

ANOPHELES MACULATUS (DIPTERA: CULICIDAE) FROM THE TYPE LOCALITY OF HONG KONG AND TWO NEW SPECIES OF THE MACULATUS COMPLEX FROM THE PHILIPPINES¹

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ABSTRACT. The adult, pupal, and larval stages are described and illustrated for *Anopheles (Cellia) maculatus* from the type locality of Hong Kong and two new species of the Maculatus Complex from the Philippines. The new species are morphologically distinct from *maculatus*, and the latter is no longer considered to occur in the Philippines. Concepts for the new species are based on morphological differences first observed in cytotyped specimens from chromosomally distinct, allopatric populations.

INTRODUCTION

Island life has always intrigued biologists. It was the biota of the Galapagos Islands that inspired Darwin to contemplate the possibility that species evolved from an earlier fauna, and the flora of the Malay Archipelago helped Wallace to reach the same conclusion. The fact that island forms generally resemble those on the nearest mainland still raises questions about when and whence they came. Unfortunately, it is not always possible to know for certain whether or not morphological differences observed between island and mainland forms are indicative of different species or isolated variants of the same species. This is the case with populations of the Maculatus Complex of *Anopheles* occurring in the Philippines. While there is no direct population-genetic evidence to support separate species status for the two new island species described below, these forms exhibit morphological and chromosomal differences which suggest that they are not conspecific with populations on the Asian mainland.

One of the new species described in this report was previously designated as *An. maculatus* Form D on the basis of chromosomal differences noted during comparative cytogenetic studies of natural populations from the Philippines, Thailand, and Malaysia (Green et al. 1985a). In 1986 we worked with C. A. Green to collect and cytotype specimens of this form from an area immediately northeast of Manila. During this trip we also made collections near Subic Bay to the west of Manila where we collected a form with polytene chromosomes quite unlike those of

Form D (Green, unpublished data). Although the chromosomal arrangements of these two forms are very different, they are not proof of genetic isolation because they were observed in specimens from allopatric populations. It would be necessary to demonstrate the absence of heterozygotes in sympatric populations to prove that these forms represent genetically separate species. However, we were able to correlate distinctive morphological traits with each of these cytotypes which then allowed us to distinguish two morphotypes from single localities. For this reason we believe that the two forms represent reproductively isolated species which are not known either morphologically or cytogenetically from the mainland. Conversely, from our study of available material, it appears that true *maculatus* does not occur in the Philippines. The two new species and *maculatus* from its type locality are described and compared in this paper.

MATERIALS AND METHODS

The material examined came largely from the National Museum of Natural History (Smithsonian Institution) and special collections made by George Shultz, formerly of the Naval Medical Research Unit No. 2 in Manila, and the authors. Some 1,192 specimens (375 females, 163 males, 9 male genitalia, 325 pupal exuviae, 278 larval exuviae, and 42 fourth-instar larvae) were examined, including 335 individual rearings and 5 progeny broods. The morphological concept of *maculatus* developed by Rattanarithikul and Green (1987) is expanded here to include descriptions of the larval and pupal stages based on reared specimens from the type locality of Hong Kong. Anatomical features of potential value in distinguishing the new species from one another, and differentiating them from related species on the mainland, were first noticed in individually reared progeny from chromosomally identified, wild-caught females. Differential characters were then observed and analyzed for variability in specimens associated in the adult, larval, and pupal stages. Some adults without associated immature exuviae were also examined.

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Except for the revised nomenclature for wing spots, which is taken from Wilkerson and Peyton (1990), the terminology and abbreviations recommended by Harbach and Knight (1980, 1982) are used in the descriptions and drawings. All measurements and counts were made on at least 10 specimens, and character states of use in distinguishing the species were correlated in the associated stages of all individually reared specimens on hand. Most of the drawings were prepared from single specimens. The taxonomic and other bibliographic references to previous reports and records of "*maculatus*" in the Philippines and Hong Kong are nearly exhaustive. Most of the abbreviations used in the literature summaries are self-evident. The letters A, P, L, and E refer to adult, pupa, larva, and egg, respectively. The symbols ♂ and ♀ refer to male and female, respectively. An asterisk (*) after one of these letters or symbols indicates that at least part of the life stage was illustrated in the publication cited.

TAXONOMIC TREATMENT

Anopheles (Cellia) maculatus Theobald

maculata Theobald, 1901:171. Lectotype male: Hong Kong; designated by Rattanakrithikul and Green 1987: 251 (BM).

hanabusai Yamada, 1925:471 (*Myzomyia*). Syntypes (♂; ♀): Kagi, Formosa [Taiwan] (IID).

Anopheles maculatus of Kinoshita 1906:643 (Taiwan; coll. rec.); Koidzumi 1924:98, 99 (Taiwan; A); Koidzumi and Hakushi 1930:234 (Taiwan; A); Morishita 1932a:196-203 (at least in part, Taiwan; A); Jackson 1936:1099-1113 (Hong Kong; A, L bionomics, med. imp.); Jackson 1938:265, 266, 269, 270 (Hong Kong; med. imp., L*, L bionomics, L key).

Anopheles (Cellia) maculatus of Rattanakrithikul and Green 1987:248-252, 264 (Hong Kong, Thailand; syn., A*, E*, distr., tax., A key).

Anopheles (Myzomyia) maculatus of Morishita 1932b:336 (at least in part, Taiwan; E); Hara 1959:108, 111 (Taiwan; ♀ gen., key).

The following are references to the chromosomal form in Thailand which corresponds to the typological concept of *maculatus* developed by Rattanakrithikul and Green (1987) and expounded below.

Anopheles (Cellia) maculatus form B of Green et al. 1985a:322-328 (Thailand; chromosomes).

Anopheles (Cellia) maculatus B of Green et al. 1985b:131, 132 (Thailand; chromosomes).

Characters that distinguish the adult and egg stages of *maculatus* from those of other known mainland species of the *Maculatus* Complex were noted by Rattanakrithikul and

Green (1987). The larval and pupal stages of the other mainland species are undescribed. Salient features of *maculatus* which distinguish it from the two island species described below include: (1) adult without accessory sector pale spot on the costa and subcosta, (2) pupa with seta 9-IV short and blunt, and (3) larva with leaflets of seta 1-II lanceolate or bearing poorly demarcated terminal filaments. The significant differences between these species are contrasted in Tables 1 and 2.

Female. **Head** (Fig. 1A,C,D): Vertex with patch of erect white scales above interocular space; erect black scales laterally and on occiput; interocular space with frontal tuft of 5 or 6 long pale yellow setae above and 9-16 very long white sinuous linear scales on each side; ocular scales white, falcate, broader laterally. Clypeus dark, bare. Pedicel of antenna light brown, with white falcate and/or spatulate scales in dorsomesal patch; antennal flagellomere 1 with black falcate scales at base on mesal and lateral surfaces, white falcate and spatulate scales on flagellomeres 1 and 2 and occasionally on base of flagellomere 3. Proboscis entirely black-scaled, length 1.32-2.24 mm, 1.05-1.15 length of forefemur. Length of maxillary palpus 1.27-2.22 mm, 0.88-1.00 length of proboscis; with semierect black fusiform scales at base on palpomere 2, other scales decumbent, with narrow apical white band on palpomeres 2 and 3; palpomere 3 black-scaled on proximal 0.90, with 0-4 median spots or longitudinal streak of white or yellowish scales along dorsomesal margin; palpomere 4 with basal and apical bands of white scales; palpomere 5 entirely white-scaled; preapical black band 0.18-0.66 length of subapical white band (palpomeres 3 and 4) and 0.24-0.80 length of apical white band (palpomeres 4 and 5), subapical white band 0.77-1.46 length of apical white band. **Thorax** (Fig. 1A): Pleural and scutal integument light to dark brown. Scutum largely covered with ashy gray tomentum; anterior promontory with long linear erect white scales, central area of scutum with narrow white spatulate scales (length 2.12-5.00 width), these longer than broad white spatulate scales (length 1.82-4.00 width) on fossa, anterolateral margin (above anteprenotum) with patch of black spatulate scales before dorsocentral setae, with white spatulate scales immediately behind black scales. Scutellum with narrow falcate or spatulate scales, sometimes with 2 or 3 white linear scales, with posterior row of light to dark brown setae (0-8 short and 5-10 long setae on middle; 1-3 short and 3-6 long setae laterally). Anteprenotum sometimes with few pale or dark scales, with 9-19 long dark setae. Postprenotum bare. Pleura with some white scales on prealar area and upper and lower areas of mesokatepisternum, prespiracular area occasionally with a single falcate or spatulate scale; pleural setae: no proepisternal, 2-8 prespiracular, 2-6 prealar, 2-5 upper and 2-7 lower mesokatepisternal, 4-8 upper mesepimeral, and no lower mesepimeral. **Wing** (Fig. 1E): Pattern variable, pale markings usually dirty white to yellow, dark markings light to dark brown, common pattern follows: prehumeral

Table 1. Summary of significant differences between *Anopheles maculatus* and the new species, *An. greeni* and *An. dispar*.

Stage	Character	<i>maculatus</i>	<i>greeni</i> and <i>dispar</i>
Adult	Accessory sector pale spot:		
	on subcosta and costa only	no	<i>greeni</i> (44%) ¹
	on subcosta only	no	<i>greeni</i> (56%); <i>dispar</i> (43%)
	missing on costa and subcosta	yes	<i>dispar</i> (57%)
Pupa	Seta 9-IV:		
	short, blunt	yes	no
	long, sharply pointed	no	yes
Larva	Leaflets of seta 1-II:		
	lanceolate or with weakly developed shoulders (rarely serrated), filament short when discernable, less than 0.25 length of leaflet	yes	no
	with distinct serrated shoulders (seldom weak), filament always long, more than 0.25 length of leaflet	no	yes
	Leaflets of seta 1-III-V:		
	with short filament, 0.15-0.33 (mean 0.27) length of leaflet	yes	no
	with long filament, 0.29-0.46 (mean 0.38) length of leaflet	no	yes

¹Percentage of specimens with the character, rounded to the nearest whole number.

(PHP) and humeral pale (HP) spots on costa, base of vein R with gray scales; presector (PSP) and sector pale (SP) spots on costa, subcosta and vein R; subcostal pale (SCP) spot on costa, subcosta and vein R₁; preapical (PP) and apical pale (AP) spots on costa and vein R₁; sector dark (SD) spot on costa and subcosta without accessory sector pale (ASP) spot; dark spot distal to accessory sector pale spot on R₁ with 1 or 2 pale interruptions, sector pale spot on R sometimes continuous with accessory sector pale spot on R₁ (forming one large pale spot); preapical dark (PD) spot on costa and R₁ 0.55-2.00 (mean 0.96) length of preapical pale spot; remigium pale-scaled; humeral cross-vein bare; presector dark (PSD) spot on vein R 0.63-1.31 (mean 0.68) length of corresponding spot on costa, R_s dark-scaled with pale spot at base, sometimes with pale spot at middle and apex; R₂ short, 1.20-2.00 length of vein R₂₊₃; R₂₊₃ long, with basal dark spot, rarely with distal dark spot; furcation of R₂₊₃ originating at or beyond

proximal one-third of preapical dark spot on R₁; R₂ and R₃ usually with pale scales at base, middle and apex; R₄₊₅ pale-scaled with 2 dark spots in subbasal and preapical positions, basal spur dark-scaled; M pale-scaled proximally, dark-scaled distally, with or without small dark spot between base of M₃₊₄ and radiomedial crossvein; M₁₊₂ and mCu largely dark-scaled, with pale scales at base and apex; M₁, M₂ and M₃₊₄ with pale scales at middle, apex and usually at base, median pale spot on M₃₊₄ 1.0-5.0 length of dark spot on either side; CuA pale-scaled except for small subbasal and preapical dark spots; 1A with 3 dark spots in subbasal, median and preapical positions, median dark spot 0.18-0.90 length of pale spot on either side; wing apex usually with 2 broad pale spots, uppermost beginning before or at R₁ and extending beyond R₂ (occasionally divided by small dark fringe spot between R₁ and R₂), lowermost beginning at R₃ and extending to R₄₊₅, additional pale fringe spots include those at apices of M₁, M₂,

Table 2. Summary of primary differences between *Anopheles greeni* and *An. dispar*.

Stage	Character	<i>greeni</i>	<i>dispar</i>
Adult	Specimens with preapical dark spot more than 1.20 length of subcostal and preapical pale spots:	8% ¹	76%
	length of vein R ₂ < 1.30 length of vein R ₂₊₃	-	61%
	length of vein R ₂ 1.30-1.40 length of vein R ₂₊₃	5%	15%
	length of vein R ₂ > 1.40 length of vein R ₂₊₃	3%	-
	Specimens with preapical dark spot 1.20 or less length of subcostal and preapical pale spots:	92%	24%
	length of vein R ₂ < 1.30 length of vein R ₂₊₃	14%	24%
	length of vein R ₂ 1.30-1.40 length of vein R ₂₊₃	37%	-
	length of vein R ₂ > 1.40 length of vein R ₂₊₃	41%	-
Pupa	Ratio of length of seta 9-III/9-IV:		
	0.09-0.20	69%	26%
	0.21-0.26	31%	35%
	0.27-0.52	-	39%
Larva	Seta 1-I:		
	with 4 or fewer branches	81%	-
	with 4 or fewer branches on one side and 5 or more on the other	17%	11%
	with 5 or more branches	2%	89%
	Seta 4-I:		
	with 5 or fewer branches	70%	6%
	with 6 branches	28%	68%
	with 7 or more branches	2%	26%

¹Percentage of specimens with the character, rounded to the nearest whole number.

M₃₊₄, CuA and 1A. *Halter*: Scabellum pale; capitellum with pale scales dorsally and on anterior margin, dark scales ventrally and at apex. *Legs* (Fig. 1A,F): Anterior surface of forecoxa with small basal and apical scale-patches, basal patch usually of dark scales with few pale scales on proximal side, sometimes entirely of pale or dark scales, apical patch usually of pale scales but sometimes of dark scales; lateral surface of midcoxa with proximal and distal patches of pale scales; apicolateral margin of hindcoxa with line of pale scales. Trochanters largely dark-scaled, posterior surfaces of fore- and midtrochanters with pale scales distally. Femora and tibiae with scattered pale spots and narrow patch and/or fringe at apex; ventral surface of forefemur with indefinite stripe of pale scales on apical 0.20-0.33; mid- and hindfemora with indefinite stripe of pale scales on basal 0.5-0.7 of ventral surface. Tarsi with pale bands and spots; tarsomere 1 of all legs with dorsal patch or band of pale scales at apex, foretarsomere 1 with

5-8 posterodorsal pale spots, foretarsomeres 2 and 3 with basal and apical pale bands or dorsal patches, 0-2 pale spots on median dark band of tarsomere 2, foretarsomere 4 with or without basal and apical pale patches or bands, foretarsomere 5 completely dark-scaled; midtarsomere 1 with 4-7 posterodorsal pale spots, midtarsomeres 1-3 with narrow pale spot dorsally at apex, midtarsomere 2 with or without median pale spot on posterodorsal surface, midtarsomere 3 occasionally with basal pale patch, midtarsomeres 4 and 5 completely dark-scaled; hindtarsomere 1 with 5-9 posterodorsal pale spots, hindtarsomere 2 with apical pale band and 0-2 median posterodorsal pale spots, hindtarsomeres 3 and 4 with basal and apical pale bands, hindtarsomere 5 completely pale-scaled. *Abdomen* (Fig. 1B): Integument light to dark brown, covered with numerous light to dark brown setae. Terga I-IV usually without scales; tergum II sometimes with few pale linear and/or falcate scales in middle posteriorly; these occasionally

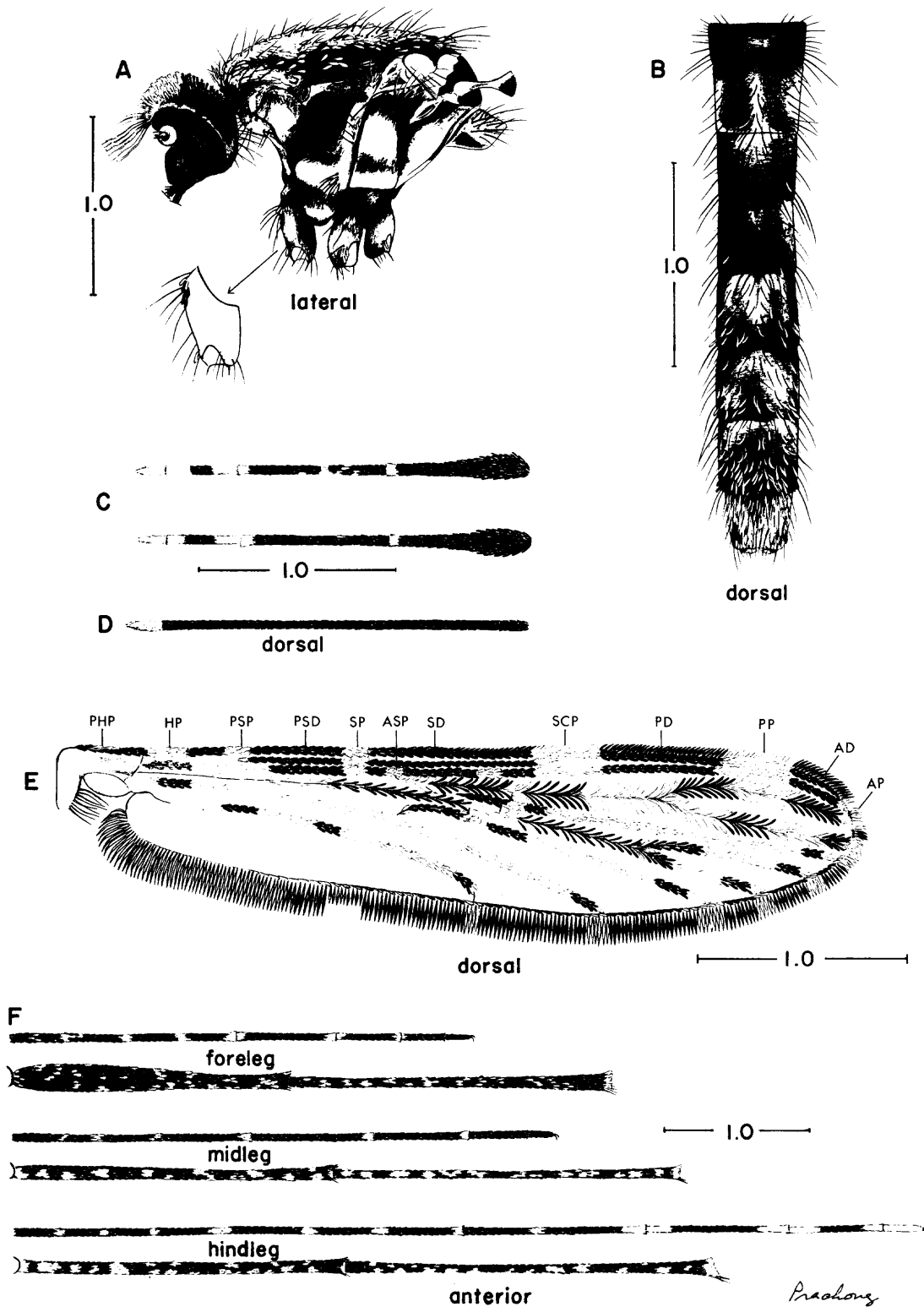
An. (Cel.) maculatus

Fig. 1. *Anopheles (Cellia) maculatus*, adult. A, Head and thorax (lateral, left side); B, Abdomen (dorsal); C, Maxillary palpus (two variations); D, Proboscis; E, Right wing (dorsal); F, Legs (anterior aspects). Scales in mm.

mixed with few narrow pale spatulate scales (length 4.0-7.0 width); tergum IV sometimes with few pale falcate and/or narrow spatulate scales on posterior one-third or less, occasionally with few pale scales laterally as well; terga V and VI without scales or with sparse pale falcate and/or spatulate scales over posterior 0.5 and lateral margins; terga VII and VIII largely or posteriorly covered with rather broad pale yellow falcate and/or spatulate scales (length 2.6-5.0 width), with or without patches of dark brown to black spatulate scales on posterolateral corners. Sterna II-V rarely with scales; sterna VI and VII with few scattered pale spatulate scales and median patch of black spatulate scales posteriorly; sternum VIII largely covered with pale spatulate and/or falcate scales laterally.

Male. Like female except as follows. **Head:** Setae of antennal whorls longer, more numerous. Proboscis length 1.67-2.13 mm, 1.34-1.51 length of forefemur. Length of maxillary palpus 1.70-2.05 mm, 0.95-1.13 length of proboscis; with 2 distal palpomeres swollen; integument pale between palpomeres 2 and 3; palpomere 3 with whitish scales along dorsomesal surface (sometimes also on palpomere 2), apex of palpomere 3 with dorsal patch of white scales and 8-10 moderately long setae; dorsal surface of palpomeres 4 and 5 white-scaled except for black scales at base, palpomere 4 with moderately long setae along mesal margin of pale scaling, ventrolateral line of dark scales and row of moderately long setae from near base of palpomere 4 to near apex of palpomere 5. **Wing:** Preapical dark spot on costa 0.40-1.66 length of preapical pale spot; presector dark spot of vein R 0.88-1.00 length of corresponding spot on costa; dark fringe spot between apices of R_1 and R_2 usually absent. **Legs:** Fore- and midtarsomeres 1-3 with narrow dorsal pale band or patch at apex, occasionally with small basal patch on foretarsomeres 2 or 3. **Abdomen:** Terga II and III without scales or with few linear or falcate scales posteriorly in middle; terga IV-VI with or without scattered pale falcate and/or spatulate scales, mainly posterior when present; tergum VII mainly with pale spatulate scales, with or without patches of black spatulate scales on posterolateral corners; tergum VIII (ventral in position) usually with scattered pale scales anteriorly, with black scales posteriorly. Sternum VII with sparse pale scaling posteriorly; sternum VIII (dorsal in position) pale-scaled. **Genitalia** (Fig. 2): Gonocoxite with yellow scales sternolaterally, black scales tergotlaterally, with 4 or 5 parbasal setae; gonostylus long, 1.3-1.5 length of gonocoxite, with row of minute setae along sternolateral margin and prominent subapical setae tergally near tip; gonostylar claw short, pigmented. Claspette with fused club formed of 2-4 separate stems on tergotlateral margin, a slender apical seta longer than club, and a smaller single or double setae on sternomesal margin; sternomesal surface with numerous minute spicules. Aedeagus narrow, apex with 3 or 4 foliform and 2 or 3 lanceolate leaflets on each side, distal leaflets serrate along one margin. Proctiger membranous, lightly sclerotized laterally.

Pupa (Fig. 2). Positions and development of setae as figured; range and modal number of branches in Table 3. Exuviae colorless to light brown. **Cephalothorax:** Trumpet simple with deep meatal cleft; length 0.38-0.46 mm, width 0.08-0.11 mm (measured at base of pinna), index 4.17-5.75, mean 4.71; meatus 0.17-0.24 trumpet length; pinna evenly rounded distally. **Abdomen:** Seta 6-I long, with 2-4 branches; 7-I short, with 2-5 branches; 9-I simple, slender, shorter to slightly longer than lateral margin of tergum; 9-II-IV short, blunt, peglike; 9-V-VII long, pointed, spine-like; 9-II transparent, 9-III-VII lightly to darkly pigmented; ratio of length of seta 9-III/9-IV 0.26-0.67 (mean 0.41), 9-IV/9-V 0.18-0.38 (mean 0.27); 9-VIII with 9-14(11) branches; I-V-VII single, as long or slightly longer than following tergum. **Paddle:** Index 1.40-2.00; fringe on approximately distal 0.5 of outer margin, gradually changing from refractile aciculae (refractile border) to non-refractile filaments 0.75-0.92 from base, with 9-20 non-refractile filaments before seta 1-P; inner margin with some filaments near 1-P. Seta 1-P strong, hooked, 0.33-0.54 length of paddle; 2-P short, single to triple.

Larva (Fig. 3). Positions and character of setae as figured; range and modal number of branches in Table 4. **Head:** Length 0.56-0.61 mm, width 0.62-0.65 mm. Antenna spiculate on mesal and ventral surfaces; seta 1-A short, single, borne on dorsolateral surface 0.27-0.38 from base; 2,3-A with one edge serrate (not shown in figure); 4-A with 2,3 branches. Seta 2-C single, usually with 4-14 short lateral aciculae, occasionally simple or split at tip; 3-C single, with 2-10 short lateral aciculae, sometimes split at tip; 4-C single, extending to or beyond base of 2-C. Dorsomentum with 9 teeth. **Thorax:** Stems of setae 1,2-P strong, borne on large separate tubercles; 3-P borne on small tubercle joined to tubercle supporting 2-P; 9-P plumose, with 10-18 branches, long, nearly length of 8-P; 10,12-P simple; 11-P well-developed, about 0.4 length of 12-P, with 3-5 branches. Seta 9-M weakly plumose, with 5-13 short branches; 10-M simple. Seta 3-T unpigmented, with 1-5 filamentous or occasionally lanceolate branches (no leaflets); 13-T with 3-5 branches. **Abdomen:** Seta 1-I with 5-10 filamentous or lanceolate branches (no leaflets); 1-II with 9-16 leaflets, leaflets lanceolate or with weakly developed shoulders and poorly demarcated terminal filament, filaments short when discernable, less than 0.2 length of leaflet; leaflets of seta 1-III-VII well-developed, each with a short filament 0.15-0.33 length of leaflet (see Table 4 for numbers of leaflets); 4-I with 5-9(7) branches; 5-VII with 6-15(11) branches. Pecten plate with 3-12 long and 4-9 short spines. Seta 1-X simple, long, 1.05-1.54 length of saddle; 2-X more pectinate than plumose, with 16-20 branches; 3-X with 4-6 long branches, ventral branch pectinate distally, most branches hooked at tip.

Systematics. At present we are retaining *hanabusai* (Yamada 1925) from Taiwan as a synonym of *maculatus* Theobald, 1901. The syntype males of *hanabusai* (two specimens) are similar to topotypic *maculatus*, but the

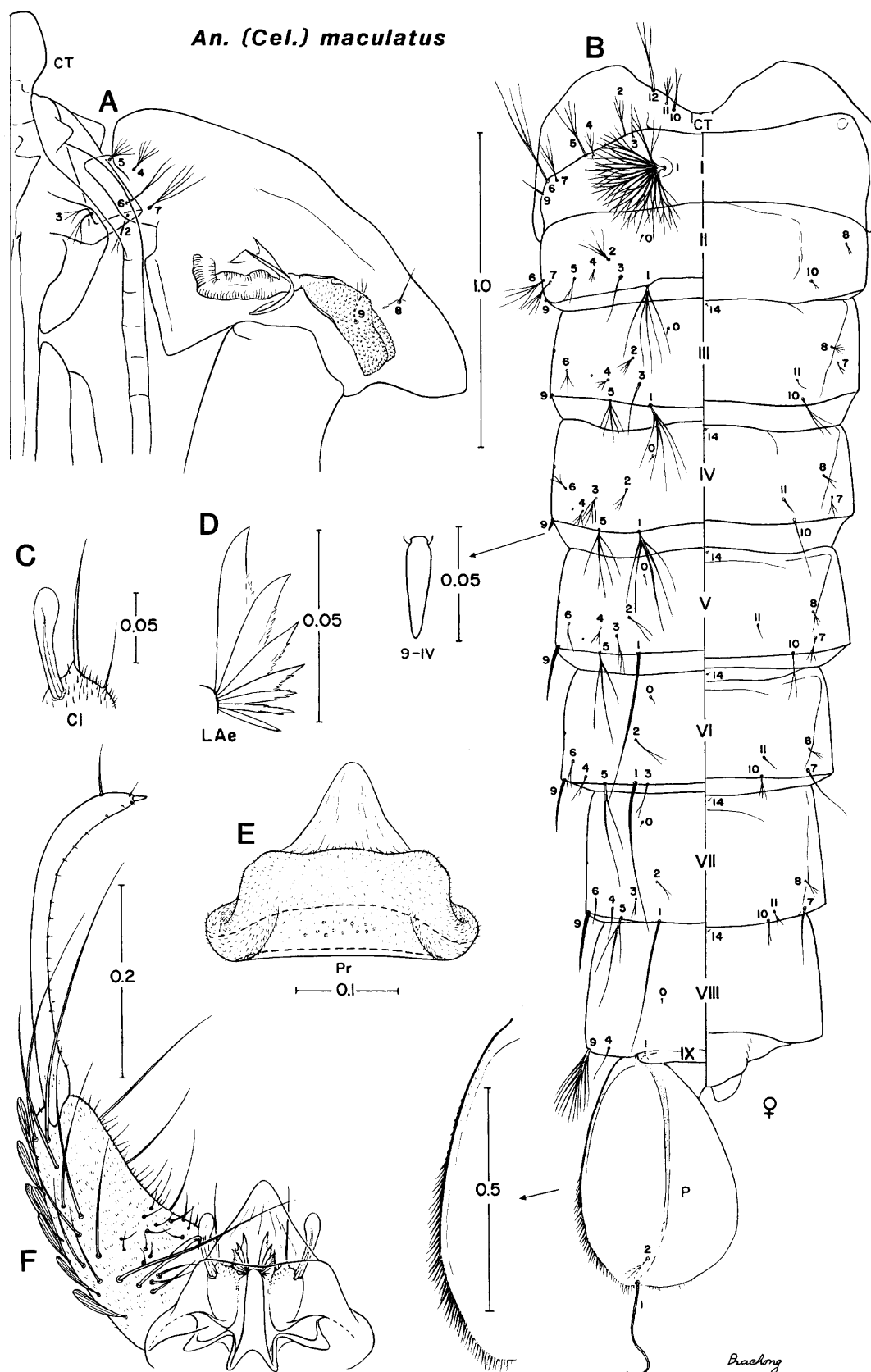


Fig. 2. *Anopheles (Cellia) maculatus*. A,B, Pupa (A, dorsolateral aspect of cephalothorax, left side; B, dorsal and ventral aspects of left side of metathorax and abdomen). C-F, Male genitalia. Scales in mm.

Table 3. Number of branches for pupal setae of *Anopheles (Cellia) maculatus* Theobald.

Seta no.	Abdominal segments				
	CT	I	II	III	IV
0	-	-	1	1	1
1	1-3 (3)	10-13 (10)*	4-7 (6)	4-6 (5)	3-5 (5)
2	1-3 (3)	3-7 (3)	3,4 (4)	3-6 (5)	2,3 (3)
3	2,3 (3)	1,2 (1)	1,2 (1)	1,2 (1)	1-6 (3)
4	2-5 (3)	2-6 (4)	1-6 (3)	3-6 (4)	1-4 (2)
5	2-6 (5)	3,4 (3)	2-4 (3)	5-8 (8)	5-7 (5)
6	1,2 (2)	2-4 (3)	3-5 (3)	3-7 (5)	1-4 (3)
7	2-5 (3)	2-5 (5)	2-5 (4)	1-5 (4)	1-5 (3)
8	1,2 (1)	-	1-3 (2) ⁺	2-5 (5)	1-4 (2)
9	1-4 (3)	1	1	1	1
10	1,2 (1)	-	1,2 (1) ⁺	2,3 (3)	1-4 (3)
11	1-4 (3)	-	-	1	1
12	1-3 (2)	-	-	-	-
13	-	-	-	-	-
14	-	-	1	1	1

Seta no.	Abdominal segments					Paddle P
	V	VI	VII	VIII	IX	
0	1	1	1	1	-	-
1	1	1	1	-	1-3 (1)	1
2	2,3 (2)	1-5 (1)	1-3 (2)	-	-	1-4 (3)
3	2,3 (2)	1-3 (2)	1,2 (2)	-	-	-
4	2-5 (3)	1,2 (2)	1,2 (1)	1-3 (2)	-	-
5	3-5 (3)	1-6 (4)	2-5 (3)	-	-	-
6	1,2 (2)	1-5 (2)	1,2 (1)	-	-	-
7	1-4 (2)	1,2 (1)	1-3 (2)	-	-	-
8	1-4 (2)	1-5 (2)	1-4 (3)	-	-	-
9	1	1	1	9-14 (11)	-	-
10	2	1-3 (3)	1-3 (1)	-	-	-
11	1	1,2 (1)	1-4 (2)	-	-	-
12	-	-	-	-	-	-
13	-	-	-	-	-	-
14	1	1	1	1	-	-

*Primary stems. Approximately 120 branches present.

⁺Normally only alveolus present.

extant syntype females (two specimens) share some similarities with *willmori* (James, in Theobald 1903) and *sawadwongporni* Rattanakrithikul and Green, 1987. For this reason we are regarding the synonymy as provisional until adequate material from Taiwan becomes available for a thorough evaluation. We are also tentatively attributing the records of *hanabusai* from Taiwan to *maculatus* as well (see the summary of taxonomic references listed above).

Bionomics. Collection records and literature reports from Hong Kong indicate that the immature stages of

maculatus are found in permanent and semipermanent bodies of clean water such as rocky streams, stream pools, springs, irrigation ditches, and seepages. Other species of mosquitoes collected in association with *maculatus* in these habitats include *Aedes (Finlaya) macfarlanei* (Edwards), *An. (Anopheles) sinensis* Wiedemann, *An. (Cel.) jeyporiensis* James, *An. (Cel.) minimus* Theobald, *Culex (Culex) pseudovishnui* Colless, *Cx. (Cux.) tritaeniorhynchus* Giles, *Cx. (Cux.) vishnui* Theobald, *Cx. (Eumelania) malayi* (Leicester), and a species of *Cx. (Lo-*

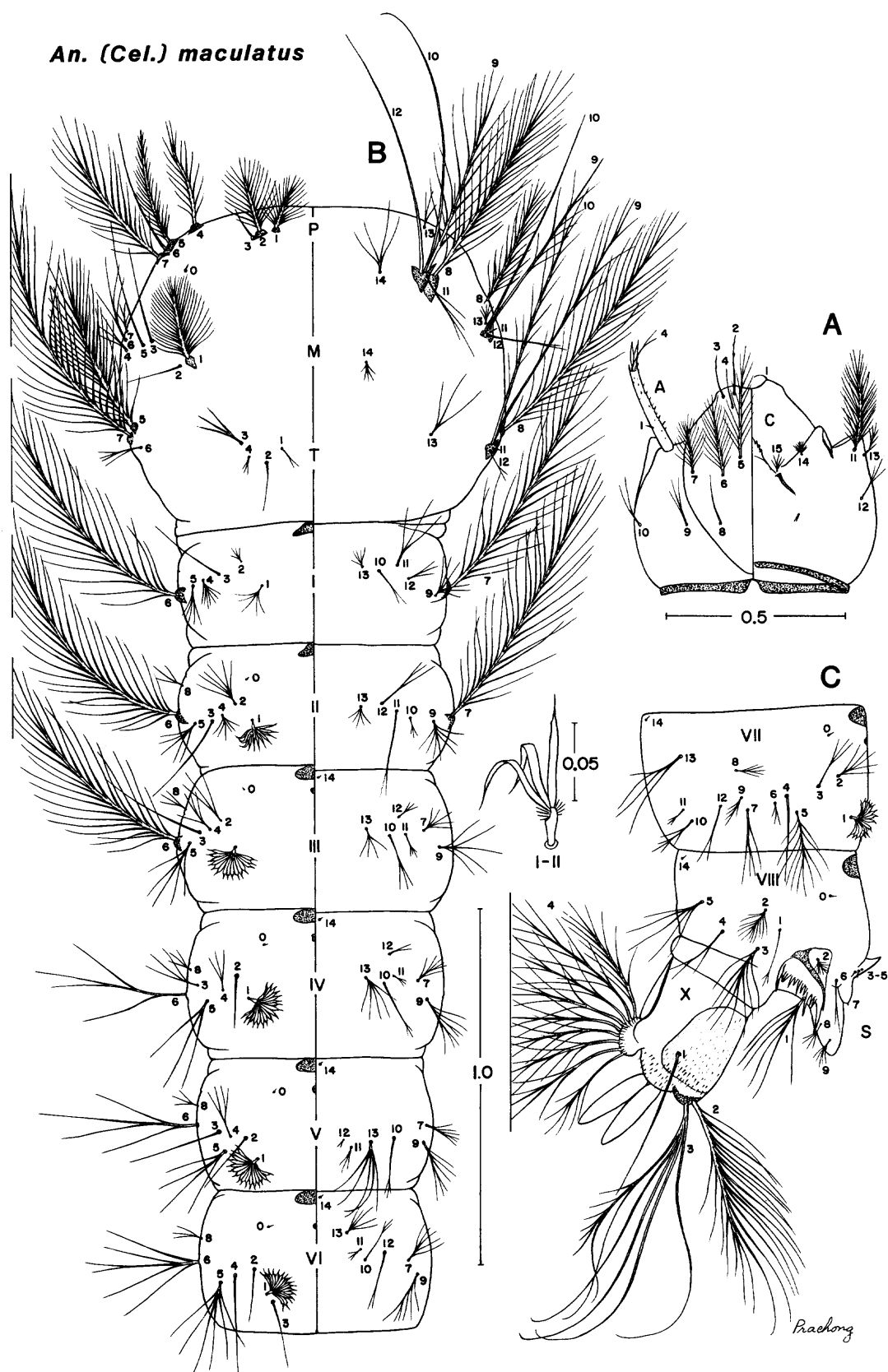


Fig. 3. *Anopheles (Cellia) maculatus*, fourth-instar larva. A, Head (dorsal and ventral aspects of left side). B, Thorax and abdominal segments I-VI (dorsal and ventral aspects of left side). C, Abdominal segments VII-X (left side). Scales in mm.

Table 4. Number of branches for fourth-instar larval setae of *Anopheles (Cellia) maculatus* Theobald.

Seta no.	Head	Thorax			Abdominal segments		
	C	P	M	T	I	II	III
0	-	1	-	-	-	1	1
1	1	17-32 (24)	22-48 (37)	1,2 (1)	5-10 (7)	9-16 (11)	15-22 (16)
2	1	15-25 (18)	1	1-3 (1)	2-5 (3)	4-7 (5)	3-7 (5)
3	1	1	1	1-5 (3)	1,2 (1)	1	1
4	1	15-22 (21)	2-4 (3)	2-4 (3)	5-9 (7)	5-8 (6)	3-5 (4)
5	15-21 (16)	27-52 (43)	1	28-44 (34)	3-6 (4)	3-7 (5)	3-6 (5)
6	16-21 (20)	1	3-5 (4)	2-4 (3)	25-35 (33)	20-37 (33)	20-31 (27)
7	16-24 (22)	22-31 (24)	2-4 (3)	29-40 (33)	27-38 (32)	31-37 (34)	3-6 (6)
8	1,2 (1)	25-37 (33)	20-30 (24)	29-41 (40)	-	2-5 (3)	1-4 (3)
9	2-6 (3)	10-18 (13)	5-13 (10)	10-24 (15)	4-11 (6)	6-11 (9)	5-9 (7)
10	1-3 (1)	1	1	15-26 (15)	1-3 (1)	1-5 (3)	1-4 (3)
11	26-50 (42)	3-5 (3)	1	1-4 (1)	2-4 (4)	1-4 (2)	2-4 (4)
12	3,4 (3)	1	1,2 (2)	2-4 (2)	3-6 (4)	2-4 (3)	2-5 (3)
13	3-6 (3)	3-5 (5)	3-7 (3)	3-5 (3)	3-6 (4)	3-8 (5)	3-5 (4)
14	7-16 (12)	3-6 (4)	4-14 (7)	-	-	-	1
15	4-10 (5)	-	-	-	-	-	-

Seta no.	Abdominal segments					
	IV	V	VI	VII	VIII	X
0	1	1	1	1	1	-
1	14-21 (17)	16-22 (19)	12-19 (14)	14-20 (16)	1-3 (1)	1
2	1	1	1-3 (1)	4-7 (6)	5-13 (10)	16-24 (21)
3	1-4 (3)	1,2 (1)	1,2 (1)	1-4 (3)	6-10 (7)	4-46 (5)*
4	2-5 (3)	2-4 (4)	1-3 (1)	1,2 (1)	1-4 (2)	9pr
5	3-6 (3)	4-8 (5)	6-11 (8)	6-15 (11)	5-9 (6)	-
6	2-7 (5)	4-6 (5)	4-6 (5)	2-6 (5)	-	-
7	4-7 (5)	2-6 (5)	3-5 (4)	3-6 (5)	1-S	4-8 (5)
8	2,3 (3)	2-4 (3)	2-4 (2)	2-8 (5)	2-S	3-11 (8)
9	4-8 (7)	4-6 (5)	4-9 (5)	4-11 (6)	6-S	2,3 (3)
10	1-3 (3)	1-3 (3)	1-3 (3)	2-8 (6)	7-S	1,2 (2)
11	2-4 (3)	1-5 (3)	3-5 (3)	1-3 (3)	8-S	3-7 (4)
12	2-6 (3)	1-4 (3)	1,2 (2)	2,3 (3)	9-S	3-7 (5)
13	3-5 (4)	4-6 (4)	3-11 (6)	3-5 (4)	-	-
14	1	1	1	1	1	-
15	-	-	-	-	-	-

*Primary stems only.

phoceraomyia). The larval habitats are normally exposed to full sunlight. Females apparently feed mainly on cattle, but are known to enter sleeping quarters (Jackson 1936) and have been collected on human bait. Jackson (1938) mentioned that *maculatus* had been found infected with malarial parasites and larval filariae resembling *Wucheria bancrofti* (Cobbold), but it is not clear whether he was

referring to *maculatus* from Hong Kong or elsewhere. Two years earlier Jackson (1936) indicated that this species was not found naturally infected with these pathogens in Hong Kong, but was able to infect specimens in the laboratory.

Distribution. Besides the type locality of Hong Kong, this species seems to be widely distributed in southeastern

Asia, southern China, and westward into Nepal, India, and Pakistan. At present, it is not known whether or not populations from all areas of this distribution are conspecific. Populations from Malaysia and Indonesia, for example, may represent an undescribed member of the *Maculatus* Complex. *Anopheles maculatus* is here removed from the list of mosquitoes known from the Philippines.

Material Examined. A total of 196 specimens: 24 females, 39 males, 3 male genitalia, 57 pupal exuviae, 50 larval exuviae, and 23 fourth-instar larvae, including 63 individual rearings, from Hong Kong.

Anopheles (Cellia) greeni, new species

Anopheles maculatus of Manalang 1931:241-248 (Rizal Prov., Luzon; malaria dissections).

Anopheles (Nyssorhynchus) maculatus in part of Barber et al. 1915:180 (Antipolo and near Taytay [Rizal Prov.], Luzon; coll. rec.).

Anopheles (Cellia) maculatus form D of Green et al. 1985a:323-327 (Montalban [Rizal Prov.], Luzon; chromosomes).

Other references that may apply to this species are listed after the discussion.

Consistent differences between this species and *maculatus* are noted in Table 1. This species resembles *maculatus* except as follows.

Female. *Head:* Proboscis (Fig. 4B) length 1.23-1.45 mm, 1.07-1.38 length of forefemur. Length of maxillary palpus (Fig. 4A) 1.13-1.43 mm, 0.91-0.98 length of proboscis; palpomere 3 black-scaled, sometimes with longitudinal streak of white or yellowish scales along dorsomesal margin; preapical black band 0.25-0.75 length of subapical white band (palpomeres 3 and 4), 0.23-0.50 length of apical white band (palpomeres 4 and 5); subapical white band 0.60-1.17 length of apical white band. *Thorax:* Central area of scutum covered with white spatulate scales (length 4.0-6.6 width). Scutellum with 2-7 short and 4-10 long setae medially, 2-5 short and 3-6 long setae laterally. Antepnotum with pale scales and 10-21 dark setae. Pleural setae: 0-4 prespiracular, 3-6 prealar, 2-4 upper and 2-4 lower mesokatepisternal, and 6-11 upper mesepimeral. *Wing* (Fig. 4E): Accessory sector pale (ASP) spot always present on subcosta and often on costa (present on both in 44% of positively identified specimens examined), basal part of sector dark (SD) spot between sector pale (SP) and accessory sector pale spots sometimes very small or absent; preapical dark (PD) spot 0.21-1.25 (mean 0.75) length of subcostal pale (SCP) spot and 0.25-1.37 (mean 0.83) length of preapical pale (PP) spot; vein R_2 0.88-1.85 (mean 1.43) length of vein R_{2+3} . *Legs* (Fig. 4D): Foretarsomere 1 with 4-10 posterodorsal pale spots, foretarsomere 2 with 0-2 pale spots on median dark band; midtarsomere 1 with 5-9 posterodorsal spots, midtarsomeres 1-3

with narrow pale spot dorsally at apex, midtarsomeres 2 and 3 with or without median pale spot on posterodorsal surface, midtarsomeres 3 and 4 occasionally with posterodorsal pale spot at base; hindtarsomere 1 with 7-10 posterodorsal pale spots, hindtarsomere 2 with 0-2 pale spots on median dark band. *Abdomen* (Fig. 4C): Integument light to dark brown. Terga I-IV usually without scales, occasionally with few falcate or narrow spatulate scales posteriorly; terga VII and VIII sparsely covered with pale yellow falcate and/or spatulate scales on posterolateral corners, scales occasionally absent.

Male. Like female except as follows. *Head:* Proboscis length 2.01-2.10 mm, 1.43-1.49 length of forefemur. Length of maxillary palpus 2.07-2.10 mm, 1.00-1.03 length of proboscis. *Wing:* Length of preapical dark spot 0.46-1.67 (mean 0.95) length of subcostal pale spot and 0.46-1.67 (mean 0.98) length of preapical pale spot; length of vein R_2 0.80-1.57 (mean 1.08) length of vein R_{2+3} . *Abdomen:* Tergum VII with patch of brown to black spatulate scales posteriorly; tergum VIII (ventral in position) dark-scaled posteriorly. Sterna V-VII with some scattered pale scales; sternum VII (and sometimes VI) also with median patch of black scales on posterior margin; sternum VIII (dorsal in position) pale-scaled. *Genitalia.* Essentially as in *maculatus*. Gonocoxite with 4-6 parabasal setae; club of claspette with 3 or 4 serrate stems. Apex of aedeagus with 3 or 4 foliiform and 1 or 2 lanceolate leaflets on each side, foliiform leaflets serrate along one margin.

Pupa (Fig. 5). Character and positions of setae as figured; range and modal number of branches in Table 5. *Cephalothorax:* Trumpet length 0.43-0.50 mm, width 0.09-0.10 mm, index 4.35-5.21. *Abdomen:* Seta 9-II,III very short, blunt; 9-IV-VII long, sharply pointed; ratio of length of seta 9-III/9-IV 0.09-0.26 (mean 0.17), 9-IV/9-V 0.56-0.83 (mean 0.72); 9-VIII with 11-20(17) branches. *Paddle:* Fringe of outer margin with refractile border ending 0.70-0.81 from base, with 15-24 non-refractile filaments before seta 1-P; inner margin usually with some filaments near seta 1-P. Seta 1-P generally shorter, 0.27-0.36 length of paddle.

Larva (Fig. 6). Character and placement of setae as figured; range and modal number of branches in Table 6. *Head:* Seta 4-A with 1-4(3) branches. Seta 2-C single, with 2-8 short lateral aciculae, occasionally simple. *Thorax:* Seta 3-T single to triple, branches filamentous or lanceolate. *Abdomen:* Seta 1-I normally with 2-4 filamentous or lanceolate branches, occasionally with 5 on one side, rarely with 5 on both sides; 1-II with 10-18 leaflets, each leaflet with distinct serrated shoulders and long terminal filament, filament usually more than 0.25 length of leaflet, shoulders occasionally somewhat weakly developed but filament always long; leaflets of seta 1-III-V each with long filament 0.29-0.46 length of leaflet; 4-I and 5-VII with fewer branches, 4-I with 3-7(5) and 5-VII with 5-9(6). Pecten plate with 4-6 long and 6-9 noticeably shorter spines.

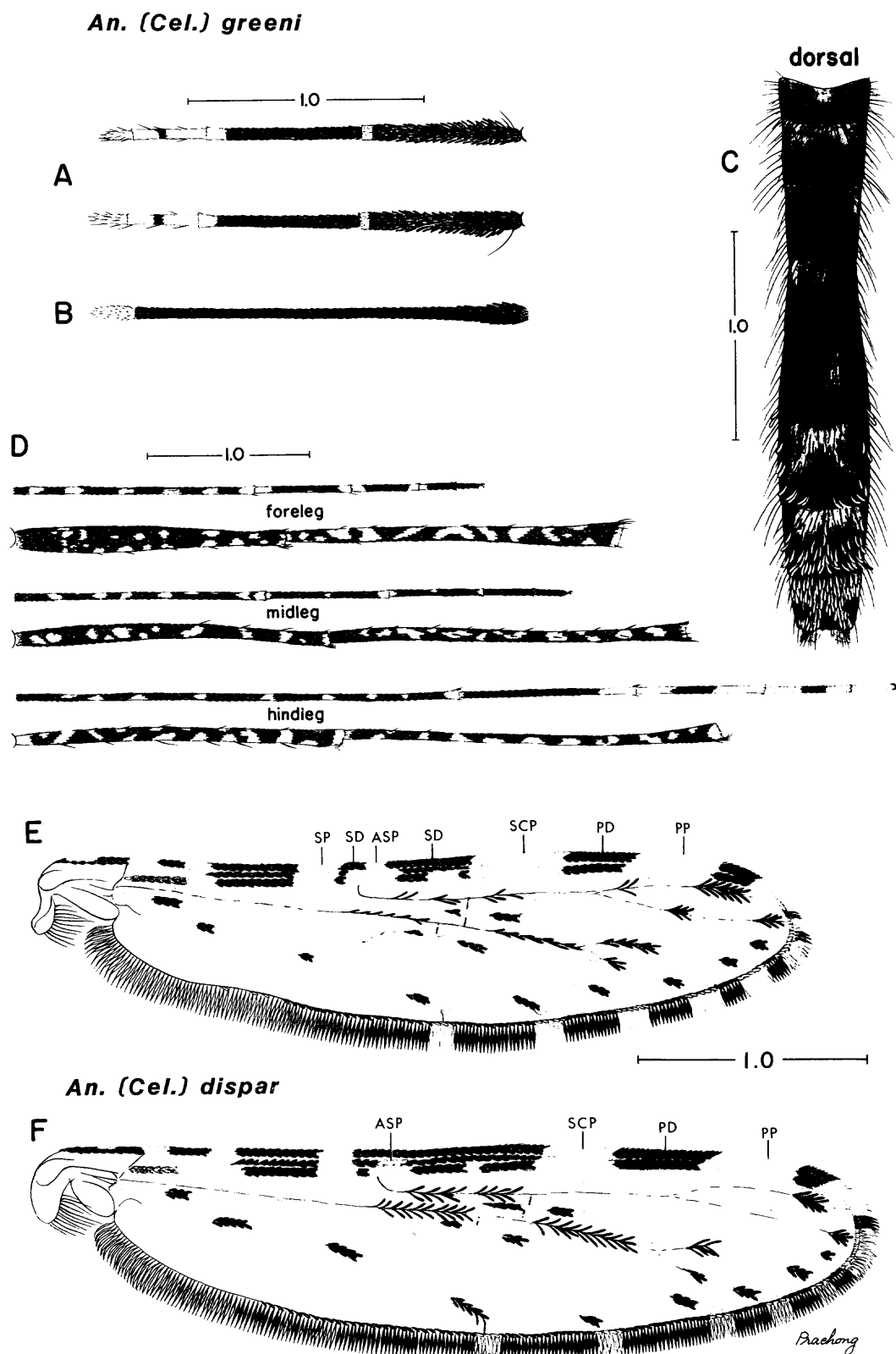


Fig. 4. A-E, *Anopheles (Cellia) greeni*, adult structures (A, maxillary palpus, dorsal and ventral views; B, proboscis; C, abdomen, dorsal; D, legs, anterior aspects; E, right wing, dorsal). F, *Anopheles (Cellia) dispar*, right wing (dorsal). Scales in mm.

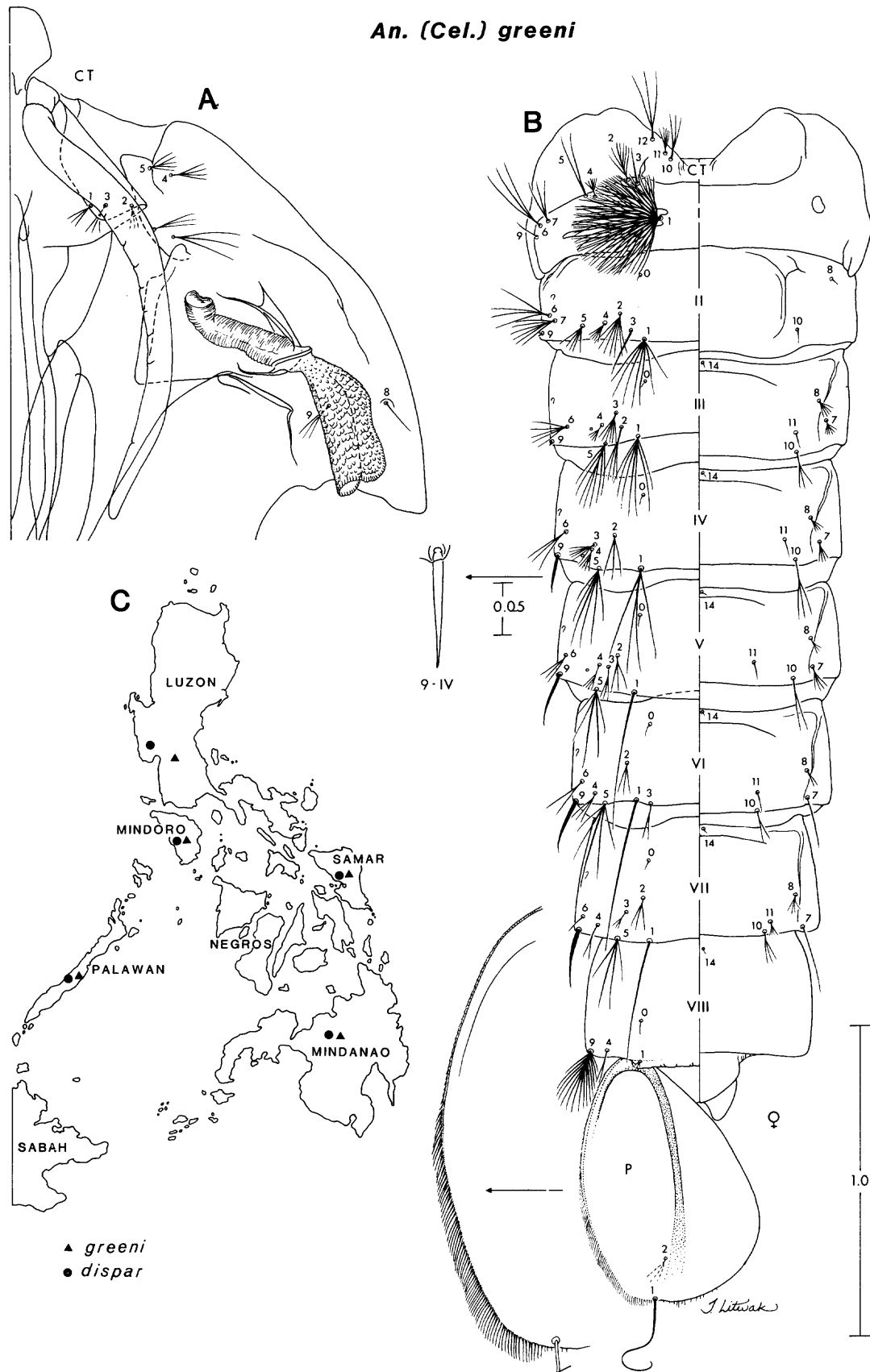


Fig. 5. A,B, *Anopheles (Cellia) greeni*, pupa (A, dorsolateral aspect of cephalothorax, left side; B, dorsal and ventral aspects of left side of metathorax and abdomen). C, Map of the Philippines showing areas where *An. (Cel.) greeni* and *An. (Cel.) dispar* have been collected. Scales in mm.

Table 5. Number of branches for pupal setae of *Anopheles (Cellia) greeni* n. sp.

Seta no.	Abdominal segments				
	CT	I	II	III	IV
0	-	-	1	1	1
1	2-4(3)	6-15*	4-10(5)	4-7(5)	2-5(3)
2	2-4(3)	3-9(7)	2-7(7)	3-7(6)	2-4(3)
3	2,3(3)	1	1,2(1)	1-4(2)	2-7(5)
4	2-8(4)	1-8(7)	1-9(6)	1-7(4)	2-5(4)
5	2-6(5)	2-5(3)	3-5(5)	6-8(7)	3-7(5)
6	2-4(3)	2-4(3)	3-7(3)	3-7(5)	2-4(3)
7	3-5(3)	1-4(3)	3-6(5)	1-7(4)	1-7(3)
8	1	-	1-5(2) ⁺	2-6(4)	2-5(4)
9	1-3(3)	1	1	1	1
10	1-5(3)	-	1,2(1)	1-3(3)	1-3(2)
11	1-6(3)	-	-	1	1
12	1-5(3)	-	-	-	-
13	-	-	-	-	-
14	-	-	1	1	1

Seta no.	Abdominal segments					Paddle P
	V	VI	VII	VIII	IX	
0	1	1	1	1	-	-
1	1	1	1	-	1	1
2	2,3(3)	2-4(3)	1-3(2)	-	-	1-3(2)
3	1-4(3)	1-3(1)	1-3(2)	-	-	-
4	2-4(3)	1-3(1)	1,2(1)	1-3(1)	-	-
5	3-6(5)	3-6(4)	3-5(3)	-	-	-
6	1-4(3)	1-4(2)	1,2(1)	-	-	-
7	1-4(3)	1,2(1)	1-4(1)	-	-	-
8	1-3(3)	1-5(3)	1-5(4)	-	-	-
9	1	1	1	11-20(17)	-	-
10	1,2(2)	1-3(2)	1-3(1)	-	-	-
11	1,2(1)	1,2(1)	3,4(3)	-	-	-
12	-	-	-	-	-	-
13	-	-	-	-	-	-
14	1	1	1	1	-	-

*Primary stems. Approximately 130 branches.

⁺Normally only alveolus present.

Material examined. A total of 307 specimens: 87 females, 37 males, 3 male genitalia, 90 pupal exuviae, 87 larval exuviae, and 3 fourth-instar larvae, including 95 individual rearings and 1 progeny brood, from the following localities in the Republic of the Philippines (see map, Fig. 5):

LUZON: *Ilocos Norte Province* - Baroyan River; *Laguna Province* - Canlubang; *Quezon Province* - Antimonan; *Rizal Province* - Montalban, Wawa; *Zambales Province* - Quinabucsan, Redondo.

MINDANAO: *Lanao Province* - Kalambugan; *Zam-*

boanga Province - San Ramon.

MINDORO: *Mindoro Oriental Province* - Barrio Pagdulang, Matapitap.

PALAWAN: *Palawan Province* - Iwahig, Napson, Puerto Princesa.

SAMAR: *Samar Province* - Osmena.

Type data. The type series includes 21 females, 3 males, 11 pupal exuviae, 11 larval exuviae, and 3 fourth-instar larvae with the following data: PHILIPPINES, Luzon, Rizal Province, Montalban, Wawa, 40 m, 6 August 1986, Coll. Harbach, Rampa and Green. The holotype and other

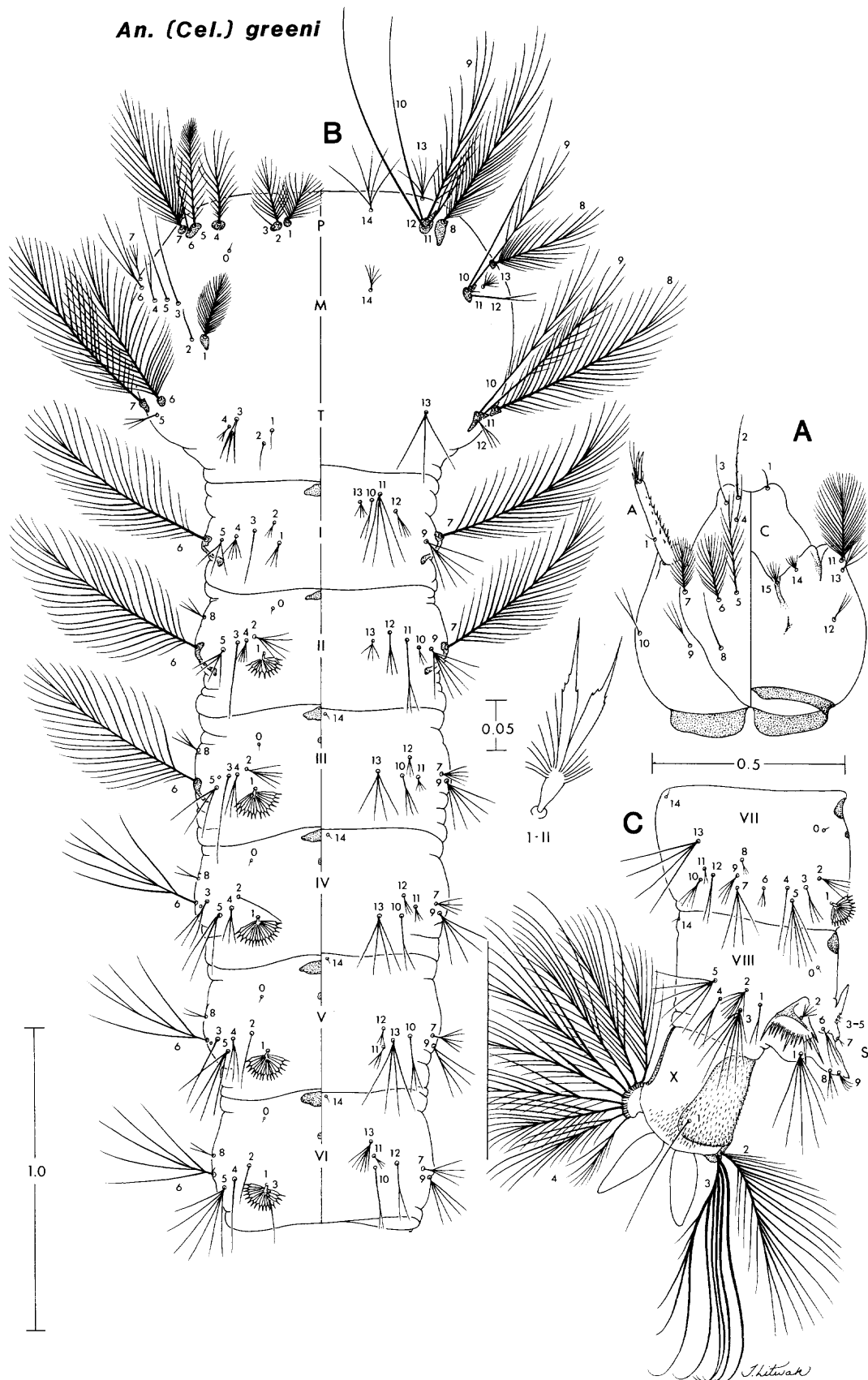


Fig. 6. *Anopheles (Cellia) greeni*, fourth-instar larva. A, Head (dorsal and ventral aspects of left side). B, Thorax and abdominal segments I-VI (dorsal and ventral aspects of left side). C, Abdominal segments VII-X (left side). Scales in mm.

Table 6. Number of branches for fourth-instar larval setae of *Anopheles (Cellia) greeni* n. sp.

Seta no.	Head	Thorax			Abdominal segments		
	C	P	M	T	I	II	III
0	-	1	-	-	-	1	1
1	1	14-20 (17)	31-40 (39)	1	2-5 (4)	10-18 (12)	13-19 (15)
2	1	14-19 (17)	1	1	2-4 (3)	4-7 (6)	3-6 (5)
3	1	1	1	1-3 (2)	1	1	1,2 (1)
4	1	15-23 (19)	2-4 (3)	2-4 (3)	3-7 (5)	3-5 (4)	3,4 (3)
5	13-19 (15)	24-35 (28)	1	26-42 (35)	3,4 (3)	3-7 (5)	3-5 (5)
6	14-19 (17)	1	3,4 (3)	3,4 (3)	28-35 (32)	27-38 (33)	20-32 (30)
7	16-23 (19)	19-30 (21)	3-6 (3)	23-39 (37)	28-38 (29)	26-39 (33)	3-6 (5)
8	1	19-36 (32)	16-25 (16)	25-41 (39)	-	2,3 (3)	2,3 (3)
9	2-6 (3)	9-15 (11)	6-12 (9)	7-16 (9)	4-6 (5)	5-9 (6)	4-6 (5)
10	1-3 (2)	1	1	8-17 (13)	1-3 (2)	1-4 (3)	1-3 (3)
11	22-38 (35)	1-4 (3)	1	1*	3-5 (4)	2,3 (3)	3-5 (4)
12	2-4 (3)	1	1,2 (2)	2-6 (3)	2-5 (5)	2,3 (3)	2-4 (3)
13	2-6 (3)	3-5 (5)	4-8 (7)	3-6 (3)	3-6 (4)	2-5 (3)	2-5 (3)
14	4-12 (8)	2-5 (4)	2-13 (5)	-	-	-	1
15	4-8 (6)	-	-	-	-	-	-

Seta no.	Abdominal segments					
	IV	V	VI	VII	VIII	X
0	1	1	1	1	1	-
1	13-17 (16)	13-18 (16)	13-18 (14)	11-17 (14)	1-3 (2)	1
2	1,2 (1)	1	1	3-5 (3)	6-11 (7)	14-24 (21)
3	1-3 (3)	1,2 (1)	1-3 (1)	2-4 (3)	5-10 (9)	6-8 (7)*
4	2-4 (3)	2-4 (3)	1	1	1-3 (2)	9pr
5	3-6 (3)	3-5 (4)	5-8 (7)	5-9 (6)	4-7 (5)	-
6	4-9 (4)	3-8 (5)	4-7 (5)	3-5 (4)	-	-
7	4-6 (5)	3-6 (5)	3-5 (4)	2-8 (4)	1-S	3-8 (6)
8	2,3 (2)	1-3 (3)	1-3 (2)	2-5 (4)	2-S	5-9 (5)
9	3-5 (4)	3-5 (4)	3-5 (4)	2-5 (4)	6-S	2-4 (3)
10	1-3 (2)	1-3 (2)	1-3 (2)	2-5 (5)	7-S	1-3 (2)
11	3,4 (3)	3,4 (3)	2-4 (3)	2-4 (3)	8-S	2-4 (3)
12	2-4 (3)	2-4 (3)	2-4 (4)	2	9-S	2-4 (3)
13	2-4 (3)	3-5 (4)	2-6 (5)	3-6 (4)	-	-
14	1	1	1	1	1	-
15	-	-	-	-	-	-

*Primary stems only.

reared specimens are part of a chromosomally identified progeny brood from a wild-caught female: PH21(1), mother; PH21(1)-1, holotype female; PH21(1)-10, allotype male; PH21(1)-2 thru -8, paratype females; PH21(1)-9 and -11, paratype males; and 3 larvae on slides bearing the same alphanumeric designation as the mother. Twelve of the paratypes are wild-caught females (Tai-1, -8, -10, -13, -16, -19, -23 thru -27, -29) identified from their ovarian polytene chromosomes. The holotype, allotype, and most

of the paratypes are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC. Several paratypes are deposited in the Natural History Museum, London.

Bionomics. Collection data associated with the specimens examined in this study indicate that larvae of this species have been collected in streamlets and ground pools in association with *An. (Ano.) manalangi* Mendoza, *An. (Ano.) vanus* Walker, *An. (Cel.) filipinae* Manalang, *An.*

(*Cel.*) *flaviostris* (Ludlow), *An. (Cel.) dispar* n. sp., *An. (Cel.) mangyanus* (Banks), *Uranotaenia (Pseudoficalbia) lagunensis* Baisas, and *Ur. (Uranotaenia) falcipes* Banks. Adults have been collected while biting carabao.

Anopheles greeni appears to be widely distributed in the lowland, hilly areas of the Philippine Islands. Although there is no direct evidence to incriminate this species as a vector of malarial parasites (Manalang 1931), it is quite likely the species which Ejercito (1934) found infected with oocysts and sporozoites of *Plasmodium falciparum* in the Bulacan Province of Luzon.

Systematics. *Anopheles greeni* appears to be a distinct species in the Maculatus Complex. This species is strongly differentiated from *maculatus* in all stages (Table 1) and is readily separated from other allied species on the mainland by the character of seta 9-IV of the pupa. A long, pointed seta 9-IV has not been observed in any population from the mainland or the islands of Borneo and Sumatra.

Etymology. *Anopheles greeni* is named in honor of Dr. Christopher A. Green for his pioneering research on the cytotaxonomy of the Maculatus Complex in Southeast Asia.

Anopheles (Cellia) dispar, new species

Anopheles maculatus in part of Russell, 1934b:105 (specimens from Baguio).

Anopheles (Cellia) maculatus of Baisas 1974:69 (Subic Bay Naval Reserve; A only, all figures and other information not based on material from Subic Bay).

Anopheles (Myzomyia) maculatus in part of Russell and Baisas, 1934b:320 (specimens from Baguio); Russell and Baisas, 1936:47,48 (specimens from Baguio, wing in fig. 24, pl. 33).

Other references that may apply to this species are listed after the discussion.

Primary differences between *dispar* and *maculatus* are listed in Table 1; those between *dispar* and *greeni* are listed in Table 2. This species is like *greeni* except for the following differences.

Female. **Head:** Proboscis length 1.28-1.40 mm, 1.08-1.19 length of forefemur. Length of maxillary palpus 1.25-1.51; preapical black band 0.25-1.00 length of subapical white band (palpomerites 3 and 4), 0.23-0.71 length of apical white band (palpomerites 4 and 5); subapical white band 0.39-1.20 length of apical white band. **Thorax:** Scutellum with 2-8 short and 6-10 long setae medially, 2-4 short and 3-6 long setae laterally. Pleural setae: 0-4 prespiracular, 3-6 prealar, 2-5 upper and 2-6 lower mesokatepisternal, and 4-9 upper mesepimeral. **Wing** (Fig. 4F): Accessory sector pale (ASP) spot often present on subcosta (present in 43% of positively identified specimens), seldom if ever present on costa (absent in all positively identified specimens examined); length of preapical dark (PD) spot 0.32-2.05 (mean 1.20) length of subcostal pale (SCP) spot and 0.55-

2.80 (mean 1.41) length of preapical pale (PP) spot; vein R_2 0.85-1.44 (mean 1.23) length of vein R_{2+3} . **Legs:** Foretarsomere 1 with 4-10 posterodorsal pale spots, foretarsomere 2 with or without pale spot on median dark band; midtarsomere 1 with 5-7 posterodorsal pale spots, midtarsomeres 3 and 4 rarely with posterodorsal pale spots at base; hindtarsomere 1 with 6-11 posterodorsal pale spots.

Male. Differs from female as follows. **Head:** Proboscis length 1.74-2.10 mm, 1.35-1.51 length of forefemur. Length of maxillary palpus 1.80-2.07 mm, 0.97-1.06 length of proboscis. **Wing:** Length of preapical dark spot 0.76-1.93 (mean 1.16) length of subcostal pale spot and 0.57-1.80 (mean 1.11) length of preapical pale spot; vein R_2 0.80-1.33 (mean 1.01) length of vein R_{2+3} . **Genitalia** (Fig. 7): As described for *maculatus* and *greeni*.

Pupa (Fig. 7). Character and placement of setae as figured; range and modal number of branches in Table 7. **Cephalothorax:** Trumpet length 0.48-0.52 mm, width 0.09-0.11 mm, index 4.46-5.45. **Abdomen:** Ratio of length of seta 9-III/9-IV 0.13-0.52 (mean 0.27) and 9-IV/9-V 0.30-0.71 (mean 0.52).

Larva (Fig. 8). Character and positions of setae as figured; range and modal number of branches in Table 8. **Abdomen:** Seta 1-I with 5-9 filamentous or lanceolate branches; leaflets of seta 1-II with distinct serrated shoulders, shoulders occasionally indistinct but filament always long, 0.27-0.43 length of leaflet; 4-I with 5-11(6) branches; 5-VII with 6-11(8) branches.

Material examined. A total of 689 specimens: 264 females, 87 males, 3 male genitalia, 178 pupal exuviae, 141 larval exuviae, and 16 fourth-instar larvae, including 177 individual rearings and 4 progeny broods, from the following localities in the Republic of the Philippines (see map, Fig. 5):

LUZON: *Bataan Province* - Morong, Pastolan, Tipo; *Mountain Province* - Baguio; *Quezon Province* - Pagbilao; *Zambales Province* - Antonio, Capintalan, Olongapo, Subic.

MINDANAO: *Zamboanga Province* - San Ramon.

MINDORO: *Mindoro Oriental Province* - Barrio Pagdulang, Matapitap.

PALAWAN: *Palawan Province* - Napson, Puerto Princesa.

SAMAR: *Samar Province* - Osmena.

Type data. The type series includes 34 females, 16 males, 35 pupal exuviae, 18 larval exuviae, and 3 fourth-instar larvae. The holotype and other reared specimens are the progeny of two cytotyped broods obtained from wild-caught females, PH22(5) and PH23(4). Fourteen females were identified from their ovarian polytene chromosomes after being captured in the field. The individual specimens are denoted as follows: PH23(4), mother; PH23(4)-1, holotype female; PH23(4)-110 allotype male; PH23(4)-2 thru -12, -100 thru -109 and -111 thru -115, paratypes (15 females, 11 males) from PHILIPPINES, Luzon, Bataan Province, Pastolan, Subic Bay, 7-8 August

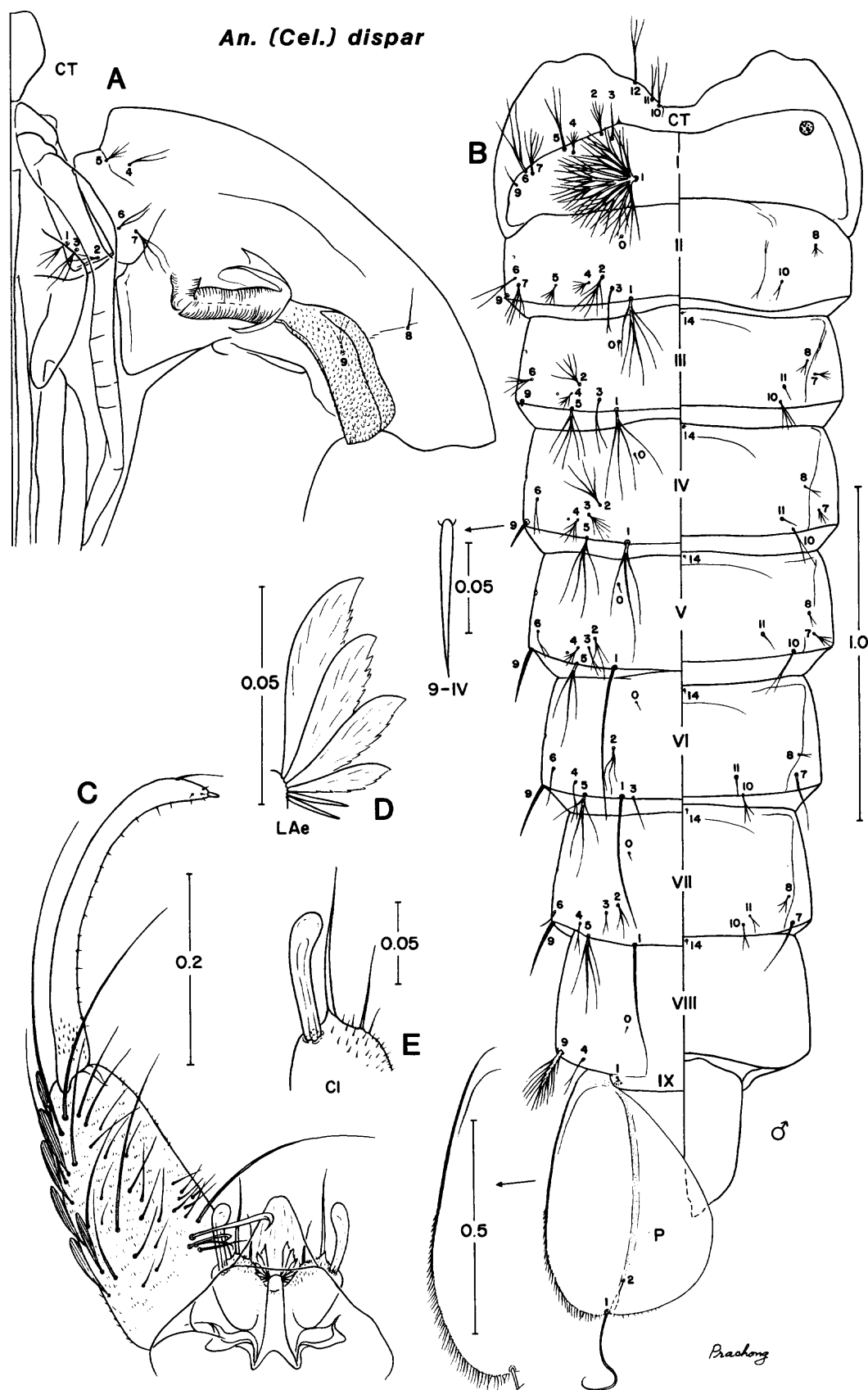


Fig. 7. *Anopheles (Cellia) dispar*. A,B, Pupa (A, dorsolateral aspect of cephalothorax, left side; B, dorsal and ventral aspects of left side of metathorax and abdomen). C-E, Male genitalia. Scales in mm.

Table 7. Number of branches for pupal setae of *Anopheles (Cellia) dispar* n. sp.

Seta no.	Abdominal segments				
	CT	I	II	III	IV
0	-	-	1	1	1
1	2-4 (3)	8-17 (15)*	4-12 (6)	3-8 (4)	1-5 (3)
2	2-4 (2)	2-8 (5)	3-8 (4)	2-8 (5)	3-5 (3)
3	2-4 (3)	1	1-3 (3)	1-3 (1)	1-8 (5)
4	2-7 (4)	1-7 (5)	3-8 (4)	1-6 (4)	1-5 (4)
5	3-7 (5)	2-5 (3)	2-7 (4)	4-11 (5)	3-7 (3)
6	1-3 (3)	2-5 (5)	2-4 (4)	2-6 (6)	1-4 (3)
7	2-4 (3)	2-7 (3)	3-6 (3)	1-7 (4)	1-7 (4)
8	1,2 (1)	-	1-6 (2)	3-6 (5)	2-5 (3)
9	1-4 (3)	1,2 (1)	1	1	1
10	1-4 (3)	-	0-2 ⁺	2-4 (3)	1-5 (2)
11	2-4 (3)	-	-	1	1
12	2-4 (3)	-	-	-	-
13	-	-	-	-	-
14	-	-	1	1	1

Seta no.	Abdominal segments					Paddle P
	V	VI	VII	VIII	IX	
0	1	1	1	1	-	-
1	1	1,2 (1)	1	-	1	1
2	2-4 (3)	1-3 (3)	2,3 (3)	-	-	2-5 (2)
3	1-4 (3)	1,2 (1)	1-3 (2)	-	-	-
4	2-6 (3)	1-3 (2)	1-3 (2)	1-3 (1)	-	-
5	3-8 (5)	3-5 (3)	3-5 (3)	-	-	-
6	2,3 (2)	1-3 (2)	1-3 (1)	-	-	-
7	1-4 (3)	1,2 (1)	1-3 (1)	-	-	-
8	1-4 (3)	1-4 (3)	2-4 (3)	-	-	-
9	1	1	1	10-20 (13)	-	-
10	1,2 (2)	2,3 (2)	1-3 (3)	-	-	-
11	1	1-3 (1)	1-4 (3)	-	-	-
12	-	-	-	-	-	-
13	-	-	-	-	-	-
14	1	1	1	1	-	-

*Primary stems. Approximately 130 branches present.

⁺Normally only alveolus present.

1986, Coll. Harbach; PH22(5)-1, -3 thru -7 and -100, paratypes (3 females; 4 males), Tai-30, -36, -52 thru -55, -57, -59, -60, -61, -69, -71, -72, and -73, paratype females (ovaries removed) from PHILIPPINES, Luzon, Bataan Province, Tipo, 6 August 1986, Coll. Harbach and Rampa. The holotype, allotype, and most paratypes are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC. Several paratypes are deposited in the Natural History Museum, London.

Bionomics. Collection data associated with the material examined indicate that larvae of *dispar* occur in ditches, seepage-springs, rock pools, and streamlets. Other species collected with *dispar* in these habitats include *An. (Ano.) manalangi*, *An. (Ano.) vanus*, *An. (Cel.) annularis* van der Wulp, *An. (Cel.) filipinae*, *An. (Cel.) flavirostris*, *An. (Cel.) greeni* n. sp., *An. (Cel.) karwari* (James), *An. (Cel.) mangyanus*, *Cx. (Cux.) pseudovishnui*, a species each of *Cx. (Eumelano-myia)* and *Cx. (Lophoceraomyia)*, and *Ur. (Ura.) mendio-*

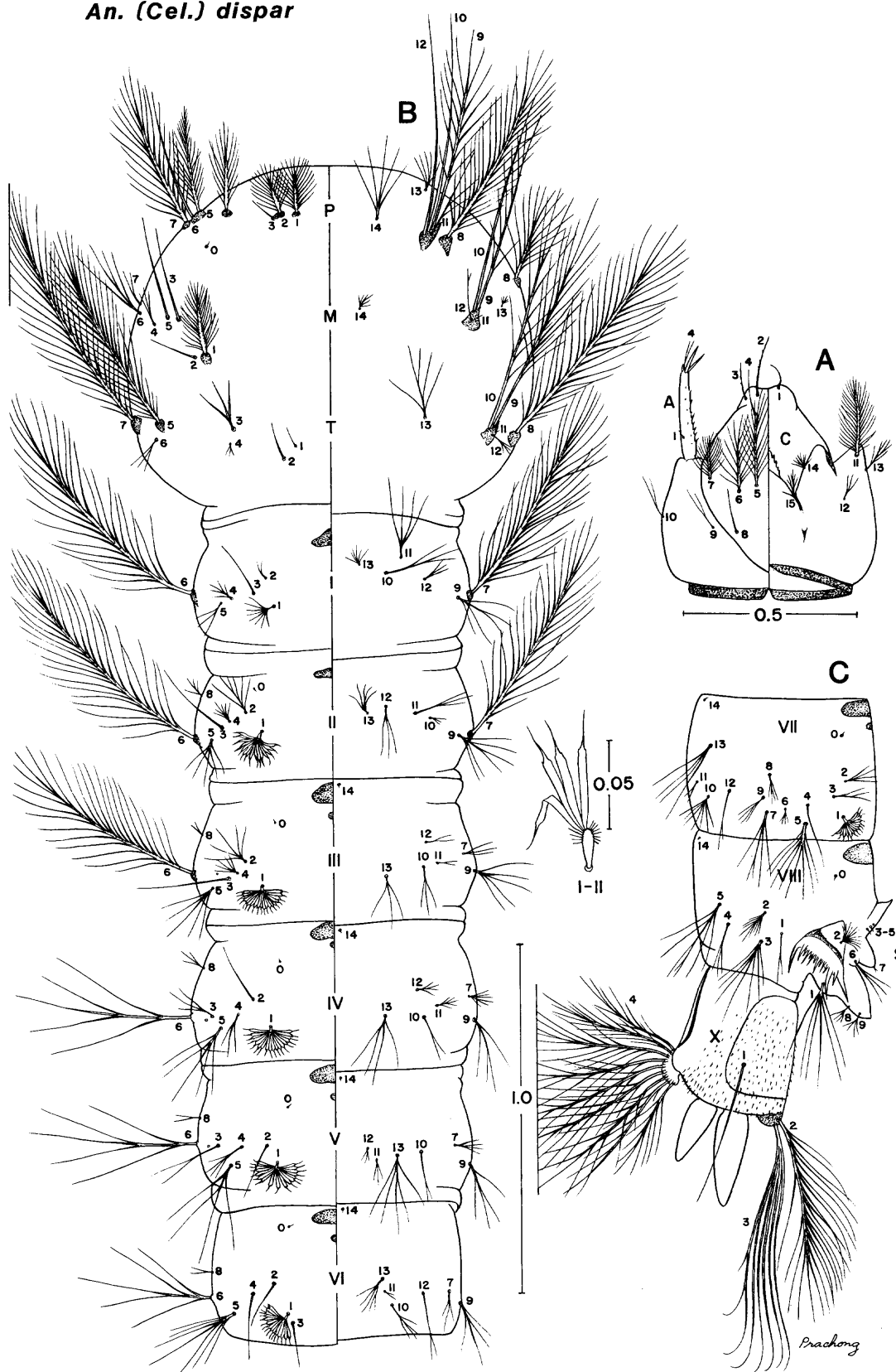
An. (Cel.) dispar

Fig. 8. *Anopheles (Cellia) dispar*, fourth-instar larva. A, Head (dorsal and ventral aspects of left side). B, Thorax and abdominal segments I-VI (dorsal and ventral aspects of left side). C, Abdominal segments VII-X (left side). Scales in mm.

Table 8. Number of branches for fourth-instar larval setae of *Anopheles (Cellia) dispar* n. sp.

Seta no.	Head	Thorax			Abdominal segments		
	C	P	M	T	I	II	III
0	-	1	-	-	-	1	1
1	1	14-26 (21)	29-42 (32)	1	5-9 (7)	10-19 (15)	10-22 (18)
2	1	14-20 (18)	1-4 (1)	1-3 (1)	2-4 (3)	4-7 (5)	4-6 (5)
3	1	1	1	2-6 (3)	1	1	1
4	1	15-22 (16)	2-4 (3)	1-5 (3)	5-11 (6)	4-8 (8)	2-5 (4)
5	10-21 (15)	29-40 (33)	1	29-49 (36)	3,4 (4)	3-5 (4)	3-5 (4)
6	10-21 (16)	1	3-6 (4)	3-6 (4)	29-36 (32)	29-38 (33)	22-32 (32)
7	11-25 (19)	20-29 (22)	2-5 (3)	28-38 (32)	31-37 (33)	25-38 (35)	3-7 (4)
8	1	22-34 (31)	12-26 (12)	32-44 (36)	-	2-4 (3)	2-4 (3)
9	1-4 (3)	9-13 (13)	6-17 (10)	12-17 (15)	4-6 (4)	5-8 (7)	4-7 (5)
10	1-3 (2)	1	1	10-21 (13)	1-3 (1)	2-4 (3)	1-5 (3)
11	22-49 (30)	2-5 (3)	1	1	3-6 (4)	1-4 (3)	2-5 (3)
12	2-5 (3)	1	1,2 (2)	3-5 (3)	3-5 (4)	1-5 (3)	2-4 (3)
13	2-7 (3)	3-6 (5)	4-10 (7)	2-5 (3)	3-7 (4)	3-8 (5)	3,4 (4)
14	3-10 (8)	3-6 (4)	3-11 (8)	-	-	-	1
15	4-7 (7)	-	-	-	-	-	-

Seta no.	Abdominal segments					
	IV	V	VI	VII	VIII	X
0	1	1	1	1	1	-
1	10-21 (15)	13-20 (19)	14-21 (16)	12-16 (15)	1-3 (3)	1
2	1	1,2 (1)	1,2 (1)	4-6 (5)	6-11 (8)	12-27 (22)
3	1-4 (3)	1-3 (1)	1-3 (1)	2,3 (3)	6-11 (8)	5-8 (7)*
4	1-5 (3)	2-5 (3)	1	1-3 (1)	2-4 (3)	9 pr
5	3-5 (3)	3-6 (5)	5-8 (7)	6-11 (8)	5-7 (6)	-
6	3-7 (6)	3-6 (5)	4-7 (5)	3-5 (3)	-	-
7	4-8 (5)	3-7 (5)	3-7 (3)	3-7 (4)	1-S	5-10 (7)
8	2,3 (3)	2-4 (2)	2,3 (2)	2-7 (3)	2-S	6-12 (9)
9	3-5 (4)	3-6 (4)	3-5 (4)	2-5 (4)	6-S	2-4 (3)
10	1-4 (3)	1-3 (3)	2-4 (3)	3-9 (7)	7-S	2
11	2-8 (3)	2-4 (3)	2-4 (4)	2,3 (2)	8-S	3-7 (4)
12	2-5 (4)	2-4 (3)	2,3 (2)	1-4 (2)	9-S	2-7 (4)
13	3-6 (4)	3-7 (5)	2-7 (5)	3-5 (4)	-	-
14	1	1	1	1	1	-
15	-	-	-	-	-	-

*Primary stems only.

lai Baisas. Adults have been collected while biting carabao. This species appears to be more common, particularly at higher elevations, than *greeni*. It is not known if it is capable of transmitting malarial parasites to man.

Systematics. About 57% of the adults of *dispar* resemble *maculatus* in lacking an accessory sector pale spot on the costa and subcosta. This species, like *greeni*, is conspicuously differentiated from *maculatus* in the larval and pupal stages (Table 1).

Anopheles dispar and *greeni* show some overlap of differential characters in all life stages (Table 2). Some 43% of the adults of *dispar* resemble *greeni* in having an accessory sector pale spot on the subcosta. These specimens usually can be distinguished from *greeni* by the characters given in the table.

Larvae of *dispar* differ noticeably from those of *greeni* in the development of seta 1-I. However, we could not separate about 15% of the larvae of these species on the

basis of this character alone. A much higher percentage of specimens are distinguishable when this character is used in combination with the character of seta 4-I.

Pupae of *dispar* and *greeni* cannot be distinguished reliably. There is a greater than 50% overlap in the ratio of the length of seta 9-III/9-IV for these species.

Etymology. The name given to this species is a Latin adjective: *dispar*, unlike, dissimilar, unequal.

DISCUSSION

Anopheles greeni and *dispar* appear to be indigenous to the Philippines. They differ from *maculatus* and all other species of the Maculatus Complex in having pupal seta 9-IV long and pointed. Individual populations of these species on the various islands do not seem to differ significantly from one another, but the material available to us was fairly limited and differences may actually exist. There is no indication that more than two species of the complex inhabit the islands. Populations of these species appear to be largely sympatric with some indication that *dispar* is more common, particularly at higher elevations. There is no indication of specific preferences for certain larval habitats and no firm evidence to indicate that either species is actively involved in the transmission of human malarial parasites.

Most of the previous bibliographic references to *maculatus* in the Philippines may apply to either one or both of the new species. Those references which cannot be ascribed completely, definitively, or confidently to either species are listed here.

Anopheles maculatus of Manalang 1929:pl.2 fig.7 (Philippines; cibarial armature*); Holt and Russell 1932:329, 330, 332-360, 364, 365 (Philippines; L bionomics, med. imp.); Ejercito 1934:342-346 (Bulacan Prov., Luzon; med. imp.); Laurel 1934:288-290, 292, 293 (Bulacan and Rizal prov., Luzon; A bionomics); Russell 1934a:46, 52-58 (Philippines; L bionomics); Russell 1934b:105 (Philippines; A); Russell 1934c:339 (Philippines; med. imp., L bionomics note); Russell and Baisas 1934a:300 (Philippines; L, bionomics, med. imp., distr.); Baisas 1935:291, 294, 304, 308, 310, (Luzon; P*, L key); Foote and Cook 1959:101-103 (Philippines; ♀*, L*, keys, bionomics); Bonne-Wepster and Swellengrebel 1953:457, 458 (in part; Luzon); Reid et al. 1966:188 (in part, Philippines); Basio et al. 1970:438, 439, 444 (Mt. Makiling, Luzon; L bionomics); Darsie and Cagampang-Ramos 1971:388, 389 (Lanao Plateau, Mindanao; L bionomics); Catangui 1985:90 (Philippines; med. imp., A, L bionomics); Catangui et al. 1985:139 (Philippines; med. imp.); Oberst et al. 1988:45 (Palawan; A coll. rec.); Salazar et al. 1988:709 (Philippines; distr.).

Anopheles maculatus maculatus of Russell et al. 1943:125, 129 (Philippines; ♀, L, keys).

Anopheles (Cellia) maculatus of Delfinado et al. 1963:436 (Philippines; checklist); Baisas and Dowell 1965:2, 12, 41 (Philippines; ♀*, L* keys); Baisas and Dowell 1967:12, 14, 21 (Philippines; ♀*, L* keys); Cagampang-Ramos and Darsie 1970:4, 17, 45 (Philippines, A*, L* keys); Basio 1971:6, 42-43, 162 (in part, Philippines; syn., A*, L bionomics., med. imp., distr.); Ramos and McKenna 1983:4 (Philippines; list); Cagampang-Ramos et al. 1985:4 (Philippines; list).

Anopheles (Myzomyia) maculatus of Russell and Baisas 1934b:320, 327 (Luzon, Mindanao; A, L*); Russell and Baisas 1936:47, 48 (Luzon, Mindanao; ♀*, ♂*); Simmons and Aitken 1942:105-107, 114, 144-148, 208, 209 (Philippines; A*, L keys, distr., A, L bionomics, med. imp.); Bohart 1945:6, 7, 10, 20 (Philippines; med. imp., A key, L, L bionomics note, distr.); Mendoza 1954a (Philippines; A pictorial key); Mendoza 1954b (Philippines; L pictorial key).

Anopheles (Nyssorhynchus) maculatus of Walker and Barber 1914:390, 421-425, 429-433 (Laguna Prov., Luzon; tax., coll. rec., bionomics, med. imp.); Barber et al. 1915:177-180, 183, 192, 232 (Luzon, Mindoro, Cebu; A, L bionomics, med. imp.).

Nyssorhynchus theobaldi of Ludlow 1908:8, 25, 28 (Philippines; coll. data); Ludlow 1911:126 (Philippines; list).

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