CONTRIBUTIONS TO THE MOSQUITO FAUNA OF SOUTHEAST ASIA. II. THE GENUS *CULEX* IN THAILAND (DIPTERA: CULICIDAE)[1]

By

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INTRODUCTION

Background

The culicine mosquito fauna of Thailand has received only scant and sporadic interest until recent years. Stanton (1920) recorded species occuring commonly in Bangkok; Edwards (1922) included a few general records from Thailand; Barraud and Christophers (1931) reported on species collected by J. A. Sinton during a 2 week railway tour of the country; Causey (1937) summarized information collected during a 4 year stay in Thailand; and Iyengar (1953) listed 48 species and subspecies from southern areas of Thailand.

More recently, Thurman and Thurman (1955) reported on the first operation of a mosquito light trap in northern Thailand (at *Chiang Mai*) and found that 78 percent of species collected were members of the genus *Culex*. The most recent faunal list which included species of the genus *Culex* of Thailand was that of E. Thurman, originally presented before the IX Pacific Science Congress in 1957 and subsequently published in 1959 and again, with slight variation, in 1963. This report dealt with species in the northern region of Thailand (*Chiang Mai, Chiang Rai, Lampang, Lamphun, Nan, Phare,* and *Tak)* but, unfortunately, locality data were not included for records of species belonging to the genus *Culex*. The Thurman collection upon which these reports were based has been deposited in the U. S. National Museum and forms an important part of the present study.

Extensive mosquito collecting in Thailand by the U. S. Army Medical Component, South East Asia Treaty Organization from 1961 through 1966 has greatly increased our knowledge of the rich fauna of this Southeast Asian kingdom. Taxonomic studies based on these collections include those of Bram (1966), Peyton and Scanlon (1966), Delfinado (1967), Bram and Rattanarithikul (1967), Scanlon and Peyton (1967), and Scanlon, Peyton, and Gould

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(1967a and 1967b). In the overall study of the genus *Culex* in Southeast Asia, Thailand was selected as the starting point because of its central position within the area under consideration and, most importantly, because the SEATO collections from Thailand are undoubtedly the most complete and extensive of any comparable portion of Southeast Asia. The SEATO collections are now housed in the U. S. National Museum and at this point, at least, have formed the foundation upon which future studies of the genus *Culex* will be based. This paper includes all material received before February 15, 1967.

In this study, 60 species and subspecies belonging to 7 subgenera of the genus *Culex* are recognized from Thailand. Of these, 5 species are described as new and 19 species are recorded for the first time from Thailand; 7 species previously recorded from Thailand are dismissed as misidentifications and 6 previous records are regarded as doubtful. In addition, 7 names are placed in synonymy and 1 subspecies is elevated to species rank.

Format and Treatment

The format utilized for the description of each species requires a brief explanation. In the synonymy under each species heading, all references considered to be pertinent to the understanding of the species are included; the mere inclusion of a species name in a checklist or key does not usually warrant citation, unless there is an historical or taxonomic significance. Within the parentheses following each citation, the symbols ♂, ♀, L, and P indicate that the publication deals with at least some part of the male, female, larva, or pupa respectively; a single asterisk following the symbol indicates that at least some portion of that stage or sex is illustrated. Abbreviations in the synonymy conform to the World List of Scientific Periodicals, 3rd ed., Academic Press, 1952.

Following the synonymy is a brief diagnosis of the species. A description of the salient features of the adult female, male, and fourth stage larva follows the diagnosis. Illustrations of the salient features of each species are included within the text following the respective species descriptions. The figures have usually been prepared from several specimens and an attempt has been made to illustrate the most common condition within the range of variation of each structure. Terminology conforms principally to that of Belkin (1962); terminology applied to the male antenna and terminalia of the subgenus *Lophoceraomyia* follows Colless (1965), except that the divisions of the antennal flagellum are termed flagellomeres and flagellomere I of this study corresponds to antennal segment III of Colless. Although the adult females of all but 4 of the species are described, this is the most difficult stage available for identification. In the subgenera *Neoculex*, *Mochthogenes*, *Lophoceraomyia*, and the *vishnui* subgroup of the *sitiens* group in the subgenus *Culex*, conclusive determinations cannot usually be based exclusively on the female. Variation within species and the absence of consistent anatomical or colorational features prevent more than subgeneric placement in many instances. Females of the subgenus *Lophoceraomyia* are particularly difficult. Some species of the *vishnui* subgroup are usually recognizable as adult females, but for the most part, conclusive determinations must depend on associated larval skins. This is indeed unfortunate since the principle vector of Japanese encephalitis virus in Southeast Asia, *tritaeniorhynchus*, belongs to the *vishnui* subgroup. In the case of *tritaeniorhynchus*, the anatomy of the buccopharyngeal armature

has been incorporated as a supplementary character; however, this structure has not so far been found to be useful in any of the other species of the *vishnui* subgroup. The adult male is described and the terminalia of all but one species illustrated. The adult male habitus is usually very similar to that of the female and only variations from the female are described. In species of the subgenus *Lophoceraomyia*, the modified setae on antennal flagellomeres V through X are described and illustrated. The anatomy of the male terminalia presents extremely useful features and conclusive determinations can usually be placed on this structure (or in the case of *Lophoceraomyia*, in combination with the antennal flagellomeres). In the subgenera *Lutzia* and *Lophoceraomyia*, and the *sitiens* and *bitaeniorhynchus* subgroups of *Culex*, it has been found desirable to describe and illustrate the lateral aspect of the lateral plate of the phallosome; in other subgenera, descriptions and illustrations apply to the dorsal aspect. Species of the *vishnui* subgroup exhibit extremely similar terminalia and determinations based exclusively on the male are not always reliable. Since the pupal characters have not so far been found taxonomically significant, this stage is not described; however, illustrations of most pupae of the subgenera *Neoculex*, *Thaiomyia*, *Culiciomyia*, and *Culex* have been included. Except for the subgenus *Lutzia*, the fourth stage larva presents the most desirable stage for conclusive determinations in the genus *Culex*. Whenever possible, an attempt should be made to collect fourth stage larvae and rear these individually so that skins may be studied concurrently with the adult males and females. Descriptions and illustrations of the larvae of all but 3 species of the genus *Culex* in Thailand have been provided. Throughout the study, the diagnoses and descriptions of the subgenera and groups within the subgenera do not necessarily apply to species outside of Thailand.

The distribution of each species in Thailand is listed according to first-order administrative units or changwats, as they are known in Thailand. Thai locality names conform to the Official Standard Names Gazetteer No. 97 of the U. S. Board of Geographic Names, Washington, D. C., 1966. Names of changwats are italicized; a double asterisk following a country name indicates a new record for that country. Unless otherwise indicated, distribution outside of Thailand is in accordance with Stone, Knight, and Starcke (1959) and Stone (1961 and 1963). Sufficient data are not presently available to permit critical evaluation of distributional patterns of species within Thailand. Figure 1 outlines the 71 changwats of Thailand and indicates the intensity of collection in the various parts of the country. No specimens of the genus *Culex* have been examined from 22 of the changwats and only 3 or less species of the genus *Culex* have been examined from 36 of the changwats. The area most in need of intensive collecting in respect to the genus *Culex* is the Korat Plateau, where only *Udon Thani* and *Nakhon Ratchasima* have been adequately sampled. Valuable distributional data would also be obtained by more extensive collecting in the Central Valley north of Bangkok.

In the "Taxonomic Discussion", reasons for proposing nomenclatorial changes are outlined and discussions of intraspecific variation are presented where appropriate. Means are also provided for separating a species from its close relatives.

The biologies of the various species of the genus *Culex* are either unknown or very poorly understood. With the exception of a few species of the subgenus *Culex* and perhaps *Lutzia*, data are restricted almost exclusively to

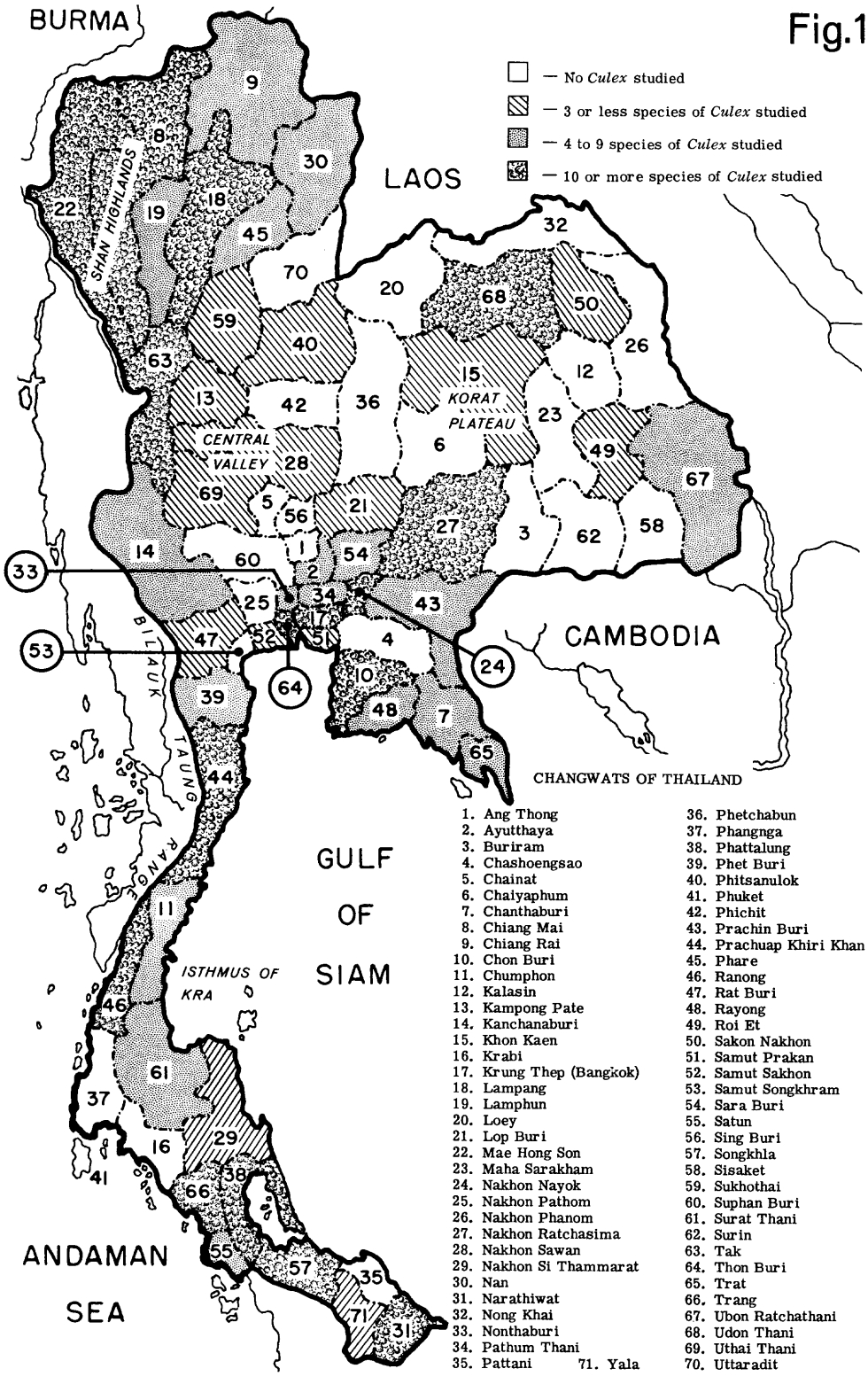
Fig.1
BURMA
LAOS
CAMBODIA
GULF OF SIAM
ANDAMAN SEA
SHAN HIGHLANDS
CENTRAL VALLEY
KORAT PLATEAU
ISTHMUS OF KRA
BILAUK TAUNG RANGE
— No Culex studied
— 3 or less species of Culex studied
— 4 to 9 species of Culex studied
— 10 or more species of Culex studied
CHANGWATS OF THAILAND
1. Ang Thong
2. Ayutthaya
3. Buriram
4. Chashoengsao
5. Chainat
6. Chaiyaphum
7. Chanthaburi
8. Chiang Mai
9. Chiang Rai
10. Chon Buri
11. Chumphon
12. Kalasin
13. Kampong Pate
14. Kanchanaburi
15. Khon Kaen
16. Krabi
17. Krung Thep (Bangkok)
18. Lampang
19. Lamphun
20. Loey
21. Lop Buri
22. Mae Hong Son
23. Maha Sarakham
24. Nakhon Nayok
25. Nakhon Pathom
26. Nakhon Phanom
27. Nakhon Ratchasima
28. Nakhon Sawan
29. Nakhon Si Thammarat
30. Nan
31. Narathiwat
32. Nong Khai
33. Nonthaburi
34. Pathum Thani
35. Pattani
36. Phetchabun
37. Phangnga
38. Phattalung
39. Phet Buri
40. Phitsanulok
41. Phuket
42. Phichit
43. Prachin Buri
44. Prachuap Khiri Khan
45. Phare
46. Ranong
47. Rat Buri
48. Rayong
49. Roi Et
50. Sakon Nakhon
51. Samut Prakan
52. Samut Sakhon
53. Samut Songkhram
54. Sara Buri
55. Satun
56. Sing Buri
57. Songkhla
58. Sisaket
59. Sukhothai
60. Suphan Buri
61. Surat Thani
62. Surin
63. Tak
64. Thon Buri
65. Trat
66. Trang
67. Ubon Ratchathani
68. Udon Thani
69. Uthai Thani
70. Uttaradit
71. Yala

the habitats from which larvae were collected. Surprisingly, our knowledge of anthropophilic species is almost as incomplete as for the presumed avian and mammalian feeders. Future studies should certainly concentrate on the biological aspects of both adult and immature stages.

Zoogeography

Although distributional data for virtually all species of the genus *Culex* in Southeast Asia are obviously incomplete and probably in some instances misleading, a zoogeographical pattern of the mosquito fauna is beginning to emerge. In the following discussion, the relationships of subgenera in the Thai fauna with the overall fauna of Southeast Asia will be treated in general terms.

The 2 species recognized in the subgenus *Lutzia* from Thailand are both widely distributed throughout the Oriental region and extend into the Palearctic region. In the subgenus *Neoculex*, *brevipalpis* is widely distributed, ranging from India and Ceylon eastward and southward through New Guinea and the Bismarck Archipelago. The other Thai species, *tenuipalpis*, extends from the East Himalayas of India into the Shan Highlands of Thailand; Brug's (1931) record from Java is open to question. The 5 other species of the subgenus in Southeast Asia include *hayashii*, a species with a northern distribution; *sumatranus*, recorded from Sumatra and China; *simplicicornis*, known only from Borneo; and *nematoides* and *okinawae*, both island species.

Of the 3 species of *Mochthogenes* known from Thailand, *malayi* is widely distributed, extending from India eastward to Taiwan and southward to New Guinea; *foliatus* extends from China southward to the Philippines; and *hinglungensis* is known only from Hainan Island and the Shan Highlands of Thailand. Elsewhere in Southeast Asia, *khazani* is known from India and Indochina, and 5 species of the subgenus are endemic to the Philippine Islands. The single species of the subgenus *Acalleomyia* is endemic to Malaya, but future collecting may possibly extend the known distribution at least to the Isthmus of Kra.

Species of *Lophoceraomyia* are best considered in respect to the various groups and subgroups of the subgenus. The *fraudatrix* group appears to be centered in New Guinea but species extend throughout the range of the subgenus. Nine species of the group are known from Thailand, and all but 2 species, *infantulus* and *rubithoracis*, are found in Malaya, Borneo, and/or the Philippines, but probably do not extend very much north or west of Thailand. Both *infantulus* and *rubithoracis* are widely distributed, extending into India and China. Species of the *brevipalpus* subgroup of the *mammilifer* group were probably differentiated in the area bordering the South China Sea, and only 2 species, *curtipalpis* and *lucaris*, are known to extend into Thailand. Of the *mammilifer* subgroup of the *mammilifer* group, *minor*, *mammilifer*, and *bengalensis* are widely distributed and range from India to the Philippines or Malaya; 3 species are known only from Malaya and Thailand; and 6 species are presently known only from Thailand.

The monotypic subgenus *Thaiomyia* demonstrates its closest affinity to *Culiciomyia* and is presently known only from the Shan Highlands and the Bilank Taung Range in Thailand. Of the 11 species of *Culiciomyia* known from

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Figure 1. ← A map of Thailand, showing the boundaries of the various changwats and general distribution of material studied.

Thailand, *bailyi*, *fragilis*, *nigropunctatus*, *pallidothorax*, and *spathifurca* exhibit broad distributions extending, in general, from India through New Guinea. *C. papuensis* extends from the Solomon Islands through New Guinea, Java, the Philippines, and to Thailand, and *scanloni* ranges from Thailand through the Philippines and Borneo. Four species, *barrinus*, *spiculothorax*, *termi*, and *thurmanorum*, are presently known only from the Shan Highlands of Thailand. In other areas of Southeast Asia, *shebbearei* extends from India to Borneo, but has not been found in Thailand; *bahri* is known from Ceylon with a questionable record from Java; *viridiventer* is restricted to northern India, Pakistan, and Nepal; and *javanensis* and *ryukyensis* are island species which have not been reported from mainland Southeast Asia.

In the *pipiens* group of the subgenus *Culex*, all 3 species (*fuscocephala*, *hutchinsoni*, and *pipiens quinquefasciatus*) have very broad distributions which extend at least from India through Malaya; *pipiens quinquefasciatus* is, of course, cosmotropical. The *sitiens* group of the subgenus *Culex* is centered in the Oriental region with some representatives extending into the Australian and Ethiopian regions. The *vishnui* subgroup of the *sitiens* group is composed of 8 species in Thailand; of these, *alienus* and *perplexus* exhibit rather limited distributions in Malaya and the southern part of the mainland, whereas the other 6 species are widely distributed and extend from India at least to the southern part of the mainland (*tritaeniorhynchus* being the most widely distributed). Species of the *sitiens* subgroup of the *sitiens* group are restricted to brackish water habitats of coastal regions. From Thailand *neolitoralis* extends through Malaya to New Guinea, and *sitiens* exhibits an extremely broad range throughout the Oriental region, Australia, the Pacific islands, east Africa, and Madagascar. It is surprising that *annulirostris*, another member of the *sitiens* subgroup, has not been found to occur in Thailand; the 2 other species of the subgroup are limited to Pacific islands. Both species of the *gelidus* subgroup, *gelidus* and *whitmorei*, are widely distributed throughout the Oriental region and extend even into New Guinea. Three species of the *bitaeniorhynchus* subgroup, *bitaeniorhynchus*, *sinensis*, and *pseudosinensis*, are known from Thailand. The first 2 of these have very broad distributions throughout the Oriental region and *bitaeniorhynchus* extends even into Africa and Madagascar; *pseudosinensis* is restricted to Malaya, Indochina, and Thailand. Another species of the *bitaeniorhynchus* subgroup, *geminus*, is known only from Singapore.

In summary, the *Culex* fauna of Thailand is shared to a large degree with Malaya and Indonesia, with a small, apparently endemic nucleus in the subgenera *Lophoceraomyia*, *Thaiomyia*, and *Culiciomyia*, and with a number of broadly distributed species extending into India. A list of species occurring in Southeast Asia but not known from Thailand may be found as Appendix A. Appendix B summarizes the status of our knowledge of the *Culex* fauna of Thailand.

GENUS *CULEX* LINNAEUS 1758

Culex Linnaeus 1758, Systema Naturae, 10th ed. 1: 602. Type species: *C. pipiens* Linnaeus 1758 (selection of Latreille 1810).

FEMALE. The diagnostic characters are: proboscis not broadened distally and not sharply recurved, although the apex may be laterally compressed and slightly downcurved; antennal flagellomeres neither short nor thick; anterior pronotal lobes of normal size and widely separated; posterior margin of scutellum trilobed, the marginal setae in three groups; postnotum without scales or setae; spiracular and postspiracular bristles absent; wing membrane with distinct microtrichia and vein 1A long, reaching wing margin beyond level of junction of Cu1 and Cu2; dorsal plume scales not forked apically; mid and hind femora without distinct tufts of scales at apices; tarsomere I of fore leg longer than II-V combined, IV longer than wide; pulvilli present on all legs; claws of hind legs very small and inconspicuous. Additional characters are as follows. *Head.* Eyes contiguous, very narrowly separated above the antennae, with the orbital bristles well developed; length of palpus approximately 1/4 or less than that of the proboscis; length of antenna equal to or greater than that of proboscis; decumbent scales of the vertex narrow at the occiput, becoming somewhat broader at the orbital line, particularly the posterolateral area; erect scales always forked, usually numerous. *Thorax.* Scutum sparsely to heavily clothed with narrow scales, acrostichal bristles present or absent, dorsocentral bristles well developed; integument of the pleuron with or without distinctive dark patterns, and with or without scattered patches of dull, pale scales (never densely covered with broad, distinctively ornamented scales); pleural setation varied, present on the anterior pronotal lobe, posterior pronotal lobe, propleuron, sternopleuron, prealar area, and upper mesepimeron, those of the lower mesepimeron either present or absent. *Wings.* Vein scales variable, but dorsal plume scales never forked; cell R_2 always longer than vein R_{2+3}. *Abdomen.* Tergum I with only a small scale patch in the middle; terga and sterna II-VII uniformly scaled; apex of abdomen truncate.

MALE. The diagnostic characters are the same as those of the female in addition to the following features of the terminalia: proctiger strongly developed and with a transverse crown of numerous apical spines; basimere with a subapical lobe which normally exhibits strongly modified or specialized setae; phallosome usually complex. Additional characters are as follows. *Head.* Antenna plumose, occasionally equal to or slightly less than the length of the proboscis; length of the palpus variable (when longer than proboscis, the last 2 segments usually slender and upturned). *Legs.* Tarsal claws of the fore and mid legs enlarged, those of the hind legs as small as in the female. *Terminalia.* Basimere well developed, without scales; a well developed subapical lobe always present, frequently separated into a proximal and distal division; the proximal division typically exhibits 3 strong, subequal rods, and the distal division generally exhibits several variable setae, one of which is frequently leaf-shaped; distimere always well developed, although somewhat variable in shape; phallosome complex, usually consisting of a pair of variable lateral plates.

LARVA. The diagnostic characters are: siphon with a short, movable dorsal valve present; accessory ventral, ventrolateral, or dorsolateral hairs

present on the siphon, but without a differentiated pair of subventral hairs at the extreme base (if the accessory hairs are short and indistinct, then the siphon is very long); a distinct basolateral acus always present on the siphon; thoracic hair 13-P always absent. Additional characters are as follows. *Head.* Mouthparts usually not modified (except in the predaceous subgenus *Lutzia* and the *brevipalpus* subgroup of the subgenus *Lophoceraomyia*); hairs 1, 4, 5, 6, 7-C well developed; 16, 17-C present or absent, when present represented by small spicules; antenna long and constricted beyond insertion of hair 1-A (except in *Lutzia* and the *brevipalpus* subgroup of *Lophoceraomyia*); hairs 2, 3-A usually subapical (except in the groups noted above). *Thorax.* Integument spiculose or glabrous; hairs 1, 2-P always well developed, usually single; 3-P variable; 4, 5, 6, 7-P well developed; 8-P variable; 9, 10, 11, 12-P always inserted on the same tubercle, 12-P the strongest of the group; 14-P simple, single or bifid. *Abdomen.* Integument glabrous or spiculose, without sclerotized plates except for the saddle on segment X; hair 1-I-VIII never palmate; comb always present on segment VIII but variable, never with a common sclerotized plate at the base of the scales; pecten variable, absent only in *C. (Thaiomyia) dispectus;* 3 or more pairs of subventral tufts usually inserted beyond the pecten; segment X with the saddle complete except in *C. (Culex) neolitoralis;* ventral brush with at least 8 tufts[1], most of which are inserted on the grid; 2 pairs of anal gills variously developed.

PUPA. So far, features have not been found which permit a definitive characterization of the genus. Some of the salient features are as follows. *Cephalothorax.* All hairs present, with variable development; 6-C weak, single or branched, usually distinctly weaker and shorter than 7-C; trumpet of variable length and form, but always with a pinna and never placed on a distinct tubercle. *Abdomen.* All normal hairs usually present; 9-IV-VII varied in position but always removed from caudolateral angle of tergite, sometimes spiniform but never on all segments; 1-IX usually present, always a simple bristle; 1-X absent; paddle variously developed but never narrow; midrib usually strongly developed and dividing paddle into subequal parts; 1, 2-P usually both present, sometimes one or both hairs absent.

DISTRIBUTION. The genus *Culex* is worldwide in distribution, with marked concentration in the tropical regions. Representatives of the genus are found throughout the Oriental region and have been collected in virtually every changwat of Thailand. Of the 17 subgenera recognized for the genus, only 8 have been recorded from the Oriental region and of these, 7 are known from Thailand (*Acalleomyia* has been recorded only from Malaya, but may be present on the Isthmus of Kra in Thailand).

TAXONOMIC DISCUSSION. Within the genus *Culex*, all subgenera cannot be separated in every instance exclusively on the basis of the adult female (particularly when dealing with individuals of the subgenera *Lophoceraomyia, Culiciomyia, Neoculex,* and *Thaiomyia*) and the pupae have not been found to exhibit consistent subgeneric features. In these instances it is necessary to have not only the adult males and females, but their associated

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[1] These tufts are often referred to as occurring in pairs whereas in actual fact they are staggered in zigzag fashion down the grid, each bar of the grid having 1 tuft only. Here, as elsewhere, the figure refers to the total number of tufts and not to pairs.

larval skins as well.

BIOLOGY. Eggs of *Culex* are typically laid in rafts on various water surfaces and there is no evidence that eggs of any species are resistant to desiccation. Larval habitats include a wide variety of ground water accumulations (primarily fresh, but also brackish) as well as tree holes, bamboo internodes and stumps, pitcher plants, and containers. Members of the subgenus *Lutzia* are predaceous on other mosquito larvae and members of the *brevipalpus* subgroup of the subgenus *Lophoceraomyia* are apparently predaceous on other small arthropods which accumulate in their pitcher plant environments. Adults of the subgenus *Culex* probably feed to a large degree on mammals and birds, while those of *Lophoceraomyia* and *Lutzia* are probably primarily avian feeders, and those of *Neoculex* are possibly reptilian and amphibian feeders. Feeding behavior of the other subgenera are even less well known.

Members of the genus *Culex* have been incriminated in the transmission of a number of pathogenic organisms in Southeast Asia, but most of these are probably incidental infections or isolations. Three species, all members of the subgenus *Culex*, are currently recognized as actual or potential disease vectors of considerable importance in Thailand. Two species, *gelidus* and *tritaeniorhynchus*, are important vectors of Japanese encephalitis in Southeast Asia, and *pipiens quinquefasciatus* is the most important vector of urban filariasis caused by periodic *Wuchereria bancrofti* (a rare disease in Thailand, but very common in neighboring countries, such as Burma).

Species of the genus *Culex* are susceptible to a wide variety of pathogens and parasites and are prey for a great number of predators. Jenkins (1964) reviewed the organisms attacking medically important arthropods and compiled an impressive list of pathogens and parasites of *Culex*. Included in this listing were viruses (2 species), rickettsiae (3 species), bacteria (5 species), spirochaetes (2 species), fungi (20 species), protozoa (41 species), rotatoria (2 species), nematodes (8 species), and trematodes (3 species). Not all species listed cause mortality and those that do are generally restricted to the polyhedrosis viruses, a few species of bacteria, several of the fungi and fungi imperfecti (particularly the Coelomomyces), some protozoa, and mermithid nematodes. Most isolations have been made from the mosquito larva, but some have been made from adults.

KEY TO THE SUBGENERA OF *CULEX* IN THAILAND - ADULTS

1. Four or more strong, lower mesepimeral bristles present; relatively large species (wing length usually ranging from 4 to 5 mm). . . . . *Lutzia* (p. 11)

   Mesepimeral bristles absent, or if present, represented by 1 or 2 rather weak ones; in general moderately sized to small species (wing length usually less than 4 mm) 2

2(1). Pleuron with distinct scale patches at least on the upper and lower sternopleuron and the anterior mesepimeron. . . . . *Culex* (p. 163)

   Pleuron without distinct scale patches 3

3(2). Acrostichal bristles well developed on the scutum; palpus of the male

less than 1/4 the length of the proboscis. . . . *Mochthogenes* (p. 33)
Acrostichal bristles not developed except at extreme anterior end and rarely near the prescutellar space; palpus of the male greater than 1/4 the length of the proboscis 4

4(3). Scaling of the scutum sparse, rough in appearance; male antenna with specialized scales and setae usually present on flagellomeres V-IX, always present on VII and VIII . . . . . *Lophoceraomyia* (p. 42)
Scaling of the scutum very dense, smooth in appearance; male antenna without specialized scales or setae 5

5(4). Palpus of the male approximately 1/2 to 3/4 the length of the proboscis . . . . . *Neoculex* (p. 23)
Palpus of the male greater than or approximately equal to the length of the proboscis 6

6(5). Palpal segment III of the male with a characteristic ventrolateral, linear series of lanceolate scales . . . . . *Culiciomyia* (p. 117)
Palpal segment III of the male without lanceolate scales. . . . . *Thaiomyia* (1 species, *dispectus*, p. 113)

KEY TO THE SUBGENERA OF *CULEX* IN THAILAND - FOURTH STAGE LARVAE

1. Pecten extending nearly to the apex of the siphon; mouthparts adapted for predation; antennal hair 1-A represented by a short, single, simple seta inserted on the proximal half of the shaft; very large species . . . . . *Lutzia* (p. 11)
Pecten restricted to the basal half of the siphon or absent; mouthparts not adapted for predation (or if moderately so, other characters not as above); antennal hair 1-A generally multiple, always inserted on the distal half of the shaft; small to moderately sized species 2

2(1). Pecten absent . . . . . *Thaiomyia* (1 species, *dispectus*, p. 113)
Pecten represented by 2 or more distinct teeth. 3

3(2). Ventral brush consisting of 8 hair tufts inserted on the grid; head hair 1-C fine and filamentous and thoracic hair 3-P much slenderer than 1-P and usually about half its length, *or* if head hair 1-C stout, 1-P bifid or trifid and 3-P with 2 or more branches . . . . . *Culiciomyia* (p. 117)
Ventral brush consisting of 10 or more hair tufts; if head hair 1-C is filamentous, then thoracic hairs 1, 3-P single and of the same order of length and thickness, *or* 1-C robust and 1-P unbranched 4

4(3). Thoracic hair 3-P always single, of the same order of length and thickness as 1-P . . . . . *Culex* (p. 163)
Thoracic hair 3-P single or branched, slenderer than 1-P and usually

less than half its length 5

5(4). Siphon shorter than the anal segment; antennal hair 1-A very weak, simple; mouthparts adapted for predation. . . . . *Lophoceraomyia* (*brevipalpus* subgroup, p. 75)

Siphon longer than the anal segment; antennal hair 1-A strong, multiple, pectinate; mouthparts not adapted for predation 6

6(5). Head hair 14-C single, often dendritic beyond the basal half. . . . . *Neoculex* (p. 23)

Head hair 14-C bifid, with the branches strongly divergent from the base 7

7(6). Individual pecten tooth fringed with many fine, parallel, closely placed denticles distally and a few coarse, widely placed denticles proximally; head hairs 5, 6-C short, weak, 5-C about 1/2 the length of 6-C . . . . . *Mochthogenes* (p. 33)

Individual pecten tooth without 2 distinct types of denticles as indicated above (although the proximal 2 or 3 denticles may be enlarged); head hairs 5, 6-C strong, long, subequal in length. . . . . *Lophoceraomyia* (in part, p. 42)

SUBGENUS *LUTZIA* THEOBALD 1903

Lutzia Theobald 1903, Mon. Cul. 3: 155. Type species: *Culex bigoti* Bellardi 1862.

Jamesia Christophers 1906, Sci. Mem. med. sanit. Dep. India 25: 12 (preoccupied by Jeckel 1861). Type species: *Culex concolor* Robineau-Desvoidy 1829 (selection of Edwards 1932, *in* Wytsman, Genera Insect., fasc. 194: 190, as *Culex fuscanus* Wiedemann).

The adult female may be recognized by its relatively large size (wing length approximately 4 to 5 mm), the ventral banding of the proboscis, and the numerous, strong lower mesepimeral bristles. The male may be recognized by the above mentioned characters as well as the simple phallosome of the terminalia and the strong but reduced number of setae on the subapical lobe of the basimere. The fourth stage larva may be identified by its large size, the predaceous mouthparts, and the pecten which extends nearly to the apex of the siphon.

FEMALE. Very large species for the genus with conspicuous ornamentation. *Head.* Proboscis with a pale median band of scales on the ventral surface and frequently encompassing the proboscis; antenna longer than the proboscis; torus with a number of broad scales on the inner margin. *Thorax.* Scutum with very dense scaling, usually with distinct but variable patches of light scales; acrostichal bristles well developed, but rather short; distinct pleural scale patches present; 4 or more strong, lower mesepimeral bristles present.

MALE. *Head.* Palpus and antenna longer than the proboscis; palpal segments IV and V upturned. *Terminalia.* Subapical lobe of the basimere with strongly developed setae, but without a leaflike seta; distimere normal

for the genus; phallosome simple; proctiger crowned with a dense tuft of rather slender, short spicules; usually 5 or more short cercal setae present.

LARVA. *Head.* Head capsule elongate; antenna glabrous, gradually tapering to a truncate apex, and not constricted beyond the insertion of hair 1-A which is short, single, simple and inserted on the proximal half of the shaft; head hair 1-C single, simple; 4-C dendritic with about 4 or 5 branches; 5, 6-C single, simple, very strong and long; 16, 17-C absent; mentum with very strong teeth; mouthparts adapted for predation and mouth brushes very broad and lamellate; integument of the head covered with a conspicuous pattern of minute spicules. *Thorax.* Integument covered with a conspicuous pattern of very dense, small, sharply pointed spicules; prothoracic hairs relatively short. *Abdomen.* Integument covered with spicules which are not nearly as apparent as those of the thorax; comb consisting of a broadly triangular patch of fan-shaped scales; siphon variable, index approaching 1:1, covered with a dense conspicuous pattern of sharply pointed spicules which seem to be modified in the form of reticulose platelets; approximately 10 subventral tufts inserted on the siphon; pecten extending almost to the apex; saddle completely ringing the anal segment; ventral brush consisting of approximately 15 individual tufts inserted within the grid.

PUPA. Very large, but similar in chaetotaxy to those of the subgenus *Culex*. Paddle broad.

DISTRIBUTION. Members of the subgenus *Lutzia* are found in tropical and semitropical areas of both the Old and New World. Both species in Thailand extend throughout the Oriental region. *C. halifaxii* reaches through the Australian region to the Solomon Islands and northward to Japan, China, Korea, the U. S. S. R. and India, whereas *fuscanus* extends through Taiwan and Japan to Korea, parts of China, the Maritime Province of U. S. S. R. and India.

TAXONOMIC DISCUSSION. Belkin (1962) suggested that *Lutzia* is an ancient derivative of the genus *Culex* with strongest affinities to the subgenera *Culex* and *Culiciomyia*. Edwards (1932) recognized two groups within the subgenus *Lutzia*, restricted respectively to the Old and New Worlds. It now appears that the Old World group (*Jamesia*) is represented by 3 species: *tigripes* Grandpre and Charmoy in the Ethiopian region, and *fuscanus* and *halifaxii* in other Old World areas. Larvae of the species found in Thailand are indistinguishable and adults are extremely variable. The male terminalia, however, exhibit consistent differences in the phallosome which are considered to be diagnostic.

BIOLOGY. Larvae of the members of the subgenus *Lutzia* are predaceous, principally on mosquito larvae of other species. They are found most often in ground water habitats, frequently where there is a high organic content, in association with *C. pipiens quinquefasciatus*. Adult females probably feed, to a great extent, on avian hosts and seldom attack man.

KEY TO SPECIES OF THE SUBGENUS *LUTZIA* IN THAILAND - ADULT FEMALES

Abdominal terga V-VIII entirely pale scaled, or with very broad apical pale bands; terga II-IV entirely dark, or with very narrow pale apical bands; median pale band of the proboscis broad, clearly encircling it . . . . . *fuscanus* (p. 13)

Abdominal terga entirely dark, or all with pale apical bands of ap-

proximately the same width; median pale band of the proboscis narrow, most prominent on the ventral surface. . . *halifaxii* (p. 17)

KEY TO SPECIES OF THE SUBGENUS *LUTZIA* IN THAILAND - MALE TERMINALIA

Phallosome, when observed in lateral aspect, without prominent denticles extending from the lateral plate; however, faint striations or suggestions of teeth may be observed. . . . *fuscanus* (p. 13)

Phallosome, when observed in lateral aspect, with a series of up to 10 prominent denticles extending from the internal margin of the lateral plate . . . . . *halifaxii* (p. 17)

(The immature stages of the subgenus *Lutzia* cannot be distinguished at the present time)

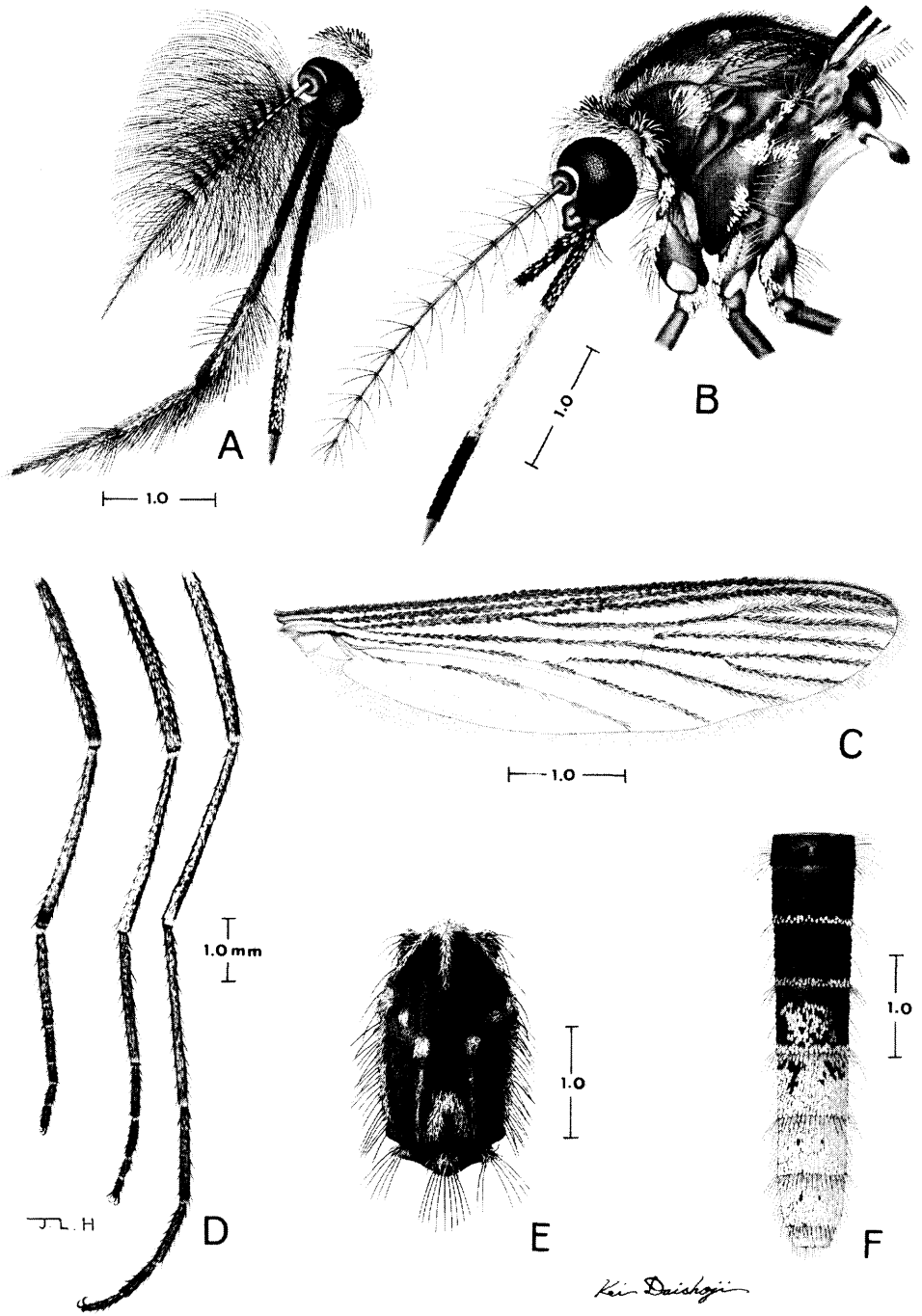
CULEX (LUTZIA) FUSCANUS WIEDEMANN 1820
(Figures 2 and 4A)

Culex fuscanus Wiedemann 1820, Dipt. Exot. 1: 9 (♂, ♀).
Culex concolor Robineau-Desvoidy 1827, Mem. Soc. Hist. nat. Paris 3: 405 (♂); Edwards 1922, Indian J. med. Res. 10: 275 (synonymy).
Culex setulosus Doleschall 1875, Natuurk. Tijdschr. Ned.-Ind. 14: 384 (♂, ♀*); Edwards 1922, Indian J. med. Res. 10: 275 (synonymy).
Culex luridus Doleschall 1875, Natuurk. Tijdschr. Ned.-Ind. 14: 384 (♂*, ♀*); Barraud 1934, Fauna Brit. India, Diptera 5: 341 (synonymy).
Lutzia fuscanus (Wiedemann): Edwards 1922, Indian J. med. Res. 10: 275 (♂*); Barraud 1924, Indian J. med. Res. 11: 973 (♂*, ♀).
Culex (Lutzia) fuscanus Wiedemann: Edwards 1932, *in* Wytsman, Genera Insect., fasc. 194: 191 (taxonomy); Barraud 1934, Fauna Brit. India, Diptera 5: 341 (♂*, ♀, L); Li and Wu 1935, Yearb. Bur. Ent. Chekiang 4: 98 (L*); Bonne-Wepster and Brug 1939, Geneesk. Tijdschr. Ned.-Ind. 79: 1261 (L*); Bohart 1945, Navmed 580: 72 (♂*); T'an 1945, Sinensia 16: 46 (L*); Bonne-Wepster 1954, Roy. trop. Inst. Amst. Spec. Pub. 111: 107 (♂, ♀*, L*); Bohart 1956, Ins. Micronesia 12: 75 (♂*, ♀); Ma and Feng 1956, Acta ent. Sinica 6: 172 (L*); Ikeshoji 1966, Jap. J. exp. Med. 36: 321-334 (biology); Delfinado 1966, Mem. Amer. ent. Inst. 7: 97 (♂*, ♀, L*, P*).

Color patterns of the adult female are extremely variable, particularly on the scutum, the legs, and the abdomen; however, abdominal terga I-IV usually exhibit very narrow apical pale bands and terga V-VIII are totally pale. In the male the phallosome is distinctive, being robust, but very simple and lacking prominent denticles. The larva cannot be distinguished from that of *halifaxii*.

FEMALE. (Figure 2). In general a large species for the genus *Culex* with outstanding color patterns particularly on the abdomen and scutum. *Head.* (Figure 2B). Proboscis dark brown, usually with an extremely broad median band of light scales clearly encircling the proboscis and with scattered pale scales proximal to the band; palpus similar in color to the proboscis, with white

Fig. 2



C. (Lutzia) fuscanus

scales scattered among the dark particularly on the apex and on the internal margin; decumbent scales of the vertex uniformly pale; erect scales numerous, uniformly dark brown. *Thorax*. (Figure 2B, E). Scutum with scales forming distinct, but variable dark and light patterns; the most prominent light scale patches present on the anterior acrostichal area, the humeral area, the posterior fossal area, and around the prescutellar space; integument of the pleuron light brown; distinct scale patches present on the prealar area, the upper sternopleuron, the posterior sternopleuron, and the upper mesepimeron; bristles also present in these areas in addition to 3 to 7 strong lower mesepimeral bristles. *Wing*. (Figure 2C). *Legs*. (Figure 2D). Anterior surface of the hind femur with a broad median stripe of pale scales and with a distinct knee spot at the apex; hind tibia with numerous white scales which also form somewhat of a median stripe; hind tarsomere I mostly pale, tarsomeres II-V dark but with a variable amount of pale scaling; markings of the fore and mid legs similar to the hind legs. *Abdomen*. (Figure 2F). Terga II-IV dark, frequently with narrow pale apical bands or with scattered pale scales, terga V-VIII completely pale or with broad, pale apical bands; sterna uniformly pale.

MALE. Similar in general appearance to the female, but frequently with the pale areas less prominent or slightly modified. *Head*. (Figure 2A). Median pale band of the proboscis usually modified to be more distal and less distinct than in the female; palpus dark, with variable pale scaling on segments III-V. *Terminalia*. (Figure 4A). Basimere conical, without scales; subapical lobe of the basimere with the basal rods strong, hooked distally; beyond the rods are approximately 5 short, fine setae, none of which are leaf-shaped; distimere robust, with up to 7 fine, scattered setae; phallosome simple, consisting of a gently curved lateral plate, the internal surface exhibiting a series of up to 7 fine denticles or striations which do not protrude when observed in lateral aspect; proctiger well developed, crowned with a dense tuft of strong spines; cercal setae variable, approximately 8 in number; basal sternal process well developed, straight.

LARVA. The larva of *fuscanus* cannot be distinguished from that of *halifaxii;* for a discussion of structure and chaetotaxy, see under the latter species.

TYPE DATA. Syntypes of *fuscanus* from India are in the Naturhistorisches Museum, Vienna, Austria. No type locality was designated for *concolor* and the type specimen is non-existent. Syntypes of *setulosus* from Gombong, Java are in the Naturhistorisches Museum, Vienna, Austria. The type locality of *luridus* was designated as Gombong, Java but the location of the type specimen is unknown.

DISTRIBUTION. This species is probably distributed throughout THAILAND. During this study specimens have been examined from: *Chiang Mai, Chon Buri, Krung Thep, Nakhon Ratchasima, Phet Buri, Prachuap Khiri Khan, Rayong, Surat Thani, Thon Buri,* and *Udon Thani*. It has also been

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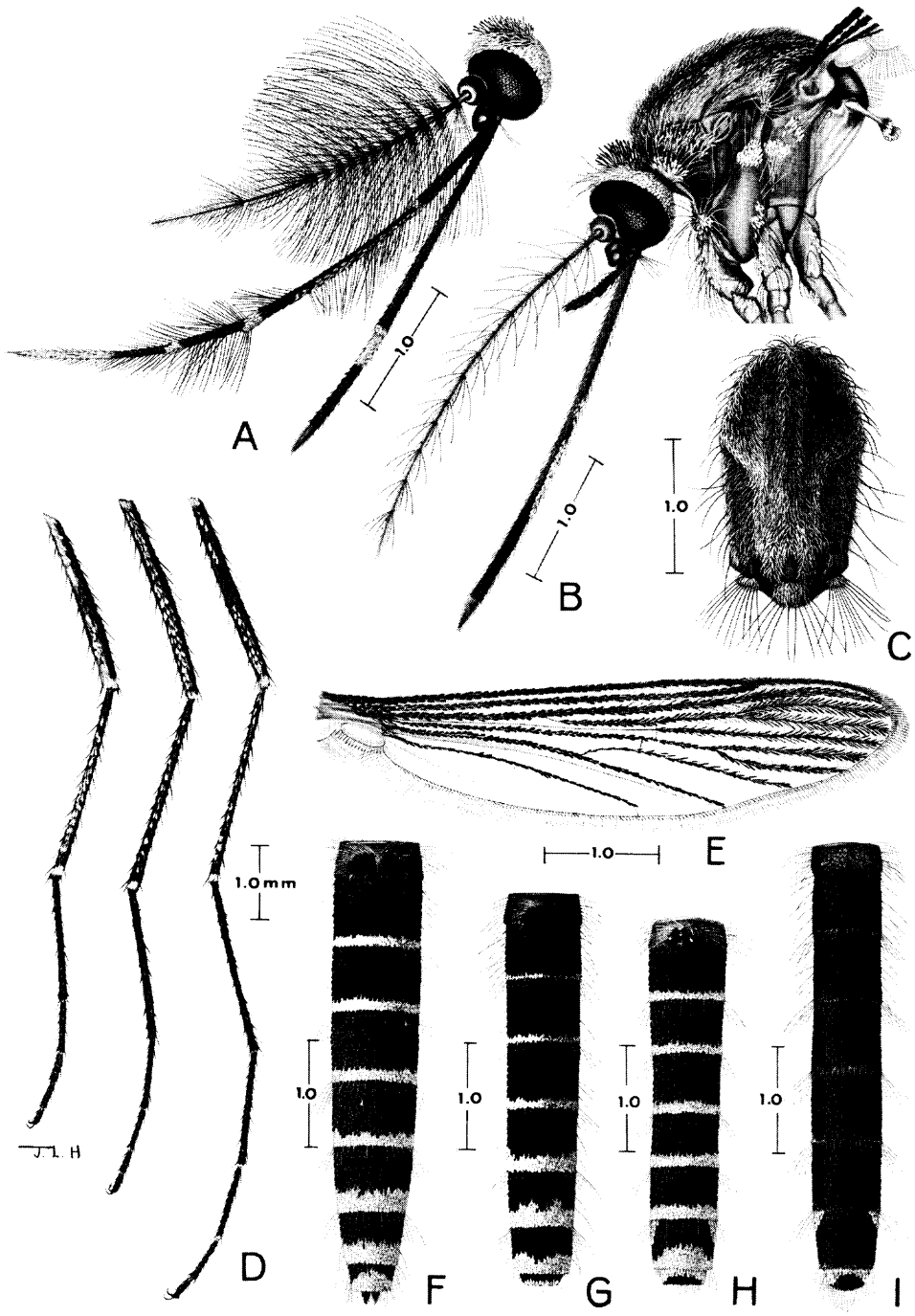
Figure 2. *C. (Lutzia) fuscanus*. Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

Fig.3



C. (Lutzia) halifaxii

Kei Daishoji

recorded from the following additional countries: INDIA, CEYLON, ANDAMAN ISLANDS, BURMA, MALAYA, SUMATRA, JAVA, BORNEO, PHILIPPINES, INDOCHINA, CHINA, TAIWAN, U. S. S. R. (Maritime Province), KOREA, JAPAN, CAROLINE ISLANDS, and PALAU ISLANDS.

The following specimens have been examined during this study: 46 males (10 with associated larval and pupal skins) and 68 females (16 with associated larval and pupal skins) from Thailand as well as 184 males and 295 females from other areas within its range. Numerous whole larvae were examined, but distinction could not be made between species of the subgenus.

BIOLOGY. The bionomics of this species has recently been studied in Rangoon, Burma by Ikeshoji (1966a). It was found that oviposition preferences of the females correspond very closely to those of *pipiens quinquefasciatus*, although the latter species is capable of tolerating higher levels of pollution. Upon hatching, the first instar larva immediately attacks another larva of similar size and over the whole period of development the individual will consume an average of 363. 8 larvae, most of which are in the early instars. Although the association of fuscanus larvae with those of *pipiens quinquefasciatus* was very striking, the population density of *fuscanus* remained relatively low throughout the year, averaging 21 larvae and pupae of *fuscanus* per 10, 000 to 50, 000 *pipiens quinquefasciatus* larvae even when both populations were at their peaks during the January-February period. Adult females apparently feed primarily on avian hosts and could not be induced to feed on man. Ikeshoji concluded that although *fuscanus* larvae are potent destroyers of *pipiens quinquefasciatus* larvae under field conditions, the predator persists at such a low level that no significant controlling effect is registered on the *pipiens quinquefasciatus* population.

CULEX (LUTZIA) HALIFAXII THEOBALD 1903
(Figures 3, 4B, and 5)

Culex halifaxii Theobald 1903, Mon. Cul. 3: 231 (♀); Edwards 1913, Bull. ent. Res. 4: 234 (taxonomy).

Culex multimaculosus Leicester 1908, Cul. Malaya: 155 (♂, ♀); Edwards 1913, Bull. ent. Res. 4: 234 (synonymy).

Culex aureopunctis Ludlow 1910, Canad. Ent. 42: 195 (♀); Edwards 1922, Indian J. med. Res. 10: 470 (synonymy).

Lutzia vorax Edwards 1921, Bull. ent. Res. 12: 327 (♂*); Barraud 1924, Indian J. med. Res. 11: 975 (♂*, ♀). NEW SYNONYMY.

Lutzia halifaxi (Theobald): Edwards 1921, Bull. ent. Res. 12: 327 (♂); Edwards 1924, Bull. ent. Res. 14: 391 (distribution); Barraud 1924, Indian J. med. Res. 11: 975 (♂*, ♀); Paine and Edwards 1929, Bull. ent. Res. 20: 307 (distribution).

Lutzia raptor Edwards 1922, Indian J. med. Res. 10: 275 (♂*); Barraud 1924, Indian J. med. Res. 11: 974 (♂*). NEW SYNONYMY.

Culex (Lutzia) halifaxi(i) Theobald: Edwards 1932, *in* Wytsman, Genera

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Figure 3. *C. (Lutzia) halifaxii.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female scutum and scutellum; D, anterior surface of the female legs; E, dorsal aspect of the female wing; F, G, H, and I, dorsal aspect of variations in the female abdomen.

Insect. fasc. 194: 191 (taxonomy); Barraud 1934, Fauna Brit. India, Diptera 5: 344 (♂*, ♀, L*); Bonne-Wepster and Brug 1937, Geneesk. Tijdschr. Ned.-Ind. 77: 62 (♂, ♀); Bonne-Wepster and Brug 1939, Geneesk. Tijdschr. Ned.-Ind. 79: 1263 (L); Knight, Bohart and Bohart 1944, Nat. Res. Counc. Div. med. Sci. 45 (key); Bohart 1945 Navmed 580: 72 (♂); Laird 1947, Trans. and Proc. Roy. Soc. N. Z. 76: 459 (L*); Knight and Chamberlain 1948, Proc. helm. Soc. Wash. 15: 18 (P*); Perry 1949, Amer. J. trop. Med. 29: 754 (L*); Penn 1949, Pacif. Sci. 3: 68 (P*); Bick 1951, Pacif. Sci. 5: 415 (ecology); Bonne-Wepster 1954, Roy. trop. Inst. Amst. Spec. Pub. 111: 108 (♂, ♀, L); Belkin 1962, Mosq. S. Pacif. 1: 220 (♂*, ♀, L*, P*); Assem and Bonne-Wepster 1964, Zool. Bijdr. (Leiden) 6: 109 (♂, ♀); Delfinado 1966, Mem. Amer. ent. Inst. 7: 99 (♂*, ♀).

Culex (Lutzia) raptor (Edwards): Edwards 1932, *in* Wytsman, Genera Insect. fasc. 194: 191 (taxonomy); Barraud 1934, Fauna Brit. India, Diptera 5: 343 (♂*, ♀, L).

Culex (Lutzia) vorax (Edwards): Edwards 1932, *in* Wytsman, Genera Insect. fasc. 194: 191 (taxonomy); Barraud 1934, Fauna Brit. India, Diptera 5: 344 (♂*, ♀, L); Robertson and Hu, 1934, China J. 20: 356 (distribution); Hsiao and Bohart 1946, Navmed 1095: 24 (distribution); Bohart and Ingram 1946, Navmed 1055: 70 (♂*, ♀, L*); LaCasse and Yamaguti 1950, Mosq. Fauna Japan and Korea: 251 (♂*, ♀*, P*, L*); Monchadskii 1951, Moscow Zool. Akad. Nauk SSSR 37: 242 (L*); Asanuma and Nakagawa 1953, Misc. Rep. Res. Inst. nat. Resour. 31: 91 (P*); Bohart 1956, Ins. Micronesia 12: 73 (♂*, ♀, L*); Ma and Feng 1956, Acta ent. Sinica 6: 172 (L*); Hara 1957, Jap. J. exp. Med. 27: 52 (♀*); Lien 1962, Pacif. Ins. 4: 630 (distribution).

Color patterns of the adult female are even more variable than in *fuscanus*; however, the abdominal banding patterns and the incomplete pale band of the proboscis are diagnostic. The phallosome of the male is characterized by having 3 to 10 strong denticles which project prominently from the inner margin of the lateral plate. The larva cannot be distinguished from that of *fuscanus*.

FEMALE. A large species for the genus *Culex* with prominent colorational features on the legs, scutum, and abdomen. *Head.* (Figure 3B). Proboscis dark brown with a very narrow, but variable ventral median band of pale scales which occasionally encircle the proboscis; palpus similar in color to the proboscis, with or without white scales scattered among the dark; decumbent scales of the vertex uniformly creamy white; erect scales usually lighter than those on the rest of the vertex. *Thorax.* (Figure 3B, C). Scutum basically covered with bronze-brown scales, but with a variable pattern of silver or white scales on the anterior promontory, the humeral area, and scattered in and around the prescutellar space; acrostichal bristles numerous

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Figure 4. Dorsal view of the male terminalia with inserts of the lateral aspect of the phallosome: A, *C. (Lutzia) fuscanus;* B, *C. (Lutzia) halifaxii.*

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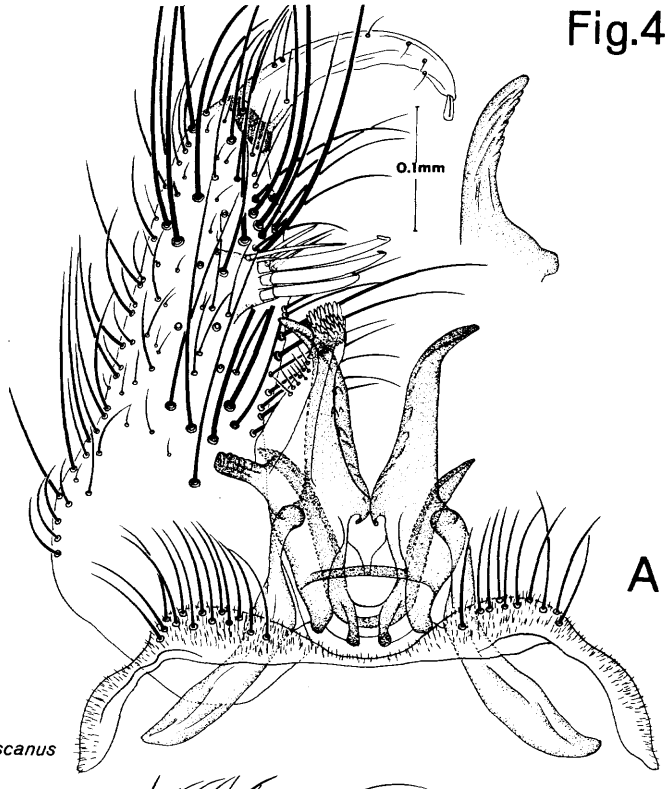
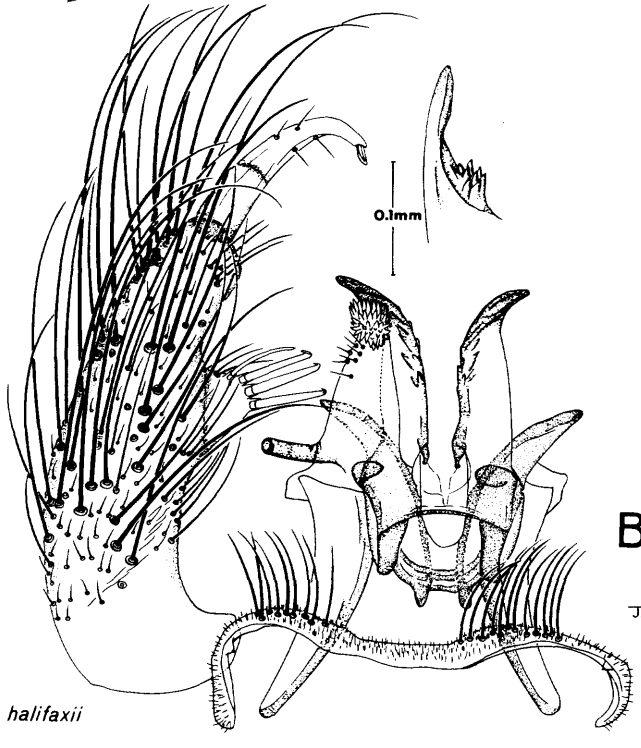
Fig.4



C.(Lutzia) fuscanus



C.(Lutzia) halifaxii

anteriad of the scutal angle; integument of the pleuron uniformly light brown; distinct white scale patches on the prealar area, the upper sternopleuron, the posterior sternopleuron, the upper mesepimeron, and the anterior mesepimeron; bristles also present in these areas in addition to several strong lower mesepimeral bristles. *Wing.* (Figure 3E). *Legs.* (Figure 3D). The color patterns of all legs similar; femora basically dark brown with flecks of white scales scattered to a greater or lesser degree and with a narrow, pale apical band; each tibia also basically dark brown, but with the light scales forming somewhat of a longitudinal stripe and with a narrow apical band; tarsi light brown with very few randomly placed light scales; considerable variation exists in the pattern of light scales on the femora and tibiae. *Abdomen.* Variation in tergal banding patterns illustrated in figure 3F-I; in the typical *halifaxii* form (3I), all of the terga are dark scaled without light basal or apical bands, however, tergum VII has a basal triangular spot of light scales laterally and VIII has a narrow white basal band; another condition exists in which all terga exhibit moderately broad apical white bands (3F) and conditions intermediate to the 2 extremes are common (3G, H); sterna with variable patterns of mixed dark and light scales.

MALE. Similar in general appearance to the female. *Head.* (Figure 3A). Proboscis with the median pale band always present on both the dorsal and ventral surfaces; palpus usually with scattered pale scales on segments II-V. *Terminalia.* (Figure 4B). Very similar to *fuscanus;* the phallosome, when viewed in lateral aspect, with a series of up to 10 prominent denticles protruding from the inner margin of the lateral plate.

LARVA. (Figure 5). *Head.* Integument rather darkly pigmented, particularly around the insertions of hairs 5, 6-C and covered with a uniform, dense pattern of small, tooth-like spicules; mouthparts adapted for predation and mouth brushes very broad and lamellate; antenna gradually tapering to a truncate apex, not sharply constricted beyond insertion of hair 1-A which is represented by a single, simple seta inserted on the proximal half of the shaft; hairs 2, 3-A single, simple, subequal in length, inserted somewhat below the apex of the shaft; head hair 1-C single, simple, arising from a distinct, small protruberance; 4-C dendritic, with 4 or 5 branches; 5, 6-C single, simple, very strong and long; 16, 17-C absent. *Thorax.* Integument covered with a conspicuous pattern of very dense, small, sharply pointed spicules; thoracic hairs 1-7-P all single, simple, rather short; 8-P branched, pectinate; 14-P single, simple. *Abdomen.* Integument minutely spiculose, the spicules not nearly as apparent as those of the thorax; comb consisting of approximately 35 fan-shaped scales arranged in a broad, triangular patch; siphon index ranging from 1:1 to 1:1.5; the siphon covered with a dense, conspicuous pattern of sharply pointed spicules which are modified in the form of reticulose platelets; approximately 12 to 20 tufts of pectinate setae inserted in a straight, single midventral line and a pair of small, bifid, simple tufts inserted dorsad of the pecten; pecten consisting of from 9 to 12 teeth located throughout the length of the siphon except at the extreme base and apex; individual pecten tooth consisting of a very strong apical spine and 1 or 2

Figure 5. *C. (Lutzia) halifaxii.* Fourth stage larva: Dorsoventral view of the head and prothorax, and lateral aspect of the terminal abdominal segments.

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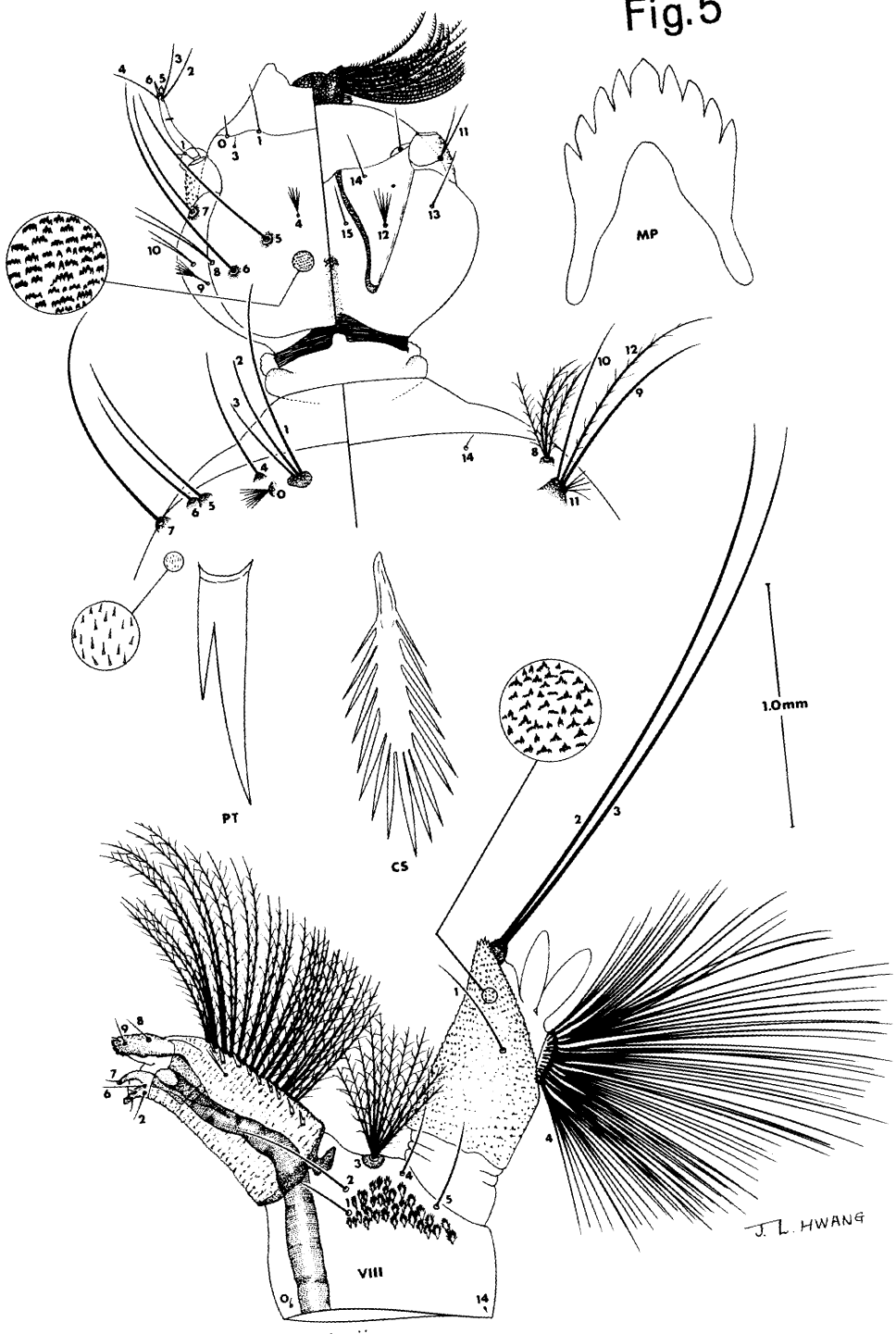
Fig.5



C.(Lutzia) halifaxii

(usually 1) strong basal barbs; ventral brush consisting of from 14 to 16 individual tufts inserted within the grid; anal gills very short; anal saddle complete, spiculose.

TYPE DATA. The holotype female of *halifaxii* from Dindings, Malaya is in the British Museum. Lectotype male of *multimaculosus* is hereby designated: Cotype male (terminalia mounted and attached to pin), "Kuala Lumpur, Fed. Malay States, Dr. G. F. Leicester, 1912-350", in the British Museum. The holotype female of *aureopunctis* from Cotabato, Mindanao, Philippines is in the U. S. National Museum. The holotype male (terminalia mounted and attached to pin) of *raptor* from Amritsar, India is in the British Museum. The holotype male (terminalia mounted and attached to pin) of *vorax* from Tokyo, Japan is in the British Museum.

DISTRIBUTION. This species is undoubtedly distributed throughout THAILAND and has been examined from: *Chanthaburi, Chiang Mai, Chon Buri, Kanchanaburi, Krung Thep, Lampang, Nakhon Nayok, Nakhon Ratchasima, Narathiwat, Nonthaburi, Phattalung, Phet Buri, Prachuap Khiri Khan, Ranong, Songkhla, Thon Buri, Trang,* and *Udon Thani. C. halifaxii,* as presently recognized to include *raptor* and *vorax,* has been reported from:MALAYA, INDIA, CEYLON, CHINA, INDONESIA, PHILIPPINES, NEW GUINEA, BISMARCK ARCHIPELAGO, SOLOMON ISLANDS, AUSTRALIA, BURMA, INDOCHINA, JAPAN, U. S. S. R. (Maritime Province), KOREA, OGASAWARA GUNTO, RYUKYU-RETTO, TAIWAN, MARIANA ISLANDS, and NEPAL.

During this study 196 adult females and 114 adult males (33 of which had associated larval and pupal skins) were examined from Thailand, as well as 138 specimens from other countries.

TAXONOMIC DISCUSSION. The division of the Oriental fauna of the subgenus *Lutzia* into 4 species has long been suspect. Edwards (1932) first questioned the practice of recognizing 5 species from the Old World, but Barraud (1934) continued to recognize 4 variable Oriental species. Belkin (1962) only provisionally recognized the 4 Oriental species of the subgenus *Lutzia,* and suggested that they may represent only 1 plastic species or possibly several distinct sibling allopatric forms. During this study, examination of over 80 glycerine preparations of *Lutzia* terminalia from Thailand, Okinawa, Japan, and the Philippines as well as considerably more adults and larvae suggests that only 2 variable species of the subgenus *Lutzia, fuscanus* and *halifaxii,* are present in the Oriental region. This conclusion is based primarily on the anatomy of the male phallosome. Specimens of the typical *halifaxii, raptor,* and *vorax* forms all demonstrate a series of 3 to 10 prominent denticles extending from the middle of the median process (a feature best observed in lateral aspect). Although color patterns of the scutum, legs, and abdomen vary considerably, the presence of prominent denticles on the phallosome are consistent. In contrast, the phallosome of *fuscanus* does not exhibit the prominent denticles but instead, possesses striations which form a suggestion of teeth on the inner margin. Again, color patterns of the scutum, legs, and abdomen are variable, but the phallosome remains consistent. Glycerine preparations of the male phallosome of the third Old World species of *Lutzia, tigripes* Grandpré and Charmoy, were also examined and found to be distinct from both *fuscanus* and *halifaxii.*

BIOLOGY. In general, it appears that larvae of *halifaxii* inhabit a broader range of habitats than do those of *fuscanus.* Belkin (1962) summarized habitats in the South Pacific and concluded that the larvae are commonly found

in various kinds of temporary and semipermanent ground water habitats and that they occur frequently in a great variety of artificial containers, as well as rock pools, stream margins, and tree holes. This species seems to display a preference for water of high organic content. LaCasse and Yamaguti (1950) reported that 45 percent of collections of this species in Japan were from movable artificial containers, whereas Bick (1951) found larvae of this species most frequently (65 percent of collections) in puddles in New Guinea. Due to its broad range of habitats, *halifaxii* is predaceous on a great number of mosquito species, as well as other arthropods of appropriate size. Host preferences of the adult females are unknown; however, man has been reported as an occasional host by several authors (Belkin 1962; LaCasse and Yamaguti 1950; Bonne-Wepster 1954). Most investigators have concluded that although the larvae are voracious feeders, populations never reach sufficient density to serve effectively as mosquito control agents. Yasuno (1965) conducted laboratory studies on *vorax (= halifaxii)* and concluded that the first stage larvae have a higher predatory efficiency than those of the second and later instars. It was also concluded that the settling behavior reduced the chance of contact between members of the predator species and that cannibalism did not occur when the prey, which moves more frequently, was present.

SUBGENUS *NEOCULEX* DYAR 1905

Neoculex Dyar 1905, Proc. ent. Soc. Wash. 7: 48. Type species: *Culex territans* Walker.
Maillotia Theobald 1907, Mon. Cul. 4: 274. Type species: *Maillotia pilifera* Theobald.
Eumelanomyia Theobald 1909, Colon. Rep. misc. Ser. No. 237: 10. Type species: *Eumelanomyia inconspicua* Theobald.
Protomelanoconion Theobald 1910, Mon. Cul. 5: 462. Type species: *Protomelanoconion fusca* Theobald.

The adult females cannot be conclusively distinguished from several closely related subgenera, but, in general, lack acrostichal bristles on the scutum and exhibit dense scaling on the scutum which is smooth in appearance. The adult males may be recognized by the characters mentioned above in addition to the short palpi and the distinctive terminalia. The fourth stage larvae are recognized by thoracic hair 3-P shorter and slenderer than 1-P and head hair 14-C single or often dendritic beyond the basal half.

FEMALE. Usually small species, without distinctive ornamentation. *Head.* Proboscis unbanded; palpus uniformly dark. *Thorax.* Dorsocentral bristles well developed; acrostichal bristles weakly developed, present only on the extreme anterior edge of the scutum; scales of scutum dense, smooth in appearance; pleura without dark integumental markings or distinct scale patches; lower mesepimeron with or without a bristle; legs all uniformly dark. *Abdomen.* Terga with or without narrow, pale, basal bands.

MALE. Similar in general appearance to the female. *Head.* Palpus 1/2 to 3/4 the length of the proboscis; antenna without specialized scales or setae. *Terminalia.* Basimere without scales and without prominent submarginal setae; distimere normal for the genus; phallosome simple, globose and covered with strong denticles, particularly on the inner margin; proctiger

crowned with a tuft of short, rather stout spicules; 3 to 5 short, cercal setae present; basal sternal process not developed.

LARVA. *Head.* Usually normal in shape and overall chaetotaxy; hair 1-C strong, tapering to a sharp point; 14-C single, often dendritic beyond the basal half; 16,17-C either present or absent, when present represented by extremely minute spicules. *Thorax.* Hairs 1,2,3-P single, but 3-P about half the length and width of 1,2-P; integument glabrous. *Abdomen.* Comb consisting of a broadly triangular patch of fan-shaped scales; siphon variable in length but always greater than the anal segment, with 5 pairs of subventral tufts; pecten restricted to the basal third or less of the siphon; saddle completely ringing segment X; ventral brush consisting of approximately 10 individual tufts of setae, the basal ones occasionally inserted before the grid.

DISTRIBUTION. The subgenus *Neoculex* is predominantly Ethiopian, but representatives are known from all major zoogeographical regions. In Thailand, species of the subgenus, primarily *brevipalpis*, are distributed throughout the country.

TAXONOMIC DISCUSSION. Although the classification and systematic arrangement of species within the subgenus are incompletely understood, it appears that *Neoculex* may possibly serve as a unifying link between *Culiciomyia*, *Lophoceraomyia*, and *Mochthogenes*, with closest affinities to the latter. The adult females are not only difficult to distinguish from these 3 subgenera, but intrasubgeneric differences are minute. The larva and male terminalia seem closest to *Mochthogenes*, but the females are similar to *Culiciomyia* in having smooth scaling on the scutum. The 2 species of the subgenus which occur in Thailand are closely related and will undoubtedly be assigned to the same group when affinities within the subgenus are finally determined.

BIOLOGY. Little is known of the biology of Oriental species of this subgenus. Larvae are usually found in container habitats such as tree holes, bamboo internodes, and restricted ground waters. Host preferences of the females are poorly understood, but man is rarely, if ever, attacked. It is possible that the females feed to some degree on amphibian and reptilian hosts. Although there is presently no indication that species of the subgenus *Neoculex* play any role in the transmission of arthropod borne viruses in Thailand, viruses for which neutralizing antibodies have been found in the human population, have been isolated from species of the subgenus in Moçambique and South Africa (see for example, Worth and de Meillon 1960).

KEY TO SPECIES OF THE SUBGENUS *NEOCULEX* IN THAILAND - ADULT FEMALES

One lower mesepimeral bristle present; abdominal terga with narrow, pale basal bands . . . . . *tenuipalpis* (p. 29)

Lower mesepimeral bristles absent; abdominal terga completely dark . . . . . *brevipalpis* (p. 25)

KEY TO SPECIES OF THE SUBGENUS *NEOCULEX* IN THAILAND - MALE TERMINALIA

Subapical lobe of the basimere with 2 large and 3 smaller leaf-

shaped setae . . . . . *tenuipalpis* (p. 29)
Subapical lobe of the basimere with only 1 leaf-shaped seta. . . . . *brevipalpis* (p. 25)

KEY TO SPECIES OF THE SUBGENUS *NEOCULEX* IN THAILAND - FOURTH STAGE LARVAE

Length of the subventral siphon tufts greater than the width of the siphon at the point of insertion; individual pecten tooth with the lateral barbs very numerous and fine on the distal half and widely spaced and coarse on the proximal half. . *tenuipalpis* (p. 29)
Length of the subventral siphon tufts less than the width of the siphon at the point of insertion; individual pecten tooth with the lateral barbs all coarse and subequal in size. . . *brevipalpis* (p. 25)

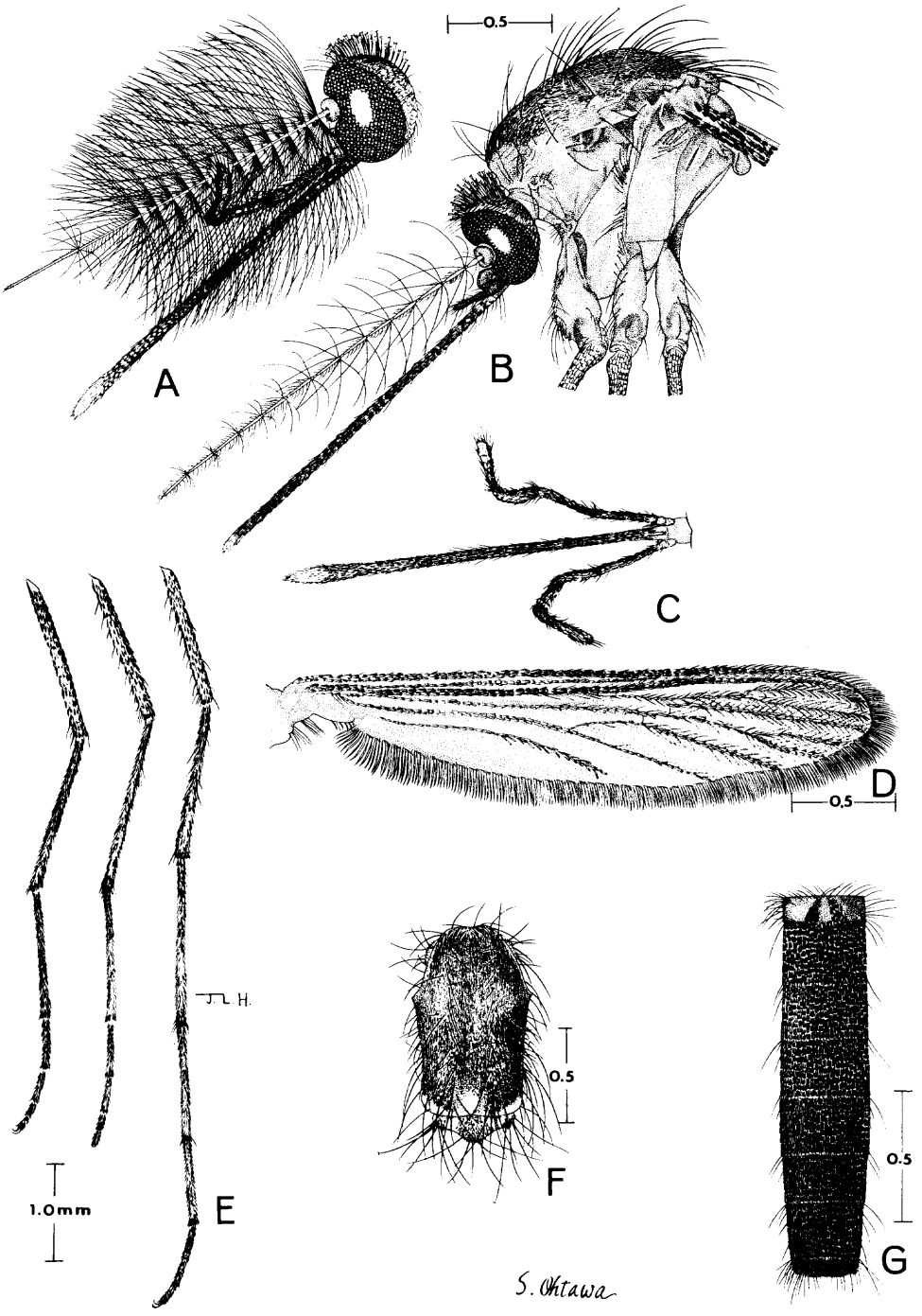
CULEX (NEOCULEX) BREVIPALPIS (GILES) 1902
(Figures 6, 7, and 8)

Culex longipes Theobald 1901, Mon. Cul. 2: 68 (♀, preoccupied by Fabricius 1850).
Stegomyia brevipalpis Giles 1902, Handb., 2nd. ed.: 384 (♂*, ♀*).
Culex brevipalpis (Giles): Theobald 1903, Mon. Cul. 3: 146 (♂, ♀); Barraud 1924, Indian J. med. Res. 11: 1277 (♂*, ♀); Barraud 1924, Indian J. med. Res. 12: 432 (L*).
Culex macropus Blanchard 1905, Les Moustiques: 327 (new name for *longipes* Theobald 1901); Barraud 1924, Indian J. med. Res. 11: 1277 (synonymy).
Melanoconion uniformis Leicester 1908, Cul. Malaya: 136 (♂, ♀); Edwards 1913, Bull. ent. Res. 4: 237 (synonymy).
Culex fidelis Dyar 1920, Insec. Inscit. menst. 8: 180 (♂); Edwards 1929, Notul. ent. 9: 4 (synonymy).
Culex (Neoculex) brevipalpis (Giles): Edwards 1932, *in* Wytsman, Genera Insect., fasc. 194: 194 (taxonomy); Barraud 1934, Fauna Brit. India, Diptera 5: 348 (♂*, ♀, L*); Baisas 1935, Philipp. J. Sci. 57: 177 (♂*, ♀); Lee 1944, Atlas mosq. Larvae Aust. Reg.: 1277 (L*); Bohart 1945, Navmed 580: 72 (♂*, L); Bohart and Ingram 1946, Navmed 1055: 72 (♂*, ♀, L*); Bonne-Wepster 1954, Roy. trop. Inst. Amst. Spec. Pub. 111: 109 (♂*, ♀, L*); Lien 1962, Pacif. Ins. 4: 631 (distribution); Delfinado 1966, Mem. Amer. ent. Inst. 7: 125 (♂*, ♀, L*, P*).

The adult female may be recognized by the absence of a lower mesepimeral bristle and the absence of narrow pale basal abdominal bands. In the male the terminalia is distinctive. The fourth stage larva possesses a long siphon with the subventral tufts shorter than the width of the siphon at the point of insertion and the pecten tooth fringed with strong, subequal barbs.

FEMALE. *Head.* (Figure 6B). Antenna normal, its length approximately equal to that of the proboscis; palpus slightly darker than the proboscis; decumbent scales of the vertex dark brown on the occiput, slightly broader and pale posteriolaterally; erect scales light brown. *Thorax.* (Figure 6B, D).

Fig. 6



C. (Neoculex) brevipalpis

Integument of the scutum light brown but with faintly darker, longitudinal stripes in the dorsocentral and acrostichal areas; covered with a uniform pattern of dark brown scales; integument of the pleuron uniformly light brown (in some specimens tinged with green); distinct scale patches absent but scattered scales may be present in some areas; lower mesepimeral bristle absent. *Wing.* (Figure 6F). *Legs.* (Figure 6E). All legs uniformly dark scaled. *Abdomen.* (Figure 6H). Terga totally dark brown; sterna pale.

MALE. Habitus similar to that of the female. *Head.* (Figure 6A). Proboscis with an apparent joint at approximately 2/3 the distance from the base; antenna plumose; length of the palpus 1/2 to 3/4 the length of the proboscis, appearing somewhat twisted (figure 6C). *Terminalia.* (Figure 7C). Subapical lobe of the basimere with 3 strong basal rods which are subequal in length, the proximal 2 hooked apically, the distal 1 gently curved followed by 3 rather straight setae and a short, narrow leaf; distimere slender; lateral plate of the phallosome simple, globose, with from 15 to 25 small denticles principally on the internal margin; proctiger well developed, crowned with a tuft of strong, broad spines and with 2 or 3 cercal setae present; basal sternal process not developed.

PUPA. (Figure 7A, B).

LARVA. (Figure 8). *Head.* Antenna spiculate basad of the insertion of hair 1-A; 2-6-A inserted at the apex of the shaft; head hair 1-C strong, robust, tapering to a sharp point; 4-C single, simple, very long; 5, 6-C with from 2 to 4 branches, pectinate; 7-C with from 5 to 10 branches, pectinate; 14-C single, frequently dendritic on the distal half; 16, 17-C absent (as illustrated), or 16-C represented by a minute spicule and 17-C absent. *Thorax.* Integument glabrous; hairs 1, 2-P single, pectinate, subequal in length; 3-P single, pectinate, about half the length and width of 1, 2-P; 4-P with from 2 to 5 branches, pectinate; 5, 6-P single, pectinate; 7, 8-P bifid, pectinate; 14-P bifid, simple. *Abdomen.* Integument glabrous; comb consisting of a broad, triangular patch of from 40 to 60 elongated, fan-shaped scales; siphon index variable, ranging from 7:1 to 15:1, the siphon very narrow, its sides parallel; 5 pairs of subventral tufts inserted on the siphon beyond the pecten, the apical tuft somewhat out of line; individual tufts with from 2 to 5 branches, their length less than the width of the siphon at the point of insertion; pecten restricted to the basal fifth of the siphon or less, consisting of from 11 to 21 teeth; individual pecten tooth with a pointed apical spine and a series of approximately 10 coarse, lateral barbs; saddle completely ringing segment X; ventral brush consisting of 10 individual tufts of setae, all located within the grid (only 5 tufts illustrated); 2 long and 2 distinctly shorter anal gills present.

Critical examination of several points of chaetotaxy and anatomical features revealed that the larva of this species is extremely variable. Range of variation in 96 specimens from 44 collections in Thailand is recorded in the above description. It is interesting to note the extensive variation in head

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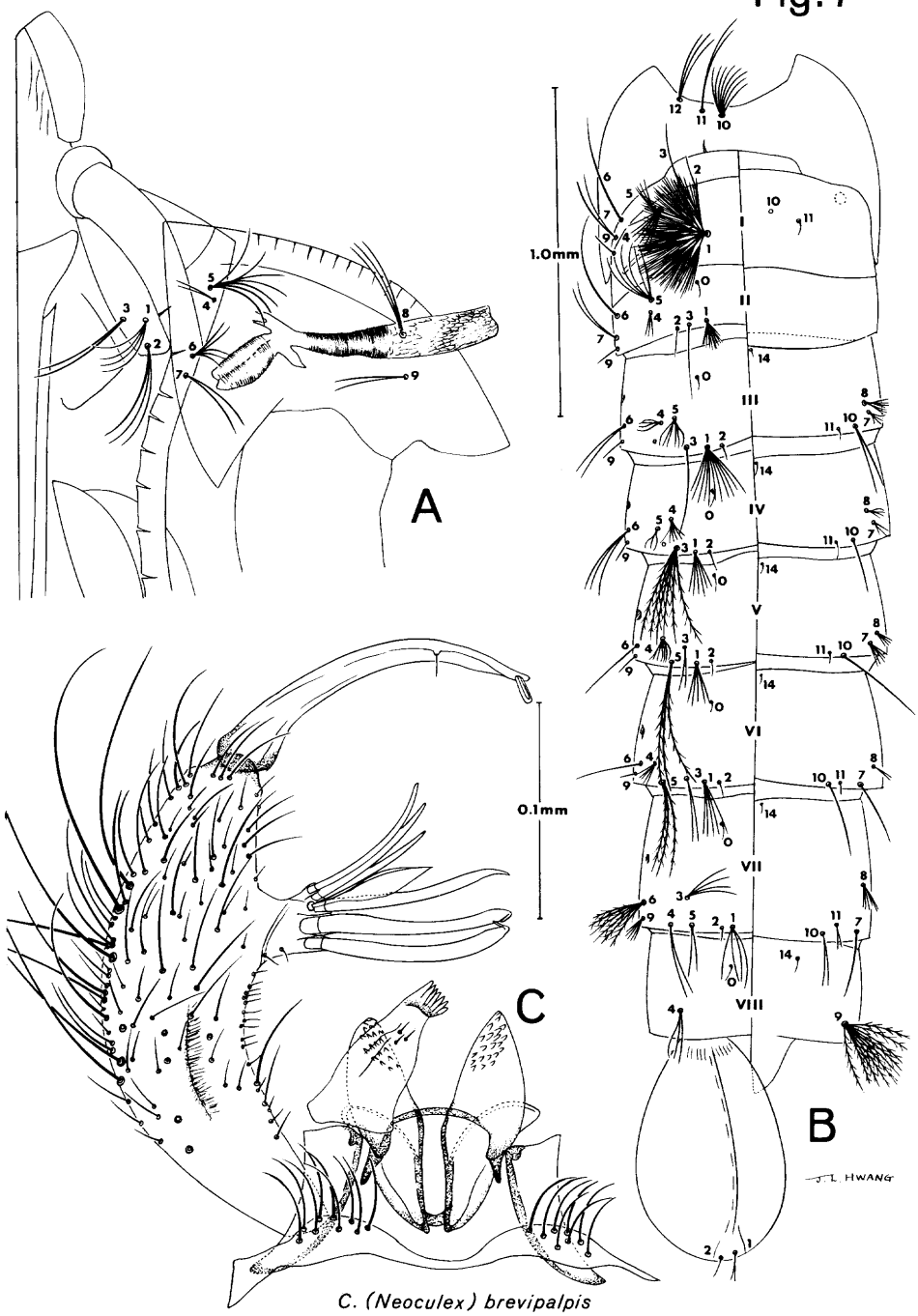
Figure 6. *C. (Neoculex) brevipalpis.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the male proboscis and palpus; D, dorsal aspect of the female wing; E, anterior surface of the female legs; F, dorsal aspect of female scutum and scutellum; G, dorsal aspect of the female abdomen.

Fig. 7



C. (Neoculex) brevipalpis

hairs 5, 6-C, thoracic hair 4-P, the number of comb scales and pecten teeth, the number and branching of the siphon tufts, and the siphon index which averaged 10.8:1, but ranged from 7:1 to 15:1. Despite this variation, consistent differences have not been found which would suggest an unrecognized species complex.

TYPE DATA. Lectotype male of *brevipalpis* hereby designated: syntype male (terminalia mounted and attached to pin), "Shajahnapur, India, 21 Oct. 1910", in the British Museum. Holotype female of *longipes* from Singapore in the British Museum. Lectotype male of *uniformis* hereby designated: cotype male (terminalia mounted and attached to pin), "Kuala Lumpur, Fed. Malay States, Dr. G. F. Leicester, 1912-35", in the British Museum. Lectotype male of *fidelis* from Los Baños, Philippine Islands in the U. S. National Museum.

DISTRIBUTION. This species is undoubtedly distributed throughout THAILAND and specimens have been studied from: *Ayutthaya, Chiang Mai, Chon Buri, Chumphon, Kanchanaburi, Krung Thep, Lampang, Mae Hong Son, Nakhon Nayok, Nakhon Ratchasima, Narathiwat, Nanthaburi, Phattalung, Prachuap Khiri Khan, Phare, Ranong, Rayong, Sakhon Nakhon, Satun, Thon Buri, Trat, Trang, Ubon Ratchatani,* and *Udon Thani.*

In addition to THAILAND, *brevipalpis* has been reported from the following areas: INDIA, CEYLON, INDOCHINA, CHINA, TAIWAN, RYUKYU-RETTO, PHILIPPINES, MALAYA, INDONESIA, NEW GUINEA, and the BISMARCK ARCHIPELAGO. Specimens have been examined in the British Museum collection from Kota Belud, NORTH BORNEO**.

During this study the following specimens were examined: 91 males and 229 females, 97 with their associated larval and pupal skins, and 522 larvae.

BIOLOGY. In Thailand larvae have been collected most frequently from tree holes and from bamboo stumps and internodes. Additional habitats included various artificial containers, rock holes, a ditch, and a pond. Baisas (1935) reported that in the Philippines the larvae are found in forest streams, but most other authors have reported habitats similar to those found in Thailand (see, for example: Bohart and Ingram 1946; Bonne-Wepster 1954; and Lien 1962). Host preferences of the adult females are unknown, but man is certainly not a normal host; however, Bonne-Wepster (1954) reported that in New Guinea man may be attacked near the breeding places.

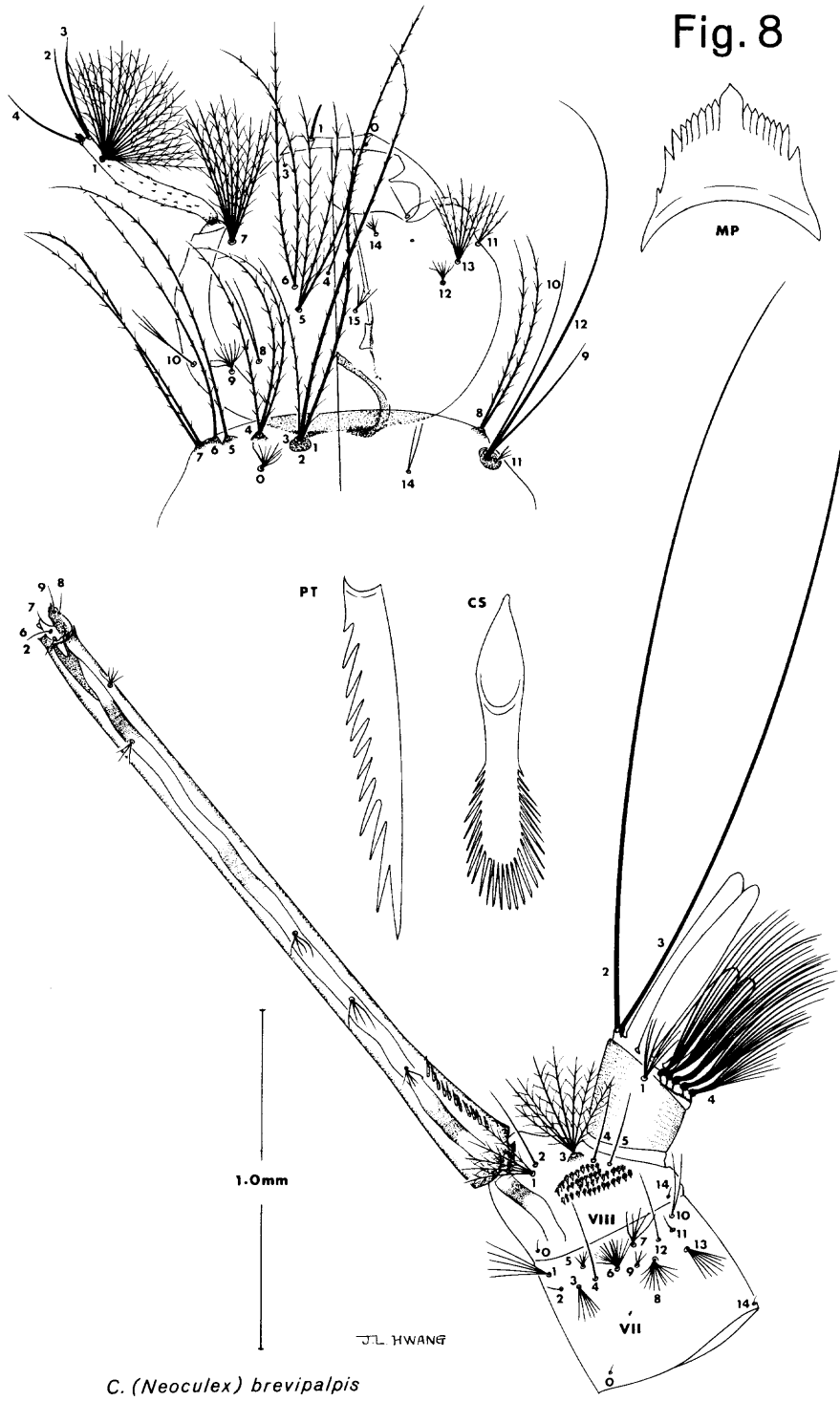
CULEX (NEOCULEX) TENUIPALPIS Barraud 1924
(Figure 9)

Culex tenuipalpis Barraud 1924, Indian J. med. Res. 11: 1278 (♂*, ♀); Barraud 1924, Indian J. med. Res. 12: 433 (L*).

Culex (Neoculex) tenuipalpis Barraud: Edwards 1932, *in* Wytsman, Genera Insect., fasc. 194: 195 (taxonomy); Barraud 1934, Fauna Brit. India, Diptera 5: 351 (♂*, ♀, L*); Thurman 1959, Univ. Md. Agric. Exp. Sta. Bull. A-100: 122 (distribution).

Figure 7. *C. (Neoculex) brevipalpis.* A, B, dorsoventral view of the pupa; C, dorsal aspect of the male terminalia.

Fig. 8



C. (Neoculex) brevipalpis

The adult female is recognized by the presence of 1 lower mesepimeral bristle and the narrow, pale, basal bands on the abdominal terga. The number and shape of the setae on the subapical lobe of the basimere of the male terminalia are diagnostic. The fourth stage larva exhibits very long subventral tufts on the siphon and possesses distinctive pecten teeth.

FEMALE. *Head.* Antenna normal, its length approximately equal to that of the proboscis; proboscis and palpus dark brown; decumbent scales of the vertex dark brown on the occiput, pale posteriolaterally; erect scales brown. *Thorax.* Scutum uniformly covered with dark brown scales; pleuron uniformly light brown, without distinct scale patches; 1 lower mesepimeral bristle present. *Legs.* Anterior surface of the hind femur predominantly pale, with a narrow apical dark band which extends proximally for a short distance along the dorsal margin; hind tibia and tarsus, as well as the fore and mid legs uniformly dark. *Abdomen.* Terga dark brown, with narrow, pale basal bands; sterna brown, somewhat lighter basally.

MALE. *Head.* Proboscis with an apparent joint at approximately 2/3 the distance from the base; length of the palpus slightly greater than half the length of the proboscis, not noticeably twisted as in *brevipalpis*. *Terminalia.* (Figure 9C). Subapical lobe of the basimere prominent, with 3 strong, subequal, hooked basal rods, a very slender leaf, 2 rather broad leaflets with fringed posterior margins, and 3 rather large, symmetrical, subequal leaflets; distimere slender, normal; lateral plate of the phallosome simple, globose, with approximately 20 strong denticles, particularly on the internal margin.

LARVA. Specimens not available for study; figure 9A, B is after Barraud (1924b).

TYPE DATA. Lectotype male of *tenuipalpis* hereby designated: syntype male (terminalia slide mounted), "India: Sureil, E. Himalayas, 5,500 ft., X 1922, P. J. Barraud, BM 1923-585" in the British Museum.

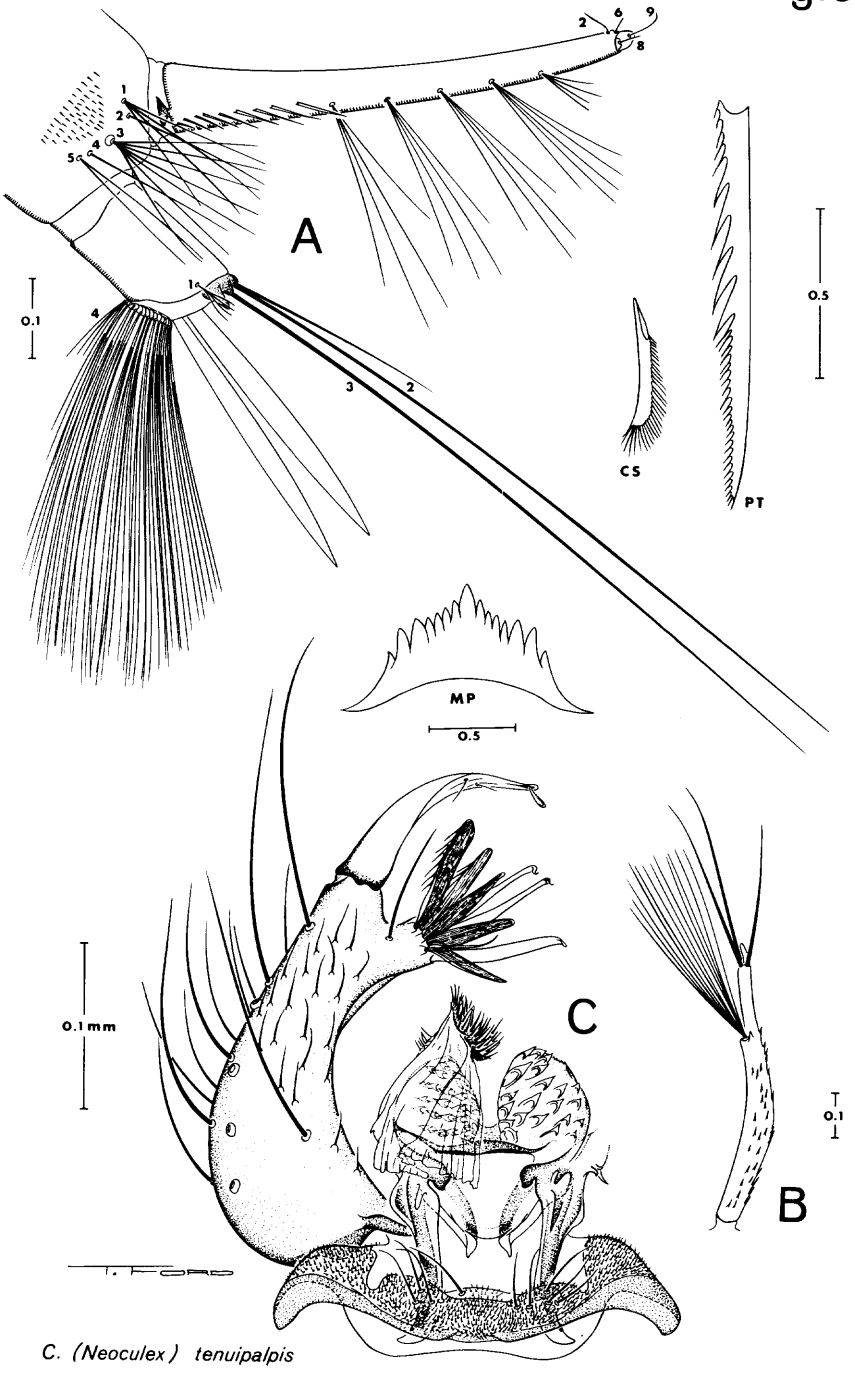
DISTRIBUTION. In THAILAND, *tenuipalpis* is known from *Ngao, Lampang* and Doi Suthep, *Chiang Mai*. In addition to the type locality in INDIA, this species has also been recorded by Brug (1931) from 1 adult female and 3 larvae collected on JAVA. During this study 7 male specimens were examined in addition to the lectotype male.

TAXONOMIC DISCUSSION. The male terminalia of this species is similar to that of *hayashii* Yamada, but slight differences exist in the shape of the setae on the subapical lobe of the basimere; *hayashii* also lacks the pale, basal tergal bands, but from the published description, the larvae appear to be very similar.

BIOLOGY. Barraud (1934) recorded the larval habitat of *tenuipalpis* as roadside pools. The specimens which have been examined from Thailand have been collected as adults, either resting or with a net during February, March, and June. Feeding preferences and habits of the adult females are unknown.

Figure 8. *C. (Neoculex) brevipalpis*. Fourth stage larva: dorsoventral view of the head and prothorax, and lateral aspect of the terminal abdominal segments.

Fig.9



C. (Neoculex) tenuipalpis

SUBGENUS *MOCHTHOGENES* Edwards 1930

Culex (Mochthogenes) Edwards 1930, Bull. ent. Res. 21: 305. Type species: *Culex malayi* Leicester.

The adult females exhibit strongly developed acrostichal bristles, one strong, lower mesepimeral bristle, and lack banding patterns on the proboscis, legs, and abdominal terga. The adult males may be recognized by the characters mentioned above as well as the palpi which are less than 1/4 the length of the proboscis. The fourth stage larvae possess a strong siphon with well developed pecten which bears distinctive teeth, head hair 1-C well developed, and thoracic hair 3-P more slender than 1-P and less than half its length; head hairs 5, 6-C are short and weak and 14-C is bifid.

FEMALE. Very small species devoid of distinctive ornamentation. *Head.* Proboscis and palpus completely dark; antenna longer than the proboscis. *Thorax.* Acrostichal, anterior dorsocentral, posterior dorsocentral, supraalar, and prescutellar bristles all well developed; pleuron without distinct scale patches; 1 strong, lower mesepimeral bristle present; all legs completely dark.

MALE. *Head.* Palpus less than 1/4 the length of the proboscis; antenna plumose, without specialized scales or setae. *Terminalia.* Basimere without scales or distinctive submarginal setae; subapical lobe having strongly developed setae; distimere either bifid or normal; phallosome simple, elongate, with or without denticles; proctiger crowned with a tuft of rather strong, short spines; 2 or 3 short cercal setae present; basal sternal process not developed.

LARVA. *Head.* Head hair 1-C well developed, tapering gradually to a sharp point; 5, 6-C short, weak, 5-C about half the length of 6-C; 14-C bifid, the branches strongly divergent; 16, 17-C present, represented by minute spicules. *Thorax.* Hairs 1, 2, 3-P single, 3-P approximately half the length and width of 1, 2-P. *Abdomen.* Comb consisting of a broadly triangular patch of scales; pecten restricted to the basal fourth of the siphon; individual pecten tooth with several broad basal barbs and a distal lateral series of fine, parallel spines; saddle completely ringing segment X; ventral brush consisting of 10 or more tufts.

DISTRIBUTION. The subgenus *Mochthogenes* is restricted to the Old World tropics. Species of the subgenus are found throughout Thailand.

TAXONOMIC DISCUSSION. *Mochthogenes* demonstrates closest affinity to the subgenera *Neoculex* and *Lophoceraomyia*. The short palpus of the male is quite distinctive and species in Thailand possess a unique pecten tooth in the fourth stage larva. The subapical lobe of the basimere in the male terminalia usually exhibits extensively developed processes and, at this stage of our knowledge, the male terminalia presents the only completely reliable structures for species diagnosis within the subgenus in Southeast Asia.

BIOLOGY. Bionomics of the adults of this subgenus are virtually unknown; however, females have never been reported feeding on man. Larvae

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Figure 9. *C. (Neoculex) tenuipalpis.* A, B, dorsal view of the fourth stage larva (after Barraud 1924b); C, dorsal aspect of the male terminalia.

have been collected from a wide variety of habitats in Thailand, ranging from stream margins to rock pools, wells, and ponds.

KEY TO SPECIES OF THE SUBGENUS *MOCHTHOGENES* IN THAILAND - ADULT FEMALES[1]

Decumbent scales of the vertex uniformly dark; anterior surface of the hind femur pale; abdominal sterna dark. . . . . *foliatus* (p. 34)
Decumbent scales of the vertex uniformly pale; anterior surface of the hind femur dark; abdominal sterna mainly pale. . *malayi* (p. 39)

KEY TO SPECIES OF THE SUBGENUS *MOCHTHOGENES* IN THAILAND - MALE TERMINALIA

1. Distimere furcate. . . . . *malayi* (p. 39)
   Distimere simple. 2

2. Lateral plate of the phallosome with distinct denticles, particularly on the inner surface; subapical lobe of the basimere with 4 leaf-shaped setae present . . . . . *foliatus* (p. 34)
   Lateral plate of the phallosome without distinct denticles; subapical lobe of the basimere without a leaf-shaped seta. . . . . *hinglungensis* (p. 37)

KEY TO SPECIES OF THE SUBGENUS *MOCHTHOGENES* IN THAILAND - FOURTH STAGE LARVAE[1]

Comb possessing 2 distinct types of scales, some fan-shaped and others with the median apical spine broader and longer than the other spines; head hairs 5, 6-C simple. . . . . *malayi* (p. 39)
All comb scales fan-shaped, fringed with subequal spines; head hairs 5, 6-C pectinate. . . . . *foliatus* (p. 34)

CULEX (MOCHTHOGENES) FOLIATUS BRUG 1932
(Figures 10 & 12A)

Culex (Culex) castrensis var. *foliatus* Brug 1932, Bull. ent. Res. 23: 82 (♂*, L*, P*).
Culex (Mochthogenes) chiyutoi Baisas 1935, Philipp. J. Sci. 57: 176 (♂*, ♀); Bohart 1945, Navmed 580: 73 (♂*); Delfinado 1966, Mem. Amer. ent. Inst. 7: 129 (♂*). NEW SYNONYMY.
Culex (Mochthogenes) castrensis var. *foliatus* Brug: Peters and Dewar 1956, Indian J. Malar. 10: 46 (♂*).
Culex (Mochthogenes) foliatus Brug: Bohart 1946, Navmed 961: 16 (distribu-

[1] The adult female and larva of *hinglungensis* are unknown.

tion, key).

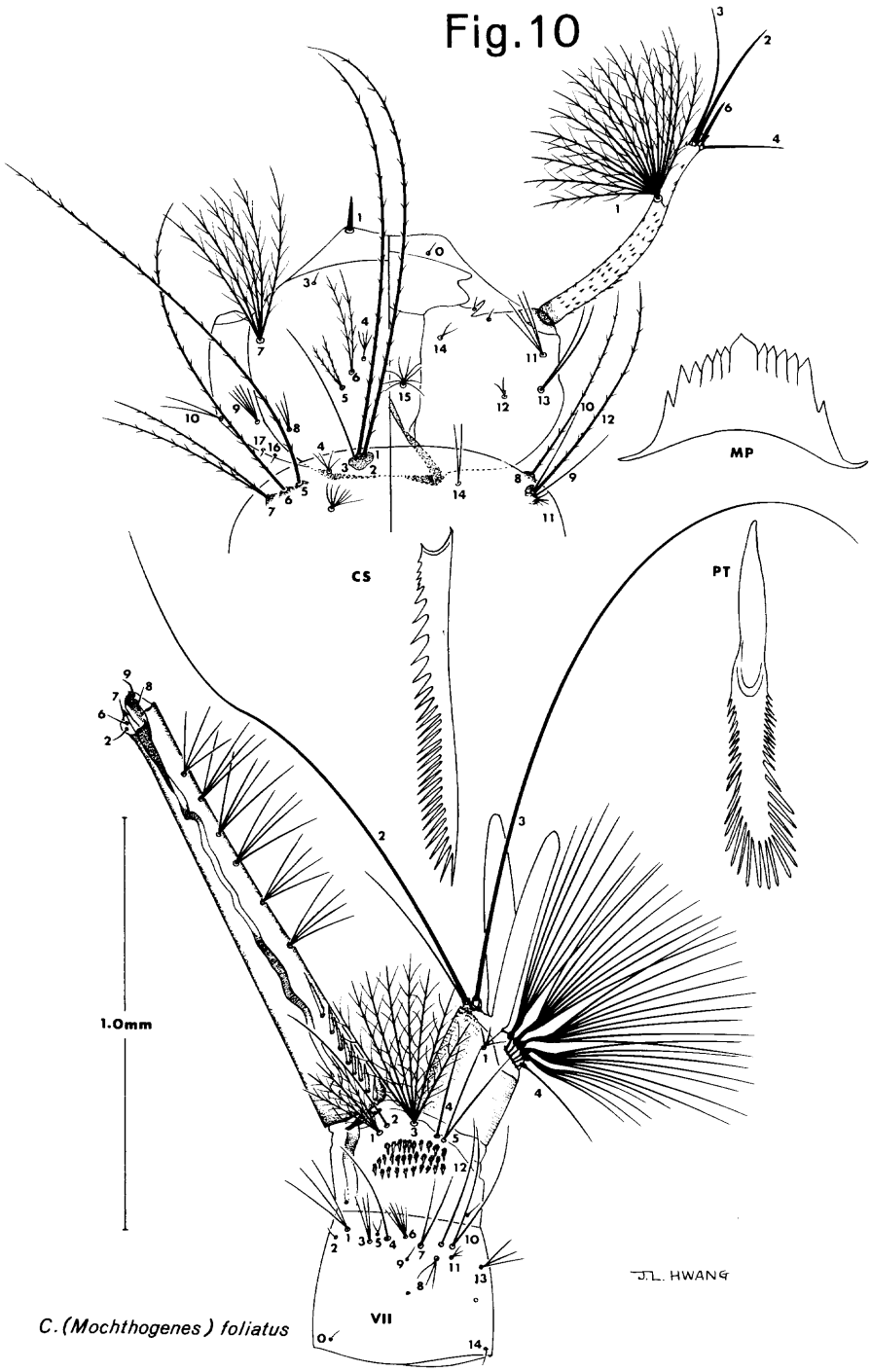
The adult female may be distinguished from the other members of the subgenus in Thailand by the uniformly dark brown decumbent scales of the vertex, the pale scaled hind femur, and the dark abdominal sterna. The larva is distinctive in that all comb scales are fan-shaped and fringed with subequal spines. The male terminalia is characterized by the distinctive chaetotaxy of the subapical lobe of the basimere.

FEMALE. A very small species without prominent ornamentation or color patterns. *Head.* Decumbent scales of the vertex uniformly dark brown, but with some lighter scales on the posterior orbital line; erect scales uniformly dark brown. *Thorax.* Integument of scutum and scutellum uniformly dark brown but with faintly lighter longitudinal stripes in the dorsocentral area; covered with a uniform pattern of bronze-brown scales; integument of the pleuron uniformly dark brown, in some specimens distinctly tinged with green, particularly in the areas of the meron, precoxa, and lower mesepimeron; scales absent; a series of approximately 5 upper mesepimeral bristles present, several upper sternopleural bristles, 1 posterior sternopleural bristle, and 1 strong lower mesepimeral bristle present; except for the pale scaled anterior surface of the hind femur, all legs uniformly dark scaled. *Abdomen.* Terga and sterna totally dark.

MALE. Generally marked as the female. *Head.* Palpus less than 1/5 the length of the proboscis, completely dark. *Terminalia.* (Figure 12A). Subapical lobe of the basimere rather flattened with 3 strong rods present, the basal 1 expanded medially and strongly elbowed with a hooked apex, median rod bent with an apical hook, distal rod gently curved and hooked apically; following the rods is a rather broad, blunt seta and 4 subequal, finely striated, rather symmetrical leaves; distimere swollen, enlarged distally, with a variable number of randomly placed setae; lateral plate of the phallosome simple, elongated, with small denticles, particularly at the apex and on the internal margins.

LARVA. (Figure 10). *Head.* Antenna spiculate basally and slightly beyond insertion of hair 1-A; antennal shaft constricted beyond insertion of 1-A; hairs 2-6-A normal for the genus, but 2, 3-A inserted slightly below the apex of the antenna; head hair 1-C robust, darkly pigmented, tapering to a sharp point; 4-C with from 2 to 4 branches, simple; 5-C bifid, finely pectinate, very short and slender; 6-C bifid, pectinate, robust; 16, 17-C represented by minute spicules. *Thorax.* Integument glabrous; hairs 1, 2-P single, pectinate, subequal in length; 3-P single, simple, about half the length and width of 1, 2-P; 4-P small, with 4 or 5 branches, simple; 5, 6-P single, pectinate; 7-P single or bifid, pectinate; 8-P single, pectinate; 14-P bifid, simple. *Abdomen.* Integument glabrous; comb consisting of a triangular patch of approximately 35 somewhat elongate, fan-shaped scales which are fringed with subequal spines; siphon index approximately 6:1, the sides of the siphon gradually tapering to a truncate apex; 6 pairs of subventral tufts evenly spaced on the siphon beyond the pecten; individual tufts 3 or 4 branched, their lengths exceeding the width of the siphon at the point of insertion; pecten restricted to the basal fourth of the siphon, consisting of approximately 8 to 10 teeth; individual pecten tooth rather elongated, fringed on the distal half with a series of 10 or more fine spines and with 3 or 4 rather coarse barbs on the proximal half; saddle completely ringing seg-

Fig.10



C. (Mochthogenes) foliatus

ment X.

TYPE DATA. The holotype male of *foliatus* (terminalia mounted and attached to pin) from Bandoeng, Java is in the British Museum. The original description of *chiyutoi* designated one male type, one female type, and five male cotypes from Kolambugan, Lanao Province, Mindanao, Philippines. Unfortunately, all specimens in the type series have been either lost or destroyed except for a single male which is undoubtedly one of the original 5 cotype males. Therefore, a lectotype is hereby designated: male cotype (terminalia slide mounted), "R 33, U. S. N. M. paratype no. 51392, slide no. 44. VII. 22b", in the U. S. National Museum.

DISTRIBUTION. In THAILAND, *foliatus* has been collected from: *Chiang Mai, Chon Buri, Chumphon, Mae Hong Son, Nakhon Nayok, Nakhon Ratchasima, Narathiwat, Prachuap Khiri Khan, Phare,* and *Songkhla*. This species has also been recorded from JAVA, CHINA, NEPAL, and the PHILIPPINES (as *chiyutoi*). Specimens have been examined in the British Museum collection from Kota Belud, NORTH BORNEO**.

During this study the following specimens have been examined from Thailand: 29 males and 32 females (32 with their associated larval and pupal skins), and 119 larvae.

TAXONOMIC DISCUSSION. Brug (1932) originally described *foliatus* as a variety of *castrensis*. Bohart (1946) treated *foliatus* as a valid species, but subsequent authors (Peters and Dewar 1956; Stone *et al.* 1959) continued to recognize *foliatus* as either a variety or subspecies of *castrensis*. Comparison of the 2 holotype males has revealed that in light of modern taxonomic practice, *foliatus* and *castrensis* should be recognized as distinct and valid species.

Examination of the holotype male terminalia of *foliatus* and the lectotype male terminalia of *chiyutoi* has revealed these forms to be conspecific. The distinctive setae on the subapical lobe of the basimere are identical in both forms, and the larva of *chiyutoi* (first described by Delfinado 1966) conforms to associated larval skins of *foliatus* from Thailand.

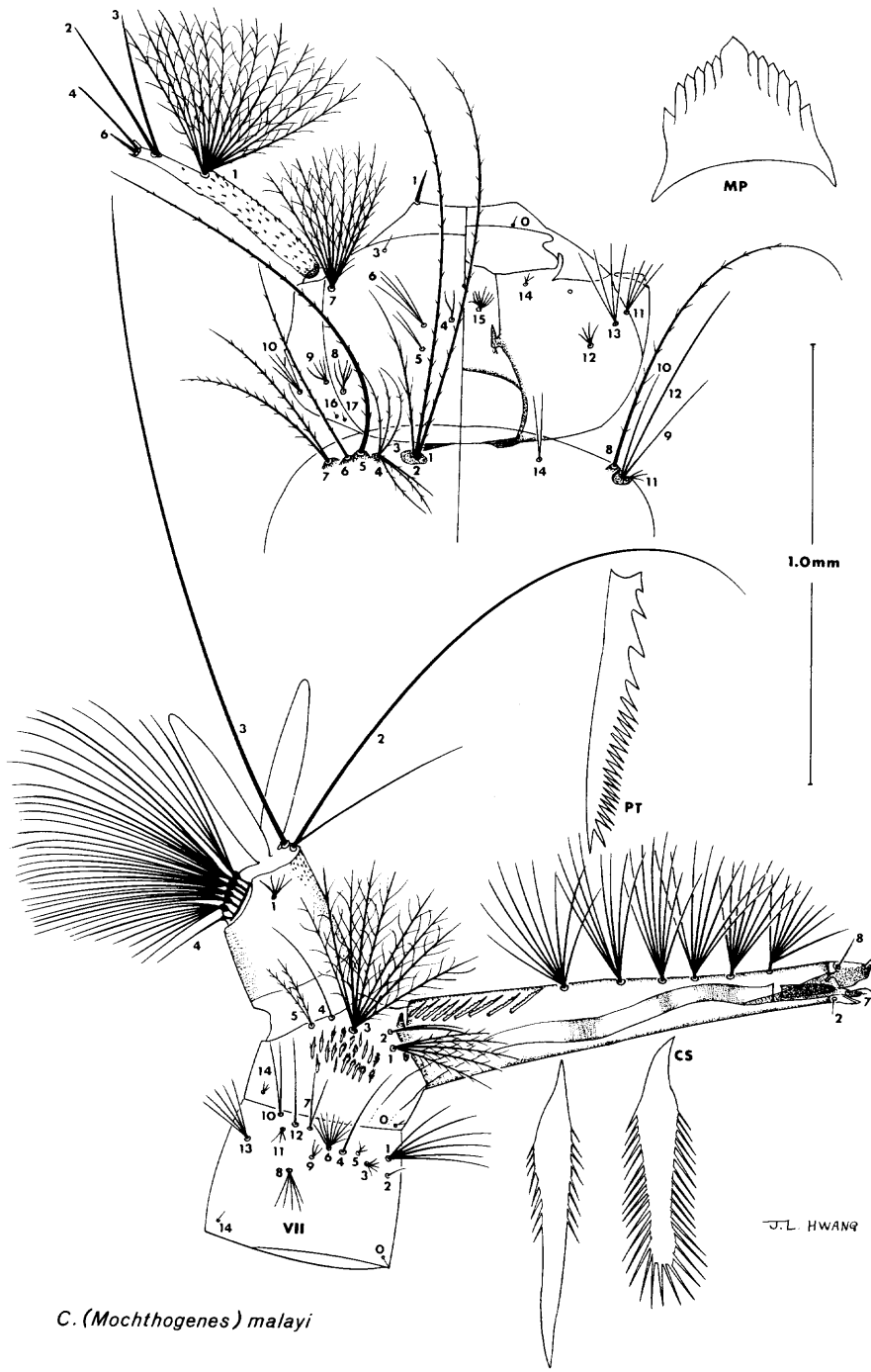
BIOLOGY. Larvae of this species have been reported exclusively from pools, generally with clear water (Brug 1932; Feng 1938). Although most collections of *foliatus* in Thailand were from stream pools, rock pools, and puddles, collections were also made from elephant hoof prints, seepage springs, a bamboo internode, and a bamboo pot. In the Philippines larvae have been reported from tree holes and small ground pools (as *chiyutoi*). Host preferences of the adult females are unknown, but they have not been reported to feed on man.

CULEX (MOCHTHOGENES) HINGLUNGENSIS CHU 1957
(Figure 12B)

Culex (Mochthogenes) hinglungensis Chu 1957, Acta. zool. Sinica 9:159 (♂); Chu 1958, Indian J. Malar. 12: 111 (♂*).

Figure 10. *C. (Mochthogenes) foliatus*. Fourth stage larva: dorsoventral aspect of the head and prothorax, and lateral aspect of the terminal abdominal segments.

Fig.11



C. (Mochthogenes) malayi

The male terminalia of this species is characterized by the absence of denticles on the lateral plate of the phallosome and by the number and arrangement of setae on the subapical lobe of the basimere.

FEMALE. Unknown.

MALE (After Chu 1958). A small dark mosquito, closely related to *C. (Mochthogenes) pluvialis* Barraud, but differing in the male terminalia. *Head.* Antenna, palpus, and proboscis dark brown, the palpus about 1/6 the length of the proboscis; a large area of flat scales with some narrow, curved and upright scales on the vertex and occiput. *Thorax.* Scutum and scutellum covered with narrow, curved, dark brown scales; pleuron dark brown, without scales; wings dark scaled; legs dark brown. *Abdomen.* Terga dark brown, sterna paler. *Terminalia.* (Figure 12B). Subapical lobe of the basimere weakly developed, with a reduced number of setae; lateral plate of the phallosome simple, rather short, without distinctive denticles.

LARVA. Unknown.

TYPE DATA. The holotype male from Hing-lung, Hainan Island, China is in the Department of Parasitology, Second Military Medical University, (precise location not given) China.

DISTRIBUTION. Apart from the type locality a single male has been collected in a light trap at Chiang Dao, *Chiang Mai*, THAILAND**.

TAXONOMIC DISCUSSION. Due to the abbreviated original and subsequent descriptions and the unavailability of the holotype for comparison, *hinglungensis* is only tentatively recognized from Thailand, pending examination of a more complete series. As far as is known, the species is represented only by the holotype male and the single male from Thailand.

BIOLOGY. The holotype male was collected in the crevice of rocks near mountain streams on Hainan Island during May. The male specimen from Thailand was collected at a light trap next to a stream during April.

CULEX (MOCHTHOGENES) MALAYI (LEICESTER) 1908
(Figures 11 & 12C)

Aedes malayi Leicester 1908, Cul. Malaya: 184 (♂, ♀).

Aedes nigrescens Theobald 1907, Mon. Cul. 4: 540 (preoccupied by Theobald 1907: 248).

Aioretomyia aedes Leicester 1908, Cul. Malaya: 189; Edwards 1917, Bull. ent. Res. 17: 228 (synonymy).

Micräedes malayi (Leicester): Edwards 1917, Bull. ent. Res. 17: 228 (taxonomy); Edwards 1922, Bull. ent. Res. 13: 92 (taxonomy).

Culex malayi (Leicester): Barraud 1924, Indian J. med. Res. 11: 1282 (♂*); Borel 1926, Arch. Insts. Pasteur Indo-Chine 3-4: 43 (♂*, ♀, L*); Borel 1930, Monogr. Coll. Soc. Path. exot. 3: 368 (♂*, ♀, L*).

Culex (Mochthogenes) malayi (Leicester): Edwards 1930, Bull. ent. Res. 21: 305 (taxonomy); Barraud 1934, Fauna Brit. India, Diptera 5: 358 (♂*, ♀, L); Li and Wu 1935, Yearb. Bur. Ent. Chekiang 4: 98 (L*); Brug

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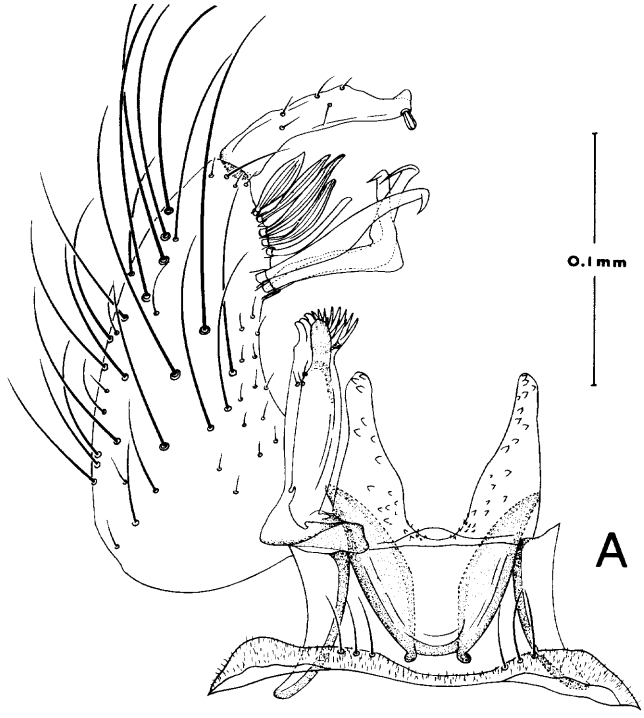
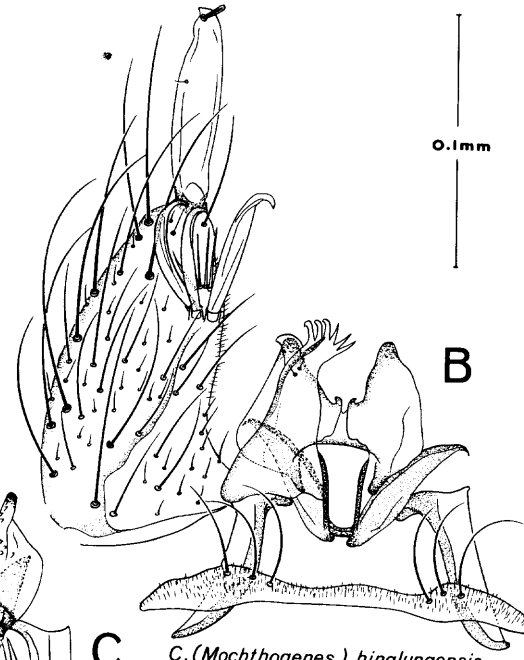
Figure 11. ← *C. (Mochthogenes) malayi.* Fourth stage larva: dorsoventral aspect of the head and prothorax, and lateral aspect of the terminal abdominal segments.

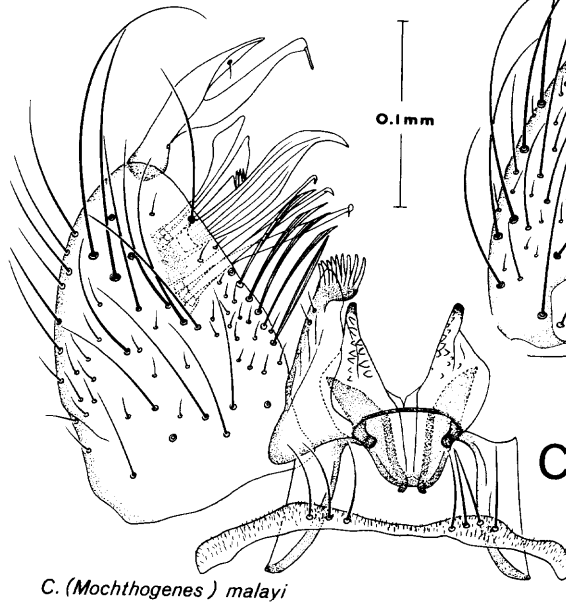
Fig.12



C.(Mochthogenes) foliatus



C.(Mochthogenes) hinglungensis



C. (Mochthogenes) malayi

1939, Tijdschr. Ent. 82: 111 (L*); Lee 1944, Atlas Mosq. Larvae Aust. Reg. 90 (L*); Galliard and Ngu 1949, Ann. Parasit. num. comp. 24: 502 (♂*, L*); Bonne-Wepster 1954, Roy. trop. Inst. Amst. Spec. Pub. 111: 111 (♂, ♀, L*); Hsieh and Liao 1956, Acta ent. Sinica 6: 376 (L*); Lien 1962, Pacif. Ins. 4: 631 (distribution).

The adult female can be distinguished by the pale decumbent scales of the vertex, the dark hind femur, and the pale sterna. The fourth stage larva possesses 2 types of scales in the comb and hair 4-P is dendritic. The male terminalia is easily recognized by the furcate distimere and the chaetotaxy of the subapical lobe of the basimere.

FEMALE. A small species without prominent ornamentation or color patterns. *Head.* Proboscis and palpus uniformly dark brown; decumbent scales of the vertex pale; erect scales dark brown. *Thorax.* Scutum uniformly dark brown with faintly paler longitudinal stripes on the dorsocentral area, and clothed with a uniform pattern of bronze-brown scales; integument of the pleuron uniformly dark brown, but frequently tinged with green in the areas of the meron, precoxa, propleuron, and lower mesepimeron; scale patches absent; 7 to 10 weak upper mesepimeral bristles and 1 strong lower mesepimeral bristle present. *Legs.* All legs uniformly light to dark brown without indication of pale bands. *Abdomen.* Terga dark brown; sterna I-IV with a mixture of pale and dark scales, sterna V-VIII completely pale.

MALE. Habitus generally as in the female. *Head.* Length of the palpus 1/5 or less than that of the proboscis. *Terminalia.* (Figure 12C). Subapical lobe of the basimere flattened, with strongly developed setae; with 3 subequal, hooked basal rods followed by a very broad, strong, striated, and characteristically shaped leaf, and 2 clavate setae, 1 of which is distinctly serrate; distimere characteristically furcate; lateral plate of the phallosome simple, elongate, covered with small, but distinct, denticles particularly at the apex and on the internal margin.

LARVA. (Figure 11). *Head.* Antenna spiculate basally and slightly beyond insertion of hair 1-A; antennal shaft constricted beyond insertion of 1-A; 2, 3-A inserted somewhat below the apex of the shaft; head hair 1-C robust, darkly pigmented, tapering to a sharp point; 4-C bifid, simple; 5-C with from 2 to 4 branches, simple, short and very fine; 6-C with from 2 to 4 branches, simple, longer than 5-C; 7-C with 9 branches, pectinate; 16, 17-C represented by extremely minute spicules. *Thorax.* Integument glabrous; hairs 1, 2-P single, finely pectinate, subequal in length; 3-P single, finely pectinate, about half as long and wide as 1, 2-P; 4-P with from 4 to 6 very fine, pectinate branches; 5, 6-P single, pectinate; 7-P bifid, pectinate; 8-P single, pectinate; 14-P bifid, simple. *Abdomen.* Integument glabrous; comb consisting of a triangular patch of approximately 20 scales; posterior scales with a prominent apical spine and fringed with minute lateral spicules, anterior scales fan-shaped, fringed with subequal spines; siphon index approximately 6:1, the sides gradually tapering to a truncate apex; 6 or 7 pairs of subventral tufts inserted beyond the pecten; individual tufts with 7 or more branches, their

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Figure 12. Dorsal aspect of male terminalia: A, *C. (Mochthogenes) foliatus;* B, *C. (Mochthogenes) hinglungensis;* C, *C. (Mochthogenes) malayi.*

length exceeding the width of the siphon at the point of insertion; pecten restricted to the basal fourth of the siphon, consisting of approximately 9 teeth; individual pecten tooth rather long and slightly curved, fringed with long, narrow, sharply pointed and numerous barbs on the distal half and short, robust barbs on the basal half; saddle completely ringing segment X; ventral brush consisting of from 12 to 14 tufts usually inserted within the grid.

TYPE DATA. Lectotype male of *malayi* hereby designated: cotype male (terminalia slide mounted), "Kuala Lumpur, Fed. Malay States, 29/9/03, G. F. Leicester, clear pool, circular road", in the British Museum. Holotype male of *aedes* (terminalia mounted and attached to pin) from Kuala Lumpur in the British Museum. Holotype male of *nigrescens* (terminalia slide mounted) from Castle Rock, Bombay, India in the British Museum.

DISTRIBUTION. In THAILAND *malayi* has been collected from: *Chiang Mai, Chon Buri, Krung Thep, Lampang, Nakhon Ratchasima, Phet Buri, Phare, Satun,* and *Songkhla.* This species has also been recorded from: MALAYA, INDIA, CEYLON, NEPAL, MALDIVE ISLANDS, ANDAMAN ISLANDS, BURMA, INDONESIA, TAIWAN, and NEW GUINEA. Specimens have been examined in the British Museum collection from Kota Belud, NORTH BORNEO**. Delfinado (1966) has cast doubt on the validity of records from the PHILIPPINES.

During this study the following specimens have been examined from Thailand: 68 males and 19 females (34 with associated larval and pupal skins) and 59 larvae.

TAXONOMIC DISCUSSION. On the basis of the male terminalia, *malayi* exhibits its closest affinity to *yeageri* Baisas and *laureli* Baisas both of which are endemic to the Philippine Islands; however, differences in the shape of the setae on the subapical lobe of the basimere are diagnostic.

BIOLOGY. Larvae have been reported from stream pools, ditches, swamps, wells, and similar ground water habitats (Carter and Wijesundara 1948; Bonne-Wepster 1954; Lien 1962). In Thailand specimens have been collected most frequently from stream margins, stream pools, and from slowly moving water in ditches. Host preferences of the adult females are unknown, but they have never been reported to attack man.

SUBGENUS *LOPHOCERAOMYIA* THEOBALD 1905

Lophoceraomyia Theobald 1905, J. Bombay nat. Hist. Soc. 16: 245 (April). Type species: *Lophoceraomyia uniformis* Theobald.

Lophoceratomyia Theobald 1905, Ann. hist.-nat. Mus. hung. 3: 93 (June, *lapsus*).

Philodendromyia Theobald 1907, Mon. Cul. 4: 623. Type species: *Philodendromyia barkerii* Theobald.

Cyathomyia Meijere 1910, Ann. bot. Gdn. Buitenz., Suppl. 3: 921. Type species: *Cyathomyia jenseni* Meijere.

The adult females are most difficult to characterize and to separate from the subgenera *Mochthogenes, Neoculex,* and *Culiciomyia;* proboscis unbanded, pleuron without distinct scale patches, acrostichal bristles weakly developed except at extreme anterior margin of the scutum, scales of the

scutum narrow, sparse, the pattern rather rough in appearance. The adult males are immediately recognized by the presence of distinctly modified scales and setae on flagellomeres V-IX or X. The fourth stage larvae possess a well developed pecten; ventral brush consisting of 10 or more tufts; thoracic hair 3-P slenderer than 1-P and approximately half its length; head hair 14-C bifid, its branches strongly divergent; head hairs 5, 6-C strong, long, subequal in length.

FEMALE. Usually small to moderately sized species. *Head.* Proboscis and palpus completely dark; length of antenna slightly greater than the length of the proboscis; decumbent scales of the vertex usually dark on the occiput and becoming slightly paler at the orbital line; erect scales usually uniformly dark. *Thorax.* Scutum sparsely covered with narrow dark scales; acrostichal bristles usually absent, weakly developed at the anterior margin of the scutum; dorsocentral bristles well developed; pleuron usually without distinct scale patches (never as extensive as seen in the subgenus *Culex*); lower mesepimeral bristle present or absent. *Wing.* All dorsal wing scales dark, sparse except towards the apex. *Legs.* Tibiae and tarsi of all legs uniformly dark scaled; anterior surface of the hind femur often predominantly pale, with an apical dark band which extends proximally as a narrow dark stripe along the dorsal border. *Abdomen.* Terga usually uniformly dark scaled, occasionally with narrow, basal pale bands; sterna variable.

MALE. Generally marked as the female. *Head.* Length of the palpus greater or less than that of the proboscis; antenna usually with modified scales and setae on flagellomeres V-IX or X (always present on flagellomeres VII and VIII). *Terminalia.* Basimere with strongly developed submarginal setae, usually in a row; subapical lobe with prominent and characteristic setae, at least 1 of which is usually leaf-shaped; distimere well developed, its shape variable although usually slender and with 2 small setae inserted on the distal third; phallosome consisting of 1 or 2 lateral plates; proctiger well developed, crowned with a tuft of several rather strong, short bristles; usually 2 or 3 cercal setae present; basal sternal process not developed.

LARVA. *Head.* Integument moderately pigmented, the antennal shaft usually concolorous with the head capsule, but with a variable, narrow, dark basal band; hair 1-C darkly pigmented, tapering to a sharp point, its length usually equal to approximately half the distance between the bases of the pair; principle head hairs well developed; 5, 6-C strong, long, subequal in length; 14-C bifid, its branches strongly divergent; 16, 17-C present or absent, when present represented by minute spicules. *Thorax.* Integument with or without spicules; hairs 1, 2, 3-P usually single, 3-P very fine, considerably shorter than 1, 2-P, occasionally bifid. *Abdomen.* Comb well developed, usually with fan-shaped scales (except in *minor* in which the scales of the posterior row are sharply pointed); siphon well developed, with 3 or 4 pairs of subventral tufts usually inserted in a line; pecten always present, restricted to the basal third of the siphon or less (except in *curtipalpis* in which the pecten covers the basal half of the siphon); ventral brush consisting of 10 or more tufts; saddle completely ringing segment X.

DISTRIBUTION. The subgenus *Lophoceraomyia* is restricted predominantly to the Oriental, Indomalayan, and Australasian regions of the Old World. In Thailand, representatives of the subgenus are found throughout the country. Colless (1965) has postulated that the subgenus originated in Southeast Asia as a derivative of the stem that includes *Neoculex, Moch-*

thogenes, and *Culiciomyia*.

TAXONOMIC DISCUSSION. As indicated above, the subgenus *Lophoceraomyia* demonstrates its closest affinity to *Neoculex*, *Mochthogenes*, and *Culiciomyia*, as well as the monotypic subgenus *Thaiomyia*. The adult females of these 5 subgenera are very similar, and the male terminalia, larvae, and pupae all show close relationships. Future investigations in Southeast Asia and other regions where these subgenera are found may well indicate the necessity for a realignment of species within a modified subgeneric framework.

Species within the subgenus *Lophoceraomyia* have been divided into the 2 major groups proposed by Colless (1965) as opposed to the 3 groups recognized by Barraud (1934). This classification, although somewhat complex, seems to clearly define the anatomical and biological differences of the 2 major groups, while recognizing the supposed phylogenetic affinities within the *mammilifer* group.

BIOLOGY. Larvae of species belonging to the *brevipalpus* subgroup of the *mammilifer* group are found predominantly in pitcher plants (*Nepenthes* spp.). Species of the *fraudatrix* group may be found as larvae primarily in various ground water habitats; larvae of the *mammilifer* subgroup are most frequently found in natural container habitats (e.g. tree holes, bamboo internodes, rock holes, etc.), but are not uncommon in ground water habitats as well. Very little is known of the biting habits of the adult females. For the most part, they probably prefer avian hosts and man rarely, if ever, serves as a host for any species within the subgenus. Three arthropod-borne viruses (Bakau, Ketapang, and Bebaru viruses) have been isolated from species of the subgenus *Lophoceraomyia* in Malaya, but the mosquito species were not determined, nor were host relationships fully investigated; however, antibodies to these viruses have been identified from humans in Malaya (Anonymous 1960; in this report Bakau virus is designated MM-2325, Ketapang is MM-2549, and Bebaru is MM-2354).

KEY TO SPECIES OF THE SUBGENUS *LOPHOCERAOMYIA* IN THAILAND - ADULT MALES

1. Phallosome with both an internal process and a spinose or toothed dorsal process; torus of antenna asymmetrical or with a distinct prominence or protuberance on the inner surface; palpus without finger-like basal processes. . (*mammilifer* group) 2
   Phallosome with a pointed, toothless dorsal process only; torus of antenna not asymmetrical and without a distinct prominence; palpus with finger-like basal processes. . . . .(*fraudatrix* group) 16

2(1). Apex of distimere noticeably expanded; basimere without long, prominent submarginal setae. . . . . (*brevipalpus* subgroup) 3
   Apex of distimere normal; basimere with long, prominent submarginal setae . . . . . (*mammilifer* subgroup) 4

3(2). Flagellomere V with a tuft of 2 or 3 dark brown, very long, filamentous scales, followed laterally by 3 or 4 shorter, narrow, pointed scales; palpus, at most, half the length of the proboscis. . . . . *curtipalpis* (p. 76)

Flagellomere V with a tuft of 6 or 7 golden, shorter and broader tapering scales; palpus from 1/2 to 3/4 the length of the proboscis. . . . . *lucaris* (p. 79)

4(2). Dorsal process of the phallosome very broad, the distal half covered with numerous strong teeth; internal process very small and toothed; torus of antenna without a mammiliform protuberance, slightly swollen on inner surface, and with a circumferential, almost slit-like depression. . . . . *wilfredi* (p. 110)
Dorsal process of the phallosome narrower, spinose or spiculate at apex and with lateral denticles on the inner surface; internal process curved and pointed; torus of antenna with a distinct prominence or protuberance on the inner surface and without a slit-like depression 5

5(4). Flagellomere V with a conspicuous tuft having from 1 to 4 long, broad scales 6
These scales on flagellomere V narrow 7

6(5). Basimere with from 6 to 8 long, prominent submarginal setae; internal process of the phallosome projecting beyond the apex of the dorsal process . . . . . *mammilifer* (p. 93)
Basimere with 3 long, prominent submarginal setae; internal process not projecting beyond the apex of the dorsal process. . . . *pholeter* (p. 103)

7(5). Basimere with a single row of long prominent, submarginal setae. . .8
Basimere with 2 irregular rows of long, prominent, submarginal setae 15

8(7). Flagellomere IX with a tuft of obviously modified dark, strong setae 9
Flagellomere IX without a tuft of obviously modified setae or with, at most, a few setae shorter than the rest, but not stronger or otherwise modified 13

9(8). Flagellomere VII with an internal tuft of from 3 to 5 gently sigmoid, specialized setae . . . . . *eukrines* (p. 85)
Flagellomere VII with an internal tuft of 5 or more strongly sigmoid or kinked, specialized setae 10

10(9). Lower mesepimeral bristle absent; flagellomere V with a tuft of from 1 to 4 very long, filamentous scales, their apices reaching beyond the tuft on flagellomere VIII . . . . . *bengalensis* (p. 82)
Lower mesepimeral bristle present; flagellomere V not as above. . .11

11(10). Flagellomere V with a tuft of long, yellowish hairs; distimere with 1 or 2 setae on the proximal third; subapical lobe of the basimere with the internal rod slightly expanded subapically, followed by a rather broad, gently curved, slightly sclerotized apex. . . . . *peytoni* (p. 100)

Flagellomere V with a tuft of short, narrow, seta-like scales; distimere without setae on the proximal third; subapical lobe of the basimere with the internal rod slightly expanded apically, then narrowing to a filamentous tip, often with a fine apical hook. . . . 12

12(11). Basal half of proboscis, distad of the joint, with a slightly swollen portion bearing numerous, long, curved hair-like, ventrolateral setae . . . . . *minor* form *bicornutus* (p. 99)
Proboscis not swollen and without ventrolateral setae. . . . . *minor* (p. 96)

13(8). Flagellomere V with a tuft of long, narrow, tapering, pointed scales, their apices reaching almost to the tuft on flagellomere VIII; flagellomere VIII with an internal tuft of strongly curved, specialized setae . . . . . *ganapathi* (p. 90)
Flagellomere V with a tuft of short, very narrow, acute scales, their apices, at most, reaching to the tuft on flagellomere VII; flagellomere VIII with an internal tuft of rather straight or gently curved, specialized setae. 14

14(13). Flagellomere VIII with an internal tuft of long, gently curved, specialized setae; internal process of the phallosome projecting beyond the apex of the dorsal process . . . . . *traubi* (p. 108)
Flagellomere VIII with an internal tuft of long, rather straight specialized setae; internal process of the phallosome not projecting beyond the apex of the dorsal process. . . . . *spiculosus* (p. 105)

15(7). Internal process of the phallosome projecting beyond the apex of the dorsal process. . . . . *fuscosiphonis* (p. 87)
Internal process of the phallosome not projecting beyond the apex of the dorsal process. . . . . *incomptus* (p. 81)

16(1). Basimere with a patch of prominent submarginal setae. . . . . *cinctellus* (p. 55)
Basimere with the prominent submarginal setae in a line. 17

17(16). Dorsal process of the phallosome with reticular markings on the entire surface; submarginal setae fine; flagellomeres V and VI without tufts of scales or specialized setae . . . . *infantulus* (p. 58)
Dorsal process of the phallosome smooth; submarginal setae strong; flagellomeres V and VI each with a tuft of scales or specialized setae. 18

18(17). Flagellomere V with a rather inconspicuous tuft of narrow, tapering, pointed scales; lower mesepimeral bristle absent; integument of the scutum often with a reddish tint. . . . . *rubithoracis* (p. 69)
Flagellomere V with a conspicuous tuft of broad scales; lower mesepimeral bristle present; integument of the scutum without a reddish tint 19

19(18). Flagellomere V with the more ventral scales rather long and expanded apically; abdominal sternum VII with white scales, markedly contrasting with the general dark integument and scaling on the other sterna . . . . . *alphus* (p. 53)
Tuft of scales on flagellomere V and abdominal scaling otherwise 20

20(19). Flagellomere V with 8 or more dorsal scales which are subequal and bluntly tipped 21
Flagellomere V with 6 or less dorsal scales which vary in length and are slightly pointed or acuminate 22

21(20). Basimere with 3 slightly curved, prominent submarginal setae; flagellomere VIII with an irregularly angulate tuft of scales which are kinked towards the apex . . . . . *variatus* (p. 72)
Basimere with 3 or 4 distinctly curved, prominent submarginal setae; scales of the tuft on flagellomere VIII only gently curved. . . *macdonaldi* (p. 61)

22(20). All scales in the tuft on flagellomere V acuminate; subapical lobe of the basimere with the internal rod expanded apically and with a scalloped margin . . . . . *reidi* (p. 66)
At most, some of these scales with a small short point; subapical lobe of the basimere with the internal rod slightly expanded apically but without a scalloped margin 23

23(22). Basimere with from 7 to 9 very long, strong, characteristically curved, submarginal setae; palpus with external basal process longer than segment I . . . . . *quadripalpis* (p. 65)
Basimere with 3 slightly curved, prominent submarginal setae; palpus with external basal process very inconspicuous, much shorter than segment I . . . . . *aculeatus* (p. 50)

KEY TO SPECIES OF THE SUBGENUS *LOPHOCERAOMYIA* IN THAILAND - FOURTH STAGE LARVAE[1]

1. Siphon shorter than saddle; antennal shaft cylindrical, not constricted beyond the insertion of antennal hair 1-A; mouthparts adapted for predation . . . . . *curtipalpis* (p. 76)
Siphon longer than saddle; antennal shaft constricted beyond insertion of antennal hair 1-A; mouthparts not adapted for predation 2

2(1). Head hair 4-C distinctly longer than the distance between the bases of the pair; abdominal hair 2-VIII single; thoracic hair 14-P bifid or trifid (except in *mammilifer* and *wilfredi*). . . . . (*mammilifer* subgroup) 3

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[1] The larvae of *lucaris* and *incomptus* are unknown.

Head hair 4-C shorter than the distance between the bases of the pair; abdominal hair 2-VIII bifid (except in *infantulus)*; thoracic hair 14-P single (except in *quadripalpis* and *infantulus)*. . . . . *(fraudatrix* group) 13

3(2). Comb consisting of 2 distinct types of scales, the posterior scales tapering to a point, the anterior scales fan-shaped. . . . . *minor* (p. 96)
All comb scales fan-shaped, fringed with fine, subequal spines 4

4(3). Head hair 6-C always single, somewhat flattened. . . *eukrines* (p. 85)
Head hair 6-C branched, usually cylindrical. 5

5(4). Siphon normally with 3 pairs of subventral tufts 6
Siphon normally with 4 pairs of subventral tufts 7

6(5). Thoracic hair 14-P single; head hairs 16, 17-C branched; abdominal hair 6-III usually with 4 branches. . . . . *mammilifer* (p. 93)
Thoracic hair 14-P bifid; head hairs 16, 17-C single, relatively long; abdominal hair 6-III usually with 3 branches . . . . . *bengalensis* (p. 82)

7(5). Thoracic hair 8-P usually branched, always short and simple; abdominal hair 6-I bifid. . . . . *pholeter* (p. 103)
Thoracic hair 8-P usually single, always long; abdominal hair 6-I trifid. 8

8(7). Subventral tufts of the siphon fine, the length of the proximal tuft less than the basal width of the siphon. 9
Subventral tufts of the siphon strong, the length of the proximal tuft at least equal to the basal width of the siphon, usually longer 10

9(8). Head hairs 16, 17-C absent; thoracic hair 14-P usually bifid; integument of the siphon dark brown . . . . . *fuscosiphonis* (p. 87)
Head hairs 16, 17-C represented by minute, bifid spicules; thoracic hair 14-P single; integument of siphon not exceptionally dark brown . . . . . *wilfredi* (p. 110)

10(8). Thoracic integument covered with fine spicules; abdominal integument mostly smooth; median caudal filament not developed. 11
Thoracic and abdominal integuments both covered with numerous spicules; median caudal filament short, but distinct. 12

11(10). Head hair 1-C usually expanded on the basal half, then narrowing or sometimes branched on the distal half; each pecten tooth fringed with subequal lateral denticles. . . . . *ganapathi* (p. 90)
Head hair 1-C never expanded on the basal half as indicated above; each pecten tooth with from 1 to 3 proximal lateral denticles much larger than the rest . . . . . *peytoni* (p. 100)

12(10). Subventral tufts of the siphon finely pectinate; head hair 5-C bifid or trifid; saddle with fine spicules on the distal margin. . . . . *spiculosus* (p. 105)
Subventral tufts of the siphon simple; head hair 5-C usually with 3 or 4 branches; saddle with stronger spines on the distal margin. . . *traubi* (p. 108)

13(2). Comb with a strongly differentiated posterior row of long scales; head hair 5-C weak, its branches noticeably finer than those of 6-C and extending only a little past the anterior margin of the head . . . . . *alphus* (p. 53)
Posterior row of comb scales not strongly differentiated; head hair 5-C with branches about as stout as those of 6-C and extending well past the anterior margin of the head 14

14(13). Head hair 9-C much longer than 8-C, with spreading branches which reach almost to the level of hair 7-C . . . . . *macdonaldi* (p. 61)
Head hair 9-C normal, shorter, or not much longer than 8-C 15

15(14). Head hair 5-C with 3 or 4 branches . . . . . *cinctellus* (p. 55)
Head hair 5-C bifid 16

16(15). Abdominal hair 7-I single 17
Abdominal hair 7-I branched 18

17(16). Thoracic hair 3-P with from 4 to 10 branches; 4-P bifid; thoracic integument strongly spiculate . . . . . *rubithoracis* (p. 69)
Thoracic hair 3-P usually single (occasionally bifid); 4-P single; thoracic integument glabrous . . . . . *reidi* (p. 66)

18(16). Thoracic hair 4-P usually single 19
Thoracic hair 4-P branched 20

19(18). Pecten teeth, particularly the proximal ones, with strong basal denticles; thoracic hair 3-P often single, pectinate. . . . . *quadripalpis* (p. 65)
Pecten teeth with a coarse fringe, but without strongly differentiated basal denticles; thoracic hair 3-P usually bifid, simple. . . . . *aculeatus* (p. 50)

20(18). Thoracic hair 14-P single; 3-P single or at most bifid; head hair 4-C often with 3 or more branches; abdominal hair 2-VIII bifid . . . . . *variatus* (p. 72)
Thoracic hair 14-P bifid; 3-P often with 2 or 3 branches; head hair 4-C often single, at most bifid; abdominal hair 2-VIII single . . . . . *infantulus* (p. 58)

FRAUDATRIX GROUP

FEMALE. In general, the scales on wing veins R_2 and R_3 are rather

broad and clavate, particularly towards the apex; otherwise inseparable from members of the *mammilifer* group.

MALE. *Head.* Torus of the antenna normal, symmetrical, without a protuberance on the inner surface; length of the palpus usually greater than that of the proboscis, the palpus with distinct but small basal processes; proboscis usually with long dorsal setae and a series of strong basoventral bristles. *Terminalia.* Subapical lobe of the basimere usually with the internal and external leaflets well developed, subequal in size and shape; lateral plate of the phallosome consisting of the dorsal process only.

LARVA. *Head.* Length of 4-C less than the distance between the bases of the pair. *Thorax.* Hair 14-P single (except in *quadripalpis* and *infantulus). Abdomen.* Hair 2-VIII bifid (except in *infantulus);* siphon with 4 pairs of subventral tufts (occasionally 9 individual tufts may be present); central filament of the siphon valves well developed.

DISTRIBUTION. Species of the *fraudatrix* group are distributed throughout the range of the subgenus. In Thailand, members of this group are undoubtedly present in every changwat.

TAXONOMIC DISCUSSION. The characters outlined above for the male and fourth stage larva clearly separate the *fraudatrix* group from the *mammilifer* group. The one distinctive feature of the adult female, although usually valid, is nebulous and should not be considered definitive.

Within the group, no definite species complexes such as those found in the *mammilifer* group, are readily apparent; however, *variatus* does exhibit extremely close relationships with *macdonaldi,* and with *whartoni* and *cubitatus* from Malaya. Similarities also seem to be shared by *quadripalpis* and *aculeatus.* Except for *cinctellus* and *infantulus,* both of which exhibit narrow, pale, basal abdominal bands, the adult females are extremely similar and cannot be conclusively recognized at the present time.

CULEX (LOPHOCERAOMYIA) ACULEATUS COLLESS 1965
(Figure 13)

Culex (Lophoceraomyia) aculeatus Colless 1965, J. med. Ent. 2: 286 (♂*, ♀, L*).

The adult male may be recognized by the presence of 7 or less dorsal scales on flagellomere V, by the presence of 3 curved submarginal setae on the basimere of the male terminalia, and by the short external basal processes of the male palpus. The fourth stage larva may be distinguished by abdominal hair 7-I being branched, thoracic hair 4-P single, and by the absence of exceptionally strong basal denticles on the pecten tooth.

FEMALE. *Head.* Proboscis with a pair of prominent basoventral bristles and a pair of smaller setae between them. *Thorax.* Integument of

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Figure 13. *C. (Lophoceraomyia) aculeatus.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through X.

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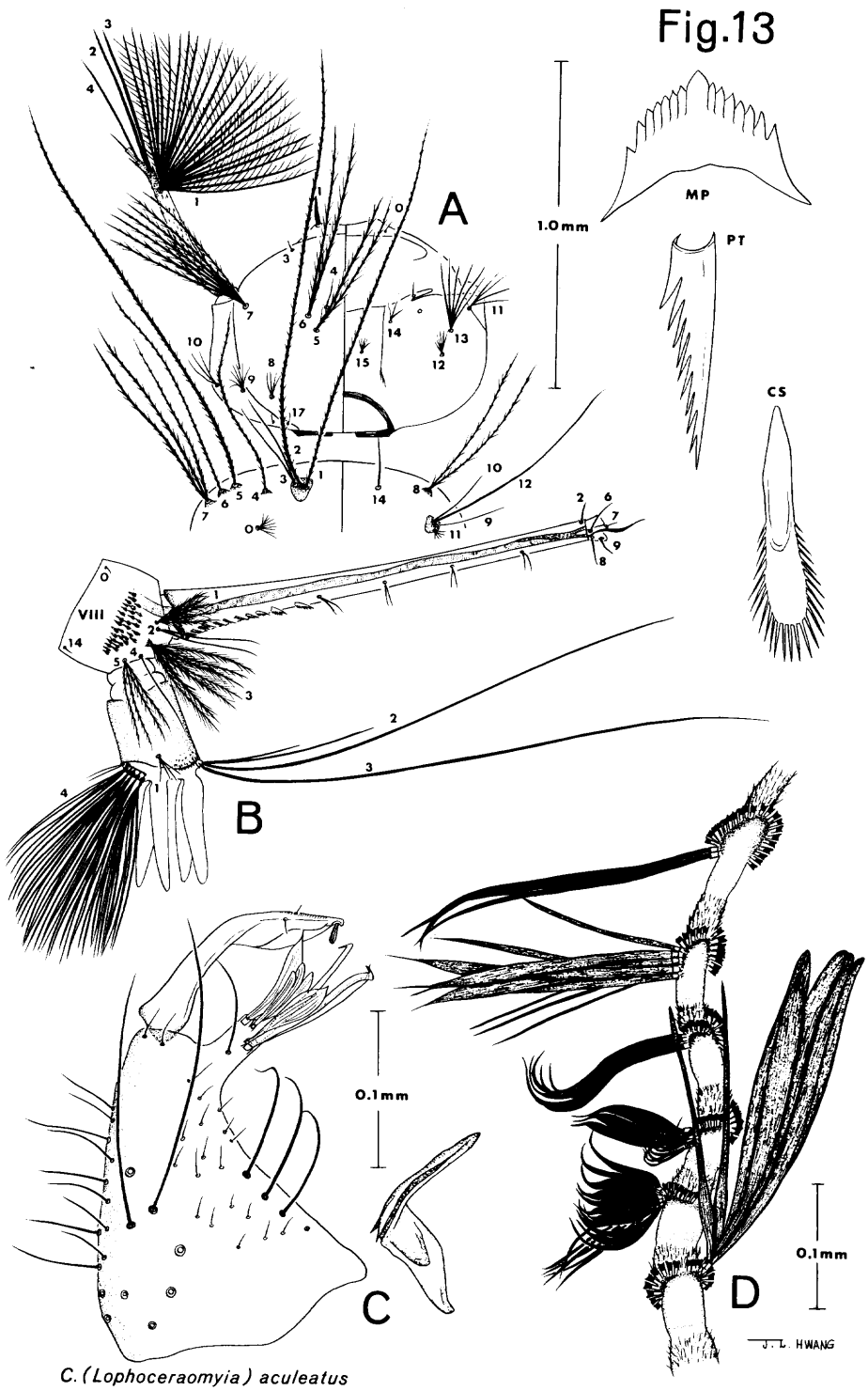


C. (Lophoceraomyia) aculeatus

the pleuron uniformly pale, occasionally with dark, indistinct patterns; 1 lower mesepimeral bristle present. *Abdomen.* Terga covered with dark brown scales; sterna dull brown, but lighter than the terga.

MALE. *Head.* Proboscis with inconspicuous, short, dorsal setae and approximately 10 fine basoventral setae; basal processes of the palpus weak, fine and inconspicuous, shorter than segment I. *Antenna.* (Figure 13D). Flagellomere V with a tuft of 2 or 3 broad scales which are blunt or slightly pointed apically followed by 2 or 3 broad, pointed scales of decreasing length and 1 or 2 narrow, long, rather slender scales; VI with an internal tuft of 10 or more short, dark, stout and twisted spines; VII with a similar, but shorter tuft of spines and a tuft of 3 very broad spines; VIII with a tuft of 5 or more long, prominent spines which are gently curved distally; IX with a series of straight, lanceolate, though narrow, leaflets; X with a tuft of from 3 to 5 strong, straight setae. *Terminalia.* (Figure 13C). Basimere with 3 gently curved submarginal setae inserted in a line; subapical lobe of the basimere with the basal rods subequal in length with the internal rod moderately expanded; internal and external leaflets subequal in size, approximately symmetrical, the internal leaflet with a fine apical filament; with up to 6 closely placed accessory setae which are subequal in length, difficult to distinguish (only 3 clearly shown in illustration); distimere normal in shape, with minute annulations on the convex surface of the apical fifth; dorsal process of the lateral plate of the phallosome strongly recurved and pointed.

LARVA. (Figure 13A, B). *Head.* Antenna with a narrow dark basal ring and progressively darker beyond insertion of hair 1-A; head hair 4-C single or with up to 4 branches, simple; 5, 6-C bifid, pectinate, subequal in length; 16, 17-C represented by fine, relatively well developed spicules. *Thorax.* Integument glabrous (occasionally appearing granulose or minutely spiculose); 3-P usually bifid (occasionally single or trifid), shorter and slenderer than 1, 2-P, superficially simple, but with extremely fine lateral barbs (not illustrated); 4, 5, 6-P single, pectinate; 7-P bifid or trifid, pectinate; 8-P bifid, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; hair 7-I branched; comb consisting of from 30 to 45 fan-shaped scales arranged in a broad triangular patch; siphon index variable, ranging from 7:1 to 10:1 (average, 7.8:1), the siphon occasionally with a broad median dark band (not illustrated); 4 pairs of subventral tufts inserted in a line on the siphon; individual tufts with 2 or 3 branches, their length approximately equal to the width of the siphon at the point of insertion; pecten consisting of from 10 to 12 teeth restricted to the basal third or less of the siphon; individual pecten tooth with a fine apical spine and from 7 to 10 lateral barbs which are progressively, but evenly, enlarged from apex to base.

TYPE DATA. Holotype male of *aculeatus* (associated larval and pupal skins and terminalia and antenna slide-mounted) from Perak, Malaya in the Australian National Insect Collection, Canberra, Australia.

DISTRIBUTION. In THAILAND**, *aculeatus* has been studied from: *Chiang Mai, Krung Thep, Lampang, Nakhon Si Thammarat, Narathiwat, Ranong, Songkhla, Tak, Trang,* and *Yala.* In MALAYA the species was recorded by Colless (1965) from Bukit Tunggal, *Perak* (the type locality) and Ampang and Ulu Gombak, *Selangor.*

During this study the following material was examined: 1 adult female (a paratype); 1 adult male with associated larval and pupal skins (a paratype),

as well as 8 males with their associated terminalia and antennae, and 23 fourth stage larvae.

TAXONOMIC DISCUSSION. As indicated previously, *aculeatus* and *quadripalpis* demonstrate close affinity in all stages but may be distinguished by anatomical features of the adult male and the fourth stage larva.

BIOLOGY. In Thailand, larvae have been collected from slow flowing streams, rock pools, ground pools, stream pools, and seepage areas. Biology of the adults is virtually unknown, but they have been taken by sweeping foliage in the jungle and at light traps. Colless (1965) has suggested that it is possible that the females may occasionally attack man in jungle foliage.

CULEX (LOPHOCERAOMYIA) ALPHUS COLLESS 1965
(Figure 14)

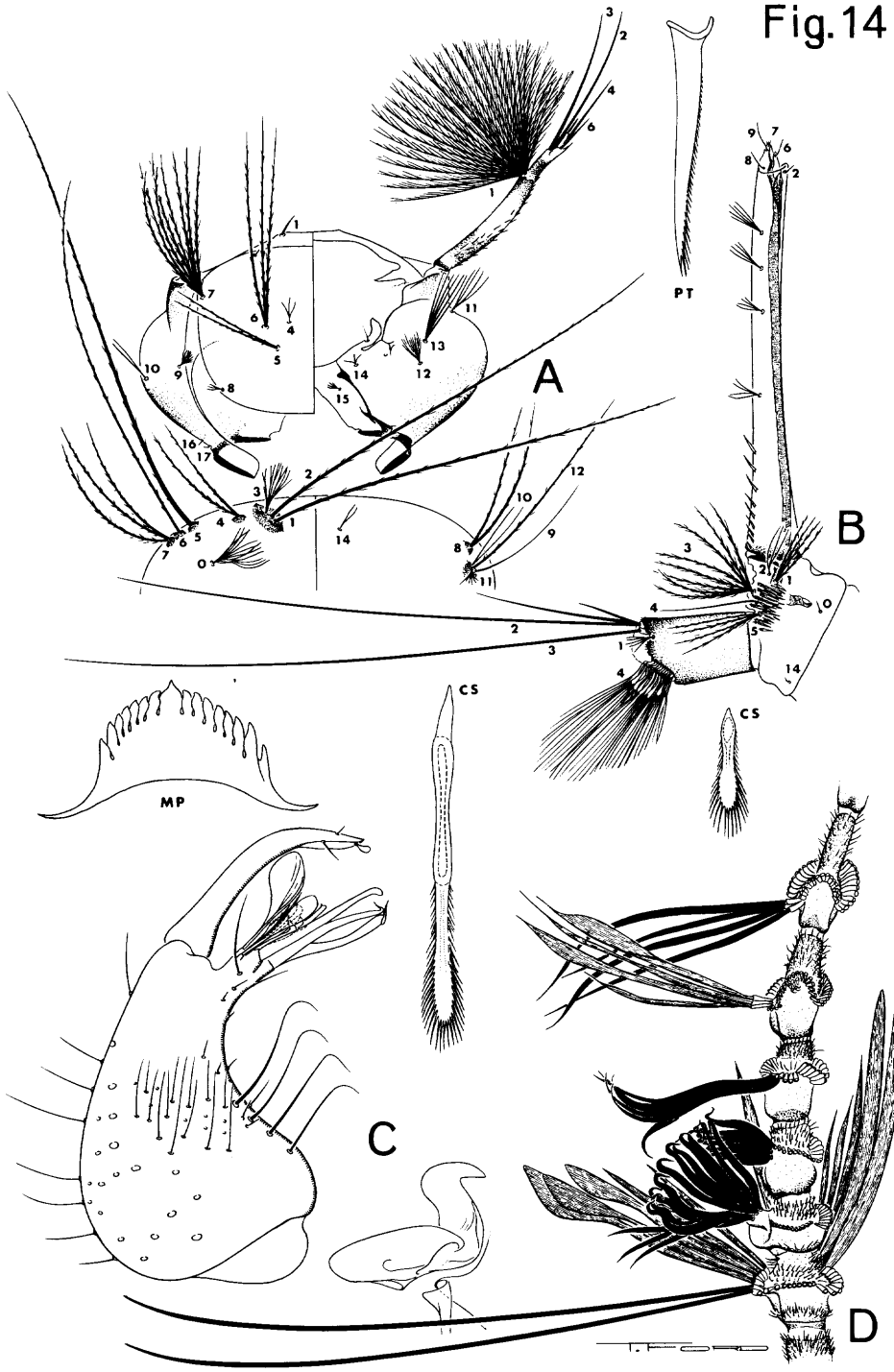
Culex (Lophoceraomyia) alphus Colless 1965, J. med. Ent. 2: 283 (♂*, ♀, L*).

The adult female may be recognized by the presence of a ventral transverse row of 5 or more strong bristles at the base of the proboscis (some of which project laterally). The adult male exhibits a distinctive scale tuft on flagellomere V and abdominal sternum VII is covered with white scales which contrast with the dark integument and scaling of the other sterna. In the fourth stage larva the comb possesses a strongly differentiated posterior row of long scales and head hair 5-C is weak, its branches noticeably finer than those of 6-C and extending only a little past the anterior margin of the head.

FEMALE. *Head.* Proboscis with 3 pairs of prominent basoventral bristles and a pair of smaller setae between them. *Thorax.* Integument of pleuron uniformly dark brown; 1 lower mesepimeral bristle present; anterior surface of hind femur completely pale proximally, dark distally. *Abdomen.* Terga dark, with a slight mixture of light and dark scales on the lateral margins of terga VI and VII; sterna completely white.

MALE. *Head.* Proboscis with numerous hairs on the distal 2/3 of the dorsal surface and with about 10 basoventral bristles present. *Antenna.* (Figure 14D). Flagellomere V with a tuft of broad, bluntly rounded scales which extend to IX followed by 4 or 5 narrow, short, pointed scales, and then 2 to 4 longer scales which have a rather narrow base but are noticeably expanded at the apex; VI with an internal tuft of 10 or more short, dark, stout and twisted spines; VII with a similar, but shorter tuft of spines; VIII with a tuft of 6 or more long, prominent spines which are gently curved distally; IX with a tuft of sharply pointed, lanceolate leaflets; X with from 3 to 5 strong, straight setae. *Abdomen.* Sternum VII with white scaling which sharply contrasts with the general dark color of the other abdominal segments. *Terminalia.* (Figure 14C, after Colless 1965). Basimere with 4 long and apically curved submarginal setae; subapical lobe of the basimere with the rods subequal in length, the internal rod slightly expanded apically; internal and external leaflets broad, the internal leaflet asymmetrical; 6 accessory setae blade-like and of varying lengths, 1 of which exhibits a serrate edge; distimere normal, without annulations; dorsal process of the lateral plate of the phallosome short, strongly recurved, and directed inwards as well as dorsally.

Fig.14



C. (Lophoceraomyia) alphus

LARVA. (Figure 14A, B). *Head.* Antenna slightly darker than the head capsule and with a narrow, dark basal ring and dark beyond insertion of hair 1-A; head hair 4-C with from 3 to 6 branches, simple, its length considerably less than the distance between the bases of the pair; 5-C bifid, pectinate, its branches noticeably finer than 6-C, extending only a little past the anterior margin of the head; 6-C bifid or trifid, pectinate, considerably longer and broader than 5-C, more than half its length projecting beyond the anterior margin of the head. *Thorax.* Integument glabrous; hair 3-P considerably shorter than 1, 2-P, with 6 to 8 branches; 4-P bifid, pectinate, inserted close to 3-P, weak and smaller than the other prothoracic hairs; 5, 6-P single, pectinate; 7-P trifid, pectinate; 8-P bifid, pectinate; 14-P single or bifid, simple; 0-P dendritic, very large, usually longer than 4-C. *Abdomen.* Integument glabrous; comb consisting of approximately 20 fan-shaped scales arranged in 2 irregular rows; the scales of the posterior row elongated, with long basal attachments, those of the anterior row short; siphon index approximately 7:1; 4 pairs of subventral tufts inserted in a line on the siphon; individual tufts with from 2 to 6 branches, their length greater than the width of the siphon at the point of insertion; pecten consisting of from 8 to 10 teeth restricted to the basal third of the siphon; individual pecten tooth consisting of a strong spine without lateral barbs, but with a very fine lateral fringe.

TYPE DATA. Holotype male (associated larval and pupal skins and terminalia and antenna slide-mounted) from Kg. Sijangkang, Selangor, Malaya in the Australian National Insect Collection, Canberra.

DISTRIBUTION. In THAILAND**, a single male has been collected from *Narathiwat* at a light trap. Colless (1965) reported examining specimens from SINGAPORE and *Selangor*, MALAYA and NORTH BORNEO.

In addition to the specimen from Thailand, the author has examined the paratype series in the British Museum, and it is from these specimens that the above description has been prepared.

TAXONOMIC DISCUSSION. This species is extremely characteristic and there should be no difficulty in identifying either the adult male (with or without antenna mounted) or the fourth stage larva.

BIOLOGY. Larvae have been collected on one occasion from a shaded well. Males have been collected at light traps and resting in secondary jungle.

CULEX (LOPHOCERAOMYIA) CINCTELLUS EDWARDS 1922
(Figure 15)

Lophoceratomyia taeniata Leicester 1908, Cul. Malaya: 127 (preoccupied by Wiedemann 1828).

Culex (Lophoceratomyia) cinctellus Edwards 1922, Indian J. med. Res. 10:

Figure 14. *C. (Lophoceraomyia) alphus.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia (after Colless 1965); D, lateral aspect of male antennal flagellomeres V through X.

281 (new name for *taeniata* Leicester); Barraud 1924, Indian J. med. Res. 12: 42 (♂*); Barraud 1934, Fauna Brit. India, Diptera 5: 366 (adult only).

Culex (Lophoceraomyia) cinctellus Edwards: Colless 1965, J. med. Ent. 2: 277 (♂*, ♀, L*); Delfinado 1966, Mem. Amer. ent. Inst. 7: 103 (♂*).

The adult female may be recognized by the basal banding of the abdominal terga and the predominantly dark decumbent scales of the vertex. The male is distinctive in that the submarginal setae of the basimere are inserted in a group rather than in a straight line. The fourth stage larva is separated from other members of the *fraudatrix* group by the presence of a 3 or 4 branched head hair 5-C.

FEMALE. *Head.* Decumbent scales of the vertex dark brown, becoming pale immediately adjacent to the orbital line. *Thorax.* Scutum and midlobe of the scutellum sparsely covered with reddish brown scales; 1 strong lower mesepimeral bristle present; anterior surface of the hind femur pale, with a very broad, dark apical band which extends proximally as a narrow dark stripe along the dorsal border. *Abdomen.* Terga dark brown, with narrow, complete pale basal bands; sterna pale brown.

MALE. *Head.* Proboscis with rather long dorsal setae and a linear series of strong basoventral setae; palpus with very short, inconspicuous basal processes. *Antenna.* (Figure 15D). Flagellomere V with a prominent tuft of from 3 to 5 dark, blade-like, sharply pointed scales which extend to VIII, accompanied by 1 to several strong, very long setae; VI with an internal tuft of 10 or more short, dark, stout and twisted spines; VII with a similar, but shorter, tuft of spines and a supplementary tuft of 3 longer, broader spines; VIII with a tuft of 7 or more long, prominent spines which are gently curved; IX with a tuft of sharply pointed, lanceolate leaflets as well as several strong, straight setae; X with a tuft of from 2 to 5 strong, straight setae. *Terminalia.* (Figure 15C). Basimere with 14 or more strong submarginal setae inserted in a conspicuous patch; subapical lobe of the basimere with the rods subequal in length and thickness, the internal rod expanded distally; internal and external leaflets broad, the apex of the internal leaflet with an extended point; accessory setae rather broad and prominent; distimere noticeably expanded throughout, with minute annulations at the apex; dorsal process of the lateral plate of the phallosome angulate and sharply pointed.

LARVA. (Figure 15A, B). *Head.* Antenna with a narrow, dark basal band and more darkly pigmented beyond insertion of hair 1-A; head hair 4-C simple, with from 2 to 4 branches; 5-C 3 or 4 branched, pectinate; 6-C bifid, pectinate; 16, 17-C represented by minute spicules. *Thorax.* Integument superficially glabrous, but with some very fine spiculation on the anteriolateral surface of the prothorax (not illustrated); hair 3-P considerably shorter

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Figure 15. *C. (Lophoceraomyia) cinctellus.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through X.

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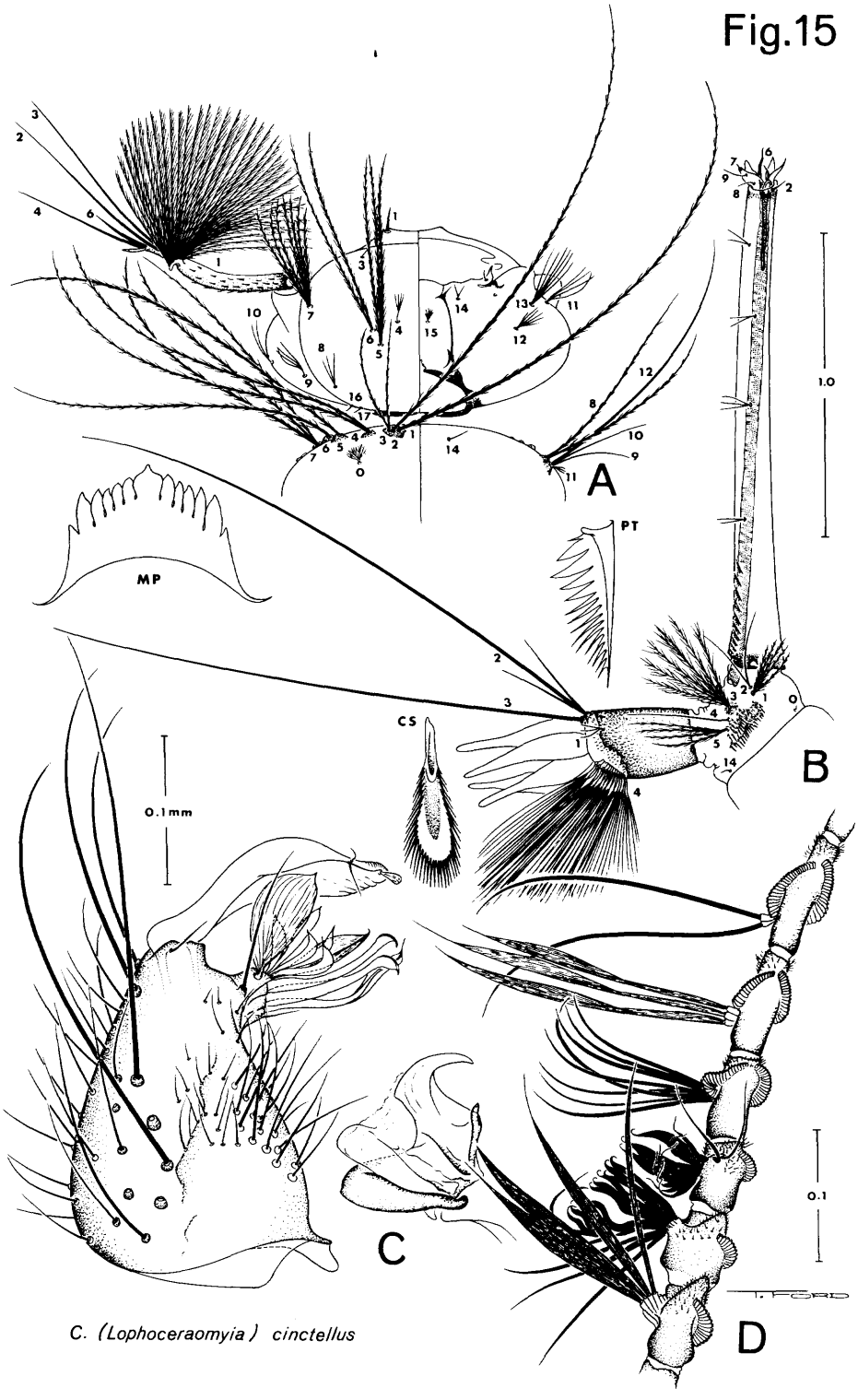
Fig.15



C. (Lophoceraomyia) cinctellus

and slenderer than 1,2-P, with from 2 to 4 pectinate branches; 4-P bifid, pectinate; 5,6-P single, pectinate; 7-P with 3 or 4 branches, pectinate; 8-P bifid, pectinate; 14-P single, simple. *Abdomen*. Integument glabrous; comb consisting of from 40 to 50 fan-shaped scales arranged in a broad, triangular patch; siphon index approximately 8:1; 4 pairs of subventral tufts inserted in a line on the siphon; individual tufts 2 or 3 branched, simple, their length less than the width of the siphon at the point of insertion; pecten consisting of from 8 to 11 teeth restricted to the basal fourth or less of the siphon; individual pecten tooth with a fine distal spine and from 11 to 14 very fine lateral barbs.

TYPE DATA. Lectotype male (terminalia mounted on a celluloid point) of *taeniata* from Kuala Lumpur, Malaya in the British Museum.

DISTRIBUTION. In THAILAND**, this species has been collected from *Chon Buri* and *Khon Kaen*. The species is also known from MALAYA, INDIA, BORNEO, INDONESIA, HAINAN, and the PHILIPPINES.

Twelve males and their associated terminalia and antennae have been studied from Thailand. One male and 1 female with their associated larval skins have been seen from Malaya and it is from these skins that the larval description was prepared.

TAXONOMIC DISCUSSION. Due to the pale, basal abdominal banding, *cinctellus* appears to have its closest affinity to *infantulus*. The male terminalia and antennal modifications of the 2 species are quite distinctive; however, Delfinado (1966) has pointed out that *cinctellus* and *fulleri* (Ludlow) from the Philippines cannot be separated on the basis of the male antenna and terminalia, but *fulleri* does not exhibit the pale basal bands on the abdominal terga.

BIOLOGY. In Thailand, adult males have been collected only at light traps and resting in a bamboo forest during the months of October and November. Colless (1959a) has suggested that adults of this species feed largely on birds, but occasionally man serves as a host. In Malaya larvae were collected in shaded ground pool waters and stream margins in or near forests.

CULEX (LOPHOCERAOMYIA) INFANTULUS EDWARDS 1922
(Figure 16)

Culex (Lophoceratomyia) infantulus Edwards 1922, Indian J. med. Res. 10: 287 (♂); Baisas 1935, Philipp. J. Sci. 57: 174 (♂*); Edwards 1935, Bull. ent. Res. 26: 131 (L); Causey 1937, Amer. J. Hyg. 25: 416 (distribution); LaCasse and Yamaguti 1950, Mosq. Fauna Japan and Korea: 197 (♂*, ♀*, L*, P*).

Culex (Lophoceratomyia) parainfantulus Menon 1944, J. Malar. Inst. India 5: 389 (♂*, ♀*); Mattingly 1949, Proc. R. ent. Soc. Lond. (B) 18: 224 (synonymy).

Culex (Lophoceraomyia) infantulus Edwards: Bohart 1945, Navmed 580: 75 (♂, L); Bohart and Ingram 1946, Navmed 1055: 73 (♂*, ♀, L*, P*); Iyengar and Menon 1955, Bull. ent. Res. 46: 10 (L*); Peters and Dewar 1956, Indian J. Malar. 10: 46 (L); Delfinado 1966, Mem. Amer. ent. Inst. 7: 106 (♂*).

The presence of pale basal abdominal bands clearly separates the adult

female from most other members of the subgenus. The male is recognized by the reduced number of modified setae on the antennal flagellum and the reticulate dorsal process of the phallosome. The fourth stage larva exhibits thoracic hair 3-P with 2 or 3 branches, 4-P branched, and 14-P bifid.

FEMALE. *Thorax.* Integument of the pleuron dark brown; 1 strong lower mesepimeral bristle present; wings with the outstanding scales of veins R2 and R3 clavate, but not as broad as in most other species of the *fraudatrix* group. *Abdomen.* Terga and sterna dark brown, with narrow, complete pale basal bands (in some specimens these bands may be represented by a single row of pale scales).

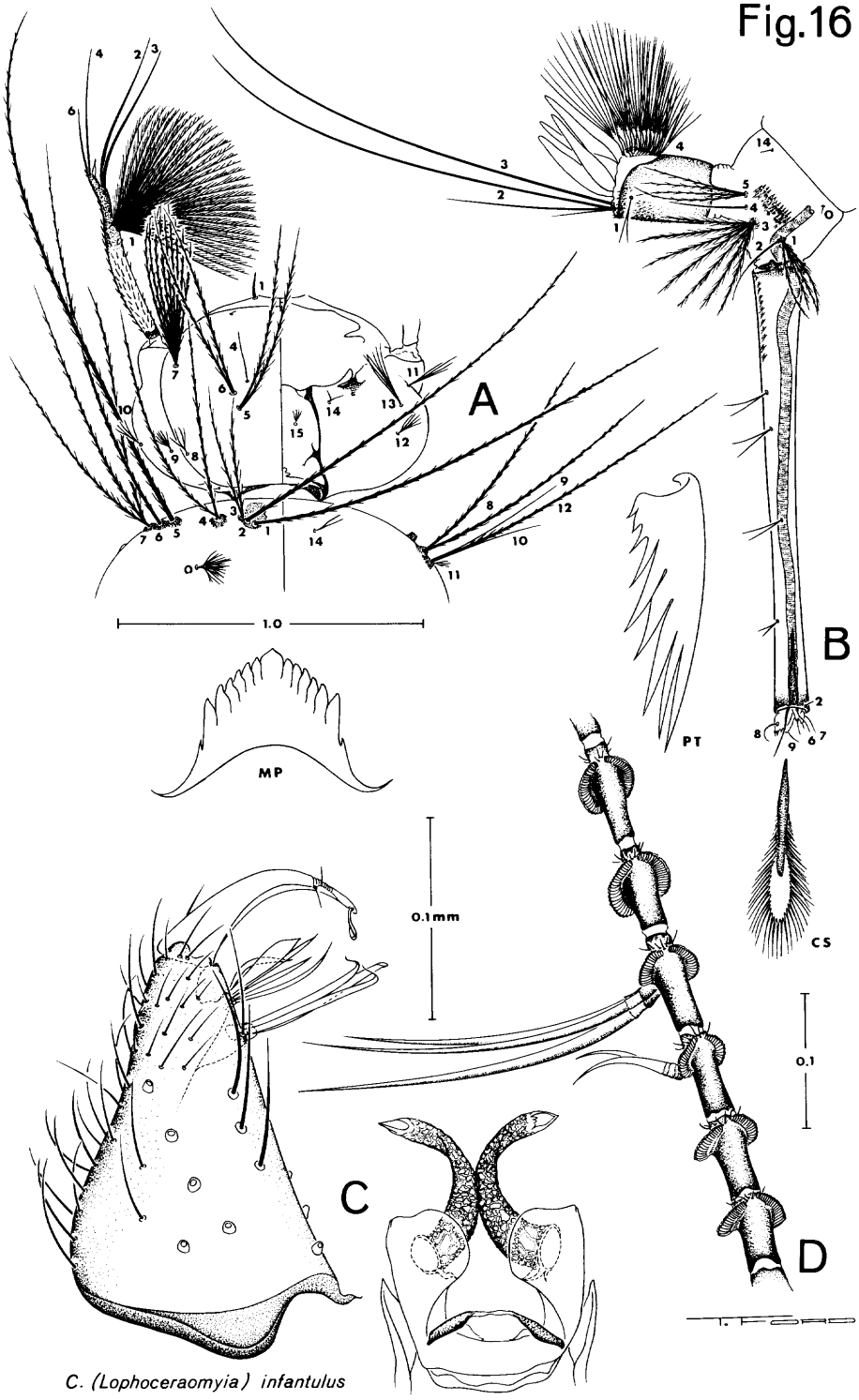
MALE. *Head.* Proboscis without exceptionally long dorsal or ventral hairs; palpus with very short, inconspicuous basal processes. *Antenna.* (Figure 16D). Flagellomeres V, VI, IX, and X without modified setae or scales; VII with a tuft of 1 or 2 very broad, dark setae and often with several narrow, pointed setae of similar length; VIII with from 3 to 5 broad, long and gently curved setae. *Terminalia.* (Figure 16C). Basimere with 3 fine submarginal setae inserted in a straight row; subapical lobe of the basimere with the internal, central, and external rods subequal in length and width, hooked apically; accessory setae reduced in size and number; internal leaflet very short, bladelike, external leaflet somewhat broader; distimere normal; dorsal process of the lateral plate of the phallosome rather broad, gently curved and pointed, exhibiting a distinctive reticular pattern over its entire surface.

LARVA. (Figure 16A, B). *Head.* Antenna with a narrow, dark basal band and somewhat darker beyond insertion of hair 1-A; head hair 4-C single, simple, its length approximately equal to or slightly shorter than the distance between the bases of the pair; 5, 6-C bifid, pectinate, subequal in length; 16, 17-C represented by minute, short spicules which are easily overlooked even in good preparations. *Thorax.* Integument glabrous; hair 3-P bifid, pectinate, the branches slenderer and shorter than 1, 2-P; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P trifid, pectinate; 8-P bifid, pectinate; 14-P bifid, simple. *Abdomen.* Integument glabrous; hair 7-I branched; 2-VIII single; comb consisting of from 30 to 50 fan-shaped scales arranged in a broad triangular patch; siphon index variable, ranging from 9:1 to 11.6:1 (average, 10:1); a rather broad median dark band occasionally present on the siphon (not illustrated), if present not as dark as the basal ring; 4 pairs of subventral tufts inserted in a line on the siphon; individual tufts usually bifid (occasionally trifid), their length equal to or less than the width of the siphon at the point of insertion; pecten consisting of from 12 to 17 teeth restricted to the basal fourth or less of the siphon; individual pecten tooth with a fine distal spine and from 5 to 8 lateral barbs.

TYPE DATA. Holotype male (terminalia mounted and attached to pin) of *infantulus* from Hong Kong in the British Museum. The type locality of *parainfantulus* is Trivandrum, Travancore, India, but the location of the type specimen is unknown.

DISTRIBUTION. In THAILAND, *infantulus* has been collected from: *Ayutthaya, Chanthaburi, Chiang Mai, Chon Buri, Nakhon Ratchasima, Nan, Pathum Thani, Phattalung, Prachin Buri, Ranong, Satun, Songkhla, Tak, Trang,* and *Udon Thani.* The species has also been recorded from CHINA, JAPAN, RYUKYU-RETTO, INDIA, CEYLON, NEPAL, MALDIVE ISLANDS, INDOCHINA, JAVA, and the PHILIPPINES. Specimens have also been ex-

Fig.16



C. (Lophoceraomyia) infantulus

amined in the British Museum from Rangoon, BURMA** (xii 1962, P. F. Mattingly).

During this study 9 individual rearings have been examined as well as 11 males, 2 females, and 40 larvae.

TAXONOMIC DISCUSSION. The pale basal abdominal bands of the adult female distinguish this species from all other members of the *fraudatrix* group except *cinctellus;* these species may be distinguished, however, on the basis of the narrow decumbent scales of the vertex which are uniformly pale in *infantulus* and predominantly dark in *cinctellus*. The male of *infantulus* is separated from all other members of the subgenus by the absence of specialized scales or setae on antennal flagellomeres V, VI, IX, and X, and by the reticular pattern on the dorsal process of the phallosome. The larva demonstrates its closest affinity to *variatus* but may be separated on the basis of head hair 4-C which is usually single in *infantulus* and branched in *variatus*, and thoracic hairs 3, 14-P which are usually bifid in *infantulus* and single in *variatus;* the larva of *infantulus* is the only member of the *fraudatrix* group in which abdominal hair 2-VIII is single.

BIOLOGY. In Thailand, larvae of this species have been collected from a wide variety of both ground water and container habitats. Collections have been made from ground pools, ditches, pools in dry stream beds, tree holes, a jar, rock pools, bamboo internodes, and small crab holes next to a stream. Nothing is known of the adult biology, but the females have never been reported biting man.

CULEX (LOPHOCERAOMYIA) MACDONALDI COLLESS 1965
(Figure 17)

Culex (Lophoceraomyia) macdonaldi Colless 1965, J. med. Ent. 2: 276 (♂*, ♀, L*); Delfinado 1966, Mem. Amer. ent. Inst. 7: 108 (♂*, L*, P*).

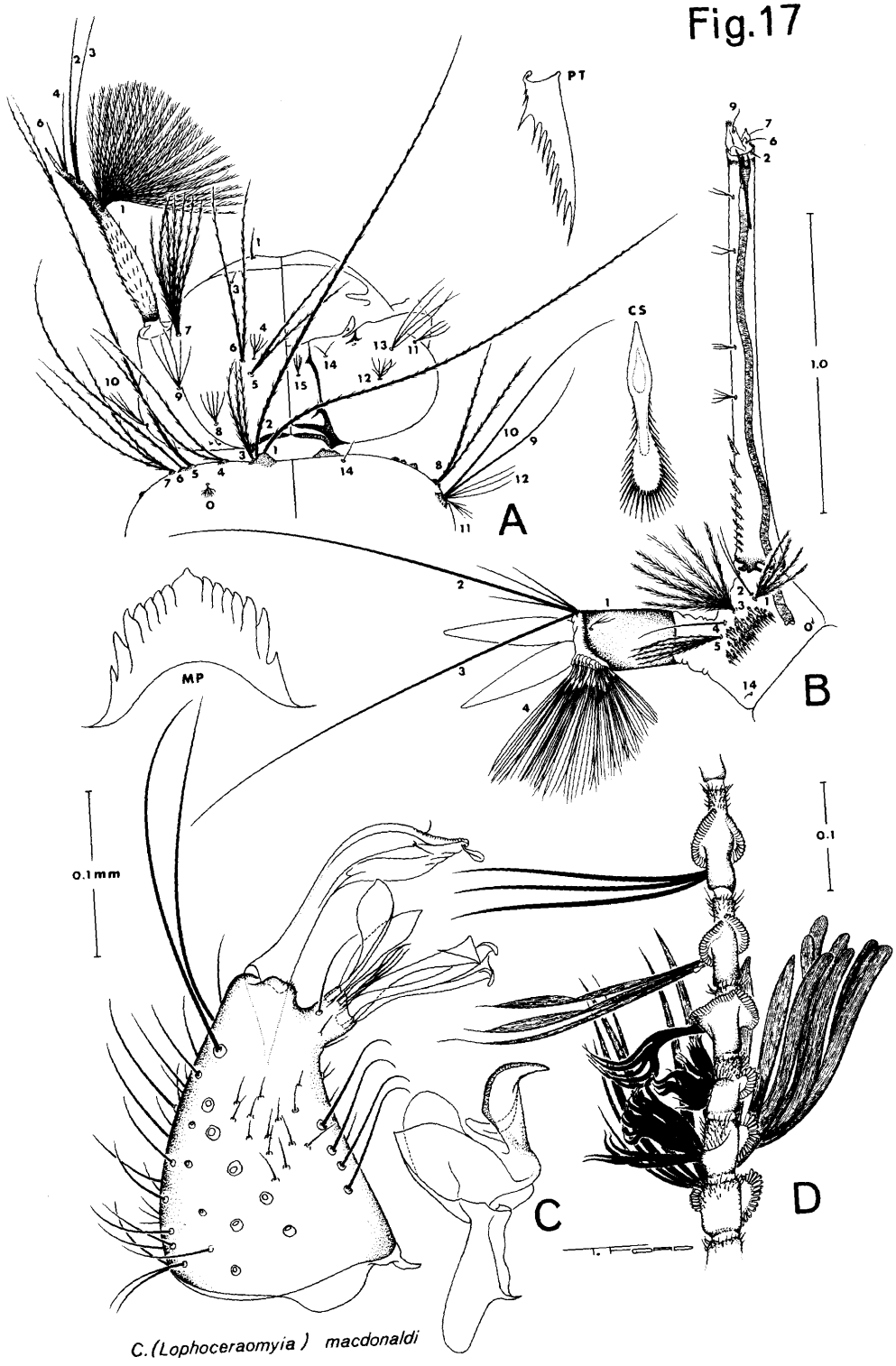
The adult male is recognized by the long basal processes of the palpus and the nature of antennal flagellomere V. The larva is immediately recognized on the basis of head hair 9-C which is much larger than 8-C.

FEMALE. Specimens not available for study.

MALE. *Head.* Proboscis with rather long, straight dorsal setae and several fine basoventral setae; palpus with long basal processes which extend beyond the apex of palpal segment II. *Antenna.* (Figure 17D). Flagellomere V with from 9 to 12 long, dark, blunt, striated scales dorsally and approximately 8 shorter, broad, striated, pointed scales which appear darker on their basal halves; VI with a tuft of 13 or more short, stout, dark and twisted spines; VII with a similar but shorter tuft; VIII with a tuft of 5 or more broad, long spines which are gently curved; IX with from 3 to 5 finely pointed lanceolate leaflets as well as several stout setae; X with an internal tuft of 3 or 4

Figure 16. *C. (Lophoceraomyia) infantulus*. A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the male terminalia; D, lateral aspect of male antennal flagellomeres V through X.

Fig.17



C.(Lophoceraomyia) macdonaldi

straight, strong, long setae. *Thorax*. Integument of the pleuron pale brown; 1 strong lower mesepimeral bristle present; anterior surface of the hind femur predominantly dark, with a small basoventral pale area. *Abdomen*. Terga dark, sterna paler. *Terminalia*. (Figure 17C). Basimere with 4 or 5 strong, submarginal setae inserted in a straight row; subapical lobe of the basimere with the basal rods subequal in length and thickness, the central rod somewhat expanded distally; accessory setae narrow, indistinct; the internal and external leaflets subequal in size and shape; distimere expanded and annulate on the apical half; dorsal process of the lateral plate of the phallosome rather short, pointed, and sharply bent, the posterior angle smooth.

LARVA. (Figure 17A, B). *Head*. Antenna with a narrow, dark, basal band and darkly pigmented beyond insertion of hair 1-A; head hair 4-C short, with from 2 to 5 branches; 5, 6-C bifid, pectinate, subequal in length; 9-C with from 4 to 6 long branches, much longer than 8-C and almost reaching to the base of 7-C; 16, 17-C represented by minute spicules. *Thorax*. Integument glabrous; 3-P considerably shorter and slenderer than 1, 2-P, with from 2 to 4 branches; 4-P bifid, pectinate; 5, 6-P single, pectinate, 5-P branched at the apex; 7-P trifid, pectinate; 8-P bifid, pectinate; 12-P with 3 short branches (in contrast to the usual single, very long branch); 14-P single, simple. *Abdomen*. Integument glabrous; comb consisting of from 35 to 45 fan-shaped scales arranged in a broad triangular patch; siphon index variable, ranging from 7:1 to 9:1; 4 pairs of subventral tufts inserted in a line on the siphon; individual tufts either single or with up to 4 branches, simple, their length less than the basal width of the siphon; pecten consisting of from 8 to 10 teeth restricted to approximately the basal 1/4 of the siphon; individual pecten tooth with a fine distal spine and from 7 to 10 fine lateral barbs, the proximal 1 or 2 barbs considerably more prominent than the other lateral barbs.

TYPE DATA. Holotype male (antennae, terminalia, and associated larval and pupal skins slide-mounted) from Singapore in the Australian National Insect Collection, Canberra.

DISTRIBUTION. In THAILAND**, *macdonaldi* has been collected from: *Chanthaburi, Chiang Mai, Chon Buri, Krung Thep, Narathiwat, Sakon Nakhon,* and *Thon Buri*. The species has also been reported from SINGAPORE, MALAYA, ASSAM and the PHILIPPINES.

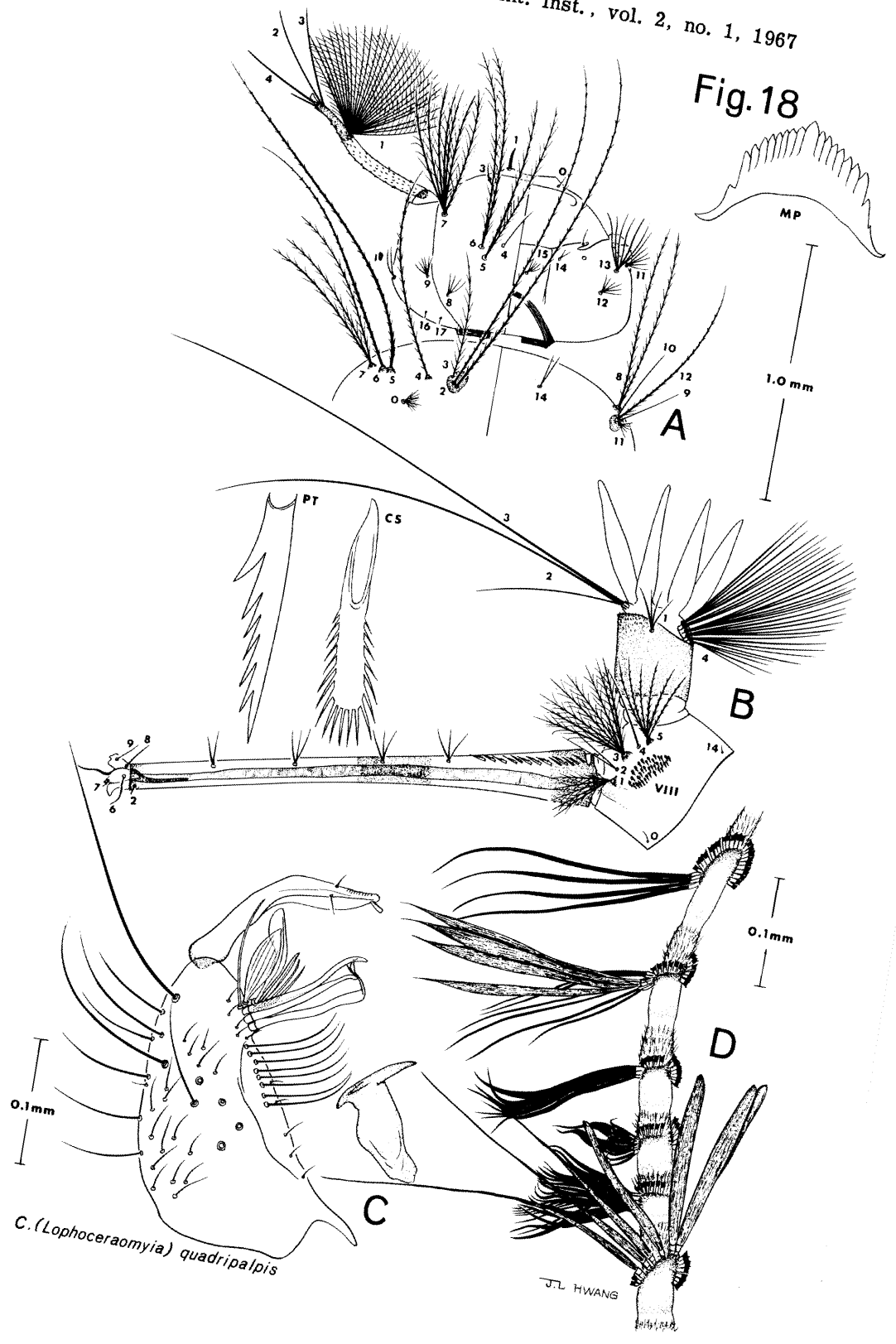
Eleven males with their associated terminalia and antennae have been examined as well as 2 larvae and a paratype male with its associated larval and pupal skins from Singapore.

TAXONOMIC DISCUSSION. Although this species demonstrates its closest affinity to *variatus*, it is easily distinguished on the basis of characters presented in the first paragraph.

BIOLOGY. Larvae have been collected from fresh water just above tidal limits and in Thailand from rock pools. Adults have been collected at light traps, but virtually nothing is known of the biology of the species.

Figure 17. *C. (Lophoceraomyia) macdonaldi*. A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through X.

Fig. 18


MP
1.0 mm
A
PT
CS
B
VIII
0.1mm
D
0.1mm
C
C. (Lophoceraomyia) quadripalpis
J.L. HWANG

CULEX (LOPHOCERAOMYIA) QUADRIPALPIS (EDWARDS) 1914
(Figure 18)

Lophoceratomyia sylvestris Leicester 1908, Cul. Malaya: 125 (not *Culex sylvestris* of Theobald 1901); Edwards 1922, Indian J. med. Res. 10: 473 (synonymy).
Lophoceratomyia quadripalpis Edwards 1914, Bull. ent. Res. 5: 80 (♂).
Culex (Lophoceratomyia) quadripalpis (Edwards): Edwards 1922, Indian J. med. Res. 10: 473 (taxonomy).
Lophoceratomyia roubaudi Borel 1926, Arch. Insts. Pasteur Indo-Chine 3-4: 38 (♂*, ♀, L*); Borel 1927, Bull. Soc. Pat. exot. 20: 25 (♂*, ♀, L*); Borel 1930, Monogr. Coll. Soc. Pat. exot. 3: 362 (♂*, ♀, L*); Edwards 1932, *in* Wytsman, Genera Insect. fasc. 194: 197 (synonymy).
Culex (Lophoceraomyia) quadripalpis (Edwards): Mattingly 1949, Proc. R. ent. Soc. Lond. (B) 18: 227 (L*, taxonomy); Colless 1965, J. med. Ent. 2: 285 (♂*, ♀, L*).

The adult male may be recognized by the presence of from 1 to 4 broad, dorsal scales on flagellomere V, by the 7 or 8 very long, curved submarginal setae on the basimere of the terminalia, and by the relatively long external basal processes of the palpus. The fourth stage larva is rather indistinctive, but abdominal hair 7-I is branched, thoracic hair 4-P is single, and the proximal pecten teeth have strong basal denticles.

FEMALE. *Thorax.* Integument of the pleuron grayish to pale brown; 1 lower mesepimeral bristle present. *Abdomen.* Terga and sterna dark brown.

MALE. *Head.* Proboscis with conspicuous dorsal setae and with 10 or more strong basoventral bristles; palpus with the basal processes extending approximately to the apex of palpal segment II. *Antenna.* (Figure 18D). Flagellomere V with a tuft of from 2 to 4 broad scales which are usually pointed (occasionally blunt or rarely notched) and extend almost to the tuft on IX, these are followed by from 3 to 5 shorter, pointed scales; VI with an internal tuft of 10 or more short, dark, stout and twisted spines; VII with a similar, but shorter tuft of spines; VIII with a tuft of 7 or more long, prominent spines which are gently curved distally; IX with a tuft of sharply pointed, lanceolate leaflets as well as several strong, straight setae; X with a tuft of from 3 to 5 strong, straight setae. *Terminalia.* (Figure 18C). Basimere with from 7 to 9 strong, characteristically curved submarginal setae; subapical lobe of the basimere with the basal rods subequal in length, the internal rod slightly expanded; internal and external leaflets broad, the external leaflet smaller than the asymmetrical internal leaflet; 6 accessory setae closely placed, equal in length and difficult to distinguish; distimere normal in shape, with minute annulations on the convex surface of the apical fifth; dorsal

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Figure 18. *C. (Lophoceraomyia) quadripalpis.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through X.

process of the lateral plate of the phallosome strongly recurved and pointed, the posterior angle of which usually exhibits from 1 to several very small teeth.

LARVA. (Figure 18A, B). *Head.* Hair 4-C simple, usually single, but sometimes exhibiting up to 3 branches; 5, 6-C bifid, pectinate, subequal in length; 16, 17-C represented by rather well developed spines. *Thorax.* Integument glabrous; hair 3-P shorter and slenderer than 1, 2-P, usually single, pectinate (occasionally bifid); 4, 5, 6-P single, pectinate (4-P occasionally bifid); 7-P trifid, pectinate; 8-P bifid, pectinate; 14-P bifid, simple, sometimes single on one side. *Abdomen.* Integument glabrous; hair 7-I branched; comb consisting of from 30 to 40 fan-shaped scales arranged in a broad, somewhat triangular patch; siphon index variable, ranging from 7.4:1 to 10:1 (average, 9.1:1); a broad, dark median band usually present on the siphon; 4 pairs of subventral tufts inserted in a line on the siphon; individual tufts 2 to 5 branched, simple, their length equal to, or slightly greater than the width of the siphon at the point of insertion; pecten consisting of from 10 to 14 teeth restricted to the basal third or less of the siphon; individual pecten tooth with a fine apical spine and from 5 to 8 lateral barbs, the proximal 1 or 2 barbs considerably stronger and more prominent than the distal barbs.

TYPE DATA. Holotype male (terminalia and antennae slide-mounted) of *quadripalpis* from Sarawak in the British Museum. Lectotype male (terminalia slide-mounted) of *sylvestris* from Kuala Lumpur in the British Museum. The type locality of *roubaudi* is Terres Rouges, Cochin-China, Indochina, but the location of the type specimen is unknown.

DISTRIBUTION. In THAILAND**, *quadripalpis* has been collected from: *Krung Thep, Nakhon Nayok, Nakhon Ratchasima, Narathiwat, Satun, Songkhla,* and *Tak.* This species has also been recorded from SINGAPORE, MALAYA, BORNEO, and INDOCHINA.

During this study the following material has been examined: 7 females with their associated larval and pupal skins; 11 males, 5 with their associated larval and pupal skins; and 56 fourth stage larvae.

TAXONOMIC DISCUSSION. In both the adult male and the fourth stage larva, *quadripalpis* demonstrates its closest affinity with *aculeatus.* In the male, these species may be distinguished on the basis of the submarginal setae of the basimere which are 7 or 8 in number in *quadripalpis* and only 3 in *aculeatus;* in the fourth stage larva the shape of the pecten tooth is diagnostic, having at least one distinctive basal denticle in *quadripalpis,* and thoracic hair 3-P usually single in *quadripalpis* but usually bifid in *aculeatus.*

BIOLOGY. In Thailand, larvae have been collected from a variety of ground water habitats including stream pools, stream margins, pits, seepage areas, and elephant hoof prints. Colless (1965) also collected larvae in Malaya from fresh water ground pools and rock pools under forest shade and usually associated with a considerable amount of decaying vegetable matter. Little is known of the adult biology, but the females have been reported occasionally attacking man in forest areas and adults have also been taken resting on forest vegetation.

CULEX (LOPHOCERAOMYIA) REIDI COLLESS 1965
(Figure 19)

Culex (Lophoceraomyia) reidi Colless 1965, J. med. Ent. 2: 279 (♂*, ♀, L*); Delfinado 1966, Mem. Amer. ent. Inst. 7: 113 (♂*).

Culex (Lophoceratomyia) quadripalpis of Edwards 1928 (not Edwards 1914), Bull. ent. Res. 18: 276 (key); Edwards and Given 1928, Bull. ent. Res. 18: 352 (L).

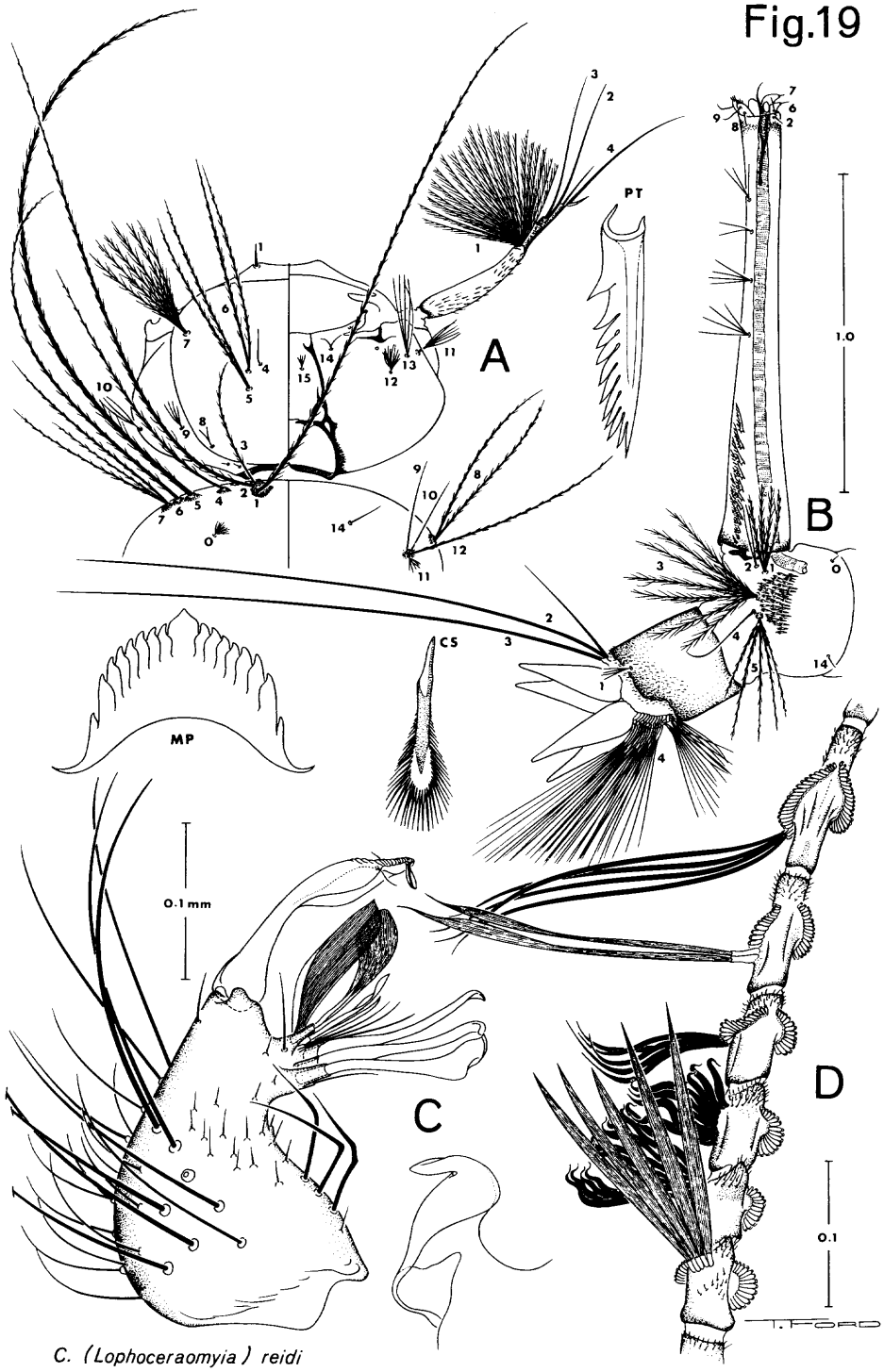
The adult male may be recognized by the presence of a tuft of 5 or 6 broad, but pointed scales on flagellomere V and by the internal rod on the subapical lobe of the basimere being expanded distally with a scalloped margin. The fourth stage larva is identified by abdominal hair 7-I single, thoracic hair 3-P usually single, 4-P single, and thoracic integument glabrous.

FEMALE. *Head.* Decumbent scales of the vertex predominantly broad, with a triangular median patch of narrow dark scales, the broad scales being quite pale on the lateral margins; erect scales uniformly dark brown. *Thorax.* Integument of the pleuron pale brown; 1 strong lower mesepimeral bristle present; anterior surface of hind femur completely dark on the distal half, predominantly pale on the basal half, but with a narrow dark stripe along the dorsal border. *Abdomen.* Terga dark scaled, frequently with paler, bronzy basolateral spots on segments VI and VII, but occasionally extending to segment II; sterna dull brown.

MALE. *Head.* Proboscis with rather long dorsal setae and with several long, basoventral bristles; palpus with long basal processes whose apices usually extend beyond the apex of palpal segment II. *Antenna.* (Figure 19D). Flagellomere V with a tuft of 5 or 6 broad, pointed scales which extend to VIII, and occasionally several straight, long setae; VI with an internal tuft of 15 or more short, stout, dark and twisted spines; VII with a similar, but smaller tuft of spines; VIII with a tuft of slightly longer, smoothly curved setae; IX with a tuft of from 2 to 5 finely pointed, lanceolate leaflets; X with a tuft of 4 strong, straight setae. *Terminalia.* (Figure 19C). Basimere with from 3 to 5 submarginal setae inserted in a straight row; individual seta somewhat expanded and sharply angled at a little past the center; subapical lobe of the basimere with the internal rod expanded apically and with a scalloped margin; central and external rods subequal in length and thickness, hooked; approximately 6 accessory setae present, apparently 2 setae and 4 blades; internal and external leaflets subequal in size, the internal leaflet asymmetrical; distimere expanded on the apical third and minutely annulate on the convex margin; dorsal process of the lateral plate of the phallosome short, sharply angled and pointed, the posterior angle of which is smooth.

LARVA. (Figure 19A, B). *Head.* Antenna with a narrow, dark basal band and in some specimens, darker beyond insertion of hair 1-A; head hair 4-C simple, with from 1 to 4 branches, inserted relatively close to 6-C; 5, 6-C bifid, pectinate, subequal in length; 16, 17-C represented by rather well developed spicules. *Thorax.* Integument glabrous; 3-P shorter and slenderer than 1, 2-P, usually single, pectinate (occasionally bifid); 4, 5, 6-P single, pectinate; 7-P bifid or trifid, pectinate; 8-P bifid, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; hair 7-I single; comb consisting of from 35 to 45 fan-shaped scales arranged in a broad, triangular patch; siphon index variable, ranging from 5.5:1 to 6.7:1 (average, 6.2:1), the siphon occasionally with a broad, slightly darker median band (not illustrated); 4 pairs of subventral tufts inserted in a line on the siphon; individual tufts with from 2 to 5 branches, simple, their length slightly greater than the width of the siphon at the point of insertion; pecten consisting of from 11 to 13 teeth restricted to approximately the basal third to fourth of the siphon; individual

Fig.19



C. (Lophoceraomyia) reidi

pecten tooth with a fine apical spine and from 8 to 12 lateral barbs, the proximal barbs somewhat more prominent than the distal ones.

TYPE DATA. Holotype male (terminalia slide-mounted) and a series of specimens reared from the same egg raft from Singapore in the Australian National Insect Collection, Canberra.

DISTRIBUTION. Specimens have been collected in THAILAND** from: *Krung Thep* (Bangkok) and *Thon Buri*. The species is also known from SINGAPORE and *Selangor*, MALAYA (Colless 1965), and from the PHILIPPINES (Delfinado 1966).

During this study 2 males with their associated terminalia and antennae and 5 larvae have been studied from Thailand, as well as a paratype male and female with associated larval and pupal skins from Singapore.

TAXONOMIC DISCUSSION. The adult female demonstrates closest affinity to *variatus* and *macdonaldi*, and no consistently distinctive characters have been found which can be used to separate these species. The adult male is separated from *variatus* and *macdonaldi* on the basis of the tuft on flagellomere V and is separated from *quadripalpis* and *aculeatus* on the basis of the internal rod on the subapical lobe of the basimere. The larva demonstrates close similarity to *rubithoracis* but the thoracic chaetotaxy is distinctive.

BIOLOGY. Colless (1965) reported collecting larvae from the tidal zone in shaded pools, axils of Nipa palms, and in crab holes. In Thailand, larvae have been collected from running water in a ditch. The adult females have been reported attacking man, but the normal host complex remains unknown.

CULEX (LOPHOCERAOMYIA) RUBITHORACIS (LEICESTER) 1908
(Figure 20)

Lophoceratomyia rubithoracis Leicester 1908, Cul. Malaya: 119 (♂, ♀); Edwards 1913, Bull. ent. Res. 4: 236 (taxonomy).

Culex (Lophoceratomyia) rubithoracis (Leicester): Barraud 1934, Fauna Brit. India, Diptera 5: 367 (♂, ♀); Hsiao and Bohart 1946, Navmed 1095: 25 (distribution); Bohart 1946, Navmed 961: 18 (key); LaCasse and Yamaguti 1950, Mosq. Fauna Japan and Korea: 192 (♂*, ♀*, L*, P*); Hara 1957, Jap. J. exp. Med. 27: 57 (♀*).

Culex (Lophoceraomyia) rubithoracis (Leicester): Dantis 1947, Mon. Bull. Philipp. Hlth. Serv. 23: 255 (L, P); Mattingly 1949, Proc. R. ent. Soc. Lond. (B) 18: 224 (L*); Colless 1959, Proc. R. ent. Soc. Lond. (B) 28: 114 (L*); Lien 1962, Pacif. Ins. 4: 632 (distribution); Colless 1965, J. med. Ent. 2: 281 (♂*, ♀, L*); Delfinado 1966, Mem. Amer. ent. Inst. 7: 113 (♂*).

The absence of a lower mesepimeral bristle and the reddish brown tint

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Figure 19. *C. (Lophoceraomyia) reidi*. A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through X.

of the thorax separate the adult female from other members of the *fraudatrix* group. The adult male may be recognized not only by the above mentioned characters, but also by the presence of an inconspicuous tuft of narrow, tapering, pointed scales on antennal flagellomere V. The fourth stage larva is distinguished by abdominal hair 7-I single, thoracic hair 3-P with from 4 to 10 branches, and by the thoracic integument strongly spiculate.

FEMALE. *Head.* Decumbent scales of the vertex with a small central patch of fine, pale brown scales, followed by a wide area of broader dark scales and large lateral areas of broad, pale scales; erect scales uniformly dark brown. *Thorax.* Scutum with the integument pale brown with a distinctly reddish tint, sparsely covered with dark scales; integument of pleuron similar in color to the integument of the scutum, without a lower mesepimeral bristle. *Abdomen.* Terga brown, with indistinct, palish anterior and posterior bands on each tergum of some specimens; sterna pale.

MALE. *Head.* Proboscis with rather long dorsal setae and shorter, forward projecting ventral hairs as well as stronger basoventral setae; palpus with very small basal processes. *Antenna.* (Figure 20D). Flagellomere V with a tuft of from 2 to 5 long, dark, sharply pointed scales, the longest of which extends to the apex of IX followed by approximately 7 long setae which are stronger than those of the normal whorl; VI with an internal tuft of 10 or more short, stout, dark and twisted spines; VII with a similar, but smaller tuft of spines; VIII with a dense tuft of long, gently curved spines; IX with from 3 to 5 well developed, lanceolate scales each of which terminates in a sharp point; X with an internal tuft of from 2 to 4 strong, straight, dark setae. *Terminalia.* (Figure 20C). Basimere with 3 long, strongly curved, submarginal setae inserted in a straight row; subapical lobe of the basimere with the internal rod expanded and sharply pointed apically, central and external rods subequal in length and thickness and hooked apically; 6 accessory setae present, all rather blade-like, and of variable length and with one of the shorter setae serrate; internal and external leaflets subequal in length, symmetrical; distimere normal but with fine annulations on the convex surface at the apex; dorsal process of the lateral plate of the phallosome long, strongly curved, and sharply pointed, the posterior angle of which is smooth.

LARVA. (Figure 20A, B). *Head.* Antenna with a narrow, dark basal band and darker beyond the insertion of hair 1-A; head hair 4-C with from 2 to 4 branches, simple; 5, 6-C usually bifid, pectinate, occasionally single or trifid on 1 side; 16, 17-C represented by minute, but well developed spicules. *Thorax.* Integument covered with a dense pattern of prominent, short spicules; hair 3-P with from 4 to 10 pectinate branches, the individual branches considerably shorter and slenderer than 1, 2-P; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P with 3 or 4 branches, pectinate; 8-P bifid, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; hair 7-I single; comb consisting of from 35 to 50 scales arranged in a broad, triangular patch; siphon index variable, ranging from 6:1 to 8:1 (average, 7.3:1); 4 pairs of subventral tufts

Figure 20. *C. (Lophoceraomyia) rubithoracis.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through X.

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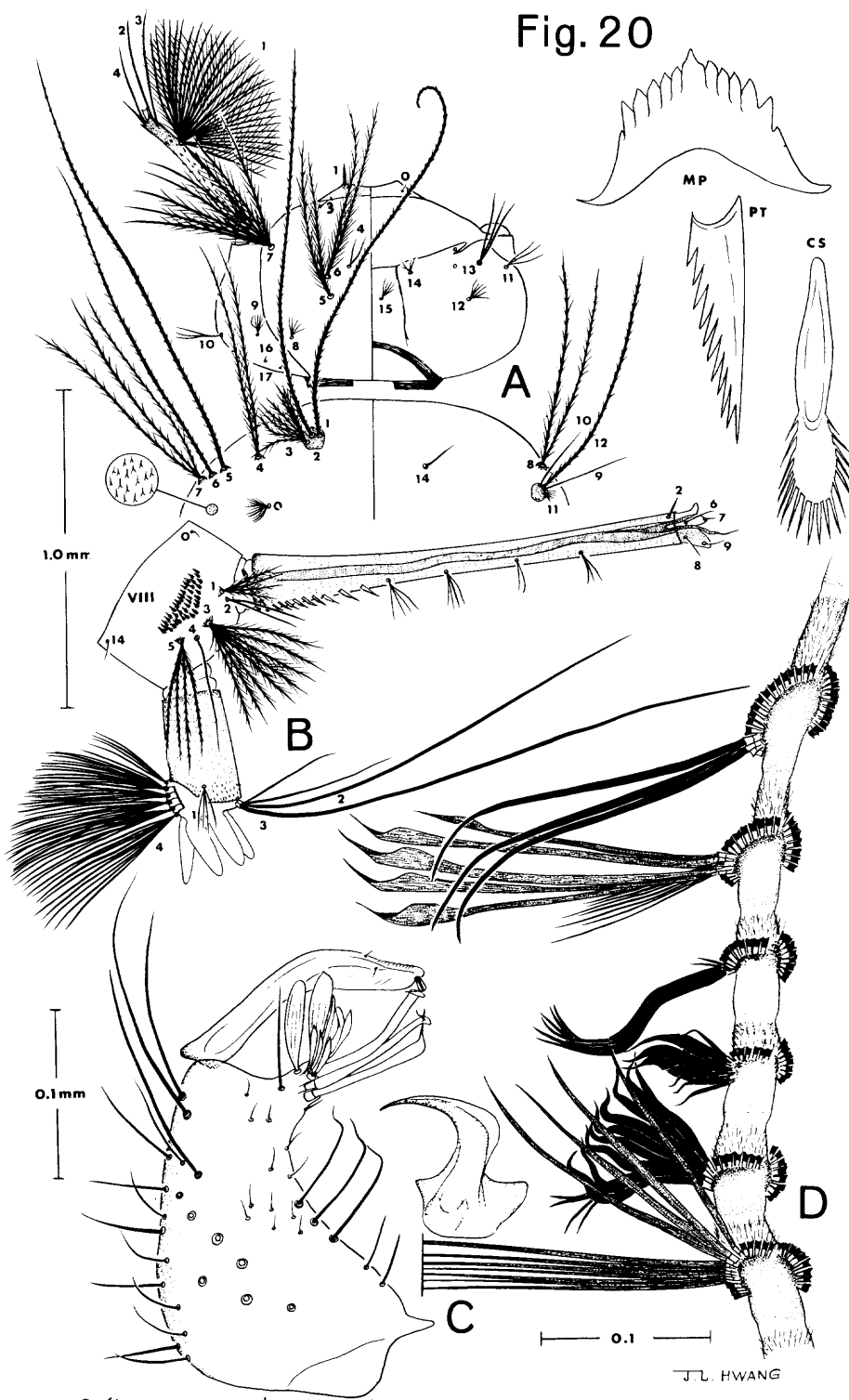

C. (Lophoceraomyia) rubithoracis

inserted in a line on the siphon; individual tufts with from 2 to 4 branches, simple, their length approximately equal to the width of the siphon at the point of insertion; pecten consisting of from 7 to 10 teeth restricted to the basal third or less of the siphon; individual pecten tooth with a fine distal spine and from 8 to 12 subequal lateral barbs.

TYPE DATA. Lectotype male (terminalia mounted on a celluloid point) from Kuala Lumpur in the British Museum.

DISTRIBUTION. In THAILAND, this species has been collected from: *Chanthaburi, Chiang Mai, Chon Buri, Krung Thep,* and *Ubon Thani.* This species has also been recorded from SINGAPORE, MALAYA, INDIA, INDONESIA, CHINA, BORNEO, JAPAN, TAIWAN, and the PHILIPPINES.

During this study 8 larvae were studied from Thailand as well as 50 males and 9 females; 1 male and 1 female with their associated larval and pupal skins have been studied from Singapore.

TAXONOMIC DISCUSSION. As indicated in the above diagnosis, there is little difficulty in distinguishing this species from other members of the *fraudatrix* group. Specimens are occasionally found in which the characteristic reddish brown tint of the thoracic integument is replaced by darker brown color; in these cases it is necessary to resort to anatomical features before drawing final conclusions.

BIOLOGY. Although the larvae have been infrequently collected in Thailand, the adults were taken in rather large numbers at light traps near Bangkok. The larvae are collected primarily in open areas such as ponds and paddy fields; however, Colless (1965) found that even where larvae were common, the adults were rarely, if ever, taken on mammalian baits and presumably fed on birds.

CULEX (LOPHOCERAOMYIA) VARIATUS (LEICESTER) 1908
(Figure 21)

Lophoceratomyia variata Leicester 1908, Cul. Malaya: 121 (♂, ♀); Edwards 1913, Bull. ent. Res. 4: 234 (synonymy with *fraudatrix).*

Culex (Lophoceraomyia) variatus (Leicester): Colless 1965, J. med. Ent. 2: 270 (revalidated, ♂*, ♀, L*).

The adult male is distinguished from other species of the *fraudatrix* group by the presence of 3 submarginal setae in a line on the basimere, 8 or more blunt scales on antennal flagellomere V, and by a sharply angulate tuft of scales on flagellomere VIII. The fourth stage larva may be separated from other species of the *fraudatrix* group by head hair 5-C being bifid and long, abdominal hair 7-I branched, thoracic hair 4-P branched, and 14-P single.

FEMALE. *Thorax.* One lower mesepimeral bristle present. *Abdomen.* Terga covered with dark brown scales, with small indistinct basolateral pale patches on tergum VII; sterna with pale scales and often with indistinct subapical dark bands on the more posterior segments.

MALE. *Head.* Proboscis with rather long dorsal setae and shorter, forward projecting ventral hairs, as well as stronger basoventral setae; palpus with short basal processes, the outer, longer processes about half the length of palpal segment II. *Antenna.* (Figure 21D). Flagellomere V with a prominent external tuft of 8 or more broad, bluntly rounded scales

which extend to the tuft of X; VI with an internal tuft of 15 or more short, stout, dark and twisted spines; VII with a similar, but smaller tuft of spines and a secondary longer tuft; VIII with a tuft of long, broad spines which are sharply angled at the apex; IX with from 4 to 6 finely pointed, lanceolate, translucent leaflets as well as several stout setae; X with an internal tuft of from 2 to 4 strong, dark setae. *Terminalia*. (Figure 21C). Basimere with 3 strong, slightly curved submarginal setae inserted in a straight row; subapical lobe of the basimere with internal rod having an expanded apex, external and central rods subequal in length, hooked apically; 5 or 6 accessory setae present, 2 of which are longer than the others, rather straight, and blade-like; internal leaflet narrow basally, then expanded and blunt distally, asymmetrical; external leaflet rather narrow, pointed apically; distimere normal, but with prominent apical annulations on the convex margin; dorsal process of the lateral plate of the phallosome long, gently curved, and sharply pointed, the posterior angle of which frequently exhibits several minute, spiculate teeth.

LARVA. (Figure 21A, B). *Head*. Hair 4-C simple, single or with up to 4 branches; 5, 6-C bifid, pectinate, subequal in length; 16, 17-C represented by minute spicules. *Thorax*. Integument covered with a rather dense pattern of minute spicules; hair 3-P very fine, pectinate, considerably shorter than 1, 2-P, either single or bifid; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P trifid, pectinate; 8-P bifid, pectinate; 14-P single, simple. *Abdomen*. Integument glabrous; hair 7-I branched; 2-VIII bifid; comb consisting of from 35 to 55 fan-shaped scales arranged in a broad, triangular patch; siphon index variable, ranging from 6.5:1 to 9:1 (average, 7.5:1), a narrow median dark band usually present; 4 pairs of subventral tufts inserted in a line on the siphon (occasionally one side will exhibit either 3 or 5 tufts); individual tufts with from 2 to 4 branches (occasionally single), simple, their length equal to, or less than the width of the siphon at the point of insertion; pecten consisting of from 9 to 13 teeth restricted to the basal fourth or less of the siphon; individual pecten tooth with a fine apical spine and from 6 to 11 fine lateral barbs, a subbasal barb frequently more prominent than the other lateral barbs.

TYPE DATA. Lectotype male (terminalia mounted and attached to pin, antenna slide-mounted) from Kuala Lumpur, Malaya in the British Museum.

DISTRIBUTION. In THAILAND**, *variatus* has been studied from: *Krung Thep*, *Narathiwat*, *Ranong*, *Satun*, *Songkhla*, and *Thon Buri*. Outside of Thailand, the species has been recorded only from MALAYA.

During this study 9 males, 2 with their associated larval and pupal skins, 3 females, 1 with associated skins, and 6 fourth stage larvae have been examined.

TAXONOMIC DISCUSSION. This species demonstrates closest affinity to *fraudatrix* of New Guinea and, as pointed out by Colless (1965), has probably been most frequently misidentified as that species. In the male, *variatus* may be separated from *fraudatrix* on the basis of the lanceolate leaflets on antennal flagellomere IX and the sharply angled spines on flagellomere VIII; also, in *fraudatrix* the accessory setae on the subapical lobe of the basimere are not as well developed as in *variatus*.

BIOLOGY. In Thailand, larvae have been collected from a variety of ground water habitats including a marsh, a large ground pool, pools in dry

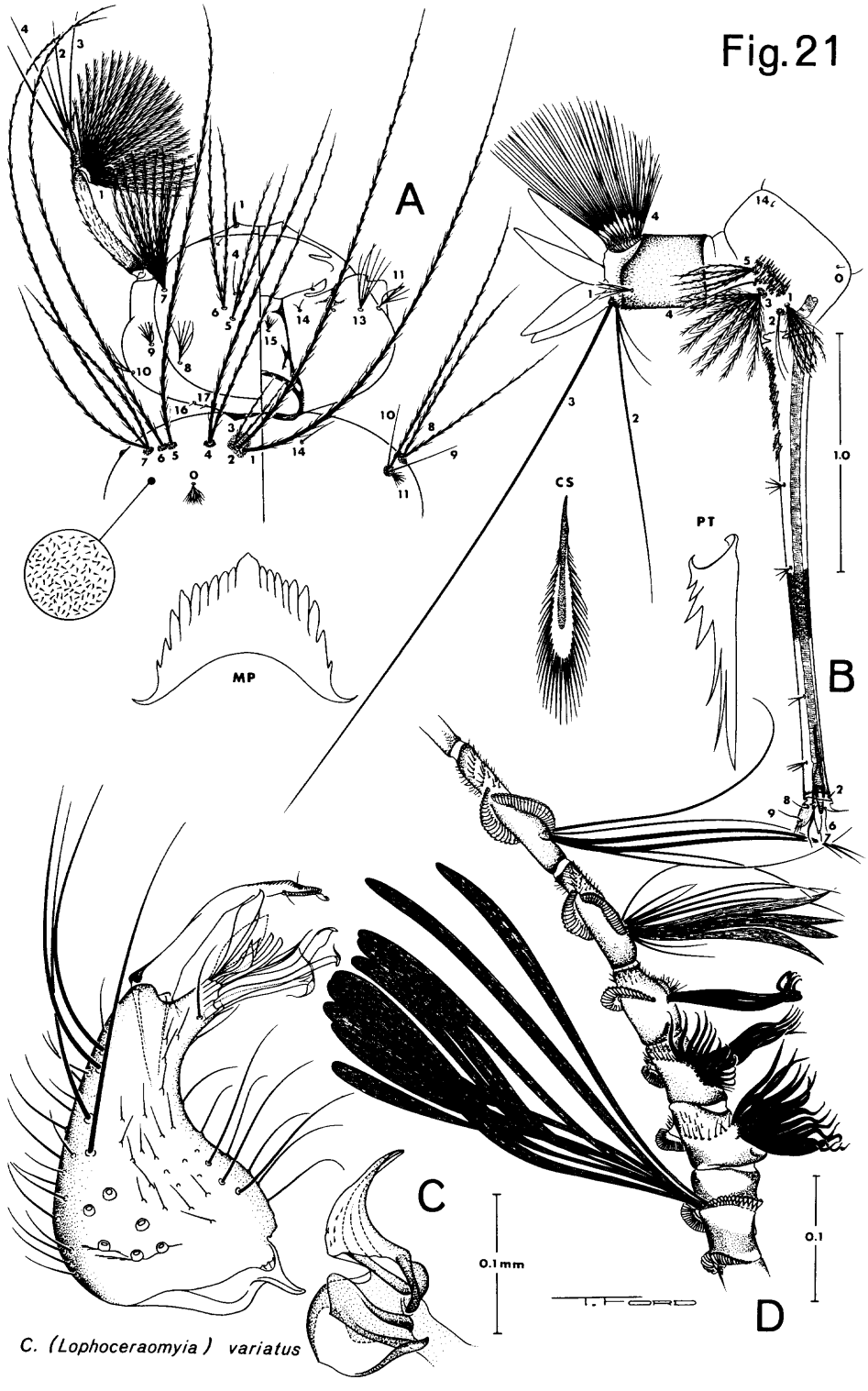
Fig. 21
A
B
C
D
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T. FORD
C. (Lophoceraomyia) variatus

stream beds, and a sump, generally with floating leaves and other organic matter. Colless (1965) suggested that the most common larval habitat of this species is partly shaded and has much organic matter in the water, which is stagnant and usually fresh; however, larvae were also collected from container habitats near the ground such as palm axils, tins, cavities in fallen logs or bamboos, and crab holes. Nothing is known of the adult bionomics, but Colless (1965) has postulated that they may normally feed on birds and forest mammals, and possibly act as vectors of certain viruses.

MAMMILIFER GROUP

FEMALE. Scales on wing veins R_2 and R_3 usually narrow, particularly on the basal half. Otherwise, consistent features are not presently recognized which can be used to separate the groups within the subgenus.

MALE. *Head.* Torus of the antenna with a mammiliform protuberance on the inner surface or (in the case of *wilfredi),* the torus asymmetrical and with a slit-like depression on the inner surface; length of the palpus variable; palpus without distinct basal processes; proboscis without long dorsal setae, but usually with dorsal pubescence, particularly on the expanded subbasal region; antenna usually with modified scales or setae on flagellomeres V through IX. *Terminalia.* Subapical lobe of the basimere usually with 1 of the leaflets modified; lateral plate of the phallosome with an internal process which is smooth and gently curved, and a dorsal process which is usually truncate with a toothed or spinose apex.

LARVA. *Head.* Length of 4-C distinctly greater than the distance between the bases of the pair. *Thorax.* Hair 14-P bifid (except in *mammilifer* and *wildredi). Abdomen.* Hair 2-VIII single; siphon with 3 or more pairs of subventral tufts; central filament of the siphon valves present or absent, when present usually weakly developed.

DISTRIBUTION. Representatives of the *mammilifer* group are restricted to the Oriental region. In Thailand, species of this group are undoubtedly distributed throughout the country.

TAXONOMIC DISCUSSION. Within the *mammilifer* group, 2 rather well defined subgroups may be recognized in terms of anatomical features as well as larval habitats. Further differentiation of these subgroups will be given below.

BREVIPALPUS SUBGROUP

FEMALE. Anatomical features cannot presently be recognized which separate members of the *brevipalpus* and *mammilifer* subgroups.

Figure 21. *C. (Lophoceraomyia) variatus.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through X.

MALE. Length of the palpus, at most, only slightly greater than that of the proboscis (in the 2 species presently recognized from Thailand, the palpus is only 1/2 to 3/4 the length of the proboscis). Distimere of the terminalia noticeably expanded at the apex.

LARVA. Antenna cylindrical, not noticeably constricted beyond insertion of hair 1-A; hairs 2-6-A all inserted at the apex of the shaft; mouthparts apparently adapted for predation.

LARVAL HABITAT. Normally, larvae of species of the *brevipalpus* subgroup are found exclusively in pitcher plant (*Nepenthes* spp.) environments.

TAXONOMIC DISCUSSION. The short male palpus and the features of the larval antenna clearly separate this subgroup from the *mammilifer* subgroup. Of a total of at least 9 species which have been described from this subgroup, only 2, *curtipalpis* and *lucaris*, have been positively identified from Thailand. A single larva, collected from a pitcher plant in Ranong, possibly represents *brevipalpus* (Theobald); however, the larvae of *brevipalpus* and *eminentia* (Leicester) have not been adequately characterized to permit an accurate determination.

CULEX (LOPHOCERAOMYIA) CURTIPALPIS (EDWARDS) 1914
(Figure 22)

Lophoceratomyia curtipalpis Edwards 1914, Bull. ent. Res. 5: 127 (♂).
Culex (Lophoceratomyia) curtipalpis (Edwards): Edwards 1921, Bull. ent. Res. 12: 78 (as synonym of *C. (Lophoceratomyia) jenseni* (Meij.)); Edwards 1928, Bull. ent. Res. 18: 279 (revalidated); Edwards and Given 1928, Bull. ent. Res. 18: 357 (L*, P).
Culex (Lophoceraomyia) curtipalpis (Edwards): Colless 1965, J. med. Ent. 2: 301 (♂*, ♀, L).

The adult female may be recognized by the absence of a lower mesepimeral bristle, by the presence of some scales on the pleuron, and by the presence of some pale, erect scales on the vertex. The adult male is distinctive in the expanded apex of the distimere, the short palpus, and the structures of the subapical lobe of the basimere. The short siphon of the fourth stage larva distinguishes this species from all other known members of the genus in Thailand.

FEMALE. *Head.* Decumbent scales of the vertex dark brown, but with a relatively wide band of pale, broad scales adjacent to the orbital line; erect scales dark brown with a golden tinge on the occiput and usually pale at the lateral margins. *Thorax.* Integument of the pleuron usually dark brown, sometimes paler, with rather distinctive patches of pale scales on the sternopleuron and sometimes on the anterior pronotal lobe; lower mesepimeral bristle absent. *Legs.* Anterior surface of hind femur predominantly pale, with a narrow, dark apical band which extends proximally along the dorsal margin; anterior surface of the mid femur similar to the hind femur, but with the dark area considerably expanded. *Abdomen.* Terga dark scaled with a paler stripe down each lateral margin; sterna pale.

MALE. *Head.* The length of the palpus at least 1/4 but less than 1/2 the length of the proboscis. *Antenna.* (Figure 22D). Flagellomere V with a tuft of 2 or 3 long, strong, straight spines followed by 4 to 7 narrow, pointed, darker scales; VI with a tuft of 4 or more simple, straight, rather short

spines; VII with a tuft of 5 short, hooked setae and from 3 to 5 longer, straight setae; VIII with a tuft of 3 or 4 narrow, lanceolate blades; IX with a tuft of from 3 to 6 strong, straight setae. *Terminalia*. (Figure 22C). Basimere without strongly distinctive submarginal setae; subapical lobe of the basimere with the internal rod very strong, long, bluntly rounded and characteristically curved, and with the central and external rods subequal in length, shorter than the internal rod, and gently hooked; internal leaflet represented by a stout, curved spine; external leaflet very broad, asymmetrical; 4 sharply angled, blade-like, characteristically pointed accessory setae present; distimere prominently expanded at the apex; dorsal process of the lateral plate of the phallosome with a spiculate apical knob and with 15 or more fine, but distinct, teeth on the lateral margin; internal process very short, gently curved, and pointed.

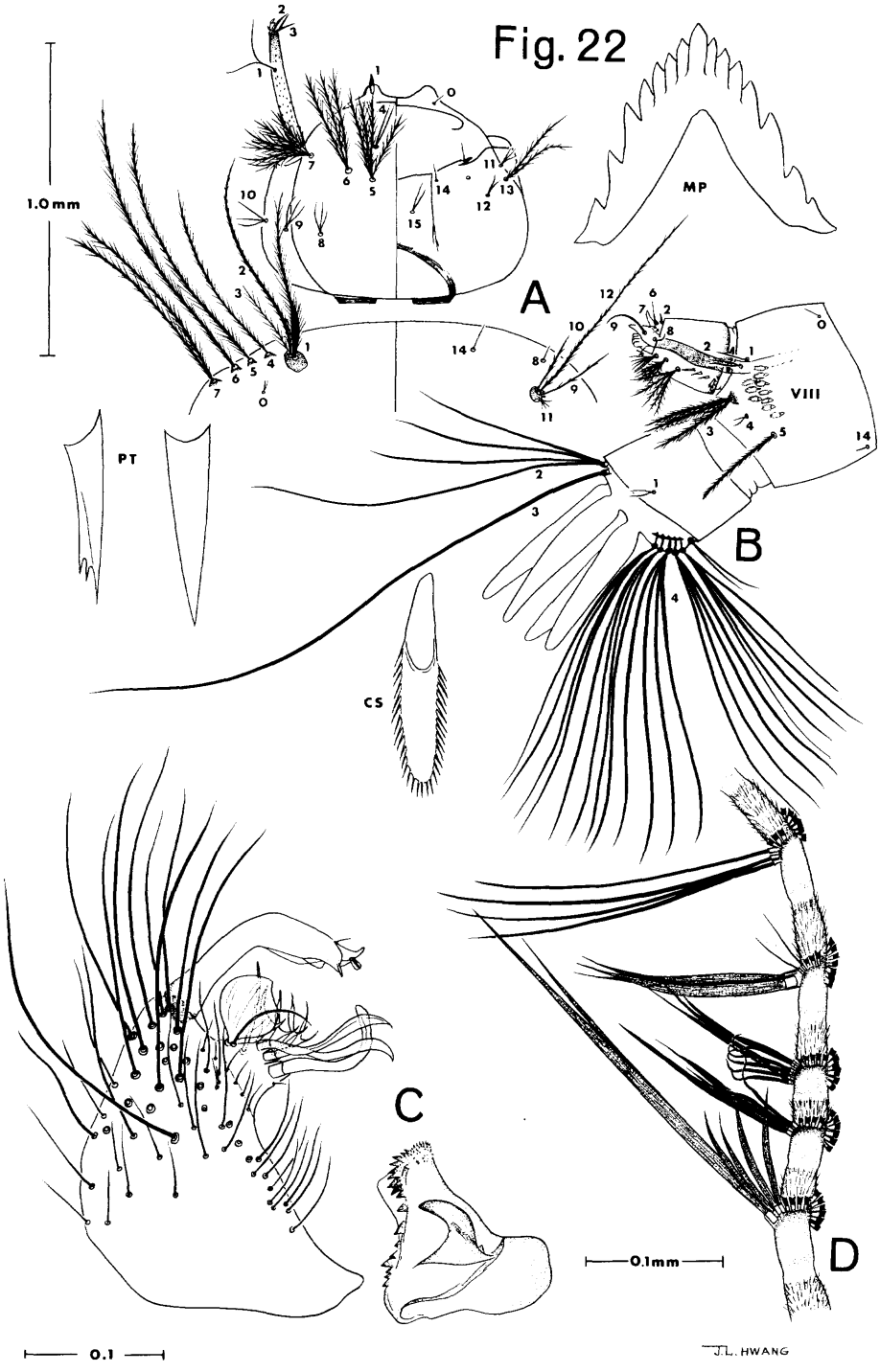
LARVA. (Figure 22A, B). *Head*. Antennal shaft cylindrical, hair 1-A very short, with from 2 to 4 simple branches, hairs 2-6-A inserted at the apex of the shaft; head hair 1-C lightly pigmented, stout, very short, and inserted in a large socket; 4-C simple, with from 1 to 3 branches, inserted rather close to the anterior margin of the head; 5, 6-C fine, pectinate, with from 2 to 4 branches, and also inserted well forward; 16, 17-C absent; ventral and internal mouth brushes very stout, hooked, apparently adapted for predation. *Thorax*. Integument glabrous; 1-P expanded basally; 3-P single, pectinate, shorter and slenderer than 1, 2-P; 4, 7-P single or bifid, pectinate; 5, 6-P single, pectinate; 8-P extremely short, fine, simple, single or bifid; 14-P single or bifid, simple. *Abdomen*. Integument glabrous; comb consisting of an irregular row of from 4 to 10 blunt, elongated scales which are fringed with fine, subequal spines; siphon shorter than the saddle on segment X, index ranging from 1.2:1 to 1.4:1; 3 or 4 pairs of subventral tufts inserted in a line on the siphon; individual tufts with from 3 to 6 branches, pectinate, the apical tuft extremely small and simple; pecten consisting of 3 or 4 stout, simple teeth restricted to the basal half of the siphon.

TYPE DATA. Holotype male (terminalia slide-mounted) from Kuching, Sarawak in the British Museum.

DISTRIBUTION. In THAILAND**, specimens of this species have been collected from *Phattalung* and *Ranong*. The species has also been reported from SINGAPORE, SARAWAK, MALAYA (Colless 1965). Specimens of *curtipalpis* have been examined in the U. S. National Museum collection from Saigon (coll. H. H. Stage, 1955) and DaNang (coll. P. J. Santana, 1965), SOUTH VIETNAM**.

The following specimens have been examined during this study: 4 females with their associated larval and pupal skins; 8 males, 4 with their associated larval and pupal skins; and 76 larvae from South Vietnam.

BIOLOGY. Prior to this study, larvae of *curtipalpis* had been collected exclusively from pitcher plants; however, on one occasion larvae of this species were collected from a tree hole in Phattalung, Thailand. The larvae apparently feed on insect remains which accumulate in the pitchers or tree holes. In Thailand, collections have been made during the months of March and October; in South Vietnam, during December, January, March, and May. Habits of the adults are unknown.



C.(Lophoceraomyia) curtipalpis

CULEX (LOPHOCERAOMYIA) LUCARIS COLLESS 1965
(Figure 23A, B)

Culex (Lophoceraomyia) lucaris Colless 1965, J. med. Ent. 2: 299 (♂*).

The adult male may be recognized by the palpus being from 1/2 to 3/4 the length of the proboscis, by the expanded apex of the distimere, and by the characteristic tuft of scales on antennal flagellomere V.

FEMALE. Unknown.

MALE. *Head.* Proboscis and palpus dark brown, the length of the palpus from 1/2 to 3/4 the length of the proboscis; erect scales of the vertex pale bronze-brown on the occiput, becoming darker posterolaterally. *Antenna.* (Figure 23B). Flagellomere V with a tuft of 6 or 7 golden, narrow, tapering scales whose apices extend beyond the tuft on IX; VI with a tuft of about 4 rather long, gently sigmoid setae with filamentous apices and 5 or more straight, slender setae; VII with a tuft of about 12 shorter scales which terminate in a recurved point and a supplementary tuft of broader scales; VIII with a tuft of 5 or more strong, gently curved setae; IX with from 6 to 10 fine, straight setae. *Thorax.* Integument of the pleuron uniformly pale brown with one lower mesepimeral bristle present. *Abdomen.* Terga covered with dark brown scales; sterna uniformly pale. *Terminalia.* (Figure 23A). Basimere without strong, distinctive submarginal setae; subapical lobe of the basimere with the internal rod stout, bent, shorter than the central and external rods, and with a filamentous apex; central rod rather narrow, smoothly curved apically; external rod longer than the other 2, expanded and hooked at the apex; internal leaflet represented by a rather long, rod-like structure; external leaflet not recognizable, possibly represented by a moderately long seta; 5 accessory setae present, the 2 near the rods strong and gently curved, the 3 between the rods and the leaflets short, rather broad, and blade-like; a dense patch of short, fine setae also present around the base of the leaflets; distimere with an expanded apex and exhibiting 3 strong apical spines; dorsal process of the lateral plate of the phallosome with a spiculate apex and 7 or more strong teeth on the lateral margin; internal process short, strongly curved and pointed.

LARVA. Unknown.

TYPE DATA. Holotype male (terminalia and antenna slide-mounted) from Singapore in the Australian National Insect Collection, Canberra.

DISTRIBUTION. *C. lucaris* is known only from the type locality (Ulu Pandan, SINGAPORE) and from *Ranong*, THAILAND**.

The author has examined 1 paratype male (in the British Museum) and a single male from Thailand.

TAXONOMIC DISCUSSION. This species is extremely close to *eminentia* (Leicester), but may be separated on the basis of the subapical

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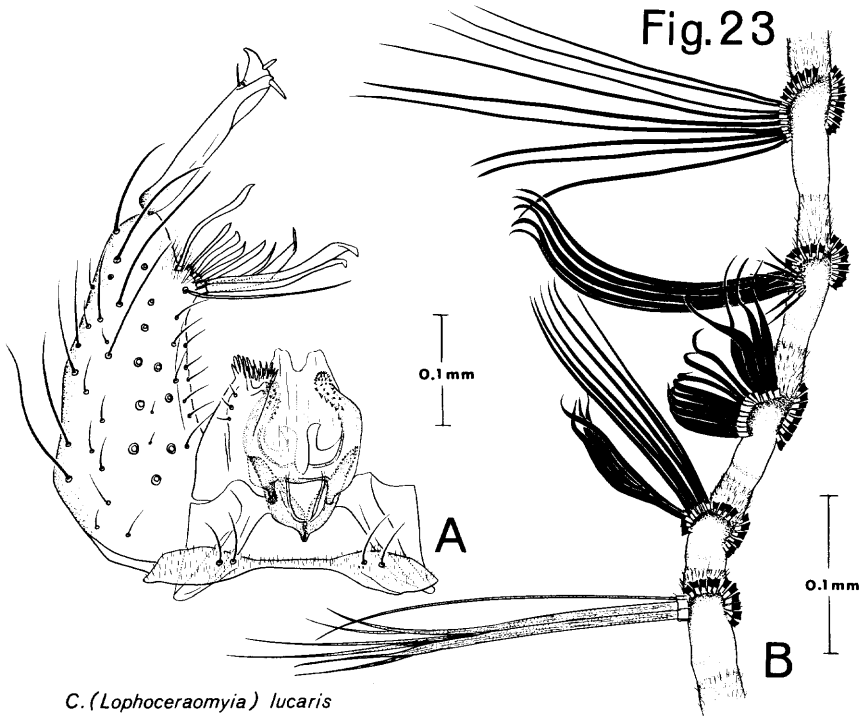
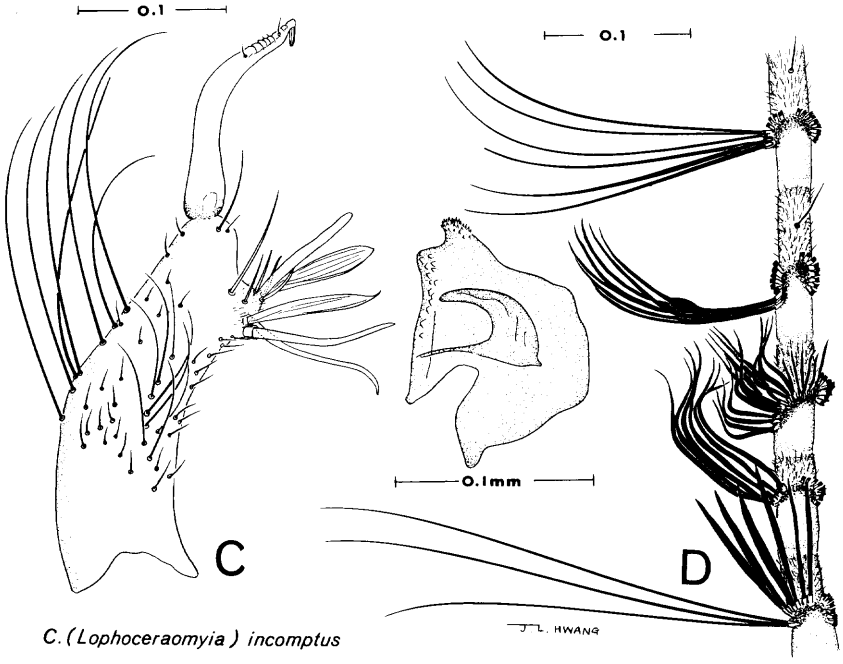
Figure 22. *C. (Lophoceraomyia) curtipalpis.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through IX.



C. (Lophoceraomyia) lucaris



C. (Lophoceraomyia) incomptus

lobe of the basimere and the flagellomere tufts. In *eminentia* the subapical lobe itself is rather narrow and conical, whereas this structure in *lucaris* is broad and truncate; although the appendages on the subapical lobe of the 2 species are very similar, the accessory setae are relatively longer in *eminentia*.

BIOLOGY. The single specimen from Thailand was reared from a pupa collected in a pitcher plant. Specimens of the type series were collected resting in rather open forest.

MAMMILIFER SUBGROUP

MALE. Length of the palpus greater than that of the proboscis (except in *traubi*, in which the palpus is never as short as 3/4 the length of the proboscis); distimere of the terminalia not expanded apically.

LARVA. Antenna noticeably constricted beyond insertion of hair 1-A which is plumose; antennal hairs 2, 3-A inserted considerably below the apex of the shaft, 4, 5, 6-A inserted at the apex; mouthparts not adapted for predation.

LARVAL HABITAT. Larvae are usually found in natural container habitats such as tree holes, bamboo internodes, rock holes, etc., but are also frequently found in a variety of ground water habitats.

TAXONOMIC DISCUSSION. Within the *mammilifer* subgroup, at least one species complex is recognizable. This group includes *traubi*, *ganapathi*, *spiculosus*, and *peytoni*, all of which exhibit a marked similarity in anatomical features as well as larval habitats. Although these species may be distinguished on the basis of the male terminalia and the tufts of the male antennal flagellomeres, it is desirable to examine the associated larval skins before drawing final conclusions.

CULEX (LOPHOCERAOMYIA) INCOMPTUS BRAM AND RATTANARITHIKUL 1967

(Figure 23C, D)

Culex (Lophoceraomyia) incomptus Bram and Rattanarithikul 1967, Proc. ent. Soc. Wash. 69: 16 (♂*).

The adult male may be recognized by the presence of 2 irregular rows of submarginal setae on the basimere of the terminalia, by the 6 acutely pointed scales on antennal flagellomere V, and by the characteristically bulbous setae on flagellomere VIII.

Figure 23. *C. (Lophoceraomyia) lucaris*. A, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; B, lateral aspect of male antennal flagellomeres V through IX. *C. (Lophoceraomyia) incomptus*. C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through IX.

FEMALE. Unknown.

MALE. *Antenna.* (Figure 23D). Flagellomere V with an internal tuft of 6 acute setae which extend to the tuft of VI; VI with a tuft of 6 rather fine, short setae which are bent distally; VII with a similar tuft of from 10 to 15 shorter setae; VIII with an internal tuft of 7 strong, dark, gently curved setae, the distal 2 of these setae with a characteristic bulbous, median expansion; IX with an internal tuft of 3 short, slender setae and 3 longer, slenderer setae. *Thorax.* Integument of the pleuron uniformly pale, tinged with green in some specimens; 1 lower mesepimeral bristle present. *Abdomen.* Terga dark brown; sterna slightly lighter. *Terminalia.* (Figure 23C). Basimere with from 9 to 11 strong, submarginal setae inserted in 2 irregular rows; subapical lobe of the basimere with the internal rod rather robust, constricted at the apex and pointed, the central and external rods subequal in length, gently curved; internal leaflet rod-like, external leaflet broad, striate; accessory processes narrow and setae-like; distimere with minute annulations on the apical third of the convex surface; dorsal process of the lateral plate of the phallosome with an apical spiculate knob and 12 or more fine, but distinct, denticles on the lateral margin; internal process robust, distinctly curved, not projecting beyond the apex of the dorsal process.

LARVA. Unknown.

TYPE DATA. Holotype male (terminalia and antennae slide-mounted) from Doi Suthep, Chiang Mai, Thailand in the U. S. National Museum.

DISTRIBUTION. In addition to the type locality, this species is known from Doi Tad Fah, *Chiang Mai,* THAILAND. During this study 4 adult males and their associated slide mounted terminalia and antennae were examined.

TAXONOMIC DISCUSSION. This species demonstrates its closest affinity to *fuscosiphonis* and *demissus* Colless (the latter presently known only from Selangor, Malaya), but the bulbous expansion of setae on flagellomere VIII and the shape of the processes on the subapical lobe of the basimere clearly separates *incomptus* from its close relatives. *C. bandoengensis* Brug (another member of the *mammilifer* subgroup whose distribution is restricted to Malaya and Java) also exhibits the submarginal setae in 2 rows but may be easily separated on the basis of the shape and number of the accessory processes on the subapical lobe of the basimere.

BIOLOGY. Larvae were collected (and the skins subsequently lost) from a tree hole on Doi Suthep Mountain during the month of January; 1 adult male was collected from a low plant in a shady damp jungle on Doi Tad Fah Mountain during May. No other biological data are available.

CULEX (LOPHOCERAOMYIA) BENGALENSIS BARRAUD 1934
(Figure 24)

Culex (Lophoceratomyia) minor var. *bengalensis* Barraud 1934, Fauna Brit. India, Diptera 5: 371 (♂).

Culex (Lophoceraomyia) bengalensis Barraud: Colless 1965, J. med. Ent. 2: 293 (♂*, ♀, L*).

Except for the absence of a lower mesepimeral bristle, the adult female cannot be distinguished from other members of the *mammilifer* subgroup. The adult male may be recognized by the presence of a tuft of from 1 to 4 very

long, filamentous scales on flagellomere V, by the tuft of obviously modified dark, strong setae on flagellomere IX, by the submarginal setae of the basimere inserted in a single row, and by the absence of a lower mesepimeral bristle. The fourth stage larva possesses only 3 pairs of subventral tufts, thoracic hair 14-P bifid, and abdominal hair 6-III usually trifid.

FEMALE. *Thorax.* Integument of pleuron dull brown, without distinct patches of pale scales; lower mesepimeral bristle absent. *Abdomen.* Terga dark; sterna somewhat paler.

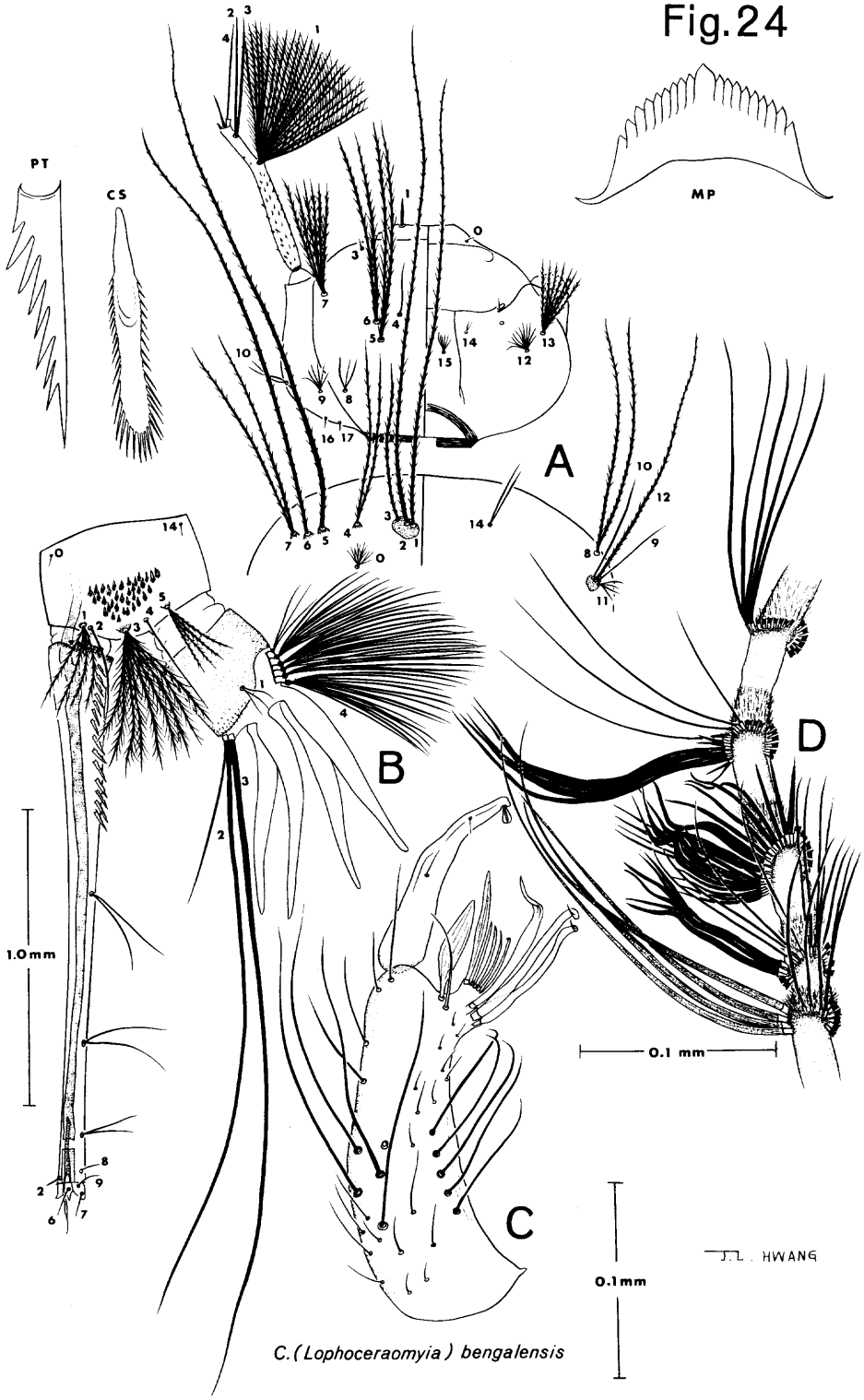
MALE. *Head.* Proboscis with a series of 8 or more short, basoventral bristles. *Antenna.* (Figure 24D). Flagellomere V with a tuft of from 1 to 4 long, strong setae which extend beyond the base of VIII; VI with an internal tuft of 6 or more broad, gently sigmoid setae which have filamentous apices; VII with a dense tuft of 10 or more fine spines which are sharply bent and a tuft of approximately 5 or more strong, darkly pigmented, gently curved setae; VIII with a tuft of from 5 to 8 long, gently curved spines; IX with a tuft of from 4 to 7 strong, straight setae. *Terminalia.* (Figure 24C). Basimere with 4 or 5 submarginal setae inserted in a line; subapical lobe with the internal rod expanded distally, frequently pointed, and slightly longer than the central and external rods which are subequal in length and hooked; internal leaflet bladelike, gently curved, external leaflet rather narrow, symmetrical and striated; 4 narrow, subequal, bladelike accessory setae present, at least 2 of which are hooked; distimere normal in shape, without annulations or retrorse spines on the convex surface; lateral plate of the phallosome with the internal process rather broad, gently curved and pointed, not exceeding the apex of the dorsal process (not illustrated); dorsal process with a spiculate apical knob and approximately 10 teeth on the lateral margin.

LARVA. (Figure 24A, B). *Head.* Antenna with a narrow dark basal ring; head hair 4-C single, simple; 5, 6-C bifid, pectinate, subequal in length; 16, 17-C developed as relatively long, simple spines. *Thorax.* Integument glabrous; 3-P single, pectinate, shorter and slenderer than 1, 2-P; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7, 8-P bifid, pectinate; 14-P bifid, simple. *Abdomen.* Integument glabrous; hair 6-III usually trifid; comb consisting of from 35 to 50 fan-shaped scales arranged in a broad, triangular patch; siphon index variable, ranging from 6.5:1 to 9:1 (average, 7.6:1); 3 pairs of subventral tufts inserted in a line on the siphon; individual tufts bifid, their length greater than the width of the siphon at the point of insertion; pecten consisting of from 12 to 15 teeth restricted to the basal third to fourth of the siphon; individual pecten tooth with a prominent apical spine and approximately 7 lateral barbs which become progressively larger from apex to base.

TYPE DATA. Lectotype male (head and terminalia mounted on separate slides, the rest of the specimen missing) from Nongpoh, Assam, in the British Museum.

DISTRIBUTION. In THAILAND**, this species has been collected from *Ranong* and *Narathiwat*. The species is also known from ASSAM, HAINAN ISLAND, and MALAYA. During this study the following specimens of *bengalensis* have been examined: 6 males, 3 females, and 6 larvae.

TAXONOMIC DISCUSSION. In the adult stage this species demonstrates its closest affinity to *minor;* however, the tuft on antennal flagellomere V and the chaetotaxy of the basimere are distinctive. The fourth stage larva is most similar to *mammilifer* and some specimens cannot always be separated with certainty; differences in chaetotaxy, as summarized in the key, may be useful in separating the 2 species.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J.L. HWANG
C.(Lophoceraomyia) bengalensis

BIOLOGY. In Malaya, larvae were collected from a rock pool, a streamside pool, and a tree hole. In Thailand, collections have been made from elephant hoof prints, a stream margin, and a tree stump hole during the month of September. Nothing is known of the adult habits.

CULEX (LOPHOCERAOMYIA) EUKRINES BRAM AND RATTANARITHIKUL 1967 (Figure 25)

Culex (Lophoceraomyia) eukrines Bram and Rattanarithikul 1967, Proc. ent. Soc. Wash. 69: 11 (♂*, ♀, L*).

The adult male exhibits an internal tuft with from 3 to 5 gently curved setae on antennal flagellomere VII and a tuft of obviously modified, dark, strong setae on flagellomere IX. The fourth stage larva may be immediately recognized by the head hair 6-C which is always single and stout.

FEMALE. *Thorax.* Integument of the pleuron pale, without distinct patches of scales; 1 lower mesepimeral bristle present. *Abdomen.* Terga dark brown; sterna somewhat lighter.

MALE. *Head.* Proboscis with a series of 6 or more short, basoventral bristles. *Antenna.* (Figure 25D). Flagellomere V with a tuft of 6 or more very fine setae extending beyond the tuft of IX; VI with a tuft of 5 or more gently curved setae; VII with an internal tuft of from 3 to 5 gently sigmoid setae and several shorter, straight setae; VIII with a tuft of from 4 to 6 strong, gently curved setae; IX with a tuft of from 3 to 5 long, strong, dark setae. *Terminalia.* (Figure 25C). Basimere with 5 or 6 rather weak submarginal setae; subapical lobe of the basimere with the internal rod slightly expanded subapically, then bent and with an extended, lightly sclerotized hooked apex; central and external rods subequal in length, sharply hooked; 4 blade-like accessory processes present; internal leaflet rod-like, gently bent; external leaflet slender, striate; distimere normal, without distal serrations or annulations; lateral plate of the phallosome with the internal process rather small, gently curved, not exceeding the apex of the dorsal process; dorsal process with an apical spiculate knob and approximately 15 short, but distinct teeth on the lateral margin.

LARVA. (Figure 25A, B). *Head.* Antenna with a narrow, dark basal ring and progressively darker beyond insertion of hair 1-A; head hair 4-C single, simple; 5-C usually bifid, sometimes single, pectinate; 6-C always single, pectinate, somewhat stouter than the individual branches of 5-C; 16, 17-C represented by minute spicules. *Thorax.* Integument glabrous; 3-P single, pectinate, shorter and slenderer than 1, 2-P; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P single or bifid, pectinate; 8-P single, pectinate; 14-P bifid, simple. *Abdomen.* Integument glabrous; comb consisting of from

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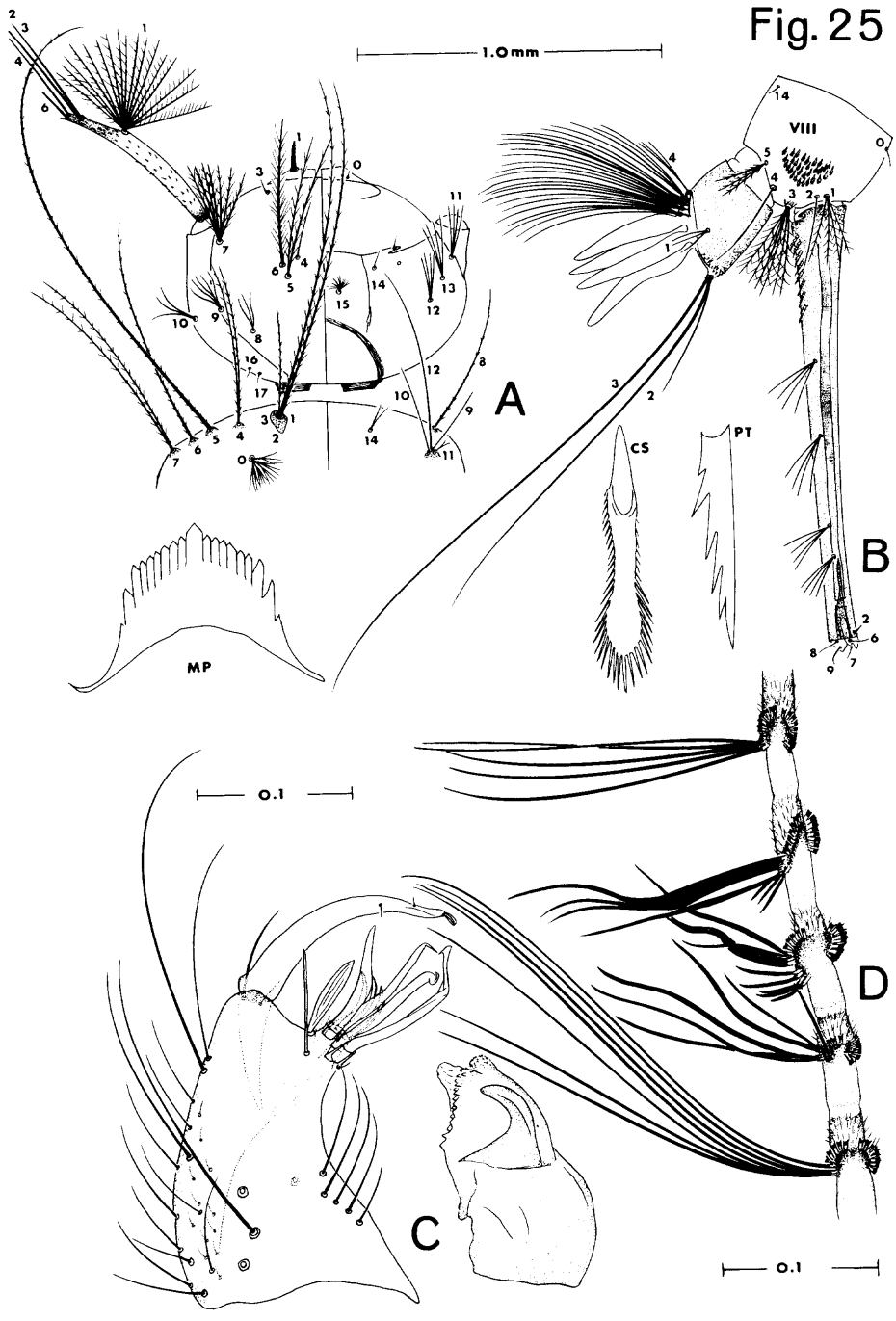
Figure 24. *C. (Lophoceraomyia) bengalensis.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere and distimere of the male terminalia; D, lateral aspect of male antennal flagellomeres V through IX.

Fig. 25



C.(Lophoceraomyia) eukrines

J.L. HWANG

35 to 50 elongate, fan-shaped scales arranged in a broad triangular patch; siphon index variable, ranging from 7:1 to 10:1 (average, 8.2:1); 4 pairs of subventral tufts inserted in a line on the siphon; individual tufts with from 2 to 4 branches, their length greater than the width of the siphon at the point of insertion; pecten consisting of from 8 to 12 teeth restricted to the basal third to fourth of the siphon; individual pecten tooth with a prominent distal spine and from 5 to 9 lateral barbs, the proximal 2 or 3 barbs more prominent than the distal barbs.

TYPE DATA. Holotype male (associated larval and pupal skins and terminalia slide-mounted) from Kanchanaburi, Thailand in the U. S. National Museum.

DISTRIBUTION. This species is known from 24 collections from *Kanchanaburi* and 1 collection each from *Nakhon Nayok* and *Trang*, THAILAND.

During this study 14 individual rearings were examined, as well as 17 additional males, 21 additional females, and 120 larvae.

TAXONOMIC DISCUSSION. The adult stage (both male and female) demonstrates affinity to the *traubi-ganapathi* species complex but the distinctive larva seems to exclude it from this group. The adult male is differentiated from the member of the *traubi-ganapathi* complex by the presence of an internal tuft of from 3 to 5 gently sigmoid setae on flagellomere VII; it differs from *peytoni* by lacking accessory setae on the basal third of the distimere and by possessing approximately 15 teeth on the lateral margin of the dorsal process of the phallosome; it differs from *spiculosus* on the basis of the internal rod on the subapical lobe of the basimere. The fourth stage larva is recognized by head hair 6-C which is always single, stout, and apparently somewhat flattened.

BIOLOGY. Larvae of *eukrines* have been collected predominantly from bamboo internodes, but additional collections have been made from rock holes, flood pools, a coconut shell, a wheel track, a tree hole, and a pandanus axil, always in close association with bamboo groves in rain forest. Collections were made during the months of March, and May through October. Nothing is known of the habits or biology of the adults.

CULEX (LOPHOCERAOMYIA) FUSCOSIPHONIS BRAM AND RATTANARITHIKUL 1967
(Figure 26)

Culex (Lophoceraomyia) fuscosiphonis Bram and Rattanarithikul 1967, Proc. ent. Soc. Wash. 69: 14 (♂*, ♀, L*).

The adult male is recognized by flagellomere V lacking a conspicuous tuft of long, broad scales, by having the prominent submarginal setae inserted

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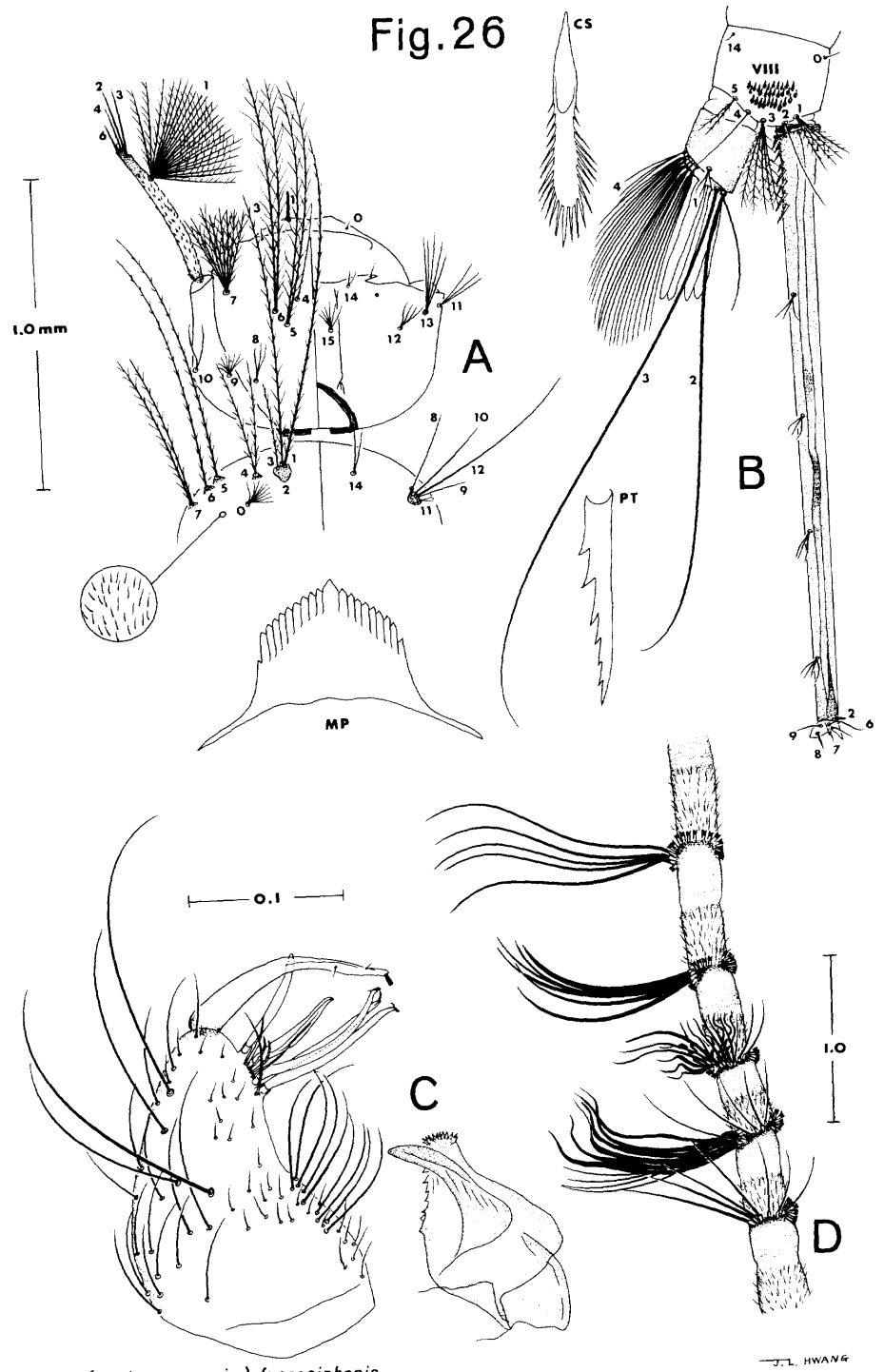
Figure 25. *C. (Lophoceraomyia) eukrines*. A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through IX.

Fig. 26



C. (Lophoceraomyia) fuscosiphonis

in 2 irregular rows on the basimere, and by the internal process of the lateral plate of the phallosome projecting beyond the apex of the dorsal process. The fourth stage larva exhibits a long, darkly pigmented siphon with 4 pairs of fine, rather short subventral tufts and thoracic hair 8-P is single, simple.

FEMALE. *Thorax.* Integument of the pleuron pale, without distinct patches of scales; 1 lower mesepimeral bristle present. *Abdomen.* Terga dark brown; sterna somewhat lighter.

MALE. *Head.* Proboscis with a series of 6 or more short, basoventral bristles. *Antenna.* (Figure 26D). Flagellomere V with an internal tuft of from 5 to 7 narrow, acute setae whose apices do not reach beyond VII; VI with a tuft of 6 or more strong, bent setae; VII with a similar, but shorter and more prominently sigmoid tuft of setae; VIII with a tuft of approximately 6 strong, gently curved setae; IX with a tuft of from 3 to 5 strong, rather long, dark setae. *Terminalia.* (Figure 26C). Basimere with approximately 9 submarginal setae inserted in 2 parallel, but irregular, rows; subapical lobe of the basimere with the internal rod rather broad, constricted at the apex and filamentous beyond the constriction; the central and external rods subequal in length, hooked; internal leaflet rod-like; external leaflet slender, striate; 4 short, accessory setae present; distimere normal, without apical annulations; lateral plate of the phallosome with the internal process rather narrow, gently curved and pointed, projecting beyond the apex of the dorsal process; dorsal process with a spiculate apical knob and approximately 10 short teeth on the lateral margin.

LARVA. (Figure 26A, B). *Head.* Antenna with a narrow, dark basal ring and darker beyond insertion of 1-A; head hair 4-C single, simple; 5, 6-C bifid, pectinate; 16, 17-C absent. *Thorax.* Integument covered with a sparse pattern of extremely fine, rather long spicules; 3-P single, pectinate, shorter and slenderer than 1, 2-P; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P bifid, pectinate; 8-P single, simple; 14-P bifid, simple. *Abdomen.* Integument covered with a pattern of spicules similar to that of the thorax; hair 6-I trifid; comb consisting of from 30 to 45 elongate, fan-shaped scales arranged in a broad triangular patch; siphon index variable, ranging from 10:1 to 12.6:1 (average, 11.8:1); 4 pairs of subventral tufts inserted in a line on the siphon; individual tufts fine, with from 2 to 4 branches, their length approximately equal to the width of the siphon at the point of insertion; pecten consisting of from 7 to 10 teeth restricted to the basal fourth or less of the siphon; individual pecten tooth slightly curved, with a prominent distal spine and with from 6 to 10 lateral barbs; distal barbs fine, proximal barbs coarse and conspicuous; siphon and anal segment very darkly pigmented, more so than in any other species of the subgroup. The association of the larva with the male is presumptive; larvae were collected along with a pupa from which the holotype male was reared.

Figure 26. *C. (Lophoceraomyia) fuscosiphonis.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through IX.

TYPE DATA. Holotype male (terminalia and antennae slide-mounted) from Phattalung, Thailand in the U. S. National Museum.

DISTRIBUTION. This species is known from THAILAND from: *Phattalung*, *Trat*, and *Trang*. During this study 2 males reared from pupae have been examined, as well as 1 female with associated larval and pupal skins, and 13 larvae.

TAXONOMIC DISCUSSION. The adult male of *fuscosiphonis* demonstrates close affinity to *demissus* (a species known only from Selangor, Malaya) and cannot be separated on the basis of the terminalia alone; however, the internal tuft of antennal flagellomere V in *fuscosiphonis* does not exhibit the distinctively long setae which are said to be present in *demissus*. The fourth stage larva exhibits close similarities with *wilfredi*, but may be distinguished on the basis of the very darkly pigmented siphon and anal segment and by hair 2 of the anal segment which is bifid in the case of *fuscosiphonis* and trifid in *wilfredi*.

BIOLOGY. Larvae have been collected in tree holes and root holes in a primary rain forest and a secondary scrub stand. Nothing is known of the adult habits or biology.

CULEX (LOPHOCERAOMYIA) GANAPATHI COLLESS 1965
(Figure 27)

Culex (Lophoceraomyia) ganapathi Colless 1965, J. med. Ent. 2: 294 (♂*, ♀, L*).

The adult male may be recognized by the single row of submarginal setae on the basimere of the terminalia, by the absence of a tuft of modified setae on antennal flagellomere IX, and by the tuft of long, narrow, pointed scales on flagellomere V. The fourth stage larva possesses 4 pairs of strong, subventral tufts on the siphon, the thoracic integument covered with fine spicules, the abdomen glabrous, and head hair 1-C usually expanded on the basal half.

FEMALE. *Thorax*. Integument of the pleuron dull brown, without distinct patches of pale scales; 1 lower mesepimeral bristle present. *Abdomen*. Terga dark; sterna somewhat paler.

MALE. *Head*. Proboscis without distinctive dorsal or ventrolateral setae, but with a series of 6 or more short, basoventral bristles. *Antenna*. (Figure 27D). Flagellomere V with a tuft of from 3 to 6 narrow, tapering, pointed scales which almost extend to the tuft on VIII; VI with a tuft of 10 or more strong, gently curved scales which have filamentous apices; VII with a tuft of 7 or more narrow, rather short, sharply bent scales followed by from 3 to 6 stronger, longer and kinked scales; VIII with a prominent tuft of 6 or more strong, darkly pigmented curved setae; IX without modified scales or

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Figure 27. *C. (Lophoceraomyia) ganapathi*. A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through IX.

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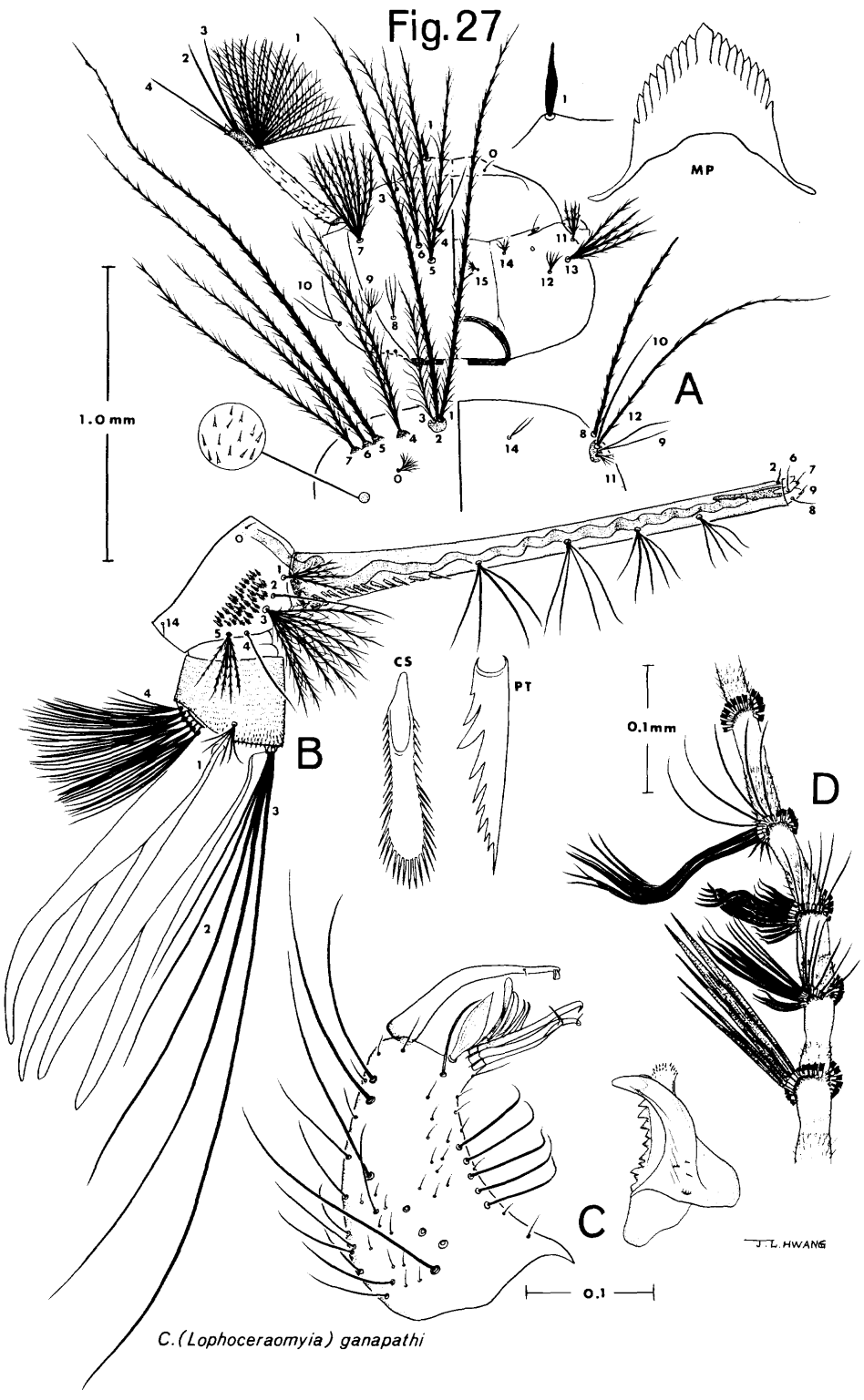


Fig. 27
MP
A
1.0 mm
B
CS
PT
0.1mm
D
C
J.L. HWANG
0.1
C.(Lophoceraomyia) ganapathi

setae. *Terminalia.* (Figure 27C). Basimere with from 4 to 6 fine submarginal setae inserted in a line; subapical lobe of the basimere with the internal rod slightly expanded subapically, then tapering to a fine hook; central and external rods close to and slightly longer than the internal rod, hooked; internal leaflet strong, rod-like, expanded and gently bent on the central third; external leaflet rather short, narrow, symmetrical, slightly pointed apically and striate; 3 rather broad, subequal, curved accessory setae present; distimere normal in shape, occasionally with a fine, indistinct crest on the apex (not illustrated); lateral plate of the phallosome with the internal process broad, gently curved and pointed; dorsal process with an apical knob which is spinose only on the apical surface and with approximately 15 denticles on the lateral margin.

LARVA. (Figure 27A, B). *Head.* Antenna with a narrow, dark basal ring and darker beyond insertion of 1-A; head hair 1-C darkly pigmented, usually swollen on the basal half, then abruptly narrowed or occasionally branched; 4-C single (infrequently bifid on 1 side), very finely and sparsely barbed (a condition too fine to be shown in the illustration); 5, 6-C bifid, pectinate, subequal in length; 16, 17-C represented by extremely minute, rather closely placed spines which may be bifid. *Thorax.* Integument covered with fine spicules; 3-P single, pectinate, shorter and slenderer than 1, 2-P; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P bifid, pectinate; 8-P single, pectinate; 14-P usually bifid, simple (occasionally single or trifid on one side). *Abdomen.* Integument mostly smooth; hair 6-I trifid; comb consisting of from 35 to 45 fan-shaped scales arranged in a broad, triangular patch; siphon index variable, ranging from 7:1 to 11:1 (average, 8.3:1); 4 pairs of subventral tufts inserted in a line on the siphon; individual tufts with from 3 to 5 strong branches of decreasing length from base to apex, the length of the basal pair approximately 4 times the width of the siphon at the point of insertion; pecten consisting of from 9 to 14 teeth restricted to less than the basal third of the siphon; individual pecten tooth with a fine distal spine and from 5 to 9 graded lateral barbs.

TYPE DATA. Holotype male (associated larval and pupal skins and terminalia slide-mounted) from Selangor, Malaya in the Australian National Insect Collection, Canberra.

DISTRIBUTION. Specimens of *ganapathi* have been studied from 123 collections in THAILAND** from: *Chanthaburi, Chiang Mai, Chumphon, Kampong Pate, Kanchanaburi, Nakhon Nayok, Nakhon Ratchasima, Narathiwat, Phattalung, Ranong, Tak,* and *Trang.* This species is also known from *Ulu Langat, Ulu Gombak,* and *Rantau Panjang,* MALAYA.

The following specimens were examined during the course of this study: 61 males, 38 of which had associated larval and pupal skins; 29 females with their associated larval and pupal skins; and 308 larvae. Included among the specimens examined were male and female paratypes, both with associated larval and pupal skins.

TAXONOMIC DISCUSSION. *C. ganapathi* belongs to the species complex which also includes *traubi, spiculosus,* and *peytoni.* These 4 species are indistinguishable as females and the males may be recognized primarily on the basis of the specialized scales and setae on flagellomeres V through IX; the fourth stage larvae are also similar, but differences exist in integumental spiculation and chaetotaxy.

BIOLOGY. In Malaya this species was collected primarily from larval

habitats in association with bamboo and secondarily from tree holes. In Thailand, 52 collections were made from tree holes and 44 from bamboo, suggesting an equal preference for these two types of habitats. Other habitats from which larvae were collected included: root holes and stump holes, stream pools, stream margins, rock pools, a coconut shell, a can, a water jug, and a pandanus axil. Collections were made from April through November. Nothing is known of the adult biology.

CULEX (LOPHOCERAOMYIA) MAMMILIFER (LEICESTER) 1908
(Figure 28)

Lophoceratomyia mammilifer Leicester 1908, Cul. Malaya: 128 (♂, ♀); Edwards 1913, Bull. ent. Res. 4: 236 (placed *bicornutus* as synonym).

Culex (Lophoceratomyia) mammilifer (Leicester): Edwards 1922, Indian J. med. Res. 10: 281, 473 (key); Barraud 1924, Indian J. med. Res. 12: 43 (♂); Edwards 1928, Bull. ent. Res. 18: 276 (L); Barraud 1934, Fauna Brit. India, Diptera 5: 374 (♂*, L); Baisas 1935, Philipp. J. Sci. 57: 174 (♂*).

Culex (Lophoceraomyia) mammilifer (Leicester): Bohart 1945, Navmed 580: 75 (distribution); Mattingly 1949, Proc. R. ent. Soc. Lond. (B) 18: 227 (L); Colless 1965, J. med. Ent. 2: 287 (♂*, ♀, L*); Delfinado 1966, Mem. Amer. ent. Inst. 7: 109 (♂*, L*, P*).

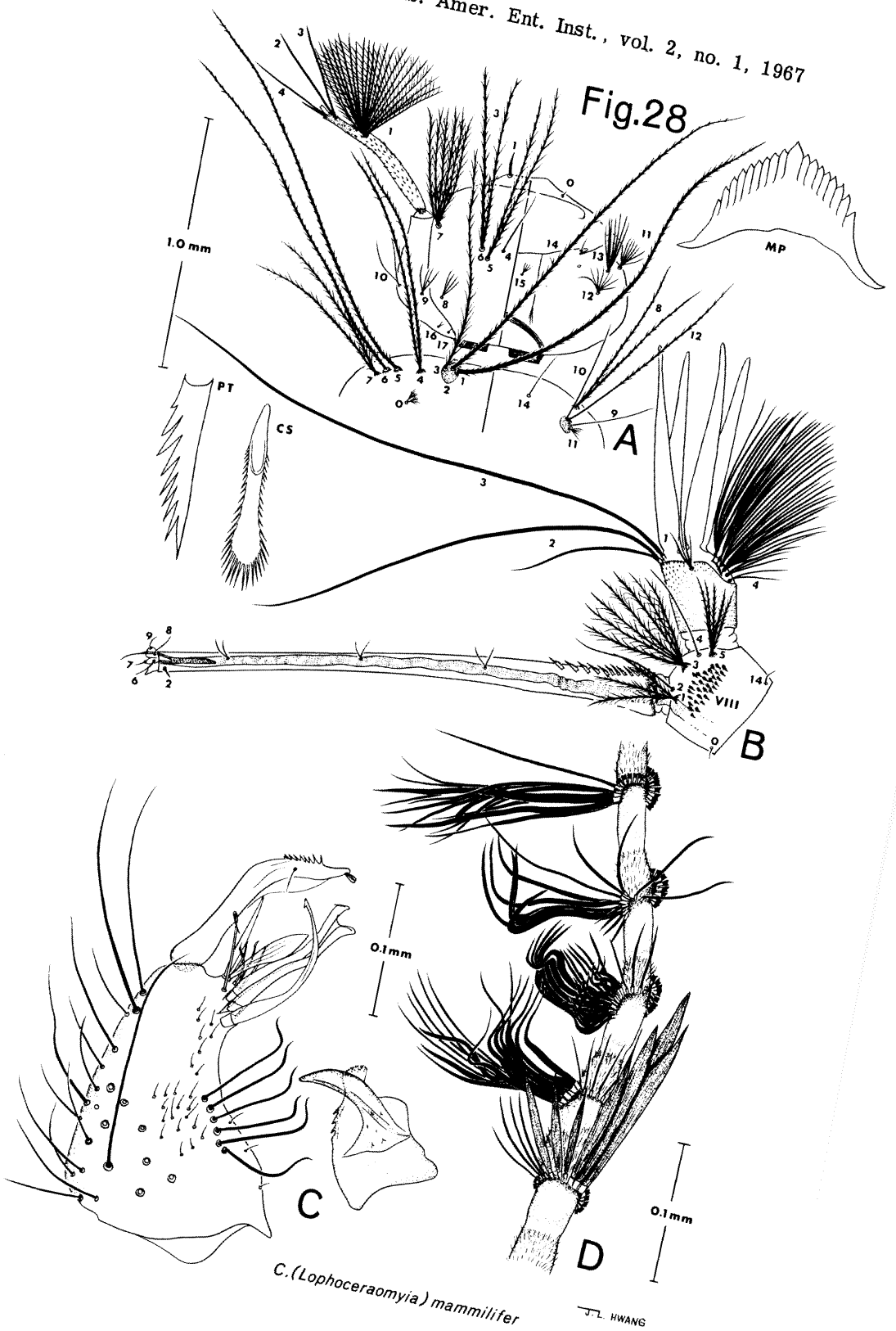
Culex (Lophoceratomyia) chiungchungensis Hsu 1963, Acta ent. Sinica 12: 231 (♂*, L*); Colless 1965, J. med. Ent. 2: 287 (synonymy).

The adult male may be recognized by the long, broad scales on antennal flagellomere V and by the 6 to 8 submarginal setae on the basimere. The fourth stage larva exhibits only 3 pairs of subventral tufts on the siphon and thoracic hair 14-P is single.

FEMALE. *Thorax*. Integument of the pleuron dull brown, without distinct patches of pale scales; 1 weak lower mesepimeral bristle present. *Abdomen*. Terga uniformly dark brown; sterna pale.

MALE. *Head*. Proboscis without conspicuous dorsal setae, but with numerous short ventral setae and a group of 10 or more short, basoventral bristles. *Antenna*. (Figure 28D). Flagellomere V with a tuft of from 1 to 4 broad scales which extend to the tuft on VIII, followed by 3 or 4 more ventral scales which are sharply pointed and shorter, and several long hairs; VI with a comb-like tuft of 10 or more short, dark, bent scales; VII with a similar but shorter tuft in which the scales are more prominently bent and with a secondary tuft of broader, longer scales; VIII with a tuft of 8 or more strong, darkly pigmented and strongly curved setae; IX with 7 or more strong, straight, modified hairs. *Terminalia*. (Figure 28C). Basimere with from 6 to 8 long, prominent submarginal setae which are distinctly bent medially; subapical lobe of the basimere with the basal rods subequal in length, the internal rod slightly expanded and curved distally; internal leaflet developed as a rod-like structure, external leaflet broader, symmetrical, and minutely striate; 4 or 5 accessory setae present; distimere normal in shape, with very fine retrorse spines forming a crest on the convex surface of the apical fifth; lateral plate of the phallosome with the internal process rather broad, gently, but slightly curved, bluntly rounded and projecting beyond the apex of the

Fig.28



C.(Lophoceraomyia) mammilifer

J.L. HWANG

dorsal process; dorsal process with a spiculate apical knob and with from 3 to 6 small denticles on the lateral margin.

LARVA. (Figure 28A, B). *Head.* Antenna with a narrow, dark basal ring and slightly darker beyond insertion of hair 1-A; head hair 4-C single, simple, very long; 5, 6-C bifid, pectinate, subequal in length; 16, 17-C represented by well developed spicules which may be single but usually at least 1 of the pair has up to 4 branches. *Thorax.* Integument usually glabrous, but occasionally the prothorax exhibits light spiculation anterolaterally (not illustrated); 3-P single, pectinate, shorter and slenderer than 1, 2-P; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7, 8-P bifid, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; hair 6-III with 4 branches; comb consisting of from 33 to 45 fan-shaped scales arranged in a broad, triangular patch; siphon index variable, ranging from 7.5:1 to 12:1 (average, 9:1); 3 pairs of subventral tufts inserted in a line on the siphon; individual tufts usually bifid, occasionally single, their length approximately equal to the width of the siphon at the point of insertion; pecten consisting of from 10 to 14 teeth restricted to the basal third or less of the siphon; individual pecten tooth with a fine distal spine and from 6 to 9 graded lateral barbs.

TYPE DATA. Lectotype male (terminalia and antenna slide-mounted) of *mammilifer* from Raub, Pahang, Malaya in the British Museum. The type locality of *chiungchungensis* is Chiungchung siang, Hainan Island, but the location of the type specimen is unknown.

DISTRIBUTION. In THAILAND, *mammilifer* has been collected from: *Chiang Mai, Kanchanaburi, Lampang, Nakhon Ratchasima, Narathiwat,* and *Yala.* This species has also been recorded from MALAYA, INDIA, CEYLON, ANDAMAN ISLANDS, HAINAN ISLAND, BORNEO, and the PHILIPPINES.

During this study 10 males (3 with associated larval and pupal skins) have been studied in addition to 3 females with associated larval and pupal skins, and 12 larvae.

TAXONOMIC DISCUSSION. This species demonstrates its closest affinity to *pholeter,* since in the male both species exhibit a conspicuous tuft of from 1 to 4 long, broad scales on antennal flagellomere V; however, differences in the male terminalia of the 2 species are distinctive. In the fourth stage larva, *mammilifer, bengalensis,* and *minor* possess only 3 pairs of subventral tufts on the siphon, but they are readily separated by differences in thoracic and abdominal chaetotaxy and in the latter species by the 2 distinct types of comb scales.

BIOLOGY. Larvae have been commonly collected from container habitats, axils of Nipa palms, and ground pools. Additional habitats from Thailand include hoof prints, elephant tracks, seepage springs, and bamboo internodes and stump holes. Collections were made during the months of April, May, June, September, and October. Habits of the adults are unknown, but they rarely, if ever, bite man and have, on occasion, been collected in

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Figure 28. *C. (Lophoceraomyia) mammilifer.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through IX.

light traps.

CULEX (LOPHOCERAOMYIA) MINOR (LEICESTER) 1908
(Figure 29)

Lophoceratomyia minor Leicester 1908, Cul. Malaya: 126 (♂); Edwards 1917, Bull. ent. Res. 17: 227 (♂, L); Borel 1926, Arch. Insts. Pasteur Indo-Chine 3-4: 35 (♂*, ♀, L*); Borel 1930, Monogr. Coll. Soc. Pat. exot. 3: 356 (♂*, ♀, L*).

Lophoceratomyia bicornuta Theobald 1910, Rec. Indian Mus. 4: 25 (♂); Edwards 1932, *in* Wytsman, Genera Insect., fasc. 194: 198 (as synonym of *mammilifer*).

Culex (Lophoceraomyia) bicornutus (Theobald): Colless 1965, J. med. Ent. 2: 291 (resurrected from synonymy with *mammilifer*, ♂*, ♀, L*). NEW SYNONYMY.

Culex (Lophoceratomyia) minor (Leicester): Edwards 1922, Indian J. med. Res. 10: 282 (key); Barraud 1924, Indian J. med. Res. 12: 44 (♂*); Edwards 1928, Bull. ent. Res. 18: 276 (key); Edwards and Given 1928, Bull. ent. Res. 18: 352 (L); Barraud 1934, Fauna Brit. India, Diptera 5: 370 (♂*, L); Safyanova *et al.* 1964, Zool. Zhur. 43: 1178 (distribution).

Culex (Lophoceratomyia) nolledoi Baisas 1935, Philipp. J. Sci. 57: 170 (♂*); Bohart 1945, Navmed 580: 76 (♂*); Colless 1965, J. med. Ent. 2: 289 (synonymy).

Culex (Lophoceraomyia) minor (Leicester): Mattingly 1949, Proc. R. ent. Soc. Lond. (B) 18: 227 (key); Colless 1965, J. med. Ent. 2: 289 (♂*, ♀, L*); Delfinado 1966, Mem. Amer. ent. Inst. 7: 111 (♂*, ♀).

The adult male exhibits a tuft of obviously modified dark, strong setae on flagellomere IX, an internal tuft of at least 5 strong, sigmoid setae on flagellomere VII, flagellomere V with a tuft of short, strong setae, 1 lower mesepimeral bristle, and lacks long, ventrolateral setae on the basal half of the proboscis. The fourth stage larva possesses a comb with 2 distinct types of scales.

FEMALE. *Thorax.* Integument of the pleuron dull brown, without distinct patches of pale scales; 1 lower mesepimeral bristle present. *Abdomen.* Terga dark; sterna somewhat paler.

MALE. *Head.* Proboscis without distinctive dorsal or ventrolateral setae, but with a series of 8 or more short, basoventral bristles. *Antenna.* (Figure 29D). Flagellomere V with a tuft of from 3 to 5 narrow, pointed strong scales which extend only slightly beyond the tuft on VI and several additional fine setae; VI with a comblike tuft of 10 or more dark, bent scales;

Figure 29. *C. (Lophoceraomyia) minor.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; A', enlarged pecten tooth of *minor* form *bicornutus;* B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through IX.

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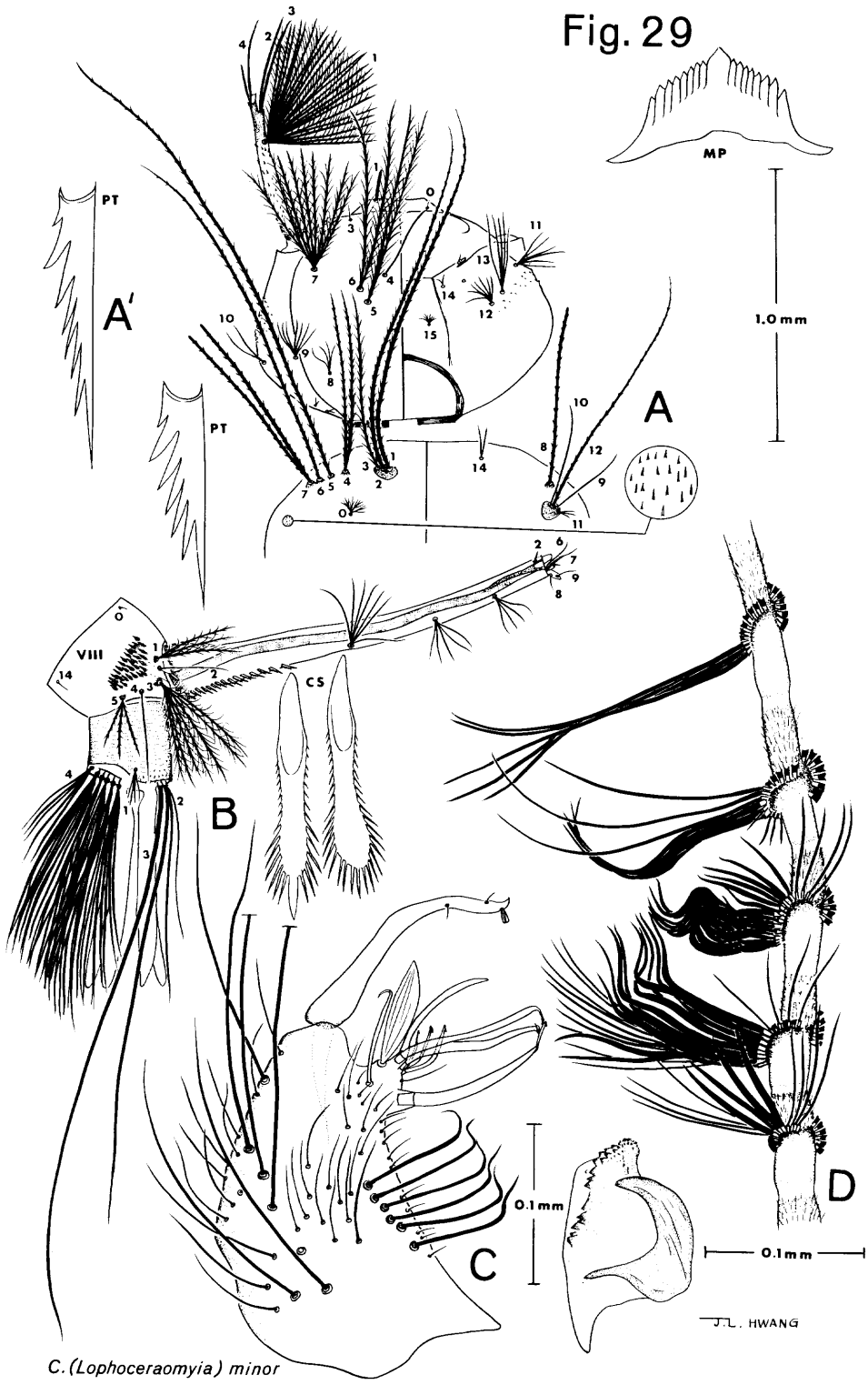

C. (Lophoceraomyia) minor

VII with a similar but shorter tuft of 5 or more sigmoid setae and a secondary tuft of broader, longer, sigmoid scales; VIII with a prominent tuft of 7 or more strong, darkly pigmented, gently curved setae; IX with 5 or more strong, straight setae. *Terminalia*. (Figure 29C). Basimere with from 5 to 7 submarginal setae inserted in a straight line, the setae strong and prominently curved; subapical lobe of the basimere with the internal rod separated from the central and external rods, slightly expanded apically, then bent and becoming narrow and terminating in a small hook; central and external rods subequal in length and strength, gently hooked; internal leaflet developed as a rather long, rod-like, gently curved structure; external leaflet symmetrical, striated, and with a slight apical point; 3 or 4 accessory setae present, rather long, blade-like, with 1 or more retrorse apical processes; distimere normal in shape, in some specimens with a few very fine retrorse spines on the convex surface (not illustrated); lateral plate of the phallosome with the internal process rather broad, gently curved and pointed, not exceeding the apex of the dorsal process; dorsal process with a spiculate apical knob and with 10 or more teeth on the lateral margin.

LARVA. (Figure 29A, B). *Head*. Antenna with a narrow, dark basal ring and darker beyond insertion of hair 1-A; head hair 4-C single (occasionally bifid), simple; 5, 6-C bifid, pectinate, subequal in length (5-C may occasionally be trifid); 16, 17-C represented by relatively well developed bifid spicules; a band of very small tubercles curving around the anterior margin of the eye. *Thorax*. Integument predominantly glabrous, but with rather distinctive spiculation on the anterolateral margins of the prothorax; 3-P single, pectinate, shorter and slenderer than 1, 2-P; 4-P usually bifid, pectinate (occasionally trifid); 5, 6-P single, pectinate; 7-P usually bifid, pectinate, but sometimes with from 1 to 4 branches; 8-P single, pectinate; 14-P usually bifid, simple, occasionally trifid. *Abdomen*. Integument glabrous; comb consisting of from 30 to 50 scales arranged in a broad, somewhat triangular patch; the posterior row of scales pointed and fringed with fine spines, the other scales fan-shaped; siphon index variable, ranging from 7:1 to 11:1 (average, 8.3:1; in Malaya the range has been reported by Colless (1965) as 6.7:1 to 8.8:1 with an average of 7.7:1); 3 pairs of subventral tufts present; individual tufts usually 3 or 4 branched, but may range from 2 to 7 branches, their length approximately twice the width of the siphon at the point of insertion; pecten consisting of from 12 to 16 teeth restricted to the basal third or less of the siphon; individual pecten tooth with a fine distal spine and from 4 to 6 graded lateral barbs, the proximal barbs usually more prominent and thicker than the distal barbs.

TYPE DATA. Lectotype male (terminalia mounted and attached to pin; antenna slide-mounted) of *minor* from Ulu Klang, Kuala Lumpur, Malaya in the British Museum. The type locality of *nolledoi* is Kolambugan, Lanao, Philippines, but the type specimen has been lost. The type locality of *bicornulus* is Dawna Hills, near Kawkarech, Lower Burma, but the location of the type specimen is unknown.

DISTRIBUTION. In THAILAND, this species has been studied from: *Chon Buri, Nakhon Ratchasima, Phattalung, Prachin Buri, Ranong, Songkhla, Tak, Trat,* and *Trang*. It is also known from MALAYA, BURMA, and the PHILIPPINES.

The following specimens have been examined from Thailand during the course of this study: 22 males, 12 with associated larval and pupal skins;

7 females, 4 with associated larval and pupal skins; 15 larvae.

TAXONOMIC DISCUSSION. The distinctive larval comb clearly separates this species from other members of the *mammilifer* group; however, the adult male demonstrates affinity to *peytoni*. The relationship of *minor* to *minor* form *bicornutus* will be discussed under the form.

BIOLOGY. Larvae of *minor* are most frequently collected in association with bamboo habitats, but have also been collected in Thailand from tree holes, rock pools, pandanus axils, stream pools, and root holes in jungle areas. Collections were made during March, August, September, and October. Nothing is known of the adult habits.

FORM *BICORNUTUS*
(Figure 29A')

FEMALE. Indistinguishable from *minor* (typical form).

MALE. Indistinguishable from *minor* (typical form) except for the following character: proboscis generally slightly expanded distad of the joint, with a distinct and characteristic ventrolateral series of rather long, curved hairs on the expanded portion.

LARVA. Virtually indistinguishable from *minor* (typical form); the individual pecten tooth has graded lateral barbs (figure 29A'), the basal ones usually not distinctly more prominent and thicker than the distal ones.

DISTRIBUTION. In THAILAND, this form has been studied from *Chiang Mai, Chon Buri, Chumphon, Kanchanaburi, Lampang, Mae Hong Son, Nakhon Nayok, Nakhon Ratchasima, Narathiwat, Phattalung, Prachin Buri, Prachuap Khiri Khan, Ranong, Songkhla, Tak, Trat,* and *Trang.* It has also been reported from MALAYA, western INDIA, lower BURMA, and Hungtow Island, TAIWAN. Specimens have been examined from Con Son, SOUTH VIETNAM**.

The following specimens have been examined during this study: 75 females with associated larval and pupal skins, 87 males with associated larval and pupal skins, 111 larvae, and 69 males and 46 females which probably represent this form.

TAXONOMIC DISCUSSION. Edwards (1932) treated *bicornutus* as a synonym of *mammilifer;* subsequently Colless (1965) properly removed *bicornutus* from the erroneous synonymy and, although recognizing the close anatomical and biological similarity with *minor*, elevated *bicornutus* to species rank. Three primary characteristics (and several variable secondary features) were presented by Colless to support his decision: (1) the presence of a ventrolateral series of rather long, curved hairs on the expanded portion of the male proboscis in *bicornutus*, as opposed to the absence of these hairs in *minor;* (2) the pecten tooth of *bicornutus* with graded lateral barbs in contrast to the condition in *minor* in which the proximal barbs are usually more prominent and thicker than the distal barbs; and (3) the larval habitats of *bicornutus* usually close to the ground and avoiding bamboo, those of *minor* frequently in association with bamboo or tree holes.

Examination of specimens from Thailand strongly suggests at least some area of overlap in these 3 main distinguishing characteristics. Although the condition of the proboscis is clearly distinctive in most instances, 5 male specimens were examined which exhibited a somewhat intermediate condition in which the ventrolateral hairs were present, but weakly developed despite

the presence of typically *bicornutus* pecten teeth on the associated larvae. The shape of the pecten teeth is quite variable, at least in specimens from Thailand. It is not uncommon to see males with well developed ventrolateral hairs on the proboscis but with both types of teeth in the pecten, or conversely, to see males without the ventrolateral hairs but with a typically *bicornutus* pecten. Of 74 collections of *bicornutus* containing individual rearings, 60 were made from habitats close to the ground; however, 3 collections were made from bamboo internodes, 3 from pandanus axils, and 8 from tree holes: of 16 collections of *minor* containing individual rearings, 9 were made from habitats associated with tree holes or bamboo, and 7 were made from rock pools, or on one occasion, a stream pool. It is therefore apparent that ecological separation of the 2 forms in Thailand is not as distinctive as suggested by Colless (1965) from data accumulated in Malaya.

Considering the above data from Thailand, it is felt that *bicornutus* and *minor* should not be recognized as distinct species at the present time, but that their close relationship could best be expressed by accepting *bicornutus* as a recognizable form of *minor*. Future ecological investigations and sibling rearings would undoubtedly contribute much to a more refined and definitive interpretation of this interesting complex.

BIOLOGY. Larvae of form *bicornutus* have been most frequently found in habitats close to the ground. Included among these are: rock pools and holes, stump holes, clay pots, coconut shells, tin containers, elephant prints, stream pools, a spring, seepage pools, and sumps. As indicated above, specimens have also been collected less frequently from bamboo internodes, pandanus axils, and tree holes. Collections have been made during every month of the year except December and February. Nothing is known of the adult habits.

CULEX (LOPHOCERAOMYIA) PEYTONI BRAM AND RATTANARITHIKUL 1967 (Figure 30)

Culex (Lophoceraomyia) peytoni Bram and Rattanarithikul 1967, Proc. ent. Soc. Wash. 69: 7 (♂*, ♀, L*).

The adult male may be recognized by the presence of only a few long hairs on flagellomere V, an internal tuft of at least 5 strongly sigmoid setae on flagellomere VII, a tuft of strong, dark setae on flagellomere IX, and by the internal rod of the subapical lobe of the basimere slightly expanded subapically, followed by a rather broad, gently curved apex. The fourth stage larva possesses a long siphon with 4 pairs of strong, long, subventral tufts; the thoracic integument is covered with fine spicules, but the abdominal integument is mostly smooth; the lateral denticles of the individual pecten teeth are very broad proximally.

FEMALE. *Thorax*. Integument of the pleuron pale, without distinct patches of scales; 1 lower mesepimeral bristle present. *Abdomen*. Terga dark brown; sterna somewhat lighter.

MALE. *Head*. Proboscis with a series of 6 or more short, basoventral bristles. *Antenna*. (Figure 30D). Flagellomere V with a tuft of yel-

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Figure 30. *C. (Lophoceraomyia) peytoni*. A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through IX.

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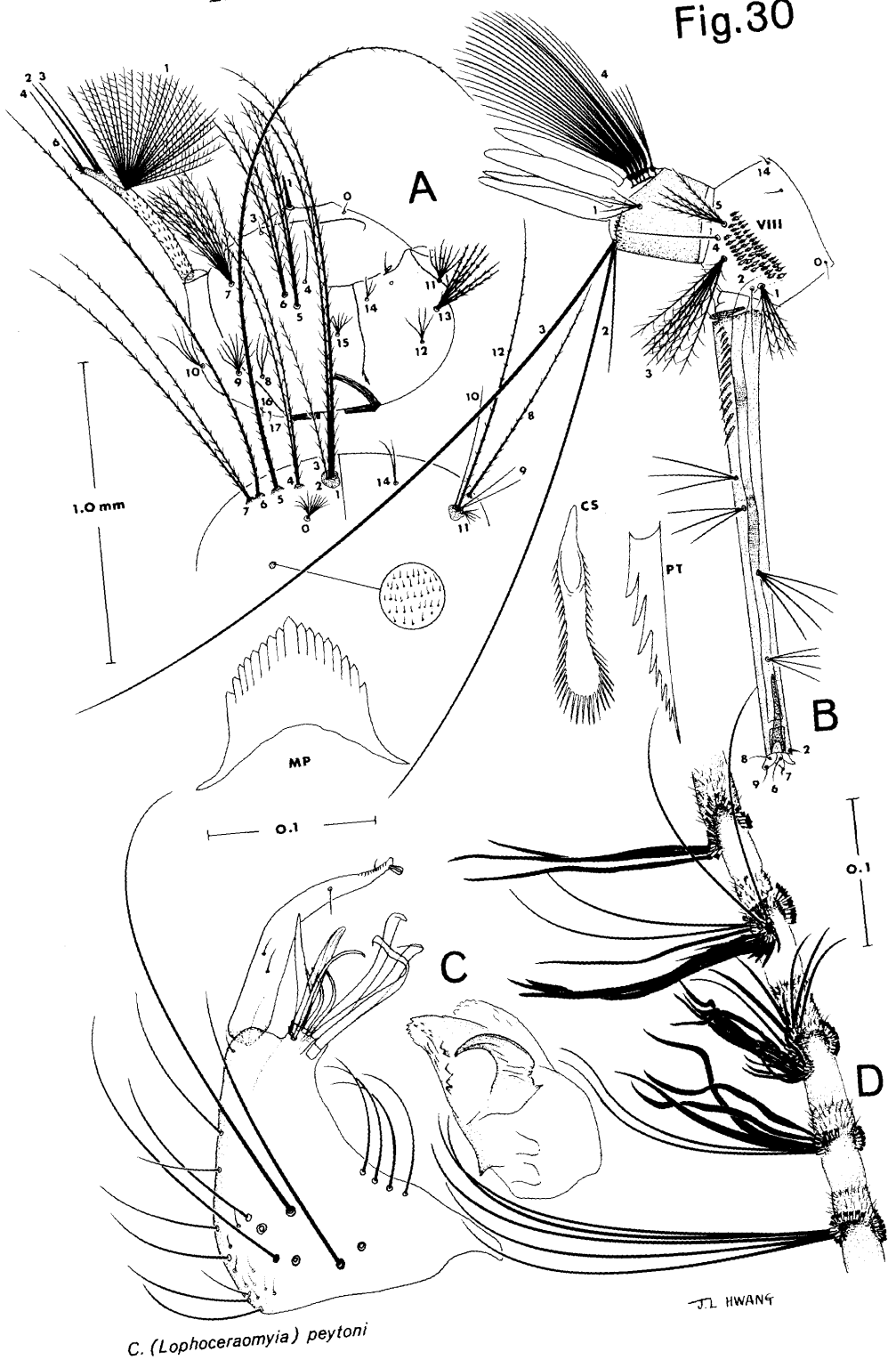
Fig.30



C. (Lophoceraomyia) peytoni

lowish, unmodified hairs which reach to the tuft of IX; VI with a tuft of 4 strong, bent setae and 2 fine, straight setae; VII with a similar but shorter tuft of 5 or more sigmoid setae; VIII with an internal tuft of from 6 to 9 gently curved, dark brown setae; IX with a small internal tuft of 3 strong, rather long, dark setae. *Terminalia.* (Figure 30C). Basimere with a straight row of 4 or 5 strong, submarginal setae; subapical lobe of the basimere with the internal rod slightly expanded subapically, then bent and with a rather broad, lightly sclerotized apex; the central and external rods subequal in length, sharply hooked; accessory processes narrow; internal leaflet rod-like, gently bent; external leaflet slender, striate; distimere with 1 or 2 additional setae on the proximal third, and with minute annulations on the convex surface of the distal third; lateral plate of the phallosome with the internal process small, recurved, and pointed, not exceeding the apex of the dorsal process; dorsal process with a subapical knob and 5 short denticles on the lateral margin.

LARVA. (Figure 30A, B). *Head.* Antenna with a narrow, dark basal ring and progressively darker beyond the insertion of hair 1-A; head hair 4-C single, simple; 5, 6-C bifid, pectinate; 16, 17-C represented by minute spicules which are easily overlooked even in good preparations. *Thorax.* Integument covered with a sparse pattern of fine and rather long spicules; 3-P single, pectinate, shorter and slenderer than 1, 2-P; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P single or bifid, pectinate; 8-P single, pectinate; 14-P bifid, simple. *Abdomen.* Integument glabrous; hair 6-I trifid; comb consisting of a broad, triangular patch of from 35 to 50 elongate, fan-shaped scales; siphon index variable, ranging from 6.6:1 to 9.2:1 (average, 8:1); 4 pairs of subventral tufts inserted in a line on the siphon; individual tufts with from 3 to 5 branches, their length greater than the width of the siphon at the point of insertion; pecten consisting of from 10 to 14 teeth restricted to the basal fourth of the siphon; individual pecten tooth with an extended, fine distal spine, and from 6 to 10 lateral barbs, the basal barb (sometimes the proximal 2 or 3 barbs) very large and rather rounded apically.

TYPE DATA. Holotype male (associated larval and pupal skins and terminalia and antenna slide-mounted) from Phattalung, Thailand in the U. S. National Museum.

DISTRIBUTION. In THAILAND, this species is known from: *Chanthaburi, Chiang Mai, Chumphon, Narathiwat, Phattalung, Ranong, Sara Buri,* and *Trang.*

During this study 16 individual rearings have been examined as well as 4 additional males and 70 larvae.

TAXONOMIC DISCUSSION. *C. peytoni* falls within the *traubi-ganapathi* species complex; its anatomical affinity is closest to *ganapathi,* but the larval biology is rather intermediate. The adult male may be separated from *ganapathi* primarily by the presence of a tuft of modified setae on flagellomere IX and by the presence of 1 or 2 setae on the proximal third of the distimere of the terminalia; the male differs from *traubi* and *spiculosus* by the presence of a tuft of long, narrow, tapering scales on flagellomere V. The fourth stage larva may be distinguished from *ganapathi* by the form of the pecten tooth in which the lateral denticles are very broad basally and by the fact that head hair 1-C is never expanded on the basal half as frequently found in *ganapathi;* the fourth stage larva is distinguished from *traubi* and *spiculosus* by the glabrous abdominal integument and undeveloped median caudal filament.

BIOLOGY. Larvae of *peytoni* have been collected in primary rain forests from tree holes, bamboo internodes, and bamboo stump holes, and 1 collection was made from a rock hole. Collections were made during the months of January, May, and July through November. Habits of the adults are unknown.

CULEX (LOPHOCERAOMYIA) PHOLETER BRAM AND RATTANARITHIKUL 1967 (Figure 31)

Culex (Lophoceraomyia) pholeter Bram and Rattanarithikul 1967, Proc. ent. Soc. Wash. 69: 13 (♂*, ♀, L*).

The adult male is distinguished by flagellomere V possessing a conspicuous tuft of from 1 to 4 long, broad scales, by the presence of 3 long, prominent submarginal setae on the basimere, and by the shape of the internal process of the lateral plate of the phallosome. The fourth stage larva exhibits a long siphon with 4 pairs of long, rather fine, usually bifid subventral tufts and thoracic hair 8-P branched, simple, and reduced in size.

FEMALE. *Thorax.* Integument of the pleuron pale, without distinct patches of scales; 1 lower mesepimeral bristle present. *Abdomen.* Terga dark brown; sterna very pale.

MALE. *Head.* Proboscis with a series of 6 or more short, basoventral bristles. *Antenna.* (Figure 31D). Flagellomere V with from 1 to 4 very broad scales which taper to a sharp point and extend to the tuft of VIII, and several more narrow, but equally long setae; VI with a tuft of 6 or more strong setae which are strongly recurved; VII with a tuft of 4 or more shorter, strongly kinked setae; VIII with a tuft of 5 or more strong, broad, dark setae which exhibit a prominent median bend; IX with an internal tuft of from 3 to 5 long, straight, strong setae. *Terminalia.* (Figure 31C). Basimere with 3 strong, submarginal setae inserted in a straight row; subapical lobe of the basimere with the internal rod tapering to a sharp point and shorter than the central and external rods which are subequal in length and broadly bent at the apex; internal leaflet rod-like, fine; external leaflet narrow, bluntly rounded and striated; accessory processes narrow, setae-like; distimere with minute annulations on the apical third of the convex surface; internal process of the lateral plate of the phallosome small, gently curved, and pointed, not exceeding the apex of the dorsal process; dorsal process with an apical knob and approximately 7 short denticles on the lateral margin.

LARVA. (Figure 31A, B). *Head.* Antenna with a narrow, dark basal ring and progressively darker beyond insertion of hair 1-A; head hair 4-C single, simple; 5, 6-C bifid, pectinate; 16, 17-C represented by small, but distinct spicules. *Thorax.* Integument glabrous; 3-P single, pectinate, shorter and slenderer than 1, 2-P; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P bifid, pectinate; 8-P with 2 or 3 branches, simple, very short and fine; 14-P bifid or trifid, simple. *Abdomen.* Integument glabrous; hair 6-I bifid; comb consisting of a broad, triangular patch of from 60 to 80 elongate, fan-shaped scales; siphon index variable, ranging from 6:1 to 7:1; 4 pairs of subventral tufts inserted in a line on the siphon; individual tufts usually bifid (occasionally trifid or single), their length greater than the width of the siphon at the point of insertion; pecten consisting of from 8 to 11 teeth restricted to approximately the basal third to fourth of the siphon; individual

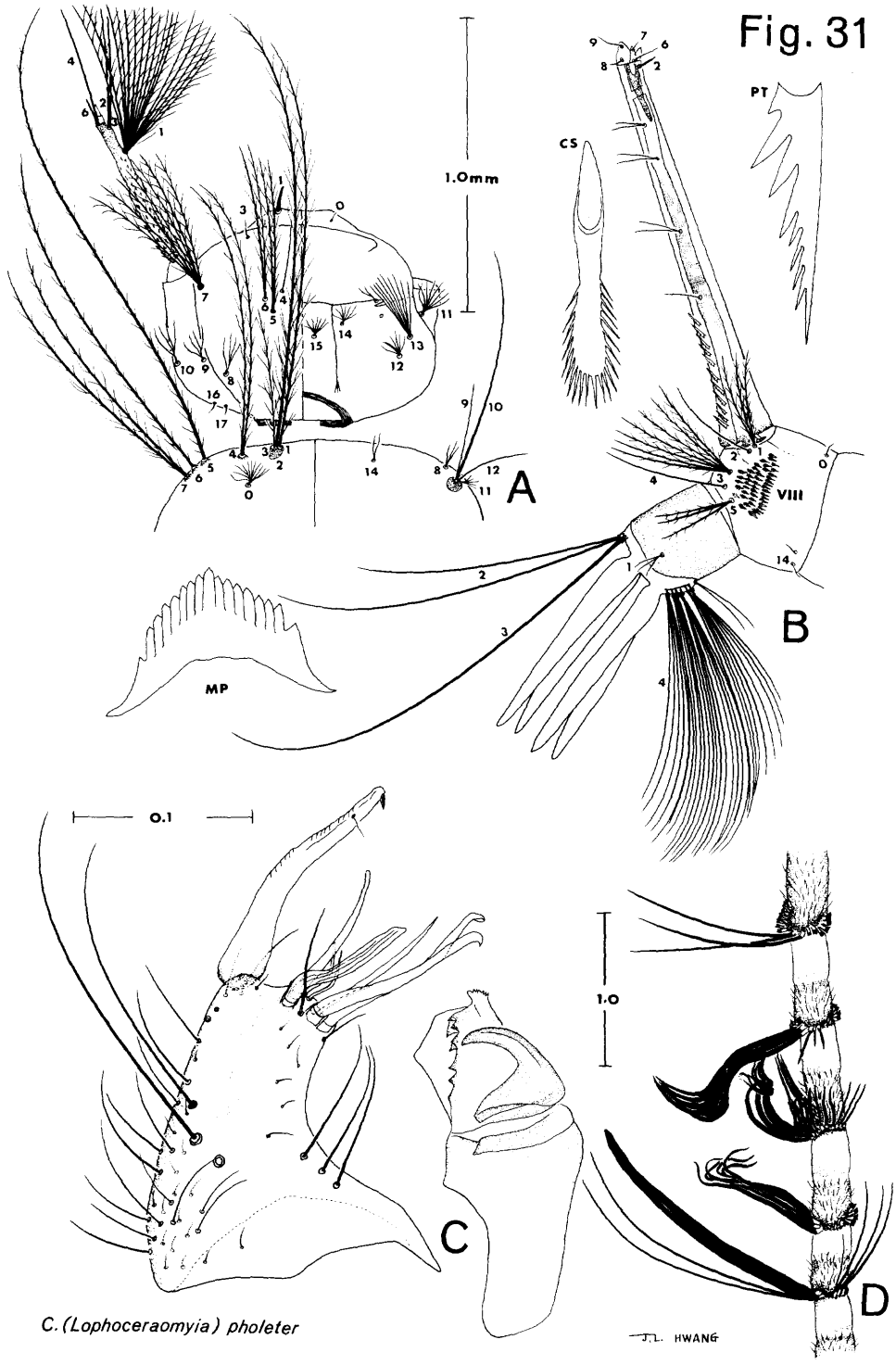


Fig. 31
1.0mm
A
PT
CS
VIII
B
MP
0.1
C
1.0
D
C. (Lophoceraomyia) pholeter
J.L. HWANG

pecten tooth with a prominent distal spine and from 7 to 10 lateral barbs, the proximal 2 barbs very coarse, the distal barbs fine.

TYPE DATA. Holotype male (associated larval and pupal skins and terminalia and antenna slide-mounted) from Chon Buri, Thailand in the U. S. National Museum.

DISTRIBUTION. This species is known only from *Chon Buri*, THAILAND. Three individual rearings were studied as well as 3 additional males and 4 larvae.

TAXONOMIC DISCUSSION. Due to the presence of a tuft of conspicuous, broad scales on flagellomere V, *pholeter* appears to have its closest affinity to *mammilifer;* however, it may be separated from the latter species by having only 3 prominent submarginal setae on the basimere and the internal process of the lateral plate of the phallosome does not project beyond the apex of the dorsal process. The fourth stage larva is also similar to *mammilifer*, but can be recognized by the presence of 4 pairs of subventral tufts on the siphon; the form of thoracic hair 8-P is very distinctive, and abdominal hair 6-I is bifid rather than 3 or 4 branched.

BIOLOGY. Larvae of this species have been collected exclusively from small crab holes in secondary rain forests. Collections were made during the months of June, August, and October. The habits and biology of the adults are unknown.

CULEX (LOPHOCERAOMYIA) SPICULOSUS BRAM AND RATTANARITHIKUL 1967
(Figure 32)

Culex (Lophoceraomyia) spiculosus Bram and Rattanarithikul 1967, Proc. ent. Soc. Wash. 69: 3 (♂*, ♀, L*).

The adult male may be recognized by the absence of conspicuous tufts on flagellomeres V and IX, by the submarginal setae of the basimere arranged in a regular row, and by the internal process of the lateral plate of the phallosome not projecting beyond the dorsal process. The fourth stage larva is characterized by possessing a long siphon with 4 pairs of strong, long, finely pectinate, subventral tufts, having head hair 5-C bifid or trifid, 16, 17-C absent, and having the thoracic and abdominal integument covered with numerous, prominent spicules.

FEMALE. *Thorax.* Integument of the pleuron pale, tinged with green in some specimens; 1 lower mesepimeral bristle present. *Abdomen.* Terga dark brown; sterna slightly lighter.

MALE. *Head.* Proboscis with a series of 6 or more short, basoventral bristles. *Antenna.* (Figure 32D). Flagellomere V with an inconspicuous group of from 6 to 8 very narrow, acute setae whose apices do not

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Figure 31. *C. (Lophoceraomyia) pholeter.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through IX.

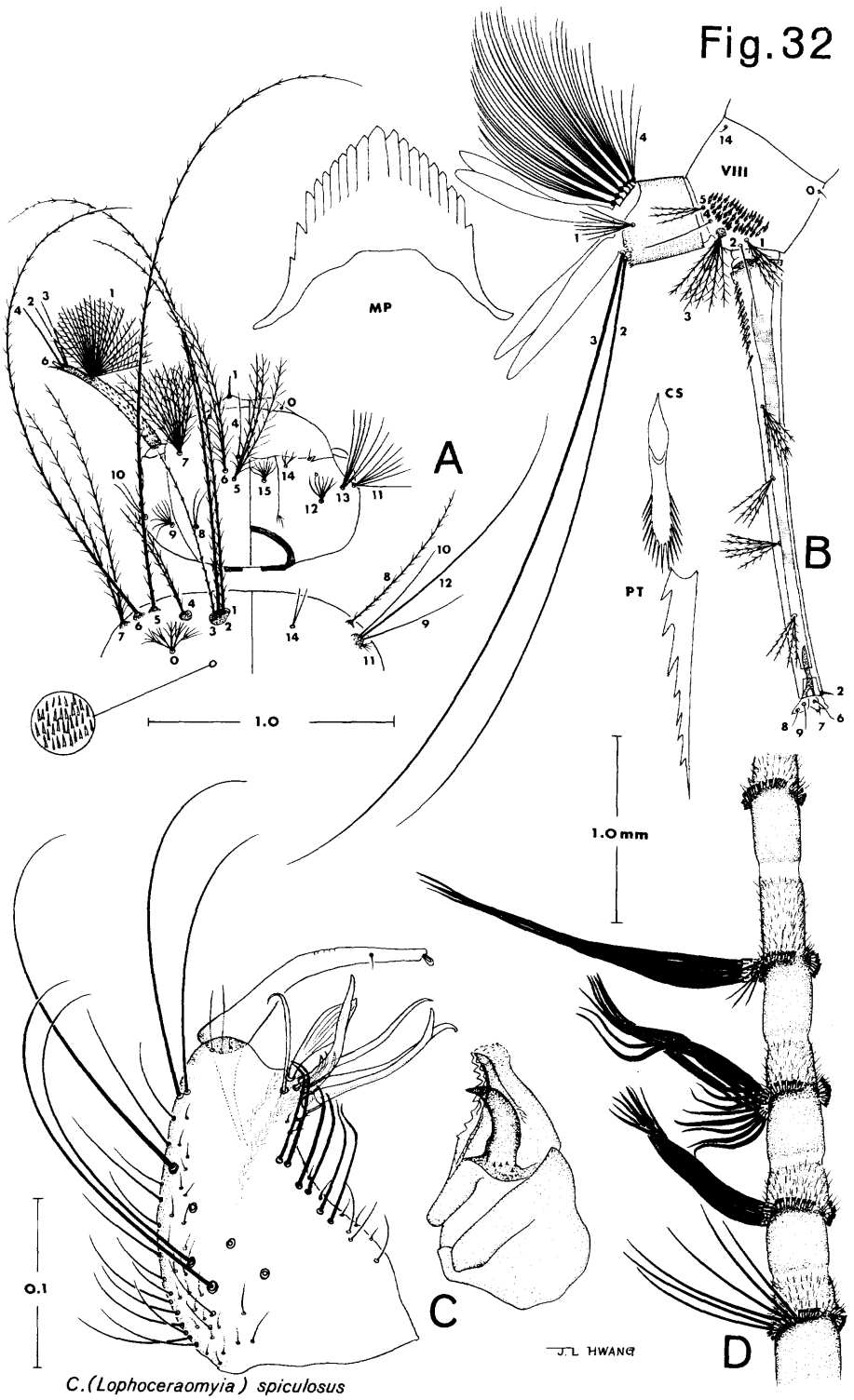
Fig.32
MP
A
VIII
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1.0
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0.1
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D
J.L. HWANG
C.(Lophoceraomyia) spiculosus

reach beyond the tuft of VII; VI with a tuft of approximately 7 strong, somewhat twisted setae; VII with a similar tuft as well as 8 short, curved setae; VIII with a tuft of long, rather straight, broad, dark setae; IX without a tuft of obviously modified setae. *Terminalia.* (Figure 32C). Basimere with from 6 to 8 strong submarginal setae inserted in a straight row; subapical lobe of the basimere with the 3 rods subequal in length and width, gently curved and pointed; internal leaflet rod-like, broad and bent; external leaflet broad, symmetrical, pointed apically and striate; accessory processes narrow, setae-like; distimere normal, without apical annulations; lateral plate of the phallosome with the internal process distinctly curved and pointed, not projecting beyond the apex of the dorsal process; dorsal process with an apical knob and approximately 10 short denticles on the lateral margin.

LARVA. (Figure 32A, B). *Head.* Antenna with a narrow, dark basal ring and progressively darker beyond insertion of hair 1-A; head hair 4-C single, simple; 5-C bifid or trifid, pectinate; 6-C bifid, pectinate; 16, 17-C absent. *Thorax.* Integument densely spiculose; 3-P single, pectinate, shorter and slenderer than 1, 2-P; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P bifid, pectinate; 8-P single, pectinate; 14-P bifid, simple. *Abdomen.* Integument spiculose, but with the spicules not as prominent as those of the thorax; hair 6-I trifid; comb consisting of from 35 to 45 fan-shaped scales arranged in a broad, triangular patch; siphon index variable, ranging from 7:1 to 11:1 (average, 8.8:1); median caudal filament short but distinct; 4 pairs of subventral tufts inserted in a line on the siphon; individual tufts with from 2 to 5 branches which are finely pectinate, their length greater than the width of the siphon at the point of insertion; pecten consisting of from 11 to 14 teeth restricted to approximately the basal fourth of the siphon; individual pecten tooth with a prominent distal spine and from 6 to 8 lateral barbs, the proximal 2 or 3 barbs very coarse; saddle with fine spicules on the distal margin.

TYPE DATA. Holotype male (associated larval and pupal skins and terminalia and antenna slide-mounted) from Tak, Thailand in the U. S. National Museum.

DISTRIBUTION. This species is known only from *Chiang Mai*, *Nakhon Nayok*, and *Tak*, THAILAND. During this study 11 individual rearings have been examined as well as 6 males, 3 females, and 50 larvae.

TAXONOMIC DISCUSSION. This species is a member of the *traubi-ganapathi* species complex and demonstrates closest affinity, both in anatomical features and larval biology to *traubi*. It may be distinguished from *traubi* by the internal process of the male phallosome which does not project beyond the dorsal process; in the larva, hair 2-VIII of the abdomen is single in *spiculosus* as opposed to bifid in *traubi*. Additional distinguishing features may be seen in the male antennae.

Figure 32. *C. (Lophoceraomyia) spiculosus*. A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through IX.

BIOLOGY. Larvae of *spiculosus* have been collected from large tree holes in primary rain forests. There have also been 2 collections from a bamboo stump and a bamboo internode. Collections were made during July, August, and September. Nothing is known of the adult biology or habits.

CULEX (LOPHOCERAOMYIA) TRAUBI COLLESS 1965
(Figure 33)

Culex (Lophoceraomyia) traubi Colless 1965, J. med. Ent. 2: 295 (♂*, ♀, L*).

The adult male may be distinguished by the single row of submarginal setae on the basimere, the absence of a tuft of modified setae on antennal flagellomere IX, by the tuft of short, narrow, acute scales on flagellomere V, and by the long internal process of the lateral plate of the phallosome. The fourth stage larva exhibits 4 pairs of strong subventral tufts on the siphon, the thoracic and abdominal integument is covered with numerous spicules, and head hair 5-C is usually 3 or 4 branched.

FEMALE. *Thorax.* Integument of the pleuron dull brown, without distinct patches of pale scales; 1 lower mesepimeral bristle present. *Abdomen.* Terga dark brown; sterna somewhat paler.

MALE. *Head.* Proboscis without distinctive dorsal or ventrolateral setae, but with a series of 6 or more short basoventral bristles; length of the palpus often less than that of the proboscis. *Antenna.* (Figure 33D). Flagellomere V with a tuft of golden, narrow, acute scales whose apices reach to the tuft of VII; VI with a tuft of 10 or more strong, gently sigmoid scales which have filamentous apices and several straight, narrow setae; VII with a tuft of 7 or more narrow, short, sharply bent scales followed by 3 or 4 stronger, longer and kinked scales; VIII with an internal tuft of from 3 to 5 strong, darly pigmented, gently curved scales; IX without modified scales or setae. *Terminalia.* (Figure 33C). Basimere with 6 or 7 strong submarginal setae usually inserted in a line, but often in an irregular row; subapical lobe of the basimere with the internal rod very slightly expanded subapically, then pointed, slightly shorter than the other rods; central and external rods subequal in length, close to the internal rod and gently hooked; internal leaflet rod-like, expanded and bent at the basal third; external leaflet rather broad, symmetrical, finely striate; 3 or 4 fine, subequal accessory setae present; distimere normal in shape, without a distal crest or annulations; lateral plate of the phallosome with the internal process rather narrow, gently curved, and projecting considerably beyond the apex of the dorsal process; dorsal process with a spinose apical knob and with 10 or more strong lateral teeth.

LARVA. (Figure 33A, B). *Head.* Antenna with a narrow dark basal

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Figure 33. *C. (Lophoceraomyia) traubi.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through IX.

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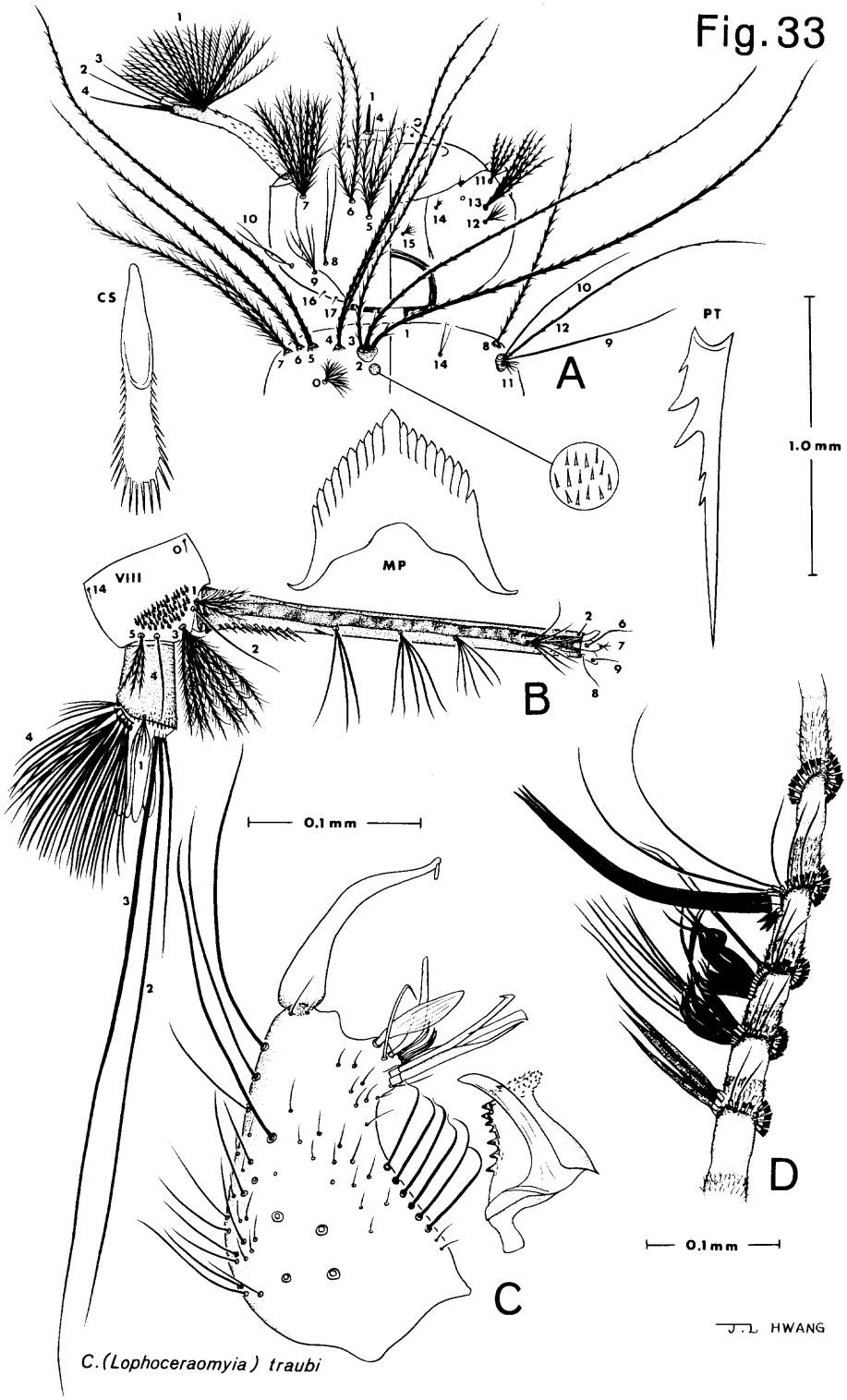
Fig. 33
A
CS
PT
1.0 mm
MP
VIII
B
0.1 mm
C
D
0.1 mm
J.L. HWANG
C. (Lophoceraomyia) traubi

ring; head hair 1-C darkly pigmented, usually tapering gradually to a point but occasionally slightly swollen on the basal half and with accessory lateral spicules; 4-C single, simple; 5-C 3 or 4 branched, pectinate; 6-C bifid or trifid, pectinate, considerably longer than 5-C; 16, 17-C represented by extremely minute spicules which are occasionally branched. *Thorax.* Integument minutely spiculate; 3-P single, pectinate, shorter and slenderer than 1, 2-P; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P bifid, pectinate, occasionally single; 8-P single, pectinate; 14-P bifid, simple, relatively long. *Abdomen.* Integument minutely spiculate; hair 6-I trifid; comb consisting of from 35 to 50 fan-shaped scales arranged in a broad, triangular patch; siphon index variable, ranging from 7:1 to 12:1 (average, 9.2:1); the siphon and segment X conspicuous by the dark pigmentation; 4 pairs of subventral tufts inserted in a line on the siphon; individual tufts with from 2 to 7 strong branches of decreasing length from base to apex, the basal pair usually with only 2 or 3 branches, its length usually about 4 times the width of the siphon at the point of insertion; pecten consisting of from 11 to 13 teeth restricted to less than the basal third of the siphon; individual pecten tooth with a fine distal spine, several very fine distal lateral barbs, and 2 strong proximal lateral barbs; saddle with strong spines on the distal margin.

TYPE DATA. Holotype male (terminalia, antenna, and associated larval and pupal skins slide-mounted) from Ulu Gombak, Selangor, Malaya in the Australian National Insect Collection, Canberra.

DISTRIBUTION. *C. traubi* has been studied from 4 THAILAND** collections from: *Nakhon Nayok, Ranong,* and *Trang.* The species has also been recorded from *Selangor* and *Perak,* MALAYA.

During this study 2 males and 2 females with associated larval and pupal skins (1 of each being a paratype) were examined in addition to 5 larvae.

TAXONOMIC DISCUSSION. As indicated under *ganapathi,* this species is a member of the species complex which includes *ganapathi, spiculosus,* and *peytoni. C. traubi* may be separated from the other members of the complex primarily on the basis of the modified setae on the flagellomeres of the male and the distinctive male terminalia; in the larval stage the abdominal spiculation and chaetotaxy of the head are diagnostic.

BIOLOGY. In Thailand larvae have been collected exclusively from tree holes during the months of September and October. In Malaya collections were also made from water in bamboo. Little is known of the adult biology, although Colless (1965) has collected adults sweeping foliage and suggested that they may attack man on occasion.

CULEX (LOPHOCERAOMYIA) WILFREDI COLLESS 1965
(Figure 34)

Culex (Lophoceraomyia) wilfredi Colless 1965, J. med. Ent. 2: 297 (♂*).

The adult male is immediately recognized by the modified torus of the antenna and by the distinctive lateral plate of the phallosome. The fourth stage larva exhibits 4 pairs of fine, rather weak, subventral tufts on the siphon, thoracic hair 14-P single and simple, and abdominal hair 2-X trifid.

FEMALE. *Thorax.* Integument of the pleuron dull brown, without distinct patches of pale scales, but with a line of small, dull scales on the lower sternopleuron; 1 lower mesepimeral bristle present. *Abdomen.* Terga

dark brown throughout; sterna somewhat paler.

MALE. *Head* Proboscis without conspicuous dorsal or lateroventral setae, but with 8 or more short, basoventral bristles. *Antenna*. (Figure 34D). Torus without the mammiliform tubercle normally found in the *mammilifer* group, but instead, slightly swollen on the inner surface and with a circumferential, almost slit-like depression; flagellomere V with a tuft of from 5 to 10 narrow yellow setae which extend beyond the tuft on IX; VI with a tuft of 12 or more darkly pigmented, strongly sigmoid setae which possess filamentous apices; VII with a similar tuft of broader setae; VIII with a tuft of 10 or more darkly pigmented, gently curved and hooked setae; IX with 5 or more strong, straight, yellow scales and a secondary tuft of fine, dark, shorter setae. *Terminalia*. (Figure 34C). Basimere with from 4 to 6 strong submarginal setae inserted in a line at the base of which is a tuft of from 3 to 8 shorter, straighter setae; subapical lobe of the basimere with the basal rods subequal in length; the internal rod terminating in a point which may at times appear to be filamentous; central and external rods gently hooked; internal leaflet very narrow, rather straight, almost rod-like; external leaflet symmetrical, finely striated; 6 accessory setae present, but viewed from the external aspect only 3 are usually visible (as illustrated); distimere normal in shape, without distal annulations, but occasionally with an extra basal seta; lateral plate of the phallosome with the internal process very short, denticulate, about 1/3 or less the length of the dorsal process; dorsal process very broad, with the apical half covered with numerous strong teeth.

LARVA. (Figure 34A, B). *Head*. Antenna with a narrow, dark basal ring and darker beyond insertion of hair 1-A; head hair 4-C single, simple; 5, 6-C bifid, pectinate, subequal in length (5-C occasionally trifid, at least on 1 side); 14-C with 5 or 6 branches; 16, 17-C represented by minute, bifid spicules (occasionally 1 of the pair may be single on one side). *Thorax*. Integument glabrous; 3-P single, pectinate, shorter and slenderer than 1, 2-P; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P bifid, pectinate (occasionally trifid, as illustrated); 8-P single, pectinate; 14-P single, simple. *Abdomen*. Integument glabrous; hair 6-I trifid; 2-X trifid; comb consisting of from 40 to 60 fan-shaped scales arranged in a broad, triangular patch; siphon index variable, ranging from 8:1 to 10.3:1 (average, 8.7:1); 4 pairs of fine, subventral tufts inserted in an irregular line on the siphon; individual tufts usually bifid, sometimes trifid, their length less than the width of the siphon at the point of insertion; pecten consisting of from 9 to 12 teeth restricted to approximately the basal third of the siphon or less; individual pecten tooth with a rather strong distal spine and from 5 to 7 graded lateral barbs.

TYPE DATA. Holotype male (terminalia and antenna slide-mounted) from "?Malaya" in the Australian National Insect Collection, Canberra.

DISTRIBUTION. In THAILAND**, *wilfredi* has been collected from: *Ayutthaya, Chiang Mai, Lampang, Nakhon Nayok, Nakhon Ratchasima,* and *Tak*. The species is also known from the type locality, probably in MALAYA.

During this study the following material was examined: 63 males, 4 with their associated larval and pupal skins; 5 females with associated larval and pupal skins; and 27 larvae.

TAXONOMIC DISCUSSION. Colless (1965) provisionally placed this species within the *mammilifer* subgroup of the *mammilifer* group. Discovery of the larval stage in Thailand confirms this decision. In the adult male, *wilfredi* is quite distinctive from all other members of the group; the unusual

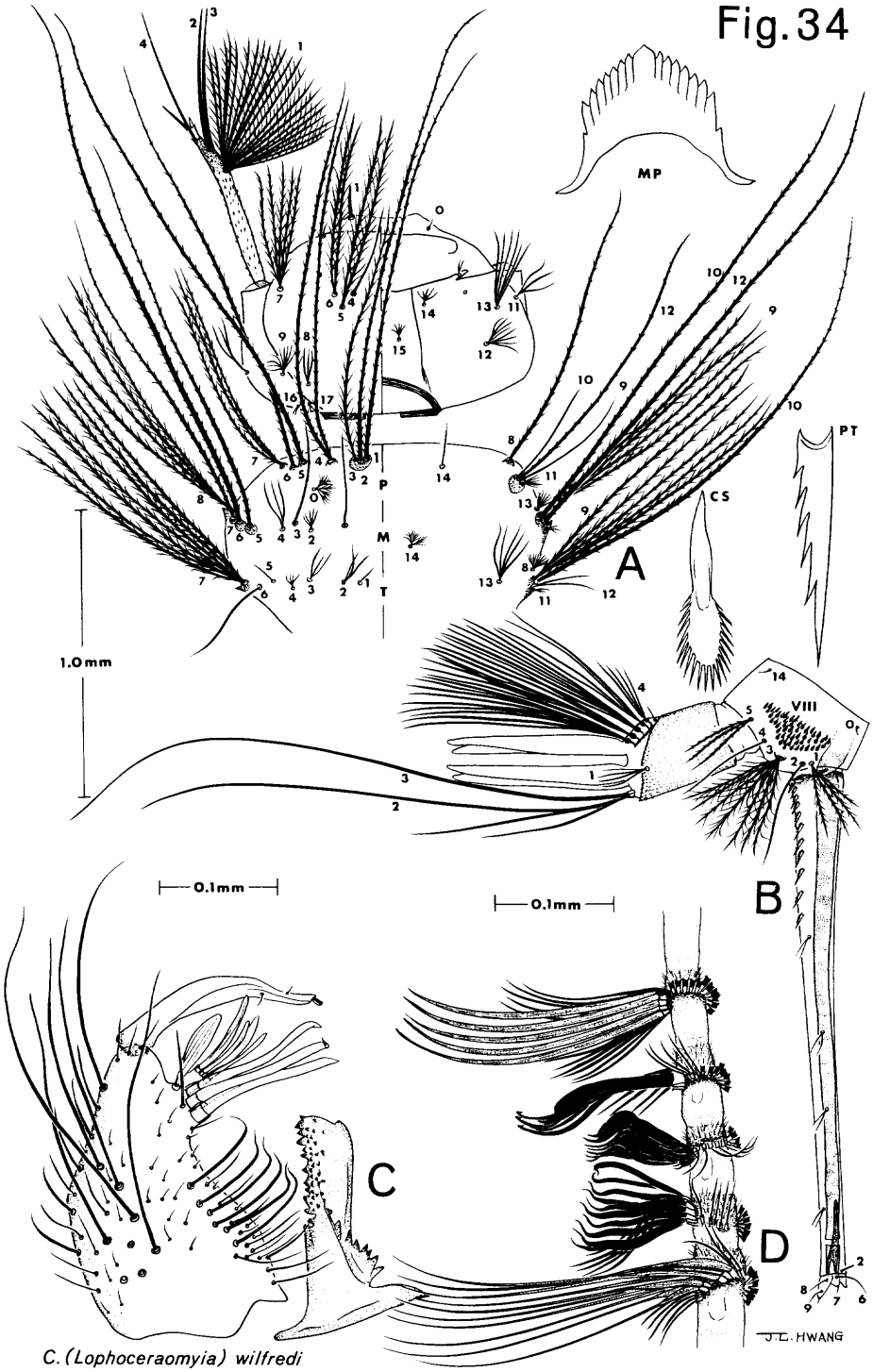
Fig. 34
MP
PT
CS
A
B
C
D
P
M
T
VIII
Ot
1.0mm
0.1mm
0.1mm
J.C. HWANG
C. (Lophoceraomyia) wilfredi

antennal torus, although noticeably swollen on the inner margin, does not exhibit the mammiliform protuberance common to the group, and the phallosome of the male terminalia is exceptional. The fourth stage larva demonstrates an affinity to *fuscosiphonis*, but is recognized by the pale siphon and features of the chaetotaxy.

BIOLOGY. Although specific data were not available, the type series of this species was associated with a collection of material bred from pitcher plants. In Thailand, larvae were collected from elephant prints, stream pools, a ground hole, a pond, a sump, and a tree hole, and adults have been collected resting on foliage. Collections were made during July, September, and December through April. Nothing is known of the adult habits.

SUBGENUS *THAIOMYIA* BRAM 1966

Culex (Thaiomyia) Bram 1966, Proc. ent. Soc. Wash. 68: 73. Type species: *Culex dispectus* Bram.

Characterization of this subgenus is based exclusively on the single species, *dispectus*, described below. *Thaiomyia* demonstrates its closest affinity to the subgenus *Culiciomyia* and the females of the 2 subgenera cannot be separated. The male terminalia of *Thaiomyia* could also easily be included with the *Culiciomyia*, but the third segment of the palpus is without the distinctive lanceolate scales on the ventral surface which are so characteristic of the latter subgenus. The fourth stage larva of *Thaiomyia* completely lacks a pecten and the ventral brush consists of 10 individual tufts of setae, the basal 1 located between the grid and the saddle. The subgenus *Thaiomyia* is known only from Thailand.

CULEX (THAIOMYIA) DISPECTUS BRAM 1966
(Figures 35, 36, and 37)

Culex (Thaiomyia) dispectus Bram 1966, Proc. ent. Soc. Wash. 68: 75 (♂*, ♀, L*, P*).

Salient features of this species are presented under the subgeneric discussion above.

FEMALE. In general a moderately sized species with overall dark brown appearance and without striking characteristics. *Head.* (Figure 35B). Proboscis and palpus uniformly dark scaled; decumbent scales of the vertex sparse, narrow and light brown medially, gradually becoming lighter and broader towards the orbital line; erect scales dark brown. *Thorax.* (Figure

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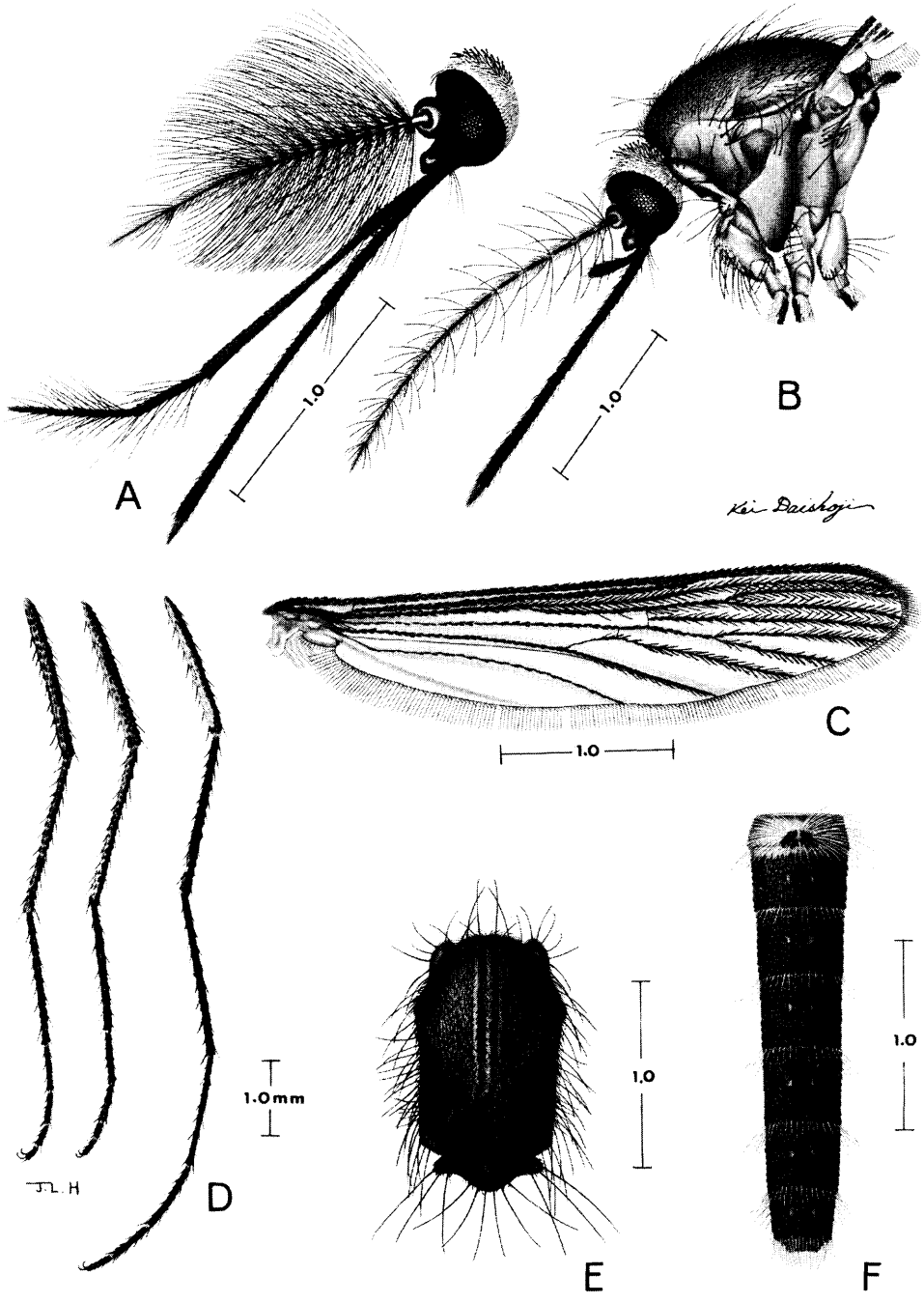
Figure 34. *C. (Lophoceraomyia) wilfredi.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia; D, lateral aspect of male antennal flagellomeres V through IX.

Fig.35



C.(Thaiomyia) dispectus

35B, E). Integument of the scutum uniformly light brown, with faintly darker stripes in the dorsocentral area which are bordered by nude areas; the scutum covered with a uniform pattern of bronze-brown scales; acrostichal bristles absent, except for a very few small dark bristles at the extreme anterior margin; anterior dorsocentral, posterior dorsocentral, supraalar, and prescutellar bristles prominent and well developed; scutellum with the integument and scales similar to that of the scutum and with the bristles normal for the genus; integument of the pleuron uniformly creamy white, occasionally with indistinct, faintly darker patterns at the postspiracular plate, and the lower sternopleuron; distinct scale patches or scattered scales absent from the pleuron; upper sternopleuron with approximately 4 large and 1 small bristle; posterior sternopleuron with a series of from 5 to 10 bristles; lower mesepimeron with 1 strong and occasionally 1 weak bristle. *Wing.* (Figure 35C). *Legs.* (Figure 35D). Anterior surface of the hind femur dark, but with a variable line of light scales on the anteroventral margin; hind tibia and tarsus as well as the fore and mid legs uniformly dark brown. *Abdomen.* (Figure 35F). Terga completely dark brown; sterna covered with a uniform pattern of light brown scales.

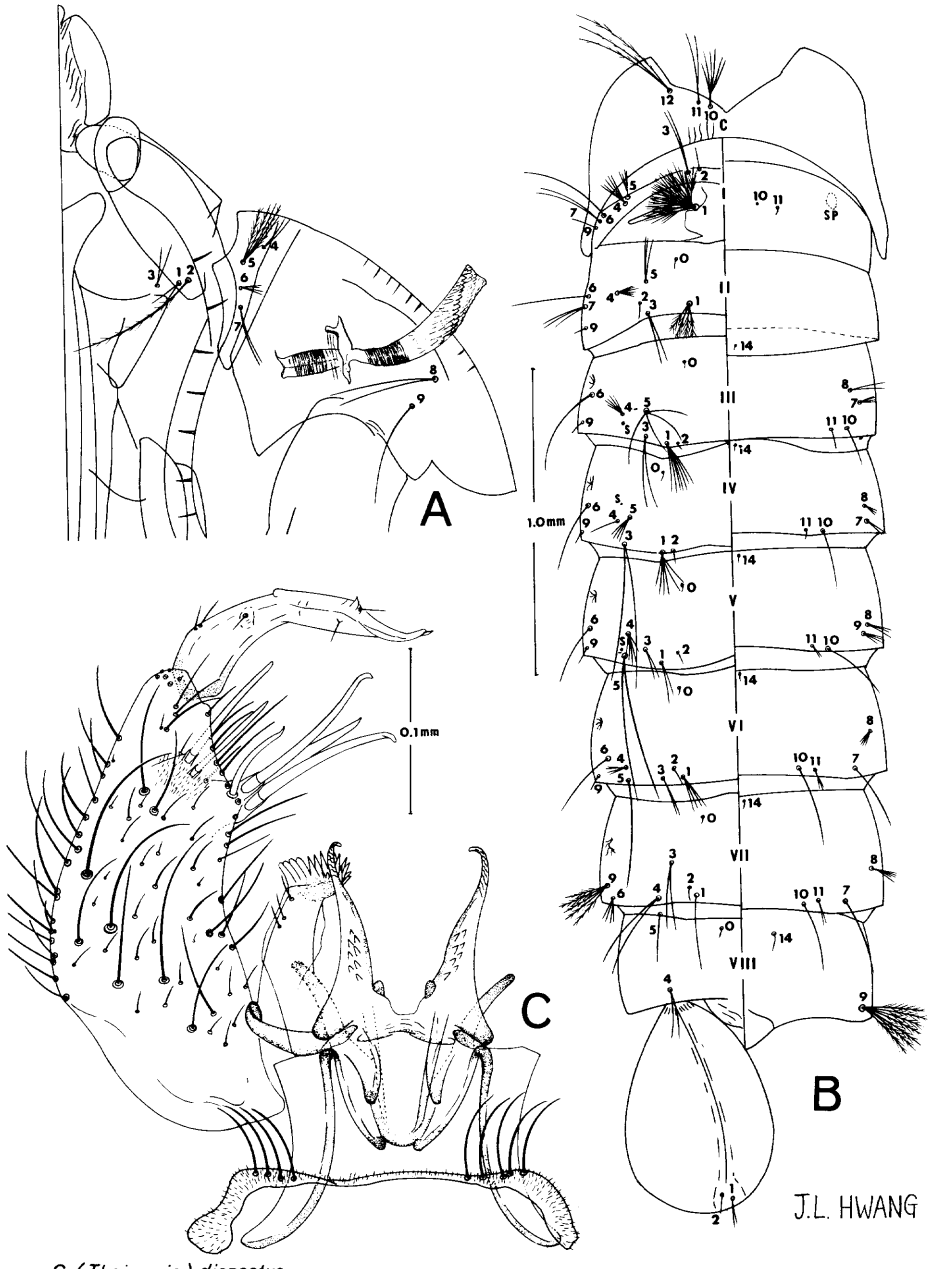
MALE. Similar in general appearance to the female except as noted below. *Head.* (Figure 35A). Proboscis with an apparent median joint, at which is inserted a ventral tuft of dark setae; length of the palpus exceeding the proboscis by approximately the fourth and fifth segments; palpal segment III without distinctive, lanceolate scales on the ventral surface; antenna normal for the genus, slightly shorter than the length of the proboscis. *Abdomen.* Terga basically dark brown, but beginning with tergum IV, a basal white spot is present which does not extend to the lateral margins and is triangular in shape. *Terminalia.* (Figure 36C). Subapical lobe of the basimere with 3 strong rods and a strong seta on the proximal division and 2 strong setae on the distal division; distimere normal in shape, usually with a crest of 1 or 2 barbs on the convex surface and with several short setae on the basal third; lateral plate of the phallosome simple, with a strong, but short basal tooth and approximately 8 lateral denticles; proctiger well developed, crowned with a tuft of strong spines, and with 3 cercal setae present; basal sternal process absent.

PUPA. (Figure 36A, B).

LARVA. (Figure 37). *Head.* Antennal shaft constricted beyond insertion of hair 1-A; hairs 2-6-A inserted at the apex of the shaft; head hair 1-C filamentous, its length approximately 3/4 the distance between the bases of the pair; 4-C simple, single or double; 5-C 12 branched, pectinate; 6-C with approximately 9 branches, pectinate; 16, 17-C represented by minute spicules. *Thorax.* Integument glabrous; 1-P trifid, pectinate; 2-P single, pectinate; 3-P with 2 or more branches, pectinate, considerably shorter and slenderer than the individual branches of 1, 2-P; 4-P trifid, pectinate; 5, 6-P

Figure 35. *C. (Thaiomyia) dispectus.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

Fig. 36



C. (Thaiomyia) dispectus

single, pectinate; 7-P trifid, pectinate; 8-P very short, simple, dendritic; 14-P single, simple. *Abdomen.* Integument glabrous; comb consisting of from 20 to 30 fan-shaped scales arranged in a broad, triangular patch; siphon index variable, ranging from 3:1 to 4:1, rather broad basally and tapering to a truncate apex; 4 pairs of subventral tufts inserted in a line, their length greater than the width of the siphon at the point of insertion; individual siphon tufts with from 3 to 6 simple branches; pecten absent; saddle completely ringing segment X; ventral brush consisting of 10 individual tufts of setae, the basal tuft usually inserted between the grid and the saddle.

TYPE DATA. Holotype male with associated larval and pupal skins and terminalia slide mounted from Tak, Thailand in the U. S. National Museum.

DISTRIBUTION. This species is known exclusively from THAILAND from: *Chiang Mai, Ranong,* and *Tak.* During this study the following material was examined: 29 females and 27 males (23 of which were individual rearings with associated larval and pupal skins), and 56 larvae.

TAXONOMIC DISCUSSION. As indicated in the subgeneric discussion above, this species is similar to species of the subgenus *Culiciomyia,* but features of the adult male and fourth stage larva clearly suggest a separate grouping. It is the only species of the genus *Culex* known from Southeast Asia which lacks a pecten in the fourth stage larva.

BIOLOGY. Larvae have been collected on 4 occasions from bamboo internodes and stumps in a primary rain forest environment. Collections were made during the months of August and September, and associated species taken with *dispectus* included *Armigeres flavus, A. subalbatus, Orthopodomyia* sp., *Uranotaenia* sp., and *C. (Lophoceraomyia)* sp. Nothing is known of the adult habits or biology.

SUBGENUS *CULICIOMYIA* THEOBALD 1907

Trichorhynchus Theobald 1905, J. Bombay nat. Hist. Soc. 16: 241 (preoccupied by Balbiani 1887). Type species: *Trichorhynchus fuscus* Theobald.

Culiciomyia Theobald 1907, Mon. Cul. 4: 227. Type species: *Culiciomyia inornata* Theobald (Edwards 1912, Bull. ent. Res. 3: 33).

Neomelanoconion Theobald 1907, Mon. Cul. 4: 514. Type species: *Culex rima* Theobald.

Pectinopalpus Theobald 1910, Ann. Mag. nat. Hist. 5: 375. Type species: *Pectinopalpus fuscus* Theobald.

Trichorhynchomyia Brunetti 1912, Rec. Indian Mus. 4: 477. Type species: *Trichorhynchus fuscus* Theobald.

The adult female may be recognized by the presence of 1 or 2 lower mesepimeral bristles, the unbanded proboscis, the absence of scale patches on the pleuron, the acrostichal bristles not developed, and the scaling of the

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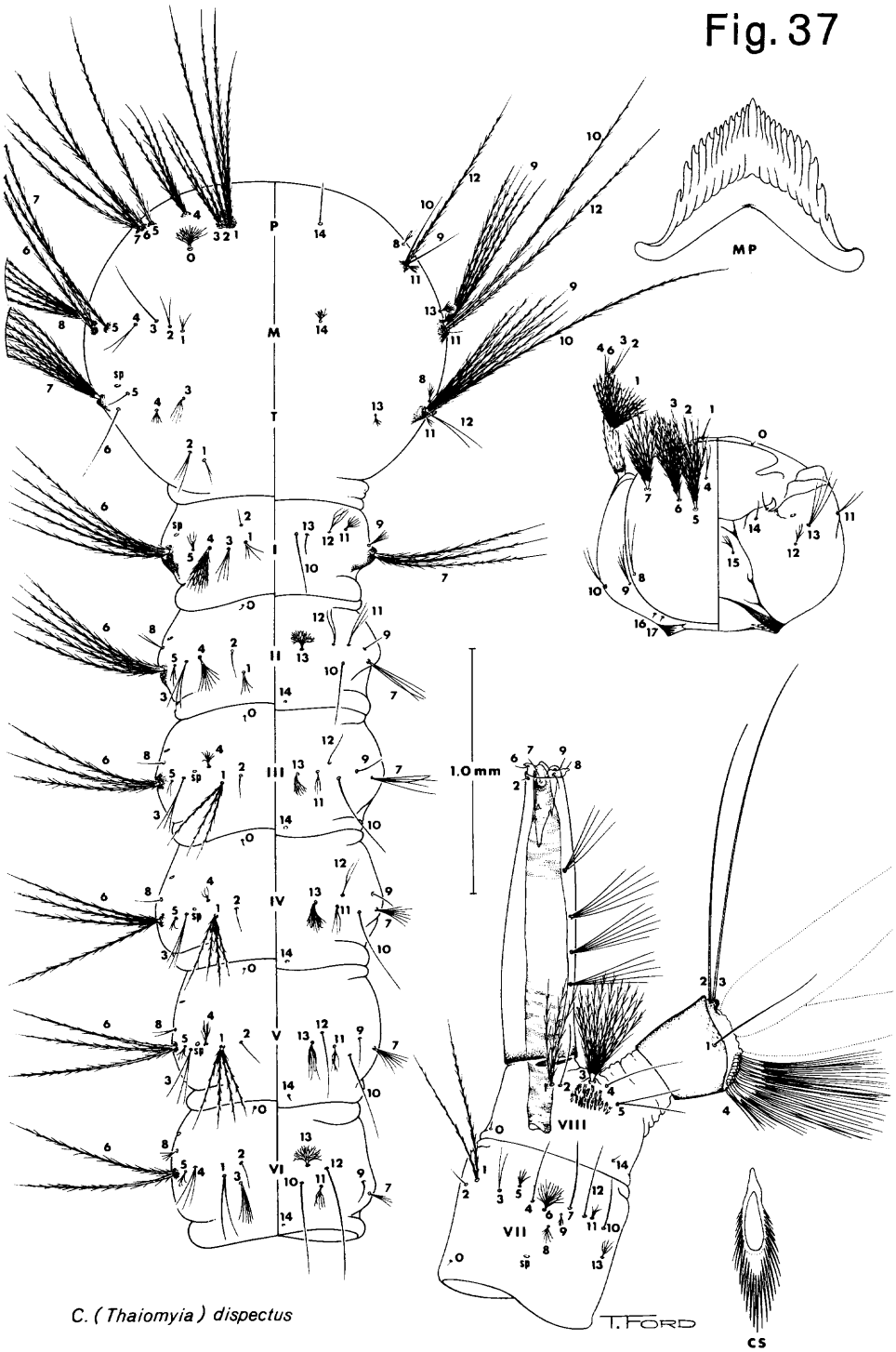
Figure 36. *C. (Thaiomyia) dispectus.* A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia.

Fig. 37



C. (Thaiomyia) dispectus

scutum very dense and smooth in appearance. The adult male may be recognized by the above characters as well as the presence of a linear series of lanceolate scales on the ventrolateral surface of the third segment of the palpus, and the characteristic terminalia. The fourth stage larva is distinguished by the pecten prominent and restricted to the basal half of the siphon, and the ventral brush consisting of 8 hair tufts inserted within the grid.

FEMALE. Usually small to medium sized species. *Head.* Proboscis unbanded; vertex with broad, decumbent scales at the orbital line, narrowing towards the occiput. *Thorax.* Scaling pattern of the scutum very dense, smooth in appearance; acrostichal bristles not developed except at extreme anterior end and rarely weakly near prescutellar space; pleuron without distinct scale patches; usually 1 or 2 strong lower mesepimeral bristles present; wings with the dorsal plume scales short and rather broad; legs without pale bands on the femur, tibia or tarsus. *Abdomen.* Terga with or without basal or apical banding patterns.

MALE. Proboscis with a median tuft of several long, ventral hairs; palpus longer than the proboscis, with a single row of flattened, distinctively lanceolate scales on the ventral surface of segment III; antenna plumose, slightly shorter than the proboscis. *Terminalia.* Subapical lobe of the basimere with strongly developed setae and with or without a leaf-like seta; some species have a prominent sternal accessory apical lobe bearing very long, hairlike setae; distimere variable in shape; phallosome simple, the lateral plate with a strong basal tooth and usually with a series of short denticles on the lateral margin; proctiger with a dense tuft of fine dorsomesal spines and prominent, spatulate lateroventral spines; cercal setae short, variable in number; basal sternal process variable.

LARVA. *Head.* Hair 1-C either fine and filamentous or robust and tapering gradually; 16, 17-C present, represented by minute spicules. *Thorax.* Integument glabrous or spiculose; hair 1-P single or bifid; 2-P always single; 3-P single or branched, the branches always much thinner than, and usually about half the length of 1-P; 4-P single or branched. *Abdomen.* Integument glabrous or spiculose; comb consisting of a triangular patch of from 25 to 70 small, fan-shaped scales; siphon variable in length and shape, with from 3 to 6 pairs of subventral tufts inserted in a line beyond the pecten; ventral brush consisting of 8 hair tufts inserted on the grid; anal gills always longer than the saddle.

PUPA. Without striking subgeneric characteristics.

DISTRIBUTION. The subgenus *Culiciomyia* is represented principally in the Old World tropics, although a few species extend to Japan and 3 species are found in the South Pacific. Collections to date indicate that members of the subgenus are distributed throughout THAILAND.

TAXONOMIC DISCUSSION. Diagnostic subgeneric and species characters of *Culiciomyia* in Thailand are indistinct in the adult female. On the basis of female characters the subgenus appears most closely related to *Thaiomyia* and *Lophoceraomyia* and can be recognized by dense, smooth scaling of the scutum, whereas these scales in *Lophoceraomyia* are generally

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Figure 37. ← *C. (Thaiomyia) dispectus*. Fourth stage larva: dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments.

sparse and rough in appearance. Within the subgenus, females of several species are extremely difficult to separate and conclusive determinations must still depend upon characters of the male terminalia and fourth stage larvae. The male terminalia of the subgenus are distinctive and are characterized by the simple phallosome and features of the basimere and distimere. The fourth stage larva can be separated from other subgenera by the ventral brush and by the thoracic chaetotaxy. At the present time the fourth stage larva exhibits the most reliable features upon which species determinations may be based.

BIOLOGY. The immature stages of species of *Culiciomyia* in Thailand are found in a variety of habitats ranging from tree holes to running creeks and swamps in tropical rain forests; however, the larvae are found most frequently in temporary accumulations of water, usually with high organic content. Host preferences and bionomics of the adult females are virtually unknown, but species of this subgenus have rarely been collected feeding on humans, even in areas where the mosquitoes are quite numerous. Two species, *pallidothorax* and *spathifurca*, have been experimentally fed on humans infected with *Wuchereria bancrofti* with subsequent isolation of infective larvae from the mosquito. It is felt, however, that these species play little if any part in the transmission of the disease in nature.

KEY TO SPECIES OF THE SUBGENUS *CULICIOMYIA* IN THAILAND - ADULT FEMALES[1]

1. At least some of the abdominal terga with apical or basal pale bands 2
   Abdominal terga unbanded 5

2(1). Dorsal wing scales creamy white; apical light bands covering the greater portion of each tergum; scutum covered with pale scales . . . . . *termi* (p. 157)
   Dorsal wing scales ranging in color from reddish-brown to black; basal pale bands covering not more than half of each tergum; scutum with dark scales 3

3(2). Integument of the pleuron uniformly pale brown or with, at most, a faint light brown stripe from the anterior pronotal lobe to the upper mesepimeron . . . . . *bailyi* (p. 123)
   Integument of the pleuron with distinct dark markings 4

4(3). Integument of the pleuron with a prominent, isolated, very dark brown to black spot present on the upper mesepimeron; a light brown spot is usually present on the upper sternopleuron . . . . . *nigropunctatus* (p. 133)
   Integument of the pleuron with a brown pattern stretching from the prespiracular areas across the prealar area and terminating at the upper mesepimeron; a light brown pattern also present on

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[1] The adult female of *spiculothorax* is unknown; the placement of *barrinus* is presumptive.

the upper sternopleuron . . . . . *pallidothorax* (p. 137)
thurmanorum (p. 159)
barrinus (p. 125)

5(1). Segment IV of the palpus over 3 times as long as III; in general, a large, dark species . . . . . *papuensis* (p. 143)
Segment IV of the palpus about twice as long as III; in general, a small, lighter species . . . . . *fragilis* (p. 129)
spathifurca (p. 151)
scanloni (p. 147)

KEY TO SPECIES OF THE SUBGENUS *CULICIOMYIA* IN THAILAND - ADULT MALES[1]

1. Distimere divided proximally into 2 unequal areas (the external arm flattened, expanded, and denticulate on the distal half; the internal arm slender, pointed, and sigmoid). . *spathifurca* (p. 151)
Distimere represented by a single, undivided arm 2

2(1). Distimere with an apical crest of at least 3 recurved spines on the convex surface 3
Distimere without a crest of spines on the convex surface 7

3(2). Abdominal terga with distinct, pale basal bands 4
Abdominal terga unbanded 6

4(3). Subapical lobe of the basimere with the leaf-like seta very broad; integument of the pleuron with a prominent, isolated, very dark brown to black spot present on the upper mesepimeron. . . . . *nigropunctatus* (p. 133)
Subapical lobe of the basimere with the leaf-like seta very slender or absent; integument of the pleuron without an isolated, dark brown spot on the upper mesepimeron 5

5(4). Basal rod on the subapical lobe of the basimere shorter and slenderer than the other 2 rods, and not inserted laterally out of line; slender leaf-like seta rather long and usually conspicuous. . . . . *pallidothorax* (p. 137)
Basal rod on the subapical lobe of the basimere as long as and broader than the other 2 rods and inserted laterally out of line; slender leaf-like seta short and usually inconspicuous . . . . . *thurmanorum* (p. 159)
barrinus (p. 125)

6(3). Subapical lobe very near the apex of the basimere; a prominent sternal apical area present bearing a patch of very fine setae . . . . . *papuensis* (p. 143)

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[1]The adult male of *spiculothorax* is unknown; the placement of *barrinus* is presumptive.

Subapical lobe distinctly below the apex of the basimere; no sternal apical area with fine setae present . . . . . *fragilis* (p. 129)
scanloni (p. 147)

7(2). Phallosome with from 4 to 6 prominent, heavily sclerotized denticles; all dorsal wing scales uniformly dark; abdominal terga with basal pale bands . . . . . *bailyi* (p. 123)
Phallosome with at most faint indications of from 7 to 13 small, lightly sclerotized denticles in addition to the large basal tooth; all dorsal wing scales pale; abdominal terga with broad apical pale bands . . . . . *termi* (p. 157)

KEY TO SPECIES OF THE SUBGENUS *CULICIOMYIA* IN THAILAND - FOURTH STAGE LARVAE

1. Siphon index approximately 30:1 or more; thoracic hair 4-P with from 6 to 8 branches . . . . . *termi* (p. 157)
Siphon index 15:1 or less; thoracic hair 4-P bifid or trifid 2

2(1). Thoracic hairs 1, 2, 3-P single 3
Thoracic hair 1-P bifid, 2-P single, and 3-P either single or with 2 or more branches 6

3(2). Siphon with a false joint beyond the middle due to lack of sclerotization in an irregular ring . . . . . *nigropunctatus* (p. 133)
Siphon without a false joint beyond the middle. 4

4(3). Basal barb of each individual pecten tooth very robust, considerably larger than the other lateral barbs; siphon index approximately 8:1 or greater . . . . . *scanloni* (p. 147)
Basal barb of each individual pecten tooth smaller than, or equal to the other lateral barbs; siphon index approximately 6:1 or less 5

5(4). Head hairs 5, 6-C with 3 or 4 branches; individual siphon tufts single . . . . . *spathifurca* (p. 151)
Head hairs 5, 6-C with from 5 to 7 branches; individual siphon tufts bifid or trifid . . . . . *fragilis* (p. 129)

6(2). Thorax and abdomen with a series of stellate setae; abdominal integument covered with a uniform pattern of round, platelet-like spicules . . . . . *thurmanorum* (p. 159)
Thorax and abdomen without stellate setae; abdominal integument without platelet-like spicules 7

7(6). Head hair 1-C robust, lightly pigmented, and frequently possessing accessory lateral spicules . . . . . *papuensis* (p. 143)
Head hair 1-C fine and filamentous 8

8(7). Thoracic integument with a conspicuous pattern of coarse spicules. . . *spiculothorax* (p. 155)

Thoracic integument glabrous, granulose, or with an inconspicuous pattern of minute spicules 9

9(8). Siphon narrow throughout its length and gently curved distally; more than 10 teeth present in the pecten; subventral tufts of the siphon either single or bifid . . . . . *bailyi* (p. 123)
Siphon enlarged medially; less than 10 teeth present in the pecten; subventral tufts of the siphon usually with 3 or 4 branches. 10

10(9). Siphon with a broad, dark, subapical band. . . . . *barrinus* (p. 125)
Siphon unbanded . . . . . *pallidothorax* (p. 137)

CULEX (CULICIOMYIA) BAILYI BARRAUD 1934
(Figures 38, 39, and 40)

Culex (Culiciomyia) bailyi Barraud 1934, Fauna Brit. India, Diptera 5: 382 (♂*, ♀); Carter and Wijesundara 1948, Ceylon J. Sci. 23: 147 (L*).

The adult female is identified by the pale basal bands of the abdominal terga and by the absence of distinct integumental markings. The adult male is recognized by the absence of a crest of spines on the convex surface of the distimere and the robust lateral plate of the phallosome. The fourth stage larva is distinguished by the characteristic shape and length of the siphon, the glabrous thoracic integument, and the chaetotaxy of the head and prothorax.

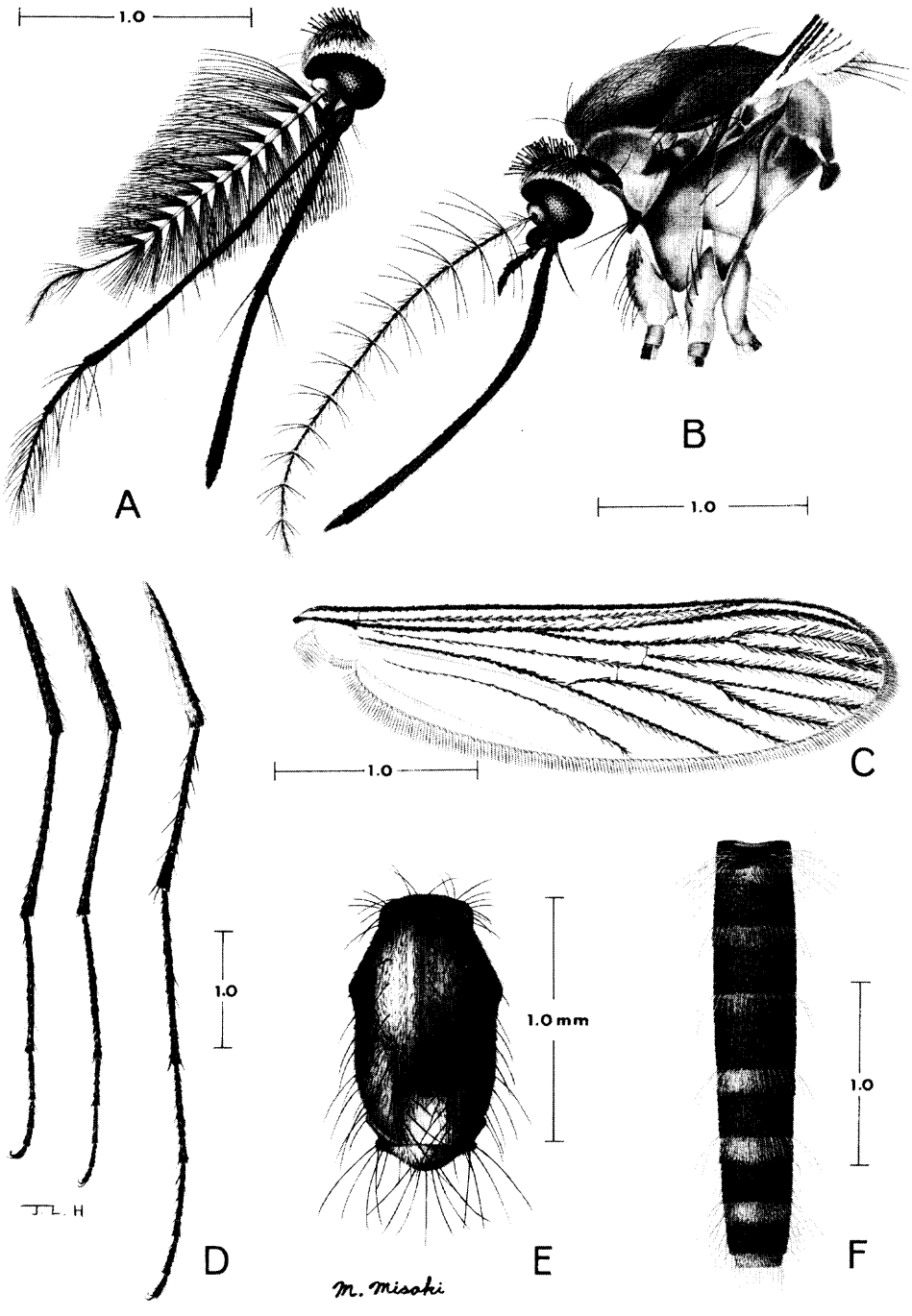
FEMALE. In general, a small to moderately sized species with overall light brown appearance and without striking characteristics other than the basal banding of the abdominal terga. *Head.* (Figure 38E). Proboscis and palpus uniformly dark scaled; decumbent scales of the vertex light brown on the occiput, gradually becoming lighter towards the orbital line. *Thorax.* (Figure 38B, E). Integument of pleuron uniformly pale or with a greenish cast in some specimens; 1 strong lower mesepimeral bristle present. *Wing.* (Figure 38C). *Legs.* (Figure 38D). Anterior surface of hind femur dark, but with a line of lighter scales on the ventral margin; hind tibia and tarsus as well as the fore and mid legs completely dark. *Abdomen.* (Figure 38F). Terga dark with rather broad, pale basal bands; sterna pale.

MALE. *Head.* (Figure 38A). Proboscis with an apparent median joint, at which is inserted a ventral tuft of dark setae. *Terminalia.* (Figure 39C). Subapical lobe of the basimere somewhat flattened but well developed near the apex of the basimere, with strong setae and rods, but without a leaf-like seta; distimere normal, without a crest of spines on the convex surface but undulating distally and with a hooked structure above the claw; lateral plate of the phallosome with a very strong and heavily sclerotized basal tooth and from 4 to 10 smaller lateral denticles.

PUPA. (Figure 39A, B).

LARVA. (Figure 40). *Head.* Antenna with a narrow, dark basal ring; head hair 1-C filamentous, its length greater than half the distance between the bases of the pair; 4-C single, bifid, or trifid, very finely pectinate; 5, 6-C with 3 or 4 branches, pectinate. *Thorax.* Integument superficially glabrous,

Fig.38



C. (Culiciomyia) bailyi

but critical examination reveals the presence of extremely minute spicules (not illustrated); thoracic hair 1-P bifid, pectinate; 2-P single, pectinate; 3-P bifid, pectinate, shorter than 1, 2-P; 4, 7, 8-P bifid, pectinate; 5, 6-P single, pectinate; 14-P single, simple. *Abdomen.* Integument with minute spicules similar to those of the thorax; comb consisting of approximately 35 fan-shaped scales arranged in a triangular patch of 3 irregular rows; siphon index variable, ranging from 6.5:1 to 7.5:1, the siphon narrow throughout its length and gently curved distally; 3 pairs of subventral tufts inserted in a line beyond the pecten; individual tufts single or bifid, their length, at most, only slightly greater than the width of the siphon at the point of insertion; pecten consisting of from 15 to 18 teeth restricted to the basal third to fourth of the siphon; individual pecten tooth with a strong apical point and 3 or 4 strong lateral barbs.

TYPE DATA. Lectotype hereby designated: syntype male (terminalia slide-mounted), "BM 1935-622, Virajpet, Coorg, S. India, VII 1927, J. D. Baily", in the British Museum.

DISTRIBUTION. In THAILAND**, *bailyi* has been studied from: *Chiang Mai, Lampang, Mae Hong Son, Nakhon Nayok, Nakhon Ratchasima, Narathiwat,* and *Ranong*. Previously it had been recorded only from the type locality in INDIA and from Hakgala, CEYLON. During this study 26 individual rearings were examined as well as 31 females, 27 males, and 75 larvae.

TAXONOMIC DISCUSSION. This species demonstrates its closest affinity to *pallidothorax,* and is related to a lesser degree to *nigropunctatus*. However, the adult female of *bailyi* may be distinguished from the other 2 species by the absence of distinct dark markings on the pleuron; the adult male lacks a distinct crest of spines on the distimere of the male terminalia; and the fourth stage larva exhibits thoracic hairs 1, 3-P branched as in *pallidothorax,* but lacks the expanded siphon of the latter species.

BIOLOGY. Carter and Wijesundara (1948) reported collecting larvae in January from a cement cistern at a height of 5,600 feet in Ceylon. In Thailand, larvae have been collected from sumps, open puddles, rock pools, elephant hoof prints, and tree holes during the months of January through May, August, September, and November. Habits and biology of the adults are unknown.

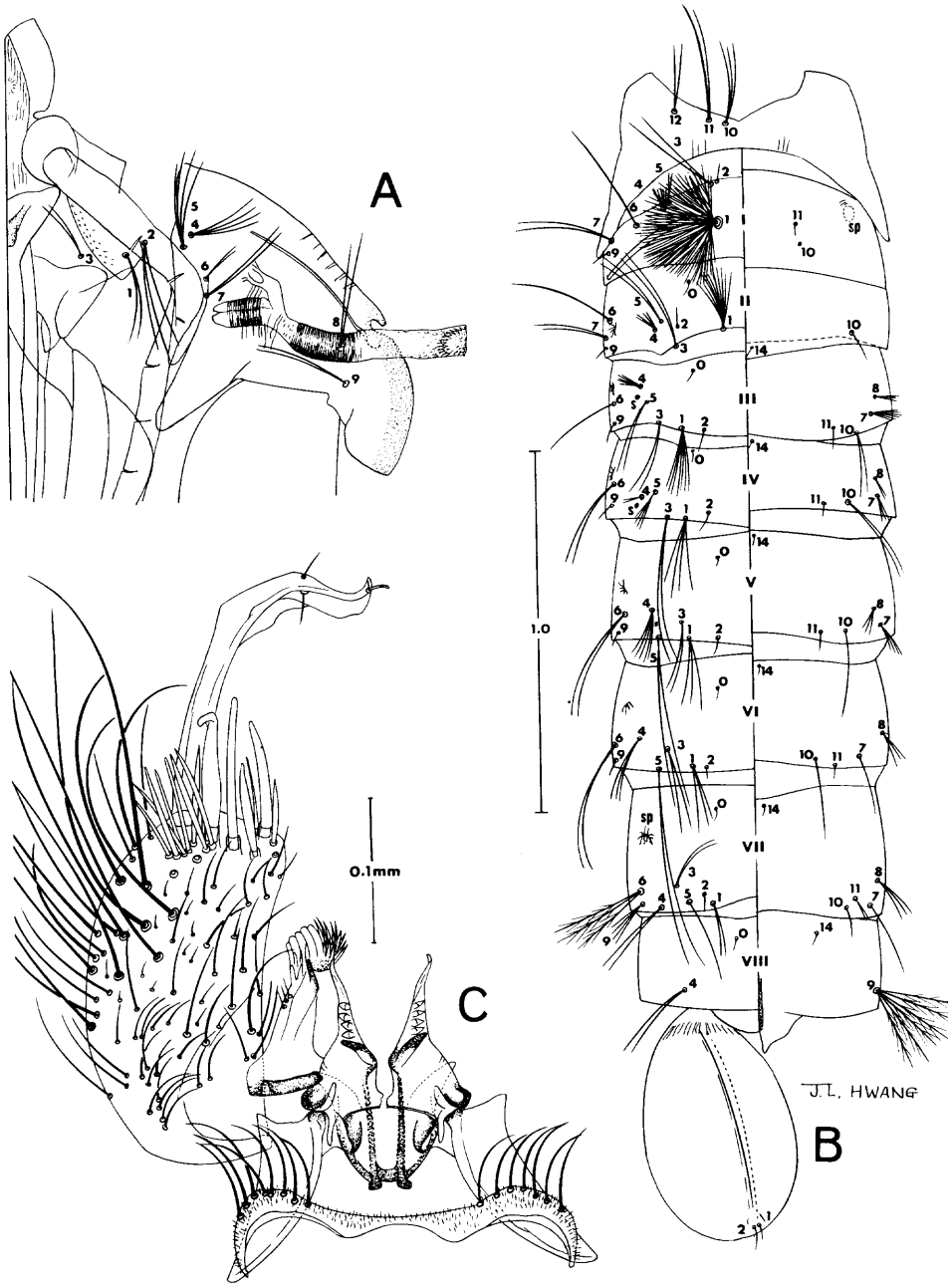
CULEX (CULICIOMYIA) BARRINUS, N. SP.
(Figure 41)

The fourth stage larva is characterized by possessing a broad, dark, subapical band on the siphon.

FEMALE, MALE (Figure 41C). Adults presumed to be this species cannot be distinguished from *thurmanorum*.

Figure 38. *C. (Culiciomyia) bailyi.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

Fig.39



C.(Culiciomyia) bailyi

LARVA. (Figure 41A, B). *Head.* Antenna without the usual darker basal ring; hair 1-C filamentous, but rather broad basally, its length slightly greater than half the distance between the bases of the pair; 4-C single, simple; 5, 6-C bifid, pectinate. *Thorax.* Integument superficially glabrous, but when examined critically, with extremely minute, fine, pointed spicules (not illustrated); hair 1-P bifid, pectinate; 2-P single, pectinate; 3-P with 3 or 4 branches, pectinate; 4, 7-P bifid, pectinate; 5, 6-P single, pectinate; 8-P bifid or trifid, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; comb consisting of approximately 35 elongate, fan-shaped scales arranged in a triangular patch; siphon index ranging from 5:1 to 6:1, the siphon expanded medially and with a conspicuous, dark, rather broad subapical band; 4 or 5 pairs of subventral tufts inserted in a line beyond the pecten; individual tufts with 3 or 4 branches, their length less than the width of the siphon at the point of insertion; pecten consisting of from 4 to 6 teeth restricted to the basal third of the siphon; individual pecten tooth with a strong distal spine and from 5 to 9 fine lateral barbs.

TYPE DATA. Holotype: fourth stage larva from Ban Pa Chi, Mae Hong Son, Thailand, 10 September 1966, S. Maniwongse, from elephant hoofprints in a secondary rain forest, at 600 m. elevation, deposited in the U. S. National Museum, No. 69512. Paratypes: 2 larvae with the same data as the holotype, deposited in the U. S. National Museum, No. 69512.

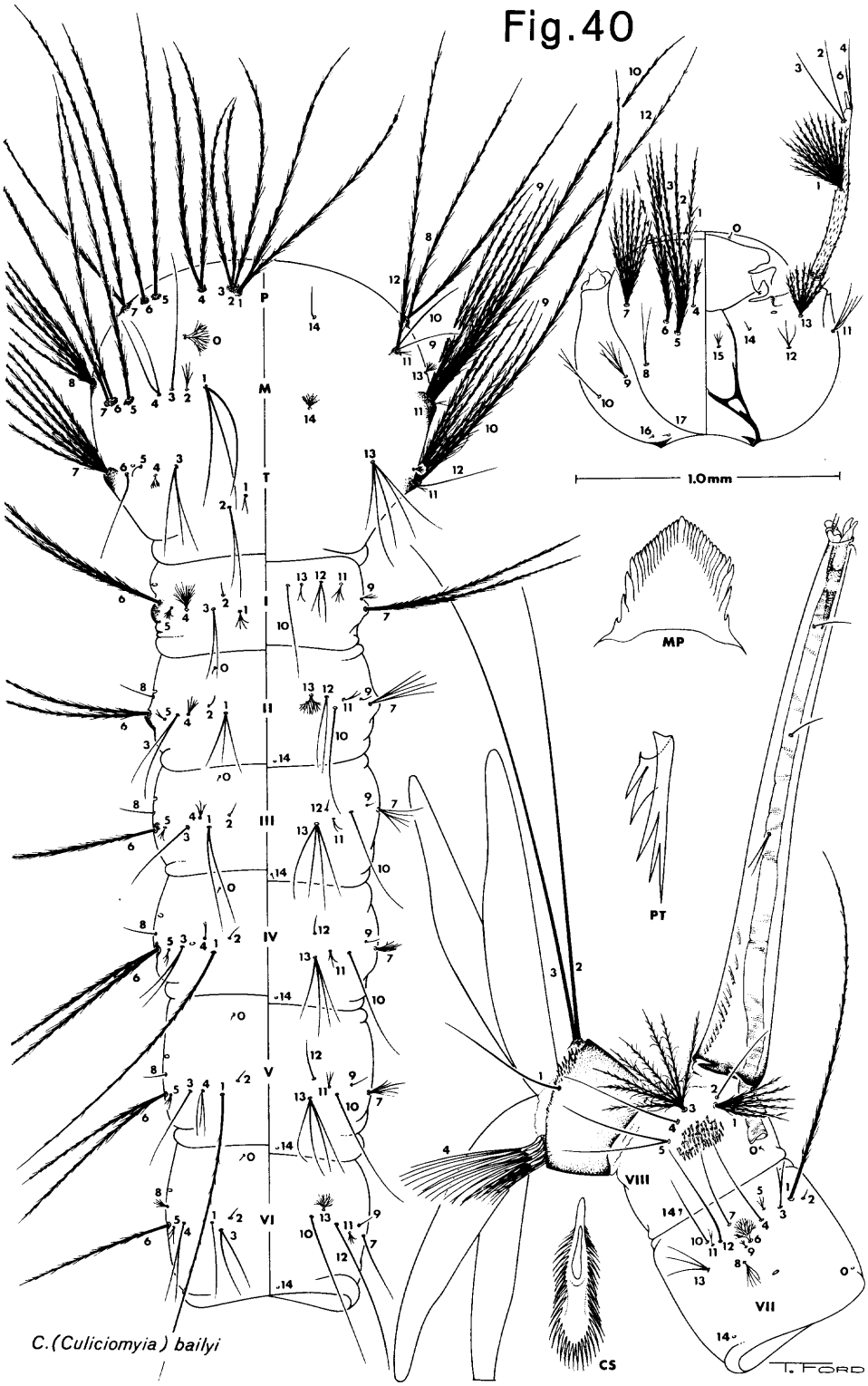
DISTRIBUTION. This species is known only from THAILAND from the type locality of *Mae Hong Son* and from *Lampang*. In addition to the type series, 10 larvae have been examined; 11 females and 7 males which are presumed to be this species were reared from pupae collected in association with the larvae, however, other closely related species of *Culiciomyia* were also collected from the same habitats.

TAXONOMIC DISCUSSION. The presumptive adults of *barrinus* cannot be separated from *thurmanorum* and are also extremely similar to *pallidothorax*. The fourth stage larva is also extremely similar to *pallidothorax*, but is immediately recognized by the broad, subapical dark band on the siphon. Larvae of both *barrinus* and *pallidothorax* have been collected from the same habitat.

BIOLOGY. Larvae of *barrinus* were first collected in March 1953 from puddles and elephant tracks at kilometer 114 on the Lampang to Phayao road. Larvae were apparently not collected again until September 1966, when 4 separate collections were made in Mae Hong Son. Each of the 1966 collections were made from elephant hoof prints. The collections from Ban Mae Ho Nua and Doi Chang included larvae of *pallidothorax*, *bailyi*, *thurmanorum*, and *Anopheles balabacensis*. In each instance collections were made at an elevation of 600 m. or above in a secondary rain forest. Nothing is known of the habits of the adults.

Figure 39. *C. (Culiciomyia) bailyi.* A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia.

Fig. 40


P
M
T
I
II
III
IV
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VII
VIII
1.0mm
MP
PT
CS
C.(Culiciomyia) bailyi
T. FORD

CULEX (CULICIOMYIA) FRAGILIS LUDLOW 1903
(Figures 42, 43, and 44)

Culex fragilis Ludlow 1903, J. N. Y. ent. Soc. 11: 142 (♂, ♀).
Trichorhynchus fuscus Theobald 1905, J. Bombay nat. Hist. Soc. 16: 242 (♀*); Edwards 1922, Indian J. med. Res. 10: 472 (synonymy).
Culiciomyia inornata Theobald 1907, Mon. Cul. 4: 227 (♂*, ♀*); Edwards 1922, Indian J. med. Res. 10: 472 (synonymy).
Culiciomyia ceylonica Theobald 1907, Mon. Cul. 4: 236 (♂, ♀*); Edwards 1922, Indian J. med. Res. 10: 472 (synonymy).
Culex graminis Leicester 1908, Cul. Malaya: 158 (♂, ♀); Edwards 1932, *in* Wytsman, Genera Insect. fasc. 194: 199 (synonymy).
Culex (Culiciomyia) fragilis Ludlow: Barraud 1934, Fauna Brit. India, Diptera 5: 385 (♂, ♀); Bohart 1945, Navmed 580: 76 (♂*); King and Hoogstraal 1946, Proc. biol. Soc. Wash. 59: 148 (♂*, L*); Penn 1947, Pacif. Sci. 3: 72 (P*); Bick 1951, Pacif. Sci. 5: 417 (ecology); Bonne-Wepster 1954, Roy. trop. Inst. Amst., Spec. Pub. 111: 113 (♂, ♀, L*); Belkin 1962, Mosq. S. Pacif. I: 231 (♂*, ♀, P*, L*); Delfinado 1966, Mem. Amer. ent. Inst. 7: 117 (♂*, ♀, L*, P*).

Due to the absence of distinctive anatomical features or color characters it is not presently possible to positively differentiate the adult female from several other species in the subgenus. The adult male is recognized on the basis of the terminalia in which the number and shape of setae on the subapical lobe of the basimere are distinctive and by the absence of a prominent sternal accessory apical lobe on the basimere. The fourth stage larva may be distinguished by head hairs 5, 6-C with from 5 to 8 branches, by the subventral tufts of the siphon bifid or trifid, by the shape of the pecten teeth, and usually by the siphon index.

FEMALE. A relatively small species without distinctive anatomical features or color patterns. *Head.* (Figure 42B). Proboscis and palpus dark scaled; palpal segment IV twice as long as III; decumbent scales of the vertex light brown at the occiput and becoming lighter as they progress to the orbital line; erect scales predominantly light brown, but several may appear creamy white. *Thorax.* (Figure 42B, E). Integument of the pleuron light brown; 1 strong, lower mesepimeral bristle present. *Wing.* (Figure 42C). *Legs.* (Figure 42D). Anterior surface of the hind femur dark with a pale stripe on the ventral margin; hind tibia and tarsus uniformly dark, occasionally with lighter scales randomly scattered, but without distinct patterns; fore and mid legs with markings similar to those of the hind legs. *Abdomen.* (Figure 42F). Terga dark to dusky brown, without pale bands or patterns; sterna somewhat lighter.

MALE. *Head.* (Figure 42A). Proboscis with a median tuft of 2 or 3 fine setae on the ventral surface. *Terminalia.* (Figure 43E). Subapical lobe of the basimere well developed, with 3 basal rods, 2 narrow, striated leaflets,

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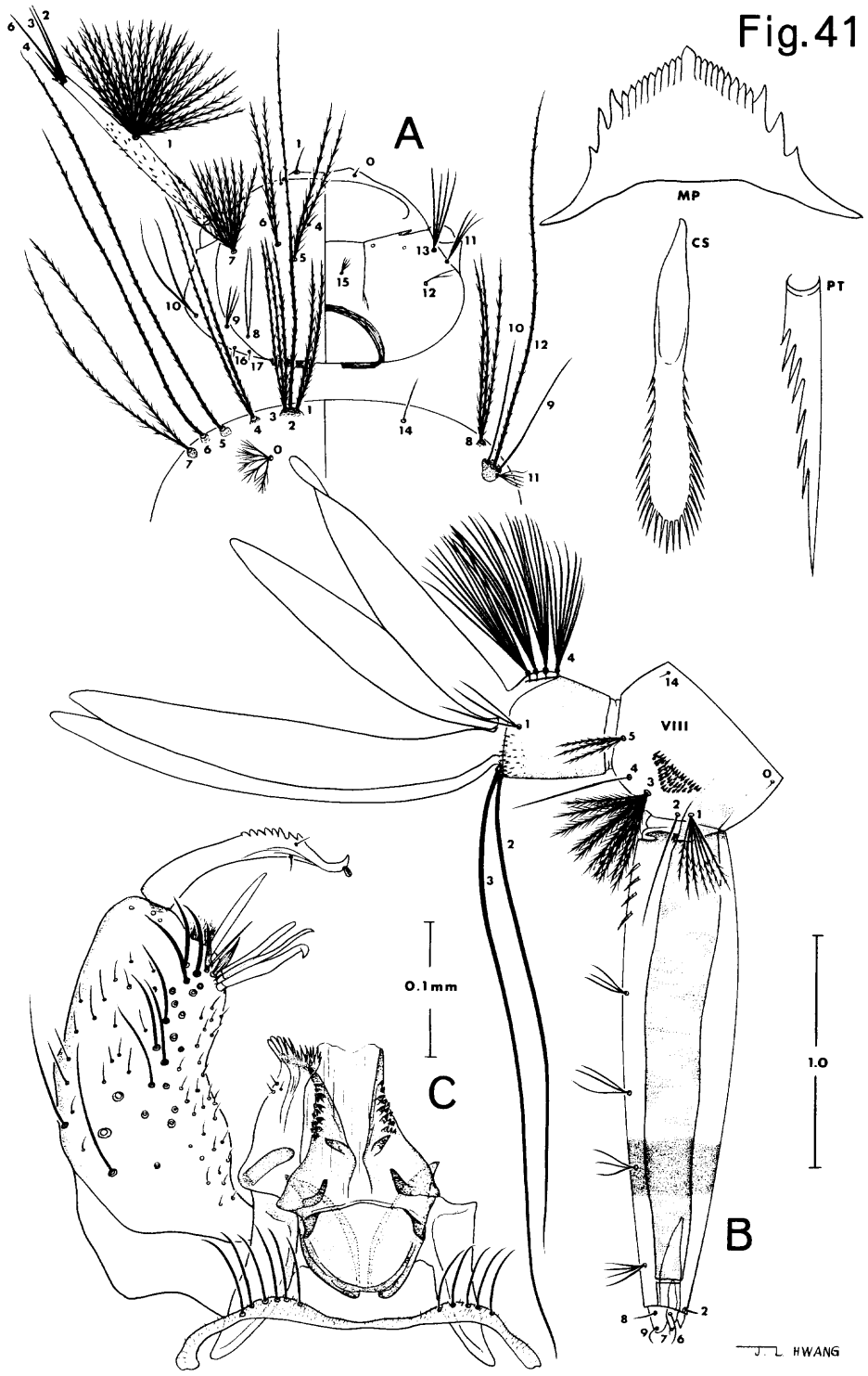
Figure 40. *C. (Culiciomyia) bailyi.* Fourth stage larva: dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments.



C. (Culiciomyia) barrinus

a broad, symmetrical, striated leaf, and a strong seta; distimere with a crest of 10 or more recurved spines on the convex surface and a moderately prominent hook opposite the claw; lateral plate of the phallosome with a strong, heavily sclerotized basal tooth and from 6 to 10 evenly spaced, strong denticles.

PUPA. (Figure 43A, B).

LARVA. (Figure 44). *Head.* Antenna with a narrow, dark basal band; head hair 1-C filamentous, its length slightly greater than half the distance between the bases of the pair; 4-C single, simple; 5, 6-C with from 5 to 8 branches, pectinate. *Thorax.* Integument glabrous; hairs 1, 2, 3-P single, pectinate, with 3-P much shorter and slenderer than 1, 2-P; 4, 7, 8-P bifid, pectinate; 5, 6-P single, pectinate; 14-P bifid, simple. *Abdomen.* Integument glabrous; comb consisting of a triangular patch of from 25 to 40 fan-shaped scales; siphon index variable, averaging between 5:1 and 6:1; 3 subventral tufts inserted in a line on the siphon beyond the pecten; individual tufts with 2 or 3 simple branches, their length greater than the width of the siphon at the point of insertion; pecten consisting of from 10 to 13 teeth restricted to the basal fourth to third of the siphon; individual pecten tooth with a strong apical spine and about 4 strong, lateral barbs.

TYPE DATA. Lectotype male of *fragilis* (terminalia slide-mounted) from Oras, Samar, Philippines in the U. S. National Museum. Holotype female of *fuscus* from Peradeniya, Ceylon in the British Museum. Lectotype of *inornata* hereby designated: syntype female, "B. M. 1907-29, Kuching, Sarawak, Dr. Barker", in the British Museum. Lectotype of *ceylonica* hereby designated: syntype female, "B. M. 1907-29, Peradeniya, Ceylon, 2-1902", in the British Museum. The type locality of *graminis* is Kuala Lumpur, Selangor, Malaya, but the type specimen is non-existent.

Considering the lack of distinguishing features in the adult female and the present inability to separate *fragilis* from *scanloni* in the adult female, it is most unfortunate that it has been necessary to select female syntypes as the lectotypes of *inornata* and *ceylonica*. In both instances, however, the syntype male lacked the terminalia and the rest of the specimen was not as well preserved as in the syntype female.

DISTRIBUTION. This species was first reported from THAILAND by Causey (1937) from "Haad Raj Samran". Collections made during the course of this study have been from: *Nakhon Ratchasima, Prachuap Khiri Khan,* and *Ranong*. This species has also been recorded from: PHILIPPINES, INDIA, CEYLON, MALAYA, and INDONESIA. The records from New Guinea, the Solomon Islands, and the Admiralty Islands (Belkin 1965), probably refer to one or more distinct, but closely related species.

The following specimens have been examined from Thailand: 5 individual rearings, 13 females, 15 males, and 22 larvae.

TAXONOMIC DISCUSSION. *C. fragilis* demonstrates its closest affinity to *scanloni* but may be recognized by the differences in the fourth stage larvae outlined in the key. The description of fragilis from the Solomon Islands

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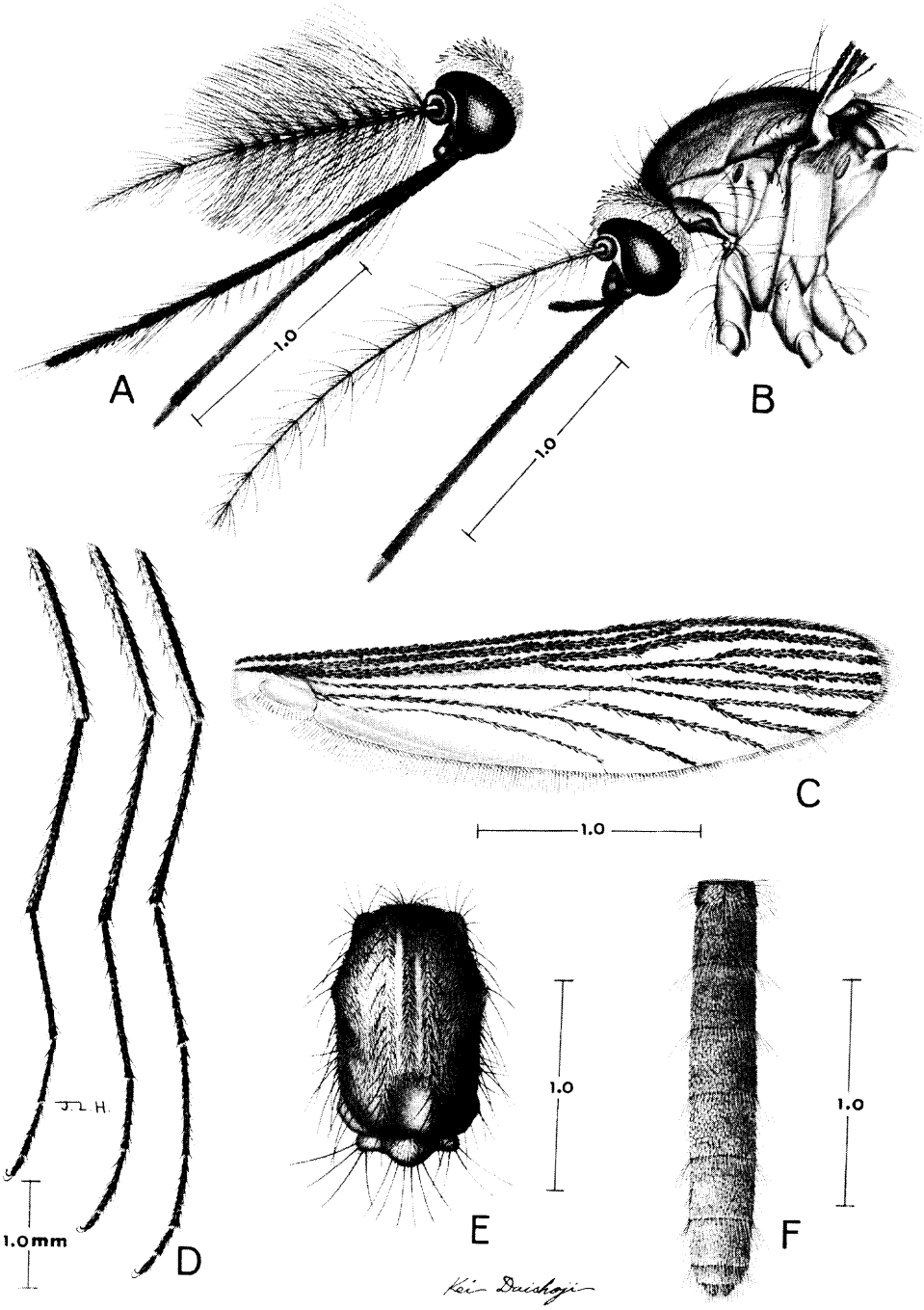
Figure 41. *C. (Culiciomyia) barrinus*. A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the male terminalia.

Fig.42



(Culiciomyia) fragilis

(1962) and specimens determined as this species by him in the U. S. National Museum collection differ to a considerable degree from the species as it occurs in Southeast Asia. In the male terminalia the structures of the subapical lobe of the basimere and the denticles on the lateral plate of the phallosome show recognizable differences; in the fourth stage larva head hairs 5, 6, 16, 17-C, the siphon index, the individual siphon tufts, and the shape of the pecten tooth all differ consistently. It is therefore concluded (as Belkin himself suspected), that the Solomon Islands form is not conspecific with *fragilis* as here presented.

BIOLOGY. In Thailand, larvae of *fragilis* have been collected from elephant tracks, ditches, and a rock pool. Bick (1951) collected larvae of *fragilis* in New Guinea primarily from artificial containers, followed by frequence by coconut shells, puddles, pot holes, tree holes, ponds, spathes and leaves, rock holes, ditches, and 1 collection from a running creek. Water pH ranged from 5.0 to 7.0 and averaged 5.8. Sixty-two percent of the collection sites were shaded, 64 percent of the sites had stagnant or polluted water, and algae occurred in 63 percent of the habitats. King and Hoogstraal (1946), also reporting from New Guinea, found larvae to be most commonly taken from temporary and semipermanent ground pools, especially with stagnant, more or less foul or algae-filled water. Biology and habits of the adults are unknown, but the females have never been reported attacking man.

CULEX (CULICIOMYIA) NIGROPUNCTATUS EDWARDS 1926
(Figures 45, 46, and 47)

Culiciomyia annulata Theobald 1907, Mon. Cul. 4: 231 (preoccupied in *Culex* by Schrank 1776).

Culex nigropunctatus Edwards 1926, Bull. ent. Res. 17: 121 (new name for *annulata* Theobald 1907, not Schrank 1776).

Culex (Culiciomyia) nigropunctatus Edwards: Barraud 1934, Fauna Brit. India, Diptera 5: 383 (♂*, ♀, L); Bohart 1945, Navmed 580: 77 (♂*); Bohart 1956(1957), Ins. Micronesia 12: 70 (♂*, ♀, L*); Lien 1962, Pacif. Ins. 4: 632 (distribution); Safyanova *et al.* 1964, Zool. Zhur. 43: 1179 (distribution); Delfinado 1966, Mem. Amer. ent. Inst. 7: 122 (♂*, ♀, L*, P*).

Culex (Culiciomyia) pullus of Bohart and Ingram 1946, Navmed 1055: 31 (misidentification).

The adult male and female are recognized by the presence of a prominent, black integumental spot on the upper mesepimeron. The male terminalia may be distinguished by the absence of an enlarged hook at the apex of the distimere, the presence of a prominent sternal accessory apical

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Figure 42. ← *C. (Culiciomyia) fragilis*. Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

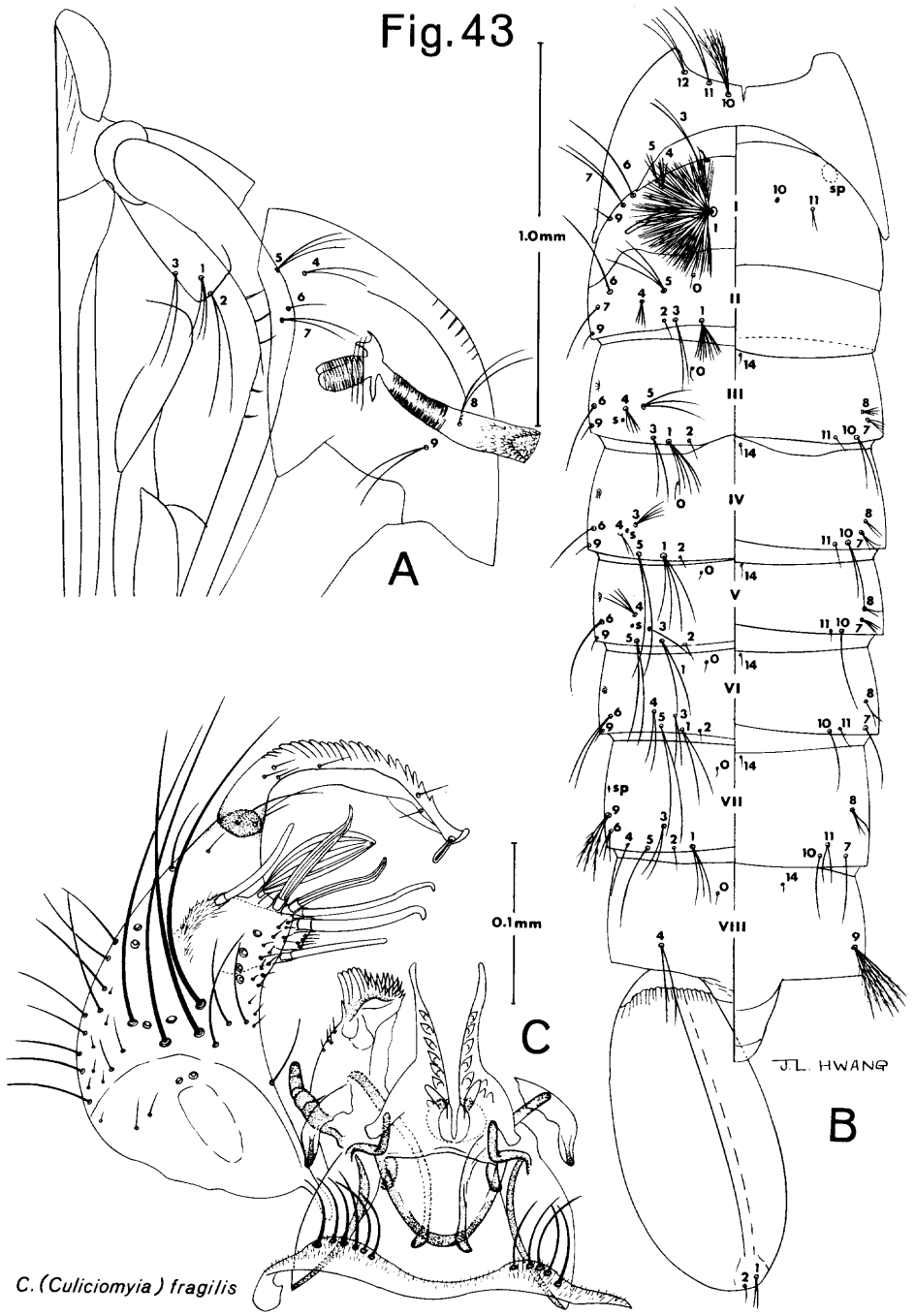


Fig. 43
1.0mm
A
B
0.1mm
C
C. (Culiciomyia) fragilis
J.L. HWANG

lobe on the basimere, and by the number and shape of the setae on the subapical lobe of the basimere. A unique feature of the fourth stage larva is the presence of a lightly sclerotized ring slightly beyond the middle of the siphon, giving the appearance of a false joint.

FEMALE. A small to medium sized species with distinctive colorational features. *Head.* (Figure 45B). Proboscis and palpus uniformly dark scaled; decumbent scales of the vertex light brown on the occiput, becoming lighter until they are creamy white at the orbital line; erect scales yellowish brown throughout. *Thorax.* (Figure 45B, E). Integument of the pleuron light brown, with a distinct, velvety black spot present on the upper mesepimeron, and a lighter, but dark brown area stretching to the upper sternopleuron; 1 strong lower mesepimeral bristle present. *Wing.* (Figure 45C). *Legs.* (Figure 45D). Anterior surface of the hind femur predominantly brown, but occasionally with some variable and randomly scattered white scales; fore and mid legs similar to the hind legs. *Abdomen.* (Figure 45F). Terga dark brown, with broad, pale basal bands and narrow, but variable, pale apical bands which may be absent in some specimens; sterna uniformly pale.

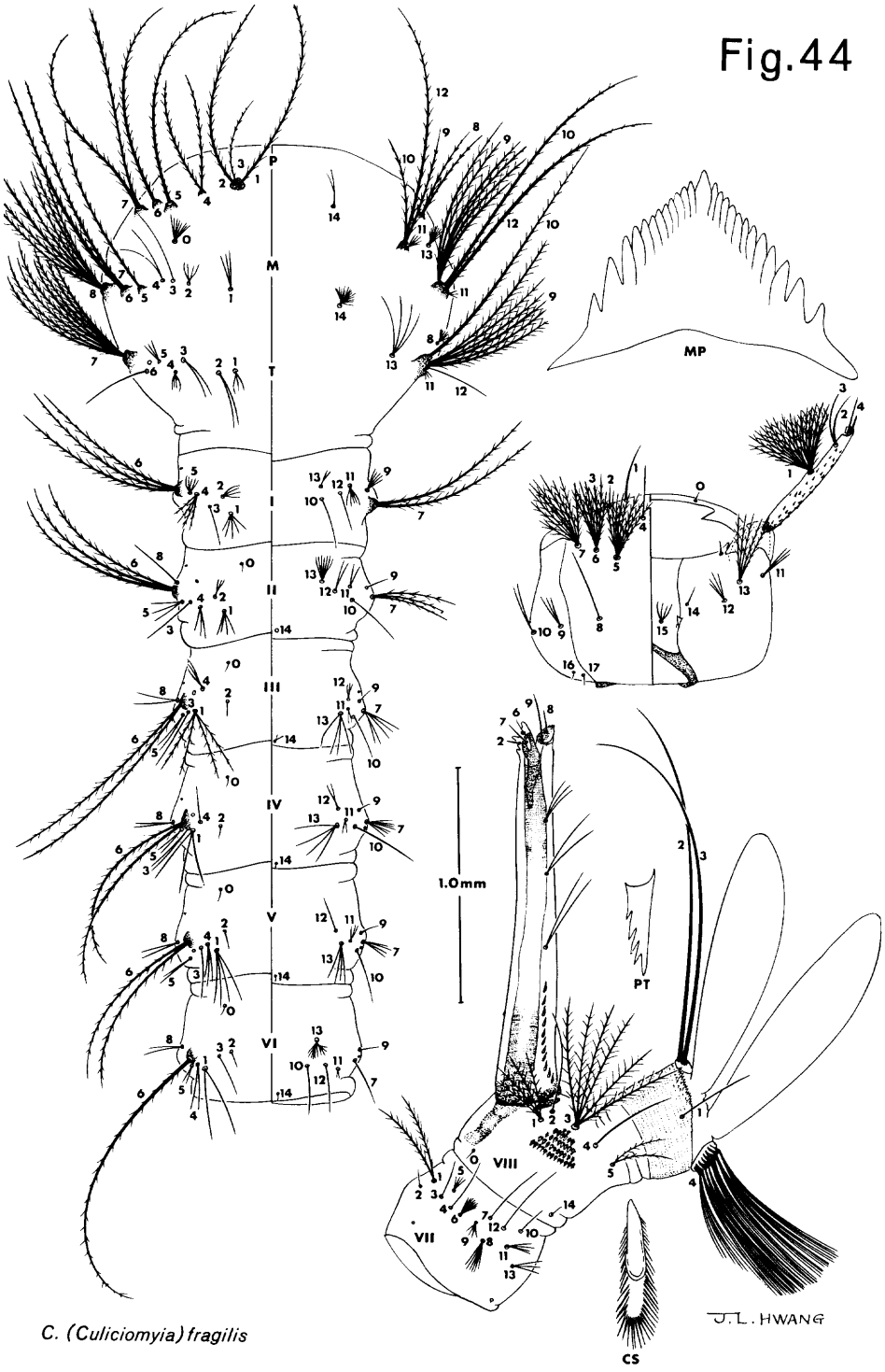
MALE. *Head.* (Figure 45A). Proboscis with a median tuft of numerous strong setae on the ventral surface. *Terminalia.* (Figure 46C). Subapical lobe of the basimere well developed, the most basal rod not on the main lobe but separated from the other 2 rods which are subequal in size and shape; following the basal rods are 2 narrow striated leaflets, 3 strong, straight accessory setae, and a broad leaf which does not exhibit striations; beyond the subapical lobe is a prominent sternal accessory lobe which is covered with numerous long, fine setae; distimere with an apical crest of 15 or more recurved spines on the convex surface, a small hook opposite the claw, and a variable number of setae on the basal half; lateral plate of the phallosome with a large, heavily sclerotized basal tooth and 4 or 5 evenly spaced denticles.

PUPA. (Figure 46A, B).

LARVA. (Figure 47). *Head.* Antenna with a narrow, dark, basal ring; hair 1-C filamentous, its length slightly greater than half the distance between the bases of the pair; 5, 6-C with 3 or 4 branches, pectinate. *Thorax.* Integument glabrous; hairs 1, 2, 3-P single, pectinate, 3-P only slightly shorter and slenderer than 1, 2-P; 4, 7, 8-P bifid, pectinate; 5, 6-P single, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; comb consisting of from 35 to 45 fan-shaped scales arranged in 3 irregular rows; siphon index variable, ranging from 9:1 to 11:1, beyond the middle is a false joint due to lack of sclerotization in an irregular ring; 3 pairs of subventral tufts inserted on the siphon, 2 basad and 1 distad of the false joint; individual tufts single or bifid, their length equal to or less than the width of the siphon at the point of insertion; pecten consisting of from 8 to 11 teeth, restricted to the basal fifth or less of the siphon; individual pecten tooth with a sharply pointed distal spine and from 5 to 8 sharp, lateral barbs.

Figure 43. *C. (Culiciomyia) fragilis.* A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia.

Fig.44



C. (Culiciomyia) fragilis

TYPE DATA. Holotype female of *annulata* from Kuching, Sarawak, Malaya in the British Museum.

DISTRIBUTION. This species was first reported in THAILAND from Bangkok and near *Chumphon* by Barraud and Christophers (1931), and Causey (1937) also collected *nigropunctatus* in Bangkok. Material has been examined during this study from *Chiang Mai, Chon Buri, Krung Thep, Lampang, Mae Hong Son, Nakhon Ratchasima, Nakhon Si Thammarat, Nonthaburi, Prachuap Khiri Khan, Ranong, Sara Buri, Satun, Songkhla,* and *Thon Buri.* The species has also been recorded from BORNEO, INDIA, CEYLON, MALAYA, SINGAPORE, SUMATRA, JAVA, PHILIPPINES, HAINAN ISLAND, RYUKYU RETTO, PALAU ISLANDS, CAROLINE ISLANDS, and TAIWAN. Two male specimens have been examined in the British Museum from Rangoon, BURMA** (XII 62, P. F. Mattingly).

During this study 26 individual rearings were examined from Thailand as well as 72 females, 58 males, and 58 larvae.

TAXONOMIC DISCUSSION. The dark markings of the pleuron and the exceptional siphon of the fourth stage larva clearly distinguishes *nigropunctatus* from any other species of the subgenus in Thailand. It is very similar to *pullus* Theobald from New Guinea, Australia, and the South Pacific, but may be distinguished most noticeably on the basis of the male terminalia which are quite distinct.

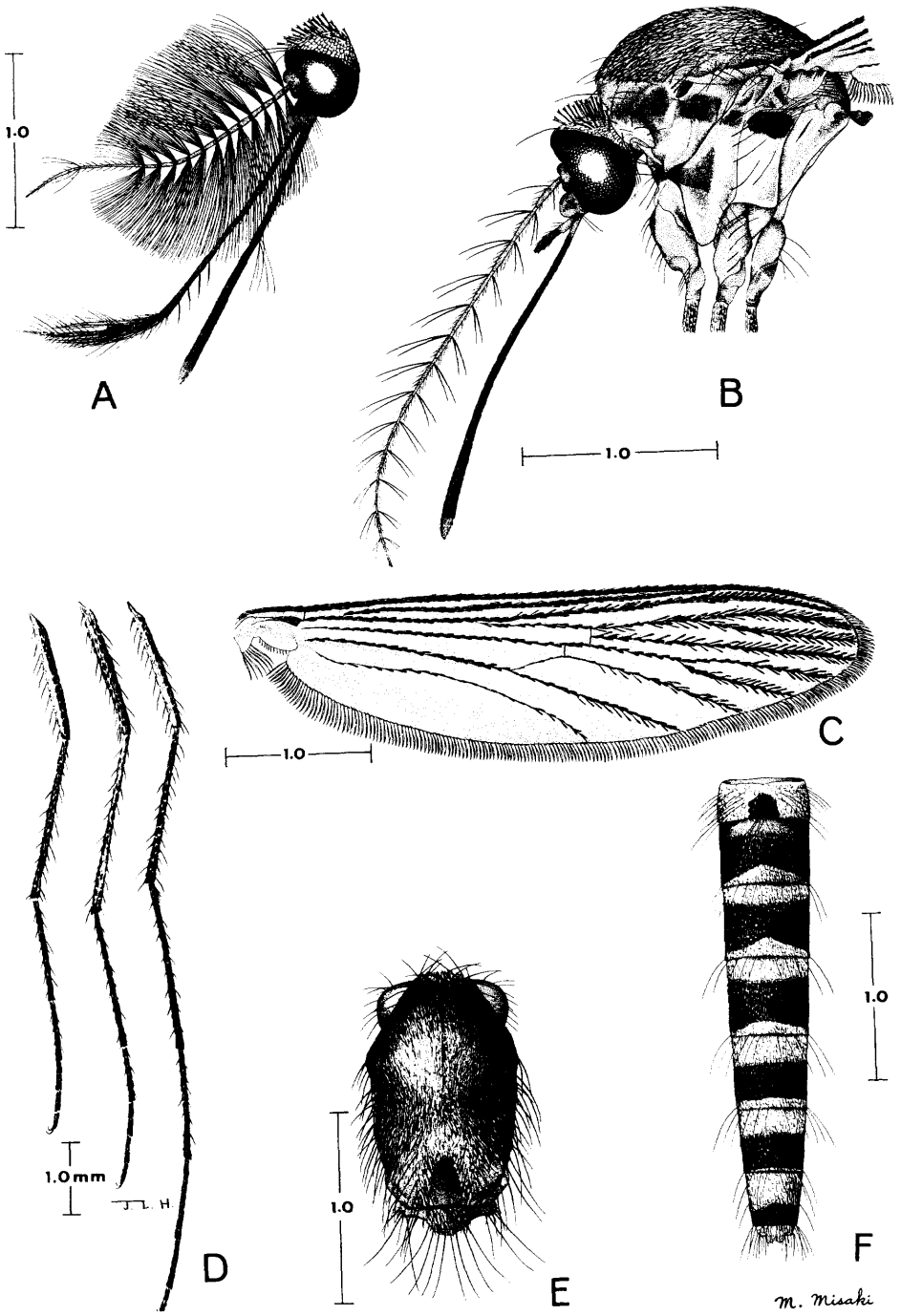
BIOLOGY. According to Bohart (1956(1957)), larvae are found principally in or near rice fields in grassy ground pools in the Oriental region. Lien (1962) reported collecting larvae in Taiwan from hoof-marks, small ground pools, and seepage pools with turbid water and grassy margins. However, Safyanova *et al.* (1964) collected larvae of *nigropunctatus* only from swamps in tropical rain forests in the Fucoy region of North Vietnam. Causey (1937) collected larvae of this species in Thailand from small shady pools and in water receptacles and collected adults at light traps throughout the year. During this study larvae have been collected in Thailand from rock holes, small ponds, puddles, rice fields, elephant tracks, buffalo hoof prints, a coconut shell, various ditches, and once from a bamboo internode. Host preference of the adult female, according to Colless (1959b), is birds, but ox may serve as a secondary host. This species has never been reported biting man.

CULEX (CULICIOMYIA) PALLIDOTHORAX THEOBALD 1905
(Figures 48, 49, and 50)

Culex pallidothorax Theobald 1905, J. econ. Biol. 1: 32 (♂, ♀).
Culex albopleura Theobald 1907, Mon. Cul. 4: 456 (♀); Edwards 1913, Bull. ent. Res. 4: 235 (synonymy).
Culiciomyia annuloabdominalis Theobald 1910, Mon. Cul. 5: 236 (♂*, ♀*); Edwards 1913, Bull. ent. Res. 4: 235 (synonymy).
Culiciomyia pallidothorax (Theobald): Borel 1926, Arch. Insts. Pasteur Indo-Chine 3-4: 30 (♂*, ♀, L*).

Figure 44. ← *C. (Culiciomyia) fragilis.* Fourth stage larva; dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments.

Fig.45



C.(Culiciomyia) nigropunctatus

Culex (Culiciomyia) pallidothorax Theobald: Edwards 1932, *in* Wytsman, Genera Insect. fasc. 194: 199 (taxonomy); Barraud 1934, Fauna Brit. India, Diptera 5: 381 (♂*, ♀, L); Bohart and Ingram 1946, Navmed 1055: 75 (♂*, ♀*, L*); LaCasse and Yamaguti 1950, Mosq. Fauna Japan and Korea: 182 (♂*, ♀*, L*, P*); Bick 1951, Pacif. Sci. 5: 419 (ecology); Hara 1957, Jap. J. exp. Med. 27: 52 (♀*); Lien 1962, Pacif. Ins. 4: 632 (distribution); Delfinado 1966, Mem. Amer. ent. Inst. 7: 119 (L*, P).

The adult female can be separated from other members of the subgenus by the pale basal banding of the abdominal terga and by the dark patterns on the integument of the pleuron. The adult male possesses a crest of spines on the convex surface of the distimere of the terminalia and lacks a broad leaf-like seta on the subapical lobe of the basimere.

FEMALE. A small to moderate sized species. *Head.* (Figure 48B). Proboscis and palpus uniformly dark scaled; decumbent scales of the vertex light brown at the occiput and becoming lighter towards the orbital line; erect scales dark brown. *Thorax.* (Figure 48B, E). Integument of the pleuron light brown, frequently tinged with green, with a distinctly darker brown pattern which stretches from the prespiracular area across the prealar area and terminates at the upper mesepimeron; another darker brown pattern present on the upper sternopleuron; 1 or 2 strong lower mesepimeral bristles present. *Wing.* (Figure 48C). *Legs.* (Figure 49D). All legs uniformly dark brown, but occasionally with pale scaling on the ventral margin of the anterior surface of the hind femur. *Abdomen.* (Figure 48F). Terga with rather broad, usually convex, pale basal bands; sterna uniformly pale.

MALE. *Head.* (Figure 48A). Proboscis with a median tuft of setae on the ventral surface. *Terminalia.* (Figure 49C). Subapical lobe of the basimere well developed, the 3 rods closely placed, the basal rod shorter and slenderer than the other 2 rods; additional strong setae and a narrow, striated, leaf-like seta follows the rods; beyond the subapical lobe is a prominent sternal accessory lobe which is covered with numerous long, fine setae; distimere with a prominent crest of 5 or more recurved spines on the convex surface and a distinct hook opposite the claw; lateral plate of the phallosome with a prominent basal tooth and approximately 5 evenly spaced denticles.

PUPA. (Figure 49A, B).

LARVA. (Figure 50). *Head.* Antenna with a narrow, dark basal ring; head hair 1-C filamentous, its length slightly greater than half the distance between the bases of the pair; 4-C single, simple; 5, 6-C with 2 or 3 branches, pectinate. *Thorax.* Integument superficially glabrous, but when examined critically, with indications of minute spicules (not illustrated); hairs 1, 3-P bifid, pectinate, 1-P slightly longer; 2-P single, pectinate; 4, 7, 8-P bifid, pectinate; 5, 6-P single, pectinate; 14-P single, simple. *Abdomen.* Integu-

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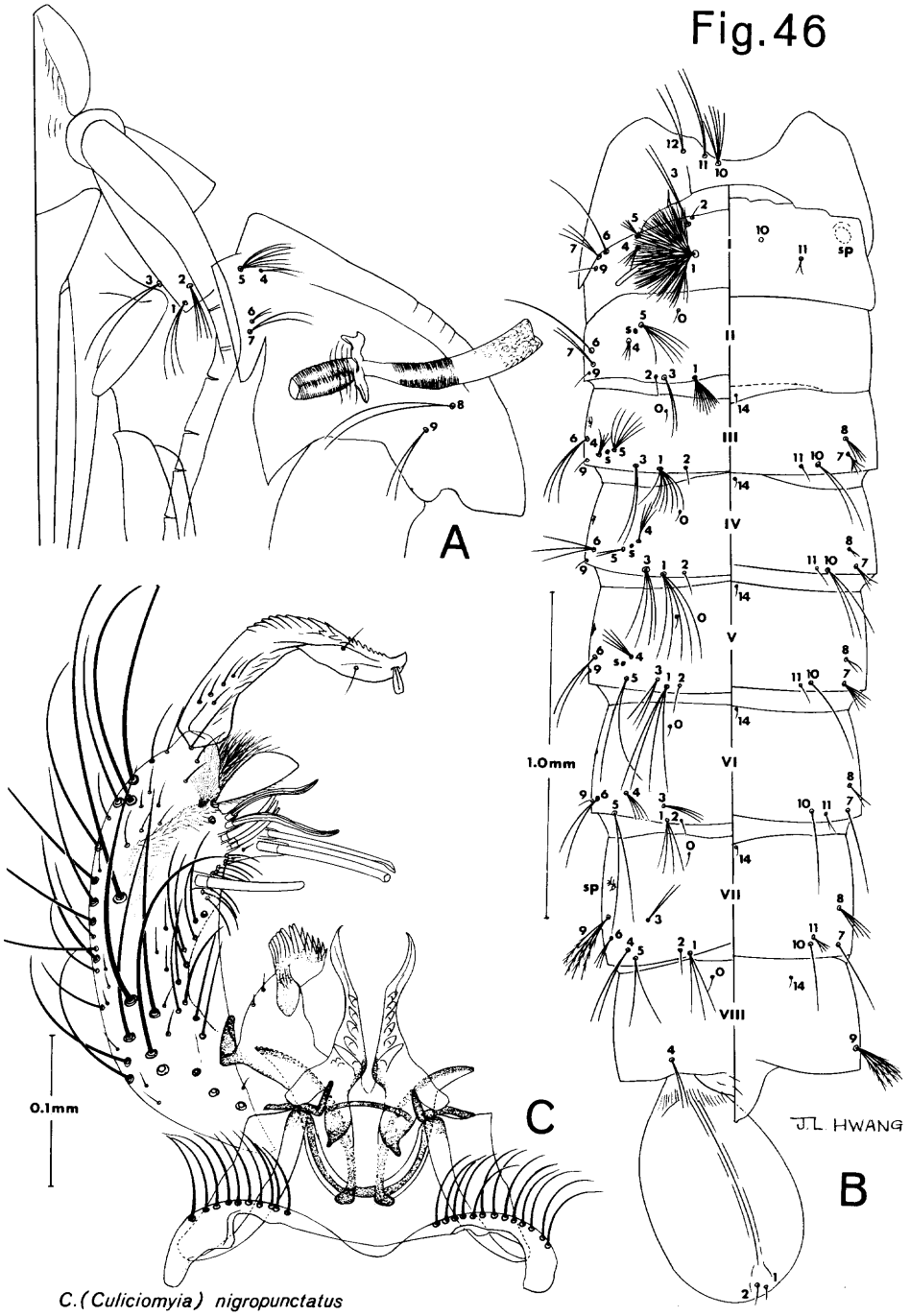
Figure 45. *C. (Culiciomyia) nigropunctatus.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

Fig. 46



C.(Culiciomyia) nigropunctatus

ment similar to that of the thorax; comb consisting of from 25 to 40 fan-shaped scales arranged in a triangular patch; siphon index variable, ranging from approximately 4:1 to 6:1, the siphon greatly expanded medially; 4 pairs of 3 or 4 branched subventral tufts inserted in a line beyond the pecten; the length of the individual tufts less than half the width of the siphon at the point of insertion; pecten consisting of from 7 to 10 teeth, restricted to the basal third or less of the siphon; individual pecten tooth with a strong distal spine and from 2 to 4 strong lateral barbs.

TYPE DATA. Lectotype of *pallidothorax* hereby designated: syntype male (terminalia mounted and attached to pin), "B. M. 1907-29, India, Capt. James", in the British Museum. Holotype female (abdomen missing) of *albopleura* from "India" in the British Museum. The type locality of *annuloabdominalis* is Peradeniya and Hakgala, Ceylon, but the type specimen is non-existent.

DISTRIBUTION. Edwards (1922) first recorded *pallidothorax* from THAILAND. Subsequently, Barraud and Christophers (1931) reported the species from Doi Suthep, and Causey (1937) recorded it from Bangkok, "Chieng Moeang", and "Scoed". During this study collections of *pallidothorax* have been made from: *Chiang Mai, Chon Buri, Kanchanaburi, Lampang, Lamphun, Mae Hong Son, Nakhon Nayok, Nakhon Ratchasima, Nan, Prachuap Khiri Khan, Phare, Ranong, Sara Buri,* and *Tak*. The species has also been recorded from CEYLON, NEPAL, BURMA, INDOCHINA, MALAYA, CHINA, TAIWAN, RYUKYU-RETTO, JAPAN, MOLUCCAS, NEW GUINEA, and the PHILIPPINES.

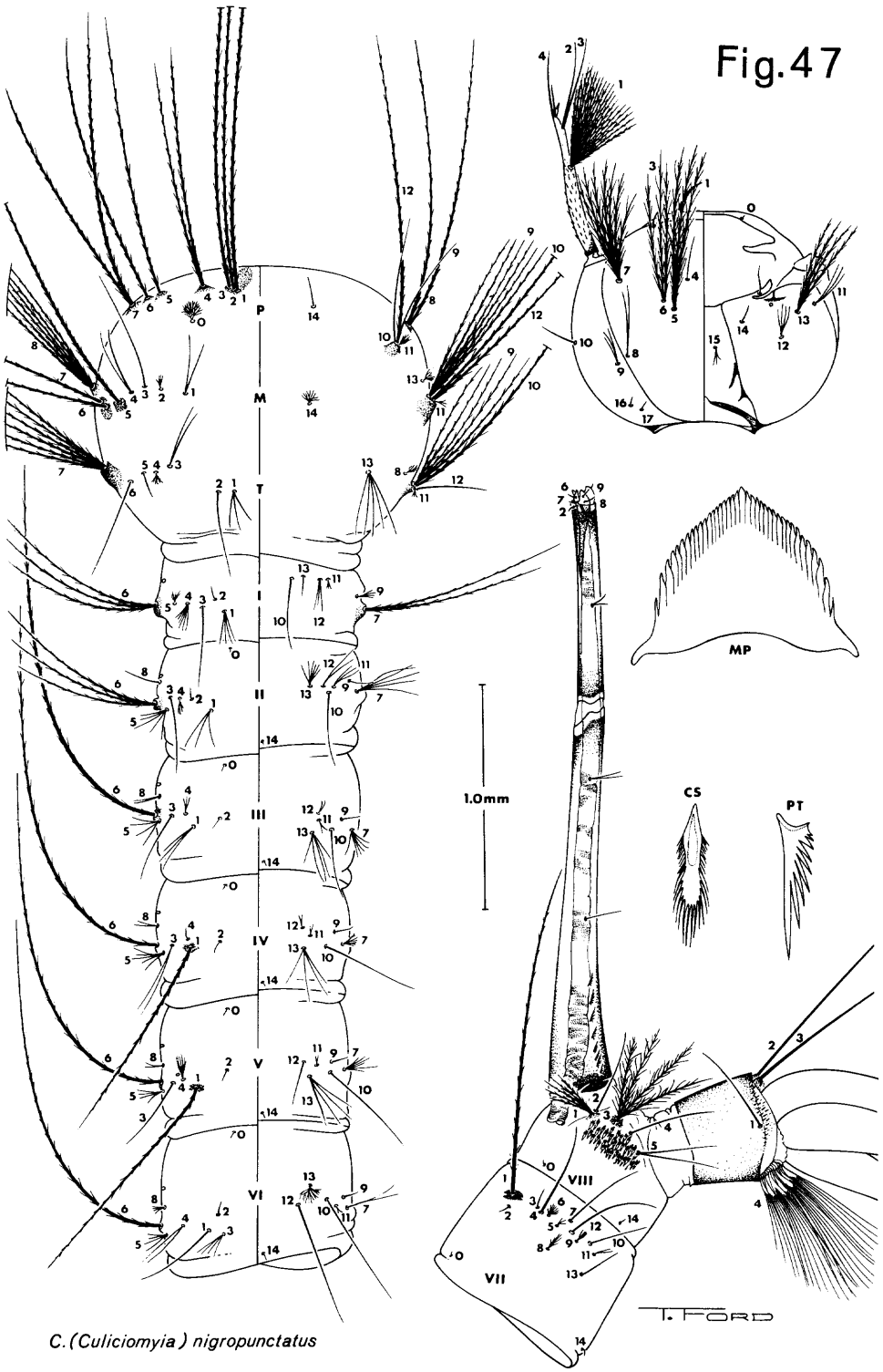
Fifty individual rearings were examined from Thailand as well as 157 females, 165 males and 347 larvae.

TAXONOMIC DISCUSSION. Although quite distinctive, *pallidothorax* has its closest affinity to *thurmanorum* and *barrinus*. Differences in the setae on the subapical lobe of the basimere in the male terminalia, and larval chaetotaxy and shape and color of the siphon clearly separate the species.

BIOLOGY. In Thailand, *pallidothorax* has been collected during this study from puddles, rock holes, sumps, stream rock pools, rice fields, elephant hoof prints, tin cans, and jungle streams from January to May, August, September, and November. Barraud (1934) reported the habitat of this species as tree holes, bamboo stems, shallow wells, stream and rock pools, and swampy ground pools. Bohart and Ingram (1946) collected larvae on Okinawa only from artificial containers, polluted ground pools, and rarely in rock pools. Bick (1951) found larvae most frequently in puddles, followed in frequency by artificial containers, pot holes, borrow pits, ditches, swamps, running creeks, coconut shells, tree holes, rock holes, and spathes and leaves. He further stated that 77 percent of the collections were made from temporary water, 67 percent of the habitats were exposed to sun, and 49 percent of the habitats demonstrated clear water in contrast to muddy, stagnant, or polluted water. Lien (1962) recorded the larvae in Taiwan from stream pools, rock pools, bamboo stumps, and artificial containers below 500 meters.

Figure 46. *C. (Culiciomyia) nigropunctatus*. A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia.

Fig.47



C.(Culiciomyia) nigropunctatus

Host preference of the adult females is unknown, but apparently they do not normally feed upon man (Feng 1938; Bohart and Ingram 1946; LaCasse and Yamaguti 1950). However, Scanlon and Esah (1965) reported that small numbers were collected biting and landing on man at the 2,500 to 4,500 feet level on Pui Doi Mountain, Chiang Mai, Thailand. Iyengar (1938) reported *pallidothorax* as a carrier of *Wuchereria malayi*. Hu (1940) induced starved females to engorge on a human filarial patient and subsequent dissection revealed the presence of infective *Wuchereria bancrofti* larvae, but he concluded that *pallidothorax* did not play an important part in transmission.

CULEX (CULICIOMYIA) PAPUENSIS (TAYLOR) 1914
(Figures 51, 52, and 53)

Melanoconion papuensis Taylor 1914, Trans. R. ent. Soc. Lond. 1914: 201 (♀).

Culex (Culiciomyia) papuensis (Taylor): Edwards 1924, Bull. ent. Res. 14: 397 (♂, ♀); King and Hoogstraal 1946, Proc. biol. Soc. Wash. 59: 146 (♂*, L*); Penn 1947, Pacif. Sci. 3: 73 (P*); Laird 1955, Bull. ent. Res. 46: 286 (L*); Belkin 1962, Mosq. S. Pacif. I: 230 (♂*, ♀, L*, P*); Assem and Bonne-Wepster 1964, Zool. Bijd. 6: 115 (♀, L*); Delfinado 1966, Mem. Amer. ent. Inst. 7: 120 (♂*, ♀, L*, P).

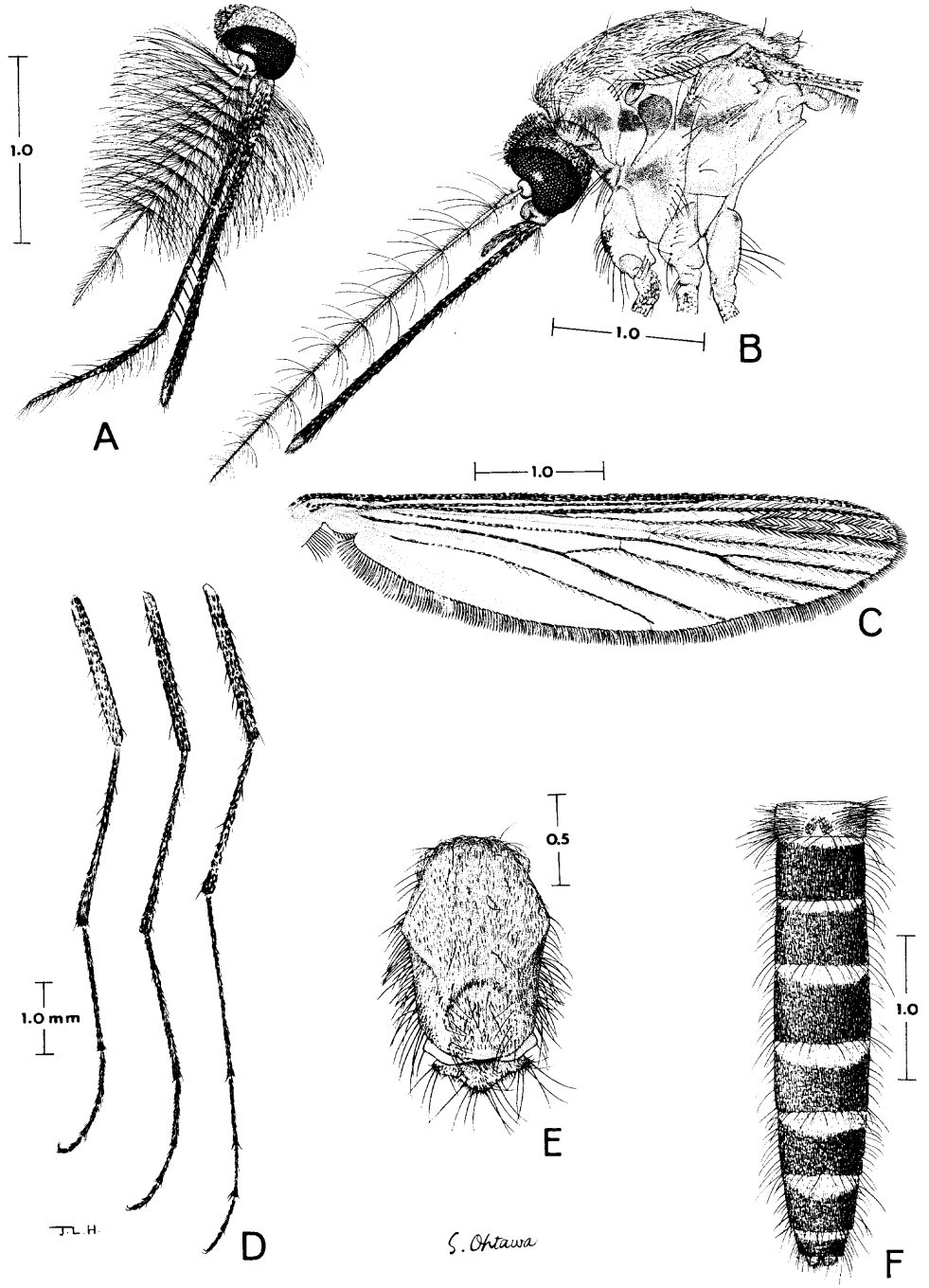
The adult female is poorly characterized but may be separated from some species of the subgenus by the absence of pale abdominal banding, and by the weak dorsocentral bristles. In the adult male, the distimere of the terminalia and the structure and number of denticles on the lateral plate of the phallosome are characteristic. The fourth stage larva may be recognized by the robust head hair 1-C and the shape of the siphon.

FEMALE. A moderate to large species without distinctive color patterns. *Head.* (Figure 51B). Proboscis and palpus uniformly dark scaled, palpal segment IV over 3 times as long as III; decumbent scales of the vertex yellowish brown on the occiput, becoming progressively lighter towards the orbital line; erect scales dark brown. *Thorax.* (Figure 51B, E). Integument of the pleuron light brown, frequently tinged with a yellowish green cast; a faint, variable integumental pattern of brown is sometimes present on the upper sternopleuron; 1 lower mesepimeral bristle present. *Wing.* (Figure 51C). *Legs.* (Figure 51D). Anterior surface of hind and mid femora dark, but occasionally with a stripe of pale scales on the ventral margin; fore femur and all tibiae and tarsi uniformly dark, although the fore femur may occasionally have some pale scales on the ventral margin. *Abdomen.* (Figure 51F). Terga uniformly dark; sterna pale.

MALE. *Head.* (Figure 51A). Proboscis with a median tuft of strong setae inserted on the ventral surface. *Terminalia.* (Figure 52C). Subapical lobe of the basimere moderately developed, the basal rod shorter than, and separated from the other 2 rods which are subequal in strength and length;

Figure 47. *C. (Culiciomyia) nigropunctatus*. Fourth stage larva: dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments.

Fig.48



C. (Culiciomyia) pallidothorax

beyond the rods are a series of 3 strong, broad, straight setae and 5 or more accessory setae, but no leaf-shaped seta; beyond the subapical lobe is a prominent sternal accessory lobe which is covered with numerous long, fine setae; distimere with a crest of 3 or 4 recurved spines on the convex surface and with a small hook opposite the claw; lateral plate of the phallosome with a prominent, heavily sclerotized basal tooth and from 4 to 8 evenly spaced denticles.

PUPA. (Figure 52A, B).

LARVA. (Figure 53). *Head.* Antenna with a narrow dark basal ring; head hair 1-C robust, lightly pigmented, frequently possessing accessory lateral spicules, its length somewhat greater than half the distance between the bases of the pair; 4-C single, simple; 5-C usually trifid, pectinate; 6-C usually with 4 branches, pectinate. *Thorax.* Integument with extremely minute spicules arranged in an irregular pattern, particularly on the antero-lateral margin (not illustrated); hair 1-P trifid, pectinate; 2-P single, pectinate, shorter than 1-P; 3-P trifid, pectinate, shorter than 1-P; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P trifid, pectinate; 8-P with 4 pectinate branches; 14-P single, simple. *Abdomen.* Integument glabrous; comb consisting of approximately 30 to 40 fan-shaped scales arranged in a broad, triangular patch; siphon index variable, ranging from 4.5:1 to 5.5:1, the siphon greatly expanded medially; 4 pairs of subventral tufts inserted in a line beyond the pecten; individual tufts with from 6 to 10 branches, their length considerably less than the width of the siphon at the point of insertion; pecten consisting of from 3 to 5 teeth, restricted to approximately the basal third of the siphon; individual pecten tooth with a strong distal spine and 3 or 4 smaller lateral barbs.

TYPE DATA. Holotype female of *papuensis* from Lahekamu Gold Field, Papua, New Guinea in the School of Public Health and Tropical Medicine, University of Sydney, Australia.

DISTRIBUTION. In THAILAND**, this species has been collected from: *Nakhon Ratchasima*, *Narathiwat*, *Phattalung*, and *Songkhla*. Previous records have been from NEW GUINEA, BISMARCK ARCHIPELAGO, the SOLOMON ISLANDS, the PHILIPPINES, and 2 larvae in the British Museum have been examined from "Java or Sumatra?, Tjoeroel".

During this study 84 individual rearings were examined as well as 17 females, 15 males, and 99 larvae.

TAXONOMIC DISCUSSION. This species shows no particularly close affinity to any of the other species of the subgenus in Thailand, although no outstandingly distinctive features may be observed in the adult female. In the male, the terminalia is similar to *nigropunctatus* and *pallidothorax*, but the setae on the subapical lobe of the basimere are distinctive, the terga lack pale,

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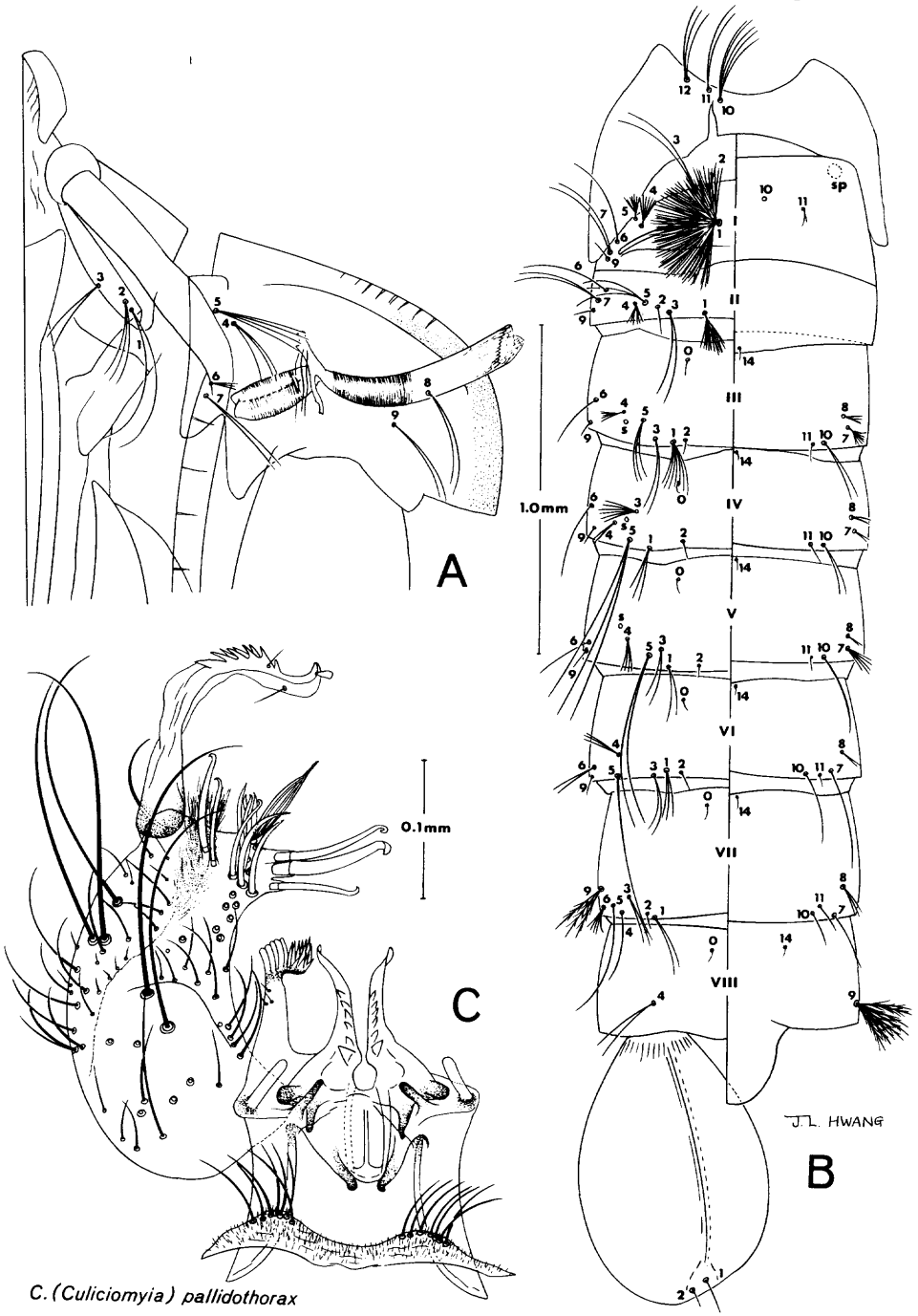
Figure 48. *C. (Culiciomyia) pallidothorax.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

Fig.49



C. (Culiciomyia) pallidothorax

basal bands, and dark integumental markings are absent from the pleuron. In the fourth stage larva, the siphon is similar to that of *pallidothorax* but the distinctive head hair 1-C and other features of the chaetotaxy are diagnostic.

BIOLOGY. In Thailand, larvae have been collected from stream pools, rock pools, elephant tracks, and a large root hole. Assem and Bonne-Wepster (1964) reported collecting larvae in New Guinea from ground water and container habitats in shade or half shade, and in either clear water or water filled with leaves; sometimes they were present in putrid water found in hollowed sage-palm trunks. Also in New Guinea, Bick (1951) collected larvae most frequently from artificial containers, followed by puddles, pot holes, borrow pits, ditches, rock holes, and tree holes. Usually vegetation was absent from the habitats, but it was 1 of the few species which Bick collected frequently in both surface water and container habitats. King and Hoogstraal (1946) found larvae in putrid water in hollowed sage trunks, in wooden kegs, tin food containers, tree holes, and drums. In the Solomon Islands larvae were collected by Belkin (1962) from large tree holes, artificial containers, and ground pools. Adult host preference and bionomics are unknown, but man has not been reported as a host.

CULEX (CULICIOMYIA) SCANLONI, N. SP.
(Figures 54, 55, and 56)

The adult female cannot be distinguished with certainty from *fragilis*. The adult male may be recognized by the setae on the subapical lobe of the basimere and by structures on the lateral plate of the phallosome. The fourth stage larva is characterized by the shape and length of the siphon and by the shape of the pecten tooth.

FEMALE. A small species without striking colorational features. *Head*. (Figure 54B). Proboscis and palpus uniformly light brown with a grayish cast; decumbent scales of the vertex creamy white; erect scales dark brown. *Thorax*. (Figure 54B, E). Integument of the pleuron yellowish brown, frequently tinged with green in some specimens, without consistent dark patterns present; 1 lower mesepimeral bristle present. *Wing*. (Figure 54F). *Legs*. (Figure 54D). Anterior surface of the femora grayish brown, with variable white stripes on the ventral margins; tibiae and tarsi brown, but appearing grayish when struck by light at an oblique angle. *Abdomen*. (Figure 54F). Terga brown; sterna pale.

MALE. *Head*. (Figure 54A). Proboscis with a median tuft of from 2 to 4 strong setae on the ventral surface. *Terminalia*. (Figure 55C). Subapical lobe of the basimere well developed, but rather narrow; the basal rod separated from the other 2 rods, beyond which are 2 sigmoid and 1 straight accessory setae and a broad, striated leaf; distimere with a crest of 15 or more recurved spines which are absent only from the extreme base and apex of the convex surface, with a small hook opposite the claw, and with several

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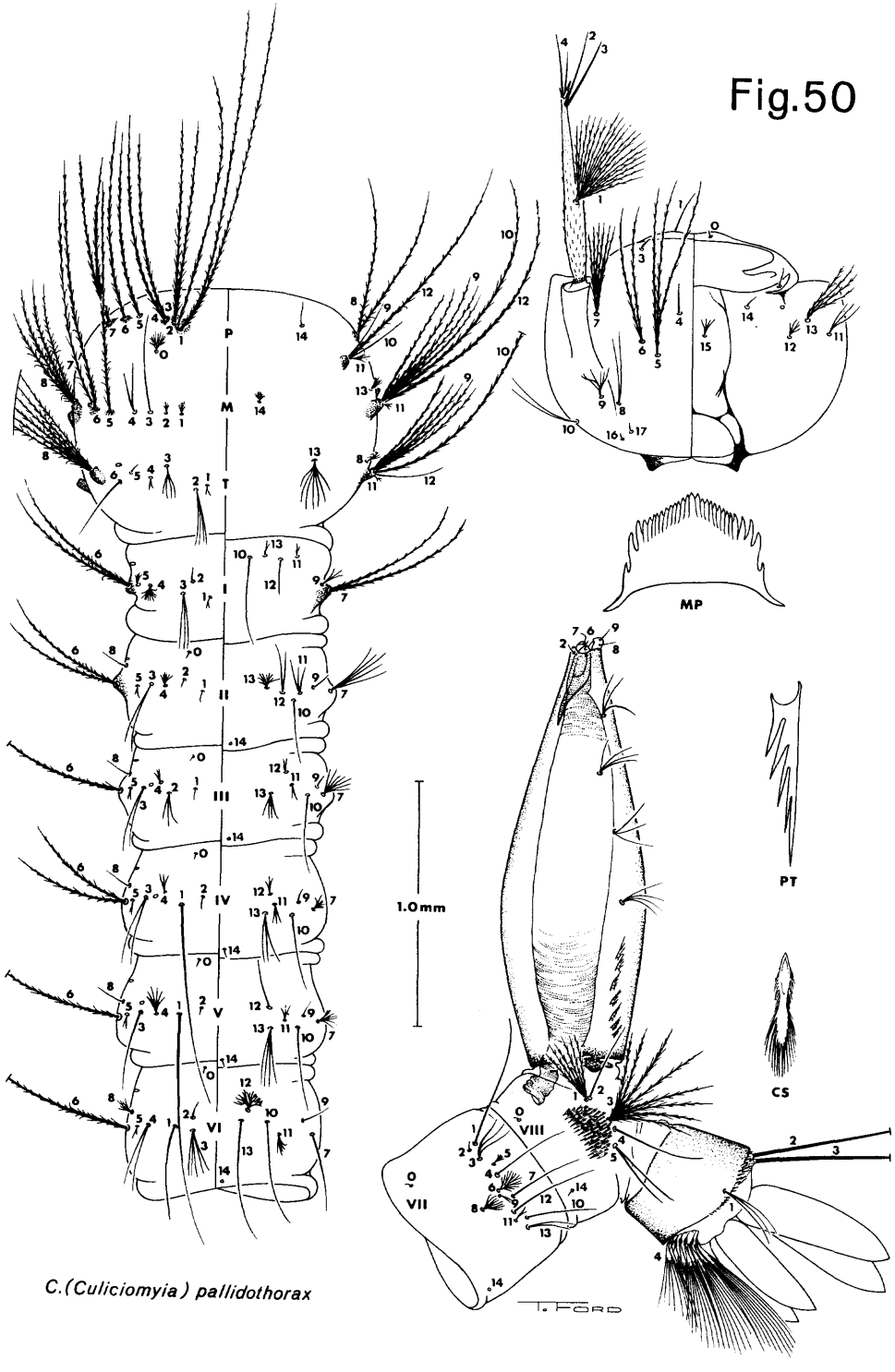
Figure 49. *C. (Culiciomyia) pallidothorax*. A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia.



C.(Culiciomyia) pallidothorax

fine setae on the basal half; lateral plate of the phallosome with a rather large, heavily sclerotized basal tooth and approximately 6 sharply pointed denticles.

PUPA. (Figure 55A, B).

LARVA. (Figure 56). *Head.* Antenna with a narrow, dark basal ring; head hair 1-C filamentous, its length slightly greater than half the distance between the bases of the pair; 4-C single, simple; 5-C trifid, pectinate; 6-C bifid, pectinate. *Thorax.* Integument superficially glabrous, but critical examination reveals the presence of minute spicules (not illustrated); hairs 1, 2, 3-P single, pectinate, 3-P shorter and slenderer than 1, 2-P; 4, 7, 8-P bifid, pectinate; 5, 6-P single, pectinate; 14-P single, simple. *Abdomen.* Integument similar to that of the thorax; comb consisting of approximately 35 to 45 fan-shaped scales arranged in a broad, triangular patch; siphon index variable, ranging from 9.5:1 to 10.5:1, the siphon gently, but characteristically curved; 3 pairs of subventral tufts inserted beyond the pecten; individual tufts single or bifid, their length approximately equal to the width of the siphon at the point of insertion; pecten consisting of approximately 15 teeth restricted to the basal fifth or less of the siphon; individual pecten tooth with a fine distal spine and 1 or 2 fine lateral barbs as well as a single, strong, stout, bluntly rounded basal barb.

TYPE DATA. Holotype male (associated larval and pupal skins and terminalia slide-mounted) from Quan Ga Lang, Satun, Thailand, 12 March 1965, E. L. Peyton, from a small, lightly shaded rock pool, ST 5-10, deposited in the U. S. National Museum, No. 69348. Paratype female with associated larval and pupal skins slide mounted from Huey Yang Waterfall, Prachuap Khiri Khan, Thailand, 27 March 1964, K. Mongkolpanya, from a rock pool, PR 159-30, deposited in the U. S. National Museum, No. 69348. Paratype male with associated larval and pupal skins and terminalia slide-mounted from 26 km. Ngao to Payae Road, Lampang, Thailand, 11 June 1964, E. L. Peyton, from a roadside puddle, LG 8-30, deposited in the U. S. National Museum, No. 69348.

This species is named in honor of Lt. Col. John E. Scanlon, MSC, USA in recognition of his contributions to Medical Entomology in Thailand.

DISTRIBUTION. In THAILAND, *scanloni* has been collected from: *Chon Buri, Kanchanaburi, Lampang, Mae Hong Son, Nakhon Ratchasima, Narathiwat, Prachuap Khiri Khan, Ranong, Satun,* and *Surat Thani.*

Larvae of this species have been examined from Subic Bay, and San Jose, Mindoro, PHILIPPINE ISLANDS, Kota Belud, NORTH BORNEO, and Bien Hoa, SOUTH VIETNAM. During this study 15 individual rearings have been examined as well as 11 females, 9 males, and 61 larvae.

TAXONOMIC DISCUSSION. This species demonstrates extremely close affinity to *fragilis,* and in the adult stage the 2 species are virtually inseparable. In the fourth stage larvae, however, distinct differences exist in the chaetotaxy of the head (eg. 5-C trifid, 6-C bifid in *scanloni,* 5, 6-C with from 5 to 8 branches in *fragilis),* prothorax (eg. 14-P single in *scanloni,* bifid in *fragilis),* but particularly in the length and shape of the siphon which is very long and gently curved in *scanloni,* and in the shape of the pecten

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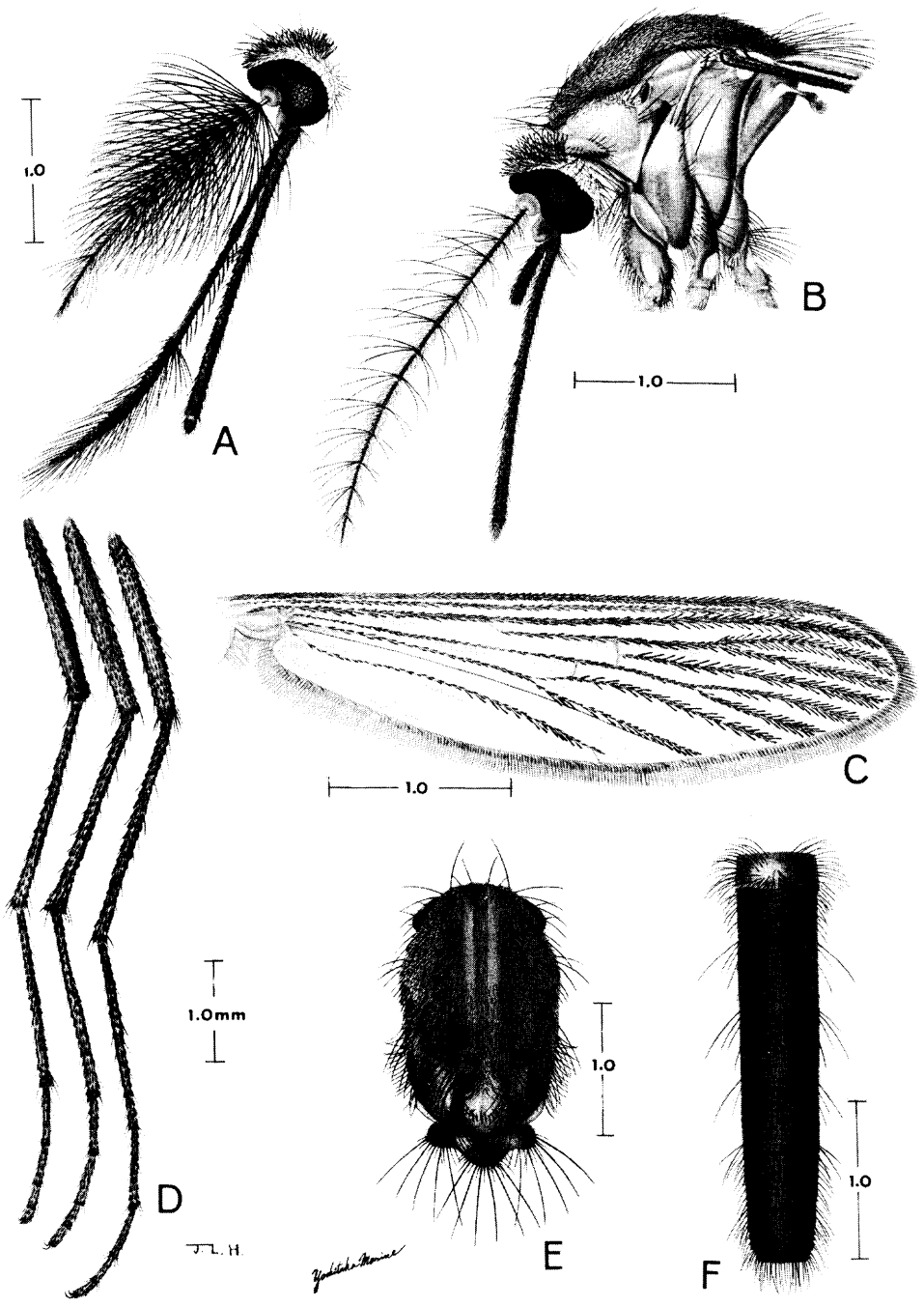
Figure 50. ← *C. (Culiciomyia) pallidothorax.* Fourth stage larva: dorso-ventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments.

Fig. 51



C. (Culiciomyia) papuensis

tooth.

BIOLOGY. Larvae of *scanloni* have been collected from rock pools, stream pools, puddles, and elephant hoof prints. Nothing is known of the adult habits or biology.

CULEX (CULICIOMYIA) SPATHIFURCA (EDWARDS) 1915
(Figures 57, 58, and 59)

Culiciomyia spathifurca Edwards 1915, Bull. ent. Res. 5: 284 (♂).
Culex (Culiciomyia) spahtifurca (Edwards): Edwards 1922, Indian J. med. Res. 10: 472 (distribution); Edwards 1926, Bull. ent. Res. 17: 120 (L); Delfinado 1966, Mem. Amer. ent. Inst. 7: 123 (♂*, ♀, L, P).
Culex (Culiciomyia) stylifurcatus Carter and Wijesundara 1948, Ceylon J. Sci. (B) 23: 145 (♂*, ♀, L*); Mattingly 1955, *in* Iyengar and Menon, Bull. ent. Res. 46: 10 (synonymy).

The adult female cannot be separated with certainty from several other members of the subgenus. In the adult male, the terminalia is unique in possessing a bifurcate distimere. The fourth stage larva may be recognized by having thoracic hairs 1, 2, 3-P single, siphon index approximately 5:1, head hairs 5, 6-C with 3 or 4 branches, and the subventral tufts of the siphon single.

FEMALE. A small to medium sized species without outstanding colorational or anatomical features. *Head.* (Figure 57B). Proboscis and palpus uniformly dark scaled; decumbent scales of the vertex yellowish brown at the occiput, becoming lighter at the orbital line; erect scales yellowish brown. *Thorax.* (Figure 57B, E). Integument of the pleuron light brown, occasionally faintly tinged with green and with a slightly darker integumental spot sometimes present on the postspiracular plate; 1 lower mesepimeral bristle present. *Wing.* (Figure 57C). *Legs.* (Figure 57D). Anterior surface of the hind femur dark brown, with a variable but distinct stripe of pale scales on the ventral margin; hind tibia also with some pale scales on the ventral margin; hind tarsus as well as the fore leg and mid tibia and tarsus dark brown; mid femur similar to the hind femur. *Abdomen.* (Figure 57F). Terga uniformly dark; sterna pale.

MALE. *Head.* (Figure 57A). Proboscis with a median tuft of strong setae inserted on the ventral surface. *Terminalia.* (Figure 58C). Basimere with the subapical lobe well developed; basal rod slender, separated from the 2 other rods which are subequal in length and inserted on a distinct tubercle; beyond the basal rods are 2 foliaceous setae and a broad leaf, as well as a number of long, straight accessory setae; distimere furcate, the proximal arm smooth and sigmoid, the distal arm broad, with numerous denticles on the outer margin, and with a variable number of short setae; lateral plate of

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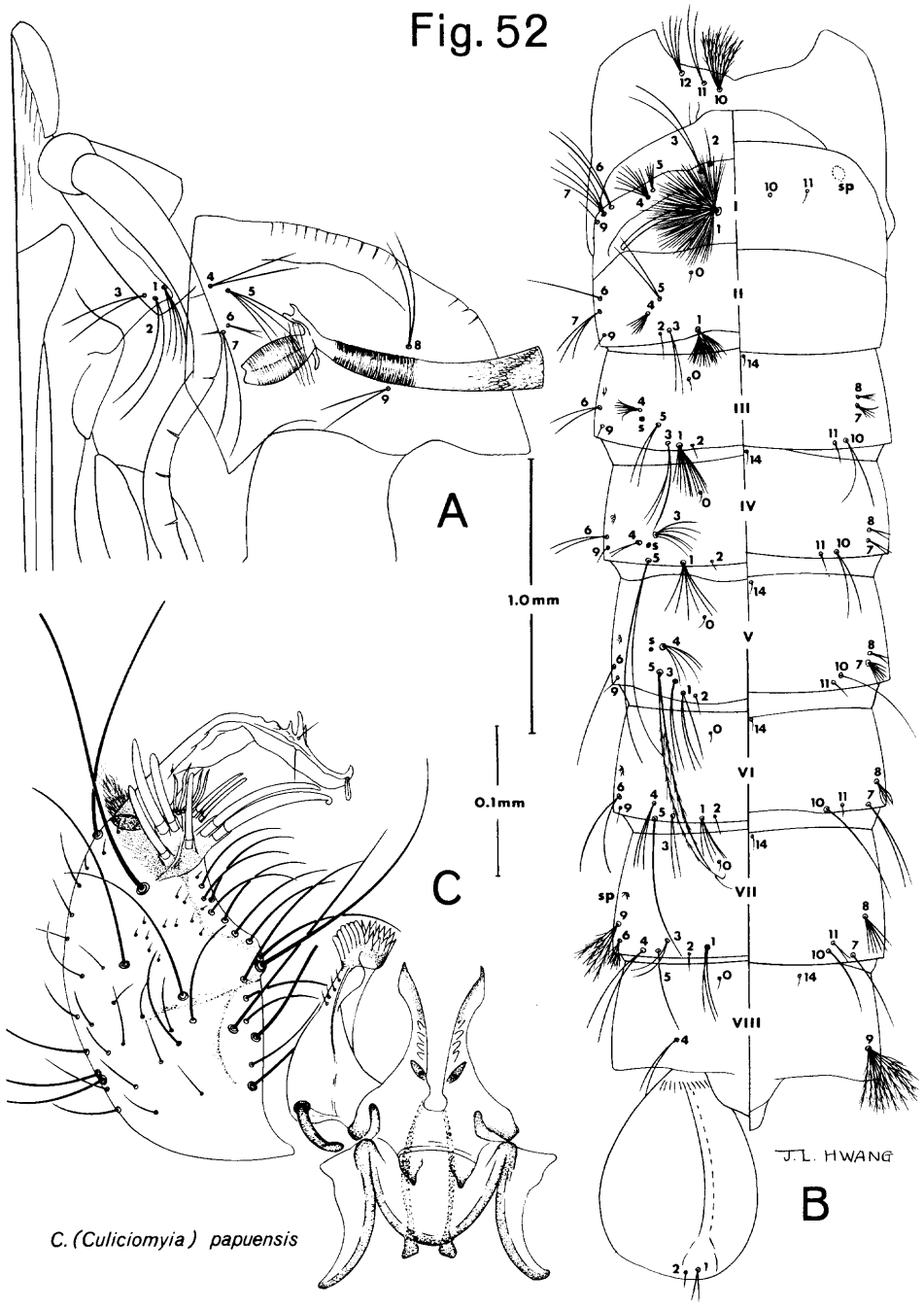
Figure 51. *C. (Culiciomyia) papuensis.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

Fig. 52



the phallosome rather small, with a basal tooth and approximately 7 denticles.

PUPA. (Figure 58A, B).

LARVA. (Figure 59). *Head.* Antenna with a narrow, dark basal ring; head hair 1-C filamentous, its length slightly less than half the distance between the bases of the pair; 4-C single, simple; 5, 6-C with three pectinate branches. *Thorax.* Integument glabrous; hairs 1, 2, 3-P single, pectinate, 3-P shorter and slenderer than 1, 2-P; 4, 7, 8-P bifid, pectinate; 5, 6-P single, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; comb consisting of approximately 40 to 50 fan-shaped scales arranged in a triangular patch; siphon index variable, approximately 5:1 to 6:1; 3 pairs of subventral tufts inserted in a line beyond the pecten; individual tufts represented by a single seta whose length is considerably less than the width of the siphon at the point of insertion; pecten consisting of approximately 11 teeth restricted to the basal 1/5 of the siphon; individual pecten tooth with a strong apical spine and 4 or 5 strong lateral barbs.

TYPE DATA. Holotype male of *spathifurca* (terminalia mounted and attached to pin) from Kuching, Sarawak, Borneo in the British Museum. Holotype male of *stylifurcatus* (terminalia slide-mounted, but both basimeres and distimeres missing) from Ratmalana and Palwatte Ganga River at Dinipitiya, Ceylon in the British Museum.

DISTRIBUTION. Causey (1937) first recorded *spathifurca* in THAILAND from the vicinity of Bangkok. During this study specimens have been identified from *Chiang Mai*, *Chon Buri*, *Lampang*, and *Ranong*. The species has also been recorded from BORNEO, JAVA, SINGAPORE, MALAYA, CEYLON, MALDIVE ISLANDS, TAIWAN, NEW GUINEA, and the PHILIPPINE ISLANDS.

Three individual rearings have been studied from Thailand as well as 15 females, 12 males, and 14 larvae.

TAXONOMIC DISCUSSION. Although the adult female cannot be separated with certainty from *fragilis* and *scanloni*, the male terminalia exhibits unique features in the bifurcate distimere, the shape and number of structures on the subapical lobe of the basimere, and by the shape of the phallosome. The fourth stage larva shows some affinity to *fragilis* but may be separated by the chaetotaxy of the head and siphon.

BIOLOGY. Causey (1937) reported that the larvae of *spathifurca* were collected from all types of artificial receptacles, temporary pools, canals, rice fields, and swamps of brackish water in the vicinity of Bangkok. Larvae were collected by Edwards (1926) from pots of urine in Singapore, and Carter and Wijesundara (1948) collected larvae as well as adults from crab holes in Ceylon. During this study larvae were collected in Thailand from elephant tracks, puddles, brackish water in nipa palm leaves, rock pools, ditches, and a bamboo stump.

The normal host of the adult female is apparently birds, but precipitin tests showed that ox may also serve as a host (Colless 1959). Slooff and van Dijk (1961) reported that on Pam Island, Netherlands New Guinea, *spathifurca* constituted 3 percent of the total number of mosquitoes captured during night catches on human bait. They further stated that 7 1/2

Figure 52. ← *C. (Culiciomyia) papuensis*. A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia.

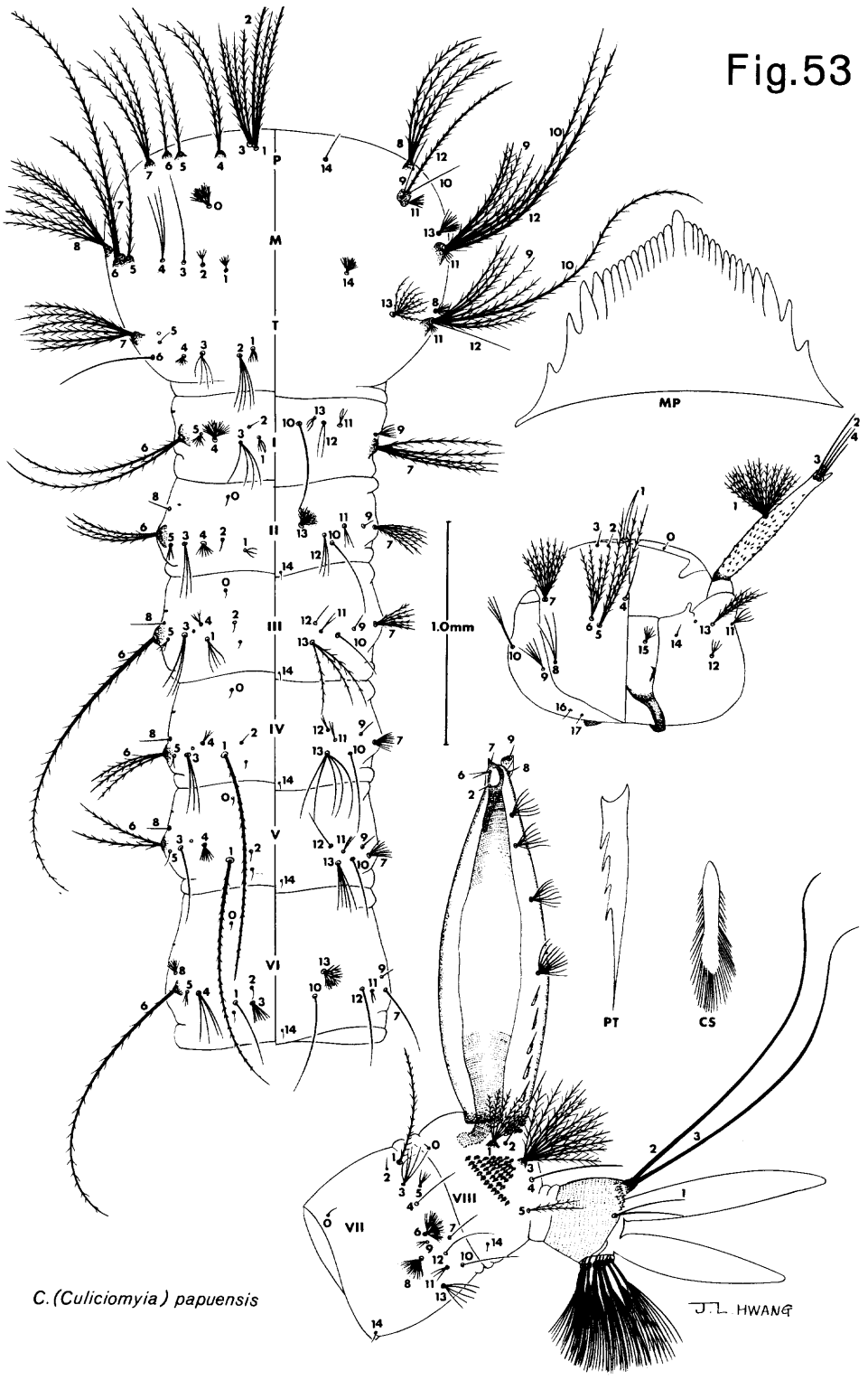


Fig.53
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C. (Culiciomyia) papuensis
J.L. HWANG

days after feeding on a human carrier of *Wuchereria bancrofti* 1 specimen of *spathifurca* was found to have 4 normally developed second instar larval *W. bancrofti* in the thorax, and they concluded that *spathifurca* is a potential vector of filariasis on Pam Island.

CULEX (CULICIOMYIA) SPICULOTHORAX, N. SP.
(Figure 60)

The fourth stage larva is characterized primarily by the nature of the thoracic spicules, but other characteristics which are diagnostic include the pectinate head hair 4-C, the spiculate clypeus, and the shape and chaetotaxy of the siphon.

FEMALE, MALE, PUPA. Unknown.

LARVA. (Figure 60). *Head.* Antenna with a narrow dark basal ring; clypeus with an irregular pattern of minute spicules; head hair 1-C filamentous, its length slightly greater than the distance between the bases of the pair; 4-C single, pectinate; 5, 6-C with 3 or 4 pectinate branches. *Thorax.* Integument conspicuously spiculate, the spicules short, conical, and dark; hairs 1, 3-P bifid, pectinate; 2-P single, pectinate; 4, 7, 8-P bifid, pectinate; 5, 6-P single, pectinate; 14-P single, pectinate. *Abdomen.* Integument spiculate, the spicules not nearly as prominent as those of the thorax; comb consisting of approximately 35 to 50 fan shaped scales arranged in a triangular patch of 3 irregular rows; siphon index variable, ranging from 3.5:1 to 4:1; 4 pairs of subventral tufts inserted in a line beyond the pecten; individual tufts with from 3 to 5 branches, their length variable, usually slightly greater than the width of the siphon at the point of insertion; pecten consisting of from 10 to 15 teeth restricted to the basal third of the siphon or less; individual pecten tooth with a strong distal spine and 3 strong, lateral barbs.

TYPE DATA. Holotype larva from Ban Khum Klang, Chiang Mai, Thailand, 19 November 1963, J. E. Scanlon, ex. bamboo stump, CM 212, deposited in the U. S. National Museum, No. 69349. Six paratype larvae with the same data as the holotype, also deposited in the U. S. National Museum.

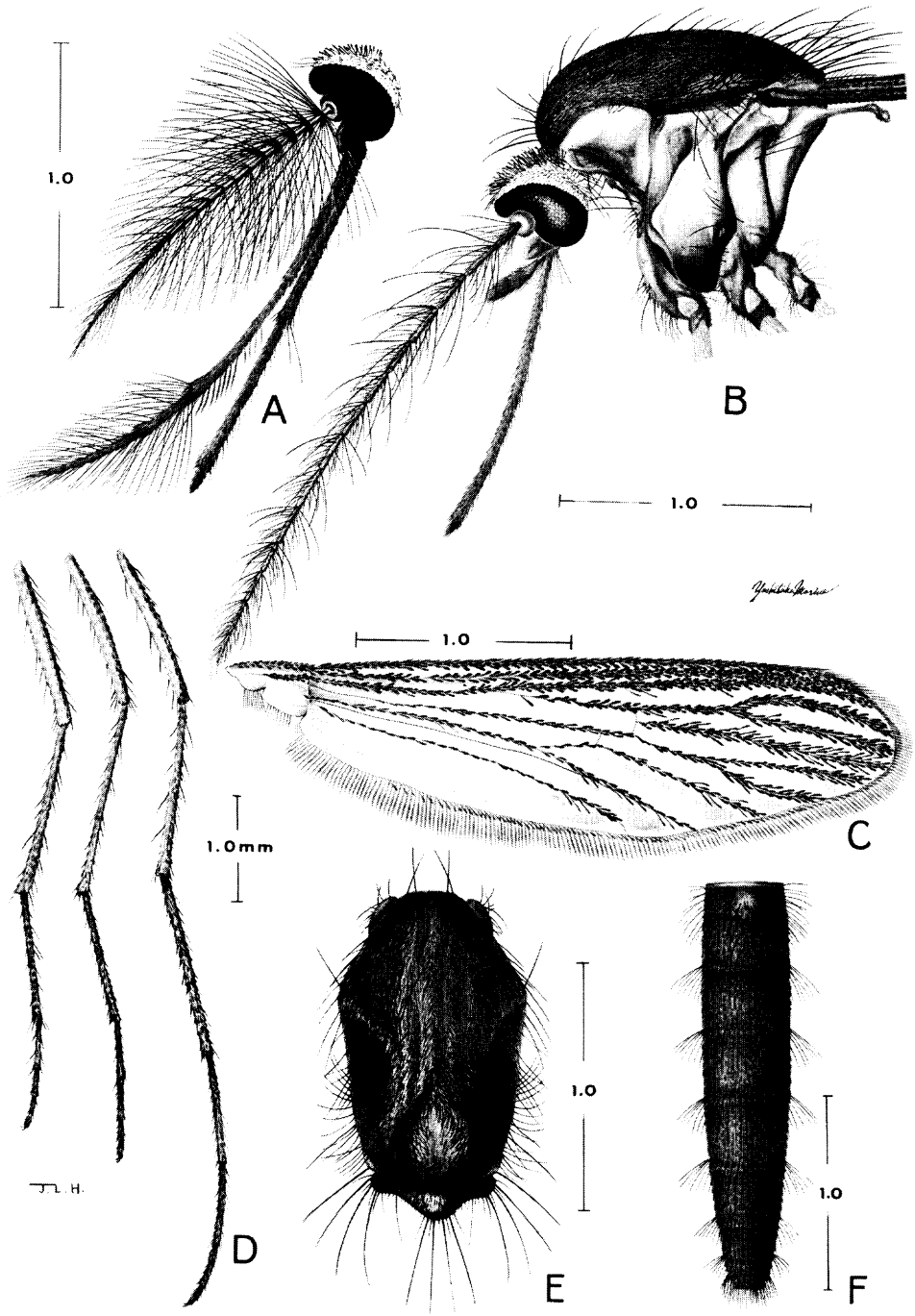
DISTRIBUTION. That of the type locality, Ban Khun Klang, *Chiang Mai,* THAILAND. This species is known only from the type series.

TAXONOMIC DISCUSSION. Although the adults are unknown, the fourth stage larva is sufficiently distinct to warrant description at this time. The distinctive thoracic and abdominal spiculation and features of the chaetotaxy easily separate *spiculosus* from other known members of the subgenus.

BIOLOGY. Other than data from the type habitat, nothing is known of the biology or habits of this species.

Figure 53. ← *C. (Culiciomyia) papuensis.* Fourth stage larva: dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments.

Fig. 54



C. (Culiciomyia) scanloni

CULEX (CULICIOMYIA) TERMI D. THURMAN 1955
(Figures 61, 62, and 63)

Culex (Culiciomyia) termi D. Thurman 1955, Proc. ent. Soc. Wash. 57: 18 (♂*, ♀, P, L*).

The adult female can be distinguished from other members of the subgenus by the overall pale scaling, the light dorsal wing scales, and the broad apical banding of the abdominal terga. The male terminalia exhibits a lightly sclerotized phallosome with denticles reduced in size, and a distinctive number and arrangement of setae on the subapical lobe of the basimere. The fourth stage larva is unique in having the siphon index 30:1 or greater, thoracic hair 4-P with from 6 to 8 branches, and the comb consisting of approximately 70 scales.

FEMALE. In general, a moderately sized species with an overall pattern of light scales. *Head.* (Figure 61B). Proboscis light brown to white medially, but somewhat darker proximally and distally; palpus with dark brown scales on the apical and subapical segments, reddish-brown scales basally, with isolated light scales also present; decumbent scales of the vertex uniformly creamy white; erect scales yellowish-white throughout except for a few dark scales on the posterior margin. *Thorax.* (Figure 61B, E). Scutum and scutellum yellowish with a uniform pattern of pale scales; integument of the pleuron uniformly light brown, with a variable dark stripe running from beneath the anterior spiracle to the upper mesepimeron; 1 lower mesepimeral bristle present and with a small, variable patch of pale scales on the upper sternopleuron. *Wing.* (Figure 61C). Dorsal wing scales predominantly pale. *Legs.* (Figure 61D). Femora and tibiae predominantly pale with some dark scales on the dorsal margins; tarsi dark. *Abdomen.* (Figure 61F). Terga with apical pale bands that cover the greater part of the segments; sterna completely pale.

MALE. *Head.* (Figure 61A). Proboscis predominantly pale, with a median tuft of strong bristles on the ventral and lateral surfaces; palpus predominantly pale with some dark scales on the apical and subapical segments. *Terminalia.* (Figure 62C). Subapical lobe of the basimere well developed, the 3 basal rods followed by 5 narrow leaflets; distimere smooth, with a hook opposite the claw and with at least 1 basal seta; lateral plate of the phallosome lightly sclerotized, with a basal tooth and approximately 7 or more very small, inconspicuous denticles.

PUPA. (Figure 62A, B). Significant in the absence of paddle hairs 1, 2.

LARVA. (Figure 63). *Head.* Antenna with a narrow, dark basal ring; head hair 1-C filamentous, its length slightly less than half the distance between the bases of the pair; 4-C single, simple; 5, 6-C with 3 or 4 branches,

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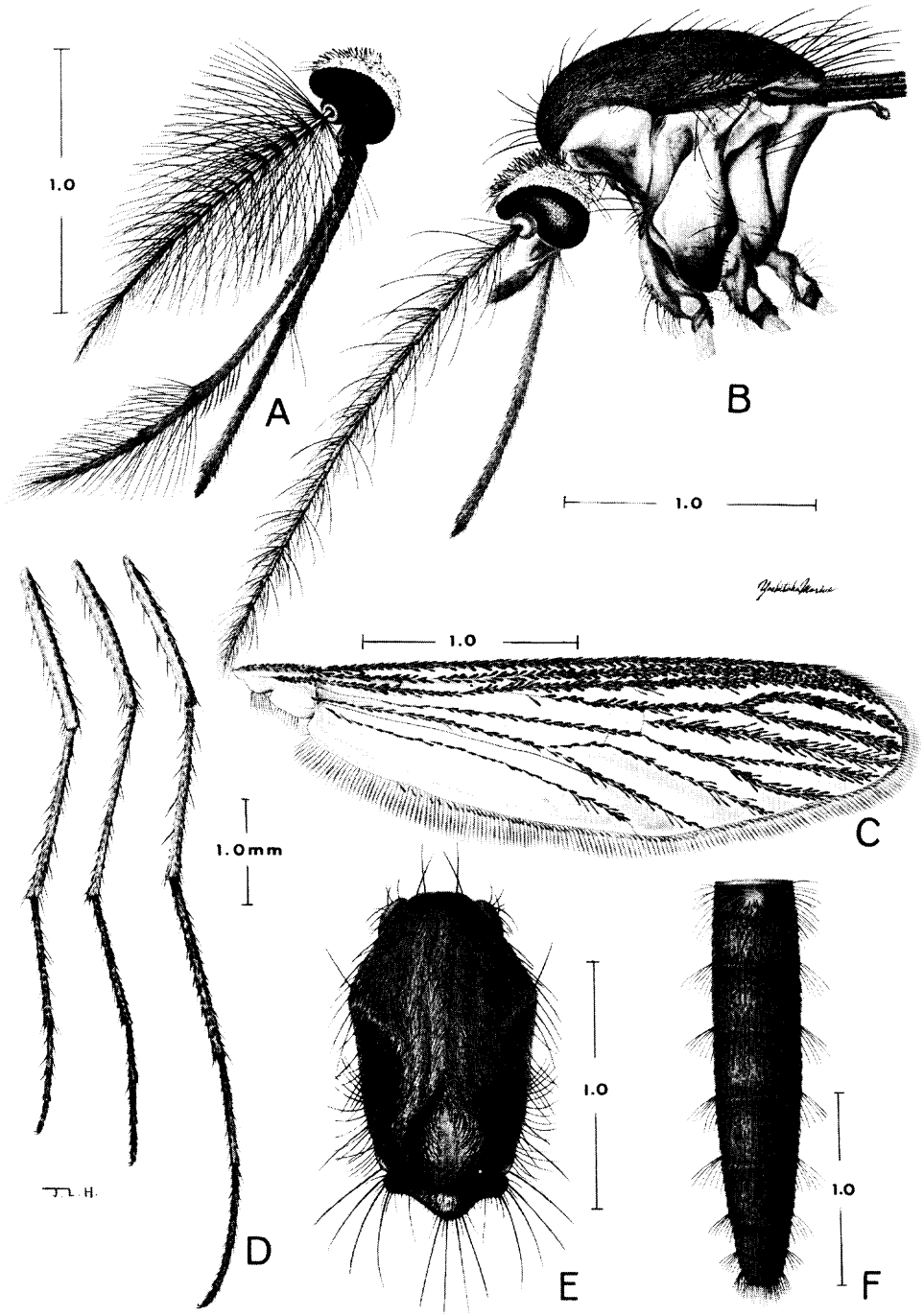
Figure 54. *C. (Culiciomyia) scanloni.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

←

Fig. 54



C. (Culiciomyia) scanloni

pectinate. *Thorax.* Integument covered with a dense pattern of sharply pointed spicules; hairs 1, 2-P single, pectinate; 3-P bifid, pectinate, its length less than that of 1, 2-P; 4-P with from 6 to 8 pectinate branches; 5, 6-P single, pectinate; 7-P with 4 pectinate branches; 8-P trifid, pectinate; 14-P single, simple. *Abdomen.* Integument similar to that of the thorax; comb consisting of approximately 60 to 70 fan-shaped scales arranged in a triangular patch; siphon index approximately 30:1 or more, the siphon slender throughout its length; 6 pairs of subventral tufts widely spaced on the siphon beyond the pecten; individual tufts single or bifid, their length slightly greater than the width of the siphon at the point of insertion; pecten consisting of from 9 to 17 teeth; individual pecten tooth with a strong distal spine and approximately 9 fine lateral barbs.

TYPE DATA. Holotype male from Ngao, Lampang, Thailand in the U. S. National Museum.

DISTRIBUTION. Known only from THAILAND, from *Lampang* and *Mae Hong Son.* During this study the following specimens have been examined: 7 females, 5 males, and 105 larvae from the original Thurman collection, and 42 females and 28 males, 41 with their associated larval and pupal skins, and 35 larvae collected from Mae Hong Son.

TAXONOMIC DISCUSSION. The pale adult habitus and the exceptionally long larval siphon unquestionably separate *termi* from all other species of the subgenus in Thailand.

BIOLOGY. Larvae of *termi* were collected by D. Thurman (1955) from elephant-track depressions in a marsh overgrown with luxuriant vegetation where the water was highly polluted with elephant dung and filled with brown algae; collections were made during March, July, August, and November. The 7 collections from Mae Hong Son were all from elephant hoof prints in a secondary rain forest at 600 m. elevation or more, and were made during September. Nothing is known of the adult habits.

CULEX (CULICIOMYIA) THURMANORUM, N. SP.
(Figures 64 and 65)

Culex (Culiciomyia) viridiventer of E. Thurman 1959, Univ. Md. Agric. Exp. Sta. Bull. A-100: 122 (misidentification); E. Thurman 1963, Proc. IX Pacif. Sci. Cong. 9: 55 (misidentification).

The adult female may be recognized by the pale basal banding of the abdominal terga and by the dark patterns on the integument of the pleuron. The adult male exhibits banded abdominal terga, a crest at the apex of the distimere, and lacks a leaf-like structure on the subapical lobe of the basimere. The fourth stage larva is distinguished from all other members of the subgenus by possessing prominent, stellate setae on both the thorax and abdomen, and by the modified scalelike spicules of the abdominal integument.

FEMALE. *Head.* Proboscis and palpus uniformly dark scaled; decumbent scales of the vertex light brown at the occiput and becoming almost

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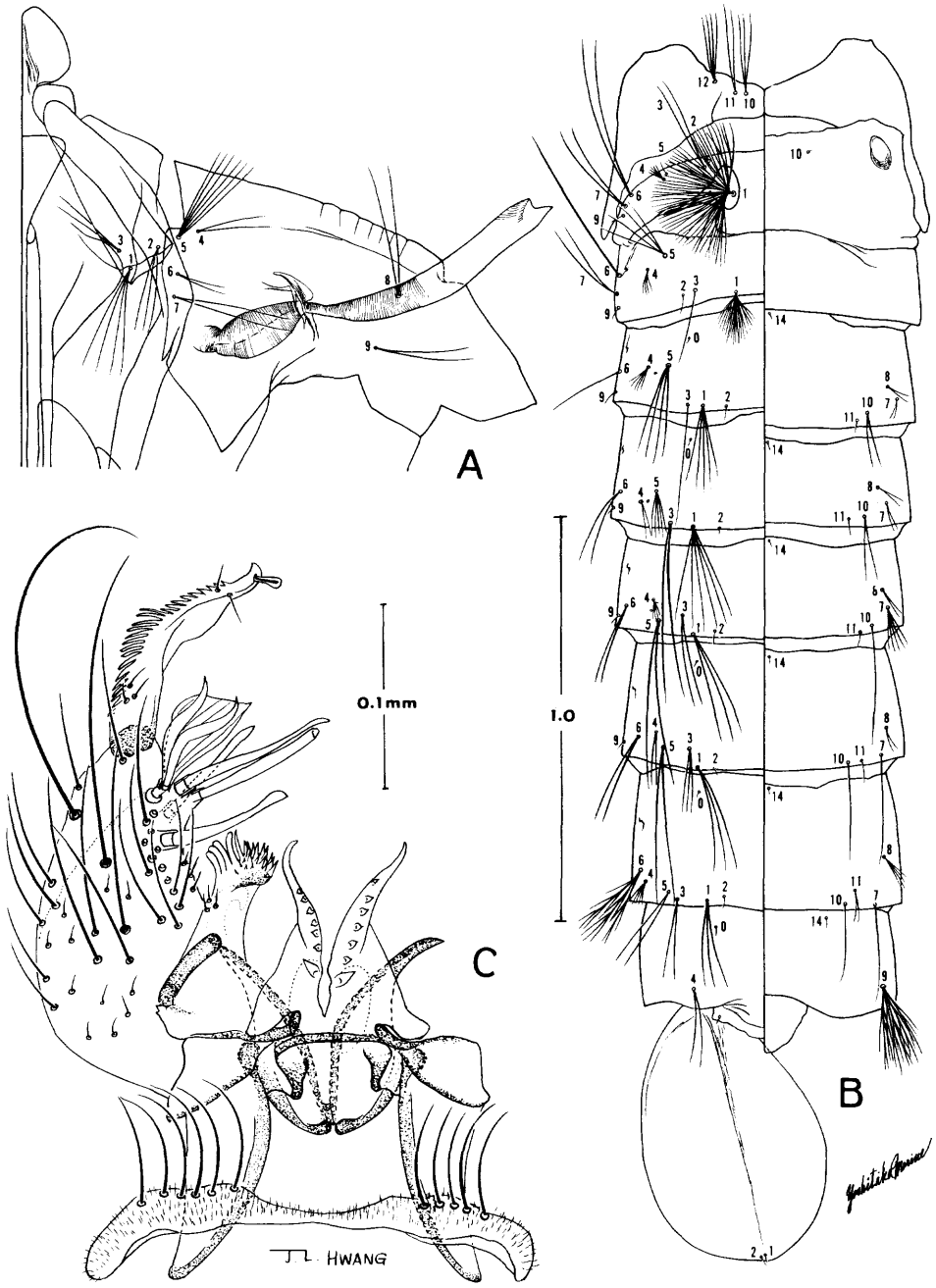
Figure 54. *C. (Culiciomyia) scanloni.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

Fig.55



C.(Culiciomyia) scanloni

white at the orbital line; erect scales dark brown. *Thorax*. Integument of the pleuron light brown, with a dark area on the postspiracular plate and a dark band stretching across the upper sternopleuron and upper mesepimeron and usually with another brown pattern on the sternopleuron; 1 or 2 strong, lower mesepimeral bristle present. *Wing*. All dorsal wing scales uniformly light brown. *Legs*. Anterior surface of the hind femur pale, with a narrow dark apical band that extends along the dorsal margin as a dark stripe; hind tibia and tarsus as well as the fore legs uniformly dark brown. *Abdomen*. Terga dark brown, with moderately broad pale basal bands on segments III-VIII; sterna uniformly pale.

MALE. *Head*. Proboscis with a ventromedian tuft of setae. *Terminalia*. (Figure 64C). Subapical lobe of the basimere well developed, with 4 strong rod-like setae, several accessory setae, and with a small, inconspicuous leaf-like structure; distimere with a crest of 6 or more small, recurved spines on the convex surface and with a small hook opposite the claw; lateral plate of the phallosome strongly sclerotized, with a prominent basal tooth and 7 or more evenly spaced, short denticles.

PUPA. (Figure 64A, B).

LARVA. (Figure 65). *Head*. Hair 1-C is not filamentous, the common condition in the subgenus, nor is it grossly robust, but assumes an intermediate form; 4-C simple, single or double; 5-C with 5 or 6 branches, pectinate; 6-C with 4 or 5 branches, pectinate; the frontal head hairs placed far forward. *Thorax*. Integument densely spiculose, with prominent, sharply pointed spicules; hair 1-P bifid, pectinate; 2, 3-P single, pectinate, 3-P considerably shorter and slenderer than 1, 2-P; 4-P bifid or trifid, pectinate; 5, 6-P single, pectinate; 7, 8-P bifid, pectinate; 14-P single, simple; 1-M, T with 5 or 6 stellate branches (this condition sharply contrasts the normal condition in which 1-M, T are short and dendritic); 3, 13-T also stellate. *Abdomen*. Integument densely spiculose, the individual spicules modified, forming a uniform pattern of scale-like platelets over the entire abdominal integument; terga I through VI with at least 2 pairs of stellate setae; comb consisting of approximately 30 scales arranged in a rather broad triangular patch; individual scales elongate with the apical spines stronger than the lateral ones; siphon index ranging from 7:1 to 8.5:1; 3 pairs of subventral tufts evenly spaced beyond the pecten; individual tufts consisting of a single seta, their length slightly greater than the width of the siphon at the point of insertion; pecten consisting of from 6 to 12 teeth restricted to less than the basal half of the siphon, the distal teeth more widely spaced than the proximal ones; individual pecten tooth with a prominent distal spine and 3 sharply pointed, strong lateral barbs. The stellate setae of the thorax and abdomen are outstandingly distinctive; variation has been noted in the number and width of the branches as well as the relative number of lateral barbs.

TYPE DATA. Holotype male (associated larval and pupal skins and terminalia slide-mounted) from Doi Chang, Mae Hong Son, Thailand, 12 September 1966, K. Mongkolpanya, from elephant hoofprints in a secondary rain forest, at 600 m. elevation, deposited in the U. S. National Museum,

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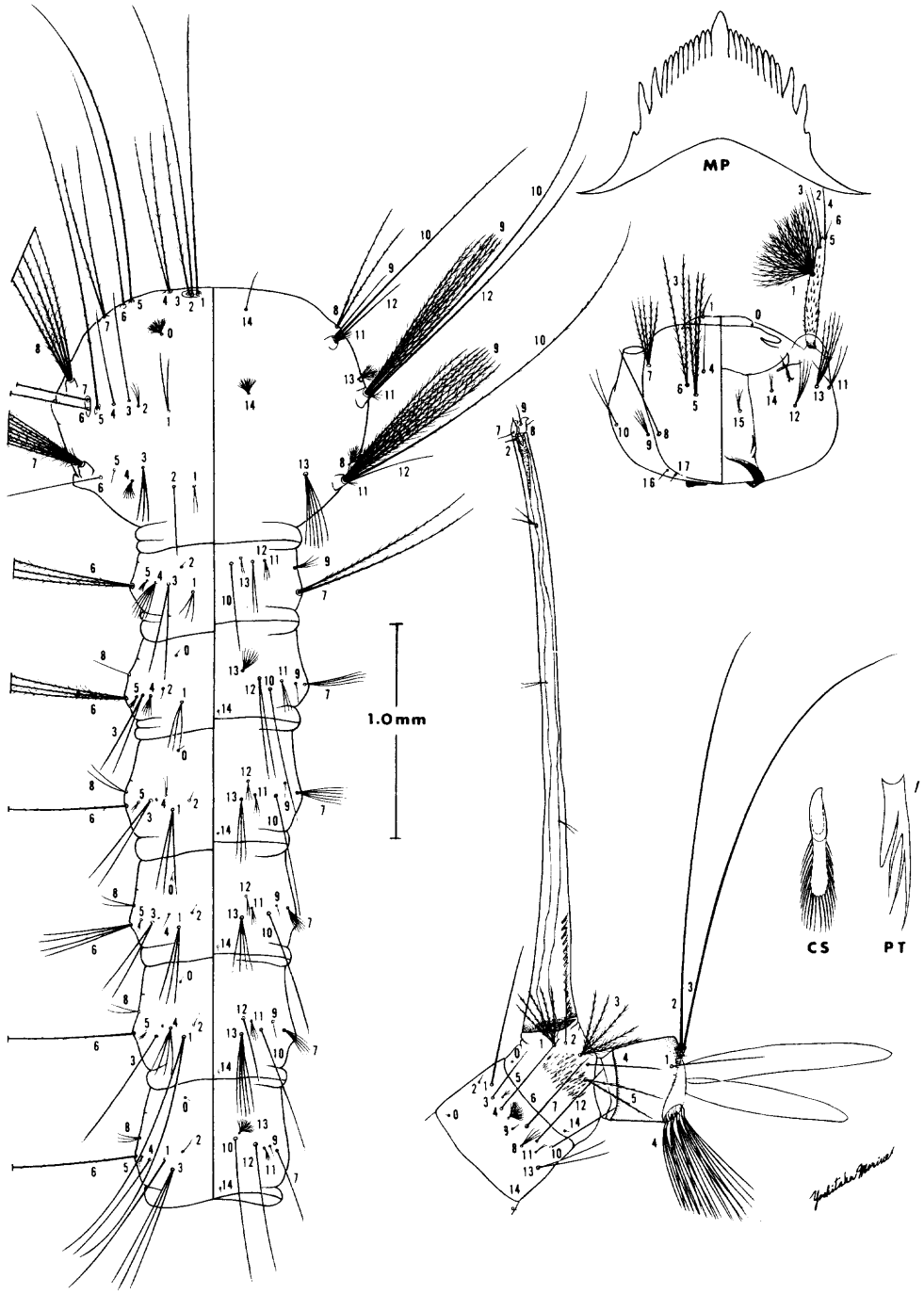
Figure 55. ← *C. (Culiciomyia) scanloni*. A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia.

Fig. 56



C. (Culiciomyia) scanloni

No. 69350. Paratypes: 3 males and 7 females with their associated larval and pupal skins, and with the same data as the holotype deposited in the U. S. National Museum. This species is named in honor of D. C. Thurman and E. B. Thurman (Mrs. C. Schwartzwalder) in recognition of their contributions to the understanding of the mosquito fauna of Thailand.

DISTRIBUTION. In addition to the type locality, *thurmanorum* has also been collected from Ban Mae Ho Kae No Chae and Ban Mae Ho Nua, both also in *Mae Hong Son*, THAILAND, and the specimens in the Thurman collection are from the Ngao district of *Lampang*.

The following specimens were studied in addition to the type series: 29 females and 24 males, 5 with their associated larval and pupal skins, and 101 larvae.

TAXONOMIC DISCUSSION. Although the adult female is extremely similar to *pallidothorax*, the fourth stage larva is so distinctive that it cannot be confused with any other species; the larva of *viridiventer* differs in many points from *thurmanorum* including the absence of the distinctive stellate setae. The male terminalia lacks the conspicuous leaf-like seta on the subapical lobe of the basimere which is present in *pallidothorax*.

BIOLOGY. This species has been collected only in the immature stages from secondary rain forests in mountainous areas (elevation 600 m. or above). Of 23 different collections, all but 2 were from elephant hoof prints; the other 2 collections were from a puddle and a stream margin near the hoofprint environments of other collections. The collections from Lampang were made in March, those from Mae Hong Son during September. Larvae have been collected in association with *termi*, *pallidothorax*, *bailyi*, and *barrinus*. Nothing is known of the habits of the adults.

SUBGENUS *CULEX* LINNAEUS 1758

Culex Linnaeus 1758, Systema Naturae, 10th ed. 1: 602. Type species: *Culex pipiens* Linnaeus (selection of Latreille 1810).

Heteronycha Lynch Arribálzaga 1891, Rev. Mus. La Plata 1: 373, 2: 155. Type species: *Heteronycha dolosa* Lynch Arribálzaga.

Lasioconops Theobald 1903, Mon. Cul. 3: 235. Type species: *Lasioconops poicilipes* Theobald.

Heptaphlebomyia Theobald 1903, Mon. Cul. 3: 336. Type species: *Heptaphlebomyia simplex* Theobald.

Pseudoheptaphlebomyia Ventrillon 1905, Bull. Mus. Hist. nat. Paris 11: 427. Type species: *Pseudoheptaphlebomyia madagascariensis* Ventrillon.

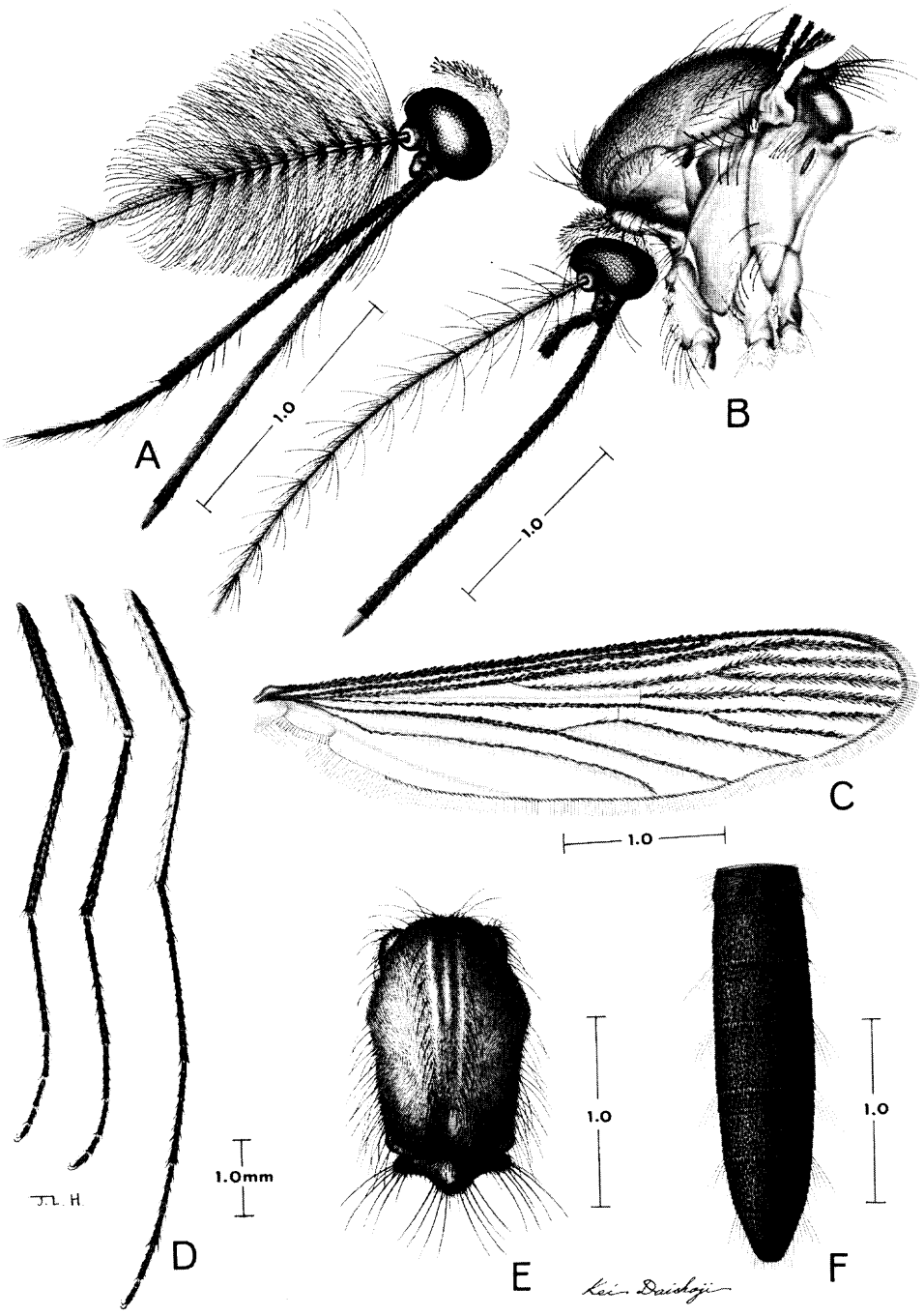
Trichopronomyia Theobald 1905, Ann. hist.-nat. Mus. hung. 3: 98. Type species: *Trichopronomyia annulata* Theobald (not Schrank 1776).

Aporoculex Theobald 1907, Mon. Cul. 4: 316. Type species: *Aporoculex punctipes* Theobald.

Leucomyia Theobald 1907, Mon. Cul. 4: 372 (preoccupied by Brauer and Bergenstamm 1891). Type species: *Culex gelidus* Theobald.

Figure 56. ← *C. (Culiciomyia) scanloni*. Fourth stage larva: dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments.

Fig.57



C. (Culiciomyia) spathifurca

Oculeomyia Theobald 1907, Mon. Cul. 4: 515. Type species: *Oculeomyia sarawaki* Theobald.
Theobaldiomyia Brunetti 1912, Rec. Indian Mus. 4: 462. Type species: *Culex gelidus* Theobald.
Phalangomyia Dyar and Knab 1914, Insec. Inscit. menst. 2: 58. Type species: *Phalangomyia debilis* Dyar and Knab.
Laiomyia Izquierdo 1916, Tesis. Col. Est. Puebla: 65. Type species: *Culex stigmatosoma* Dyar.
Culex (Transculicia) Dyar 1917(1918), Insec. Inscit. menst. 5: 184. Type species: *Culex eleuthera* Dyar.
Culex (Cacoculex) Dyar 1918, Insec. Inscit. menst. 6: 100. Type species: *Culex habilitator* Dyar and Knab.

The adult female may be recognized by the presence of distinct scale patches on the pleuron and by the presence of a median band of white scales on the proboscis in all but the 3 species of the *pipiens* group. The adult male is distinguished by the above characters as well as the complex phallosome of the terminalia. The fourth stage larva exhibits a distinct pecten restricted to the basal third or less of the siphon, 10 or more tufts in the ventral brush, and thoracic hair 3-P single, of the same order of length and thickness as 1-P.

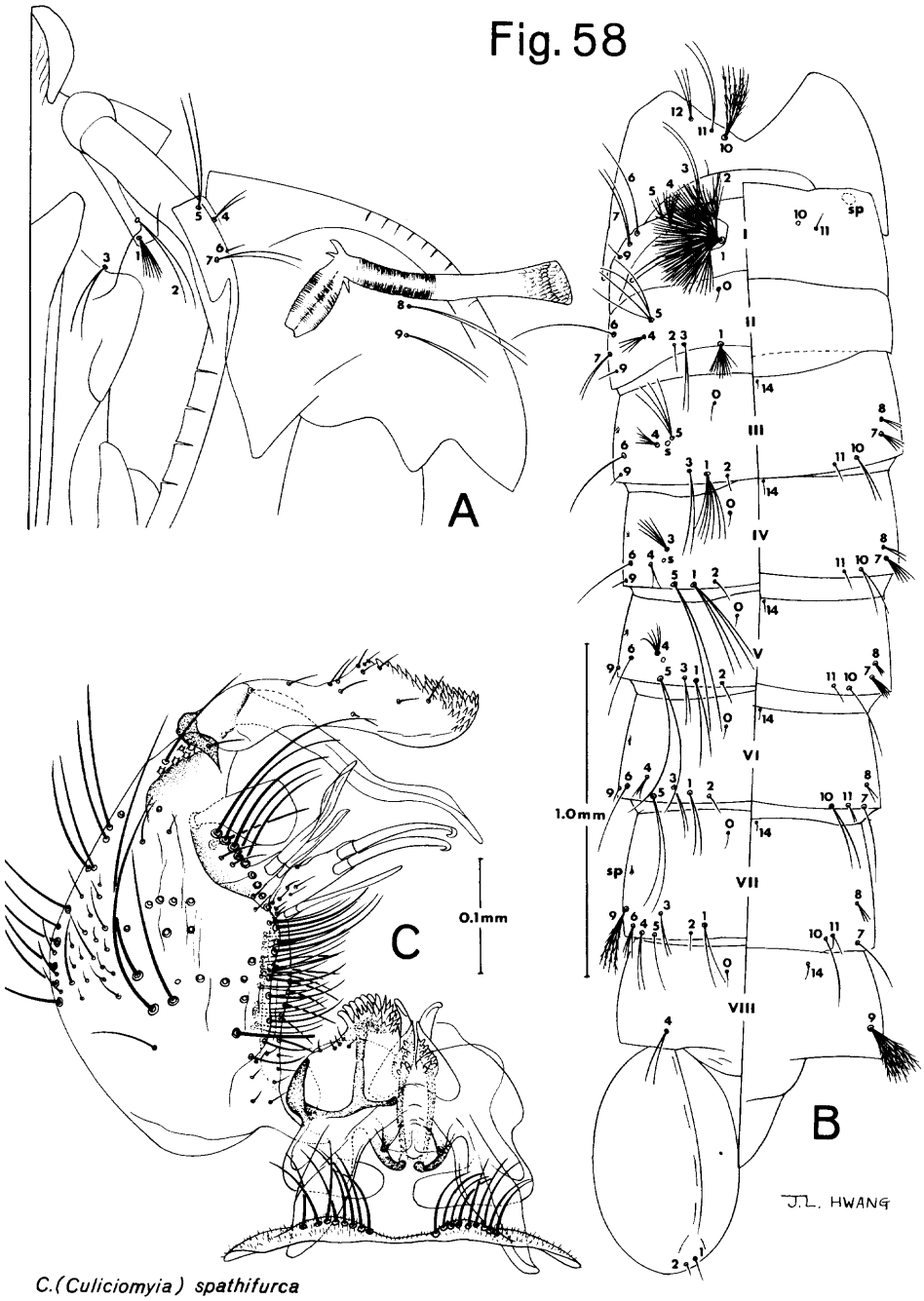
FEMALE. Medium to large sized species. *Head.* Proboscis with or without a median dorsal band of pale scales (absent only in members of the *pipiens* group). *Thorax.* Scales of the scutum very dense, smooth, with or without a distinct pattern; acrostichal bristles well developed, as are the anterior dorsocentral, posterior dorsocentral, supraalar, prescutellar, and scutellar bristles; pleuron with distinct scale patches and with extensive, but varied bristle patterns; 1 or 2 lower mesepimeral bristles present in those species without a banded proboscis, no lower mesepimeral bristles present when proboscis is banded; wings with dense scaling which may be either all dark or with dark and light scales; legs with or without pale bands. *Abdomen.* Terga with or without basal and/or apical pale bands.

MALE. *Head.* Palpus with 5 segments and usually longer than the proboscis, the distal 2 segments upturned and without distinctive lanceolate scales on the ventral surface of segment III; antenna approximately as long as the proboscis, without distinctive specialized hairs or scales. *Terminalia.* Subapical lobe of the basimere well developed, having strongly developed setae and always with at least 1 leaf-shaped seta; distimere with or without distal annulations, somewhat expanded medially in a few species; phallosome complex, the lateral plate frequently spiculose or rugulose, with both an inner and outer division; paraproct crowned with a dense tuft of spicules; cercal setae short, variable in number; basal sternal process always present, but variable.

LARVA. *Head.* Hair 1-C variable in shape; 16, 17-C absent. *Thorax.*

Figure 57. ← *C. (Culiciomyia) spathifurca.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

Fig. 58



C.(Culiciomyia) spathifurca

Integument spiculose or glabrous; hairs 1, 2, 3-P single, pectinate, subequal in length and width; 4-6, 8-P well developed. *Abdomen.* Comb variable, with from 4 to approximately 50 scales; siphon variable in size and shape, with from 3 to 7 subventral tufts; 1 or more subventral tufts may or may not be inserted laterally out of line; pecten restricted to the basal third or less of the siphon; ventral brush consisting of 10 or more tufts inserted on the grid; anal gills variable in size and shape; saddle completely ringing segment X except in *neolitoralis*.

PUPA. Without striking subgeneric characteristics.

DISTRIBUTION. Members of the subgenus *Culex* are distributed throughout all zoogeographical regions of the world and are the most common members of the genus *Culex*. The subgenus is widely distributed throughout Thailand, but some species are limited by ecological requirements. Apparently no species of the subgenus is endemic to Thailand.

TAXONOMIC DISCUSSION. Females of the subgenus *Culex*, although usually exhibiting banding and other features of ornamentation, are frequently difficult to determine accurately. Many species which show unique features in the immature stages have extremely similar females, and in these cases final determinations must depend upon study of the associated larval skins. The male terminalia of most species are quite distinct, but in certain groups (*e.g.* the *vishnui* subgroup) subtle differences separate species with broadly different larvae. The fourth stage larva seems to consistently demonstrate distinctive anatomical characteristics; however, even in this stage, considerable variation exists in some groups, and at times forms with widely divergent adults have very similar larvae. A case in point is found between *tritaeniorhynchus* and *mimulus*. As adults these species can be separated by cursory examination owing to the wing scale patterns in *mimulus;* but as larvae, the species are extremely similar.

Intraspecific variation in the subgenus is quite extensive wherever sufficient material is available to permit critical evaluation. *C. bitaeniorhynchus* is an example frequently cited as possibly representing a species complex, due to its extensive variation in both the adult and immature stages. Evaluation of adult and larval features, however, reveals that this is probably a plastic species with considerable variation even among siblings.

BIOLOGY. Larvae of Thai species of the subgenus *Culex* are found in a wide variety of temporary or semipermanent ground water habitats. Common habitats include rice paddies, seepage pools, pot holes, and ditches. *C. pipiens quinquefasciatus* is normally found in highly polluted temporary waters, particularly in urban situations. *C. sitiens* and *neolitoralis* are restricted to brackish water habitats in coastal areas and *bitaeniorhynchus* is found in association with dense green algal mats.

Biology of adults is even more sketchy than that of the larvae. A number of species are known to be anthropophilous but host preferences of most species are poorly understood. *Culex* is the most important of the subgenera from the viewpoint of disease transmission. Two of its members, *tritaeniorhynchus* and *gelidus*, are important vectors of Japanese B encephalitis virus in Southeast Asia. Rudnick and Hammon (1961) reported isolating

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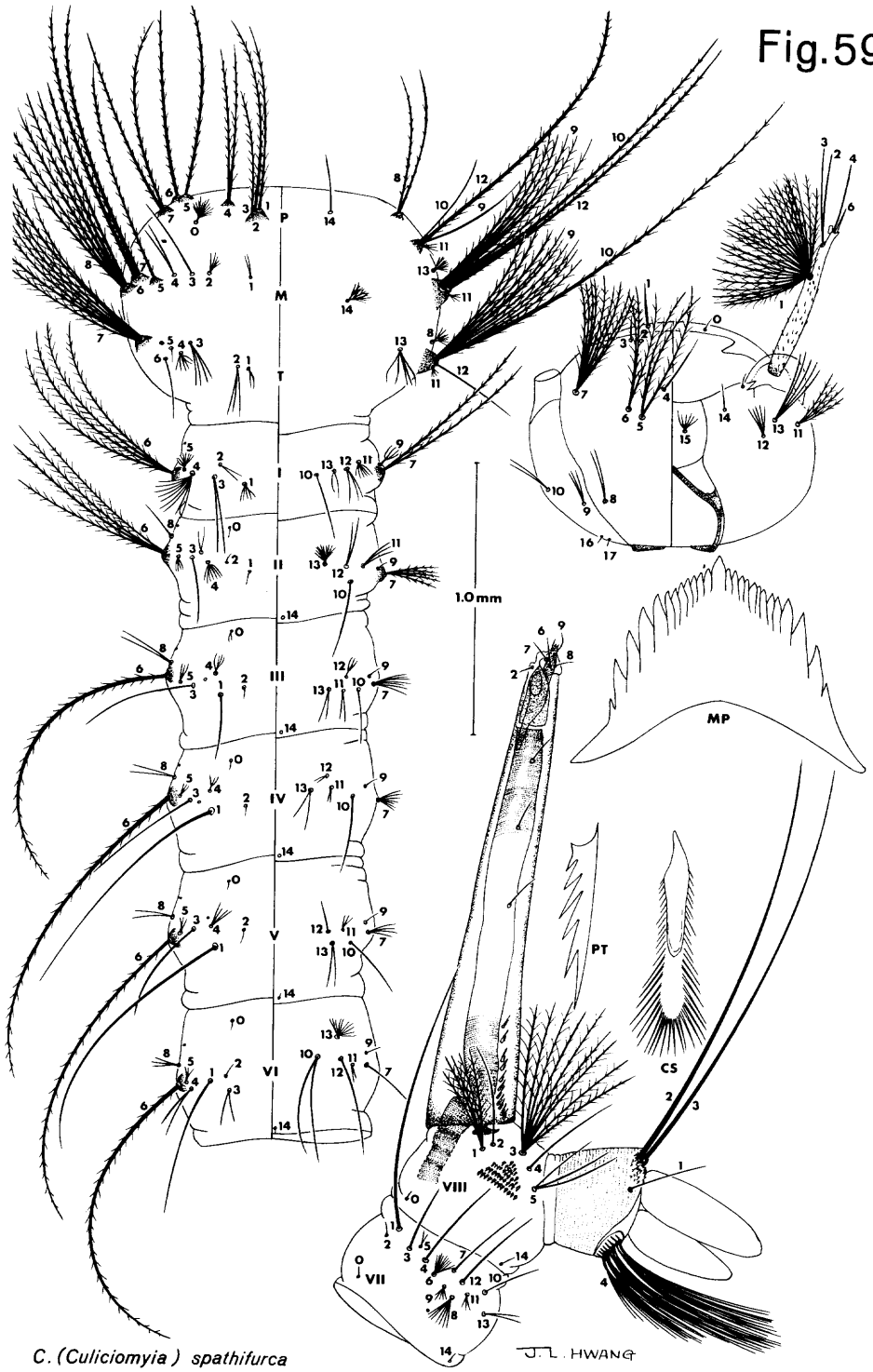
Figure 58. ← *C. (Culiciomyia) spathifurca*. A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia.

Fig.59



C. (Culiciomyia) spathifurca

dengue virus from *tritaeniorhynchus* in Thailand, but no epidemiological significance was attached to this report (Rudnick 1966). Chichungunya virus was isolated from *pipiens quinquefasciatus* in Bangkok (Rudnick and Hammon 1961), but later work indicated that this observation was not significant epidemiologically. The same is true of the reported isolation of eastern equine encephalitis virus from *pipiens quinquefasciatus* in Bangkok (Rudnick and Hammon 1961). However, *pipiens quinquefasciatus* is the most important vector of urban filariasis caused by periodic *Wuchereria bancrofti* wherever the disease occurs.

Bennett, Warren, and Cheong (1966) and Bennett and Warren (1966) reported that in Malaya, 2 species of the subgenus *Culex*, *annulus* and *sitiens*, are natural vectors of *Plasmodium juxtanucleare* (a parasite of gallinaceous birds). Other species of the subgenus, *tritaeniorhynchus*, *gelidus*, and *pseudovishnui*, are at least potential vectors, but the parasite failed to develop in *pipiens quinquefasciatus*.

KEY TO SPECIES OF THE SUBGENUS *CULEX* IN THAILAND - ADULT FEMALES

1. Proboscis without distinct white banding; 1 or 2 lower mesepimeral bristles present; tarsomeres unbanded. . . . . (*pipiens* group) 2
   Proboscis ringed with a distinct white band; lower mesepimeral bristles absent; tarsomeres with narrow, pale basal bands. . . . . (*sitiens* group) 4

2(1). Abdominal terga unbanded. . . . . *fuscocephala* (p. 184)
   Abdominal terga with narrow, white, basal bands. 3

3(2). Integument of the pleuron with blackish-brown areas. . . . . *hutchinsoni* (p. 188)
   Integument of the pleuron usually uniformly pale. . . . . *pipiens quinquefasciatus* (p. 192)

4(1). Abdominal terga with white apical bands, with apical, lateral triangular patches and basal bands, or with the distal segments completely covered with pale scales. . . . . (*bitaeniorhynchus* subgroup) 5
   Abdominal terga with white basal bands or, rarely, unbanded; apical bands or patches not present 7

5(4). Wings with pale scales scattered among the dark, particularly on the costa and subcosta; scutum without silver scales. . . . . *bitaeniorhynchus* (p. 258)
   Wings without pale scales scattered among the dark; scutum with

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Figure 59. ← *C. (Culiciomyia) spathifurca*. Fourth stage larva: dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments.

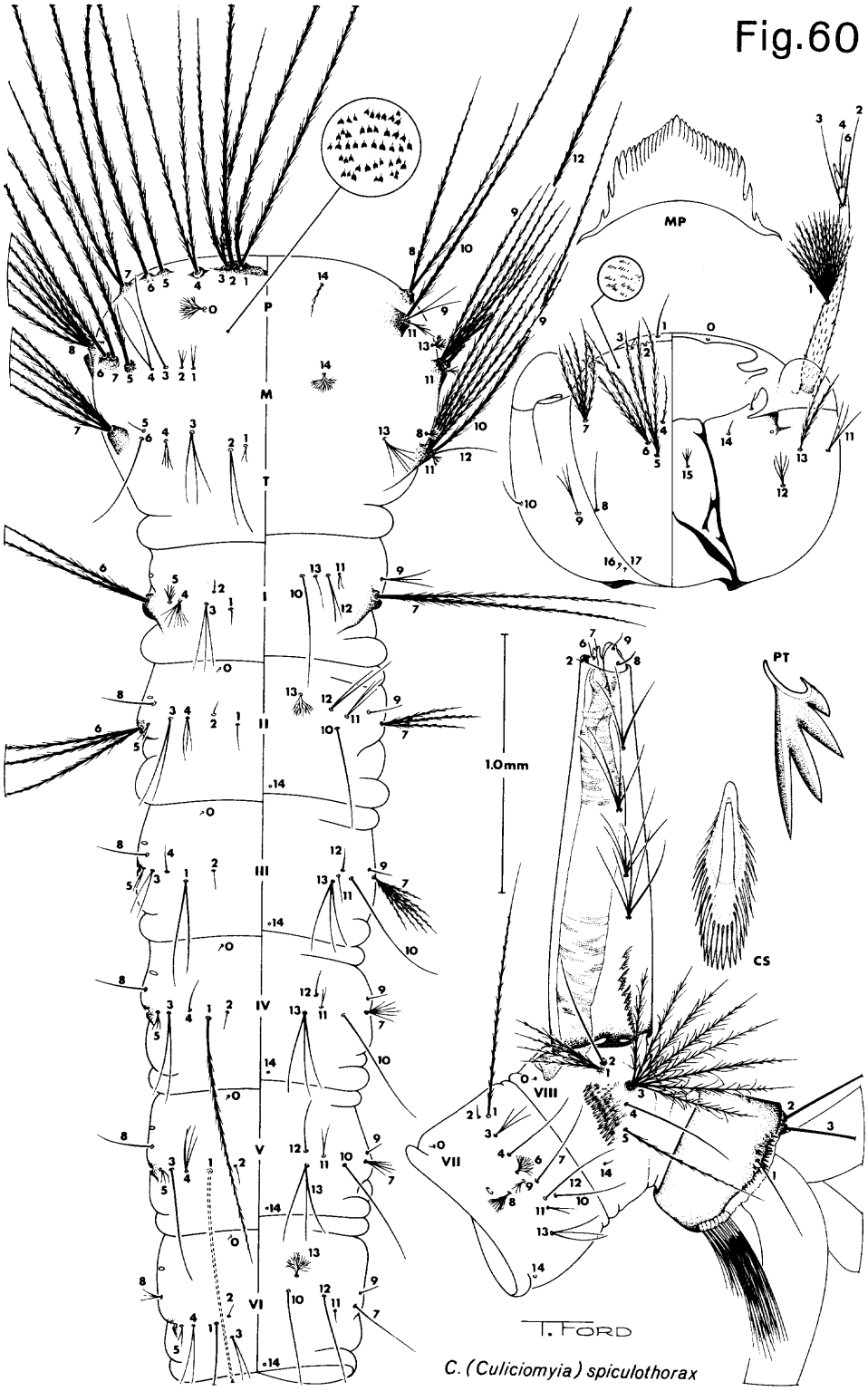
Fig.60
MP
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VII
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T. FORD
C. (Culiciomyia) spiculothorax

silver scales anterior to the prescutellar space. 6

6(5). Apical pale tergal bands with the proximal margin straight; basal tergal bands very narrow . . . . . *sinensis* (p. 268)
Apical pale tergal bands represented on the proximal segments by triangular lateral patches which may converge at the center; basal tergal bands rather broad. . .*pseudosinensis* (p. 265)

7(4). Scutum densely covered with distinct, silvery scales, at least anterior to the prescutellar space. . . . . (*gelidus* subgroup) 8
Scutum uniformly brown or with some golden or yellow scales. 9

8(7). Silver scaling on the scutum terminating at the level of the wing base; basal abdominal bands reaching to the lateral edges of the terga, frequently with a v-shaped median, posterior projection. . . . . *gelidus* (p. 247)
Silver scaling on the scutum continued posteriorly through the prescutellar space and onto the middle of the scutellum; basal abdominal bands not reaching the lateral edges of the terga . . . . . *whitmorei* (p. 253)

9(7). Wings with 2 or more distinct patches of light scales on the costa and subcosta, and with some variable patches on the other veins. . . . . *mimulus* (p. 213)
Wings without distinct patches of white scales. 10

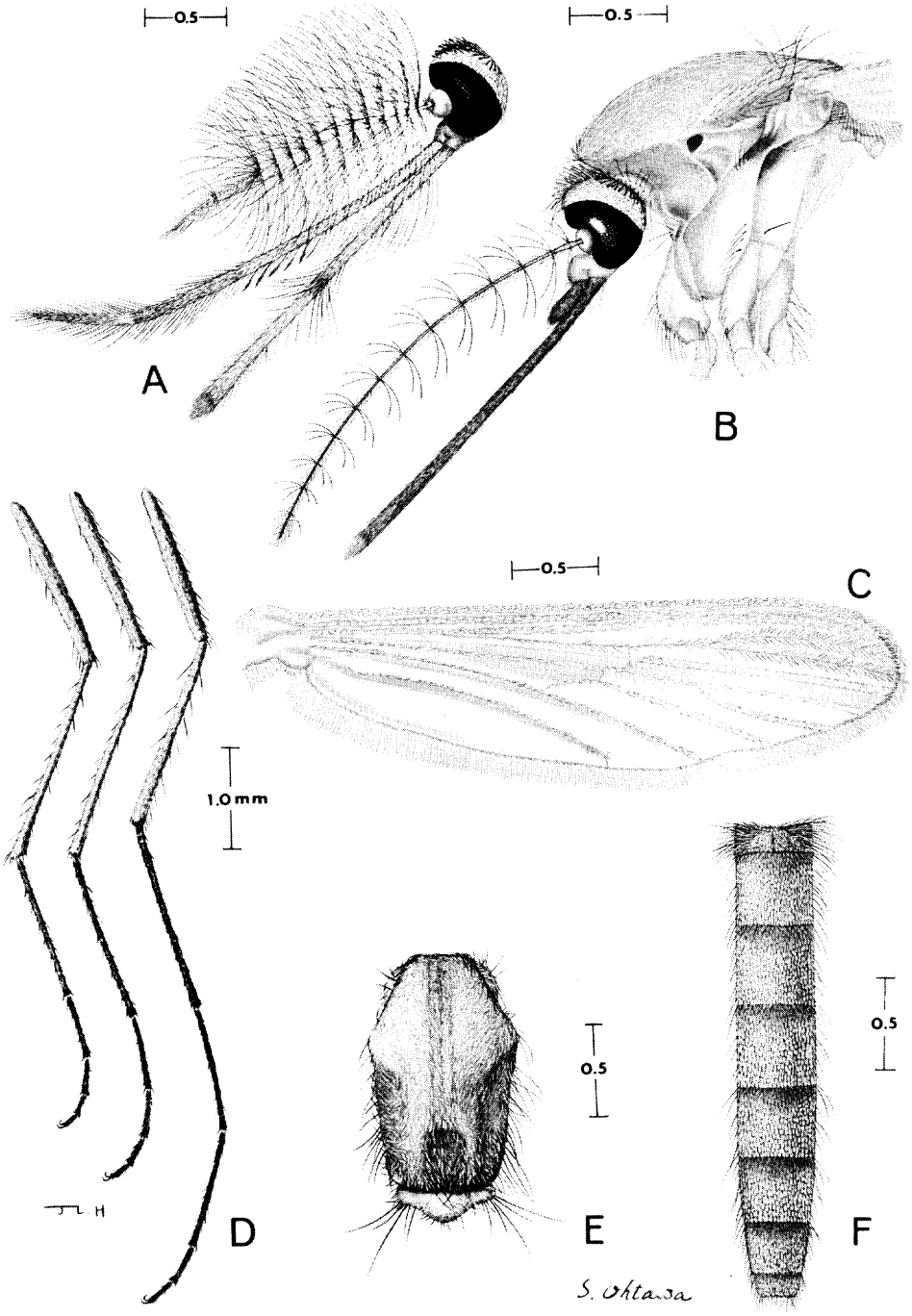
10(9). Anterior surface of the mid and hind femora and tibiae with distinct, pale stripes. . . . . *barraudi* (p. 209)
Mid and hind femora and tibiae without pale stripes on the anterior surface 11

11(10). Proboscis usually with accessory pale patches proximal to the median pale band on the ventral surface; teeth of the buccopharyngeal armature very long and filamentous; erect scales on the occiput dark brown; usually a small, dark brown species. . . . . *tritaeniorhynchus* (p. 275)
Proboscis without accessory pale patches on the ventral surface; teeth of the buccopharyngeal armature short, not filamentous; erect scales on the occiput varying from pale golden to dark brown; usually larger species 12

12(11). Erect scales of the vertex uniformly dark brown, or dark brown on the occiput and with several almost black scales postero-laterally. 13

Figure 60. ← *C. (Culiciomyia) spiculothorax.* Fourth stage larva: dorso-ventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments.

Fig.61



C.(Culiciomyia) termi

Erect scales of the vertex yellowish to golden brown on the occiput, dark brown to black posterolaterally. 14

13(12). Anterior surface of the mid femur speckled with brown and white scales; mid and hind tibiae dark with a trace of pale scales forming somewhat of a stripe. . . . . *sitiens* (p. 239)
Anterior surface of the mid femur predominantly dark, slightly lighter on the ventral margin, but without white speckling; mid and hind tibiae not as above. . . . . *annulus* (in part, p. 205)

14(12). Abdominal terga II-VI without basal pale bands . . . . . *perplexus* (in part, p. 221)
Abdominal terga II-VI with basal pale bands . . . . *neolitoralis* (p. 236)
pseudovishnui (p. 222)[1]
whitei (p. 233)
alienus (p. 202)
perplexus (in part, p. 221)
annulus (in part, p. 205)[1]

KEY TO SPECIES OF THE SUBGENUS *CULEX* IN THAILAND - ADULT MALES

1. Arms of the outer division of the phallosome simple, nearly parallel in dorsal aspect; arms of the inner division simple, curved laterally; basal sternal process of the proctiger very short, straight, usually lightly pigmented. . . . . *pipiens quinquefasciatus* (p. 192)
Arms of the outer division of the phallosome widely divergent; arms of the inner division usually with numerous teeth (except in *hutchinsoni, fuscocephala,* and *sinensis*); basal sternal process of the proctiger long and curved, usually strongly pigmented (except in *neolitoralis*). 2

2(1). Subapical lobe of the basimere distinctly divided, the 3 basal rods on a tubercle separated from the leaf and accessory setae; arms

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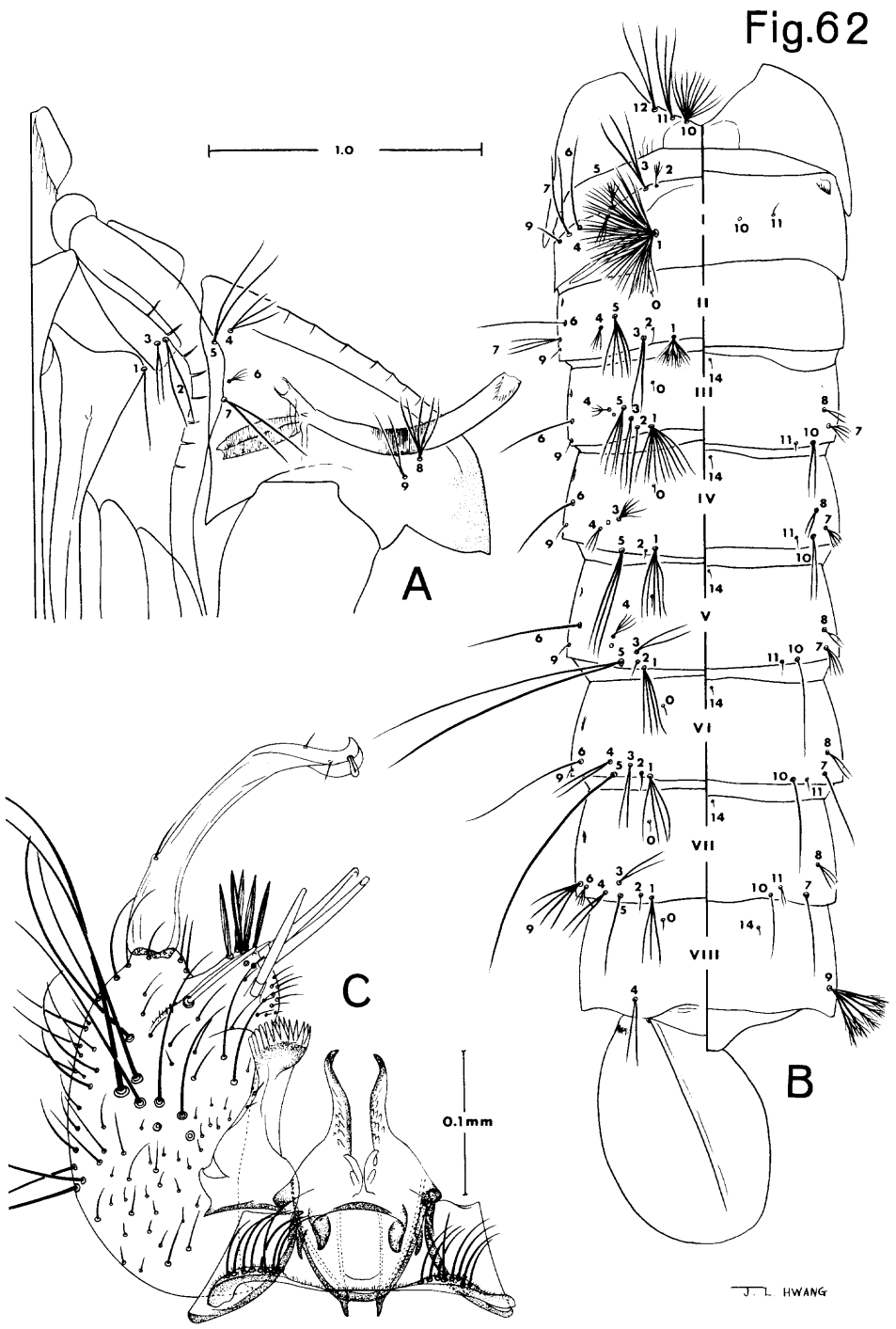
[1] Of the 6 species which cannot be conclusively recognized on the basis of the adult female, *pseudovishnui* and *annulus* are undoubtedly the most common in Thailand according to larval collections.

Figure 61. *C. (Culiciomyia) termi.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.



C. (Culiciomyia) termi

of the inner division of the phallosome simple, but with faint striations or minute denticles, and truncate distally. . . . . *fuscocephala* (p. 184)

Subapical lobe of the basimere undivided; arms of the inner division of the phallosome usually complex, if simple without faint striations 3

3(2). Distimere expanded medially; inner division of the phallosome short, slightly curved laterally, and heavily sculptured; outer division shorter, broad, bluntly rounded and spiculose. . . . . *gelidus* (p. 247)

Distimere not noticeably expanded medially; inner and outer divisions of the phallosome not as above. 4

4(3). Inner division of the phallosome simple, without denticles. 5

Inner division of the phallosome complex with at least some denticles; when observed in lateral aspect, with a spiculate portion (except in *whitmorei* and *whitei*). 6

5(4). Arms of the inner division of the phallosome straight, parallel, minutely spiculose; outer division greatly reduced, represented by a small basal protuberance . . . . . *sinensis* (p. 268)

Arms of the inner division of the phallosome simple, prominently curved and directed laterally; outer division complex, with some laterally directed processes. . . . . *hutchinsoni* (p. 188)

6(4). Basal rod of the subapical lobe of the basimere considerably longer and broader than the other 2 rods; inner division of the phallosome without a spiculate portion. . . . . *whitmorei* (p. 253)

Basal rod of the subapical lobe of the basimere shorter than the other 2 rods, if longer, only slightly so; inner division of the phallosome with a spiculate portion (except in *whitei*). 7

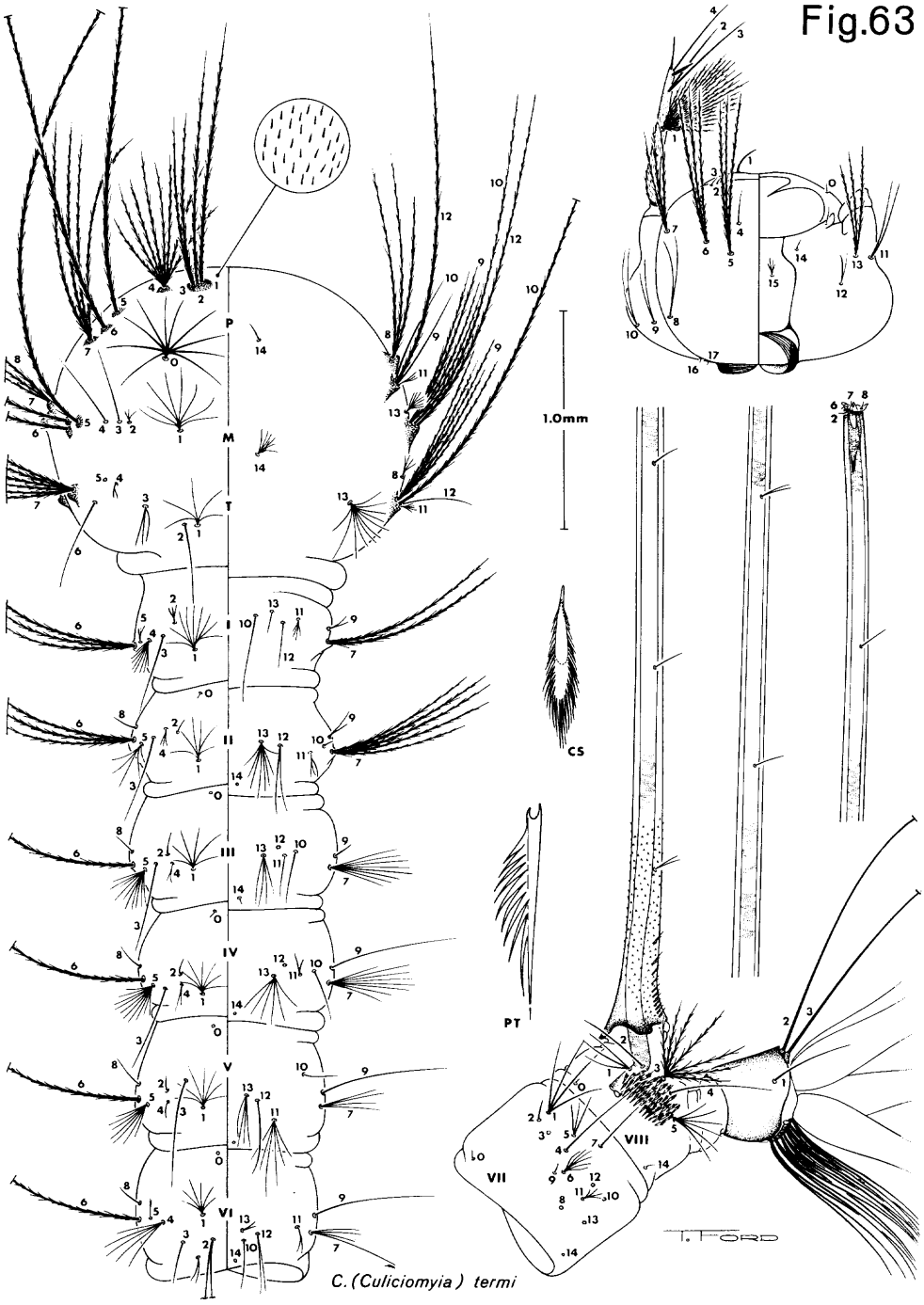
7(6). Inner division of the phallosome with from 2 to 4 large, bluntly rounded denticles, the spiculate portion very prominent with an extended projection directed away from the denticles; leaf-like seta on the subapical lobe of the basimere short. 8

Inner division of the phallosome with 3 or more smaller, sharply pointed denticles; the spiculate portion without an extended projection directed away from the teeth (except in *neolitoralis* and *sitiens*); leaf-like seta on the subapical lobe of the basimere moderate to large in breadth and length 9

8(7). Basal sternal process of the proctiger represented by a bluntly rounded protuberance; leaf on the subapical lobe of the basimere very slender . . . . . *bitaeniorhynchus* (p. 258)

Figure 62. ← *C. (Culiciomyia) termi.* A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia.

Fig.63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T. FORD
C. (Culiciomyia) termi

Basal sternal process of the proctiger short, but distinctly developed and gently directed posteriorly; leaf on the subapical lobe of the basimere somewhat broader. . . *pseudosinensis* (p. 265)

9(7). Outer division of the phallosome with a series of at least 3 denticles similar in size and shape to those of the inner division; subapical lobe of the basimere with 4 accessory setae next to the leaf. . . . . *whitei* (p. 233)

Outer division of the phallosome without a series of denticles similar to those of the inner division; subapical lobe of the basimere usually with 3 accessory setae next to the leaf. 10

10(9). Spiculate portion of the inner division of the phallosome with a distinct heel or projection on the inner margin; all 3 accessory setae next to the leaf on the subapical lobe of the basimere subequal in length and hooked 11

Spiculate portion of the inner division of the phallosome smoothly rounded, without a heel or projection on the inner margin; accessory setae next to the leaf on the subapical lobe of the basimere not as above. 12

11(10). Spiculate portion of the inner division of the phallosome with a prominent projection exhibiting fine denticles; basal sternal process of the proctiger rather short and straight. . . . . *neolitoralis* (p. 236)

Spiculate portion of the inner division of the phallosome with a small spiculate heel on the inner margin; basal sternal process of the proctiger long and curved. . . . . *sitiens* (p. 239)

12(10). Wings with 2 or more distinct patches of light scales on the costa and subcosta, and with some variable patches on the other wing veins. . . . . *mimulus* (p. 213)

Wings without distinct patches of white scales. 13

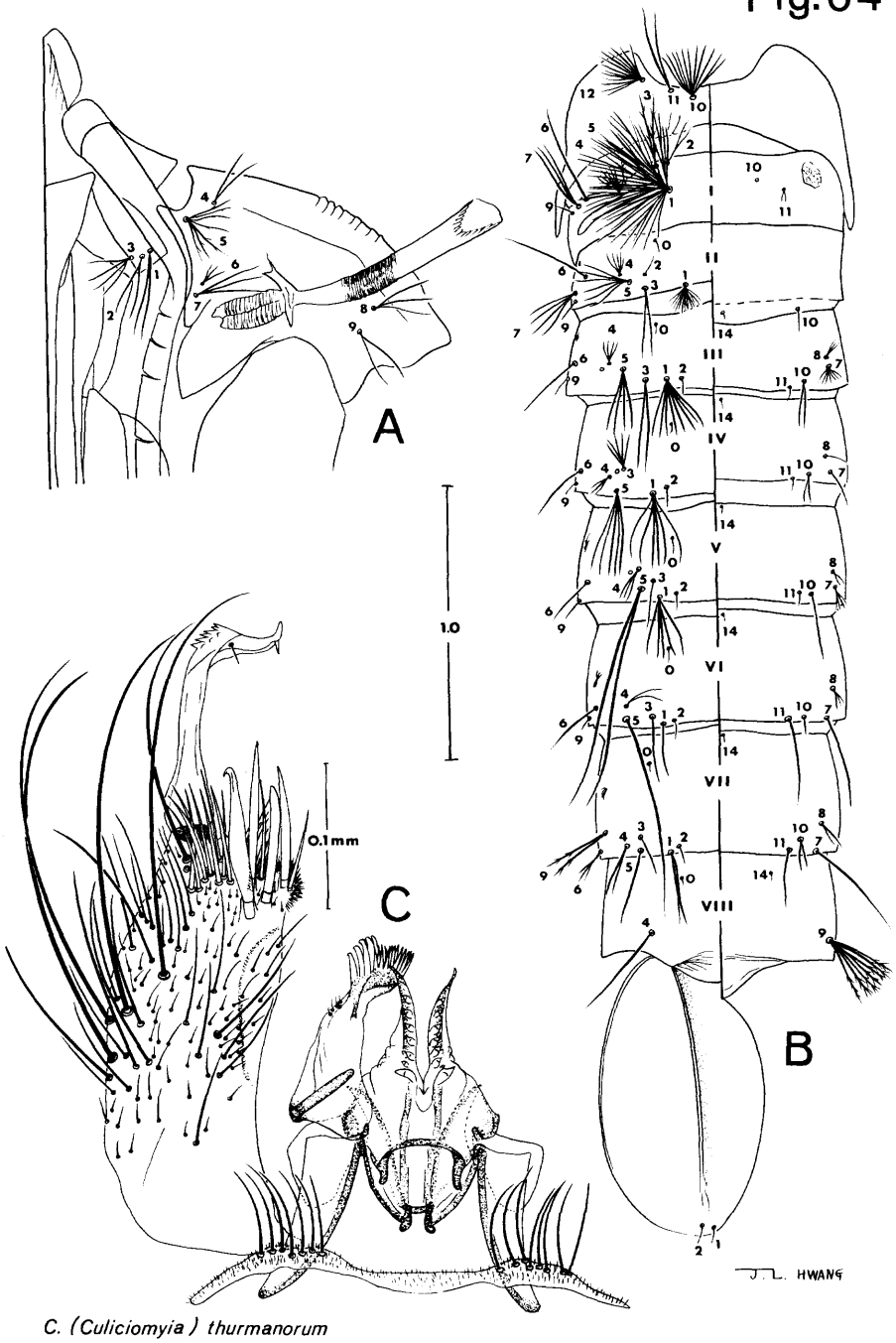
13(12). Anterior surface of the mid and hind femora and tibiae with distinct longitudinal pale stripes . . . . . *barraudi* (p. 209)

Mid and hind femora and tibiae without longitudinal pale stripes on the anterior surface. . . . . *alienus* (p. 202)
annulus (p. 205)
perplexus (p. 221)
pseudovishnui (p. 222)[1]

[1] Colless (1957) has suggested that *pseudovishnui* does not usually possess the long ventral hairs at the base of the band on the proboscis which are present in the other closely related species. This character appears to be consistent, although in some specimens of *pseudovishnui* 1 or 2 shorter hairs may be present.

Figure 63. ← *C. (Culiciomyia) termi.* Fourth stage larva: dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments.

Fig.64



C. (Culiciomyia) thurmanorum

13(12). . . . . *tritaeniorhynchus* (p. 275)[1]

KEY TO SPECIES OF THE SUBGENUS *CULEX* IN THAILAND - FOURTH STAGE LARVAE

1. Head hair 1-C fine, tapering and filamentous distally. 2
Head hair 1-C thicker, acuminate, truncate, or bluntly pointed. . . . 3

2(1). Siphon index approximately 5:1 or greater; head hairs 5, 6-C with 2 or 3 branches . . . . . *fuscocephala* (p. 184)
Siphon index approximately 3:1, the siphon expanded medially; head hairs 5, 6-C with 5 or more branches. . . . . *pipiens quinquefasciatus* (p. 192)

3(1). Head hair 1-C lightly pigmented, long, of even width to apex; pecten inconspicuous, restricted to the basal fifth of the siphon or less 4
Head hair 1-C strongly pigmented, shorter, tapering to apex or short and truncate; pecten obvious, extending through approximately the basal 1/4 or 1/3 of the siphon 6

4(3). Lateral teeth of the mentum robust, distinctly separated and less than 10 on each side; thoracic hair 4-P short, simple. . . . . *sinensis* (p. 268)
Lateral teeth of the mentum numerous, extremely short and compact; thoracic hair 4-P long, pectinate. 5

5(4). Siphon usually with 4 pairs of subventral tufts; individual comb scales elongated; pecten extending only a very short distance from the base . . . . . *bitaeniorhynchus* (p. 258)
Siphon with 3 pairs of subventral tufts, the basal tuft frequently not paired; individual comb scales relatively short; length of the pecten somewhat greater than above. . *pseudosinensis* (p. 265)

6(3). Head hair 1-C broad and somewhat flattened, its apex rounded or irregular; anal gills bulbous, not as long as the saddle. 7
Head hair 1-C slender or moderately thickened, its apex acuminate;

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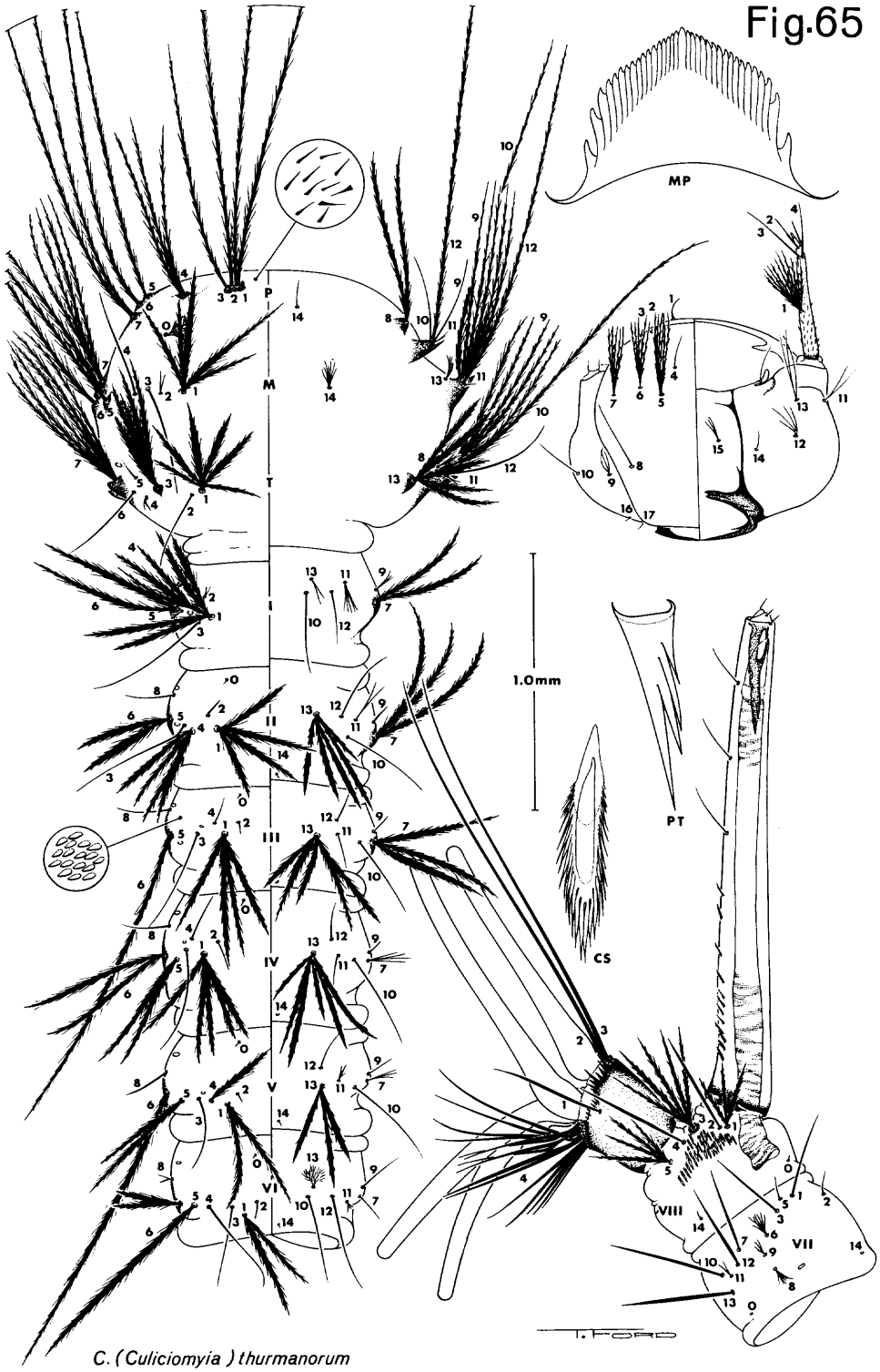
[1] In *tritaeniorhynchus*, the spiculate portion of the inner division of the phallosome usually exhibits a slightly expanded apex which projects somewhat beyond the attachment of the teeth (see insert on figure 77C); however, if the specimen is not positioned exactly, this feature may be distorted, and must therefore be used with caution.

Figure 64. ← *C. (Culiciomyia) thurmanorum*. A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia.

Fig.65



C. (Culiciomyia) thurmanorum

anal gills elongate, at least as long as the saddle, usually longer. 8

7(6). Anal saddle completely ringing segment X; pecten tooth with approximately 9 fine, lateral barbs. . . . . *sitiens* (p. 239)
Anal saddle incomplete, consisting of separate dorsal and ventral plates; pecten tooth with from 2 to 7 coarse lateral barbs. . . . . *neolitoralis* (p. 236)

8(6). Individual comb scales fan-shaped, fringed with subequal spicules, or rarely with the median distal spicule only slightly longer than the lateral spicules. 9
At least some of the individual comb scales with the median distal spine obviously longer and broader than the lateral spicules. . . . 13

9(8). Siphon with a single, prominent, subapical spine. . . . . *hutchinsoni* (p. 188)
Siphon without a prominent, subapical spine. 10

10(9). Siphon greatly expanded medially; subventral tufts of the siphon all inserted in a straight line . . . . . *gelidus* (p. 247)
Siphon not greatly expanded medially; 1 or more pairs of subventral tufts of the siphon inserted laterally out of line. 11

11(10). Thoracic hair 4-P single; median distal spicule of the comb scale occasionally slightly longer than the lateral spicules. . . . . *mimulus* (p. 213)
Thoracic hair 4-P bifid; median distal spicule of the comb scale never longer than the lateral spicules 12

12(11). Stirrup-shaped piece of the siphon without a proximally directed prolongation; abdominal hair 1-X with 3 or 4 short branches. . . . . *tritaeniorhynchus* (p. 275)
Stirrup-shaped piece of the siphon with a prolongation of the ventral cornu directed proximally; abdominal hair 1-X usually with 2 fairly long, fine branches. . . . . *barraudi* (p. 209)

13(8). Subventral tufts of the siphon bifid, pectinate, with 2 additional shorter, simple pairs inserted laterally out of line. . . . . *whitmorei* (p. 253)
Subventral tufts of the siphon with 2 or more branches which are always simple, usually with only 1 pair inserted laterally out of line. 14

14(13). Subventral tufts of the siphon usually with 6 or more branches;

Figure 65. ← *C. (Culiciomyia) thurmanorum.* Fourth stage larva: dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments.

thoracic integument minutely spiculose . . . . . *annulus* (p. 205)
Subventral tufts of the siphon usually with 5 or less branches; thoracic integument glabrous 15

15(14). Comb consisting of approximately 40 scales; subventral tufts equal to or less than the width of the siphon at the point of insertion, usually all bifid . . . . . *whitei* (p. 233)
Comb consisting of 25 or less scales; length of the subventral tufts greater than the width of the siphon at the point of insertion, at least some of the tufts with 3 or more branches 16

16(15). Head hairs 5, 6-C usually bifid; the length of the basal subventral tuft greater than 3 times the width of the siphon at the point of insertion . . . . . *alienus* (p. 202)
Head hair 5-C with from 3 to 5 branches, 6-C with 2 or 3 branches; length of the basal subventral tuft less than 2 times the width of the siphon at the point of insertion 17

17(16). Comb consisting of from 5 to 13 long, sharp scales arranged in an irregular row; head hair 4-C usually bifid or trifid; abdominal hairs 6-V, VI with 3 branches; head hair 1-C never with accessory lateral spicules . . . . . *pseudovishnui* (p. 222)
Comb consisting of from 12 to 20 rather short scales arranged in 2 or 3 irregular rows; head hair 4-C usually single; abdominal hairs 6-V, VI bifid; head hair 1-C frequently with accessory lateral spicules . . . . . *perplexus* (p. 221)

PIPIENS GROUP

ADULT. *Head.* Proboscis without a median band of pale scales. *Thorax.* At least 1 lower mesepimeral bristle present; legs without pale bands on the tarsomeres. *Abdomen.* Terga with or without pale basal bands.

LARVA. *Head.* Hair 1-C usually fine and filamentous, except in *hutchinsoni* which exhibits a prominent subapical spine on the siphon.

DISTRIBUTION. Species of this group are distributed primarily in the Ethiopian region and the New World, with only a few representatives in the Oriental region. The species found in Thailand are usually common and widely distributed, except for *hutchinsoni* which apparently has a more limited distribution.

TAXONOMIC DISCUSSION. Edwards (1932) included *fatigans (= pipiens quinquefasciatus)* in the *pipiens* series of group B; *fuscocephala* and *hutchinsoni* were included with species of uncertain position in group B. The *pipiens* group, as here recognized, encompasses Edwards' group B without

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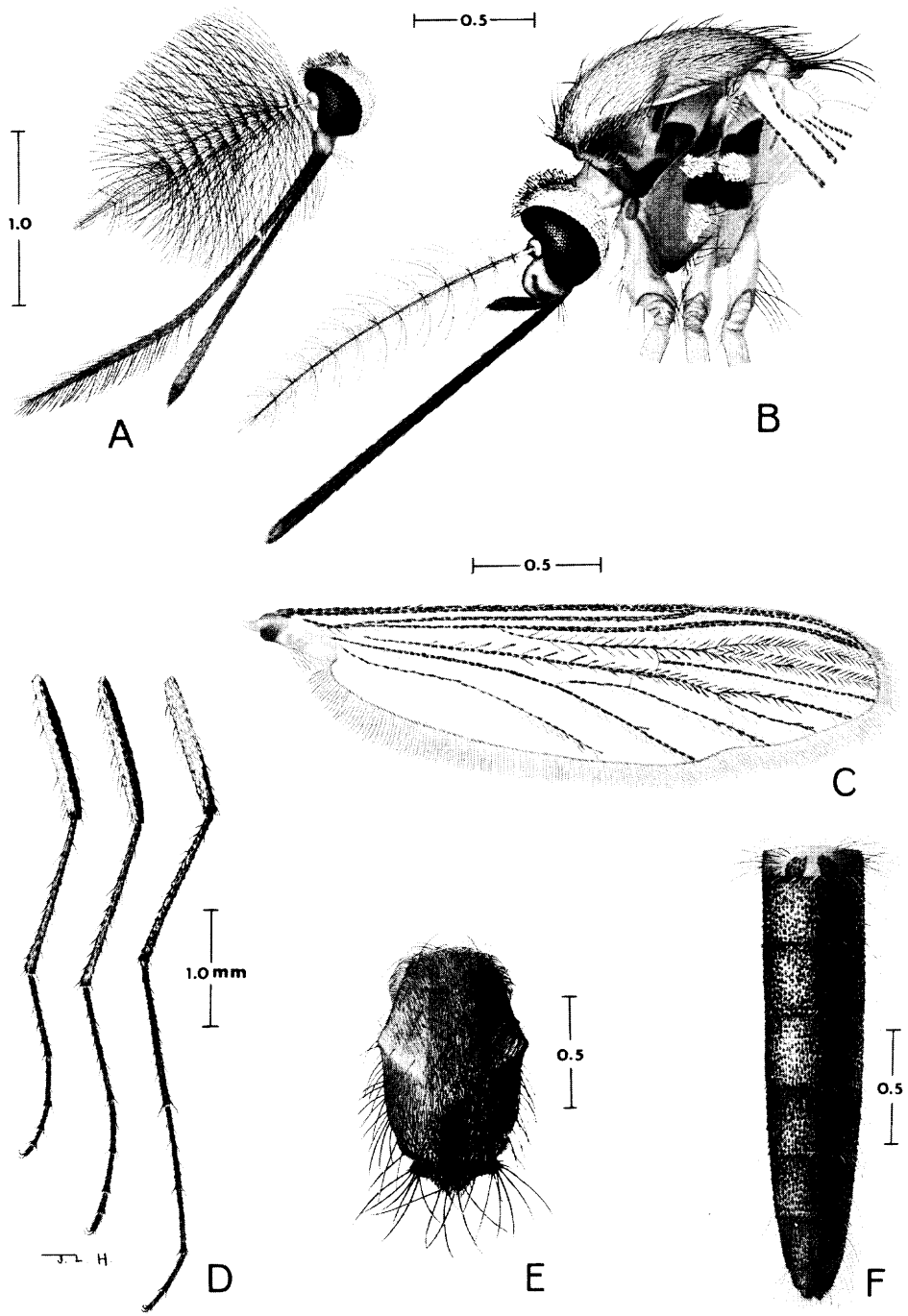
Figure 66. *C. (Culex) fuscocephala.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen. →

Fig.66



C. (Culex) fuscocephala

recognizing subgroups. Of the 3 species found in Thailand, *pipiens quinquefasciatus* and *fuscocephala* fall within the *pipiens* series of Edwards due to the presence of 1 or more lower mesepimeral bristles in the adult female and the absence of a median pale band on the proboscis. *C. hutchinsoni* possesses the distinctive characters of the adult, but head hair 1-C in the fourth stage larva is robust and acuminate in contrast to the filamentous form found in the other 2 species.

CULEX (CULEX) FUSCOCEPHALA THEOBALD 1907
(Figures 66, 67, and 68)

Culex fuscocephala Theobald 1907, Mon. Cul. 4: 420 (♀); Theobald 1910, Mon. Cul. 5: 363 (distribution); Barraud 1924, Indian J. med. Res. 11: 1270 (♂*, ♀).

Culex uniformis Leicester 1908, Cul. Malaya: 159 (♀); Edwards 1917, Bull. ent. Res. 7: 225 (synonymy).

Culex minimus Leicester 1908, Cul. Malaya: 160 (♀, ♂); Edwards 1932, *in* Wytsman, Genera Insect. fasc. 194: 212 (synonymy).

Culex taytayensis Banks 1909, Philipp. J. Sci. 4: 545 (♂, ♀); Edwards 1913, Bull. ent. Res. 4: 234 (synonymy).

Culex luteola Theobald 1910, Mon. Cul. 5: 378 (♀*); Edwards 1913, Bull. ent. Res. 4: 234 (synonymy).

Culex inelegans Dyar 1920, Insec. Inscit. menst. 8: 179 (♂); Barraud 1934, Fauna Brit. India, Diptera 5: 424 (synonymy).

Culex fuscitarsis Barraud 1924, Indian J. med. Res. 11: 1272 (♂*, ♀). NEW SYNONYMY.

Culex (Culex) fuscocephalus Theobald: Barraud 1934, Fauna Brit. India, Diptera 5: 424 (♂*, ♀, L*); Bonne-Wepster and Brug 1937, Geneesk. Tijdschr. Ned.-Ind. 77: 80 (♂, ♀*); Bonne-Wepster and Brug 1939, Geneesk. Tijdschr. Ned.-Ind. 79: 1277 (L*); Bohart 1945, Navmed 580: 78 (♂*, L); Bonne-Wepster 1954, Roy. trop. Inst. Amst. Spec. Pub. 111: 133 (♂, ♀*, L*); Lien 1962, Pacif. Ins. 4: 633 (distribution); Safyanova *et al.* 1964, Zool. Zhur. 43: 1177 (distribution).

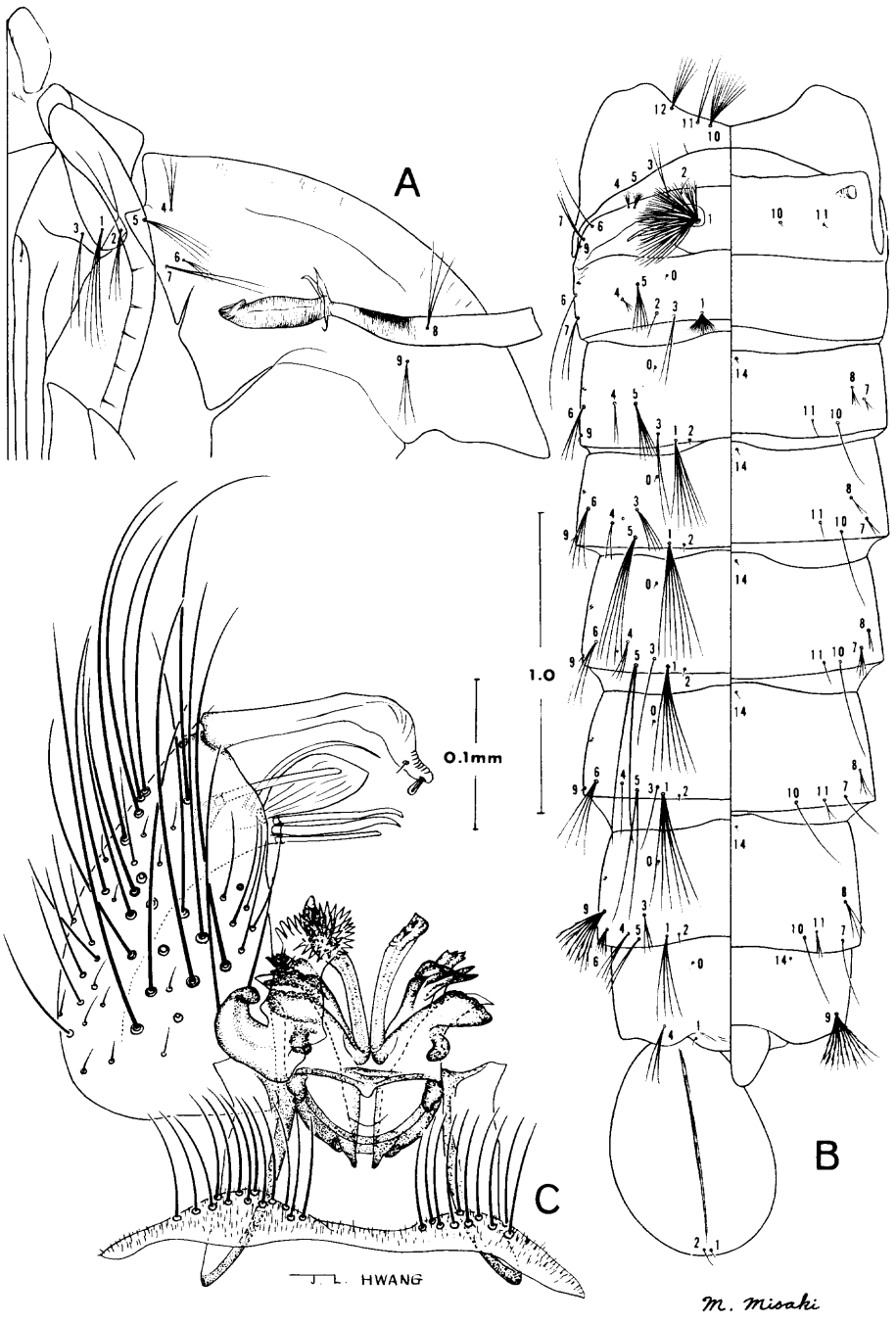
Culex (Culex) fuscocephala Theobald: Delfinado 1966, Mem. Amer. ent. Inst. 7: 143 (♂*, ♀, L).

The adult female may be recognized by the unbanded abdominal terga and by the presence of dark areas on the integument of the pleuron. In the adult male, the distinctive phallosome is diagnostic. The fourth stage larva is distinguished by chaetotaxy of the head and by the characteristic siphon.

FEMALE. A moderate to small sized, exceptionally dull species. *Head.* (Figure 66B). Proboscis bronze-brown, without light bands or scattered light scales; palpus similar in color to the proboscis; decumbent scales of the vertex white; erect scales dark brown. *Thorax.* (Figure 66B, E). Scutum covered with bronze-brown scales, but with somewhat lighter scales in the area of the anterior pronotal lobe and the prescutellar space;

Figure 67. *C. (Culex) fuscocephala.* A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia. →

Fig.67



C.(Culex) fuscocephala

integument of the pleuron basically light brown, but with variable dark patches on the mesepimeron, sternopleuron, and posterior spiracular plate; 1 or 2 lower mesepimeral bristles present; patches of light scales on the upper mesepimeron and upper and posterior sternopleuron. *Wing.* (Figure 66C). *Legs.* (Figure 66D). Hind femur virtually all white on the anterior surface, but with a very dark band at the apex which extends proximally along the dorsal margin; hind tibia and tarsus uniformly covered with bronze-brown scales; fore and mid legs bronze-brown, but with varying amounts of light scales on the anterior surface of the femora. *Abdomen.* (Figure 66F). Terga completely bronze-brown, but with some faint suggestion of narrow light basal bands on the proximal terga of some specimens; sterna light brown.

MALE. *Head.* (Figure 66A). Palpus uniformly dark, but in some specimens somewhat lighter on the distal segments. *Terminalia.* (Figure 67C). Subapical lobe of the basimere well developed, distinctly divided, the 3 basal rods on a tubercle separated from the leaf and with a rather strong, bluntly rounded seta set on another small independent tubercle; distimere characteristically curved, with minute annulations on the convex surface of the apex; outer division of the phallosome consisting of 4 or more strong denticles, inner division rather long and slender, covered with faint striations or minute denticles; proctiger crowned with a strong tuft of spines, with 3 cercal setae present; basal sternal process strong and curved.

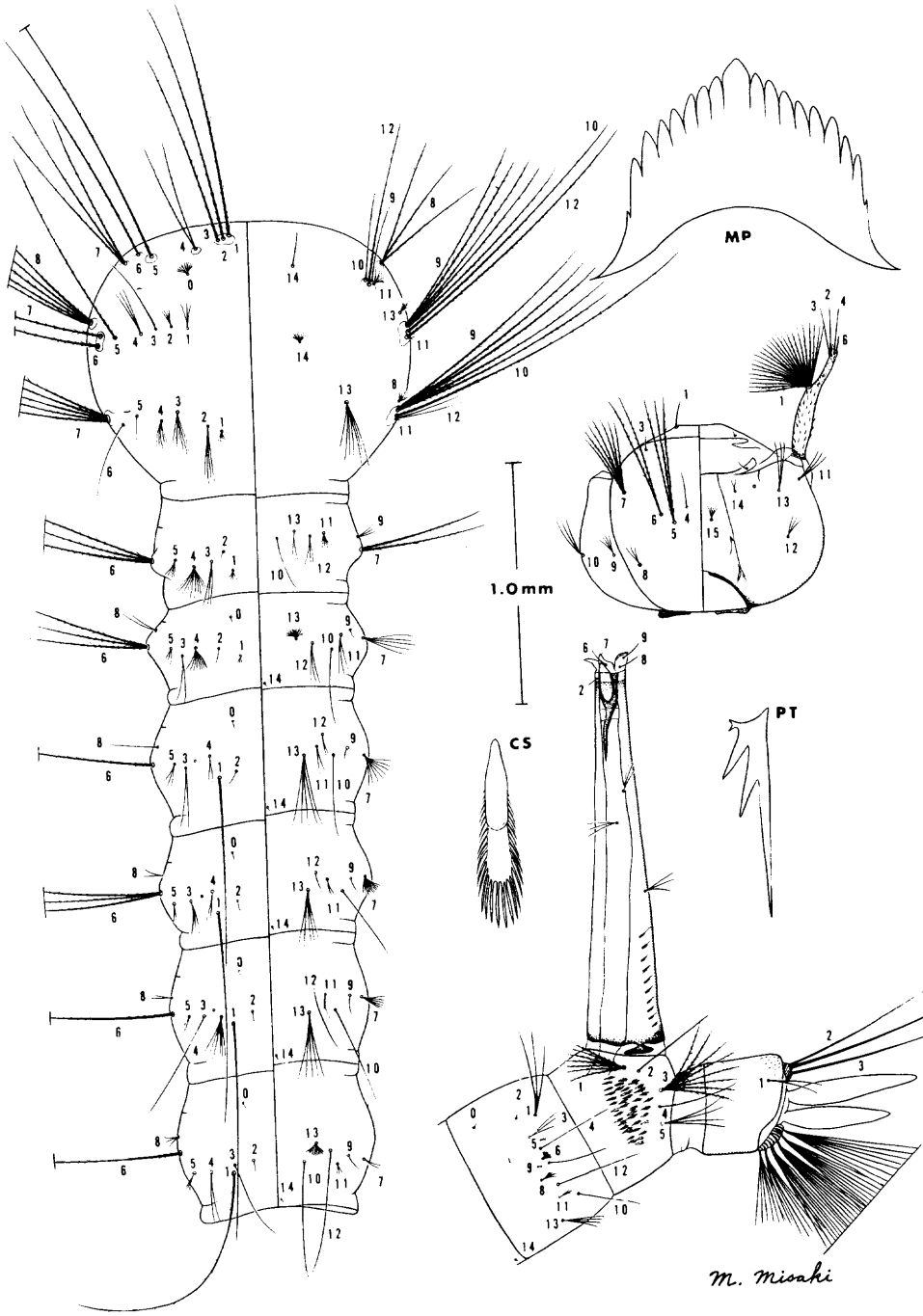
PUPA. (Figure 67A, B).

LARVA. (Figure 68). *Head.* Antenna with a narrow, dark basal ring and often somewhat darker beyond insertion of hair 1-A; head hair 1-C filamentous, its length greater than half the distance between the bases of the pair; 4-C single, simple, very fine and filamentous; 5, 6-C usually bifid or trifid, pectinate. *Thorax.* Integument glabrous; hairs 1, 2, 3-P single, pectinate, subequal in length; 4-P usually bifid, occasionally single, pectinate; 5, 6-P single, pectinate; 7, 8-P with 2 or 3 branches, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; comb consisting of from 35 to 40 fan-shaped scales arranged in a triangular patch; siphon index variable, ranging from 4.8:1 to 7:1; 3 or 4 pairs of subventral tufts inserted on the siphon beyond the pecten, the subapical tuft inserted laterally out of line; individual tufts with from 2 to 4 branches, their length less than the width of the siphon at the point of insertion; pecten consisting of from 10 to 12 teeth restricted to the basal third of the siphon; individual pecten tooth with a strong, narrow, pointed distal spine and from 1 to 3 strong lateral barbs; saddle completely ringing segment X.

TYPE DATA. Holotype female of *fuscocephala* from Peradeniya, Ceylon in the British Museum. The type locality of *uniformis* is Batu Gajah, (Perak), Malaya, but the type specimen is non-existent. The type locality of *minimus* is Kuala Lumpur, (Selangor), Malaya, but the type specimen is non-existent. The holotype of *taytayensis* has been destroyed, but a paratype male (terminalia mounted and attached to pin) from Taytay, Philippine Islands is in the British Museum. Holotype female of *luteola* from Peradeniya, Ceylon in the British Museum. Holotype male of *inelegans* (terminalia slide-mounted)

Figure 68. *C. (Culex) fuscocephala.* Fourth stage larva: dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments. →

Fig. 68



C. (Culex) fuscocephala

from Los Baños, Philippines in the U. S. National Museum. Lectotype male of *fuscitarsis* hereby designated: syntype male (terminalia slide-mounted), "no. 1701, Pachmari, India, July 1915, V. H. Dowson, B.M. 1923-585", in the British Museum.

DISTRIBUTION. In THAILAND, this species is common and probably widely distributed throughout the country and specimens have been examined from: *Ayutthaya, Chiang Mai, Chiang Rai, Chon Buri, Krung Thep, Lampang, Lamphun, Mae Hong Son, Nakhon Nayok, Nakhon Ratchasima, Narathiwat, Pathum Thani, Phitsanulok, Phare, Sara Buri, Surat Thani, Thon Buri, Ubon Ratchathani,* and *Udon Thani.* The species has also been reported from CEYLON, INDIA, NEPAL, BURMA, CHINA, TAIWAN, PHILIPPINES, INDONESIA, MALAYA, ANDAMAN ISLANDS, and INDOCHINA. Specimens have been examined in the British Museum collection from Kota Belud, NORTH BORNEO**.

During this study the following specimens from Thailand have been examined: 1,044 females and 395 males, 9 of which were individual rearings, and 133 larvae.

TAXONOMIC DISCUSSION. In the original description of *fuscitarsis,* Barraud (1924a) indicated that the species differed slightly from *fuscocephala* in the form of the male terminalia and by possessing pale narrow, ochreous bands on the abdominal terga. Examination of an extensive series of *fuscocephala* has revealed that these differences cited by Barraud fall well within the normal range of variation of *fuscocephala.* Comparison of the type specimens of both species confirms the conclusion that *fuscitarsis* and *fuscocephala* are conspecific.

BIOLOGY. Larvae are found primarily in various ground water habitats such as rice fields, ground pools of various sizes, impounded water, and other semipermanent aquatic habitats usually with emergent vegetation. The adults of both sexes are readily attracted to light, and adult females have been reported feeding on man and buffalo. Hu (1958) reported a positive isolation of Japanese B encephalitis from this species in Taiwan.

CULEX (CULEX) HUTCHINSONI BARRAUD 1924
(Figures 69, 70, and 71)

Culex hutchinsoni Barraud 1924, Indian J. med. Res. 11: 1261 (♂*, ♀).
Culex (Culex) hutchinsoni Barraud: Barraud 1934, Fauna Brit. India, Diptera 5: 423 (♂*, ♀); Colless 1955, Ann. trop. Med. Parasit. 49: 316 (♂, ♀, L*); Thurman 1959, Univ. Md. Agric. Exp. Sta. Bull. A-100: 122 (distribution).

The adult female may be recognized by the markings on the integument of the pleuron and by the abdominal banding patterns. The distinctive phallo-

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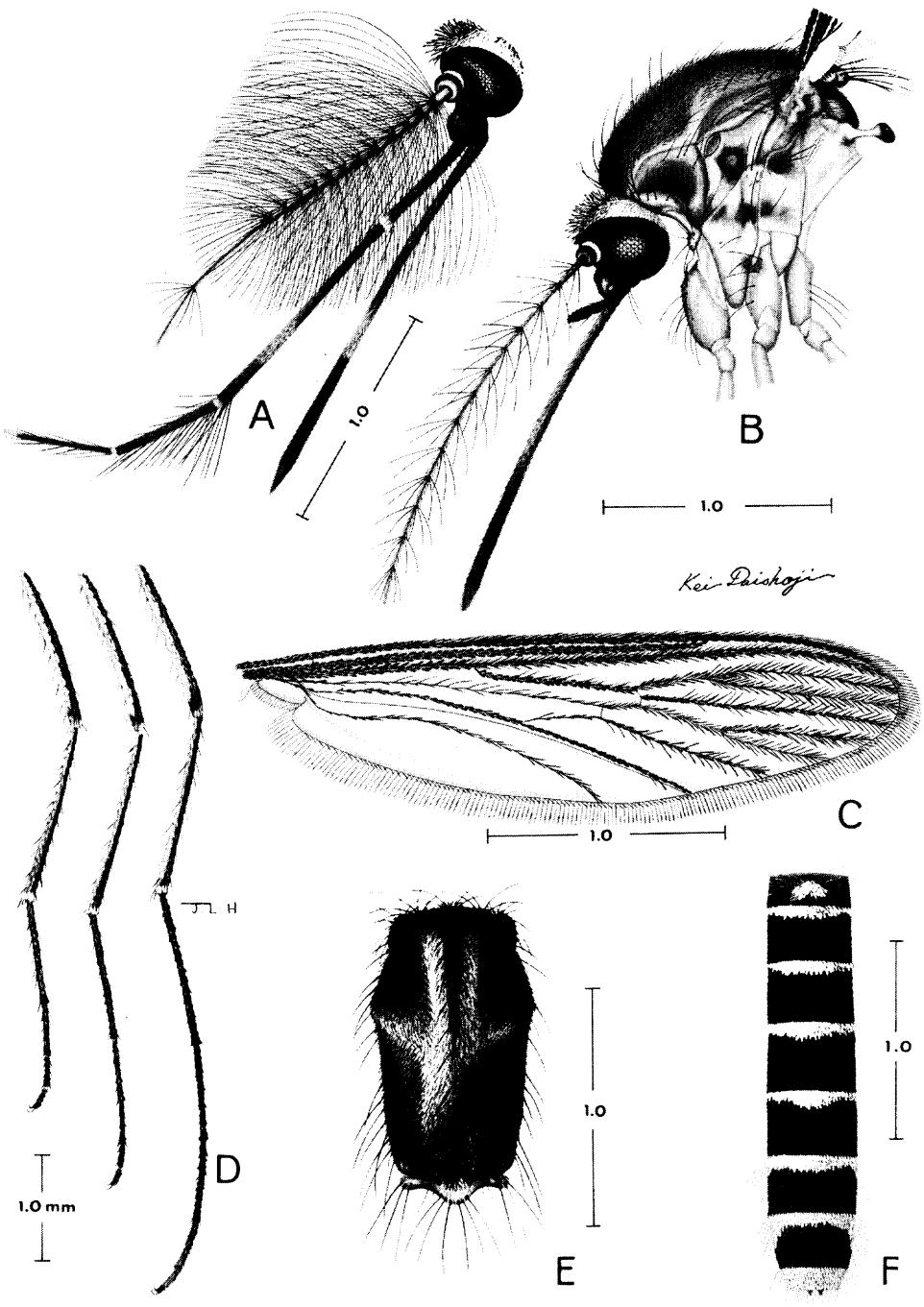
Figure 69. *C. (Culex) hutchinsoni.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

→

Fig.69



C. (Culex) hutchinsoni

some of the male terminalia is diagnostic. In the fourth stage larva, the single subapical spine on the siphon clearly distinguishes this species from all other Oriental members of the genus.

FEMALE. *Head.* (Figure 69B). Proboscis without distinct light bands or scattered light scales but with the ventral scales and those of the proximal half somewhat paler than the distal scales; palpus dark brown, usually without pale scales; decumbent scales of the vertex light brown, becoming lighter at the orbital line; erect scales dark brown. *Thorax.* (Figure 69B, E). Scutum sparsely covered with bronze-brown scales and with indistinct but slightly darker areas along the acrostichal line and in the area of the fossa; integument of the pleuron light brown, with indistinct and variable dark bands across the upper and lower sternopleuron and mesepimeron; small patches of light scales on the upper and posterior sternopleuron and middle mesepimeron; 1 lower mesepimeral bristle present. *Wing.* (Figure 69C). *Legs.* (Figure 69D). Anterior surface of the hind femur with a white longitudinal stripe on the ventral half and dark dorsally and apically; hind tibia dark with a narrow apical white band and somewhat lighter on the ventral margin; hind tarsus completely dark; fore and mid legs similar in color to the hind legs. *Abdomen.* (Figure 69F). Terga dark scaled with rather narrow, variable and sometimes indistinct, pale basal bands on segments II-VII; tergum VIII usually completely pale; sterna uniformly covered with pale golden-brown scales.

MALE. *Head.* (Figure 69A). Proboscis with a narrow median band of pale scales; palpus dark brown, with a rather broad, but variable subapical pale band on segment III; frequently with variable amounts of basal pale scaling on segments IV and V. *Terminalia.* (Figure 70C). Subapical lobe of the basimere well developed, with 3 strong basal rods followed by 3 hooked accessory setae, a broad, striated leaf and a gently curved seta; distimere normal in shape, without distal annulations; outer division of the phallosome very broad, and tapering gradually to a point, but without noticeable denticles and with the basal arm well developed and tapering to a sharp point; inner division narrow, acutely angled and tapering to a sharp point; proctiger crowned with a strong tuft of spines, with 2 or 3 cercal setae present; basal sternal process strong and curved.

PUPA. (Figure 70A, B).

LARVA. (Figure 71). *Head.* Antenna with a very narrow dark basal ring; hair 1-A inserted somewhat beyond the middle of the shaft; head hair 1-C darkly pigmented, robust, tapering gradually to a sharp point, its length approximately half the distance between the bases of the pair; 4-C single, simple; 5, 6-C usually trifid, pectinate. *Thorax.* Integument covered with a random pattern of very minute spicules (not illustrated); hairs 1, 2, 3-P single, pectinate, 3-P considerably shorter than 1, 2-P; 4-P with 4 or 5 pectinate branches; 5, 6-P single, pectinate; 7, 8-P bifid, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; comb variable, consisting of approximately 35 fan-shaped scales arranged in 3 irregular rows; siphon index variable, ranging from 2.5:1 to 3.5:1, enlarged basally and tapering rapidly at the distal third; a single, very prominent subapical spine projecting from the

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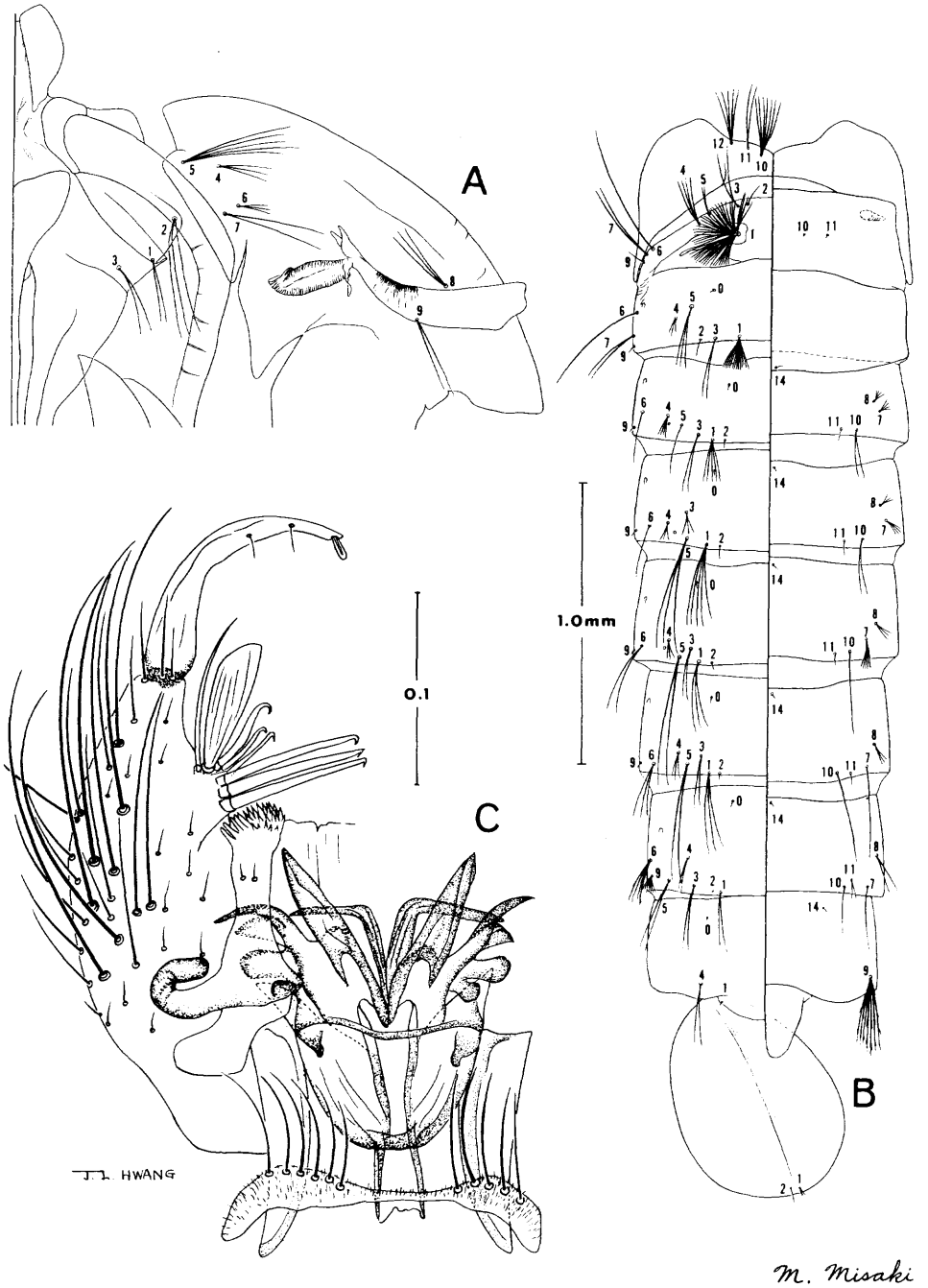
Figure 70. *C. (Culex) hutchinsoni.* A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia. →

Fig.70



C. (Culex) hutchinsoni

lateral margin of the siphon; 4 subventral tufts inserted on the siphon, the subapical tuft laterally out of line; individual tufts with from 2 to 6 branches, their length less than the width of the siphon at the point of insertion; pecten consisting of from 4 to 8 teeth restricted to approximately the basal third to half of the siphon; individual pecten tooth elongated, with a long, narrow, sharply pointed apical spine and from 1 to 3 short, strong basolateral barbs; saddle completely ringing segment X.

TYPE DATA. Lectotype of *hutchinsoni* hereby designated: syntype male, "India, Nongpoh, Assam, VII. 1922, P. J. Barraud, B.M. 1923-585, 1726", in the British Museum.

DISTRIBUTION. In THAILAND, specimens of *hutchinsoni* have been collected from: *Chiang Mai, Lampang, Nakhon Ratchasima, Nan,* and *Thon Buri.* This species has also been reported from Assam, INDIA, Selangor, MALAYA, and SINGAPORE. Specimens have been received in the U. S. National Museum from An Khe, SOUTH VIETNAM**, and the author has seen material in the British Museum from Nampam, Shan States, BURMA**.

During this study the following material was examined: 22 females and 19 males, 12 with their associated larval and pupal skins, and 78 larvae.

TAXONOMIC DISCUSSION. The adult female may possibly be confused with *pipiens quinquefasciatus,* but markings on the integument of the pleuron and the lighter scaling of the proboscis are usually diagnostic. In the adult male, the distinctive phallosome clearly separates this species from all other members of the subgenus. The fourth stage larva is immediately recognized by the single subapical spine on the siphon. Other Oriental species of the subgenus *Culex* which exhibit spines on the siphon include *mimeticus, jacksoni,* and an undescribed species from China, but in each instance more than 1 spine is present.

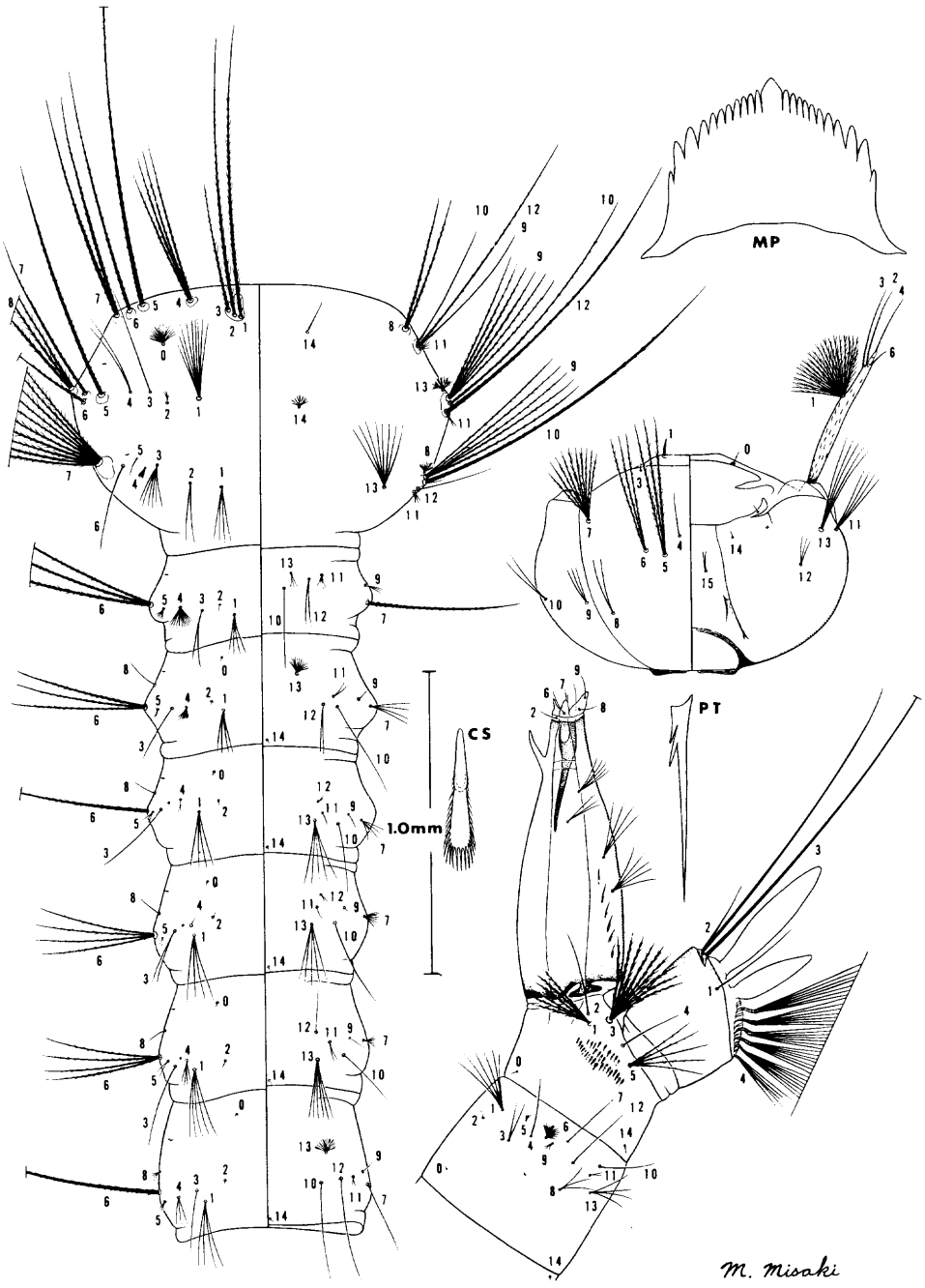
BIOLOGY. Colless (1955) reported that breeding habits of *hutchinsoni* resemble those of *pipiens quinquefasciatus* and that adults appear to frequent houses. Collections from Thailand do not confirm these observations, and larvae have been collected from pools, rock holes, stream pools, and elephant track depressions. Larvae were collected in South Vietnam from a ground pool.

CULEX (CULEX) PIPIENS QUINQUEFASCIATUS SAY 1823
(Figures 72, 73, and 74)

Culex quinquefasciatus Say 1823, J. Acad. nat. Sci. Phila. 3: 10 (adult).
Culex fatigans Wiedemann 1828, Aussereurop. Zweifl. Inseckten 1: 10 (♂, ♀); Stone 1956(1957), Proc. ent. Soc. Wash. 58: 342 (synonymy).
Culex cingulatus Doleschall 1856, Natuurk. Tijdschr. Ned.-Ind. 10: 405 (preoccupied by Fabricius 1805).
Culex doleschallii Giles 1900, Handb.: 338 (new name for *cingulatus* Doleschall); Barraud 1934, Fauna Brit. India, Diptera 5: 420 (synonymy).

Figure 71. *C. (Culex) hutchinsoni.* Fourth stage larva: dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments. →

Fig. 71



C. (Culex) hutchinsoni

Culex fouchowensis Theobald 1901, Mon. Cul. 2: 137 (♂*, ♀*); Barraud 1934, Fauna Brit. India, Diptera 5: 420 (synonymy).

Culex reesi Theobald 1901, Mon. Cul. 2: 145 (♂*, ♀*); Barraud 1934, Fauna Brit. India, Diptera 5: 420 (synonymy).

Culex sericeus Theobald 1901, Mon. Cul. 2: 147 (♀*); Barraud 1934, Fauna Brit. India, Diptera 5: 420 (synonymy).

Culex hensemaeon Dyar 1920, Insec. Inscit. menst. 8: 178 (♀); Edwards 1922, Ind. J. med. Res. 10: 278 (synonymy).

Culex (Culex) fatigans Wiedemann: Barraud 1924, Ind. J. med. Res. 11: 1264 (♂*, ♀); Barraud 1924, Ind. J. med. Res. 12: 430 (L*); Borel 1926, Arch. Insts. Pasteur Indo-Chine 3-4: 24 (♂*, ♀, L*); Barraud 1934, Fauna Brit. India, Diptera 5: 420 (♂*, ♀, L*); and some other British authors.

Culex (Culex) quinquefasciatus Say: Bohart 1945, U. S. Navmed 580: 79 (♂, L); LaCasse and Yamaguti 1950, Mosq. Fauna Japan and Korea: 220 (♂*, ♀*, L*); Belkin 1962, Mosq. S. Pacif.: 195 (♂*, ♀, P*, L*); and some other American authors.

Culex (Culex) pipiens quinquefasciatus Say: Stone, Knight, and Starcke 1959, Synoptic Cat. Mosq. Wld.: 254 (systematics); and some other American authors.

NOTE. The above synonymy is incomplete and lists pertinent references for the Oriental region only; for complete synonymy in all geographical regions consult Stone, Knight, and Starcke 1959, Synoptic Cat. Mosq. Wld.: 254, and Stone 1963, Proc. ent. Soc. Wash. 65: 135.

The adult female may be recognized by the absence of a median pale band on the proboscis, by the banded abdominal terga, and by the pale integument of the pleuron. The simple phallosome of the male terminalia and the short basal sternal process of the proctiger are diagnostic. The fourth stage larva is identified by the chaetotaxy of the head and siphon.

FEMALE. *Head.* (Figure 72B). Proboscis and palpus dark brown, without light bands or scattered pale scales; decumbent scales of the vertex pale; erect scales usually dark, but with some pale scales at the occiput. *Thorax.* (Figure 72B, E). Scutum covered with variable pale brown scales, frequently lighter on the front, sides and on the prescutellar area; integument of the pleuron pale brown, usually without darkened areas; usually 1, but sometimes 2 lower mesepimeral bristles present; small patches of dull white scales present on the upper mesepimeron, anterior mesepimeron, upper sternopleuron, and posterior sternopleuron. *Wing.* (Figure 72C). *Legs.* (Figure 72D). Anterior surface of the hind femur with pale scales on the ventral half, completely covered with pale scales at the base, and completely dark at the apex; hind tibia dark scaled, with a few pale scales at the apex; hind tarsus dark; fore and mid legs similar to the hind legs. *Abdomen.* (Figure 72F). Terga dark with moderately broad convex white basal bands

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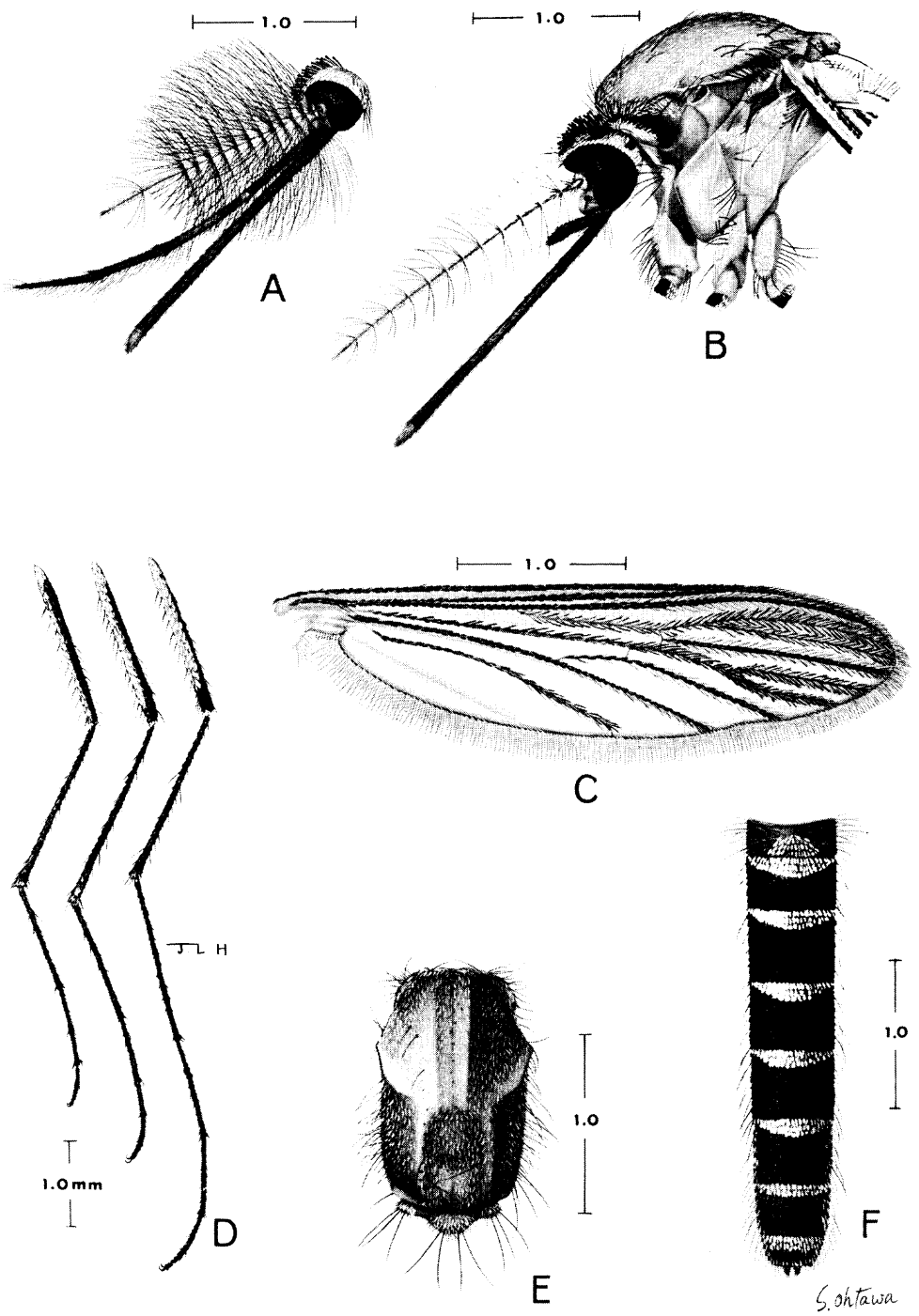
Figure 72. *C. (Culex) pipiens quinquefasciatus.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

→

Fig. 72



C. (Culex) pipiens quinquefasciatus

and usually with light basolateral white patches on terga II-VII; sterna predominantly pale, with variable patches of dark scales.

MALE. (Figure 72A). Antenna shorter than the proboscis; palpus dark, with a somewhat paler area at the base of segment III, with a ventral line of white scales on segment IV, and with a basal ventral patch of white scales on segment V. *Terminalia.* (Figure 73C). Subapical lobe of the basimere well developed, with 3 basal rods followed by 2 fine, hooked accessory setae, a broad, blunt seta, a broad leaf, and a long curved seta; distimere normal in shape, without distal annulations; arms of the inner division of the phallosome rather broad, directed laterally and tapering to a point, arms of the outer division straight, tapering to a sharp point, nearly parallel in dorsal aspect; proctiger crowned with a strong tuft of spines, with 2 or 3 cercal setae present; basal sternal process weakly developed, short and straight.

PUPA. (Figure 73A, B).

LARVA. (Figure 74). *Head.* Antenna with a narrow, dark basal ring; head hair 1-C filamentous, its length approximately equal to half the distance between the bases of the pair; 4-C usually single, simple; 5-C usually with 6 pectinate branches; 6-C usually with 5 pectinate branches. *Thorax.* Integument glabrous; hairs 1, 2, 3-P single, pectinate, subequal in length; 4, 7, 8-P bifid, pectinate; 5, 6-P single, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; comb variable, consisting of from 30 to 50 fan-shaped scales arranged in a broad, triangular patch; siphon index usually approximately 3:1, almost always less than 5:1; the siphon rather broad medially with 4 pairs of subventral tufts, the subapical tuft placed laterally out of line; individual tufts with from 2 to 9 branches, their length less than the width of the siphon at the point of insertion; pecten variable, consisting of from 5 to 12 teeth restricted to the basal third of the siphon; individual pecten tooth with a strong apical spine and 3 or 4 strong lateral barbs and occasionally several short basolateral spines; saddle completely ringing segment X.

TYPE DATA. The type locality of *quinquefasciatus* is "Mississippi River, United States" but the type specimen is non-existent. Syntypes of *fatigans* from Indonesia in the Naturhistorisches Museum, Vienna, Austria. The type locality of *cingulatus* is Ambarawa, Java but the location of the type is unknown. Lectotype of *fouchowensis* hereby designated: type male (terminalia slide-mounted), "84, Foochow, T. Rennie, 7/8/00, common native quarters in suburbs", in the British Museum. The type locality of *reesi* is Hong Kong, China but the type has apparently been lost. The type locality of *sericeus* is Hong Kong, China but the location of the type is unknown. The holotype female of *hensemaeon* from Los Baños, Philippines is the U. S. National Museum.

DISTRIBUTION. This species is cosmotropical and is undoubtedly distributed throughout THAILAND. During this study the following specimens from Thailand were examined: over 750 males and over 300 females, 26 with their associated larval and pupal skins, and 568 larvae.

TAXONOMIC DISCUSSION. The use of the name *quinquefasciatus* in preference to *fatigans* is based on considerations outlined by Stone (1956(1957)). Briefly stated, if both names apply to the same taxon (and they have, in fact,

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Figure 73. *C. (Culex) pipiens quinquefasciatus.* A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia.

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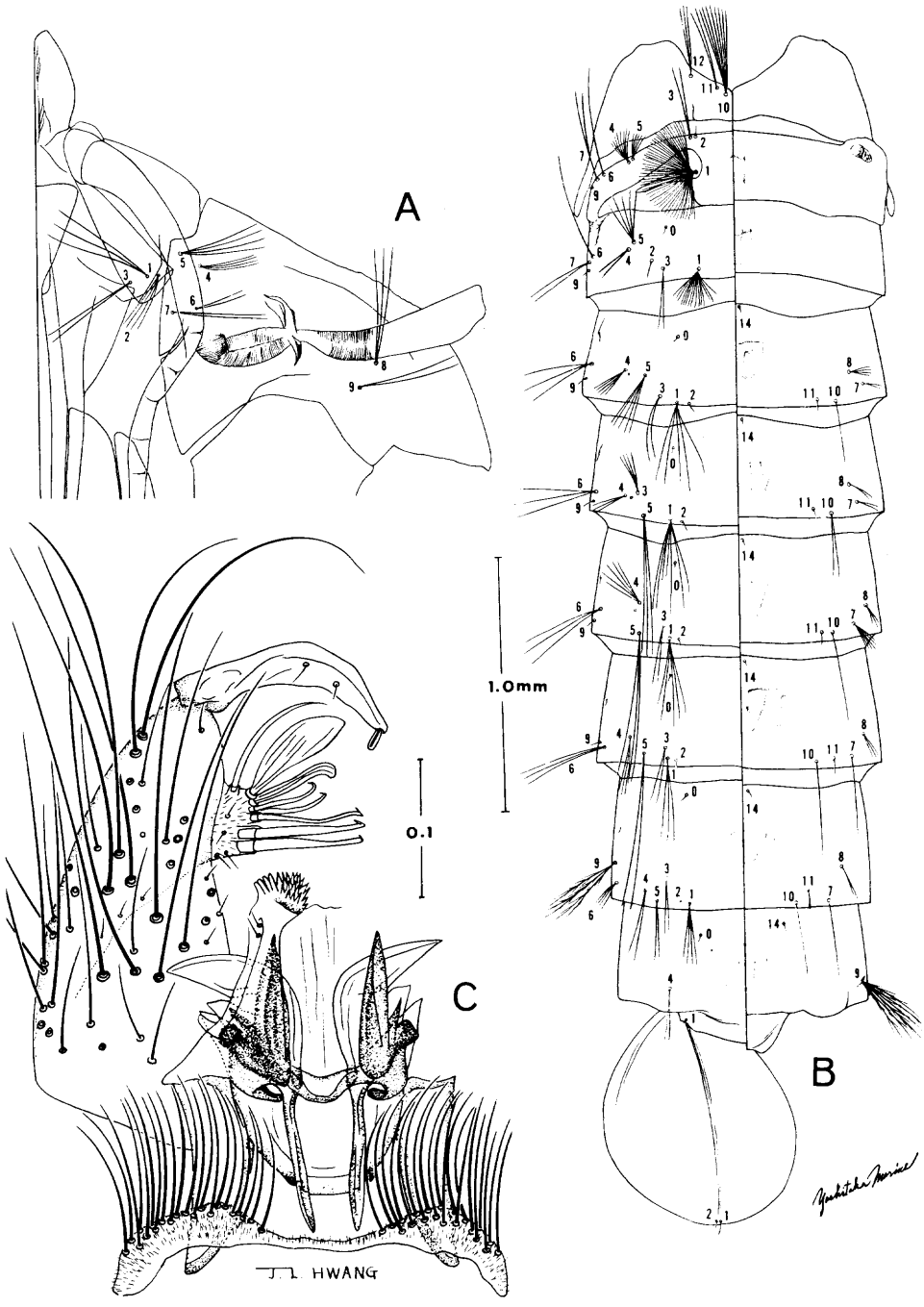
Fig.73



C. (Culex) pipiens quinquefasciatus

been so generally accepted for a number of years), then the name with priority in accordance with the International Rules of Zoological Nomenclature is the one to be used. The treatment of *quinquefasciatus* as a subspecies of *pipiens* Linnaeus, reflects the concept summarized by Mattingly (1965) that *pipiens* is a single polytypic species. Hybridization and apparent gene flow between various identifiable populations tend to strengthen the polytypic concept and anatomical studies have demonstrated intermediate forms in limited areas where at least *p. pipiens* and *p. quinquefasciatus* are sympatric (see for example, Bekku 1956, Barr 1957, and Barr 1960).

BIOLOGY. The biologies of various populations of *pipiens quinquefasciatus* have been studied to a greater or lesser degree in virtually every area of its distribution. A great volume of data on the biology of this subspecies has accumulated, but unfortunately there still remains critical gaps in our knowledge. It must be recognized that results of investigations in one geographical area are not necessarily valid when applied to another population of the same subspecies in a different geographical area. The following summary of the biology of *pipiens quinquefasciatus* is drawn primarily from recent literature dealing with the subspecies in Southeast Asia. No attempt has been made to include all biological references and emphasis has been placed on results of investigations carried out at the W. H. O. Filariasis Research Unit, Rangoon (assuming that the population found in Rangoon is most similar to that of Thailand).

The biological cycle of *pipiens quinquefasciatus* begins when the gravid female searches for an oviposition site, which generally consists of virtually any body of water in close association with human habitation which contains a high degree of organic pollution. Ikeshoji (1966b) reported that breeding field waters (*e.g.* water in which larvae are already developing) are more inducive to oviposition than non-breeding waters. An ether extract of an attractant has been isolated (but not yet identified) which elicits a high response from normal females but which cannot be discriminated for by antennectomized females. De Meillon, Sebastian, and Khan (1966) demonstrated that gravid females exhibit positive geotaxis and as a result, prefer to oviposit at ground level. The gravid females have been found to show peaks of oviposition and visitation to breeding places (de Meillon, Sebastian, and Khan 1967a). The first of these peaks is characterized by a sharp rise just after sunset and a gradual fall; this is followed by a second peak which occurs at about sunrise with dramatic rise and fall.

Eggs are deposited on the surface of the water in rafts which usually consist of from 200 to 250 eggs (Horsfall 1955). Schriver and Bickley (1964) suggested that water temperature is the only environmental factor which influences hatching of *pipiens quinquefasciatus* eggs, and determined that the optimum temperature range for embryonic development is 23.8°C. to 29.4°C. at which 70 percent of the eggs hatch in about 30 hours. They also determined that embryonic development stops at 37.5°C. and at 15.3°C., and that egg diapause is non-existent. De Meillon, Sebastian, and Khan (1967b) found that in Rangoon the incubation period of an egg raft is 27.11±0.57 hours at a

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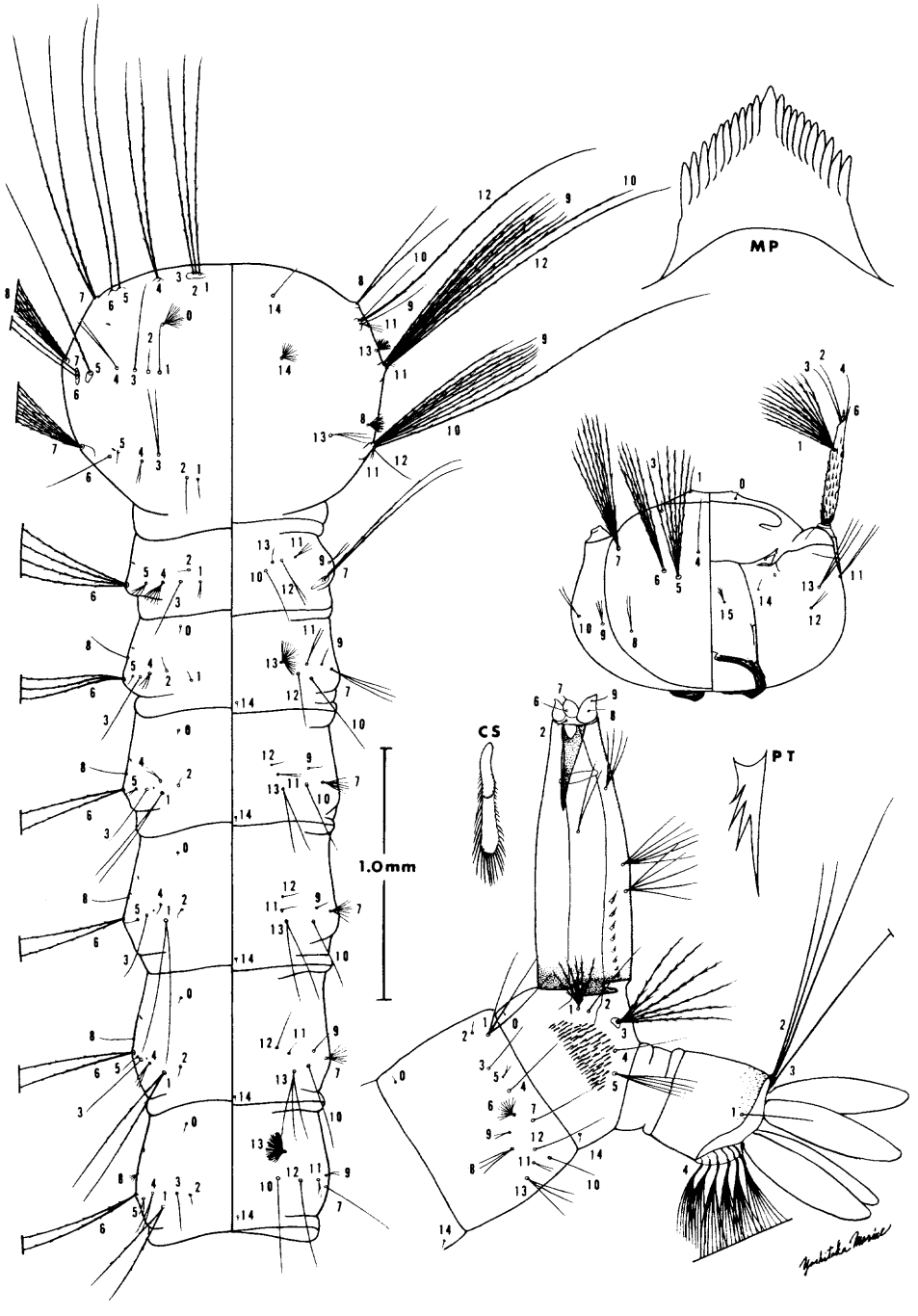
Figure 74. *C. (Culex) pipiens quinquefasciatus*. Fourth stage larva: dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments. →

Fig.74



C. (Culex) pipiens quinquefasciatus

temperature of 28.1±0.66°C., with 92 percent hatch. The eggs of a raft usually all hatch within 3 minutes following the emergence of the first free larva.

The larvae feed on a wide variety of organic material including diatoms, algae, bacteria, decaying vegetable matter, flagellates, etc. (Horsfall 1955). The duration of the larval stage is dependent on a great number of environmental variables, most of which are incompletely understood. Kurihara (1963) investigated the effects of temperature, amount of food, size of containers, and density on larval mortality and longevity. De Meillon, Sebastian, and Khan (1967b) determined that at a temperature of 28.59±0.84°C., the duration of the female larval life is 135±4.4 hours and for male larvae is 118.4±2.4 hours. Thus, it can be seen that, all things being equal, the male larvae pupate approximately 17 hours before the female larvae pupate. The duration of pupal life was determined by these same authors to be 32.95±0.75 hours for males and 34.16±0.74 hours for females (at 28.59±0.84°C.).

Adults emerge from their pupal skins in 2 clearly defined peaks, one at 19.00 hours and the other at 21.00 hours (de Meillon, Sebastian, and Khan 1967c). There is a mass exodus of adults of both sexes from the breeding site at about sunset. Between 17.00 and 20.00 hours an exodus peak is reached, and it was concluded that those adults which emerge from the pupa too late to take part in the sunset exodus must wait until the following night when the next opportunity for exodus presents itself. The adults then disperse, and Lindquist *et al.* (1967) reported that in a highly populous area of Rangoon, P^{32} tagged adults were capable of traveling at least 0.56 miles within 36 hours after release. Fussell (1964) recovered P^{32} tagged adults from distances of up to 3.5 miles from their release point in Hawaii.

Horsfall (1955) summarized mating behavior and concluded that insemination effected by 1 mating is sufficient for the life of the female. Laboratory studies by Umino (1966) using marker genes with *p. molestus* and *p. pallens* indicated that females can copulate with 2 or more males and their offspring from the same egg raft may have different fathers.

The adult females feed primarily on mammalian hosts and in all probability man is one of the preferred hosts whenever available. In the Kemmendine area of Rangoon, de Meillon and Sebastian (1967a) found that 93 percent of the females caught indoors had fed on mammal and 6.7 percent on avian blood or avian and mammal blood, as compared with 89.5 percent and 10.5 percent respectively when caught out of doors. This sharply contrasts the results of Hammon *et al.* (1945) who collected freshly engorged females away from houses in California and found that 88 percent had fed on birds and the remainder had fed on horse, cow, or dog. However, Toumanoff (1935) reported that 100 percent of blooded females collected in dwellings in Indochina contained human blood and that 84 percent caught in stables had fed on man and only 16 percent had fed on buffalo. Normally, feeding commences at around 19.00 hours, reaching a peak at 02.00 hours and ending at 06.00 hours (de Meillon and Sebastian 1967b). Kurihara and Sasa (1965) reported that in Bangkok biting activity was highest at about midnight. The gonotrophic cycle of the female (the time from blood feed to oviposition) was found by de Meillon and Sebastian (1967b) to be 3 days both in the laboratory and in the field in Rangoon; however, Kurihara and Hayashi (1965) suggested that the gonotrophic cycle of *p. pallens* is somewhat longer in the laboratory. Following feeding,

the females may be found resting both in and out of doors, and de Meillon, Myo Paing, Sebastian, and Khan (1967) concluded that there is every reason to believe that the outside biting population, which is very large, is drawn from the outside resting population just as the inside biting population is drawn from the inside resting population. De Meillon, Sebastian, and Khan (1967d) found that there was extensive outdoor feeding by both sexes on crushed sugar cane when this was available in Rangoon. Numerous additional recent references to the biology of *pipiens quinquefasciatus* may be found in the summary of a seminar on the ecology, biology, and control of the *Culex pipiens* complex, sponsored by the World Health Organization (WHO/Vector Control/125. 65).

The importance of *pipiens quinquefasciatus* as a primary vector of urban filariasis caused by periodic *Wuchereria bancrofti* is generally acknowledged. Although this disease is rare in Thailand, it is very common in neighboring countries such as Burma, and therefore *pipiens quinquefasciatus* is at least potentially dangerous. Recent studies of the relationships between *pipiens quinquefasciatus* and *Wuchereria bancrofti* include those of de Meillon, Hayashi, and Sebastian (1967), de Meillon, Grab, and Sebastian (1967), de Meillon and Sebastian (1967c), Yamamoto (1964), and Yamamoto and Hayashi (1965).

Chickungunya virus has been isolated from pools of *pipiens quinquefasciatus* in Thailand (Hammon, Rudnick, and Sather 1960; Robin *et al.* 1963; Halstead *et al.* 1963) and Singharaj *et al.* (1966) suggested the possibility of mechanical transfer of the virus. However, Shah *et al.* (1964) and Ramachandra Rao (1964) have reported that virus survival and transmission could not be demonstrated in this species. Eastern equine encephalitis virus has also been isolated from *pipiens quinquefasciatus* (Hammon *et al.* 1960), but the significance of this observation remains open to question. Hodes (1946) and Reeves and Hammon (1946) recorded laboratory transmission of Japanese B encephalitis virus by *pipiens quinquefasciatus.*

SITIENS GROUP

ADULT. *Head.* Proboscis with a median band of pale scales. *Thorax.* Lower mesepimeral bristles absent. *Abdomen.* Terga usually with narrow, pale basal bands; apical pale bands or patches also present in the *bitaeniorhynchus* subgroup.

LARVA. *Head.* Hair 1-C never fine and filamentous, usually darkly pigmented, but in the *bitaeniorhynchus* subgroup, long, cylindrical, and lightly pigmented.

DISTRIBUTION. Species of the *sitiens* group are centered in the Oriental region with some representatives extending into the Australian and Ethiopian regions, but none are known from the New World. Species of this group are found throughout Thailand and several species (*e.g. tritaeniorhynchus, annulus, gelidus*) are extremely common.

TAXONOMIC DISCUSSION. The presence of the pale band of the proboscis and the absence of a lower mesepimeral bristle are the most outstanding features which separate the two principle groups of the subgenus *Culex.* The *sitiens* group corresponds to group A of Edwards (1932) and in Thailand is composed of 4 subgroups as follows: *vishnui* subgroup, *sitiens*

subgroup, *gelidus* subgroup, and *bitaeniorhynchus* subgroup.

VISHNUI SUBGROUP

FEMALE. *Thorax.* Scutum uniformly brown or with yellow or golden scales, never with a dense, distinct pattern of silver scales. *Abdomen.* Terga with white basal bands (except in some specimens of *perplexus),* never with pale apical bands or patches.

MALE. Distinctive features as indicated above for the female. *Terminalia.* Phallosome complex, usually with the spiculate portion of the inner division smoothly rounded.

LARVA. *Head.* Hair 1-C darkly pigmented, slender or moderately thickened, its apex acuminate. *Abdomen.* Anal gills elongate, at least as long as the saddle, usually longer; saddle completely ringing segment X.

TAXONOMIC DISCUSSION. Edwards (1932) included most of the species presently recognized as comprising the *vishnui* subgroup within his *sitiens*-series, and 1 species, *mimulus,* was included in the *mimeticus*-series. It is felt that the present reassignment of subgroups more accurately reflects affinities based on all stages.

Members of this subgroup are extremely difficult to recognize on the basis of the adult males and females alone. Similarities and overlaping variation render field identification of adults virtually impossible without access to their associated larval skins. For this reason, the necessity for individual rearings with associated larval skins cannot be overemphasized.

CULEX (CULEX) ALIENUS COLLESS 1957
(Figure 75)

Culex (Culex) alienus Colless 1957, Ann. trop. Med. Parasit. 51: 97 (♂, ♀, L*).

The adults cannot be conclusively distinguished from several other members of the subgroup at the present time. The fourth stage larva may be recognized by number and shape of the comb scales, by the 2 to 5 branched subventral tufts of the siphon, and by head hairs 5, 6-C which are usually bifid.

FEMALE. *Head.* Proboscis dark brown with a median band of pale scales; palpus somewhat darker than the proboscis, tipped at the apex with one to several randomly placed pale scales; decumbent scales of the vertex creamy white; erect scales similar in color to decumbent scales (in a male paratype the scales of the vertex are not as described above, but are almost identical to the condition found in *pseudovishnui). Thorax.* Scutum basically dark brown, but with a variable indistinct grouping of pale golden and silver

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Figure 75. *C. (Culex) alienus.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the basimere, lateral aspect of the phallosome of the male terminalia.

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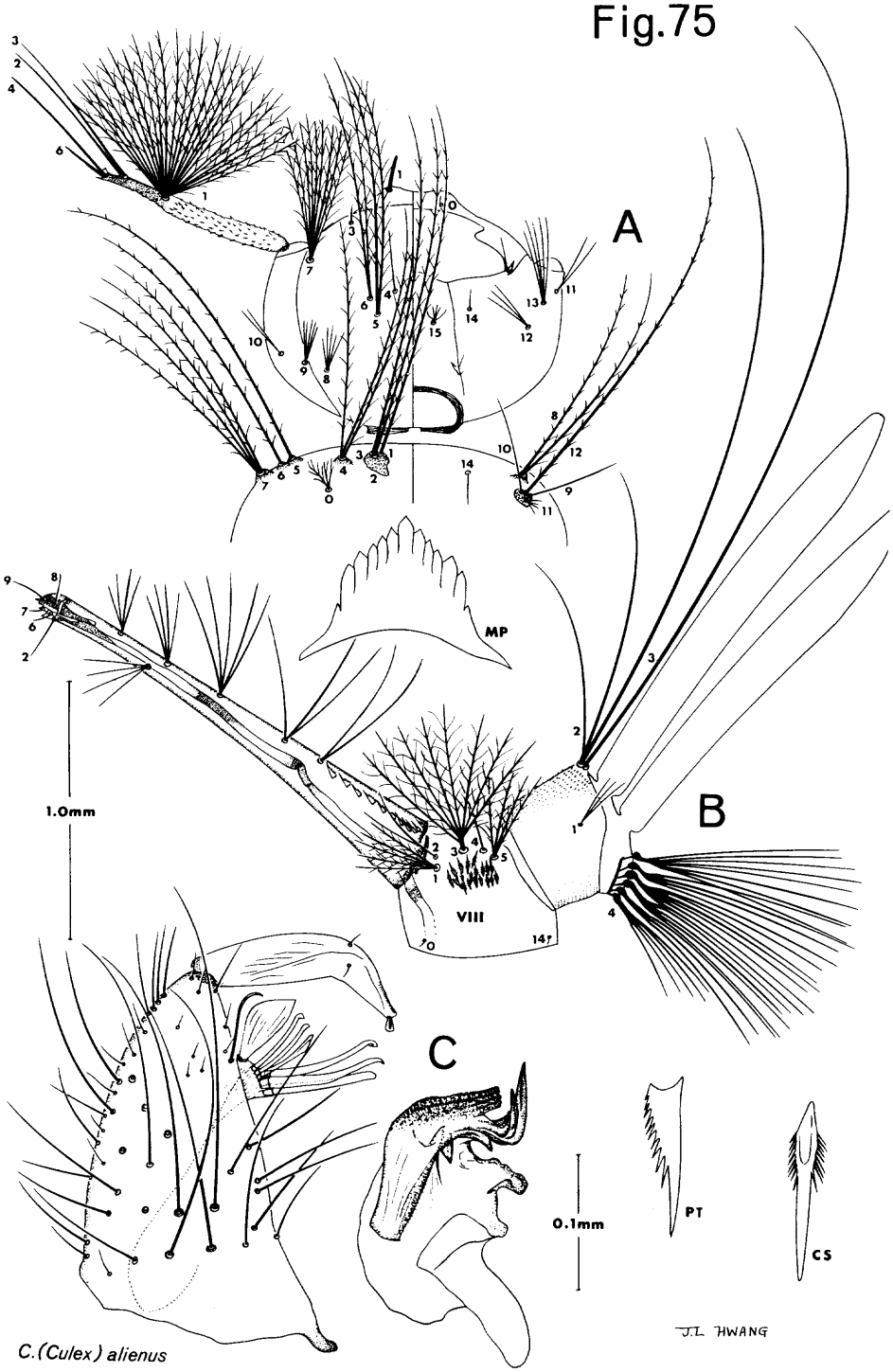
Fig.75



scales which are particularly noticeable along the lateral margins, the dorsocentral areas, the supraalar area, and the prescutellar area; pale scales extend onto the midlobe of the scutellum. *Wing.* All dorsal wing scales uniformly light brown. *Legs.* Anterior surface of the hind femur predominantly pale with a broad, subapical dark band which extends proximally along the dorsal border to form a stripe and with a small apical patch of pale scales; hind tibia dark with a pale apical band; hind tarsus dark, with narrow pale basal bands on all tarsomere; fore and mid femora dark with a small apical tuft of pale scales; fore and mid tibiae and tarsi marked as in the hind legs. *Abdomen.* Terga dark, with variable but usually moderately broad convex pale basal bands on segments III-VIII and a median basal pale spot on segment II, and with triangular basolateral pale patches present but not visible from above; sterna variable, dark with broad basal pale bands. The above description has been prepared from the holotype female and 1 paratype female, both from Sarawak, Malaya.

MALE. *Head.* Palpus dark, with narrow pale bands at the middle of segment III, at the base of IV, and at the base and apex of V. *Terminalia.* (Figure 75C). Subapical lobe of the basimere well developed, with a blunt basal rod and 2 hooked rods followed by 3 accessory setae, a broad, striated leaf, and a slender, gently curved seta; distimere somewhat swollen, with minute apical annulations on the convex surface; inner division of the phallosome with approximately 4 strong teeth, the spiculate portion with a truncate apex and with a slight extension beyond attachment of the teeth; proctiger (not illustrated) crowned with a strong tuft of spines, and with 2 or 3 cercal setae present; basal sternal process strong and well developed.

LARVA. (Figure 75A, B). *Head.* Antenna with a narrow dark basal ring and with progressively darker pigmentation beyond insertion of hair 1-A; head hair 1-C darkly pigmented, bluntly rounded, its length slightly less than half the distance between the bases of the pair; 4-C single, simple; 5, 6-C usually bifid, pectinate, subequal in length. *Thorax.* Integument glabrous; hairs 1, 2, 3-P single, pectinate, subequal in length; 4-P with 2 or 3 pectinate branches; 5, 6-P single, pectinate; 7-P with 4 branches, pectinate; 8-P bifid, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; comb consisting of from 16 to 23 scales arranged in a broad patch (10 to 23 scales in specimens from Sarawak); individual comb scale elongated, with a prominent apical spine and a series of fine basolateral spines; siphon broad basally, tapering characteristically to a narrow apex; siphon index variable, ranging from 4.3:1 to 6:1 (5.9:1 to 7.9:1 in specimens from Sarawak); 6 pairs of subventral tufts inserted on the siphon, the subapical pair laterally out of line; individual tufts 2 to 5 branched, the length of the basal tuft 3 or more times the width of the siphon at the point of insertion; pecten restricted to approximately the basal third of the siphon, consisting of from 11 to 14 teeth (12 to 16 teeth in specimens from Sarawak); individual pecten tooth with a prominent apical spine and approximately 10 fine lateral barbs.

TYPE DATA. Holotype female from Long Tebangan, Fourth Division, Sarawak, Malaya in the British Museum.

DISTRIBUTION. In THAILAND**, *alienus* is known from a single collection of fourth stage larvae from Leamngob, Korchang, *Trat.* Colless (1957a) reported the species from SARAWAK, MALAYA, and SINGAPORE. Fourth stage larvae have been examined in the U. S. National Museum collection from CuChi, SOUTH VIETNAM**, and Tarakan, BORNEO**.

During this study 11 fourth stage larvae have been examined as well as the holotype female and 2 "morphotypes" with their associated larval and pupal skins.

TAXONOMIC DISCUSSION. The adult female and the male terminalia are virtually indistinguishable from *pseudovishnui;* however, the fourth stage larva is distinctive and clearly supports Colless' conclusion that this is a valid species despite its obvious affinity to *pseudovishnui* and *perplexus.*

BIOLOGY. Colless (1957a) suggested that the larval habitat is similar to that of *pseudovishnui.* The Thailand collection was made from a well, the South Vietnam collection from a ground pool, and the Borneo collection from a puddle. Habits of the adults are unknown.

CULEX (CULEX) ANNULUS THEOBALD 1901
(Figures 76, 77, and 78)

Culex annulus Theobald 1901, Mon. Cul. 1: 358 (♀); Giles 1902, Handb. 2nd ed.: 405 (♀); Blanchard 1905, Les Moustiques: 293 (♀); Leicester 1908, Cul. Malaya: 144 (♀); Theobald 1910, Mon. Cul. 5: 323 (key); Edwards 1913, Bull. ent. Res. 4: 233 (placed in synonymy with *tritaeniorhynchus).*

Culex pseudoinfula Theobald 1911, Tijdschr. Ent. 54: 237 (♀); Colless 1957, Ann. trop. Med. Parasit. 51: 93 (synonymy).

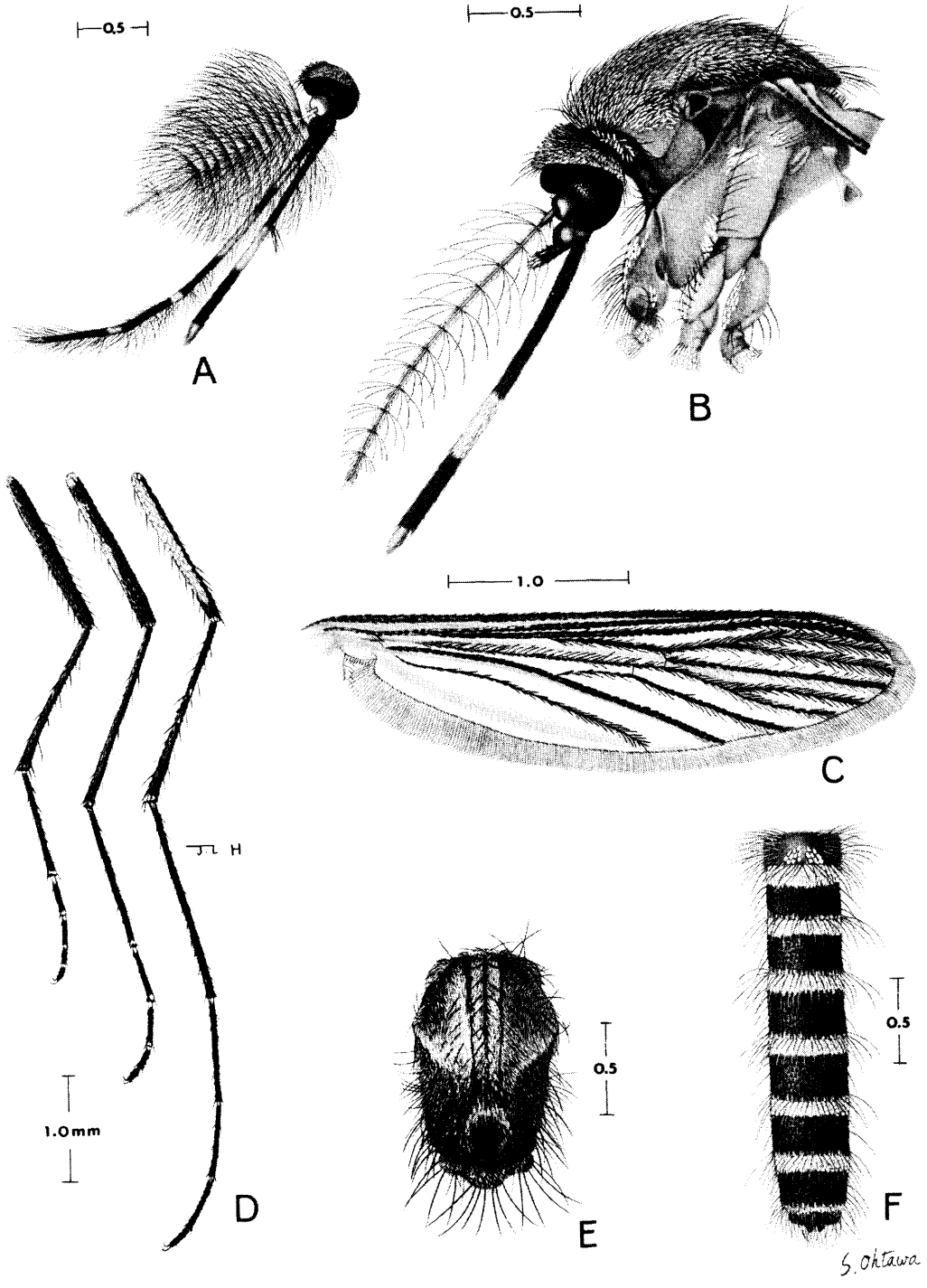
Culex adelae Baisas 1938, Mon. Bull. Philipp. Bur. Hlth. Serv. 18: 200 (♂*, ♀, L*, P*); Colless 1957, Ann. trop. Med. Parasit. 51: 93 (synonymy).

Culex (Culex) annulus Theobald: Colless 1957, Ann. trop. Med. Parasit. 51: 93 (♂, ♀, L*, revalidated); Delfinado 1966, Mem. Amer. ent. Inst. 7: 138 (♂*, ♀, L*).

The adults may not always be conclusively distinguished from several closely related species of the *vishnui* subgroup. The fourth stage larva may be identified by the thoracic and abdominal chaetotaxy, the distinctive comb scales, and the spiculose thoracic and abdominal integument.

FEMALE. *Head.* (Figure 76B). Proboscis dark brown with a moderately broad median pale band; palpus similar in color to the proboscis, with several randomly scattered pale scales at the apex; decumbent scales of the vertex pale golden brown at the occiput and becoming white at the orbital line; erect scales uniformly dull brown, or pale golden at the occiput and dark brown posterolaterally. *Thorax.* (Figure 76B, E). Scutum and scutellum covered with dense, variable, dark brown and golden scales, those of the fossa usually darker, those of the prescutellar space and scutellum usually lighter; integument of the pleuron uniformly pale, occasionally with indistinct, irregular darker areas; patches of dull, white scales on the upper mesepimeron and the upper and posterior sternopleuron. *Wing.* (Figure 76C). Dorsal scales dark brown, but usually with a small patch of pale scales on the posterior margin of the costa in the area of the humeral cross vein, and occasionally with several other randomly scattered pale scales. *Legs.* (Figure 76D). Anterior surface of hind femur predominantly pale with a rather narrow subapical dark band which extends proximally along the dorsal margin; hind tibia dark, occasionally with several basal pale scales and a narrow pale

Fig.76



C. (Culex) annulus

apical band; hind tarsus dark, with narrow pale basal bands on tarsomeres I-IV; fore and mid femora dark, with an apical tuft of pale scales and with occasional, randomly scattered pale scales; fore and mid tibiae and tarsi marked, in general, as the hind legs, but with occasional pale or dusky scales randomly scattered among the dark. *Abdomen.* (Figure 76F). Terga dark with variable but usually moderately broad basal white bands on segments I-VIII; sterna variable, predominantly pale with dark apical bands.

MALE. *Head.* (Figure 76A). Proboscis with a ventrolateral tuft of strong setae at approximately the base of the median pale band; palpus dark, with a broad apical pale band on segment II, a broad median pale band on segment III, a pale basal band on segment IV, and a basal and apical pale band on segment V. *Terminalia.* (Figure 77C). Subapical lobe of the basimere with a blunt basal rod and 2 hooked rods followed by 2 or 3 accessory setae, a broad striated leaf, and a slender, gently curved seta; distimere normal in shape, with minute apical annulations on the convex surface; inner division of the phallosome with 4 strong, darkly pigmented teeth, the spiculate portion with a somewhat scalloped apex; proctiger crowned with a strong tuft of spines and with 2 or 3 cercal setae; basal sternal process well developed and strongly curved.

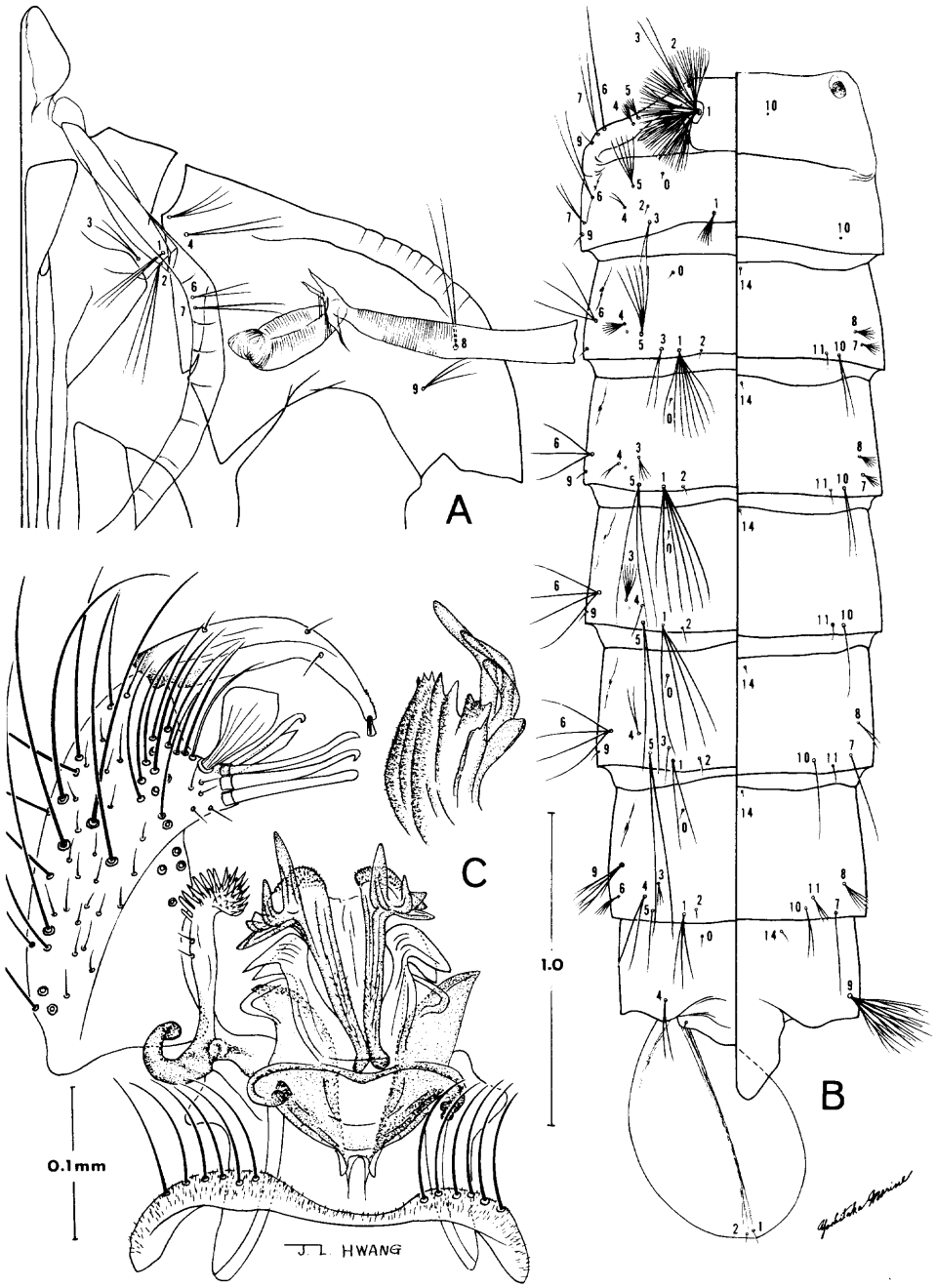
PUPA. (Figure 77A, B).

LARVA. (Figure 78). *Head.* Antenna with a narrow dark basal ring and somewhat darker beyond insertion of hair 1-A; head hair 1-C darkly pigmented, robust, tapering to a blunt point, its length about half the distance between the bases of the pair; 4-C short, simple, single or bifid; 5-C usually trifid, pectinate; 6-C with 2 or 3 pectinate branches. *Thorax.* Integument covered with very minute spicules, particularly on the anterolateral margin; hairs 1, 2, 3-P single, pectinate, subequal in length; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P trifid, pectinate; 8-P bifid, pectinate; 14-P single, simple. *Abdomen.* Integument with spicules similar to those of the thorax; comb consisting of from 25 to 35 scales arranged in a broad, triangular patch; individual comb scale with a prominent apical spine and fringed laterally with subequal spinules; siphon index variable, ranging from 4:1 to 6:1; 5 or 6 pairs of subventral tufts inserted on the siphon, the antepenultimate tuft laterally out of line, and the other tufts inserted at the extreme margin; individual tufts with 6 or more branches, their length greater than the width of the siphon at the point of insertion; pecten restricted to the basal third of the siphon, consisting of approximately 12 rather long teeth; individual pecten tooth with a strong apical spine and from 4 to 6 strong, lateral barbs, the apical pecten tooth may have fewer lateral barbs and be somewhat curved.

TYPE DATA. Holotype female of *annulus* from Hong Kong, China in the British Museum. Holotype female of *pseudoinfula* from Pasuruan and Samarang, Java in the University of Amsterdam Museum, Amsterdam, Netherlands. The type locality of *adelae* is Tungkong Manga, San Jose, Bulacan, Philippines, but the type specimen has been lost.

Figure 76. ← *C. (Culex) annulus.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

Fig. 77



C.(Culex) annulus

DISTRIBUTION. The only previous THAILAND record for *annulus* has been that of Scanlon and Esah (1965) from Doi Pui, *Chiang Mai,* but the species was undoubtedly reported from Thailand prior to 1965 under a different name (see taxonomic discussion below). The species is probably distributed throughout the country and has been examined from: *Chiang Mai, Chiang Rai, Krung Thep, Lampang, Nakhon Ratchasima, Nan, Pathum Thani, Phet Buri, Sakon Nakhon, Sara Buri,* and *Udon Thani.*

In addition to Thailand, *annulus* has been reported from CHINA, JAVA, SINGAPORE, MALAYA, TAIWAN, NORTH VIETNAM, and the PHILIPPINES. Specimens have been studied in the U. S. National Museum collection from Assam, INDIA**, Rangoon, BURMA**, and Phu-tai, Di-An, Soctrang, An-Khe and Qui-nhon, SOUTH VIETNAM**.

During this study the following specimens have been examined from Thailand: 78 females and 35 males, 17 with their associated larval and pupal skins, and 143 larvae.

TAXONOMIC DISCUSSION. From 1913 until revalidated by Colless in 1957, *annulus* was recognized only as a synonym of *tritaeniorhynchus.* During this period it was probably reported from Thailand as the latter species and, as pointed out by Colless (1957a), also as *vishnui.*

Although the adult female is very similar to *tritaeniorhynchus, pseudovishnui,* and several other members of the *vishnui* subgroup, the fourth stage larva is easily distinguished on the basis of the comb scales, the spiculate thorax, and the multiply branched siphon tufts.

BIOLOGY. Larvae of *annulus* have been reported from rice fields, ponds, and ground pools on Taiwan (Lien 1962) and from farm reservoirs and salt water reservoirs in North Vietnam (Safyanova *et al.* 1964). In Thailand, larvae have also been collected from puddles in dry stream beds, ditches, pot holes, hoof prints, and on one occasion from a bamboo stump.

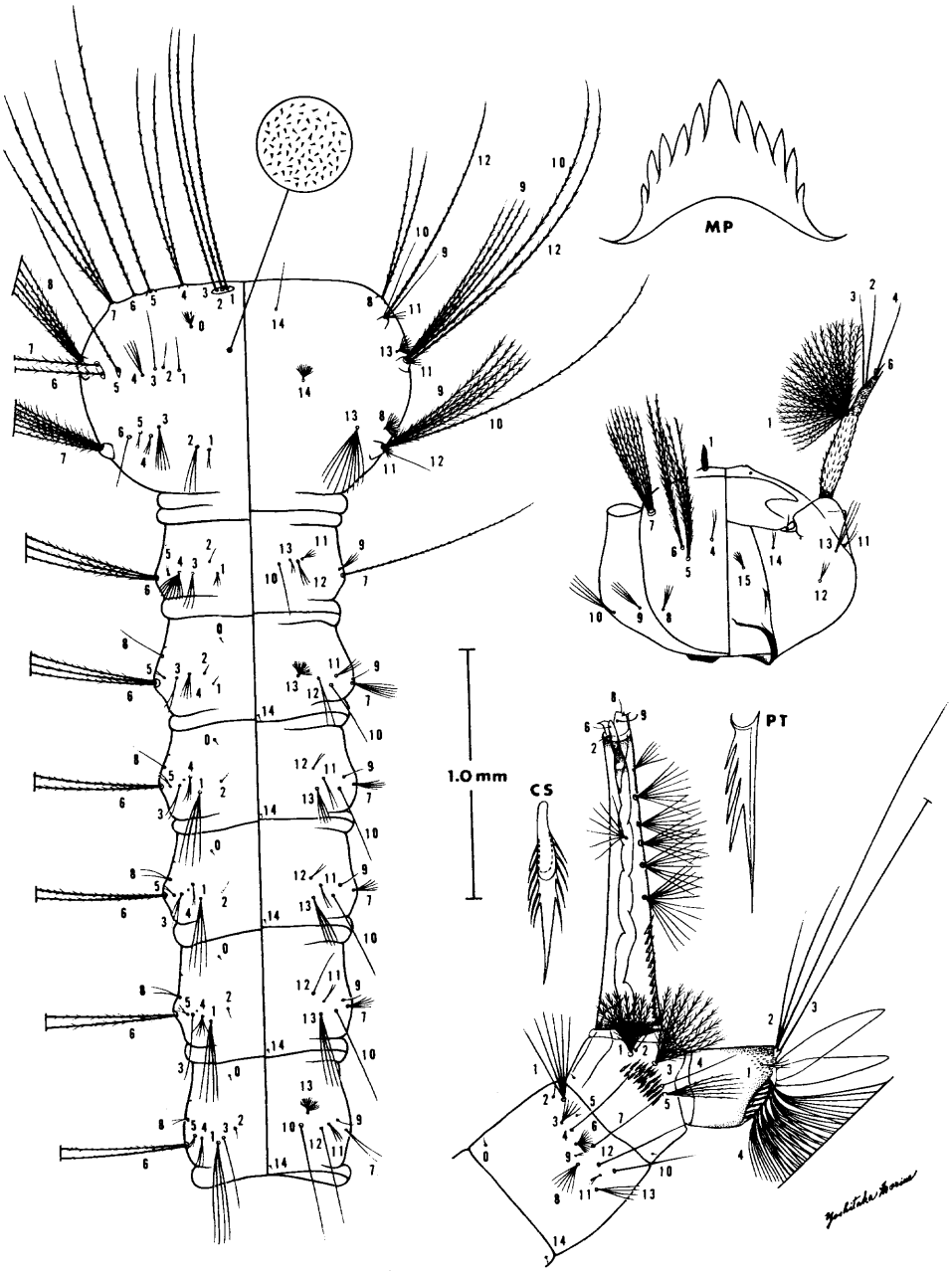
Scanlon and Esah (1965) reported abundant night-time human biting collections of this species in a forest at an elevation of up to 4,500 feet. Although Lien (1962) reported that this species was especially active at dusk, Colless (1957b) suggested that the species remains active throughout the night, but progressively reduced catches reflect a reduction in the immediately available unfed population, rather than a crepuscular tendency in the species itself. Lien (1962) has tentatively suggested that *annulus* may have been found to harbor first stage filaria larvae of *Wuchereria* sp., but the collection probably represents an incidental infection.

CULEX (CULEX) BARRAUDI EDWARDS 1922
(Figure 79)

Culex barraudi Edwards 1922, Indian J. med. Res. 10: 284 (♂*); Barraud 1923, Indian J. med. Res. 10: 939 (L*); Barraud 1924, Indian J. med. Res. 11: 997 (♂*); Senior-White 1927, Spolia. zeylan. 14: 71 (L*).

Figure 77. ← *C. (Culex) annulus.* A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia with enlarged insert of the lateral aspect of the inner division of the phallosome.

Fig.78



C.(Culex) annulus

Culex edwardsi Barraud 1923, Indian J. med. Res. 11: 507 (♀); Barraud 1934, Fauna Brit. India, Diptera 5: 397 (♂*, ♀); Carter and Wijesundara 1948, Ceylon J. Sci. (B) 23: 148 (L*). NEW SYNONYMY.

Culex (Culex) barraudi Edwards: Edwards 1932, *in* Wytsman, Genera Insect., fasc. 194: 204 (taxonomy); Barraud 1934, Fauna Brit. India, Diptera 5: 403 (♂*, L*); Peters and Dewar 1956, Indian J. Malar. 10: 46 (♂*, L*).

The adults may be identified by the presence of a distinct white line of scales on the mid and hind femora. The fourth stage larva can be separated from other members of the *vishnui* subgroup on the basis of the proximal prolongation of the stirrup-shaped piece of the siphon.

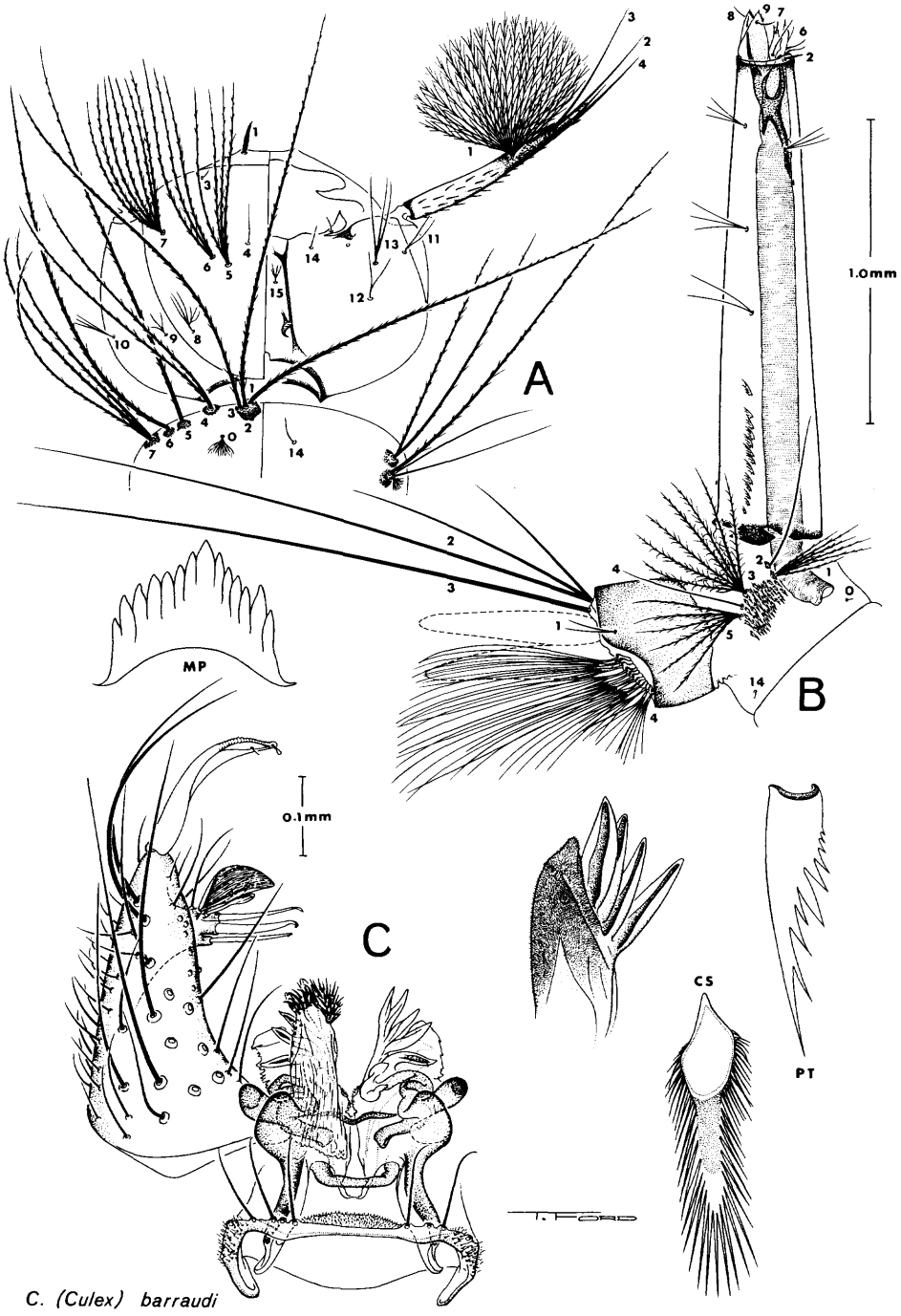
FEMALE. *Head.* Proboscis dark brown with a median band of white scales; palpus similar in color to proboscis, with a dense tuft of pale scales at the apex of the last segment; decumbent scales of the vertex uniformly creamy white; erect scales light brown. *Thorax.* Scutum covered with golden brown scales, with some silver scales forming indistinct patches on the humeral, anterior dorsocentral, antealar areas, and in and around the prescutellar space; scutellum with scattered white scales; integument of the pleuron uniformly dark brown; patches of white scales present on the upper sternopleuron, posterior sternopleuron, anterior mesepimeron, upper mesepimeron, and the propleuron. *Wing.* All dorsal wing scales dark brown. *Legs.* Anterior surface of the hind femur basically dark, but with a broad median stripe of white scales which terminates somewhat before the apex; hind tibia dark, with a narrow median stripe of white scales and with white scales at the apex; hind tarsomeres I and II with very narrow basal and apical pale bands; hind tarsomere III with a narrow basal white band, and IV and V completely dark; mid femur dark, but with a narrow median pale stripe; mid tibia and tarsus similar to that of the hind leg; fore femur completely dark; fore tibia with a very narrow basal white band; fore tarsus similar to the hind tarsus. *Abdomen.* Terga dark brown, with moderately broad basal white bands which extend posteriorly along the lateral margins on each segment; sterna with the scaling similar to that of the terga.

MALE. *Terminalia.* (Figure 79C). Subapical lobe of the basimere well developed, with 3 hooked rods, 3 rather broad accessory setae, a broad, striated leaf, and a slender, gently curved seta; distimere normal; inner division of the phallosome with 4 strong, broad teeth, the spiculate portion smoothly curved and rather narrow; proctiger crowned with a strong tuft of spines and with 3 cercal setae; basal sternal process well developed and strongly curved.

LARVA. (Figure 79A, B). *Head.* Antenna with a narrow, dark basal ring and more darkly pigmented beyond insertion of hair 1-A; head hair 1-C robust, darkly pigmented, its length approximately half the distance between the bases of the pair; 4-C single, simple; 5-C with 4 branches, pectinate; 6-C with 3 pectinate branches. *Thorax.* Integument glabrous; hairs 1, 2, 3-P

Figure 78. ← *C. (Culex) annulus.* Fourth stage larva: dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments.

Fig. 79



single, pectinate; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P trifid, pectinate; 8-P bifid, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; comb consisting of approximately 45 fan-shaped scales arranged in a broadly triangular patch; siphon index ranging from 4:1 to 4.5:1, the siphon tapering gradually to a truncate apex; stirrup-shaped piece at the apex of the siphon with a prolongation of the ventral cornu directed proximally; 4 pairs of subventral tufts inserted on the siphon, the subapical pair inserted laterally out of line; individual tufts with from 1 to 4 branches, their length equal to or less than the width of the siphon at the point of insertion; pecten consisting of approximately 12 teeth restricted to the basal third of the siphon; individual pecten tooth with a strong apical spine and from 5 to 9 strong lateral barbs.

TYPE DATA. Holotype male (terminalia slide-mounted) of *barraudi* from Mahdopur, India in the British Museum. Holotype female of *edwardsi* from Shillong, Assam, India in the British Museum.

DISTRIBUTION. In THAILAND, *barraudi* in known only from *Chiang Mai* and *Prachuap Khiri Khan.* The species has also been recorded from INDIA, CEYLON, and NEPAL. Specimens have been examined in the U. S. National Museum from Lahore, EAST PAKISTAN**, and in the British Museum collection from S. Highlands, Minj., 5,400 ft., T. P. N. G., NEW GUINEA**.

During this study 2 fourth stage larvae have been examined from Thailand. In addition 5 males, 6 females, and 10 larvae have been studied from areas outside of Thailand.

TAXONOMIC DISCUSSION. The original description of this species by Edwards and subsequent discussions by Barraud (1923, 1924, 1934) did not consider ornamentation of the legs, particularly the longitudinal stripes on the hind and mid femora and tibiae. This feature is also characteristic of *edwardsi,* and considering that the male terminalia of both species are identical, it is concluded that *edwardsi* and *barraudi* are conspecific.

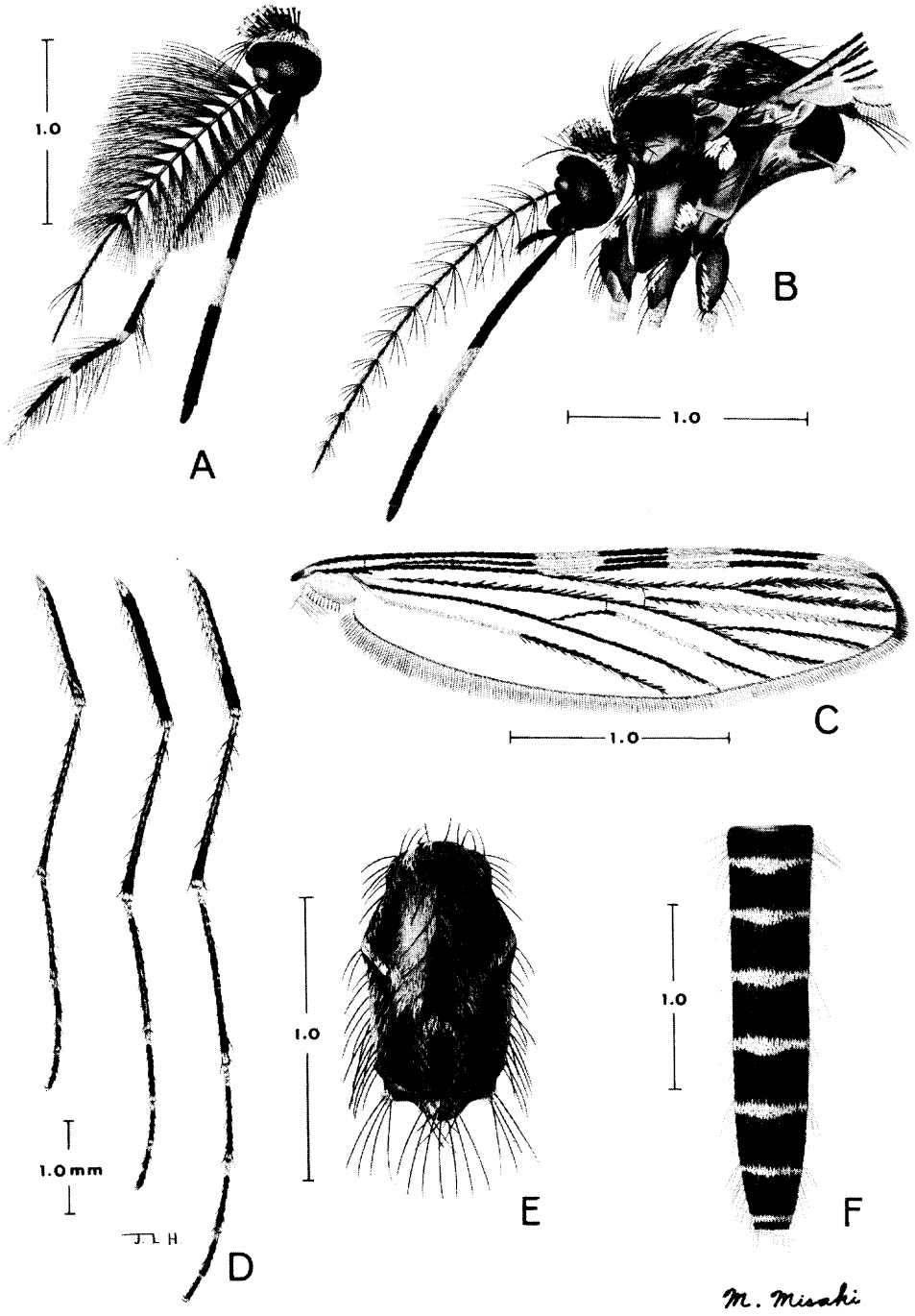
BIOLOGY. In Thailand, larvae of *barraudi* have been collected from a stream and from a roadside pond, and it is probable that this species is restricted to rather high elevations. Scanlon and Esah (1965) reported collecting females of this species biting man at between 2,500 and 4,500 feet in a forest environment in Chiang Mai.

CULEX (CULEX) MIMULUS EDWARDS 1915
(Figures 80, 81, and 82)

Culex mimulus Edwards 1915, Bull. ent. Res. 5: 284 (♂, ♀); Barraud 1923, Ind. J. med. Res. 10: 942 (L*); Barraud 1924, Ind. J. med. Res. 11: 993 (♂*); Borel 1926, Arch. Insts. Pasteur Indo-Chine 3-4: 12 (♂*, ♀, L*).

Figure 79. *C. (Culex) barraudi.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the male terminalia with enlarged insert of the lateral aspect of the inner division of the phallosome.

Fig.80



C. (Culex) mimulus

Culex mossmani Taylor 1915, Proc. Linn. Soc. N. S. W. 40: 181 (♂*, ♀); Edwards 1924, Bull. ent. Res. 14: 394 (synonymy).

Culex (Culex) mimulus Edwards: Edwards 1922, Ind. J. med. Res. 10: 471 (taxonomy); Barraud 1934, Fauna Brit. India, Diptera 5: 412 (♂*, ♀, L*); Edwards 1934, *in* Barraud, *ibid:* 450 (key); Bonne-Wepster and Brug 1937, Geneesk. Tijdschr. Ned.-Ind. 77: 66 (♂, ♀*); Baisas 1938, Mon. Bull. Philipp. Hlth. Serv. 18: 214 (♂*); Bonne-Wepster and Brug 1939, Geneesk. Tijdschr. Ned.-Ind. 79: 1275 (L*); Lee 1944, Atlas Mosq. Larvae Aust. Reg.: 104 (L*); Bonne-Wepster 1954, Roy. trop. Inst. Amst. Spec. Publ. 111: 127 (♂, ♀*, L*); Bonne-Wepster 1954, Doc. Med. Geog. et Trop. 6: 377 (♂, ♀*, L*); Safyanova *et al.* 1964, Zool. Zhur. 43: 1178 (distribution); Delfinado 1966, Mem. Amer. ent. Inst. 7: 150 (♂*, ♀).

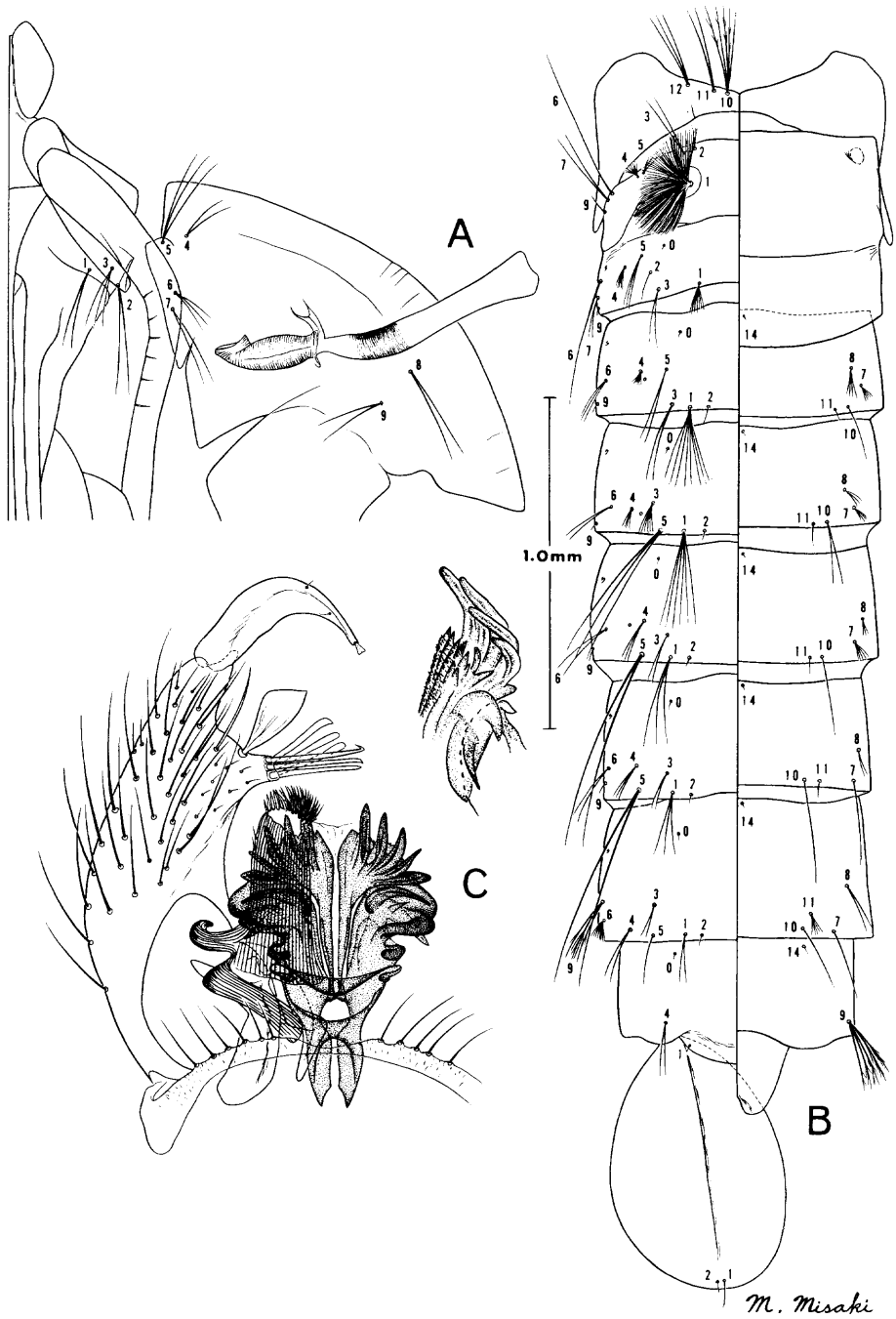
Culex (Culex) confusus Baisas 1938, Mon. Bull. Philipp. Hlth. Serv. 18: 216 (♂*, ♀); Delfinado 1966, Mem. Amer. ent. Inst. 7: 150 (synonymy).

The adults are readily identified by the presence of distinct patches of white scales on the wings. The fourth stage larva may be distinguished by chaetotaxy of the head and thorax, and by features of the siphon.

FEMALE. *Head.* (Figure 80B). Proboscis dark brown with a median band of white scales; palpus similar in color to the proboscis with several randomly placed scales present, particularly on the apical segment; decumbent scales of the vertex pale, lighter at the orbital line; erect scales light golden brown on the occiput, dark brown posteriolaterally. *Thorax.* (Figure 80B, E). Scutum covered with light bronze-brown scales and having indistinct, variable dark and light areas; darker in the area of the fossa, lighter on the anterior promentory, posterior fossal area, supraalar area, and around the prescutellar space; integument of the pleuron light brown with variable and indistinct darker areas present, particularly on the sternopleuron and mesepimeron; dense patches of light scales on the upper sternopleuron, posterior sternopleuron, and anterior mesepimeron. *Wing.* (Figure 80C). Dorsal wing scales mostly dark, but with variable white patches usually as illustrated; R_S may or may not be dark basally; R_1 usually white apically, but may occasionally be dark; fork of R_2, R_3 frequently white, but may be dark; R_2 with or without white scales apically; r-m may or may not be dark; other minor variations in intensity of pale scaling have also been noted. *Legs.* (Figure 80D). Anterior surface of the hind femur mainly dark but with white scales on the ventral half proximally and with a few white scales at the apex; hind tibia dark, with a narrow basal white band, a variable stripe of white scales medially, and a narrow apical white band; hind tarsomeres I-III dark, with narrow basal and apical white bands, tarsomeres IV and V with basal white bands only, or V without white scales; fore and mid legs with markings similar to those of the hind legs. *Abdomen.* (Figure 80F). Terga dark, with moderately broad convex white basal bands;

Figure 80. ← *C. (Culex) mimulus.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

Fig. 81



C. (Culex) mimulus

sterna primarily pale, but with narrow, dark apical bands.

MALE. *Head.* (Figure 80A). Palpus dark, with a broad, median pale band on segment III, a basal white band on segment IV, and basal and apical pale bands on segment V. *Terminalia.* (Figure 81C). Subapical lobe of the basimere well developed, with a blunt basal rod followed by 2 hooked rods, 3 rather broad accessory setae, a broad leaf, and a slender, gently curved seta; distimere normal in shape, with or without minute annulations on the convex surface of the apex; inner division of the phallosome with 4 or 5 very strong, sharply pointed teeth, the spiculate portion also toothed apically; proctiger crowned with a strong tuft of spines, and with 2 or 3 cercal setae present; basal sternal process well developed and strongly curved.

PUPA. (Figure 81A, B).

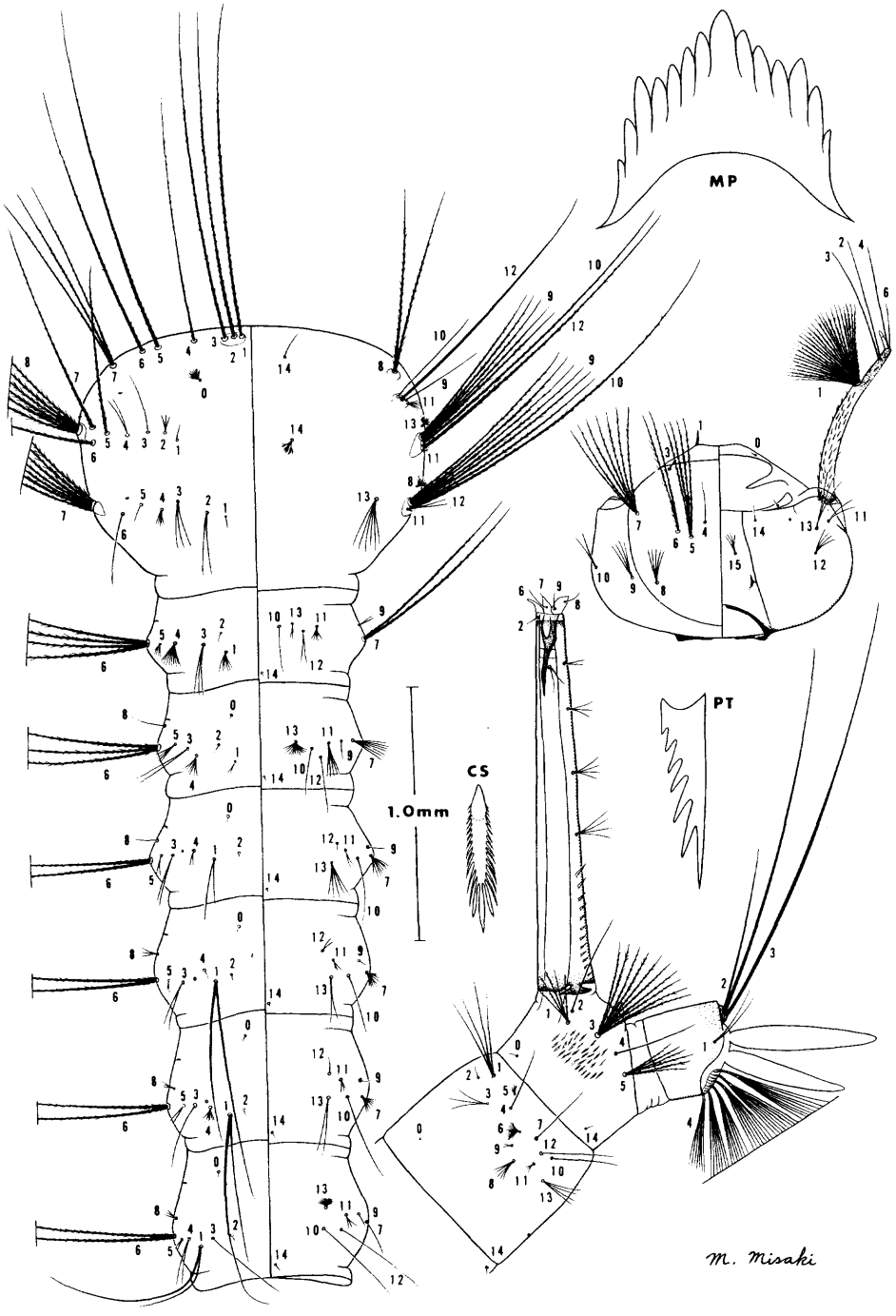
LARVA. (Figure 82). *Head.* Antenna with a narrow dark basal band and progressively darker beyond insertion of hair 1-A; head hair 1-C robust, strongly pigmented, gradually tapering to a sharp point, its length 1/3 to 1/2 the distance between the bases of the pair; 4-C usually single, occasionally double, simple; 5-C with from 3 to 6 branches, pectinate; 6-C usually bifid (occasionally trifid), pectinate. *Thorax.* Integument glabrous; hairs 1, 2, 3-P single, pectinate, subequal in length; 4-P usually single (rarely bifid), pectinate; 5, 6-P single, pectinate; 7-P trifid, pectinate; 8-P bifid, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; comb variable, consisting of from 20 to 45 scales arranged in a triangular patch; individual comb scale fan-shaped, but with the median apical spine frequently slightly longer than the lateral ones; siphon index extremely variable, ranging from 5:1 to 12:1, if the siphon is short it is usually truncate apically, if long it is gradually tapering; 5 to 7 pairs of subventral tufts inserted on the siphon, the subapical tuft laterally out of line; individual tufts with from 1 to 4 branches, their length usually less than the width of the siphon at the point of insertion; pecten consisting of approximately 12 to 15 teeth restricted to the basal 1/5 to 1/3 of the siphon depending on the siphon length; individual pecten tooth with a prominent apical spine and from 4 to 6 lateral barbs, the apical pecten tooth may be somewhat separated from the rest of the pecten and gently curved.

TYPE DATA. Holotype male (terminalia slide-mounted) of *mimulus* from "Kuching?, Sarawak, Borneo" in the British Museum. Type of *mossmani* from Mossman, Queensland, Australia in the University of Sydney, New South Wales. The type locality of *confusus* is Balabac, Balabac Island, Palawan, Philippines, but the type specimen has been lost.

DISTRIBUTION. In THAILAND, specimens of *mimulus* have been collected from: *Chiang Mai, Chiang Rai, Chon Buri, Kampong Pate, Kanchanaburi, Lampang, Lamphun, Mae Hong Son, Nakhon Nayok, Nakhon Ratchasima, Narathiwat, Ranong, Sara Buri, Satun, Songkhla, Surat Thani, Tak, Trang,* and *Trat.* This species has also been reported from MALAYA, INDONESIA, INDOCHINA, CHINA, BURMA, NEPAL, INDIA, CEYLON, NEW GUINEA, AUSTRALIA, and the PHILIPPINES.

Figure 81. ← *C. (Culex) mimulus.* A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia with enlarged insert of the lateral aspect of the inner division of the phallosome.

Fig. 82



C. (Culex) mimulus

During this study the following specimens from Thailand have been examined: 172 females and 143 males, 60 with their associated larval and pupal skins, and 296 larvae.

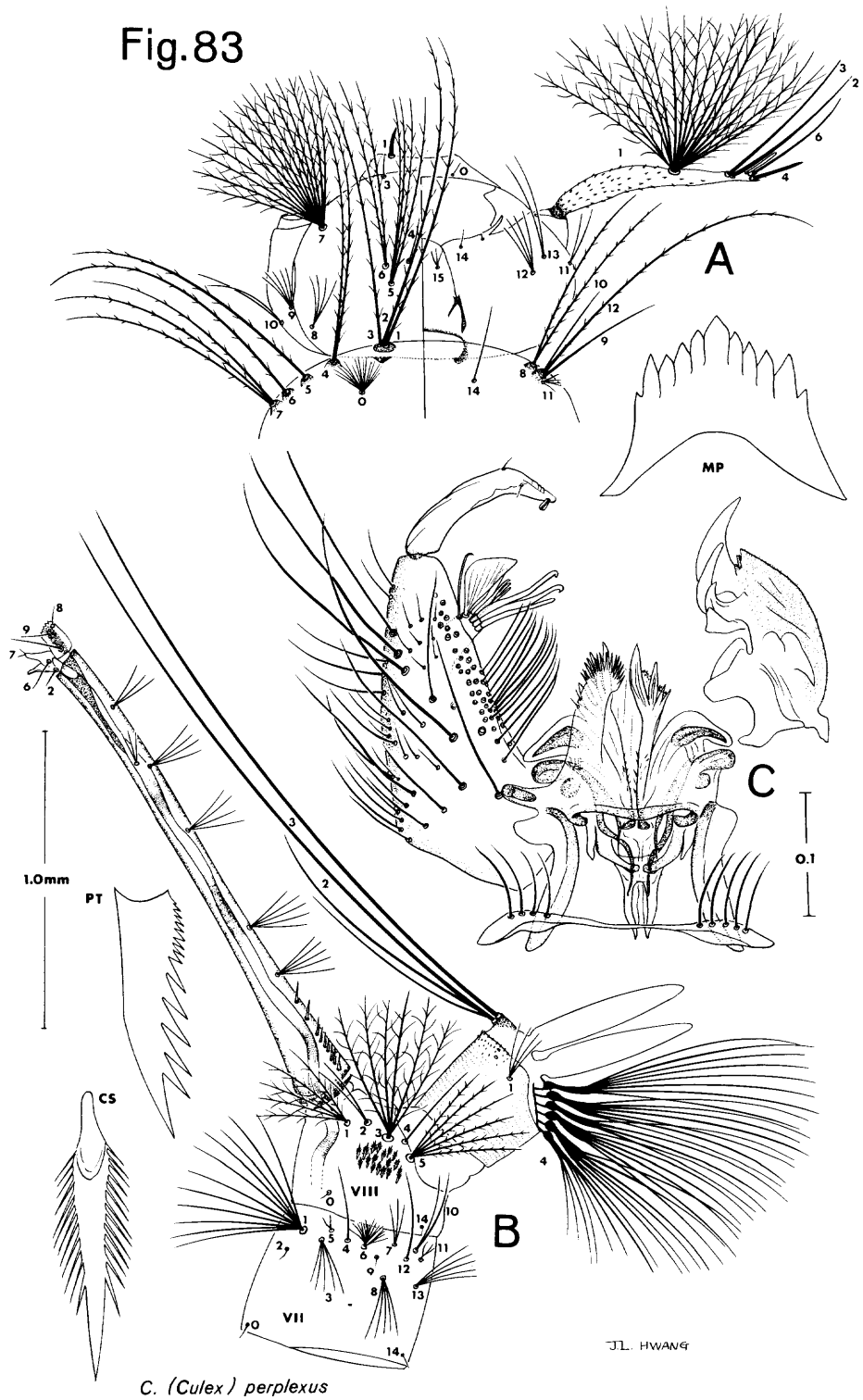
TAXONOMIC DISCUSSION. When extensive series of this species were originally examined, it was felt that several anatomical and colorational characters were indicative of species or subspecies recognition. In the male terminalia, the distimere may be minutely annulate on the convex surface apically or smooth; in the larva, the siphon may be relatively long and narrow, or short and broad; however, no correlation could be established between these 2 characters. Other characters, seemingly associated with the long siphon condition, include extensive white scaling on the wing veins of the adult female (involving vein R_S and the fork of R_2 and R_3) and the degree of basal white banding on the abdominal terga. Again, correlation could not be established between larval anatomy and adult ornamentation and, in fact, so much variation and integradation occurred that even infraspecific categories could not be established. In general, populations from northern Thailand demonstrate a short, stout siphon, no white scales on wing vein R_S or the fork of R_2 and R_3, extensive abdominal banding, and a smooth distimere; contrasting this are specimens from southern Thailand, Indonesia, and the Philippines which exhibit a long, narrow siphon, extensive white scale patterns on the wing, sparse banding on abdominal terga VI to VIII, and an annulate distimere (the type male being included among the latter group). However, integradation and mixing of characters is common and definite zoogeographical forms cannot be established. It is, therefore, concluded that *mimulus* is a plastic species which, although apparently undergoing speciation, cannot be validly divided into specific or infraspecific taxa at the present time. Future collections may supply sufficient biological data so that meaningful correlations between anatomy and ecology can be established.

The adult of *mimulus* may be separated from its close relative, *mimeticus*, by having the first pale costal spot (at middle of wing) extending over vein R, whereas in *mimeticus* this spot extends only to the subcosta; in the fourth stage larva the comb scales of *mimeticus* exhibit a strongly developed, long and broad median distal spine, whereas this spine in *mimulus* is, at most, only slightly longer than the lateral ones.

BIOLOGY. In Thailand, larvae have been collected from a wide variety of ground water sources as well as from sumps, hoofprints, stream pools, and rock holes. Larvae have additionally been reported from sphagnum pools, swamps covered with vegetation, tree holes, and broken bamboo stumps. Although adults have been collected in houses, nothing is known of the feeding habits; however, man is certainly not a primary, or even secondary host.

Figure 82. ← *C. (Culex) mimulus*. Fourth stage larva: dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments.

Fig.83



C. (Culex) perplexus

CULEX (CULEX) PERPLEXUS LEICESTER 1908
(Figure 83)

Culex perplexus Leicester 1908, Cul. Malaya: 150 (♂, ♀); Edwards 1917, Bull. ent. Res. 7: 225 (placed in synonymy with *vishnui*); Colless 1957, Ann. trop. Med. Parasit. 51: 95 (♂, ♀, L*, revalidated).

The adults may be recognized by the unbanded abdominal terga in some specimens; other specimens with banded abdominal terga cannot be conclusively separated from several closely related members of the *vishnui* subgroup. The fourth stage larva is characterized principally by the distinctive comb, pecten, and siphon shape.

FEMALE. *Head.* Proboscis dark brown with a rather narrow median band of light scales; palpus similar in color to the proboscis, the apical segment tipped with a few white scales; decumbent scales of the vertex light golden brown, becoming white at the orbital line; erect scales pale golden brown medially and dark brown posteriolaterally. *Thorax.* Scutum covered with dense, narrow pale golden scales anteriorly and dark brown scales from the supraalar area posteriorly, except for a few light scales surrounding the prescutellar space and on the scutellum; integument of the pleuron uniformly dark brown, with patches of dull white scales on the upper sternopleuron, posterior sternopleuron, and anterior mesepimeron. *Wing.* All dorsal wing scales uniformly bronze-brown. *Legs.* Anterior surface of the hind femur with rather pale brown scales basally and toward the apical fourth, with dark scales at the apex and along the dorsal margin, and with a tuft of a few pale scales at the extreme apex; hind tibia dark but with a few pale scales at the apex; hind tarsus dark, with very narrow pale basal bands on tarsomeres I-III; fore and mid femora without pale scales or with only a narrow basal band of pale scales; fore and mid tibiae and tarsi marked as the hind legs, but tarsal markings reduced. *Abdomen.* Terga dark brown, in some specimens without pale basal bands, in others with narrow convex basal bands; sterna dark brown, with rather broad pale basal bands.

MALE. *Head.* Palpus with a broad median pale band on segment III, a basal white band on segment IV, and basal and apical bands on segment V. *Terminalia.* (Figure 83B). Subapical lobe of the basimere with a blunt basal rod followed by 2 hooked rods, 4 accessory setae, a broad leaf, and a slender, gently curved seta; inner division of the phallosome with 4 strong teeth, the spiculate portion somewhat scalloped apically; proctiger crowned with a strong tuft of spines and with 2 or 3 cercal setae; basal sternal process well developed and strongly curved.

LARVA. (Figure 83A, C). *Head.* Antenna with a narrow dark basal ring and frequently darker beyond insertion of hair 1-A; head hair 1-C robust, darkly pigmented, gradually tapering to a sharp point and frequently with from 1 to 3 accessory lateral spicules; 4-C single, simple; 5-C usually with

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Figure 83. *C. (Culex) perplexus.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, dorsal aspect of the male terminalia with enlarged insert of the lateral aspect of the inner division of the phallosome; C, lateral aspect of the terminal abdominal segments of the fourth stage larva.

4 or 5 branches, pectinate; 6-C usually bifid, pectinate. *Thorax.* Integument glabrous; hairs 1, 2, 3-P single, pectinate, subequal in length; 4-P usually bifid, pectinate; 5, 6-P single, pectinate; 7-P trifid, pectinate; 8-P bifid, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; comb consisting of from 12 to 20 scales arranged in 2 or 3 irregular rows; individual comb scale elongate, strong, with a prominent distal spine fringed with fine lateral spicules; siphon index variable, ranging from 5.5:1 to 8.0:1, the siphon rather narrow and usually with a gentle distal curvature; 5 to 7 irregular pairs of subventral tufts inserted on the siphon, the subapical tuft inserted laterally out of line; individual tufts with from 3 to 5 simple branches, their length greater than the width of the siphon at the point of insertion; pecten variable, consisting of from 8 to 12 teeth restricted to the basal fourth of the siphon; individual pecten tooth robust, with a prominent apical spine and a fringe of from 10 to 15 lateral barbs; the distal 2 or 3 pecten teeth more widely separated from the rest of the pecten, these teeth usually without lateral barbs or, at least, with a reduced number.

TYPE DATA. Lectotype hereby designated: syntype female, "Kuala Lumpur, F. M. S., G. F. Leicester, 1914-274, pupae from large stagnant pool filled with floating water weed near houses, 12/3/03", in the British Museum.

DISTRIBUTION. In THAILAND**, *perplexus* has been collected from: *Phet Buri, Prachin Buri, Nakhon Ratchasima,* and *Surat Thani (?).* Other known localities include the type locality of Kuala Lumpur, MALAYA and SINGAPORE.

The following specimens from Thailand have been examined during this study: 15 females and 10 males, 6 with their associated larval and pupal skins, and 45 larvae.

TAXONOMIC DISCUSSION. The concept of *perplexus* as here presented conforms to the description by Colless (1957a). The adult female of *perplexus* demonstrates extremely close affinity to *pseudovishnui,* and in specimens which exhibit convex basal abdominal bands, the 2 species cannot be distinguished with any degree of certainty. The male terminalia of the 2 species are also extremely similar. In the fourth stage larva the comb, pecten, and shape of the siphon of *perplexus* is distinctive.

BIOLOGY. Larvae of *perplexus* have been collected in Thailand from a sump with heavy pollution and light vegetation, from a swamp, and from stream pools and stream margins during the months of January and February. Colless (1957c) reported *perplexus* as one of the principal culicine species found in hyacinth ponds at Singapore. Biology of the adults is unknown.

CULEX (CULEX) PSEUDOVISHNUI COLLESS 1957
(Figure 84)

Culex pseudovishnui Colless 1957, Ann. trop. Med. Parasit. 51: 88 (♂*, ♀, L*).

Figure 84. *C. (Culex) pseudovishnui.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the male terminalia with enlarged insert of the lateral aspect of the inner division of the phallosome. →

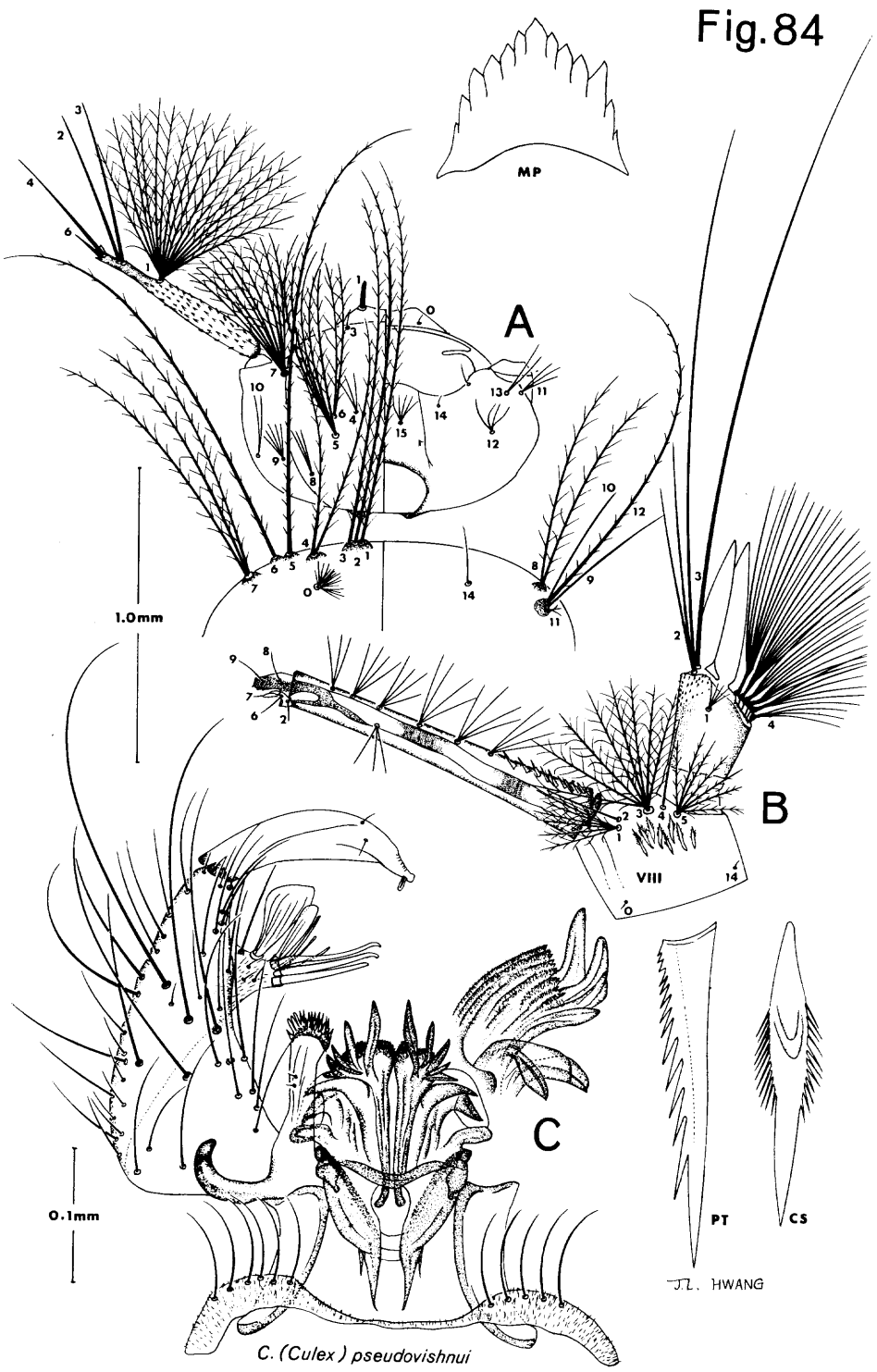


Fig.84
MP
A
B
C
VIII
PT
CS
1.0mm
0.1mm
J.L. HWANG
C. (Culex) pseudovishnui

The adults are most difficult to separate from several other members of the *vishnui* subgroup but, in general, may be recognized by the banding of the hind femur and the color patterns of the erect scales of the vertex. The fourth stage larva is characterized by the distinctive comb, pecten, and siphon.

FEMALE. *Head.* Proboscis dark brown with a moderately broad median band of pale scales; palpus similar in color to the proboscis, occasionally tipped with several randomly placed pale scales; decumbent scales of the vertex pale golden brown, becoming white at the orbital line; erect scales pale golden brown at the occiput and dark brown posteriolaterally. *Thorax.* Scutum with a variable grouping of brown, pale golden, and white scales, darker at the fossa and along the acrostichal and posterior dorsocentral lines, lighter on the lateral prescutal and supraalar areas; integument of the pleuron uniformly light brown, but occasionally with some irregular darker areas; patches of white scales present on the upper and posterior sternopleuron and the upper mesepimeron. *Wing.* All dorsal wing scales dark brown. *Legs.* Anterior surface of the hind femur mainly pale, with a broad dark subapical band which extends proximally to form a dark stripe along the dorsal margin; hind tibia dark with a narrow apical band of pale scales and a poorly defined stripe posteriorly; hind tarsus dark, with narrow pale basal bands on tarsomeres I-III, occasionally on tarsomeres IV and V, and a narrow apical pale band on tarsomere I and often on II; anterior surface of the fore and mid femora usually dark with narrow basal and apical pale bands; fore and mid tibiae and tarsi usually marked as the hind legs. *Abdomen.* Terga dark with narrow pale basal bands on segments III-VIII, terga II usually with a central basal pale patch; terga II-VII with large basolateral pale spots not visible from above; sterna predominantly pale with variable dark apical bands.

MALE. *Head.* Palpus dark, segment III with a narrow pale basal band and a broad median pale band, IV with a basal white band, and V with basal and usually apical white bands. *Terminalia.* (Figure 84C). Subapical lobe of the basimere well developed, with a blunt basal rod and 2 hooked rods followed by 3 or 4 accessory setae (one of which may be very broad), a broad, striated leaf, and a seta; distimere normal in shape, with fine annulations on the convex surface at the apex; inner division of the phallosome with 3 or 4 strong teeth, the spiculate portion very finely toothed or scalloped apically; proctiger crowned with a strong tuft of spines, and with 2 or 3 cercal setae present; basal sternal process well developed and strongly curved.

LARVA. (Figure 84A, B). *Head.* Antenna with a narrow, dark basal ring and progressively darker beyond insertion of hair 1-A; head hair 1-C strongly pigmented, robust, gradually tapering to a sharp point, its length about half the distance between the bases of the pair; 4-C single or branched, simple; 5-C with 3 or 4 branches, pectinate; 6-C with 2 or 3 branches, pectinate. *Thorax.* Integument usually glabrous, rarely covered with a random pattern of minute spicules; hairs 1, 2, 3-P single, pectinate, subequal in length; 4-P most frequently bifid or occasionally trifid, pectinate, its length about 3/4 the length of 3-P; in some specimens 4-P is weak and short and possesses from 5 to 10 distinct branches; 5, 6-P single, pectinate; 7-P trifid, pectinate; 8-P bifid, pectinate; 14-P single, simple. *Abdomen.* Integument similar to that of the thorax; comb consisting of from 5 to 13 scales arranged in an irregular row; individual comb scale elongate, with an extremely

prominent apical spine and with inconspicuous lateral spicules; siphon index variable, ranging from 4.5:1 to 8.5:1; 5 to 7 irregular pairs of subventral tufts inserted on the siphon as well as from 1 to 3 irregular pairs of lateral tufts; individual tufts with from 2 to 6 simple branches, their length greater than the width of the siphon at the point of insertion; pecten consisting of from 8 to 11 teeth restricted to the basal third of the siphon; individual pecten tooth with a prominent apical spine and from 6 to 12 basolateral barbs.

TYPE DATA. Holotype female with associated larval and pupal skins from Singapore in the British Museum.

DISTRIBUTION. In THAILAND, *pseudovishnui* is probably widely distributed throughout the country and has been studied from: *Chiang Mai, Chiang Rai, Chon Buri, Krung Thep, Lampang, Mae Hong Son, Nakhon Nayok, Nakhon Ratchasima, Nan, Narathiwat, Patum Thani, Phet Buri, Prachuap Khiri Khan, Ranong, Rayong, Surat Thani, Trang, Udon Thani,* and *Yala.* The species is also widely distributed throughout the ORIENTAL REGION.

During this study the following specimens have been examined from Thailand: 104 females and 18 males, 10 with their associated larval and pupal skins, and 96 larvae.

TAXONOMIC DISCUSSION. This species has been most frequently misidentified as *vishnui.* During this study an attempt was made to correlate anatomical features of the head hairs, comb, pecten, and siphon with distributional patterns. In no instance could correlations be established, although in general it appears that the condition in which thoracic hair 4-P is bifid and stout is most frequently found in the more northern areas (Thailand, Taiwan, etc.) and the multiple-branched, fine condition is seen in the more southern areas (Indonesia, Malaya, Philippines), although both conditions are probably found throughout the range of the species.

BIOLOGY. In Thailand, larvae of *pseudovishnui* have been collected from a wide variety of ground water habitats including ditches, rice fields, ponds, streams, and sumps. Colless (1959b) reported that the adult females feed primarily on birds and pig, and to a lesser degree on ox, dog, horse, and man. Scanlon and Esah (1965) collected females biting man at elevations greater than 4,500 feet on Doi Pui, Chiang Mai, Thailand.

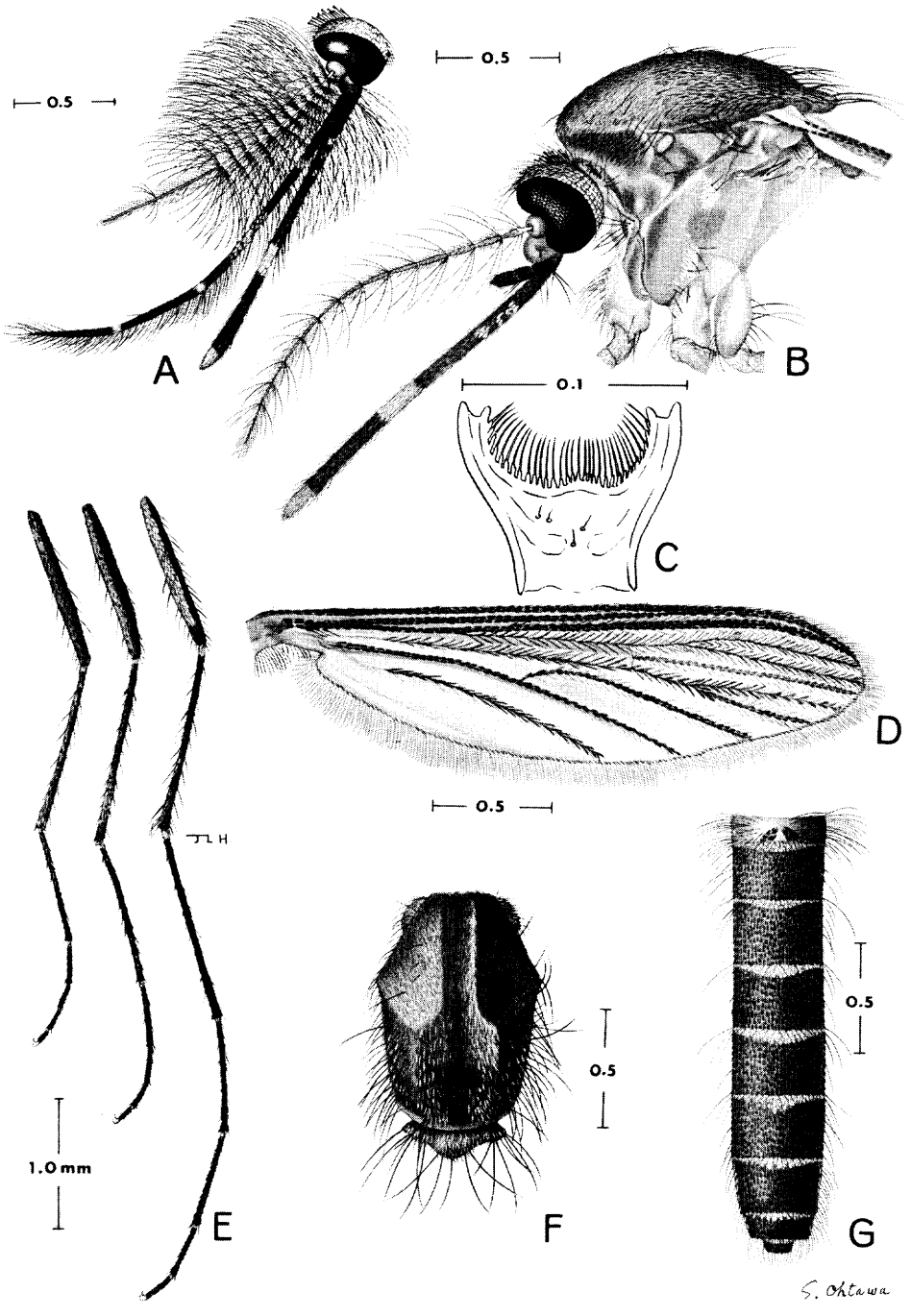
CULEX (CULEX) TRITAENIORHYNCHUS GILES 1901
(Figures 85, 86, and 87)

Culex tritaeniorhynchus Giles 1901, J. Bombay nat. Hist. Soc. 13: 606 (adult); Theobald 1901, Mon. Cul. 1: 364 (♂*, ♀*); Giles 1902, Handb., 2nd ed.: 401 (♂, ♀); Edwards 1913, Bull. ent. Res. 4: 233 (taxonomy); Edwards 1917, Bull. ent. Res. 7: 224 (♂, ♀); Edwards 1921, Bull. ent. Res. 12: 339 (L); Macfie and Ingram 1922, Ann. trop. Med. Parasit. 16: 180 (♀*); Barraud 1923, Ind. J. med. Res. 10: 940 (L*); Barraud 1924, Ind. J. med. Res. 11: 995 (♂*, ♀); Borel 1930, Monogr. Coll. Soc. Pat. exot. 3: 336 (♂*, ♀, L*); Ho 1931, Bull. Fan. Inst. Biol., Peking 2: 158 (♂*, ♀).

Culex biroi Theobald 1905, Ann. hist.-nat. Mus. hung. 3: 82 (♂*, ♀); Edwards 1913, Bull. ent. Res. 4: 233 (synonymy).

Culex summorosus Dyar 1920, Insec. Inscit. menst. 8: 180 (♂); Baisas 1938, Mon. Bull. Philipp. Hlth. Serv. 18: 196 (♂*, ♀*, P*, L*); Colless 1957,

Fig. 85



C. (Culex) tritaeniorhynchus

Ann. trop. Med. Parasit. 51: 98 (♂*, ♀, L*, as ssp. of *tritaeniorhynchus);* Delfinado 1966, Mem. Amer. ent. Inst. 7: 153 (♂*, ♀, P, L*, as ssp. of *tritaeniorhynchus).* NEW SYNONYMY.

Culex tritaeniorhynchus var. *siamensis* Barraud and Christophers 1931, Rec. Malar. Surv. India 2: 283 (♂); Brug 1934, Bull. ent. Res. 25: 515 (♂); Bonne-Wepster and Brug 1937, Geneesk. Tijdschr. Ned.-Ind. 77: 72 (♂, ♀*); Bonne-Wepster and Brug 1939, Geneesk. Tijdschr. Ned.-Ind. 79: 1270 (L*); Lee 1944, Atlas Mosq. Larvae Aust. Reg.: 105 (L*); Bonne-Wepster 1954, Roy. trop. Inst. Amst., spec. publ. 111: 125 (♂, ♀*, L*); Mattingly 1956, Proc. R. ent. Soc. Lond. (A) 31: 37 (lectotype designation); Colless 1957, Ann. trop. Med. Parasit. 51: 98 (as synonym of *tritaeniorhynchus summorosus).*

Culex (Culex) tritaeniorhynchus Giles: Edwards 1932, *in* Wytsman, Gen. Insect., fasc. 194: 204 (taxonomy); Barraud 1934, Fauna Brit. India, Diptera 5: 404 (♂*, ♀, L*); Li and Wu 1935, Yearb. Bur. Ent. Chekiang 4: 101 (L*); Stackelberg 1937, Faune de l' URSS, Ins. Dipt. 3: 235 (♂*); Edwards 1941, Mosq. Ethiop. Reg. 3: 299 (♂, ♀); Bohart 1945, Navmed 580: 80 (♂*, L); Bohart and Ingram 1946, Navmed 1055: 81 (♂*, ♀, L*); LaCasse and Yamaguti 1950, Mosq. Fauna Japan Korea: 230 (♂*, ♀*, P*, L*); Monchadskii 1951, Moscow zool. Inst. Acad. Nauk SSSR 37: 277 (L*); Iyengar and Menon 1955, Bull. ent. Res. 46: 6 (L*); Khattat 1955, Bull. end. Dis. 1: 165 (L*); Bohart 1956, Ins. Micronesia 12: 83 (♂*, ♀, L*); Ovazza, Hamon, and Nori 1956, Soc. Path. exot. Bull. 49: 169 (♂*); Ma and Feng 1956, Acta ent. Sinica 6: 172 (L*); Hara 1957, Jap. J. exp. Med. 27: 56 (♀*); Senevet and Andarelli 1959, Encycl. ent. (A) 37: 142 (♂, ♀, L, P); Foote and Cook 1959, USDA Agric. Handb. 152: 140 (biology).

The adult female is most difficult to distinguish from several other members of the subgroup, but may usually be recognized by the rather small size, the brown scaling of the scutum, the accessory pale scaling on the ventral surface of the proboscis; the long, filamentous teeth of the buccopharyngeal armature are diagnostic. In the adult male, the terminalia is also similar to other members of the subgroup, but may be recognized to some degree by the structure of the inner division of the phallosome. The fourth stage larva is characterized by the thoracic chaetotaxy, the shape of the comb scales, and by anatomical features of the siphon.

FEMALE. A rather small species with overall dull appearance. *Head.* (Figure 85B). Proboscis dark brown, with a moderate sized median band of pale scales and usually with accessory patches of pale scales on the ventral surface proximal to the band (this character is extremely variable and may range from no pale scales to a condition in which virtually the entire ventral surface of the proboscis proximal to the band is pale); a few randomly scattered

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Figure 85. ← *C. (Culex) tritaeniorhynchus.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female buccopharyngeal armature; D, dorsal aspect of the female wing; E, anterior surface of the female legs; F, dorsal aspect of the female scutum and scutellum; G, dorasl aspect of the female abdomen.

pale scales may occasionally be present on the dorsal surface of the proboscis; palpus similar in color to the proboscis, the apex occasionally exhibiting several randomly placed scales; decumbent scales of the vertex golden brown, becoming somewhat paler at the orbital line; erect scales dark brown; teeth of the buccopharyngeal armature very long and filamentous (figure 85C)[1]. *Thorax.* (Figure 85B, F). Scutum almost uniformly covered with dense, bronze-brown scales, but with a few paler scales on the supra-alar and prescutellar areas; integument of the pleuron usually pale brown, occasionally with variable and irregular darker and paler areas; patches of dull white scales present on the anterior mesepimeron, and upper and lower sternopleuron. *Wing.* (Figure 85D). *Legs.* (Figure 85E). Anterior surface of the hind femur predominantly pale with a narrow dark apical band which frequently extends proximally along the dorsal border; hind tibia dark, with a narrow basal pale band; hind tarsus dark with narrow, pale basal bands on tarsomeres I-V; fore and mid femora variable, usually darker than the hind femur; fore and mid tibiae and tarsi variable, but in general similar to the hind legs. *Abdomen.* (Figure 85G). Terga dark with variable, usually narrow, convex pale basal bands (these bands are occasionally represented by only a few pale scales); sterna variable, predominantly pale, usually with rather broad apical dark bands.

MALE. *Head.* (Figure 85A). Proboscis with a rather narrow median pale band, and with a small ventrolateral tuft of setae at approximately the base of the median band; palpus dark, with a narrow basal and usually a broad median pale band on segment III and with narrow basal bands on segments IV and V. *Terminalia.* (Figure 86C). Subapical lobe of the basimere well developed, with a blunt basal rod followed by 2 subequal, hooked rods, 4 accessory setae (one of which is quite broad and long), a broad, striated leaf, and a slender, gently curved seta; distimere normal in shape, with minute annulations on the convex surface at the apex; inner division of the phallosome usually with 4 strong, recurved teeth, the spiculate portion with a slightly expanded apex projecting somewhat beyond the attachment of the teeth; proctiger crowned with a strong tuft of spines and with 2 or 3 cercal setae; basal sternal process well developed and strongly recurved.

PUPA. (Figure 86A, B).

LARVA. (Figure 87). *Head.* Antenna with a narrow, dark basal ring and somewhat darker beyond insertion of hair 1-A; head hair 1-C strongly pigmented, gradually tapering to a sharp point, its length slightly greater than half the distance between the bases of the pair; 4-C single, simple; 5-C with 3 or 4 pectinate branches; 6-C with 2 or 3 pectinate branches. *Thorax.*

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[1] de Meillon (1967 - personal communication) has examined specimens of *tritaeniorhynchus* from: Ramsar, Iran; Chinhae, Korea; Pakistan; Honshu, Japan; Karwar, India; Port Lewis, Mauiritius; and Al Khabar, Saudi Arabia. In each instance the anatomy of the buccopharyngeal armature has reamined consistent.

Figure 86. *C. (Culex) tritaeniorhynchus.* A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia with enlarged insert of the lateral aspect of the inner division of the phallosome.

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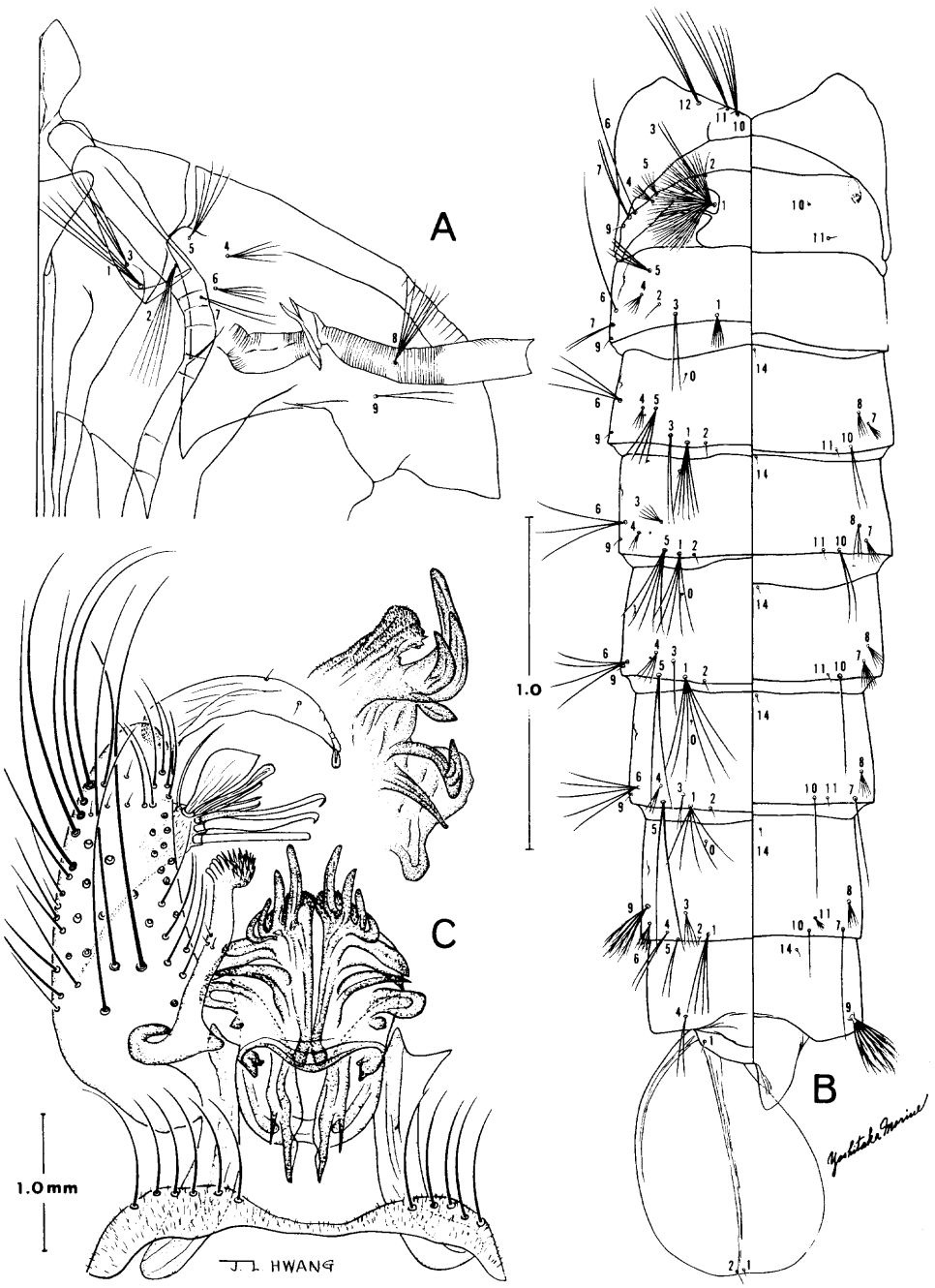
Fig.86



C. (Culex) tritaeniorhynchus

Integument glabrous; hairs 1, 2, 3-P single, pectinate, subequal in length; 4-P usually bifid, pectinate; 5, 6-P single, pectinate; 7-P trifid, pectinate; 8-P bifid, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; 1-X with 3 or 4 short branches; comb variable, consisting of from 25 to 40 evenly fringed, fan-shaped scales arranged in a triangular patch of 3 irregular rows; siphon index variable, ranging from approximately 5:1 to 9.5:1 (average, 7.5:1), the siphon evenly tapering from base to apex; stirrup-shaped piece without a prolongation of the ventral cornu; from 5 to 7 (usually 7) pairs of subventral tufts inserted on the siphon, the subapical tuft inserted laterally out of line; individual tufts with from 2 to 5 branches, their length slightly greater than the width of the siphon at the point of insertion; pecten consisting of from 9 to 15 teeth restricted to the basal third of the siphon or less; individual pecten tooth with a prominent apical spine and approximately 6 lateral barbs.

TYPE DATA. Holotype female of *tritaeniorhynchus* from Travancore, India in the British Museum. Syntypes male and female of *biroi* from Bombay, India in the Magyar Nemzeti Muzeum, Budapest, Hungary. Holotype male (terminalia slide-mounted) of *summorosus* from Los Baños, Luzon, Philippines in the U. S. National Museum. Lectotype male (terminalia slide-mounted) of *tritaeniorhynchus* var. *siamensis* from Chiang Mai, Thailand in the British Museum.

DISTRIBUTION. This species is undoubtedly widely distributed throughout THAILAND and during this study specimens have been examined from: *Ayutthaya, Chanthaburi, Chiang Mai, Chiang Rai, Chon Buri, Lampang, Lamphun, Lop Buri, Nakhon Nayok, Nakhon Ratchasima, Nan, Nonthaburi, Pathum Thani, Phet Buri, Prachuap Khiri Khan, Ranong, Rayong, Roi Et, Samut Prakan, Sara Buri, Songkhla, Surat Thani, Thon Buri, Trang, Udon Thani,* and *Yala.*

C. tritaeniorhynchus has been reported from: INDIA, CEYLON, MALDIVE ISLANDS, MALAGASY, MOCAMBIQUE, ZANZIBAR, KENYA, UBANGI-SHARI, NIGERIA, DAHOMEY, TOGO, GOLD COAST, GAMBIA, SENEGAL, EGYPT, ARABIAN PENINSULA, ISRAEL, LEBANON, SYRIA, TURKEY, IRAQ, IRAN, TRANSCAUCASIA, and TURKMEN S. S. R. It has also been reported as *tritaeniorhynchus* ssp. *summorosus* from: PHILIPPINES, TAIWAN, OGASAWARA GUNTO, RYUKYU-RETTO, JAPAN, KOREA, MANCHURIA, CHINA, INDO-CHINA, INDONESIA, MALAYA, INDIA, and MARITIME PROVINCE U. S. S. R. Specimens have been examined in the British Museum collection from Rangoon, BURMA**.

During this study, the following specimens were examined from Thailand: 135 females and 83 males, 10 with their associated larval and pupal skins, as well as 400 larvae. In addition, material has been examined from: Malaya, Okinawa, Philippines, Borneo, South Vietnam, Pakistan, Iran, Saudi Arabia, Taiwan, Japan, Korea, India, Iraq, and Egypt.

TAXONOMIC DISCUSSION. Colless (1957a) formally recognized *summorosus* as a subspecies of *tritaeniorhynchus,* although he did so with reservations. Two anatomical features were cited as the primary differentiat-

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Figure 87. *C. (Culex) tritaeniorhynchus.* Fourth stage larva: dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments.

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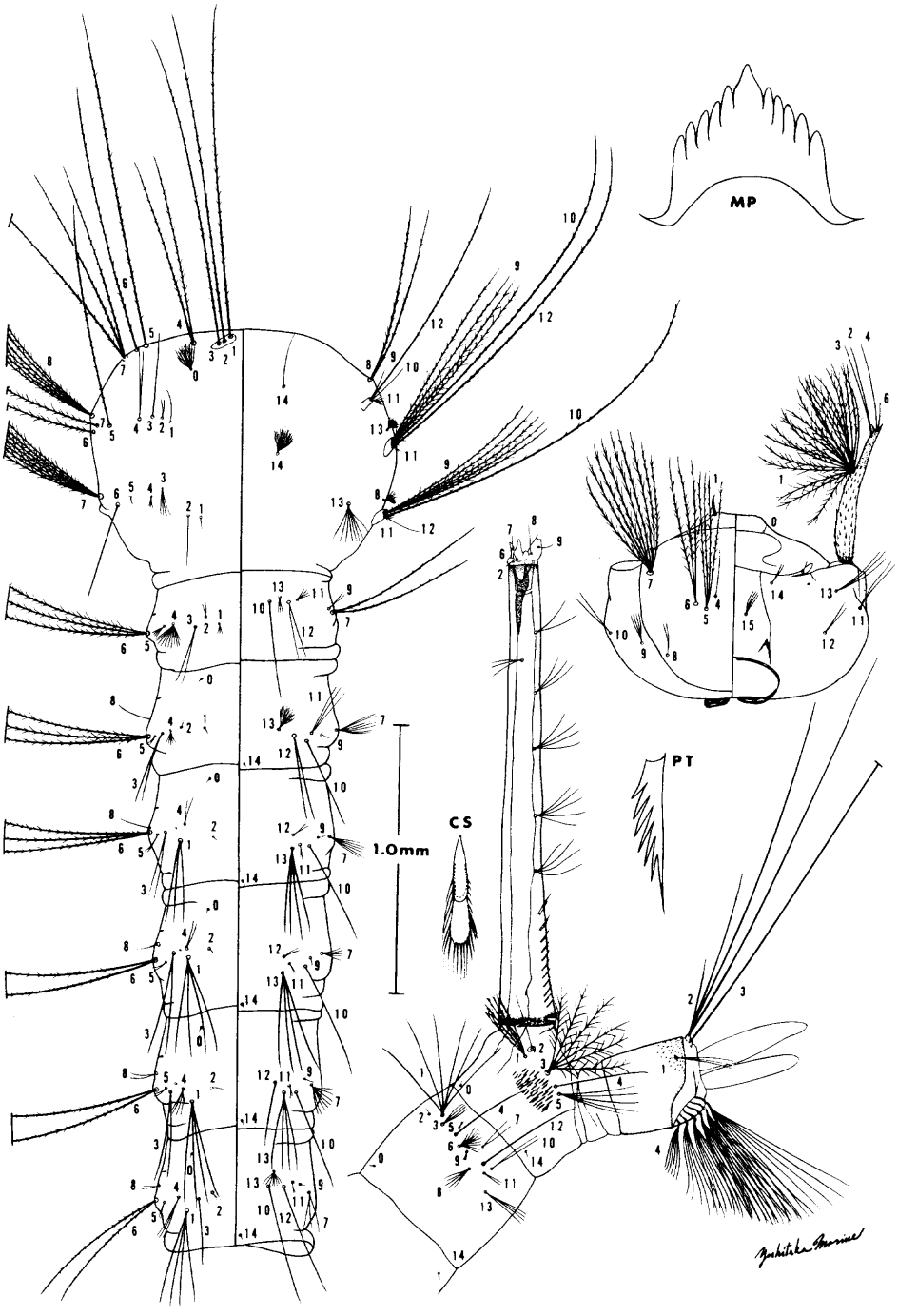
Fig. 87



C. (Culex) tritaeniorhynchus

ing characteristics for the 2 subspecies (*i.e.*, *t. tritaeniorhynchus* and *t. summorosus*). The first of these is the form and structure of the lateral plate of the phallosome of the male terminalia: in *tritaeniorhynchus* the teeth are somewhat weakly developed and only gently curved, where in *summorosus* they are strongly developed, considerably longer, and sharply recurved. The second feature is the general length and shape of the larval siphon; in *tritaeniorhynchus* the siphon is rather short, the sides parallel, and the apex truncate, and in *summorosus* the siphon is slenderer (particularly towards the apex) and considerably longer.

Variation exists in both structures, and material collected from Thailand suggests integration of these characters; however, in the material from Thailand both extremes have been seen as well as a large number of intermediate forms. Variation and integradation appears to be most pronounced in the larva, with the greatest majority of specimens from Thailand conforming to the *summorosus* form *sensu* Colless. A form with an extremely long siphon (see Barraud 1934 and Colless 1957a) has been found principally in southern Thailand (from Bangkok southward). The form with the short siphon, or *tritaeniorhynchus sensu* Colless, has been studied from Chiang Mai, Songkhla, and Roi Et (changwats located in the northern, penninsular, and eastern parts of the country). A limited amount of material was available for study from India, Iraq, and Egypt, but in each case these specimens exhibited the short siphon. Consideration of variation within the two primary differentiating characteristics strongly suggests, at the present time, that *tritaeniorhynchus* represents a plastic species with clinal variation in certain anatomical features, but is not amenable to a strictly subspecific interpretation. On the basis of data from specimens collected in Thailand, it is concluded that *summorosus* should be recognized as a synonym of *tritaeniorhynchus* until additional anatomical, biological, and vector potential data are available for the species throughout its range.

Due to the difficulty in conclusively recognizing some adults of *tritaeniorhynchus*, it has been necessary to resort to the buccopharyngeal armature of the female as a supplementary character. In *tritaeniorhynchus* the teeth of the buccopharyngeal armature are quite long and filamentous, whereas in the other closely related members of the subgroup studied (*annulus*, *perplexus*, *pseudovishnui*, and *whitei*, as well as both species of the *sitiens* subgroup) these teeth are short and acuminate.

BIOLOGY. In Thailand, larvae have been collected from a wide variety of temporary and semipermanent ground water habitats and have also been collected from streams and swamps. Colless (1957c) found this to be the most common species in hyacinth ponds and suggested that almost any sunlit permanent fresh water pond containing some vegetation would be particularly favorable. Larvae were also reported from tidal marshes of low salinity, transient pools with emergent vegetation, obstructed streams, and occasionally from tins or durms sunk into the earth and showing features in common with ground pools. In Japan, LaCasse and Yamaguti (1950) reported that the larvae were collected from fresh water habitats early in the season and as the season advanced, the diversity of situations in which larvae were collected broadened to include practically all habitats (except container habitats, tree holes, and some unspecified specialized habitats).

The adult females feed primarily on cow and pig, but will occasionally feed on birds and man (Colless 1959b). Colless (1959c) concluded that in the

absence of cattle, the species is attracted to man but is slow to feed, whereas in the presence of cattle, man is almost completely ignored. Flemings (1959) noted that females will bite black crowned night herons (a host of Japanese encephalitis virus) at all levels of elevation up to 50 ft., but the biting rate was overwhelmingly higher at ground level and decreased with altitude. Scanlon and Esah (1965) collected females biting man at elevations up to 4,500 ft. on a mountain in Chiang Mai. Nakao (1959) has suggested that *tritaeniorhynchus* may be an indoor resting species.

This species has been incriminated as a vector of Japanese encephalitis virus (Tigertt and Hammon 1950, and other authors) and is generally regarded as the principle vector in the Oriental region. Dengue virus has also been isolated from *tritaeniorhynchus* (Rudnick and Hammon 1961), but no epidemiological evidence is available to suggest that it serves any role as a natural vector. Evaluation of the role *tritaeniorhynchus* plays in the transmission of arthropod-borne viruses is complicated by the afore mentioned difficulties in conclusively recognizing the females. Caution must, therefore, be exercised in the collection and interpretation of data relating to this and other species of the *vishnui* subgroup.

CULEX (CULEX) WHITEI BARRAUD 1923
(Figure 88)

Culex whitei Barraud 1923, Ind. J. med. Res. 11: 508 (♂, ♀); Barraud 1924, Ind. J. med. Res. 11: 998 (♂*).

Culex (Culex) whitei Barraud: Edwards 1932, *in* Wytsman, Gen. Insect., fasc. 194: 205 (taxonomy); Barraud 1934, Fauna Brit. Ind., Diptera 5: 402 (♂*, L); Peters and Dewar 1956, Ind. J. Malar. 10: 46 (L*).

The adult female cannot be conclusively distinguished from several other members of the *vishnui* subgroup. The male terminalia exhibits distinctive setae on the subapical lobe of the basimere and possesses 3 or more strong teeth on the outer division of the phallosome. The fourth stage larva is distinctive in the shape of the comb scale, and the chaetotaxy of the head and siphon.

FEMALE. *Head.* Proboscis dark brown with a moderately sized median band of pale scales; palpus dark brown, without pale scales; decumbent scales of the vertex pale brown at the occiput, becoming almost white at the orbital line; erect scales pale golden to light orange at the occiput and dark brown posteriolaterally. *Thorax.* Scutum covered with a variable, irregular pattern of pale golden and dark brown scales, usually darkest on the fossal, dorsocentral, and posterior acrostichal areas and lightest on the humeral, antealar, and supraalar areas and the scutellum; integument of the pleuron predominantly pale brown, with a variable, irregular darker brown area on the sternopleuron; patches of pale scales on the upper mesepimeron and upper and posterior sternopleuron. *Wing.* All dorsal wing scales dark brown. *Legs.* Anterior surface of the hind femur predominantly white, with a broad, subapical dark band and an apical tuft of white scales; hind tibia basically dark with a narrow basal white band and occasionally with a median stripe of pale scales and a narrow apical pale band; hind tarsus dark brown, with a narrow basal pale band on tarsomeres I-III; mid femur dark, with a

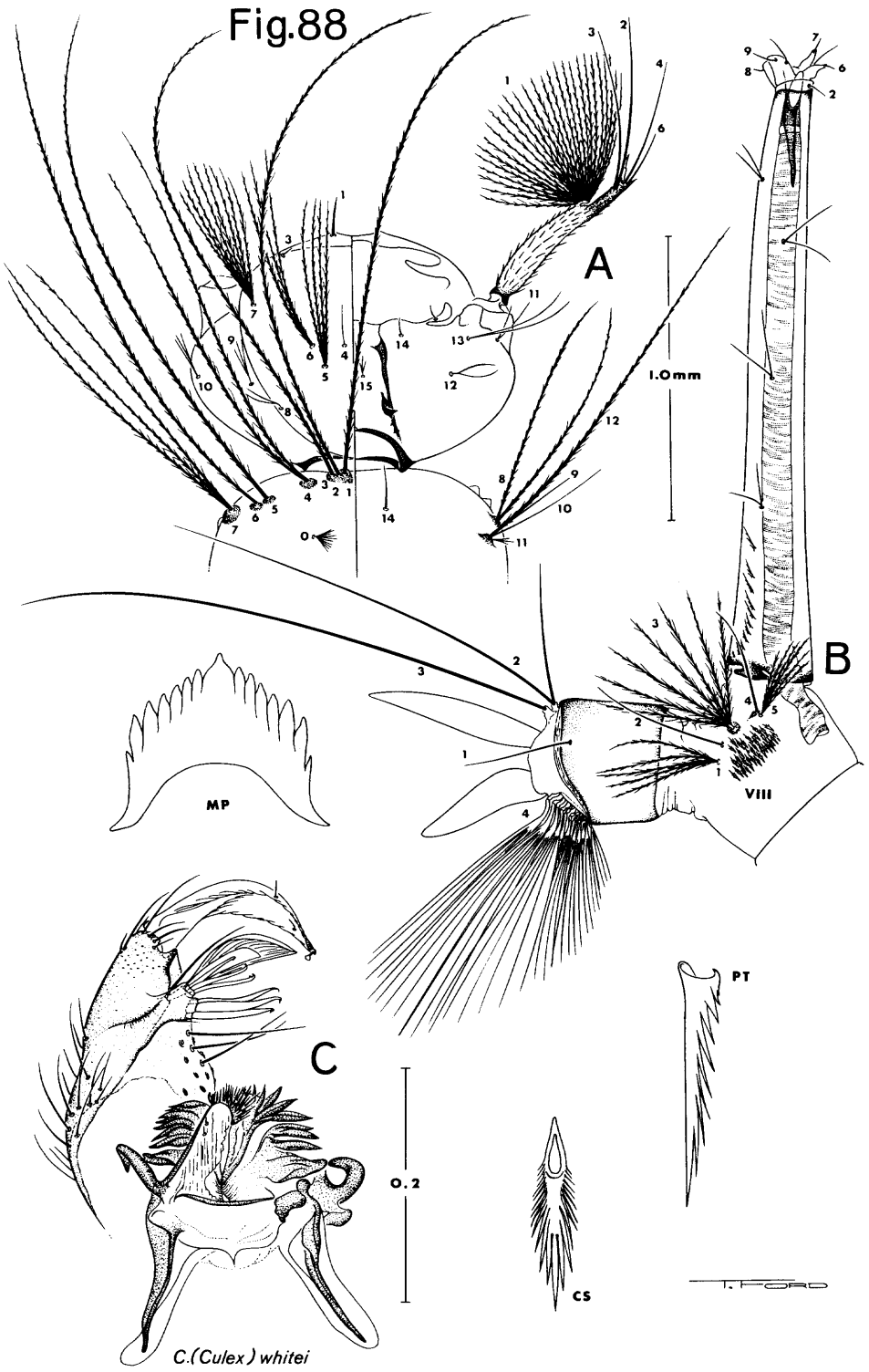


Fig.88
A
1.0mm
B
VIII
MP
C
0.2
PT
CS
C.(Culex) whitei

narrow pale basal band and a narrow apical tuft of pale scales; mid tibia and tarsus similar in color to the hind legs but with the pale scales more sparse; fore femur similar to the mid femur; fore tibia dark but with an apical tuft of several pale scales; fore tarsus marked as the hind legs. *Abdomen.* Terga dark scaled with moderately broad convex pale basal bands on segments II-VIII and with basolateral triangular white patches not visible from above; sterna variable, predominantly pale.

MALE. *Head.* Proboscis with a small basomedian tuft of short setae; palpus dark, with a narrow apical band of pale scales on segment II, a narrow basal and broad median band of pale scales on III, a narrow basal band of pale scales on IV, and narrow basal and apical pale bands on V. *Terminalia.* (Figure 88C). Subapical lobe of the basimere well developed, with 3 subequal, hooked rods followed by 4 accessory setae (one of which is very broad), a broad, striated leaf, and a gently curved seta; distimere somewhat expanded, with minute annulations on the convex surface of the apex; inner division of the phallosome with 4 or more strong, pointed teeth, without a spiculate portion; outer division of the phallosome with 3 or more strong teeth similar to those of the inner division; proctiger crowned with a strong tuft of spines, and with 2 or 3 cercal setae present; basal sternal process well developed and strongly curved.

LARVA. (Figure 88A, B). *Head.* Antenna with a narrow, dark basal band and slightly darker beyond insertion of hair 1-A; head hair 1-C strongly pigmented, robust, gradually tapering to a sharp point, its length approximately half the distance between the bases of the pair; 4-C single, simple; 5, 6-C with 3 or 4 pectinate branches. *Thorax.* Integument glabrous; hairs 1, 2, 3-P single, pectinate, subequal in length; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P usually with 3 branches, but with up to 5 branches, pectinate; 8-P bifid, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; comb variable, consisting of approximately 40 scales arranged in a broadly triangular patch; individual comb scale elongated, with a prominent apical spine and fringed laterally with spicules which become progressively smaller basally; siphon index variable, ranging from 5:1 to 7:1; 4 or 5 pairs of subventral tufts inserted on the siphon, the subapical tuft inserted laterally out of line; individual tufts usually bifid, always simple, their length equal to or less than the width of the siphon at the point of insertion; pecten consisting of from 8 to 12 teeth restricted to the basal fourth or less of the siphon; individual pecten tooth with a prominent apical spine and from 5 to 8 strong lateral barbs.

TYPE DATA. Lectotype hereby designated: syntype female, "India, Haflang Hill, Assam, VIII, 1922, Capt. P. J. Barraud, BM 1923-523", in the British Museum.

DISTRIBUTION. In THAILAND, *whitei* has been collected from: *Chiang Mai, Chiang Rai, Lampang, Mae Hong Son, Nakhon Ratchasima, Phet Buri,* and *Ranong.* This species has also been recorded from INDIA and NEPAL. Specimens have been examined in the U. S. National Museum

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Figure 88. *C. (Culex) whitei.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the male terminalia.

collection from Ba Long and An Khe, SOUTH VIETNAM**.

During this study the following material has been examined from Thailand: 4 females and 1 male with their associated larval and pupal skins, and 32 larvae.

TAXONOMIC DISCUSSION. This species is most easily identified in the larval stage and may be separated from its closest relative, *alienus*, by the short subventral tufts of the siphon and by head hairs 5, 6-C having 3 or 4 branches.

BIOLOGY. Virtually nothing is known of the biology of this apparently rare species. The larval habitat appears to be limited to ground water accumulations. Host preferences of the adults are unknown.

SITIENS SUBGROUP

ADULT. Indistinguishable from the *vishnui* subgroup.

LARVA. *Head.* Hair 1-C broad, somewhat flattened, its apex rounded or irregular. *Abdomen.* Anal gills short, bulbous, their length less than that of the saddle.

LARVAL HABITAT. Larvae are normally found in brackish water, usually tidal marshes, and are restricted to coastal regions.

TAXONOMIC DISCUSSION. Although distinguishing features have not been found which could separate the adults of the *sitiens* subgroup from other subgroups within the *sitiens* group, the 2 distinctive anatomical features of the larva seem sufficiently unique to warrant separate consideration. The form of head hair 1-C as noted above is not known in any other members of the subgenus; the bulbous anal gills are also unique to the subgroup and probably represent adaptations to the brackish larval habitat.

Five species fall naturally within this subgroup: *sitiens* Wiedemann, *roseni* Belkin, *whittingtoni* Belkin, *litoralis* Bohart, and *neolitoralis*, n. sp.; however, only 2 of these species are known to occur in Thailand, namely *sitiens* and *neolitoralis*. Belkin (1962) recognized the 4 previously known species as the *sitiens* complex of the *sitiens* subgroup of the *sitiens* group and included as other members of the *sitiens* subgroup *annulirostris* Skuse and *omani* Belkin (neither of which are known to occur in Thailand).

CULEX (CULEX) NEOLITORALIS, N. SP.
(Figure 89)

Culex (Culex) litoralis of Colless 1957, Med. J. Malaya 12: 465 (L*).

Although this species is clearly a member of the *sitiens* subgroup, the adult female is indistinguishable from *alienus*. The adult male may be

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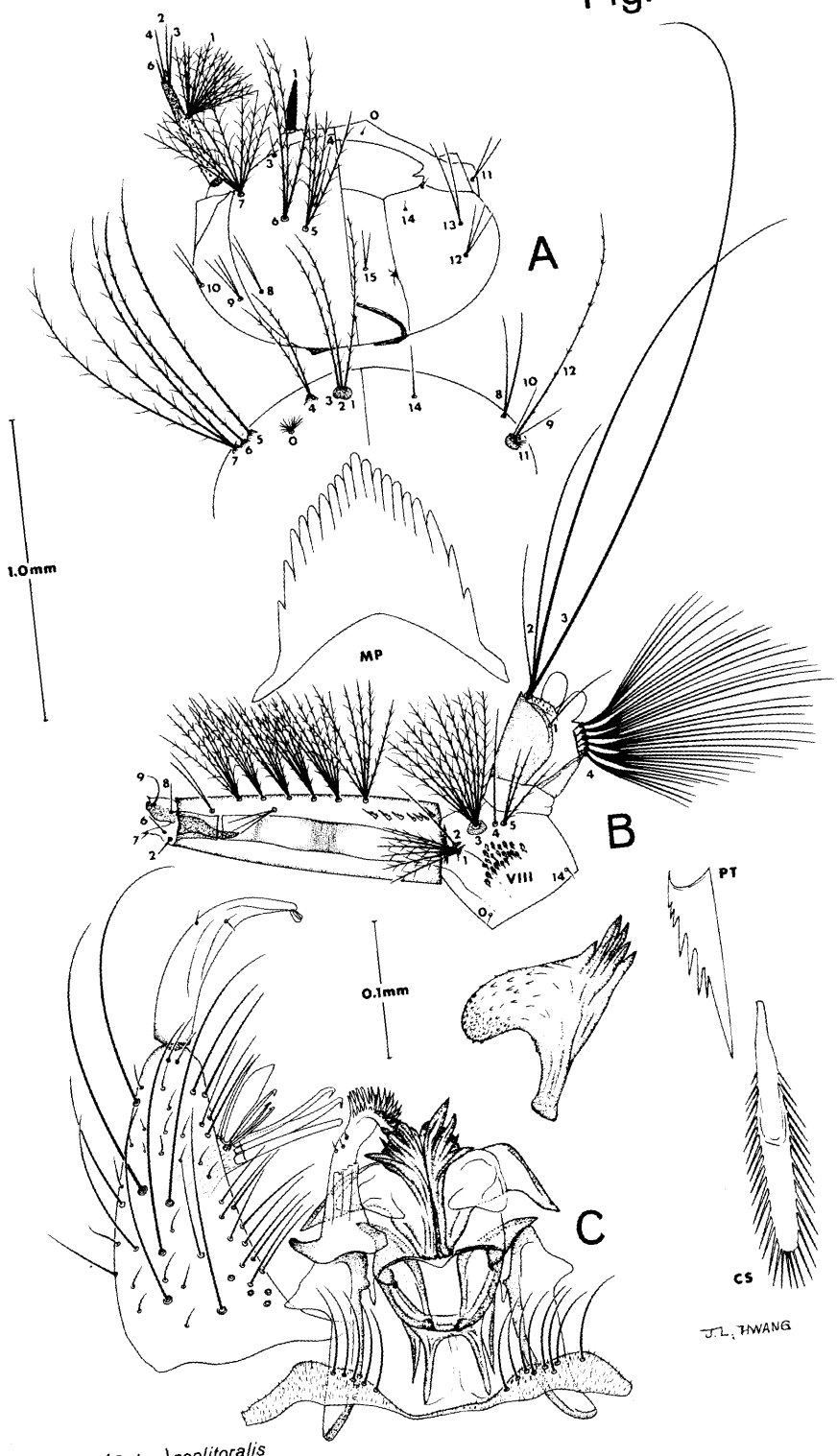
Figure 89. *C. (Culex) neolitoralis*. A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the male terminalia with enlarged insert of the lateral aspect of the inner division of the phallosome.

→

Fig.89



C. (Culex) neolitoralis

recognized by the distinctive inner division of the phallosome of the terminalia. The fourth stage larva is distinguished on the basis of the unusual structure of the anal saddle and the pectinate subventral tufts of the siphon.

FEMALE. *Head.* Proboscis dark brown to black, with a moderately broad median band of pale scales; palpus similar in color to the proboscis, but without pale scales; decumbent scales of the vertex pale golden brown at the occiput, becoming lighter at the orbital line; erect scales golden brown at the occiput, but dark brown to black posteriolaterally. *Thorax.* Scutum basically dark brown but with variable groupings of golden scales which are particularly dense at the scutal angle, the posterior dorsocentral area, and the supraalar area, very sparse in the prescutellar space; scutellum with golden scales prominent on the midlobe; integument of the pleuron usually pale brown with variable, indistinct darker patterns on the posterior spiracular plate, the posterior sternopleuron, and the anterior mesepimeron; patches of pale scales present on the upper sternopleuron, posterior sternopleuron, anterior mesepimeron, and upper mesepimeron. *Wing.* All dorsal wing scales dark brown. *Legs.* Anterior surface of the hind femur mainly pale but with a broad, very dark subapical band which extends proximally to form a dark stripe along the dorsal border; hind tibia dark with a narrow apical band of pale scales; hind tarsus dark, with narrow pale basal bands on tarsomeres I-IV; fore and mid femora dark, appearing somewhat paler in the median area, and with a small apical patch of pale scales; fore and mid tibiae and tarsi marked as the hind legs. *Abdomen.* Terga dark, with narrow, slightly convex pale basal bands on segments III-VIII and with a median spot on segment II; with rather broad basolateral triangular patches which are not visible from above; sterna dark with broad, pale basal bands.

MALE. *Head.* Proboscis with a basomedian tuft of a few short setae; palpus dark with a narrow apical pale band on segment II, narrow basal and broad median pale bands on III, a narrow basal pale band on IV, and narrow basal and apical pale bands on V. *Terminalia.* (Figure 89C). Basimere with the subapical lobe well developed, with a blunt basal rod and 2 hooked rods followed by 3 hooked accessory setae, a rather narrow leaf, and a gently curved seta; distimere normal in shape, without distal annulations; lateral plate of the phallosome complex, with 5 straight, strong teeth, the spiculate portion developed away from the teeth, with a prominent projection exhibiting fine denticles; proctiger crowned with a strong tuft of spines and with 3 cercal setae; basal sternal process strong, but rather short and straight.

LARVA. (Figure 89A, B). *Head.* Antenna with a narrow, dark basal ring and considerably darker beyond insertion of hair 1-A; head hair 1-C variable in shape, but usually broad, rather bluntly rounded, and somewhat flattened, its length slightly greater than half the distance between the bases of the pair; 4-C single, simple; 5-C with from 3 to 5 branches, pectinate; 6-C with 3 or 4 pectinate branches. *Thorax.* Integument glabrous; hairs 1, 2, 3-P single, finely pectinate, subequal in length; 4-P bifid, finely pectinate; 5, 6-P single, pectinate; 7-P trifid, pectinate; 8-P bifid, simple; 14-P single, simple. *Abdomen.* Integument glabrous; comb consisting of from 20 to 35 elongate, fan-shaped scales arranged in a triangular patch; siphon index variable, ranging from 2.5:1 to 3.5:1 (average, 3:1); from 6 to 8 pairs of subventral tufts inserted on the siphon; the apical and antepenultimate tufts smaller than the other tufts, with from 1 to 3 simple branches, and inserted laterally out of line; the other tufts with from 4 to 7 branches, pectinate, their

length greater than the width of the siphon at the point of insertion, and inserted almost in a line so that superficially they do not appear as pairs; pecten consisting of 7 to 13 teeth restricted to the basal third or less of the siphon; individual pecten tooth with a prominent apical spine and from 2 to 7 coarse lateral barbs; saddle incomplete, consisting of 2 sclerotized plates, the dorsal plate normal, the ventral plate triangular, frequently meeting the dorsal plate at the proximal margin; anal gills bulbous, shorter than the saddle.

TYPE DATA. Holotype male (associated larval and pupal skins and terminalia slide-mounted) from Ban Laem Sing, Chanthaburi, Thailand, 6 November 1965, from brackish rock pools on a beach, coll. Somboon Maneechai, deposited in the U. S. National Museum, No. 69351. Paratypes: 3 females and 2 males with their associated pupal skins slide-mounted, and 3 larvae, all with the same data as the holotype.

DISTRIBUTION. In addition to *Chanthaburi*, the type locality, specimens have also been collected in THAILAND from Ko Si Chang, *Chon Buri*. Specimens in the U. S. National Museum collection have been examined from Finschafen, NEW GUINEA. Colless (1957d) reported what is unquestionably this species from SINGAPORE harbor, and reported examining specimens from Seroei, DUTCH NEW GUINEA. Adults and larvae of this species have been studied from Con Son, SOUTH VIETNAM.

During this study the following specimens were examined in addition to the type series: 15 females, 13 males, and 54 larvae.

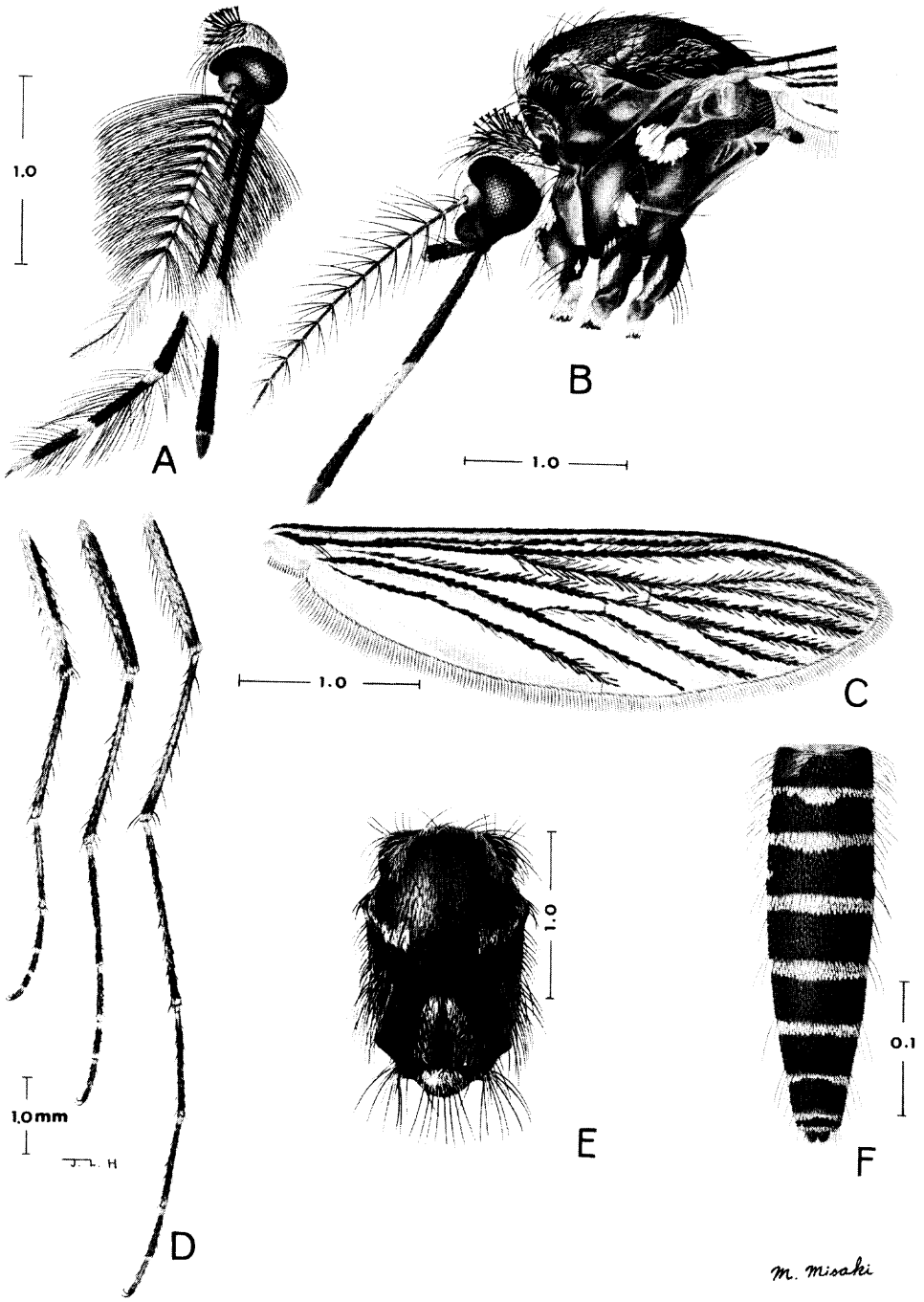
TAXONOMIC DISCUSSION. Colless (1957d) recognized the exceptional saddle on specimens collected from Singapore, but concluded that this was a normal feature of *litoralis* Bohart. Although the male terminalia of *neolitoralis* and *litoralis* are strikingly similar, distinctive differences exist in the adult female and fourth stage larva. The unusual larval saddle of *neolitoralis* contrasts the normally incomplete saddle found in *litoralis*. In the adult, colorational patterns of the occiput, scutum, abdomen, and legs differ significantly between the 2 species. Another closely related species is *whittingtoni* Belkin, a species known only from the larval stage; differences exist, however, in the siphon index, chaetotaxy of the head and prothorax, and in the shape of the saddle.

BIOLOGY. Larvae and pupae of this species were collected from the type locality during the month of November. Eight of these collections were from brackish rock pools near a salt marsh, 1 collection was from a depression in the salt marsh itself, and 1 collection was made from a large tree hole within the salt marsh. The material from Chon Buri was collected from brackish rock pools. Colless (1957d) collected material at Singapore during June to October, but did not specify the habitat. The specimens from New Guinea were collected during December from coral pools. Nothing is known of the abult habits.

CULEX (CULEX) SITIENS WIEDEMANN 1828
(Figures 90, 91, and 92)

Culex sitiens Wiedemann 1828, Aussereurop. zweifl. Ins. 1: 542 (♀); Theobald 1901, Mon. Cul. 1: 360 (♀*); Giles 1902, Handb., 2nd ed.: 400 (♀); Blanchard 1905, Les Moustiques: 293 (♀); Leicester 1908, Cul. Malaya: 143 (♂, ♀); Theobald 1910, Mon. Cul. 5: 324 (key); Edwards

Fig. 90



C.(Culex) sitiens

1913, Bull. ent. Res. 4: 232 (taxonomy); Barraud 1924, Ind. J. med. Res. 11: 993 (♂*, ♀); Barraud 1924, Ind. J. med. Res. 12: 427 (L*); Buxton and Hopkins 1927, Res. Polynesia and Melanesia 3: 79 (L, P*); Borel 1930, Monogr. Coll. Soc. Pat. exot. 3: 330 (♂*, ♀, L*).

Culex impellens Walker 1859, Proc. Linn. Soc. Lond. 4: 91 (♀); Theobald 1901, Mon. Cul. 1: 362 (♀*); Giles 1902, Handb., 2nd ed.: 405 (♂*, ♀); Theobald 1903, Mon. Cul. 3: 161 (♂); Blanchard 1905, Les Moustiques: 294 (♀); Leicester 1908, Cul. Malaya: 142 (♀); Theobald 1910, Mon. Cul. 5: 331 (distribution); Edwards 1913, Bull. ent. Res. 4: 232 (synonymy).

Culex microannulatus Theobald 1901, Mon. Cul. 1: 353 (♂*, ♀*); Blanchard 1905, Les Moustiques: 292 (♀); Leicester 1908, Cul. Malaya: 140 (♂, ♀); Theobald 1910, Mon. Cul. 5: 329 (distribution, taxonomy); Edwards 1913, Bull. ent. Res. 4: 232 (synonymy).

Culex gnophodes Theobald 1903, Mon. Cul. 3: 163 (♀); Leicester 1908, Cul. Malaya: 145 (♀); Edwards 1913, Bull. ent. Res. 4: 232 (synonymy).

Culex somaliensis Neveu-Lemaire 1906, Arch. Parasit., Paris 10: 254 (♂*, ♀*); Edwards 1911, Bull. ent. Res. 2: 261 (taxonomy); Edwards 1913, Bull. ent. Res. 4: 232 (synonymy).

Culex nigricephala Leicester 1908, Cul. Malaya: 149 (♂, ♀); Edwards 1932, *in* Wytsman, Genera Insect., fasc. 194: 204 (synonymy).

Culex salus Theobald 1908, Rep. Wellcome trop. Res. Lab. 3: 256 (♂*, ♀*); Theobald 1910, Mon. Cul. 5: 338 (♂*, ♀*, as *salsus*); Edwards 1913, Bull. ent. Res. 4: 232 (synonymy).

Culex jepsoni Theobald 1910, Entomologist 43: 158 (♀*); Edwards 1924, Bull. ent. Res. 14: 394 (synonymy).

Culex saibaii Taylor 1912, Rep. Comm. publ. Hlth. Qd.: 28 (♀); Edwards 1924, Bull. ent. Res. 14: 394 (synonymy).

Culicelsa paludis Taylor 1913, Rep. Aust. Inst. trop. Med. 1911: 56 (♀); Taylor 1915, Proc. Linn. Soc. N.S.W. 40: 181 (♂); Edwards 1924, Bull. ent. Res. 14: 394 (synonymy).

Culicada annulata Taylor 1914, Trans. R. ent. Soc. Lond. 1913: 689 (♂, ♀*); Edwards 1924, Bull. ent. Res. 14: 394 (synonymy).

Culicelsa annulirostris var. *milni* Taylor 1914, Trans. R. ent. Soc. Lond. 1914: 196 (♂*, ♀); Edwards 1924, Bull. ent. Res. 14: 394 (synonymy).

Culex (Culex) sitiens Wiedemann: Edwards 1932, *in* Wytsman, Genera Insect., fasc. 194: 204 (taxonomy); Barraud 1934, Fauna Brit. India, Diptera 5: 398 (♂*, ♀, L*); Brug 1934, Bull. ent. Res. 25: 514 (♀); Bonne-Wepster and Brug 1937, Geneesk. Tijdschr. Ned.-Ind. 77: 67 (♂, ♀*); Bonne-Wepster and Brug 1939, Geneesk. Tijdschr. Ned.-Ind. 79: 1268 (L*); Edwards 1941, Mosq. Ethiop. Reg. 3: 296 (♂*, ♀); Williams 1943, Hawaii Planters Rec. 47: 215 (♀*, L*); Taylor 1943, Serv. Publ. Sch. Pub. Hlth. trop. Med. Univ. Sydney 4: 99 (♂, ♀*, L*, P); Paine 1943, Fiji Dept. Agric. Bull. 22: 12 (♀, P*, L*); Bohart 1945,

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Figure 90. ← *C. (Culex) sitiens*. Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

Navmed 580: 80 (♀); Bohart and Ingram 1946, Navmed 1055: 18 (♂*, L*); Carter and Wijesundara 1948, Ceylon J. Sci. 23: 150 (♀, L*); Penn 1949, Pacif. Sci. 3: 80 (P*); Bick 1951, Pacif. Sci. 5: 421 (ecology); Bonne-Wepster 1954, R. trop. Inst. Amst., Spec. Publ. 111: 123 (♂*, ♀*, L*); Iyengar and Menon 1955, Bull. ent. Res. 46: 7 (♂*, ♀, L*); Mattingly and Knight 1956, Bull. Brit. Mus., Ent. 4: 104 (♀, L); Bohart 1956, Ins. Micronesia 12: 82 (♂*, ♀, P, L*); Hsieh and Liao 1956, Acta ent. Sinica 6: 375 (♂*, L*); Belkin 1962, Mosq. S. Pacif. 1: 205 (♂*, ♀, P*, L*); Lien 1962, Pacif. Ins. 4: 635 (ecology); Delfinado 1966, Mem. Amer. ent. Inst. 7: 151 (♂*, ♀, L*).

Culex (Culex) salinus Baisas 1938, Mon. Bull. Philipp. Hlth. Serv. 18: 204 (♂*, ♀*, P*, L); Delfinado 1966, Mem. Amer. ent. Inst. 7: 152 (synonymy).

The adult female may be identified by the dark and pale speckling of the femora and the relatively narrow pale, basal bands on the abdominal terga. The male terminalia is characterized by the shape and number of setae on the subapical lobe of the basimere and by the shape of the lateral plate of the phallosome. The fourth stage larva may be recognized by the broad, somewhat flattened head hair 1-C, by the bulbous anal gills, and by the complete anal saddle.

FEMALE. *Head.* (Figure 90B). Proboscis dark brown with a moderately broad median band of pale scales and, in some specimens, with a few randomly scattered white scales proximal to the band; palpus similar in color to the proboscis, usually tipped with several white scales and with an occasional white scale on segments I-III; decumbent scales of the vertex pale golden brown, becoming lighter at the orbital line; erect scales dark brown, or in some specimens pale brown at the occiput, dark brown posteriolaterally. *Thorax.* (Figure 90B, E). Scutum brown, with a variable, irregular grouping of lighter and darker scales; lighter scales usually found on the humeral, posterior fossal, anterior and posterior dorsocentral, supraalar, and prescutellar areas with pale scales also present on the scutellum; integument of the pleuron uniformly dark brown, with patches of pale scales on the upper mesepimeron, and the upper and posterior sternopleuron. *Wing.* (Figure 90C). Dorsal wing scales predominantly dark, usually with some pale scales on the posterior border of the costa and occasionally with some pale scales on Sc. *Legs.* (Figure 90D). Anterior surface of the hind femur predominantly white, but with some dark scales interspersed among the white, and with dark scales on the dorsal border, with a broad subapical dark band, and with a small tuft of yellowish scales at the apex; hind tibia predominantly dark, with an irregular, broad median stripe of lighter scales and a moderately broad apical pale band; hind tarsus dark, with basal pale bands on tarsomeres I-IV and a variable number of pale scales among the dark ones, particularly on tarsomere I; anterior surface of mid femur uniformly speckled with dark and light scales and with a very narrow apical band of pale scales; mid tibia and tarsus marked as in the hind legs; fore femur with an irregular pattern of dark scales with some light scales interspersed and with a very narrow apical band of pale scales; fore tarsus marked as in the hind legs. *Abdomen.* (Figure 90F). Terga dark brown with variable basal pale bands on segments II-VIII; segment I either dark or with a median pale basal spot; sterna variable, predominantly

white and usually with a complete, rather broad apical dark band.

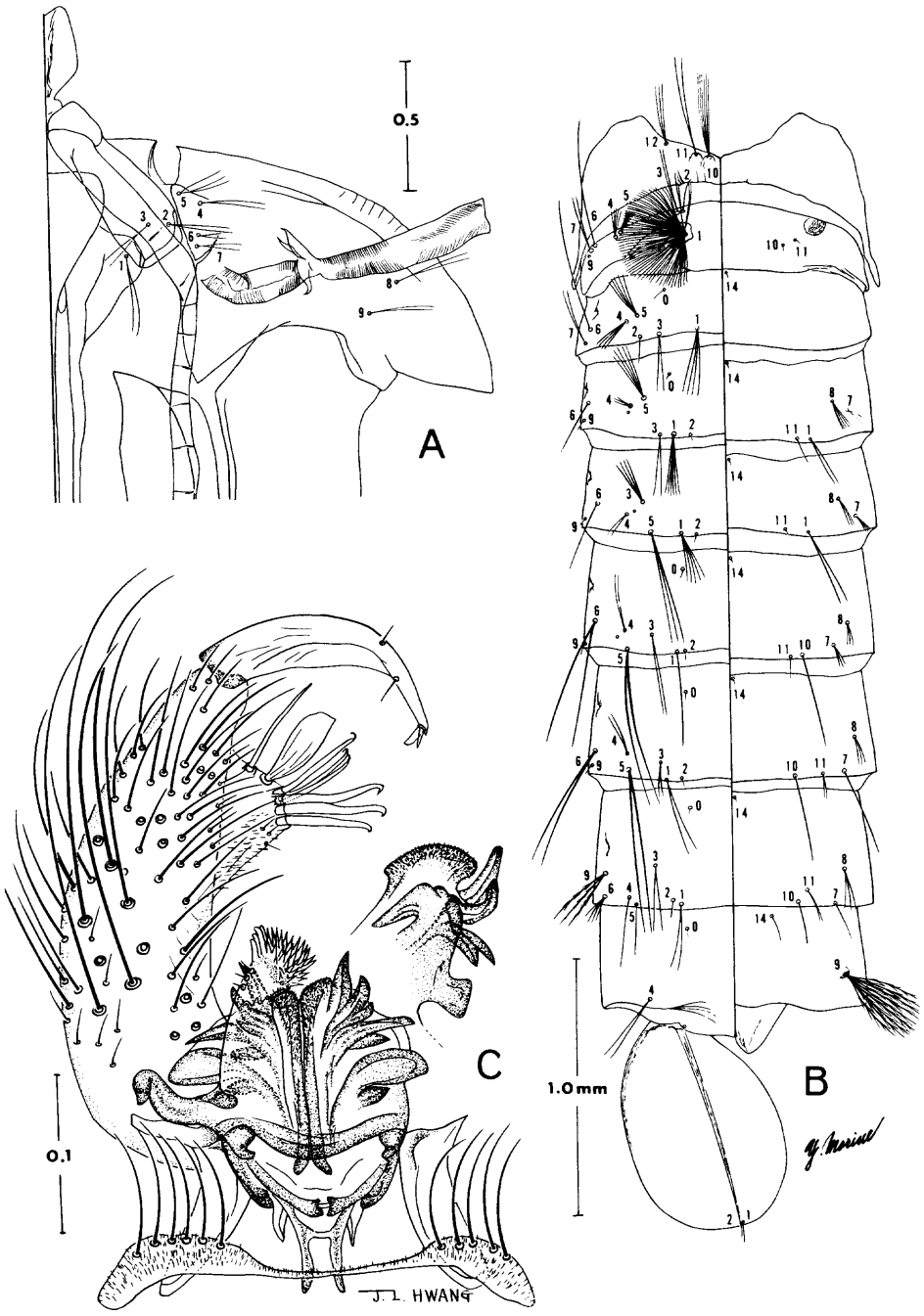
MALE. *Head.* (Figure 90A). Proboscis with a rather strong basomedian tuft of straight setae; palpus dark, with a narrow, variable apical pale band on segment II, narrow basal and broad median pale bands on III, a narrow basal pale band on IV, and basal and apical pale bands on V. *Terminalia.* (Figure 91C). Basimere with the subapical lobe well developed, the 3 rods hooked, well developed, followed by 3 or 4 accessory setae, one of which is longer and broader than the others, a broad leaf, and a gently curved seta; distimere normal in shape, frequently with extremely minute annulations at the apex on the convex surface (not illustrated); inner division of the phallosome with 5 to 7 strong teeth, the spiculate portion appearing as a broad knob in lateral aspect (figure 91C); proctiger crowned with a strong tuft of spines and with 3 cercal setae; basal sternal process strong, long, and prominently curved.

PUPA. (Figure 91A, B).

LARVA. (Figure 92). *Head.* Antenna with a narrow dark basal band and progressively darker beyond insertion of hair 1-A; head hair 1-C strongly pigmented, variable in shape, but usually broad and somewhat flattened, gradually tapering to a bluntly rounded or irregular apex, its length approximately half the distance between the bases of the pair; 4-C single, simple; 5-C with from 5 to 7 pectinate branches; 6-C usually with 4 branches, pectinate. *Thorax.* Integument glabrous; hairs 1, 2, 3-P single, pectinate, subequal in length; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P trifid, pectinate; 8-P bifid, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; comb consisting of at least 30 fan-shaped scales arranged in a broad, triangular patch; siphon index variable, ranging from 3.5:1 to 5.5:1; usually 7 or 8 pairs of subventral tufts inserted on the siphon, one of the tufts inserted laterally out of line; individual tufts with from 2 to 5 finely pectinate branches, the apical and laterally placed tufts simple, the others pectinate, their length greater than the width of the siphon at the point of insertion; pecten consisting of at least 10 or more teeth restricted to the basal 1/4 to 1/3 of the siphon; individual pecten tooth with a prominent apical spine and approximately 9 rather fine lateral barbs; saddle completely ringing the tenth segment at the base, but deeply indented caudoventrally; anal gills bulbous, shorter than the saddle.

TYPE DATA. Holotype female of *sitiens* from Sumatra in the Zoologisk Museum, Copenhagen, Denmark. Holotype female (in extremely poor condition) of *impellens* from Makessar, Celebes in the British Museum. Lectotype of *microannulatus* hereby designated: syntype male (terminalia slide-mounted), "8.2 1900, Quilon, Travencore, S. India, S. P. James", in the British Museum. Holotype female of *gnophodes* from Bruas, Dindings, Malaya in the British Museum. The type locality of *somaliensis* is Djibouti, French Somaliland but the type specimen is probably non-existent. The type locality of *nigricephala* is Batu Gajah, (Perak), Malaya but the type specimen is non-existent. Holotype female (in very poor condition) of *salus* from Port Sudan, Sudan in the British Museum. Holotype female of *jepsoni* from Suva, Fiji Islands in the British Museum. Holotype female of *saibaii* from Saibai Island, New Guinea in the School of Public Health and Tropical Medicine, University of Sydney, Australia. Holotype female of *paludis* from Townsville, Australia in the School of Public Health and Tropical Medicine, University of Sydney, Australia. Syntypes of *annulata* from Townsville,

Fig.91



C.(Culex) sitiens

Queensland, Australia in the School of Public Health and Tropical Medicine, University of Sydney, Australia. Syntype male and female of *annulirostris* var. *milni* from Milne Bay, Papua, New Guinea in the School of Public Health and Tropical Medicine, University of Sydney, Australia.

DISTRIBUTION. In THAILAND, *sitiens* has been collected from: *Chanthaburi, Chon Buri, Krung Thep, Pathum Thani, Prachuap Khiri Khan, Ranong, Rayong, Samut Prakan,* and *Samut Sakhon.* This species is widely distributed throughout the coastal areas of the ORIENTAL REGION, EAST AFRICA, MADAGASCAR, northern AUSTRALIA, and the PACIFIC ISLANDS.

The following specimens from Thailand were examined during this study: 81 females and 26 males, 7 with their associated larval and pupal skins, and 150 larvae.

TAXONOMIC DISCUSSION. The systematic position of this variable species was reviewed by Belkin (1962) who concluded that this is a single, plastic species with many different populations that have been separated and then mixed at different times in the past.

Since the adult female may, at times, be confused with some members of the *vishnui* subgroup, final determinations should be based on the male terminalia and the fourth stage larva.

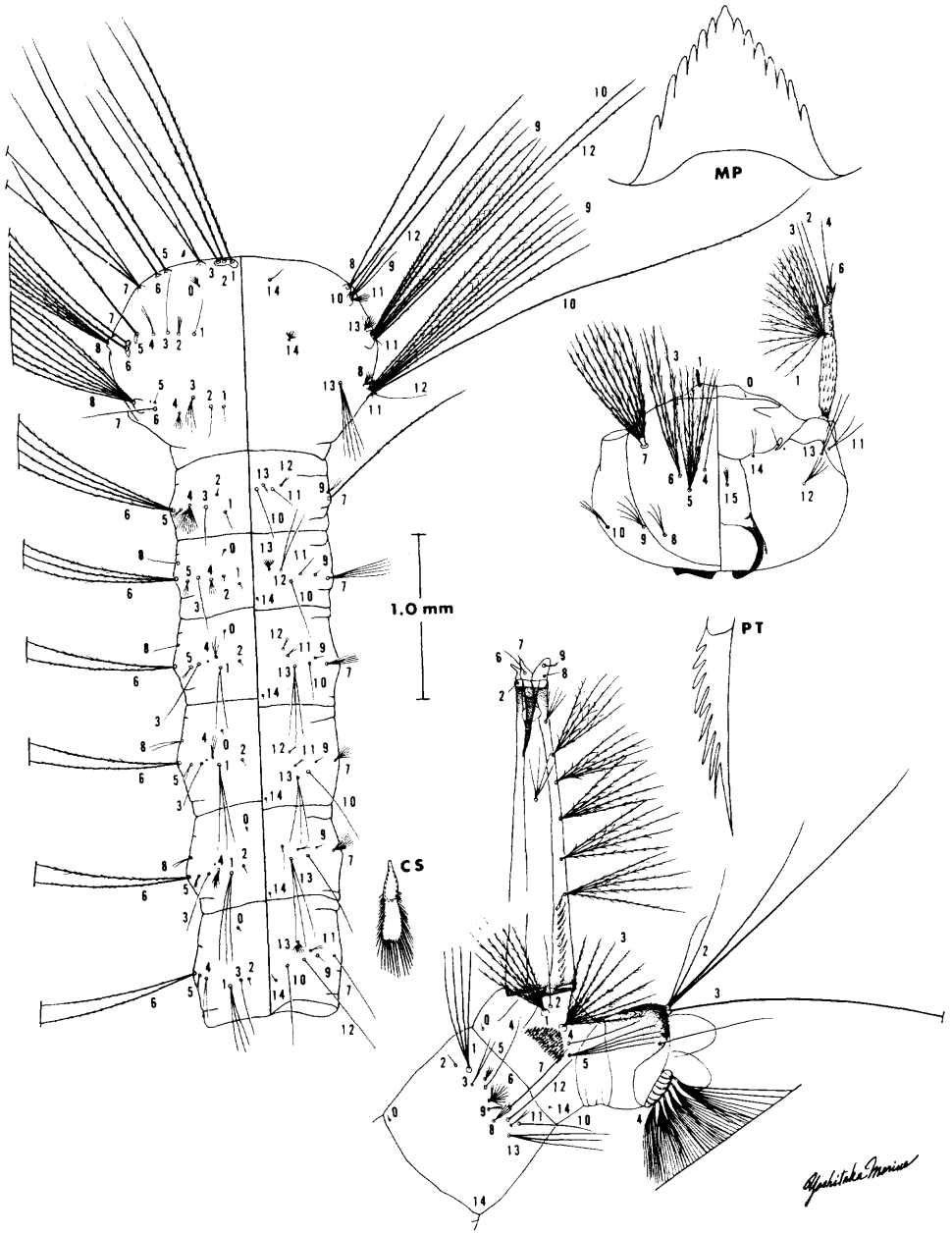
BIOLOGY. In Thailand, larvae of *sitiens* have been collected from salt marshes and from ground water habitats and some artificial containers with brackish water. Collections were made throughout the year. Bick (1951) reported that in New Guinea coral pools constituted the predominant larval habitat, and Belkin (1962) collected larvae in the South Pacific from brackish and sometimes fresh water in ground pools, coral holes, canoes, and artificial containers. Other authors (*e.g.* Bonne-Wepster and Brug 1937 and 1939) have attributed a somewhat wider variety of habitats to the larvae. Colless (1957c) has suggested that this is the typical species found in the tidal marsh. In all cases, however, the species is generally regarded as being restricted to coastal regions.

The females have not been reported to attack man in the New Hebrides and the Solomons (Belkin 1962), but Paine (1943) reported *sitiens* as a vicious biter in Fiji. Colless (1959b) utilized precipitin tests to determine that the females feed primarily on birds and pig, but additional records included cow, dog, and man; females have also been fed on chicken, mouse, and rabbit in the laboratory.

Little is known of the disease relations of this species. Iyengar (1953) found early stages of *Wuchereria malayi* larvae in a wild-caught female but concluded that the species was not capable of transmitting the infection. Hodes (1946) reported laboratory transmission of Japanese B encephalitis by *Culex jepsoni* (= *sitiens*), but the significance of this experiment is probably not great.

Figure 91. ← *C. (Culex) sitiens.* A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia with enlarged insert of the lateral aspect of the inner division of the phallosome.

Fig.92



C.(Culex) sitiens

GELIDUS SUBGROUP

ADULT. *Thorax.* Scutum covered with a dense, conspicuous pattern of silver-white scales on the anterior two-thirds. *Abdomen.* Pale markings restricted mainly or entirely to the bases of the terga.

LARVA. Indistinguishable from the *vishnui* subgroup.

TAXONOMIC DISCUSSION. Edwards (1932) recognized 4 species as comprising his *gelidus*-series and 2 of these, *gelidus* and *whitmorei*, are found in Thailand and are here assigned to the *gelidus* subgroup of the *sitiens* group. The *gelidus* subgroup is extremely close to the *vishnui* subgroup and may be separated only on the basis of the distinctive markings of the scutum in the adult; however, at the present time it is considered best to segregate these two species until more positive relationships can be established.

CULEX (CULEX) GELIDUS THEOBALD 1901
(Figures 93, 94, and 95)

Culex gelidus Theobald 1901, Mon. Cul. 2: 20 (♀*); Giles 1902, Handb., 2nd ed.: 421 (♀); Theobald 1903, Mon. Cul. 3: 180 (distribution); Blanchard 1905, Les Moustiques: 316 (♀); Leicester 1908, Cul. Malaya: 147 (♂, ♀); Barraud 1924, Indian J. med. Res. 11: 990 (♂*); Barraud 1924, Indian J. med. Res. 12: 428 (L*); Borel 1930, Monogr. Coll. Soc. Pat. exot. 3: 327 (♂*, ♀, L*); Barraud and Christophers 1931, Rec. Malar. Surv. India 2: 282 (distribution); Senior-White 1934, Bull. ent. Res. 25: 560 (biology).

Culex gelidus var. *cuneatus* Theobald 1901, Mon. Cul. 2: 22 (♀*); Theobald 1910, Mon. Cul. 5: 313 (distribution); Edwards 1932, *in* Wytsman, Genera Insect., fasc. 194: 203 (synonymy).

Leucomyia gelida (Theobald): Theobald 1907, Mon. Cul. 4: 372 (♂*, taxonomy); Theobald 1910, Mon. Cul. 5: 312 (distribution).

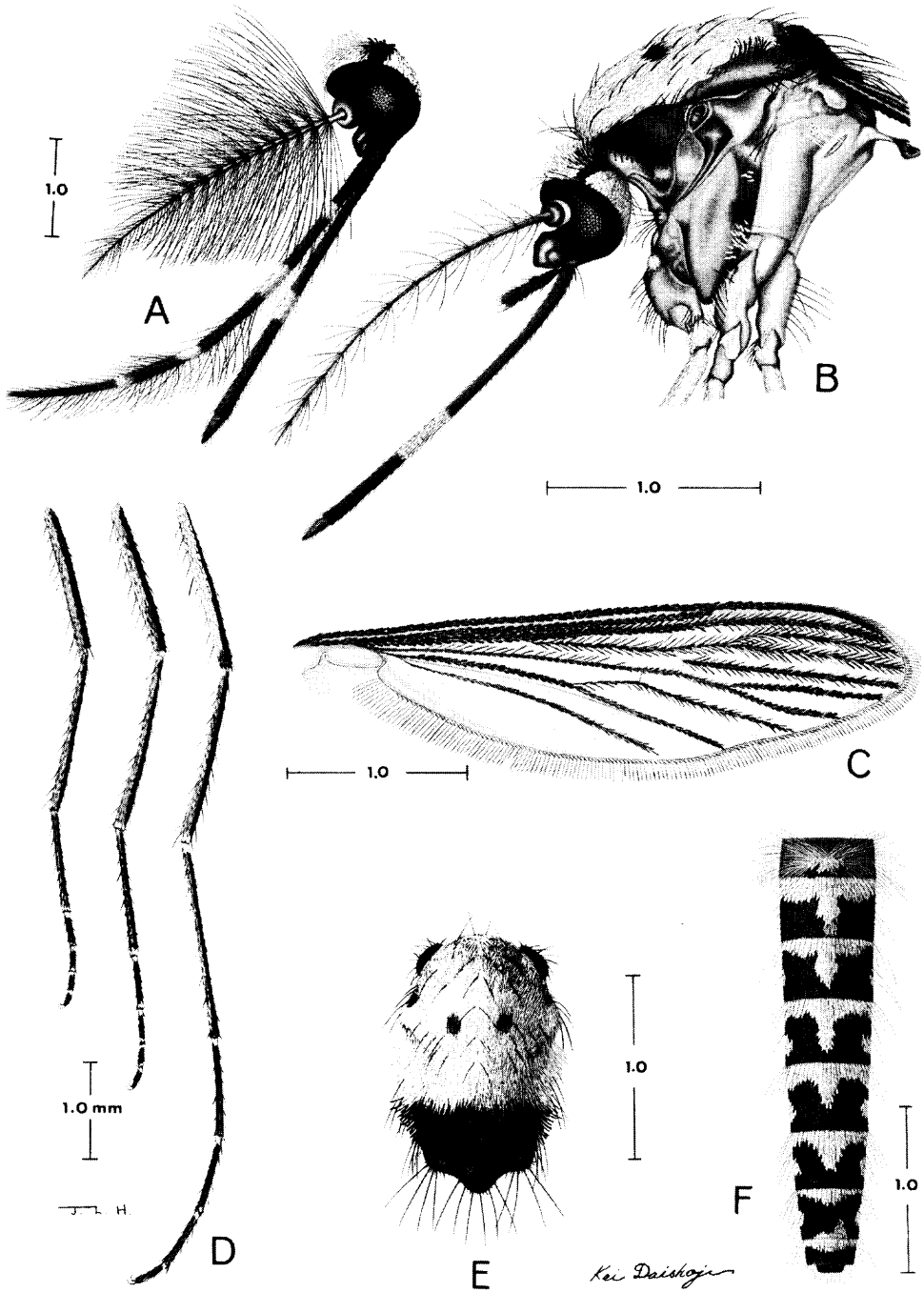
Leucomyia gelida var. *bipunctata* Theobald 1907, Mon. Cul. 4: 374 (♂); Edwards 1932, *in* Wytsman, Genera Insect., fasc. 194: 203 (synonymy).

Theobaldiomyia gelidus (Theobald): Brunetti 1912, Rec. Indian Mus. 4: 462 (taxonomy).

Culex (Culex) gelidus Theobald: Edwards 1932, *in* Wytsman, Genera Insect., fasc. 194: 203 (taxonomy); Barraud 1934, Fauna Brit. India, Diptera 5: 407 (♂*, ♀, L*); Bonne-Wepster and Brug 1937, Geneesk. Tijdschr. Ned.-Ind. 77: 74 (♂, ♀*); Baisas 1938, Mon. Bull. Philipp. Hlth. Serv. 18: 212 (♂*, ♀*, L*, P*); Bonne-Wepster and Brug 1939, Geneesk. Tijdschr. Ned.-Ind. 79: 1271 (L*); Mondchadskii 1951, Moscow zool. Inst. Akad. Nauk SSSR 37: 262 (L*); Bonne-Wepster 1954, Roy. trop. Inst. Amst., spec. publ. 111: 119 (♂, ♀*, L*); Delfinado 1966, Mem. Amer. ent. Inst. 7: 144 (♂*, ♀, L*).

Figure 92. ← *C. (Culex) sitiens.* Fourth stage larva: dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments.

Fig.93



C.(Culex) gelidus

The adult female may be recognized by the presence of a dense covering of silver-white scales on the anterior 2/3 of the scutum and the absence of silver scales on the scutellum. The male is distinguished by the scales of the scutum and by the simple inner division of the phallosome of the terminalia, which is covered with fine sculpturings. The fourth stage larva exhibits an expanded siphon and the subventral tufts are all inserted in a line.

FEMALE. *Head.* (Figure 93B). Proboscis dark brown, with a moderately broad median band of paler scales; palpus dark brown, in some specimens with several white scales randomly scattered among the dark; decumbent scales of the vertex silver-white at the occiput, then with a narrow area of dark brown scales, and with dull brownish white scales posterolaterally; erect scales silver-white at the occiput and dark brown posterolaterally. *Thorax.* (Figure 93B, E). Scutum covered with a dense pattern of silver-white scales which terminate at approximately the level of the wing base; within the silver-white scale pattern are 2 or 4 variable, round patches of dark brown scales; the posterior third of the scutum and the scutellum more sparsely covered with dark brown scales; integument of the pleuron light brown, with some faintly darker brown areas on the sternopleuron; distinct but sparse patches of white scales on the upper and posterior sternopleuron. *Wing.* (Figure 93C). All dorsal wing scales light brown. *Legs.* (Figure 93D). Anterior surface of the hind femur lightly scaled proximally, with a dark apical band which extends along the dorsal margin; hind tibia clothed with light brown scales and with a narrow apical light band; hind tarsus light brown, with narrow basal white bands on tarsomeres I-V; fore and mid femora darker; fore and mid tibiae and tarsi marked as the hind legs. *Abdomen.* (Figure 93F). Terga dark scaled with moderately broad basal light bands which reach to the lateral margins and with a median, posteriorly directed "V" which in some cases almost reaches the posterior margin of the tergum and with lateral triangular patches which are barely visible from above (specimens with a straight posterior margin are occasionally found); sterna primarily pale, but with dark scales at the anterior and posterior margins.

MALE. *Head.* (Figure 93A). Proboscis with a well defined pale band near the middle, without a basomedian patch of conspicuous setae; palpus dark, with narrow basal and broad median pale bands on segment III, and narrow basal pale bands on IV and V. *Terminalia.* (Figure 94C). Subapical lobe of the basimere well developed with 3 basal rods followed by 3 accessory setae (one of which is very broad), a broad symmetrical leaf, and a gently curved seta; distimere expanded medially with minute annulations on the convex surface at the apex; inner division of the phallosome short, blunt, slightly curved laterally and heavily sculptured; outer division evenly rounded, spiculate; proctiger crowned with a tuft of strong spines and with 2 or 3 cercal setae; basal sternal process long, darkly pigmented, and strongly curved.

PUPA. (Figure 94A, B).

LARVA. (Figure 95). *Head.* Antenna pale, with a narrow, dark

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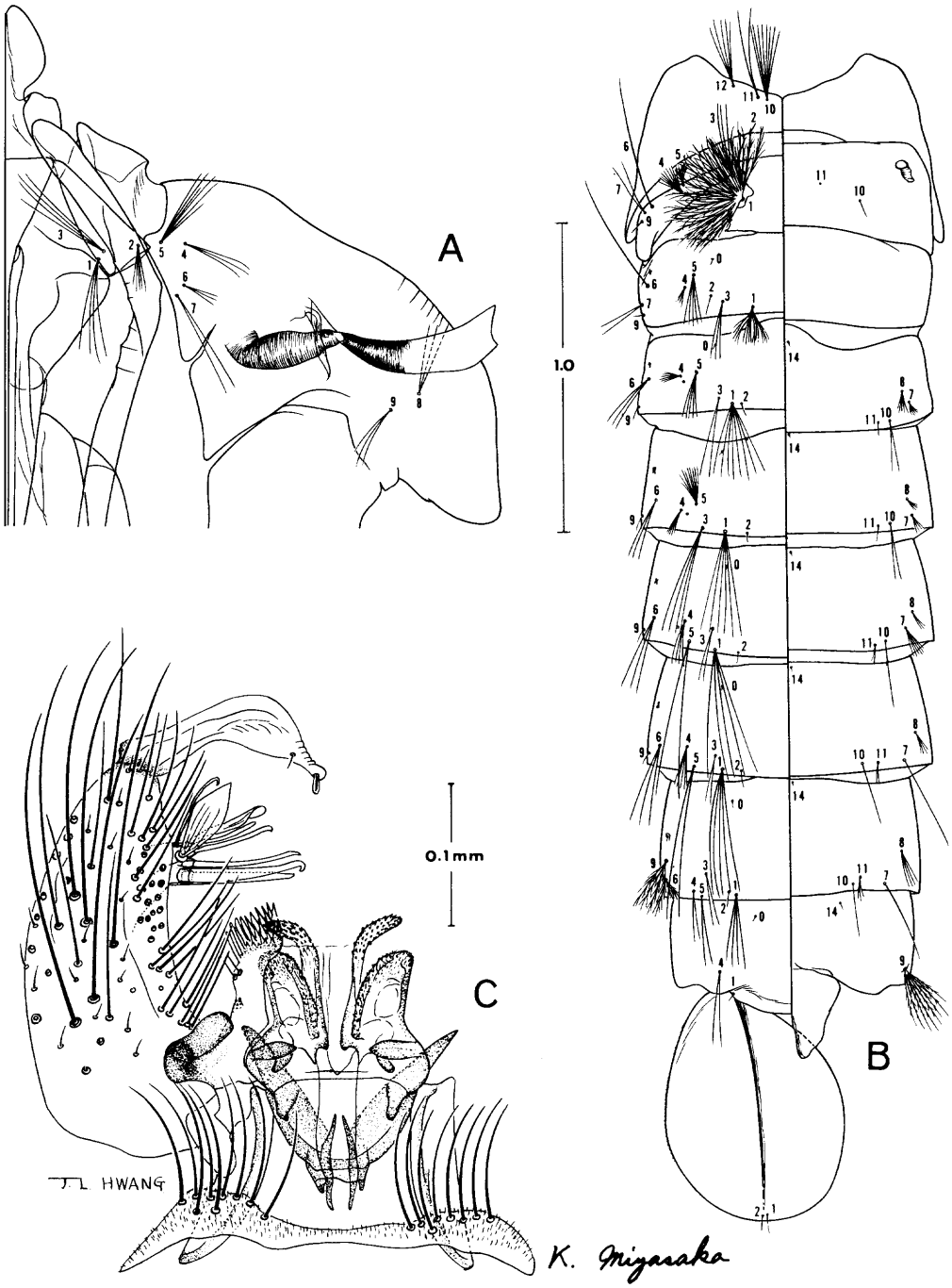
Figure 93. *C. (Culex) gelidus.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

Fig. 94



C.(Culex) gelidus

basal ring; head hair 1-C darkly pigmented, tapering to a sharp point, its length approximately half the distance between the bases of the pair; 4-C single, simple; 5, 6-C trifid, pectinate. *Thorax*. Integument glabrous; hairs 1, 2, 3-P single, pectinate, subequal in length; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P trifid, pectinate; 8-P bifid, pectinate; 14-P single, simple. *Abdomen*. Integument glabrous; comb consisting of from 30 to 40 fan-shaped scales arranged in a broad, triangular patch; siphon index variable, ranging from 3:1 to 3.5:1, the siphon expanded medially; 4 pairs of subventral tufts inserted in a straight line on the siphon; individual tufts with from 3 to 6 branches, their length less than the width of the siphon at the point of insertion; pecten consisting of from 7 to 12 teeth restricted to the basal third of the siphon; individual pecten tooth elongated, with a sharp apical spine and from 4 to 7 sharp lateral barbs.

TYPE DATA. In the British Museum are 2 female specimens labeled in Theobald's hand as "type" of *gelidus*: one from "Malay Penin. Selangor, Kelang, A. L. Butler"; the other from "29.11. & 21 12 99, Strait Settlements, Perak, Taiping, L. Wray Junr.". The first of these is hereby designated lectotype for *Culex gelidus;* the latter is hereby designated lectotype for *Culex gelidus* var. *cuneatus*. This decision is based on Theobald's (1901) statement that the original description of *gelidus* was prepared from a single female, and by the fact that his description applies perfectly to the designated lectotype. Theobald's (1901) description (including locality data) of var. *cuneatus* conforms precisely to the above lectotype designated for this variety. Holotype male of *Leucomyia gelida* var. *bipunctata* from "India" in the British Museum.

DISTRIBUTION. This species is probably distributed throughout THAILAND and during this study specimens have been examined from: *Chiang Mai, Chiang Rai, Chon Buri, Ayutthaya, Krung Thep, Lampang, Lamphun, Narathiwat, Nonthaburi, Pathum Thani, Phet Buri, Ranong, Rayong, Thon Buri, Trang,* and *Udon Thani*. In addition, *gelidus* has been recorded from: MALAYA, INDONESIA, NEW GUINEA, PHILIPPINES, TAIWAN (?), JAPAN, CHINA, INDOCHINA, BURMA, NEPAL, INDIA, PAKISTAN, and CEYLON.

During this study the following specimens have been studied from Thailand: 486 females and 362 males, 2 with their associated larval and pupal skins, and 154 larvae.

TAXONOMIC DISCUSSION. Although the female of *gelidus* resembles *whitmorei*, the male terminalia and fourth stage larva are distinctive from other members of the subgenus. In *gelidus* females the silver-white scales of the scutum terminate at about the level of the wing base, whereas in *whitmorei* these scales continue posteriorly through the prescutellar space and onto the mid-lobe of the scutellum.

BIOLOGY. Larvae of *gelidus* have been collected from a variety of habitats associated with temporary or semipermanent fresh ground water such as pools, puddles, small streams, etc., and have occasionally been collected from artificial containers such as barrels and water tanks. Colless (1957c) reported a high level of abundance in hyacinth ponds, but also collected larvae from transient pools with emergent vegetation.

Adult females are vicious biters but feed on man only in the absence of

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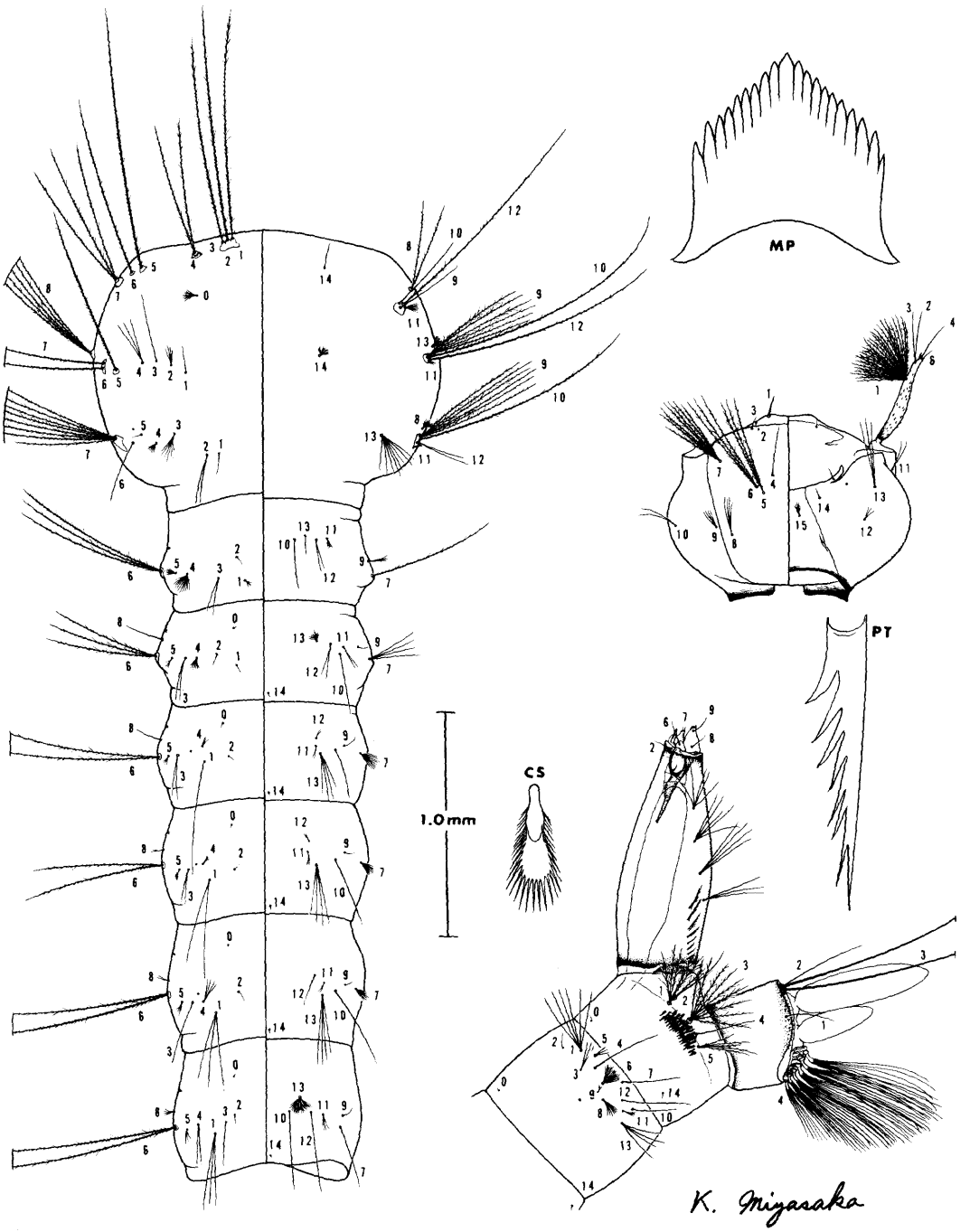
Figure 94. *C. (Culex) gelidus*. A, B, dorsoventral aspects of the pupa; C, dorsal aspect of the male terminalia.

Fig.95



C. (Culex) gelidus

other suitable hosts. Colless (1959b) concluded that the adults feed primarily on the larger domestic animals but show a general lack of interest in man (Colless 1959c). Scanlon and Esah (1965) reported collecting *gelidus* females biting man at 2,500 to 4,500 feet of elevation on a mountain in Chiang Mai.

Japanese B encephalitis virus has been isolated from *gelidus* females in Malaya (Gould *et al.* 1962) and in Thailand (Anon. 1964), and the species is recognized to be at least a potential vector.

CULEX (CULEX) WHITMOREI (GILES) 1904
(Figures 96 and 97)

Taeniorhynchus whitmorei Giles 1904, J. trop. Med. 7: 367 (♀).
Taeniorhynchus argenteus Ludlow 1905, Canad. Ent. 37: 98 (♀); Theobald 1910, Mon. Cul. 5: 426 (♀*); Edwards 1913, Bull. ent. Res. 4: 232 (synonymy).
Leucomyia plegepennis Theobald 1907, Mon. Cul. 4: 375 (♀); Edwards 1913, Bull. ent. Res. 4: 232 (synonymy).
Culex albus Leicester 1908, Cul. Malaya: 148 (♀); Edwards 1913, Bull. ent. Res. 4: 232 (synonymy).
Culex loricatus Leicester 1908, Cul. Malaya: 151 (♀); Edwards 1917, Bull. ent. Res. 7: 225 (synonymy).
Culex whitmorei (Giles): Edwards 1913, Bull. ent. Res. 4: 232 (taxonomy); Edwards 1917, Bull. ent. Res. 7: 225 (taxonomy); Barraud 1923, Indian J. med. Res. 10: 941 (L*); Barraud 1924, Indian J. med. Res. 11: 988 (♂*, ♀).
Culex (Culex) whitmorei (Giles): Edwards 1932, *in* Wytsman, Genera Insect., fasc. 194: 203 (taxonomy); Barraud 1934, Fauna Brit. India, Diptera 5: 406 (♂*, ♀, L*); Stackelberg 1937, Faune de l'URSS, Ins. Dipt. 3: 232 (♂*, ♀); Bonne-Wepster and Brug 1937, Geneesk. Tijdschr. Ned.-Ind. 77: 77 (♂, ♀*); Baisas 1938, Mon. Bull. Philipp. Hlth. Serv. 18: 211 (♂*, ♀, P*, L*); Bonne-Wepster and Brug 1939, Geneesk. Tijdschr. Ned.-Ind. 79: 1273 (L*); Bohart 1945, Navmed 580: 81 (♀, L); LaCasse and Yamaguti 1950, Mosq. Fauna Japan and Korea: 211 (♂*, ♀*, L*, P*); Monchadskii 1951, Moscow zool. Inst. Akad. Nauk SSSR 37: 281 (L*); Bonne-Wepster 1954, Roy. trop. Inst. Amst., Spec. Publ. 111: 120 (♂, ♀*, L*); Hara 1957, Jap. J. exp. Med. 27: 56 (♀*); Delfinado 1966, Mem. Amer. ent. Inst. 7: 155 (♂*, ♀, L*).

The adult female may be identified by the prominent silver-white pattern of the scutum which extends through the prescutellar space and onto the mid-lobe of the scutellum. The adult male is recognized by the above mentioned characters as well as the distinctive setae on the subapical lobe of the basimere of the terminalia. The fourth stage larva is characterized by

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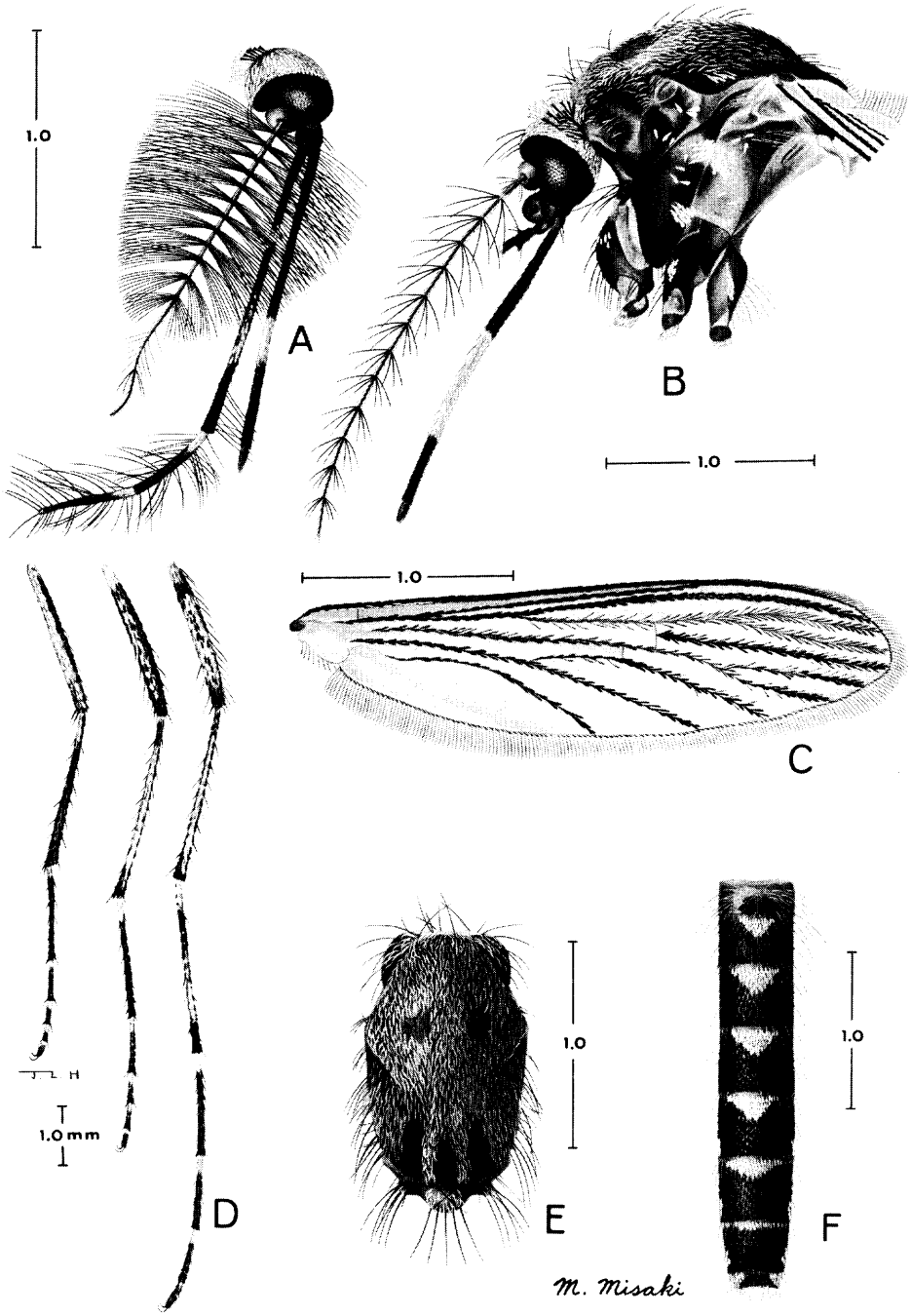
Figure 95. ← *C. (Culex) gelidus*. Fourth stage larva: dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments.

Fig.96



C. (Culex) whitmorei

the siphon shape and the pectinate subventral tufts of the siphon.

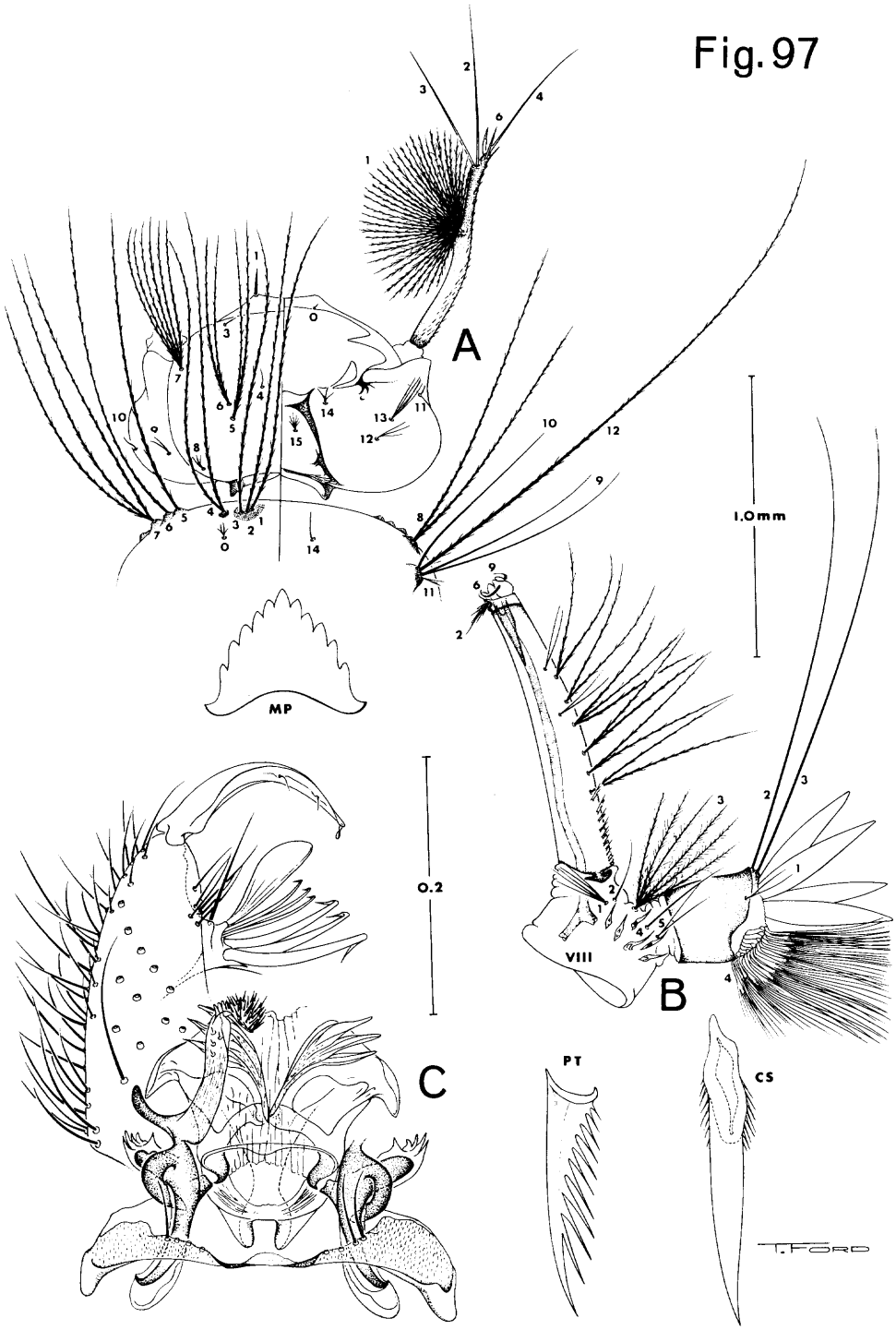
FEMALE. *Head.* (Figure 96B). Proboscis dark brown with a rather broad median band of white scales; palpus similar in color to the proboscis, tipped with several white scales at the apex; decumbent scales of the vertex silver-white; erect scales similar in color to the decumbent scales, but usually with some darker brown scales posterolaterally. *Thorax.* (Figure 96B, E). Scutum with a pattern of silver-white scales (usually not as dense as found in *gelidus*) which extend through the prescutellar space and onto the mid-lobe of the scutum; within the silver-white pattern is a pair of indistinct small brown patches in the anterior dorsocentral area and occasionally a single, variable brown patch in the posterior acrostichal area; integument of the pleuron variable, the sternopleuron usually darker than the mesepimeron; patches of pale scales on the upper mesepimeron and upper and posterior sternopleuron. *Wing.* (Figure 96C). All dorsal wing scales brown. *Legs.* (Figure 96D). Anterior surface of the hind femur with a variable scattering of pale scales medially; hind tibia predominantly dark, usually with a median stripe of pale scales; hind tarsus dark, with moderately broad basal white bands on tarsomeres I-V and occasionally with a paler median band on tarsomere I; fore and mid femora with scattered pale scales; mid tibia marked as the hind tibia; fore tibia completely dark, or occasionally with a narrow white basal patch of scales; fore and mid tarsi marked as the hind tarsus but without the median band on tarsomere I. *Abdomen.* (Figure 96F). Terga dark scaled with variable pale basal bands on segments II-VII; the basal pale bands usually greatly expanded medially and usually not reaching the lateral margins; apicolateral pale patches usually present, but not visible from above; sterna predominantly pale.

MALE. *Head.* (Figure 96A). Proboscis without a basomedian patch of conspicuous setae; palpus dark, with a narrow apical pale band on segment II, narrow basal and rather broad median pale bands on III, and narrow basal pale bands on IV and V. *Terminalia.* (Figure 97C). Subapical lobe of the basimere well developed, with an exceptionally strong, hooked basal rod followed by 2 shorter, hooked rods, 3 or 4 hooked accessory setae, a broad leaf, and a straight seta; distimere normal in shape, without annulations on the convex surface; inner division of the phallosome with 3 strong, laterally directed teeth; proctiger crowned with a tuft of strong spines and with 3 or 4 cercal setae; basal sternal process relatively short, gently curved.

LARVA. (Figure 97A, B). *Head.* Antenna with a narrow, dark basal ring and somewhat darker beyond insertion of hair 1-A; head hair 1-C strongly pigmented, gradually tapering to a sharp point, its length approximately half the distance between the bases of the pair; 4-C single, simple; 5-C bifid, pectinate; 6-C usually bifid, sometimes trifid, pectinate. *Thorax.* Integument glabrous; hairs 1, 2, 3-P single, pectinate, subequal in length; 4-P usually bifid, pectinate; 5, 6-P single, pectinate; 7-P trifid, pectinate; 8-P usually bifid (sometimes single), pectinate; 14-P single, simple. *Abdomen.*

Figure 96. *C. (Culex) whitmorei.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

Fig. 97



C. (Culex) whitmorei

Integument glabrous; comb consisting of from 4 to 8 scales arranged in an irregular row; individual comb scale with a very strong, extended apical spine and fringed with minute basolateral spicules; siphon index variable, ranging from 4:1 to 5.5:1, the siphon gradually tapering to a narrow apex and gently curved; 7 or 8 pairs of subventral tufts inserted on the siphon, the apical and one median pair inserted laterally out of line; individual tufts bifid, pectinate, their length greater than the width of the siphon at the point of insertion; the tufts which are laterally displaced are bifid, simple, shorter and slenderer than the other tufts; hair 2 of the siphon exceptionally large, frequently with accessory hairlets arising from the base; pecten consisting of from 6 to 12 teeth restricted to the basal fourth or less of the siphon; individual pecten tooth with a prominent apical spine and with approximately 10 fine lateral barbs.

TYPE DATA. Holotype female of *whitmorei* from Pampanga, Luzon, Philippines in the British Museum. Holotype female of *argenteus* from Pampanga, Luzon, Philippines in the U. S. National Museum. Holotype female of *plegepennis* from Kobe, Honshu, Japan in the British Museum. Holotype female (badly damaged with head missing) of *albus* from Kuala Lumpur, Malaya in the British Museum. Holotype female of *loricatus* from Kuala Lumpur, Malaya in the British Museum.

DISTRIBUTION. In THAILAND, this species has been collected from: *Chiang Mai, Chiang Rai, Chon Buri, Krung Thep, Lampang, Lamphun,* and *Nakhon Nayok;* however, it is probably more extensively distributed within the country. In addition, *whitmorei* has been reported from throughout the ORIENTAL REGION as well as from NEW GUINEA, CHINA, KOREA, JAPAN, and Maritime Province, U. S. S. R.

During this study the following material has been examined from Thailand: 268 females, 52 males, and 10 larvae.

TAXONOMIC DISCUSSION. As indicated under *gelidus,* the two species are similar as adults but may be easily separated on the basis of the male terminalia and fourth stage larva.

BIOLOGY. Although distributed over a broad geographical region, *whitmorei* is encountered rather infrequently and, as a result, little is known about its biology and behaviorial patterns. Larvae have been collected from fresh ground water habitats such as pools, rice paddies, and the margins of slowly moving streams. Delfinado (1966) reported females entering houses and biting at night.

BITAENIORHYNCHUS SUBGROUP

ADULT. *Thorax.* Scutum usually covered with an indistinct pattern of golden or whitish scales on at least the anterior half. *Abdomen.* Terga with white apical bands, with apicolateral triangular patches and basal bands, or with several segments completely covered with pale scales.

LARVA. *Head.* Hair 1-C lightly pigmented, rather long and cylindrical.

Figure 97. ← *C. (Culex) whitmorei.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the male terminalia.

Abdomen. Comb consisting of a few very long, simple scales; siphon relatively long; pecten inconspicuous, consisting of a few teeth restricted to the basal 1/5 of the siphon or less.

TAXONOMIC DISCUSSION. Edwards (1932) assigned 12 species to his *bitaeniorhynchus* series and there appears to be no doubt that this is a valid and distinctive subdivision of the *sitiens* group. Although Thurman (1959) recorded *cornutus* Edwards as being represented in fauna of Thailand, the record is regarded as questionable and only 3 species, *bitaeniorhynchus*, *pseudosinensis*, and *sinensis*, are presently recognized as members of the *bitaeniorhynchus* subgroup of Thailand.

CULEX (CULEX) BITAENIORHYNCHUS GILES 1901
(Figures 98, 99, and 100)

Culex bitaeniorhynchus Giles 1901, J. Bombay nat. Hist. Soc. 13: 607 (adult); Edwards 1913, Bull. ent. Res. 4: 231 (taxonomy); Edwards 1921, Bull. ent. Res. 12: 337 (♀); Edwards 1922, Indian J. med. Res. 10: 282 (♂*, ♀); Barraud 1923, Indian J. med. Res. 10: 936 (L*); Barraud 1924, Indian J. med. Res. 11: 984 (♂*, ♀).

Taeniorhynchus ager Giles 1901, Entomologist 34: 196 (♀); Giles 1902, Handb., 2nd ed.: 365 (♀); Blanchard 1905, Les Moustiques: 385 (♀); Leicester 1908, Cul. Malaya: 168 (♂, ♀); Edwards 1912, Bull. ent. Res. 3: 30 (taxonomy); Edwards 1913, Bull. ent. Res. 4: 231 (synonymy).

Culex infula Theobald 1901, Mon. Cul. 1: 370 (♀*); Giles 1902, Handb., 2nd ed.: 407 (♀); Blanchard 1905, Les Moustiques: 298 (♀); Leicester 1908, Cul. Malaya: 146 (♀); Edwards 1912, Bull. ent. Res. 3: 30 (synonymy with *ager*).

Taeniorhynchus tenax Theobald 1901, Mon. Cul. 2: 198 (♀*); Giles 1902, Handb., 2nd ed.: 365 (♀); Theobald 1903, Mon. Cul. 3: 258 (♀*); Blanchard 1905, Les Moustiques: 386 (♀); Leicester 1908, Cul. Malaya: 167 (♀); Edwards 1913, Bull. ent. Res. 4: 231 (synonymy); Edwards 1922, Indian J. med. Res. 10: 283 (♂*, ♀, as variety of *bitaeniorhynchus);* Barraud 1924, Indian J. med. Res. 11: 985 (♂*, ♀); Barraud 1934, Fauna Brit. India, Diptera 5: 393 (♀, L); Bohart 1956, Ins. Micronesia 12: 84 (synonymy).

Grabhamia ambiguus Theobald 1903, Mon. Cul. 3: 248 (♂); Edwards 1913, Bull. ent. Res. 4: 231 (synonymy); Edwards 1922, Indian J. med. Res. 10: 283 (♀, as variety of *bitaeniorhynchus);* Barraud 1924, Indian J. med. Res. 11: 985 (♀, L); Barraud 1934, Fauna Brit. India, Diptera 5: 393 (♀); Baisas 1938, Mon. Bull. Philipp. Hlth. Serv. 18: 211 (♂); Bohart 1956, Ins. Micronesia 12: 84 (synonymy).

Grabhamia taeniarostris Theobald 1907, Mon. Cul. 4: 299 (♀); Edwards

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Figure 98. *C. (Culex) bitaeniorhynchus.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

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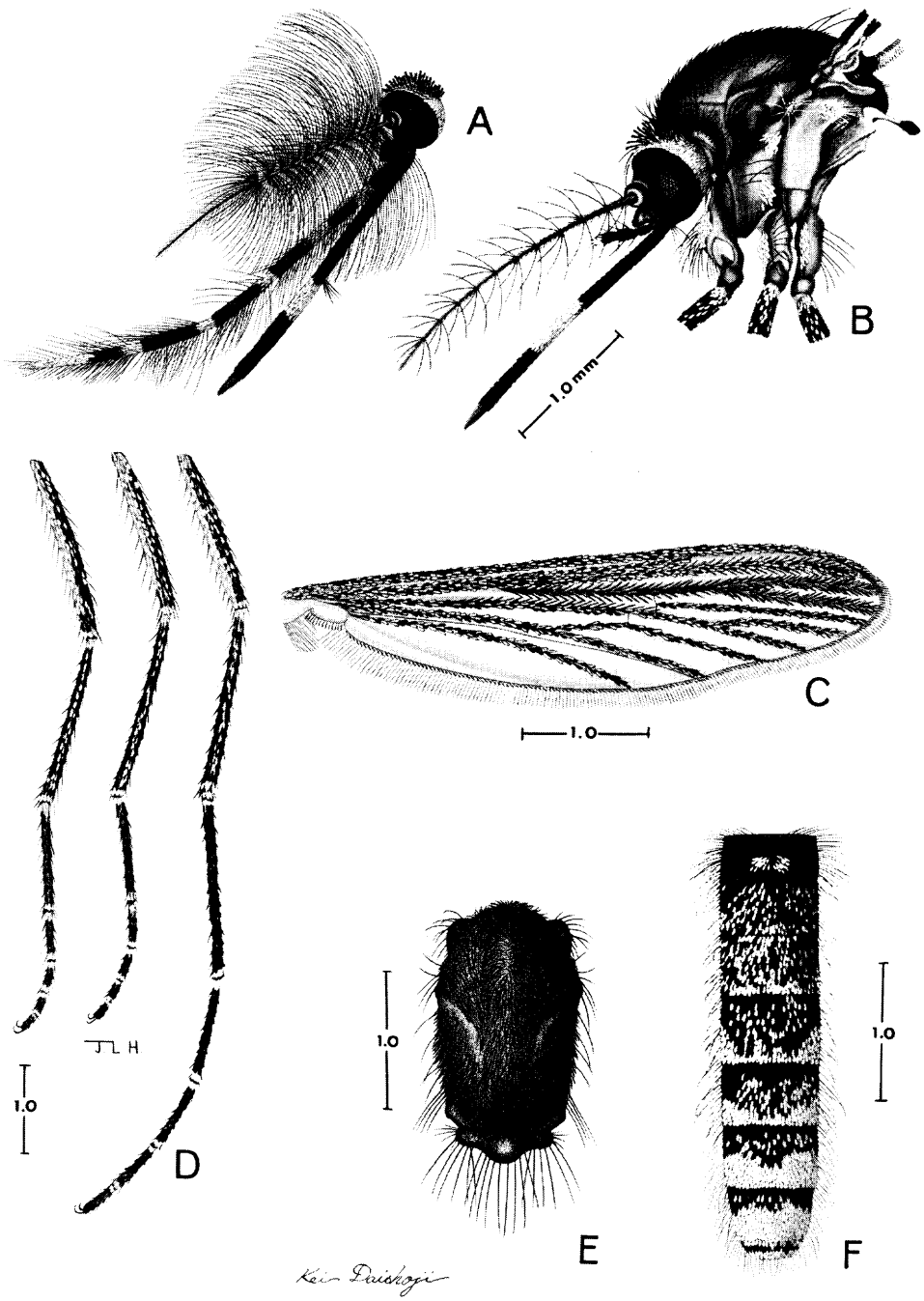
Fig.98



C. (Culex) bitaeniorhynchus

1913, Bull. ent. Res. 4: 231 (synonymy).

Taeniorhynchus tenax var. *ocellata* Theobald 1907, Mon. Cul. 4: 488 (♀*); Edwards 1913, Bull. ent. Res. 4: 231 (synonymy).

Oculeomyia sarawaki Theobald 1907, Mon. Cul. 4: 515 (♀*); Edwards 1913, Bull. ent. Res. 4: 231 (synonymy).

Taeniorhynchus domesticus Leicester 1908, Cul. Malaya: 169 (♂, ♀); Edwards 1913, Bull. ent. Res. 4: 231 (as variety of *bitaeniorhynchus*); Barraud 1924, Indian J. med. Res. 11: 984 (synonymy); Edwards 1932, *in* Wytsman, Genera Insect., fasc. 194: 202 (synonymy with *aurantapex* Edwards). NEW SYNONYMY.

Culicelsa abdominalis Taylor 1913, Rep. Aust. Inst. trop. Med. 1911: 7 (♀*); Edwards 1913, Bull. ent. Res. 4: 231 (synonymy).

Culex karatsuensis Mochizuki 1913, Fukuoka Acta med. 7: 28 (♂*, ♀*, E); Tokunaga 1944, Iyo konchu gaku 1: 722 (as variety of *bitaeniorhynchus);* LaCasse and Yamaguti 1950, Mosq. Fauna Japan and Korea: 201 (synonymy).

Culex (Culex) bitaeniorhynchus Giles: Edwards 1932, *in* Wytsman, Genera Insect., fasc. 194: 202 (taxonomy); Barraud 1934, Fauna Brit. India, Diptera 5: 391 (♂*, ♀, L*); Hopkins 1936, Mosq. Ethiop. Reg. 1: 198 (L); Bonne-Wepster and Brug 1937, Geneesk. Tijdschr. Ned.-Ind. 77: 73 (♂, ♀); Baisas 1938, Mon. Bull. Philipp. Hlth. Serv. 18: 211 (♂*, ♀*, P*, L*); Edwards 1941, Mosq. Ethiop. Reg. 3: 290 (♂*, ♀); Bohart 1945, Navmed 580: 78 (♀, L); Bohart and Ingram 1946, Navmed 1055: 77 (♂*, ♀, L*); Mohan 1950, Indian J. Malar. 4: 167 (♀, P*, L, E); LaCasse and Yamaguti 1950, Mosq. Fauna Japan and Korea: 201 (♂*, ♀*, L*, P*); Monchadskii 1951, Moscow zool. Inst. Akad. Nauk SSSR 37: 258 (L*); Asanuma and Nakagawa, 1953, Misc. Rep. Res. Inst. nat. Resour. 31: 93 (P*); Laird 1954, Bull. ent. Res. 45: 288 (L*); Belkin 1962, Mosq. S. Pacif. 1: 215 (♂*, ♀, L*, P*); Delfinado 1966, Mem. Amer. ent. Inst. 7: 140 (♂*, ♀, P, L*).

The adult female, male terminalia, and fourth stage larva of this species are extremely variable. The female may be recognized by the combination of apical tergal bands and the scattered white wing scales. The male terminalia is characterized by the setae on the subapical lobe of the basimere, and the expanded spiculate portion of the lateral plate of the phallosome. The fourth stage larva may be recognized by the distinctive mentum, by the elongated comb scales, and by the reduced pecten.

FEMALE. *Head.* (Figure 98B). Proboscis dark brown with a broad median band of white scales, in some specimens with a few scattered white scales proximal to the band; palpus similar in color to the proboscis, with some scattered white scales, particularly at the apex; decumbent scales of the vertex light brown, somewhat lighter at the orbital line; erect scales darker brown. *Thorax.* (Figure 98B, E). Scutum extremely variable, ranging from the condition in which all scales are dark brown (illustrated in figure 98E) to a condition in which there exists an indistinct grouping of golden scales which terminates at about the level of the wing base; a variety of intermediate forms exist and in some specimens indistinct darker and lighter patches may be recognized; integument of the pleuron basically light brown, but with indistinct and variable darker patterns sometimes present, particularly on the posterior spiracular plate and the sternopleuron; scattered variable light

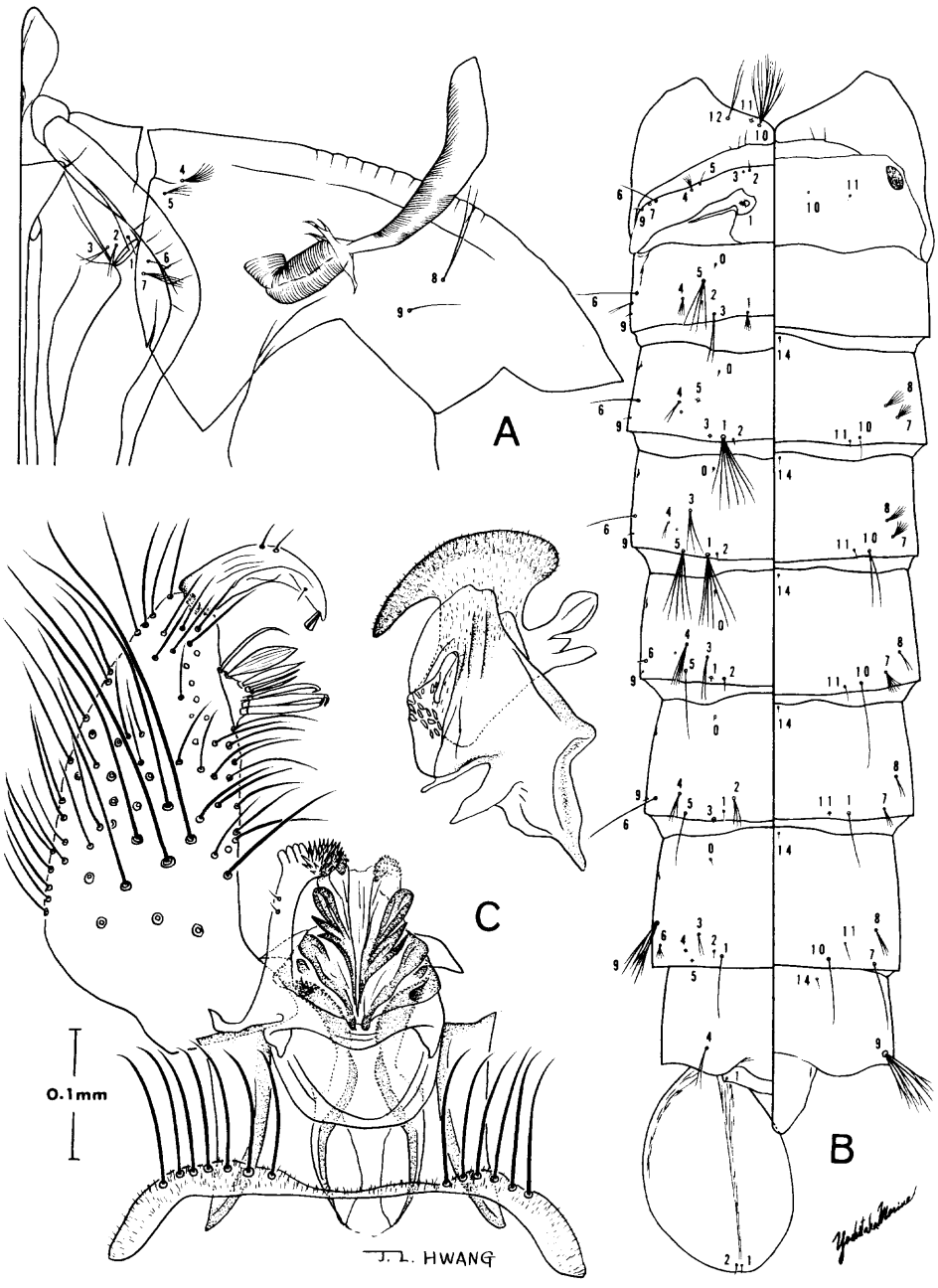
scale patches on the posterior pronotum, anterior pronotum, sternopleuron, and propleuron (in figure 98B illustrated on the sternopleuron only). *Wing.* (Figure 98C). All dorsal wing scales usually equally mixed with dark brown and white scales; this condition is extremely variable and in some specimens there may be only a few pale scales present, or in other specimens concentrated particularly on the costa, subcosta and vein R_1; scales of the plume series usually broadly clavate, but narrow in some specimens. *Legs.* (Figure 98D). Hind femur and tibia basically dark brown, usually with narrow basal and apical pale bands and with a variable number of pale scales randomly scattered among the dark; hind tarsus dark, but also with some randomly scattered pale scales and with narrow basal pale bands on tarsomeres I-V and with very narrow apical pale bands on tarsimeres I-IV; markings of the fore and mid legs similar to the hind legs. *Abdomen.* (Figure 98F). Terga extremely variable, most commonly dark with a distinct, broad apical pale band on all segments and with some light scales scattered among the dark; the apical band is extended anteriorly at the lateral margins; in some specimens (the "*tenax*" form), the proximal terga are almost entirely dark and only a few of the distal terga demonstrate pale apicolateral patches, and in other specimens (the "*ambiguus*" form) there are median basal as well as apical lateral triangular pale patches, or occasionally with the distal segments completely pale; sterna predominantly pale, but with variable apical and basal dark patches.

MALE. *Head.* (Figure 98A). Proboscis banded and with a strong medioventral tuft of setae; palpus dark, with variable banding, usually with a basal pale band on segment II, basal and median pale bands on III, a basal pale band on IV, and basal and apical pale bands on V. *Terminalia.* (Figure 99C). Subapical lobe of the basimere rather flat, with a broad basal rod, 2 more slender rods, 3 or 4 accessory setae, one of which is rather broad and leaf-like, a slender, short leaf, and a gently curved seta; distimere normal in shape, but rather short and without annulations; inner division of the phallosome with from 1 to 3 very broad, blunt teeth, and with the spiculate portion greatly expanded and extending to a point; proctiger crowned with a tuft of strong spines and with 2 or 3 cercal setae; basal sternal process short, usually straight.

PUPA. (Figure 99A, B).

LARVA. (Figure 100). *Head.* Antenna with a narrow, dark basal ring and progressively darker beyond insertion of hair 1-A; head hair 1-C lightly pigmented, its length approximately equal to the distance between the bases of the pair; 4-C usually bifid, but may range from 1 to 4 branches, simple; 5-C usually trifid, occasionally with from 2 to 5 branches, pectinate; 6-C almost always bifid, occasionally single or trifid, pectinate; mentum darkly pigmented, triangular in shape, consisting of 40 or more narrow, bluntly rounded, tightly compacted denticles on each side. *Thorax.* Integument glabrous; hairs 1, 2, 3-P single, pectinate, subequal in length; 4-P usually bifid, occasionally single, pectinate; 5, 6-P single, pectinate; 7-P trifid, pectinate; 8-P bifid, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; comb consisting of from 4 to 8 scales arranged in an irregular row; individual comb scale a single, very strong, elongated, sharply pointed spine with a basolateral series of fine spicules on each side; siphon index variable, in specimens from Thailand ranging from 5:1 to 9:1; usually 4, occasionally 3 or 5 pairs of subventral tufts inserted in a line on the siphon;

Fig.99



C. (Culex) bitaeniorhynchus

individual tufts usually bifid, simple, occasionally with from 1 to 4 branches, their length less than the width of the siphon at the point of insertion; pecten consisting of from 4 to 10 teeth restricted to the proximal fifth or less of the siphon; individual pecten tooth with a strong but short apical spine and from 2 to 5 strong lateral barbs.

TYPE DATA. The type locality of *bitaeniorhynchus* is Travancore, India but the type specimen has been lost. Although Giles' (1901) original description of *ager* was of a female, there are 2 males in the British Museum labeled as "type" and from these 2 specimens a lectotype is hereby designated: type male (terminalia mounted and attached to pin), "Capt. Cornwall, Madras, Paddy field, 24.12.99" in the British Museum. Holotype female of *infula* from Taipang, Perak, Malaya in the British Museum. Holotype female of *tenax* from Perak, Malaya in the British Museum. Holotype male (terminalia mounted and attached to pin) of *ambiguus* from Quilon, Travancore, India in the British Museum. Holotype female of *taeniarostris* from Peradeniya, Ceylon in the British Museum. Holotype female of *tenax* var. *ocellata* from Kuching, Sarawak, Borneo in the British Museum. Holotype female of *sarawaki* from Sarawak, Borneo in the British Museum. Lectotype of *domesticus* hereby designated: cotype male (terminalia slide-mounted), "Fed. Malay States, G. F. Leicester, 1912-350", in the British Museum. The type locality of *abdominalis* is Ayr and Townsville, Queensland, Australia, but the type specimens are non-existent. The type locality of *karatsuensis* is Karatsu, Kyushu, Japan but the location of the type specimen is unknown.

DISTRIBUTION. This species is widely distributed throughout THAILAND and during this study specimens have been examined from: *Ayutthaya, Chanthaburi, Chiang Mai, Chiang Rai, Chon Buri, Chumphon, Kanchanaburi, Krung Thep, Lampang, Mae Hong Son, Nakhon Nayok, Nakhon Ratchasima, Nakhon Sawan, Nan, Nrathiwat, Nonthaburi, Pathum Thani, Prachuap Khiri Khan, Phare, Ranong, Rat Buri, Sara Buri, Satun, Songkhla, Sukhothai, Surat Thani, Tak, Thon Buri, Trang, Ubon Ratchathani, Udon Thani,* and *Uthai Thani.* In addition, *bitaeniorhynchus* has been reported from throughout the ORIENTAL REGION, large areas of the ETHIOPIAN REGION (including MADAGASCAR), AUSTRALIA, NEW GUINEA, some islands of the SOUTH PACIFIC, and the SOVIET FAR EAST.

During this study the following specimens of *bitaeniorhynchus* have been examined from Thailand: 103 females and 165 males, 40 with their associated larval and pupal skins, and 360 larvae.

TAXONOMIC DISCUSSION. A number of authors, most recently Belkin (1962), have suggested the possibility that *bitaeniorhynchus* represents a complex of species and that at least some of the presently regarded synonyms are, in fact, valid species. Examination of over 100 collections from throughout Thailand and comparison with material from other areas of Southeast Asia has led to the conclusion that *bitaeniorhynchus* is an extremely plastic species. Concordance of anatomical and colorational variations could not be established and, at least for populations on mainland Southeast Asia, it seems that specia-

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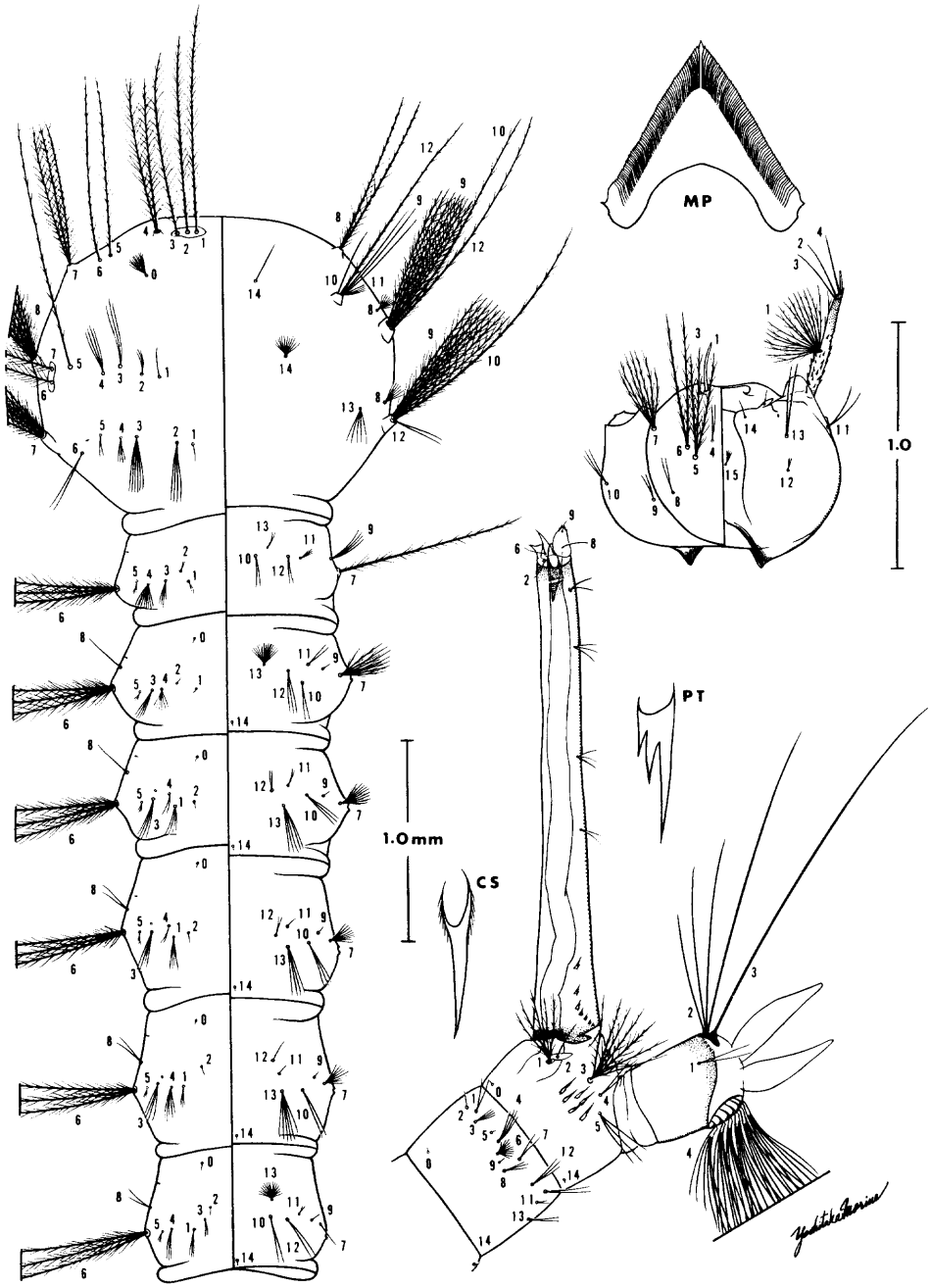
Figure 99. ← *C. (Culex) bitaeniorhynchus.* A, B, dorsoventral aspect of the pupa; C, dorsal aspect of the male terminalia with enlarged insert of the lateral aspect of the inner division of the phallosome.

Fig.100



C. (Culex) bitaeniorhynchus

tion has not progressed to the degree where variant forms may be validly designated as species. Future investigations involving sibling rearings, ecology, and perhaps cytogenetic studies may well indicate a need for the reevaluation of this interesting species.

BIOLOGY. The larval habitat of *bitaeniorhynchus* is restricted to accumulations of water containing *Spirogyra*, a filamentous green algae (Senior-White 1926). Mohan (1950) summarized observations from laboratory rearings and also concluded that larvae were incapable of developing to maturity in the absence of green algae. It was also observed that oviposition is usually postponed until induced by the presence of the algae. Similarly, Colless (1957c) collected larvae of this species exclusively in the presence of green algae from ponds, obstructed streams, and other similar impoundments.

Sasa and Sabin (1950) collected adults in Japan most frequently from traps baited with chicken, followed in importance by dog, goat, chicken and rabbit, man, and rabbit alone; however, only 57 percent of the mosquitoes from the chicken baited trap were engorged, 40 percent from dog, 8 percent from goat, 97 percent from chicken and rabbit, none from man, and 50 percent from rabbit alone. In Singapore, Colless (1959b) found that the origin of blood meals in females collected from unbiased sources were exclusively from birds, but also collected females from traps baited with pig, fowl, and cow, but not man. In contrast, *bitaeniorhynchus* has been reported biting man in Russia (Chagin 1948 as quoted in Colless 1959b) and in New Guinea (Bonne-Wepster 1956). Williamson and Zain (1937) induced this species to feed on man in Malaya.

In New Guinea, de Rook (1957) reported that the most numerous of 3 culicine species found naturally infected with mature forms of *Wuchereria bancrofti* was a *Culex bitaeniorhynchus*-like mosquito; however, it was suggested that, although the specimens agreed rather well with the morphological concept of *bitaeniorhynchus*, the form involved may actually have represented a distinct, man-feeding species. Williamson and Zain (1937) reported laboratory infection and sporozoite development of *Plasmodium vivax* in *bitaeniorhynchus*, but Mohan (1950) was unable to verify this work.

CULEX (CULEX) PSEUDOSINENSIS COLLESS 1955
(Figures 101 and 102)

Culex (Culex) pseudosinensis Colless 1955, Ann. trop. Med. Parasit. 49: 311 (♂*, ♀, L*).

The adult female may be separated from other members of the subgroup by the absence of pale scales on the wing veins, and by the presence of rather broad, pale basal abdominal bands and by apicolateral triangular patches which may converge at the center of the terga. The adult male is recognized by the above characters as well as the rather broad leaf on the

Figure 100. ← *C. (Culex) bitaeniorhynchus*. Fourth stage larva: dorsoventral view of the head, thorax and abdomen, and lateral aspect of the terminal abdominal segments.

subapical lobe of the basimere in the terminalia. The fourth stage larva is characterized by the rather short comb scales and the length of the pecten.

FEMALE. *Head.* (Figure 101B). Proboscis dark brown with a moderately broad median band of pale scales; palpus similar in color to the proboscis, but wihout light scales present; decumbent scales of the vertex pale golden; erect scales predominantly pale golden, but some of the scales dark posterolaterally. *Thorax.* (Figure 101B, E). Scutum covered with narrow pale golden to white scales anterior to the level of the wing base, with irregular dark patches in the area of the fossa, and completely dark posterior to the level of the wing base; scutellum with dark scales only; integument of the pleuron uniformly pale brown; with patches of pale scales on the upper and posterior sternopleuron and occasionally with some scattered pale scales on the mesepimeron. *Wing.* (Figure 101C). All dorsal wing scales uniformly bronze brown. *Legs.* (Figure 101D). Anterior surface of the hind femur predominantly dark brown, with a narrow basal band of golden scales and with an indistinct grouping of paler scales on the basoventral margin; hind tibia dark brown, with a few randomly scattered pale scales and with a narrow apical pale band; hind tarsus dark brown, with narrow basal and apical pale bands on tarsomeres I-IV and with a narrow basal band only on tarsomere V; fore and mid femora marked as the hind femur but with occasional scattered pale scales; fore and mid tibiae and tarsi marked as the hind legs. *Abdomen.* (Figure 101F). Terga basically dark scaled, but on terga II-VII with moderately broad, pale basal bands and triangular apicolateral spots which may meet at the center on terga V-VII; sterna predominantly pale, with scattered apical dark scales.

MALE. *Head.* (Figure 101A). Proboscis with the median pale band broader than in the female, and with some pale scales on the apex proximal to the band; with a basomedian tuft of strong setae; palpus dark, with narrow basal and broad median pale bands on segment III, narrow basal pale bands on IV and V, and a broad apical pale band on V. *Terminalia.* (Figure 102C). Subapical lobe of the basimere well developed with 3 rods, 3 accessory setae, a rather broad, short leaf, and a gently curved seta; distimere normal in shape, without annulations; lateral plate of the phallosome with 2 blunt teeth originating from a common base, with the spiculate portion very large and extended to both dorsal and ventral points; proctiger crowned with a tuft of strong spines and with 2 or 3 cercal setae; basal sternal process moderately long, gently curved.

LARVA. (Figure 102A, B). *Head.* Antenna with a narrow dark basal ring and slightly darker beyond insertion of hair 1-A; head hair 1-C lightly pigmented, cylindrical, pointed apically, its length slightly greater than the distance between the bases of the pair; 4-C single or bifid, simple; 5-C with 3 or 4 branches, pectinate; 6-C bifid, pectinate; mentum heavily sclerotized, triangular in shape, consisting of 40 or more narrow, bluntly rounded, tightly compacted denticles on each side. *Thorax.* Integument glabrous; hairs

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Figure 101. *C. (Culex) pseudosinensis.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen.

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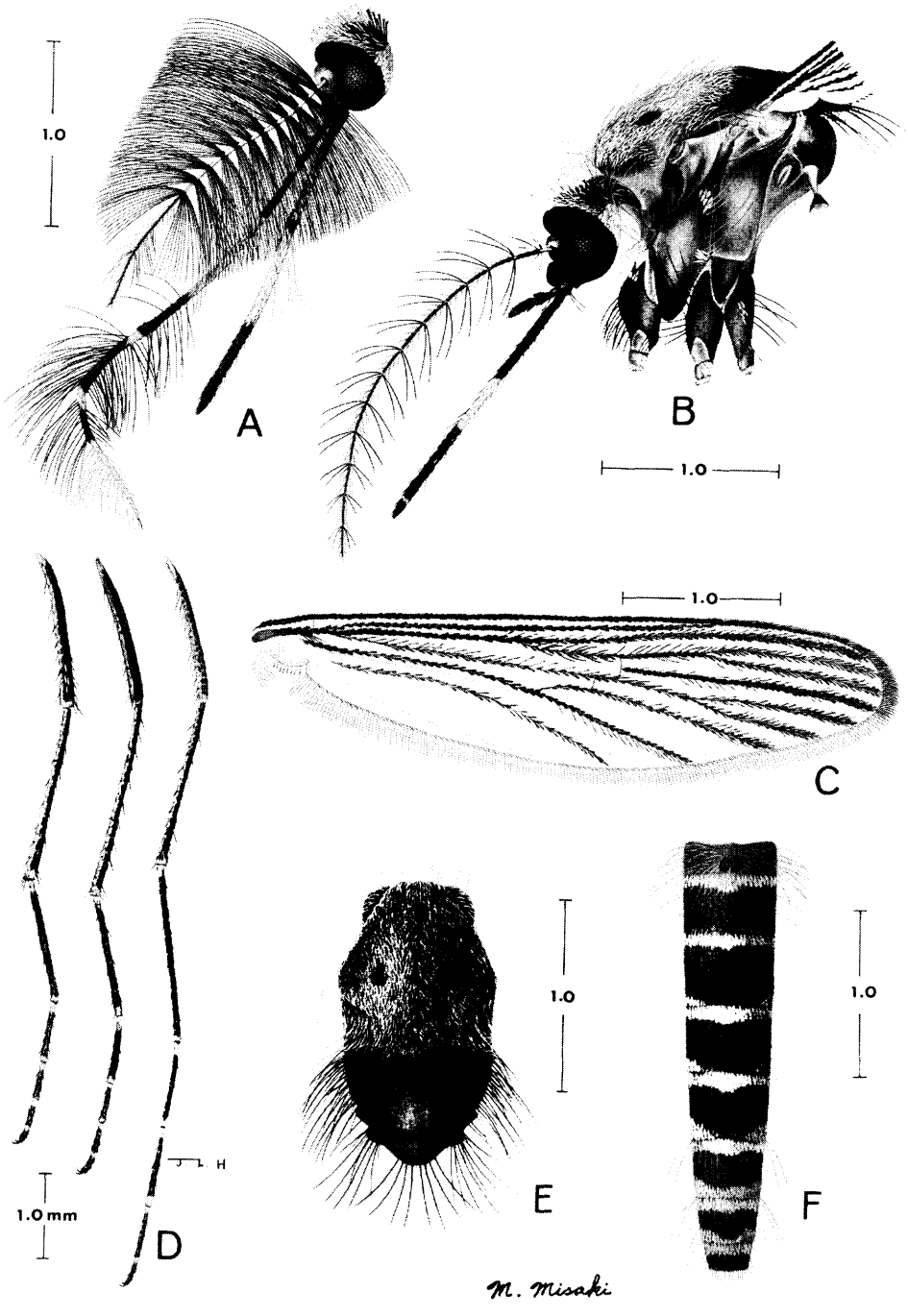
Fig.101



C. (Culex) pseudosinensis

1, 2, 3-P single, pectinate, subequal in length; 4-P bifid, pectinate; 5, 6-P single, pectinate; 7-P trifid, pectinate; 8-P bifid, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; comb variable, consisting of from 4 to 12 scales usually arranged in 2 irregular rows; individual comb scale with a strong, prominent apical spine and with 6 or more fine basolateral spicules on each side; siphon index variable, ranging from 5.5:1 to 7.5:1 (average, 6.5:1); 3 irregular pairs of subventral tufts inserted on the siphon, the basal tuft frequently not paired; individual tufts inconspicuous, with 2 or 3 branches, their length less than the width of the siphon at the point of insertion; pecten consisting of from 8 to 12 teeth restricted to the base of the siphon, but usually extending further than in *bitaeniorhynchus;* individual pecten tooth with a prominent apical spine and 1 or 2 strong basolateral barbs.

TYPE DATA. Holotype female from Singapore (Adelphi Estate), Malaya in the British Museum.

DISTRIBUTION. In THAILAND**, *pseudosinensis* is known from a single collection at Waeng, *Narathiwat.* In addition to the type locality of SINGAPORE, this species has also been recorded from INDOCHINA and specimens have been examined in the U. S. National Museum collection from Saigon, SOUTH VIETNAM**, and *Selangor,* MALAYA**.

During this study the following specimens have been examined: the holotype female and a paratype female with their associated larval and pupal skins, and 2 males, 1 female, and 3 larvae.

TAXONOMIC DISCUSSION. As indicated by Colless (1955) in his original description, *pseudosinensis* demonstrates its closest affinities to *bitaeniorhynchus* and *geminus* Colless with superficial similarity to *sinensis.* The adult female is almost indistinguishable from both *geminus* and *sinensis* and the fourth stage larva is extremely close to *bitaeniorhynchus.* The male terminalia, particularly the spiculate portion of the lateral plate of the phallosome, is sufficiently distinctive to permit accurate determination and it is strongly suggested that final conclusions not be drawn without examination of this structure.

BIOLOGY. The type habitat of the larvae was recorded as a moderately large stream pool just inside the jungle fringe. In Thailand, pupae were collected from rock pools beside a waterfall. Nothing else is known about the biology of this apparently rare species.

CULEX (CULEX) SINENSIS THEOBALD 1903
(Figures 103 and 104)

Culex gelidus var. *sinensis* Theobald 1903, Mon. Cul. 3: 180 (♀).
Culex sepositus Leicester 1908, Cul. Malaya: 152 (♀); Edwards 1913, Bull. ent. Res. 4: 231 (synonymy).
Taeniorhynchus tenax Leicester 1908 (not Theobald 1901), Cul. Malaya: 167

Figure 102. *C. (Culex) pseudosinensis.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the male terminalia with enlarged insert of the lateral aspect of the inner division of the phallosome.

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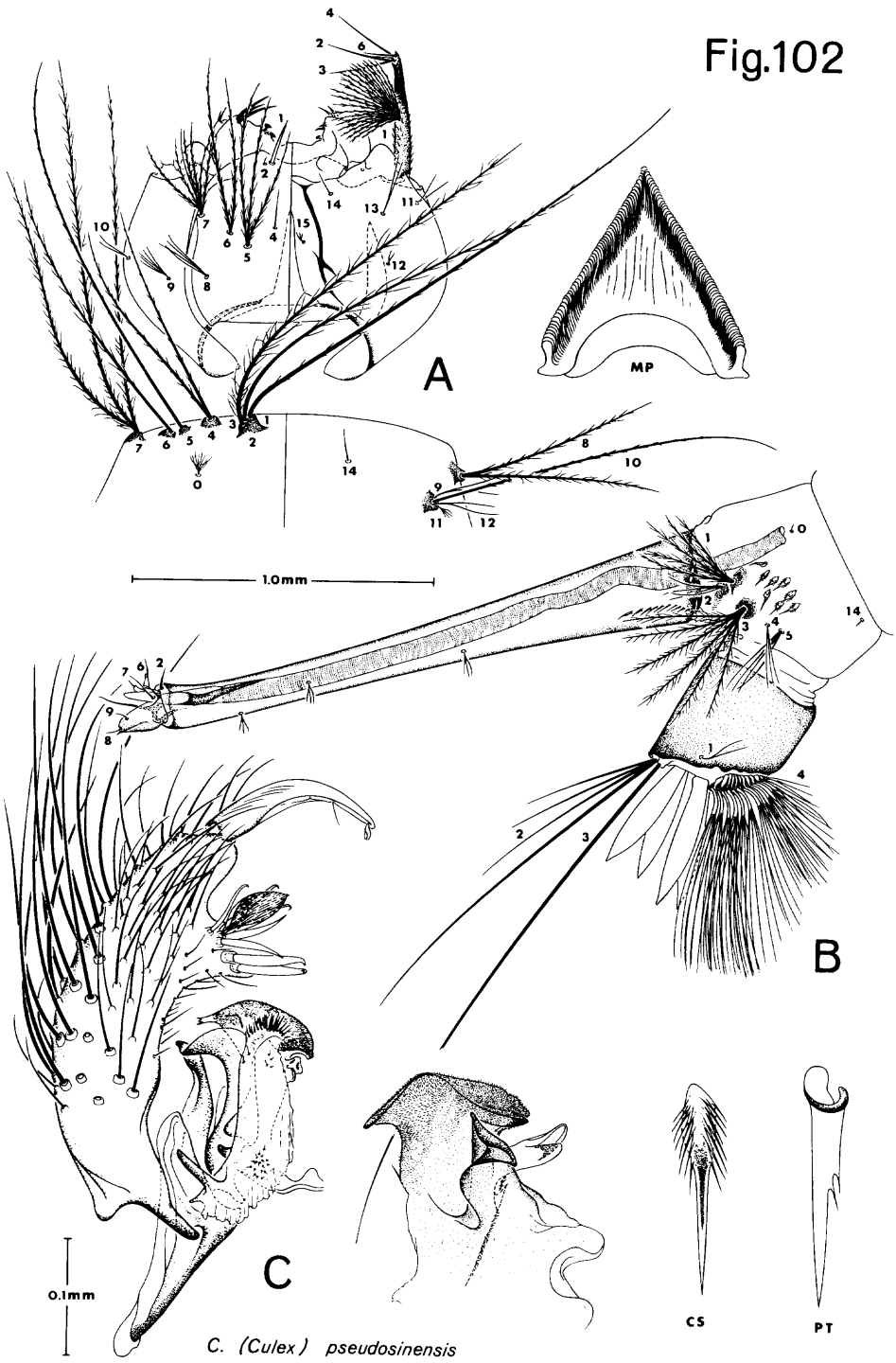
Fig.102
A
MP
1.0mm
B
C
0.1mm
CS
PT
C. (Culex) pseudosinensis

(♀); Edwards 1913, Bull. ent. Res. 4: 231 (synonymy).

Leucomyia sinensis (Theobald) 1910, Mon. Cul. 5: 313 (taxonomy).

Culex sinensis Theobald: Edwards 1913, Bull. ent. Res. 4: 231 (taxonomy); Edwards 1921, Bull. ent. Res. 12: 337 (♂, ♀); Barraud 1924, Indian J. med. Res. 11: 986 (♂*, ♀).

Culex tripunctatus Mochizuki 1913, Fukuoka Acta med. 7: 24 (♂*, ♀*, E); Edwards 1922, *in* Wytsman, Genera Insect., fasc. 194: 203 (synonymy).

Culex (Culex) sinensis Theobald: Edwards 1932, *in* Wytsman, Genera Insect., fasc. 194: 203 (taxonomy); Barraud 1934, Fauna Brit. India, Diptera 5: 394 (♂*, ♀, L); Stackelberg 1937, Fauna de l'URSS, Ins. Diptera 3: 231 (♂*); Bonne-Wepster and Brug 1937, Geneesk. Tijdschr. Ned.-Ind. 77: 78 (♂, ♀*); Baisas 1938, Mon. Bull. Philipp. Hlth. Serv. 18: 209 (♀, E); Bonne-Wepster and Brug 1939, Geneesk. Tijdschr. Ned.-Ind. 79: 1274 (L*); Bohart and Ingram 1946, Navmed 1055: 79 (♂*, ♀, L*); LaCasse and Yamaguti 1950, Mosq. Fauna Japan and Korea: 206 (♂*, ♀*, L*, P*); Monchadskii 1951, Moscow zool. Inst. Akad. Nauk. SSSR 37: 275 (L*); Bonne-Wepster 1954, Roy. trop. Inst. Amst. Spec. Pub. 111: 116 (♂, ♀*, L*); Hara 1957, Jap. J. exp. Med. 27: 55 (♀*); Delfinado 1966, Mem. Amer. ent. Inst. 7: 151 (♀).

The adult female may be recognized by the nature of the apical and basal banding of the abdominal terga and by the uniformly dark dorsal wing scales. The simple, distinctive phallosome of the male terminalia is characteristic. The fourth stage larva may be identified by the chaetotaxy of the head and the shape of the mentum.

FEMALE. *Head.* (Figure 103B). Proboscis dark brown, with a rather broad median pale band of scales; palpus similar in color to the proboscis, tipped with pale scales and occasionally with several randomly placed pale scales on segments I-III; decumbent scales of the vertex pale golden, becoming lighter at the orbital line; erect scales golden to pale golden at the occiput and dark brown posterolaterally. *Thorax.* (Figure 103B, E). Scutum covered with variable pale brown to white scales anterior to the supraalar area, dark posterior to the supraalar area with some pale scales in the prescutellar space, and with variable dark patches on the fossa; scutellum dark but with some light scales on each of the 3 lobes; integument of the pleuron light brown, occasionally with variable, indistinct darker areas particularly on the sternopleuron and posterior spiracular plate; patches of dull white scales present on the upper mesepimeron and upper and posterior sternopleuron. *Wing.* (Figure 103C). Dorsal wing scales usually uniformly dark brown but with some scattered pale scales and a variable row of white scales occasionally present on the posterior margin of the costa. *Legs.* (Figure 103D). Anterior surface of the hind femur with a narrow pale basal band, a uniform pattern of light and dark scales, a subapical dark band, and

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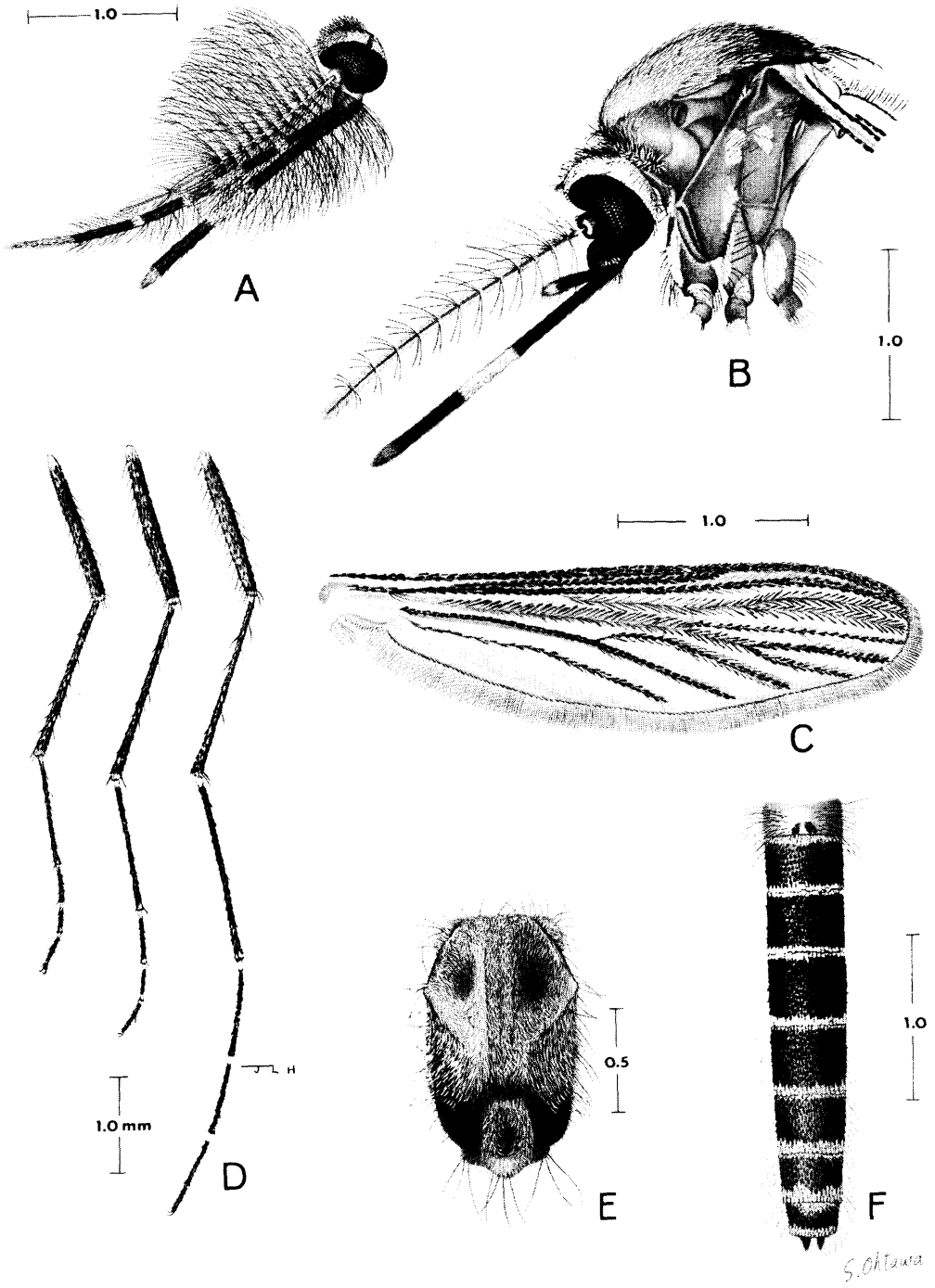
Figure 103. *C. (Culex) sinensis.* Adult habitus: A, lateral aspect of the male head; B, lateral aspect of the female head and thorax; C, dorsal aspect of the female wing; D, anterior surface of the female legs; E, dorsal aspect of the female scutum and scutellum; F, dorsal aspect of the female abdomen. →

Fig.103



C. (Culex) sinensis

an apical tuft of pale scales; hind tibia with a variable mixture of dark and pale scales; hind tarsus dark, with narrow, basal pale bands on tarsomeres I-IV; markings of the fore and mid legs variable, but similar to those of the hind legs. *Abdomen.* (Figure 103E). Terga dark with variable basal and apical pale bands on segments II-VIII; basolateral pale patches present on each tergum, but not visible from above; sterna predominantly pale, with mediolateral dark patches.

MALE. *Head.* (Figure 103A). Proboscis with a small basomedian tuft of setae; palpus dark, with narrow basal and broad median pale bands on segment III, with a narrow basal pale band on IV, and narrow basal and apical pale bands on V. *Terminalia.* (Figure 104C). Subapical lobe of the basimere well developed, with 3 hooked rods, 3 fine and 1 strong accessory setae, a well developed leaf, and a gently curved seta; distimere normal in shape, without distal annulations; phallosome simple, the inner division gradually tapering, slightly curved, and spiculate, the arms parallel; outer division greatly reduced, represented by a small basal protuberance; proctiger crowned with a tuft of strong spines and with 2 or 3 cercal setae; basal sternal process well developed, darkly pigmented, and strongly recurved.

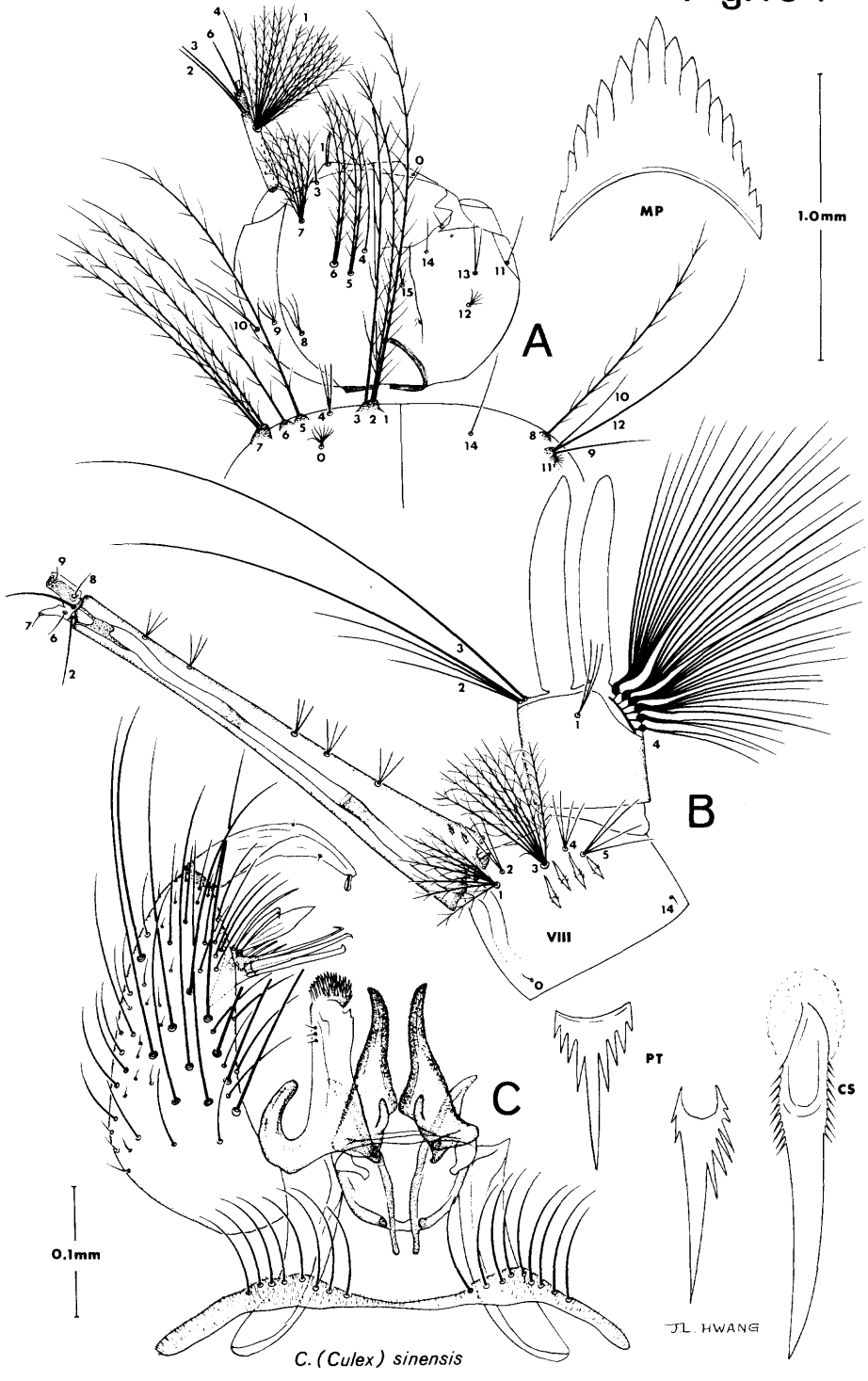
LARVA. (Figure 104A, B). *Head.* Antenna with a narrow dark basal ring and progressively darker beyond hairs 2, 3-A, which are inserted considerably below the apex of the shaft; head hair 1-C lightly to moderately pigmented, its length approximately half the distance between the bases of the pairs; 4-C single, simple, exceptionally long; 5, 6-C usually bifid, pectinate; mentum triangular, strongly pigmented, with approximately 7 robust, distinctly separated lateral teeth on each side. *Thorax.* Integument glabrous; hairs 1, 2, 3-P single, pectinate, subequal in length; 4-P very short and fine, with from 2 to 4 simple branches; 5-P single, pectinate; 6-P single or bifid, pectinate; 7-P trifid, pectinate; 8-P single, pectinate; 14-P single, simple. *Abdomen.* Integument glabrous; comb consisting of from 3 to 5 scales arranged in an irregular row; individual comb scale a strong, prominent, sharply pointed spine with a series of fine, basolateral spicules on each side; siphon index variable, ranging from 6:1 to 8:1; 5 or 6 irregular pairs of subventral tufts inserted on the siphon; individual tufts with 2 or 3 branches, their length less than the width of the siphon at the point of insertion; pecten consisting of from 1 to 5 teeth, restricted to the extreme base of the siphon; individual pecten tooth with a strong distal spine and from 1 to 5 fine basolateral barbs on one side, or the basal tooth may consist of a strong distal spine with fine basolateral barbs on each side.

TYPE DATA. Holotype female of *sinensis* from Shaohyling, China in the British Museum. The type locality of *sepositus* is Kuala Lumpur, Selangor, Malaya but the type specimen is non-existent. The type locality of *tenax* is Kuala Lumpur, Selangor, Malaya but the type specimen is non-existent. The type locality of *tripunctatus* is Fukuoka, Kyushu, Japan but the location of the type specimen is unknown.

DISTRIBUTION. In THAILAND, *sinensis* has been studied from:

Figure 104. *C. (Culex) sinensis.* A, dorsoventral aspect of the head and prothorax of the fourth stage larva; B, lateral aspect of the terminal abdominal segments of the fourth stage larva; C, dorsal aspect of the male terminalia. →

Fig.104



C. (Culex) sinensis

Ayutthaya, Chiang Mai, Chon Buri, Narathiwat, Nakhon Nayok, Nakhon Si Thammarat, Nonthaburi, Prachuap Khiri Khan, Trang, Ubon Ratchathani, and *Udon Thani.* The species has also been reported from CHINA, USSR, KOREA, JAPAN, RYUKYU-RETTO, TAIWAN, PHILIPPINES, INDONESIA, MALAYA, BURMA, INDIA, and CEYLON. Specimens have been studied in the U. S. National Museum collection from Qui Nhon, SOUTH VIETNAM**.

During this study the following specimens were examined from Thailand: 60 females, 16 males, and 12 larvae.

TAXONOMIC DISCUSSION. Although the adult female demonstrates a similarity to *pseudosinensis*, the male terminalia and fourth stage larva are clearly distinctive.

BIOLOGY. Larvae are found in a variety of ground water habitats, frequently in association with green algae; predominant among these are rice fields, ditches, ponds, and streams. Habits of the adults are poorly known, but Lien (1962) reported that on Taiwan *sinensis* enters houses, human baited net traps, and light traps. Scanlon and Esah (1965) collected this species biting man up to 4,500 feet near Chiang Mai, Thailand.

MISIDENTIFICATIONS

CULEX (MOCHTHOGENES) CASTRENSIS EDWARDS 1922

Culex castrensis Edwards 1922, Indian J. med. Res. 10: 285 (♂*, ♀).

Causey (1937) tentatively recorded *castrensis* from Thailand, but it is felt that his record actually referred to *foliatus*, which at that time was regarded as a subspecies of *castrensis*.

CULEX (LOPHOCERAOMYIA) FLAVICORNIS BARRAUD 1924

Culex (Lophoceratomyia) flavicornis Barraud 1924, Indian J. med. Res. 12: 45 (♂*, ♀).

Specific locality data were not included in the original record of this species by Thurman (1959). Specimens in the U. S. National Museum collection from Thailand and determined as *flavicornis* by E. Thurman have been examined and found to represent *incomptus*.

CULEX (LOPHOCERAOMYIA) FRAUDATRIX (THEOBALD) 1905

Lophoceratomyia fraudatrix Theobald 1905, Ann. hist.-nat. Mus. hung. 3: 94 (♂*, ♀*).

Causey (1937) and Iyengar (1953) recorded *fraudatrix* from Thailand, however, Colless (1959a) showed that there is no evidence for the occurrence of this species in the Oriental region. Previous records from Thailand are considered to be in error and probably represent *macdonaldi* and *variatus*.

CULEX (LOPHOCERAOMYIA) UNIFORMIS (THEOBALD) 1905

Lophoceraomyia uniformis Theobald 1905, Bombay nat. Hist. Soc. 16: 245 (♂*, ♀).

Although Thurman (1959) reported that this species had been recorded from Thailand between 1950 and 1956, no reference can be located which establishes this record. Specimens in the Thurman collection, determined as *uniformis*, have been examined and found to belong to 2 species, *minor* and *spiculosus*. The Thurman record was probably based on these misidentified specimens.

CULEX (CULICIOMYIA) VIRIDIVENTER GILES 1901

Culex viridiventer Giles 1901, J. Bombay nat. Hist. Soc. 13: 609 (adult).

Thurman (1959) recorded *viridiventer* from Thailand but did not include specific locality data. Specimens in the U. S. National Museum collection, determined by E. Thurman as *viridiventer*, have been examined and found to represent a new species which is described earlier in this paper as *thurmanorum*.

CULEX (CULEX) PIPIENS PIPIENS LINNAEUS 1758

Culex pipiens Linnaeus 1758, Syst. Nat. 10th ed. 1: 602 (adult).

Thurman and Thurman (1955) recorded this subspecies (as *pipiens* in contrast to *quinquefasciatus)* from Thailand, but examination of over 800 male terminalia slides of *pipiens sensu lat.* (including specimens in the Thurman collection) from throughout Thailand has not suggested the presence of *pipiens pipiens*.

CULEX (CULEX) THEILERI THEOBALD 1903

Culex theileri Theobald 1903, Mon. Cul. 3: 187 (♂*, ♀*).

Thurman (1959) originally recorded *theileri* from Thailand but did not include specific locality data. Specimens in the U. S. National Museum collection from Thailand, determined by E. Thurman as *theileri*, have been studied and found to be *annulus*. No specimens from Thailand have been seen which can be attributed to this species.

DOUBTFUL RECORDS

CULEX (MOCHTHOGENES) KHAZANI EDWARDS 1922

Culex khazani Edwards 1922, Indian J. med. Res. 10: 286 (♂*).

The original record of this species for Thailand was that of Thurman (1959). Although locality data were not included, the material upon which the report was based was probably collected in northern Thailand. Specimens determined as this species have not been located in the Thurman collection, nor have specimens of *khazani* been seen from any of the Thailand collections.

CULEX (LOPHOCERAOMYIA) MINUTISSIMUS (THEOBALD) 1907

Culiciomyia minutissimus Theobald 1907, Mon. Cul. 4: 235 (♀).

As in the case of *khazani* above, Thurman (1959) recorded *minutissimus* from Thailand, but no specimens can be located which can be attributed to this species.

CULEX (CULEX) CORNUTUS EDWARDS 1922

Culex cornutus Edwards 1922, Indian J. med. Res. 10: 283 (♂*, ♀).

Thurman (1959) recorded *cornutus* from Thailand without including specific locality data. No specimens have been found in the Thurman collection which can be attributed to this species, and no specimens have been seen from any of the Thailand collections.

CULEX (CULEX) MIMETICUS NOÉ 1899

Culex mimeticus Noé 1899, Boll. Soc. ent. ital. 31: 240 (♀).

Causey (1937) recorded *mimeticus* from the northern hill area of Thailand. During this study, specimens from Thailand have not been seen which could be ascribed to this species and it is suggested that Causey's record may possibly have been a misidentification of *mimulus*.

CULEX (CULEX) UNIVITTATUS THEOBALD 1901

Culex univittatus Theobald 1901, Mon. Cul. 2: 29 (♂*, ♀*).

Thurman (1959) recorded *univittatus* from Thailand without listing specific locality data. No specimens of this species have been found in the Thurman collection or in any other material from Thailand.

CULEX (CULEX) VISHNUI THEOBALD 1901

Culex vishnui Theobald 1901, Mon. Cul. 1: 355 (♀*).

Edwards (1922) recorded the distribution of *vishnui* as throughout the Oriental region and Barraud and Christophers (1931), Causey (1937), Iyengar

(1953), and Thurman and Thurman (1955) have all recorded the species from Thailand. The validity of all references to *vishnui* prior to 1957 has been seriously challenged by Colless (1957a) who pointed out that 4 species of the subgenus, *pseudovishnui, alienus, annulus,* and *perplexus,* were identifiable in the adult stage as *vishnui* as defined prior to 1957. Most of the above records from Thailand probably referred to *pseudovishnui* or *annulus.*

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APPENDIX A

SPECIES OF THE GENUS *CULEX* OCCURRING IN SOUTHEAST ASIA BUT NOT KNOWN FROM THAILAND[1]

SPECIES	♂	♀	L	P	DISTRIBUTION
NEOCULEX					
hayashii Yamada	*	*	*	*	Japan, Ryukyu-Retto, Taiwan, China, Korea, USSR.
nematoides Dyar & Shannon	X	X	-	-	Philippines.
okinawae Bohart	*	X	*	X	Ryukyu-Retto.
simplicicornis Edwards	X	-	-	-	Borneo.
sumatranus Brug	*	-	*	-	Sumatra, China.
MOCHTHOGENES					
culionicus Delfinado	*	X	-	-	Philippines.
hackeri Edwards	X	X	-	-	Malaya.
khazani Edwards	*	X	*	-	India, Indochina.
latifoliatus Delfinado	*	X	-	-	Philippines.
laureli Baisas	*	X	*	*	Philippines.
tricontus Delfinado	*	-	-	-	Philippines.
yeageri Baisas	*	-	-	-	Philippines.
ACALLEOMYIA					
obscurus (Leicester)	*	X	-	-	Malaya.

[1] * = stage or sex described and illustrated; X = stage or sex described; - = stage or sex unknown; ? = stage or sex described but questionable.

SPECIES	♂	♀	L	P	DISTRIBUTION
LOPHOCERAOMYIA					
acutipalus Colless	*	X	X	-	Singapore.
bandoengensis Brug	*	X	X	-	Malaya, Java.
barkerii (Theobald)	*	-	-	-	Borneo.
bernardi (Borel)	*	-	*	-	Indochina.
brevipalpus (Theobald)	*	X	X	-	Singapore.
coerulescens Edwards	*	X	X	-	Singapore, Borneo.
crassicomus Colless	*	-	-	-	Malaya.
cubitatus Colless	*	X	X	-	Singapore.
demissus Colless	*	-	-	-	Malaya.
eminentia (Leicester)	*	-	-	-	Malaya, Singapore, Borneo.
fulleri (Ludlow)	*	-	-	-	Philippines.
gibbulus Delfinado	*	-	-	-	Philippines.
hewitti (Edwards)	*	X	X	-	Borneo, Singapore, Sumatra.
inculus Colless	*	X	X	-	Malaya.
jenseni (Meijere)	*	-	X	-	Singapore, Java, Sumatra.
josephineae Baisas	*	X	-	-	Philippines.
lavatae Stone & Bohart	*	-	-	-	Philippines.
minutissimus (Theobald)	*	X	*	-	Ceylon, India, Java, Borneo, China, Maldive Is.
navalis Edwards	*	X	*	-	Singapore, Borneo.
niger (Leicester)	*	X	*	-	Malaya, Sumatra.
pachecoi Baisas	*	X	X	X	Philippines.

SPECIES	♂	♀	L	P	DISTRIBUTION
plantaginis Barraud	*	-	?	-	India, ?Nepal.
tuberis Bohart	*	X	X	X	Ryukyu-Retto.
uniformis (Theobald)	*	X	*	*	Ceylon, India, Hainan Is., New Guinea, Philippines.
whartoni Colless	*	X	*	-	Malaya, Singapore.
CULICIOMYIA					
bahri (Edwards)	X	X	-	-	Ceylon, ?Java.
javanensis Bonne-Wepster	*	*	-	-	Java.
ryukyensis Bohart	*	X	*	-	Ryukyu-Retto, Japan.
shebbearei Barraud	*	X	X	-	India, Ceylon, Borneo, China.
viridiventer Giles	*	*	*	-	India, Pakistan, Nepal.
CULEX					
annulirostris Skuse	*	*	*	X	Indonesia, Philippines, Australasian region.
bihamatus Edwards	X	-	-	-	Timor.
diengensis Brug	*	X	-	-	Java.
fasyi Baisas	*	X	-	-	Philippines.
geminus Colless	*	X	*	-	Singapore.
incognitus Baisas	*	*	*	*	Philippines.
jacksoni Edwards	X	X	X	-	China, Korea, Nepal, USSR.
mimeticus Noé	*	*	*	*	Oriental region.
orientalis Edwards	*	*	*	*	Japan, Siberia, Korea, China, Taiwan.
propinquus Colless	*	-	-	-	Singapore.
solitarius Bonne-Wepster	*	*	X	-	New Guinea, ?Java.

Since the above appendix was compiled, my attention has been drawn to the following additional species described from the Andaman Islands: C (Mochthogenes) shrivastavii Wattal, Kalra, and Krishnan 1966, Bull. Indian Soc. Malar. Com. Dis. 3: 159 (♂*).

APPENDIX B

PRESENT STATUS OF THE *CULEX* FAUNA OF THAILAND[1]

SPECIES	♂	♀	L	P	BIOLOGY
LUTZIA					
fuscanus Wiedemann	*	*	X	*	Well known from Rangoon.
halifaxii Theobald	*	*	*	*	Fairly well known.
NEOCULEX					
brevipalpis (Giles)	*	*	*	*	Larval habitats known.
tenuipalpis Barraud	*	X	?	-	Poorly known.
MOCHTHOGENES					
foliatus Brug	*	X	*	*	Larval habitats known.
hinglungensis Chu	*	-	-	-	Unknown.
malayi (Leicester)	*	X	*	-	Larval habitats known.
LOPHOCERAOMYIA					
aculeatus Colless	*	X	*	-	Larval habitats known.
alphus Colless	*	X	*	-	Poorly known.
bengalensis Barraud	*	X	*	-	Poorly known.
cinctellus Edwards	*	X	*	-	Poorly known.
curtipalpis (Edwards)	*	X	*	-	Larval habitats known.
eukrines Bram and Rattanarithikul	*	X	*	-	Larval habitats known.
fuscosiphonis Bram and Rattanarithikul	*	X	*	-	Poorly known.
ganapathi Colless	*	X	*	-	Larval habitats known.

[1] * = stage or sex described and illustrated; X = stage or sex described; - = stage or sex unknown; ? = stage or sex described but questionable.

SPECIES	♂	♀	L	P	BIOLOGY
incomptus Bram and Rattanarithikul	*	-	-	-	Unknown.
infantulus Edwards	*	X	*	-	Larval habitats known.
lucaris Colless	*	-	-	-	Unknown.
macdonaldi Colless	*	X	*	-	Poorly known.
mammilifer (Leicester)	*	X	*	-	Larval habitats known.
minor (Leicester)	*	X	*	-	Larval habitats known.
minor form *bicornutus* (Theobald)	*	X	*	-	Larval habitats known.
peytoni Bram and Rattanarithikul	*	X	*	-	Larval habitats known.
pholeter Bram and Rattanarithikul	*	X	*	-	Larval habitats known.
quadripalpis (Edwards)	*	X	*	-	Larval habitats known.
reidi Colless	*	X	*	-	Poorly known.
rubithoracis (Leicester)	*	X	*	-	Poorly known.
spiculosus Bram and Rattanarithikul	*	X	*	-	Larval habitats known.
traubi Colless	*	X	*	-	Larval habitats known.
variatus (Leicester)	*	X	*	-	Larval habitats known.
wilfredi Colless	*	X	*	-	Larval habitats known.
THAIOMYIA					
dispectus Bram	*	*	*	*	Larval habitats known.
CULICIOMYIA					
bailyi Barraud	*	*	*	*	Larval habitats known.
barrinus, n. sp.	?	?	*	-	Larval habitats known.
fragilis Ludlow	*	*	*	*	Larval habitats known.

SPECIES	♂	♀	L	P	BIOLOGY
nigropunctatus Edwards	*	*	*	*	Larval habitats known.
pallidothorax Theobald	*	*	*	*	Larval habitats known.
papuensis (Taylor)	*	*	*	*	Larval habitats known.
scanloni, n. sp.	*	*	*	*	Larval habitats known.
spathifurca (Edwards)	*	*	*	*	Larval habitats and some host preferences known.
spiculothorax, n. sp.	-	-	*	-	Poorly known.
termi Thurman	*	*	*	*	Larval habitats known.
thurmanorum, n. sp.	*	X	*	*	Larval habitats known.
CULEX					
alienus Colless	*	X	*	-	Poorly known.
annulus Theobald	*	*	*	*	Fairly well known.
barraudi Edwards	*	X	*	-	Poorly known.
bitaeniorhynchus Giles	*	*	*	*	Fairly well known.
fuscocephala Theobald	*	*	*	*	Fairly well known.
gelidus Theobald	*	*	*	*	Fairly well known.
hutchinsoni Barraud	*	*	*	*	Larval habitats known.
mimulus Edwards	*	*	*	*	Larval habitats known.
neolitoralis, n. sp.	*	X	*	-	Larval habitats known.
perplexus Leicester	*	X	*	-	Larval habitats known.
p. quinquefasciatus Say	*	*	*	*	Well known from Rangoon.
pseudosinensis Colless	*	*	*	-	Poorly known.
pseudovishnui Colless	*	X	*	-	Larval habitats and some host preferences known.

SPECIES	♂	♀	L	P	BIOLOGY
sinensis Theobald	*	*	*	*	Larval habitats and some adult biology known.
sitiens Wiedemann	*	*	*	*	Fairly well known.
tritaeniorhynchus Giles	*	*	*	*	Fairly well known.
whitei Barraud	*	X	*	-	Poorly known.
whitmorei (Giles)	*	*	*	-	Poorly known.

INDEX

In the following index, all names are listed alphabetically, regardless of whether they are genus-group or species-group names. Valid names are set in roman type, synonyms are italicized. The italicized pages are those which begin the primary treatment of the species. Numbers in parentheses refer to the figures illustrating the species in question.