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THE *CULEX* SUBGENUS *LOPHOCERAOMYIA* IN NEW GUINEA AND BISMARCK ARCHIPELAGO

(DIPTERA: CULICIDAE)[1,2]

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Abstract: This taxonomic revision of the mosquitoes of the genus *Culex*, subgenus *Lophoceraomyia* is based on the examination of 4354 specimens of 33 species (2015 ♂, 1337 ♀, 976 larvae and 27 pupae) from New Guinea and Bismarck Archipelago. Of this material, 600 individual rearings of 23 species were carried out mainly during a collecting trip from December 1965 to May 1966.

Twenty-one new endemic species are recognized and named, 10 previously reported species are redescribed and 2 extra-limital species are recorded for the first time from the area. The descriptions of 23 species are based on all stages associated through individual rearings; those of the other 10 species are based on adult ♂♂ and also on provisionally associated ♀♀ of 4 species.

The taxonomic characters used in the descriptions and diagnoses of species are analysed and evaluated by considering both individual and ecological variations. The systematic treatment of the subgenus includes a revised morphological description of the subgenus, followed by reviews of the reported bionomics and distribution and a critical discussion of the previous taxonomic treatment of the subgenus. Keys are provided for the identification of species in all known stages. The various groups and complexes are treated in a similar manner and the descriptions of the individual species follow the same format.

The members of the subgenus represented in the area are segregated according to the formerly adopted scheme into the *mammilifer* and *fraudatrix* groups. The *mammilifer* group is represented by 3 subgroups of 4 species: 1) subgroup B-1 with *kuhnsi;* 2) subgroup B-3 with *bolii;* 3) subgroup B-4 with *digoelensis* and *confusus.* The *fraudatrix* group is represented by 10 complexes of 29 species: 1) *petersi* complex with *petersi, steffani, crowei,* and *shanahani;* 2) *hilli* complex with *lakei;* 3) *marksae* complex with *marksae, versabilis, muruae, kowiroensis, wamanguae* and *leei;* 4) *ornatus* complex with *ornatus;* 5) *christiani* complex with *christiani, gressitti, pseudornatus* and *minjensis;* 6) *fraudatrix* complex with *fraudatrix, atracus, schilfgaardei, insularis, kaviengensis, collessi* and *rajaneeae;* 7) *solomonis* complex with *solomonis* and *durhami;* 8) *hurlbuti* complex with *hurlbuti;* 9) *pseudorubithoracis* complex with *pseudorubithoracis* and *sedlacekae;* 10) *cottlei* complex with *cottlei.*

INTRODUCTION

The present revision of the subgenus *Lophoceraomyia* is strictly regional, treating the species from New Guinea and the Bismarck Archipelago. It was stimulated by the fragmentary knowledge of the subgenus within this area. Regional works in other areas, especially those by Belkin (1962) and Colless (1965), have aroused an interest in the systematics and faunistic relationships of this complex and difficult subgenus.

Lophoceraomyia, as presently understood, is confined almost exclusively to the tropics and subtropics of the Oriental and Australasian regions and the islands in the Western Pacific (Micronesia) and South Pacific. The subgenus forms a significant element in the culicid fauna of the Indomalayan area (Colless 1965) and of the South Pacific (Belkin 1962). In the recent reviews and studies (Stone et al. 1959, Stone 1961, 1963; Colless 1965; Delfinado 1966; Bram & Rattanarithikul 1967), approximately 76 species have been recognized, 48 from the Oriental region, 13 from the Australasian, 3 from the Western Pacific and 12 from the South Pacific.

Previous studies of *Lophoceraomyia* in New Guinea and adjacent islands were confined largely to descriptions of species and the subgenus within these areas was very poorly known. Prior to this study, 11 species had been recognized, 10 from New Guinea and 1 from the Bismarck Archipelago. Theobald (1905) described the male of *fraudatrix* and the female of *ornatus*. The latter species was incorrectly placed in the subgenus *Melanoconion* but was shifted to *Lophoceraomyia* by Edwards (1924). In 1932, Brug described *digoelensis* from Netherlands New Guinea. After a lapse of some 20 years, King & Hoogstraal (1955) described 3 new species, *kuhnsi*, *leei*, and *marksae*, and provided additional descriptions for the male and larva of *ornatus* and the male antenna and genitalia of *digoelensis*. Van den Assem (1958) gave additional descriptions of the larva and the female of *marksae*. Colless (1959) described 4 new species, *atracus* from the Bismarck Archipelago, and *pseudornatus*, *petersi*, and *christiani* from New Guinea. He also redescribed *fraudatrix* from sev-

eral localities, provided additional descriptions for *ornatus* and recognized another form, "Sp. A 2 near *fraudatrix*" which he later (Colless 1965) synonymized with *cubitatus* from Malaya.

All the above species were characterized primarily by males. Although the larvae were described for 5 species the majority of these could not be identified except by association with the males because of superficial descriptions. The pupae were described for only 2 species (Penn 1949).

It is evident from previous regional studies (Belkin 1962, Colless 1965) that the systematics of *Lophoceraomyia* are extremely complex and that future studies must be based on a careful analysis of the morphology of all stages associated through rearings and a consideration of the bionomics and distribution of all species.

THE AREA AND GENERAL ENVIRONMENT

The name New Guinea as used here includes West Irian (Indonesian West New Guinea, formerly Netherlands New Guinea), the Australian Territory of Papua and the United Nations Trusteeship territory of New Guinea. For purposes of discussion of distribution, New Guinea is divided into 4 sectors. This system has been used by Bishop Museum staff and collaborators. NE New Guinea corresponds to the U.N. trusteeship territory of New Guinea. SE New Guinea is Papua. NW and SW New Guinea are divisions of West Irian (see fig. 1). NE and SE New Guinea are further divided into 9 and 6 districts, respectively.

The total land area of New Guinea is 891, 629 km^2, including all adjacent small islands. The climate is very hot and humid, with high rainfall throughout the year. Only a small part of the main island receives less than 150 cm annually. On the north coast, precipitation is generally at least 250 cm, and many places receive much more rain. November to April is the season of the northwest monsoon which brings heavy precipitation to all parts. May to October is the season of the southeast trades which bring little rain to the southern coastline, but more to other areas. The average temperature in the lowlands is about 27°C (80°F) throughout the year. The climate of the high mountain areas is much cooler and sometimes drier than that of the coastal areas.

The island of New Guinea has a very complex topography and reaches altitudes of over 5000 m. In the center of the island, a complex chain of mountains runs in a southeasterly direction from West Irian to Milne Bay peninsula in Papua. In the lowlands along the coast, there are vast areas of flat and swampy ground. Farther inland, there are many large rivers and streams and in the highlands, small rivers, intermittent streams, springs and brooks almost everywhere.

In most parts of New Guinea, tropical rain forests are predominant. Along the coasts the rain forest intermingles with mangroves, pandanus, sago and nipa palms. In the inland areas, patches of grasses (particularly "kunai") cover extensive areas between the forests on the flat plains and along the hillsides. In the highlands, the natural vegetation is variable. Above 800 m, the canopy of the rain forest decreases in height. Between 1500 and 2000 m, there are temperate forests dominated by beeches and in certain areas large stands of cassurina trees are very common. Added to the natural vegetation are extensive plantations of coconuts in nearly all native villages along the coast. Coffee, tea, potatoes, taro and sago are common agricultural and domestic plants in the inland and highland communities.

On the basis of altitude, topographical and physiographical factors, New Guinea can be roughly separated into 2 main geographically isolated areas—the lowlands which include all areas along the coast and inland to 200 m and the highlands above 800 m. The intermediate area (200–800 m) is heavily forested, inaccessible and without settlements.

The localities where present collections were carried out are: NE NEW GUINEA. SEPIK: Vanimo, Wewak, Kowiro, Wamangu, Maprik, Kunjingini, Korogo and Kandannge; MADANG:

Alexishafen, Baitabag, Gum River, and Yagaum Lutheran Mission; WESTERN HIGHLANDS: Minj; CHIMBU: Kundiawa; MOROBE: Lae and Wau. SE NEW GUINEA. GULF: Kerema and Murua; CENTRAL: Port Moresby; NORTHERN: Popondetta.

The Bismarck Archipelago (fig. 1) comprises several islands separated from New Guinea to the north and east by 80 to 640 km. The total land area is 49, 658 km^2. Three principal islands in which field studies and collections were made are Manus (2072 km^2), New Ireland (9842 km^2) and New Britain (36,519 km^2). At present these islands are all combined with New Guinea and Papua in the Australian Trust Territory. New Britain is nearest to New Guinea and is separated from it by an ocean gap of about 80 km, from New Ireland by St George channel of about 48 km and from Manus by a distance of about 400 km.

In general, these islands have an equatorial climate similar to that of New Guinea but they are much less complex topographically. Manus is typified by a vast area of flat mangrove swamps and coconut plantations along the coast, and a dense forest in the interior with a few mountains not exceeding 800 m. New Ireland is generally flat with an extensive coastal fringe of coconut plantations and swampy ground in most of the northern part and a dense forest within the interior. The southern end is a rugged country with mountains as high as 2000 m. New Britain is more complex topographically than the other 2 islands and is still under the influence of volcanic activity. The eastern part of the island, in the Gazelle Peninsula, is developed agriculturally with much of the cleared land used for rice fields, cacao and coconut plantations. The western part, from Jacquinot Bay to Kandrian, is a very rugged country with extremely dense forests. The localities where present collections were made are: MANUS: Lorengau and Loniu Village; NEW IRELAND: Kavieng; NEW BRITAIN: Keravat.

MATERIAL AND METHODS

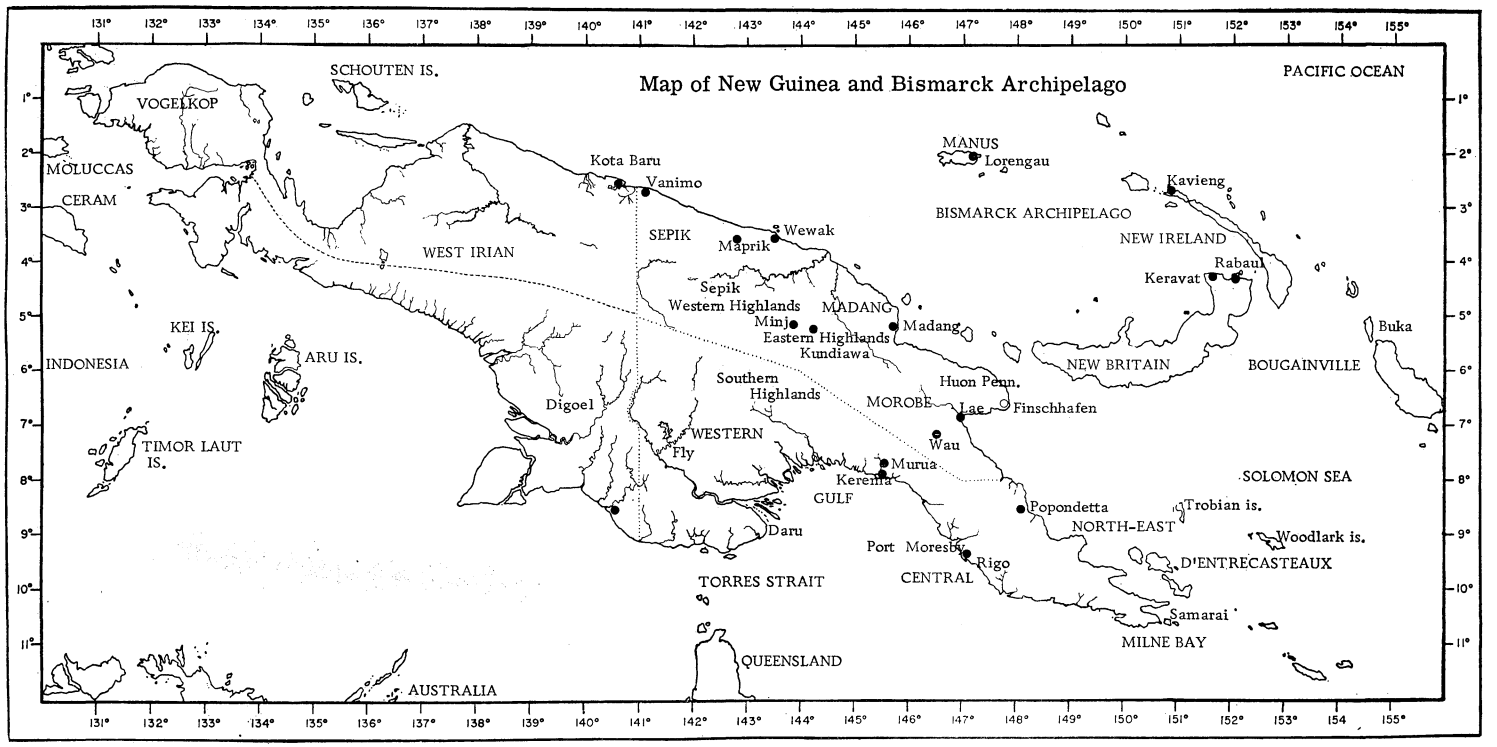
Material. This study is based primarily on material collected by myself and on specimens accumulated at the Bernice P. Bishop Museum from 1964 to 1966. Some additional specimens from other institutions were also studied: from the United States National Museum, adults and larvae collected by W. V. King and H. Hoogstraal at Hollandia, Netherlands New Guinea during 1944–1945; from the California Academy of Sciences, adults collected by E. S. Ross from various parts of New Guinea in 1944; from CSIRO, Division of Entomology, Canberra, Australia, adults collected by D. H. Colless in Sepik District, New Guinea, in 1964; and from the New Guinea Dept. of Public Health, adults and reared specimens collected by S. H. Christian and H. Lake at Minj and Port Moresby.

The following topotypic and other critical specimens of previously recognized species were examined: 1) adult paratypes of *kuhnsi* and *leei;* 2) adult males and females of *fraudatrix* and *ornatus* identified by King and Hoogstraal; 3) holotype and paratypes and some larval morphotypes of *atracus, pseudornatus, petersi, christiani* and sp. A. 2 near *fraudatrix*. Adult paratypes and some identified larvae of 30 other species known outside of New Guinea were used for comparison. These are distributed as follows: 6 species from the South Pacific; 3 species from Micronesia; 19 species from the Oriental region; and 3 species from Australia.

Collecting trip. My collecting trip began in December 1965 and was carried on until May 1966. Roughly from 1 to 2 weeks were spent at each locality listed in the section on "The Area and General Environment". The field work emphasized individual rearings of adults from the immature stages and general field catches. The type localities of the previously recognized species in the eastern part of New Guinea and the islands of Bismarck Archipelago were revisited.

The major transportation in this area was by commercial or missionary planes except in the

Fig. 1


Map of New Guinea and Bismarck Archipelago
PACIFIC OCEAN
SCHOUTEN IS.
VOGELKOP
MOLUCCAS
CERAM
WEST IRIAN
Kota Baru
Vanimo
SEPIK
Wewak
Maprik
Sepik
Western Highlands
MADANG
Minj
Madang
Eastern Highlands
Kundiawa
Southern Highlands
Digoel
MOROBE
Lae
Finschhafen
Huon Penn.
WESTERN
Fly
Wau
Murua
Kerema
GULF
Daru
TORRES STRAIT
Port Moresby
CENTRAL
Rigo
Popondetta
NORTH-EAST
Trobian is.
Woodlark is.
D'ENTRECASTEAUX
Samarai
MILNE BAY
SOLOMON SEA
MANUS
Lorengau
BISMARCK ARCHIPELAGO
Kavieng
NEW IRELAND
Rabaul
Keravat
NEW BRITAIN
BOUGAINVILLE
Buka
KEI IS.
ARU IS.
INDONESIA
TIMOR LAUT IS.
QUEENSLAND
AUSTRALIA

neighborhood of native villages or government stations where I had to depend almost entirely on foot travel or occasionally on native canoes and government trucks or jeeps. In most localities, collections were made within a radius of 8 to 16 km of human settlements.

Collections and rearings. In nearly every step, procedures for collecting and rearing and the preparations of specimens were those recently outlined by Belkin et al. (1965). Owing to limited time and difficult field conditions it was not possible to subdivide collections into individual sublots for each species and only 1 continuous series of numbers was used to label all the material set up for individual rearing in a given collection. In mass rearings, the immature stages, without sorting to species, were separated into convenient units of 5 to 10. Such mass rearings were identified by a continuous numerical sublot sequence preceded by the latter M.

Usually at a locality, both larvae occurring in breeding sites and the adults flying or resting on plants nearby were collected. A sample of mature larvae was set up for individual and mass rearings and the field-caught males were examined and tentatively identified. After the rearings were completed, the reared males were checked and compared with the field-caught ones. Whenever there appeared to be different species or forms, 2 to 6 revisits were made to the same habitat to search for more larvae and/or adults. Two species were usually obtained in 1 habitat but as many as 5 species, both from rearings and field catches, were obtained in several instances.

Field notes. The coding system for locality was devised by abbreviating the district name. All collections within that district were labeled in a single numerical sequence. For instance, collections in villages within the Sepik District were all coded SP, followed by collection number 1, 2, 3, and so on. All full names of villages, station headquarters, etc., were entered. All other miscellaneous field data as described in the field sheets used by Belkin's group were completed.

Methods of study and presentation. The following procedures were used in the identification of species and in the presentation of data. The diagnostic and other taxonomic characters used are discussed in the chapter on "Morphology and Terminology".

a) *Identification.* Species were originally recognized and identified from reared male specimens as done by Colless (1960). The diagnostic characters of the larvae and pupae were then determined through study of the associated skins of the males. The females were associated with the males by comparison of their reared associated immature stages. All field-caught adults were sorted out and identified through detailed comparison with the reared specimens.

b) *Species recognition.* Adult males showing striking constant differences in a combination of 2 or more characters in genitalia, antenna, palpus or labium were provisionally regarded as different species. All reared specimens which appeared to be consistently different in at least 2 different stages were also separated as distinct forms. Specimens of similar forms from different habitats or localities showing slight differences from one another were usually determined as being conspecific or left for more detailed analysis and comparison. The final judgment in recognizing a new species was based on the constancy in correlated characters of several specimens in different local populations. Differences in ecology, breeding habitat, altitude and distribution were used only to substantiate the evidences in morphology.

c) *Synonymy and taxonomic references.* In previously recognized species, full data are given for the original description of both the valid name and synonyms, including all available data for the type specimens. An asterisk (*) following the mention of a type indicates that I have personally examined it. All subsequent taxonomic references for a species are placed in chronological order following the data for the nominal species as done by Belkin (1962). In case of new species, the entire type series, holotype male, allotype female and paratypes, are always from the same locality. All type specimens of new species are at present deposited at B. P. Bishop Museum, Honolulu, to

be distributed to other institutions at a later date.

d) *Descriptions.* The descriptions of species begin with the general and external characters of the male, followed in order by the male genitalia, female, larva and pupa and with separate sections for Bionomics, Systematics and Distribution. To avoid unnecessary repetition, only 1 representative species of a complex is described in detail, the others being compared with it.

e) *Keys.* The most conspicuous characters are used in the keys. Usually at least 2 characters are used in a couplet, the first of these being of greater reliability.

f) *Illustrations.* All drawings are semidiagramatic and are made to fit a standard size plate. Detailed structures of genitalia and antennae were drawn from more than 1 specimen and the hair branches in larval and pupal drawings represent the usual or modal number which was determined from at least 5 specimens.

g) *Abbreviations.* The morphological abbreviations used here are self explanatory and in general follow Belkin's (1962) practice except for a few terms explained in the section on "Morphology and Terminology".

The following abbreviations for the names of institutions and collectors are used: Institutions—ANIC, Australian National Insect Collections, CSIRO, Canberra, Australia; BISHOP, Bernice P. Bishop Museum, Honolulu, Hawaii, U. S. A.; BMNH, British Museum (Natural History), London, England; BUDA, Magyar Nemzeti Museum, Budapest, Hungary; UCLA, Department of Zoology, University of California, Los Angeles, California, U. S. A.; USNM, United Stated National Museum, Washington, D. C.

Collectors—DHC, Donald H. Colless; ESR, E. S. Ross; HH, Harry Hoogstraal; HL, Harry Lake; JLG, J. Linsley Gressitt; LQ, L. W. Quate; MA, Martin Awa; PFM, Peter F. Mattingly; PS, Peter Shanahan; RC, Robert Cottle; SC, S. H. Christian; SS, Sunthorn Sirivanakarn; WAS, Wallace A. Steffan; WVK, W. V. King; YMH, Yiau-Min Huang.

MORPHOLOGY AND TERMINOLOGY

The following morphological discussion is limited to taxonomic characters which I found useful in the present study.

MALE CHARACTERS. The terminology used here is modified from Belkin (1962) and Colless (1965).

Antenna. The antenna of mosquitoes consists of 3 primary morphological divisions: the scape, the pedicel (usually called torus) and the flagellum which is subdivided into 13 subsegments. The torus and the flagellum present characters of taxonomic importance. In several members of the *mammilifer* group the torus has a protuberance on the inner side which is absent in the *fraudatrix* group. Present in all species of *Lophoceraomyia* are modified setae or scales forming tufts of various shapes on 2 to 6 flagellar segments. In most descriptive works, the flagellar segments are usually counted as true segments of the whole antenna as originally done by Theobald (1905). When the torus is counted as the first segment of the antenna then the first flagellar segment bearing the modified tuft of setae is numbered as segment 6; when the scape is considered to be the first antennal segment, then this flagellar segment is numbered as segment 7 as done by Colless (1965). In Belkin's work (1962) this segment was counted as flagellar segment 5 by assigning separate numbering for the individual segments of the flagellum. The latter system is morphologically sounder since it takes into account the basic morphology of the antenna by considering that the flagellar segments are not true segments. Therefore, I have adopted Belkin's separate numbering system for the flagellar segments but have substituted for "flagellar segment" the more convenient and shorter term "flagellomere" which is abbreviated as "F" in the present descriptions. The details of flagel-

lomeres are best studied from slide preparations with the lateral aspect of the antenna mounted upwards. A general description of the characteristic development of specialized setae on each of the flagellomeres, as found in the *fraudatrix* group, is given below.

1. Flagellomere 5 may bear a variable number of broad, brown scales or a series of short, hairlike setae forming a tuft of varied shape and size. The tuft is located on the dorsolateral surface but sometimes may extend down to the ventral surface. The form and detailed characters of the tuft are very useful in differentiating species.

2. Flagellomere 6 usually bears 2 series of dark brown, flattened and pointed setae. One series is ventrolateral with a rather constant number of crumpled or curled setae, the other is usually ventromesal and with more or less straight setae. The form of the tufts appears to be very constant within a group but is not useful in separating closely related species.

3. Flagellomere 7 usually bears 2 tufts as on flagellomere 6 but with their bases separated from one another. The tufts are very similar in closely related species. The external tuft is in a form of a comb of curled setae, the internal tuft is composed of apparently fused setae with their apices twisted.

4. Flagellomere 8 usually bears a ventral hooked tuft consisting of dark brown, fused setae with the apices more or less spread out. The size and shape of this tuft are useful characters.

5. Flagellomere 9 has a lateral or ventral group of 3 to 8 bladeshaped scales and a mesal group of a few short stout setae in varying number. The number, color and shape of the bladelike-scales are useful specific characters.

6. Flagellomere 10 has a ventrolateral series of 2 to 5 stout, dark brown setae. The number of these setae is extremely variable within a species and is practically useless as a taxonomic character. Also located on the internal side of this segment is a variable number of short, slender setae.

Palpus. The maxillary palpus of male mosquitoes is generally regarded as being composed of 5 segments and without a distinct basal palpifer. Two of these segments are separated by a "false joint" without membrane and have been considered by some workers as a single long segment only. These workers then consider the palpus to be 4-segmented. As pointed out by Colless (1965), in *Lophoceraomyia* the basal segment of the palpus is subdivided by membrane into 2 apparent segments, the basal 1 of which bears at its apex the characteristic fingerlike processes of the *fraudatrix* group. Thus the male palpus of *Lophoceraomyia* appears to have 6 segments. Without extensive comparative morphological studies it is impossible to determine the true segmentation of the male palpus of mosquitoes. For this study I am following Belkin (1962) and am considering that in *Lophoceraomyia* segment 1 of his interpretation is secondarily subdivided. Accordingly, Colless' segment 1 becomes the proximal part of segment 1 in the present sense, segment 2 becomes the distal part of segment 1, and segments 3 to 6 become 2 to 5. The characters of taxonomic importance in the male palpus are as follows:

1. Basal processes (BP): Fingerlike processes at the apex of the proximal part of segment 1 are developed only in the *fraudatrix* group. They are ventral in position, 1 being mesal (or internal) and the other lateral (or external). Their relative length with respect to the distal part of segment 1 is of some taxonomic value, but it is not very useful in separating closely related species.

2. Segment 2 may have 1 or several rows of lateroventral setae which are variously developed in different forms. These setae are usually minute and may be confined to the basal 0.5 or may be present throughout the entire length of the segment.

3. Segment 3 usually has 1 or more ventral rows of shiny, minute setae, which are closely packed in the basal 0.5 or 0.3 but are more widely spaced distally. In certain forms, there is another group of stronger and longer setae forming a ventrolateral tuft which is usually basal in position.

The relative length of the latter setae is useful in separating species. Another useful character is the number of long, dark brown bristles ventrolaterally near the apex of the segment.

4. Segments 4 and 5 bear ventromesal and ventrolateral irregular rows of dark brown, stout bristles. The number, density and length of these bristles are useful diagnostic characters.

5. The relative length of the palpus to the proboscis is, in general, a good group character but is not very useful in distinguishing closely related forms.

Proboscis. Most species of *Lophoceraomyia* which I studied and all those belonging to the *fraudatrix* group have a false joint at about 0.25–0.20 of the length from the base of the proboscis. In some dry specimens the proboscis is flexed at this joint. The position of this false joint near the base of the proboscis appears to be a characteristic feature of the subgenus as noted by Colless (1965) in the Malayan forms. In other subgenera of *Culex* the false joint is submedian in position (Belkin 1962). The dorsal surface of the proboscis may bear 2 rows of upright or slanting slender setae. The extent of these rows and the length of the setae are characteristic of some species complexes. The setae in the basal row on the underside of the proboscis are also useful as they may be stout and spinelike or long and hair-like in different species.

Genitalia. The term genitalia is used here in the sense of Belkin (1962) for the complex of all structures used in mating whether or not some of these perform other functions as well, as in the case of the proctiger which bears the anus. Details of the genitalia are best studied from slide preparations of dissected parts mounted in various aspects. One sidepiece should be mounted in lateral aspect and the other in mesal. Other structures may be left in a natural position or may be completely dissected and mounted in lateral and mesal aspects to show the details of individual sclerites.

1. The sidepiece: Of diagnostic value are the long specialized setae developed on or usually near the tergomesal margin of the sidepiece, and the specialized setae of the subapical lobe. The specialized setae near the tergomesal margin correspond to the submarginal setae of Colless (1965) and the tergomesal setae of Belkin (1962). I use the terminology of Colless for these setae since he distinguishes them from another series of shorter setae on the tergomesal margin which he designates as marginal setae. The submarginal setae when present are usually arranged in linear rows parallel to the tergomesal margin or sometimes in the form of a triangle if 3 are present. The number of these setae may be very constant in a group of related forms, but in general, I find that the characteristic development of these setae is extremely useful in delimiting forms. The subapical lobe (SAL) is considered to be composed of a *proximal part* and *distal part*. This division is not obvious in most groups of *Lophoceraomyia*. However, each of the parts bears characteristic setae and the usual terminology for these parts in other subgenera of *Culex* is retained here. The proximal part bears 3 rodlike, stout setae or rods (*a–c*) and 1 hairlike seta ventral to the bases of these. The distal part has a lateral group of 1 leaflet (*g*1) and 1 basal seta (*h*) and a mesal group of 1 leaflet (*g*2) and 2 to 6 accessory setae (*d–f*). The character and particularly the shapes of these setae and leaflets are variously modified and the number of accessory setae is varied in different species. The accessory setae can be accurately resolved and counted under phase contrast and oil immersion microscopy. The rods of the proximal part are conveniently referred to as external (*a*), central (*b*), and internal (*c*) rods and the leaflets of the distal part as external (*g*1) and internal (*g*2) as described by Colless (1965).

2. The phallosome (PH): The most conspicuous elements of the phallosome are 2 lateral plates (LP) connected by a tergal sclerotized bridge near the base. Each plate consists of 2 portions which were described by Colless as the *ventral lobe* towards the sternal margin and the *dorsal lobe* (DL) towards the tergal margin. The ventral lobe is probably a part of the intromittent organ

proper, judging from its position when the phallosome is everted (Belkin 1962, fig. 154). It is usually in the form of a thin plate evenly rounded sternally and is very well developed in the *fraudatrix* group but absent or greatly reduced in the *mammilifer* group. The dorsal lobe is well developed in all species and usually has a strongly developed tergal process (or dorsal process or arm of Colless) in the *fraudatrix* group. This process is rather constant in its beak-like shape and is bent at different angles from the apex of the dorsal lobe; its length is sometimes diagnostic. In the *mammilifer* group, the dorsal lobe usually has another *internal process* (IP) developed from the base and the apex of the dorsal lobe is usually provided with minute tubercles or spicules and its tergal surface with coarser tubercles or teeth.

3. The proctiger (PR) as seen in lateral aspect has 2 sclerites on each side, 1 ventrolateral (the paraproct), the other dorsal (the cercal sclerite). The apex of the paraproct bears a varied number of toothlike spicules (the crown). It is strongly developed in some New Guinea species. The distal sternal surface of the paraproct is expanded to form a prominent lobe in the *marksae* complex. This lobe is distinct from the external and internal lobes as described by Colless which are found in almost all New Guinea species and which are of lesser diagnostic value.

4. The lobe of the 9th tergite is strongly developed in some forms. The number of setae found on this lobe is of little diagnostic value in separating members of species complexes but is usually characteristic of a given complex.

General Characters of Adults. The following characters applicable to both sexes are of some taxonomic value: color of scales on the head, color of the thoracic integument and scales, total number of bristles on the propleuron and forecoxa, and presence or absence of basal bands on abdominal tergites.

In the female, the following additional characters are of some taxonomic significance: presence or absence of basolateral abdominal tergal spots, number and length of basoventral bristles of proboscis, length of wing and fore femur, and density of scales on wing veins.

Larval Characters. In the general characters, there are qualitative and quantitative differences in the pigmentation, spiculation, siphon length and anal gills. Although, as is well known, these characters are subject to considerable environmental modification, in certain species or species groups they may be very constant and can be of diagnostic value.

1. *Pigmentation.* A characteristic color pattern, involving the head capsule, thorax, abdomen and siphon, is diagnostic of some species complexes. The antennal shaft is variously colored in different species. It may be completely white or creamy, or dark from base to tip. In several species, it is usually dark at base, creamy white in the middle and dark beyond the antennal tuft.

2. *Spiculation.* Numerous spicules are usually seen on the thorax at 100× magnification. The spicules may be uniformly distributed over the entire thorax or they may be confined to the pleural and ventral areas on the meso- and metathorax. The density of spiculation varies also and is described in general terms as light, moderate or dense. The character of the individual spicules is distinguished as to length and thickness.

3. *Siphon.* Length of the siphon in a given species is subject to considerable individual variation and ecological modification. However, within a given habitat the configuration of the siphon is generally characteristic for each species. In comparing siphon lengths, 2 kinds of indices are used here. One is the classical index derived from the ratio of siphon length to its basal width. The other is the siphon-saddle index, or "ratio" as developed by Colless (1962, 1965). The number of pecten teeth may be diagnostic for some forms and the characteristic denticles of a pecten tooth are generally of taxonomic importance as a group character.

4. *Anal gills.* The length of anal gills is generally highly variable in New Guinea species of

Lophoceraomyia, but in some species it is of some taxonomic value.

5. *Comb scales.* The number of scales in the comb is of limited diagnostic value. The characteristic fringe of spicules on the posterior margin of the scale is of some taxonomic value as a group character, but is practically useless in the diagnosis of species.

6. *Chaetotaxy.* The numerical system of nomenclature of the chaetotaxy as used by Belkin (1962) is followed here. Chaetotaxic characters are in general of considerable taxonomic significance. Since it appears that almost any hair may be of taxonomic value, I have followed Belkin's practice of plotting the entire chaetotaxy of the larva for every species. Hairs of diagnostic value were selected by comparing different species on the basis of mean number of hair branches determined in a minimum of 5 specimens of each species, usually from correlated larval skins or when a sufficient number of these was not available from additional whole larvae. In the verbal descriptions and in the key only these diagnostic hairs are used. The following hairs were found to be useful in separating species:

a. Head hairs: Particularly the relative length and branching of hair 4; branching of hairs 5, 6, 7, 14 and sometimes hairs 12 and 13.

b. Thoracic hairs: Prothorax, hairs 3, 4, 8, and sometimes hair 7; *mesothorax*, usually hairs 8 and 9, sometimes hairs 3 and 4; *metathorax*, usually hairs 7 and 9, sometimes hairs 12 and 13.

c. Abdomen: Segment I, particularly the branching of hairs 1, 6, and 7; segment II, hairs 3 and 6; segments III–VI, usually the branching of hairs 1, 3, 6, and sometimes hairs 8, 10 and 13; segment VII, particularly hairs 4, 7 and sometimes hairs 10; segment VIII, particularly hair 2, sometimes hairs 1 and 5; *anal segment*, usually the branching of hair 2-X and sometimes 1-X.

Pupal Characters. The general characters of taxonomic value in the pupal stage are: 1) shape, pigmentation and index (Belkin 1962) of the trumpet, 2) pigmentation and color pattern of the cephalothorax, metanotum and abdomen, and 3) degree of sclerotization of paddle midrib. For the very useful chaetotaxic characters the homologous terminology of Belkin (1962) is followed here. The same procedure was followed for selecting diagnostic hairs as described above for the larva. The following hairs were found to be of taxonomic significance:

1. *Cephalothorax and Metanotum*, usually hairs 1,3,5,8,9, and 12; sometimes hair 7,10 and 11.

2. *Abdomen;* segment I, usually the branching of hair 7; segment II, particularly hairs 5 and 7; segment III, hairs 1,5,6 and 10; segment IV, hairs 1,4,5,6, and 10; segment V, hairs 1,3,5 and 6 (occasionally 10); segment VI, hairs 1,3,5,6 (sometimes 7 and 10); segment VII, hairs 1,3,4 and 5; segment VIII, particularly the branching and plumosity of hair 4 and hair 9.

SYSTEMATIC TREATMENT

Subgenus *Lophoceraomyia* Theobald, 1905

Lophoceraomyia Theobald, 1905, J. Bombay Nat. Hist. Soc. **16:** 245. Type-species: *L. uniformis* Theobald, 1905, Ceylon; monobasic. Considered as a lapsus for *Lophoceratomyia* by some authors.

Lophoceratomyia Theobald, 1905, Ann. Budapest Magyar Nemezeti Mus. **3:** 93. Type-species: *L. fraudatrix* Theobald 1905, New Guinea; the first of 2 included species, selection of Brunetti (1914: 64). Considered as a lapsus for *Lophoceraomyia* by some authors, as a valid emendation by others.

Philodendromyia Theobald, 1907, Monog. Culicidae **4:** 623. Type-species: *P. barkerii* Theobald, 1907, Sarawak; monobasic.

Cyathomyia de Meijere, 1910, Buitenzorg Lands Plant., Ann. Jard. Bot., Sup. **3:** 921–922. Type-species: *C. jenseni* de Meijere, 1910, Java; monobasic.

♂. Small to medium-sized species; usually without marked ornamentation; labium, palpus and legs dark scaled. *Head:* vertex with distinct orbital line and a broad lateral patch of pale scales. *Palpus:* varied in length, usually exceeding proboscis by about 0.5 to full length of segment 5, sometimes shorter (some Malayan species); basal process usually present, sometimes absent. *Proboscis:* false joint present at 0.2–0.25 of length from base; dorsal upright setae usually present in the distal 0.2–0.5 of labium, sometimes completely absent. *Antenna:* torus simple or with spiculose prominence on its inner dorsal surface; modified tufts of scales and setae present at least on flagellomere 8; usually on flagellomeres 5–10. *Thorax:* acrostichal bristles absent except on extreme anterior promontory; mesonotal scales narrow, usually dark, rarely yellow golden, vestiture sparse, producing a rough appearance; pleural areas usually without scales, except in *ornatus* complex and a few other species, 1 lower anterior mesepimeral bristle almost always present. *Wing:* scales narrow, dark and usually scanty except on veins C, Sc, and R_1 and R_2. *Legs:* femora usually pale scaled underneath, dark scaled above; tibiae and tarsi unornamented; claws of foreleg unequal, both toothed at base; claws of midleg usually unequal, 1 of which is toothed; claws of hindleg equal and simple. *Abdomen:* usually entirely dark scaled or sometimes with basal transverse bands or basolateral pale spots.

Genitalia: Segment IX: lobe of 9th tergite usually well developed, with number of setae varying between 3 and 12, or sometimes poorly developed, with 1 or 2 weak setae; 9th sternite moderately broad, with or without scales and setae. *Sidepiece:* external tergal surface without strong bristles, submarginal setae usually present, sometimes absent. *Subapical Lobe:* proximal part and distal part not clearly divided but well defined by the presence of the characteristic setae; proximal part with 1 basal seta and 3 stout rods (*a–c*); distal part with 1 basal seta (*h*), usually 1 external leaflet or hairlike seta (g_1), 1 internal leaflet (g_2) and 2–6 accessory setae (d–f). *Clasper:* dorsal subapical margin usually with very light, but distinct crest of fine spicules; subapical claw (spiniform of Belkin 1962) moderately broad and long; 2 setae present, 1 dorsal, the other ventral, placed distad of middle of curvature. *Phallosome:* lateral plate with or without an internal process, but with strongly sclerotized dorsal lobe and usually with distinctly marked ventral lobe; dorsal lobe with simple beak-like dorsal process projecting tergally or with spinose and toothed apex. *Proctiger:* crown usually small, with minute, sharp spicules or occasionally with coarse, flattened and blunt spicules; ventrolateral sclerite narrow or broad; cercal sclerite very narrow, cercal setae from 2–5.

♀. As described for ♂ except for the following. *Head:* all scales usually darker than those of ♂. *Proboscis:* base of labium usually with 2 ventral bristles, sometimes 4–7. *Wing:* scales more numerous than in ♂. *Legs:* all claws equal and simple. *Abdomen:* with basal and basolateral pale markings, or entirely dark scaled.

LARVAE. Varied depending on types of habitat; most ground pool forms are extremely similar to *Neoculex*, or sometimes to *Culex*, *Mochthogenes* and *Culiciomyia;* those in pitcher plants highly modified and superficially resembling *Aedes* larvae. *Head:* usually broader than long; hairs 16, 17-C usually present. *Antenna:* variable in length, usually as long as head, rarely shorter; hairs 2, 3-A usually basad of 4, 5, 6-A, rarely placed adjacent to latter. *Thorax:* hair 3-P weak and about 0.25 of length of hairs 1, 2-P, usually single or double, rarely triple or with more branches; hair 4-P slightly weaker than hairs 1, 2-P, rarely as long as or shorter than 3-P, usually single or double; hair 8-P usually as strong as hair 7-P, sometimes weaker and shorter, usually double, rarely single; hair 14-P usually single, rarely double. *Siphon:* usually very slender and long; index 7–10; ratio 4.0–6.0; pecten teeth usually 10–16, rarely fewer or more. *Anal Segment:* saddle complete; ventral brush with 5, 6 pairs of hairs, all inserted within the grid.

PUPAE. *Trumpet:* meatus usually uniformly cylindrical and longer than in other *Culex* larvae; index 9–15. *Cephalothorax and Metanotum:* hair 1-C usually triple; 8, 9-C usually double; 10, 11-C double or single. *Abdomen:* hair 5-V–VI usually double; hairs 4, 5-VII double or single; hair 9-VIII well removed from the caudolateral angle.

BIONOMICS. As previously recorded in areas outside New Guinea and adjacent islands, the breeding habitats of *Lophoceraomyia* species are general ground pools, tree holes, bamboo stumps, pitcher plants, leaf axils of aroids and Pandanaceae, and artificial containers. Within New Guinea,

the majority of species generally breeds in ground pools, particularly in sago swamps and at the margins of rain forests. Present records indicate that certain forms in this area also breed in other container habitats such as palm bracts, sago stumps and occasionally sago leaf axils. The adults of a number of species are very common and are frequently encountered in general field catches or in collections from light traps and Malaise traps. For resting they appear to prefer shaded areas, particularly at the base of large trees, under fallen and rotten trunks, and under leaves and fronds. In swamp habitats, they were caught resting under sago bracts or fronds or flying around nearby. At the margin of forest streams, they were found resting on mosses, ferns and moist soil or on hairy roots drooping over the steep banks. A number of species were frequently encountered in small aggregations.

Few records are available on the blood feeding habits and disease relations of species of *Lophoceraomyia*. Colless (1965) cites an instance of natural viral infection. Marks (1960) observed that some Australian *Lophoceraomyia* feed on the blood of frogs and occasionally on man. In New Guinea, no direct evidence was obtained to indicate that species of *Lophoceraomyia* bite man or animals. However, several field-caught females were found to be engorged with a reddish or blackish substance which suggests that they might feed on wild birds or other animals in nature.

SYSTEMATICS. The subgenus *Lophoceraomyia* is strikingly differentiated from other subgenera of *Culex* in the presence of modified scales or setae on the flagellomeres of the male antenna. In the adults, the absence of acrostichal bristles on the mesonotum and the rough-scaled appearance of the mesonotum are rather characteristic and were found very useful in separating the females from *Culiciomyia* and other *Culex* subgenera. The male genitalia are of subgeneric importance and provide both group and specific characters within the subgenus. Most of the larvae can be distinguished from other subgenera of *Culex* by the chaetotaxic characters given in the diagnosis although they appear to be very similar to certain forms of *Neoculex*. The pupae combine various chaetotaxic features of the subgenera *Culex*, *Culiciomyia* and *Neoculex*, but appear to have a relatively longer trumpet than most members of these subgenera. The combination of the branching of metanotal hairs 10- and 11-C, branching of abdominal hair 5-V, VI, and 4,5-VII, and the insertion of hair 9-VIII are very constant and diagnostic of most *Lophoceraomyia* pupae.

The subgenus was subdivided by Edwards (1932) into 3 groups based primarily on the male antenna and palpus as follows:

Group A (*minutissimus* group). Torus of male antenna without prominence; flagellomeres 5 to 7 without scale tufts; palpus simple.

Group B (*fraudatrix* group). Torus of male antenna without prominence; flagellomeres 5 to 10 with scale tufts; palpus with a pair of basal processes.

Group C (*mammilifer* group). Torus of male antenna with prominence; flagellomeres 5 to 7 with scale tufts; palpus reduced in length.

Later, Edwards (*in* Barraud 1934) suggested a modification of this scheme by combining groups A and B into 1 group (*fraudatrix*) and subdividing group C to separate the pitcher plant breeders from those which breed in rock pools, tree holes and bamboos. Recently, Colless (1965) followed the latter scheme, characterized the *fraudatrix* and *mammilifer* groups and distinguished 2 subgroups in the *mammilifer* group.

The subdivision of *Lophoceraomyia* into 2 major groups appears to be a sound one. However, when features of all stages are considered, as they are in the present study, a great deal of diversity and discordance is evident within both groups. I have recognized a number of more or less distinct species complexes representing what I believe to be separate lineages or phyletic lines. Many of these show overlap in characters in 1 or more stages with 1 or more other complexes. The affinities of the various complexes can only be determined when all the existing phyletic lines are recognized

and only then will it be possible to develop a natural classification of *Lophoceraomyia*. For the present the various complexes in the New Guinea area are placed in either the *mammilifer* or the *fraudatrix* group on the basis of what I consider to be the most fundamental features and the 2 groups are redefined in all stages to accommodate them.

Prior to this study, 11 species of *Lophoceraomyia* had been recognized from New Guinea and the Bismarck Archipelago. Of these, 10 were described from New Guinea (*fraudatrix*, *ornatus*, *digoelensis*, *kuhnsi*, *leei*, *marksae*, *pseudornatus*, *christiani*, *petersi* and *cubitatus*) and 1 from New Ireland and New Britain (*atracus*). These species were very well characterized in males but the larvae were described for only 6 species, the females were almost completely unknown and the pupae were described for only 2 species.

In the present work, I am describing 33 forms including all but *cubitatus* of the 10 previously known species, 21 additional new species and 3 new records of South Pacific species of which 1 is here synonymized with *atracus* of Colless (1959). The presence of the Malayan *cubitatus* in New Guinea (Colless 1965: 273–274) cannot be definitely confirmed here since I have seen only the single male originally reported by Colless (1959: 385) as sp. A-2 near *fraudatrix*. For this reason, *cubitatus* is not treated in the present revision.

Four species are placed in the *mammilifer* group and 29 species in the *fraudatrix* group. The *mammilifer* group includes *kuhnsi*, *bolii*, *digoelensis* and *confusus*. The *fraudatrix* group includes *petersi*, *steffani*, *crowei*, *shanahani*, *lakei*, *marksae*, *versabilis*, *muruae*, *kowiroensis*, *wamanguae*, *leei*, *ornatus*, *christiani*, *gressitti*, *pseudornatus*, *minjensis*, *fraudatrix*, *atracus*, *schilfgaardei*, *insularis*, *kaviengensis*, *collessi*, *rajaneeae*, *solomonis*, *durhami*, *hurlbuti*, *pseudorubithoracis*, *sedlacekae*, and *cottlei*. Both groups may contain more members than recognized here since there are still vast forested areas within New Guinea and on several adjacent islands where collections have not yet been made. It seems probable that there are more species of the *mammilifer* group in New Guinea than are recognized here.

Distribution. All *Lophoceraomyia* species as far as known occur exclusively in the Oriental and Australasian regions and on many islands in the Western and South Pacific. The *fraudatrix* group occurs in all of these areas, while the *mammilifer* group is almost exclusively Oriental and appears to be dominant in the Indomalayan area (Colless 1965, Delfinado 1966, Bram & Rattanarithikul 1967). In the Papuan subregion, *Lophoceraomyia* species have been recorded from New Guinea, Manus, New Ireland and New Britain.

Key to Males

(30. *hurlbuti* not included)

1. Palpus without basal processes; labium without dorsal upright setae; lateral plate of phallosome spinose or toothed apically on dorsal lobe and with an internal process (*mammilifer* group) 2
   Palpus with 2 basal apical processes; labium with dorsal upright setae on at least apical 0.25; lateral plate of phallosome with large simple beaklike dorsal lobe and without internal process (*fraudatrix* group) 5
2 (1). Torus of antenna with spiculose prominence on inner side apically; internal process of lateral plate of phallosome long and projecting dorsad of dorsal lobe ..... 1. **kuhnsi**
   Torus of antenna without inner apical prominence; internal process of lateral plate of phallosome short, not projecting dorsad of dorsal lobe 3
3 (2). Antennal F-5 to F-10 all with external and ventral tufts of modified setae or scales; dorsal lobe of lateral plate of phallosome toothed apically ..... 2. **bolii**
   Antennal F-6, F-9 and F-10 without modified setae or scales on internal surface; dorsal lobe of lateral plate of phallosome spinose apically 4

4 (3). Antennal F-5 with 1 internal modified seta; internal leaflet of subapical lobe simple, external leaflet present....4. **confusus**
Antennal F-5 without any modified setae; internal leaflet of subapical lobe deeply emarginate distally and divided into 2 parts, external leaflet not developed....3. **digoelensis**

5 (2). Mesonotum with some yellowish scales; abdominal tergites with basal white bands or with basolateral white spots.... 6
Mesonotum entirely brown scaled; abdominal tergites unbanded, basolateral spots usually absent 10

6 (5). Abdominal tergites without basal bands but with basolateral white spots; propleuron with numerous scales; upper corner and posterior border of sternopleuron with an extensive patch of numerous pale scales (*ornatus* complex)....16. **ornatus**
Abdominal tergites with white basal bands; propleuron without scales; upper corner of sternopleuron with or without small patch of pale scales (*christiani* complex).... 7

7 (6). Antennal F-5 with a tuft of 11–14 broad scales and setae of unequal lengths....17. **christiani**
Antennal F-5 with a tuft of 4–6 broad or narrow scales of equal lengths.... 8

8 (7). Modified scales on antennal F-5 broad, bluntly tipped and slightly longer than the next 4 flagellomeres ....19. **minjensis**
Modified scales on antennal F-5 narrow, sharply pointed and shorter then the next 4 flagellomeres.... 9

9 (8). Sidepiece with a linear row of 3 submarginal setae; distal part of subapical lobe with 4 assessory setae (*d-f*)....20. **gressitti**
Sidepiece with a linear row of 6, 7 submarginal setae; distal part of subapical lobe with 1 accessory seta....18. **pseudornatus**

10 (5). Ventrolateral sclerite of proctiger broad, with pronounced lobelike expansion on its distal sternal margin; dorsal process of lateral plate relatively long and sustaining a 45° angle with stem; lobe of 9th tergite well developed, usually with 6-16 strong setae (*marksae* complex)....11
Ventrolateral sclerite of proctiger relatively narrow, without pronounced lobelike expansion on its sternal margin; dorsal process of lateral plate relatively short and sustaining an angle of nearly 90° with stem; lobe of 9th tergite poorly developed, usually with 3 weak setae....16

11(10). Labium with 2 or 3 pairs of dorsal upright setae in distal 0.25; modified tuft of antennal F-5 with hairlike setae or with slender yellowish scales unaccompanied by broad scales 12
Labium with more than 3 pairs of dorsal upright setae in at least distal 0.5; modified tuft of antennal F-5 always with some broad, dark scales, slender yellowish scales may be present in addition 13

12(11). Modified tuft on antennal F-5 with 10–12 hairlike setae as long as the next 2 flagellomeres ....15. **leei**
Modified tuft of antennal F-5 with 9, 10 yellowish narrow scales as long as the next 4 flagellomeres....14. **wamanguae**

13(11). Modified tuft of antennal F-5 without any narrow, slender yellowish scales, all scales broad, deep brown to almost black; sidepiece usually with 6 subequal long submarginal setae....13. **kowiroensis**
Modified tuft of antennal F-5 with a group of slender yellowish scales in addition to some broad scales; sidepiece usually with 4, 5 subequal long submarginal setae....14

14(13). Modified tuft of antennal F-5 with 20–27 dark and yellow scales; proboscis with linear transverse row of stiff basoventral setae....12. **muruae**
Modified tuft of antennal F-5 with 12–17 dark and yellow scales; proboscis with an irregular transverse row of stiff basoventral setae....15

15(14). Modified tuft of antennal F-5 with 4, 5 broad dark scales in the dorsal group, 4 narrow yellow scales in the lateral (middle) group and 5 broad dark scales in the ventral group; submarginal setae of sidepiece 4 in number....10. **marksae**

Modified tuft of antennal F-5 with 5–9 broad dark scales in the dorsal group, scales in the lateral and ventral groups all narrow and yellow; submarginal setae of sidepiece usually 5 in number....11. **versabilis**

16(10). Antennal F-7 with an external tuft of fused setae; sidepiece bulbous and strongly convex basally and tergally, with 6 very long and several shorter submarginal setae in a cluster of 4 or 5 parallel rows near the tergomesal margin....33. **cottlei**

Antennal F-7 with an external tuft of curled setae in form of a comb; sidepiece normal; submarginal setae usually in 1 linear row....17

17(16). Palpal segment 3 with a ventrolateral tuft of relatively long slender setae in its proximal 0.25–0.3 18

Palpal segment 3 without a ventrolateral tuft of long slender setae....24

18(17). Labium with a few dorsal upright setae confined to subapical portion; sidepiece without any submarginal setae; external leaflet replaced by a weak seta (*solomonis* complex in part)....29. **durhami**

Labium with several pairs of dorsal upright setae in distal 0.5; sidepiece with 3 submarginal setae, external leaflet developed, foliform (*fraudatrix* complex in part)....19

19(18). Basal processes of palpal segment 1 as long as the distal part of the segment; sidepiece with the 3 submarginal setae in a line parallel to the tergomesal margin....20

Basal process of palpal segment 1 shorter than the distal part of the segment; sidepiece with the 3 submarginal setae forming a triangle....21

20(19). Modified tuft of antennal F-5 with 9–11 very broad dark scales dorsally and 12 or 13 narrow pale scales lateroventrally; basolateral abdominal spots present or absent...26. **collessi**

Modified tuft of antennal F-5 with 1 or 2 narrow dark scales dorsally and 10 or 11 narrow pale scales lateroventrally; basolateral abdominal spots absent....27. **rajaneeae**

21(20). Modified scales of antennal F-5 all deep brown....22

Modified tuft of antennal F-5 with the dorsal group deep brown, the lateroventral group whitish to yellowish distally....23

22(21). Modified tuft of antennal F-5 with 7–10 narrow, more or less pointed scales of equal lengths; basal seta of the distal part of subapical lobe flattened and strong....22. **atracus**

Modified tuft of antennal F-5 with 13–18 broad and narrow scales of unequal lengths, the upper group of 3–6 longest and bluntly tipped, the lateroventral group of 6 or 7 lanceolate and decreasing in lengths, the ventral group of 3 or 4 flattened setae of increasing lengths; basal seta of the distal part of subapical lobe strong but not markedly flattened....23. **schilfgaardei**

23(21). Antennal F-5 with a tuft of 12–16 scales; palpal segment 3 with 2 or 3 rows of ventral setae, its apex with 4 or 5 strong bristles....24. **insularis**

Antennal F-5 with larger tuft of usually 18–20 scales; palpal segment 3 with 4 or 5 rows of ventral setae, its apex with 6–8 strong bristles....21. **fraudatrix**

24(17). Modified tuft of antennal F-5 inconspicuous, with 4 or 5 linear hair-like setae, preceded dorsally by 4, 5 long normal hairs (*fraudatrix* complex in part) ....25. **kaviengensis**

Modified tuft of antennal F-5 conspicuous, with 3–19 flattened setae and broad scales, not preceded dorsally by any long normal hairs, but sometimes by short setae 25

25(24). Modified tuft of antennal F-5 small, with 3–5 bristle like setae (*pseudorubithoracis* complex)....26

Modified tuft of antennal F-5 larger, with 6–19 broad or narrow scales....27

26(25). Basal processes of palpus very short, inconspicuous; labium with a few dorsal upright setae in subapical portion only; sidepiece with 3 or 4 submarginal setae....31. **pseudorubithoracis**

Basal processes of palpus as long as distal part of segment 1; labium with several dorsal

setae in distal 0.6; sidepiece with 7 submarginal setae.....32. **sedlacekae**

27(25). Modified tuft of antennal F-5 small, with about 6 scales slightly longer than the next 2 flagellomeres; basal processes of palpus shorter than distal part of segment 1 (*solomonis* complex in part).....28. **solomonis**

Modified tuft of antennal F-5 with 11–19 scales as long as the next 4 flagellomeres; basal processes of palpus as long as distal part of segment 1.....28

28(27). Antennal F-5 with 10–12 modified deep brown scales; sidepiece with 1 submarginal seta; external leaflet of subapical lobe apically serrated (*hilli* complex).....9. **lakei**

Antennal F-5 with 12–19 modified scales, broad and dark dorsally, narrow and distally whitish lateroventrally; sidepiece with 3 submarginal setae in line; external leaflet of subapical lobe not serrated (*petersi* complex).....29

29(29). Antennal F-5 with tuft of 18–19 scales, 7–10 dark brown in the dorsal group, 10, 11 narrow and distally white in the lateroventral group.....30

Antennal F-5 with tuft of 11–15 scales, 2–5 dark brown in the dorsal group, 7–11 narrow and distally white in the lateroventral group.....31

30(29). Antennal F-9 with tuft of 5–7 very broad blade-like scales; the 3 submarginal setae of sidepiece usually subequal.....8. **shanahani**

Antennal F-9 with tuft of 4 or 5 narrow blade-like scales; basal submarginal seta of sidepiece usually shorter than the other 2.....7. **crowei**

31(29). Antennal F-5 with tuft of 11, 12 scales, 2 or 3 broad and dark in the dorsal group, rest distally whitish; antennal F-9 with tuft of 6 or 7 very broad blade-like scales.....6. **steffani**

Antennal F-5 with tuft of 14 or 15 scales, 4 or 5 broad and dark in the dorsal group, rest distally whitish; antennal F-9 with tuft of 4 or 5 relatively narrow blade-like scales...5. **petersi**

Key to Females

(10. *marksae*, 27. *rajaneeae*, 29. *durhami*, 31. *pseudorubithoracis*, 32. *sedlacekae* unknown; 1. *kuhnsi*, 28. *solomonis*, 30. *hurlbuti* not included)

1. Abdominal tergites with complete white basal bands..... 2

Abdominal tergites without complete white bands but sometimes with basolateral pale spots..... 4

2(1). Upper corner of sternopleuron with a distinct patch of pale scales.....18. **pseudornatus; 19. minjensis**

Upper corner of sternopleuron without scales or with an inconspicuous patch of a few pale scales..... 3

3(2). Frontal and orbital bristles yellow; mesonotum with an extensive area of yellow scaling.....20. **gressitti**

Frontal and orbital bristles brown to deep brown; dorsum of thorax with yellow scales confined to mesonotal margin, fossa, prescutellar space and scutellar lobes.....17. **christiani**

4(1). Abdominal tergites with basolateral pale to white spots..... 5

Abdominal tergites entirely dark scaled.....14

5(4). Mesonotum with numerous yellow scales; propleuron with numerous scales and bristles; posterior border of sternopleuron with an extensive patch of pale translucent scales.....16. **ornatus**

Mesonotal scales all brown to deep brown; propleuron without scales, propleural bristles few; sternopleuron without any pale scales..... 6

6(5). Base of proboscis with a ventral row of 4–7 bristles..... 7

Base of proboscis with 2 ventral bristles.....10

7(6). Base of proboscis with 6 or 7 strong ventral bristles as long as or longer than palpus...6. **steffani**

Base of proboscis with a ventral row of 4 bristles; the longest ones 0.5 of length of palpus..... 8

8(7). Abdominal tergites with very distinct basolateral pale spots; head with several broad pale scales forming a distinct patch at side; large species, wing over 3.0 mm.....5. **petersi**

Abdominal tergites with rather small, indistinct basolateral pale spots; broad scales of head almost all brownish black except for a very small patch at sides; small species, wing not over 2.5 mm..... 9

9(8). Ventral bristles at base of proboscis subequal and hair-like; tergites V–VII with inconspicuous basolateral pale spots.....9. **lakei**

Ventral bristles at base of proboscis stronger, external ones distinctly longer; tergites III–VII with inconspicuous pale spots.....7. **crowei,** 8. **shanahani**

10(6). Anterior surface of forecoxa with 1 striking linear row of strong bristles.....11

Anterior surface of forecoxa with 1 or 2 irregular rows of strong bristles.....12

11(10). Narrow decumbent scales of vertex yellow.....23. **schilfgaardei**

Narrow decumbent scales of vertex dingy white to dark.....
.....21. **fraudatrix;** 24. **insularis;** 22. **atracus;** 25. **kaviengensis**

12(10). Basolateral abdominal spots very small to completely absent.....
.....in part 11. **versabilis** and 13. **kowiroensis**

Basolateral abdominal spots very distinct.....13

13(12). Palpus 0.2 of length of proboscis.....26. **collessi**

Palpus less than 0.2 of length of proboscis.....12. **muruae**

14(4). Mesonotal scales yellow; head with numerous yellowish erect scales.....2. **bolii**

Mesonotal scales brown to dark brown; erect scales of head all dark brown to black.....15

15(14). Base of proboscis with 4 ventral bristles as long as or longer than palpus .....
.....4. **digoelensis,** 3. **confusus**

Base of proboscis with 2 ventral bristles shorter than palpus.....16

16(15). Basal ventral bristles of palpus about as long as palpal segment 1 .....33. **cottlei**

Basal ventral bristles of palpus as long as palpal segment 4 or 0.5 of length of palpus.....
.....15. **leei** and 14. **wamanguae**
.....in part 11. **versabilis** and 13. **kowiroensis**

Key to Larvae

(2. *bolii*, 3. *confusus*, 8. *shanahani*, 10. *marksae*, 19. *minjensis*, 27. *rajaneeae*, 29. *durhami*, 31. *pseudorubithoracis*, 32. *sedlacekae* unknown)

1. Prothoracic hair 8-P very weak, about the same order of magnitude as hair 11-P..... 2

Prothoracic hair 8-P as strong as hair 7-P..... 3

2(1). Head hair 1-C large, flattened and with 1 or 2 lateral denticles; thorax and abdomen densely covered with hair-like spicules (*mammilifer* subgroup).....1. *kuhnsi*

Head hair 1-C slender and simple; spiculation of thorax and abdomen light to completely absent (*hurlbuti* complex).....30. *hurlbuti*

3(1). Prothoracic hair 8-P single; abdominal hair 6-IV–VI 2, 3 b..... 4

Prothoracic hair 8-P double; abdominal hair 6-IV–VI 4, 5 b..... 6

4(3). Prothoracic hair 14-P double; hair 6-III triple (*digoelensis* subgroup).....3. **digoelensis**

Prothoracic hair 14-P single; hair 6-III double..... 5

5(4). Antennal shaft *entirely* dark; siphonal tufts 9 or 10 in number; abdominal hair 1-III–VI 3–5 b (*christiani* complex).....18. **pseudornatus**

Antennal shaft dark at extreme base, white in the middle and dark beyond hair 1-A; siphonal tufts 8 in number; abdominal hair 1-III–VI double (*fraudatrix* complex in part).....25. **kaviengensis**

6 (3). Prothoracic hair 4-P single; head hair 4-C weak and shorter than 0.5 of distance between its bases; head, thorax and abdomen with striking dark and white color pattern (*hilli* and *petersi* complexes)..... 7

Prothoracic hair 4-P double; head hair 4-C equal to or longer than 0.5 of distance between its bases; head, thorax and abdomen usually without striking dark and white color

pattern 9

7 (5). Head hair 5-C single; 7-C usually with more than 10 branches and strongly barbed; abdominal hair 6-I usually double (*hilli* complex).....9. **lakei**

Head hair 5-C double; 7-C usually with less than 10 branches and lightly barbed; abdominal hair 6-I triple (*petersi* complex)..... 8

8 (7). Prothoracic hair 3-P single; hair 1–IV, V 3, 4b; siphon without dark median ring.....5. **petersi**

Prothoracic hair 3 double; hair 1–IV, V 4, 6b; siphon with dark median ring...6. **steffani;** 7. **crowei**

9 (4). Abdominal hair 13-III–V weaker than hair I-III–V, about the same order of magnitude as hair 7-III–V; siphon with 10 subventral tufts which are 2–4 × siphonal width at point of attachment (*christiani* complex).....20. **gressitti**

Abdominal hair 13-III-V as strong as hair 1-III-V; siphon with 7–10 subventral tufts which are usually shorter than or about as long as siphonal width at point of attachment 10

10 (9). Antennal shaft completely dark from base to apex.....11

Antennal shaft dark at extreme base, white in the middle and dark beyond antennal tuft 12

11(10). Hair 2-VIII double; 4-VII double; pecten with 9–12 teeth; thorax densely covered with short blunt spicules (*ornatus* complex).....16. **ornatus**

Hair 2-VIII single; 4-VII single; pecten with 14–16 teeth; thoracic spiculation very light to completely absent (*christiani* complex).....17. **christiani**

12(10). Hair 4-VII single (*marksae* complex; *fraudatrix* complex in part).....**13**

Hair 4-VII double (*fraudatrix* complex; *marksae* complex in part).....17

13(12). Abdominal hair 10-III always single; head hair 14-C usually double (*fraudatrix* complex in part).....24. **insularis**

Abdominal hair 10-III usually double; head hair 14-C usually 3, 4b (2–5) (*marksae* complex) 14

14(13). Head hair 4-C very long, usually longer than or about as long as distance between its bases; abdominal hair 1-V, VI double.....15

Head hair 4-C shorter, its length usually 0.5 of distance between its bases; abdominal hair 1-V, VI 3, 4b (3–5).....16

15(14). Head hairs 5, 6-C usually triple; 6-I usually 4b (2–5); siphon relatively long, S/S index 5.3–6.7 .....14. **wamanguae**

Head hairs 5, 6-C double; 6-I triple; siphon relatively short, S/S index 4.5–5.4.....15. leei

16(14). Abdominal hair 3-IV triple; 3-V double; 3-VI single; siphon without median dark ring .....13. **kowiroensis**

Abdominal hair 3-IV double; 3-V single; 3-VI double; siphon usually with median dark ring.....11. **versabilis**

17(12). Siphon with 10 subventral tufts; 4-M usually more than 3b (3–5); 7-VI 3–5b.....26. **collessi**

Siphon with 8 subventral tufts; 4-M usually 3b (3–4); 7-VI 1, 2b.....18

18(17). Hair 7-VI double; 10-VII triple.....12. **muruae**

Hair 7-VI single; 10-VII usually double.....19

19(18). Hair 2-VIII always single; mesothoracic hair 4-M usually double; head hair 4-C longer than the distance between its bases.....23. **schilfgaardei**

Hair 2-VIII usually double, rarely single; mesothoracic hair 4-M 3, 4b, head hair 4-C shorter than the distance between its bases.....20

20(19). Abdominal hair 6-IV, V usually triple, hair 1-III–VI usually triple; head hair 14-C usually triple.....33. **cottlei**

Abdominal hair 6-IV, V 4, 5b; hair 1-III–VI 4, 5b; head hair 14-C usually double.....21

21(20). Hair 4-VI 2, 3b; 4-V 5, 6b.....22. **atracus**

Hair 4-VI 4, 5b; 4-V 6-8b.....21. **fraudatrix**

Key to Pupae

(2. *bolii*, 3. *confusus*, 8. *shanahani*, 10. *marksae*, 18. *pseudornatus*, 19. *minjensis*, 27. *rajaneeae*, 29. *durhami*, 31. *pseudorubithoracis*, 32. *sedlacekae* unknown)

1. Hair 11-C single (*mammilifer* group, *fraudatrix* group in part)..... 2
Hair 11-C double (*fraudatrix* group)..... 3

2 (1). Hair 3-C single; 6-IV–VI usually single; 8-C usually more than 2b (2–5b); cephalothorax, metanotum and abdomen brownish.....1. **kuhnsi**
Hair 3-C double; 6-IV–VI usually triple; 8-C double; cephalothorax, metanotum and abdomen uniformly yellowish.....25. **kaviengensis**

3 (1). Hair 8-C 4b; 12-C 6b or more.....32. **digoelensis**
Hair 8-C 1-3b; 12-C usually less than 6b..... 4

4 (3). Hair 8-C single; 6-III–VI single (*hurlbuti* complex).....30. **hurlbuti**
Hair 8-C 2, 3b; 6-III–VI 2-4b..... 5

5 (4). Hair 5-II 3b; 5-III 2–4b (*marksae* complex)..... 6
Hair 5-II usually at least 4b; 5-III usually at least 5b.....12

6 (5). Hair 7-I single or double, rarely triple; 6-IV, V single or double, rarely triple..... 7
Hair 7-I usually triple; 6-IV, V usually triple..... 9

7 (6). Hair 6-VI usually triple; 7-II usually double; 12-C usually double (highlands ground pool form).....11. **versabilis**
Hair 6-VI single or double; 7-II usually single; 12-C usually triple..... 8

8 (7). Hair 5-VI single; 7-I usually single; 6-VI single.....15. **leei**
Hair 5-VI double; 7-I double; 6-VI double.....14. **wamanguae**

9 (6). Hair 1-C double; 6-III usually double.....13. **kowiroensis**
Hair 1-C usually triple; 6-III triple.....10

10 (9). Hair 4-VII single; trumpet relatively short and stout, index 9.4 (lowlands palm bract form).....11. **versabilis**
Hair 4-VII double; trumpet relatively long and slender, index 10.0–15.0.....11

11(10). Hair 9-VII usually triple; trumpet uniformly cylindrical from base to apex (lowlands ground pool form).....11. **versabilis**
Hair 9-VII usually double; trumpet narrowed beyond the middle to base of its expanded pinna .....12. **muruae**

12 (5). Hair 8-C triple (*christiani* complex).....13
Hair 8-C double.....14

13(12). Hair 9-C double; 6-V, VI usually triple; 5-VII usually double.....17. **christiani**
Hair 9-C triple; 6-V, VI usually double; 5-VII usually single.....20. **gressitti**

14(12). Hair 10-III 3, 4b (*fraudatrix* complex, *ornatus* complex in part).....15
Hair 10-III double.....20

15(14). Trumpet slender and uniformly cylindrical from base to apex; paddle midrib usually pale and weakly sclerotized.....16
Trumpet stout, with markedly increased diameter from base to middle then gradually narrowed distally; paddle midrib usually dark and strongly sclerotized.....19

16(13). Hair 6-IV, V usually triple, rarely 4b; 5-VII single.....23. **schilfgaardei**
Hair 6-IV, V 4b; 5-VII double.....17

17(16). Hair 6-III, IV 4b; 10-IV triple.....21. **fraudatrix**
Hair 6-III, IV usually triple; 10-IV double.....18

18(17). Hair 4-VIII usually double; 7-C double; 8-C double.....24. **insularis**
Hair 4-VIII almost always triple; 7-C triple; 8-C triple.....22. **atracus**

19(15). Hair 1-C 2-4b; 12-C 3, 4b; 7-VI, VII single.....16. **ornatus**
Hair 1-C 5, 6b; 12-C 5, 6b; 7-VI, VII double.....26. **collessi**

20(14). Trumpet with a prominent swelling dorsally near the middle; cephalothorax, metanotum and abdomen uniformly yellowish white; hair 4-VIII triple.....33. **cottlei**
Trumpet uniformly cylindrical; cephalothorax, metanotum and abdomen with extensive brownish areas; hair 4-VIII double.....21
21(20). Hair 6-III, IV 4, 5b; 6-V, VI 5, 6b; 5-V usually triple (*hilli* complex).....9. **lakei**
Hair 6-III, IV usually triple; 6-V, VI 3, 4b; 5-V 4b (*petersi* complex).....22
22(21). Hair 5-C triple; 10-IV single; 9-VIII 1, 2b; 7-II single.....5. **petersi**
Hair 5-C 4, 5b; 10-IV double; 9-VIII 3-6b; 7-II usually double.....6. **steffani; 7. crowei**

Mammilifer Group

♂. *Head:* palpus varied in length, usually as long as or exceeding proboscis by about 0.5 of segment 5; basal finger-like processes absent; segments 4 and 5 with very weak and fewer bristles than in *fraudatrix* group. *Proboscis:* base of labium with 6–10 thin ventral setae; distal part of labium without dorsal upright setae; false joint present or absent, if present usually not distinctly marked or obviously flexed in dried specimens. *Antenna:* torus usually with a prominence on its inner dorsal surface, sometimes simple; F-5, 7, 8 with modified setae or tufts of setae and scales; F-6, 9, 10 with or without modified tufts of setae or scales. *Abdomen:* entirely deep brown to black-scaled.

Genitalia: Sidepiece: shape varied, submarginal setae usually present, rarely absent. *Subapical Lobe:* distal part with or without external leaflet; internal leaflet simple or modified; 3–6 accessory setae usually present. *Clasper:* with relatively larger claw than in *fraudatrix* group, its apex usually truncate, tapered to a distinct point dorsally; dorsal subapical crest rudimentary and inconspicuous; ventral subapical seta usually longer and stronger than dorsal subapical seta. *Phallosome:* lateral plate with an internal process; dorsal lobe with toothed or spinose dorsal process; ventral lobe absent or poorly developed. *Proctiger:* crown of paraproct with variable number of blunt and flattened spicules; cercal sclerite usually with 2, 3 minute setae, sometimes with 5 stronger setae. *Segment IX:* lobe of 9th tergite very poorly developed to completely absent, usually with 1 weak seta or none; 9th sternite very broad, with varied number of setae and a few scales.

♀. Similar to ♂ in ornamentation. Proboscis with 2–4 basoventral bristles which are 0.5–1.0 of length of palpus. Abdomen without lateral or basolateral pale markings.

LARVAE (New Guinea species). *Spiculation* strongly developed on thorax and abdomen (*C. kuhnsi*) or absent (*C. digoelensis*). *Prothorax:* hair 8-P very weak or as strong as hair 7-P, always single; 14-P single or double. *Abdomen:* hair 6-IV–VI usually triple. *Siphon:* pecten usually with 14–16 teeth, usually with varied number of characteristic denticles; siphonal tufts usually 8–10, more or less regularly paired.

PUPAE (New Guinea species). Hair 8-C 3-, 4-branched, 12-C 5-, 6-branched.

BIONOMICS. The reported breeding habitats of extralimital species of the *mammilifer* group are mainly natural containers such as pitcher plants, tree holes, bamboo stumps and palm axils, and only rarely ground pools including rock pools. In New Guinea, however, only *C. kuhnsi* utilizes tree holes and bamboo as breeding habitats. *C. digoelensis* is a ground pool form and *C. confusus* and *bolii* are probably also ground pool breeders.

SYSTEMATICS. The characterization of the *mammilifer* group as given here is based on a study of 4 New Guinea species as well as a number of Malayan forms representing both subgroup B-1 (*mammilifer*) and subgroup B-2 (*brevipalpus*) of Colless (1965). The presence of a prominence or similar modification of the male torus, considered to be diagnostic for the group by Edwards (1932: 196–198) and Colless (1965: 264–265), I regard here as being of secondary importance only. This particular character seems to be well developed in a limited number of lineages represented in the Oriental region but is absent in 3 species from New Guinea which share with *mammilifer* a number of much more basic and significant features in the male phallosome, palpus and proboscis. I, therefore, base the definition of the group on these latter features, as given in the diagnosis, and consider that the *mammilifer* group includes several different lineages, only some of which are characterized by modifications of the male torus.

In New Guinea the *mammilifer* group is represented by 3 distinct subgroups: B-1 (*mammilifer*) of Colless (1965) with *kuhnsi*, and 2 new subgroups which I am recognizing here for the first time, B-3 (*bolii*) containing only the nominate species, and B-4 (*digoelensis*) which includes *digoelensis* and *confusus*. These 2 new subgroups lack the modifications of the male torus and may perhaps represent more generalized lineages than groups B-1 and B-2. The characteristics of the 3 subgroups are summarized in the following.

B-1 (*mammilifer*). ♂: antennal torus with a spiculose prominence toward the inner dorsal margin; flagellomeres 5–9 with tufts of modified setae; palpus about as long as proboscis; lateral plate of phallosome with numerous large toothlike spicules on the apex and tergal surface. *Larva:* prothoracic hair 8-P greatly reduced, about 0.1 of length of hair 7-P; hair 14-P single; proximal pecten teeth of siphon with 3,4 denticles, distal teeth with or without denticles; thorax and abdomen heavily spiculose.

B-3 (*bolii*). ♂: antennal torus unmodified; flagellomeres 5–10 with tufts of modified setae; palpus exceeding proboscis by about 0.5 of length of segment 5; lateral plate of phallosome with a few large toothlike spicules confined to apex. *Larva:* unknown.

B-4 (*digoelensis*). ♂: antennal torus unmodified; flagellomeres 7 and 8 or 5,7 and 8 with tufts of modified setae; palpus exceeding proboscis by about 0.5 of length of segment 5; lateral plate of phallosome with small spinelike spicules on apex. *Larva:* prothoracic hair 8-P as strong as hair 7-P; hair 14-P double; proximal pecten teeth of siphon with 10-11 denticles, distal teeth with 7-9 denticles; thorax and abdomen without spiculation.

DISTRIBUTION. The *mammilifer* group is at present known only from the Oriental region (30 sp.) and the Papuan subregion (4 sp. treated here).

Mammilifer Subgroup

1. **Culex (Lophoceraomyia) kuhnsi** King & Hoogstraal Fig. 2, 3.

Culex (Lophoceraomyia) kuhnsi King & Hoogstraal, 1955, Proc. Ent. Soc. Wash. **57:** 1–4. *Type: Holotype ♂ (766 C), Doromena, Hollandia (Kota Baru), Netherlands New Guinea (West Irian), reared from larva from shaded treehole in open coastal hillside woods, 24. II. 1945, H. Hoogstraal and W.H. Christ (USNM).

Culex (L.) kuhnsi of Stone, Knight & Starcke (1959).

Culex (L.) uniformis of Penn (1949, Pacific Sci. **3:** 71–72).

♂ (fig. 2). Essentially as described by King & Hoogstraal (1955). *Head:* erect forked scales narrow, long, varying from rather pale to dark brown and occupying an extensive area on vertex and occiput. *Palpus:* equal to or sometimes a little longer than proboscis; segment 2 slightly exceeding 0.5 of length of segment 3; segment 3 with ventral row of short slender setae evenly and closely spaced in basal 0.25 and more widely spaced distally, its apex with 1, 2 strong bristles; segments 4 and 5 with weak bristles. *Proboscis:* labium with 6, 7 hair-like basoventral setae; false joint indistinctly marked at about 0.25 from base. *Antenna:* torus with a spiculose prominence toward the inner dorsal margin; F-5 with a small tuft of 9, 10 yellowish hair-like setae as long as the next flagellomere, preceded dorsally by 1, 2 long normal hairs; F-6 and F-7 with crumpled comb-shaped tufts of dark long curled scales; F-8 with a very prominent tuft of 8, 9 brownish scales, proximally fused, distally spread out, not forming a hook; F-9 with an external series of short, hair-like setae only; F-10 without any modified setae. *Thorax:* mesonotal integument dark brown, pleural area paler and with greenish tint; sternopleuron with a patch of a few pale scales over its posterior upper corner; propleuron with 3 strong and 6 short bristles; usually 1 lower anterior mesepimeral, sometimes 2. *Wing:* scales narrow and dark, usually very scanty on veins M, Cu and A. *Legs:* claws of foreleg subequal, both toothed at base. *Abdomen:* tergites dark scaled, venter paler.

Genitalia: (fig. 2) As figured. *Sidepiece:* with a linear row of 3, 4 submarginal setae and many shorter

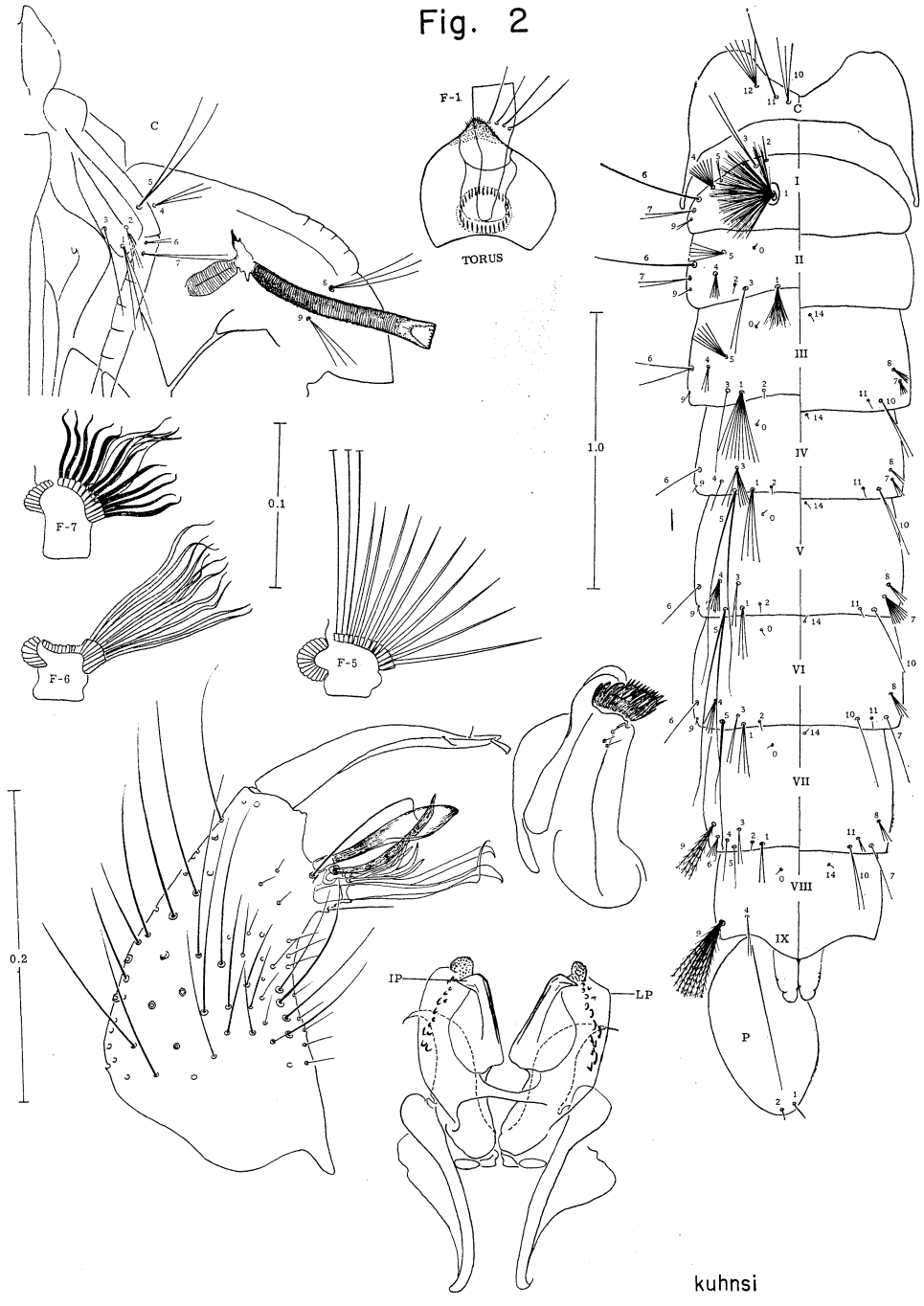


Fig. 2. Pupa, male genitalia, antenna, torus and modified tuft of flagellomeres 5–7 of *C.* (*L.*) *kuhnsi*.

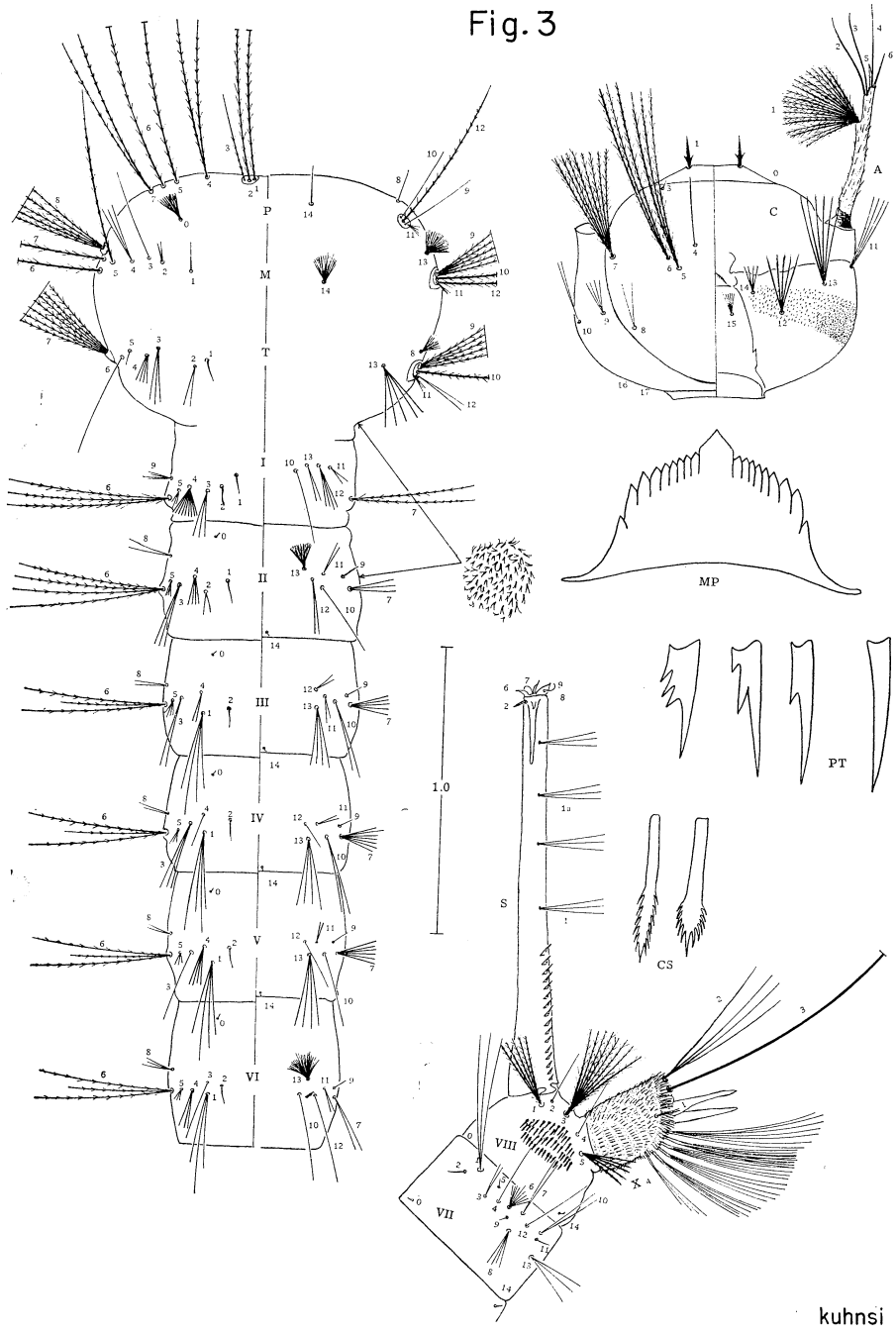


Fig. 3. Larva of *C.* (*L.*) *kuhnsi*.

setae. *Subapical Lobe:* proximal part with 1 basal seta and 3 stout rods; distal part with 1 relatively long basal seta, 1 broad external leaflet, 1 narrow, rod-like internal leaflet and 5 accessory setae, all flattened and with apices bent toward the internal leaflet. *Clasper:* proximal 0.5 broad, distal 0.5 narrowed gradually and tapered into a pointed tip; subapical claw small but moderately long; dorsal subapical seta nearer to the apex than ventral subapical seta, both tiny and subequal. *Phallosome:* lateral plate cone shaped, with strong blade-like internal process arising from base and projecting tergally a little beyond apex of dorsal lobe; apex of dorsal lobe and its tergal surface armed with numerous tooth-like spicules, apical ones finer, tergal ones coarser and somewhat tubercular in shape in dorsal aspect. *Proctiger:* with a large crown of coarse spicules; ventrolateral sclerite strongly sclerotized; 2 cercal setae present. *Segment IX:* tergal lobe very poorly developed, with 2, 3 weak setae or none; sternite very broad, with 9–11 strong setae near its apical margin.

♀. As described by King & Hoogstraal (1955); no material available for additional description.

LARVA. (fig. 3) *Head:* 0.7 mm. *Siphon:* 1.3 mm; index 8–11; ratio** 5.0–5.7. As figured; diagnostic characters as in the key. Head light brown, concolorous with thorax and abdomen, siphon and saddle darker; ocular bulge of head with a transverse band of numerous spicules ventrally and laterally; thorax and abdomen densely covered with strong, heavy hair-like spicules; saddle with numerous spine-like spicules over its posterior margin. *Chaetotaxy:* most hairs strongly developed. *Head:* hair 1-C large and flattened, usually with 1 denticle on each side; 4-C single, strong, reaching almost to level of anterior margin of frontoclypeus; 5, 6-C usually triple (2–4); 14-C usually 4-branched (4–6); mentum with 9, 10 lateral teeth. *Antenna:* slender, lighter than or concolorous with head capsule; subapical hairs distinctly basad of apical. *Thorax:* 3-P single; 7-P double; 8-P very short, minute and weaker than the spicules, usually single, rarely double; 14-P always single. *Abdomen:* hair 1-III–V usually 4-branched (3–5), 1-VI always triple; 6-III–VI usually triple, rarely 2-, 4- or 5-branched; 4-VII single; 7-VII double; 2-VIII always single. *Comb:* scales fringed with rough denticles. *Siphon:* pecten with 16–20 teeth, 2 or 3 distal teeth simple, basal ones with 3 or 4 heavy denticles; siphonal tufts 8 in number, usually 3-branched, their length 2 or 3 × siphonal width at the points of attachment. *Anal Segment:* hair 2-X with 4 subequal branches; ventral brush usually with 6 pairs of hairs.

PUPA. (fig. 2) *Abdomen:* 2.0–2.6 mm. *Paddle:* 0.63–0.65 mm. *Trumpet:* 0.54–0.63 mm; index 10.0–12.5. Described as *uniformis* by Penn (1949). Chaetotaxy as figured; diagnostic characters as in the key. Pigmentation uniformly light brown to reddish brown throughout. Trumpet cylindrical, with slightly expanded pinna. *Cephalothorax and Metanotum:* hair 3-C usually single (1, 2); 8-C usually triple (2–5); 10-C usually triple (2–7); 11-C always single; 12-C usually 5-branched (5–7). *Abdomen:* hair 1-V usually triple (1–4); 1-VI 2-, 3-branched; 5-IV–V usually double (1–2), almost 2× as long as following tergite; 5-VI always single; 6-III–IV single or double; 9-VIII long, usually 6-branched (7–6) and strongly plumose. *Paddle* with weak midrib.

BIONOMICS. King & Hoogstraal (1955: 2–4) recorded *C. kuhnsi* breeding in tree holes and in an instance in a fallen palm bract. In the present survey, larvae were collected in tree holes in deep shade in dense forests and in large bamboo stumps on a river margin near the coast at Vanimo, about 38–64 km from the type locality of Kota Baru (Hollandia). The larvae were not very numerous and usually only a few were found in each breeding site. Difficulty was experienced in rearing this species in the laboratory, in isolation as well as in mass, as most larvae failed to pupate after a long period. The pupal stadium lasted 2 to 3 days. Only males were reared and these were rather short lived and fragile after emergence. Adults have never been collected in the field and and it appears that *kuhnsi* is a rare species and probably very limited in distribution as it has never been reported from elsewhere in New Guinea.

SYSTEMATICS. *C. kuhnsi* is 1 of the 4 representatives of the *mammilifer* group in New Guinea. It appears to be closely related to *uniformis* (Theobald 1905) from India and *C. mindanaoensis* Baisas 1935 from the Philippines (King & Hoogstraal 1955) and on the basis of male and larval characters falls into the *mammilifer* subgroup B-1 of Colless (1965).

**For definition of "ratio", See page 84

DISTRIBUTION. Material examined: 15 ♂ (13 with associated larval and pupal skins); 27 whole larvae; 4 pupae. NW NEW GUINEA. Kota Baru, Hollandia, 12–28. II. 1945, H. Hoogstraal, W. B. Christ, ♂ holotype (766C) (USNM), 1 ♂ paratype (428) (Bishop). NE NEW GUINEA. SEPIK: Vanimo, Daunda Village 9, tree hole, 20.II.1966, SS, 3 1p♂, 1 1p♀ (adult damaged), 15 L (SP78); tree hole, 21.II.1966, SS, 1 1p♂, 10 L, 3 P (SP91); bamboo stumps, 23.II.1966, SS, 8 1p♂, 2 L, 1 P (SP108) (BISHOP).

Bolii Subgroup

2. **Culex** (**Lophoceraomyia**) **bolii** Sirivanakarn, new species Fig. 4.

TYPES: Holotype ♂ (EH22) with slide of antenna and genitalia (660711-9), Kundiawa in Chimbu, Eastern Highlands, NE New Guinea, Marani Creek, near Waghi River, 22.I.1966, S. Sirivanakarn and Martin Awa (BISHOP 7724). Allotype ♀ (EH22) with slide of buccopharyngeal armature and genitalia (660726-1), same data as holotype (BISHOP). Paratypes same data as holotype; 1 ♂ and 1 ♀ (EH22) (USNM); 1 ♂ and 1 ♀ (EH22) (BMNH); 1 ♂ and 1 ♀ (EH22) (ANIC); 1 ♂ and 1 ♀ (EH22) (UCLA). This species is named in honor of Mr Boli, Native Assistant, Malaria Service, Minj, Western Highlands in recognition of his contributions to the knowledge of Highlands *Lophoceraomyia*.

♂. (fig. 4) Similar in size to ♀. *Head:* yellowish narrow decumbent scales numerous; all broad scales yellowish; erect scales yellowish brown to coppery; frontal and orbital bristles yellow to golden. *Palpus:* exceeding proboscis by about 0.5 of length of segment 5; proximal part of segment 1 longer than distal part; segment 3 with a few ventral rows of tiny setae, apex with 2 or 3 bristles; segment 4 and 5 upturned, with several weak bristles; apex of segment 5 with 2 deep brown spines. *Proboscis:* labium with a row of 10 basoventral hair-like setae. *Antenna:* as figured; torus unmodified; F-5 with a tuft of 4 or 5 flattened setae; F-6 with a tuft of 7 curled setae, preceded dorsally by 3 or 4 very short hairs; F-7 with a comb-shaped tuft of about 10 hair-like curled setae and an internal group of about 4 tiny hairs; F-8 with a prominent tuft of about 7 long, pointed scales, proximally fused, distally spread out and subapically bent; F-9 and F-10 with 4 and 3 very long bristlelike setae, respectively. *Thorax:* mesonotum with numerous yellowish scales; mesonotal integument deep brown; anterior pronotum with some yellowish bristles; propleuron with 3 or 4 bristles; upper corner of sternopleuron with or without a few pale translucent scales; lower anterior mesepimeral bristle present. *Wing:* no marked ornamentation. *Leg:* claws of foreleg equal and toothed; claws of midleg unequal and simple; claws of hindleg equal and simple. *Abdomen:* tergites brown to dark scaled.

Genitalia: (fig. 4) As figured. *Sidepiece:* stout and broad; submarginal setae absent; marginal setae weak and very few in number; tergal surface completely devoid of setae; sternal surface with 5 or 6 bristles submarginally and 2 or 3 bristles on distal margin. *Subapical Lobe:* proximal part with 1 long basal seta, 2 subequal rods, and 1 short pointed rod; distal part divided into lateral group of 1 or 2 basal setae and 1 long-stemmed broad leaflet, and a mesal group of 1 hair-like seta and 2 or 3 blade-like setae. *Clasper:* as long as sidepiece, with rather broad, long subapical claw. *Phallosome:* lateral plate with internal process projecting tergally a little beyond tergal margin; dorsal lobe strongly sclerotized, proximally broad, distally narrowed, and constricted subapically into small toothed apex. *Proctiger:* ventrolateral sclerite strongly sclerotized, its apex with a crown of flat blunt spicules; cercal sclerite with 5 tiny setae. *Segment IX:* lobe of tergite very poorly developed, sometimes with 1 very weak seta; sternite broad, usually with a number of scales and strong setae.

♀. *Wing:* usually over 3.3 mm. *Forefemur:* 2.0 mm. *Palpus:* about 0.2 of length of proboscis. In general, as described for ♂ except for denser wing scales. Labium with 2–4 hair-like basoventral bristles. Abdomen without any basolateral or lateral pale markings.

IMMATURE STAGES. Unknown.

BIONOMICS. *C. bolii* is rather common in highland areas at altitudes just above 1500 m. Several adults were obtained from general field catches among plants at the margin of mountain streams

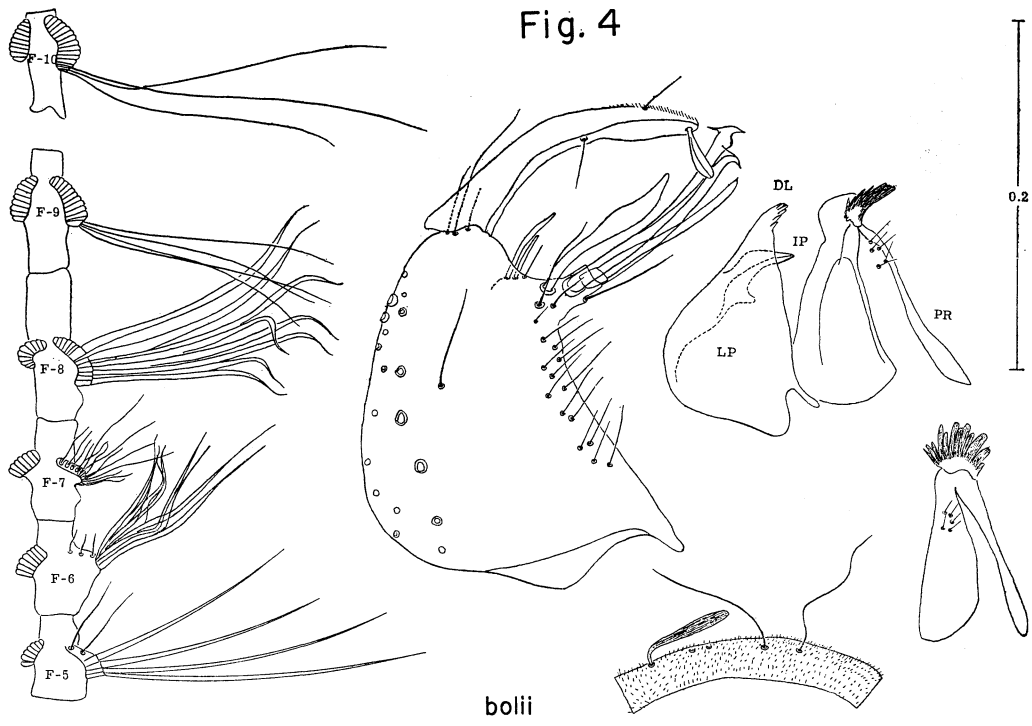


Fig. 4. Male genitalia and modified tufts of annal flantegellomeres 5–10 of *C.* (*L.*) *bolii*.

under deep shade of a dense forest. They were found associated with *christiani* and *minjensis*.

SYSTEMATICS. *C. bolii* is a very distinct species, quite different from any other *Lophoceraomyia*. The association of the sexes is presumptive only but appears to be correct on the basis of general external morphology. The male phallosome, palpus and proboscis all agree with the typical condition in the *mammilifer* group but the male antennal torus is simple. A separate subgroup, B-3, is here recognized for this species. *C. bolii* is exclusively a highland form and probably endemic to New Guinea.

DISTRIBUTION. Material examined: 52 adults (36 ♂♂, 16 ♀♀). NE NEW GUINEA. WESTERN HIGHLANDS: Minj, Tengen Stream, 1500–1700 m, 16–18.I.1966, Boli and SS, 1 ♂ (WH19); 3 ♂♂ (WH30). CHIMBU: Kundiawa, Marani Creek, 1700 m, 12–22. I. 1966, SS and M. Awa, 1 ♂, 1 ♀ (EH13); 4 ♂♂ (EH15); 1 ♂ (EH17); 3 ♂♂, 5 ♀♀ (EH19); 3 ♂♂, 2 ♀♀ (EH20); as listed in type series (EH22) and the following, 13 ♂♂, 3 ♀♀ (EH22). MOROBE: Wau, Mt Missim, mountain stream, 1800 m, 16–18. IV. 1966, SS, 1 ♂ (MR65); 1 ♂ (MR74) (BISHOP).

Digoelensis Subgroup

3. **Culex** (**Lophoceraomyia**) **digoelensis** Brug Fig. 5, 6.

Culex (*Lophoceratomyia*) *digoelensis* Brug, 1932, B. Ent. Res. **23:** 81–82. Type: Lectotype ♂, Upper Digoel River, Netherlands New Guinea (West Irian), Dr H. deRook; present selection (BMNH).

Culex (*Lophoceraomyia*) *digoelensis* of King & Hoogstraal, Proc. Ent. Soc. Wash. **57:** 10–11. Stone, Knight & Starcke (1959).

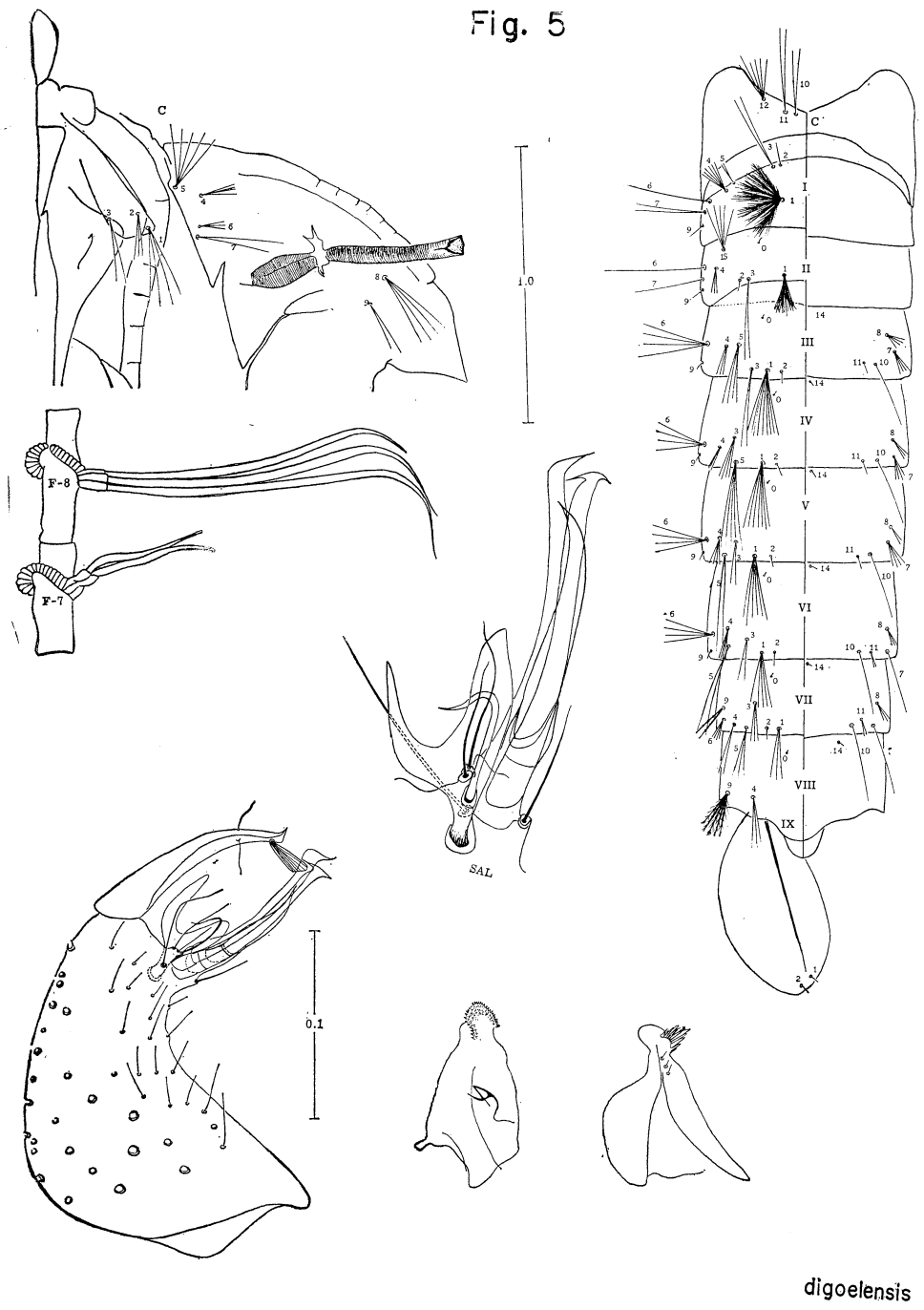


Fig. 5. Pupa, male genitalia and modified tufts of antennal flagellomeres 7 and 8 of *C.* (*L.*) *digoelensis*.

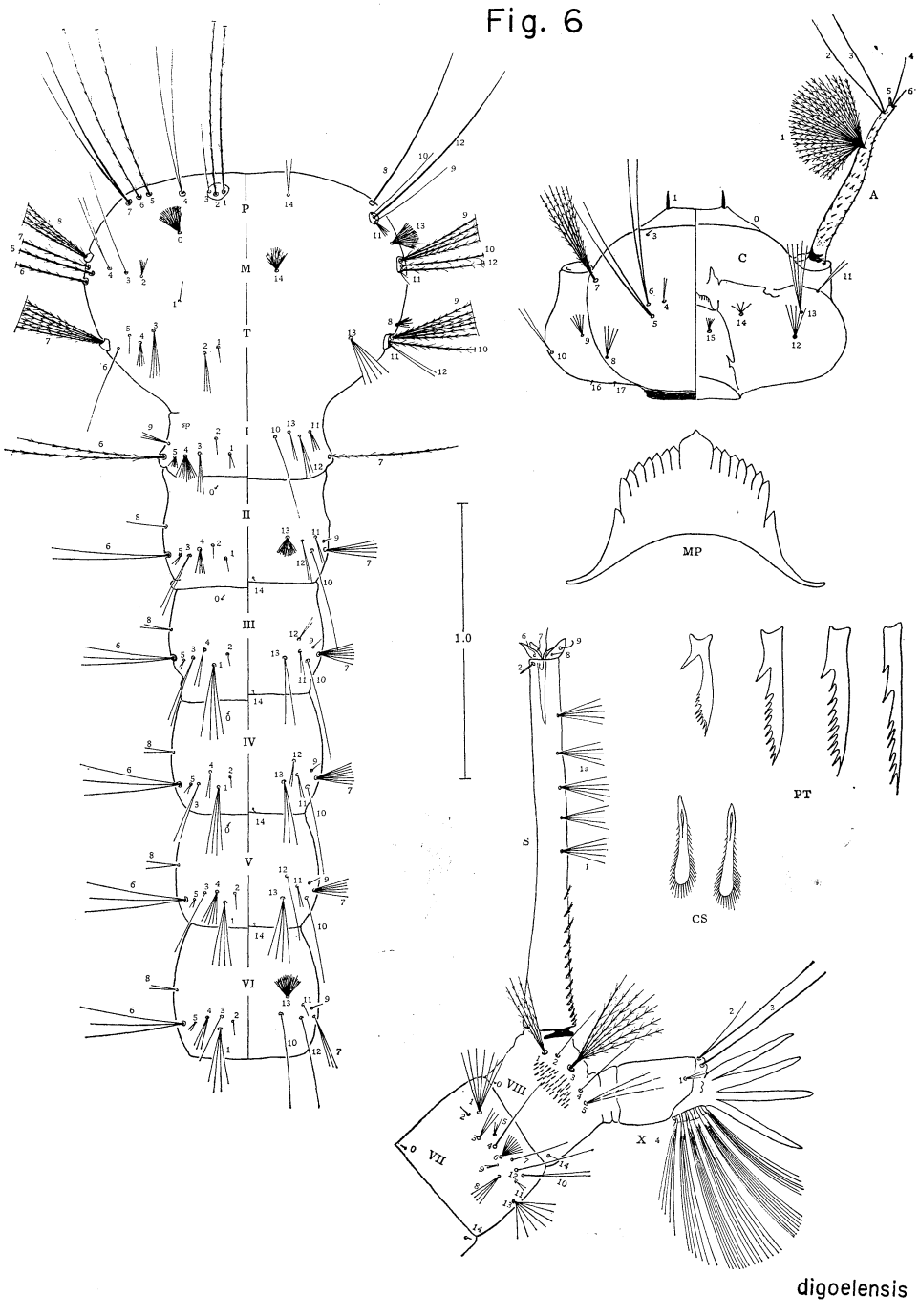


Fig. 6. Larva of *C.* (*L.*) *digoelensis*.

♂. (fig. 5) Small species. *Palpus:* exceeding proboscis by about 0.5 of length of segment 5; segment 2 about 0.3–0.4 of length of segment 3; segment 3 with a ventral row of short inconspicuous setae and usually with 1 or 2 lateral bristles apically. *Proboscis:* labium with 7 or 8 basoventral setae, all weak, slender, hair-like; false joint not developed. *Antenna:* torus unmodified; F-5, 6, 9 and 10 without tufts of modified setae or scales; F-7 with a small internal tuft of 2 or 3 short, proximally flattened, subapically curved, pointed setae subequal in length to flagellomere 8; F-8 with an internal tuft of 2–4 (usually 3) long stout, smoothly curved setae as long as the next 3 flagellomeres. *Thorax:* color of integument varied from light brown to deep brown; mesonotal scales deep brown; propleuron with 2 strong and a few weak bristles; 1 anterior lower mesepimeral bristle present. *Wing:* scales narrow, usually scanty except on costa, subcosta and radial veins. *Leg:* claws of foreleg subequal, both toothed; claws of midleg unequal, the smaller one toothed, the longer simple; claws of hindleg equal and simple. *Abdomen:* tergites entirely dark scaled; venter paler.

Genitalia: (fig. 5) *Sidepiece:* submarginal setae absent, tergal surface with weak widely spaced setae. *Subapical Lobe:* proximal part with 3 rods, the internal rod with longer basal tubercle than the other 2 rods, its distal 0.25 narrowed and tapered into a fine tip, external and central rods smoothly curved and apically hooked; distal part without external leaflet, basal seta present, internal leaflet mesal, broad and deeply emarginated, divided into 2 distinct portions, the distal one narrowed and apically pointed, the proximal one broad and apically rounded, 3 accessory setae present, 2 hair-like, the other flattened and strongly curved apically. *Clasper:* about 0.5 of length of sidepiece, proximally broad, distally narrow and with truncate apex; subapical claw broad and long; dorsal and ventral subapical setae opposite each other, dorsal longer than ventral. *Phallosome:* lateral plate with an internal process; dorsal lobe more slender than in most species in the *mammilifer* group, its apex rounded and armed with numerous spine-like spicules. *Proctiger:* crown with several flattened and blunt spicules tergally, finer and pointed spicules centrally and internally; ventrolateral sclerite strongly sclerotized; cercal sclerite with 2 or 3 minute setae. *Segment IX:* lobe of tergite very poorly developed, with 2 very weak setae; sternite rather broad, with variable number of long setae and scales.

♀. *Wing:* 2.8 mm. *Forefemur:* 1.5 mm. *Proboscis:* 1.8 mm. *Palpus:* 0.15–0.17 of length of proboscis. In general very similar to ♂ in ornamentation, differing slightly in having fewer broad pale scales on head and darker mesonotal integument. *Palpus:* segment 2 with apical bristles as long as or longer than segments 3 and 4 combined. *Proboscis:* labium with 4 strong basoventral bristles, as long as or slightly exceeding the whole length of palpus. *Abdomen:* tergites entirely dark scaled.

Larva. (fig. 6) *Head:* 0.58 mm. *Siphon:* 1.0 mm; index 6–7; ratio about 5. Pigmentation of head, thorax, abdomen, siphon and anal segment uniformly yellowish white; antennal shaft usually dark at extreme base and whitish distally toward apex. Spiculation of thorax absent. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* hair 1-C short and slender; 4-C very short and usually forked beyond the middle into 2 branches; 7-C, 5–7-branched; 14-C, 3–5-branched. *Thorax:* hair 4-P usually double (2-5); 7-P double; 8-P single; 14-P double; 3-M usually double (1-2); 8 and 9-M, 4-branched; 7 and 9-T, 6-branched. *Abdomen:* hair 6-I and II double; 7-I single; 6-III–VI triple; 4-VII single. *Comb:* with about 40 evenly fringed scales. *Siphon:* with 10 ventrolateral tufts, regularly paired, 5-branched and about 1.5 × siphonal width at the points of attachment; pecten with 14–16 teeth, proximal teeth with 1 heavy basal and 9 or 10 fine distal denticles, distal teeth with 1 or 2 heavy basal and 6 or 7 fine distal denticles. *Anal Segment:* hair 2-X with 1 short and 1 long branch; ventral brush with 6 pairs of hairs.

Pupa. (fig. 5) *Abdomen:* 2.0 mm. *Paddle:* 0.6 mm. *Trumpet:* 0.5 mm; index about 9. Differs strikingly from other New Guinea species in having a short trumpet. Chaetotaxy as figured; diagnostic character as in the key. *Cephalothorax and Metanotum:* hair 8-C, 4-branched; 12-C, 6-branched. *Abdomen:* hair 6-III–VI, 4-branched; all hairs 10 single. *Paddle:* with very indistinct margin and weak midrib.

Bionomics. *C. digoelensis* is commonly found along stream margins in the rain forest. Numerous adults were collected resting in small aggregations under leaves of seedlings or under fallen logs in heavy shade. A few were also collected in open sago swamps. They were found associated with *fraudatrix*, *schilfgaardei* and *ornatus*. Larvae were collected only on 2 occasions, once in a gravel pool on the margin of an intermittent stream, and once in a seepage pool with numerous decayed sago fronds. A small number of pupae were obtained among numerous larvae of *schilfgaardei* col-

lected in a blocked gravel pool in a forest stream.

SYSTEMATICS. *C. digoelensis* was only superficially described when it was recognized by Brug in 1932. Later, King & Hoogstraal (1955) provided additional descriptions of the male genitalia and antenna. The internal process and the form of the lateral plate of the phallosome were very well illustrated by these authors, but the taxonomic significance of these characters was completely overlooked by them and subsequent investigators. Together with *confusus*, *digoelensis* forms a distinct lineage in the *mammilifer* group and is here recognized as subgroup B-4 (*digoelensis*) within this group.

C. digoelensis is strikingly different from most *Lophoceraomyia* in all stages. The male is easily recognized by its small size and by the presence of a few dark modified setae on flagellomeres 7 and 8. These tufts project mesally and are easily overlooked from a lateral aspect but readily seen from above. The female is distinguished from most New Guinea forms (except *confusus*) by the long basoventral bristles of the labium. The larva is also distinctive in having prothoracic hair 14-P branched and in the characteristic development of the denticles of the pecten teeth. The pupa is almost completely unpigmented and can be separated readily from all other forms by its short trumpet.

DISTRIBUTION. Material examined: 152 adults (95 ♂♂, 57 ♀♀), 7 individual rearings (1 larval, 6 pupal); 1 whole larva and 1 larval skin. SW NEW GUINEA. Upper Digoel River (Brug 1932). NW New Guinea. Kota Baru-Hollandia (King & Hoogstraal 1955). NE NEW GUINEA. SEPIK: Kowiro, island from Wewak, elev. 150 m, 2.III.1966, SS, 1 ♂, 1 ♀ (SP137). Maprik, Upau Stream, 6–13.II.1966, SS, 11, 1 L (SP16) (BISHOP). MOROBE: Lae, Singuawa river area, 30 m, 10–13.IV.1966, SS, 2p ♂♂, 37 ♂♂, 4p ♀♀, 30 ♀♀ (SP11); 8 ♂♂ (MR24); 9 ♂♂, 10 ♀♀ (MR25); 8 ♂♂, 6 ♀♀ (MR26); 1 1p♀ (MR30); 28 ♂♂, 6 ♀♀ (MR32) (BISHOP). SE NEW GUINEA. GULF: Murua, sea level, 1–3. V. 1966, SS, 1 ♂ (G11); 1 ♀ (G12) (BISHOP).

4. **Culex** (**Lophoceraomyia**) **confusus** Sirivanakarn, new species Fig. 7

TYPES. Holotype ♂ (MR 11) with slide of antenna and genitalia (66072-8), Morobe, Lae, NE New Guinea, Singuawa River Area, 10.IV.1966, S. Sirivanakarn (BISHOP 7725). Paratypes: same locality and data as holotype; 1 ♂ (MR 11) with slide of antenna and genitalia (6608 11-17); 6 ♂♂ (MR 11, MR24, MR 32) (BISHOP).

♂. (fig. 7) Extremely similar to *C. digoelensis* in size, general ornamentation, palpal and labial characters, differing from the latter chiefly in having a stout bristle-like mesal seta developed on antennal F-5 in addition to those developed on F-7, 8.

Genitalia: (fig. 7) As figured; diagnostic characters as in the key. Very similar to *digoelensis*, differing chiefly in the following. *Sidepiece* with a dense group of several strong setae on its tergal surface. *Subapical Lobe:* basal tubercles of the 3 rods of the proximal part subequal; distal part with 1 broad external leaflet, 1 basal seta, 1 broad, simple internal leaflet, and 2 hairlike accessory setae.

♀. Unknown.

IMMATURE STAGES. Unknown.

BIONOMICS. This species was found along stream margins under the shade of sago palms and rain forest trees in association with numerous specimens of *digoelensis* and *fraudatrix*.

SYSTEMATICS. *C. confusus* is superficially extremely similar to *digoelensis* but can be readily distinguished by details of the antenna and genitalia of the males as indicated in the diagnosis. Without associated immature stages it is impossible to separate females of *confusus* from those of *digoelensis*. It is very probable that some females I have identified as *digoelensis* are actually *confusus*.

DISTRIBUTION. Material examined: 9 ♂♂. NE NEW GUINEA. SEPIK: Kowiro, inland from Wewak, 2.III.1966, SS, 1 ♂ (SP137) with antenna and genitalia slide (660801–9) (BISHOP). MOROBE: Lae, Singuawa River area, 10–13.IV.1966, as listed in type series (MR 11, 24, 32) (BISHOP).

Fig. 7

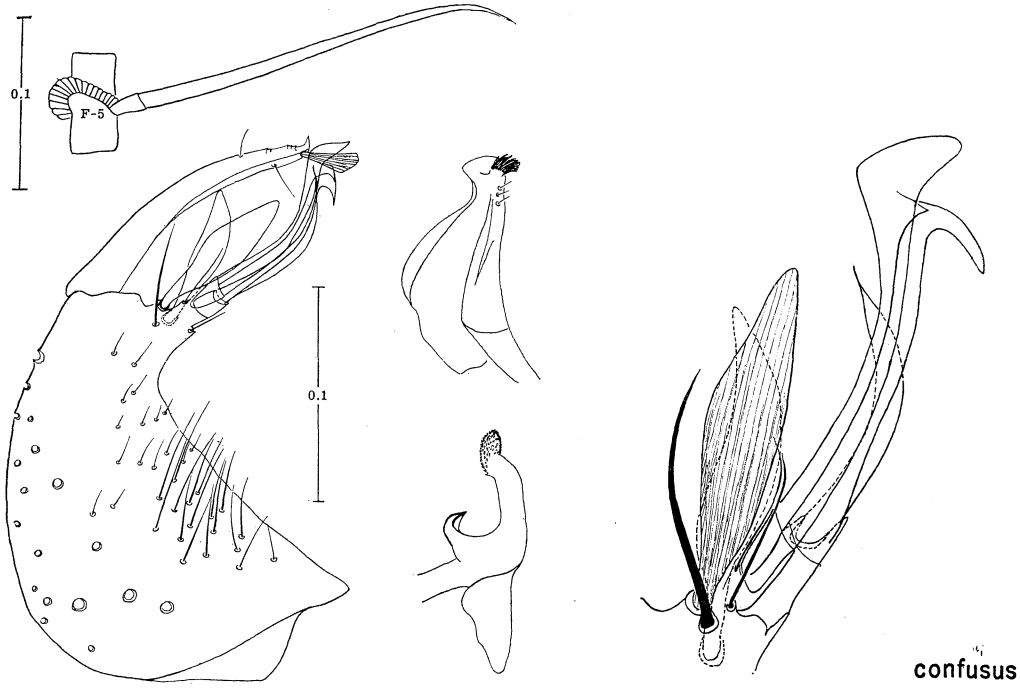


Fig. 7. Male genitalia and modified seta of antennal flagellomere 5 of *C.* (*L.*) *confusus*.

Fraudatrix Group

♂. *Palpus:* usually exceeding proboscis by about full length of segment 5; basal finger-like processes present; segments 4 and 5 usually with numerous strong bristles. *Proboscis:* base of labium with a transverse ventral row of 10–12 stout spine-like setae; distal part of labium usually with dorsal upright setae in apical 0.25–0.75; false joint present and distinctly marked by flexion at 0.25 of distance from base. *Antenna:* torus unmodified; F-5 to F-10 with modified tufts of scales and setae. *Abdomen:* usually dark brown scaled, sometimes with basal white bands or basolateral white spots.

Genitalia: Sidepiece: usually slender; submarginal setae almost always present, rarely absent. *Subapical Lobe:* distal part usually with broad external leaflet, which is sometimes replaced by a hair-like seta; internal leaflet simple and usually not modified; 1–6 accessory setae present. *Clasper:* with smaller claw than in *mammilifer* group, its apex more or less pointed; dorsal subapical crest very light but distinct distad of dorsal subapical seta, sometimes extending basad to near curvature; ventral subapical seta as long and as strong as dorsal subapical seta. *Phallosome:* lateral plate without an internal process but with distinct dorsal and ventral lobes; dorsal lobe with a large simple beak-like process. *Proctiger:* crown of paraproct without any blunt spicules, but with fine pointed spine-like spicules; cercal sclerite usually with 2 or 3 setae. *Segment IX:* lobe of tergite small, usually with 2 or 3 setae, sometimes strongly developed and with 6–12 strong setae; sternite without any setae or scales.

♀. Similar to males in ornamentation. Proboscis usually with 2 basoventral bristles, sometimes with 4–7 setae usually less than 0.5 of length of palpus, rarely as long as or longer than palpus. Abdomen usually with basolateral pale markings or spots.

LARVAE. *Spiculation:* completely absent or confined to lateral areas of thorax. *Prothorax:* hair 8-P

usually as strong as hair 7-P, usually double, rarely single; hair 14-P always single. *Abdomen:* hair 6-IV–VI usually 4- or 5-branched, rarely double or triple. *Siphon:* pecten teeth with an even fringe of fine sharp denticles; siphonal tufts usually 8 (rarely 10 or 12), usually irregularly paired.

PUPAE. Hair 8-C usually double, rarely triple; hair 12-C usually 3- or 4-branched.

BIONOMICS. Most species of the *fraudatrix* group are breeders in ground pools. Only a few species have been found breeding in natural containers such as palm bracts, sago stumps, and occasionally in tree holes, pandanus and sago axils. The adults may be found in great numbers near their breeding sites and some forms may be rather gregarious in their resting habits. No definite records are available regarding their relation to man or to other animals.

SYSTEMATICS. The *fraudatrix* group contains the largest number of species in the subgenus. The total number of species recorded prior to this study was approximately 46 (18 from the Oriental region, 3 from the Western Pacific, 12 from the South Pacific, 13 from the Australasian region). In this study 19 new species are added, bringing the total up to 32 for the Australasian region and to 65 for all zoogeographic regions.

The adults of most species of the *fraudatrix* group lack striking ornamentation on the thorax and abdomen. The males of many forms are extremely similar in genitalia but differ strikingly in antennal scale tufts, palpus or labium. The larvae are not as highly modified as in the *mammilifer* group in spite of the fact that some normally breed in natural containers.

The *fraudatrix* group is the most complex assemblage of species in the subgenus. Edwards (1932: 196–198) first restricted it to his group B (*Lophoceratomyia*) but later (1934: 360–72) expanded it to include also group A (*minutissimus*). Colless (1965: 264) agreed with the latter action but pointed out that *minutissimus* itself does not possess all the diagnostic characters of the *fraudatrix* group in the broader sense, although 2 included species, *cylindricus* and *infantulus*, appear to be related to *fraudatrix*. It seems probable that 2 or more complexes have been included in group B and that these should be recognized as distinct entities in the *fraudatrix* group, with *minutissimus* probably as a distinct subgroup. All that can be done with our present fragmentary knowledge is to recognize complexes of closely similar species.

In the present study, 29 species of the *fraudatrix* group are recognized and these appear to fall into 10 more or less distinct lineages or complexes as follows:

1) *petersi* complex with *petersi*, *steffani*, *crowei*, and *shanahani*
2) *hilli* complex with *lakei*
3) *marksae* complex with *marksae*, *versabilis*, *muruae*, *kowiroensis*, *wamanguae*, and *leei*
4) *ornatus* complex with *ornatus*
5) *christiani* complex with *christiani*, *gressitti*, *pseudornatus*, and *minjensis*
6) *fraudatrix* complex with *fraudatrix*, *atracus*, *schilfgaardei*, *insularis*, *kaviengensis*, *collessi* and *rajaneeae*
7) *solomonis* complex of Belkin (1962) with *solomonis* and *durhami*
8) *hurlbuti* complex of Belkin (1962) with *hurlbuti*
9) *pseudorubithoracis* complex with *pseudorubithoracis* and possibly *sedlacekae*
10) *cottlei* complex with *cottlei*

Except for the distinguishing characters as indicated in the keys, a great deal of similarity in morphology, possibly due to parallelism or convergence, is evident in 1 or more stages among these complexes. The *petersi* complex is clearly distinguished from almost all forms in other complexes in male genitalia and palpus, but its immature stages overlap with those of the *hilli* complex and the tufts of male antennae are similar to some forms of the *fraudatrix* complex. The *marksae* complex is very distinctive in male genitalia and antennal tufts but the larvae of some forms show a great

deal of overlap with the *fraudatrix* complex. Most species of the *christiani* complex are distinctive in all stages except *christiani* itself which has many similarities with the *fraudatrix* complex in larval and pupal chaetotaxy. The *ornatus* complex has very distinctive males and females but the larval and pupal chaetotaxy is very similar to that of *collessi* and *fraudatrix*. The *fraudatrix* complex (including the *buxtoni* complex of Belkin 1962) shows striking similarity in the male antenna and palpus with the condition described for *variatus*, *cubitatus* and other Indomalayan forms. Most members of the *solomonis* complex of Belkin (1962) are distinct from the *fraudatrix* complex in all stages except for *durhami* which has the male antennal tufts and palpus very similar to *fraudatrix* and *collessi*. The *hurlbuti*, *pseudorubithoracis* and *cottlei* complexes are all distinctive in male characters. The immature stages of *cottlei*, however, show a considerable overlap in chaetotaxy with the members of the *fraudatrix* complex. The presence of intermediate conditions in sympatric forms of these complexes suggests that speciation in *Lophoceraomyia* may have taken place through hybridization and that this may be occurring on a large scale at the present time as postulated by Belkin (1962).

DISTRIBUTION. The *fraudatrix* group in the broad sense is widely distributed in the Oriental and Australasian regions and in the islands northeast and southeast of New Guinea. In the Papuan part of the Australasian region, the group is better represented than anywhere else by many forms of numerous complexes as indicated above. The *marksae* and *christiani* complexes both are probably endemic to New Guinea. The *petersi*, *hilli* and *fraudatrix* complexes may have several representatives in Australia and on the islands to the east of New Guinea. *C. cottlei* appears to be a relict form confined to Manus I., while the *pseudorubithoracis* complex may have several representatives in the Oriental region.

Petersi Complex

♂. Usually small, wing usually between 2.5–3.0 mm, rarely over 3.0 mm. *Head:* broad scales pale brown, forming a narrow white line above the eyes and a small dingy white patch at side. *Palpus:* basal processes relatively long, as long as or slightly exceeding the distal part of segment 1; segment 3 without ventrolateral tuft of long setae, ventral setae present, closely spaced in proximal 0.5, widely spaced distally. *Proboscis:* labium with dorsal upright setae in apical 0.5. *Antenna:* F-5 with a fan-shaped tuft of 11–20 scales as long as or slightly shorter than the next 4 flagellomeres, the dorsal group of 2–10 scales dark, broad and blunt-tipped, the lateroventral group of 7–11 scales, narrow, pointed apically, dark proximally and white distally; F-6 with a crumpled tuft of brown curled setae; F-7 with an external tuft of 15 or 16 brown setae in form of a comb and an internal tuft of 4 or 5 fused, stout setae with twisted apices; F-8 with a hooked tuft of 7 or 8 fused setae; F-9 with 5–7 deep brown, rather broad blade-like scales; F-10 with 3–5 long, stout, dark brown setae. *Thorax:* mesonotal integument deep chestnut brown, mesonotal scales dark. *Abdomen:* tergites entirely dark brown scaled.

Genitalia: Sidepiece: with 3 submarginal setae in line, the most basal 1 usually weaker than the other 2. *Subapical Lobe:* proximal part with or without basal seta; 3 rods present, smoothly curved, 2 with hooked apices and 1 truncate apically; distal part with 1 strong basal seta, 1 narrow, apically-blunt or truncate external leaflet, 1 broader and apically-rounded internal leaflet, 5–6 accessory setae, all flattened and the most distal one with subapical serrate margin, the rest simple. *Phallosome:* lateral plate with short beak-like dorsal process. *Proctiger:* ventrolateral sclerite narrow, ribbon-like; cercal sclerite with 2 or 3 setae. Lobe of 9th tergite small, with 3 weak setae.

♀. Essentially similar to ♂ in size and ornamentation except for the following. *Proboscis:* with 4–7 rather strong basoventral bristles. *Abdomen:* tergites III–VII with very distinct to very inconspicuous basolateral pale spots.

LARVAE. *Pigmentation:* rather characteristic, usually with contrasting dark and white areas on head, thorax and abdominal segments; siphon usually with median dark ring. *Head:* hair 4-C very weak and short, never exceeding 0.5 of distance between bases; 5-C double; hair 14-C 3–4-branched. *Thorax:* prothoracic

hair 4-P usually single, rarely double. *Abdomen:* hairs 4-VII and 2-VIII always double. *Siphon:* with 8 tufts about as long as or slightly shorter than siphonal width at points of attachment.

PUPAE. *Pigmentation:* cephalothorax and metanotum pale brown, darker on antennal, palpal, labial, wing and leg cases. *Trumpet:* deep brown proximally, paler distally; very uniformly cylindrical and rather long; index 12–15. *Abdomen:* anterior segments pale brown, posterior darker, deep brown; genital lobe deep brown. *Paddle:* with dark, strong midrib. *Chaetotaxy:* essentially as in the *fraudatrix* complex except as noted in the key.

BIONOMICS. The larvae of the *petersi* complex all breed in ground pools such as ponds, grassy ditches, blocked stream pools or seepage pools. Usually the water is clear and fresh, and contains numerous green algae, duck weeds or other aquatic plants.

SYSTEMATICS. The *petersi* complex includes 4 species—*petersi*, *steffani*, *crowei* and *shanahani*. The male genitalia are very similar in all species and show only slight differences from one another. The species are characterized primarily by differences in the scale tufts of antennal F-5 and F-9 in the males and by the number of basoventral bristles in the females. Most species of the complex are allopatric, showing little or no overlap with one another. This complex appears to be closely related to the *hilli* complex in larval and pupal characters and possibly to the Oriental *cubitatus* and *quadripalpis* as described by Colless (1965).

DISTRIBUTION. The *petersi* complex is endemic to New Guinea. All the species except *petersi* are confined to the lowlands, primarily to the coastline in southern Papua and northern New Guinea. *C. petersi* is known only from the highlands at altitudes of 1500–1700 m.

5. **Culex (Lophoceraomyia) petersi** Colless Fig. 8, 9.

Culex (Lophoceraomyia) petersi Colless, 1959, Proc. Linn. Soc. N. S. W. **84:** 388. *Type: Holotype ♂ (CH81, CT499) with associated larval and pupal skins, Minj, Western Highlands, NE New Guinea, reared from larva taken in shallow pool with emergent vegetation, altitude 1700 m, 1958, S. H. Christian (ANIC).

♂. (fig. 8) As described by Colless (1959) and with the following distinguishing features. *Head:* narrow decumbent scales yellowish; broad appressed scales pale brown to dingy white, forming an orbital line and a distinct broad patch at side; erect forked scales on occiput dark brown. *Palpus:* exceeding proboscis by about length of segment 5; basal processes as long as or slightly longer than the distal part of segment 1; segment 2 covered with loosely packed brown scales; segment 3 with a ventral row of tiny setae, its apex with 4 or 5 dark brown bristles laterally and ventrally; segments 4 and 5 with several strong bristles. *Proboscis:* labium with a basoventral row of 10 stout spine-like setae; false joint at about 0.2 from base; distal 0.5 with 2 dorsal rows of upright setae, the most distal ones usually longest and about 2 or 3 times labial width at the points of attachment. *Antenna:* F-5 with a fan-shaped tuft of 14 or 15 scales, the most dorsal group of 4 or 5 scales broad, deep brown and blunt-ended, the lateroventral group of 10 or 11 scales narrow and slightly longer, pointed, dark proximally, and white distally; F-6, F-7 and F-8 with tufts as described for the complex; F-9 with 5 brownish blade-like scales of moderate width, all tapered to a fine point on 1 side. *Thorax:* mesonotal integument brown to dark brown; scales narrow, dark to almost black; pleuron with dark areas on *apn*, *ppn*, *psp*.

Genitalia: (fig. 8) As described by Colless (1959) and as figured here. *Sidepiece:* with 3 submarginal setae in a line parallel to the tergomesal margin, the basal 1 weaker and about 0.7 of length of other 2. *Subapical Lobe:* proximal part with 3 stout rodlike setae and with or without basal seta; distal part with a long basal seta, external leaflet with narrow stem, distally broadened and more or less truncate apically, internal leaflet with evenly rounded apex, 6 accessory setae usually present, 4 subapically curved towards the internal leaflet, 1 with serrate margin on its subapical 0.5, 1 blade-like with truncate apex and 1 short, straight spine-like. *Phallosome:* lateral plate with relatively short dorsal process, bent at approximately 90° from the stem. *Proctiger:* with small crown of sharp and fine spicules; ventrolateral sclerite narrow. *Lobe* of 9th tergite small, usually with 3 weak setae.

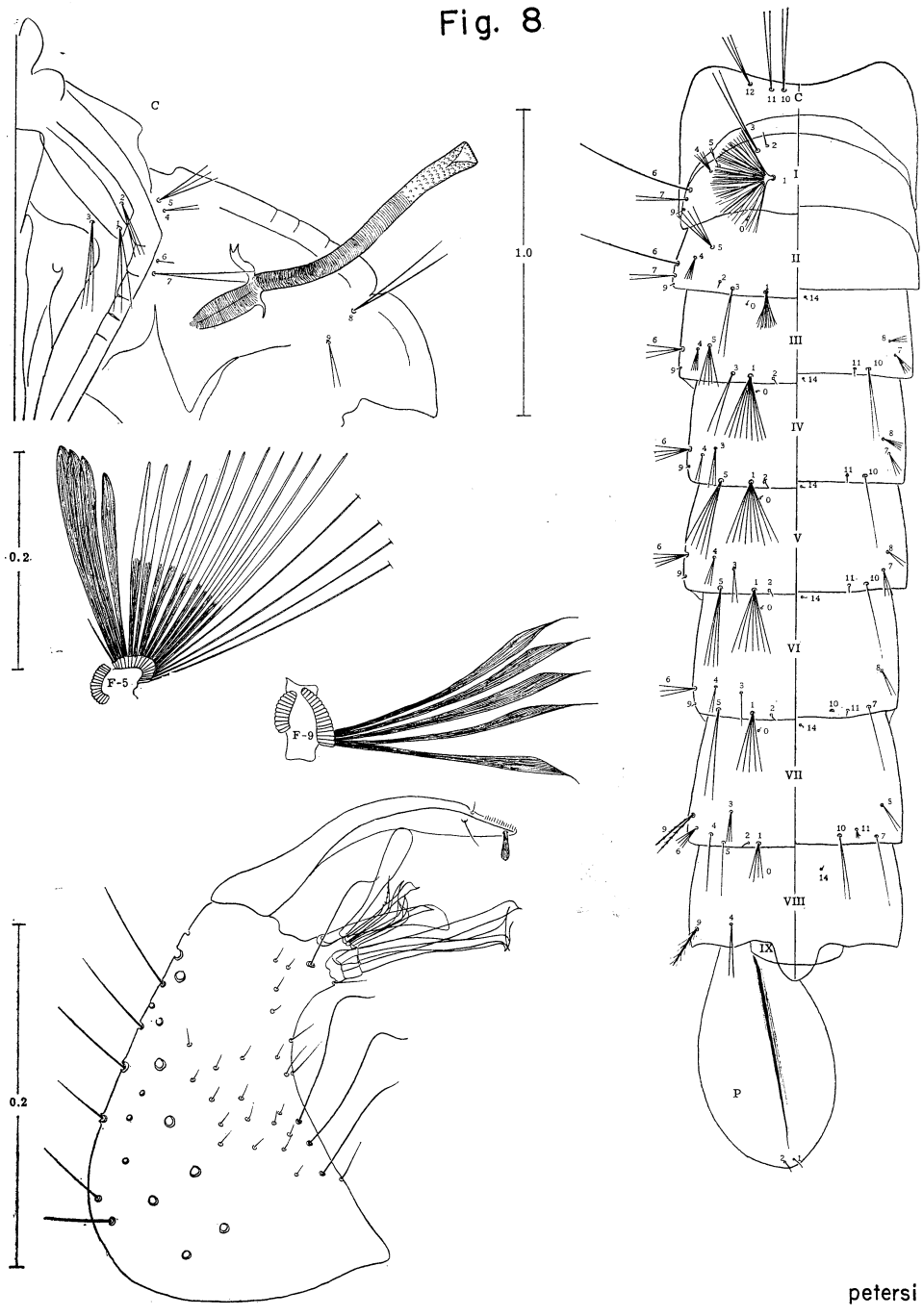


Fig. 8. Pupa, male genitalia and modified tufts of antennal flagellomeres 5 and 9 of *C.* (*L.*) *petersi.*

Fig. 9

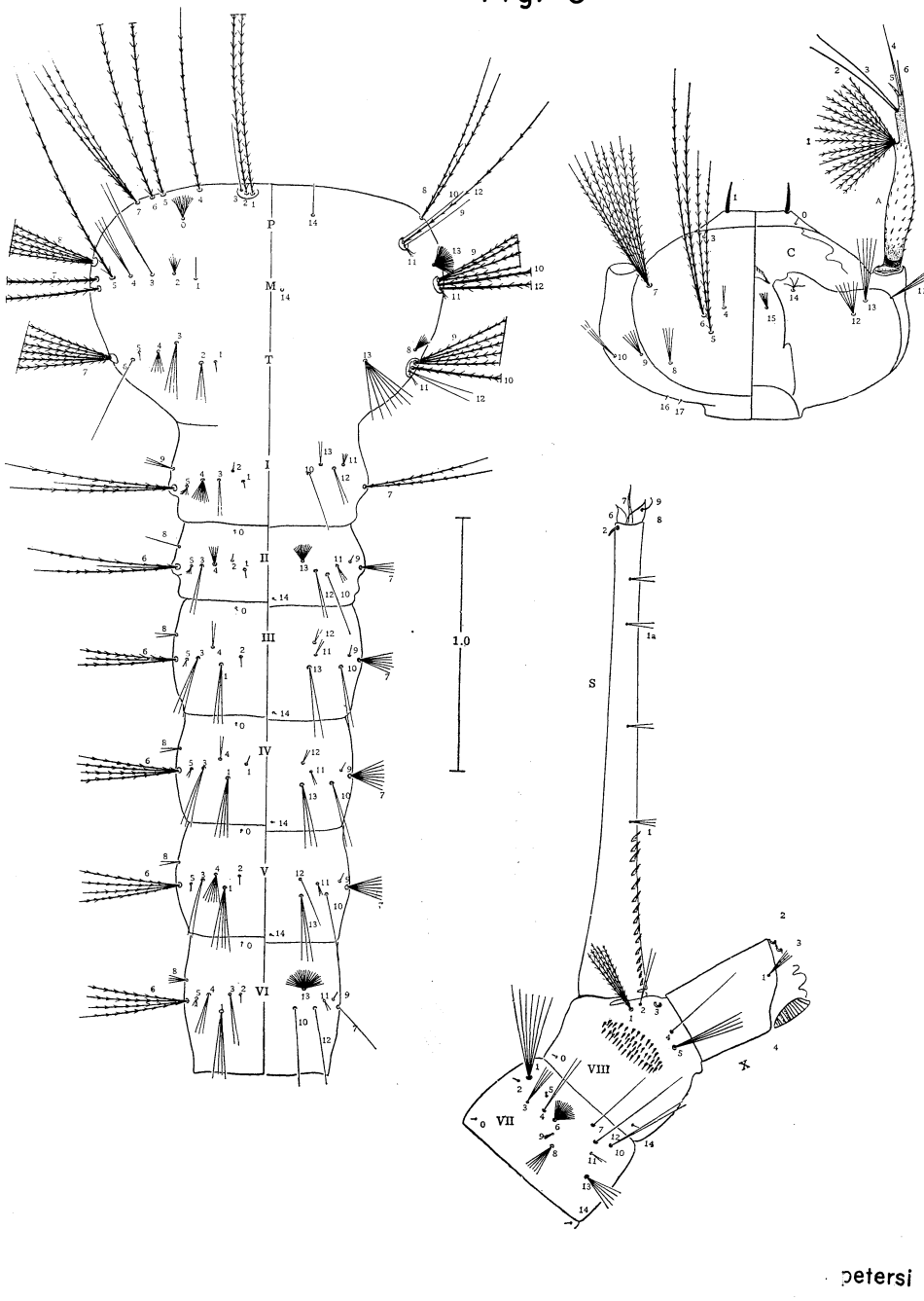


Fig. 9. Larva of *C.* (*L.*) *petersi*.

♀. *Wing:* 3.5 mm. *Forefemur:* 1.8 mm. *Proboscis:* 2.3 mm. *Palpus:* 0.15 of length of proboscis. Similar to ♂ in size and in general ornamentation, differing in having the broad appressed scales on the head darker; abdominal tergites III–VII with distinct basolateral pale spots; abdominal sternites yellowish scaled. Proboscis with 4 basoventral bristles.

LARVA. (fig. 9) Known only from the holotype skin. *Head:* 0.75 mm. *Siphon:* 1.8 mm; index 7.3; ratio 4.5. Obviously differing from closely related forms in the absence of dark pigmentation on head and in the middle of siphon. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* hair 4-C weak, shorter than 0.5 of distance between bases, usually forked into 2 branches; 7-C, 10-branched; 14-C, 3- or 4-branched. *Thorax:* hair 3-P single; 4-P single; 8-M, 4- or 5-branched; 9-M, 4-branched; 7-T, 6-branched; 9-T, 5-branched. *Abdomen:* hair 1-III–VI, 3- or 4-branched; hair 6-I–III triple: 6-IV, -VI, 4-branched; 2-VIII double. *Siphon:* 8 subventral tufts with 2 or 3 branches slightly shorter than siphonal width at the points of attachment; pecten with 15 teeth, the most distal one barbed with about 10 fine denticles. *Anal Segment:* hair 2-X with 1 long and 3 short branches.

PUPA. (fig. 8) Known only from the holotype skin. *Abdomen:* 2.5 mm. *Paddle:* 0.75 mm. *Trumpet:* 0.78 mm; index 15.0 Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax and Metanotum:* hair 1-C, 2- or 3-branched; 5-C triple; 6-C single; 12-C double. *Abdomen:* hair 6-III–VII triple; 9-VII double; 9-VIII, 1- or 2-branched. *Paddle* with dark and strong midrib.

BIONOMICS. The only information regarding the breeding habitat of *C. petersi* is that of Colless (1959: 389) given above under the holotype. During the present survey not a larva or pupa was found in spite of diligent search at the type locality for nearly 2 weeks. However, a few males and females were collected in pit shelters near native plantations. The adults appear to prefer resting on moist soil in deep or partial shade and were found associated with *christiani* and *minjensis*.

SYSTEMATICS. *C. petersi* is known only from the type locality at Minj, Western Highlands, New Guinea, at elevation above 1500 m. The above description is based on the type series. This species is differentiated from other closely related forms primarily by differences in the scale tufts of antennal flagellomeres 5 and 9. The adults which I have examined also seem to differ considerably from *steffani*, *crowei* and *shanahani* in being larger in size. The females can be clearly distinguished by the presence of relatively larger basolateral abdominal spots than in the above-mentioned species.

DISTRIBUTION. Material examined: 5 adults (2 ♂♂, 3 ♀♀), 1 L, 1 P. NE NEW GUINEA: WESTERN HIGHLANDS: Minj, elevation 1500–1700 m, 1958, S. H. Christian, 1 1p♂ (holotype), 1 L (morphotype), (ANIC); pit shelters, I. 1967, SC, 1 ♂ and 3 ♀ (BISHOP).

6. **Culex** (**Lophoceraomyia**) **steffani** Sirivanakarn, new species Fig. 10, 11.

TYPES: Holotype ♂ (CP5-10) with associated larval and pupal skins, Rigo Road, Port Moresby, Central District, SE New Guinea, margin of blocked stream, 22.XII.1965, S. Sirivanakarn (BISHOP 7726). Allotype ♀ (CP5-12) with associated larval and pupal skins, same data as holotype (BISHOP). Paratypes, same data as holotype; 2 ♂♂ (CP5-13, 14) with associated larval and pupal skins, 4 ♂♂ (CP5-103, 106-108) with associated pupal skins and slide mounts of genitalia and antenna; 1 ♂ (CP5) with slide mount of antenna (660711-4), 2 ♂♂ (CP5) with genitalia slides (660712-1, 660712-2), 3 ♂♂ (CP23) with genitalia and antenna slides (660711-1, 660711-2, 660711-3), 2 ♀♀ (CP5-111 and CP5-20) with associated pupal skins, 1 ♀ (CP5) (BISHOP).

♂. (fig. 10) In general similar to *C. petersi* in palpal, labial and genitalic characters, differing in a smaller size and in the following features. *Head:* broad appressed scales almost all brown. *Palpus:* segment 3 with 1 or 2 apical bristles. *Antenna:* F-5 with a tuft of 11 or 12 narrower scales, a dorsal group of 2–5 (usually 2) dark, broad short scales, a ventrolateral group of 7–9 narrow, distally pale and pointed scales of increasing length, the latter as long as or slightly longer than the next 4 flagellomeres; F-9 with 6 or 7 dark, broad, blade-like scales, all with truncate apices; F-10 with 3 or 4 long, stout setae.

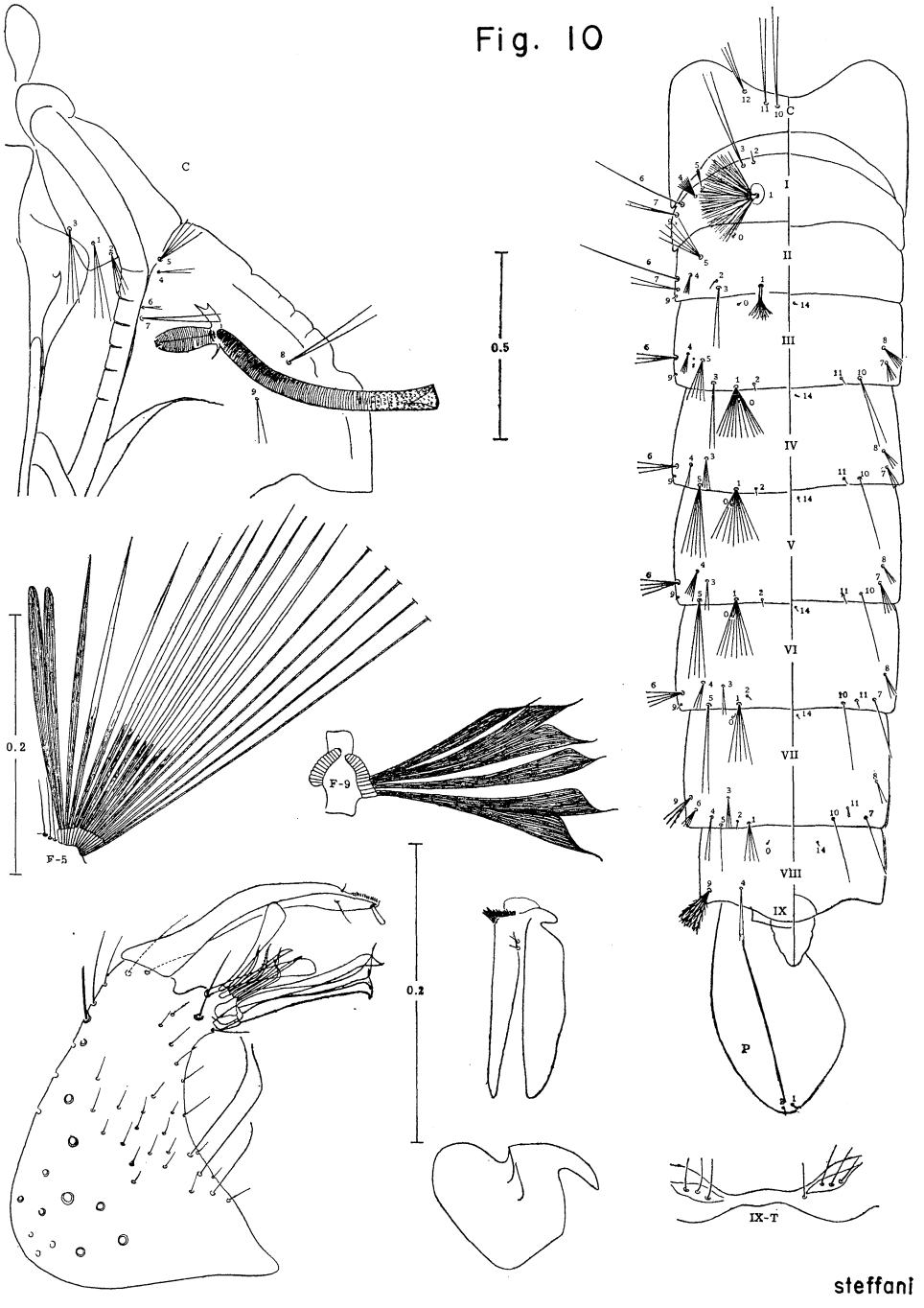


Fig. 10. Pupa, male genitalia and modified tufts of antennal flagellomeres 5 and 9 of *C.* (*L.*) *steffani*.

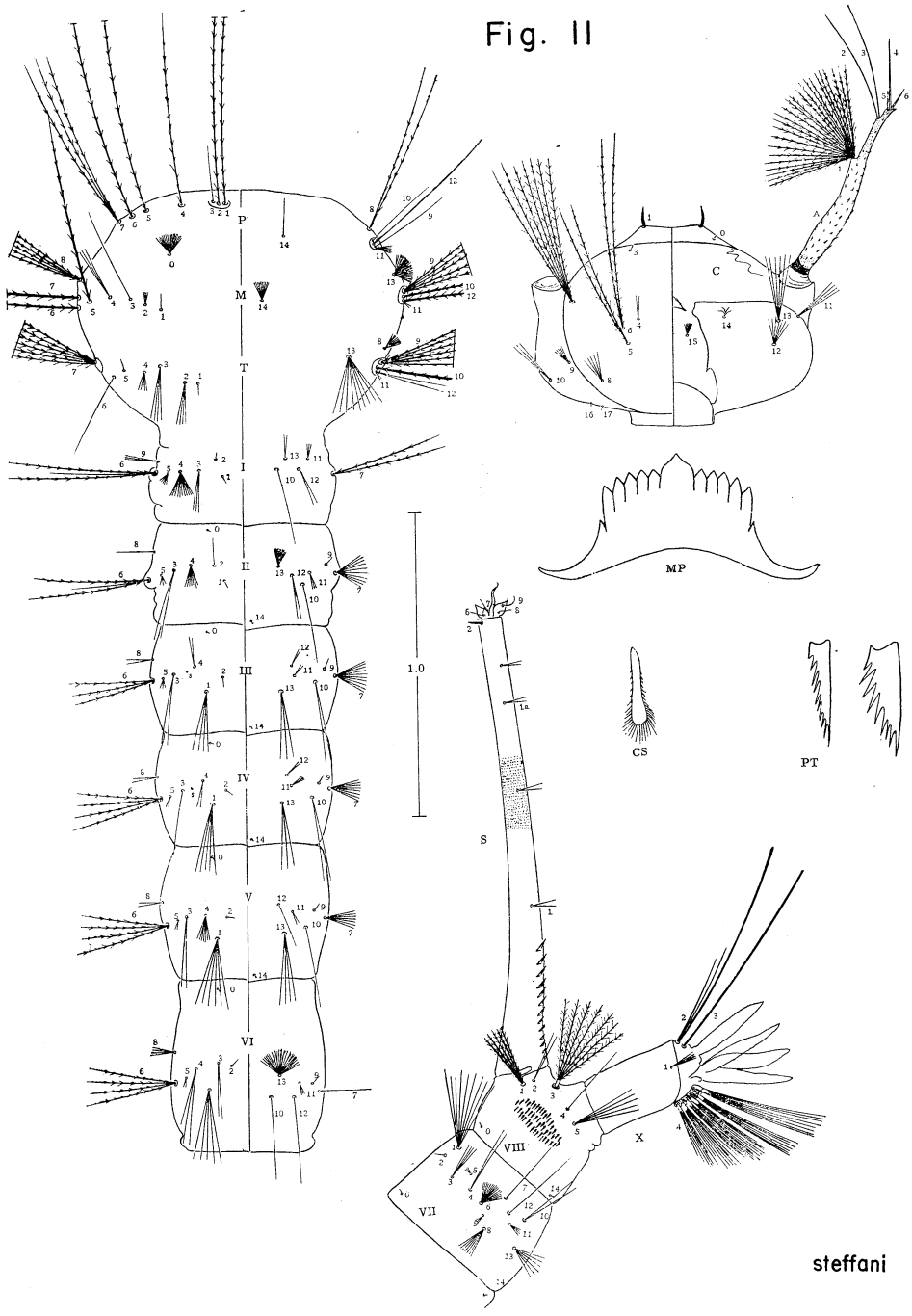


Fig. 11. Larva of *C.* (*L.*) *steffani.*

Genitalia: (fig. 10) Extremely similar to *C. petersi* except for narrower and apically blunt external leaflet of distal part of subapical lobe.

♀. *Wing:* 2.8 mm. *Forefemur:* 1.3 mm. *Proboscis:* 1.8 mm. *Palpus:* 0.17 of proboscis. *Abdomen:* 2.0 mm. In general similar to ♂, differing from *petersi* primarily in the following. Head with small, indistinct lateral patch of broad pale scales, proboscis with a row of 6 or 7 strong basoventral bristles as long as palpus, abdominal tergites with small, very indistinct basolateral pale spots.

LARVA. (fig. 11) *Head:* 0.65 mm. *Siphon:* 1.4 mm; index 7 3–9.0 (average 8.7); ratio 4.0–4.7 (average 4.3). Pigmentation as described for the complex. Thoracic spiculation very light to almost completely absent. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* hair 7-C usually 7-branched (6–9); 14-C usually 4-branched (3–6). *Antenna:* dark at extreme base, creamy white in the middle and dark beyond the antennal tuft (hair 1-A). *Thorax:* hair 3-P usually double (1–2); 4–P usually single (1–2); 8, 9-M, 5-branched (4–6); 9, 7-T, 6-branched (5–7). *Abdomen:* hair 6-I–III usually with 3 branches (2–4); 1-III–VI with average of 4, 5, 6 and 5 branches, respectively; 4-VII always double; 2-VIII always double. *Siphon:* usually with median dark ring; pecten with 11–14 teeth; tufts 8 in number, 2-branched, about as long or slightly shorter than siphon width at the points of attachment. *Anal Segment:* hair 1-X triple; 2-X, 3-, 4-branched.

PUPA. (fig. 10) *Abdomen:* 1.9 mm. *Paddle:* 0.58 mm. *Trumpet:* 0.58 mm; index 11.5. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax and Metanotum:* hair 5-C usually 4-branched (3–4); 12-C usually triple (2–3). *Abdomen:* hair 1-III–VII usually with 12 (8–14), 10 (8–13), 8 (6–9), 5 (3–6), and 4 (3–5) branches, respectively; 5-II–VII usually with 5 (4–5), 5 (4–7), 6 (4–6), 4 (3–5) and 2 (1–2) branches, respectively; 6-III–VI usually with 3 (2–4), 3 (3–4), 4 (3–5), and 4 (3–5) branches, respectively; 9-VIII usually 5-branched (3–6); 10-III–VII usually single, rarely double.

BIONOMICS. Several larvae of *steffani* were collected from a blocked pool in a stream under heavy shade of trees and bamboo. In the same locality (CP5, 23, 24), adults were collected resting among roots of bamboo drooping over the bank. In the another locality (CP4, 26) a few larvae were found associated with *lakei* in a blocked drainage pool, and with *fraudatrix*, *ornatus* and *versabilis* in a seepage pond. The females are usually engorged with reddish or blackish substance indicating that they probably fed on the blood of wild or domestic animals.

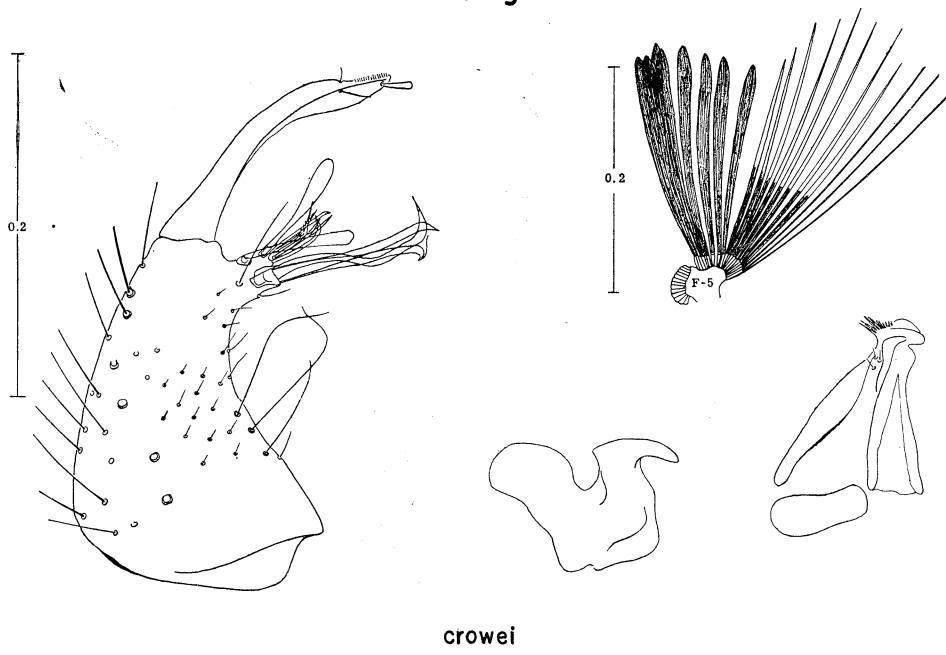
SYSTEMATICS. *C. steffani* is distinguished from other members of the complex chiefly by the form of the modified tufts on male antennal flagellomeres 5 and 9. The female differs strikingly from *petersi*, *crowei* and *shanahani* in having 6 or 7 stronger and longer basoventral bristles on the labium. The larva and pupa cannot be clearly separated from *crowei*, but can be distinguished from *petersi* by the chaetotaxy as described above and as indicated in the keys.

DISTRIBUTION. Material examined: 101 adults (71 ♂♂, 30 ♀♀), 25 individual rearings (14 larval, 11 pupal), 36 L. NE NEW GUINEA: SEPIK: Upau Stream, Maprik, 150–160 m, 6.II.1966, SS, 2 1p ♂ (SP16-105, -109) with slides of antennae and genitalia, 3 L; 1 1p♂♂ (SP17-110) with slide of antenna and genitalia (BISHOP). MADANG: Baitabag, Malaise trap, 1.XII.1964, WAS (BBMNG C-88), 1 ♂ (BISHOP). SE NEW GUINEA. GULF: Murua, Malaise trap, 11–12.XII.1964, WAS (BBMNG C-144), 1 ♂; (BBMNG C-153), 1 ♂, 4 ♀♀; (BBMNG C-163), 1 ♂; (BBMNG C-167), 5 ♂♂, 1 ♀; (BBMNG C-168), 3 ♂♂; (BBMNG C-169), 6 ♂♂, 2 ♀♀; (BBMNG C-170), 12 ♂♂; (BBMNG C-222), 6 ♂♂, 1 ♀. CENTRAL: Port Moresby, Rigo road, blocked drainage pool, 22.XII.1965, SS and HL, 2 1p♀ (CP4-27, -28), 2 L (CP4), 5 L (CP26); blocked stream pool, as listed in type series (CP5, 23) and the following, 15 ♂♂ (CP5), 4 1p♀ (CP5-100, 101, 102, 104), 9 L (CP5); same habitat as CP5, 29.XII.1965, SS and HL, 3 ♂♂, 10 ♀♀ (CP23); 1 1p♂ (CP24-14), 2 1p♀ (CP24-11, -12), 17 L (CP24) BISHOP).

7. **Culex** (**Lophoceraomyia**) **crowei** Sirivanakarn, new species Fig. 12.

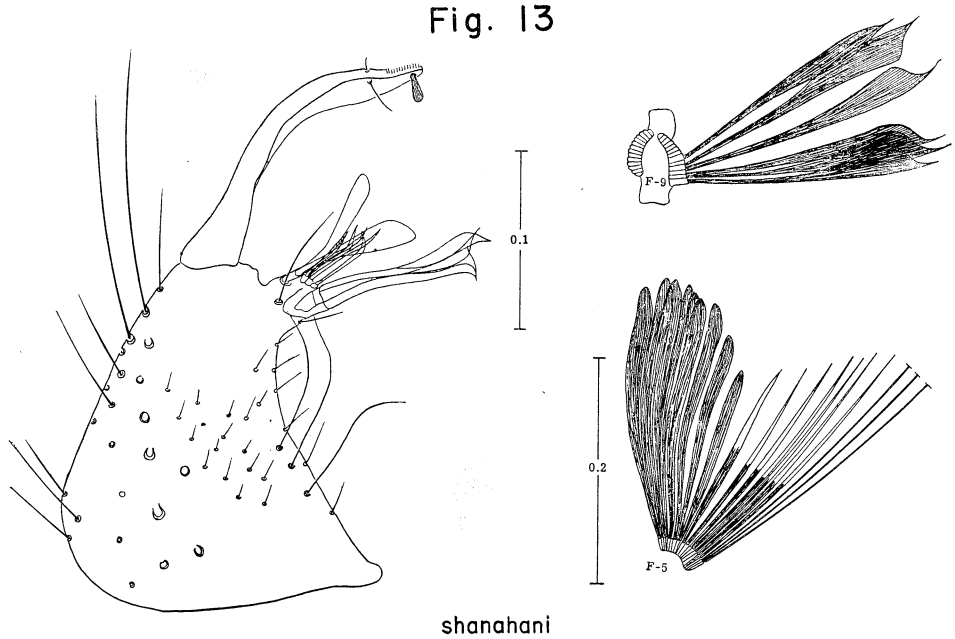
TYPES: Holotype ♂ (SP118) with slide of antenna and genitalia (660715–10), Daunda Village

Fig. 12



crowei

Fig. 13



shanahani

Fig. 12. Male genitalia and modified tuft of antennal flagellomere 5 of *C.* (*L.*) *crowei.*
Fig. 13. Male genitalia and modified tufts of antennal flagellomeres 5 and 9 of *C.* (*L.*) *shanahani.*

9, Vanimo, Sepik District, NE New Guinea, under shade of fallen sago leaves and herbs in shallow swamp, 24.II.1966, S. Sirivanakarn and L. Crowe (BISHOP 7727). Allotype ♀ (SP87–21) with associated larval and pupal skins, same locality as holotype, ground pool at margin of sago swamp (BISHOP). Paratypes same locality as holotype; 1 ♂ (SP87–13) with associated larval and pupal skins and slide of antenna and genitalia, 1 ♀ (SP87–22) with associated larval and pupal skins, 4 ♂♂ (SP118) with antenna and genitalia slides (660830-3, 660715-9, 660715-11, 660715-12), 1 ♂ (SP120) with antenna genitalia slide (660801-11) (BISHOP). This species is dedicated to Lockland Crowe, Malaria Service, Vanimo Hospital, Dept. of Public Health, Territory of Papua and New Guinea.

♂. (fig. 12) In general as described for *C. steffani*, differing from it in the following. *Palpus:* segment 3 with 4 or 5 lateral apical bristles. *Antenna:* F-5 with tuft of 18–20 scales, the dorsal group of 8–10 scales dark and broad, followed lateroventrally by 10 narrow, pointed and distally white scales of increasing length; F-9 with 2 or 3 short and 3 or 4 long, narrow, dark blade-like scales; F-10 with 4 or 5 bristle-like setae.

Genitalia: (fig. 12) Extremely similar to *steffani* and *petersi;* differing slightly from both in having the internal rod of the proximal part of the subapical lobe rather narrow and strongly curved; external leaflet of distal part as in *steffani.*

♀. *Wing:* 2.3 mm. *Forefemur:* 1.3 mm. *Proboscis:* 1.8 mm. *Palpus:* 0.15 of proboscis. In general as in ♂; differing from *steffani* in having 4 or 5 weaker and shorter ventral bristles at the base of proboscis; from *petersi* in being smaller in size and in having smaller, inconspicuous basolateral pale spots on abdominal tergites III–VII.

LARVA. *Head:* 0.7 mm. *Siphon:* 1.3 mm; index 6.4; ratio 4.0. Chaetotaxy as figured for *C. steffani;* diagnostic characters as in the key. In general and in detailed chaetotaxy very similar to *steffani* in nearly every respect except for lighter pigmentation.

PUPA. *Abdomen:* 2.0 mm. *Paddle:* 0.56 mm. *Trumpet:* 0.6 mm; index 10–15. Extremely similar to *steffani;* no clear cut character has been found to distinguish it from this species.

BIONOMICS. Only a few larvae of *crowei* were collected from a seepage pool under the shade of sago palms at the edge of a mixed rain forest. They were found associated with numerous larvae of *fraudatrix* and a species of *Culex* (*Culiciomyia*). Adults were collected under fallen sago leaves near this breeding site.

SYSTEMATICS. *C. crowei* can be differentiated from *steffani* only by a few male and female characters as described above. The immature stages of the 2 species are indistinguishable. Since the 2 forms are entirely allopatric there is a strong possibility that they are only subspecifically distinct.

DISTRIBUTION. Material examined: 92 adults (73 ♂♂, 19 ♀♀); 3 individual larval rearings; 5 whole larvae and 1 larval skin. NE NEW GUINEA. SEPIK: Vanimo, Daunda Village, elev. 5–10 m, 20.II.1966, SS and L. Crowe, 1 ♂, 2 ♀♀ (SP72); 21.II.1966, SS, as listed in type series and the following, 5 L and 11 (SP87); 24.II.1966, SS as listed in type series and the following, 63 ♂♂, 14 ♀♀ (SP118); 1 ♀ (SP120). Kowiro Village, 2.III.1966, SS, 1 ♂ (SP137) with slide of antenna and genitalia (660715-3). MADANG: Alexishafen, elev. 10 m, 25.I.1966, SS, 1 ♂ (MD5) with slide of antenna and genitalia (660830-6) (BISHOP).

8. **Culex** (**Lophoceraomyia**) **shanahani** Sirivanakarn, new species Fig. 13.

TYPES: Holotype ♂ (NEP15), with slide of antenna and genitalia (660810-14), Cape Killerton, Popondetta, SE New Guinea, mixed forest swamp, 0.8 km from sea coast, 28.IV.1966, S. Sirivanakarn and P. Shanahan (BISHOP 7728). Paratypes same locality as holotype; 2 ♂♂ (NEP13) with slides of antenna and genitalia (660810-10, -13); 5 ♂♂ (NEP15) with slides of antenna and genitalia (660721-5, -6, -15, -16, -17); 3 ♂♂ (NEP17) with slides of antenna and genitalia (660810-18, -19, -20) (BISHOP).

♂. (fig. 13) In general very similar to *crowei* and *steffani* except for the following. *Antenna:* F-5 with tuft of 18–20 scales, the dorsal group of 8 or 9 scales dark, broad and bluntly tipped, the lateroventral group of 10 or 11 narrow, distally white scales of increasing length; F-9 with 6 or 7 dark, broad, blade-like scales, all subequal in length and with truncate apices; F-10 with 4–6 long stout setae.

Genitalia: (fig. 13) Extremely similar to *steffani*, *crowei* and *petersi* except as noted. Sidepiece usually with 3 subequal long submarginal setae; external leaflet of distal part of subapical lobe more or less truncate apically as in *petersi*.

♀ (Tentatively associated with ♂). In general similar to ♂ in ornamentation and exceedingly similar to *crowei* and *steffani* in having rather indistinct basolateral abdominal pale spots on tergites III-VII. Proboscis with 4 or 5 basoventral bristle as in *crowei*.

LARVA and PUPA. Unknown.

BIONOMICS. *C. shanahani* is a typical swamp form. The adults were collected mainly at 2 different localities near the coast in association with *fraudatrix* and *collessi*.

SYSTEMATICS. *C. shanahani* is differentiated from *steffani* and *crowei* on male antennal characters and genitalia as described above. These characters are more or less intermediate between *steffani* and *crowei* except that the 3 submarginal setae of the sidepiece of *shanahani* are equally strong and are distinctive for this species. Although *shanahani* is partially sympatric with *steffani* it has never been found together with the latter in a given collection.

DISTRIBUTION. Material examined: 32 adults (21 ♂♂, 11 ♀♀). SW NEW GUINEA: Mandopo, Bover Digoel River, 5.IV.1929, de Rook, 4 ♂♂ (7086-7089), 1 ♀ (7090), 1 ♂ (7091) (BISHOP). SE NEW GUINEA. GULF: Murua, sago swamp, 1–4.V.1966, SS (G21), 3 ♂♂ (2 ♂♂ with slides of antenna and genitalia 661207-5, 660830-5). Northern Popondetta, mixed forest swamp, 28.IV.1966, SS and P. Shanahan, as listed in type series (NEP 13, 15, 17), 3 ♂♂ (NEP13) (BISHOP).

Hilli Complex

♂. Small species; very similar to the *petersi* complex in general ornamentation, palpal, and labial characters, differing from it chiefly in the following. *Antenna:* F-5 with a tuft of 5–11 dark scales only; F-9 with a tuft of narrow bladelike scales as in the *fraudatrix* complex except that these scales are somewhat longer.

Genitalia: Sidepiece: 1 submarginal seta present; marginal setae very sparse and weak. *Subapical Lobe:* proximal part with 3 strong, curved rods and a strong basal seta; external leaflet of the distal part with a serrated apex, internal leaflet narrow and with acute apex, 6 accessory setae present, all flattened, with pointed tips and none with subapical serrate margin.

♀. Very similar to the *petersi* complex except that proboscis has shorter and weaker basoventral bristles, wing more numerous scaled, and basolateral abdominal pale spots are small and very indistinct.

LARVAE. Essentially as described for the *petersi* complex; differing primarily in having head hair 5-C single, 7-C usually at least 10-branched, each branch markedly flattened and strongly barbed.

PUPAE. Extremely similar to the *petersi* complex except as noted in the key.

BIONOMICS. This complex consists of typical ground pool breeders as in the *petersi* complex. The larvae are found in blocked ditches, ponds and seepage pools containing green algae or other aquatic plants. They prefer fresh, clear water normally containing no decaying organic matter. The adults are rarely encountered in general field catches.

SYSTEMATICS. In New Guinea, the *hilli* complex is represented only by *lakei*. This complex appears to be very similar to the *petersi* complex in the larval and pupal stages but the male is clearly distinguished by the characteristic antennal tufts and genitalia as described above.

DISTRIBUTION. The *hilli* complex is widely distributed along the coastlines of New Guinea. It is also known from NE Australia (Edwards 1922).

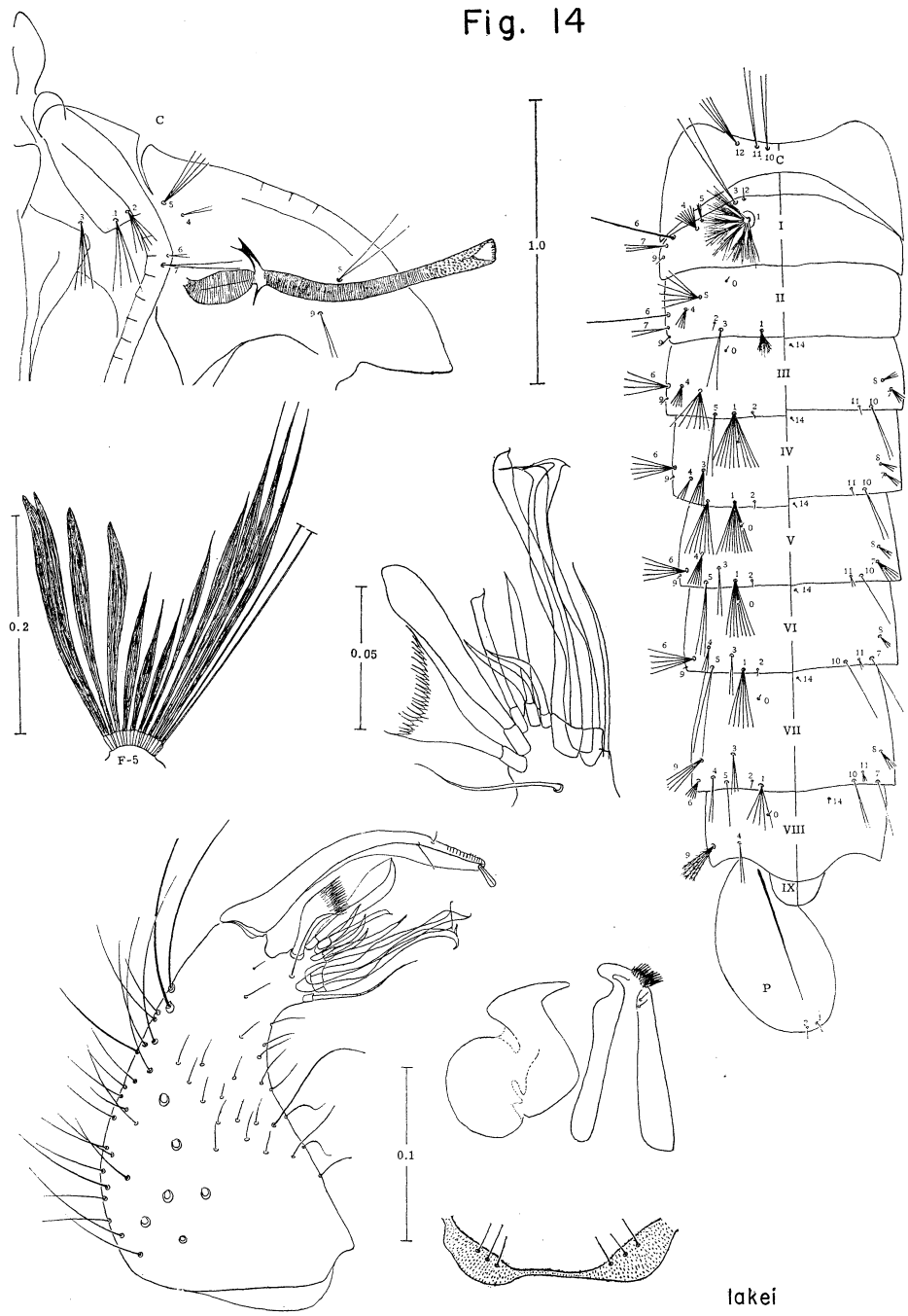


Fig. 14. Pupa, male genitalia and modified tuft of antennal flagellomere 5 of *C.* (*L.*) *lakei*.

9. **Culex (Lophoceraomyia) lakei** Sirivanakarn, new species Fig. 14, 15.

TYPES: Holotype ♂ (CP26-107) with associated larval and pupal skins and slide of antenna, Rigo road, Port Moresby, SE New Guinea, elev. 10–50 m, from deep pond with dense growth of algae, duck weeds and aquatic herbs, 21.VII.1965, S. Sirivanakarn and H. Lake (BISHOP 7729). Allotype ♀ (CP4-91) with associated larval and pupal skins, 22.VII.1965, same data as holotype (BISHOP). Paratype same data as holotype; 4 ♂♂ (CP4-102, -103, -110, CP26-109) with correlated pupal skins and antenna-genitalia slides, 1 ♀ (CP4-24) with correlated larval and pupal skins (BISHOP). This species is dedicated to Harry Lake, Malaria Service, Dept. of Public Health, Port Moresby, Territory of Papua and New Guinea.

♂. (fig. 14) *Head:* narrow decumbent scales white, intermixed with some bluish broad scales on vertex and occiput; broad appressed scales pale brown; erect scales brown to deep brown. *Palpus:* exceeding proboscis by about 0.5 of length of segment 5; segment 1 with long basal processes, the external one as long as or sometimes a little longer than the distal part of the segment; segment 2 about 0.6 of length of segment 3, with ventrolateral rows of subequal setae slanting downward and forward, their lengths a little more than the width of the segment; segment 3 with 1 or 2 ventral rows of short whitish setae over its basal 0.5, apex with 4 or 5 bristles laterally and ventrally; segment 4 and 5 with several bristles laterally and ventrally. *Proboscis:* labium with false joint at 0.2–0.25 of distance from base, distal 0.5 with 2 dorsal rows of upright setae, their lengths about 2 × segment width, base with a ventral row of 10–12 spine-like setae. *Antenna:* F-5 with a tuft of 11 dark brown scales, the uppermost 4 or 5 scales long and bluntly tipped, followed laterally by 3 or 4 lanceolate scales of decreasing length and ventrally by 4 or 5 narrow scales of increasing length, the latter usually broadened and lanceolate in apical 0.5; F-6, F-7 and F-8 with tufts of scales similar to those in *petersi* complex; F-9 with a ventral projecting tuft of 4 long, narrow bladelike setae 1 of which is shorter and narrower than the others, and an internal group of 4 short hair-like setae; F-10 with 3 or 4 long, stout bristle-like setae. *Thorax:* integument of mesonotum and pleuron pale brown to reddish brown; scales of mesonotum dark brown; propleuron with 4 strong bristles and few weak ones; 1 lower anterior mesepimeral bristle present. *Wing:* scales on distal 0.5 of costa, subcosta and radial veins broader than scales on other wing veins. *Abdomen:* tergites with deep brown to almost black scales; venter with paler scales.

Genitalia: (fig. 14) *Sidepiece:* with 1 submarginal seta, sometimes with another short seta in line with it. *Subapical Lobe:* proximal part with 3 rods, the internal rod distinctly bent at about the middle and with truncate apex, the other 2 rods smoothly curved and apically hooked, basal seta strong, about 0.7 of length of the rods; distal part with a characteristic external leaflet, broad distally, truncate and serrated apically, internal leaflet broadened in its distal 0.5 and round or acute apically, 6 accessory setae present, all blade-like, 2 long, 1 blade-like and with truncate apex, the other with pointed apex, the rest very inconspicuous, with apices all bent toward the internal leaflet, basal seta weaker than that of the proximal part. *Phallosome:* lateral plate with short dorsal process, somewhat swollen proximally and narrowed distally, sustaining angle of about 90° with the stem. *Proctiger:* with small crown of fine and sharp spicules; 3 cercal setae present. Lobe of 9th tergite small, usually with 3 or 4 short hair-like setae.

♀. *Wing:* 2.5 mm. *Forefemur:* 1.3 mm. *Proboscis:* 1.6 mm. *Palpus:* 0.2 of proboscis. *Abdomen:* 1.8–2.0 mm. In general similar to ♂; differing in having a smaller patch of broad pale scales at side of head, abdominal segments III–VII with small basolateral tergal spots, denser wing scaling, and proboscis with 4 basoventral hair-like bristles.

LARVA. (fig. 15) *Head:* 0.6–0.7 mm. *Siphon:* 1.25–1.45 mm; index 7.0–9.5; ratio 3.6–4.4. In general, very similar to *steffani* and *crowei* in color pattern of head, thorax and abdomen but darker than these forms; pigmentation varied from deep green to dark blue. Thoracic spiculation moderate but dense, confined to pleural areas. Chaetotaxy as figured; diagnostic characters as in the key; similar to *steffani* except as noted. *Head:* hair 5-C usually single, rarely double; 7-C strongly barbed and flattened, usually 10- or 11-branched (10–14); 14-C, 3- or 5-branched. *Antenna:* dark at base, creamy white in the middle, dark beyond the antennal tuft (hair 1-A), proximally with several sharp, dark spicules. *Thorax:* hair 3-P usually double; 4-P always single; 8-M, 4- or 5-branched; 9-M usually 4-branched; 7-T usually 6-branched (6–8); 9-T usually

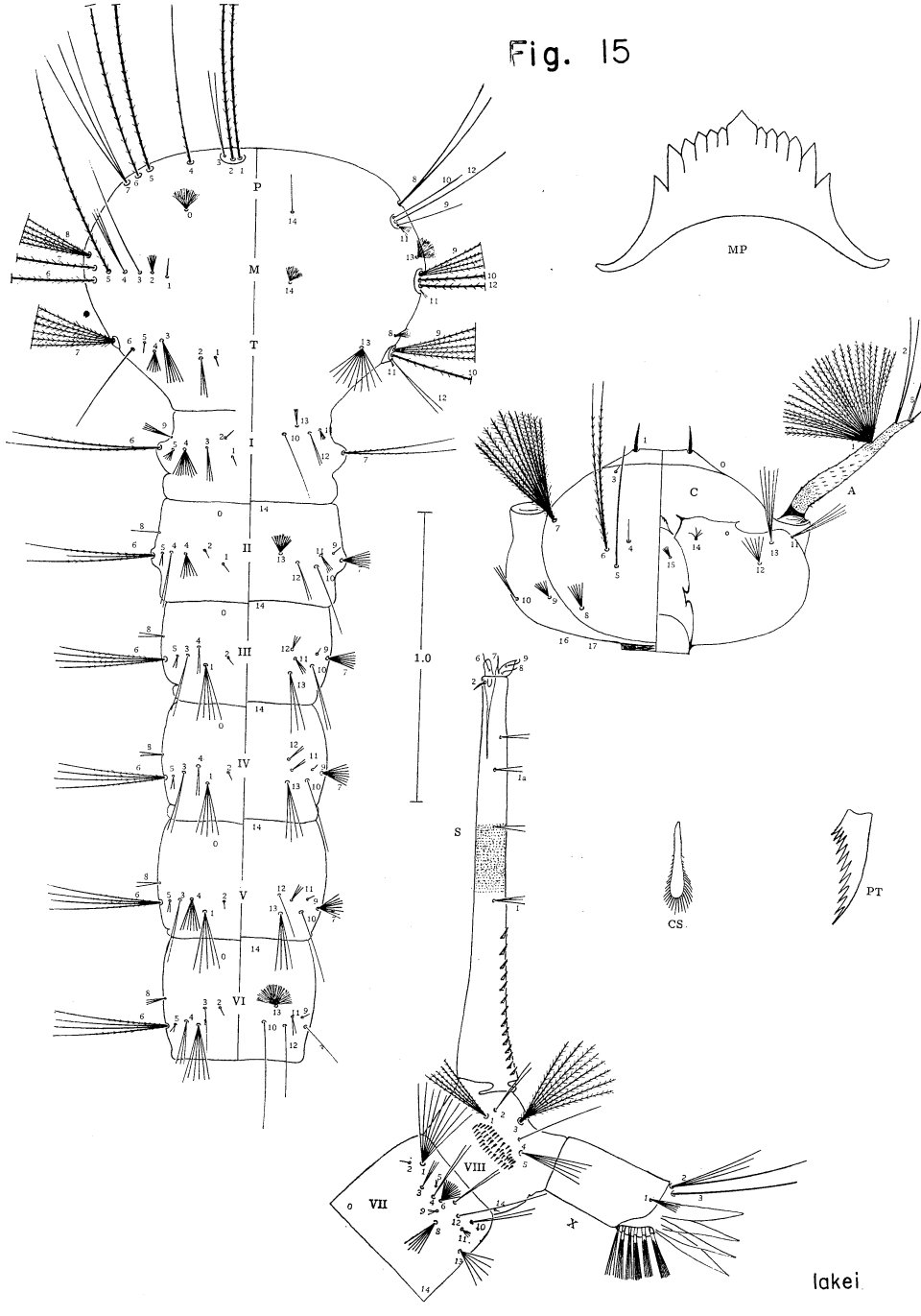


Fig. 15. Larva of *C.* (*L.*) *lakei.*

5-branched (5–7); 13-T usually 10-branched (10–12). *Abdomen:* hair 1-III–VI with average of 5 branches (4–7); 6-I almost always double, rarely single, 6-II usually triple, 6-III with average of 4 branches (3–5), 6-IV usually 4-branched, rarely 3-branched; 1-VII usually 8-branched (8–12); 2-VIII always double. *Comb* with 37–40 evenly fringed scales. *Siphon:* pecten with 11–14 teeth (average 13), distal 3 teeth with 9 or 10 denticles; tufts 8 in number, usually 2-branched; median subcaudal filament very strongly developed. *Anal Segment:* hair 1-X with 5 branches (4–5); 2-X, 3-branched (3–4); anal gills as long as saddle.

PUPA. (fig. 14) *Abdomen:* 1.9–2.4 mm (average 2.1 mm). *Paddle:* 0.6–0.63 mm. *Trumpet:* 0.63–0.72 mm (average 0.69 mm); index 12.5–14.5 mm (average 13.5). *Pigmentation:* trumpet brown over its basal 0.7, lighter distally, cephalothorax brownish on leg, antennal and wing cases; abdominal segments V–VII and genital lobe darker than anterior segments. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax and Metanotum:* hair 1-C, 5-branched (3–6); 2-C, 5-branched (4–6); 3-C, 4-branched (3–4); 12-C, 4-branched (3–5). *Abdomen:* hair 1-III, IV with average of 11 branches; 5-III and IV with average of 7 branches (6–8); 6-III usually 4- or 5-branched, rarely 3-branched; 5-V triple (2–4), 5-VI always double.

BIONOMICS. Several larvae of *lakei* were found in a blocked drainage pool (CP4, 26) shaded by trees and containing numerous green algae, duck weeds and aquatic herbs. On the other occasion a few larvae were collected from a seepage pool (SP122) under grass and shrub cover in a sago swamp. This species appears to prefer fresh, clear water without decaying vegetation. The larvae are cryptically colored and seem to be very sensitive to disturbance of the breeding sites. They were found associated with *steffani* and *Anopheles* larvae. Only a few males were located near the breeding sites.

SYSTEMATICS. The male of *lakei* is clearly distinguished from the *petersi* complex (*steffani*, *crowei*, *shanahani* and *petersi*) by the external leaflet of the subapical lobe, presence of 1 submarginal seta on the sidepiece and the characteristic tuft of antennal flagellomere 5. The larva is very similar to the *petersi* complex in general characters and chaetotaxy but differs in its unbranched head hair 5 and the multibranching and flattening of head hair 7. The pupa also shows a great deal of similarity to *steffani* and *crowei* from which, however, it is distinguished by the branching of head hair 1-C and abdominal hair 6-III–VI.

C. lakei resembles the Australian *C. hilli* Edwards, 1922 in characters of male genitalia but is differentiated from it by the longer, broader and more numerous scales in the tuft of flagellomere 5. The *hilli* complex is represented by several other forms in NE Australia. I have examined, through the kindness of Dr E. N. Marks, 3 different types of "*hilli*" and "Lockhart sp. Y" from Queensland. *C. lakei* may be conspecific with "Lockhart sp. Y" but the male appears to differ from it in lacking basolateral pale spots on abdominal tergites III-VII. The larva of "Lockhart sp. Y" also shows a constant difference from *lakei* in having abdominal hair 6-I triple.

DISTRIBUTION. Material examined: 36 adults (27 ♂♂, 9 ♀♀); 17 individual rearings (11 larval, 6 pupal); 26 whole larvae, 2 pupae. NE NEW GUINEA. SEPIK: Wewak, sago swamp, sea level to 5 m, 27.II.1966, SS, 4 ♂♂, 1 ♀ (SP121); 1 1p ♂ (SP122-10), 1 1p ♀ (SP122-11), 1 P (SP122), 3 ♂♂ (SP161). Koroko, Sepik River, III. 1964, DHC, 8 ♂♂ (BISHOP). SE NEW GUINEA. CENTRAL: Port Moresby, Rigo road, 10–20 m, 21.VII.1965, SS and H. Lake, as listed in type series and the following, 3 1 p ♂ (CP4-22, -26, -90), 3 ♀♀ (CP4-25, -28, -29), 2 p ♀ (CP4-100, -101), 10 L (CP4); 1 p ♂ (CP26-109), 16 L, 1 p (CP26) (BISHOP).

Marksae Complex

♂. Small to medium-sized species, wing usually about 3.0 mm, rarely shorter or longer. *Palpus:* with thicker, shorter basal processes than in the *petersi* complex, length about 0.5 of the distal part of palpal segment 1; segment 3 without ventrolateral tuft of setae. *Proboscis:* false joint present; distal part of labium with dorsal upright setae in apical 0.2–0.5. *Antenna:* F-5 with varied number of scales forming tufts of vari-

ous shapes and sizes; F-6, F-7 with tufts of setae similar to the *petersi* complex; F-8 with a weak tuft of fused hooked setae; F-9 with a group of 1 or 2 short and 4 or 5 long, narrow yellowish bladelike scales. *Thorax:* mesonotal integument deep brown to black; mesonotal scales dark; pleural areas without scales; 1 lower anterior mesepimeral bristle present. *Wings and legs* without marked ornamentation. *Abdomen:* tergites with dark scales only.

Genitalia: Sidepiece with 3–6 submarginal setae in line. *Subapical Lobe:* proximal part with 1 basal seta and 3 rods, the internal rod spatulate and with truncate apex; distal part with broad acuminate external leaflet and a narrow-stemmed, club-shaped internal leaflet, 2–4 acuminate accessory setae without subapical serrated margin. *Phallosome:* very characteristic; lateral plate with long slender dorsal process, markedly curved dorsally and strongly bent, sustaining an angle of 45° with the stem. *Proctiger:* very characteristic; ventrolateral sclerite remarkably expanded sternally forming a prominent lobe; cercal sclerite narrow, with 2 or 3 setae. Lobe of 9th tergite strongly developed, usually with 7–12 strong setae.

♀. Similar to ♂ in size and ornamentation. Proboscis with 2 weak basoventral bristles of varied length. Abdominal tergites III-VII with or without basolateral pale markings.

LARVAE. *Pigmentation* varied depending on type of habitat; usually without striking color pattern on head, thorax and abdomen; siphon with or without median dark band. *Head:* hair 4-C about 0.5–1.5 distance between bases; hair 14-C usually triple. *Abdomen:* hair 1-I and II usually double, 1-III–VI, 2- or 3-branched; 4-VII single, rarely double; 2-VIII usually single, rarely double. *Siphon:* with 8 ventrolateral tufts, branches as long as siphon width at points of attachment. *Anal Segment:* anal gills varied, from 1–4 × saddle length.

PUPAE. Pigmentation variable, usually uniformly yellowish white throughout. *Trumpet:* short or long, uniformly cylindrical or slightly narrowed in distal 0.5. Diagnostic characters as given in the key; most forms with hair 5-II double or triple and 5-III, 3- or 4-branched. *Paddle* with weak midrib.

BIONOMICS. Members of the *marksae* complex normally breed in natural or artificial containers such as palm bracts and sago stumps and occasionally in small ground pools along stream margins in sago swamps or in the rain forest. The adults are rarely encountered in general field catches.

SYSTEMATICS. The *marksae* complex includes *marksae, versabilis, muruae, kowiroensis, wamanguae* and *leei*. These species are exceedingly similar in male genitalia, but differ strikingly from one another in the development of flagellomere 5 of the male antenna or in the number of dorsal upright setae on the labium. The immature stages of some species show a great deal of overlap in chaetotaxy, but others show constant differences in the branching of many hairs. On the basis of male characters 2 distinct lineages may be recognized tentatively: 1) the *wamanguae-leei* lineage with few dorsal upright setae in subapical 0.25 of the labium and antennal F-5 with a small tuft of narrow yellowish scales or pale brown short setae; 2) the *marksae* lineage with several pairs of dorsal upright setae in apical 0.5 of the labium and antennal F-5 with fan-shaped tufts composed entirely of broad dark scales (*kowiroensis*), of broad dark scales dorsally and ventrally, and narrow yellow scales laterally (*marksae*), or of broad dark scales followed by narrow yellow scales ventrally (*versabilis* and *muruae*). This complex appears to be very distinct from other complexes and seems to be undergoing active speciation at the present time as in the case of the *fraudatrix* complex.

10. **Culex** (**Lophoceraomyia**) **marksae** King & Hoogstraal Fig. 16.

Culex (*Lophoceraomyia*) *marksae* King and Hoogstraal, 1955, Ent. Soc. Wash. Proc. **57:** 6–7. *Type: Holotype ♂, Hollandia (Kota Baru), Netherlands New Guinea (West Irian), taken in light trap at edge of rain forest, elevation 76 m, 23.IV.1945, W. V. King and H. Hoogstraal (USNM).

Culex (*L.*) *marksae* of J. van den Assem (1958); Stone et al. (1959).

♂. (fig. 16) As figured; diagnostic characters as in the key; essentially as described by King & Hoogstraal (1955) with the antennal characters reinterpreted as in the following. Antennal F-5 with a bicolored fan-shaped tuft of 13 or 14 scales as long as the next 4 flagellomeres, the dorsal group of 4 or 5 scales dark, broad and blunt tipped, the lateral (middle) group of 4 scales yellowish, narrow, hair-like, slightly longer than

Fig. 16

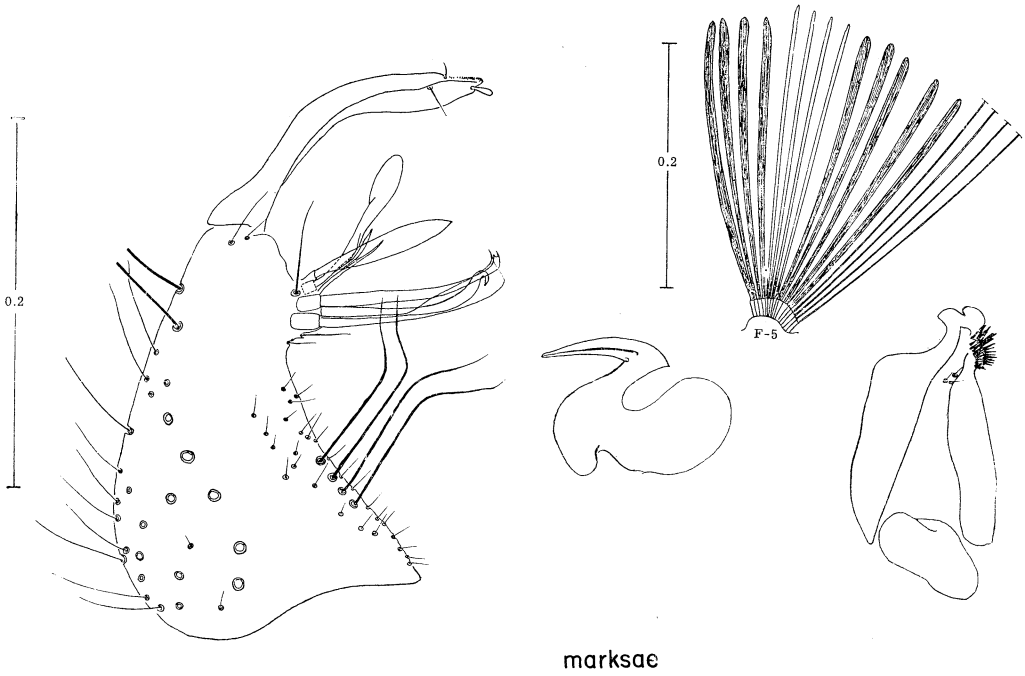


Fig. 16. Male genitalia and modified tuft of antennal flagellomere 5 of *C.* (*L.*) *marksae*.

the dorsal group, followed ventrally by 5 dark, broad, bluntly tipped scales as long as those in the dorsal group; F-8 with a strong, apically hooked tuft of fused setae; F-9 with 2 long and 2 short blade-like scales; F-10 with 2 long stout setae.

Genitalia: (fig. 16) As figured; diagnostic characters as in the key; very similar to *versabilis*, differing from it in the following. *Sidepiece* with a linear row of 4 long subequal submarginal setae and 1 very weak seta next to uppermost submarginal. *Subapical Lobe:* distal part with 2 very inconspicuous accessory setae.

♀. No material available for the present study.

LARVA. No material is available for the present study Possibly conforms to description by van den Assem (1958), but the association with ♂ is still doubtful as these larvae were collected at a higher elevation. The following larval characters are quoted from van den Assem's description with revised terminology in parentheses "Head hair A (7-C) with 6–8 frayed branches, reaching to the base of antennal tuft, basal stem conspicuously long; hair B and C (5 and 6-C) close together, 2-branched, frayed. Comb on 8th abdominal segment with many slender teeth, rather irregularly arranged, frayed at apex. Siphon long and slender, index 8–10: 1, acus present; pecten in basal third part, 16–19 sharp teeth, apical ones slightly larger and further apart than basal ones, teeth with many lateral denticles; siphonal tufts 2- or 3-branched, only slightly longer than width of siphon Anal segment about 2 times longer than wide, completely chitinous around, posterior margin with minute spicules; isc hair (2-X) with 2 unequal branches, osc hair (3-X) single; anal hair (1-X) single–3-branched, small and bare; anal gills about twice as long as segment, slender, pointed at apex "

PUPA. Unknown.

BIONOMICS. A single male of *marksae* was collected by King & Hoogstraal (1945) in a light trap

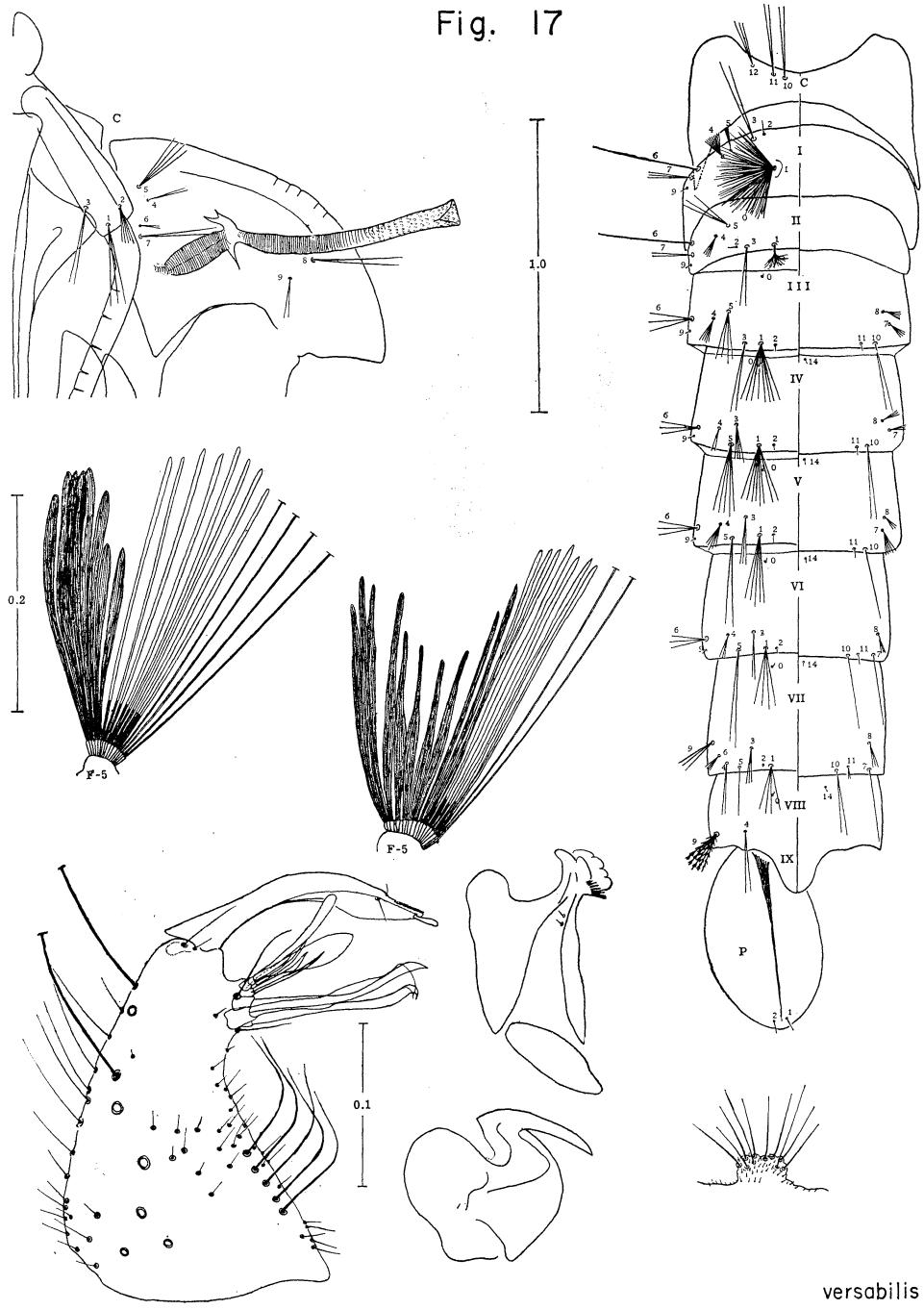


Fig. 17. Pupa, male genitalia and modified tuft of antennal flagellomere 5 of *C.* (*L.*) *versabilis.*

at the edge of a rain forest at the altitude of ca 80 m (260 feet). The larvae, according to van den Assem (1958), were collected in large numbers from rock crevices in the heavily shaded bed of a mountain stream at an altitude of ca 300 m (1000 feet).

SYSTEMATICS. The male type of *marksae* has the tuft of flagellomere 5 with about the same number of modified scales as *versabilis* but these scales are arranged into dorsal and ventral dark groups of broad scales separated by narrow yellowish scales. In addition, antennal F-10 in *marksae* has 2 instead of 3, 4 long and stout setae present in *versabilis*. In the genitalia the accessory setae in the distal part of subapical lobe are fewer and less conspicuous than in *versabilis*.

DISTRIBUTION. Material examined: Holotype ♂.

11. **Culex (Lophoceraomyia) versabilis** Sirivanakarn, new species Fig. 17, 18.

TYPES: Holotype ♂ (MD16-24) with associated larval and pupal skins and slide of antenna and genitalia, Madang, Gum River area, NE New Guinea, from fallen palm bract, 27.I.1966, S. Sirivanakarn (BISHOP 7730). Allotype ♀ (MD16-10) with associated larval and pupal skins, same data as holotype (BISHOP). Paratypes same data as holotype; 1 ♂ (MD16-11) with associated larval and pupal skins and slide of antenna and genitalia, 1 ♀ (MD16-13) with associated larval and pupal skins, (USNM); 1 ♂ (MD16-14) with associated larval and pupal skins and genitalia slide, 1 ♀ (MD16-16) with associated larval and pupal skins (BMNH); 1 ♂ (MD16-15) with associated larval and pupal skins, 1 ♀ (MD16-18) with associated larval and pupal skins (ANIC); 1 ♂ (MD16-20) with associated larval and pupal skins (UCLA).

♂. (fig. 17) *Head:* narrow decumbent scales yellowish; broad appressed scales very pale to almost white forming a narrow line just above the eye and a larger lateral patch at side; erect fork scales on occiput dark brown. *Palpus:* segment 2 with a lateral row of short setae; segment 3 with a ventral row of short semitranslucent setae, closely spaced in proximal 0.5, widely spaced distally; apex with 2–4 bristles laterally; segments 4 and 5 upturned, with lateral, ventral and mesal rows of several strong bristles. *Proboscis:* base of labium with an irregular ventral row of 10–12 spinelike setae, distal 0.5 with several pairs of dorsal upright setae which are 2, 3 × labial width. *Antenna:* F-5 with a fan-shaped tuft of 15–17 scales as long as the next 4 flagellomeres, the dorsal group of 8, 9 long subequal scales dark, broad, blunt or slender tipped, followed lateroventrally by 6–9 yellowish narrow scales of increasing length and 4, 5 long normal hairs; F-8 with a weak apically hooked tuft of 7, fused setae; F-9 with 1 short and 4 long yellowish bladelike scales; F-10 with 3–5 long stout setae. *Thorax:* propleuron with 3, 4 strong and a few weak bristles. *Legs:* forecoxa with 1, 2 irregular rows of curved bristles; claws of foreleg unequal, both toothed; claws of midleg unequal, small one toothed, larger one simple; claws of hindleg equal and simple.

Genitalia: (fig. 17) As described for the complex. *Sidepiece* usually with a linear row of 5(4–6) submarginal setae. *Subapical Lobe:* distal part with 3 accessory setae, 2 flattened and curved subapically, 1 hairlike and inconspicuous. *Lobe* of 9th tergite with strong setae varying from 10–16.

♀. *Wing:* 3.0 mm. *Forefemur:* 1.7 mm. *Proboscis:* 2.0 mm. *Palpus:* 0.16 of proboscis. In general as described for ♂ except for the following. *Head:* all scales darker; white line and lateral patches of broad appressed scales narrower and smaller. *Abdomen:* tergites usually without but sometimes with basolateral pale spots or lateral pale markings on segments III–VII.

LARVA. (fig. 18) *Head:* 0.7 mm. *Siphon:* 1.35 mm; index 6.7 (6.5–6.8); ratio: 4.1 (3.7–4.4). Thoracic spiculation moderate and usually visible under 100 × magnification. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* antenna dark at base, creamy white in the middle and usually dark beyond the antennal tuft. *Thorax:* hair 3-P single or double; 8, 9-M usually 5-branched (5–6); 7-T, 8-branched (6–9); 9-T, 6-branched (6–7). *Abdomen:* hair 1-III–VI usually triple, rarely 4-branched; 3-III–IV triple or double, 3-V single or double; 2-VIII usually single, rarely double. *Comb* with 37–52 evenly fringed scales. *Siphon* usually with median dark ring; pecten with 12–17 teeth; tufts usually 8 in number, sometimes 7, more or less regularly paired, 3-, 4-branched. *Anal Segment:* hair 2-X usually with 1 long and 1 short branch (2–4); anal gills usually 4 × length of saddle.

Fig. 18

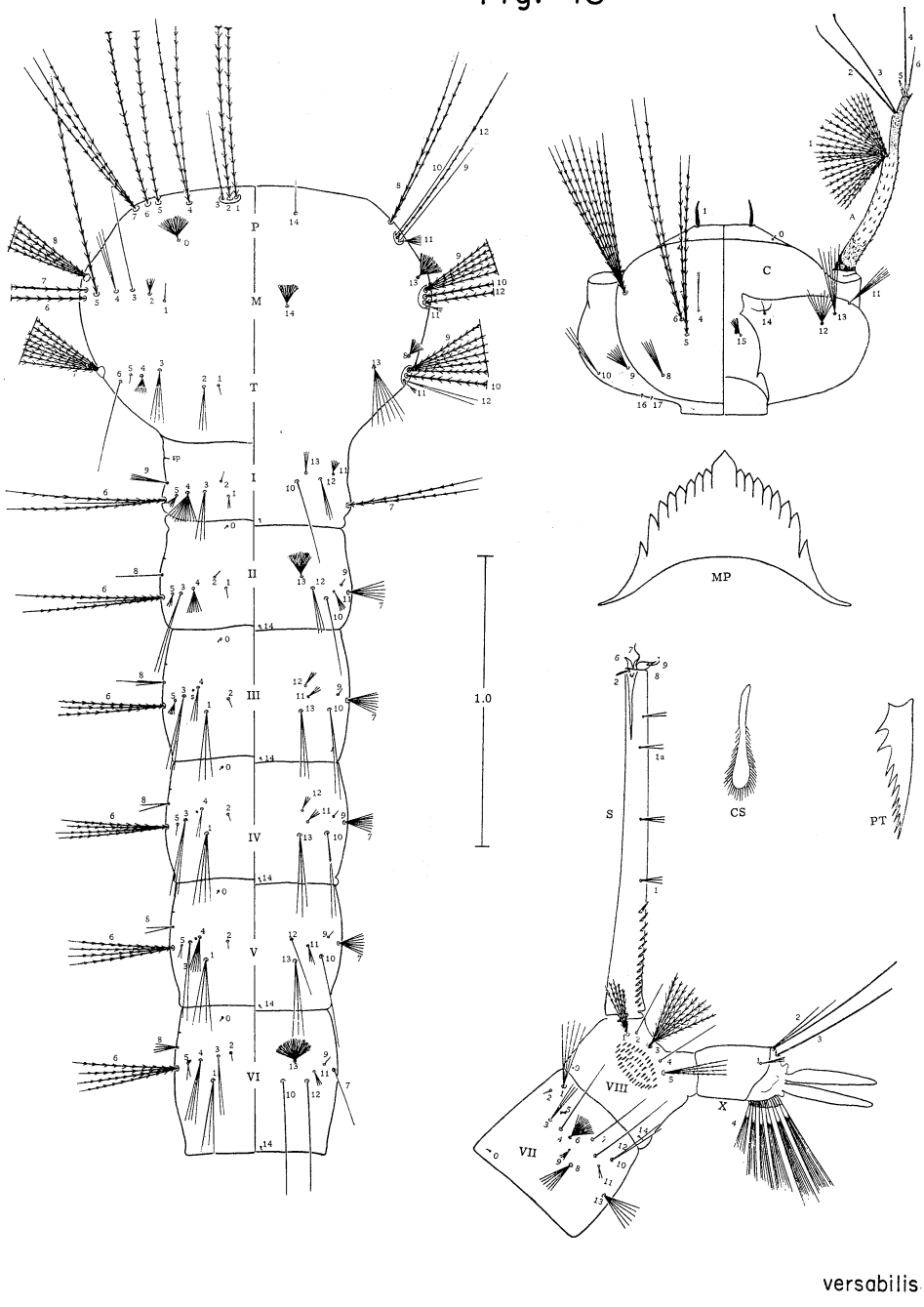


Fig. 18. Larva of *C.* (*L.*) *versabilis*.

PUPA. (fig. 17) *Abdomen:* 2.4 mm. *Paddle:* 0.7 mm. *Trumpet:* 0.63 mm; index 8.0–12.5 (average 9.4). Pigmentation of cephalothorax, metanotum and abdomen light brown, darker on wing, antennal and leg cases. Trumpet uniformly cylindrical, pinna sometimes slightly expanded. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax and Metanotum:* hair 1-C usually triple (2–4); 3-C usually double (2–3); 5-C usually 4-branched (2–5); 12-C usually triple (2–4). *Abdomen:* hair 1-III–VII with 8 (6–10), 8(7–9), 5(5–7), 4(3–5) and 4(2–5) branches, respectively; 6-III–VI usually triple, rarely double; 4, 5-VII usually single, rarely double; 4-VIII always double. *Paddle* with moderately dark midrib. *Genital Lobe* brownish.

BIONOMICS. Adults of *versabilis* were rarely encountered in the field and only a small number was obtained from general field catches in the rain forest and in sago swamps. The larvae were collected in great numbers particularly in palm bracts (MD16), ground pools (SP131, 134) sago stumps (MD23), gravel pools (MR61) and puddles (MD24) at elevations ranging from just above sea level to 1200 m. In ground pools in the lowlands they were frequently found associated with numerous larvae of *fraudatrix;* in palm bracts with *schilfgaardei* and in sago stumps with *leei.*

SYSTEMATICS. The males of *versabilis* are quite similar to *marksae* but can be separated by differences in antennal flagellomere 5 and genitalia as indicated under the latter species. The larvae and pupae are clearly distinguished from *leei, wamanguae,* and *muruae,* but show a great deal of overlap with *kowiroensis.*

There is considerable variation in all stages of *versabilis,* but the specimens from different habitats and localities conform to the diagnosis and the description as given above. The variations in the male and immature stages which appear to show some correlation with breeding habitats and localities are noted below.

1. *Madang population* (palm bract form). Essentially as described above except for the following. *Male:* antennal F-5 sometimes with the dorsal dark group of 8 or 9 scales narrow and pointed; sidepiece usually with 5 submarginal setae and 1 or 2 shorter setae. *Larva:* color pattern present; siphon shorter than in other 2 forms. *Pupa:* darker than in other populations; trumpet shorter than in other 2 forms. *Distribution:* elevation 20 m.

2. *Kowiro-Maprik population* (lowlands ground pool form). *Male:* antennal F-5 with the dorsal dark group 8 scales relatively broad and blunt tipped; sidepiece with 4 or 5 submarginal setae. *Larva:* uniformly yellowish white; siphon 1.2–1.6 mm long, index 8.5, ratio 4.5; chaetotaxy as in form 1. *Pupa:* yellowish white; trumpet 0.7 mm long, index 13.5; chaetotaxy as in form 1. *Distribution:* sea level to 160 m.

3. *Wau population* (highlands ground pool form). *Male:* antennal F-5 with the dorsal dark group 4–6 scales longer than in other 2 populations. *Larva:* pigmentation intermediate between the 2 above; siphon longest, 1.7–1.9 mm, index 10, ratio 5.5; prothoracic hair 3-P always single; abdominal hair 3-V always single. *Pupa:* darker than form 2, but lighter than form 1; trumpet with similar length and indices as form 2; hair 3-C always double; 6-III–IV usually double; 4, 5-VII usually single. *Distribution:* elevation 1200 m.

DISTRIBUTION. Material examined: 73 adults (48 ♂, 25 ♀); 57 individual rearing (38 larval, 19 pupal); 74 larvae; 1 larval skin. NE NEW GUINEA. SEPIK: Wewak, sea level, sago swamp, 7.III.1966, SS, 3 ♂♂ (SP159). Inland of Wewak, Kowiro Village, 60–70 m, 28.II.1966, SS (SP128), 1 ♂; 2.III.1966, SS, 2 1p ♂ (SP131-12, -13), 1 1p ♂ (SP131M), 2 1p ♀ (SP131-10, -11), 1p ♂ (SP134-102), 1 p♀ (SP134-107), 17 L (SP134), 2 ♂♂ (SP137); small ground pool at stream margin, SS, 12 L (SP140); ground pool, SS, 11 (SP143). Wamangu, small ground pool, 3.III.1966, SS, 5 L (SP151), 1 ♂ (SP152). Kowiro, 4.III.1966, SS, 3 ♂♂ (SP156), 1 ♂ (SP157). Maprik, Upau stream, 160 m, seepage pool, 6.II.1966, SS, 1 L (SP17); 16.II.1966, SS, 2 p♀♀ (SP63-100,

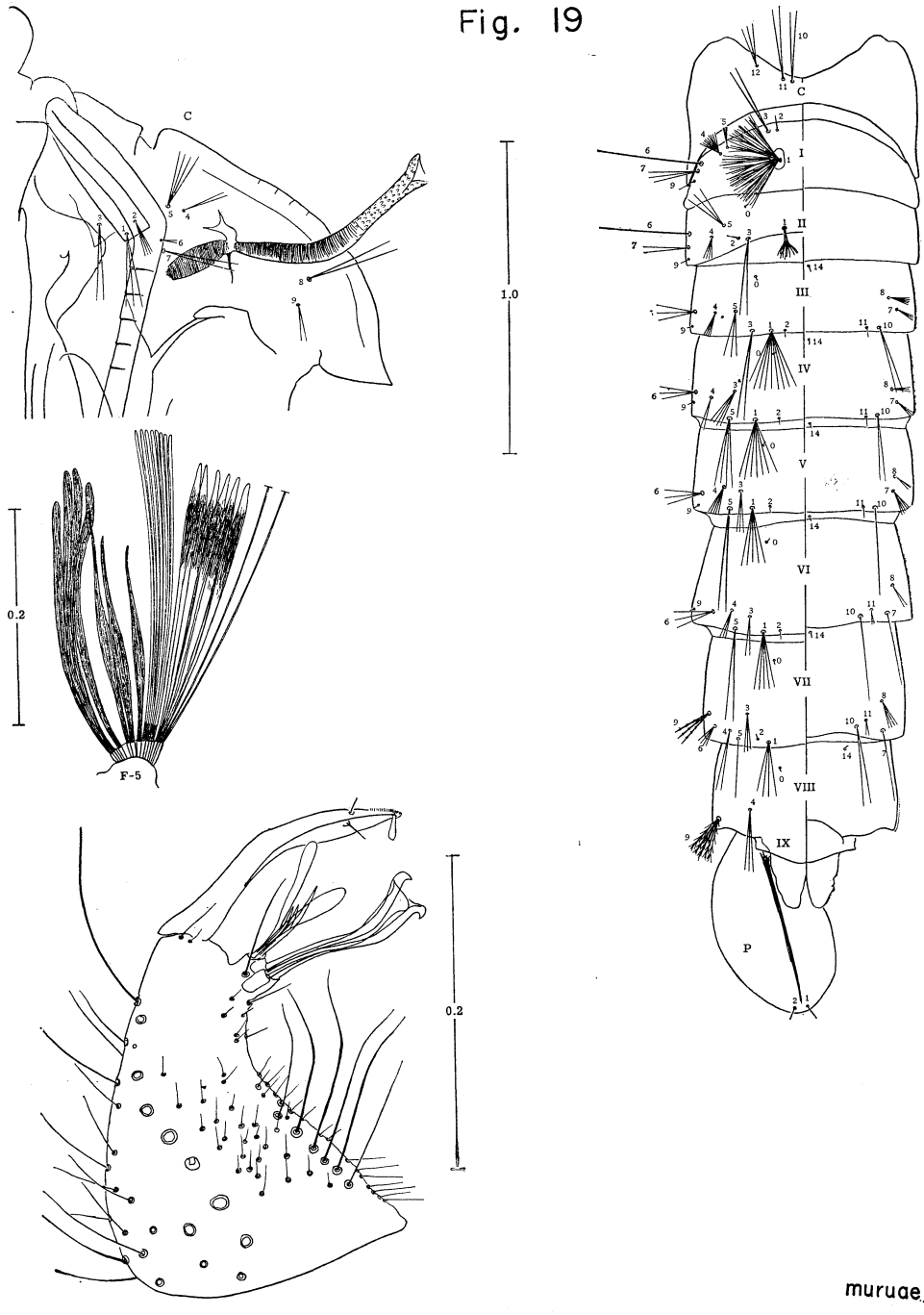


Fig. 19. Pupa, male genitalia and mosified tuft of antennal flagellomere 5 of *C.* (*L.*) *muruae.*

-108), 1 L (SP63). (BISHOP). MADANG: Gum River area, 20 m, palm bract, 27.I.1966, SS, as listed in type series (MD16) and the following, 3 1p♂♂ (MD16-12, -19, -21), 7p♂♂ (MD16-100, -101, -105, -108, -109, -113, -114), 7 p♀♀ (MD16-102, -103, -104, -106, -110, -111, -112); 1 1p♂ (MD16A-101), 2 1 p♀♀ (MD16A-100, -102), several L (MD16); field catch, SS, 1 ♂ (MD14); sago stump, 27.I.1966, SS, 2 1 p♂♂ (MD23-14, -18), 2 1 p♀♀ (MD23-10, -11); puddles in flooded area, 27.I.1966, SS, 4 1 p♂♂ (MD24-11, -12, -13, -16), 1 1 p♀ (MD24-17) (BISHOP). MOROBE: Lae, Singuawa River Area, 30 m, field catches, 10–13.IV.1966, SS, 3 ♂♂, 3 ♀♀ (MR 32). Wau, 1200 m, muddy pool at margin of mountain stream, 18.IV.1966, SS, 2 1 p♀♀ (MR61-100, -101); gravel pool under rocks, 7 1 p♂♂ (MR62-100, -101, -102, -103, -105, -106, -107), 1 1p♀ (MR62-104), 10 L (MR62) (BISHOP).

12. **Culex** (**Lophoceraomyia**) **muruae** Sirivanakarn, new species Fig. 19, 20.

TYPES: Holotype ♂ (G25-100) with associated pupal skin and slide of antenna and genitalia, Murua (Gulf), SE New Guinea, from flooded sago swamp just above sea level, 3.V.1966, S. Sirivanakarn (BISHOP 7731). Allotype ♀ (G26-103) with associated larval and pupal skins, same data as holotype (BISHOP). Paratypes same data as holotype; 1 ♂ (G10) with slide of antenna and genitalia (660721-7) (USNM); 1 ♂ (G11) with slide of antenna and genitalia (660727-6) (BMNH); 1 ♂ (G21) with slide of antenna and genitalia (660722-1) (ANIC); 1 ♂ (G21) with slide of antenna and genitalia (660722-2) (UCLA).

♂. (fig. 19) In general, similar to *versabilis*, differing in the following *Palpus:* segment 3 with more numerous ventral setae as long as width of segment *Proboscis:* base of labium with a regular ventral row of 10–12 brownish spine-like setae *Antenna:* F-5 with a larger tuft of 20–27 scales, the uppermost 6–8 scales dark brown, broad, more or less bluntly tipped and reaching slightly beyond F-8, the middle group of 9 or 10 yellowish, slender scales about as long as the next 4 flagellomeres, the ventral group of 5–7 scales narrow and yellow proximally, broad and brownish distally and blunt apically; F-9 with 3–5 long and 1 short blade-like scales; F-10 with 2–4 (average 3) long stout setae

Genitalia: (fig 19) Very similar to *versabilis* and other closely related forms, differing from them in the following *Sidepiece:* submarginal setae 4 or 5, usually with 2 other weak and shorter setae in line *Proctiger* with larger crown of sharp spicules; ventrolateral sclerite with less pronounced lobe on its dorsal sternal margin *Lobe* of 9th tergite with 9 or 10 strong setae.

♀. *Wing:* 2.8 mm. *Forefemur:* 1.3 mm. *Proboscis:* 2.0 mm. *Palpus:* 0.15 of length of proboscis. Similar to ♂ in general ornamentation; differing from *versabilis* in rather distinct white basolateral spots on abdominal tergites III–VII.

LARVA. (fig. 20) *Head:* 0.68 mm. *Siphon:* 1.4–1.7 mm (average 1.5); index 7.3–10.0 (average 9); ratio 4.0–5.5 (average 4.5). Head with dark area between the ocular bulges and collar and on the posterior margin of frontoclypeus. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* hair 5-C usually double, sometimes triple. *Thorax:* ventral and pleural areas lightly spiculated; hair 3-P always double. 7 or 8-P usually triple and double, sometimes 4 and 3-branched, respectively. *Abdomen:* hair 1-III–VI, 3–5-branched (average 4); 6-IV–VI usually 4-branched; 4-VII double; 10-VII usually triple (2–3); 2-VIII always double. *Comb* with about 48 fringed scales. *Siphon* with or without median dark ring; pecten usually with 12 teeth (10–14). *Anal Segment:* saddle darker than or concolorous with siphon; hair 2-X usually with 1 long and 3 short branches; anal gills as long as dorsal length of saddle.

PUPA. (fig. 19) *Abdomen:* 2.25 mm. *Paddle:* 0.6 mm. *Trumpet:* 0.75 mm; index 10–15. Trumpet relatively longer than in *versabilis;* proximal 0.5 stout, distal 0.5 narrow but with distinctly expanded pinna. *Cephalothorax and Metanotum:* hair 1-C usually triple; 3-C double. *Abdomen:* hair 5-II and III triple; 9-VII usually double (2–3); 4-VII always double; 5-VII always single. *Paddle* with strong midrib.

BIONOMICS. The immature stages and adults of *muruae* were all collected in a sago swamp near sea level. The larvae were found associated with *ornatus* and *collessi* (Gulf form). The adults

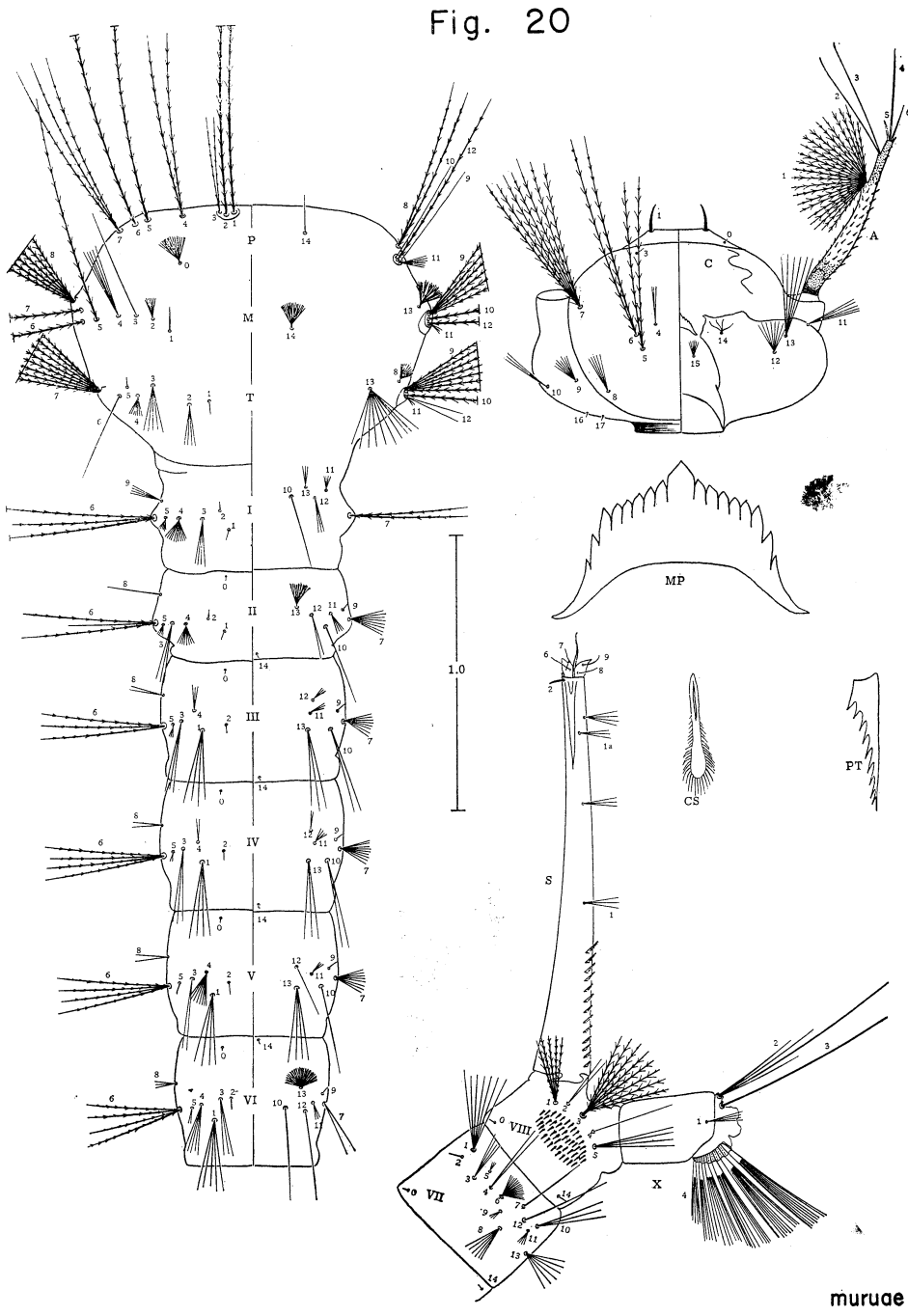


Fig. 20. Larva of *C.* (*L.*) *muruae*.

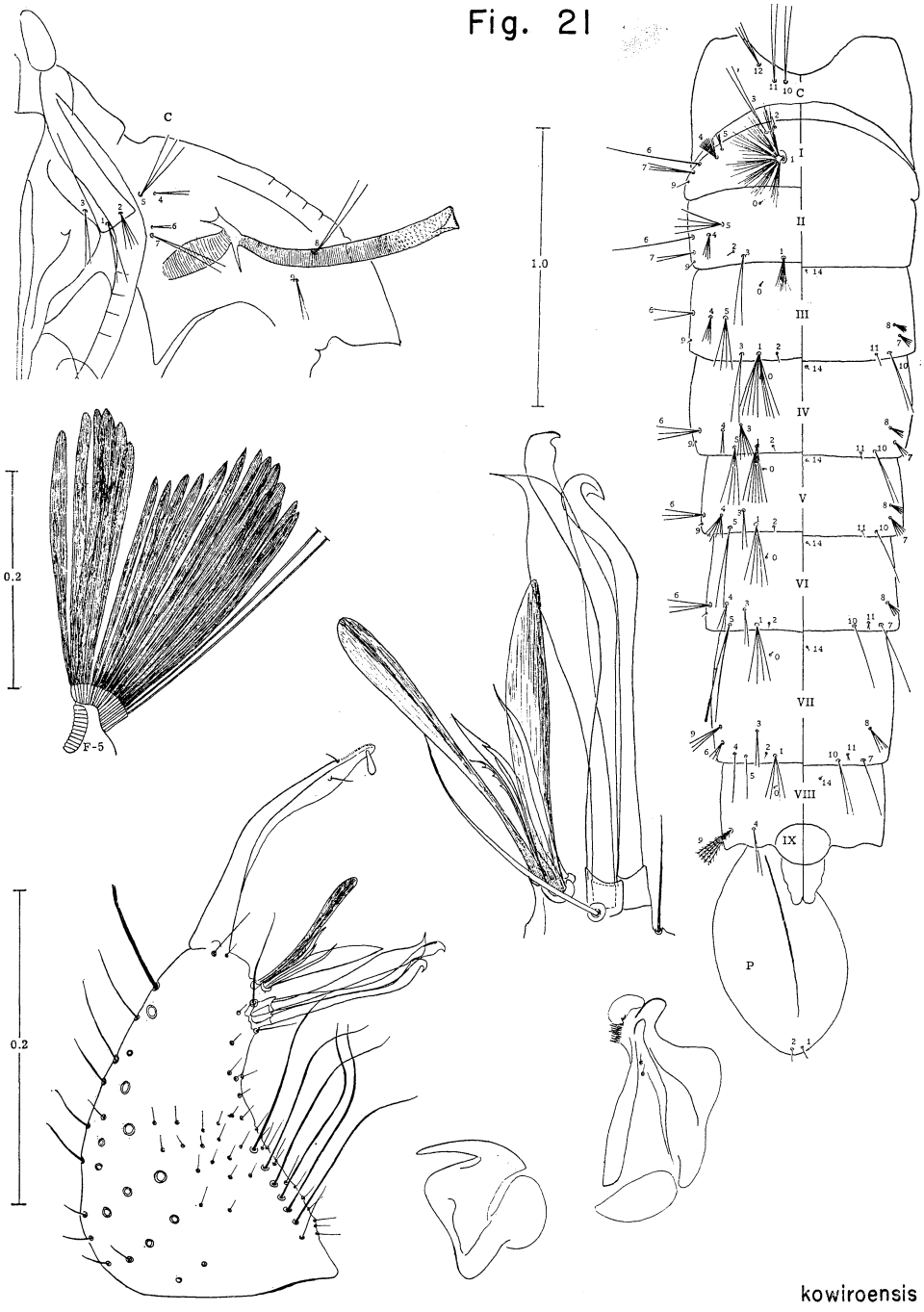


Fig. 21. Pupa, male genitalia and modified tuft of antennal flagellomere 5 of *C.* (*L.*) *kowiroensis.*

were collected resting under fallen sago leaves and on plant seedlings and herbs or by disturbing these objects near a breeding site.

SYSTEMATICS. *C. muruae* is very clearly marked by the form of the scale tuft on flagellomere 5 of the male antenna. The females can be distinguished from *versabilis* and other closely related forms by the presence of distinct basolateral spots on abdominal tergites III–VII. The larva differs from all forms of the *marksae* complex in the double branching of hairs 4-VII and 2-VIII and the triple branching of 10-VII. The pupa is rather distinctive in the shape and length of the trumpet.

DISTRIBUTION. Material examined: 31 adults (23 ♂♂, 8 ♀♀); 4 individual rearings (2 larval, 2 pupal); 4 whole larvae. SE NEW GUINEA. GULF: Murua, sea level to 10 m, sago swamp, 1-3.V.1966, SS, as listed in type series (G10, 11, 21, 25, 26) and the following, 2 ♂♂ (G10); 2 ♂♂ (G11); 14 ♂♂, 5 ♀♀ (G21) 1 1p♀ (G24-101); 1 p♀ (G26-102), 4 L (G26) (BISHOP).

13. **Culex (Lophoceraomyia) kowiroensis** Sirivanakarn, new species Fig. 21, 22.

TYPES: Holotype ♂ (SP154-112) with associated pupal skin and slide of genitalia and antenna, Kowiro, inland of Wewak Sepik, NE New Guinea, from palm bract, 4.III.1966, S. Sirivanakarn (BISHOP 7732). Allotype ♀ (SP154-12) with associated larval and pupal skins, same data as holotype (BISHOP). Paratypes same data as holotype; 4 ♂♂ (SP154-101, 102, 105, 113) with associated pupal skins and slides of antenna and genitalia; 1 ♀ (SP154-107) with associated pupal skin (BISHOP).

♂. (fig. 21) Very similar to *versabilis*, differing chiefly in the following. *Antenna:* F-5 with a large tuft of 18–20 dark broad scales, the dorsal group of 4–5 scales and the ventral group of 9 scales are subequal in length, bluntly tipped and as long as the next 4 flagellomeres, the middle group of 5–6 scales narrower, shorter, with apices more or less pointed; F-9 usually with 1 short and 3–4 long blade-like scales; F-10 with 3 long stout setae and 1 hair-like seta.

Genitalia: (fig. 21) Extremely similar to *versabilis*, differing in a few details as follows: *Sidepiece:* tergomesal margin usually with 6 submarginal setae (4–6) and 1 or 2 other weaker setae in line; marginal setae more numerous. *Proctiger:* ventrolateral sclerite with less pronounced lobe on its upper sternal margin.

♀. *Wing:* 2.7 mm. *Forefemur:* 1.3 mm. *Proboscis:* 1.8–2.0 mm. *Palpus:* 0.15 of proboscis. *Similar* to ♂ in size and general ornamentation. Abdominal tergites entirely dark scaled, basolateral pale spots absent; venter paler scaled.

LARVA. (fig. 22) *Head:* 0.68 mm. *Siphon:* 1.2–1.4 mm (average 1.3); index: 8; ratio: 4. Thoracic spiculation very light to almost absent. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* hair 4-C usually single and rather weak. *Thorax:* hair 3-P usually single, rarely double. *Abdomen:* hair 1-III–VI triple (2–4); 3-V double (1–2); 2-VIII always single. *Comb* scales 40–42. *Siphon:* pecten with 15 teeth (14–16); tufts 8 in number. *Anal Segment:* hair 2-X usually with 1 short and 1 long branch; anal gills usually long, from 2–4 × dorsal length of saddle.

PUPA. (fig. 21). *Abdomen:* 2.3 mm. *Paddle:* 0.68 mm. *Trumpet:* 0.65 mm; index about 13. Very similar to *versabilis;* differing in having slightly shorter and stouter trumpet. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax and Metanotum:* hair 1-C usually double, rarely triple; 3-C usually double, rarely single or triple. *Abdomen:* hair 5-II, 3- or 4-branched; 6-III double (2–3); 4 or 5-VII usually single (1–2).

BIONOMICS. Larvae of *kowiroensis* were collected twice in an inland depression. One lot (SP141) was from a muddy foot print under grass cover containing little water and numerous microscopic green algae; the other (SP154) was from a fresh palm bract containing rain water. The larvae from palm bracts were found associated with *wamanguae*. Males were collected near the breeding sites resting under sago leaves in heavy shade.

SYSTEMATICS. *C. kowiroensis* is distinguished from *versabilis* and other closely related forms by the striking differences in the tuft of the male antennal flagellomere 5. The larva shows a great deal of overlap in chaetotaxy with *versabilis* except in the diagnostic characters.

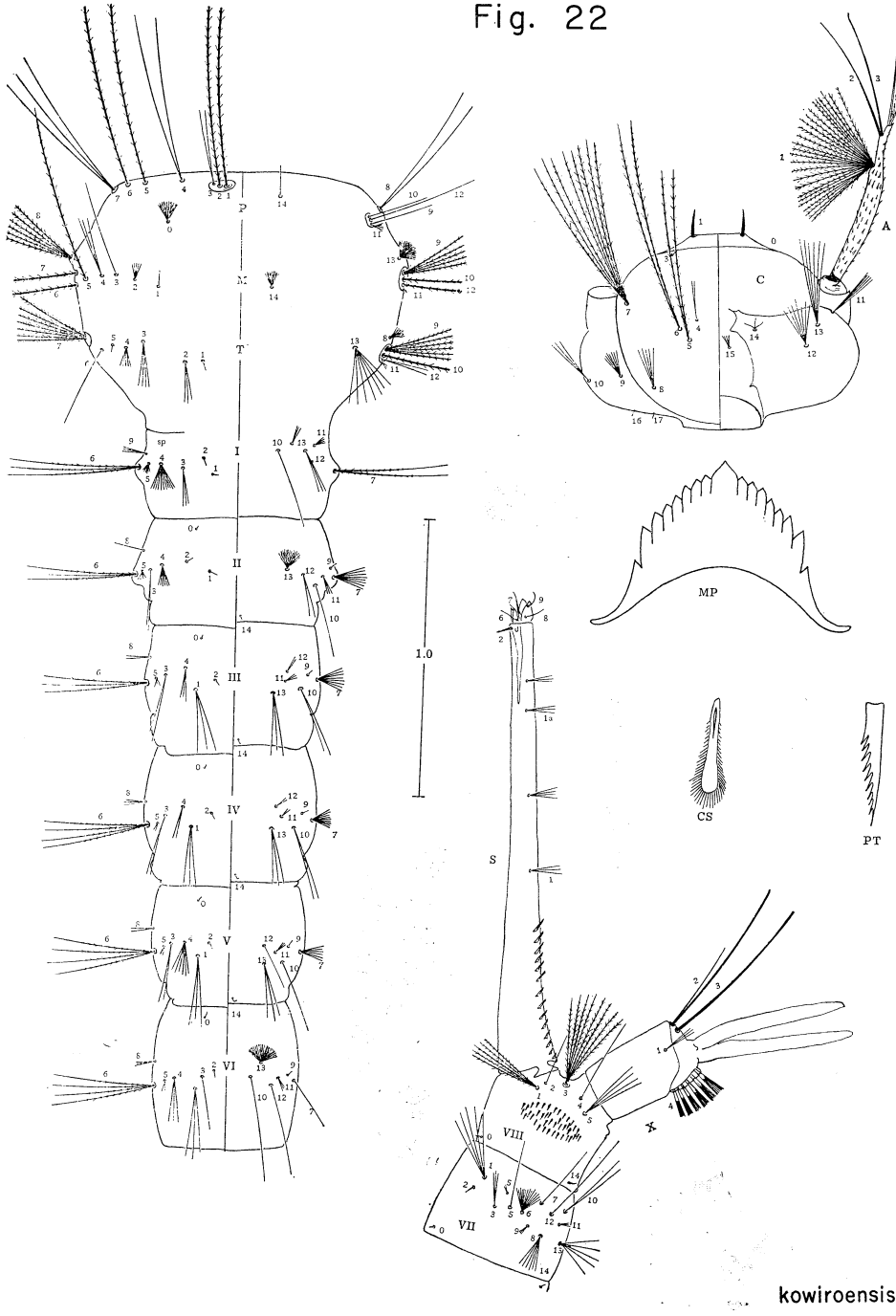


Fig. 22. Larva of *C.* (*L.*) *kowiroensis*.

DISTRIBUTION. Material examined: 42 adults (22 ♂♂, 20 ♀♀); 12 individual rearings (2 larval, 10 pupal); 18 mass rearings; 11 whole larvae; 4 larval skins. NE NEW GUINEA. SEPIK: Inland, of Wewak, Kowiro village, 60–70 m, human foot print, 2.III.1966, SS, 2 p♂♂ (SP141-101, 103), 2 p♀♀ (SP141-100, 102), 41 (associated with above pupal skins), 1 L (SP141); betel nut bract, 4.III.1966, SS, as listed in type series (SP154) and the following, 9 p♂♂ and 9 p♀♀ from mass rearings (SP154-100, 103, 104, 106, 108, 114), 10 L (SP154); 6 ♂♂ and 6 ♀♀, field-caught near the breeding site (SP154) (BISHOP).

14. **Culex** (**Lophoceraomyia**) **wamanguae** Sirivanakarn, new species Fig. 23, 24.

TYPES: Holotype ♂ (SP147-100) with associated pupal skin and antenna-genitalia slide, Wamangu, inland of Wewak, Sepik, NE New Guinea, from decayed sago stump, 3.II.1966, S. Sirivanakarn (BISHOP 7733). Allotype ♀ (SP147-108) with associated pupal skin, same data as holotype (BISHOP). Paratypes, same data as holotype; 5 ♂♂ (SP147-102, -104, -107) with associated pupal skins, 2 ♀ ♀ (SP147-101, -103) with associated pupal skins; 4 larvae (SP147-1-4) (BISHOP).

♂. (fig. 23) As described for the complex; with labial characters similar to *leei;* differing from other species chiefly in the following: *Palpus* with thicker basal processes; segments 4 and 5 with more numerous bristles. *Proboscis:* labium thicker, false joint clearly marked by a swelling at about 0.2 from base; subapical 0.25 with 3 pairs of dorsal upright setae. *Antenna:* F-5 with a tuft of 9 or 10 yellowish brown to bronzy, flattened subequal setae as long as the next 4 flagellomeres, preceded dorsally by 3 or 4 tiny setae and followed ventrally by 4 long normal hairs. *Thorax:* mesonotal scales brown to almost black.

Genitalia: (fig. 23) In general, as described for the complex. *Sidepiece* usually with 4 submarginal setae, sometimes with 1 or 2 weaker and shorter setae in line next to the uppermost submarginal. *Subapical Lobe:* distal part with 5 or 6 accessory setae, 1 of which is inconspicuous. *Lobe* of 9th tergite with 6 or 7 strong setae.

♀. *Wing:* slightly over 3.0 mm. *Forefemur:* 1.5 mm. *Proboscis:* 2.0 mm. *Palpus:* about 0.17 of proboscis. Similar to ♂ in general ornamentation. Resembling most forms of the complex except that abdominal tergites lack basolateral pale spots.

LARVA. (fig. 24) *Head:* 0.70 mm. *Siphon:* 1.6–2.3 mm (average 2.0 mm); index 10; ratio 5.3–6.7 (average 6.0). Strikingly different from all other forms of the *marksae* complex in large size, longest siphon with highest index and ratio. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* hairs 5, 6-C usually triple, rarely double or 4-branched. *Thorax:* hair 3-P always double; 1-M and T stronger and longer than 2-M. *Abdomen:* hair 6-I, II with average of 4 branches (2–7); 1-II usually triple (2–4); 1-III–IV usually triple (2–3); 3-II–IV double; 6-III, 4-branched; 1-V–VI usually double (2-3); 3-V–VI always single. *Comb* with 50–65 scales. *Siphon:* pecten with 16–18 teeth (average 17). *Anal segment:* hair 2-X with average of 1 long and 9 short branches (2–4).

PUPA. (fig. 23) *Abdomen:* 2.5 mm. *Paddle:* 0.75 mm. *Trumpet:* 0.63 mm; index 7–11 (average 9.5). Trumpet stout and shorter than in *versabilis.* All hairs rather strong. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax and Metanotum:* hairs 1, 3-C usually double; 8-C double. *Abdomen:* hair 1-III–VII with average of 8, 7, 4, 3 and 3 branches, respectively; 5-V, VI double, longer than following tergite. *Paddle* darkened proximally; with distinct margin; midrib strong, brown to almost dark.

BIONOMICS. Larvae of *wamanguae* were collected on 3 occasions; in a sago stump (SP147) half filled with rain water and numerous shredded fibers at the margin of an inland stream; in a palm bract (SP154) lying upon the ground in a depression and the other in a sago leaf axil (SP158) in a swamp. They were found associated with *kowiroensis* in the palm bract and with *schilfgaardei* in the sago leaf axil. Adults appear to be very rare and only 1 male was caught near a breeding site (SP154).

SYSTEMATICS. *C. wamanguae* is very distinctive in male and larval characters. Specimens from different habitats do not show significant variation from the above description. In the male

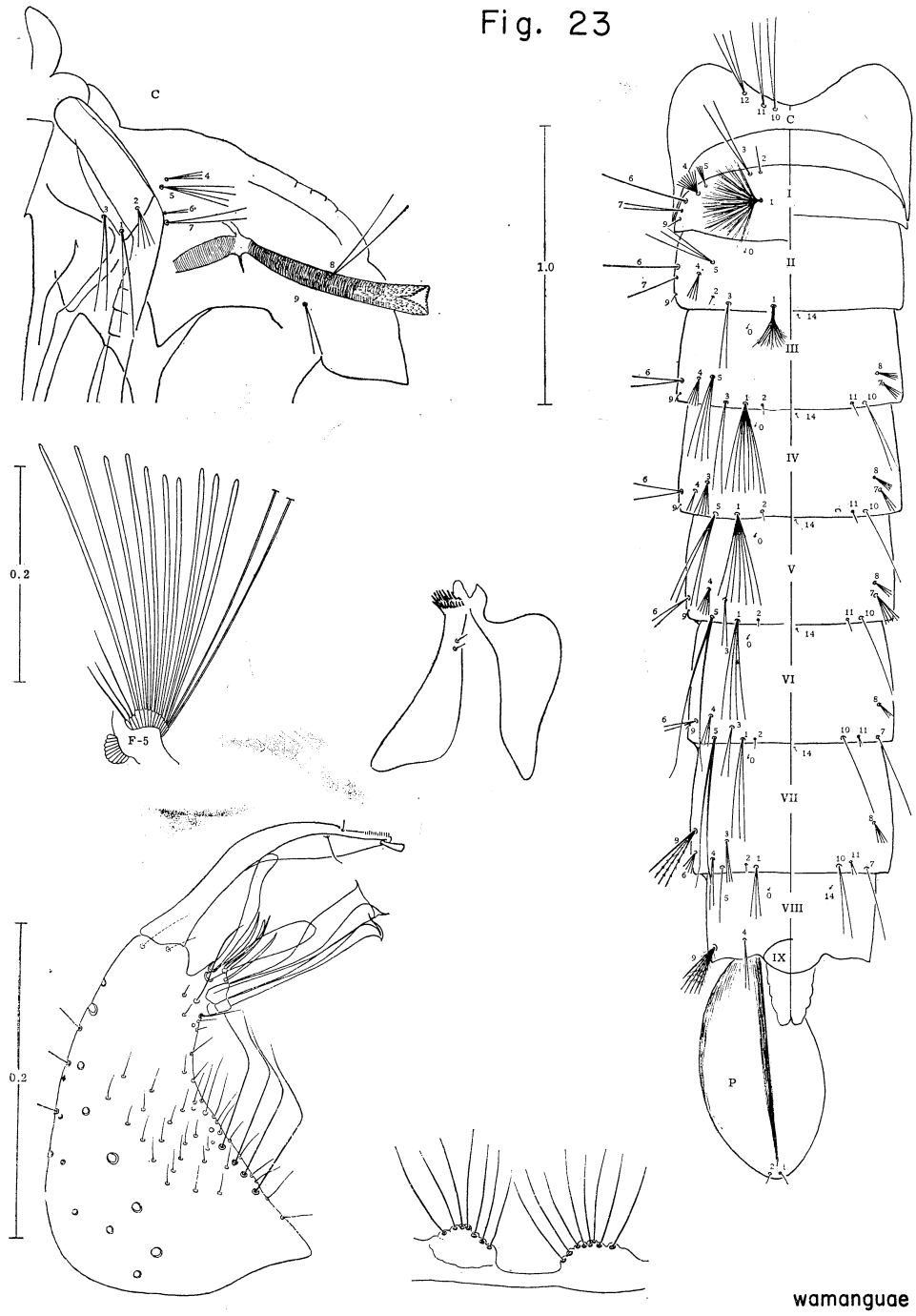


Fig. 23. Pupa, male genitalia and modified tuft of antennla flagellomere 5 of *C.* (*L.*) *wamanguae.*

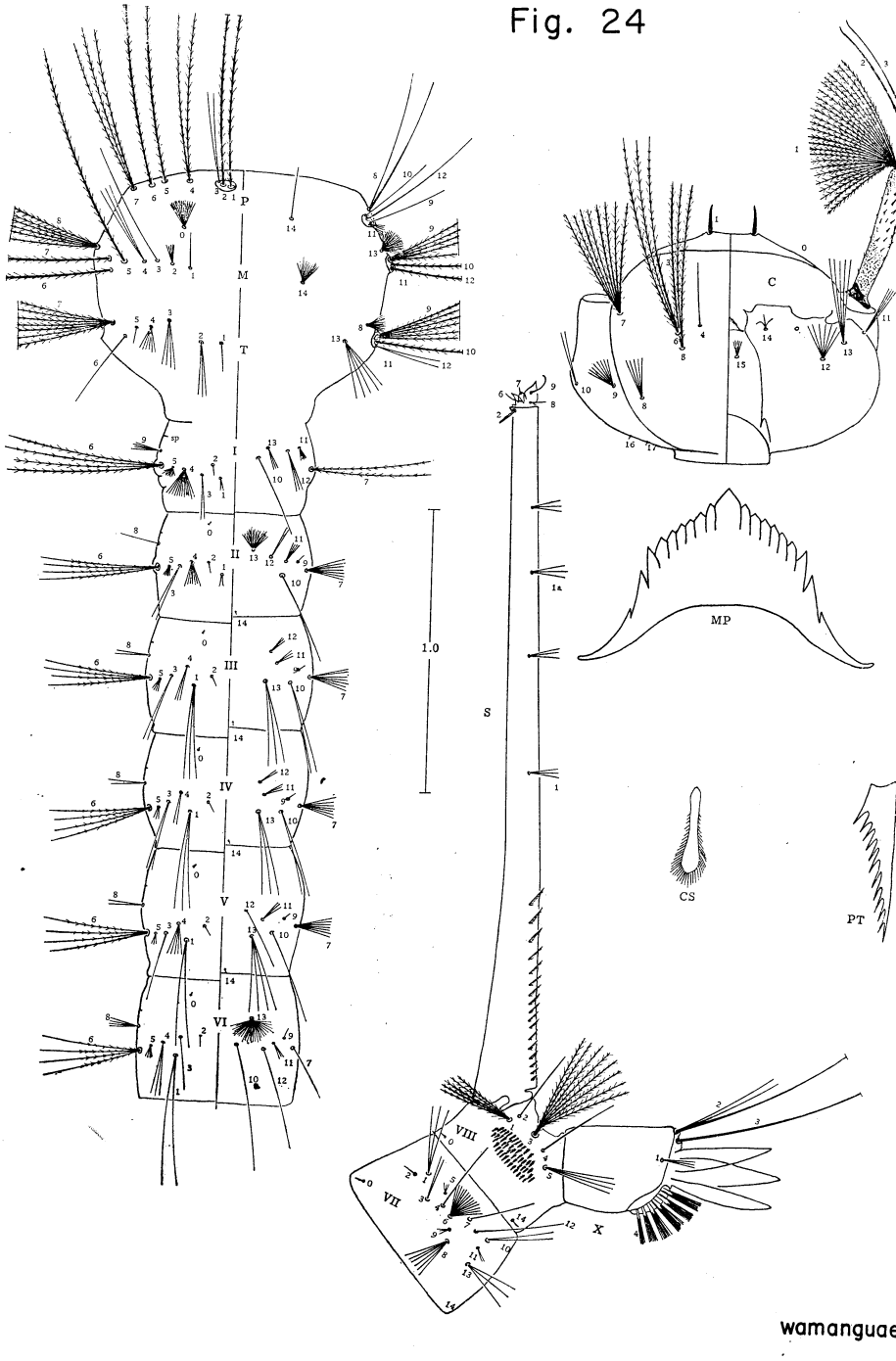


Fig. 24. Larva of *C.* (*L.*) *wamanguae*.

the form of the tuft on antennal flagellomere 5 and the presence of 5 or 6 accessory setae on the distal part of the subapical lobe are very constant and diagnostic. The larva is also strikingly different from other members in the complex in the triple branches of head hairs 5 and 6.

DISTRIBUTION. Material examined: 9 ♂, 3 ♀; 11 individual pupal rearings; 20 whole larvae and 5 larval skins. NE NEW GUINEA. SEPIK: Inland of Wewak, Wamangu Village, elev. 60–70 m, decayed sago stump, 3.III.1966, SS, as listed in type series, 17 L, 51 (SP147). Kowiro Village, elev. 60–70 m, palm bract, 4.III.1966, SS, 2 L (SP154); 1 ♂ (SP155) with slide of antenna and genitalia (660802-4). Wewak, sea level, sago axil, 6.III.1966, SS, 1 L (SP158) (BISHOP).

15. **Culex** (**Lophoceraomyia**) **leei** King & Hoogstraal Fig. 25, 26.

Culex (*Lophoceraomyia*) *leei* King & Hoogstraal, 1955, Proc. Ent. Soc. Wash. **57:** 4–6. *Type: Holotype ♂ (1063-3) with slide mounts of genitalia, both antennae and larval and pupal skins, reared from larva collected from "Rozeboom pond" near Pollimac Road, Hollandia (Kota Baru), Netherlands New Guinea (West Irian), 5.V.1945, H. Cook (USNM).

Culex (*L.*) *leei* of Stone, Knight & Starcke, 1959.

♂. (fig. 25) Essentially as in the original description of King & Hoogstraal (1955: 4–6). Similar to most forms in the *marksae* complex, differing from them chiefly in the following. *Head:* broad appressed scales on vertex and occiput bluish white to gray, intermixed with several pale brown scales at side. *Palpus:* basal processes slender, slightly exceeding 0.5 of length of distal part of palpal segment 1; segment 3 with 2, 3 weak apical bristles; segments 4 and 5 with fewer and weaker bristles than in *wamanguae*. *Proboscis:* labium usually with 2, 3 pairs of dorsal upright setae in subapical 0.2. *Antenna:* F-5 with a small tuft of 10–14 hairlike setae, the first 2, 3 setae as long as the next 2 flagellomeres, the rest paler and slightly longer, followed ventrally by 4 long normal hairs; F-9 with 3, 4 yellowish bladelike scales; F-10 with 3 long stout setae.

Genitalia: (fig. 25) As figured, extremely similar to most forms in the *marksae* complex and particularly *wamanguae*, differing from them in the following significant details. *Sidepiece* with a linear row of 3, 4 submarginal setae, the most distal or proximal seta sometimes weaker and shorter than the rest. *Subapical Lobe:* distal part with 5 accessory setae, 1 of which is inconspicuous. *Lobe* of 9th tergite with 6, 7 strong setae.

♀. *Wing:* 2.7 mm. *Forefemur:* 1.3 mm. *Proboscis:* 1.7 mm. *Palpus:* 0.2 of length of proboscis. In general similar to ♂ in ornamentation; extremely similar to *wamanguae* except that it is smaller in size; differing only slightly in the following. Head with broad appressed scales darker; abdominal tergites entirely black scaled.

LARVA. (fig. 26) *Head:* 0.68 mm. *Siphon:* 1.3–1.63 mm. (average 1.5 mm); index 7.7–9.3 (average 8.5); ratio: 4.5–5.4 (average 5). Without distinct color pattern; thoracic spiculation very light to almost completely absent. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* hair 4-C very long, almost reaching the anterior border of the frontoclypeus, usually forked at the middle into 2 branches. *Antenna:* more slender than in other species in the *marksae* complex, either entirely dark or dark at base, creamy white in the middle and dark beyond the antennal tuft. *Thorax:* hair 3-P usually double, rarely single; 8, 9-M with average of 5 branches (4–5); 7, 9-T, 8-, 7-branched (6–8); 12-T usually single, rarely double; 13-T with average of 5 branches (4–6). *Abdomen:* hair 1-III–VII always double; 3-II–IV usually double (2–3); 3-V–VI single; 6-III–VI usually triple, rarely 4-branched; 2-VIII always single. *Comb* with 50–70 evenly fringed scales. *Siphon* without dark median band; short and with low index and ratio; pecten with 13–17 teeth (average 15), distal teeth usually barbed with 9–11 sharp fine denticles. *Anal Segment:* hair 1-X always triple; 2-X always with 1 short and 1 long branch; anal gills extremely variable in length, usually 2-4 × length of saddle.

PUPA. (fig. 25). *Abdomen:* 2.3 mm. *Paddle:* 0.63 mm. *Trumpet:* 0.53; index 11.0. Chaetotaxy as figured; diagnostic characters as in the key. Trumpet shorter than in other members of the *marksae* complex. *Cephalothorax and Metanotum:* hair 1-C always double; 3-C usually double, rarely single; 5-C usually triple (3–4); 8-C almost always single, rarely double; 10-C usually single (1–2). *Abdomen:* hair 7-I, II usually single (1–2); 1-III–VII with average of 5, 4, 2, 2 and 2 branches, respectively; 5-VI single; all hairs 10 usually single

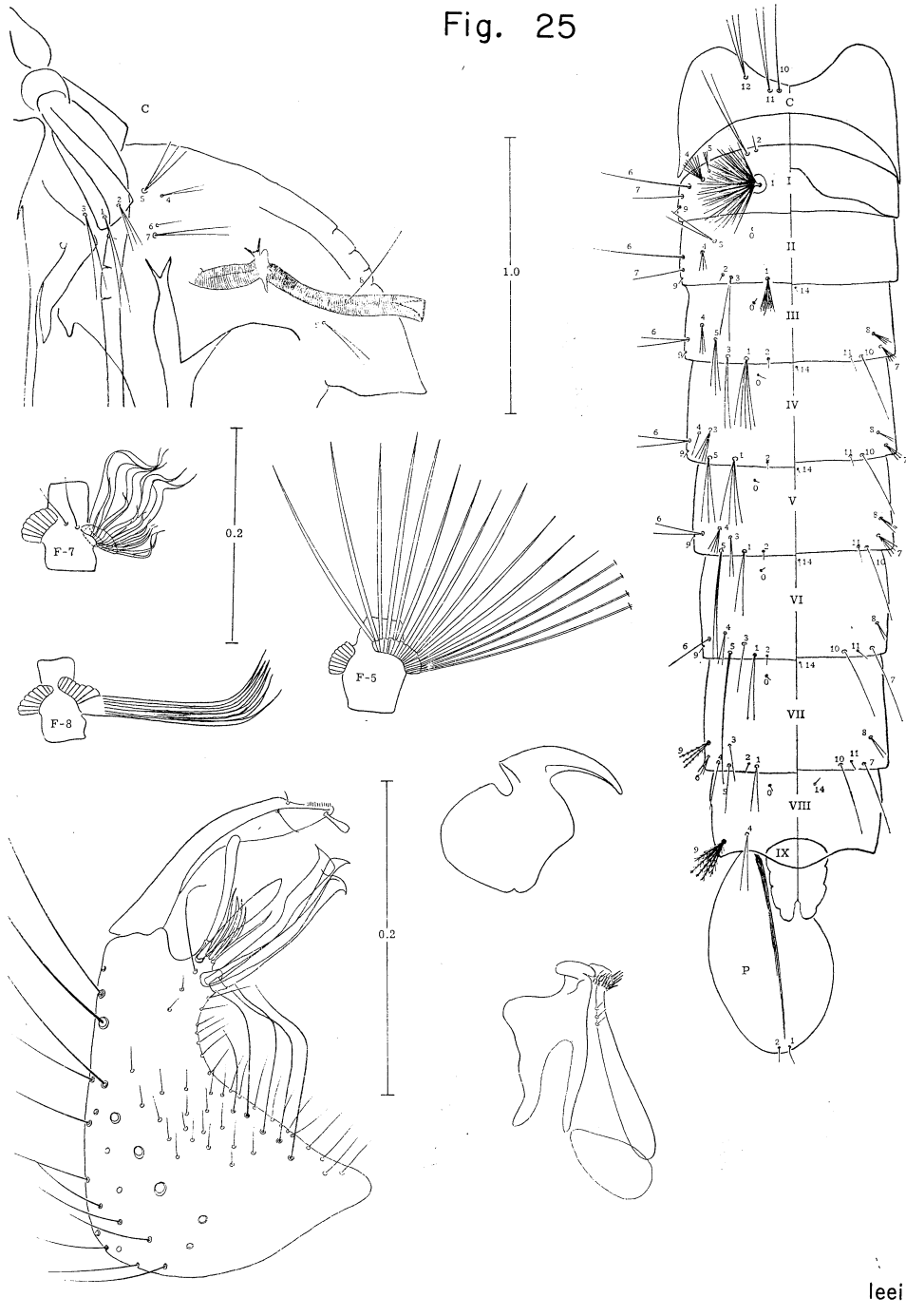


Fig. 25. Pupa, male genitalia and modified tufts of antennal flagellomeres 5, 7 and 8 of *C.* (*L.*) *leei*.

Fig. 26

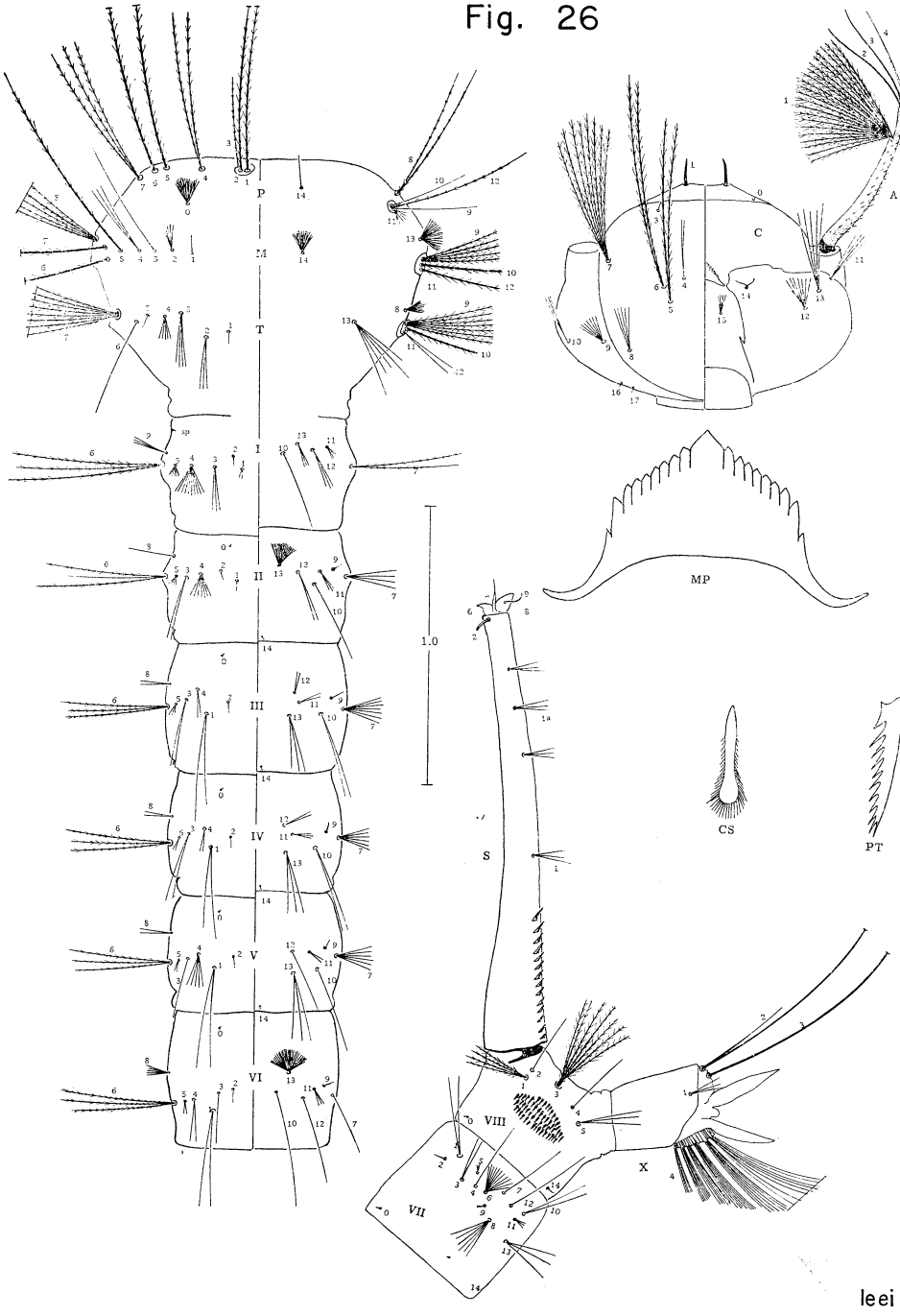


Fig. 26. Larva of *C.* (*L.*) *leei.*

(1–2); 4-VII usually single (1–2); 5-VII always single; 4-VIII single or double. *Paddle* with weak midrib and indistinct margin.

BIONOMICS. Adults of *leei* were rarely encountered in general field catches and only a few were collected resting singly under leaves of herbs near river margins and among grass stems under shade of sago palms of a low inland depression. King & Hoogstraal (1955) reported larvae from a pond and a log hole. In the present survey, the immature stages were collected only in decayed sago stumps under heavy shade in association with *versabilis* and a species of *Culex* (*Lutzia*).

SYSTEMATICS. *C. leei* is distinguished from other forms of the *marksae* complex by the small tuft of short, hairlike setae on flagellomere 5 and a slender palpus with few bristles on segments 4 and 5. The male genitalia are indistinguishable from *wamanguae*, but are clearly separated from *versabilis*, *kowiroensis* and *muruae* by the presence of 5 accessory setae in the distal part of the subapical lobe and fewer setae on the lobe of the 9th tergite. The larval chaetotaxy is strikingly different from the other species in the branching of abdominal hairs 1 and 6. The pupa is easily recognized by the short trumpet and unbranched hairs 8-C, 10-C, 5-VI and abdominal hair 10. Considering all stages, *leei* appears to be more closely related to *wamanguae* than to any other species in the *marksae* complex.

DISTRIBUTION. Material examined: 17 adults (6 ♂♂, 11 ♀♀); 5 individual rearings (1 larval, 4 pupal); 14 whole larvae and 2 larval skins. NW NEW GUINEA. Kota Baru (Hollandia), 5.V.1945, H. Cook, (1063), 1 ♂, 2 ♀♀ paratypes, 11. NE NEW GUINEA. SEPIK: Vanimo, Daunda River, elev. 5–10 m, 24.II.1966, SS (SP117), 1 ♂ with slide mount of antenna and genitalia (660714-4), 3 ♀♀. Inland of Wewak, Kowiro Village, elev. 60–70 m, sago stump, 2.III.1966, SS, 1 p♂ (SP142-100) with slide of antenna and genitalia, 1 p♂ (SP142-101) 1 1p♀ (SP142-10), 8 L (SP142); 4.III.1966, SS, 1 ♂ (SP156) with slide of antenna and genitalia (660801-8). elev. 20 m, sago stump, 28.I.1966, SS, 1 p♂ (MD23-100) with slide of antenna and genitalia; MADANG: Gum River, 1 p♂, 6 L, 4 ♀♀ (MD23M) (BISHOP).

Ornatus Complex

16. **Culex** (**Lophoceraomyia**) **ornatus** (Theobald) Fig. 27, 28.

Melanoconion ornatus Theobald, 1905, Budapest Magyar Nemezeti Mus. Ann. **3:** 100. Type: Holotype ♀, Friedrich-Wilhelmshafen (Madang), New Guinea, XII.1900, M. Biro (BUDA).
Culex (*L.*) *ornatus* of Edwards (1924: 398); King & Hoogstraal (1955: 7–10); Colless (1959: 386); Stone et al. (1959). *Melanoconion ornatus* of Theobald, Monog. Culicidae **4:** 508–509.

♂. (fig. 27) Medium sized species. *Head:* narrow decumbent scales yellowish, confined to occiput and along the middorsal line on vertex; all broad scales pale to whitish, bordering the eyes and forming rather large white patches at sides; erect scales pale brown to deep brown; frontal and orbital bristles deep brown. *Palpus:* exceeding proboscis by about full length of segment 5; basal processes strongly developed, about 0.5 of length of distal part of segment 1; segment 3 with a ventrolateral tuft of slender setae which are 2, 3 × segment width, a ventral row of shorter setae as long as the width of segment, apex with 6, 7 dark brown bristles laterally and ventrally; segments 4 and 5 upturned and with numerous strong bristles laterally and ventrally. *Proboscis:* false joint present as in most forms of the *fraudatrix* group; base of labium with a ventral row of 10–12 stout spinelike setae, distal 0.5–0.75 with several pairs of dorsal upright setae. *Antenna:* F-5 with a very large fan-shaped tuft of 26–30 subequal scales as long as or usually a little longer than the next 4 flagellomeres, the dorsal group of 11–13 scales broad, deep brown and bluntly ended, the lateroventral group of 13–17 scales narrower, distally pale to whitish and more or less pointed; F-6 and F-7 with crumpled tufts of curled setae as in most forms of the *fraudatrix* group; F-8 with 6, 7 fused setae projecting ventrally in form of a J; F-9 with 4–6 long subequal bladelike scales and 6, 7 hairlike setae; F-10 with 2, 3 long, smoothly curved, stout setae. *Thorax:* integument light brown to deep brown; mesonotum covered with numerous yellow to golden scales;

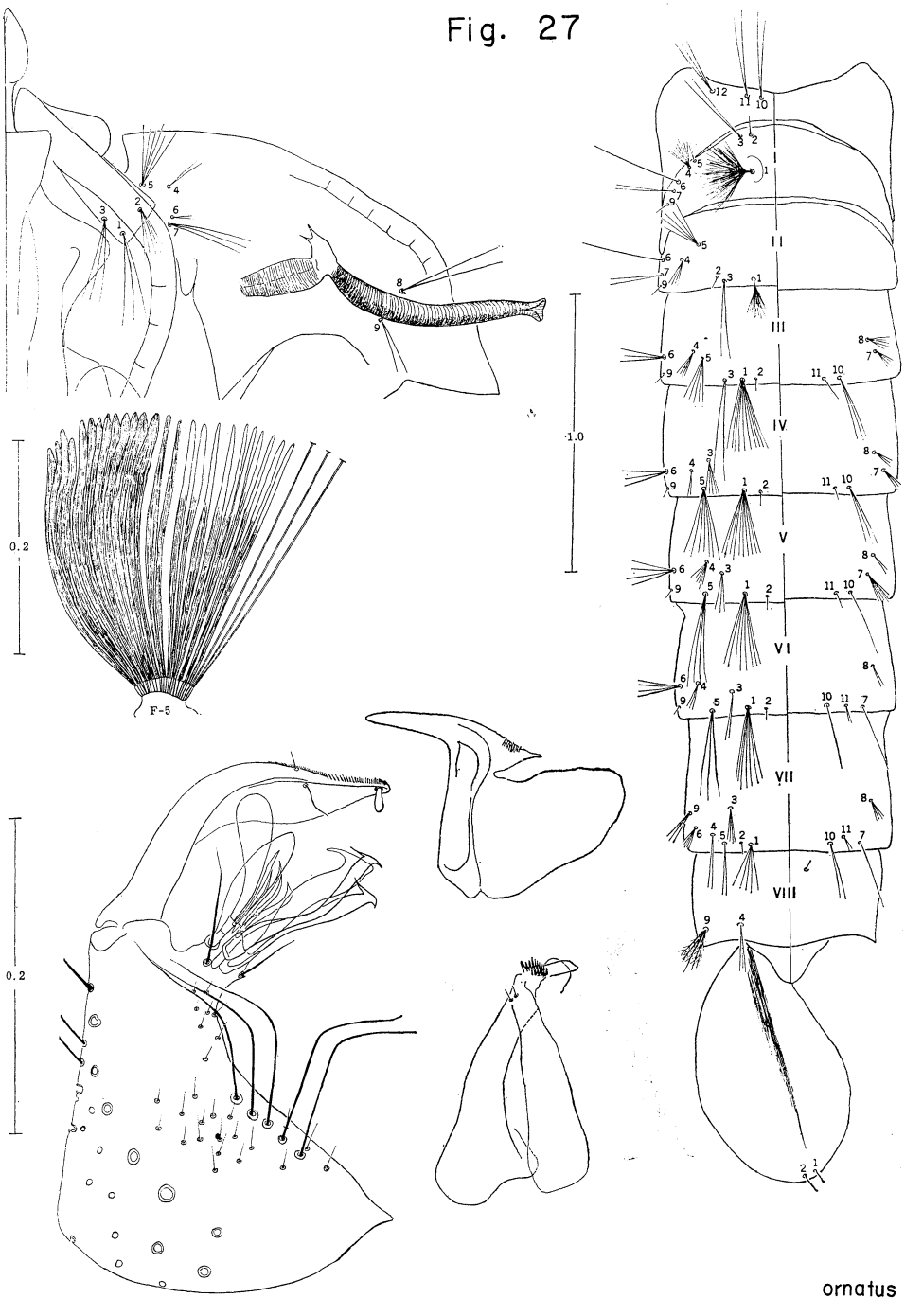


Fig. 27. Pupa, male genitalia and modified tuft of antennal flagellomere 5 of *C.* (*L.*) *ornatus*.

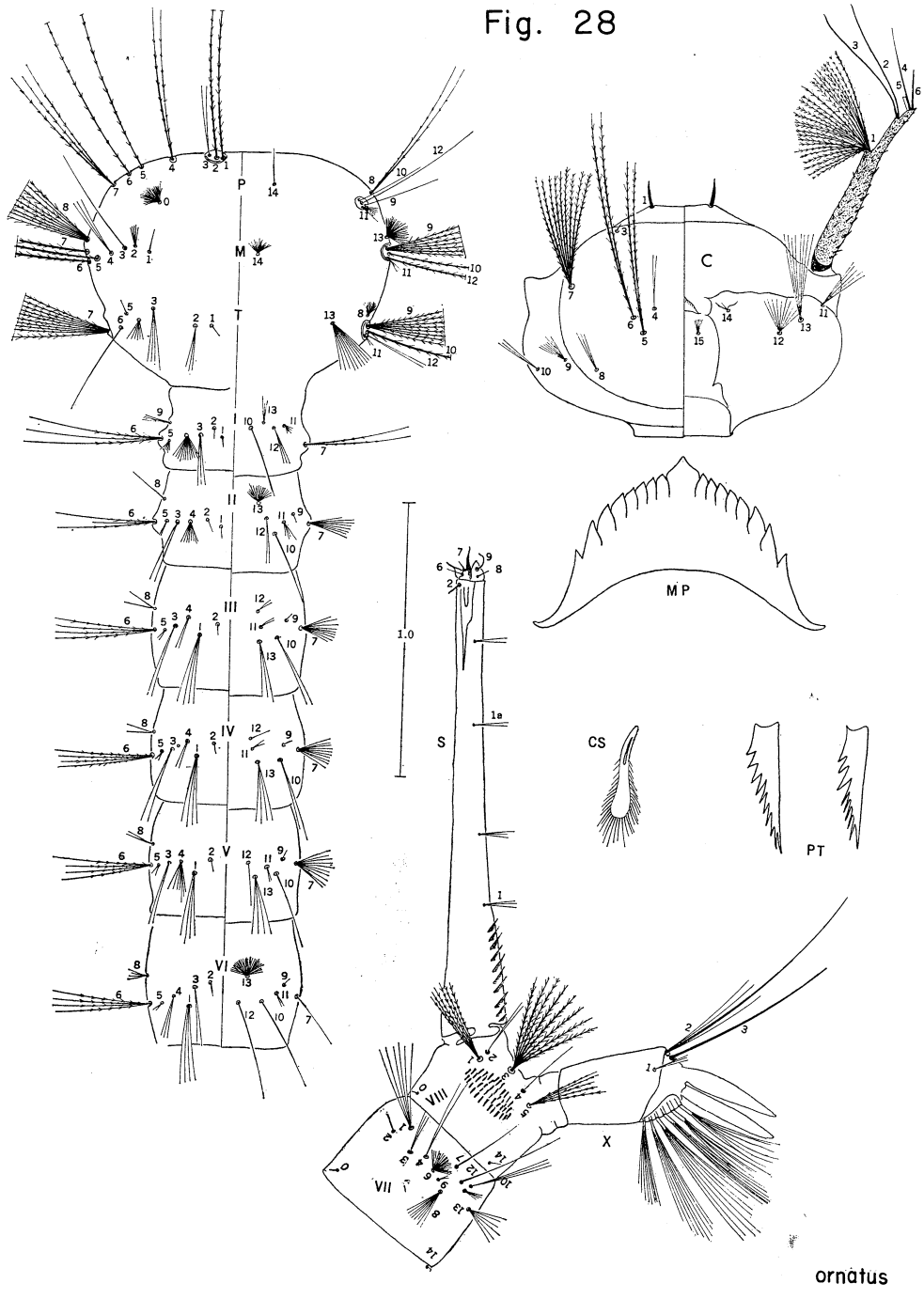


Fig. 28. Larva of *C.* (*L.*) *ornatus*.

propleuron with numerous pale scales; propleural bristles numerous, all weak, hairlike and yellowish; posterior border of sternopleuron with a broad patch of numerous pale translucent scales; lower anterior mesepimeral bristle present. *Wing:* scales dark, narrow and dense on C, Sc, R_1 and R_2. *Legs:* without marked ornamentation; forecoxa with several strong bristles; claws as described for the group. *Abdomen:* tergites III–VII with pale yellow to whitish basolateral spots.

Genitalia: (fig. 27) *Sidepiece* with 4, 5 long subequal submarginal setae; marginal setae very few. *Subapical Lobe:* proximal part with 1 basal seta and 3 rods, the external and central ones markedly curved in the middle and hooked apically, the internal rod with truncate apex, very thin and rather inconspicuous in outline; distal part with moderately strong basal seta, external leaflet broad but extremely thin, internal leaflet with rounded apex, 5, 6 accessory setae present, all flattened and curved subapically. *Clasper* with a very conspicuous crest of fine spicules from tip to near curvature; claw moderately long; dorsal and ventral subapical setae nearly opposite each other. *Phallosome:* lateral plate with long slender dorsal process ending in a sharp point. *Proctiger:* crown small, with numerous fine spicules; ventrolateral sclerite narrow; cercal sclerite with 2 minute setae. *Lobe* of 9th tergite with 3, 4 weak setae.

♀. *Wing:* usually over 3.0 mm. *Forefemur:* 1.6 mm. *Proboscis:* 2.1 mm. *Palpus:* 0.15–0.17 of proboscis. In general, similar to ♂ in ornamentation, differing in the following. *Head:* narrow decumbent scales dark brown. *Thorax:* mesonotum with more numerous yellow scales, forming rather definite patches on the marginal areas, covering anterior promontory, scutal angle, fossa, supraalar, antealar, prescutellar areas, and scutellar lobes. *Legs:* all claws small, simple and equal. *Abdomen:* with broad and distinct basolateral tergal pale spots.

LARVA. (fig. 28) *Head:* 0.7 mm. *Siphon:* 1.4–1.68 mm (average 1.5); index 7.0–8.3 (average 7.5); ratio 4.0–4.8 (average 4.2). Chaetotaxy as figured; diagnostic characters as in the key. In general, similar to *fraudatrix* and *collessi*, differing from them in having the antennal shaft completely dark, thorax densely covered with dotlike spicules, and in the following features. *Head:* hair 1-C a long slender sharp spine; 7-C, 9-branched (8–11); 14-C usually double (2–3). *Thorax:* hair 8-M, 9-branched (7–10); 9-M, 7-branched (6–8); 7-T, 10-branched (8–12); 9-T, 8-branched (6–9); 13-T, 10-branched (8–12). *Abdomen:* hair 1-III–VI 4 (4–6), 4 (4–5), 4 (4–7) and 4 (3–6)-branched, respectively; 3-II–VI usually double (1–3); 4-VII double; 10-VII usually triple (2–3); 2-VIII always double. *Comb* with about 44 fringed scales. *Siphon* without dark median ring; pecten usually with 10–12 teeth (9–15); siphonal tufts 8 in number, irregularly paired, usually 3-branched and as long as siphon width at points of attachment. *Anal Segment:* hair 1-X usually triple (2–3); 2-X with 1 long and 3 short branches.

PUPA. (fig. 27) *Abdomen:* 2.4 mm. *Paddle:* 0.7 mm. *Trumpet:* 0.7 mm; index 9.3–10 (average 9.8). Chaetotaxy as figured; diagnostic characters as in the key. *Pigmentation* darker than in most forms of the *fraudatrix* complex; paddle with strong and very dark midrib, margin distinct. *Trumpet:* narrow at extreme base, very broad and thick in proximal 0.5–0.75, gradually narrowed beyond and ending in a small, slightly expanded pinna. *Cephalothorax and Metanotum:* hair 1-C usually triple (2–4); 5-C, 6-branched (4–6); 9-C double; 12-C triple (3–4). *Abdomen:* hair 6-III–IV usually triple (3–4), 6-V–VI usually 4-branched (3–4); 5-V–VI, 3- and 4-branched, respectively; 10-III–IV triple (1–3); 9-VIII usually with 5 plumose branches (4–6).

BIONOMICS. *C. ornatus* is the most widespread *Lophoceraomyia* in New Guinea and the Bismarck Archipelago. Adults were encountered almost everywhere from sea level to 1200 m in the mountains. They were especially abundant in swamp habitats, lowland depressions and flooded forests, but appeared to be scarce along the margins of streams. Immature stages were collected only in general ground pools such as drainage ditches, puddles, seepage ponds and swamp pools under heavy shade. Ground waters ranged from fresh spring and rain water in the inland areas to brackish water in swamps along the coast where the larvae seem to be highly tolerant of the salt content. They were found associated with almost all other species of *Lophoceraomyia* utilizing similar larval habitats and appeared to be semidomestic in the coast villages.

SYSTEMATICS. The adults of *ornatus* are large forms easily recognized by the dense yellow scaling on the mesonotum, the numerous scales and weak bristles on the propleuron, and a broad patch of

pale scales on the posterior border of the sternopleuron. The larva is characterized by a dark antennal shaft, spiculation of the thorax and few pecten teeth. The color of antenna is sometimes paler than described but is obviously darker than in all sympatric forms. The shape of the trumpet is characteristic and distinguishes the pupa from all forms except *collessi* which is differentiated from it by hair branching as noted above. No significant variation in diagnostic characters was observed. However, several geographical races may be present but could not be differentiated in the present study.

C. ornatus appears to be closely related to the *fraudatrix* complex on the bases of male antenna, palpus and labium as well as the chaetotaxy of the immature stages. However, because of the conspicuous ornamentation of the adults and numerous diagnostic features it is placed in a distinct complex.

DISTRIBUTION. Material examined: 192 adults (64 ♂♂, 128 ♀♀); 25 individual rearings; 66 whole larvae. NW NEW GUINEA. Kota Baru (Hollandia), III.1945, WVK and HH, 10 ♂♂, 6 ♀♀. Toem, Maffin Bay, 1.VIII.1944, ESR, 3 ♂♂, 13 ♀♀. NE NEW GUINEA. SEPIK: Vanimo, 5–10 m, 20–24.II.1966, SS, 1 ♂ (SP75), 1 ♂ (SP118). Wewak, sea level, 6–7.III.1966, SS, 1 ♂, 25 ♀♀ (SP157); 2 ♀♀ (SP158); 5 ♂♂, 31 ♀♀ (SP159); 4 ♀♀ (SP160), 2 ♂♂, 2 ♀♀ (SP161), 3 ♀♀ (SP162). Kowiro, 160 m, 28.II.1966, SS, 2 ♂♂ (SP128). Maprik, 5–16.II.1966, SS, 5 ♂♂, 1 ♀♀ (SP12); 1 ♂ (SP14); 1 1p♂ (SP45); 2 p♂♂ (SP63), 1 1p♂, 1 ♀♀ (field catch (SP63). Siutmeri, Sepik River, 16.III.1964, DHC, 1 ♂, 4 ♀♀. Kandannge, Sepik River, 12.II.1966, SS, 1 1p♂ and 1 1p♀ (SP48). MADANG: Finschafen, 10 m, 25.I.1966, SS, 2 1p♀ (MD1); 2 ♂♂ (MD6); 2 ♂♂ (MD14). MOROBE: Lae, Singuawa River, 30 m, 10–13.IV.1966, SS, 2 ♂♂, 1 ♀ (MR26). Wau, 18–22.IV.1966, SS, 1 ♂ (MR57); 3 ♂♂ (MR63); 1 ♀ (MR65); 1 ♀ (MR74). Mt Missim, 10.IV.1965, WAS and YMH BBMNG2036), 1 ♂, 1 ♀. (BISHOP).

SE NEW GUINEA. POPONDETTA: Oro Bay, 8–9.V.1965, WAS (BBM NGC2235), 1 p♂. Cape Killerton, 26–27.IV.1966, SS, 1 ♂ (NEP2); 1 ♀ (NEP17). GULF: Murua, 1–3.V.1966, SS, several L (G8); 4 1p♂♂, 5 1p♀♀ (G9); 5 ♀♀ (G11); 2 ♀♀ (G13); 1 ♂, 1 ♀ (G21) 1 1p♂, several L (G26) (BISHOP).

BISMARCK ARCHIPELAGO. MANUS: Lorengau, grass ditch, 11.III.1966, SS, 2 1p♂, 4 1p♀ (MN12), several L (MN12). NEW IRELAND: Kavieng, field catches, 16–20.III.1966, SS, 2 ♂♂ (NI17); 1 ♀ (NI19); 2 ♂♂, 1 ♀ (NI29); 5 ♀♀ (NI44); 1 ♀ (NI47); 2 ♀♀ (NI50). NEW BRITAIN: Keravat, 26.III.–7.IV.1966, SS, 1 ♂ (NB2); 1 ♂ (NB5); 1 ♂ (NB22) (BISHOP).

Christiani Complex

♂. Medium sized species, wing usually 3.0–3.5 mm, not exceeding 4.0 mm. *Head:* vertex with more numerous narrow, yellow decumbent scales than in other complexes; anterior erect scales yellow to golden; broad scales dusky or pale brown except for a lateral white patch at side. *Palpus:* basal processes slightly more than 0.5 of distal part of segment 1; segment 3 without ventrolateral tuft of setae. *Proboscis:* distal 0.5–0.75 of labium with dorsal upright setae. *Antenna:* normal hairs of flagellar whorls fewer than in the *ornatus* or *fraudatrix* complexes; F-5 with tufts of 4–14 dark scales; F-6, 7, 8 with tufts of setae as described for *petersi* and *fraudatrix* complexes; F-9 with 1 short and 3, 4 long yellowish brown bladelike scales; F-10 with 2–4 long stout setae. *Thorax:* mesonotum with numerous yellow scales; pleural bristles brownish or yellowish; upper corner of sternopleuron with or without a very small patch of a few translucent scales. *Abdomen:* tergites II–VIII with basal white bands.

Genitalia: Sidepiece with 3–7 submarginal setae; marginal setae more numerous and stronger than in other complexes. *Subapical Lobe:* proximal part with 1 basal seta and 3 rather straight rods; distal part with 1 broad acuminate external leaflet, 1 internal leaflet, 1–6 accessory setae, all flattened and with acuminate apices. *Phallosome:* lateral plate with long, slender pointed dorsal process. *Proctiger:* ventrolateral

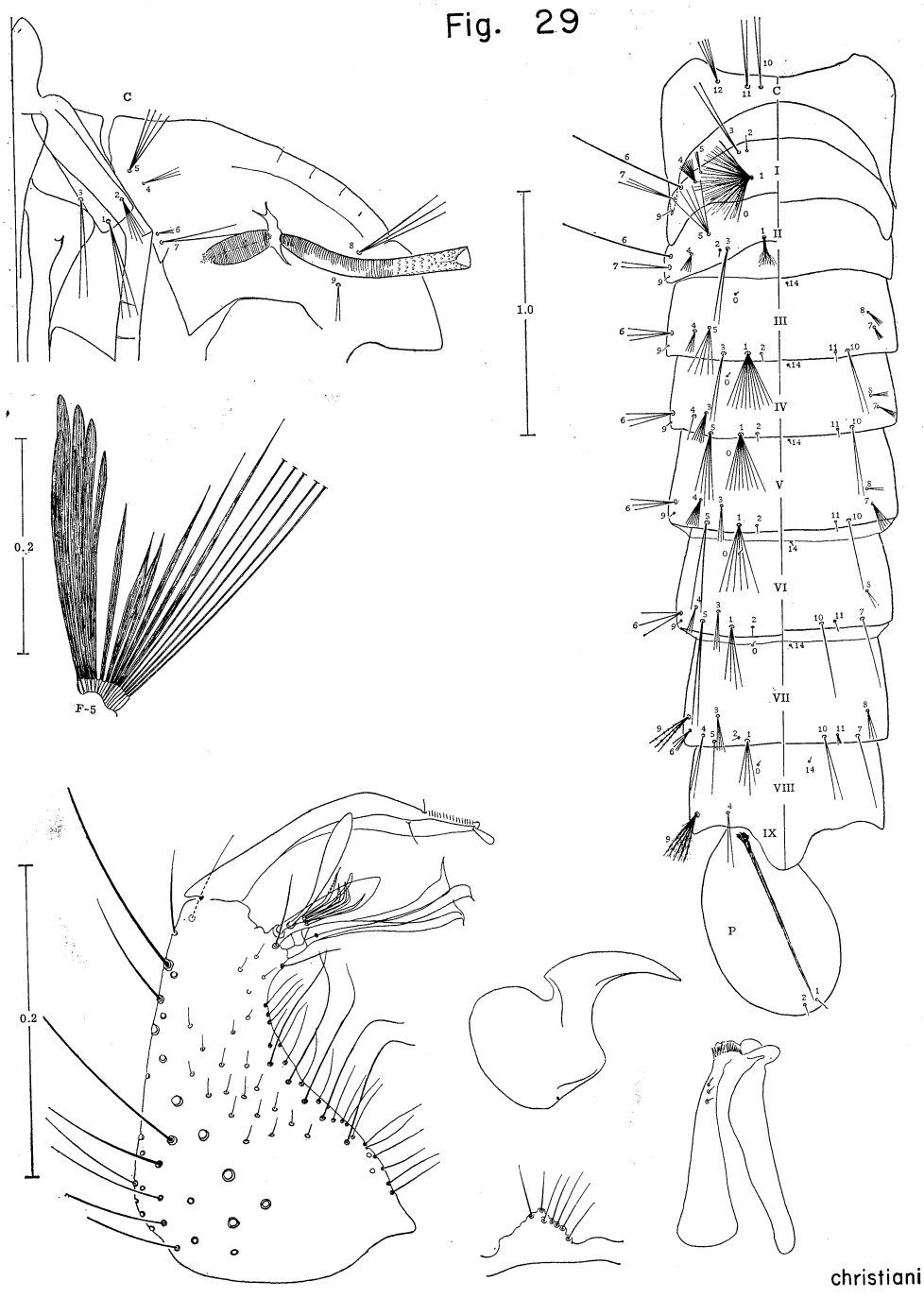


Fig. 29. Pupa, male genitalia and modified tuft of antennal flagellomere 5 of *C.* (*L.*) *christiani*.

sclerite narrow; cercal sclerite with 2, 3 setae. *Lobe* of 9th tergite with 6–9 strong setae.

♀. Similar to ♂ in size and ornamentation; usually 1 lower anterior mesepimeral bristle present, sometimes 2; abdominal bands narrower than in males.

LARVAE. *Head:* antennal shaft usually entirely dark, sometimes dark at base, lighter in the middle and dark beyond the antennal tuft. *Thorax:* hair 3-P single. *Abdomen:* hairs 4-VII and 2-VIII single. *Siphon* with 8–12 ventrolateral tufts 1–3 × siphonal width at points of attachment.

PUPAE. *Pigmentation* similar to the *ornatus* complex or yellowish white. *Trumpet* uniformly cylindrical from base to apex. Chaetotaxy very similar to certain forms in the *fraudatrix* complex, differing in having hair 8-C triple.

BIONOMICS. All members of the *christiani* complex are exclusively highlands forms and are typical ground pool breeders. The adults are commonly found along margins of mountain stream.

SYSTEMATICS. The *christiani* complex is represented by *christiani*, *pseudornatus*, *minjensis* and *gressitti*. These species are larger in size than most of the lowlands species except *ornatus*. Every species is very distinct in the larval stage but all are included within 1 complex primarily on the basis of similarity of ornamentation of the adults.

DISTRIBUTION. The *christiani* complex is endemic to New Guinea and is known from Minj, Western Highlands; Kundiawa, Chimbu and Wau, Morobe.

17. **Culex** (**Lophoceraomyia**) **christiani** Colless Fig. 29, 30.

Culex (*Lophoceraomyia*) *christiani* Colless, 1959, Proc. Linn. Soc. N. S. W. **84:** 389. *TYPE: Holotype ♂ (CH81) with associated larval and pupal skins, Minj, Western Highlands, NE New Guinea, 1958, W. Peters (ANIC).

Culex (*L.*) *christiani* of Stone, 1961.

♂. (fig. 29) As described by Colless (1959) and as in the description of the complex, with the following distinctive features. *Head:* frontal and orbital bristles light brown to deep brown. *Palpus:* exceeding proboscis by a little more than length of apical segment; apex of segment 3 with 4, 5 dark brown bristles; segments 4 and 5 with numerous strong bristles. *Proboscis:* distal 0.75 of labium with 2 dorsal rows of upright setae which are 3 × as long as labial width. *Antenna:* F-5 with tuft of 11–14 deep brown scales, dorsal group of 4–6 scales broad, blunt tipped and as long as next 4 flagellomeres, lateroventral group of 3, 4 scales shorter, lanceolate in shape, followed by 2, 3 narrow scales of increasing length; F-9 with 1, 2 short and 3, 4 long bladelike scales. *Thorax:* integument brown to dark brown; mesonotum covered with numerous yellow to golden scales as in *ornatus;* all bristles deep brown. *Pleuron:* propleuron with few strong deep brown bristles and 5–7 weak bristles; sternopleuron completely devoid of scales, its upper corner with or without a minute patch of scales; 1 lower anterior mesepimeral bristle always present. *Abdomen:* tergites III–VII with broad basal white bands; venter yellowish to pale scaled.

Genitalia: (fig. 29) *Sidepiece:* marginal setae numerous; the 3–5 submarginal setae 2 × as long as marginals. *Subapical Lobe:* distal part with 6 accessory setae, 1 apparently with serrate margin on its subapical portion. *Phallosome:* lateral plate with a large, slender beaklike dorsal process terminating in a sharp point. *Proctiger:* ventrolateral sclerite narrow, ribbonlike; cercal sclerite with 2–3 minute setae. *Lobe* of 9th tergite with 6–9 strong setae.

♀. *Wing:* usually a little over 3.0 mm. *Proboscis:* 2.3 mm. Palpus: 0.15–0.17 of proboscis. In general, as described for ♂; very similar to *minjensis*, differing from the latter in the following. *Head* with most of broad scales dusky except a small white patch at sides; yellow erect scales confined to anterior part of occiput. *Thorax:* small patch of scales on upper corner of sternopleuron usually absent. *Abdomen:* basal bands of white scales narrow.

LARVA. (fig. 30) *Head:* 0.75 mm. *Siphon:* 1.7 mm; index 7.6–9.0 (average 8.5); ratio 4.3–5.1 (average 4.6). Antennal shaft usually dark along the whole length; spiculation of thorax very light to completely absent; siphon without dark median ring. Chaetotaxy as figured; diagnostic characters as in key. *Head:* hair 1-C slender and moderately long; 4-C double (2-3). *Thorax:* hair 3-P always double; 8-M, 6-branched

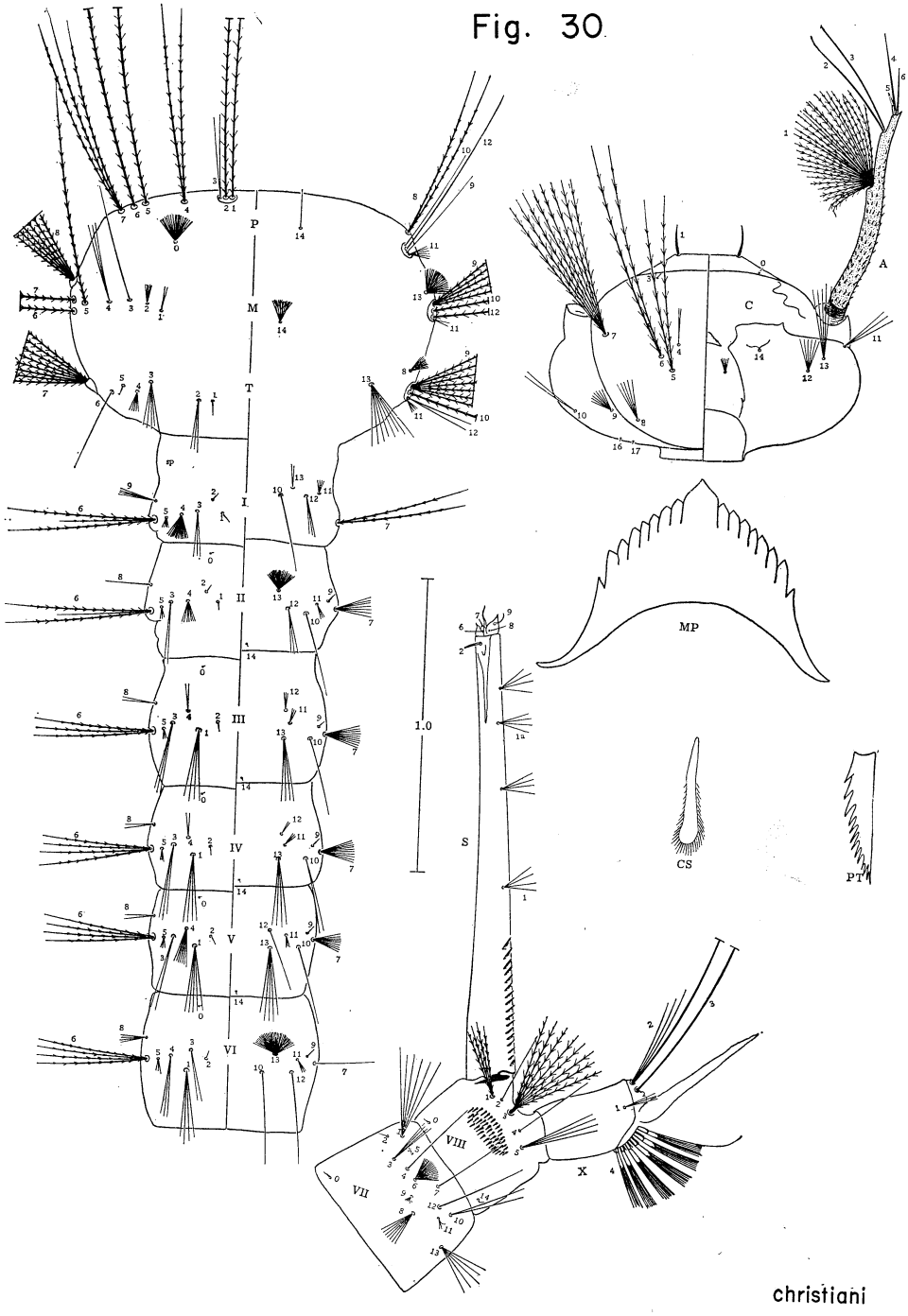


Fig. 30. Larva of *C.* (*L.*) *christiani.*

(5–6); 9-M, 5-branched (5–6); 7-T, 8-branched (7–8); 9-T, 7-branched (7–8). *Abdomen:* hair 1-III–VI usually 4-, 4-, 5-, 4-branched, respectively; 3-III–IV usually triple (2–3); 3-V–VI double; 4-VII single; 2-VIII single. *Siphon* with 8 ventrolateral tufts with 3, 4 branches as long as or slightly longer than siphon width at the points of attachment; pecten with 14–18 teeth. *Anal Segment:* hair 1-X usually 3-branched (3–4); 2-X with 1 long and 3 short branches.

PUPA. (fig. 29) *Abdomen:* 2.7 mm. *Paddle:* 0.75 mm. *Trumpet:* 0.73 mm; index: 9.7–14.5 (average 12.0). *Pigmentation:* cephalothorax and abdomen uniformly yellowish white, contrasting with deep brown trumpet; paddle with dark, strong midrib. *Trumpet* slender and uniformly cylindrical from near base to apex. Chaetotaxy as figured; diagnostic characters as in key. *Cephalothorax and Metanotum:* hair 5-C, 4-branched (3–5); 8-C usually triple (3–4); 12-C usually 4-branched (4–5). *Abdomen:* hair 1-III–VII with average of 12, 9, 6, 4 and 4 branches, respectively; 5-II–III usually 5-branched; 6-III–VI usually triple; 5-V–VI always double; 9-VII with average of 5 plumose branches.

BIONOMICS. *C. christiani* is known only from highland areas at altitudes between 1200 and 1700 m where it is 1 of the most abundant species of *Lophoceraomyia* along river margins in mountain valleys. The immature stages are common in drainage ditches and in ground pools on the open hillsides or under partial shade of elephant grasses, bamboos or cassurina trees. They were found associated with *minjensis*, *petersi* and *bolii*. Adults were found on several occasions resting on moist soil in pit shelters and on dead ferns and herbs along stream margins. Although *christiani* appears to be semidomestic in breeding habitat in some areas it does not feed on man.

SYSTEMATICS. The adults of *christiani* are superficially similar to *minjensis*, *pseudornatus* and *gressitti*, but are clearly distinguished from these species by the male antenna and genitalia. The female is practically indistinguishable from *minjensis* and *gressitti* except as indicated in the diagnosis. The larva is rather similar to *schilfgaardei* of the lowlands but has the antennal shaft dark as in *ornatus* and *pseudornatus*. The pupa is very similar to *gressitti* and resembles some members of the *fraudatrix* complex. There is little variation in diagnostic male characters in *christiani* from different localities. In the larva the color of the antennal shaft may sometimes be paler in the middle of the shaft instead of being completely dark as in most specimens.

DISTRIBUTION. Material examined: 138 adults (91 ♂♂, 47 ♀♀); 52 individual larval and pupal rearings; 72 whole larvae and 3 larval skins. NE NEW GUINEA. WESTERN HIGHLANDS: Minj, 1500–1700 m, 14-19.I.1966, SS and MA, 1 1p♂ (WH1); 1 1p♀ (WH2); 1 1p♂ (WH3); 4 1p♂♂, 3 1p♀♀, 20 L and 2 1 (WH5); 3 L (WH10); 12 1p♂♂, 9 1p♀♀ (WH12); 2 ♂♂ (WH13); 9 ♂♂, 4 ♀♀ (WH19); 1 L (WH20); 1 1p♂ (WH23); 1 1p♂ (WH28) 2 1p♀, 7 L, 1 1 (WH29); 9 ♂, 8 ♁ (WH30); 13 p♂♂, 4 p♀♀, 9 ♂♂, 1 ♀♀ (mass rearing), 41 L (WH35). Chimbu: Kundiawa, Marani Creek, near Waghi River, 1500 m, field catches at margin of mountain creek, 12–22.I.1966, SS and MA, 2 ♂♂, 2 ♀♀ (EH13); 2 ♂♂, 1 ♀ (EH15); 7 ♂♂, 1 ♀ (EH19); 2 ♂♂, 2 ♀♀ (EH20); 10 ♂♂, 1 ♀ (EH22). MOROBE: Wau, 1200 m, 16–18.IV.1966, SS, 2 1p♂♂ (MR58); field catches, SS, 3 ♂♂, 4 ♀♀ (MR65); 1 ♂, 4 ♀♀ (MR74) (BISHOP).

18. **Culex (Lophoceraomyia) pseudornatus** Colless Fig. 31.

Culex (Lophoceraomyia) pseudornatus Colless, 1959, Proc. Linn. Soc. N. S. W. **84:** 386. *Type: Holotype ♂ (CH87), Edie Creek, Wau, Morobe, NE New Guinea, F. H. Taylor (ANIC). *Culex (L.) pseudornatus* of Stone, 1961.

♂. (fig. 31) As described by Colless (1959). In general, superficially similar to *christiani* in ornamentation. *Head:* narrow decumbent scales bronzy or shiny brown; all erect scales dull yellowish. *Palpus:* exceeding proboscis by about 1.5 of length of segment 5; basal processes 0.5 of length of distal part of segment 1; segment 3 with 4, 5 bristles apically. *Proboscis:* distal 0.5–0.6 of labium with 2 dorsal rows of upright setae about 1.5 × labial width. *Antenna:* flagellar hairs weaker and less dense than in *christiani*, F-5 with a tuft of

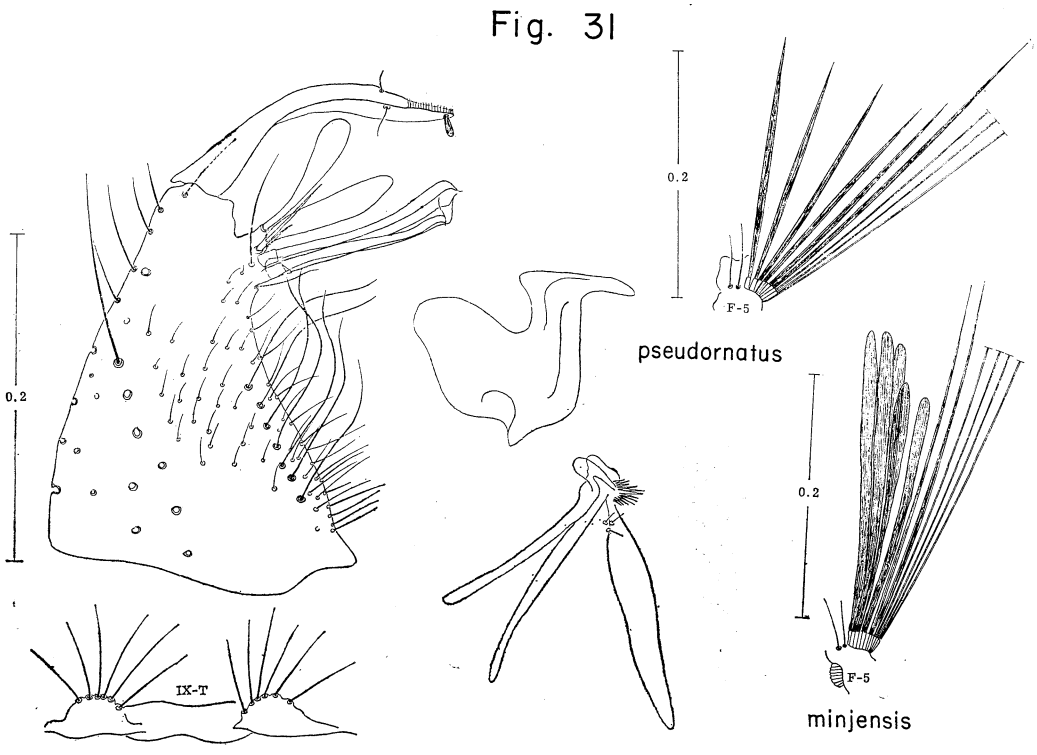


Fig. 31. Male genitalia and modified tufts of antennal flagellomere 5 of *C.* (*L.*) *pseudornltus* and *minjensis*.

4, 5 flattened and pointed setae as long as the next 3 flagellomeres; F-8 with a spoon-shaped tuft of fused setae; F-9 with 3 yellowish brown bladelike scales and 1 short narrow scale; F-10 with 2 long stout setae. *Thorax:* mesonotal scales mostly yellowish and golden brown, mesonotal bristles all bronzy or coppery. *Pleuron:* sternopleuron with a small patch of about 8 translucent scales on its posterior upper corner; propleuron with 4 long yellow bristles and 10 short hairlike bristles. *Abdomen:* tergites III–VII with broad white basal bands, tergite VIII sometimes entirely covered with white scales.

Genitalia: (fig. 31) *Sidepiece* with linear row of 6, 7 submarginal setae and several marginal setae. *Subapical Lobe:* proximal part with 3 rods; distal part with a broad acuminate external leaflet, 1 basal seta, 1 narrow internal leaflet and 1 hairlike accessory seta. *Phallosome:* lateral plate with slender dorsal process. *Lobe* of 9th tergite usually with 6, 7 setae (6–10).

♀. *Wing:* slightly over 3.0 mm. *Forefemur:* 1.8 mm. *Proboscis:* 2.0 mm. *Palpus:* 0.2 of proboscis. In general, as in ♂; differing primarily in broader abdominal bands and 2 lower anterior mesepimeral bristles present.

LARVA. *Head:* 0.64 mm. *Siphon:* 1.3 mm; index 8.3; ratio 4.0–4.2. Tentatively associated with adults. In general, very similar to *gressitti* from which it differs in the following. *Head:* antennal shaft entirely dark; hair 1-C long and slender. *Thorax:* hair 3-P single; 7-P usually double, sometimes triple on one side; 8-P always single. *Abdomen:* hair 1-III triple and relatively weak, 1-IV–VI stronger, 4-, 5-branched; 6-III double, 6-IV–VI all triple; 4-VII single; 2-VIII single. *Comb* with 45–55 scales. *Siphon* with darkened area in distal 0.25; pecten with about 15 teeth; 9, 10 siphonal tufts, more or less regularly paired, usually 5-branched and as long as siphon width at points of attachment. *Anal Segment:* hair 2-X with

1 long and 3 short branches; anal gills about 4 × length of saddle.

PUPA. Unknown.

BIONOMICS. The adults of *pseudornatus* are very delicate and sluggish, and can be caught readily flying or resting. They were found resting on moist soil, mosses, ferns or herbs along the margins of mountain streams. Only a few larvae were obtained from shallow pools and puddles near these streams, usually in association with *gressitti*.

SYSTEMATICS. *C. pseudornatus* is extremely similar to *gressitti* in adult ornamentation and in male antenna, but can be easily separated from the latter by fewer accessory setae in the distal part of the subapical lobe and by more numerous submarginal setae on the male genitalia. The 2 species may be members of a sibling complex. The larva described above is tentatively associated with the male but probably correctly so because no other form except *gressitti* was found at this locality. These larvae show constant differences from the latter in the dark antennal shaft and in the branching of several hairs.

DISTRIBUTION. Material examined: 15 adults (12 ♂♂, 3 ♀♀); no individual rearings; 5 whole larvae. NE NEW GUINEA. MOROBE: Meri Creek, Wau, elev. 2100 m, 12.XI.1964, WAS (BBMNGC:22), 2 L. Edie Creek, Wau, elev. 2000 m, 12.XI.1964, WAS, 1 L (BBMNGC:23); 5.IV.1965, YMH, 2 L (BBMNGC:424); 15.IV.1966, SS, 1 ♂ (MR38) with slide of antenna and genitalia (660726-2), 2 ♂♂ (MR48) with slide of genitalia (660726-5, 660726-6), 9 ♂♂, 3 ♀♀ (MR48) (BISHOP).

19. **Culex** (**Lophoceraomyia**) **minjensis** Sirivanakarn, new species Fig. 31.

Types: Holotype ♂ (WH19) with slide of antenna and genitalia (660712-6), Tengen stream, Minj, Western Highlands, NE New Guinea, 16.I.1966, S. Sirivanakarn and Boli (BISHOP7734). Allotype ♀ (WH30), same locality as holotype, 18.I.1966, S. Sirivanakarn and Boli (BISHOP). Paratypes same data as holotype (WH19); 1 ♂ with slides of antenna and genitalia (660712-5), 1 ♀ (USNM); 1 ♂ with slides of antenna and genitalia (660712-7), 1 ♀ (BMNH); 1 ♂ with slides of antenna and genitalia (660712-8), 1 ♀ (ANIC); 1 ♂ with slides of antenna and genitalia (660712-9), 1 ♀ (UCLA).

♂. (fig. 31) Extremely similar to *pseudornatus* in ornamentation of head, thorax and abdomen; differing primarily in the following features. *Head:* labium with longer dorsal upright setae in its distal 0.75. *Antenna:* F-5 with tuft of 4, 5 broad, bluntly tipped scales as long as next 4 flagellomeres, followed laterovent-rally by 1 flattened longer seta; F-10 usually with 3 long stout setae.

Genitalia: Extremely similar to *pseudornatus* except for sidepiece with more numerous marginal setae and the most basal submarginal seta usually weaker and shorter than distal ones. *Lobe* of 9th tergite with 7–12 setae.

♀. In general, very similar to *pseudornatus* in size and proportions; differing primarily in deep chestnut brown mesonotum and pleuron, and 1 mesepimeral bristle.

LARVA AND PUPA. Unknown.

BIONOMICS. *C. minjensis* is a common form in some highland areas of New Guinea. It occurs at altitudes between 1500 and 1800 m and, as far as known, is confined to the Western and Eastern Highlands. Adults were frequently collected with *christiani*, *bolii* and *petersi* resting on ferns, mosses or dead branches in deep shade at the margins of mountain streams and in pit shelters near native plantations. Living specimens appear to be more robust than *pseudornatus*.

SYSTEMATICS. *C. minjensis* is recognized as distinct from *pseudornatus* on the basis of constant differences in the scale tuft of the male antenna and in the coloration of the female as described above. The 2 species are both highland forms but appear to be completely allopatric, *minjensis*

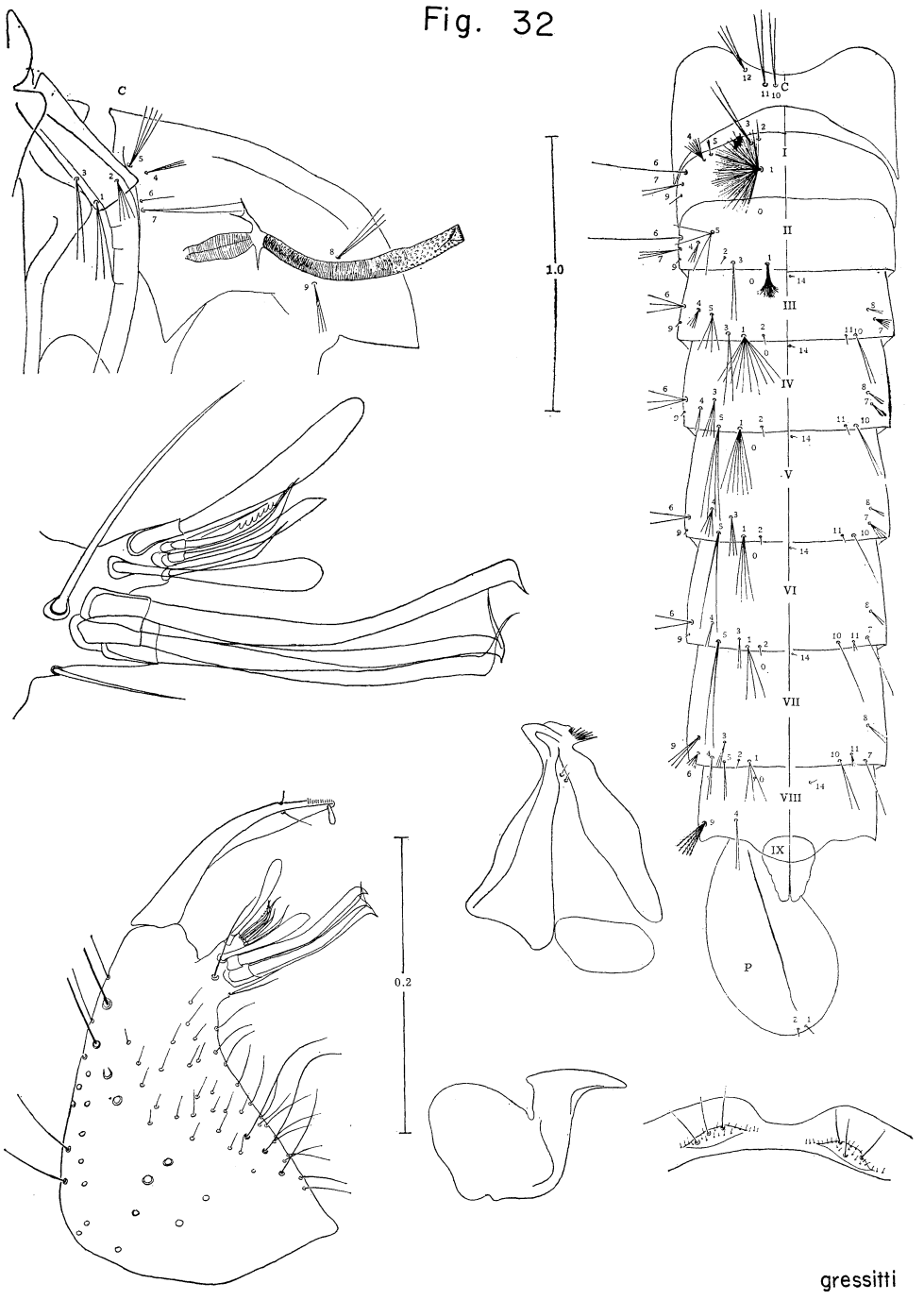


Fig. 32. Pupa and male genitalia of *C.* (*L.*) *gressitti*.

being restricted to the north of the central mountain range and *pseudornatus* confined to 1 locality south of the range.

DISTRIBUTION. Material examined: 94 adults (58 ♂♂, 36 ♀♀). NE NEW GUINEA. WESTERN HIGHLANDS: Tengen stream, Minj, 1700 m, 15.I.1966, SS, MA and Boli, 1 ♂, 2 ♀♀ (WH13); 16.I.1966, SS and Boli (SH19), as listed in type series, 4 ♂♂, 8 ♀♀; 17.I.1966, SS and Boli, 7 ♂♂, 1 ♀ (WH24); 18.I.1966, SS and Boli, 29 ♂♂, 18 ♀♀ (WH30). CHIMBU: Marani creek, Kundiawa, 1800 m, 12.I.1966, SS and MA, 5 ♂♂ (EH15); 13.I.1966, SS and MA, 1 ♂ (EH19), 2 ♂♂ (EH20); 22.I.1966, SS, 4 ♂♂ (EH22). (BISHOP).

20. **Culex** (**Lophoceraomyia**) **gressitti** Sirivanakarn, new species Fig. 32, 33.

Types: Holotype ♂ (MR37-10) with associated larval and pupal skins and slide of antenna and genitalia, Edie Creek, Wau, Morobe, NE New Guinea, margin of mining pond, 15.IV.1966, SS and JLG (BISHOP 7735). Allotype ♀ (MR43-102) with associated larval and pupal skins, drainage ditch, same data as holotype (BISHOP). Paratypes same data as holotype; 1 ♂ (MR37-105) with associated pupal skin and slide of antenna and genitalia, 2 whole larvae (USNM); 1 ♂ (MR37-106) with associated pupal skin and slide of antenna and genitalia, 2 whole larvae, (BMNH); 1 ♂ (MR 37-110) with associated pupal skin and slide of antenna and genitalia, 2 whole larvae (ANIC); 1 ♂ (MR37) with slide of antenna and genitalia (UCLA). This species is named in honor of Dr J. Linsley Gressitt for his contributions to the knowledge of the insect fauna of New Guinea and the Papuan subregion.

♂. As described for the complex; extremely similar to *pseudornatus* in ornamentation, palpus, labial and antennal characters; differing from it chiefly in a smaller size and upper corner of sternopleuron usually without any scales, sometimes with an inconspicuous patch of a few scales.

Genitalia: (fig. 32) *Sidepiece* with 3 submarginal setae in line, the basal one very weak and about 0.5–0.7 of length of other 2; marginal setae few. *Subapical Lobe:* distal part with 4 accessory setae, all flattened and subapically bent toward the internal leaflet, 1 with subapical serrated margin in the distal 0.5, the rest simple, bladelike. *Phallosome:* lateral plate with short dorsal process. *Lobe* of 9th tergite usually with 3, 4 weak setae (3–6).

♀. *Wing:* 3.0 mm. *Forefemur:* 1.5 mm. *Proboscis:* 1.8 mm. *Palpus:* about 0.2 of proboscis. In general, similar to ♂ in ornamentation and to *pseudornatus* ♀ from which it is distinguished by the absence of scales on the upper corner of sternopleuron and by the presence of 1 lower anterior mesepimeral bristle.

LARVA. (fig. 33) *Head:* 0.7 mm. *Siphon:* 1.3–1.65 mm (average 1.5 mm); index 6.4–9.0 (average 8); ratio 3.8–4.1 (average 4.0). No striking coloration on head, thorax or abdomen; antennal shaft with small dark ring at base, creamy white in the middle and slightly darker beyond the antennal tuft; spiculation of thorax not visible. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* hair 1-C long and slender; 12-C very weak, usually triple (3–4). *Thorax:* hair 3-P single, rarely double; 13-T very weak and short, usually 6-branched (6–7). *Abdomen:* hair 1-I double or triple, 1-III–VI with average of 5, 7, 6, 5 branches, respectively; 6-III–VI usually triple (3–4); 10-II–VI single; 13-III–V very weak and short, usually 3-, 4-branched; 4-VII single; 2-VIII single. *Comb* with about 48 evenly fringed scales. *Siphon* narrow and slightly curved dorsally, always darkened in distal 0.3–0.5; pecten with 12–17 teeth, distal 2, 3 teeth with 10–14 fine denticles; 12 siphonal tufts, usually 4-branched and 2–3 × siphonal width at points of attachment. *Anal Segment:* hair 2-X usually with 1 long and 2 short branches; anal gills variable in length, usually 3–4 × dorsal length of saddle.

PUPA (fig. 32) *Abdomen:* 2.3 mm. *Paddle:* 0.70 mm. *Trumpet:* 0.65 mm; index 12.5–13.5 (average 13.0). *Pigmentation* of cephalothorax and abdomen concolorous and uniformly yellowish white. Trumpet almost uniformly cylindrical, usually dark proximally, pale just beyond the middle and dark toward apex. Paddle with very dark and strong midrib. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax and Metanotum:* hair 8-C usually triple (2–4); 9-C usually triple, rarely double. *Abdomen:* hair 7-II usually triple (2–3); 5-II–III usually 5-branched; 6-III–VI double or triple.

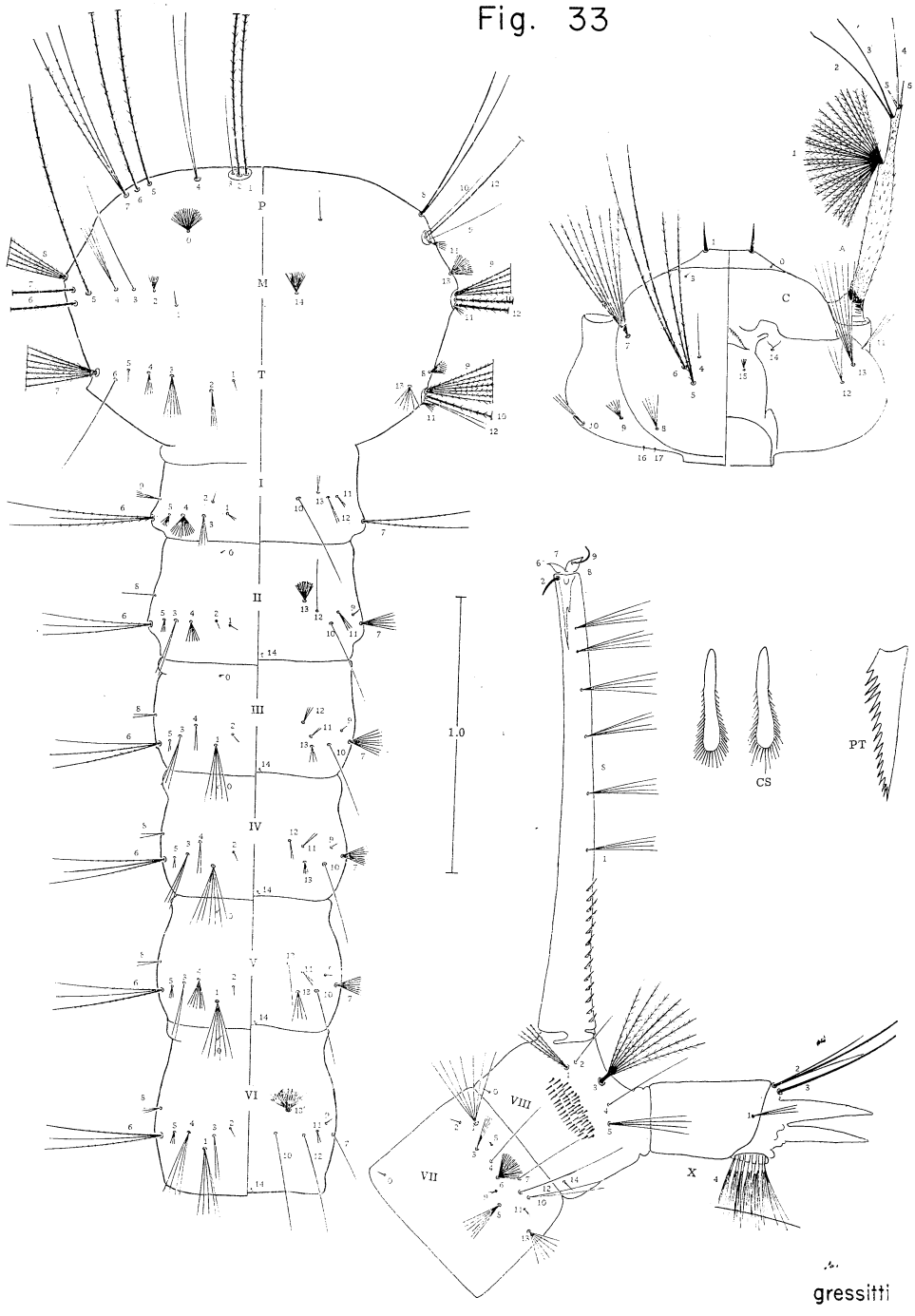


Fig. 33. Larva of *C.* (*L.*) *gressitti*.

BIONOMICS. The immature stages of *gressitti* were all collected at the margins of mining ponds and drainage ditches in 1 locality at an altitude of about 2000 m. The adults were found near the breeding sites. They were rather sluggish and easy to catch and were associated with a few *pseudornatus*.

SYSTEMATICS. The adults of *gressitti* and *pseudornatus* are indistinguishable on external characters. The absence of the small scale patch on the upper corner of the sternopleuron in *gressitti* is not a reliable character as these scales are easily rubbed off. However, the 2 species are readily separated by constant differences in the male genitalia. The larva is readily separated from *christiani* by the stronger and more numerous siphonal tufts and by differences in the branching of several hairs as described above.

DISTRIBUTION. Material examined: 41 adults (19 ♂♂, 22 ♀♀); 22 individual rearings; 29 whole larvae and larval skins. NE NEW GUINEA. MOROBE: Edie Creek, Wau, elev. 2000 m, 6.IV.1965, WAS (BBMNG C:2008), 3 1p♂ and 3 1p♀, 2 L; 15.IV.1966, SS and JLG (MR37), as listed in type series, 2 p♂♂, 6 p♀♀, 4 ♂♂ and 3 ♀♀ (field catch at the breeding site), 22 L and 1 5 P; 3 ♂♂, 7 ♀♀ (MR38) (field catch near MR37); margin of mining pond, SS, 1 p♀, 4 L (MR42); drainage ditch, SS, 1 p♂, 2 P (MR43); drainage ditch, SS, 1 p♂ and 1 p♀, 15 L, 5 P (MR44) (BISHOP).

Fraudatrix Complex

♂. Small to medium-sized species, wing 2.5–3.0 mm. *Head:* broad scales forming a distinct white line above eye at vertex and a broad lateral bluish white patch at side. *Palpus:* basal processes slender, usually about 0.5 of length of distal part of segment 1, rarely longer; segment 3 usually with a conspicuous ventrolateral tuft of 15–25 setae which are 3–5 × as long as segment width, 2–5 rows of ventral setae as long as width of segment. *Proboscis:* false joint present and usually flexed at 0.2–0.25 from base; labium usually with dorsal upright setae in distal 0.5, base with a transverse ventral row of 12 stout spinelike setae. *Antenna:* F-5 with tufts of various shapes and sizes; F-6 with a crumpled external tuft of 16 strongly curled setae and an internal group of 6, 7 more or less straight setae; F-7 with an external tuft of 15–16 curled setae forming a comb and an internal tuft of 4, 5 stout setae with twisted apices; F-8 with 1 short and 4 long subequal yellowish bladelike scales; F-10 with 2–5 long stout setae. *Thorax:* mesonotal integument deep brown; mesonotal scales narrow and dark; pleural areas without scales; 1 lower anterior mesepimeral present. *Wings:* vein scales narrow, dark and scanty. *Abdomen:* tergites covered with dark scales, rarely with basolateral pale spots or markings.

Genitalia: Sidepiece usually with 3 submarginal setae, rarely 4, usually forming a triangle, rarely in line parallel to the tergomesal margin; marginal setae weaker and fewer than in *christiani* complex. *Subapical Lobe:* proximal part with 1 basal seta and 3 smoothly curved rods; distal part with 1 strong basal seta, 1 broad, abruptly acuminate external leaflet, 1 broad, apically-rounded or abruptly acuminate internal leaflet, 4, 5 accessory setae, all usually flattened. *Phallosome:* dorsal process of lateral plate varied in length. *Proctiger:* ventrolateral sclerite narrow and ribbonlike; cercal sclerite with 2, 3 setae. *Lobe* of 9th tergite with 3–5 setae which are weaker than in *marksae* complex.

♀. Similar to ♂ in size and general ornamentation except that head with broad scales darker and smaller lateral white patch at side. *Proboscis:* base of labium with 2 short basoventral bristles. *Abdomen:* tergites III–VII with basolateral pale spots.

LARVAE. Pigmentation variable, usually no constant color pattern as in *petersi* complex; siphon with or without median dark band. *Head:* hair 4-C usually 0.5–1.0 of distance between bases or slightly longer; 14-C double. *Thorax:* hair 4-P double; 7-P usually triple, rarely double; 8-P double, rarely single. *Abdomen:* hair 1-I, II single; 4-VII usually double, rarely single; 2-VIII double or single. *Siphon* with 8–10 ventrolateral tufts, irregularly paired, as long as or a little shorter than siphonal width at point of attachment. *Anal Segment:* anal gills as long as or shorter than saddle, rarely longer.

PUPAE. Pigmentation uniformly yellowish white in almost all forms. Trumpet dark proximally, white distally; usually uniformly cylindrical, rarely asymmetrical. Hair 1-C usually 4-branched; 5-II, III, 4–6-

branched; 4-VIII double or triple; 6-III–VI usually 4-branched. Paddle with weaker midrib than in *ornatus* complex.

BIONOMICS. Most species of the *fraudatrix* complex breed in ground pools, rarely in sago stumps, tree holes or other container habitats. The adults of most forms are very abundant in the shade of sago palms in swamps and on tree trunks in the rain forest.

SYSTEMATICS. The *fraudatrix* complex is represented in New Guinea and the Bismarcks by *fraudatrix*, *atracus*, *schilfgaardei*, *insularis*, *kaviengensis*, *collessi* and *rajaneeae*. The first 5 species are exceedingly similar in almost every detail in the male genitalia, but differ strikingly from one another in the development of the tuft of antennal flagellomere 5 and in the immature stages. *C. collessi* and *rajaneeae* on the other hand are quite distinct in the male genitalia but have palpal and labial characters similar to other members of the complex. The *fraudatrix* complex includes the *buxtoni* complex of the South Pacific (Belkin 1962), and probably *variatus*, *cubitatus* and some other Malayan forms described by Colless (1965) also should be referred to it.

The *fraudatrix* complex appears to be closely related to the *ornatus* and *petersi* complexes. *C. collessi*, in particular shows a mixture of features of all 3 complexes.

DISTRIBUTION. The *fraudatrix* complex is widespread in New Guinea, the Bismarck Archipelago and is also very well represented in the Solomon Is. It may also be represented in Australian subregion as well as in the Oriental region.

21. **Culex (Lophoceraomyia) fraudatrix** (Thelbald) Fig. 34, 35, 36.

Lophoceratomyia fraudatrix Theobald, 1905, Ann. Budapest Magyar Nemezeti Mus. **3:** 94. Type: Lectotype ♂ marked as holotype, Friedrich Wilhelmshafen (Madang), New Guinea 1900, M. Biro, PRESENT SELECTION (BUDA).

C. (L.) fraudatrix of Penn, 1949, Pacific Science **3:** 69–71.—Colless, 1959, Proc. Linn. Soc. N.S.W. **84:** 382–83.—Stone, 1957, Ann. Ent. Soc. Amer. **50:** 172.—Stone et al., 1959.—Stone, 1961; van den Assem & Bonne Wepster, **1964:** 111–113.

Lophoceratomyia fraudatrix of Theobald, **1907:** 474–477.

♂. (fig. 34) *Head:* narrow decumbent scales yellowish to shiny brown, occupying a triangular area on vertex and occiput; broad appressed scales pale to whitish on the orbital line and forming an extensive lateral white patch at side; all erect scales dark brown. *Palpus:* exceeding probosics by about full length of segment 5, sometimes a little longer; basal processes usually 0.75 of length of distal part of segment 1; segment 2 about 0.3 of length of segment 3, with a lateral row of setae along entire length; segment 3 with a ventrolateral tuft of 20–25 long setae on proximal 0.5, the longest setae 4.5 × width of segment, apex with 4–6 long bristles. *Proboscis:* distal 0.5–0.7 of labium with 2 dorsal rows of upright setae, middle ones longest and usually 4.5 × labial width. *Antenna:* F-5 with a fan-shaped tuft of 12–26 scales (average 18–20) as long as the next 4, 5 flagellomeres, the most dorsal 8–14 scales broad, deep brown, and bluntly tipped followed laterally and ventrally by 8–12 narrow pointed scales of equal or slightly greater length, the lateral scales narrow and slightly curved, dark on basal 0.25–0.5, whitish beyond; F-9 usually with 5 bladelike scales and 1 short narrow scale; F-10 usually with 3, 4 long smoothly curved stout setae. *Thorax:* integument brown to reddish brown; mesonotal scales narrow, dark brown or shiny brown but not yellow; propleuron with 3, 4 strong and a few weak bristles. *Legs:* anterior margin of forecoxa with a strikingly linear row of curved bristles.

Genitalia: (fig. 34) *Sidepiece* with 3 closely spaced submarginal setae with bases forming a triangle. *Subapical Lobe:* (fig. 35) proximal part with 1 basal seta and 3 stout rods, external rod smoothly curved near the middle and terminating in a slightly hooked apex, central rod nearly straight, strongly hooked apically, internal rod with truncate apex; distal part with basal seta strong but not flattened, external leaflet broad, apically rounded or with short acuminate tip, internal leaflet narrower and with rounded apex, 4, 5 accessory setae present, 2, 3 flattened, others narrow and hairlike. *Clasper:* dorsal and ventral subapical setae nearly opposite each other. *Phallosome:* dorsal process of lateral plate short, stout proximally, narrow distally, terminat-

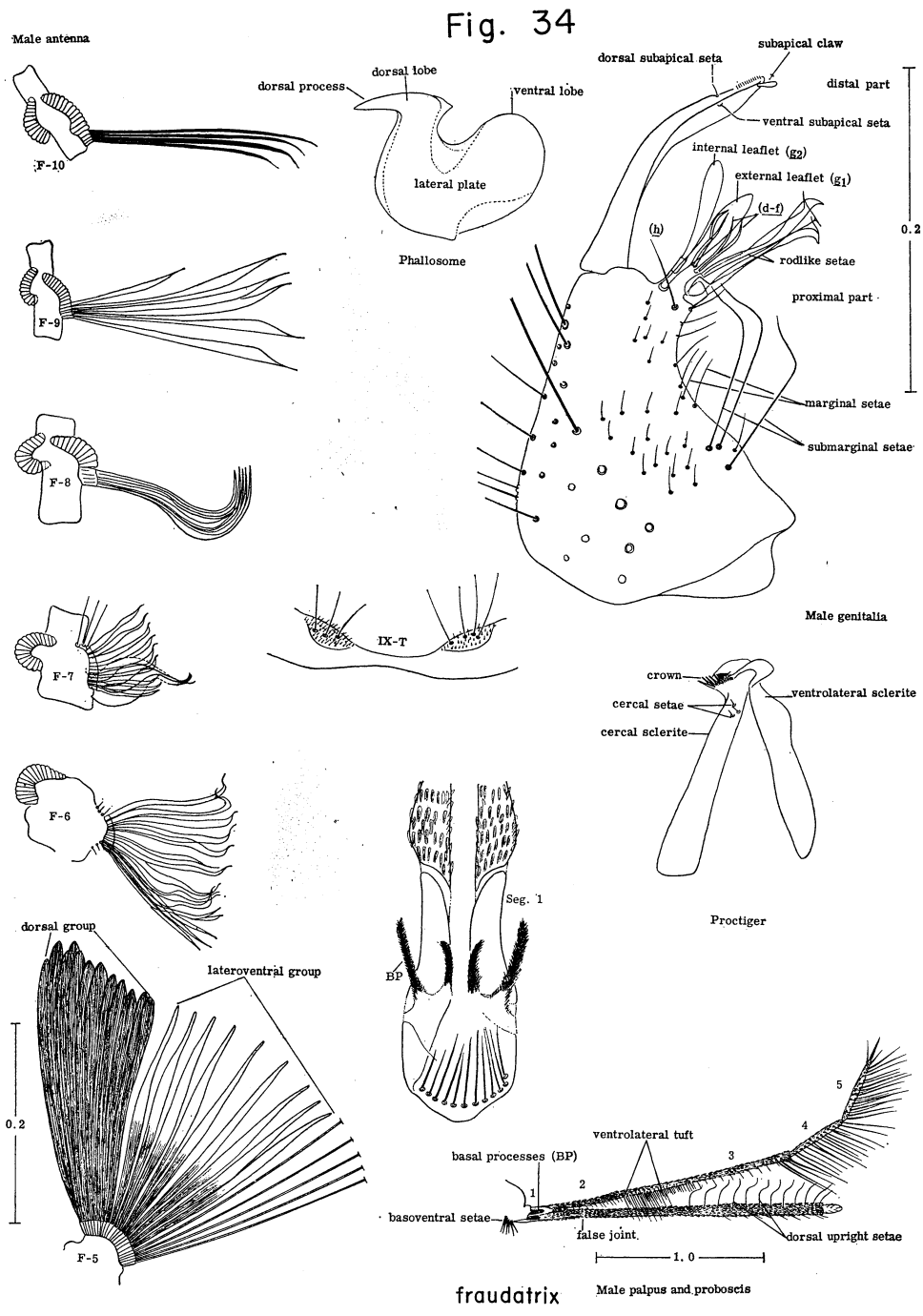


Fig. 34. Modified tufts of antennal flagellomeres 5–10, male genitalia, palpus and proboscis of *C.* (*L.*) *fraudatrix*.

Fig. 35

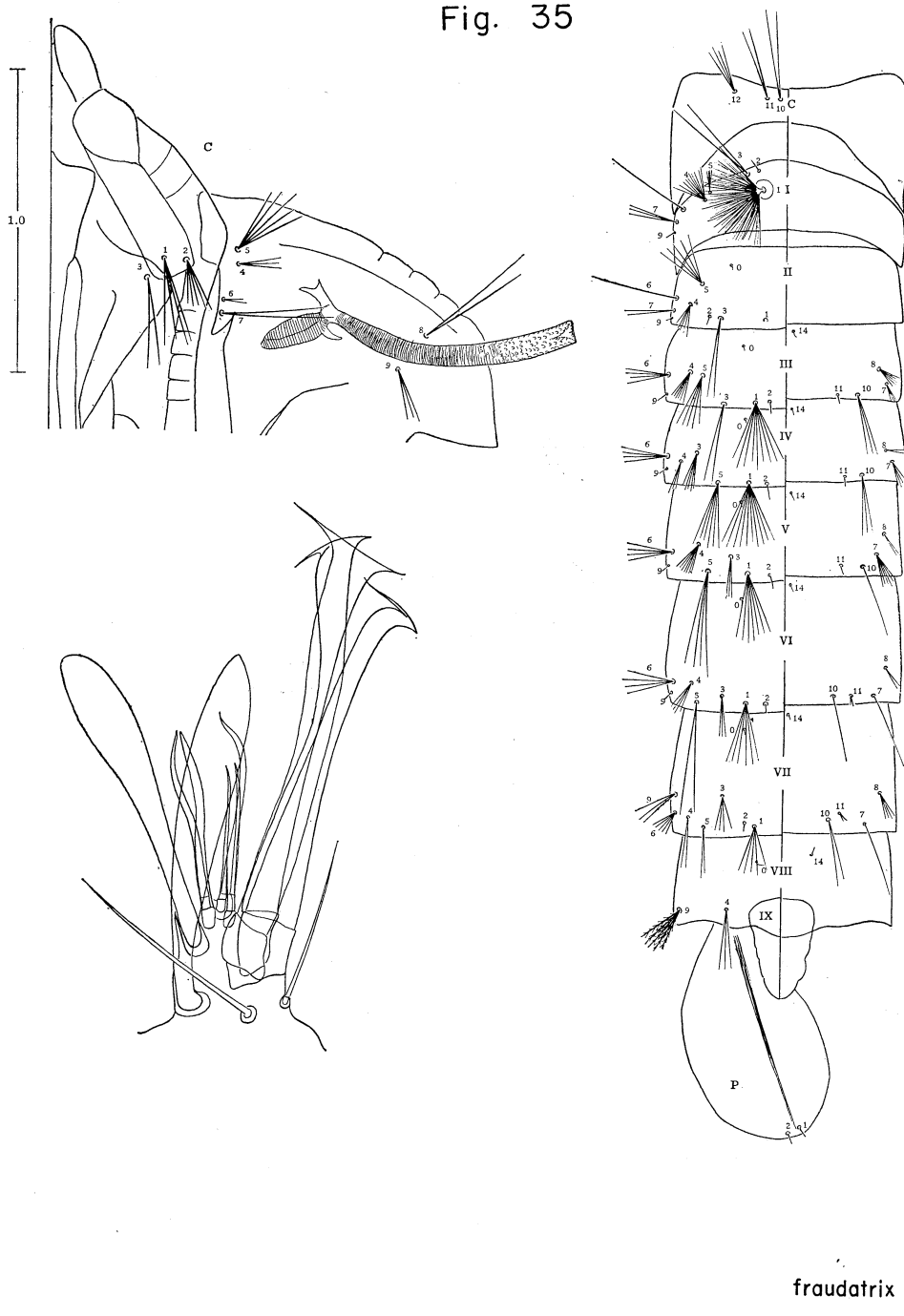


Fig. 35. Pupa and subapical lobe of *C.* (*L.*) *fraudatrix.*

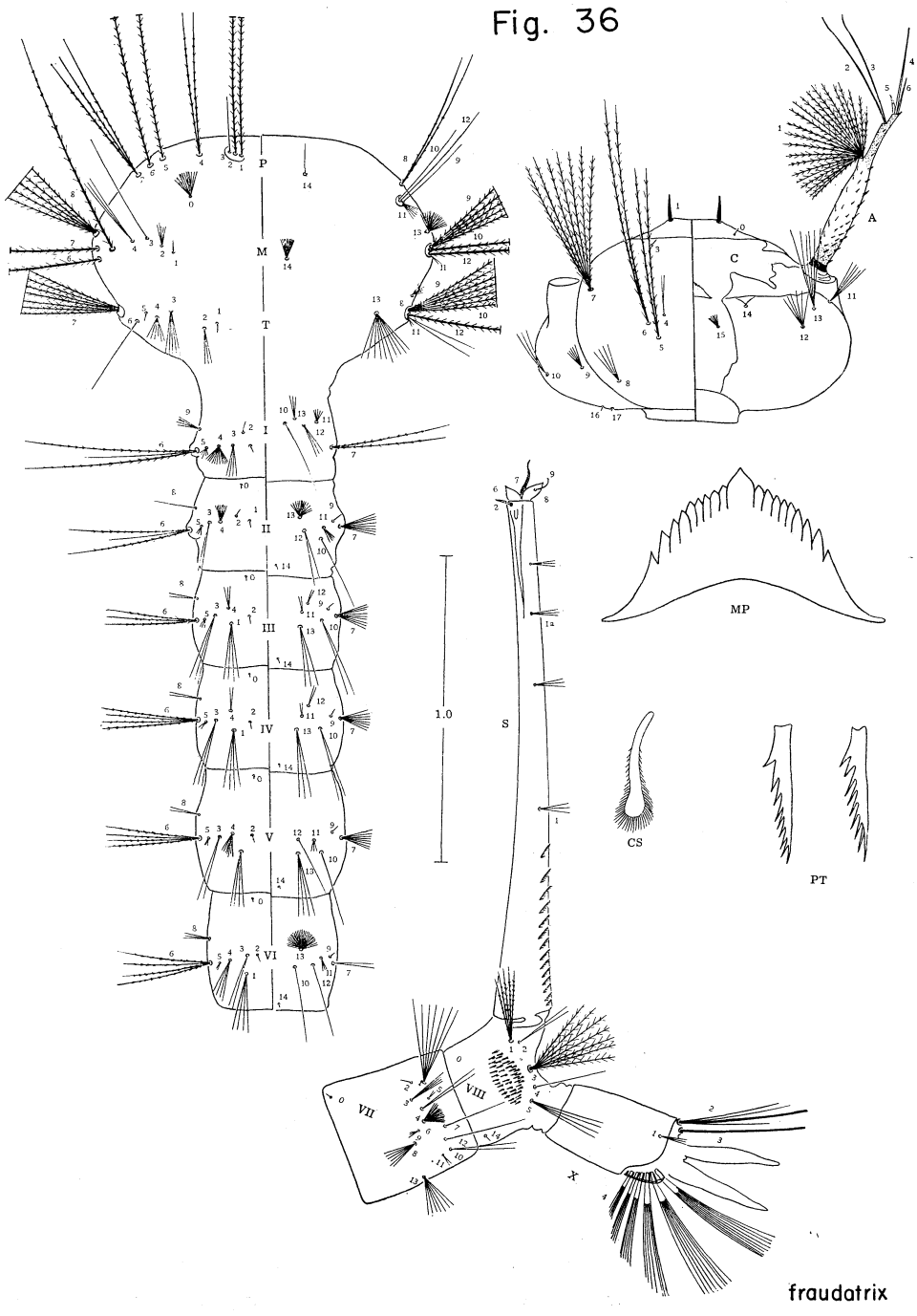


Fig. 36. Larva of *C.* (*L.*) *fraudatrix*.

ing in a more or less pointed apex. *Proctiger* with small crown of sharp spicules; apex of ventrolateral sclerite with an external beaklike process. *Lobe* of 9th tergite small, usually with 3 short setae.

♀. *Wing:* 3.0 mm. *Forefemur:* 1.3–1.5 mm. *Proboscis:* 1.8 mm. *Palpus:* 0.2 of proboscis. Similar to ♂ in general ornamentation except for darker head scales and abdominal tergites III–VII with distinct but small basolateral pale spots. *Proboscis:* labium with 2 weak basoventral bristles less than 0.5 of length of palpus.

LARVA. (fig. 36) *Head:* 0.65 mm. *Siphon:* 1.4–1.85 mm; index: 8–11; ratio: 4.7–5.7. *Pigmentation* extremely variable, usually without definite color pattern on head, thorax and abdomen. Thorax lightly spiculated laterally and ventrally to almost entirely bare. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* hair 1-C dark, moderate and usually curved ventrally; 4-C as long as or a little longer than 0.5 of distance between bases, usually forked just beyond the middle into 2 branches; mentum with 7–8 lateral teeth. *Thorax:* hair 3-P usually single, sometimes double or with 1, 2 branches on each side; 3-M always single; 13-T, 9–12-branched (average 10). *Abdomen:* hair 1-III–VI with average of 4 branches (3-5); 6-IV–VI usually 4-branched; 3-III, IV usually triple (2–3), 3-V usually double (2–3); 2-VIII usually double, rarely single. *Comb* with 40–45 scales. *Siphon* with or without median dark ring; pecten with 12–17 teeth (average 14), most distal tooth usually with 9, 10 denticles; siphonal tufts usually 8, rarely 9 or 10, with 3 branches as long as or a little shorter than siphonal width at points of attachment. *Anal Segment:* hair 1-X usually triple (3–5); 2-X, 3-, 4-branched; anal gills varied in length but usually not longer than saddle.

PUPA. (fig. 35) *Abdomen:* 2.3 mm. *Paddle:* 0.63 mm. *Trumpet:* 0.58-0.75 (average 0.68); index 11–15. Pigmentation variable; specimens from dense shade usually darker than those from partial shade. Trumpet long, slender and uniformly cylindrical from base to tip. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax and Metanotum:* hair 1-C, 4-branched, rarely 3 or 5; 3-C usually double; 9-C usually double (2–3); 12-C, 3-, 4-branched. *Abdomen:* hair 1-III–VII with average of 10, 10, 7, 6 and 5 branches, respectively; 6-III–VI usually 4-branched, rarely 3- or 5-branched; 5-V usually triple, 5-VI always double; 4, 5-VII always double; 4-VIII usually triple. *Paddle* with weak midrib.

BIONOMICS. *C. fraudatrix* is the dominant and most widespread species of *Lophoceraomyia* within New Guinea. The immature stages occur in huge numbers in typical ground pool habitats such as seepage pools, puddles, shallow ponds, drainage ditches, open sago swamps, and at the margins of flooded rain forest. Usually the breeding sites are in dense or partial shade of grasses, sago palms or trees. *C. collessi*, *ornatus*, *versabilis*, *digoelensis* and occasionally *steffani* and *crowei* have been found associated with *fraudatrix*. Adults are frequently encountered in large numbers resting under fallen logs and on tree and sago palm trunks and flying in swarms. Females apparently do not bite man.

SYSTEMATICS. *C. fraudatrix* is apparently endemic to New Guinea but it may occur in northeast Australia. Considerable local variation is evident in all stages of *fraudatrix*. On the basis of the number of scales and the form of the tuft in male antennal flagellomere 5 and of larval characters, 3 more or less distinct forms may be recognized:

1) *Maprik-Kowiro form* (low inland populations). Usually with the largest tuft consisting of 18–26 long subequal scales. Larva with longest siphon; abdominal hair 2-VIII single or double.

2) *Madang form* (topotypic populations). Usually with a medium-sized tuft of 18–20 long subequal scales. Larva with siphon of moderate length; abdominal hair 2-VIII always double.

3) *Popondetta form* (coastal populations). Usually with the smallest tuft of 16–18 scales, the lateroventral group of narrow, distally pale scales gradually decreasing in length. Larva similar to the *Madang* form.

The male genitalia in all 3 forms are essentially similar except that the dorsal process of the phallosome of the Popondetta form is slender and with a sharp apex as in *collessi*.

C. fraudatrix is extremely similar to *insularis* in male characters but appears to be quite different from the latter in larval chaetotaxy.

DISTRIBUTION. Material examined: 1361 adults (826 ♂♂, 535 ♀♀); 177 individual rearings; 300 whole larvae and larval skins. NW NEW GUINEA. Vogelkop, Kebar Valley, Manokwari, 500 m, 4–31.I.1962, LQ, 28 ♂♂, 2 ♀♀; Kota Baru (Hollandia), III.1945, WK and HH, 6 ♂,♂ 6 ♀♀ (BISHOP). NE NEW GUINEA. SEPIK: Vanimo, 19–24.II.1966, SS, (SP66), 1 ♂ (r.); (SP67), 6 ♂♂, 2 ♀♀ (r.) 3 ♂♂, 4 ♀♀ (mass r.); (SP69), 1 ♀ (r.) (SP71), 3 ♀♀ (r.); (SP72), 4 ♂♂, 3 ♀♀; (SP75), 2 ♂♂; (SP77), 3 ♂♂, 3 ♀♀; (SP87), 4 ♂♂, 1 ♀ (r.); (SP106), 5 ♂♂, 14 ♀♀; (SP107), 1 ♂ (r.); (SP118), 15 ♂♂, 2 ♀♀. Wewak, 2.II.1966, SS (SPI), 4 ♂♂, 1 ♀; (SP6), 7 ♂♂ (r.); 27.II.1966, SS (SP121), 3 ♂♂, 6 ♀♀ (r.); (SP125), 1 ♂ (r.); 7.III.1966, SS (SP159), 3 ♂♂; (SP161), 2 ♂♂. Kowiro, 28.II–4.III.1966, SS (SP128), 150 ♂♂, 129 ♀♀; (SP134), 4 ♂♂, 5 ♀♀ (r.); (SP137), 14 ♂♂; (SP152), 4 ♂♂; (SP155), 3 ♂♂; (SP156), 7 ♂♂. Maprik, 21.III.1964, DHC, 15 ♂♂; 5–16.II.1966, SS (SP12), 27 ♂♂, 26 ♀♀; (SP14), 17 ♂♂, 2 ♀♀; (SP16), 2 ♂♂, 5 ♀♀ (r.), several L; (SP17), 13 ♂♂, 5 ♀♀ (r.), several L; (SP18), 13 ♂♂, 10 ♀♀; (SP19), 27 ♂♂, 26 ♀♀; (SP36), 1 ♀ (r.). Kunjingini, 7.II.1966, SS (SP38), 2 ♂♂. Maprik, 14–16.II.1966, SS (SP39), 1 ♂, 1 ♀; (SP40), 10 ♂♂, 9 ♀♀; (SP41), 17 ♂♂, 12 ♀♀; (SP42), 5 ♂♂, 14 ♀♀ (SP43) 7 ♂♂, 1 ♀; (SP44) 1 ♂ (r.); (SP46), 1 ♂; (SP47), 10 ♂♂, 9 ♀♀; (SP63), 6 ♂♂, 5 ♀♀ (r.). Kandange, 12–13.II.1966, SS (SP48), 1 ♂ (r.); (SP54), 8 ♂♂, 17 ♀♀; (SP55), 1 ♂ (r.); (SP61), 9 ♂♂, 9 ♀♀; (SP62), 1 ♂ (r.); 2.III.1964, DHC 10 ♂♂. Korogo, 8.III.1964, DHC 18 ♂. Siutmeri, 16.III.1964, DHC 26 ♂. MADANG: Alexishafen, 1.XII.1964 WAS (BBMNG-C117), 1 ♂, 1 ♀; (BBMNG-C118) 4 ♂♂ (r.); (BBMNG-C121), 4 ♂♂; 25.II.1966 SS (MD1), 1 ♂, 1 ♀ (r.), several larvae; (MD5), 1 ♂, 7 ♀♀. Baitabag, 27–10.XI.1964, WAS (BBMNG-C74) 1 ♂; 26.I.1966, SS (MD6), 6 ♂♂, 5 ♀♀; (MD7), 1 ♀; (MD8), 1 ♂ (r.); (MD10), 1 ♂. Yagaum Lutheran Mission, 26.I.1966, SS (MD14), 25 ♂♂, 7 ♀♀. Gum River Area, 26.I.1966 SS (MD20), 1 ♂. MOROBE: Lae, 10–13.IV.1966, SS (MR5), 93 ♂♂, 29 ♀♀; (MR6), 47 ♂♂, 6 ♀♀; (MR11) 2 ♂♂, 1 ♀; (MR22), 1 ♀; (MR24), 13 ♂♂; (MR26), 5 ♂♂, 1 ♀; (MR32), 12 ♂♂; (MR33), 7 ♂♂, 5 ♀♀. Wau, 16–19.IV.1966, SS (MR63), 1 ♂; (MR65), 1 ♀ (BISHOP). SE NEW GUINEA. NORTHERN: Popondetta, 6–9.V.1965, PS and WAS (BBMNG-C570), 2 ♂♂, 2 ♀♀ (r.); (BBMNG-C2145), 1 ♂, 4 ♀♀ (r.); (BBMNG-C2180), 1 ♂ (r.); (BBMNG-C2224), 3 ♂♂, 2 ♀ (r.); (BBMNG-C2227), 1 ♂; (BBMNG-C2235), 2 ♂, 3 ♀ (ind. r.); (BBMNG-C2237), 1 ♂; (BBMNG-C2303), 4 ♂♂; 26–29.IV.1966, SS (NEP1), 1 ♂; (NEP2), 41 ♂♂; 30 ♀♀; (NEP3), 3 ♀♀; (NEP6), 1 ♂, 1 ♀ (r.), several L; (NEP9), 49 ♂♂, 51 ♀♀; (NEP10), several L; (NEP13), 2 ♂♂; (NEP17), 2 ♂♂; (NEP20), several L. GULF: Murua, 1–3.V.1966, SS (G2), 1 ♂; (G11), 3 ♂♂, 11 ♀♀; (G10), 1 ♂; (G17), 3 ♀♀; (G21), 20 ♀♀. CENTRAL: Brown River, Port Moresby, 24. XII.1965, SS (CP13) 3 ♂♂ (r.), 5 ♂♂, 3 ♀♀, (field caught) (BISHOP).

22. **Culex (Lophoceraomyia) atracus** Colless Fig. 37.

Culex (Lophoceraomyia) atracus Colless, 1959, Proc. Linn. Soc. N. S. W. **84:** 385. Type: Holotype ♂ (CH101, CT506), Kavieng, New Ireland, Bismarck Archipelago, F. H. Taylor (ANIC).

Culex (Lophoceraomyia) franclemonti Belkin, 1962, Mosq. So. Pacific **1:** 256–257. Type: Holotype ♂ with genitalia slide (590114-10), Munda, New Georgia, British Solomon Is., XI.1943–X.1944, J. G. Franclemont (USNM, 64760). **New Synonymy.**

C. (L.) atracus of Stone, 1961.

C. (L.) franclemonti of Stone, 1963.

♂. (fig. 37) In general as described by Colless (1959: 375) and Belkin (1962: 256–257, as *franclemonti*); very similar to *insularis* and *fraudatrix* in general ornamentation, palpal and labial characters, differing from both in the following. *Antenna:* F-5 with a smaller tuft of 7–12 dark narrow pointed scales only, most dorsal 1, 2 scales longest, as long as the next 4 flagellomeres or sometimes slightly shorter, preceded dorsally by 2, 3

Fig. 37

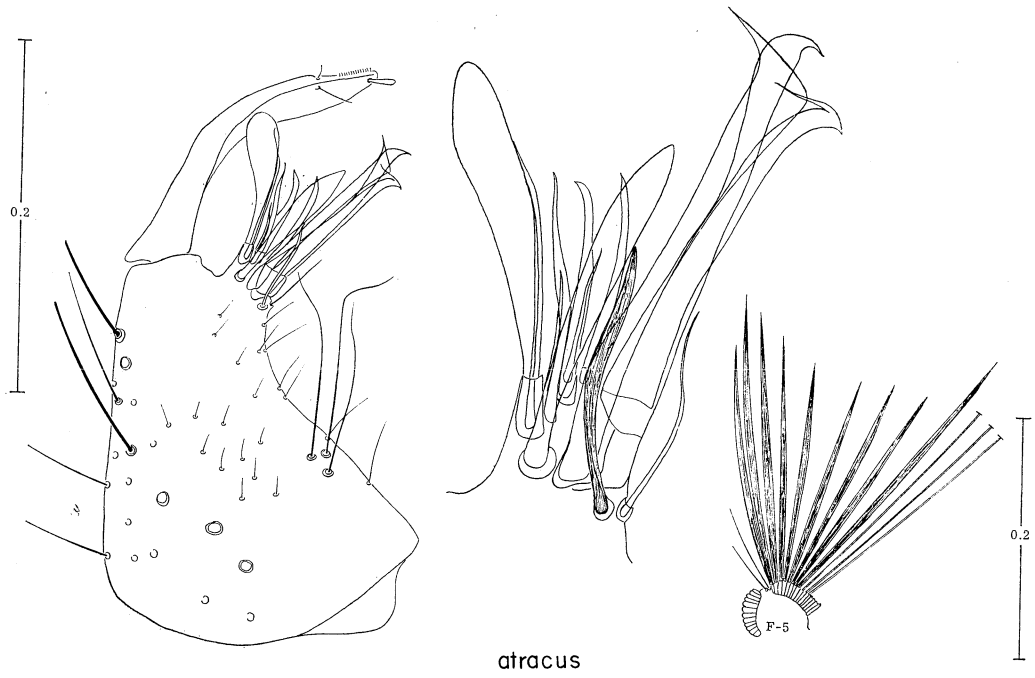


Fig. 37. Male genitalia and modified tuft of antennal flagellomere 5 of *C.* (*L.*) *atracus*.

short hairlike setae and followed ventrally by several long normal hairs; F-9 with 4, 5 subequal bladelike scales.

Genitalia: (fig. 37) As figured by Colless (1959) and Belkin (1962). Almost indistinguishable from *insularis* and *fraudatrix;* differing slightly in the following. *Sidepiece* usually with 3 long subequal submarginal setae, sometimes 2 or 4 on a side, the most mesal one usually strongest, the other sometimes weaker and shorter. *Subapical Lobe:* basal seta of the distal part relatively strong and obviously flattened, its base proximal or slightly ventral to those of the proximal rod; 5 accessory setae present, 2 bladelike and straight, 1 spinelike and 2 hairlike with curved apices.

♀. *Wing:* 2.8 mm. *Forefemur:* 1.3 mm. *Proboscis:* 1.7 mm. Tentatively associated with ♂. In general, as described by Belkin (1962: 256), similar to ♂ in ornamentation except for abdominal tergites III-VII with basolateral spots.

LARVA. *Head:* 0.6 mm. *Siphon:* 1.4 mm; index: 8.1; ratio: 4.5. As figured and described by Belkin (1962: 256–257). Very similar to *fraudatrix*, differing from it in the following. *Head:* hair 1-C slender and straight. *Thorax:* hair 3-P usually single, sometimes with 2, 3 branches on a side; 4-P usually double, sometimes single. *Siphon:* usually with median dark ring.

PUPA. *Abdomen:* 2.2 mm. *Paddle:* 0.62 mm. *Trumpet:* 0.7 mm, index: 12.0. As figured and described by Belkin (1962: 256–257); in general, similar to *fraudatrix* except hair 1-C usually triple, rarely 4-branched; 5-V always double; 6-III triple; 5-VII single.

BIONOMICS. *C. atracus* is the most abundant *Lophoceraomyia* in New Ireland and New Britain. Adults were encountered in aggregations on tree trunks in dense shade, frequently in association with *insularis* and occasionally with *collessi* and *ornatus*. Only a few larvae and pupae were collected in a drainage ditch at the margin of a forest in New Britain (NB50).

SYSTEMATICS. I am synonymizing *franclemonti* Belkin, 1962 from the Solomons with *atracus* on the basis of similarity in male genitalia, antenna and palpus. The larva and pupa of *atracus* are also very similar to topotypic material of *franclemonti*. *C. atracus* is closely related to *fraudatrix* of New Guinea as well as to the species in the *buxtoni* complex of the Solomons (Belkin 1962). The immature stages resemble *fraudatrix* very closely and show a great deal of overlap in chaetotaxy with this species. However, *atracus* is clearly distinguished from *fraudatrix* by the form of the scale tuft on antennal flagellomere 5 and in the markedly flattened basal seta in the distal part of the subapical lobe of the male.

DISTRIBUTION. Material examined: 221 adults (117 ♂, 104 ♀); 1 individual rearing; 4 whole larvae. BISMARCK ARCHIPELAGO. NEW IRELAND: Kavieng, sea level to 5 m, 19–24.III. 1966, SS (NI5), 1 ♂, 2 ♀; (NI15), 3 ♂; (NI17), 1 ♂, 3 ♀; (NI19), 2 ♂, 9 ♀; (NI29), 1 ♂, 1 ♀; (NI44), 2 ♂, 26 ♀; (NI47), 1 ♀; (NI50), 3 ♂, 1 ♀; (NI53), 6 ♂, 1 ♀. NEW BRITAIN: Keravat, 5–10 m, 26.III–7.IV.1966, SS (NB2), 7 ♂; (NB4), 2 ♂; (NB5), 3 ♀; (NB7), 4 ♂, 4 ♀; (NB22), 1 ♂, 4 ♀; (NB23), 26 ♂, 9 ♀; (NB27), 1 ♂; (NB28), 3 ♂, 5 ♀; (NB35), 1 ♂; (NB38), 6 ♂, 5 ♀; (NB45), 30 ♂, 22 ♀; (NB47), 16 ♂, 9 ♀; (NB50), 1 p♂, 4 L (BISHOP). SOUTH PACIFIC. SOLOMON ISLANDS: Bougainville, New Georgia; Guadalcanal (Belkin 1962).

23. **Culex (Lophoceraomyia) schilfgaardei** Sirivanakarn, new species Fig. 38, 39.

Types: Holotype ♂ (MR11-33) with associated pupal skin and antenna-genitalia slide, Singuawa River area, elevation 20–30 m, Lae, Morobe, NE New Guinea, blocked gravel pool in forest stream, 10–13.IV.1966, S. Sirivanakarn (BISHOP 7736). Allotype ♀ (MR11-10) with associated larval and pupal skins, same data as holotype (BISHOP). Paratypes same data as holotype; 1 ♂ (MR11-11) with associated larval and pupal skins, 1 ♂ (MR11-34) with associated pupal skin, 1 ♀ (MR11-12) with associated larval and pupal skins, 2 ♂ (MR24, 32) with slides of antenna and genitalia (660720-9, 660809-9) (BISHOP). This species is named in honor of R. Schilfgaarde, Department of Agriculture, Madang, Territory of Papua and New Guinea.

♂. (fig. 38) In general, very similar to *fraudatrix* and *atracus* in ornamentation, labial and palpal characters; differing from both chiefly in the following. *Antenna:* F-5 with a tuft of 13–18 scales, all dark brown, the dorsal group of 3–6 scales broad, more or less blunt at tips and a little longer than the next 4 flagellomeres, followed laterally by 6, 7 narrow lanceolate scales of gradually decreasing length and ventrally by 2–4 flattened setae of increasing length; F-10 with 4, 5 long stout setae. *Leg:* anterior surface of forecoxa with an irregular row of curved bristles.

Genitalia: (fig. 38) Extremely similar to *atracus;* differing slightly in the following. *Sidepiece:* basal setae of distal part of subapical lobe not markedly flattened; bases of the 3 submarginal setae of sidepiece more widely spaced. *Phallosome:* dorsal process of the lateral plate long, slender and tapered into a sharp point. *Lobe* of 9th tergite usually with 4 setae.

♀. *Wing:* 2.8 mm. *Forefemur:* 1.3 mm. *Proboscis:* 1.7 mm. *Palpus:* 0.2 of proboscis. In general, similar to ♂ in ornamentation except that abdominal tergites V–VII with distinct basolateral pale spots. Extremely similar to *fraudatrix*, *atracus* and *insularis* except as noted in the key.

LARVA. (fig. 39) *Head:* 0.7 mm. *Siphon:* 1.5–2.0 mm (average 1.7 mm); index 7.5–12.0 (average 10); ratio: 4.3–6.3 (average 5.8). Pigmentation very variable, usually darker in specimens from deeply shaded pools than in those from palm bracts, sago leaf axils and gravel pools in partial shade. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* hair 4-C a little longer than the distance between bases, usually double. *Thorax:* hair 3-P always single; 4-M usually double (2–3). *Abdomen:* hair 1-III–VI usually 2-, 3-branched; 1-VII usually 4-branched (3–4); 3-V–VI always single; 2-VIII always single. *Comb* with 40–50 fringed scales. *Siphon:* extremely variable in length; median dark ring present or absent. *Anal Segment:* hair 2-X always with 1 short and 1 long branch.

PUPA. (fig. 38) *Abdomen:* 2.2–2.4 mm (average 2.3). *Paddle:* 0.6–0.72 (average 0.65). *Trumpet:* 0.5–0.7 mm (average 0.6); index 8–14 (average 13). Chaetotaxy as figured; diagnostic characters as in

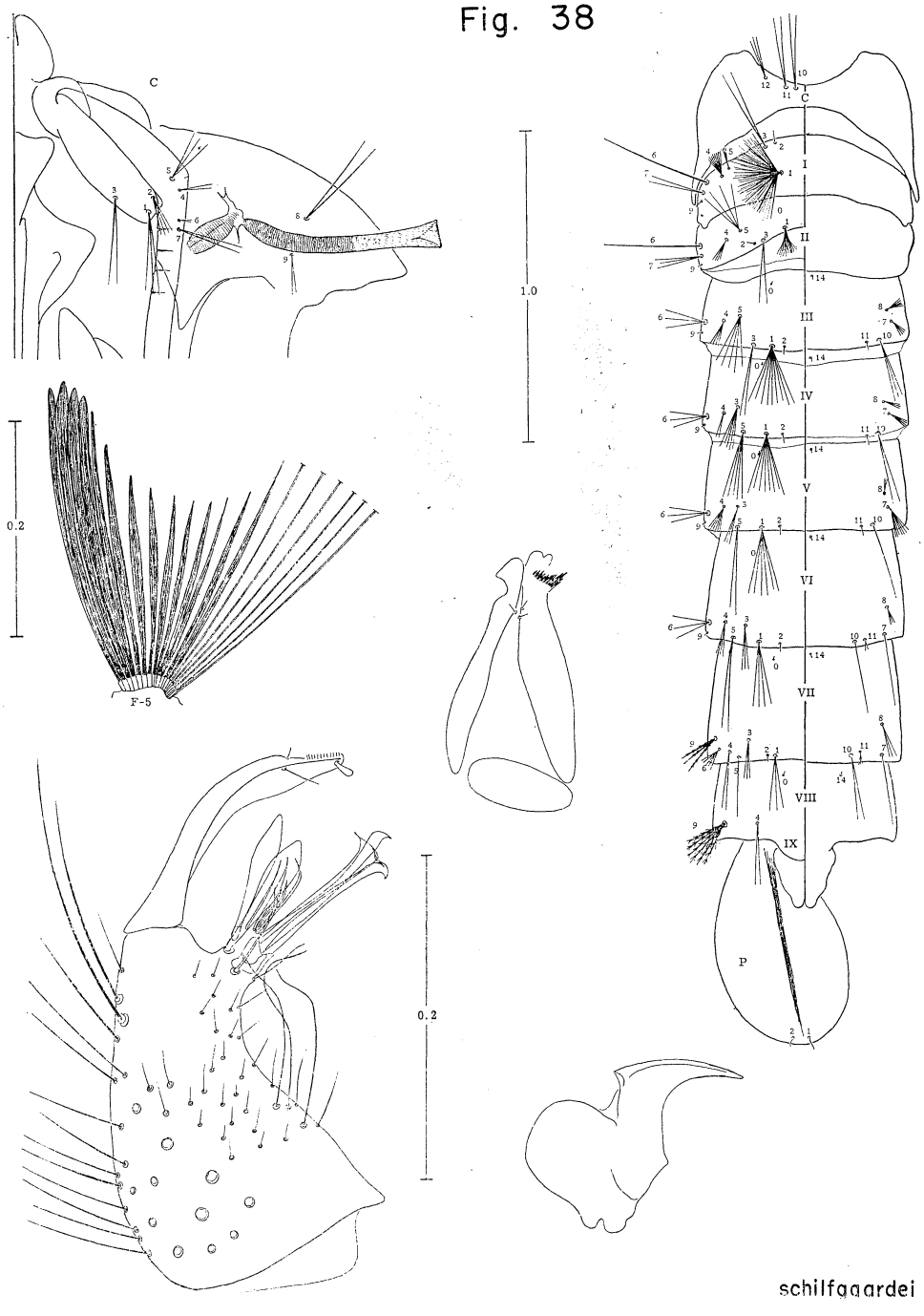


Fig. 38. Pupa, male genitalia and modified tuft of antennal flagellomere 5 of *C.* (*L.*) *schilfgaardei.*

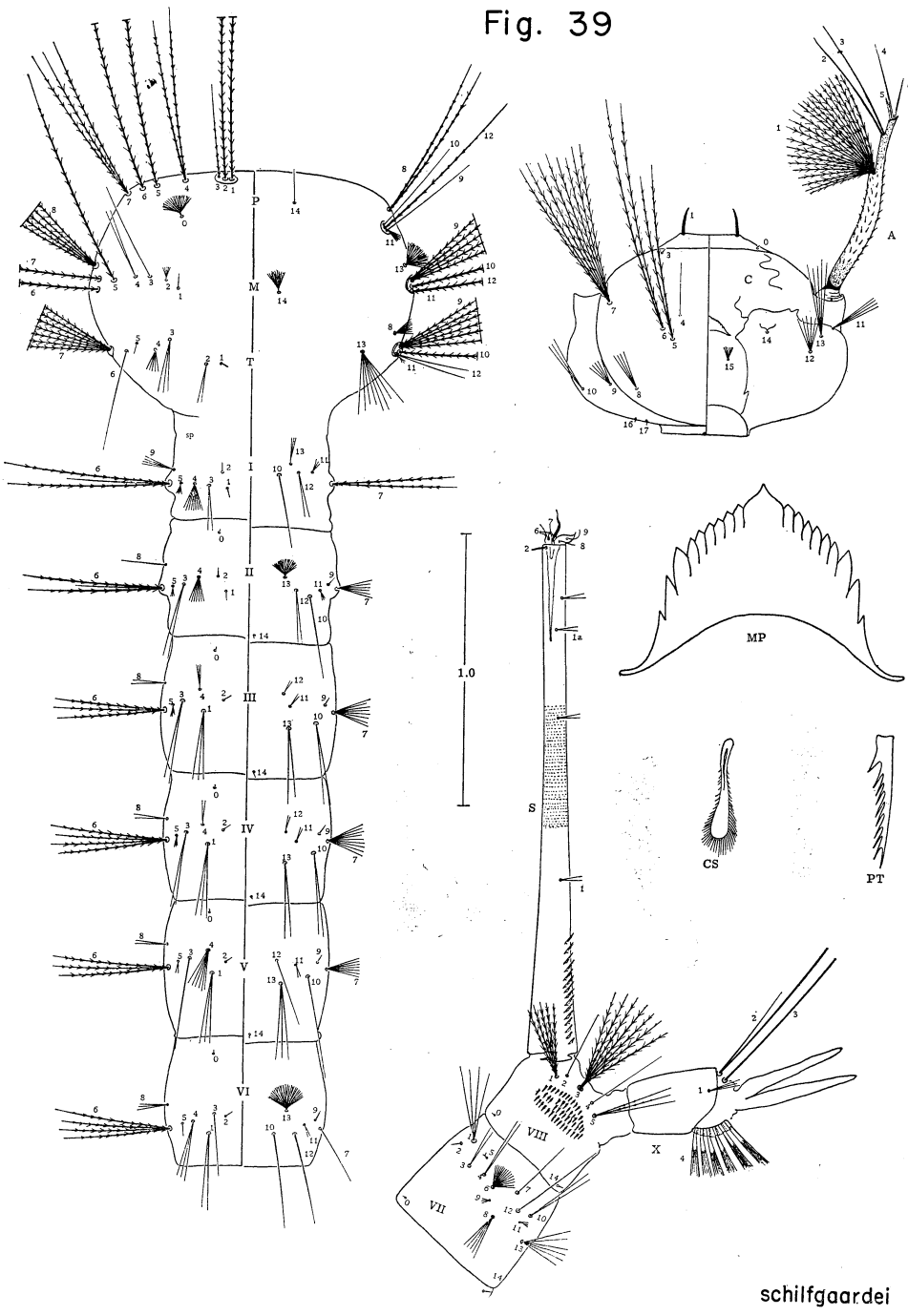


Fig. 39. Larva of *C.* (*L.*) *schilfgaardei.*

the key; the combination of the following features is characteristic. *Cephalothorax:* hair 1-C usually triple (2–3); 5-C usually triple (2–4). *Abdomen:* hair 5-V always double; 6-III–VI usually triple (2–4); 5-VII usually single (1–2).

BIONOMICS. Adults of *schilfgaardei* are found only in small numbers in a given resting place. The immature stages were collected from 3 different types of habitats, a palm bract upon the ground (MD16), a sago palm axil (SP158) and from gravel pools (MR11). Only a few were obtained from the container habitats, but they were taken in enormous numbers in the gravel pools. It is interesting that in all of these habitats *schilfgaardei* was never found in association with *fraudatrix* although the latter was very abundant in nearby pools.

SYSTEMATICS. *C. schilfgaardei* shows a great deal of variation in quantitative characters of the immature stages but the diagnostic characters are remarkably constant. In the male the form of the scale tuft of flagellomere 5 is also very stable, showing no overlap with other species. The nearest relative of *schilfgaardei* seems to be *atracus*.

DISTRIBUTION. Material examined: 93 adults (47 ♂, 46 ♀); 54 individual rearings; numerous larvae and 3 larval skins. NE NEW GUINEA. Apparently restricted to the north coast. SEPIK: Maprik, Upau Stream, 150 m, 8–16.II.1966, SS (SP40), 4 ♂; (SP63), 1 ♀. Wewak, sago axils, sea level to 2 m, 6.III.1966, SS, 1 1p♂ (SP158-100); (SP159), 2 ♂. MADANG: Gum River area, fallen palm bract, 10–20 m, 27.I.1966, SS (MD16), 4 1p♂ (MD16-32, -33, -36, -38), 5 ♂ and 1 ♀ (from mass rearings). MOROBE: Lae, Singuawa River Area, 10–13.IV.1966, SS, as listed in type series (MR11), 19 ♂, 26 ♀ (mass rearings), numerous L; (MR20), 2 1p♀, several L; (MR24), 4 ♀; (MR32), 4 ♂, 11 ♀ (BISHOP).

24. **Culex** (**Lophoceraomyia**) **insularis** Sirivanakarn, new species.

Holotype ♂ (NB1-15) with associated larval and pupal skins and slide of genitalia and antenna, Keravat, New Britain, Bismarck Archipelago, from shaded ground pool, 26.III.1966, S. Sirivanakarn (BISHOP 7737). Allotype ♀ (NB1-12) with associated larval and pupal skins; same data as holotype (BISHOP). Paratypes same data as holotype; 2 ♂ (NB1-10, -17) and 4 ♀ (NB1-11, -13, -14, -16, -18) with associated larval and pupal skins (BISHOP).

Culex (*L.*) *fraudatrix* in part of Colless (1959: 382); Stone et al., 1959; Stone, 1961.

♂. Extremely similar to *fraudatrix* in palpal, labial and antennal characters; differing from it as noted in the key and in the following. *Antenna:* F-5 with smaller tuft of 12–15 scales, dorsal group of 5–7 scales deep brown, broad and bluntly tipped, almost as long as next 4 flagellomeres, followed lateroventrally by a group of 5–7 distally pale scales; F-9 usually with 5 bladelike scales (4–5); F-10 with 2 long stout setae.

Genitalia: Exceedingly similar to *fraudatrix* except that lateral plate of phallosome with long and slender beaklike dorsal process, its apex ending in a sharp point.

♀. *Wing:* 3.0 mm. *Forefemur:* 1.5 mm. *Proboscis:* 1.8 mm. *Palpus:* 0.2 of proboscis. General ornamentation similar to male. No clear cut characters have been found to distinguish it from *fraudatrix*.

LARVA. *Head:* 0.65 mm. *Siphon:* 1.3–1.65 mm (average 1.5); index: 7.6–10.7 (average 9); ratio: 4.2–5.0 (average 4.8). In general, similar to *fraudatrix;* differing primarily in the following features. *Head:* hair 4-C longer, usually forked into 2 branches. *Thorax:* hair 3-P almost always single; 12-T single or double; 13-T, 5–8-branched (average 7). *Abdomen:* hair 10-I–VI single; 1-III usually triple (2–4); 3-V single or double; 4-VII always single; 2-VIII always single. *Siphon:* median dark ring usually absent. *Anal Segment:* hair 2-X usually with 1 long and 1 short branch, rarely 3-branched.

PUPA. *Abdomen:* 2.2 mm. *Paddle:* 0.63 mm. *Trumpet.* 0.62–0.7 mm (average 0.65); index: 12–14 (average 13). In general, as figured for *fraudatrix*, differing in the combination of following characters: trumpet shorter; hair 3-C usually triple; hair 5-V usually double (2–3); hair 4-VIII usually double, rarely triple.

BIONOMICS. *C. insularis* is a common species of *Lophoceraomyia* in New Ireland and New Britain. The adults are frequently found in large aggregations under fallen logs, on dead branches and on tree trunks generally in association with *atracus* and occasionally *collessi*. The usual habitats of the immature stages are muddy or gravelly pools in deep shade in dense forests. Larvae were found in great numbers, frequently in association with larvae of *Uranotaenia* and *Aedes* but never with *atracus* or *collessi*.

SYSTEMATICS. *C. insularis* is most similar to *fraudatrix* on male characters but the chaetotaxy of the immature stages resembles that of the *solomonis* complex. The larva is clearly distinguished from *fraudatrix* by the unbranched hairs 4-VII and 2-VIII. All diagnostic characters of *insularis* show very limited variation indicating that it is a distinct species. The presence of mixed features in *insularis* suggests that it may be derived through hybridization between a member of the *solomonis* complex and *fraudatrix*.

DISTRIBUTION. Material examined: 179 adults (109 ♂, 70 ♀); 74 individual rearings (from larvae or pupae); 102 whole larvae. BISMARCK ARCHIPELAGO. NEW IRELAND: Kavieng, sea level, 19–22.III.1966, SS (NI5), 2 ♂; (NI17), 2 ♀; (NI44), 2 ♂, 6 ♀. NEW BRITAIN: Keravat, 5–10 m, 26.III, 6.IV.1966, SS, as listed in type series (NB1), 6 ♂, 9 ♀ (r.); several L; (NB2), 19 ♂; (NB3), 1 ♂, 1 ♀ (r.); (NB4), 3 ♂, 1 ♀; (NB5), 3 ♂; (NB7), 6 ♂, 3 ♀; (NB22), 2 ♂; (NB23), 1 ♂; (NB24), 5 ♂, 10 ♀ (r.), several L; (NB28), 6 ♂; (NB35), 5 ♂, 6 ♀ (r.), several L; (NB36), 1 ♂, 2 ♀ (r.), several L; (NB37), 5 ♂, 2 ♀ (r.), several L; (NB38), 11 ♂; (NB39) 1 ♂, 3 ♀ (r.); (NB40), 1 ♂, 6 ♀ (r.), several L; (NB41), 4 ♂, 4 ♀ (r.), several L; (NB44), 1 ♂, 1 ♀ (r.), a few L; (NB45), 19 ♂, 8 ♀; (NB46), 1 ♀ (r.), a few L; (NB47), 6 ♂, 4 ♀ (BISHOP).

25. **Culex** (**Lophoceraomyia**) **kaviengensis** Sirivanakarn, new species Fig. 40, 41.

Types: Holotype ♂ (NI4-101) with associated pupal skin and slide mount of antenna and genitalia, Kavieng, New Ireland, Bismark Archipelago, sago stump in swamp along the coast, 19.III.1966, S. Sirivanakarn (BISHOP 7738). Allotype ♀ (NI4-103) with correlated larval and pupal skins, same data as holotype (BISHOP). Paratypes same data as holotype; 1 ♂ (NI4-102) with associated pupal skin and antennal genitalia slide; 1 ♀ (NI4-104) with associated larval and pupal skins (BISHOP).

♂. (fig. 40). In general, similar to *atracus* and *insularis*, strikingly differing from both in the following. *Palpus* exceeding proboscis by a little less than 0.5 of length of segment 5; segment 3 without ventrolateral tuft of setae but with a few ventral rows of tiny setae along the whole length; segments 4 and 5 with fewer bristles. *Proboscis:* dorsal 2 rows of upright setae scanty and confined to distal 0.25 of labium. *Antenna:* F-5 with an indistinct tuft of 5 linear hairlike setae, preceded dorsally by 4 and followed ventrally by several long normal hairs; F-9 with 1 short and 2 long bladelike scales; F-10 with 3 long stout setae.

Genitalia: (fig. 40) Extremely similar to *atracus* and *insularis*, differing slightly in the following. *Sidepiece* usually with 3 subequal submarginal setae and 1 short seta, the first 3 forming a triangle, closely spaced basally, the weaker seta usually in line with the other 2. *Proctiger:* cercal sclerite with 2 minute setae. *Phallosome:* lateral plate with short beaklike dorsal process. *Lobe* of 9th tergite with 4–6 setae.

♀. *Wing:* 2.9 mm. *Palpus:* 0.2 of proboscis. Similar to ♂ in general ornamentation except for abdominal tergites IV–VII with indistinct pale basolateral spots.

LARVA. (fig. 41) *Head:* 0.63–0.68 mm (average 0.65 mm). *Siphon:* 1.23–1.4 mm (average 1.30 mm); index 7.0–8.5 (average 7.7); ratio 3.7–4.3 (average 4.0). Thoracic spiculation absent. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* hair 4-C a little longer than the distance between bases, usually single. *Thorax:* hair 8-P usually single. *Abdomen:* hair 1-III–VII usually double, rarely single; 6-III–VI usually double, rarely triple; 4-VII single; 2-VIII always single. *Siphon:* rather short, with lower index and ratio than other forms in the complex; dark ring absent; pecten with 14–19 teeth (average 16); siphonal tufts 8, regularly paired, 3-branched and a little longer than siphon width at point of attachment.

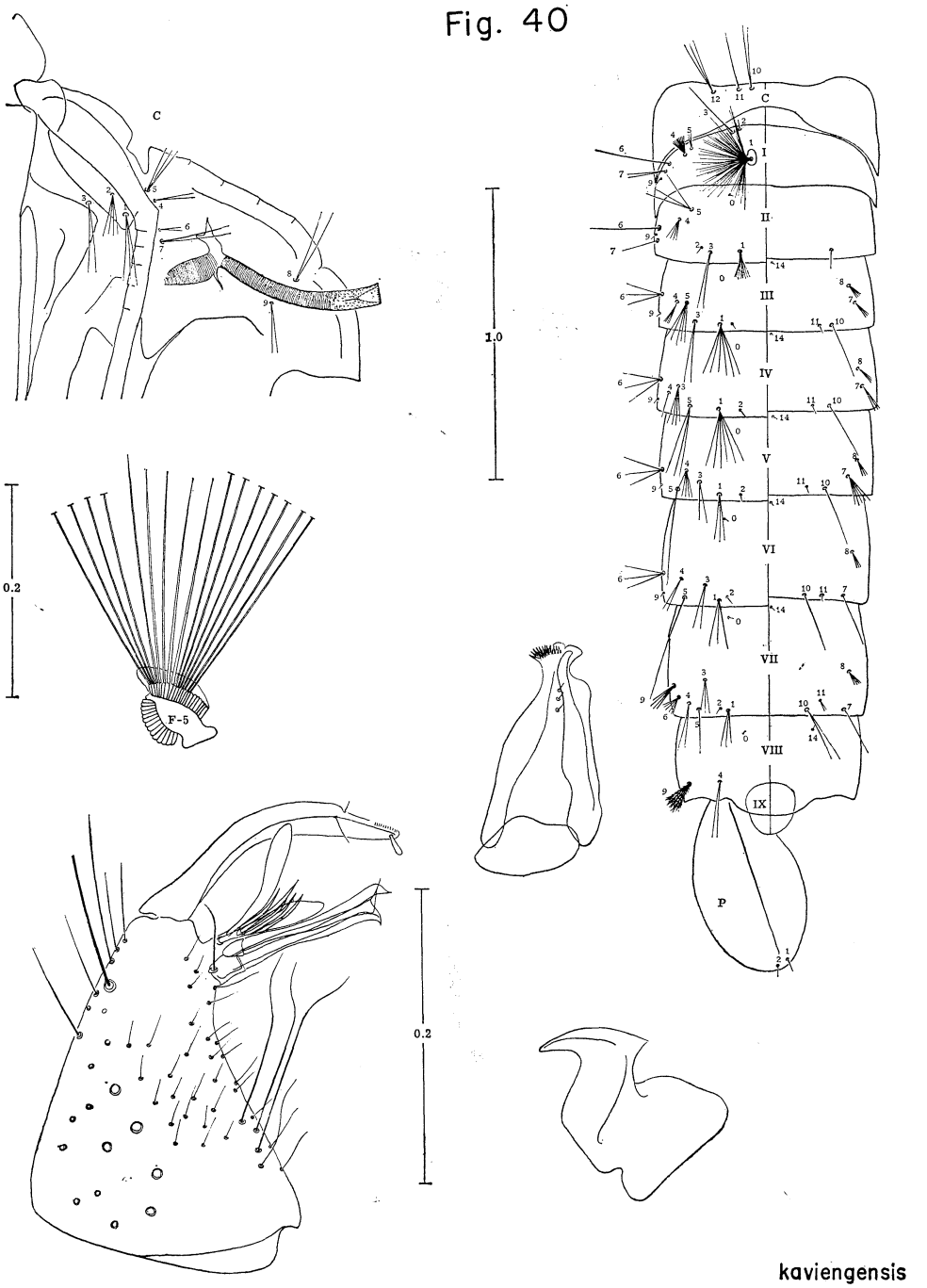


Fig. 40. Pupa, male genitalia and modified tuft of antennal flagellomere 5 of *C.* (*L.*) *kaviengensis*.

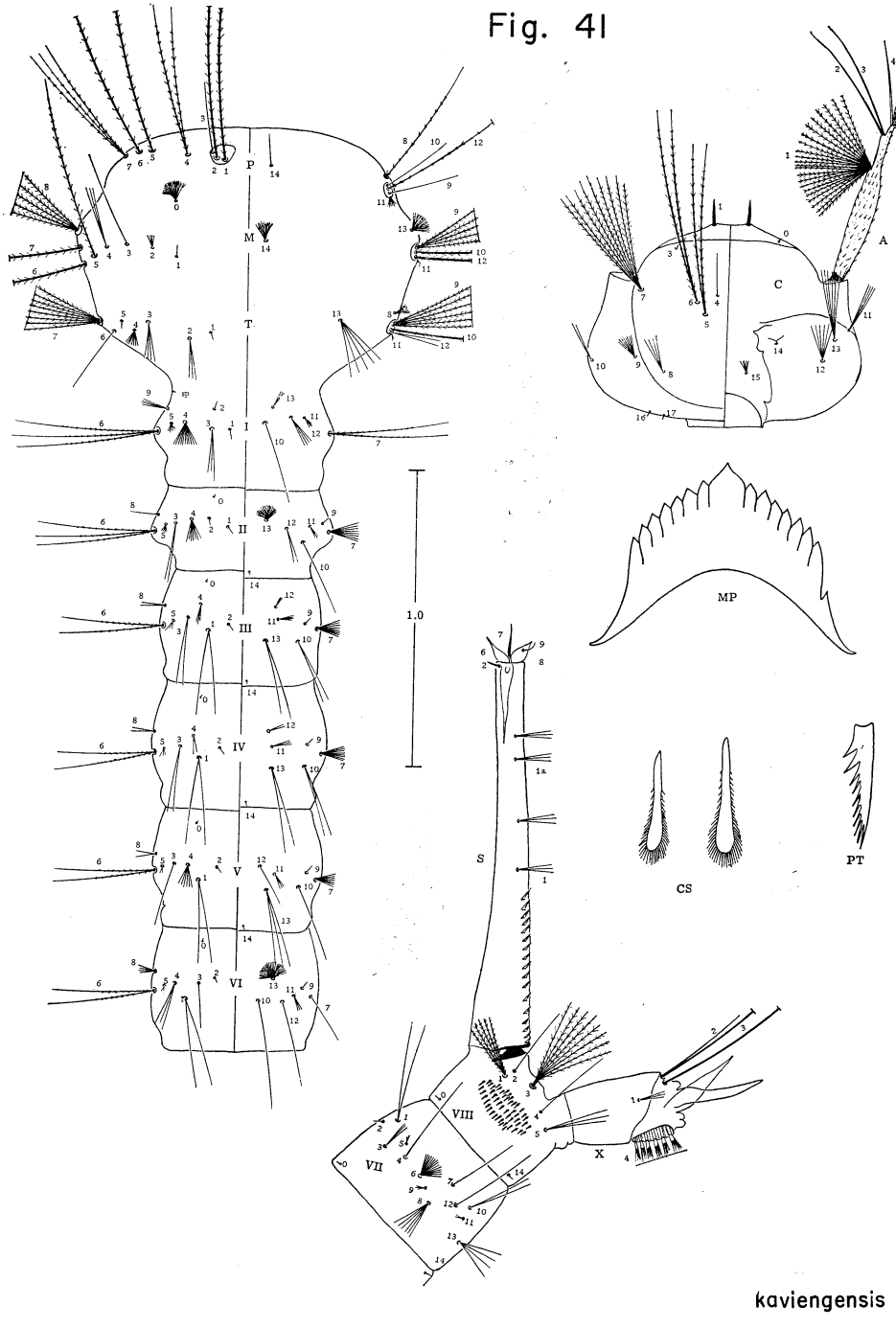


Fig. 41. Larva of *C.* (*L.*) *kaviengensis*.

Anal Segment: hair 2-X with 1 long and 1 short branch; anal gills about as long as saddle.

PUPA. (fig. 40) *Abdomen:* 2.2–2.6 mm (average 2.4). *Paddle:* 0.63–0.75 mm (average 0.7). *Trumpet:* 0.6–0.7 mm (average 0.63); index 9.3–12.0 (average 10.5). Chaetotaxy as figured; diagnostic characters as in the key; the combination of following characters is distinctive. *Cephalothorax and Metanotum:* trumpet stout and short; hair 3-C usually double (1–2); 5-C usually triple (2–3); 11-C usually single (1–2). *Abdomen:* hair 1-III–VII with average of 6, 6, 3, 3, and 3 branches, respectively; 5-V, VI, always single. *Paddle* with weak midrib; its posterior margin indistinct.

BIONOMICS. The immature stages of *kaviengensis* were collected in a sago stump partly filled with rain water and numerous reddish sago shreds (NI4) and from 2 tree holes (NI21, 26) in a rain forest. Adults were not encountered in the field.

SYSTEMATICS. The description of this species is based on material reared from a sago stump. The larvae from tree holes have a similar chaetotaxy but differ in having the head, siphon and saddle deep brown and a longer siphon . The pupa differs in having hair 10-C single, 11-C double and 5-V double. Since no males were reared from tree holes, the above differences are considered to be ecotypic modifications for the present.

C. kaviengensis is distinctive in all stages except that its male genitalia are similar to *insularis*, *atracus* and *fraudatrix*. The immature stages show mixed features of the *bergi* complex (Belkin 1962) and of the *fraudatrix* complex suggesting that *kaviengensis* might have been derived through hybridization between members of these complexes.

DISTRIBUTION. Material examined: 6 adults (2 ♂, 4 ♀); 6 individual rearings; 37 whole larvae, 1 pupa. BISMARCK ARCHIPELAGO. NEW IRELAND: Kavieng, Panapai Village, sea level to 5 m, sago stump, 19.III.1966, SS, as listed in type series (NI4), 8 L. Panavungel Mission, 10 m, tree holes, 21.III.1966, SS (NI21), 25 L; (NI26), 1 1p♀ (NI26-10) 9 L, 1 P (BISHOP).

26. **Culex** (**Lophoceraomyia**) **collessi** Sirivanakarn, new species Fig. 42, 43.

Types: Holotype ♂ (NB49-106) with associated larval and pupal skin and slide of genitalia, Keravat, New Britain, Bismarck Archipelago, grassy drainage ditch near margin of rain forest, 5.IV.1966, S. Sirivanakarn (BISHOP 7739). Allotype ♀ (NB49-102) with associated pupal skin, same data as holotype (BISHOP). Paratypes same data as holotype; 4 ♂ (NB49-100, -101, -104, -105) with associated larval and pupal skins and slides of antenna and genitalia; 3 ♀ (NB49-103, NB49-108, NB49-109) with associated pupal skins (BISHOP). This species is dedicated to Dr Donald H. Colless, Div. of Ent., CSIRO, Canberra, Australia, for his contributions to the knowledge of *Lophoceraomyia*.

♂. (fig. 42) Superficially similar to *fraudatrix* and *ornatus* in antennal scale tufts; differing from both in longer basal processes of palpus, from *ornatus* in the absence of pleural scales, and in the following. *Head:* erect scales on vertex pale brown; narrow decumbent scales white to yellow; broad scales on vertex brown, bluish white laterally. *Palpus:* exceeding proboscis by a little more than length of segment 5; segment 2 with a patch of dark scales above at base; proximal 0.4 of segment 3 with ventrolateral tuft of long setae. *Proboscis:* labium thickened distally; base with a ventral row of about 10 spinelike setae; distal 0.5 with 2 dorsal rows of upright setae about 1.5 × labial width. *Antenna:* F-5 with a fan-shaped tuft of 22 scales as long as the next 4, 5 flagellomeres, the dorsal group of 9–11 scales broad, brown, bluntly tipped, followed laterally and ventrally by 12, 13 narrow, distally pale, pointed scales. *Thorax:* integument yellowish brown, mesonotal scales narrow and brown. *Legs:* forecoxal bristles weak, in 2, 3 irregular rows. *Abdominal tergites* usually with brown scales, sometimes with basolateral pale spots.

Genitalia: (fig. 42) Very similar to *petersi* and *crowei*, differing in the following features. *Sidepiece* with 3 submarginal setae in a line subparallel to the margin, 2 dorsal ones subequal, basal one usually weaker and shorter. *Clasper* with fine but distinct subapical crest from tip to near curvature. *Subapical Lobe:* distal part with basal seta lateral in position, external leaflet broad and rounded apically, internal leaflet oblong

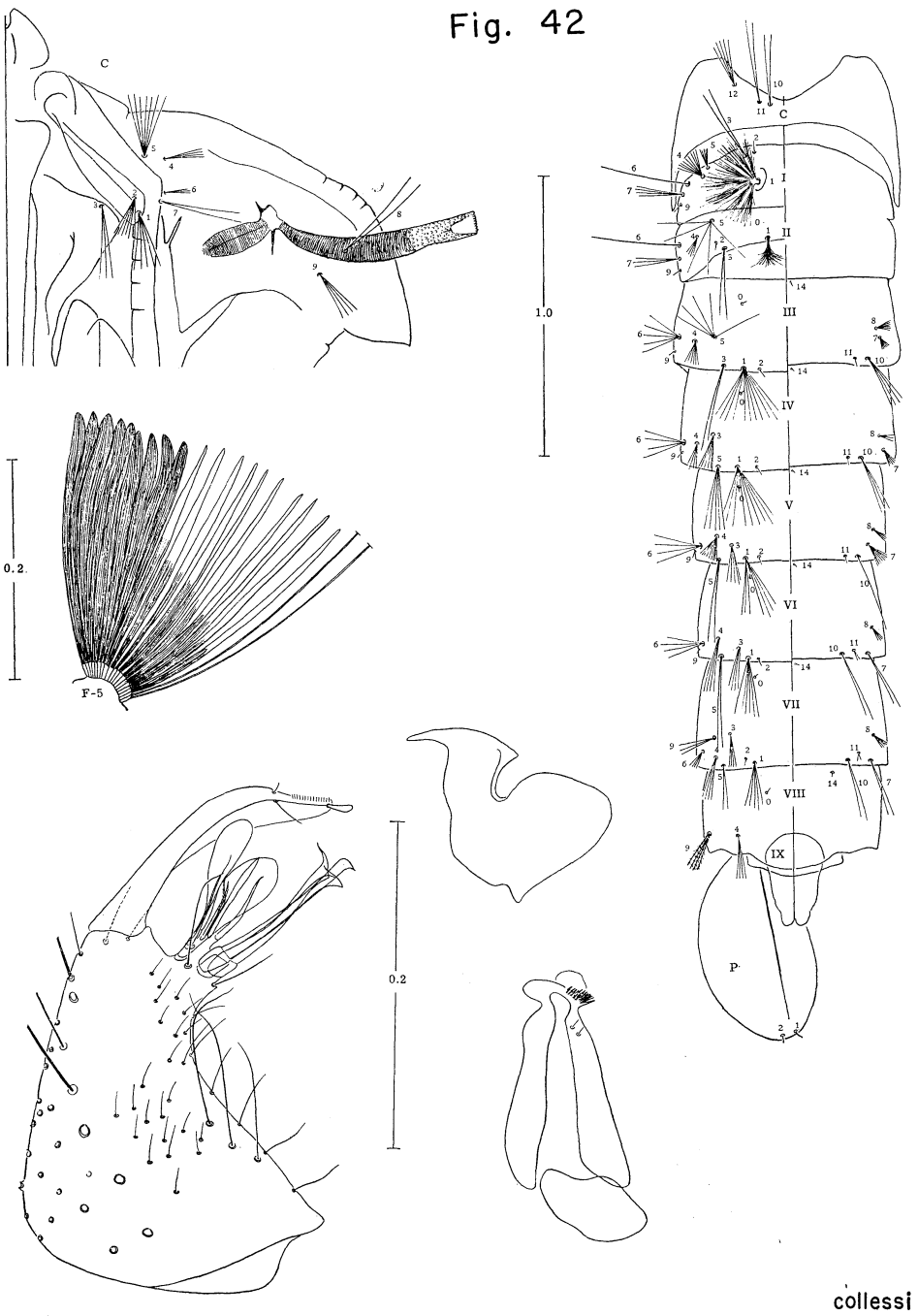


Fig. 42. Pupa, male genitalia and modified tuft of antennal flagellomere 5 of *C.* (*L.*) *collessi.*

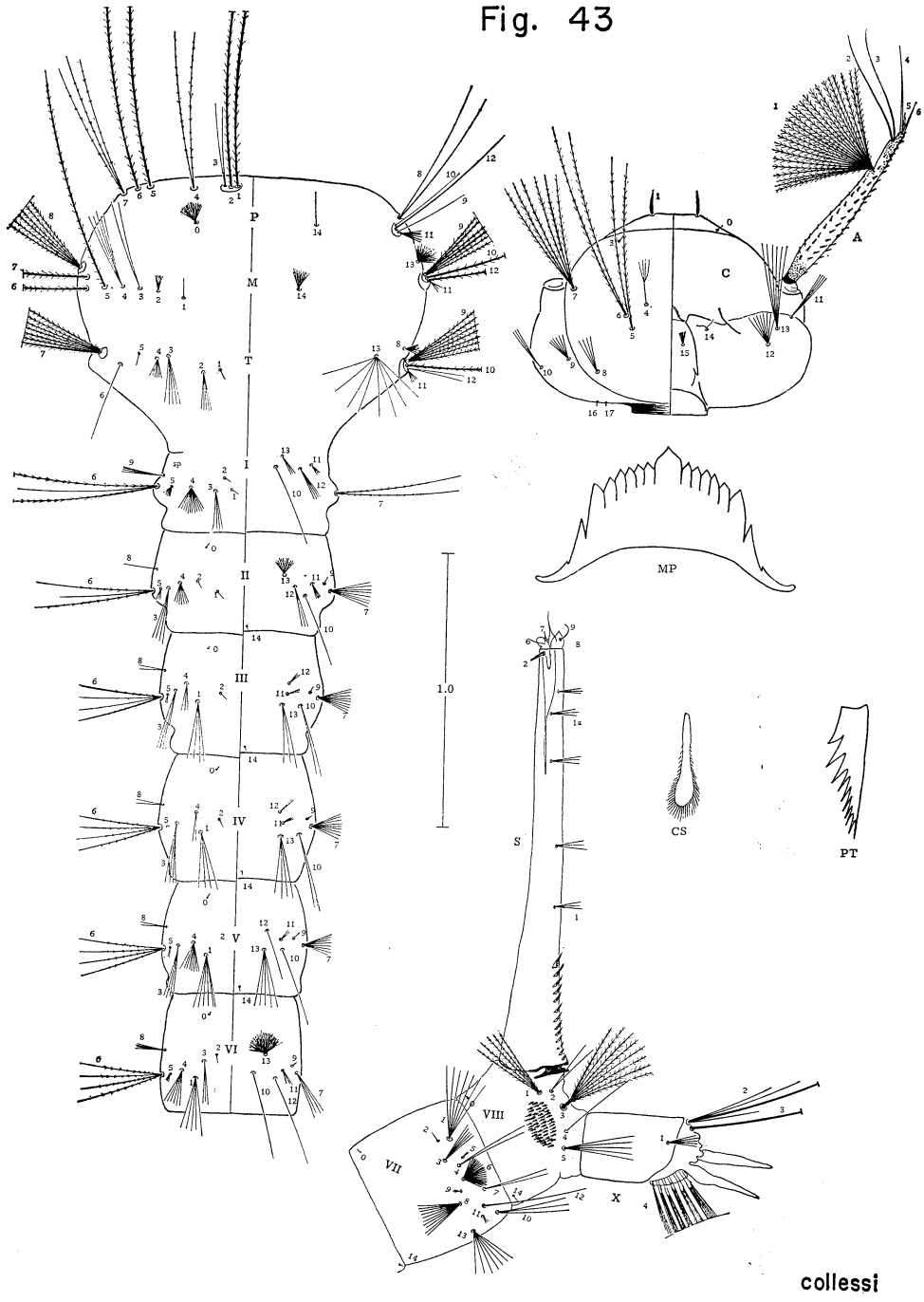


Fig. 43. Larva of *C.* (*L.*) *collessi.*

and expanded distally, 5 accessory setae, the one close to internal leaflet with subapical serrated margin, others apparently flattened and bladelike spines. *Phallosome:* lateral plate with long slender dorsal process. *Lobe* of 9th tergite with 4 weak setae.

♀. *Wing:* 2.8 mm. *Forefemur:* 1.4 mm. *Proboscis:* 1.8 mm. *Palpus:* 0.2 of proboscis. In general, Abdominal tergites IV–VII with rather broad, distinct white basolateral spots, tergite III with a small indistinct spot.

LARVA. (fig. 43) *Head:* 0.63–0.73 mm (average 0.7 mm). *Siphon:* 1.35–1.6 mm (average 1.5 mm); index 7.7–9.1 (average 8.5); ratio 4.0–4.6 (average 4.3). *Pigmentation* uniformly yellowish white throughout; antenna concolorous with head capsule except for a narrow dark ring at extreme base; siphon without dark ring in the middle. *Spiculation* almost invisible, confined to pleural areas of thorax. Chaetotaxy as figured; diagnostic characters as in key. *Head:* hair 4-C usually forked beyond the middle into 3, 4 branches; 7-C, 6-branched. *Thorax:* hair 3-P always double; 3-M usually double (1–2); 4-M with average of 5 branches (3–5); 2-T with average of 5 branches (3–5). *Abdomen:* hair 3-I–VI usually 3-, 4-branched (2–4); 12-I usually 4-branched (4–6); 1-III–VI, 4–6-branched; 7-VI usually 5-branched (3–5); 3-VII usually 5-branched (4–6); 7-VII always double; 10-VII triple (2–4); 2-VIII double (2–3). *Comb* with about 55 fringed scales. *Siphon:* pecten with 11–14 teeth (average 13); siphonal tufts 10, irregularly paired, usually 3-, 4-branched. *Anal Segment:* hair 1-X usually 5-branched (4–5); 2-X usually 4-branched (3–4).

PUPA. (fig. 42) *Abdomen:* 2.0–2.5 mm (average 2.3 mm). *Paddle:* 0.63–0.7 mm (average 0.65 mm). *Trumpet:* 0.63–0.7 mm (average 0.65); index 8.3–9.3 (average 8.5). Trumpet shape very similar to *ornatus*, differing slightly from it in being shorter and more uniformly cylindrical along most of its length. Chaetotaxy as figured; diagnostic characters as in key; differing from most forms in more numerous branches as noted. *Cephalothorax and Metanotum:* hair 1-C usually 5-branched (5–6); 2-C usually 6-branched (5–7); 5-C usually 7-branched (5–9); 9-C usually 4-branched (3–5); 12-C usually 5-branched (5–6). *Abdomen:* hair 10-III–VII usually with 4, 3, 2, 2, and 3 branches, respectively; 7-VI always double; 4-VIII usually 4-branched (4–5). Paddle with dark, strong midrib.

BIONOMICS. *C. collessi* is an abundant species in the lowlands of New Guinea, New Ireland and New Britain. The adults are frequently encountered resting with *fraudatrix*, *insularis*, *atracus* and *shanahani* in the rain forests. The larvae were collected only twice in New Britain in a drainage ditch densely shaded with tall grasses, and in SE New Guinea in a sago swamp where they were associated with *ornatus* and *muruae*.

SYSTEMATICS. The male of *collessi* is very similar to *fraudatrix* and *ornatus* in the development of the tuft of antennal flagellomere 5 and palpal characters. It also shows a number of similarities with *fraudatrix*, *insularis*, *shanahani* and *durhami*. However, it can be distinguished from all these species by the diagnostic features of the palpus, antenna and genitalia as described above. The larva and pupa are readily recognized by the strong branching of the larger hairs. The morphology of the male and pupa of *collessi* suggests an intermediate condition between either *fraudatrix-ornatus* or *ornatus-shanahani*. For the present *collessi* is placed in the *fraudatrix* complex since most stages appear to show closer similarity to *fraudatrix* than to the others. As in other species in the *fraudatrix* complex the mixture of characters of *collessi* suggests a hybrid origin of this form.

DISTRIBUTION. Material examined: 250 adults (136 ♂, 114 ♀); 11 individual rearings; 57 whole larvae; 1 larval and 1 pupal skin. NE NEW GUINEA. SEPIK: Maprik, Upau stream, 150–160 m, 5–16.II.1966, SS (SP38), 1 ♂; (SP42), 1 ♀; (SP43), 1 ♀; (SP47), 5 ♀. Kandannge, 12–13.II.1966, SS (SP54), 2 ♂, 8 ♀. Kowiro, 28.II–4.III.1966, SS (SP128), 2 ♂; (SP156), 3 ♂, 2 ♀. Wewak, 7.III.1966, SS (SP159), 3 ♂; (SP160), 2 ♂ (BISHOP). SE NEW GUINEA. NORTHERN: Popondetta, 5 m, 16–19.IV.1966, SS (NEP1), 7 ♂; (NEP7), 1 ♂; (NEP9), 2 ♂; (NEP13), 2 ♂, 5 ♀; (NEP17), 2 ♂. GULF: Murua, 1–3.V.1966, SS (G2), 2 ♂; (G8), several L; (G9), several L; (G10), 2 ♂, 1 ♀; (G11), 3 ♂; (G17), 2 ♂, (G20), 3 ♂, 1 ♀; (G21), 29 ♂; (G25), 1 1p♂, 1 1p♀, several L; (G26), several L. CENTRAL: Port Moresby, Vanapa River, 30 m, 30.III.

1966, PFM (BBMNG-C361), 1 ♂; 18–20.III.1965, YMH and WAS (BBMNG-C2260), 38 ♀; (BBMNG-C2261), 24 ♂; 18–22.V.1965, YMH and WAS (BBMNG-C2270), 24 ♀; (BBMNG-C2279), 30 ♀; (BBMNG-C2309), 2 ♂; (BBMNG-C2315), 6 ♀ (Bishop). BISMARCK ARCHIPELAGO. New Ireland: Kavieng, 19–24.III.1966, 5–10 m, SS (NI5), 1 ♂, 3 ♀; (NI15), 1 ♂; (NI17), 4 ♂, 3 ♀; (NI19), 2 ♀; (NI29), 2 ♂; (NI44), 4 ♂, 7 ♀; (NI50), 1 ♀; (NI53), 4 ♂, 4 ♀. New Britain: Keravat, 20–30 m, 28.III–7.IV.1966, SS (NB4), 6 ♂; (NB6), 3 ♂, 2 ♀; (B22), 2 ♂; (NB27), 2 ♂; (NB28), 1 ♂, 1 ♀; (NB37), 1 ♂, 1 ♀; (NB38), 18 ♂, 2 ♀; (NB45), 3 ♂; (NB47), 3 ♂, 1 ♀; (NB49), as listed in type series, 5 L (Bishop).

27. **Culex** (**Lophoceraomyia**) **rajaneeae** Sirivanakarn, new species Fig. 44.

Type. Holotype ♂ (MN28) with slide of antenna and genitalia (661207-6), Lorengau, Manus Is., Bismarck Archipelago, collected among ferns along stream margin under deep shade of secondary forest, 15.III.1966, S. Sirivanakarn (Bishop 7740). This species is named after my wife, Rajanee Sirivanakarn for her interest in and numerous contributions to this study.

♂. (fig. 44) In general, similar to *cottlei* in size and ornamentation and to *buxtoni* in antennal scale tufts; with the following diagnostic features. *Palpus:* segment 3 with a ventrolateral tuft of 12–15 long setae. *Antenna:* F-5 with a fan-shaped tuft of 13, 14 very narrow subequal scales as long as the next 4 flagellomeres, the most dorsal 1, 2 scales usually dark, bluntly tipped and broad, followed lateroventrally by 10–12 pale whitish narrower scales and ventrally by 5–6 long normal hairs; F-7 with a comb-shaped tuft of curled setae as in *fraudatrix*.

Genitalia: (fig. 44) *Sidepiece* with 3 submarginal setae, widely spaced and in line close to tergomesal

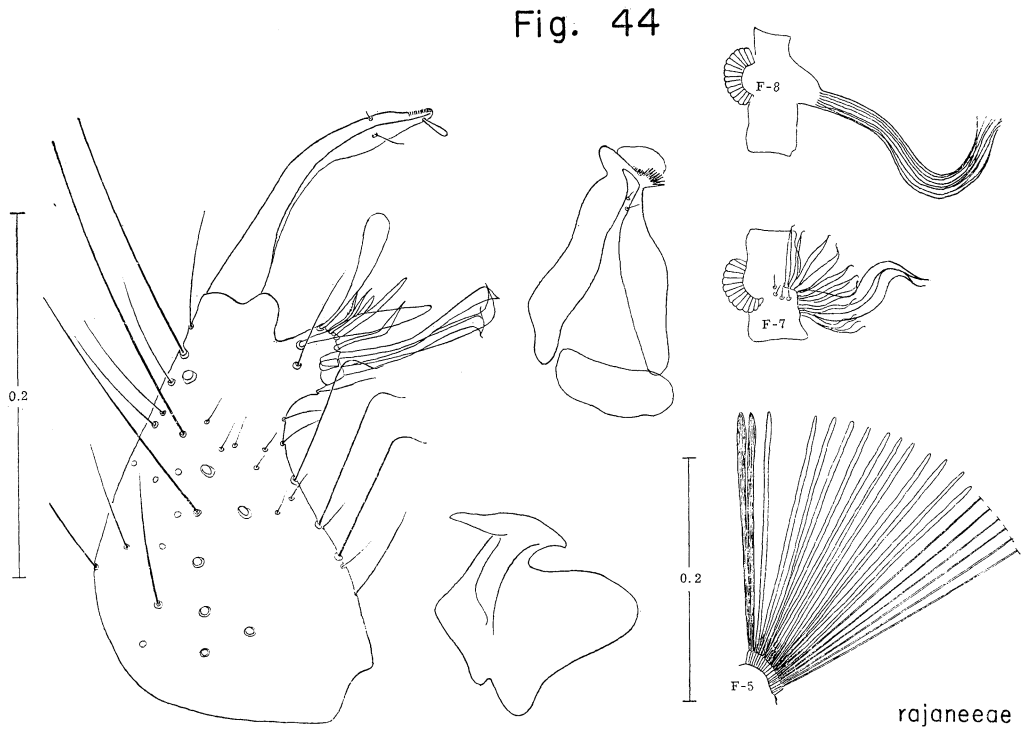


Fig. 44. Male genitalia and modified tufts of antennal flagellomeres 5, 7 and 8 of *C.* (*L.*) *rajaneeae*.

margin; marginal setae very few and about 0.25 of length of submarginals. *Subapical Lobe:* proximal part with 1 basal seta and 3 normal rods; distal part with 1 strong basal seta, 1 very broad and apically rounded external leaflet, 1 short, but distally broadened internal leaflet, and 4 accessory setae, 1 of which is subapically serrated. *Phallosome:* lateral plate with a short dorsal process with the outline of a duck's head. *Proctiger:* crown small. *Lobe* of 9th tergite with 2, 3 weak setae.

♀ AND IMMATURE STAGES. Unknown.

BIONOMICS. The unique specimen of *rajaneeae* was found in association with several specimens of *cottlei* along a stream margin in a very humid forest, in deep shade in a dense growth of ferns.

SYSTEMATICS. *C. rajaneeae* is superficially similar to *cottlei* and *buxtoni* but is clearly distinguished from both by the presence of a ventrolateral tuft of setae in the proximal part of palpal segment 3 and also in details of the genitalia. The form of the tuft on antennal flagellomere 5, the palpal and genital characters suggests that it is related to the *fraudatrix* complex and the *buxtoni* complex of Belkin (1962).

DISTRIBUTION. Known only only from Lorengau, *Manus* Is., as indicated for the holotype.

Solomonis Complex

The *solomonis* complex was established by Belkin (1962): 262–266) for *solomonis*, *walukasi*, *becki* and several unnamed species, all from the Solomon Is. This complex is distinguished from the *fraudatrix* complex (including Belkin's *buxtoni* complex) in the male by the absence of submarginal setae on the tergomesal margin of the sidepiece and the external leaflet of the subapical lobe replaced by a hairlike seta. In the larval stage, the unbranched hairs 4-VII and 2-III separate the *solomonis* complex from most species in the *fraudatrix* complex.

28. **Culex (Lophoceraomyia) solomonis** (Edwards) Fig. 45.

Culex (Lophoceratomyia) fraudatrix var. *solomonis* Edwards, 1929, *in* Paine & Edwards, B. Ent. Res. **20:** 316. Type: Lectotype ♂ with attached genitalia mount, Manaba, Malaita, Solomon Is., from shallow pool with rotting coconut leaves, 10.IX.1928, R. Paine; selection of Belkin (1962: 262) (BMNH).

Culex (Lophoceraomyia) solomonis of Belkin, Mosq. South Pacific, **1:** 262–264; Stone, 1963.

♂. (fig. 45) As figured and diagnosed in the present key. In general, as described by Belkin (1962); the 1 New Guinea specimen differing slightly in the following: *Antenna:* F-5 with a tuft of 6 brown acuminate scales and 1 flattened seta, the most dorsal scale longest, reaching almost to the level of flagellomere 8, the rest narrower and gradually decreasing in length, the tuft preceded dorsally by 1, 2 short hairlike setae and followed ventrally by 9, 10 long normal hairs; F-9 with a short and 4 long bladelike scales; F-10 with 4 bristle-like setae.

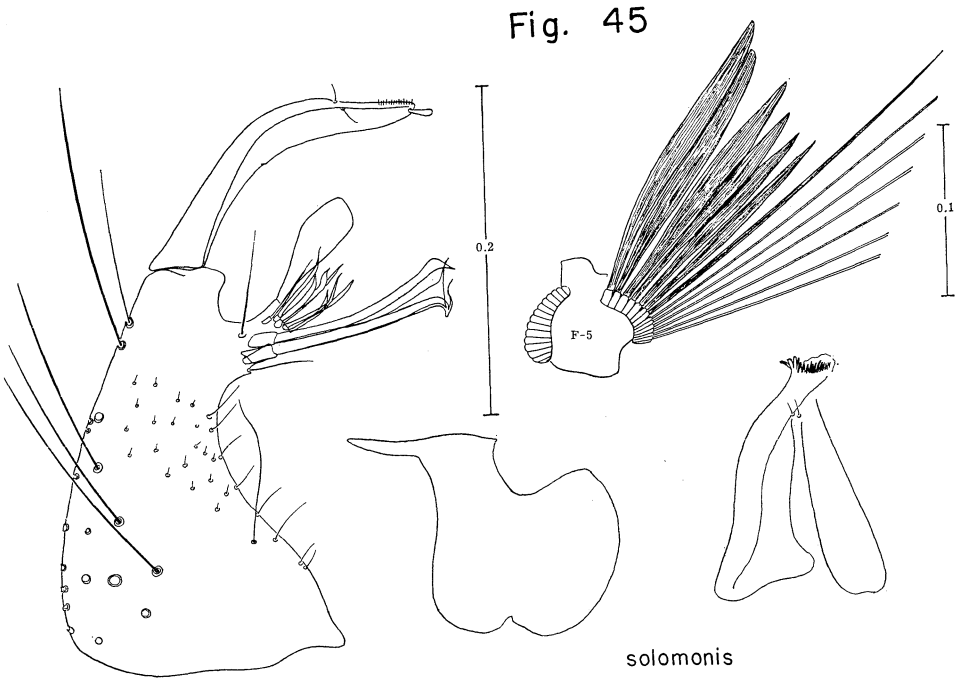
Genitalia: (fig. 45) As figured here; essentially as described and figured by Belkin (1962: 263); New Guinea specimen differing in the following. *Sidepiece* with 1 submarginal seta on 1 side, absent on the other. *Subapical Lobe:* distal part with 7, 8 markedly flattened accessory setae; internal leaflet very broad and rounded apically. *Lobe* of 9th tergite with 4 setae.

♀ AND IMMATURE STAGES. No specimens are available from New Guinea.

BIONOMICS. As given by Belkin (1962: 264).

SYSTEMATICS. The record of *C. solomonis* from New Guinea is based on a single male collected by E. S. Ross (24.IV.1944) in Finschafen, Morobe. This species differs from *fraudatrix* in having a smaller tuft of broad scales on antennal flagellomere 5, the external leaflet replaced by a hairlike seta, and more numerous accessory setae in the distal part of the subapical lobe.

DISTRIBUTION. Material examined: 1 ♂. NE NEW GUINEA. MOROBE: Finschafen, 24.IV.1944, ESR, 1 ♂ with slide of antenna and genitalia (651013-3). SOUTH PACIFIC.



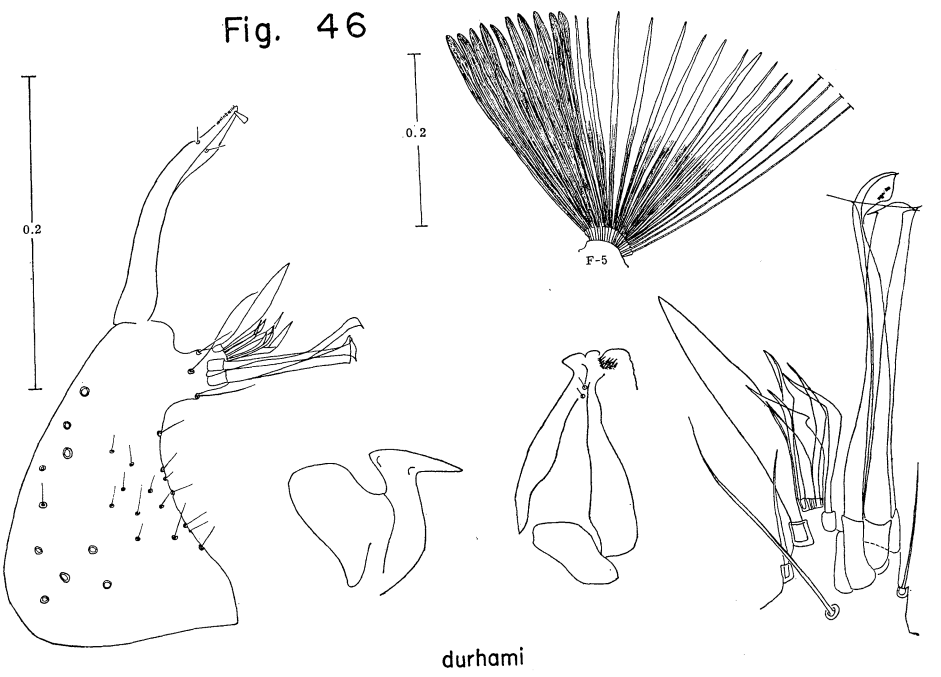


Fig. 45. Male genitalia and modified tuft of antennal flagellomere 5 of *C.* (*L.*) *solomonis*.
Fig. 46. Male genitalia and modified tuft of antennal flagellomere 5 of *C.* (*L.*) *durhami*.

SOLOMON Is.: Bougainville; Treasury; Kolombangara; New Georgia; Rendova, Guadalcanal; Florida; Malaita (Belkin 1962: 264).

29. **Culex** (**Lophoceraomyia**) **durhami** Sirivanakarn, new species Fig. 46.

Types: Holotype ♂ (SP19) with slide of antenna and genitalia (660916-2), Upau Stream, Maprik, Sepik, NE New Guinea, 6.II.1966, S. Sirivanakarn (BISHOP 7741). Paratypes: 3 ♂ (SP19), 2 ♂ (SP12), 1 ♂ (SP14), same locality as holotype; 2 ♂ (SP128) and 1 ♂ (SP156), Kowiro, inland of Wewak, Sepik, 28.II, 4.III.1966, S. Sirivanakarn (BISHOP). This species is dedicated to Dr S. Durham, Malaria Service, Maprik, Dept. of Public Health, Territory of Papua and New Guinea.

♂. (fig. 46) Small species with modified tuft on antennal flagellomere 5 as described for *fraudatrix* and *collessi;* differing from both in the following. *Palpus* more slender, projecting laterad from base of segment 2, not parallel to labium; segment 3 with ventrolateral tuft of setae 4, 5 × width of segment; segments 4 and 5 with fewer bristles. *Proboscis:* false joint at 0.2 from base; basoventral setae all weak, hairlike; a few dorsal upright setae in apical 0.2. *Antenna:* F-5 with a tuft of about 23 scales, all narrow; F-10 usually with 3 bristlelike setae. *Thorax:* mesonotal integument yellowish brown; propleuron with 1, 2 strong and 4–6 short weak bristles. *Abdomen:* tergites usually brown scaled or sometimes with basolateral pale spots on segments III–VII.

Genitalia: (fig. 46) As figured and very distinct from all New Guinea forms in the following. *Sidepiece:* submarginal setae absent; marginal setae 6–7. *Subapical Lobe:* proximal part with a strong basal seta and 3 very straight rods; distal part with the external leaflet replaced by a hairlike seta, basal seta strong, internal leaflet broad, with acuminate apex, 5 markedly flattened accessory setae, 2, 3 of which are in the form of a scalpel blade with a sharp apex. *Phallosome:* lateral plate with small slender dorsal process. *Proctiger:* crown very small, with minute spicules; ventrolateral sclerite narrow, ribbonlike; cercal sclerite with 2 minute setae. *Lobe* of 9th tergite very poorly developed, usually with 1, 2 weak setae.

♀ AND IMMATURE STAGES. Unknown.

BIONOMICS. This species is known only from low inland areas of New Guinea, where males were found along the margins of small streams in dense rain forest in association with numerous specimens of *fraudatrix*.

SYSTEMATICS. *C. durhami* is very similar to *fraudatrix* and *collessi* in the tuft of antennal flagellomere 5. However, it is strikingly different from both forms in a smaller size, presence of a few dorsal upright setae on the labium and in details of genitalia as described. This species is placed in the *solomonis* complex because the external leaflet of the subapical lobe is replaced by a hairlike seta and because of the absence of submarginal setae on the sidepiece.

DISTRIBUTION. Material examined: 10 ♂. NE NEW GUINEA. SEPIK: Kowiro, Maprik; as listed in type series.

Hurlbuti Complex

The *hurlbuti* complex was proposed by Belkin (1962) for *hurlbuti, perryi* and an undescribed species, all from the Solomon Is. The male characters of this complex are essentially similar to the *solomonis* complex. The larval chaetotaxy, however, differs markedly from the latter in the branching of several hairs and particularly in the reduction of prothoracic hair 8-P (Belkin 1962 v. 2, fig. 174).

30. **Culex** (**Lophoceraomyia**) **hurlbuti** Belkin

Culex (*L.*) *hurlbuti* Belkin, 1962, Mosq. South Pacific **1:** 266–268. Type: Holotype ♂ (JNB 920-205) with associated larval and pupal skins and genitalia slide, Tenaru Area, Guadalcanal, Solomon Is., from leaf axil of pandanaceous plant, 15.III.1945, J. N. Belkin and M. Cohen (USNM, 65768).

Culex (*L.*) *hurlbuti* of Stone, 1963.

♂. No material available from the Bismarck Archipelago.

♀. *Wing:* 2.3 mm. *Forefemur:* 1.1 mm. *Proboscis:* 1.5 mm. *Palpus:* 0.16 of proboscis. In general, as described by Belkin (1962); obviously differing from most ground pool forms in smaller size; slender palpus; proboscis with 2 very weak basoventral setae; wing scales very narrow and scanty; abdominal tergites dark scaled dorsally, pale scaled laterally.

LARVA. *Head:* 0.6 mm. *Siphon:* 1.2 mm; index 9.0; ratio 4.6. Diagnostic characters as in key; chaetotaxy essentially as figured by Belkin (1962) except for the following. *Abdomen:* hair 1-III–VI double; 6-III–V triple. *Siphon:* longer; pecten with 16 teeth; siphonal tufts 3, 4 × width of siphon at points of attachment. *Anal Segment:* hair 2-X double, the shorter branch about 0.75 of length of the longer.

PUPA. *Abdomen:* 1.8 mm. *Paddle:* 0.6 mm. *Trumpet:* 0.5 mm; index about 15. As figured and described by Belkin (1962), differing slightly in the following. *Metanotum:* hair 10-C double; 12-C as strong as 10-C, with 3 branches. *Abdomen:* hair 5-II triple, 5-III–VI double.

BIONOMICS. Only 1 larva and 1 pupa were collected in an axil of a smooth-leaved pandanus in a flooded mangrove swamp about 45 m from the coast. No adults were found in the field.

SYSTEMATICS. The limited material from Kavieng obviously belongs to the *hurlbuti* complex. It is provisionally identified as *hurlbuti* although it may be represent a new species in the complex. The *hurlbuti* complex apparently belongs to the *fraudatrix* group on the basis of male characters as described by Belkin (1962). The larva is very distinct from other members of the group in having prothoracic hair 8-P very weak as in several members of the *mammilifer* group. This similarity is probably due to convergence.

DISTRIBUTION. Material examined: 1 adult ♀ with associated pupal skin, 1 whole larva. BISMARCK ARCHIPELAGO. NEW IRELAND: Kavieng, 5 m, pandanus leaf axil, 21.III.1966, SS (NI33), 1 p♀, 1 L. SOUTH PACIFIC. Solomon Is.: Bougainville, Guadalcanal (Belkin 1962).

Pseudorubithoracis Complex

The *pseudorubithoracis* complex is recognized here for *pseudorubithoracis* and *sedlacekae*. It may also include *rubithoracis* Leicester 1908 and *niger* Leicester 1908 as described by Colless (1965) from the Indomalayan area. The diagnostic characters of the *pseudorubithoracis* complex are: flagellomere 5 of male antenna with a small tuft of 6–7 short hairlike setae; palpal segment 3 without ventrolateral tuft of setae; internal leaflet of the distal part of subapical lobe narrow, rodlike.

31. **Culex** (**Lophoceraomyia**) **pseudorubithoracis** Sirivanakarn, new species Fig. 47.

Types: Holotype ♂ (CR0) with slide of antenna and genitalia (660812-9), Korogo, Sepik River, NE New Guinea, 8.III.1964, D. H. Colless (BISHOP 7742). Paratypes, same data as holotype; 6 ♂ (CR0) with slides of antenna and genitalia (650820-2, 660817-6, 660817-7, 660817-8) (BISHOP); 2 ♂ (CR0) with slides of antenna and genitalia (650820-1, 650820-4) (USNM); 2 ♂ (CR0) with slides of antenna and genitalia (651012-3, 660817-1) (BMNH); 2 ♂ (CR0) with slides of antenna and genitalia (660817-2, 660817-3) (ANIC); 2 ♂ (CR0) with slides of antenna and genitalia (660817-4, 660817-5) (UCLA).

♂. (fig. 47) *Head:* broad scales on vertex predominantly pale to whitish, intermixed with some darker ones on occiput; palpus and proboscis covered with pale scales underneath. *Antenna:* F-5 usually with a very small tuft of 6, 7 flattened and pointed setae, the most ventral one usually longest, as long as the next 4 flagellomeres, the rest shorter, subequal; F-7 with a comb-shaped tuft of curled setae of gradually decreasing length and an internal tuft of 2 narrow, strongly curled setae; F-8 with a slender hooked tuft of 4 fused setae. *Thorax:* mesonotal integument yellowish brown; lower anterior mesepimeral bristle present.

Genitalia: (fig. 47) As figured; diagnostic characters as in key. *Sidepiece* with 1 short, weak and 3 long subequal submarginal setae in line, rather widely spaced. *Subapical Lobe:* proximal part usually without

Fig. 47

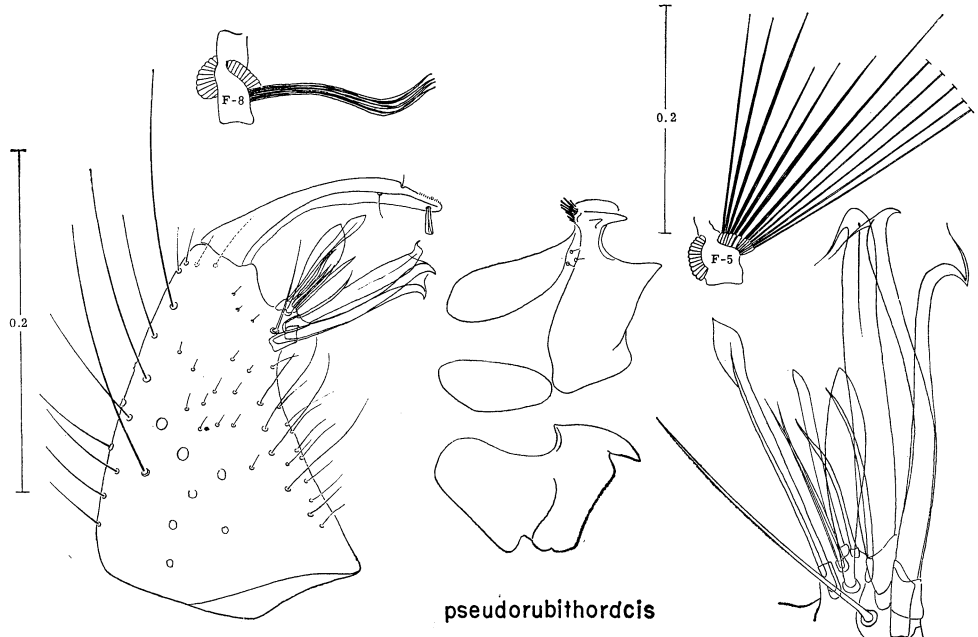


Fig. 48

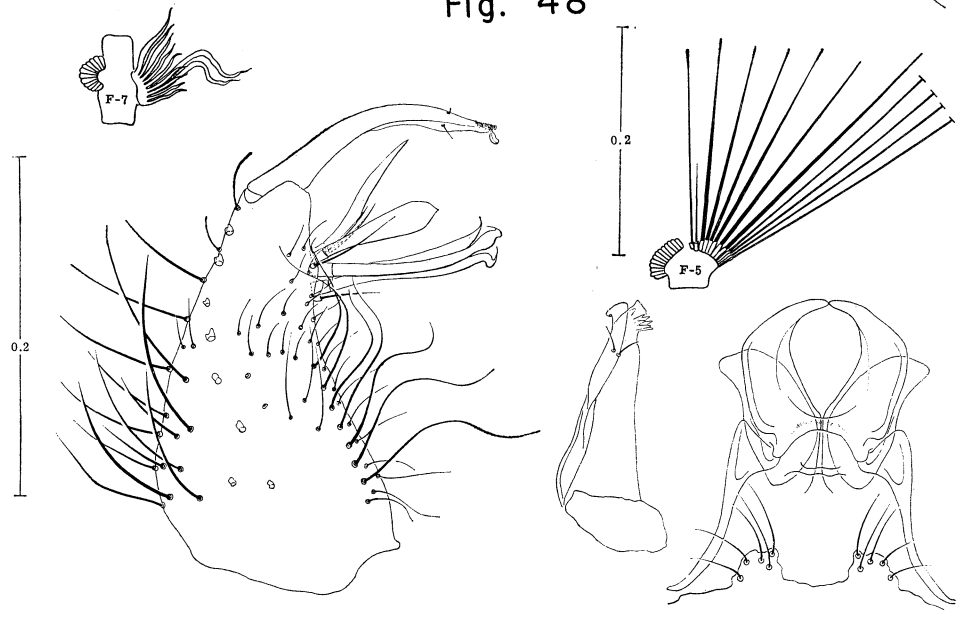


Fig. 47. Male genitalia and modified tufts of antennal flagellomeres 5 and 8 of *C.* (*L.*) *pseudorubithoracis.*

Fig. 48. Male genitalia and modified tufts of antennal flagellomeres 5 and 7 of *C.* (*L.*) *sedlacekac.*

basal seta, internal rod very thick and broad, its base removed distad of the other 2 rods; distal part with a strong basal seta, a broad external leaflet, a very narrow internal leaflet and 4, 5 accessory setae. *Phallosome:* lateral plate with very short dorsal process. *Proctiger:* ventrolateral sclerite produced sternally into a sharp ridge; cercal sclerite with 2, 3 setae. *Lobe* of 9th tergite very poorly developed, usually with 2 weak setae.

♀ AND IMMATURE STAGES. Unknown.

BIONOMICS. The males of *pseudorubithoracis* were obtained in general field catches in bushes along a river margin. They were found associated with *fraudatrix*, *ornatus*, *collessi*, and *lakei*.

SYSTEMATICS. *C. pseudorubithoracis* is very similar to *rubithoracis* from which it is distinguished especially by the presence of a mesepimeral bristle, characteristic development of the ventrolateral sclerite of the proctiger, and details of the subapical lobe as described. This species is also very similar to *sedlacekae* in the male antenna but is strikingly different from the latter in the genitalia, palpus and proboscis.

DISTRIBUTION. Material examined: 49 ♂. NE NEW GUINEA. SEPIK: Korogo, Sepik River, 10 m, 8.III.1964, DHC (CR0), 31 ♂. Siutmeri, Sepik River, 16.III.1964, DHC (CR0), 16 ♂. Kandannge, Sepik River, 2.III.1964, DHC (CR0), 1 ♂, 13.II.1966, SS (SP61), 1 ♂ (BISHOP).

32. **Culex** (**Lophoceraomyia**) **sedlacekae** Sirivanakarn, new species Fig. 48.

Type: Holotype ♂ (BBMNG-C2086) with slide of antenna and genitalia (660817-2), Lae, Morobe, New Guinea, Malaise trap, 16–30.III.1965, W. A. Steffan and Y. M. Huang (BISHOP 7743). This species is named after Marie Sedlacek, Bishop Museum Field Station, Wau, Morobe, NE New Guinea.

♂. (fig. 48) Very similar to *pseudorubithoracis* in size, general ornamentation and antenna, differing chiefly in the following. *Palpus:* basal fingerlike processes strongly developed, slightly exceeding distal part of segment 1. *Proboscis:* labium with 2 dorsal rows of sinuous setae in apical 0.6–0.7, the most distal seta about 4 × labial width. *Antenna:* individual setae of tuft of F-5 darker and more flattened. *Thorax:* mesonotal integument brownish.

Genitalia: (fig. 48) As figured; diagnostic characters as in the key; distinctive in the following features. *Sidepiece:* slender, its length almost 2 × basal width; 7 submarginal setae all equally strong, distally bent toward or away from the subapical lobe. *Subapical Lobe:* proximal and distal parts poorly defined; proximal part with 3 smoothly curved rods and 1 basal sata; distal part with 1 strong basal seta, 1 oblong external leaflet, 1 rodlike internal leaflet and 2, 3 hairlike accessory setae. *Phallosome:* lateral plate with stout dorsal process. *Proctiger:* with crown of strong spinelike spicules; ventrolateral sclerite ribbonlike, its apex with a single external lobe.

♀ AND IMMATURE STAGES. Unknown.

BIONOMICS. Only 1 male was collected in a Malaise trap set over a ground pool at the margin of a secondary forest.

SYSTEMATICS. *C. sedlacekae* is very distinct in the male genitalia but is rather similar to the members of the *petersi* complex in having a long basal process on the palpus and in the presence of several dorsal upright setae in the distal part of the labium.

DISTRIBUTION. Material examined: 1 ♂. NE NEW GUINEA. MOROBE: Lae, secondary rain forest, 10–20 m, 16–30.III.1965, WAS and YMH (BBMNG-C2086), (BISHOP).

Cottlei Complex

33. **Culex** (**Lophoceraomyia**) **cottlei** Sirivanakarn, new species Fig. 49, 50.

Types: Holotype ♂ (MN1-10) with associated larval and pupal skins and slide of antenna and genitalia, Lorengau, Manus Is. swamp depression with a few sago palms, 10.III.1966, R. Cottle and S. Sirivanakarn (BISHOP 7744). Paratypes same data as the holotype; 1 ♂ (MN1-11) with associated larval and pupal skins and slide of antenna and genitalia; 1 ♂ (MN1-108) with asso-

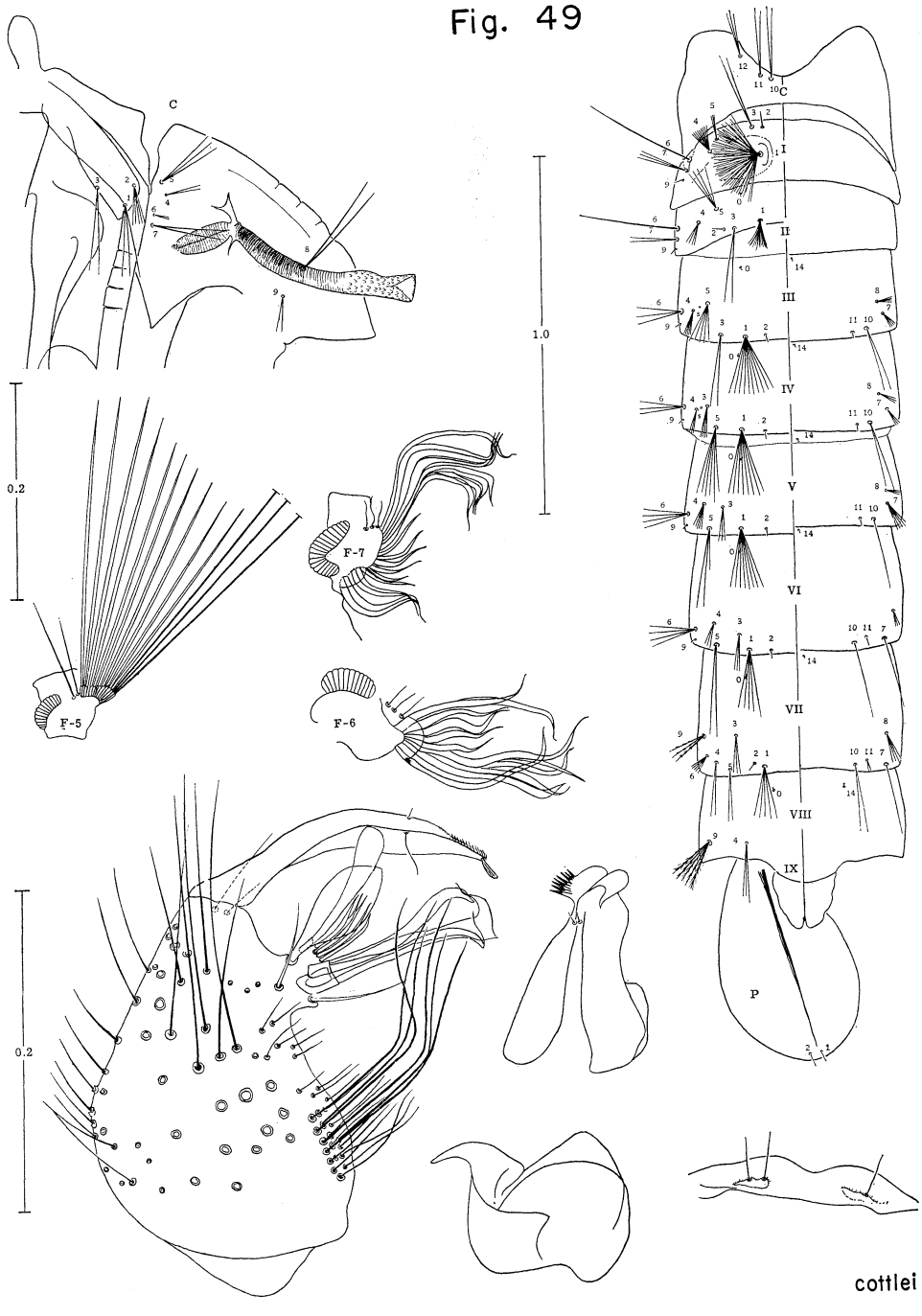


Fig. 49. Pupa, male genitalia and modified tufts of antennal flagellomeres 5–7 of *C.* (*L.*) *cotrlei.*

Fig. 50

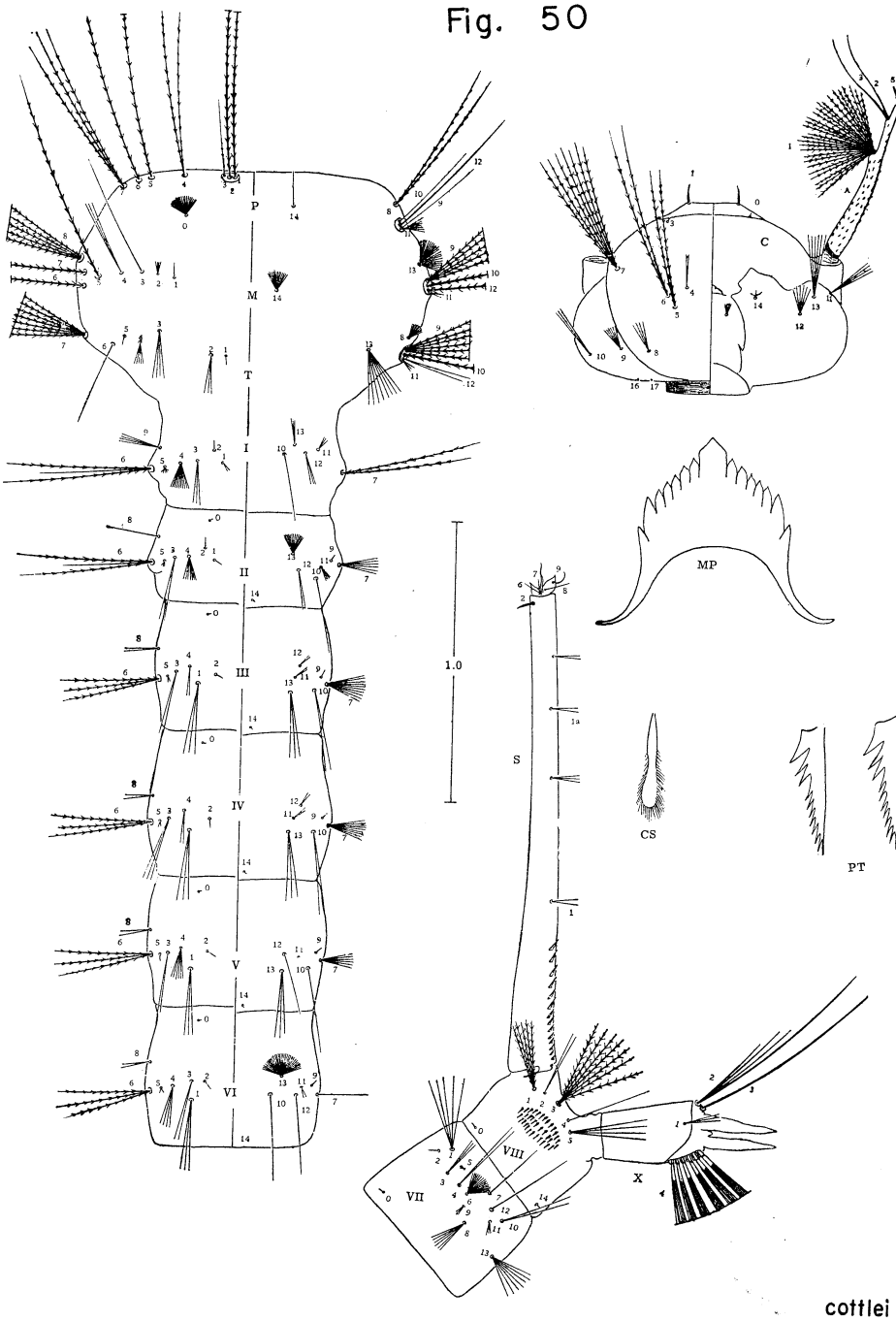


Fig. 50. Larva of *C.* (*L.*) *cottlei*.

ciated pupal skin and slide of palpus, antenna and genitalia; 1 ♂ (MN1-103) with associated larval and pupal skins, 1 larva (MN1) (BISHOP). This species is dedicated to Robert Cottle, Dept. of Agriculture, Manus Headquarters, Territory of Papua and New Guinea.

♂. (fig. 49) Small dark species; distinctive in the following features. *Head:* narrow decumbent scales confined to lateral areas of occiput. *Palpus:* very thin, exceeding proboscis by about 0.5 of length of the apical segment; basal processes very slender, slightly shorter than the distal part of segment 1; segment 3 without ventrolateral tuft of setae, its apex with 1, 2 bristles; segments 4 and 5 with rather weak bristles. *Proboscis:* false joint present; distal 0.5 of labium with 2 dorsal rows of upright setae which are as long as or a little longer than labial width; basoventral setae very slender and hairlike. *Antenna:* F-5 with a tuft of 9, 10 hairlike setae as long as next 4 flagellomeres, preceded dorsally by 1, 2 tiny setae and followed ventrally by 4, 5 long normal hairs; F-7 with a group of 6, 7 long, fused setae forming an elbow just beyond the middle and several short curled setae forming a comb; F-8 with slender hooked tuft; F-9 with 1, 2 short and 2, 3 bladelike scales; F-10 with 3, 4 long, stout setae. *Thorax:* mesonotal scales dark brown to almost black; lower anterior mesepimeral bristle present. *Wings:* scales pale and very scanty. *Legs:* without marked ornamentation. *Abdomen:* tergites entirely dark scaled.

Genitalia: (fig. 49) As figured; diagnostic characters as in the key. *Sidepiece* stout and bulbous basally, strongly convex tergally, with several strong bristles sternally and a dense group of several short and 5, 6 long submarginal setae in 3, 4 rows. *Subapical Lobe:* proximal part with 1 strong basal seta and 3 normal rods; distal part with 1 strong basal seta, 1 very broad external leaflet, 1 club-shaped internal leaflet and 4, 5 bladelike accessory setae. *Clasper* with rather long ventral subapical seta. *Phallosome* and *proctiger* similar to most forms in the *fraudatrix* group except that dorsal process of the lateral plate shorter. *Lobe* of 9th tergite very poorly developed, usually with 1, 2 very weak setae.

♀. *Wing:* 2.6 mm. *Forefemur:* 1.4 mm. *Proboscis:* 1.8 mm. *Palpus:* 0.2 of proboscis. In general, as described for ♂ except that head scales darker, wing scales darker and denser, abdominal tergites usually dark scaled or occasionally with some indistinct basolateral pale spots.

LARVA. (fig. 50) *Head:* 0.65 mm. *Siphon:* 1.3–1.65 mm (average 1.53); index: 6.7–10.6 (average 9); ratio 4.3–5.3 (average 5). *Pigmentation* variable depending on type of habitat, usually uniformly yellowish white in all specimens from ground pools, darker in specimens from sago stumps. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* hair 4-C weak, a little longer than 0.5 of distance between bases, usually forked beyond the middle in 2 branches. *Antenna:* usually creamy white along the whole shaft. *Thorax:* hair 3-P usually single (1–2). *Abdomen:* hair 1-I usually branched (1–3); 1-III–VI usually triple (3–4); 4-VII usually double (1–2); 2-VIII always double. *Comb* with 42–46 evenly fringed scales. *Siphon:* usually with 8 subventral tufts (8–10) with 2, 3 branches as long as siphon width at points of attachment; pecten with 13–18 teeth. *Anal Segment:* hair 2-X usually with 1 long and 2, 3 short branches; anal gills as long as saddle or slightly longer.

PUPA. (fig. 49) *Abdomen:* 2.0 mm. *Paddle* 0.6 mm. *Trumpet:* 0.55 mm; index 8–11 (average 10). Trumpet with characteristic swelling above just beyond the middle, shorter than in most forms. Chaetotaxy as figured; diagnostic characters as in the key; extremely similar to *C. fraudatrix*, differing in the combination of following features. *Cephalothorax and Metanotum:* hair 5-C with average of 3 branches (2–5); 12-C always triple. *Abdomen:* hair 7-I usually triple (2–3); 6-III–IV usually triple.

BIONOMICS. Adults of *cottlei* were collected resting in or flying among ferns and herbs along stream margins in a secondary forest. The immature stages were found in a swamp depression in the shade of scattered sago palms, in a deeply shaded sago stump and in a grassy ditch in a coconut plantation. The larvae from sago stumps were associated with numerous larvae of *Culex* (*Mochthogenes*).

SYSTEMATICS. The very constant peculiar development of the tuft on flagellomere 7 and the male genitalia separate *cottlei* from all other forms in the *fraudatrix* group. The larvae from sago stumps are darker than the type series, while those from grassy ditches have the shortest siphon. The pupae in all collections are all very similar and easily recognized by a peculiar swelling in the

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New names are indicated by **bold face** types, synonyms by *italics*