form; 1, 2, and 3 greatly elongate, single; hairs 9 and 10 slender, single; hair 11 small, with 4-7 branches; hair 12 large, greatly elongate, single. Mesothoracic hair 9 greatly elongate, with 4-5 branches; 10 and 12 large, greatly elongate, single; 11 minute, with 3-4. Metathoracic hairs 9, 10, and 11 (with 2-5 branches) as on mesothorax; hair 12 much reduced in length, slender, single. *Abdomen*: Dorsolateral hair of I with 2-4 branches, lateral hair of I double; lateral hair of II with 3 (once 4); of III-VI double. Pentad hair 1 with 5-7 branches, 3 with 6-8; 5 with 2-3. Comb consisting of a patch of approximately 32-37 scales, each scale with a complete lateral and apical fringe. Sipon pale; index 6.0-10.6; acus present; 3 hair tufts (once 4 on one side) present, the first inserted just beyond the most apical pecten tooth and the last near the apex, each with 2 or 3 branches (once single and once with 4); 8-15 pecten teeth, each tooth with a complete ventral

fringe of denticles. Anal plate complete; pale; with small denticles lateroposteriorly; *lh* single; *isc* single, *osc* single. Ventral brush composed of 8 tufts arising from a barred area posterior to the anal plate, each tuft with 3-6 branches. Anal gills somewhat fingerlike, the dorsal pair 2.0-2.6 times as long as the anal plate and just slightly longer than the ventral pair. *Variations*: A rather extensive range in the siphon index was the most important larval variation noted.

*Types*.—HOLOTYPE: Male (30-9), with associated larval and pupal skins and mounted genitalia (U. S. N. M. no. 58808), Sokas Island, Ponape Island, Caroline Island Group, January 27, 1948 (H. S. Hurlbut), reared from a taro axil. PARATYPES (13 males, 19 females, 31 sets of adult-associated larval and pupal skins, 5 larval slides): Seven males, 5 females, 11 sets of associated skins, 1 larval slide, same data as for holotype; 2 males, 7 females, 9 sets of associated skins, 1 larval slide, Colonia, Ponape Island, January 10, 1948, reared from a tin can; 1 female with associated skins, 2 larval slides, Paliej, Not District, Ponape Island, January 16, 1948, reared from a steel tub; 4 males, 6 females, 10 sets of associated skins, 1 larval slide, Matalanim Village, Ponape Island, Jan. 21, 1948, reared from steel barrels; all the paratypes collected by Hurlbut.

*Bionomics*.—The adults were not collected in nature. Caged females reared in the laboratory failed to take blood from a mouse during several overnight exposures, nor would they bite man. The larvae were very numerous in artificial containers around native dwellings, often being found in polluted water in tin cans and steel drums along with *quinquefasciatus*, and in cement tanks in the foundations of destroyed Japanese houses. Two larval collections were made from water collected in the leaf axils of taro plants. The egg rafts were easily distinguished from those of *quinquefasciatus* by their shape, the former being roughly circular in outline while the latter are elongate with pointed ends.

*Systematics*. The adult described above is well distinct from all of the known Pacific *Culiciomyia* species<sup>4</sup> except *pullus* Theobald. From this species it is distinguishable only in the

<sup>4</sup>The following 14 species of *Culiciomyia* are at present recognized from the Pacific area: *bahri* Edwards, *bailyi* Barraud, *fragilis* Ludlow, *fuscicinctus* King and Hoogstraal, *javanensis* Bonne-Wepster, *nailoni* King and Hoogstraal, *nigropunctatus* Edwards, *pallidothorax* Theobald, *papuensis* (Taylor), *pullus* Theobald, *ryukyensis* Bohart, *shebbearei* Barraud, *spathifurca* Edwards, and *viridiventer* Giles.

larval stage. The larva of *pullus*, although definitely similar in general form, is distinct in having a transverse unsclerotized band in the siphon (also true of *nigropunctatus*). Fourteen larval specimens of *pullus* from Guadalcanal, Solomons; Hollandia, New Guinea; and Morotai, Moluccas disclosed the following additional differences from *maplei*: head hair 5 triple (once with 4 branches), and the lateral hair of abdominal segments III-VI single.

Because the differences between *pullus* and the Ponape species occur only in the larval stage, and because the two species are geographically separate, it was thought best to name the latter as a subspecies of the first.

Bohart and Ingram (1946) report a larval collection (no adults were obtained) from the Palau Group which could be either *pullus* or *nigropunctatus* (the larvae of the two being undistinguishable at present). This is the only other record of a *Culiciomyia* from the Caroline Islands. The range of *pullus* extends from the Solomons through New Guinea and Australia to the Moluccas, and that of *nigropunctatus* from the Celebes to India and the Philippines. These two species are well distinct from one another on male genital characters.

This new species is dedicated to Dr. John D. Maple, II, formerly of the Bureau of Entomology and Plant Quarantine, and of the U. S. Navy, who lost his life on April 11, 1945, while engaged in mosquito research duties on Okinawa.

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