

## DESCRIPTIONS AND KEYS FOR ANOPHELINES OF GUAM<sup>1</sup>

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**ABSTRACT.** For years only one species of *Anopheles*, *An. indefinitus* Ludlow, has been known on Guam. Darsie and Ramos (1971) studied anopheline collections made there in 1970 and 1971 and found two additional species, i.e., *Anopheles vagus* Donitz and *Anopheles subpictus*

For years only one species of *Anopheles*, *An. indefinitus* Ludlow, has been known on Guam. Darsie and Ramos (1971) studied anopheline collections made there in 1970 and 1971 and found two additional species, i.e., *Anopheles vagus* Donitz and *Anopheles subpictus* Grassi. The purpose of this paper is to present descriptions and keys for the species, including adult females, male genitalia, pupae and larvae, based on a detailed study of individually reared specimens.

The following morphological notes form the basis for the species determinations.

### *Anopheles (Cellia) vagus* Donitz.

This was the most common species in the collections. Its identity is unmistakable.

**Adult Female.** Subapical dark band of palpi  $\frac{1}{3}$  or less as long as apical pale band, usually  $\frac{1}{4}$ – $\frac{1}{5}$  (see Fig. 1); only two Guam specimens had shorter apical pale bands on palpi; proboscis with light gray, subapical band or patch in all specimens; prehumeral pale scales present on wings in all but two specimens (not the same two which had the short apical pale bands on

Grassi. The purpose of this paper is to present descriptions and keys for the species, including adult females, male genitalia, pupae and larvae, based on a detailed study of individually reared specimens.

palpi). The presector pale spot character used by Stone *et al.* (1966) for separating *vagus* from *subpictus* does not apply to the Guam specimens; only 3 of 33 wings measured had vein R dark spot less than  $\frac{1}{2}$  that on costa.

**Adult Male.** Fore tarsi with conspicuous pale bands on joints 1–2 and 2–3 but very small or absent on 3–4 and 4–5; longest leaflets of phallosome 2.5 or more times as long as width of phallosome just below attachment of leaflets, those measured varied from 55–66 microns long, compared to an average of 68 microns reported by King (1932); see Fig. 4.

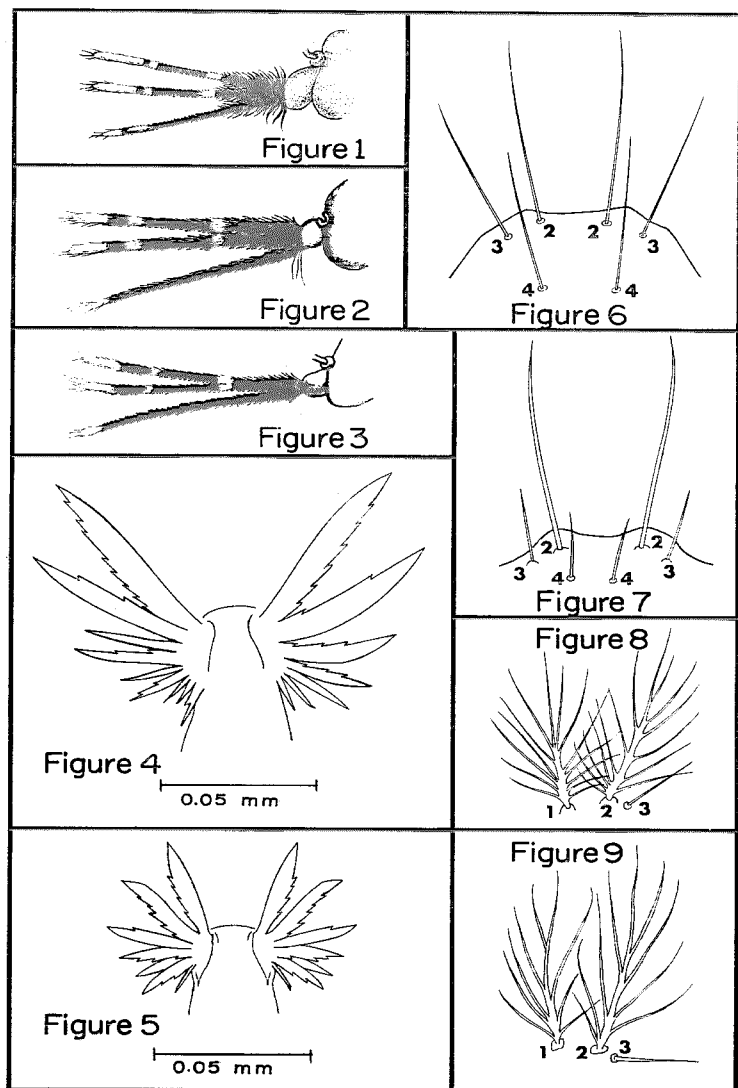
**Pupa.** Abdominal hair 6–IV single or double and about  $\frac{1}{2}$  as long as lateral length of tergite IV (see Fig. 12), generally agreeing with description of Reid (1968); hair 5 on abdominal segment I relatively weak, shorter than mid-dorsal length of tergite I, base of main stem smaller than that of 6–I (Fig. 10).

**Fourth Instar Larva.** Outer and posterior clypeal hairs short,  $\frac{1}{3}$ – $\frac{1}{5}$  length of inner clypeals (Fig. 7); posterior clypeals placed far forward on frontoclypeus, bases close to and medial to bases of inner clypeals; prothoracic seta 1 with 11–17 branches; metathoracic hair 3 (thoracic palmate) with 3–4 thin branches; palmate hair on abdominal segment I with differentiated leaflets, but few in number, 3–8; abdominal hairs 6–IV–V mostly 2-branched; spiracular hair 1 usually triple (2–5).

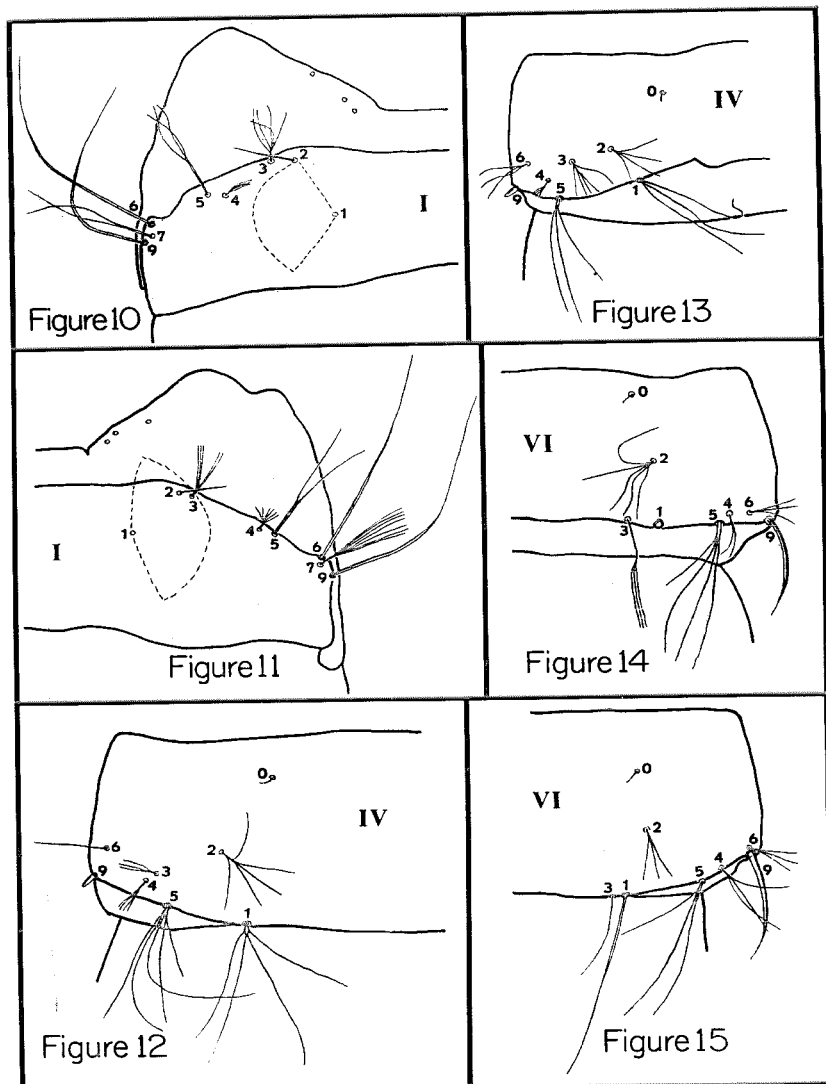
Specimens examined: 19 ♀♀ and 24 ♂♂ with associated lar. and pup., 4 ♀♀ and 5 ♂♂ with associated pup. and 3 ♀♀ and 1 ♂ from Apra Heights, Agat District, IX–24–70; 7 ♀♀ and 7 ♂♂ with associated lar. and pup. from Navy Magazine Area, Agat District, II–10–71;

<sup>1</sup> The work was supported by the Agency for International Development, U. S. Department of State. The authors are indebted to Capt. W. K. Reisen and SMSgt. John P. Burns, 1st Med. Ser. Wing, Clark AB, Philippines, for furnishing collections of Guam anophelines and to Capt. L. P. Eisman, Environmental Health Officer, Naval Forces, Marianas, Guam, for providing assistance in making and processing all the collections.

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FIGS. 1-9.—Palpi and proboscis of adult female of (1) *An. vagus*; (2) *An. indefinitus*; (3) *An. subpictus*. FIGS. 4-5. Phallosome leaflets of adult male genitalia of (4) *An. vagus*; (5) *An. subpictus* (after King, 1932). FIGS. 6-7. Clypeal head hairs of fourth instar larva of (6) *An. indefinitus*; (7) *An. vagus*. FIGS. 8-9. Prothoracic hairs, 1, 2, 3 of fourth instar larva of (8) *An. indefinitus* and (9) *An. subpictus*.



FIGS. 10-15.—Pupae: first abdominal tergite of (10) *An. vagus* and (11) *An. indefinitus*; fourth abdominal tergite of (12) *An. vagus* and (13) *An. subpictus*; sixth abdominal segment of (14) *An. indefinitus* and (15) *An. subpictus*.

3 ♀♀ and 1 ♂ with associated lar. and pup., and 10 lar. from Yigo, Yigo District, II-14-71.

*Anopheles (Cellia) indefinitus* Ludlow. The species was raised to specific rank by Reid (1966, 1968) and listed as such by Stone (1967) in the world catalogue. Therefore, it should be referred to as *An. indefinitus* Ludlow.

The specimens of this species and of *An. subpictus* are easy to distinguish from *An. vagus*, especially if associated larvae and pupae are available, but they are difficult to differentiate from each other, particularly the males.

*Adult Female.* Subapical pale band of palpi more than  $\frac{1}{3}$  as long as subapical dark band, the Guam specimen measures  $\frac{2}{3}$  (see Fig. 2); the subapical dark band of palpi  $\frac{1}{3}$ - $\frac{1}{2}$  as long as apical pale band; proboscis and prehumeral area of costal wing all dark-scaled.

*Adult Male.* Pale bands of fore tarsi similar to *vagus*, band usually present on joint between tarsi 3-4, but only slightly broader than on *vagus*, where present; longest leaflets of phallosome short, less than 2.5 times as long as width of phallosome just below attachment of leaflets; longest leaflets measure 33-43 microns, compared with an average of 36 microns reported by King (1932).

*Pupa.* Abdominal hair 6-IV with 3-4 branches and relatively short, less than  $\frac{1}{2}$  as long as lateral length of tergite IV,  $\frac{1}{3}$ - $\frac{1}{7}$  in Guam specimens (Fig. 13); hair 5 of abdominal segment I strong, longer than mid-dorsal length of tergite I, base of main stem equal to that of 6-I (Fig. 11); hair 3 on abdominal segment VI with 3 or more branches on at least one side (Fig. 14), if not, then hair 4 on abdominal segment VIII double.

*Fourth Instar Larva.* Outer and posterior clypeal hairs long, about  $\frac{1}{2}$  or more as long as inner clypeals; posterior clypeals placed farther back on frontoclypeus, their bases nearly even with those of the inner clypeals, Fig. 6; prothoracic hair 1 with 13 or more branches, 13-15 in the Guam

specimens, Fig. 8; mesothoracic hair 4 with 3 or more branches, seldom double; abdominal palmate hair 1-I with 9 or more leaflets, sometimes notched, 9-11 in the Guam *indefinitus*; abdominal hairs 6-IV-V with 3 branches; spiracular hair 1 with 5 branches.

Specimens examined: 1 ♀ and 2 ♂♂ with associated lar. and pup., and 1 ♀ with associated pup. from Apra Heights, Agat District, IX-24-70.

*Anopheles (Cellia) subpictus* Grassi.

*Adult Female.* Subapical dark band of palpi broad,  $\frac{1}{2}$  or more length of apical pale band; subapical pale band very narrow,  $\frac{1}{3}$  or less length of subapical dark band; proboscis all dark; prehumeral pale scales absent in Guam specimens; presector dark spot on vein R more than  $\frac{1}{2}$  that on costa.

*Adult Male.* Indistinguishable from *indefinitus*, average length of phallosome leaflets 27.5 microns (see Fig. 5); identification based on associated pupae and larvae.

*Pupa.* Abdominal hairs 6-IV and 5-I same as in *An. indefinitus* (see Figs. 13, 11); hair 3 on abdominal segment VI single or double (Fig. 15); hair 4 on abdominal segment VIII simple, seldom double.

*Fourth Instar Larva.* Inner, outer and posterior clypeal hair and abdominal hairs 6-IV-V same as in *An. indefinitus*; prothoracic hair 1 with 8-11 branches (Fig. 9); mesothoracic hair 4 double, seldom triple; abdominal palmate hair 1-I usually with fewer than 9 branches, range 6-9 in Guam specimens.

Specimens examined: 3 ♂♂ with associated lar. and pup., and 1 ♀ from Apra Heights, Agat District, IX-24-70.

DISCUSSION. Three closely related, sympatric species of the *Pyretophorus* series, Subgenus *Cellia*, have been collected on Guam. Since 1948, *indefinitus* has been assumed to be the only anopheline there. When the other two were introduced is unknown, but it is reasonable to assume, as Hull (1952) did for *indefinitus*,

that they were transported from the Philippines. It is possible that they have been there for some time, but escaped notice because anopheline generic characters were used in the identification keys, e.g., Holway and Bridges (1970). The palpal characters used herein for the adult female, the stage most often collected, are somewhat subtle, requiring close scrutiny.

Of the three species, only *subpictus* appears to be a likely good vector of malaria. It is a vector of some importance in the Celebes (van Hell, 1952), and on the south coast of Java, in Indonesia (Sundar-

araman *et al.*, 1957). Ferreira and Breda (1962) also reported it, along with *An. sundaicus* (Rodenwaldt), as the principal vector of malaria around Dili, the capital of Portuguese Timor. Christophers (1933) reported that *vagus* was found naturally infected in Indonesia.

*An. subpictus* has also been taken naturally infected with *Wuchereria* [= *Brugia*] *malayi* in Ceylon; and it and *An. vagus* have been recorded infected in nature with *W. bancroftii* in India, as reported by Raghavan (1961).

### KEYS TO THE ANOPHELES OF GUAM<sup>3</sup>

#### ADULT FEMALE

1. Costal vein of wing with 3 or fewer pale spots.....2  
Costal vein of wing with at least 4 pale spots.....4
2. Palpi without pale bands.....*baezai*  
Palpi with pale banding.....3
3. Apical pale spot of costal wing vein short, extending only to vein R<sub>3</sub>.....*lesteri*  
Apical pale spot of costa long, extending at least to vein R<sub>4+5</sub>.....*sinensis*
4. Outer half of proboscis mostly pale scaled.....*tessellatus*  
Proboscis with at most a short pale band or patch.....5
5. Subapical dark band of palpi short, usually  $\frac{1}{3}$  or less as long as apical pale band; proboscis with subapical, light gray band or patch.....*vagus*  
Subapical dark band on palpi mostly more than  $\frac{1}{3}$  as long as apical pale band; proboscis usually all dark.....6
6. Subapical pale band of palpi usually  $\frac{1}{2}$  or more as long as subapical dark band, and the latter is commonly more than  $\frac{1}{3}$  and less than  $\frac{1}{2}$  as long as apical pale band.....*indefinitus*  
Subapical pale band of palpi  $\frac{1}{3}$  or less as long as subapical dark band, the latter is more than  $\frac{1}{2}$  as long as apical pale band.....*subpictus*

#### ADULT MALE

1. Coxite of male genitalia with 2 parabasals spines.....2  
Coxite with 3 or more parabasals spines.....4
2. Leaflets of phallosome smooth.....*baezai*  
Leaflets of phallosome serrated near apex and base.....3
3. Pale and dark scales present on dorsal surface of coxite.....*sinensis*  
Dorsal surface of coxite without scales.....*lesteri*

<sup>3</sup> After this manuscript was accepted for publication, the authors learned that four additional species of *Anopheles* have been found breeding on Guam; i.e., *baezai* Gater, *lesteri* Baisas & Hu, *sinensis* Wiedemann, and *tessellatus* Theobald. To make this article of maximum usefulness they have been incorporated in the identification keys. See Reisen, W.K., J.P. Burns & R.G. Baisio. 1972. A mosquito survey of Guam, Marianas Islands, with notes on the vector-borne disease potential. Jour. Med. Ent. (in press).

4. Legs speckled; apical seta of harpago only a little longer than club. . . . . *tessellatus*  
 Legs unspeckled; apical seta of harpago much longer than club. . . . . 5
5. Longest leaflets of phallosome more than 2.5, usually more than 3, times  
 as long as width of phallosome just below attachment of leaflets. . . . . *vagus*  
 Longest leaflets of phallosome less than 2.5, usually less than 2, times as  
 long as width of phallosome just below attachment of leaflets. . . . . *indefinitus*  
*subpictus*

## PUPAE

1. Seta 9 on abdominal segments V-VII short, less than  $\frac{1}{2}$  as long as  
 segment . . . . . 2  
 Seta 9-V-VII long, about  $\frac{3}{4}$  as long as segment. . . . . 5
2. Respiratory trumpet with secondary lobe, the tragus. . . . . *baezai*  
 Respiratory trumpet without tragus . . . . . 3
3. Respiratory trumpet with rim thickened and saw-toothed. . . . . *lesteri*  
 Respiratory trumpet with rim thin and uniform. . . . . 4
4. Hair 5 on abdominal segment III with 14 or more branches; trumpet  
 with longest axis at right angles to pinna. . . . . *sinensis*  
 Hair 5-III with no more than 11 branches; trumpet with longest axis  
 vertical, parallel to pinna. . . . . *tessellatus*
5. Hair 6 on abdominal segment IV single or double; hair 5 on abdominal  
 segment I relatively weak, shorter than mid-dorsal length of tergite I,  
 base of main stem smaller than that of 6-I. . . . . *vagus*  
 Hair 6-IV with 3-4 branches; hair 5-I strong, longer than mid-dorsal  
 length of tergite I, its base as strong as that of hair 6-I. . . . . 6
6. Hair 3 on abdominal segment VI with 3 or more branches at tip on at  
 least one side, if fewer, then hair 4 on abdominal segment VIII 2-  
 branched in outer half. . . . . *indefinitus*  
 Hair 3-VI simple or with 2 branches at tip, if more, then hair 4-VIII  
 simple . . . . . *subpictus*

## FOURTH INSTAR LARVAE

1. Outer clypeal hairs dendritic. . . . . 2  
 Outer clypeal hairs unbranched. . . . . 4
2. Hair 1 on abdominal segments III-VII with hair-like branches. . . . . *baezai*  
 Hair 1-III-VII palmate, with leaf-like branches. . . . . 3
3. Hair 6 on abdominal segment III usually with more than 20 branches;  
 hair 5 on abdominal segment II mostly with 11 or more branches. . . . . *sinensis*  
 Hair 6-III usually with fewer than 20 branches; hair 5-II with 6-10  
 branches . . . . . *lesteri*
4. Hair 1 on abdominal segment II not a well-developed palmate hair,  
 usually with hair-like branches. . . . . *tessellatus*  
 Hair 1 on II a well-developed palmate hair. . . . . 5
5. Posterior clypeal hairs placed far forward on frontoclypeus very near  
 and markedly mesad to inner clypeals; outer and posterior clypeal hairs  
 short,  $\frac{1}{3}$  or less as long as inner clypeals. . . . . *vagus*  
 Posterior clypeals located farther back on frontoclypeus and only a little  
 mesad to inner clypeals, if at all; outer and posterior clypeal hairs long,  
 $\frac{1}{2}$  or more as long as inner clypeals. . . . . 6

6. Prothoracic hair 1 usually with 13 or more branches; mesothoracic hair 4 with three branches, seldom two; palmate hair on abdominal segment I mostly with nine or more leaflets.....*indefinitus*  
 Prothoracic hair 1 usually with 12 or fewer branches; mesothoracic hair 4 two-branched, seldom triple; palmate hair on abdominal segment I mostly with fewer than nine leaflets.....*subpictus*

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### MOSQUITO CONTROL WORKSHOP

Members of AMCA will be interested to know that there will be a workshop on mosquito control problems at the annual meeting of the Eastern Branch of the Entomological Society of America, which will be held on October 18-19 at the Hotel Dennis in Atlantic City, N.J. The workshop will probably be on the evening of the 18th. Many members of AMCA are also members of Section D (Medical and Veterinary Entomology) of the ESA, and Section D has a large membership in the Eastern Branch. Most of those who will lead discussions at the workshop are members of AMCA.