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Publications of the United States National Museum

The scientific publications of the United States National Museum include two series, *Proceedings of the United States National Museum* and *United States National Museum Bulletins*.

In these series are published original articles and monographs dealing with the collections and work of the Museum and setting forth newly acquired facts in the fields of anthropology, biology, geology, history, and technology. Copies of each publication are distributed to libraries and scientific organizations and to specialists and others interested in the various subjects.

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In the *Bulletin* series, the first of which was issued in 1875, appear longer, separate publications consisting of monographs (occasionally in several parts) and volumes in which are collected works on related subjects. *Bulletins* are either octavo or quarto in size, depending on the needs of the presentation. Since 1902, papers relating to the botanical collections of the Museum have been published in the *Bulletin* series under the heading *Contributions from the United States National Herbarium*.

FRANK A. TAYLOR

Director, United States National Museum

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A NEW SPECIES OF BURROWING ACONTIATE ANEMONE FROM CALIFORNIA (ISOPHELLIIDAE: FLOSMARIS)

By CADET HAND *and* RALPH BUSHNELL¹

In a series of papers, Hand (1955, 1955a, 1956, 1958) described certain of the sea anemones of central California. The new species herein considered adds to that list.

The first specimens were collected in 1949 from intertidal mud flats of San Francisco Bay adjacent to Bay Farm Island, Alameda County, California. The flat is composed of fairly firm sand in which is mixed considerable mud and accumulated mollusk shells in various stages of disintegration.

The anemones occur with the base attached to fair sized remains of clam shell, small stones or even pieces of wood some 30–46 cm. beneath the surface. The oral end extends to the surface. Thus, when located in their original habitat, most of the 70 animals so far found, were about 30–46 cm. in length; however, they are only about 6–7 mm. in diameter except at the disc and base. The base may be up to 2.5 cm. in diameter and well covered with bits of clam shell and much sand, which remain adhering when the animal is dug from its burrow. Much care is needed in digging this species from its natural position as it is very easy to misjudge the depth at which the base is located,

¹ Both authors: Department of Zoology, University of California, Berkeley, Calif.

and, as frequently happens, the specimen may be cut in two before the base is freed from its attachment.

The area inhabited by this species is between the midintertidal and the mean lower-low water level, and they are most easily obtained by searching for them when there is a good minus tide. At these times they are commonly observed with their tentacles extended at the entrance to their burrow, but any movement near them will cause them to contract so that the body is drawn down into the burrow. As one starts to dig for them, they continue to contract until they reach one-third or less of their normal length. When the collector is successful in dislodging them he retrieves an anemone appearing to be about 10–15 cm. long and about 2 cm. in diameter at its widest part (exclusive of the foot). Occasionally, when too much pressure is applied against them in their burrows they will be seen to emit tiny jets of water from cinclis-like openings in the upper column. We do not believe that this is a natural reaction or one that would occur frequently in the absence of abnormal pressure. Weak areas evidently occur in the upper part of the column, but histologically these do not appear to be typical cinclides.

So far in the laboratory, we have not been able to relax specimens to anywhere near their normal length, i.e., 30–46 cm. On preservation they tend to shorten to 15 cm. or less.

We wish to thank both Mr. Marshall and Mr. Holleman for making the observations reported herein available to us.

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Family Isophelliidae

ISOPHELLIIDAE Stephenson, 1935, p. 183.

Thenaria (Acontaria). Sphincter mesogloal. Mesenteries divisible into macro- and microcnemes; the older microcnemes may, however, be provided with filaments and acontia. Acontia with two categories of nematocysts, basitrichs, and microbasic amastigophores.

Genus *Flosmaris*

Flosmaris Stephenson, 1920, p. 441.

Isophelliidae with the elongate column divisible into scapus and scapulus, the former with tenaculi. Cinclides present or possibly absent. Margin tenaculate. Tentacles simple, their longitudinal muscles ectodermal as are the radial muscles of oral disc. Sphincter mesogloal; situated in upper part of scapulus. Twelve pairs of macrocnemes bearing gonads, though number may vary as result of

asexual reproduction. Macrocnemes all perfect and with strongly restricted to circumscribed retractors. Microcnemes weak, consisting chiefly of parietal muscle. Acontia present on macrocnemes and sometimes on some microcnemes. Cnidom: spirocysts, basitrichs, microbasic amastigophores; also atrichs and holotrichs if catch-tentacles are present.

The generic diagnosis above is the one given by Hand (1961). It differs slightly from that of Stephenson (1920) and incorporates certain modifications resulting from the inclusion of *Flosmaris bathamae* Hand (1961) in this genus.

Flosmaris grandis, new species

FIGURES 1, 2

Base: Generally circular, adherent and usually larger than scapus. Basilar muscles present and well developed.

Column: Elongate, divided into scapus and scapulus, cylindrical and up to 20 cm. long and 2 cm. diameter in the preserved condition. In living condition within their burrows, column is up to 46 cm. long. Diameter of column tapers from less than 0.5 cm. just above base to about 1.5 cm. in region of scapulus in a large individual. Removed from natural surroundings, column usually expanded in upper two-thirds, tapering to meet flaring base, and resembling long, slender goblet (fig. 1). Column translucent or pale white, depending on degree of expansion or contraction of individual. Mesenterial insertions visible as pale white lines.

Scapulus short, usually less than one-fifth of total column, somewhat more transparent than scapus and thereby distinguished from the latter. Histological preparations show a thinning of all layers in the scapulus. No cinclides or tenaculi present in scapulus and there appear to be fewer gland cells in scapus.

Scattered tenaculi present in upper third of scapus, but sand grains rarely found attached to them. Weakened areas somewhat comparable to poorly developed cinclides present in upper part of scapus. Mesogloea of column about of the same thickness as endoderm but only about 0.8 as thick as ectoderm.

Mesogloea sphincter (fig. 2a) fairly well developed at top of the scapulus and immediately adjacent to tentacle bases.

Circular, endodermal muscles present throughout length of column but not extensively developed.

Tentacles and Oral Disc: All the specimens so far examined have only regular tentacles, catch tentacles being unobserved. From 90 to 144 tentacles have been counted on various individuals. Inner tentacles usually hexamerously arranged. Individual tentacles extend to 1.6 cm. in length, and total crown may attain a diameter of as much as 3.5 cm. Tentacles thin, transparent, and gently tapered.

Only a small amount of coloration is found on animal and is in bars or incomplete rings of white granules against a dark background at bases of tentacles. Lips seldom seen raised above level of disc and are smooth and unpigmented.

Tentacles fully retractile and have ectodermal longitudinal muscles. Radial musculature of disc is ectodermal also.

Mesenteries: In upper part of body of perfect specimens there are 12 pairs of complete and fertile macrocnemes, including 2 pairs of directives that correspond to the 2 siphonoglyphs, and 36 pairs of

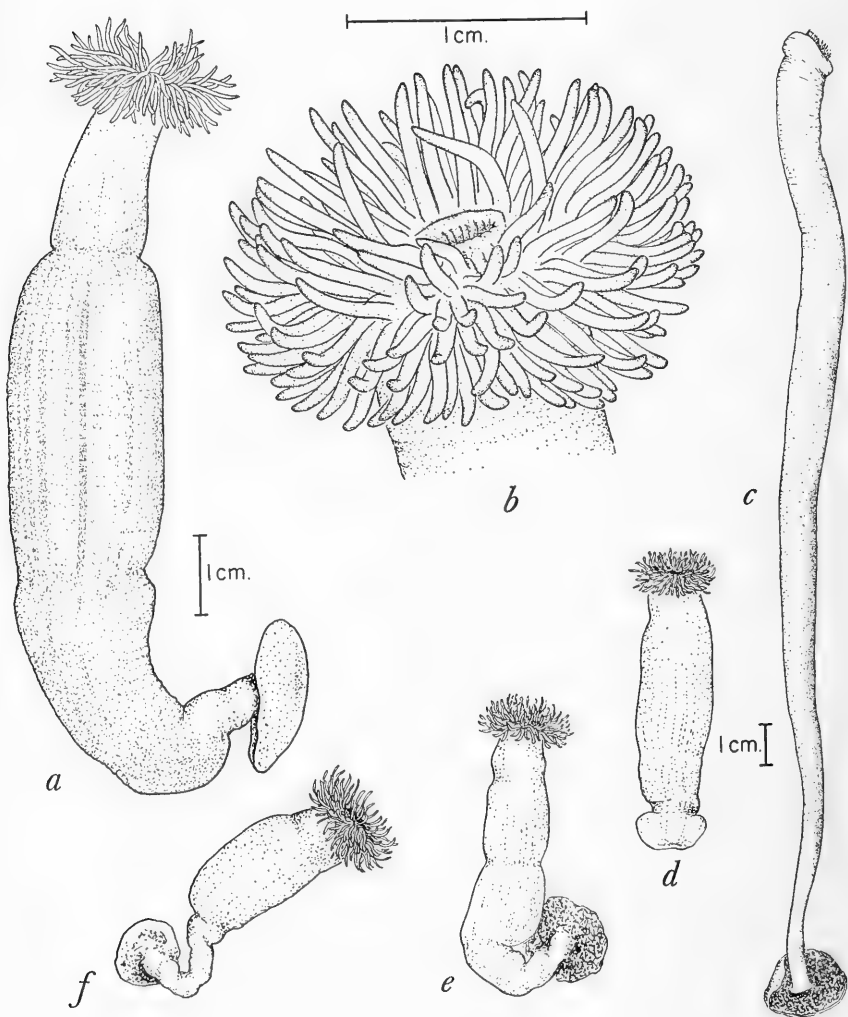


FIGURE 1.—*Flosmaris grandis*: a, d-f, live specimens removed from their burrows; b, enlargement of the oral disc and tentacles; c, relaxed and extended preserved specimen.

microcnemes (fig. 2*b*). In scapus, especially lower parts, number of mesenteries decreases, and there are approximately half as many mesenteries at base as in oral end (fig. 2*c*). Dissections of 12 specimens and sections of 6 showed from 8 to 12 pairs of mesenteries may be perfect, fertile macrocnemes (fig. 2*d*). No form of asexual reproduction has been observed in this species.

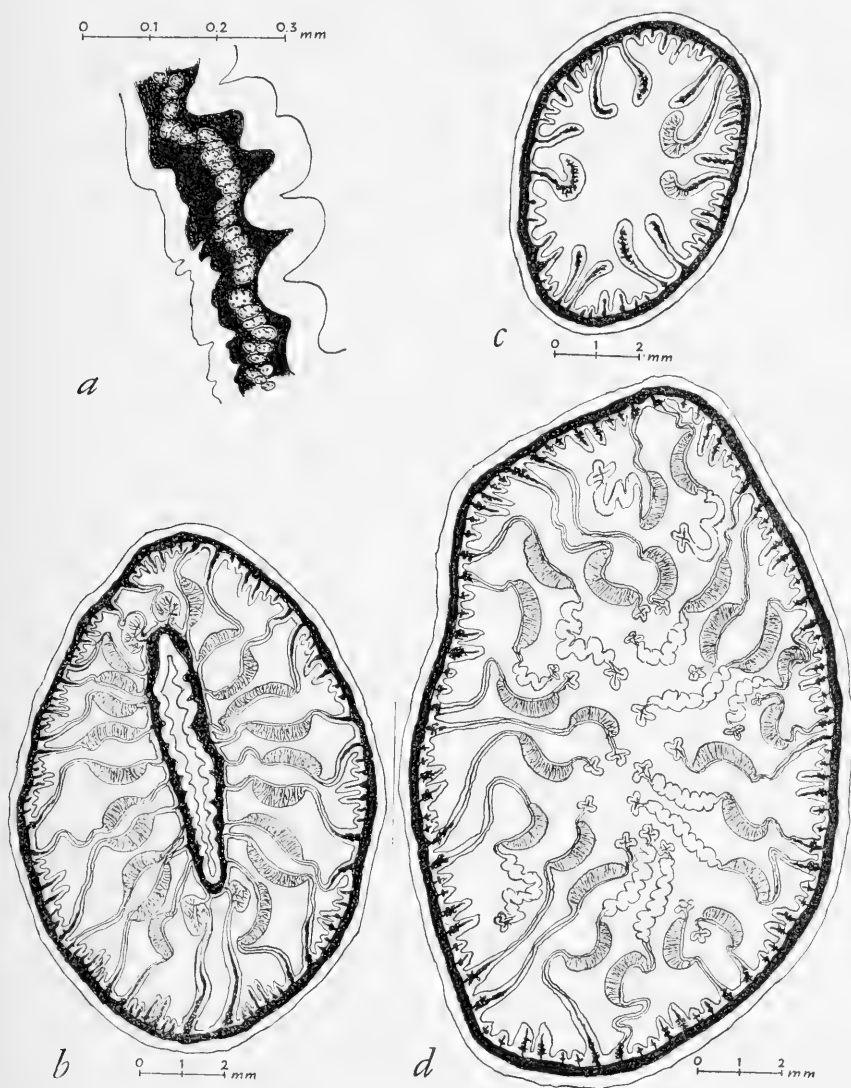


FIGURE 2.—*Flosmaris grandis*: *a*, sphincter muscles within the mesogloea; *b*, cross section of mesenteries in region of actinopharynx; *c*, cross section of column just above pedal disc; *d*, mesenteries in midregion of the column.

The 6 pairs of macrocnemes of first cycle have large restricted retractors (fig. 2b) running throughout their length, while second cycle has only slightly smaller restricted retractors. Directive retractors tend to be circumscribed. There is a moderately well-developed parietal musculature on macrocnemes, while microcnemes (fig. 2b) consist only of parietal muscles, there being no mesenterial sheet. A trifid mesenterial filament and acontium are present on each macrocneme, but were not observed on any microcneme.

Cnidom (spirocysts, atrichs, basitrichs, and microbasic amastigophores):

<i>tentacles</i>	<i>microns</i>
spirocysts	17-22×3.0-4.0
basitrichs	19-27×3.0-4.0
basitrichs	14-16×2.5-3.0
<i>scapus</i>	
basitrichs	18-26×3.0-3.5
basitrichs	9-14×2.0-2.5
atrichs (rare)	8-10×3.0
<i>actinopharynx</i>	
basitrichs	26-34×5.0-6.0
basitrichs (rare)	18-20×4.0-5.0
microbasic amastigophores	16-20×5.0-6.0
<i>filaments</i>	
basitrichs	24-29×3.0-4.0
basitrichs (rare)	12-16×2.0-3.0
microbasic amastigophores	14-18×4.5-6.0
<i>acontia</i>	
basitrichs	20-29×2.5-3.0
basitrichs (rare)	16-18×2.0-2.5
microbasic amastigophores	33-42×5.0-7.0

Type locality: Bay Farm Island, Alameda Co., Calif.

Holotype: Deposited in the United States National Museum as no. 52592.

Paratypes: Five additional specimens are deposited in the United States National Museum as nos. 52593 and 52594.

Discussion

The new species described herein is abundant in the intertidal zone of many parts of San Francisco Bay and also occurs in the estuary separating Alameda from Oakland, Calif. *Flosmaris grandis* is only the third species assigned to this genus, the others being the type species, *F. phellioides* Stephenson, 1920, and *F. bathamae* Hand, 1961. *F. phellioides* was described from a single specimen collected at Hulule Island, N. Male Atoll, Maldivé Archipelago, and *F. bathamae* is known only from Otago Harbor in southern New Zealand. *F. bathamae* is a small species, the maximum length being about 2.5 cm.,

while *F. grandis* is some 18 times longer than this. The size of *F. phellioides* is not known. There is some question, certainly, whether *F. bathamae* and *F. grandis* are cogenetic with *F. phellioides*. Stephenson's original description of *F. phellioides* is very brief and no diagnosis of nematocysts was given. The new species agrees with the type species in having more mesenteries distally than proximally, but differs from *F. bathamae* in this respect. Also, no catch tentacles have been observed in *F. grandis* or *F. phellioides*, but they are present in *F. bathamae*. *F. grandis* resembles *F. bathamae* in its restricted retractors whereas *F. phellioides* is reported to have circumscribed retractors. For the time being it seems most reasonable to treat all these species as members of the genus *Flosmaris*, and what is most needed is fresh material of *F. phellioides*. When *F. phellioides* is rediscovered it should be possible to make a more detailed comparison of these species and, hopefully, to understand better the nature of this genus.

Some interesting observations on *F. grandis* in captivity have been made by Mr. Edward Arthur Marshall, a student at Oakland City College. We received these observations through Mr. John Holleman, a biology instructor at the College. Mr. Marshall has kept individuals of this species in unaerated aquaria for several months and has observed that when detached from the substrate and placed on sand in water that the animals actively burrow and reattach. Burrowing is apparently accomplished by extensions of the pedal disc and undulations of the body. After attaching at a given point on the bottom of an aquarium with a 6.5 cm. deep layer of sand, movement from place to place occurs, and individuals were recorded as having moved a distance of 13 cm. overnight. The captive animals accepted a wide variety of foods including almost any small, soft-bodied organism. They readily accept small flies, the larvae of several insects, gnats, small spiders, small gastropods, and land slugs, brine shrimps, copepods, and small marine organisms in general, but refuse earwigs and small beetles. When food objects are dropped near an anemone, they extend the upper part of the body from their burrow toward the food. Successful capture of the food usually follows. When an injured, but living, house fly is placed on the surface of the aquarium, the anemone actively extends toward the surface of the aquarium, and captures it with its tentacles. This occurs only when the fly is still active and moving but trapped in the surface film. One might wonder if this last described behavior occurs in nature, and while no absolute answer is possible, it is readily demonstrable that many, many insects are indeed blown into the Bay.

The behavior described may then be one which is adaptively valuable to the species and a perfectly normal bit of behavior as well.

Summary

A new species of *Flosmaris*, *F. grandis* is described. This is the third species known in this genus. The genus is not well understood, and the type species, *F. phellioides* from the Maldiv Islands needs to be restudied. Some observations on the living animals are reported, and the capture of food on the surface of an aquarium is described.

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REVIEW OF SOUTH AMERICAN FRESHWATER ANGELFISHES—GENUS *PTEROPHYLLUM*

By LEONARD P. SCHULTZ

Senior Scientist, Department of Vertebrate Zoology

The illustration of the new *Plataxoides leopoldi* Gosse (1963, Inst. Roy. Sci. Nat. Belgique Bull., vol. 39, no. 35, pp. 4–6, pl. 1, fig. 2) so closely resembled the illustration of *Plataxoides dumerilii* Castelnau (1855, Animaux nouveaux ou rares . . . d'Amérique du Sud, p. 21, pl. 11, fig. 3) that I decided to review the taxonomic status of all the nominal species of *Pterophyllum*. I shall attempt (1) to clarify the nomenclatural validity of the generic names *Pterophyllum* and *Plataxoides*, (2) to review the species complexes of *Pterophyllum scalare* (= *P. eimekei*) and *Plataxoides dumerilii* (= *P. leopoldi*), and (3) to discuss the relationship between *Pterophyllum altum* Pellegrin and *P. scalare* (Lichtenstein).

I have studied all nonaquarium specimens of *Pterophyllum* available in the following museums: British Museum of Natural History (BMNH); California Academy of Sciences (CAS); Chicago Natural History Museum (CNHM); Museum of Comparative Zoology, Harvard (MCZ); Museum National Histoire Naturelle, Paris (MNHN); Institut Royal des Sciences Naturelles de Belgique, Bruxelles (IRSNB); Stanford University (SU); U.S. National Museum (USNM). To the authorities of the above institutions, I wish to express my gratitude for their help and other courtesies.

In the "Tropical Fish Hobbyist" (1953, vol. 1, no. 5, pp. 5-7, 20) I attempted to distinguish three species of aquarium-bred *Pterophyllum*. Since then I have studied specimens collected from their natural habitat, the syntypes of *Pterophyllum altum* Pellegrin, a syntype of *P. eimekei* Ahl, 27 paratypes of *Plataxoides leopoldi* Gosse, and the holotype of *P. dumerilii* Castelnau.

In my 1953 study I recognized *Pterophyllum scalare*, *P. eimekei*, and *P. altum* as valid species; however, with additional material my conclusions have changed and in this review I now recognize as valid *P. scalare*, *P. altum*, and *P. dumerilii*. *P. eimekei* is a synonym of *P. scalare*.

In the synonymy for each species I have recorded only the most pertinent references, omitting those related to aquaria.

I have attempted to record each locality from which *Pterophyllum* has been reported by latitude and longitude as found in "The Times Atlas of the World," 1957, vol. 5 ("The Americas"); "U.S. Board of Geographic Names Gazetteer," no. 56 ("Venezuela") and no. 71 ("Brazil"); Eigenmann's "The American Characidae," 1917, pt. 1, pl. 1; and Eigenmann and Allen's "Fishes of Western South America," 1942, pp. 67-81. Since I was unable to find a few localities, specimens from such places are not included in the distributional map for the species (pl. 1). Some of the other records are so unspecific in locality, e.g., "Rio Orinoco," that these cannot be plotted on the map. I have studied the routes followed by the collectors; the latitude and longitude used represents the best estimate for the information available.

The specific localities from which specimens of *Pterophyllum* have been collected are as follows:

locality	longitude	latitude
Ambyiacu, Río, Peru	3°10' S	73°13' W
Araguaia, Río, near Aruana, Brazil	14°54' S	51°05' W
Atabapo, Río, Colombia	4°03' N	67°45' W
Belém [= Pará], Brazil	1°30' S	48°55' W
Cacaul or Cacaual [= Cacoal], Brazil	1°59' S	46°13' W
Cashiboya, Lago above Contamana, Peru	7°19' S	75°04' W
Casiquire, Río, Venezuela	2°01' N	67°07' W
Coary, Brazil	4°08' S	63°07' W
Crab Falls, British Guiana	5°17' N	58°59' W
Cupai [probably Rio Cupari], Brazil	3°04' S	55°25' W
Demerara or Georgetown, British Guiana	6°46' N	58°10' W
Iquitos, Peru	3°51' S	73°13' W
Jutahy, Brazil	3° S	66°57' W
Manacapurú, Brazil	3°18' S	60°37' W
Manacapurú, Lago, Brazil	3°10' S	61°30' W
Manaus, Brazil	3°06' S	60°00' W
Marajó I, in Amazon, Brazil	1°45' S	49° W
Maximo, Lago, Brazil	(?)	(?)
Monte Alegre, Brazil	2°01' S	54°04' W

locality	longitude	latitude
Nazareth, Brazil	1°13' N	67°51' W [probably]
Óbidos, Brazil	1°52' S	55°30' W
Pacaya, Río [see Yarinacocha]		
Pévas [= Pébas] Caño, Peru	3°10' S	71°46' W
Pôrto Alegre, Brazil	4°23' S	52°45' W
Pôrto do Móz, Brazil	1°45' S	52°10' W
Pôrto Negro [probably near Manaus], Brazil		
Purus, Río, Brazil	3°42' S	61°28' W
Rockstone, British Guiana	6°00' N	58°30' W
Rupununi River, British Guiana	3°55' N	59°06' W
Santarém, Brazil	2°26' S	54°41' W
Solimões, Rio, at Manacapurú, Brazil	3°18' S	60°37' W
Tabatinga, near Leticia, Brazil	4°14' S	69°44' W
Tefé [= Tefé], Rio, Brazil	3°24' S	64°45' W
Tonantins, Brazil	2°46' S	67°45' W
Ueranduba, Brazil	(?)	(?)
Urubu Río, Brazil	2°55' S	58°25' W
Villa Bella [Rio Ramos], Brazil	2°36' S	56°39' W
Xingu, Rio [Pôrto Alegre], Brazil	4°23' S	52°45' W
Yarinacocha [Río Pacaya], Peru	5°10' S	74° W

Pterophyllum Heckel

Pterophyllum Heckel, 1840, Ann. Wien. Mus., vol. 2, no. 12, p. 334 [type species:

P. scalare Heckel=*Platax scalaris* Cuvier and Valenciennes].—Ahl, 1928, Zool. Anz., vol. 76, p. 252 [revision of 3 species].

Plataxoides Castelnau, 1855, Animaux nouveaux ou rares . . . de l'Amerique du Sud . . . , p. 21, pl. 11, fig. 3 [type species: *P. dumerilii* Castelnau].

TABLE 1.—Number of vertebrae in *Pterophyllum*

Species and localities	Abdominal			Caudal					Total					
	12	13	14	14	15	16	17	18	27	28	29	30	31	
<i>dumerilii</i>														
British Guiana			1			1					1			
Rio Negro-Amazon			2	1		1	2				2			
Rio Negro, types of <i>leopoldi</i>	5	21				7	16	3			10	15	1	
Belém and Marajó Island	1							1				1		
<i>altum</i>														
Upper Orinoco		2					2						2	
<i>scalare</i>														
British Guiana			26			1	8	13	4		1	8	13	4
Middle and lower Amazon			13				6	6	1			6	6	1
Belém and Marajó Island			7					7					7	
Peruvian Amazon			7				2	4	1			2	4	1

The validity of the generic name *Pterophyllum* Heckel, long in use by ichthyologists and aquarists, needs to be clarified because Gosse (1963, p. 4) used the generic name *Plataxoides* Castelnau instead of *Pterophyllum*. Gosse (loc. cit.) and Whitley (1951, Proc. Roy. Zool.

Soc. New South Wales, p. 68) were in error in considering that *Pterophyllum* Heckel is not available as a generic name with the type species *Pterophyllum scalare* Heckel (= *Zeus scalaris* Lichtenstein). Myers (1940, Stanford Ichthy. Bull., vol. 2, no. 1, p. 36) pointed out that Neave (1940, Nomenclator zoologicus, vol. 3, p. 1028) was in error in the following statement: "*Pteropyhllum* (pro-lla, Kirby 1825), Harris 1833, in Hitchcock, Rept. Geol. Min. Bot. Zool. Massach., 582-Orth." I have checked Harris (1833, 1835, Rep. Geol. Mineral. Bot. Zool. Massachusetts) and can verify Myers' observation that Harris consistently used *Pterophylla*, leaving *Pterophyllum* available.

***Pterophyllum dumerilii* (Castelnau)**

PLATE 2

Plataxoides dumerilii Castelnau, 1855, Animaux nouveaux ou rares . . . de l'Amérique du Sud . . . , p. 21, pl. 11, fig. 3 [Pará=Belém].

Plataxoides leopoldi Gosse, 1963, Inst. Roy. Sci. Nat. Belgique Bull., vol. 39, no. 35, p. 4, pl. 1, fig. 2 [mouth of Rio Solimões, about 90 km above Manacapurú].

Specimens studied (see page 2 for more precise locality): BMNH 1902-11-4-10-12, Marajó, 3 (27 to 40 mm); BMNH 1902-2-11-4-9, Tonantins, 1 (41 mm); MCZ (out of 14992), Tefé, 2 (33 and 37mm); CNHM (out of 15254); Santarém, 1 (40 mm); CNHM 53846 Rupununi River, 2 (33 and 54 mm); CNHM (out of 54370), Santarém, 1 (37 mm.); USNM 167772, Rupununi River, 1 (40 mm.); USNM 198177, Rio Urubu, 1 (45 mm.); USNM 198178, Rio Purús, 2 (29 and 31 mm.); IRSNB 460, Rio Solimões. 90 km above Manacapurú, 27 paratypes of *P. leopoldi*, (34 to 61 mm); MNHN A 254, Pará, Brazil, holotype of *P. dumerilii* (49 mm); MNHN 221-61-3-7, Cacaual, 1 (37 mm); MNHN 221-61-3-6, Caldron, 2 (42 and 51 mm).

I examined the holotype of *Plataxoides dumerilii* Castelnau at the Museum National Histoire Naturelle, Paris, and found that Castelnau's illustration (1855, pl. 11) is in error. In his illustration, a black spot is shown behind the prominent black vertical bar that extends from the middle of the dorsal fin across body to the middle of the anal fin, whereas in the holotype this spot now shows as a trace in front of that dark bar, not behind it. Also, the dark vertical bars anteriorly on the illustration are incorrectly portrayed. On the holotype a short bar extends from the spiny dorsal origin ventrally to the lateral line, another short bar occurs halfway between the eye and the spiny dorsal origin; there is also a dorsoventral bar through the eye and across the cheek. These bars are prominent in well-preserved specimens and their positions differ notably from those of *Pterophyllum scalare* and *P. altum*. On the latter two species, the black bar through the eye extends dorso-posteriorly to the origin

of the spiny dorsal fin, replacing the two middle predorsal vertical bars on *P. dumerilii*. Thus, on the basis of coloration *P. dumerilii* can always be distinguished from *P. scalare* and *P. altum*. The number of vertebrae averages slightly fewer in *P. dumerilii* than in the other two species (table 1) and there are also slightly fewer soft dorsal and soft anal rays and fewer oblique scale rows (from rear of head to midbase of caudal fin) (table 2) than in *P. scalare* and

TABLE 2.—Counts recorded for *Pterophyllum dumerilii*

Localities	Dorsal fin rays										Pectoral fin rays	
	XI	XII	XIII	18	19	20	21	22	23	24	10	11
British Guiana		3		1	1	1						2
Rio Negro-Amazon	1	8	1		3	1	2	1	1	2	2	10
Rio Negro (types of <i>leopoldi</i>)	4	20	2		7	14	5				2	24
Mouth of Amazon		3	1							4	1	3
Holotype of <i>dumerilii</i>		1								1		1

Localities	Anal fin rays										Oblique scale rows									
	VI	19	20	21	22	23	24	25	26	27	28	26	27	28	29	30	31	32 ^{III}	33	
British Guiana	3		2	1										1	1					
Rio Negro-Amazon	10		2	2	2		1	3				1	2	2		3	1		1	
Rio Negro (types of <i>leopoldi</i>)	26	1	8	11	5	1						1	3	9	8	4	1			
Mouth of Amazon	4						1		2	1						1	3			
Holotype of <i>dumerilii</i>	1						1									1				

P. altum (table 3); however, these differences are not great enough to enable me to identify all specimens on the basis of fin ray and scale counts, even if the dorsal and anal rays are added to the oblique scale rows to form a character index (table 4).

An examination of table 2, shows that the specimens of *P. dumerilii* collected near Belém, at the mouth of the Amazon have a slightly greater number of fin rays and scales than do specimens further up the Amazon—Rio Negro systems.

The counts made on the holotype of *P. dumerilii* from Pará (now Belém) with XII,23 dorsal, VI,24 anal, 11 pectoral fin rays, and 30 scale rows along the side, fit into the higher end of the frequency distributions (table 2) for *P. dumerilii*; however, since the frequency distributions partly overlap for the various localities and the number of specimens are not sufficient to establish the extent of variability among populations, if such exist, I am recognizing only a single species, *P. dumerilii*.

P. dumerilii has been collected in the Amazon basin and in the Rupununi River of British Guiana (see open circles in map, pl. 1).

Pterophyllum altum Pellegrin

PLATE 3

Pterophyllum altum Pellegrin, 1903a, Bull. Mus. Hist. Nat. Paris, vol. 9, p. 125 [Rio Atabapo, Orinoco]; 1903b, Mem. Soc. Zool. France, vol. 16, p. 252, pl. 4, fig. 4 [Atabapo].—Regan, 1905, Ann. Mag. Nat. Hist., ser. 7, vol. 16, p. 442 [Rio Orinoco].—Eigenmann, 1910, Rep. Princeton Univ. Exped. Patagonia 1896–1899, vol. 3 (Zool.), pt. 4, p. 479 [Orinoco].—Ahl, 1928, Zool. Anz., vol. 76, p. 255 [Orinoco].—Schultz, 1949, Proc. U.S. Nat. Mus., vol. 99, p. 167 [Rio Atabapo]; 1953, Tropical Fish Hobbyist, vol. 1, no. 5, pp. 5–7, 20 [key to aquarium-bred angelfish].

Specimens studied (see page 2 for more precise locality): BMNH 1904–6–28–2–3, Rio Orinoco, 2 (59 and 60 mm); MNHN 221–61–1–3, Chaffanjon (Rio Atabapo), 5 syntypes of *P. altum* (42 to 62 mm); MNHN 221–61–1–1, Chaffanjon, 4 syntypes of *P. altum* (63 to 75 mm); MNHN 221–61–1–2, Chaffanjon, 5 syntypes of *P. altum* (59 to 65 mm); USNM 163204, Venezuela, 1 (79 mm); USNM 196007, Colombia, 1 (67 mm); CAS [no number], Rio Casiquiare, 1 (53 mm).

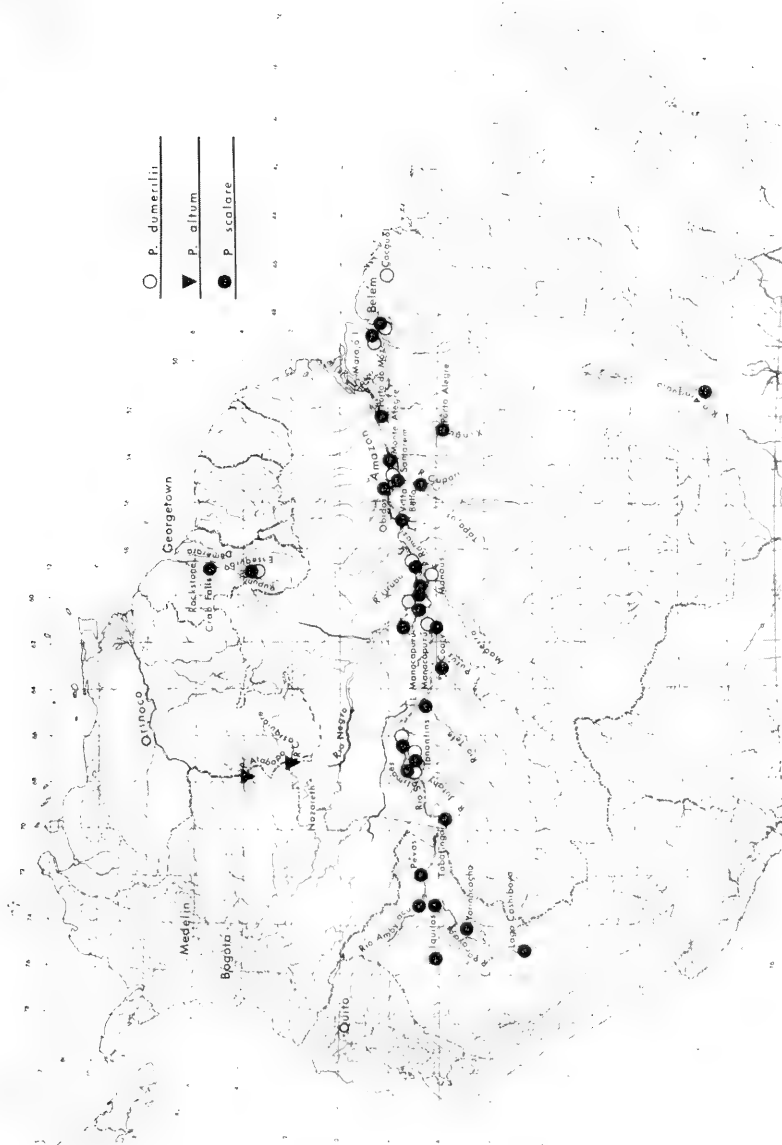
Pterophyllum altum Pellegrin has a color pattern identical with that of *P. scalare*; however, no black spot occurs on the upper midside as in *P. dumerilii*. The black bar through the eye curves dorso-posteriorly to the origin of the spiny dorsal and is not broken into three separate bars as in *P. dumerilii*.

This species is best recognized from *P. scalare* by the greater average number of median fin rays, oblique scale rows, and vertebrae (tables 1–4). Undoubtedly *P. altum* represents the *P. scalare* type of angelfish in the upper Orinoco, and in having a higher average number of dorsal, anal, oblique scale rows and vertebrae than *P. scalare*, it might be considered to represent only a subspecies of *P. scalare*; however, since *P. altum* has been taken so far only in the upper Orinoco basin, I prefer tentatively to recognize it as a distinct species.

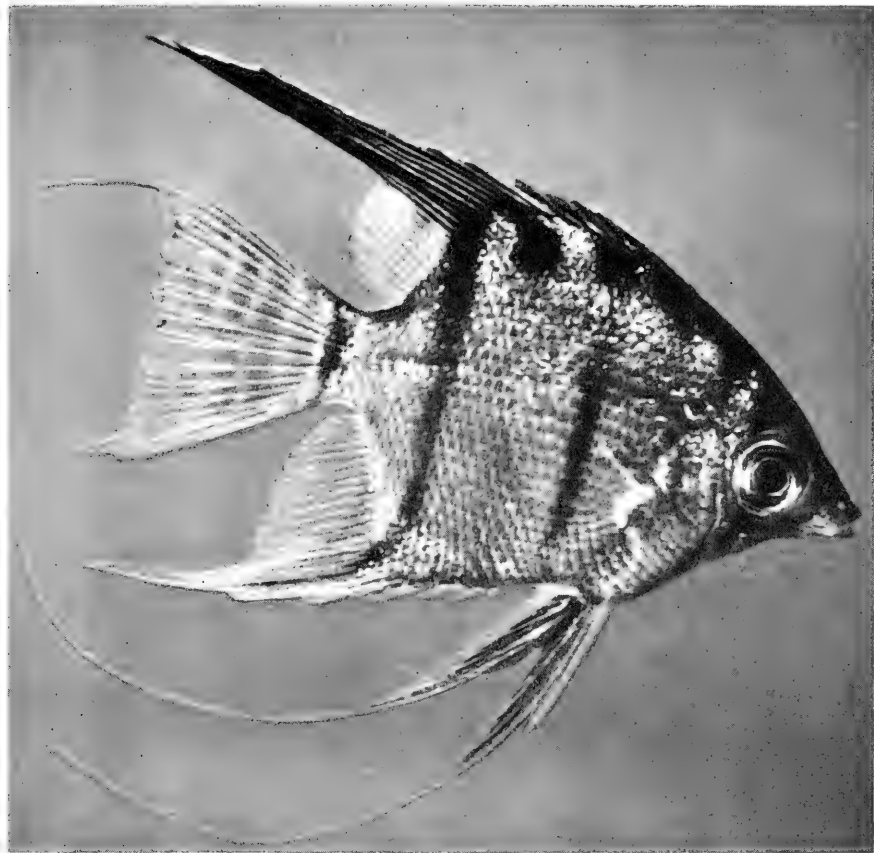
Pterophyllum scalare (Lichtenstein)

PLATE 4

Zeus scalaris Lichtenstein, 1823, Verz. Doubl. Zool. Univ. Berlin, p. 114 [Brazil].
Platax scalaris Cuvier and Valenciennes, 1831, Histoire naturelle des poissons, vol. 7, p. 237 [Brazil, in "Collection de Bloch, au Musée de Berlin"].
Pterophyllum scalaris Heckel, 1840, Ann. Wien. Mus., vol. 2, p. 335, pl. 30, figs. 5, 6, 7–7a, 8–8b [Reo Negro].
Pterophyllum scalaris Günther, 1862, Catalogue of the fishes in the British Museum, vol. 4, p. 316 [Rio Cupai; Brazil].—Kner, 1862, Sitz. Akad. Wiss. Wien., vol. 46, p. 295, pl. 1, figs. 1–1a.—Cope, 1872, Proc. Acad. Nat. Sci. Philadelphia, p. 250 [Rio Ambyiaçu].—Steindachner, 1875, Sitz. Akad. Wiss. Wien., vol. 71, p. 76 [Amazon at Santarém, Monte Alegre, Villa Bella, Óbidos, Coary, Ueranduba, Tonantins, Tabatinga, Rio Jutahy, Xingu, Lago Manacapurú, Lago Maximo, Pará, Rio Ambyiaçu; ?Barra do Rio Negro].—Eigenmann and Eigenmann, 1891, Proc. U.S. Nat. Mus., vol. 14, p. 71



Distributional map for species of *Pterophyllum*.



Pterophyllum dumerilii (Castelnau).



Pterophyllum altum Pellegrin.



Pterophyllum scalare (Lichenstein) (courtesy of T.F.H. Publications, Inc.).

[Amazon].—Eigenmann and Bray, 1894, Ann. New York Acad. Sci., vol. 7, p. 624.—Pellegrin, 1903, Mem. Soc. Zool. France, vol. 16, p. 251 [high Peru; upper Amazon, Tefé; Pará].—Regan, 1905a, Ann. Mag. Nat. Hist., ser. 7, vol. 16, p. 441 [Rio Cupai; Tabatinga; Manaus; Tonantins; Marajo Island in Rio Amazon]; 1905b, Proc. Zool. Soc. London, pt. 1, p. 190 [Rio Negro, Brazil].—Ihering, 1907, Rev. Mus. Paulista, vol. 7, p. 335 [Amazon at Tabatinga and tributaries].—Eigenmann, 1910, Rep. Princeton Univ. Exped. Patagonia, 1896–1899, vol. 3 (Zool.), pt. 4, p. 479 [Amazon].—Haseman, 1911, Ann. Carnegie Mus., vol. 7, p. 372 [Santarém, Manaus].—Eigenmann, 1912, Mem. Carnegie Mus., vol. 5, p. 521 [Rupununi River; Rockstone; Crab Falls].—Ribeiro, 1915, Arch. Mus. Nac. Rio de Janeiro, vol. 17, p. 56 [Amazon and tributaries].—Ahl, 1928, Zool. Anz., vol. 76, p. 254 [Amazon].—Eigenmann and Allen, 1942, Fishes of western South America, p. 406 [Iquitos, Yarinacocha].—Fowler, 1945, Los peces del Peru, Mus. Hist. Nat. Javier Prado, Univ. Nac. Mayor de San Marcos, p. 253, fig. 88 [Amazon, Peru].—Schultz, 1949, Proc. U.S. Nat. Mus., vol. 99, p. 167 [Venezuela]; 1953, Tropical Fish Hobbyist, vol. 1, pp. 5–7, 20 [key to aquarium-bred angelfish].

Pterophyllum eimekei Ahl, 1928, Zool. Anz., vol. 76, p. 252, fig. 1 [Rio Negro in the Amazon].

Specimens studied (see page 2 for more precise locality).—The following have USNM catalog numbers: 163210, probably British Guiana, 20 (28 to 63 mm); 198180, Belém, 5 (72 to 78 mm); 198179, Rio Purús, 4 (46 to 67 mm); 179565 and 179566, Rio Urubu, 54 (33 to 80 mm); 163210, probably lower Amazon, 6 (72 to 81 mm); 191591, upper Rio Araguaia, 1 (17.5 mm); 167754, Yarinacocha, 1 (54 mm); 167755, Iquitos, 2 (41 and 63 mm); 26664, Tabatinga, 1 (42 mm); 174942, British Guiana, 3 (71 to 81 mm); 175933, Pévas, 3 (27 to 31 mm). The following have BMNH numbers: 1926–3–3–3, Rio Negro, 1 (60 mm); 1925–10–28–452–457, Manacapurú, 6 (44 to 99 mm); 1926–10–27–488, Monte Alegre, 1 (50 mm); 53–3–19–42, Rio Cupai [probably Rio Cupari], 1 [not measured]; 81–5–13–129, Lago Cashiboya, 1 (43 mm); 85–1–14–71, Tabatinga, 1 (55 mm). The following have MNHN numbers: 221–61–2–1, Rio Negro, 1 syntype of *P. eimekei* (55 mm); 221–61–3–10, French Guiana, 3 (63 to 71 mm); 221–61–3–2, Tefé, 2 (90 and 101 mm); 221–61–3–3, Peru (Amazon), 5 (41 to 51 mm); 221–61–3–4, Peru (Amazon), 3 (50 to 82 mm); 221–61–3–5, Tefé, 5 (30 to 44 mm); 221–61–3–6, Caldron, 2 (65 and 79 mm); 221–61–3–9, Brazil, 3 (49 to 52 mm). The following have CAS numbers: [no number], Rio Negro, 4 (72 to 84 mm); [no number], Santarém, 11 (34 to 50 mm); IU 17780, Yarinacocha, 1 (47 mm); IU 2096, Tabatinga, 1 (43 mm); IU 5106, Lower Amazon, 1 (51 mm); IU 12502, Rupununi River, 1 (34 mm); IU 12504, Essequibo River, 2 (48 and 50 mm); IU 13368, Manaus, 1 (84 mm); [no number] “Pôrto Negro,” 4 (46 to 61 mm); 5100, Marajó, 1 (57 mm); IU 12503, Essequibo River, 2 (43 and 44 mm); IU 15988, Iquitos, 4 (42 to 69 mm). The following have MCZ numbers: 14989, Coary, 4 (84 to

94 mm); 14993, Manacapurú, 2 (59 and 60 mm); 14984, Pôrto do Moz, 2 (47 and 51 mm); 14988, Tonantins, 3 (59 to 94 mm); 14997, Tabatinga, 2 (92 and 99 mm); 14985, Pôrto do Moz, 20 (37 to 48 mm); 14994, Santarém, 10 (46 to 54 mm); 14998, Óbidos, 4 (47 to 71 mm); 14991, Jutahy, 5 (43 to 73 mm); 14992, Jutahy, 3 (39 to 41 mm); 14987, Pôrto do Moz, 5 (40 to 44 mm); 14977 to 14980, Tefé, 10 (51 to 101 mm); 14977 to 14980, 14982 and 14983, Tefé, 6 (74 to 100 mm); 14996, Santarém, 3 (35 to 46 mm); 14990, Villa Bella, 6 (36 to 41 mm); 14999, Pará, 1 (54 mm); 14995, Santarém, 1 (44 mm); 14976, Monte Alegre, 6 (33 to 39 mm); 14981, Tefé, 10 (63 to 98 mm). The following have CNHM numbers: 15254, Santarém, 1 (38 mm); 54371, Manaus, 4 (81 to 90 mm); 54233, Manaus, 1 (49 mm); 53847, Essequibo River, 2 (41 and 43 mm); 54370, Santarém, 3 (40 to 56 mm); 53848, Essequibo River, 4 (44 to 47 mm); 15562, Peru, 1 (53 mm). The following have SU numbers: 36799, Pévas, 1 (62 mm); 36660, near Pévas, 1 (28 mm); 2205, Lower Amazon, 1 (59 mm); 36661, near Pévas, 2 (23 and 26 mm); 36797, near Pévas, 1 (37 mm); 54245, Santarém, 3 (45 to 57 mm); 60504, Pévas, 1 (75 mm); 36798, near Pévas, 3 (22 to 36 mm); 36659, near Pévas, 2 (37 and 46 mm); 36796, near Pévas, 3 (47 to 74 mm).

P. scalare (Lichtenstein) is the common angelfish of aquarists. Since 1928, when Ahl described *P. eimekei* from the mouth of the Rio Negro in the Amazon basin considerable confusion has occurred as to the validity of that species. *P. eimekei* was thought to average fewer dorsal and anal rays and fewer oblique rows of scales (Schultz, 1953) and as indicated by Ahl (1928) and Ladiges (1949, Deutsche Aquar. Terr., year 2, no. 3, pp. 50–52); however, most of their counts were based on aquarium specimens, undoubtedly inbred strains in aquaria, which most probably did not represent the species complex of natural populations found in the Amazon basin. The counts recorded in tables 3 and 4 are based on specimens from definite natural localities and not on aquarium-reared material.

The counts for the syntype of *P. eimekei* with XIII, 24 dorsal, VI, 26 anal, 10 pectoral fin rays, and 36 scale rows on the side fall nearly in the middle of the frequency distributions for Amazon specimens of *P. scalare* (tables 3 and 4). Thus, I conclude that *P. eimekei* is a synonym of *P. scalare*.

The differences between the color patterns of *P. scalare* and *P. dumerilii*, discussed under the latter species and shown in plates 1 and 3, should make identification easy; however, *P. scalare* and *P. altum* cannot be distinguished on the basis of coloration. The chief differences are the greater number of soft dorsal and soft anal fin rays and the number of scales in *P. altum* (tables 3 and 4). *P. altum* has 27 to 31 soft dorsal rays whereas *P. scalare* rarely has more than 26.

Although proportional measurements were made on all three species of *Pterophyllum*, the great variability even at nearly equal sizes suggests that little reliance can be placed on measurements for identification purposes.

TABLE 4.—*Character index: Total number of rays in dorsal and anal fins added to number of scale rows for Pterophyllum*

Species and localities	83	85	87	89	91	93	95	97	99	101	103	105	107	109	111	113	115	117	119	121	123	125
	84	86	88	90	92	94	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126
<i>altum</i>																						
Upper Rio Orinoco																		3	5	4	4	
<i>scalare</i>																						
British Guiana				1	1	3	4	5		3	3	1	6	3	2							
Upper R. Araguaia										1												
Belém; Marajó I.								1	3		1					2	1	1	1			
Pôrto do Móz								1	5	2	5	2	1	1								
Santarém; Óbidos,																						
Villa Bella; R.																						
Cupari; Pôrto																						
Negro; Monte Alegre							3	4	8	8	11	3				1	1					
Manaus; R. Urubu; R.																						
Purus; Manacapurú;																						
Coary											3	5	17	8	19	7		1	1			
Tefé								1			1	1	6	7	5	1						
Tonantins; R. Jutahy;																						
R. Solimões; Tabatinga																						
Peruvian Amazon																						
<i>dumerilii</i>																						
British Guiana					1	2																
Rio Negro-Amazon				2		3					2	1		1								
Rio Negro (type of <i>leopoldi</i>)																						
Mouth of Amazon,					1	8	9	7	1													
Cacaual																						
					1				1		2											

An inspection of tables 3 and 4 indicates that for *P. scalare* there may be certain areas where distinct populations exist; the specimens from Pôrto do Moz, Santarém, Óbidos, for example, average fewer soft dorsal fin rays than specimens from Manaus, Rio Urubu, and Tefé. Specimens from British Guiana have about the same counts as those listed from Pôrto do Moz. Before any conclusion can be made for the "population" at the mouth of the Amazon, large series will need to be studied to find out the meaning of the bimodal nature of the frequency distribution for specimens from Belém and Marajó Island.

P. scalare ranges in the Amazon Basin and in the Rupununi and Essequibo Rivers of British Guiana with a single record from French Guiana (MNHN 221-61-3-10), the exact locality unknown. The known localities represented by specimens studied by me are recorded in plate 1.

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SOME PORTUNID CRABS FROM THE PACIFIC AND INDIAN OCEANS IN THE COLLECTIONS OF THE SMITHSONIAN INSTITUTION

By WILLIAM STEPHENSON and MAY REES ¹

Introduction

The material on which the following report is based was received for identification as part of a program of systematic research on the marine fauna of the tropical Pacific area, with studies of related faunas as required, sponsored jointly by the Biology Branch of the Office of Naval Research [Contract NONR 1354(09)] and the Division of Biology and Medicine of the Atomic Energy Commission [Contract AT (30-1)2409]. No attempt has been made in this study to incorporate material previously identified and cataloged in the collections of the Smithsonian Institution.

The collections as received included 96 species, but only 82 are reported below. The remaining are western American species, which have been included in a monograph by Dr. John S. Garth and the senior author (Garth and Stephenson, 1966), and species of *Ovalipes*, which are to be included in a revision of the genus.

Initially, 12 of the 82 species were new, but Crosnier (1962) described 5 of them. No doubt a considerable number of Indo-West-Pacific species still await description, and the time for a comprehensive monograph is still distant.

¹ Both authors: Department of Zoology, University of Queensland, St. Lucia, Brisbane, Australia. Manuscript submitted for publication in February 1965.

As the group becomes better known, identifications become easier only in certain directions. In the present work some clarification is effected by recognizing the validity of species previously synonymized. As more species are discovered, however, the distinctions between them become narrower, and the difficulties of relating them to the older descriptions increase. Until type material is reexamined and redescribed, several groups must remain confused. In the present work these are termed "complexes," and the *Portunus gladiator* and *P. longispinosus* complexes have caused particular difficulty.

A more fundamental problem concerns the importance attached to differences in male secondary sexual characteristics. Shapes of male abdomens have long been recognized as having diagnostic importance, and since Stephenson (1945), following Brocchi (1875), increasing stress has been laid upon male first pleopods.

In both these structures the extent of "expectable" variation has been known in general terms, and few cases of greater variation have been described (e.g., male pleopods of *P. orbitosinus* by Gordon, 1938, and male abdomens of *P. granulatus* by Crosnier, 1962). In the present work unexpected variability in male pleopod structure has been noted in several cases. In one species (*P. orbitosinus*) there is approximately continuous gradation between wide extremes, and in three others (*Thalamita stimpsoni*, *T. danae*, and *Portunus argentatus*) there is distinct male dimorphism. If a species is defined in terms of a distinct morphological gap between two forms, *T. stimpsoni*, *T. danae*, and *P. argentatus* should each be split into two species. However, apart from male pleopods and abdomens, no structural differences could be found. For the purposes of the present paper, *P. argentatus* was taken as a "test case" of the concept of a portunid species (see p. 19). This concept implies a distinct morphological gap in general facies, as well as in the shape of the male abdomens and structure of the male pleopods. If no distinctions were noted in general facies, groups with different pleopods are here recorded as different "forms." Possibly they are incipient species.

Details of synonymy vary from species to species; where there had been past confusion, reasonable detail is given, but in other cases only critical references are cited. Brief morphological comments are given upon species adequately treated in recent literature, and fuller redescrptions are restricted to inadequately described species. Subfamily headings follow Stephenson and Campbell (1960); within subfamilies genera are in alphabetical order, and within genera species are also in alphabetical order, except where similar species are grouped into "complexes."

Geographical distributions adhere closely to the expected pattern, with the better known species extending from East Africa and the Red Sea to India, Japan, Australia, and the mid-Pacific islands. Only one of the present species (*Thalamita picta*) and one species of *Ovalipes* (see later work) are known to cross the mid-Pacific boundary.

Listed specimens within the 16 main locality groupings are recorded in chronological order. The locality groupings are: East Africa, including Saudi Arabia and the Red Sea; Malay Peninsula, including Rangoon and Sumatra; China, including Hong Kong and Formosa; Philippines, including the Sulu Sea and North Borneo; Celebes; Australia; Melanesia, including New Guinea, Fiji, and the Solomon Islands; Palau Islands, including the Carolines; the Marianas, including Yap and Guam; Japan; the Marshalls; the Gilbert Islands; Samoa; Fanning Island; Hawaii; and the Tuamotu and Society Islands.

Throughout, two abbreviations are used: "Alb." for collections of the U.S. Fish Commission Steamer *Albatross* either from the Philippines, Japan, or Samoa, and "GVF" for "George Vanderbilt Foundation." And, throughout, dimensions are those of total breadths, including the last anterolateral teeth. In cases of damage, the approximate estimated breadth of the undamaged specimen is given.

Specimens considered too small or too damaged for identification have been excluded from this account.

It is obvious that this paper could never have been written but for the kindness of Dr. Feener A. Chace, Jr., who asked us, in the name of the Smithsonian Institution, to report upon the collections. We are also deeply grateful to the following museums and their directors for allowing us to borrow specimens for comparative study: Australian Museum, Sydney (Dr. J. W. Evans), Western Australian Museum (Dr. W. D. L. Ride), Queensland Museum (the late Mr. G. Mack), Central Marine Fisheries Research Institute, India (Dr. S. Jones), Muséum National d'Histoire Naturelle, Paris, Laboratoire de Zoologie (Arthropodes) (Dr. J. Forest). The following carcinologists have helped materially either in loans or in examination of specimens or by their advice: Dr. John C. Yaldwyn, Dr. Ray W. George, Mme. Danièle Guinot, Dr. Lipke B. Holthius, Dr. John S. Garth, and Dr. Raymond B. Manning.

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Checklist

Subfamily CATOPTRININÆ Borradaile

Genus *Carupa* Dana
tenuipes Dana

Genus *Libystes* A. Milne Edwards
truncatifrons (de Man)

Subfamily MACROPIPINÆ Stephenson and Campbell

Genus *Parathranites* Miers
orientalis Miers

Subfamily CAPHYRINÆ Alcock

Genus *Caphyra* Guérin
rotundifrons (A. Milne Edwards)

Genus *Lissocarcinus* Adams and White
orbicularis Dana

Subfamily PORTUNINÆ Stephenson and Campbell

Genus *Charybdis* de Haan
(Charybdis) anisodon de Haan
(Charybdis) callianassa (Herbst)
(Charybdis) curtilobus, new species
(Charybdis) feriatus (L.)
(Charybdis) cf. feriatus (L.)
(Charybdis) hellerii (A. Milne Edwards)
(Charybdis) japonica (A. Milne Edwards)
(Charybdis) miles (de Haan)
(Charybdis) natator (Herbst)
(Charybdis) orientalis Dana
(Goniohellenus) truncata (Fabricius)
(Goniohellenus) vadorum Alcock
(Gonioleptus) bimaculata (Miers)
(Goniosupradens) erythrodactyla (Lamarck)
(Goniosupradens) obtusifrons Leene

Genus *Portunus* Weber
acerbiterminalis, new species
argentatus (A. Milne Edwards)
brockii (de Man)
dubius (Laurie)
euglyphus (Laurie)
P. gladiator complex
gladiator (Alcock)
pseudoargentatus Stephenson
granulatus (H. Milne Edwards)
hastatoides Fabricius
P. longispinosus complex
emarginatus Stephenson and Campbell
iranjæ Crosnier

Genus *Portunus* Weber—Continued
P. longispinosus complex—Con.
macrophthalmus Rathbun
tenuicaudatus Stephenson
species (unidentifiable)
orbitosinus Rathbun
pelagicus (L.)
pubescens (Dana)
pulchricristatus (Gordon)
rubromarginatus (Lanchester)
cf. rubromarginatus (Lanchester)
rugosus (A. Milne Edwards)
sanguinolentus (Herbst)
spiniferus, new species
spinipes (Miers)
tenuipes (de Haan)
tuberculatus (Miers)
tuberculosis (A. Milne Edwards)
tweddiei (Shen)

Genus *Scylla* de Haan
serrata (Forskål)
Genus *Thalamita* Latreille
admète (Herbst)
auauensis Rathbun
bouvieri Nobili
chaptalii (Audouin)
coeruleipes Jacquinet
corrugata Stephenson and Rees
crenata (Latreille)
dakini Montgomery
danae Stimpson
demani Nobili
foresti Crosnier
gatavakensis Nobili

Genus *Thalamita* Latreille—Continued

gloriensis Crosnier
granosimana Borradaile
imparimana Alcock
integra Dana
mitsienseis Crosnier
multispinosa, new species
oculea Alcock
parvidens (Rathbun)
philippinensis, new species
picta Stimpson
pilumnoides Borradaile
poissonii (Audouin and Savigny)
prymna (Herbst)

Genus *Thalamita* Latreille—Continued

pseudopoissoni, new species
quadrilobata Miers
sexlobata Miers
sima H. Milne Edwards
spinifera Borradaile
spinimana Dana
spinimera, new species
stephensoni Crosnier
stimpsoni A. Milne Edwards

Genus *Thalamitoides* A. Milne Edwards

quadridentis A. Milne Edwards
tridentis A. Milne Edwards

Subfamily PODOPHTHALMINAE Borradaile

Genus *Podophthalmus* Lamarek

vigil (Weber)

Subfamily CATOPTRINAE Borradaile, 1907

Genus *Carupa* Dana, 1851*Carupa tenuipes* Dana

Carupa tenuipes Dana, 1851, p. 129; 1852a, p. 85; 1852b, pp. 279–280.—Leene, 1940, pp. 165–168, figs. 1, 2.—Stephenson and Campbell, 1960, p. 88, pl. 2 (fig. 1).—Crosnier, 1962, pp. 19–20, figs. 16–23, pl. 1 (fig. 1).—Miyake, Sakai, and Nishikawa, 1962, p. 128 (record only).

Carupa laeviscula Heller, 1862, p. 520; 1865, p. 27, pl. 2 (fig. 2).—Alcock, 1899, p. 26.—Leene, 1938, pp. 9–10.—Sakai, 1939, p. 373, pl. 44 (fig. 3).—Edmondson, 1954, pp. 226–227, figs. 3b, 4e, 4f, 4g.

MATERIAL.—Melanesia: Marienberg, New Guinea, May 10, 1929, Albert W. Herre, 1 female.

Marianas: Saipan, coral heads, 1945, A. H. Banner, 1 male.

Marshalls: Lagoon reef, Latoback Is., Rongarik, Aug. 18, 1947, F. M. Bayer, F. C. Zimmerman, 1 male; Aug. 21, 1947, 1 male.

Hawaii: Waikiki Marine Lab., Honolulu, under stones near shore, Feb. 9, 1942, G. S. Mansfield, 1 female.

Tuamotus and Societies: Sta. 29a–57, outer reef, Tickahau Atoll, Maiai Is.; Apr. 14, 1957, Bredin Exped., 1 female; Huahine Is., head of Baie de Maroe, from branching coral, Apr. 30, 1957, Bredin Exped., 1 male; Huahine, off Point Teffaaao, Sta. 90a–57, from dead coral, May 2, 1957, Bredin Exped., 1 female; Moorea, Society Is., outside barrier reef, 200 yds. E. of pass to Papetoai Bay, 70 ft., May 15, 1957, J. Randall, 1 female.

MEASUREMENTS.—Males, 8–11 mm.; females, 9–22 mm.

REMARKS.—Specimens resemble Crosnier's (1962) figure 16, rather than his figure 17.

DISTRIBUTION.—Madagascar to Hawaii, including Australia and Japan.

Genus *Libystes* A. Milne Edwards, 1867

See Stephenson and Campbell, 1960, p. 85, for synonymy.

***Libystes truncatifrons* (de Man)**

- Catopterus nitidus* A. Milne Edwards, 1870, p. 82.—Ortmann, 1894, p. 687.—Alcock, 1900, p. 307.—Laurie, 1906, p. 422 (in part). Rathbun, 1911, pp. 238–239.—Tesch, 1918, pp. 179–180, pl. 9 (figs. 4, 4a–d).—Sakai, 1936, p. 135, pl. 35 (fig. 2).—Balss, 1938, p. 29.—Sakai, 1939, p. 372, pl. 44 (fig. 2).
Goniocapthya truncatifrons de Man, 1887b, p. 339, pl. 14 (fig. 1); 1890, p. 67.—Zehntner, 1894, p. 163, pl. 8 (fig. 12).—Borradaile, 1900, p. 577.
Libystes truncatifrons (de Man).—Stephenson and Campbell, 1960, pp. 85–86 (in key).—Crosnier, 1962, pp. 16–17, figs. 11–15.
 ?*Catopterus nitidus* A. Milne Edwards.—Edmondson, 1946, p. 277; 1954, p. 224, figs. 2e–g.

MATERIAL.—Tuamotus and Societies: Both coll. Bredin Exped., Huahine Is., Sta. 84a–57, head of Baie de Maroe, from branching coral, Apr. 5, 1957, 1 male (6 mm.). Tickahau Lagoon, Sta. 10a–57, Apr. 11, 1957, 1 ovig. female (9 mm.).

REMARKS.—If Tesch (1918, pp. 177–178) is correct in stating that there are no reasons for maintaining the genus *Catopterus* A. Milne Edwards, 1870, then the above synonymy follows.

Serene (pers. comm.) has drawn our attention to Barnard's suggestion (1954, p. 100) that *C. inequalis* Rathbun (1906), which is very close to the present species, may be a synonym of *L. edwardsi* Alcock (1900).

The male abdomen resembles that figured by Crosnier (1962, fig. 14); unfortunately no male pleopods are present so that Edmondson's (1954) figures 2f and g cannot be checked.

DISTRIBUTION.—Madagascar to Hawaii, including Mauritius, Amirante, Coetivy, Ceylon, Amboina, Batavia, Japan, Samoa, and Fiji.

Subfamily MACROPIPINAE Stephenson and Campbell, 1960

Genus *Parathranites* Miers, 1886

***Parathranites orientalis* (Miers)**

- Lupocyclus* (*Parathranites*) *orientalis* Miers, 1886, pp. 186–187, pl. 17 (figs. 1, 1a, b, c).
Parathranites orientalis (Miers).—Alcock, 1899, pp. 17–18.—Sakai, 1939, pp. 376–377, pl. 43 (fig. 2).—Barnard, 1950, pp. 148, 149, figs. 29 i–l.—Stephenson, 1961a, pp. 97–98, figs. 1B, 2H, pls. 1 (fig. 2), 4B.—Crosnier, 1962, p. 22, fig. 24.

MATERIAL.—Philippines: Sta. 5154, Bakun Point, 5°14'50"N., 119°58'45"E., 12 fm., coarse sand, Feb. 19, 1908, *Alb.*, 1 fragmented female (ca. 18 mm.).

DISTRIBUTION.—Madagascar, Seychelles, Ki Is., Admiralty Is., India, Andamans, Solomon Bank, Japan, and eastern Australia.

Subfamily CAPHYRINAE Alcock, 1899

Genus *Caphyra* Guérin, 1832

Caphyra rotundifrons (A. Milne Edwards)

Camptonyx rotundifrons A. Milne Edwards, 1869, p. 156, pl. 7 (figs. 11, 12).

Caphyra rotundifrons (A. Milne Edwards).—Stephenson and Campbell, 1960, pp. 101-102, figs. 1H, 2J, 3A-C, 3K, pls. 3 (fig. 4), 5J.—Crosnier, 1962, p. 30, fig. 39, pl. 1 (fig. 2).

MATERIAL.—Tuamotus and Societies: Matu Uta Is., Papeete Harbor, Tahiti, Sta. 42-57, outer reef, Apr. 20, 1957, Bredin Exped., 1 male (7 mm.); Sta. 62-57, Bora Bora, inner edge of outer reef, Apr. 25, 1957, Bredin Exped., 1 female (7 mm.).

DISTRIBUTION.—Mauritius to Fiji and Marianas, including Australia.

Genus *Lissocarcinus* Adams and White, 1849

Lissocarcinus orbicularis Dana

Lissocarcinus orbicularis Dana, 1852a, p. 288, pl. 18 (figs. a-e); 1852b, p. 86.—Alcock, 1899, pp. 20-21.—Leene, 1938, p. 7.—Sakai, 1939, pp. 379-380, pl. 45 (fig. 1).—Barnard, 1950, pp. 145-146, fig. 28g.—Edmondson, 1954, p. 230, fig. 6b.—Stephenson and Campbell, 1960, pp. 95-96, pl. 3 (fig. 2).—Forest and Guinot, 1961, p. 27, figs. 15a, b, 16.—Crosnier, 1962, pp. 25-27, figs. 26, 27, 31.

MATERIAL.—Hawaii: All from or near the Waikiki Marine Lab., Honolulu, in 1942; March 22, G. S. Mansfield, 1 male, 1 female; April 30, G. S. Mansfield, 1 female; May 22, G. S. Mansfield, 1 male (damaged); May 23, Mansfield and Bonne, 2 females (1 ovig.); May 30, 1 male.

Tuamotus and Societies: All coll. Bredin Exped. 1957; Sta. 13-57 Tikahau Atoll, from *Holothuria atra*, ocean reef, April 12, 1 female (damaged); Sta. 77-57 Uturoa, Raiatea, 1-3 ft., April 28, 1 female; Sta. 79-57, Taoru Is., Raiatea, reef near shore, shallow water, April 29, 1 male, 1 female; Sta. 84-57, head of Baie de Maroe, Huahine, from holothurian, sandy shoal, 2-3 ft., April 30, 1 male; Sta. 86-57, Baie de Bourayne, Huahine, sandy reef, May 1, 1 male.

MEASUREMENTS.—Males, 7-10 mm.; females, 8-12 mm.; ovig. female, 9 mm.

REMARKS.—After prolonged preservation, no traces of pigmentation remained.

DISTRIBUTION.—Africa to Hawaii and Tuamotus, including Australia and Japan.

Subfamily PORTUNINAE Stephenson and Campbell, 1960

Genus *Charybdis* de Haan, 1833

Subgenus *Charybdis* de Haan, 1833

Charybdis (Charybdis) anisodon (de Haan)

Portunus anisodon de Haan, 1835, p. 42.

Charybdis (Charybdis) anisodon (de Haan).—Leene, 1938, pp. 64–67, figs. 29, 30.—Stephenson, Hudson, and Campbell, 1957, p. 493, pl. 1 (fig. 1).—Crosnier, 1962, pp. 81–82, figs. 141–142, pl. 6 (fig. 1).

Charybdis anisodon (de Haan).—Sakai, 1939, pp. 405–406.

MATERIAL.—Malay Peninsula: Cham Han Bight, Siam, Jan. 9, 1924, H. M. Smith, 1 male, Chantabun River at Lem Sing, Siam, May 7, 1927, H. M. Smith, 2 females; Thailand, Sta. 26, entrance to Trat Bay, Gulf of Thailand, flat mud bottom, 11°58'30"N., 102°44'05"E., 5 m., Oct. 29, 1957, GVF, 1 male; Sta. 27, east coast, Gulf of Thailand, S. of Trat Bay off Lam Son Village near Cambodian border, 11°57'00"N., 102°44'45"E., 10 m., Oct. 29, 1957, GVF, 2 males; Thailand, anchorage in Mae Nam Chantaburi River at Tha Chalaep Harbor, Chantaburi Province, Sta. 134, Dec. 24, 1957, GVF, 1 female.

Philippines: Manila Bay, Dec. 7, 1907, *Alb.*, 1 male; Manila Bay, outside of breakwater, mud, small rocks, Dec. 12, 1907, *Alb.*, 1 male; Tacloban Anchorage, about ship, hand dredge, 3 fm., Apr. 12, 1908, *Alb.*, 2 males (1 fragmented), 1 female.

MEASUREMENT.—Males, 12–45 mm.; females, 13–28 mm.

REMARKS.—In larger males the borders of ultimate and penultimate abdominal segments form an uninterrupted curve instead of the indented separation shown by Crosnier (1962, fig. 142).

DISTRIBUTION.—Madagascar and Red Sea to New Caledonia, Japan, and Australia.

Charybdis (Charybdis) callianassa (Herbst)

?*Cancer callianassa* Herbst 1789, pl. 54 (fig. 7) (fide Leene, 1938).

Charybdis (Goniosoma) callianassa (Herbst).—Chopra, 1935, pp. 489–491, fig. 11, pl. 9 (fig. 1).

Charybdis (Charybdis) callianassa (Herbst).—Leene, 1938, pp. 81–84, figs. 41–43.—Stephenson, Hudson, and Campbell, 1957, pp. 493–495, figs. 1B–D, 2C, 3D, pls. 1 (fig. 2), 4A.

MATERIAL.—Malay Peninsula: East coast Gulf of Thailand, S. of

Trat Bay off Lam Son Village, near Cambodian border, $11^{\circ}57'00''\text{N.}$, $102^{\circ}44'45''\text{E.}$ GVF Sta. 27, Oct. 29, 1957, 1 male (without chelipeds) (32 mm.).

DISTRIBUTION.—Karachi to eastern Australia.

Charybdis (Charybdis) curtilobus, new species

PLATE 1A

MATERIAL.—Philippines: Sta. 5594, near Mount Putri, $4^{\circ}14'20''\text{N.}$, $117^{\circ}53'12''\text{E.}$, 11 fm., Sept. 30, 1909, *Alb.*, 1 female (21 mm., holotype, cat. no. 111729).

DESCRIPTION.—Front: 6-toothed. Medians rounded, protruding slightly beyond submedians, separated by narrow incision. Submedians broader, lobelike, with inner border curved and outer border running straight backward. Laterals roundedly triangular. Front distinctly separated from and prominent beyond inner supraorbital angles. These strongly arched and short (about as broad as lateral frontal lobes).

Anterolateral teeth: Six. First four stout and square cut, but with distinct anterior points becoming sharper in more posterior teeth. Fifth tooth sharp and the smallest. Sixth distinctly the largest.

Carapace: Relatively broad, $B./L.=1.7$. Posterolateral borders strongly convergent forming curve with nearly straight posterior border. Bearing sparse pile of fine hairs on frontal and lateral portions, microscopically granular throughout. Following ridges present: Frontals (short), protogastrics (convex anteriorly), mesogastrics (continuous sinuous line), epibranchials (interrupted at cervical groove but not in midline), cardiac (obscure), anterior mesobranchial (short, oblique), posterior mesobranchial (forward surface only ridgelike, remainder an extensive granulated area).

Chelipeds: Right larger. Granular and pilose on upper and outer surfaces. Anterior border arm with two spines, posterior border smooth. Wrist normal. Upper surface palm with two granular carinae terminating in spines about four-fifths distance along segment. Outer surface with three carinae, uppermost the most granular. Inner surface with ill-developed, smooth, central carina. Under surface microscopically granular.

Fifth leg: Merus short ($L./B.=1.7$), with posterior spine.

REMARKS.—This species resembles *C. rathbuni* Leene (1938, pp. 97–99, fig. 52) but differs as follows:

a. Broader carapace ($B./L.$ ca. 1.7 instead of ca. 1.4) due mainly to the longer last anterolateral tooth.

b. Narrower inner orbital lobe which is not much wider than the lateral frontal lobe. The specific name refers to this feature.

c. Center of mesobranchial areas of carapace is covered with a large diffusely granular area which has no counterpart in *C. rathbuni*. This effectively obliterates the two most posterior mesobranchial ridges.

d. Only two spines on upper surface of palm (excluding that at wrist articulation) against four in *C. rathbuni*.

Charybdis (Charybdis) feriatus (Linnaeus)

Cancer feriatus L. 1758, p. 627 (fide Holthius, 1962, pp. 234-235).

Cancer cruciatus Herbst, 1790, pl. 8 (fig. 53) (fide Alcock, 1899).

Charybdis (Charybdis) cruciata (Herbst).—Leene, 1938, pp. 24-27, figs. 1, 2.—Stephenson, Hudson, and Campbell, 1957, pp. 495, 497, figs. 2E, 3F, pls. 1 (fig. 3) 4B.—Crosnier, 1962, pp. 75-77, figs. 130-132.

Charybdis cruciata (Herbst).—Sakai, 1939, pp. 403-404, pl. 82 (fig. 3).—Miyake, Sakai, and Nishikawa, 1962, p. 128 (record only).

MATERIAL.—Malay Peninsula: Sta. 10001, from Thailand, purchased, received Aug. 24, 1955, R. E. Elbel, 1 male (120 mm.); Thailand, NE. of Goh Krah I., middle of Gulf of Thailand, 08°38.2'N., 101°14.6'E., GVF Sta. 40, Oct. 31, 1957, 1 male (55 mm.).

REMARKS.—Justifications for changing the long-accepted name of this species are given by Holthius (1962).

DISTRIBUTION.—Madagascar, South Africa, India, to Japan and Australia.

Charybdis cf. feriatus (Linnaeus)

MATERIAL.—China: Namru-2, Taipei, 12 mi. S. of Tau Hsui, Sta. AT-51, beach, 1957, R. E. Kuntz, 1 male (27 mm.).

REMARKS.—Probably a juvenile, as evidenced by the flexibility of the male pleopods. With many features of *C. feriatus*, except the basal antennal joint does not touch the front.

Charybdis (Charybdis) hellerii (A. Milne Edwards)

Goniosoma hellerii A. Milne Edwards, 1867, p. 282.

Charybdis (Goniosoma) merguensis Chopra, 1935, pp. 484-486, fig. 8.

Charybdis (Charybdis) hellerii (A. Milne Edwards).—Leene, 1938, pp. 44-49, figs. 15-17.

Charybdis merguensis Chopra.—Barnard, 1950, p. 168, figs. 27d, 32b.

Charybdis hellerii (A. Milne Edwards).—Edmondson, 1954, pp. 247-248, figs. 32e, f.

Charybdis (Charybdis) helleri (A. Milne Edwards).—Stephenson, Hudson, and Campbell, 1957, pp. 497-498, figs. 1A, 2I, 3J, pls. 1, (fig. 4), 4C, 5B.—Crosnier, 1962, pp. 77-78, figs. 133-135, pl. 5 (fig. 1).

MATERIAL.—Malay Peninsula: Rangoon, Burma, Gordon E. Gates, 1 male (35 mm.).

Melanesia: Sta. 4, Bougainville I., received Jan. 10, 1945, W. A. Bartos, 1 female (72 mm.).

DISTRIBUTION.—Mediterranean and East African coast to Hawaii, including Australia.

***Charybdis (Charybdis) japonica* (A. Milne Edwards)**

Goniosoma japonicum A. Milne Edwards, 1861, p. 373.

Charybdis (Charybdis) japonica (A. Milne Edwards).—Leene, 1938, pp. 30–35, figs. 5–7.

Charybdis japonica (A. Milne Edwards).—Sakai, 1939, pp. 400–401, pl. 45 (fig. 5).—Miyake, Sakai, and Nishikawa, 1962, p. 128 (record only).

MATERIAL.—China: Tan Shui Beach, northwest coast of Taiwan, Aug. 15, 1965, R. E. Kuntz, 1 male.

Japan: Tangku, Fan Memorial Institute of Biology, May 8, 1929, C. J. Shen (coll. and ident.), 1 male, 1 female.

MEASUREMENTS.—Males, 34, 63 mm.; female, 73 mm.

DISTRIBUTION.—Red Sea, China, and Japan. As Leene notes, the absence of specimens from intermediate localities is surprising.

***Charybdis (Charybdis) miles* (de Haan)**

Portunus (Charybdis) miles de Haan, 1835, p. 41, pl. 11 (fig. 1).

Charybdis (Charybdis) miles (de Haan).—Leene, 1938, pp. 38–42, figs. 10–13.—Stephenson, Hudson, and Campbell, 1957, pp. 500–501, figs. 2H, 3I, pls. 2 (fig. 3), 4F.

Charybdis miles (de Haan).—Sakai, 1939, p. 405, pl. 46 (fig. 2).—Miyake, Sakai, and Nishikawa, 1962, p. 128 (record only).

MATERIAL.—Philippines: Sta. 5442, west coast of Luzon, South Fernando Point Light, 16°30'36"N., 120°11'06"E., 45 fm., coarse sand, May 11, 1909, *Alb.*, 1 female (22 mm.).

DISTRIBUTION.—India to Japan and Australia, including South China Sea and Hong Kong.

***Charybdis (Charybdis) natator* (Herbst)**

Cancer natator Herbst, 1789, pl. 40 (fig. 1) (fide Leene, 1938).

Charybdis (Charybdis) natator (Herbst).—Leene, 1938, pp. 93–97, figs. 50, 51.—Stephenson, Hudson, and Campbell, 1957, pp. 501–502, figs. 2G, 3H, pls. 2 (fig. 4), 4J.—Crosnier, 1962, pp. 82–83, figs. 143–144, pl. 13 (fig. 2).

Charybdis natator (Herbst).—Sakai, 1939, p. 407.—Barnard, 1950, pp. 169–170.

MATERIAL.—Malay Peninsula: Singapore, Mar. 20, 1934, Herre collection, 1 male.

Australia: Low tide, Little Lagoon, Groote Eylandt, on sand bar, about one-fourth mile from south shore, speared by native, May 11, 1948, 1 male.

MEASUREMENTS.—Males, 55, 98 mm.

DISTRIBUTION.—Southeast Africa to Japan and Australia.

***Charybdis (Charybdis) orientalis* Dana**

Charybdis orientalis Dana, 1852a, p. 285, pl. 17 (fig. 10); 1852b, p. 85.—Sakai, 1939, pp. 407–408, pl. 83 (fig. 2).

Charybdis (Charybdis) orientalis Dana.—Leene, 1938, pp. 68–72, figs. 32–34 (excluding some synonymy).—Stephenson, Hudson, and Campbell, 1957, pp. 502–503, figs. 2B, 3B, pls. 3 (fig. 1), 4G.—Crosnier, 1962, pp. 80–81. Not *Charybdis orientalis* Edmondson, 1946, p. 281, fig. 173e (= *C. hawaiiensis*).

MATERIAL.—China: Tan Shui Beach, northwest coast of Taiwan, Aug. 15, 1956, R. E. Kuntz, 1 female (44 mm.).

DISTRIBUTION.—Madagascar and East Africa to Japan and Australia.

Subgenus *Goniohellenus* Alcock, 1899

Charybdis (Goniohellenus) truncata (Fabricius)

Portunus truncatus Fabricius, 1798, p. 365 (fide Leene, 1938).

Charybdis (Goniohellenus) truncata (Fabricius).—Leene, 1938, pp. 118–121, figs. 66, 67.—Stephenson, Hudson, and Campbell, 1957, pp. 503–504, figs. 2D, 3E, pls. 3 (fig. 3), 4I.—Stephenson, 1961a, p. 117.—Crosnier, 1962, pp. 87, 89, figs. 149–150, pl. 8 (fig. 1).—Miyake, Sakai, and Nishikawa, 1962, p. 128 (record only).

MATERIAL.—Philippines: Sta. 5442, west coast of Luzon, South Fernando Point Light, 16°30'36"N., 120°11'06"E., 45 fm., coarse sand, May 11, 1909, *Alb.*, 1 male (23 mm.).

DISTRIBUTION.—Madagascar, Ceylon, India, Japan, Philippines, and Australia.

Charybdis (Goniohellenus) vadorum Alcock

Charybdis (Goniohellenus) hoplites var. *vadorum* Alcock, 1899, p. 67.

Charybdis (Goniohellenus) vadorum Alcock.—Leene, 1938, pp. 114–117, figs. 63–65.

MATERIAL.—Philippines: Sta. 5442, west coast of Luzon, South Fernando Point Light, 16°30'36"N., 120°11'06"E., 45 fm., coarse sand, May 11, 1909, *Alb.*, 1 male (17 mm.), 1 female (21 mm.).

REMARKS.—The carapace ornamentation is slightly different from that figured by Leene, the mesobranchial granulated areas being distinctly separated from the posterolaterals. The frontal incisions separating the lateral frontal teeth from the remainder are deep and relatively broad, more so than Leene's figure 63. This causes difficulties in her key (pp. 22–23).

DISTRIBUTION.—Red Sea and Persian Gulf to Hong Kong.

Subgenus *Gonioneptunus* Ortmann, 1893

Charybdis (Gonioneptunus) bimaculata (Miers)

Goniosoma variegatum var. *bimaculatum* Miers, 1886, p. 191, pl. 15 (fig. 3).

Charybdis (Gonioneptunus) bimaculata (Miers).—Leene, 1938, pp. 126–129, figs. 70, 71.—Stephenson, Hudson, and Campbell, 1957, pp. 504–505, figs. 2J, 3K, pls. 3 (fig. 4), 4H, 5A.

Charybdis bimaculata (Miers).—Sakai, 1939, pp. 410–412, figs. 10, 11.—Miyake, Sakai, and Nishikawa, 1962, p. 128 (record only).

Charybdis (Gonioneptunus) subornata (Ortmann).—Leene, 1938, pp. 122–125, figs. 68, 69.

Charybdis (Gonioneptunus) whiteleggei (Ward).—Leene, 1938, pp. 125–126.

MATERIAL.—Philippines: Sta. 5391, Tubig Point, Destacado 1., 12°13'05"N., 124°05'03"E., 118 fm., Mar. 13, 1909, *Alb.*, 1 female (15 mm.).

REMARKS.—As indicated by Sakai (1939, pp. 410–412), *C. subornata* is probably a synonym of *C. bimaculata*. Stephenson, Hudson, and Campbell (1957, pp. 504–505) supported this synonymy, adding *C. whiteleggei*. The present specimen has long last anterolateral teeth as in Leene's figure (fig. 68) of *C. subornata*.

DISTRIBUTION.—India and Maldives to Japan and eastern Australia.

Subgenus *Goniosupradens* Leene, 1938

Charybdis (Goniosupradens) erythrodactyla (Lamarck)

Portunus erythrodactylus Lamarck, 1818, p. 259.

Thalamita erythrodactyla (Lamarck).—H. Milne Edwards, 1834, p. 464.

Charybdis (Goniosoma) erythrodactyla (Lamarck).—Rathbun, 1906, p. 872, pl. 4.

Charybdis (Goniosupradens) erythrodactyla (Lamarck).—Leene, 1938, pp. 134–137, figs. 77–80.—Crosnier, 1962, p. 86, pl. 7 (fig. 1).

Charybdis erythrodactyla (Lamarck).—Sakai, 1939, pp. 408–409, pl. 83 (fig. 1).—Holthuis, 1953, p. 6.—Forest and Guinot, 1961, p. 30.

MATERIAL.—Marshalls: Outer reef, Namu I., Bikini Atoll, collected at night, by light, Aug. 7, 1947, F. M. Bayer, 2 males.

Tuamotus and Societies: Bora Bora, Farepiti Point Sta. 50–57, Apr. 23, 1957, Bredin Exped., 1 ovig. female; Sta. 126–57, reef, Nuarei Bay, Moorea, May 12, 1957, Bredin Exped., 1 male.

MEASUREMENTS.—Males, 55–94 mm.; ovig. female, 81 mm.

DISTRIBUTION.—Mauritius and Red Sea to Hawaii, Tahiti, and Marquesas, including Japan. Not recorded from Australia.

Charybdis (Goniosupradens) obtusifrons Leene

Charybdis obtusifrons Leene, 1936, p. 124, figs. 11, 12.—Sakai, 1939, pp. 409–410, pl. 83 (fig. 3).

Charybdis (Goniosupradens) obtusifrons Leene, 1938, pp. 140–143, figs. 85–87.—Sankarankutty, 1961, pp. 123–124.—Crosnier, 1962, pp. 84–85, figs. 146, 146 bis a-c, pl. 6 (fig. 2).

MATERIAL.—Melanesia: Bougainville I., received Jan. 10, 1945, W. A. Bartos, 2 males (dried) (8, 13 mm.).

REMARKS.—Because of their fragile state, detailed examination was impossible. Compared with Leene's figures and description, the differences in present specimens are: Submedian frontal teeth are broader; protogastric ridges are equidistant between frontals and

mesogastrics; and mesobranchial ridges are longer and slightly inclined.

DISTRIBUTION.—Madagascar, Red Sea, India, and Japan.

Genus *Portunus* Weber, 1795

***Portunus acerbiterminalis*, new species**

FIGURE 1; PLATE 1B

MATERIAL.—East Africa: U-48-74 Saudi Arabia, Tarut Bay, Ras Tanura, fish pier at night, May 26, 1948, Erdmann, 1 male (fragmented, two walking legs, one fifth leg missing) (16 mm., holotype, cat. no. 112-656); U-48-89, Saudi Arabia, Tarut Bay, 1¼ mi. N. of Ras Tanura, 100 yds. offshore, June 7, 1948, Erdmann, 1 male (19 mm.), 1 female (missing most appendages, with only one left cheliped, one walking leg, one left fifth leg) (ca. 19 mm.). All specimens soft, initially formalin preserved.

DESCRIPTION.—Front: 4-lobed, upraised, protruding well beyond inner supraorbital angles. Medians much smaller, more rounded, and less projecting than laterals, which are obtusely rounded. Inner supraorbital angle very obtuse. Two fissures on upper border of orbit, both slightly open. Single suborbital fissure. Suborbital tooth reasonably prominent.

Anterolateral teeth: Nine, first blunt, remainder sharp; fourth, sixth, and eighth slightly smaller than intervening odd-numbered teeth. Ninth distinctly elongate.

Carapace: Reasonably broad, approximately twice as broad as long, with conspicuously elevated areas (some almost tubercular), separated by regions with dense pubescence. Posterior-posterolateral junction elevated, forming an obtuse or right angle. Following areas recognizable: Protogastrics diffuse and broadly separated; mesogastrics each divided into two portions, median with almost ridgelike termination, lateral with dense cluster of granules to form a tubercle; metagastric continuous across midline with ridged border; central longitudinal patch present, running from level of protogastrics but not quite confluent with metagastrics; between metagastrics and cardials a small, central, transverse, granular patch; paired cardials, conspicuously elevated, each bearing a tubercle, broadly separate in midline; median postcardiac an unusually conspicuous, tuberculate elevation; lateral postcardials conspicuous, but diffuse; anterolaterals, sizable patch opposite third anterolateral tooth, smaller one opposite fifth, and smaller still opposite seventh; epibranchial feebly developed laterally, well developed toward center; anterior and posterior mesobranchials present, former with short ridgelike border sometimes

tuberculate, latter variable, either diffuse or tuberculate; postero-laterals well developed, sometimes merging with posterior meso-branchials. Two additional small, paired, granular patches present, one midway between epibranchials and metagastriacs, the other midway between anterior mesobranchials and cardiacs.

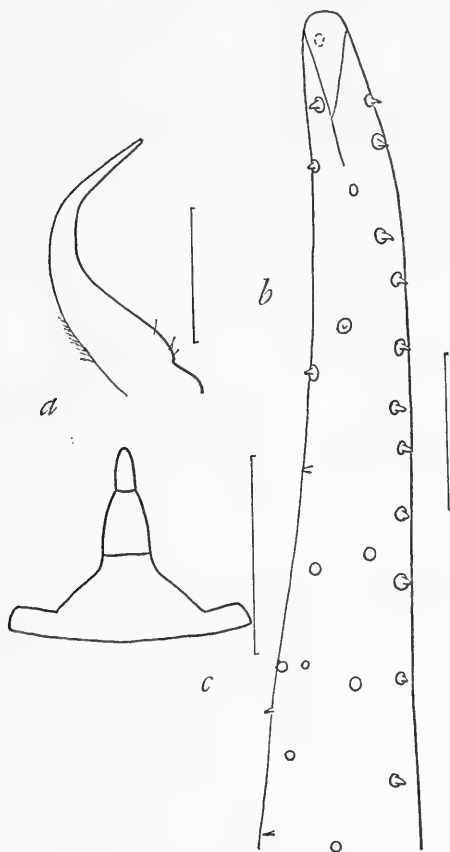


FIGURE 1.—*Portunus acerbiterminalis*, new species, male holotype: *a*, pleopod; *b*, pleopod tip, under surface; *c*, abdomen. (Scales=*a*, 1 mm.; *b*, 0.1 mm.; *c*, 5 mm.)

Chelipeds: Short, stout, right stouter than left, with squamiform markings on under surface. Posterior border of arm with two well-developed spines, anterior border with four spines. Wrist with well-developed spines on inner and outer surfaces. Hand with well-developed shelflike carina separating upper from inner surface, and bearing on each left chela a terminal spine (none on right chela). Two carinae on outer surface of hand, both regularly granular, lowermost very prominent. Well-developed granular carina on inner surface of hand. Fingers short, stout but thin.

Fifth leg: Merus, relatively stout (B/L ca. 1.5), posterodistal border coarsely serrated.

Third maxilliped: Anteroexternal angle conspicuously expanded in lateral direction.

Male abdomen: Elongate, ultimate segment lanceolate with rounded tip, twice as long as broad. Penultimate segment, distally parallel sided, then converging regularly, 1.4 times as long as broad.

Male first pleopod: Short, stout, robust, smoothly but conspicuously curved. Subterminal armature on outer surface, of scattered spinules with portions of three or four (only) visible in profile view. Inner side without subterminal armature or with a single bristle in profile view. Under surface with scattered reasonably numerous spinules.

REMARKS.—This species differs considerably from *P. hastatoides*, although it keys out similarly in Stephenson and Campbell (1959). It differs obviously in the carapace ornamentation.

The strongly embossed carapace is reminiscent of *P. petreus*, but the present species differs as follows: Spines on inner and outer sides of wrist are approximately equal size; last anterolateral tooth is distinctly longer (see Crosnier, 1962, fig. 86, pl. 4, fig. 1); has angled posterior-posterolateral junctions of the carapace.

It resembles *P. rugosus* in its embossed carapace but differs in the details of granulation and in having a 4-lobed front.

It possibly resembles *P. tuberculosus* more closely than any other species but differs in having: A more conspicuously produced antero-external border of the merus of the third maxilliped; less protruding median frontal teeth; a much larger first anterolateral tooth; a longer ninth anterolateral tooth; a differently shaped epibranchial carapace ridge; and the posterior border of the arm of the cheliped bearing two distinct spines instead of one and a doubtful second.

Portunus argentatus (A. Milne Edwards)

FIGURE 2

Amphitrite argentata White, 1847, p. 146 (descriptio nulla).

Neptunus argentatus A. Milne Edwards, 1861, pp. 332, 339, pl. 31 (figs. 4, 4a, 4b).

Portunus (Achelous) argentatus (A. Milne Edwards).—Rathbun, 1906, p. 871.—

Edmondson, 1954, pp. 238–239, figs. 14, 15.

Portunus argentatus (A. Milne Edwards).—Stephenson, 1961a, pp. 105–106, figs.

1F, 3D, pls. 2 (fig. 2), 4D, 5A.—Crosnier, 1962, pp. 50–51, figs. 71, 75, 77, 80, 81, pl. 3 (fig. 1).

MATERIAL.—As indicated below, two forms are distinguishable in adult males, designated forms A and B respectively. These are listed separately, as are females and juveniles.

MALES (FORM A)

China: Sta. 5308, China Sea, vicinity Hong Kong, $21^{\circ}54'N.$, $115^{\circ}42'E.$, 62 fm.; Nov. 4, 1908, *Alb.*; 1 *Sacculina* infected male; Sta. 5309, China Sea, vicinity Hong Kong, $21^{\circ}53'N.$, $115^{\circ}51'E.$, 62 fm., green mud, Nov. 4, 1908, *Alb.*, 4 males.

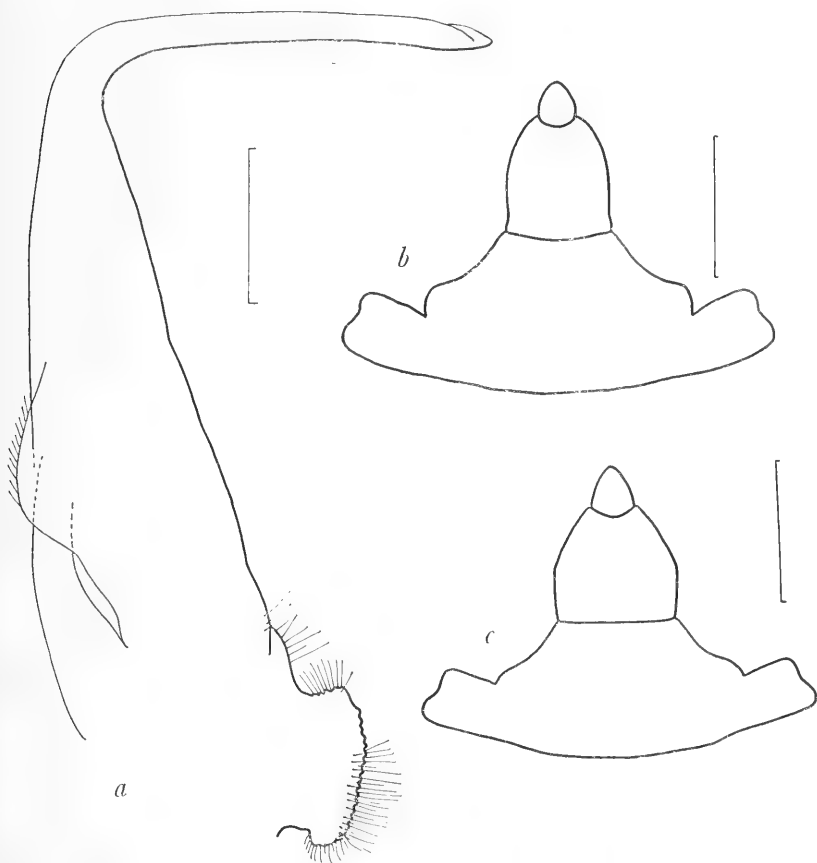


FIGURE 2.—*Portunus argentatus* (A. Milne Edwards), male: *a*, form B, pleopod, Philippines, Sta. 5442, *Alb.*, 30 mm.; *b*, abdomen, same specimen; *c*, form A, abdomen, Philippines, Sta. 5442, *Alb.*, 29 mm. (Scales=*a*, 1 mm.; *b*, *c*, 5 mm.)

Philippines: Sta. 5152, Pajumajan I., $5^{\circ}22'55"N.$, $120^{\circ}15'45"E.$, Feb. 18, 1908, *Alb.*, 1 male; Sta. 5442, west coast of Luzon, South Fernando Point Light, $16^{\circ}30'36"N.$, $120^{\circ}11'06"E.$, 45 fm., coarse sand, May 11, 1909, *Alb.*, 16 males (1 damaged).

MALES (FORM B)

Philippines: Sta. 5442, west coast of Luzon, South Fernando Point Light, 16°30'36"N., 120°11'06"E., 45 fm., coarse sand, May 11, 1909, *Alb.*, 3 males.

FEMALES

China: Sta. 5303, China Sea, vicinity Hong Kong, 21°44'N., 114°48'E., 34 fm., blue mud, Aug. 9, 1908, *Alb.*, 1 female; Sta. 5304, China Sea, vicinity Hong Kong, 21°46'N., 114°47'E., 34 fm., black mud, Aug. 9, 1908, *Alb.*, 1 female; Sta. 5309, China Sea, vicinity Hong Kong, 21°53'N., 115°51'E., 62 fm., green mud, Nov. 4, 1908, *Alb.*, 2 females; Takao, Formosa, Dec. 3 and 4, 1914, Fred Baker, 2 females (1 soft and fragmented).

Philippines: Port Binanga, ship's side, 6 fm., Jan. 8, 1908, *Alb.*, 1 female (deformed abdomen); Panabutan Bay, Mindanao, electric light, soft mud and sand, Feb. 5, 1908, *Alb.*, 1 female; Sta. 5152, Pajumajan I., 5°22'55"N., 120°15'45"E., Feb. 18, 1908, *Alb.*, 1 female; Sta. 5157, Tinakta I., Sulu Archipelago, Tawitawi Group, 5°12'30"N., 119°55'50"E., 18 fm., fine sand, Feb. 21, 1908, *Alb.*, 1 female (damaged); Sta. 5442, west coast of Luzon, South Fernando Point Light, 16°30'36"N., 120°11'06"E., 45 fm., coarse sand, May 11, 1909, *Alb.*, 22 females (4 ovig., 2 *Sacculina* infected, 1 damaged), 1 damaged unsexable specimen; Sta. 5480, Tacbuc Point (Leyte), 10°44'36"N., 125°19'E., 62 fm., fine sand, July 29, 1909, *Alb.*, 1 female.

JUVENILES

Philippines: Port Binanga, ship's side, 6 fm., Jan. 8, 1908, *Alb.*, 2 juvs.

MEASUREMENTS.—Males (form A), 21–39 mm. (1 damaged male, ca. 40 mm.); males (form B), 30–33 mm.; females, 18–36 mm.; ovig. females, 35–37 mm.; juvs. 14 mm.; damaged unsexable specimen, ca. 27 mm.

REMARKS.—In most specimens, and after long preservation, there are no detectable spots on the dactylus of the swimming legs and the general nacreous luster is far from obvious. Most males have pleopods resembling those figured and described by Stephenson (1961a) with short, curved, distally swollen appendages bearing a complex and dense subterminal armature. These possess abdomens with relatively broad, sharply converging penultimate segments.

In three cases male pleopods are quite different, with long gradually tapering appendages bent at more than a right angle near their centers, and with inconspicuous subterminal armature consisting of small spinules on the outer surface (fig. 2a). These possess abdomens with relatively narrow, gradually converging penultimate segments.

This second form of pleopod resembles that figured by Edmondson (1954, fig. 14 c,d), differing only in subterminal armature which Edmondson shows as a distinct row of sizable bristles on the outer surface. This form of pleopod has also been figured by Crosnier (1962, figs. 77, 80, 81). The corresponding abdomen is apparently intermediate between those mentioned above.

Apart from male pleopods and abdomens, no structural heterogeneity could be found in the present material. There are two possibilities:

a. The material belongs to two distinct species, separable only in adult males and effectively only by pleopods. To accept this would involve several difficulties. First, the two "species" would be sympatric in distribution, or at least seriously overlapping, since both occur in one collection. Second, to establish which was the true *P. argentatus* would necessarily await reexamination of Milne Edwards' material. Third, it would involve the assumption of reproductive isolation, with females being capable of fertilization with only one or another type of male. Until the detailed role of pleopods in fertilization has been determined, this must remain doubtful. Fourth, there are other cases of heterogeneity in male pleopods (e.g., *Thalamita stimpsoni*, *T. danae*, *P. orbitosinus*—see text), and these should be treated similarly. This presents particular difficulty in *P. orbitosinus* where pleopod variation is more continuous than in the present case.

b. The second possibility is that a species can be polymorphic as regards male pleopods.

As stated in the Introduction, for the purposes of the present paper, *P. argentatus* was taken as the "test case" of the concept of a portunid species. This concept implies a distinct morphological gap between other species in general facies as well as pleopod structure.

Thus there are two male forms of *P. argentatus*, form A corresponding with that figured and described by Stephenson (1961a) and form B corresponding to that given in figure 2a. Possibly Edmondson's (1954) and Crosnier's (1962) specimens belong to a third form, resembling form B in general shape of the pleopod, but differing in its much better developed bristles.

DISTRIBUTION.—Natal to Honolulu, including Japan and Australia.

Portunus brockii (de Man)

Neptunus brockii de Man, 1887a, pp. 328–331, pl. 13 (fig. 4).

Neptunus (Hellenus) brockii de Man.—Alcock, 1899, pp. 43–44.—Shen, 1937, p. 111, figs. 7, 8e, 8f.

Portunus brocki (de Man).—Stephenson and Campbell, 1959, pp. 106–107, figs. 2G, 3G, pls. 2 (fig. 3), 4G, 5G.

MATERIAL.—Philippines: Subig Bay, China Sea, off southern Luzon, shore, seine, sand, Jan. 7, 1908, *Alb.*, 1 male; Sta. 5160, Tinakta

I., Sulu Archipelago, Tawitawi Group, 5°12'40"N., 119°55'10"E., 12 fm., sand, Feb. 22, 1908, *Alb.*, 1 male; Catabata, Mindanao, below mouth of river, seine, May 20, 1908, *Alb.*, 1 male; Port San Vicente, 130 ft. seine, Nov. 18, 1908, *Alb.*, 1 male, 1 ovig. female; Buena Vista, Guimaras Is., Iloilo Strait, seine in mouth of river, Jan. 14, 1909, *Alb.*, 1 male; near Mariveles, Luzon, 1913, A.M. Reese, 1 male.

Palau: Sta. 12-832, Madalai district, west end of Koror I., mangrove shore grading into mud and sand flat, July 9, 1955, GVF, 1 male.

MEASUREMENTS.—Males, 12-29 mm.; ovig. female, 15 mm.

REMARKS.—A male "16 mm., Port San Vicente, Nov. 18, 1908 *Alb.*" has a very broad, female-like abdomen, but fully developed male pleopods are present.

DISTRIBUTION.—Amboina, Andamans, Singapore, and Australia.

Portunus dubius (Laurie)

FIGURE 3; PLATE 2A

Neptunus (Achelous) dubia Laurie, 1906, pp. 416-417, fig. 9.

MATERIAL.—Philippines: Sta. 5140, Jolo Lt., 6°08'45"N., 121°03'E., 76 fm., fine coral sand, Feb. 15, 1908, *Alb.*, 1 female (13 mm.); Sta. 5432, Corandagos I., 10°37'50"N., 120°12'E., 51 fm., Apr. 8, 1909, *Alb.*, 1 male (12 mm.).

DESCRIPTION.—Front: Protruding beyond inner supraorbital angles and 4-toothed. Teeth sharp and directed dorsally, laterals the larger and inclined outward. Inner supraorbital angles rounded, upper border of orbit with single fissure, lower border with acute forward-directed tooth.

Anterolateral teeth: Nine, first the stoutest, gradually decreasing in size with eighth the smallest and ninth slightly larger.

Carapace: Very long, breadth about 1.3 times length. Surface microscopically granular among which major patches of granules are visible. Protogastrics diffuse and merging with ill-developed mesogastrics, which in turn connect by a central granular line to transversely situated metagastrics. Patch behind orbit in line with third anterolateral tooth; further diffuse patch opposite fourth to ninth teeth, and merging with epibranchial. Paired cardiac merges with median postcardiac. Pair of lateral postcardiacs. Mesobranchials large and diffuse but terminates abruptly on posterolateral margins by granular ridges.

Fifth leg: Merus short, length 1.8 times breadth, and with finely denticulated posterior margin. Propodus with fine hairs but no spines.

Third maxilliped: Hirsute and produced laterally.

Male abdomen: Penultimate segment with regularly tapering sides, ultimate segment triangular.

Male first pleopod: Grossly swollen so that normal distinction between basal and terminal elongate portions cannot be made. Inner side curves regularly and bears forwardly directed bipinnate bristles along half its length. Outer surface bears conspicuous flattened lobe thinly beset with elongate bipinnate bristles or hairs, these extending to upper surface where they are denser. Appendage terminates

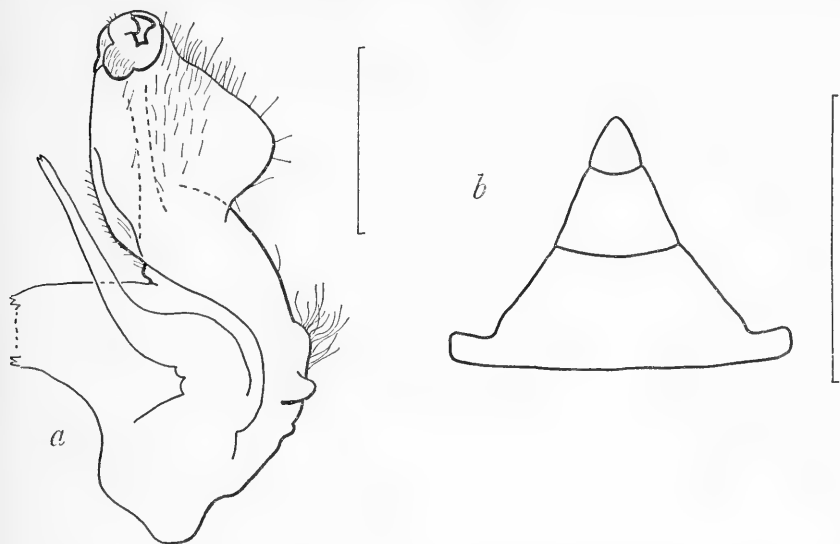


FIGURE 3.—*Portunus dubius* (Laurie), male, Philippines, Sta. 5432, *Alb.*: a, pleopod; b, abdomen. (Scales=*a*, 1 mm.; *b*, 5 mm.)

abruptly and bears subterminal aperture directed upward. Folds of cuticle surrounding this aperture give a rosette appearance and are densely covered with minute inwardly directed spinules.

REMARKS.—This species resembles *P. orbicularis* (Richters) which has been redescribed recently by Crosnier (1962). It differs in possessing a spiniform front, more granular carapace, and a male pleopod which is different from all other known species of the genus.

The abdomen of the single male in the present collection is narrower, and the ultimate segment is longer than figured by Laurie (1906, fig. 9).

DISTRIBUTION.—Previously from Gulf of Manaar and Negombo, Ceylon.

***Portunus euglyphus* (Laurie)**

FIGURE 4; PLATE 2B

Neptunus (Amphitrite) euglyphus Laurie, 1906, pp. 413–414, figs. 6, 7.

Portunus (Achelous) granulatus Edmondson, 1954, p. 239, figs. 16a, b (not fig. 17a).

Not *Lupea granulata* H. Milne Edwards, 1834, p. 454.

MATERIAL.—Philippines: Guijulugan, Negros, shore seine, Apr. 2, 1908, *Alb.*, 1 male (19 mm.); Paluan Bay, Mindoro, 130 ft. seine, Dec. 11, 1908, *Alb.*, 1 male (18 mm.).

DESCRIPTION.—Front: 4-lobed, outer lobes roundedly triangular and protruding beyond the much smaller, similar shaped medians.

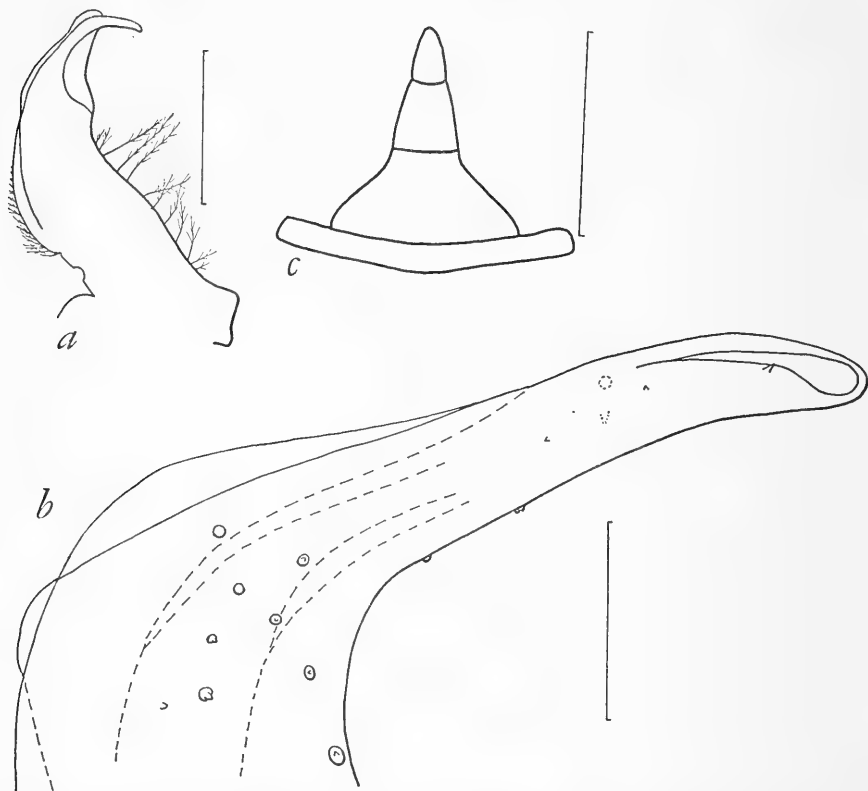


FIGURE 4.—*Portunus euglyphus* (Laurie), male, Philippines, Guijulugan, *Alb.*: a, pleopod; b, pleopod tip, upper surface; c, abdomen. (Scales=a, 1 mm.; b, 0.1 mm.; c, 5 mm.)

These merge with epistomial projection so that in some views front appears 3-lobed. Inner orbital angle short. Two incisions on upper border and rounded tooth on lower.

Anterolateral teeth: Anterolateral borders practically straight. First tooth relatively stout, fourth and fifth the smallest, then increasing in size to ninth, much the largest. Apart from first, all bear sharp, forwardly directed points.

Carapace: With inconspicuous pubescence and distinct granulated areas. Frontals and orbitals poorly developed. Mesogastrics and metagastrics distinct granular transverse lines connected by broad central granular patch. Protogastrics with larger anterior and smaller posterior region, latter with ridgelike anterior boundary. Cardiacs, median postcardiac, and lateral postcardiacs all conspicuously raised, rounded, granular areas. Mesobranchials resolvable into three patches. Epibranchials and posterolaterals well developed. Posterior-posterolateral junction rounded.

Chelipeds: Pubescent and markedly granular, especially on inner surfaces. Posterior border of arm with two sharp spines, anterior border with four spines. Wrist with inner and outer spine. Hand with two well-marked outer carinae, upper being granular. Two carinae on upper surface of hand, inner being the better developed and terminating in a spine just before end of segment. No recognizable carinae on inner surface of hand, this completely covered with large rounded granules showing through fairly dense pubescence.

Fifth leg: Posterior borders of merus, carpus, and propodus ornamented only with hairs.

Third maxilliped: Anteroexternal angle markedly produced laterally.

Male abdomen: Penultimate and ultimate segment gradually tapering, latter three-fifths length of former. Male abdomen and entire undersurface shining.

Male first pleopod: Short and stout with undulating outer side and sharply curved tip pointing outward. Outer surface bearing long, and inner surface bearing shorter bipinnate hairs. Terminal armature ill developed and consisting of three or four minute spinules on upper surface and five or six on lower.

REMARKS.—In its general facies this species resembles *P. gladiator* Stephenson and Campbell (1959) but differs from it in having a much shorter last anterolateral spine so that the anterolateral borders appear almost without curvature, in the absence of serrations on the posterodistal border of the fifth merus, and in possessing a male pleopod unique to the genus.

The species is probably closest to *P. granulatus*, particularly in the granular areas of the carapace and the form of male pleopod, but differs conspicuously in carapace shape, in having a longer last anterolateral tooth, and in the characteristic form of its male pleopod. Edmondson's (1954) figure 16b of this pleopod obviously refers to the present species and not to *P. granulatus*.

DISTRIBUTION.—Previously known only from the Gulf of Manaar and Negombo, Ceylon, and Hawaii.

The *Portunus gladiator* Complex

Crosnier (1962) concluded that *P. pseudoargentatus* Stephenson (1961a) is synonymous with his *P. gladiator*; however, the present collection contains three specimens identical with *P. pseudoargentatus* and two identical with *P. gladiator* Crosnier. These differ in a sufficient number of small particulars for *P. pseudoargentatus* to stand as a valid species.

Crosnier suspected that numerous confusions had occurred in the past regarding *P. gladiator* and particularly that *P. gladiator* Stephenson and Campbell (1959) differed from the species he recognized under this name. Reexamination of Stephenson and Campbell's material confirms that this is so. The penultimate segment of the male abdomen in Stephenson and Campbell's species is not swollen in its distal third, and the ultimate segment is more rounded and elongate. (Note that the plates in Stephenson and Campbell are mislabelled, the male abdomen of *P. gladiator* is plate 4, figure I, not figure J.) In addition, the carapace granulation is much coarser and more obvious, with posterolaterals almost merging with mesobranchials, and these again almost merging with the epibranchials. In addition, the serrated distal border of the fifth merus bears a posterior spine, not an anterior spinous projection. Until the "true" *P. gladiator* has finally been decided upon, by reference to Fabricius type, the correct name for *P. gladiator* Stephenson and Campbell must remain undecided.

Yet other authors have described different species under *P. gladiator*. Thus the shape of the male abdomen figured by Sakai (1939, fig. 5a) differs from those figured similarly by Shen (1937, fig. 2b) and Crosnier (1962, fig. 72), and described by Alcock (1899) and Barnard (1950). Sakai's figure is identical with that of *P. pseudoargentatus* Stephenson (1961a, pl. 4F), and his colored plate (pl. 47, fig. 3) is generally similar to *P. pseudoargentatus* and specifically bears an identical pigmentation of the propodus and dactylus of the fifth leg. It is concluded that *P. gladiator* Sakai and *P. pseudoargentatus* are synonyms.

De Haan's (1835) description and figures of *Portunus (Amphitrite) gladiator* appear to resemble *P. pseudoargentatus* more closely than *P. gladiator* Crosnier in possessing a parallel-sided male abdomen. The position as regards shape of the merus of the fifth leg is more ambiguous. The left side of de Haan's plate 1, figure 5, shows a relatively broad merus, approximating to *P. gladiator* Crosnier and the right side a relatively elongate one, approximating to *P. pseudoargentatus* (see p. 25). Because de Haan's plate shows pigmentation of the fifth leg resembling that of *P. pseudoargentatus* and because the

last anterolateral tooth points in a similar direction, his species is here regarded (tentatively) as being a synonym of *P. pseudoargentatus*.

***Portunus gladiator* (Alcock)**

Neptunus (Amphitrite) gladiator Alcock, 1899, pp. 35-36.—Shen, 1937, pp. 101-103, figs. 2a-c.

Monomia gladiator Barnard, 1950, p. 156.

Portunus gladiator Crosnier, 1962, pp. 51-54, figs. 72, 76, 78, 82-83, pl. 3 (fig. 2).

?*Portunus gladiator* Fabricius, 1798, p. 368.

Not *Portunus gladiator* Stephenson and Campbell, 1959, pp. 110-111, figs. 2J, 3J, pls. 3 (fig. 2), 4I, 5J.

MATERIAL.—Africa: Natal, from W. F. H. Rosenberg, 1 male (70 mm.), 1 female (66 mm.).

***Portunus pseudoargentatus* Stephenson**

Portunus (Amphitrite) gladiator De Haan, 1835, p. 39, pl. 1 (fig. 5).

Neptunus (Amphitrite) gladiator Sakai, 1939, pp. 390-391, text-fig. 5a, pl. 47 (fig. 3).

Portunus pseudoargentatus Stephenson, 1961a, pp. 109-111, figs. 2A, 3F, pls. 2 (fig. 4), 4F, 5D.

?*Portunus gladiator* Fabricius, 1798, p. 368.

MATERIAL.—Philippines: Lembeh Strait, Celebes, June 14, 1929, Herre collection, 1 male (25 mm.).

Japan: Fukura, Awaji, Y. Hirase, 1 female (28 mm.); Shimizu, Suruga, shore, Oct. 14, 1906, *Alb.*, 1 male (20 mm.).

REMARKS.—This species differs in the following details from *P. gladiator*, as described and figured by Crosnier (1962) (the comparison has been facilitated by Crosnier's kindness in forwarding one of his named specimens):

a. A more strongly embossed carapace with coarser granulation. In particular the cardiac, lateral postcardiacs, posterolaterals, and two mesobranchials are larger and less diffuse than in *P. gladiator*.

b. Form of male abdomen. The ultimate segment relatively longer and without concave lateral borders, penultimate segment not swollen in distal third.

c. Relatively narrower fifth merus. In *P. pseudoargentatus* breadth is about 0.75 times length, in *P. gladiator* about 0.9 times.

d. Differently armed anterodistal border of fifth merus. In *P. pseudoargentatus* it is finely serrated, in *P. gladiator* it bears small but distinct teeth.

e. The last anterolateral tooth is not directed slightly posteriorly, as in *P. gladiator*.

***Portunus granulatus* (H. Milne Edwards)**

FIGURE 5

Lupea granulata H. Milne Edwards, 1834, p. 454.

Neptunus (Achelous) granulatus (H. Milne Edwards).—Alcock, 1899, pp. 45-46.—

Sakai, 1939, p. 397, pl. 81 (fig. 3).

Portunus (Achelous) granulatus (H. Milne Edwards).—Rathbun, 1906, p. 871, pl. 41 (fig. 6); 1911, p. 205, pl. 15 (fig. 10).—Balss, 1938, p. 31.—Edmondson, 1954, p. 239 (in part).

Neptunus granulatus (H. Milne Edwards).—Balss, 1924, p. 3 (excluding synonymy).

Portunus granulatus (H. Milne Edwards).—Stephenson and Campbell, 1959, pp. 108–110, figs. 2I, 3I, pls. 3 (fig. 1), 4J, 5I (not pl. 4I as stated in text).—Sankarankutty, 1961a, p. 104; 1961b, p. 124.—Crosnier, 1962, pp. 57–58, figs. 89, 92, 94a, b.

Not *Portunus (Achelous) granulatus* Edmondson, 1954, figs. 16a, b = *P. euglyphus* (Laurie) 1906.

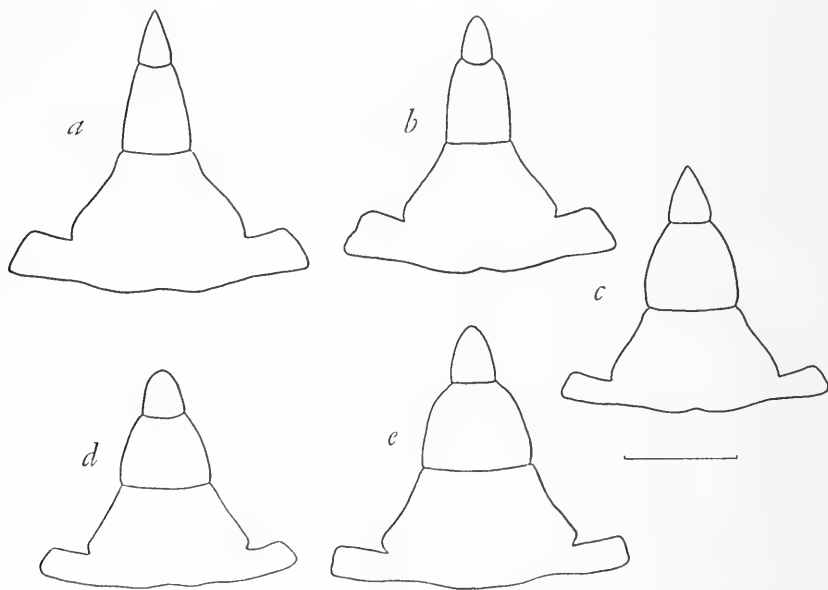


FIGURE 5.—*Portunus granulatus* (H. Milne Edwards), male abdomens: *a*, Hawaii, shallow water Mokuleia, Degener, 27 mm.; *b*, Hawaii, reef off Mokuleia, Degener, 26 mm.; *c*, Philippines, Capurmypugan Pt., *Alb.*, 26 mm.; *d*, Marianas, Agfayan Bay, Baker, 23 mm.; *e*, Philippines, Pandanon Is., Mar. 24, 1909, *Alb.*, 28 mm., right branchial area swollen. (Scale=5 mm.)

MATERIAL.—Philippines: Zamboanga, Mindanao, May 1904, Dr. E. A. Mearns, 1 male; Capurmypugan Point, Mindanao, 150 ft. seine, May 9, 1908, *Alb.*, 3 males, 1 female, 4 ovig. females; Galera Bay, Verde Is. Passage and Batanga Bay, 150 ft. seine, June 9, 1908, *Alb.*, 1 male; Tara Is., Mindora Strait, 130 ft. seine, Dec. 15, 1908, *Alb.*, 1 ovig. female; Sirinas I., Nakoola Bay, near Alphonzo XIII, Dec. 30, 1908, *Alb.*, 1 damaged male; near Sta. 5412, Pandanon Is., between Cebu and Bohol, seine, Mar. 23, 1909, *Alb.*, 1 male; Pandanon Is., between Cebu and Bohol, seine, 130 ft., Mar. 24, 1909, *Alb.*, 4 males.

Melanesia: Pacific Ser. A, received Nov. 13, 1944, Lt. George H. Penn, Malaria Control Team 28, Com. M. J. B. Rons, 7th Fleet, Advance Base 3, 1 male [Amsterdam Island, then Dutch New Guinea, coll. Aug. 15–Oct. 3, 1944, fide F. A. Chace, Jr.]; Florida I., Solomon Is., Sta. P2, Oct. 28, 1944, R. E. Kuntz, 2 females, 1 ovig. female.

Marianas: Sta. 112–65, Ajayan River, Guam, June 19, 1945, D. H. Johnson, 2 females; Sta. 110–63, Bija Point, Guam, June 22, 1945, McElroy and Markley, 9 males, 7 females; Agfayan Bay, Guam, 145/R.H.B. 150, July 7, 1945, R. H. Baker, 5 males, 1 female; Ackang Bay, Guam, Sta. 151/R.H.B. 158, July 16, 1945, R. H. Baker, 5 males, 4 females, 1 juv.

Japan: Okinawa, Oct. 5, 1945, W. B. S. Thomas, 1 male.

Marshalls: E1–9, Arno Atoll, received 1952, Hiatt, 1 male.

Samoa: U–39–521–591, Tutuila I., reef at Alofau, June 3, 1939, L. P. Schultz, 1 male.

Hawaii: Shallow water on reef at Mokuleia, Oahu, 1938, Degener, 1 male; reef off Mokuleia, Waialua, Oahu, received June 23, 1939, Otto Degener, 2 males (1 fragmented), 1 ovig. female.

Tuamotus and Societies: East side of Papetoai Bay, Moorea, poison, shore reef, 3–20 ft., Apr. 30, 1957, J. Randall, 1 male.

MEASUREMENTS.—Males, 9–27 mm.; females, 6–21 mm.; ovig. females, 14–21 mm.; juv., 5 mm.

REMARKS.—One specimen, a large male (27 mm., Pandanon I., Mar. 24, 1909) has the right branchial cavity swollen, presumably due to a parasite, and has a broader than usual abdomen.

Crosnier has drawn attention to the remarkable variation in the form of the male abdomen. In the specimens he examined, the penultimate segment was approximately as long as broad and resembled those figured by Rathbun and Sakai; however, a penultimate segment much longer than broad is shown by Gordon and again by Stephenson and Campbell. In the present collection most of the specimens resemble Crosnier's, but these intergrade to a few others with elongate penultimate and ultimate segments (figs. 5a–e).

Edmondsons' *P. granulatus* is discussed under *P. euglyphus* (Laurie).

DISTRIBUTION.—Madagascar and Red Sea to Hawaii, Samoa, and Fiji, including Japan and Australia.

Portunus hastatoides Fabricius

Portunus hastatoides Fabricius, 1798, p. 368.—Stephenson and Campbell, 1959, pp. 101–102, figs. 2D, 3D, pl. 1 (fig. 4), pls. 4D, 5D.—Crosnier, 1962, pp. 68–69, figs. 96, 109, 117, 122–123.—Miyake, Sakai, and Nishikawa, 1962, p. 128 (record only).

Neptunus (Amphitrite) hastatoides (Fabricius).—De Haan, 1835, pp. 39–40, pl. 1 (fig. 3).

Neptunus (Hellenus) hastatoides (Fabricius).—Alcock, 1899, pp. 38–39, Sakai, 1939, pp. 391–392, pl. 47 (fig. 1).

Neptunus (Hellenus) hastatoides var. *unidens* Laurie, 1906, pp. 414–415.

Hellenus hastatoides (Fabricius).—Barnard, 1950, pp. 158–159.

MATERIAL.—China: Kowloon, electric light, Sept. 14, 1908, *Alb.*, 1 juv; Takao, Formosa, Dec. 3 and 4, 1914, F. Baker, 6 males, 1 female, 2 ovig. females.

Philippines: Sandakan Bay, Borneo, seine, Mar. 2, 1908, *Alb.*, 1 female; Sta. 5182, Antonia I., off eastern Panay, 11°36'40"N., 123°26'35"E., 26 fm., Mar. 27, 1908, *Alb.*, 1 female; Sta. 5208, Taratara I., 11°45'53"N., 124°42'50"E., 26 fm., Apr. 14, 1908, *Alb.*, 1 male; Sta. 5342, Endeavour Point, (S.), 10°56'55"N., 119°17'24"E., 12–25 fm., Dec. 23, 1908, *Alb.*, 1 male; Sta. 5360, Corregidor Lt., 14°21'N., 120°41'E., 12 fm., Feb. 8, 1909, *Alb.*, 2 females, 1 ovig. female; Sta. 5442, west coast of Luzon, South Fernando Point Light, 16°30'36"N., 120°11'06"E., 45 fm., coarse sand, May 11, 1909, *Alb.*, 4 males, 4 females, 7 ovig. females; Sta. 5461, Caringo Is., 13°57'42"N., 123°06'42"E., 11 fm., June 14, 1909, *Alb.*, 1 ovig. female; Sta. 5594, near Mount Putri, 4°14'20'N., 117°53'12'E., 11 fm., Sept. 30, 1909, *Alb.*, 1 *Sacculina* infected male, 1 ovig. female; Sandakan Harbor, British North Borneo, June 28, 1929, Herre collection, 1 female.

Japan: Shimbara Gulf, Imperial University, Tokyo, 6 males, 3 females.

MEASUREMENTS.—Males, 24–41 mm.; females, 25–41 mm.; ovig. females, 27–36 mm.; juv., 20 mm.; *Sacculina* infected male, 37 mm.

REMARKS.—The third maxilliped shows slight iridescence on the last three segments of the endopodite and also on the forwardly directed portion of the fourth. This feature, presumably of some specific importance, has not been noted previously.

DISTRIBUTION.—Madagascar and East Africa to Japan, Philippines, and Australia.

The *Portunus longispinosus* Complex

Crosnier (1962) has suggested that two and possibly three different species have been given the name *longispinosus* by Rathbun (1906), by Sakai (1939), and by Stephenson and Campbell (1959), respectively. He also notes that *Amphitrite vigilans* Dana 1852, which has been synonymized with *A. longispinosa* Dana 1852, is probably a distinct species and is possibly identical with his own *P. iranjae*. In the opinion of the present authors, it will prove impossible to relate specimens to one or another of Dana's species unless the types can be discovered. The differences in anterolateral teeth lie within the range of a single species, and neither of Dana's figures of carapace ornamentation conform exactly to those of known species.

Apart from the above species (i.e., *P. longispinosa* (Dana), *P. vigilans* (Dana), and *P. iranjae* Crosnier, the remaining closely

related species are: *P. macrophthalmus* Rathbun 1906, *P. longispinosus bidens* Laurie 1906, *P. emarginatus* Stephenson and Campbell, 1959, and *P. tenuicaudatus* Stephenson, 1961a.

Disregarding synonymy problems, most of the undamaged males in the present collection could be referred to one or another of the above species without great difficulty. Problems arose over two dissimilar sized males (10 mm. and 20 mm. carapace breadths) from the same collection (Palau, Sta. 124-1183). Although undoubtedly belonging to the same species, they differed in certain features which have been relied upon heavily in past descriptions, viz the length and acuteness of the lateral frontal teeth, and the proportions and shapes of the ultimate and penultimate segments of the male abdomen. In the smaller specimen the frontal teeth are low and rounded (cf. *P. emarginatus*); the male abdomen is short and broad, with only slightly concave outer borders of the penultimate segment and with an ultimate segment as long as broad (cf. *P. longispinosus* Stephenson and Campbell). In the larger specimen the frontal teeth, while low and rounded, project farther (as in *P. longispinosus* Stephenson and Campbell), and the male abdomen, although moderately long and with distinctly concave borders to the penultimate segment (as in *P. emarginatus*), has the ultimate segment slightly longer than broad.

P. longispinosus Stephenson and Campbell and *P. emarginatus* show many points of similarity, including an absence of tuberculate elevations upon the granulated areas of the carapace and quite similar pleopods. Tentatively they are treated as synonyms, and specimens are listed under *P. emarginatus*.

While, as indicated, frontal teeth and male abdomens may have less diagnostic importance than previously thought, they still have some value. It is believed, however, that the details of ornamentation of the dorsal surface of the carapace offer the best opportunities for separating the species, although here again there is variation.

In the mesobranchial areas of the carapace both of the present specimens of *P. iranjae* bear elevated tubercular projections that were not present in the specimens submitted by Crosnier to the senior author. Stephenson's comments are quoted in Crosnier's description.

Recently Described Species in *P. longispinosus* Complex

1. Upper surface of palm of chelipeds with a single distal spine.

P. longispinosus bidens (Laurie) 1906
Upper surface of palm of chelipeds with two distal spines or with a spine and a spiniform tubercle 2
2. (1) Outer frontal teeth low and rounded (granular eminences of carapace without tubercles).

P. emarginatus Stephenson and Campbell, 1959
Outer frontal teeth triangular, projecting, and typically sharp . . . 3

3. (2) Cheliped very long and slender, $2\frac{1}{2}$ times the carapace length.
P. longispinosus Sakai, 1939
 Chelipeds of moderate length and robustness, less than $2\frac{1}{2}$ times the carapace length 4
4. (3) Carapace with conspicuous tubercular elevations within the granular patches 5
 Carapace (apparently) without conspicuous tubercular elevations within the granular patches **P. longispinosus** Rathbun, 1906
5. (4) Carapace strongly embossed, with spiniform elevations in cardiac and mesobranchial areas (lateral postcardiacs distinct and separate).
P. tenuicaudatus Stephenson, 1961a
 Carapace moderately strongly embossed with tuberculate but not spiniform elevations in the cardiac and mesobranchial areas . . . 6
6. (5) Metagastric area with two tubercles, lateral postcardiac granular patch not distinctly recognizable . . . **P. macrophthalmus** Rathbun, 1906
 Metagastric area with short ridges but without tubercles, lateral postcardiac granular patch distinct and separate.
P. iranjae Crosnier, 1962

***Portunus emarginatus* Stephenson and Campbell**

Portunus emarginatus Stephenson and Campbell, 1959, pp. 107-108, figs. 2H, 3H, pls. 2 (fig. 4), 4H, 5H.—Crosnier, 1962, pp. 66-68, figs. 108, 112-114, 116, 120-121.

?*Portunus longispinosus* Rathbun.—Stephenson and Campbell, 1959, pp. 104-106, figs. 2F, 3F, pls. 2 (fig. 2), 4F, 5F.

MATERIAL.—Palau: Sta. 124-1183, Yos Passage, W. of Kasao Reef, $3\frac{3}{4}$ mi. SSE. of Ngaremdiu, E. of Urukthapel, sand, 15-18 fm., Aug. 24, 1955, 2 males (10, 20 mm.).

***Portunus iranjae* Crosnier**

Portunus iranjae Crosnier, 1962, pp. 61-65, figs. 107, 110-111, 115, 118-119, pl. 4 (fig. 2).

MATERIAL.—Philippines: Reef at Tileg, Lubang I., July 11, 1908, Paul Bartsch, *Alb.*, 1 male (19 mm.).

Tuamotus and Societies: Papetoai Bay, Moorea, poison sta. shore reef, 3-20 ft., Apr. 30, 1957, J. Randall, 1 male (23 mm.).

***Portunus macrophthalmus* Rathbun**

Portunus macrophthalmus Rathbun, 1906, p. 871, fig. 31, pl. 12 (fig. 15).

MATERIAL.—Philippines: Sta. 5218, Anima Solo I., between Burias and Luzon, 20 fm., Apr. 22, 1908, *Alb.*, 1 ovig. female (11.5 mm.).

REMARKS.—In comparison with the various species examined by the authors, the present specimen comes closest to *P. tenuicaudatus* but differs in having more protruding and sharper lateral frontal teeth, these being distinctly acute; in having the carapace less strongly embossed, this applying particularly to the cardiac eminences and the lateral postcardiacs, which are only indistinctly recognizable; in possessing two small tubercular eminences instead of rows of gran-

ules in the metagastric region; and in having longer and more slender chelipeds.

These four points of difference seem to be confirmed by examination of Rathbun's plate 12, figure 5.

***Portunus tenuicaudatus* Stephenson**

Portunus tenuicaudatus Stephenson, 1961a, pp. 114-116, figs. 2C, 3H, pls. 3 (fig. 2), 4H, 5C.

MATERIAL.—Philippines: Sta. 5160, Tinakta I., Sulu Archipelago, Tawitawi Group, 5°12'40"N., 119°55'10"E., 12 fm., sand, Feb. 22, 1908, *Alb.*, 1 male (14 mm.).

REMARKS.—This species is very close to *P. longispinosus bidens* (Laurie) as described and figured by Sakai. Both species have spiniform tubercles on the dorsal surface of the carapace, and many of them are identically situated. (These are not mentioned by Laurie, 1906.) However, *P. tenuicaudatus* lacks the tubercles of the posterior mesobranchial regions described by Sakai, and in the holotype (but not in the present specimen) there is a tubercle in each median postcardiac region. The median frontal teeth in *P. longispinosus bidens* appear much larger than those in *P. tenuicaudatus*. It also possesses a spiniform tubercle at the end of the central carina of the upper surface of the hand which has no described counterpart in *P. longispinosus bidens*. There is marked similarity but not absolute identity in the pigmentation of recently collected specimens.

***Portunus* Species**

MATERIAL.—Marshalls: 4707, Rongelap Lagoon, 2 mi. W. of Busch I., 20 fm.; June 21, 1946, Taylor, 1 male (18 mm.).

REMARKS.—This specimen lacks the ultimate and penultimate segments of the abdomen and is either *P. longispinosus* Rathbun or *P. longispinosus* Sakai. Its chelipeds, although long and slender, are less so than Sakai described.

***Portunus* Species**

MATERIAL.—Marshalls: EL-160, Arno Atol, received 1952, Hiatt, 1 damaged male (10 mm.).

REMARKS.—This specimen cannot be identified with certainty because the dorsal surface of the carapace, which bears tuberculate elevations on some of its granular patches, is damaged.

***Portunus orbitosinus* Rathbun**

FIGURE 6

Portunus (*Amphitrite*) *gladiator* de Haan, 1837, only p. 65, pl. 18 (fig. 1) (not *Portunus gladiator* Fabricius, 1798).

Portunus (*Achelous*) *orbitosinus* Rathbun, 1911, p. 205, pl. 15 (fig. 11).

- Neptunus (Achelous) orbitosinus* (Rathbun).—Gordon, 1938, pp. 182-185, figs. 5a-g, 6c, 6d (including *N. octodentata*).
- Neptunus (Achelous) orbitospinus* (Rathbun).—Sakai, 1939, p. 396, pl. 81 (fig. 2).
- Portunus orbitosinus* Rathbun.—Stephenson and Campbell, 1959, pp. 113-114, figs. 2L, 3L, pls. 3 (fig. 4), 4L, 5L.—Stephenson, 1961a, pp. 108-109.—Crosnier, 1962, pp. 55-57, figs. 88, 90-91, 93.—Miyake, Sakai, and Nishikawa, 1962, p. 128 (record only).

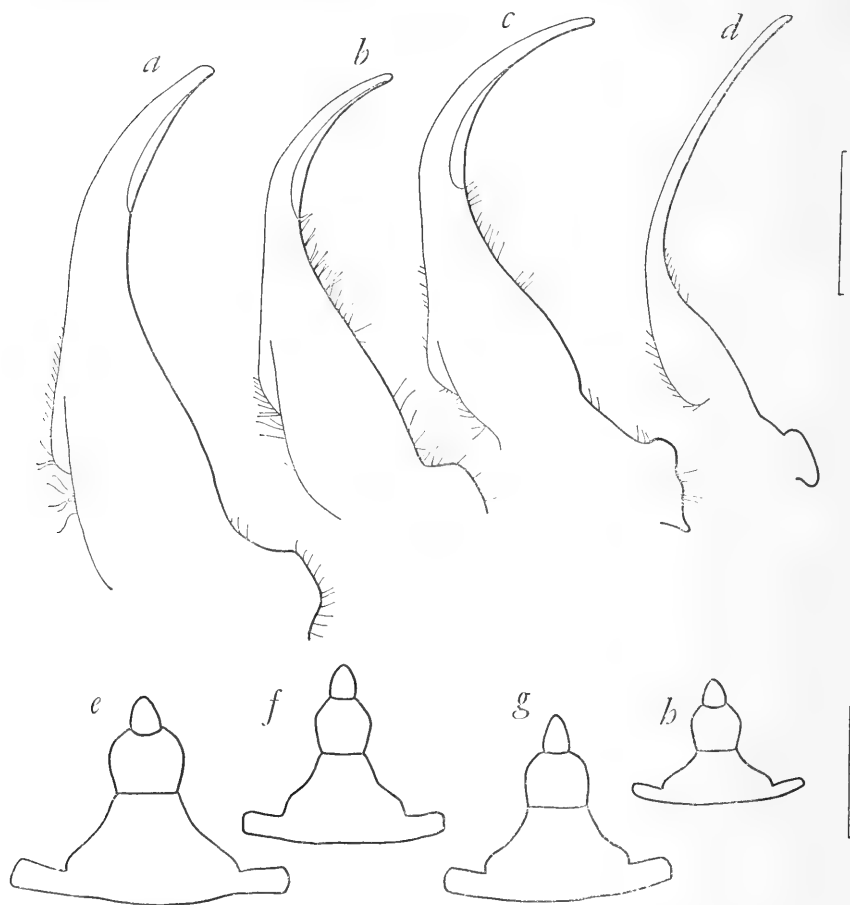


FIGURE 6.—*Portunus orbitosinus* Rathbun, male pleopods and abdomens, respectively. Three variants of form A: *a* and *e*, Philippines, Mariveles, No. 27, Reese; *b* and *f*, Philippines, Sta. 5158, *Alb.*; *c* and *g*, same as *a* and *e*. Form B: *d* and *h*, Philippines, Labuan Blanda I., *Alb.* (Scales=*a-d*, 1 mm.; *e-h*, 5 mm.)

MATERIAL.—Two forms are recognized in adult males, called forms A and B, respectively. These are listed separately as are females.

MALES (FORM A)

Philippines: Subig Bay, China Sea off southern Luzon, shore,

seine, sand, Jan. 7, 1908, *Alb.*, 2 males; Alongapo, Luzon, shore, Jan. 7, 1908, *Alb.*, 1 male; Port Binanga, ship's side, 6 fm., Jan. 8, 1908, *Alb.*, 2 males; Sta. 5158, Tinakta I., Sulu Archipelago, Tawitawi Group, 5°12'N., 119°54'30"E., 12 fm., Feb. 21, 1908, *Alb.*, 1 male; Sta. 5169, Sibutu Is., 4°32'15"N., 119°22'45"E., 10 fm., Feb. 27, 1908, *Alb.*, 1 male; Guijulugan, Negros, sta. shore, sand, gravel, mud, Apr. 2, 1908, *Alb.*, 1 male; Capurmypugan Point, Mindanao, 150 ft. seine, May 9, 1908, *Alb.*, 1 male; Point Jarnelo, Luzon, 150 ft. seine, July 13, 1908, *Alb.*, 1 male; Hinunangan Beach, Leyte, seine, July 30, 1909, *Alb.*, 1 male; No. 27, Mariveles, Luzon, June 27, 1913, A. M. Reese, 6 males; no. 33, other data as last, 13 males; near Mariveles, Luzon, 1913, A. M. Reese, 2 males; Cebu, 1929, *Eclipse* Exped., 2 males.

MALES (FORM B)

Philippines: Labuan Blanda I., Buton Strait, marginal coral, Dec. 13, 1909, *Alb.*, 2 males.

FEMALES

Philippines: Subig Bay, China Sea, off southern Luzon, shore seine, sand, Jan. 7, 1908, *Alb.*, 2 ovig. females; Sta. 5159, Tinakta I., Sulu Archipelago, Tawitawi Group, 5°11'50"N., 119°54'E., Feb. 21, 1908, *Alb.*, 1 ovig. female; Labuan Blanda I., Buton Strait, marginal coral, Dec. 13, 1909, *Alb.*, 1 female; no. 27, Mariveles, Luzon, June 27, 1913, A. M. Reese, 3 ovig. females; no. 33, other data as last, 3 females, 1 ovig. female; near Mariveles, Luzon, 1913, A. M. Reese, 1 female, 3 ovig. females.

Marshalls: Sta. VI, Bikini I., outer reef, Aug. 5, 1947, F. M. Bayer, 1 female.

MEASUREMENTS.—Males form A, 11–26 mm.; males form B, 12, 13 mm.; females, 17–24 mm., ovig. females, 13–21 mm.

REMARKS.—Gordon (1938, pp. 179–185, figs. 4 and 5) discussed *Neptunus orbitosinus* and particularly an unusual specimen with eight instead of nine anterolateral teeth and with a more robust male pleopod than in one of Rathbun's cotypes. Stephenson and Campbell (1959, p. 144) supported Gordon's suggestion that she was dealing with an undescribed species (*Neptunus octodentata*) and stated: "It is inconceivable that the variation in pleopod structure within *P. orbitosinus* could encompass the structures she figures (figs. 4c, 4c¹)."

Actually Gordon figured the pleopod of a further variant of a "male near to *orbitosinus* from Admiralty Is. ('Challenger' Colln.)," which was distinctly longer and thinner than any of the remainder.

In the present collection, there is a very considerable variation in pleopod structure between males which are indistinguishable in

general facies. Four main variants were noted and are figured (fig. 6). In the first, the pleopod is short and stout, little curved and naked on the center of its outer surface. In the second, the appendage is relatively thinner, more curved, and with hairs in the center of its outer surface. In the third, the appendage is even more curved but otherwise resembles the second form. In the fourth, the appendage is very long and slender, slightly curved, and resembles Gordon's specimen from the "Challenger" collection.

The first three variants show a certain amount of intergrading and are concluded to belong to the same morphological entity, whether a species, subspecies, or "form." What Stephenson and Campbell considered "inconceivable variation" apparently occurs. On the other hand, there seems to be a distinct hiatus between these and the fourth variant. Following the pattern established for *P. argentatus*, the first three variants are designated form A and the fourth, form B.

Crosnier (1962) figured a male pleopod of *P. orbitosinus* from Madagascar, greatly resembling figure 6 (c). Most of the present specimens differ from Crosnier's in having a larger first anterolateral tooth well separated from the second tooth. All differ in having smaller ninth teeth pointing less directly outward.

DISTRIBUTION.—Seychelles to Japan, and Australia.

Portunus pelagicus (Linnaeus)

FIGURES 12c,d, 17b

Cancer pelagicus Linnaeus, 1766, p. 1042.

Neptunus pelagicus (Linnaeus).—Alcock, 1899, p. 34.—Sakai, 1939, pp. 387–388, pl. 49.

Lupa pelagica (Linnaeus).—Barnard, 1950, pp. 152, 153–154, fig. 27.

Portunus pelagicus (L.).—Stephenson and Campbell, 1959, pp. 96–98, figs. 2A, 3A, pls. 1 (fig. 1), 4A, 5A.—Sankarankutty, 1961a, pp. 103–104.—Crosnier, 1962, pp. 43–44, figs. 58, 61, 67.—Miyake, Sakai, and Nishikawa, 1962, p. 128 (record only). Dell, 1964a, pp. 303–304, 2 figs.

MATERIAL.—Malay Archipelago: Tachalorn, Siam, July 24, 1923, H. M. Smith, 1 male; Bangkok, Siam, July 24, 1923, H. M. Smith, 1 female; off Paknam, Gulf of Siam, Sept. 8, 1923, 1 female; Gulf of Siam, Lang Suen, Sept. 17, 1923, H. M. Smith, 1 female; Bandon Bight, Siam, September 1923, H. M. Smith, 1 male, 1 ovig. female; Chantabun River, at Lem Sing, Siam, May 7, 1927, H. M. Smith, 1 female; Singapore, Mar. 14, 1934, Herre, 1 female; Sta. 1004, purchased from Thailand, received Aug. 24, 1955, R. E. Elbel, 2 males, 1 female; Sta. 27, east coast of Gulf of Thailand, S. of Trat Bay off Lam Son Village, near Cambodian border, 11°57'00"N., 102°44'45"E., 10 m., shrimp trawl, Oct. 29, 1957, GVF, 1 male; Thailand, Songkhla, channel between Songkhala City and Goh Gnu I., Nov. 3, 1957, GVF, 1 female.

China: U.S. Nav. Med. Res. Unit 2, Taipei, Formosa, purchased, received Feb. 13, 1958, Kuntz, 1 female.

Philippines: Grande I., Subic Bay, Luzon, October 1907, Dr. J. C. Thompson, 1 ovig. female; Manila Bay, Dec. 9, 1907, *Alb.*, 1 male; Manila Harbor, Dec. 30, 1907, *Alb.*, 1 female; Sta. 5346, Cliff I., Malampaya Sound, Palawan Is., 10°50'30"N., 119°22'20"E., 7 fm., Dec. 26, 1908, *Alb.*, 1 female; Iloilo, Mar. 24, 1929, H. C. Kellers, 2 males; Iloilo, May 5, 1929, H. C. Kellers, 1 male, 1 female; Sandakan Harbor, British North Borneo, June 28, 1929, Herre, 1 male, 2 females; Manila Bay, Dec. 22, 1933, Herre collection, 1 male.

Australia: Lake Macquarie, N.S.W., M. Filmer, Henry J. Brown, 1 male; Umba Kumba, south side of Little Lagoon, northeast end of Groote Eylandt, Gulf of Carpentaria, between Apr. 6 and May 18, 1948, R. R. Miller, 2 males, 1 female, 3 juvs.; Little Lagoon, northeast end of Groote Eylandt, Gulf of Carpentaria, 1948, R. R. Miller, 8 juvs.

MEASUREMENTS.—Males, 26–129 mm.; females, 38–125 mm.; ovig. females, 108–118 mm., juvs. 13–40 mm.

DISTRIBUTION.—East Africa to Tahiti, including Japan, Philippines, Australia, and New Zealand.

Portunus pubescens (Dana)

Lupa pubescens Dana, 1852a, pp. 274–275, pl. 16 (fig. 9); 1852b, p. 84.

Portunus pubescens (Dana).—Rathbun, 1906, p. 870, pl. 14 (fig. 1).—Edmondson, 1954, pp. 237–238, figs. 12, 13.—Stephenson and Campbell, 1959, pp. 99–101, figs. 2c, 3c, pls. 1 (fig. 3), 4C, 5C.—Stephenson, 1961a, p. 111.

Neptunus pubescens (Dana).—Sakai, 1934, p. 303; 1939, pp. 388–389, pl. 80 (fig. 1).

MATERIAL.—China: AT-51, Namru-2-Taipei, Formosa, 12 mi. S. of Tau Hsui, seashore, Lighthouse Beach, 1957, R. E. Kuntz, 1 male (19 mm.).

Philippines: Port San Pio, in small stream near mouth, 20 ft. seine, Nov. 11, 1908, *Alb.*, 1 female (17 mm.).

REMARKS.—Crosnier (1962) in redescribing *P. convexus* de Haan has drawn attention to its close similarity to *P. pubescens*; however, male *P. convexus* are easily distinguished by their sinuous pleopods (Crosnier, 1962, figs. 64–66).

DISTRIBUTION.—Eastern and Western Australia, Japan, and Hawaii.

Portunus pulchricristatus (Gordon)

FIGURE 7

Neptunus (*Hellenus*) *spinipes* Alcock, 1899, pp. 31–32, 39–40.

Neptunus (*Hellenus*) *pulchricristatus* Gordon, 1931, p. 534, figs. 8, 10a.

Not *Neptunus* (*Amphitrite*) *spinipes* Miers, 1886, p. 178, pl. 15 (fig. 1).

MATERIAL.—Philippines: Sta. 5097, Corregidor Lt., China Sea, off southern Luzon, 14°19'15"N., 120°33'52"E., 30 fm., Jan. 2, 1908,

Alb., 1 female; Sta. 5100, Corregidor Lt., China Sea, off southern Luzon, $14^{\circ}17'15''\text{N.}$, $120^{\circ}32'40''\text{E.}$, 35 fm., Jan. 2, 1908, *Alb.*, 1 male; Sta. 5104, China Sea, off southern Luzon, $14^{\circ}45'48''\text{N.}$, $120^{\circ}12'20''\text{E.}$, Jan. 8, 1908, *Alb.*, 5 males, 1 female, 2 ovig. females, 2 juvs., 1 *Sacculina* infected female, 1 *Sacculina* infected unsexable specimen; Sta. 5105, Suesti Point Light, China Sea, 25 fm., $14^{\circ}43'55''\text{N.}$, $120^{\circ}12'50''\text{E.}$, Jan. 8, 1908, *Alb.*, 1 male, 3 females, 1 juv., 1 unsexable *Sacculina* infected specimen; Sta. 5181, Antonia Is., eastern Panay, $11^{\circ}36'40''\text{N.}$, $123^{\circ}26'35''\text{E.}$, 26 fm., Mar. 27, 1908, *Alb.*, 1 ovig. female; Sta. 5192, off North Cebu Is., Jilantaguan Is., $11^{\circ}09'15''\text{N.}$, $123^{\circ}50'\text{E.}$, 32 fm., Apr. 3, 1908, *Alb.*, 1 male; Sta. 5207, Badian Is., off western Samar, $11^{\circ}38'05''\text{N.}$, $124^{\circ}40'45''\text{E.}$, 35 fm., green mud, sand, Apr. 14, 1908, *Alb.*, 1 male, 1 female; Utara Point, Bongo I., $7^{\circ}21'\text{N.}$, $124^{\circ}07'\text{E.}$, May 22, 1908, *Alb.*, 2 females; Sta. 5342, Endeavour Point (S.), $10^{\circ}56'55''\text{N.}$, $119^{\circ}17'24''\text{E.}$, 12–25



FIGURE 7.—*Portunus pulchricristatus* (Gordon), male, Philippines, Sta. 5100, *Alb.*: *a*, pleopod; *b*, pleopod tip, upper surface; *c*, abdomen. (Scales=*a*, 1 mm.; *b*, 0.5 mm.; *c*, 5 mm.)

fm., Dec. 23, 1908, *Alb.*, 5 males, 1 female, 1 ovig. female; Sta. 5442, west coast of Luzon, South Fernando Point Lt., $16^{\circ}30'36''\text{N.}$, $120^{\circ}11'06''\text{E.}$, 45 fm., coarse sand, May 11, 1909, *Alb.*, 16 males; Sta. 5448, South Miguel Point, east coast Luzon, $13^{\circ}23'10''\text{N.}$, $123^{\circ}45'19''\text{E.}$, 47 fm.; June 4, 1909, *Alb.*, 3 males; Sta. 5644, Makassar I., Buton Strait, $5^{\circ}27'24''\text{S.}$, $122^{\circ}38'00''\text{E.}$, 22 fm.; Dec. 16, 1909, *Alb.*, 1 male; Sta. 5646, North I., Buton Strait, $5^{\circ}31'30''\text{S.}$, $122^{\circ}22'40''\text{E.}$, 456 fm., green mud, Dec. 16, 1909, *Alb.*, 1 male.

China: All from China Sea, vicinity Hong Kong, *Alb.*, 1908. Sta. 5302, $21^{\circ}42'\text{N.}$, $114^{\circ}50'\text{E.}$, 38 fm., Aug. 9, 4 males, 4 females, 1 ovig. female; Sta. 5303, $21^{\circ}46'\text{N.}$, $114^{\circ}47'\text{E.}$, 34 fm., black mud, Aug. 9, 5 males, 2 females; Sta. 5304, $21^{\circ}46'\text{N.}$, $114^{\circ}47'\text{E.}$, 34 fm., black mud, Aug. 9, 4 males, 3 females, 1 ovig. female; Sta. 5305, $21^{\circ}54'\text{N.}$,

114°46'E., 37 fm., Oct. 24, 2 males; Sta. 5308, 21°54'N., 115°42'E., 62 fm., Nov. 4, 1 male.

MEASUREMENTS.—Males, 15–29 mm., females, 14–23 mm., ovig. females, 16–22 mm., juvs. 6–10 mm., *Sacculina* infected specimens, 14–18 mm.

REMARKS.—In addition to the distinctions between this species and *P. spinipes* as listed by Gordon, it lacks the very fine tapering point on the male pleopod (compare figs. 7c and 14c).

DISTRIBUTION.—Madras, Andamans, Gulf of Martaban, Arakan Coast, and Muscat.

***Portunus rubromarginatus* (Lanchester)**

Achelous rubromarginatus Lanchester, 1900, pp. 746–747, pl. 46 (fig. 8).

Neptunus (*Amphitrite*) *rubromarginatus* (Lanchester).—Shen, 1937, p. 104.

Portunus rubromarginatus (Lanchester).—Stephenson and Campbell, 1959, pp.

112–113, figs. 2K, 3K, pls. 3 (fig. 3), 4K, 5K.

MATERIAL.—Philippines: Jolo, ship's side, electric light, 14 fm., Feb. 8, 1908, *Alb.*, 1 female; Jolo anchorage, electric light, Mar. 5, 1908, *Alb.*, 1 female; Sta. 5561, Tutu Bay (Jolo), coral and sand, Sept. 19, 1909, *Alb.*, 3 males, 1 female; Labuan Blanda I., Buton Strait, marginal coral, Dec. 13, 1909, *Alb.*, 1 female.

MEASUREMENTS.—Males, 11–16 mm.; females, 16–29 mm.

REMARKS.—The anteroexternal angle of the merus of the third maxillipeds is produced laterally but not strongly so (see Stephenson and Campbell, 1959, pl. 5K). This leads to uncertainty in the key (above authors p. 90, couplet 16). The species is possibly closest to *P. curvipenis* Stephenson (1961a, pp. 106–108, figs. 1G, 3E; pl. 2, fig. 3; pls. 4E, 5B).

DISTRIBUTION.—Malay Archipelago, Hong Kong, South China Sea, and Australia.

Portunus cf. rubromarginatus

PLATE 3A

MATERIAL.—Japan: Sta. 5081, off Omai Saki, 35°14'N., 138°05'E., surface, Oct. 19, 1906, *Alb.*, 1 incomplete female (13 mm.).

REMARKS.—Only the carapace and two chelae are present. The differences compared with typical *P. rubromarginatus* are more spiniform frontal teeth (pl. 3A), more rounded granular eminences in the cardiac region of the carapace, more spiniform first eight anterolateral teeth, and longer ninth tooth.

***Portunus rugosus* (A. Milne Edwards)**

FIGURES 8–11; PLATES 3B, 4, 5

Neptunus rugosus A. Milne Edwards, 1861, p. 335, pl. 33 (fig. 3).—Hess, 1865, p. 139.—A. Milne Edwards, 1873, pp. 156–157.—Miers, 1886, pp. 176–177

(partim).—de Man, 1887, pp. 70–73 (under *N. andersoni*).—Henderson, 1893, p. 369 (under *N. andersoni*).

Portunus rugosus (A. Milne Edwards).—Guinot, 1957, p. 480 (under *P. mariei*).—Stephenson, 1961a, pp. 111–114, figs. 2B, 3G, pls. 3 (fig. 1), 4G, 5E.

INTRODUCTION.—Original sorting of specimens gave seven different forms resembling *P. rugosus*. Differences between them concerned shape of frontal teeth, length of last anterolateral tooth, acuteness or otherwise of posterior-posterolateral junction of the carapace, occurrence of a paired or single metagastric granular elevation of the carapace, curvature and spinulation of the pleopod, and relative length of penultimate segment of male abdomen. Later it was shown that some of these features varied with size of specimens within a single collection (e.g., length of last anterolateral tooth), while others varied between adjacent collections (e.g., acuteness or roundedness of frontal teeth). To separate most of the remaining

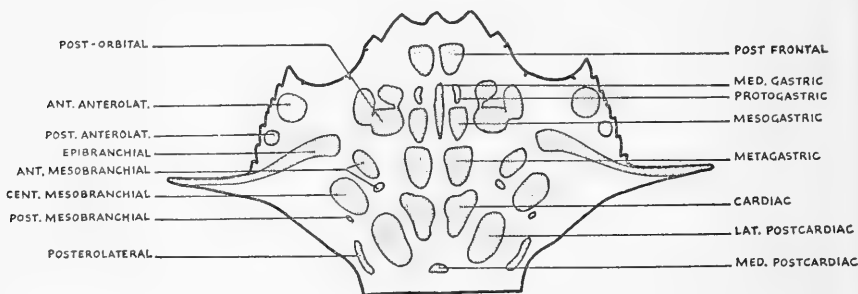


FIGURE 8.—*Portunus rugosus* (A. Milne Edwards): Diagram of elevated granular areas of carapace.

forms involved reliance upon a single character (e.g., paired or single metagastric elevation), and it was concluded that two forms, here designated I and II, were present.

These were compared with the Western Australian material upon which Stephenson's (1961a) redescription of the species is based. This material belongs to form I.

The features common to all variants are listed below, followed by accounts of the variation within forms I and II and of the distinctions between them. These are followed by a brief report upon Milne Edwards' material.

MATERIAL.—Form I: Philippines: Jolo, ship's side, Feb. 8, 1908, *Alb.*, 1 female (dried); Jolo anchorage, electric light, Feb. 13, 1908, *Alb.*, 1 male; Sta. 5156, Tinakta I., Sulu Archipelago, Tawitawi Group, 5°12'50"N., 119°55'55"E., Feb. 21, 1908, *Alb.*, 1 male; Sta. 5157, Tinakta I., Sulu Archipelago, Tawitawi Group, 5°21'30"N., 119°55'50"E., 18 fm., fine sand, Feb. 21, 1908, *Alb.*, 5 males, 3

females, 1 ovig. female, 1 juv.; Sta. 5158, Tinakta I., Sulu Archipelago, Tawitawi, $5^{\circ}12'N.$, $119^{\circ}54'30''E.$, 12 fm., Feb. 21, 1908, *Alb.*, 1 juv.; Sta. 5159, Tinakta I., Sulu Archipelago, Tawitawi Group, $5^{\circ}11'50''N.$, $119^{\circ}54'E.$, Feb. 21, 1908, *Alb.*, 1 male; Sta. 5182, Antonia I., eastern Panay, $11^{\circ}30'40''N.$, $123^{\circ}23'20''E.$, Mar. 27, 1908, *Alb.*, 1 juv.

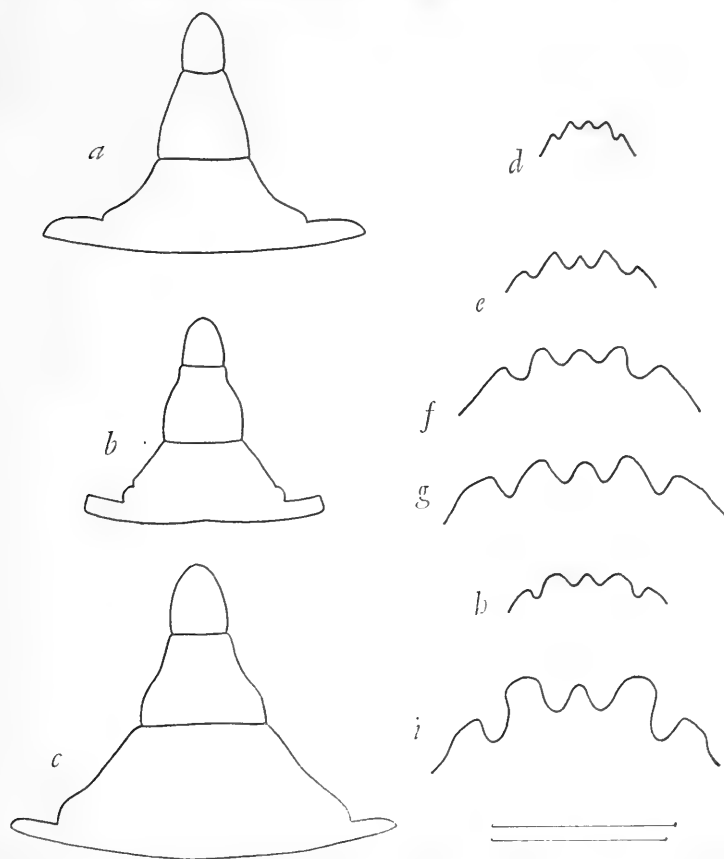


FIGURE 9.—*Portunus rugosus* (A. Milne Edwards). Male, abdomens, form I: *a*, Philippines, Sta. 5159, *Alb.*; *b*, W. Australian Mus. Reg. No. 47-60; form II: *c*, Philippines, Sta. 5159, *Alb.*, 30 mm. Fronts, form I: *d*, Philippines, Sta. 5158, *Alb.*, 8 mm. juv.; *e*, Philippines, Port Uson, *Alb.*, 16 mm. ovig. female; *f*, Philippines, Sta. 5159, *Alb.*; *g*, W. Australian Mus. Reg. No. 51-60; form II: *h*, Philippines, Sta. 5169, *Alb.*; *i*, Philippines, Sta. 5159, *Alb.*, 30 mm. male. (Scale=approximately 5 mm., 2 lines indicate range.)

male, 1 female, Cataingan Bay, Masbete, electric light, Apr. 19, 1908, *Alb.*, 1 juv.; Busin Harbor, Burias I., electric light, Apr. 22, 1908, *Alb.*, 2 males, 1 juv. female; Looc, Lubang I., electric light, July 18, 1908, *Alb.*, 1 female; Port Uson, W. of Pinas I., electric light, Dec. 17, 1908, *Alb.*, 1 ovig. female; Endeavour Strait, electric light, Dec. 23, 1908, *Alb.*, 2 juv. females.

Form II: Philippines: Sta. 5159, Tinakta I., Sulu Archipelago, Tawitawi Group, $5^{\circ}11'50''\text{N.}$, $119^{\circ}54'\text{E.}$, Feb. 21, 1908, *Alb.*, 2 males (ca. 21, 30 mm.), female (23 mm.), ovig. female (25 mm.); Sta. 5160, Tinakta I., Sulu Archipelago, Tawitawi Group, $5^{\circ}12'40''\text{N.}$, $119^{\circ}55'10''\text{E.}$, 12 fm., sand, Feb. 22, 1908, *Alb.*, 2 females (17, 18 mm.); Sta. 5169, Sibutu I., $4^{\circ}32'15''\text{N.}$, $119^{\circ}22'45''\text{E.}$, 10 fm., Feb. 27, 1908, *Alb.*, 2 females (both 16 mm.).

MEASUREMENTS.—Form I: Males, 16–36 mm.; females, 15–38 mm.; ovig. females, 16, 32 mm., juvs. unsexed, 8–17 mm.; juv. male, 17 mm.; juv. females, 12–15 mm.

FEATURES IN COMMON.—Front: 3-toothed, middle tooth usually the smallest and least projecting.

Cheliped: Robust but elongate. Posterior border of arm with single spine, anterior border with three spines, distal being widely separate from remainder. Ventrodistal extremity of arm bearing boss with small spine. Hand with upper surface bearing two granular carinae of which only inner ends in a subterminal spine; outer surface

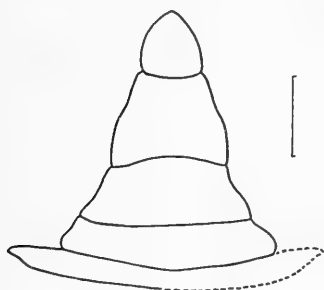


FIGURE 10.—*Portunus rugosus* (A. Milne Edwards): Male abdomen, New Caledonian specimen from Muséum National d'Histoire Naturelle. (Scale=1 mm.)

with two upper carinae clearly distinguishable and granular, but with lowermost merging into granulation of under surface; under surface with regular rows of granules giving a squamiform effect; inner surface with central row of carina of rounded granules (except in one juvenile).

Anteroexternal angle of merus of third maxilliped: Produced forward.

Ventral surface of thorax: Bearing conspicuous beaded granules.

Dorsal surface of carapace: With hairy pile, through which project conspicuously elevated granular regions. These are more numerous than those figured by Stephenson and Campbell (1959, fig. 1b), and a modified terminology is adopted as shown in figure 8. Additional granulated areas are a pair of postfrontals and pair of post orbitals typically divided into three indistinct subareas. Gastric region with distinct median gastric patch with protogastrics and mesogastrics on each side, and metagastric behind. Protogastrics small, and typically

indistinctly separate from mesogastrics, which themselves typically bear ridgelike anterior terminations. Metagastric area sometimes bears two granular areas separated in midline, and sometimes a single continuous area with central ridge or tubercle. Two conspicuous anterolateral patches, anterior being the larger. Three pairs of mesobranchials, the anterior often subdivided into larger anteroexternal and smaller posteromedian patch. Central mesobranchial either oval or rectangular; posterior either short line of granules or small tubercle formed of fused granules. Cardiacs conspicuously elevated, usually triangular, and with ridgelike or tubercle-like anterior termination. Lateral postcardiacs large and oval, median postcardiac small and with ridgelike or tuberculate anterior termination. Posterolaterals forming an arc.

Anterolateral teeth: Fourth and sixth the smallest, occasionally one or the other rudimentary or absent.

Posterodistal border of merus of fifthlegs: Finely serrated.

VARYING FEATURES.—Features that vary within a form are described below under each form respectively.

FORM I

Frontal teeth: Median tooth usually shorter than laterals, but sometimes projecting forward slightly farther. Lateral teeth varying from acute to bluntly rounded.

Length of last anterolateral tooth: Varying within a collection depending on size of specimen, e.g., Sta. 5157 specimens less than 20 mm. carapace breadth with long tooth (equivalent in length to three or four preceding teeth), and specimens greater than 35 mm. breadth with short teeth (equivalent in length to one and a half preceding teeth). Also varying from collection to collection. Overall from lengths of one and a half to six preceding teeth.

Posterior-posterolateral junction of carapace: Sometimes distinctly acute, sometimes slightly more acute than a right angle, typically obtusely angled, sometimes obtusely rounded. Acuteness varies within a collection (acuter teeth in smaller specimens) and also between collections.

General granulated areas of carapace: Typically coarsely granular and conspicuously elevated. In some collections more finely granular and less conspicuous, in others more conspicuous and tending to form elevated tubercles.

Male abdomen: Length of penultimate segment varying from slightly longer than broad to conspicuously so. Length of ultimate segment also varying.

Male pleopod: Varying in curvature with size of specimen being slightly curved in small and conspicuously curved in larger specimens. Subterminal bristles on inside varying from zero to nine. Subterminal bristles on center of under surface varying from sparse to dense.



FIGURE 11.—*Portunus rugosus* (A. Milne Edwards), male pleopods and pleopod tips, respectively. Form I: *a* and *e*, Philippines, Sta. 5159, *Alb*; *b* and *f*, W. Australian Mus. Reg. No. 51-60; *d*, Philippines, Sta. 5157, *Alb*, largest male. Form II: *c* and *g*, Philippines, Sta. 5159, *Alb*. (Scales=*a-d*, 1 mm.; *e-g*, approximately 0.5 mm., 2 lines indicate range.)

The most conspicuous variation is the presence of a single metagastric elevated area instead of two, as shown by the following: Endeavour Strait, 2 specimens; Looc, 1 specimen.

One specimen (Port Usón, Dec. 17, 1908) possesses acute frontal teeth and conspicuously elevated central mesobranchial areas. Be-

cause it is distinctly small for an ovigerous female (16 mm.), it is possible it should be separated from the remainder.

FORM II

Only eight specimens from three stations are available, but even so variation between them is less than might be expected from a study of form I. In smaller specimens the lateral frontal teeth are relatively shorter, less projecting, and less outwardly inclined. In two specimens (Sta. 5169) there is a single instead of a pair of meta-gastric granulated elevations.

Unexpectedly constant features in form II comprise:

- a. Anterolateral teeth always long, equivalent in length to about five of the preceding teeth.
- b. Posterior-posterolateral junction of carapace always near to a right angle and moderately sharp.
- c. General granulated areas of carapace relatively inconspicuous amongst the pile of hairs, not very coarsely granular, and without any tendency to be tuberculate.

MILNE EDWARDS' MATERIAL.—Through the good offices of Mme. Danièle Guinot, the following specimens were received from the Muséum National d'Histoire Naturelle, Paris: 1 male (ca. 14 mm.), 1 ?female, labelled "*Neptunus rugosus* A. M. Edw. Auct. det. Coll. A. Milne Edwards 1903 (Marie) Nouvelle-Calédonie—Iles des Pins, 1873, p. 156. Ancienne collection sèche. D. Guinot 1963." Unfortunately, when received they were so damaged that the central portions of the carapace could not be studied, and one specimen could not be measured at all accurately. Remaining details are:

Frontal teeth: Acutely rounded, median almost as long as laterals. Similar to those of form I.

Last anterolateral tooth: Length equivalent to a little more than three preceding teeth, sinuous, and directed slightly backward. Similar to those of form I in length and form II in shape.

Carapace granulation: On undamaged areas, granulation much coarser than form II. Visible areas conspicuously elevated, as in form I.

Male abdomen: Ultimate segment as broad as long with rounded tip. Penultimate segment broader than long (breadth 1.37 times length), with sinuous convex sides. (See fig. 10.)

In general, these specimens are closest to form I, except for the shapes of both ultimate and penultimate segments of the male abdomen, which are closer to form II.

They bridge some of the gap between the two forms, and further collecting may result in a complete bridging. Meanwhile it is retained to emphasize the variability of the species.

DIFFERING FEATURES.—Features serving to distinguish between the two forms are tabulated as follows:

	<i>lateral frontal teeth</i>	<i>last anterolateral teeth</i>	<i>granulated areas of carapace</i>	<i>male abdomen</i>	<i>male pleopod, under surface</i>
Form I	Directed forward or in- ward but never outward; tips acute or bluntly rounded	Relatively straight	Conspicu- ous, coarsely granular, some- times tu- berculate	Penulti- mate segment either slightly or dis- tinctly longer than broad	Row of spinules extending a long way back from the tip
Form II	Directed outward; tips rec- tangularly rounded	Slightly curved or sinuous; slightly back- wardly directed	Relatively incon- spicuous and less coarsely granular, not tu- berculate	Penulti- mate segment as broad as long	Row of spinules only ex- tending a short dis- tance back from the tip

These features are not thought sufficiently weighty to merit specific separation for the following reasons:

a. One of the smaller specimens of form II (Sta. 5169) (fig. 9*h*) has frontal teeth intermediate between those typical of this form (see fig. 9*i*) and a specimen of form I from Western Australia (see fig. 9*g*).

b. The proportions of the penultimate segment of the male abdomen vary in form I, and little extension of the range would encompass form II.

c. There are insufficient mature males of form II (only two) to establish that minor differences between the very similar pleopods in the two forms are not due to variability.

d. Milne Edwards' original description included some features of form I and some of form II, and seems to bridge most of the gap between them. Partial examination of his damaged specimens tends to confirm this bridging. The features of form I, including one or another of its variants, are: "Carapace très-fortement bosselée" and "Angles postérieurs de la carapace aigus et spiniformes." The features of form II are first, "Cornes laterales très-grandes, très minces et légèrement dirigées en arrière," and second, obtuse lateral frontal teeth.

It should be noted that Milne Edwards' figures (pl. 33, figs. 3, 3*a*) show differences from both forms as follows:

a. The posterior anterolateral granulated patch is shown as almost the same size as the anterior.

b. The postorbital patch is shown more discretely than in any of the present specimens.

Portunus sanguinolentus (Herbst)

FIGURES 12a, b

Cancer sanguinolentus Herbst, 1783, p. 161, pl. 8 (figs. 56, 57).

Portunus sanguinolentus (Herbst).—Rathbun, 1906, p. 870.—Edmondson, 1954, pp. 236–237, figs. 12, 13.—Stephenson and Campbell, 1959, pp. 98–99, figs. 2B, 3B, pls. 1 (fig. 2), 4B, 5B.—Sankarankutty, 1961a, p. 103.—Crosnier, 1962, pp. 45–47, figs. 59, 62–63, 68.—Miyake, Sakai, and Nishikawa, 1962, p. 128 (record only).

Neptunus sanguinolentus (Herbst).—Alcock, 1899, pp. 32–33.—Sakai, 1939, p. 387, pl. 48 (fig. 1).

Lupa sanguinolentus (Herbst).—Barnard, 1950, pp. 152, 154–155.

MATERIAL.—Malay Peninsula: Gulf of Siam, beach, North Singora, Oct. 5, 1923, H. M. Smith, 2 females; Benkoelen, Sumatra, November



FIGURE 12.—Fronts. *Portunus sanguinolentus* (Herbst): a, Japan, Sta. 4920, *Alb.*, 19 mm. male; b, Malay Peninsula, Sta. 53, G.V.F., 35 mm. male. *P. pelagicus* (Linnaeus): c, Australia, Umba Kumba, Miller, 22 mm. male; d, same as c, 30 mm. male. (Scale=5 mm.)

1925, Kellers, 1 male; Sriracha, southeast Siam, Apr. 20, 1934, H. M. Smith, 1 juv; Thailand, Songkhla Channel between Songkhla City and Goh Gnu I., GVF Sta. 53, Nov. 3, 1957, 1 male; Thailand, Songkhla Channel next to city, Songkhla Province, purchased in fish market, 07°12'07"N., 100°37'15"E., GVF Sta. 44, Nov. 4, 1958, 5 males, 5 females, 1 juv. (damaged); Thailand, near rock jetty, S. of Chol Buri, between Bangsaen and Chol Buri, GVF Sta. 84, Dec. 1, 1957, R. Rofen, 1 female.

China: Kowloon, electric light, Sept. 14, 1908, *Alb.*, 1 juv.; AT-51, Namru-2-Taipei, Formosa, 12 mi. S. of Tau Hsui, seashore, Lighthouse Beach, 1957, R. E. Kuntz, 4 males, (2 damaged), 2 females, 2 juvs.

Philippines: Manila Bay, Dec. 7, 1907, *Alb.*, 1 female; Manila Bay, Dec. 8, 1907, *Alb.*, 1 female; San Vicente Port, Luzon Beach, Nov. 15, 1908, *Alb.*, 1 female; Linapacan I., Malcochin Harbor, electric light, Dec. 18, 1908, *Alb.*, 1 male; Nakochin Harbor, Linapacan I., seine, Dec. 19, 1908, *Alb.*, 1 female; near Sta. 5344, Malampaya, Palawan,

130 ft. seine, Dec. 26, 1908, *Alb.*, 1 male (dried); San Miguel Bay, Colssi Point, east coast of Luzon, June 14, 1909, *Alb.*, 1 juv; Sta. 5539, Apo I., between Negros and Siquijor, 9°03'20"N., 123°24'45"E., Aug. 19, 1909, *Alb.*, 1 juv; Philippine Is., E. A. Mearns, 2 males, 1 female; near Mariveles, Luzon, 1913, A. M. Reese, 1 female; Manila, Feb. 25, 1929, Kellers, 1 male; Iloilo, Apr. 20, 1929, H. C. Kellers, 2 males, 41 juvs., 2 damaged specimens; Iloilo, May 9, 1929, H. C. Kellers, 2 females; no. 363, Pandan, Antique, from trap at mouth of tidal stream, Apr. 7, 1946, D. G. Frey, 1 female.

Australia: M48-28, Port Bradshaw near Cape Arnhem, July 25, 1948, R. R. Miller, 1 female.

Marianas: 112-x-65, Ajayan River, Guam, June 19, 1945, D. H. Johnson, 1 female; Agfayan Bay, Guam, 145/R.H.B. 150, July 7, 1945, R. H. Baker, 1 male.

Japan: Sta. 4920, Kusakaki Jima, 30°34'N., 129°22'E., surface, Aug. 13, 1906, *Alb.*, 1 juv; Sta. 5081 off Omai Saki, 34°14' N., 138°05' E., surface, Oct. 19, 1906, *Alb.*, 6 juvs.

MEASUREMENTS.—Males, 21–43 mm.; females, 20–121 mm.; juvs., 9–20 mm.

REMARKS.—In many specimens the red marks on the carapace are indistinct or unrecognizable because they have faded after prolonged preservation. In such cases the species can be recognized by frontal teeth (figs. 12*a*, *b*) that are more equal in size and more evenly spaced than in *P. pelagicus* and by the merus of the third maxilliped, which is hairy as opposed to the smoothness in *P. pelagicus*.

Possibly *P. madagascariensis* (Hoffmann) is a synonym and based upon a faded specimen (see Crosnier, 1962, p. 47).²

DISTRIBUTION.—East Africa to Hawaii, including Japan and Australia and also from the Adriatic.

Portunus spiniferus, new species

FIGURE 13; PLATE 6A

MATERIAL.—Philippines: Varadero Bay, Mindanao, 10:30–11:30, electric light, July 22, 1908, *Alb.*, 1 male (23 mm., holotype, cat. no. 112094); Bolinao Bay, west coast of Luzon (on label, "Bohiao"), electric light, May 9, 1909, *Alb.*, 1 female (24 mm.); Batananan I., Dyn., June 13, 1909, *Alb.*, 1 female (28 mm.). Sta. 408, Dinagat, Surigao, light plankton, May 22, 1946, D. G. Frey, 1 male (30 mm.).

DESCRIPTION.—Front: 3-lobed, somewhat protruding. All lobes roundedly triangular, median about one-half size of laterals. Two conspicuous notches in upper border of orbit, lower border with stout, rounded tooth.

² Later studies indicate it belongs to *Callinectes*.

Anterolateral teeth: Nine, first stout, fourth and sixth quite small, eighth larger than ninth, ninth the longest, stoutest, and very projecting.

Carapace: Much broader than long (ca. 2.2 times), with posterior-posterolateral junction forming an acute upturned spine, covered throughout by very fine, dense pubescence, through which small conspicuously raised granular areas are evident, several of these being spiniform. Beneath hairs, most of carapace smooth and shining. (Granulated areas showing through pile correspond with

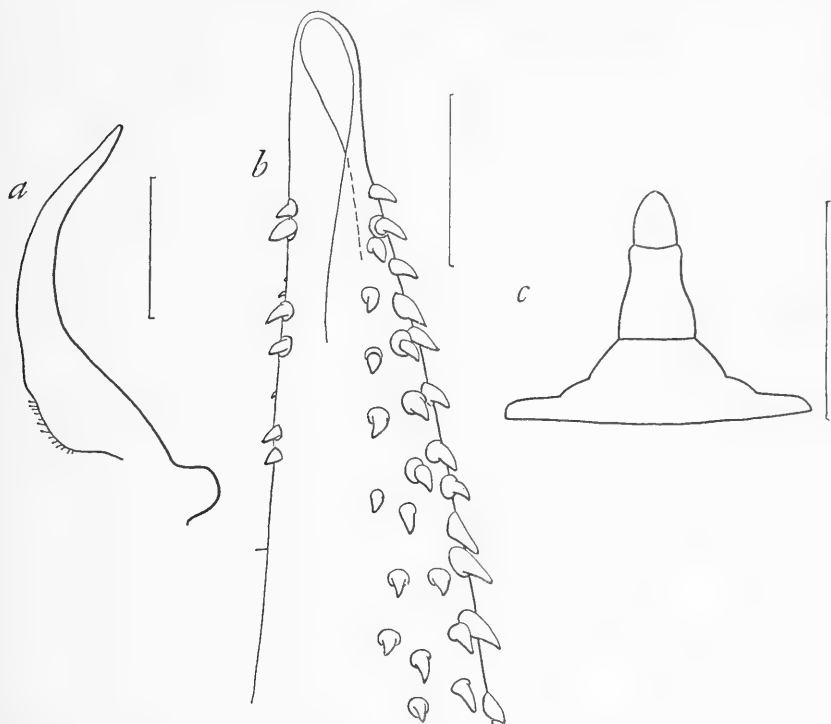


FIGURE 13.—*Portunus spiniferus*, new species, male holotype: *a*, pleopod; *b*, pleopod tip, upper surface; *c*, abdomen. (Scales=*a*, 1 mm.; *b*, 0.1 mm.; *c*, 5 mm.)

those in *Portunus rugosus* complex and the terminology of figure 8 is employed.) Postfrontals relatively inconspicuous; median gastric elongate; protogastrics small and inconspicuous; mesogastrics terminated anteriorly by tubercle-like elevation; metogastrics each a small tubercle; postorbitals each composed of four reasonably distinct patches, the two posterior patches with ridgelike anterior terminations; anterolaterals large and conspicuously elevated; epibranchials conspicuous; anterior mesobranchial two discrete patches, both elevated, one much smaller than the other; central mesobranchial,

linear patch; posterior mesobranchial, short line or patch; cardials conspicuously elevated with tuberculate or spiniform tips; lateral postcardials resolvable into three or four tubercle-like clusters of granules; median postcardiac conspicuously elevated ridge or spine; posterolaterals, forming curved arc, terminated anteriorly with forwardly directed spinelike tubercle. In one case two spines on posterolaterals, also two on lateral postcardials, and one on posterior mesobranchial. In another case approximately four spines on posterolaterals and one on posterior mesobranchial.

Chelipeds: Right larger. With well-developed spines, covered by fine pile overlying squamiform markings. Posterior border of arm bearing two sharp spines, anterior border with three unusually large sharp spines, middle the largest. Wrist with large inner and outer spines. Upper surface of hand with two spines (excluding that at wrist articulation), outer near the finger articulation, inner a little distance back. Spines better developed on smaller left chela. Two granular carinae on upper surface of hand, two less developed ones on outer surface, and one barely recognizable on inner surface. Spaces between carinae, also under surface, with conspicuous squamiform markings.

Fifth leg: Merus very short (length almost exactly equalling breadth) with finely denticulate posterior border.

Third maxilliped: Anterior portion of merus produced strongly forward but not laterally.

Male abdomen: Penultimate segment elongate and with concave borders, ultimate segment, cordiform, slightly more than half length of penultimate.

Male first pleopod: Short, stout, regularly curving to pointed tip.

REMARKS.—This species keys out in Stephenson and Campbell (1959) with *P. tweediei*, *P. tenuipes*, *P. mariei*, and *P. alcocki* but differs from all in the elevated spiniform areas on the posterior portion of the carapace.

It is clearly separable from *P. rugosus* by two spines on the posterior border of the arm.

Portunus spinipes (Miers)

FIGURE 14

Neptunus (*Amphitrite*) *spinipes* Miers, 1886, pp. 178-179, pl. 15 (figs. 1a-c).

Neptunus (*Hellenus*) *spinipes* Miers.—Gordon, 1931, p. 534 (under *N. pulchricristatus*), figs. 9, 10a.

Not *Neptunus* (*Hellenus*) *spinipes* Alcock, 1899, pp. 31-32, 39-40 (= *P. pulchricristatus* (Gordon)).

MATERIAL.—Philippines: Sta. 5164, Observation I., Sulu Archipelago, Tawitawi Group, 18 fm., green mud, Feb. 24, 1908, *Alb.*, 2

males (wet), 3 males, 1 female (dried); Sta. 5181, Antonia I., eastern Panay, $11^{\circ}36'40''\text{N.}$, $123^{\circ}26'35''\text{E.}$, 26 fm., Mar. 27, 1908, *Alb.*, 1 *Sacculina* infected male; Sta. 5642, Buton Strait, $4^{\circ}31'40''\text{S.}$, $122^{\circ}49'42''\text{E.}$, 37 fm., grey mud, Dec. 14, 1909, *Alb.*, 5 males, 6 females; Sta. 5644, Makassar I., Buton Strait, $5^{\circ}27'24''\text{S.}$, $122^{\circ}38'00''\text{E.}$, 22 fm., Dec. 16, 1909, *Alb.*, 1 male (damaged).

MEASUREMENTS.—Males, 16–26 mm.; females, 18–24 mm.; *Sacculina* infected male, 15 mm.

REMARKS.—Gordon has shown that Alcock's *Neptunus spinipes* differs from Miers' and has listed the distinctions as well as giving figures of the carapaces and male pleopods of the two species. Her figure of the carapace of one of the cotypes differs noticeably from

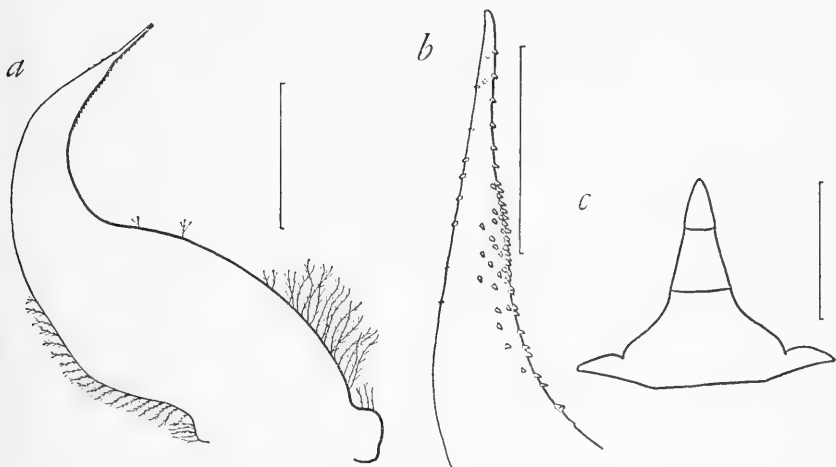


FIGURE 14.—*Portunus spinipes* (Miers), male, Philippines, Sta. 5642, *Alb.*: a, pleopod; b, pleopod tip, upper surface; c, abdomen. (Scales = a, 1 mm.; b, 0.1 mm.; c, 5 mm.)

Miers' figure in having a much less prominent front. The present specimens resemble her figure.

The male pleopods are refigured. The species is incorrectly placed in the key of Stephenson and Campbell (1959) because the posterior-posterolateral junction of the carapace is obtuse.

DISTRIBUTION.—Apparently only known previously from Miers' material, from the Philippines, and close to *Albatross* Sta. 5181, viz $11^{\circ}37'00''\text{N.}$, $123^{\circ}31'00''\text{E.}$

Portunus tenuipes (de Haan)

FIGURE 15

Amphitrite tenuipes de Haan, 1835, p. 39, pl. 1 (fig. 4).

Neptunus tenuipes (de Haan).—A. Milne Edwards, 1861, pp. 335, 339.

Neptunus (Hellenus) tenuipes (de Haan).—Alcock, 1899, p. 42.—Shen, 1937, p. 104, figs. 4, 8.

Neptunus (Amphitrite) tenuipes (de Haan).—Sakai, 1939, pp. 389–390, pl. 80 (fig. 2).

Portunus tenuipes (de Haan).—Guinot, 1957, p. 480 (under *P. mariei*).—Stephenson and Campbell, 1959, pp. 103–104, figs. 2E, 3E, pls. 2 (fig. 1), 4E, 5E.

MATERIAL.—Philippines: Subig Bay, shore, seine, Jan. 7, 1908, *Alb.*, 4 males (1 *Sacculina* infected), 2 females, 3 ovig. females; Port Binanga, ship's side, Jan. 8, 1908, *Alb.*, 2 females; Tachloban Anchorage, about ship, hand dredge, 3 fm., Apr. 12, 1908, *Alb.*, 1 ovig. female; Busin Harbor, Burias Is., electric light, Apr. 22, 1908, *Alb.*, 2 males; Surigao, Mindanao, 150 ft. seine, May 8, 1908, *Alb.*, 1 male, 1 female; Davao, Mindanao, 150 ft. seine, May 16, 1908, *Alb.*, 1 male, 1 female; near Sta. 5459, Cabugao, east coast of Luzon, electric light, June 9, 1909, *Alb.*, 1 male, 1 female; no. 27 Mariveles, Luzon, June 27, 1913, A. M. Reese, 1 male; no. 33 Mariveles, Luzon, June 28, 1913, A. M. Reese, 5 males, 1 ovig. female; near Mariveles, Luzon, 1913, A. M.

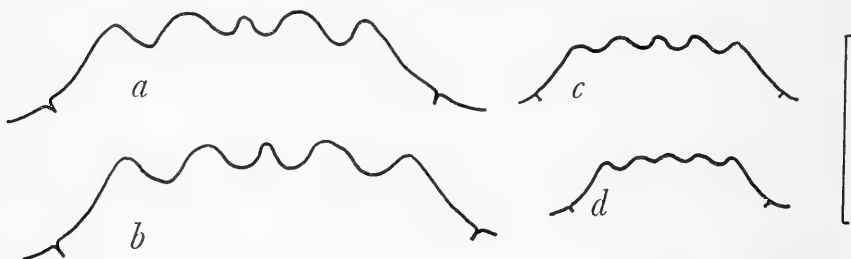


FIGURE 15.—*Portunus tenuipes* (de Haan), fronts: *a*, Philippines, Mariveles, No. 33, Reese, 32 mm. male; *b*, Philippines, Surigao, *Alb.*, 36 mm. male; *c*, same as *a*, 22 mm. male; *d*, Philippines, Pt. Binanga, *Alb.*, 16 mm. female. (Scale=5 mm.)

Reese, 1 male; Waigin, tide pool, June 8, 1929, Herre collection, 1 male.

MEASUREMENTS.—Males, 14–36 mm.; females, 16–35 mm.; ovig. females, 22–25 mm.

REMARKS.—As specimens become larger, the frontal lobes become more acute and prominent (see fig. 15).

Distribution.—Andamans to Japan and the Philippines, including Australia.

Portunus trituberculatus (Miers)

FIGURES 16, 17a

Portunus pelagicus de Haan (not Linnaeus) 1835, p. 37, pls. 9, 10.

Neptunus trituberculatus Miers 1876b, p. 222; 1886, p. 172.—Sakai, 1934, p. 303; 1936, p. 129, pl. 37.

Portunus trituberculatus (Miers).—Rathbun 1902, p. 26.—Stephenson and Campbell, 1959, p. 90 (in key).—Miyake, Sakai, and Nishikawa, 1962, p. 128 (record only).

Neptunus (Neptunus) trituberculatus (Miers).—Sakai, 1939, p. 388, pl. 50.

MATERIAL:—East Africa: Ras Banas, Red Sea, 1950, Sozon Vatikiotis, 1 male, 3 females.³

Malay Peninsula: S.1166, Singapore, "China," Arthur de Sowerby, 1 male.

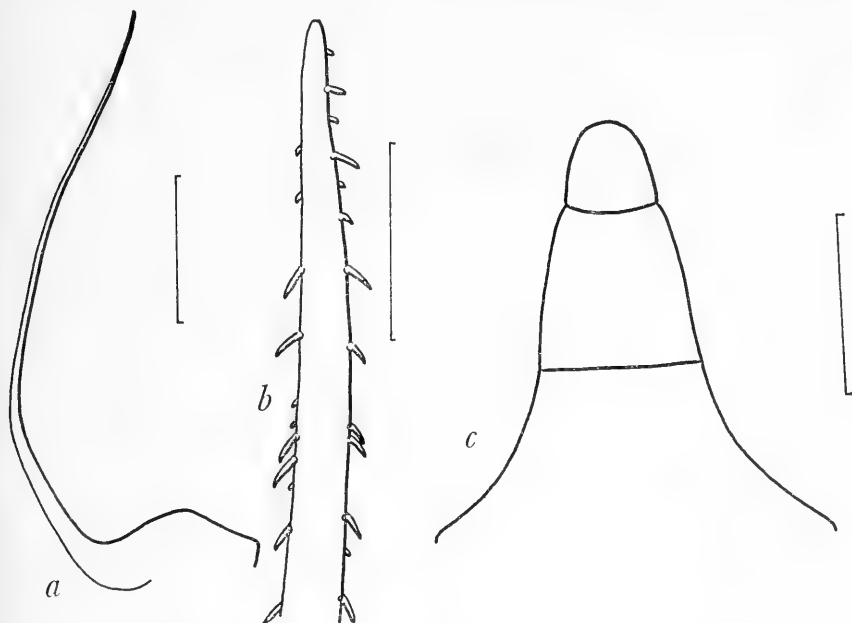


FIGURE 16.—*Portunus trituberculatus* (Miers), male: *a*, pleopod, Malay Peninsula, Singapore, de Sowerby; *b*, pleopod tip, upper surface, same specimen; *c*, abdomen, E. Africa, Ras Banas, Vatikiotis. (Scale=*a*, 10 mm.; *b*, 1 mm.; *c*, 5 mm. Identity of specimen now doubtful.)

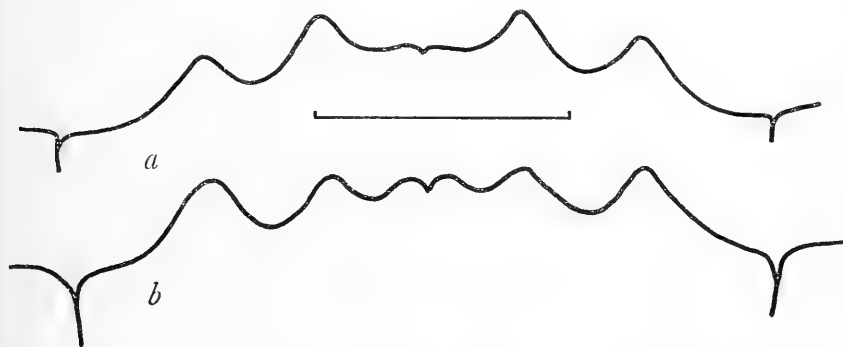


FIGURE 17.—Fronts. *Portunus trituberculatus* (Miers): *a*, East Africa, Ras Banas, Vatikiotis, 56 mm. female (identity of specimen now doubtful). *P. pelagicus* (Linnaeus): *b*, Philippines, Sta. 5346, *Alb.*, 66 mm. female. (Scale=5 mm.)

³ Doubts have arisen concerning the identity of these specimens, which may be reported on in a later publication.

China: S.1165, China, 1925-1927, Arthur de Sowerby, 1 female. (Probably like the last specimen, this came from Singapore.)

MEASUREMENTS.—Males, 45-180 mm.; females, 45-90 mm.

REMARKS.—This species is very close to *P. pelagicus*, and the difference in the fronts is shown better by figures than by words (fig. 17). The male pleopods are also very similar although the overall curvature in *P. trituberculatus* departs farther from the circular than with *P. pelagicus* (see Stephenson and Campbell, 1959, fig. 2A). Additional material will be required to determine whether the details of terminal armature do differ slightly in the two species.

DISTRIBUTION.—China and Japan (Sakai, 1939).

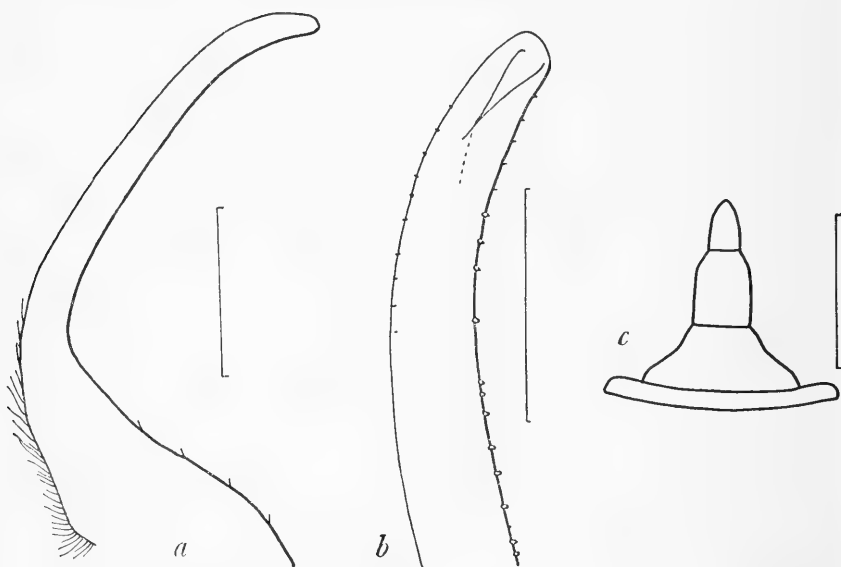


FIGURE 18.—*Portunus tuberculosus* (A. Milne Edwards), male, Philippines, Sta. 5159, *Alb.*: *a*, pleopod; *b*, pleopod tip, upper surface; *c*, abdomen. (Scales=*a*, 1 mm.; *b*, 0.5 mm.; *c*, 5 mm.)

***Portunus tuberculosus* (A. Milne Edwards)**

FIGURES 18; PLATE 6B

Neptunus tuberculosus A. Milne Edwards, 1861, pp. 333-334, pl. 31 (fig. 5).

Neptunus (Amphitrite) tuberculosus A. Milne Edwards.—Miers, 1886, p. 176.

Neptunus (Hellenus) tuberculosus A. Milne Edwards.—Alcock, 1897, pp. 42-43.

Portunus tuberculosus (A. Milne Edwards).—Stephenson and Campbell, 1959, p. 89 (in key).—Crosnier, 1962, pp. 69-71, figs. 97-98, 124-127.

MATERIAL.—China: Sta. 5309, China Sea, vicinity Hong Kong, 21°53'N., 115°51'E., 62 fm., green mud, Nov. 4, 1908, *Alb.*, 1 female.

Philippines: Sta. 5104, China Sea off southern Luzon, 14°45'48"N., 120°12'20" E., Jan. 8, 1908, *Alb.*, 1 male, 1 female, 1 ovig. female;

Sta. 5159, Tinakta I., Sulu Archipelago, Tawitawi Group, 5°11'50" N., 119°54'E., Feb. 21, 1908, *Alb.*, 1 male; Varadero Bay, Mindanao, 10:30–11:30, electric light, July 22, 1908, *Alb.*, 1 female; Sta. 5442, west coast of Luzon, South Fernando Point Light, 16°30'36"N., 120°11'06"E., 45 fm., coarse sand, May 11, 1909, *Alb.*, 7 males, 1 female, 2 ovig. females; Sta. 5478, Tacbuc Point, (Leyte), 10°46'24" N., 125°16'30"E., July 29, 1909, *Alb.*, 1 female; Sta. 5642, Buton Strait, 4°31'40"S., 122°49'42"E., 37 fm., grey mud, Dec. 14, 1909, *Alb.*, 1 male.

Palau: Sta. 125–1187 Palau I., about 1¾ mi. NE. of Ngabadongu, 7°17'36"N., 134°21'42"E., 17 fm., Aug. 24, 1955, GVF., 1 female.

MEASUREMENTS.—Males, 18–49 mm.; females 15–30 mm.; ovig. females, 21–26 mm.

REMARKS.—Originally it was suspected that two different species were present, some being more strongly embossed and possessing spiniform tubercles on the cardiac and lateral postcardiac regions of the carapace. Later intergrades were found. The following, the only adequate description in English, amplifies Crosnier's (1962) French description.

DESCRIPTION.—Front: Projecting, four round, approximately equal lobes, medians the more prominent.

Anterolateral teeth: Irregularly sized and spaced, first and second almost confluent, fourth and sixth small and depressed, third and fifth with enlarged granular bases, ninth the longest.

Carapace: Moderately broad (B/L.=1.6–1.7). Regions varying from moderately to very strongly embossed, and carrying beaded granules or occasionally tubercles. Strongly depressed posterior to protogastric and mesogastric areas. Main granular patches as follows: Protogastriacs subdivided into two; mesogastriacs, typically two oblique patches; metagastriacs, transverse ridge with anterior prolongation; cardiacs either an elevated patch, or pair of patches, or pair of elevated granular tubercles; lateral postcardiacs elevated and sometimes bearing tubercles; median postcardiac present; anterolaterals diffuse; epibranchials with marked change in curvature near middle and interrupted on cervical groove to form discrete patch; three meso-branchials; diffuse posterolateral.

Chelipeds: Elongate, right slightly the stouter. Upper surfaces covered with beaded granules and lower surfaces, particularly of hands, bearing squamiform markings. Anterior border of arm bearing two spines typically followed by a tubercle, occasionally by a third spine. Posterodistal border with single spine. (Crosnier describes two teeth, the second "méritant à peine le nom de dent.") Wrist normal. Upper surface of hand bearing three granular carinae of which innermost terminates in distal spine or spiniform tubercle. Conspicuous

carinae on outer surface of hand, but inner carina represented only by double row of enlarged granules.

Fifth leg: Merus short ($L/B=1.2$). Posterior border composed of rounded granules or spinules.

Third maxilliped: Anterior border of merus produced forward and a little laterally.

Male abdomen: Penultimate segment about 1.3 times as long as broad and with gently curving sides. Ultimate segment about 2.5 times as long as broad.

Male first pleopod: Sharply curved near middle and slightly curved behind tip which is blunt, and bears only microscopic spinules (see fig. 18*b*).

The present material differs from Crosnier's (1962) figure (fig. 124) in having blunter first anterolateral teeth, epibranchial ridge of carapace often ending in a swollen granulated patch, and posterolateral angle of the carapace generally much sharper.

In the fragmented specimen from Sta. 5642, Dec. 14, 1909, *Alb.*, the left anterior branchial region is swollen as if from a parasite.

The species is clearly separable from *P. macrophthalmus* Rathbun, *P. emarginatus* Stephenson, and *P. tenuicaudatus* Stephenson by differences in the detailed ornamentation of the carapace.

DISTRIBUTION.—Madagascar, Persian Gulf, Ceylon, Hawaii.

Portunus tweediei (Shen)

FIGURE 19

Neptunus (Hellenus) tweediei Shen, 1937, p. 109, fig. 6.

Portunus tweediei (Shen).—Stephenson and Campbell, 1959, p. 90 (in key).

MATERIAL.—Malay Peninsula: Thailand, entrance to Trat Bay, Gulf of Thailand, flat mud bottom, 5 m., $11^{\circ}58'30''N.$, $102^{\circ}44'05''E.$, GVF, Sta. 26, Oct. 29, 1957, 1 fragmented female.

Philippines: Manila Bay, off Eremita, June 5, 1907, *Alb.*, 1 male, 2 ovig. females; Manila Bay, Dec. 7, 1907, *Alb.*, 1 male; Manila Bay, outside of breakwater, mud, small rocks, Dec. 12, 1907, *Alb.*, 41 males, 23 females (3 ovig.), 1 juv; Little Harbor at Lunela, Manila Harbor, Dec. 12, 1907, *Alb.*, 1 male, 1 female; Tacloban Anchorage, about ship, hand dredge, Apr. 12, 1908, *Alb.*, 1 male; Sta. 5346, Cliff I., Malampaya Sound, Palawan Is., seine, gravel, rocks, Dec. 29, 1908, *Alb.*, 1 ovig. female.

MEASUREMENTS.—Males, 8–21 mm.; females, 7–16 mm.; ovig. females, 15–25 mm.; juv., 10 mm.

REMARKS.—The posterior-posterolateral junctions of the carapace are possibly more spinous than indicated by Shen; frontal teeth are a little more rounded; the postcardiac granular patch is lozenge

shaped instead of triangular; and the mesobranchial granular patches are arranged slightly differently. The male abdomen is longer and thinner (particularly so in the smaller specimens) with penultimate segment tapering from halfway along its length, and ultimate almost twice as long as broad and with a rounded tip. The male pleopod is more robust centrally and more pointed distally than figured by Shen. However, details of terminal armature coincide with Shen's figure 8d. The present specimens, which include some obviously mature, are all much smaller than Shen's.

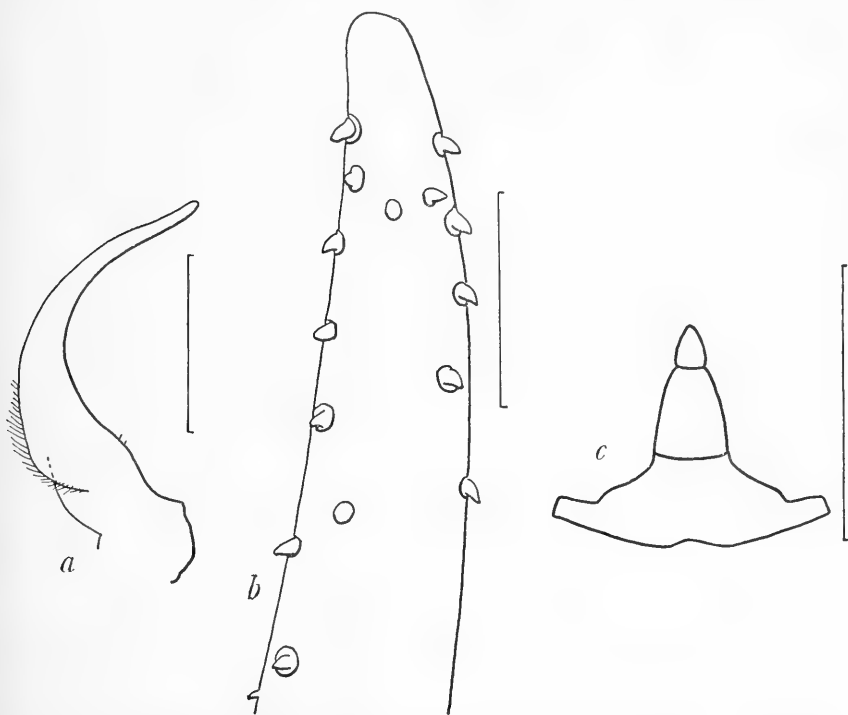


FIGURE 19.—*Portunus tweedei* (Shen), male, Philippines, Tacloban, *Alb.*: *a*, pleopod; *b*, pleopod tip, upper surface; *c*, abdomen. (Scales=*a*, 1 mm.; *b*, 0.1 mm.; *c*, 5 mm.)

DISTRIBUTION.—Previously known only from Singapore (Shen, 1937).

Genus *Scylla* de Haan, 1833

Scylla serrata (Forskål)

Cancer serratus Forskål, 1755, p. 90.

Scylla serrata (Forskål).—Stephenson and Campbell, 1960, pp. 111–115; fig. 2N, pls. 4 (fig. 4), 5N, 6C.—Crosnier, 1962, pp. 72–73, figs. 128, 129.—Miyake, Sakai, and Nishakawa, 1962, p. 128 (record only).—Dell, 1964b, pp. 59–62.

MATERIAL.—East Africa: Strait at Changamive, $3\frac{3}{4}$ mi. from Mombasa, Nov. 21–30, 1909, E. A. Mearns, 2 males.

Malay Peninsula: Menam at Paknam, Siam, July 5, 1923, H. M. Smith, 1 juv; Chao Phya River, Paknam, Siam, June 3, 1927, H. M. Smith, 1 male, 1 juv; Bangpa Kong River, Siam, June 4, 1928, H. M. Smith, 3 males, 1 female; Sta. 10002, from Thailand, purchased, received Aug. 24, 1955, R. E. Elbel, 1 male.

China: U.S. Nav. Med. Res. Unit 2, Taipei, Formosa, purchased, received Feb. 13, 1958, R. E. Kuntz, 1 male.

Philippines: Port San Pio Quinto, China Sea, vicinity of Batanes, in small stream near mouth, 20 ft. seine, Nov. 11, 1908, *Alb.*, 1 male.

Australia: U42–728 Ironstone Reef about 3 mi. W. of Yirrkala, Aug. 27, 1948, R. R. Miller, 1 ovig. female; Little Lagoon and vicinity northeastern end Groote Eylandt, Gulf of Carpentaria, 1948, R. R. Miller, 2 females.

Japan: OPM958, Hentonia, Okinawa, Sept. 19, 1945, O. A. Muenink, 1 female.

MEASUREMENTS.—Males, 29–88 mm.; females, 26–123 mm.; ovig. female, 170 mm.; juvs., 26–28 mm.

DISTRIBUTION.—East Africa to Tahiti. Recorded from New Zealand by Miers (1876), with the record repeated by later workers including Chhapgar (1957) and Stephenson (1961b). Hutton (1882) suspected this record, but it has been confirmed by Dell (1964b).

Genus *Thalamita* Latreille, 1829

See Stephenson and Hudson, 1957, p. 361, for synonymy.

Thalamita admete (Herbst)

FIGURE 20

Cancer admete Herbst, 1803, pp. 40–41, pl. 57 (fig. 1).

Thalamita admete (Herbst).—Latreille, 1829, p. 33 (fide Miers, 1886).—A. Milne Edwards, 1861, pp. 356–357.—Heller, 1865, p. 28.—Miers, 1884, p. 230.—Ortmann, 1893, p. 83.—Borradaile, 1900, p. 579.—Calman, 1900, p. 23.—Lenz, 1905, p. 362.—Rathbun, 1907, p. 63.—Nobili, 1907, p. 383.—Rathbun, 1911, p. 208.—Edmondson, 1923, p. 1550; 1925, p. 37; 1954, pp. 255–256, figs. 30a,b, 31a–e.—Sakai, 1939, pp. 414, 421–422, pl. 85 (fig. 1).—Ward, 1942, p. 80.—Barnard, 1950, p. 176, fig. 33c.—Holthius, 1953, p. 7.—Stephenson and Hudson, 1957, pp. 320, 324–326, figs. 2I, 3I, pls. 1 (fig. 1), 7A, 10A.—Stephenson, 1961a, p. 117.—Forest and Guinot, 1961, p. 30, figs. 19a,b.—Sankarankutty, 1961a, p. 106; 1961b, p. 122.—Crosnier, 1962, pp. 96–97, figs. 154, 157, 162–164, 168.

Thalamita savignyi A. Milne Edwards, 1861, pp. 357–358, 367.—Ortmann, 1894, p. 46.

Thalamita admata (Herbst).—Alcock, 1899, pp. 82–84.—Tweedie, 1950a, p. 84, fig. 2b.

Thalamita admete var. *edwardsi* Borradaile, 1900, p. 579.—Nobili, 1907, p. 383.

- Thalamita admeta* var. *A admeta* Borradaile, 1902, pp. 202-203.
Thalamita admeta var. *B edwardsi* Borradaile, 1902, pp. 202-203.
Thalamita admeta var. *C savignyi* Borradaile, 1902, pp. 202-203.
Thalamita edwardsi Borradaile.—Rathbun, 1906, p. 873.—Edmondson, 1925, p. 37; 1954, pp. 254-255, figs. 28b, 29a-d.—Forest and Guinot, 1961, p. 32, figs. 20a, b.—Crosnier, 1962, p. 98, fig. 158.—Guinot, 1962, pp. 2-3.
Thalamita admeta var. *savignyi* Borradaile.—Nobili, 1906a, pp. 202, 206-208.
Thalamita dispar Rathbun, 1914, p. 657, pl. 1, fig. 4.
Thalamita admete var. *savignyi* Borradaile.—Laurie, 1915, pp. 440-441.
Thalamita edwardsi Borradaile.—Holthius, 1953, p. 8.
?Thalamita spiceri Edmondson, 1954, pp. 258-260, fig. 33a-c.

MATERIAL: China: Nau Wan, Formosa, China Sea, Jan. 27, 1910, *Alb.*, 1 male.

Philippines: Subig Bay, China Sea off southern Luzon, shore, seine, sand, Jan. 7, 1908, *Alb.*, 1 female; Tataan, Simaluc, shore, Feb. 19, 1908, 1 female; Guijulugan, Negros, station shore, sand, gravel, mud, Apr. 2, 1908, *Alb.*, 1 ovig. female; Makinog, Camiguin I., between Leyte and Mindanao, tide pool, Aug. 3, 1909, *Alb.*, 5 males, 1 female, 4 ovig. females; Sta. 5561, Tutu Bay (Jolo), coral and sand, Sept. 19, 1909, *Alb.*, 1 female; Great Toba I., tide pool, sand, coral, Dec. 15, 1909, *Alb.*, 3 males, 2 females, 1 ovig. female; Makasser I., Buton Strait, 5°27'24"S., 122°38'00"E., tide pools, Dec. 16, 1909, *Alb.*, 1 male, 1 female; Philippine Is., E. A. Mearns, 1 male.

Australia: Reef at Yirrkala, July 12, 1948, R. R. Miller, 1 male; M.48-21, ironstone reefs (not coral) and rock pools at Yirrkala, NW. of Cape Arnhem, Aug. 6, 1948, R. R. Miller, 2 males; C-7 Yirrkala, NW. of Cape Arnhem, coral reef, Aug. 25, 1948, R. R. Miller, 1 ovig. female; Little Lagoon and vicinity, northeastern end of Groote Eylandt, Gulf of Carpentaria, 1948, R. R. Miller, 1 male.

Melanesia: Malaluva reef, Fiji, June 19, 1922, State University of Iowa, 1 male, 1 ovig. female; Ovalau I., Fiji, Mar. 17, 1929, Herre, 1 male, 1 female; New Georgia, Jan. 10, 1945, W. A. Bartos, 4 males, 3 females, 1 ovig. female.

Marianas: No. 83/X-48, Piti Bay, Guam, June 30, 1945, McElroy and Baker, 1 ovig. female; 145/RHB-150, Agfayan Bay, Guam, July 17, 1945, R. H. Baker, 1 male; Saipan, in coral heads, 1945, A. H. Banner, 2 males, 1 female, 1 juv; Y-128G, from under rocks, tidal flats, Tomil Harbor, 1952, Hiatt, 1 male; Y-193 B, C, from under rocks, tidal flats of Balabat, Yap Is., 1952, Hiatt, 3 males, 1 female; 177-G-1, Ifaluk, Caroline Is., 1953, F. M. Bayer, 9 juvs.

Japan: Tanego Shima, 1906, *Alb.*, 1 female.

Marshalls: Eniwetok, reef, low tide, February 1940, Ziesenhenné, 2 males; no. 4331, Sta. 6, one-third mi. W. of Southeast Point, Bikini I., Apr. 23, 1946, J. P. E. Morrison, 1 female; no. 4351, Sta. 4, one-third mi. SW. of southeastern point, Bikini I., 3½ fm., forams,

sand, Apr. 23, 1946, 1 female; no. 49, Bikini I., outer reef flats, July 22, 1947, F. M. Bayer, 1 male.

Hawaii: Black Point, Haunama Bay, Oahu, 1937, L. R. Woodward,

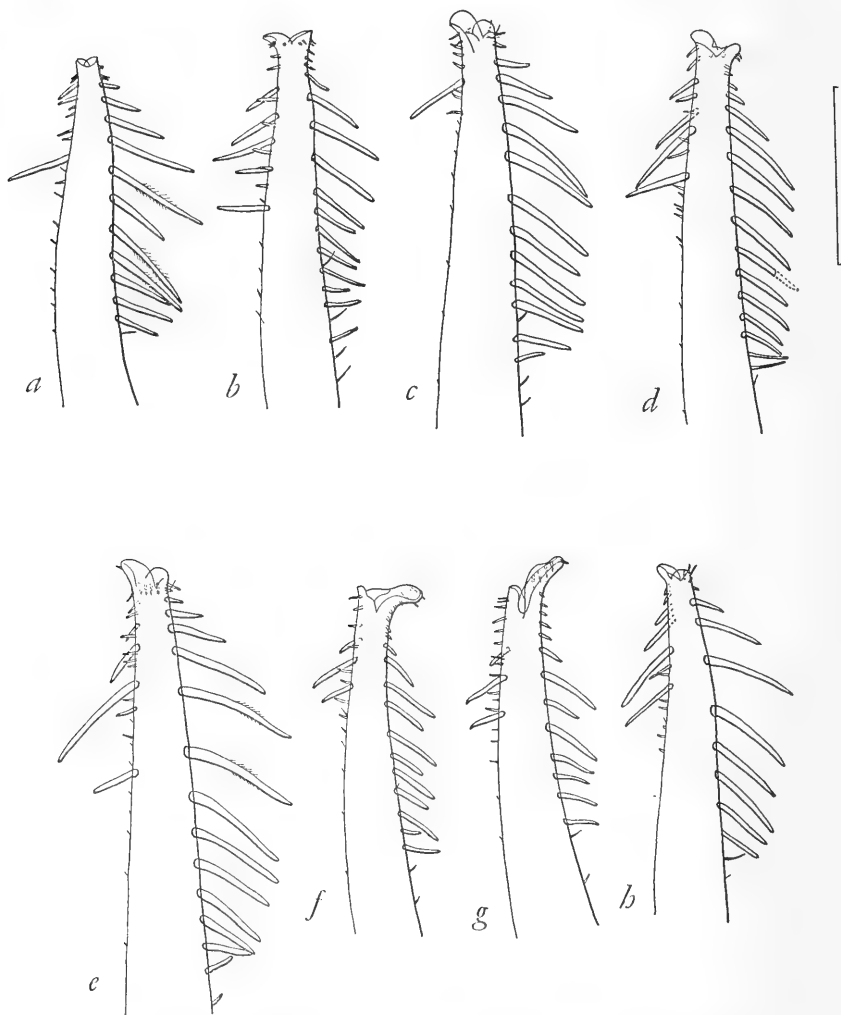


FIGURE 20.—*Thalamita admete* (Herbst), male pleopod tips, upper surface: *a*, Hawaii, Oahu, Army Med. Mus.; *b*, Australia, Yirrkala, M48-21, Miller, 21 mm.; *c*, Samoa, Apia, June 27, 1902, *Alb.*, 21 mm.; *d*, Philippines, Makasser I., *Alb.*; *e*, Samoa, Apia, June 27, 1902, *Alb.*, 23 mm.; *f*, Samoa, Apia, June 1, 1902, *Alb.*; *g*, China, Nau Wau, *Alb.*; *h*, Samoa, Pago Pago, *Alb.*, 13 mm. (Scale=0.5 mm.)

S. F. Light, 1 male, 2 females; Mokuleia, Oahu, shallow water, reef, 1938, Degener, 2 males, 1 female, 1 juv; Waikiki Marine Lab., under stones, near shore, Feb. 9, 1942, G. S. Mansfield, 1 male; Waikiki

Marine Lab., Feb. 12, 1942, G. S. Mansfield, 1 male, 1 female; Waikiki Marine Lab., Mar. 6, 1942, G. S. Mansfield, 2 males; Waikiki Marine Lab., Mar. 13, 1942, G. S. Mansfield, 1 male, 1 female, 2 ovig. females; Waikiki Marine Lab., Mar. 22, 1942, G. S. Mansfield, 3 males; Waikiki Marine Lab., Mar. 23, 1942, G. S. Mansfield, 2 males, 1 female, 1 ovig. female; Waikiki Marine Lab., Mar. 28, 1942, G. S. Mansfield, 2 females; Waikiki Marine Lab., Apr. 6, 1942, G. S. Mansfield, 1 male, 1 female, 1 ovig. female, 2 juvs; Waikiki Marine Lab., Apr. 24, 1942, G. S. Mansfield, 6 males, 2 females; off Waikiki Marine Lab., Apr. 30, 1942, G. S. Mansfield, 1 female; Oahu, 1945, Army Medical Museum, 1 male, 2 ovig. females; Hanauma Bay, Oahu, July 13, 1945, Army Medical Museum, 1 male.

Tuamotus and Societies: Society Is., summer 1945, J. M. Clements, 2 males; remainder Bredin Exped. 1957; Sta. 3-57, Papeete Harbor, Tahiti, anchor chain, April 8, 3 males, 2 females, 2 ovig. females; Sta. 14a-57 Tikahau Atoll, Tuamotus Is., from *Holothuria atra*, ocean reef, April 12, 7 males (1 damaged), 2 females, 2 ovig. females; Sta. 51-57 Bora Bora, three-eighths mi. S. of Farepiti Point, fringing reef 2-3 ft. in algae in sand, April 23, 1 juv; Sta. 56-57, 57-57, Bora Bora, dredged, April 25, 1 male; Sta. 62-57, Bora Bora, inner edge of outer reef, April 25, 2 males; Sta. 64-57 Motu Tapu Is., Bora Bora Is., along northwestern shore, shallow water, April 26, 2 males, 2 females; Sta. 75-57, E. of dock at Uturoa, Raiatea, from coral boulders in muddy water, April 28, 1 female; Sta. 86-57, Baie de Bourayne, Huahine, sandy reef, May 1, 1 male, 1 ovig. female; Sta. 106-57, Moorea, northwestern Motu Fareme I., fossil coral along shore, May 8, 1 male; Sta. 127-57, Moorea, Nuarei Bay, coral in shallow sandy beach, May 11, 2 males.

Samoa: Apia, at mouth of river, June 1, 1902, *Alb.*, 1 male; Apia, outer reef, June 27, 1902, *Alb.*, 3 males, 1 female; Apia, outer coral reef at low tide, July 1, 1902, *Alb.*, 1 female; Pago Pago, August 1902, *Alb.*, 4 males, 4 females (1 *Sacculina* infected), 3 ovig. females; Canton I., 1941, C. A. Ely, 7 males, 8 females, 3 ovig. females; Canton I., Lagoon West, in coral head near Flemings, January 1942, C. A. Ely, 2 females, 3 ovig. females; Tafuna, Tutuila, Jan. 9, 1949, L. Zachowski, 1 female.

Fanning Is.: Inner Lagoon, Dec. 16, 1913, Fred and Charlotte Baker, 3 males, 2 females.

MEASUREMENTS.—Males, 6-38 mm.; females, 6-ca. 28 mm.; ovig. females, 8-29 mm.; juvs. 5-8 mm.

REMARKS.—A few specimens from Makinog (Cumigium I., between Leyte and Mindanao, tide pool, Aug. 3, 1909, *Alb.*) have one side of the front bilobed. One of the females has only third and fifth antero-lateral teeth on the right side.

A female from Black Point (Haunama Bay, Oahu, T.H., 1937, L. R. Woodward, S. F. Light) lacks the second anterolateral tooth on the right.

In 1957, Stephenson and Hudson gave an extensive synonymy for this species. A further extension to include *T. dispar* has been given by Stephenson (1961a).

Since then Forest and Guinot (1961) have revived *T. edwardsi* Borradaile as a separate species on the basis of three specimens from Tahiti which included a single mature male. The bases of separation of *T. edwardsi* from *T. admete* concern the general facies, and also, according to Forest and Guinot, the structure of the male pleopods. *T. edwardsi* is supposed to be distinguishable on general facies by the following: Cardiac ridges of carapace absent; posterior mesobranchial ridges absent; hands of chelae smoother and with ill-developed carinae; and fourth anterolateral tooth either absent or rudimentary.

Forest and Guinot distinguish the male pleopods of *T. edwardsi* by large subterminal bristles of outer surface of irregular size and the row not extending so far (relatively) backward from the tip, and by large subterminal bristles of inner surface slightly more numerous (relatively) and extending farther backward from the tip.

As regards general facies, Stephenson and Hudson (1957) on the basis of 152 specimens stated (pp. 31-32):

... the only dubious point appears to be the status of Borradaile's "var. *edwardsi*," which is typified by the carination and granulation of the outer surface of the hand of the chelipeds. The existence of gradations between smoothness and carination, and the absence of correlated characters which would serve for distinction, suggests that this "variety" should not be retained.

Since then, field examination of several hundred further specimens has confirmed the gradations in cheliped structure and failed to reveal features of color, habitat, or behavior, which merited a detailed reinvestigation of the situation.

As regards pleopod structure, figures already published cast doubt upon the distinguishing criteria of Forest and Guinot. Thus the outer surface of the figure of Stephenson and Hudson (1957, fig. 3I) resembles their *T. admete*, while the inner surface resembles their *T. edwardsi*. To obtain unequivocal data, 25 males were selected at random from the present collection. Since specimens with carinated chelae predominated, five males with smoother chelipeds (the first five encountered) were added. The total was examined for seven of the supposedly distinguishing features of *T. edwardsi* from *T. admete*, and the results given in table 1 (p. 113) are arranged with *T. edwardsi*-like specimens first and *T. admete*-like specimens last. In certain features, particularly those of the pleopods, it was difficult

to place a given specimen in a definite category, but wherever possible this was attempted.

The results show that there is every gradation from specimens which might be categorized "6/7 *edwardsi* and 1/7 *admète*" to those which are "7/7 *admète*," and that there is a lack correspondence between any two features.

Several pleopods are figured (fig. 20). These show intermediates between the two figured by Forest and Guinot and extend the range beyond their limits. A further extension is provided by Stephenson and Hudson (1957, fig. 3I).

Following the publications of Crosnier (1962) and Guinot (1962), the entire collection was reinvestigated separately by each of the present authors who agreed that, if two forms were present, the only hope of separation lay in the carination of the outer surface of the chelipeds. Investigation then showed that in some specimens both upper and middle carinae are strongly developed and granular. In others the upper carina is strongly granular and the middle one, while strongly developed, is without granules. In yet others the upper carina of the smaller cheliped is granular but that of the larger, nongranular. In others there is a distinct but smooth lower carina, while the upper one is barely distinguishable or indistinguishable. Finally in some, the upper carina has disappeared, and the lower one is distinguishable with difficulty or not at all. In other words there is a complete gradation between extremes.

T. spiceri, based upon three females, remains a doubtful synonym. Edmondson compares it with *T. pilumnoides* but not with *T. admète*, which it appears to resemble closely.

DISTRIBUTION.—Red Sea and East Africa to Hawaii and Tahiti, including Japan and Australia.

Thalamita auauensis Rathbun

FIGURES 21, 22

Thalamita auauensis Rathbun, 1906, p. 874, pl. 12 (fig. 1).—Edmondson, 1951, p. 222, fig. 24b; 1954, pp. 257–258, figs. 32a–d.—Stephenson and Campbell 1957, pp. 319, 320 (in key).

MATERIAL.—China: Sta. 5321, Ibugos Is., China Sea, Formosa, 20°19'30" N., 121°51'15" E., 26 fm., white sand, coral, broken shells, Nov. 9, 1908, *Alb.*, 1 male.

Philippines: Sta. 5557, Sept. 18, 1909, *Alb.*, 1 ovig. female; Great Tobea I., tide pool, sand, coral, Dec. 15, 1909, *Alb.*, 1 female.

Marianas: 148/R.H.B.–155, Ritidian Point, Guam, July 12, 1945, R. H. Baker, 1 ovig. female; Guam, October–November 1945, J. L. Gressitt, 1 ovig. female; Saipan, in coral heads, 1945, A. H. Banner, 1 juv; 177–G–1, Ifaluk, Caroline Is., 1953, F. M. Bayer, 2 juvs.

(also 7 juvs. of a species near this but too small to identify positively).

Samoa: U.01096, 1 ovig. female.

MEASUREMENTS.—Male, 17 mm; female, 21 mm; ovig. females, 11–20 mm; juvs., 4–5 mm.

REMARKS.—Very close to *T. admete* in its general facies and also in its pleopod structure and distinguished by: Carapace being more convex and typically more hirsute; granulation between two lowermost ridges on outer side of chelae; more inclined borders of penultimate segment of male abdomen and more elongate ultimate segment; and by marked reduction in spinulation of male pleopods (see figs.

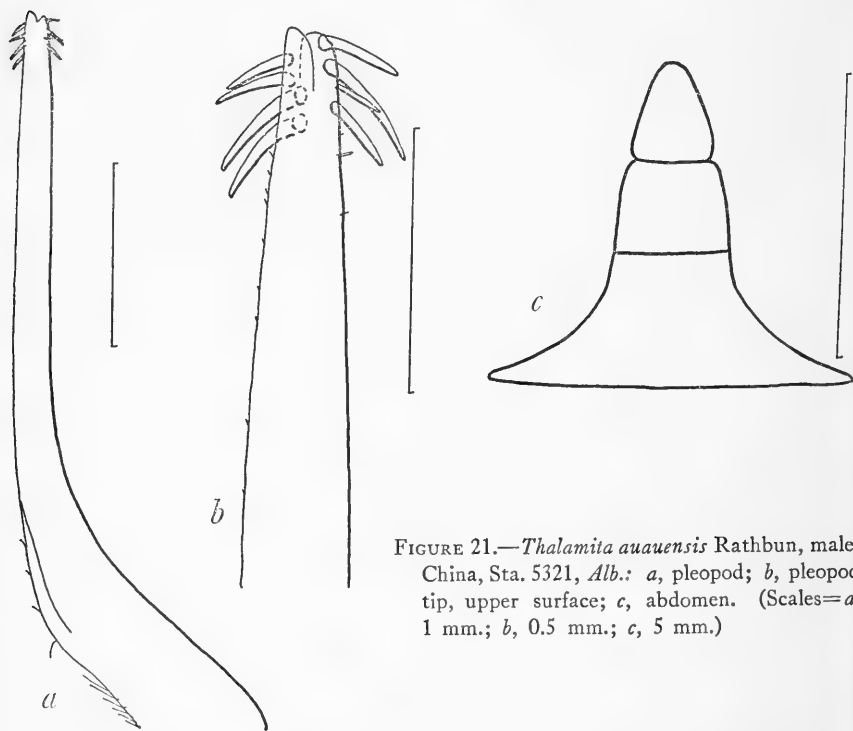


FIGURE 21.—*Thalamita auauensis* Rathbun, male, China, Sta. 5321, *Alb.*: *a*, pleopod; *b*, pleopod tip, upper surface; *c*, abdomen. (Scales=*a*, 1 mm.; *b*, 0.5 mm.; *c*, 5 mm.)

21*a*, *b*). Only four slightly recurved stout bristles of more or less uniform size are present on each.

Evidently the size of the fourth anterolateral tooth varies as in *T. admete*. Rathbun (1906) describes this tooth as rudimentary, while Edmondson (1954) implies that it is either very small or absent. Edmondson comments on the bright pink color of specimens.

The species is also close to *T. granosimana* Borradaile and was listed as a queried synonym of this species by Stephenson (1961*a*, pp. 119–121). It differs in the armature of the male pleopods, in the penultimate segment of the male abdomen being less parallel sided

and ultimate segment longer, and in having a more convex carapace.

The front varies in the curvature of both inner orbital lobes and frontal lobes.

Edmondson (1951, fig. 24b; 1954, fig. 32a) does not show the conspicuous frontal ridges which are clearly visible in Rathbun's (1906) plate 12, figure 1. In his figures he shows what appears to be a ridge which continues behind the orbit; in the present specimens this is a groove, not a ridge.

DISTRIBUTION.—Previously known only from Hawaiian waters.

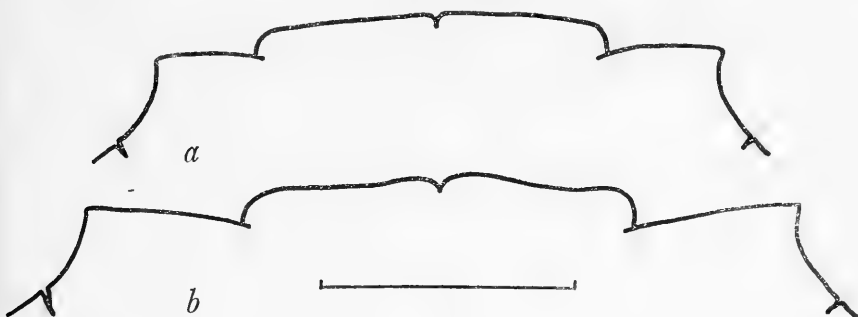


FIGURE 22.—*Thalamita auauensis* Rathbun, fronts: *a*, China, Sta. 5321, *Alb.*; *b*, Philippines, Great Tobea I., *Alb.* (Scale=5 mm.)

Thalamita bouvieri Nobili

Thalamita bouvieri Nobili, 1906b, p. 262; 1907, pp. 384–385, pl. 2 (fig. 2).—Rathbun, 1911, p. 210.—Balss, 1938, p. 34.—Crosnier, 1962, pp. 119–121, figs. 201–204, pl. 10 (fig. 2).

Thalamita inhacae Barnard, 1950, p. 179, fig. 33g.—Stephenson and Hudson, 1957, pp. 337–339, figs. 2L, 3L, pls. 3 (fig. 2), 7H, 10E.—Stephenson, 1961a, p. 121.

MATERIAL.—Details of sex, size, and spinulation of the chelipeds are given with each specimen.

Australia: Dredged off Bottle and Glass Reef, 2 fm., Melbourne Ward, 1 female, 7 mm. (Right cheliped only present, with 2 spines, 1 spiniform tubercle, 1 indistinct tubercle.)

Marshalls: Eniwetok Lagoon, 3 mi. N. of Jieraru I., dredged 15–20 fm., June 5, 1946, Taylor, 1 ovig. female, 10 mm. (Both chelipeds with 2 spines, 1 spiniform tubercle, 2 tubercles.) Rongelap Lagoon 2 mi. W. of Busch I., 20 fm., June 21, 1946, Taylor, 1 male, 6 mm. (Both chelipeds with 3 spines, 2 tubercles.)

Samoa: Pago Pago, August 1902, *Alb.*, 1 female, 12 mm. (Left cheliped only present with 3 spines, 2 tubercles.)

REMARKS.—The above specimens are conspecific with material from both east and west Australia which was identified as *T. inhacae*

(Stephenson and Hudson, 1957; Stephenson, 1961a). In the single small male, the pleopod differs slightly from that figured in Stephenson and Hudson (1957) in possessing fewer subterminal bristles. On the inner side, only five stout spines are present, while on the outer side there are only five bristles, two of which are large.

Barnard's description of *T. inhacae* from Inhaca Bay in South Africa did not include comparison with *T. bowvieri*. The distinctions between the two species seem to be solely in the ornamentation of the hand of the cheliped. In *T. inhacae*, five blunt spines and one outer ridge are described by Barnard, while there are three spines and three ridges in *T. bowvieri*. Throughout the genus *Thalamita*, spines on the upper surface of the cheliped are invariably borne upon partial or complete carinae, and the presence of five spines necessarily implies more than one carina, with a suspicion of the usual two on the upper surface. These are certainly present in the Australian and present material. Spines are invariably subject to wear and capable of being reduced to obscure tubercles. Evidence of this is given in the details of the present collection.

Crosnier (1962) has examined female syntypes of *T. bowvieri* and provided the final confirmation of the synonymy.

DISTRIBUTION.—South Africa, Amirantes, Australia, Gilbert, and Tuamotou Is.

Thalamita chaptalii (Audouin)

Portunus chaptalii Audouin, 1826, p. 83 [figs. in Savigny, 1809, pl. 4 (fig. 1)].

Thalamita chaptalii (Audouin).—Alcock, 1899, pp. 80–81.

Thalamita chaptali (Audouin).—Stephenson and Hudson, 1957, pp. 327–328, figs. 2F, 3F, pls. 1 (fig. 3), 7C, 10B.—Forest and Guinot, 1961, p. 34, figs. 21A, B.—Sankarankutty, 1961a, p. 106.—Crosnier, 1962, pp. 111, 113, figs. 184, 189, 191.

MATERIAL.—Philippines: Tara I., Mindoro Strait, 130 ft. seine, Dec. 15, 1908, *Alb.*, 1 male, 1 female, 1 ovig. female; Mariveles, Luzon, June 27, 1913, A. M. Reese, 1 male.

Melanesia: Florida I., Solomon I., Oct. 28, 1944, Lt. R. E. Kuntz, 1 male, 1 female.

Marshall: S-46-44, dredged 180–200 ft., Bikini Lagoon, Mar. 29, 1946, L. P. Schultz, 2 females.

MEASUREMENTS.—Males, 10–24 mm.; females, 10–18 mm.; ovig. female, 13 mm.

DISTRIBUTION.—Madagascar and Red Sea to Australia and Tahiti.

Thalamita coeruleipes Jacquinot

Thalamita coeruleipes Jacquinot, 1852, pl. 5 (figs. 6–10).—Jacquinot and Lucas, 1853, pp. 53–54.—Edmondson, 1954, pp. 265–267, figs. 38a–f, 39a.—Stephenson and Hudson, 1957, pp. 329–331, figs. 2P, 3P, pls. 2 (fig. 1), 7D, 9B.—

Forest and Guinot, 1961, pp. 32-33.—Crosnier, 1962, pp. 128-130, figs. 219 bis a-b, pl. 11 (fig. 2).

MATERIAL.—Philippines: Sta. 5159, Tinakta I., Sulu Archipelago, Tawitawi Group, 5°11'50" N., 119°54' E., Feb. 21, 1908, *Alb.*, 1 male, 1 female.

Australia: Great Barrier Reef, Apr. 8–May 29, 1952, John K. Howard, 1 male.

Marianas: Saipan I., in coral heads, 1945, A. H. Banner, 1 female; Aganta Bay, Guam, Sta. 85-x-44, May 20, 1945, R. H. Baker, 1 female; Agfayan Bay, Guam, 135/RHB 150, July 7, 1945, R. H. Baker, 1 female; Y259, Gillifitz, Yap I., sand, rocky coral covered reef, received 1952, Hiatt, 1 male.

Samoa: Apia, at mouth of river, June 1, 1902, *Alb.*, 2 females, 1 ovig. female; Apia, outer reef, June 27, 1902, *Alb.*, 2 males, 1 ovig. female; Apia, outer reef, June 27, 1902, *Alb.*, 1 juv; Apia, coral reef, July 1902, *Alb.*, 1 female; Apia, outer coral reef at low tide, July 1, 1902, *Alb.*, 2 males; Pago Pago, no. 10, August 1902, *Alb.*, 8 males, 2 females, 3 ovig. females; Pago Pago, August 1902, *Alb.*, 2 males.

Fanning Is.: Inner Lagoon, Fanning Is., Dec. 16, 1913, Fred and Charlotte Baker, 1 ovig. female.

Tuamotus and Societies: Sta. 84a-57 Huahine, head of Baie de Maroe, from branching coral, Apr. 30, 1957, Bredin Exped., 2 males.

MEASUREMENTS.—Males, 10-40 mm.; females, 18-53 mm.; ovig. females, 26-46 mm.

REMARKS.—The fourth anterolateral tooth is smaller than the fifth in small specimens, which hence key out as *T. prymna*. They are distinguished from *T. prymna* by the form of the front and inner orbital angles. In the Australian specimen the second of the normal anterolateral teeth is missing, and the first is greatly enlarged.

DISTRIBUTION.—Mauritius to Australia and Central Pacific Is.

Thalamita corrugata Stephenson and Rees

FIGURE 23

Thalamita cooperi Stephenson and Hudson, 1957, pp. 331-332, pls. 1 (fig. 4), 10C [in part, some specimens of *T. demani* Nobili, q.v.].

Thalamita corrugata Stephenson and Rees, 1961, pp. 421-425, figs. 1A, C, E, F, 2A-C.—Guinot, 1962, p. 9.

Not *Thalamita cooperi* Borradaile, 1902, pp. 206-207, fig. 37.—Sankarankutty, 1961a, p. 122, fig. 113.

MATERIAL.—Tuamotus and Societies: Sta. 10a-57, Tickahau Lagoon, Apr. 11, 1957, Bredin Exped., 2 males (6, 8 mm.), 2 females (5, 6 mm.).

REMARKS.—In general facies, the present material agrees in all respects with the females from Queensland, described by Stephenson and Hudson (1957) as *T. cooperi*.

The male pleopod and abdomen (figs. 23*a-c*) are described in Stephenson and Rees (1961, pp. 423-424). This pleopod shows considerable resemblances to that of *T. trilineata* Stephenson and Hudson (1957)(=*T. demani* Nobili), the differences being extra subterminal bristling on the outer side in *T. trilineata* where there is a relatively close packed elongate patch or double row. The species as a whole is close to *T. demani* but differs in the relatively narrower lateral frontal lobes (one-fifth instead of one-third breadth of the medians) and in the median cardiac ridge of the carapace being separated from the mesobranchials.



FIGURE 23.—*Thalamita corrugata* Stephenson and Rees, 8 mm. male, Tuamotus and Societies, Sta. 10a-57, Bredin: *a*, pleopod; *b*, pleopod tip, upper surface; *c*, abdomen. (Scales=*a*, 1 mm.; *b*, 0.5 mm.; *c*, 1 mm.)

DISTRIBUTION.—Queensland and the Gilbert Is.

***Thalamita crenata* (Latreille)**

Portunus crenatus Latreille, 1829, fide H. Milne Edwards, 1834, p. 461.

Thalamita crenata (Latreille).—Alcock, 1899, pp. 76-77.—Sakai, 1939, pp. 413-415, pl. 84 (fig. 3).—Edmondson, 1954, pp. 267-269, figs. 39b, 40a-f.—Stephenson and Hudson, 1957, pp. 332-334, figs. 2Q, 3Q, pls. 2 (fig. 3), 7F, 9C.—Sankarankutty, 1961a, pp. 106-107.—Crosnier, 1962, pp. 130-132, figs. 220, 226-227, 232-233.

MATERIAL.—Malay Peninsula: All from Siam: Taleui I., Sept. 27, 1923, 1 male (front damaged, median lobes confluent), 2 ovig. females; Koh Chang, Jan. 14, 1924, 1 dried male (left median and lateral

frontal lobes fused); Koh Chang, Apr. 5, 1924, H. M. Smith, 1 male; Koh Chang, west side of Gulf of Siam, July 15, 1926, 1 ovig. female; Hualap I., Sept. 26, 1926, H. M. Smith, 1 female; Sri Raja, Feb. 5, 1927, H. M. Smith, 1 male; Sri Raja, Feb. 5, 1927, 1 male, 1 female; Spiracha, southeastern Siam, rocks, May 6, 1929, 1 female; Gulf of Siam, Apr. 30, 1934, H. M. Smith, 1 female; Mayor Stream on north side of Goh Chang I., east side of Gulf of Siam, Oct. 28, 1957, Fehlmann, 1 female.

Philippines: Grand I., Subig Bay, Luzon, October 1907, Dr. J. C. Thompson, 1 female; Panabutan Bay, shore, Feb. 6, 1908, *Alb.*, 1 ovig. female; Tataan, Simaluc, shore, Feb. 19, 1908, *Alb.*, 1 male, Tataan Tawitawi, shore, Feb. 20, 1908, *Alb.*, 2 males; Borrgoa I., Tawitawi, shore, Feb. 23, 1908, *Alb.*, 1 male, 1 ovig. female; Sandakan, Borneo, seine, Mar. 2, 1908, *Alb.*, 6 females; Jolo, Jolo I., shore, Mar. 6, 1908, *Alb.*, 1 male; reefs opposite Cebu, Apr. 7, 1908, *Alb.*, 1 male; east side Tagbilaran Strait, Bohol I., shore, Apr. 9, 1908, *Alb.*, 4 males, 5 females; San Miguel Harbor, Ticao I., between Burias and Luzon Is., Apr. 21, 1908, *Alb.*, 1 fragmented male; shore about Iloilo River, 130 ft. seine, June 2, 1908, *Alb.*, 2 males, 1 female; Point Jarnelo, Luzon River, 150 ft. seine, July 13, 1908, *Alb.*, 1 male, 2 females; Sta. 5292, July 23, 1908, *Alb.*, 1 male, 1 female; Port San Pio, in small stream near mouth, 20 ft. seine, Nov. 11, 1908, *Alb.*, 1 male; Luzon shore, San Vicente Harbor, seine, Nov. 11, 1908, *Alb.*, 1 male; Luzon shore, San Vicente Harbor, seine, mud, sand, sticks, and leaves, Nov. 13, 1908, *Alb.*, 1 male, 1 female; Port Uson, W. of Pinas I., electric light, Dec. 17, 1908, *Alb.*, 2 males; Nakochin Harbor, Linapacan I., seine, Dec. 19, 1908, *Alb.*, 1 male, 1 female; Ulugan Bay, near mouth of Caiholo River, Palawan I., seine, Dec. 28, 1908, *Alb.*, 1 male, 1 female; Buena Vista, Guimaras I., Iloilo Strait, seine in mouth of river, Jan. 14, 1909, *Alb.*, 1 male; Alimango River, Burias I., Mar. 5, 1909, *Alb.*, 1 male (*Sacculina* infected), 1 female; San Pascual, Burias I., tide pool, Mar. 8, 1909, *Alb.*, 1 female; Caumahala Bay, Ragay Gulf, mouth of small stream, Mar. 11, 1909, *Alb.*, 1 male (front damaged), 4 ovig females; Cebu Market, Mar. 26, 1909, *Alb.*, 1 male; Cuyo I., 130 ft. seine, Apr. 9, 1909, *Alb.*, 1 male, 1 female; Nato River, east coast Luzon, San Bernadino Strait to San Miguel Bay, June 18, 1909, *Alb.*, 1 female; Fishermen Makinog, Camiguin I., between Leyte and Mindanao I., tide pool, Aug. 3, 1909, *Alb.*, 1 female; Labuan Blanda I., Dec. 14, 1909, *Alb.*, 2 males, 3 females (2 ovig.); Great Toba I., tide pool, sand, coral, Dec. 15, 1909, *Alb.*, 1 male; Iloilo, Panay I., Apr. 6, 1929, H. C. Kellers, 1 female; Jolo, Sulu, mud, sand, sticks, and leaves, July 13-19, 1929, Herre collection; 1 male, 1 female (Philippine Is.; E. A. Mearns, 3 males, 2 females).

Australia: Little Lagoon and vicinity northeastern end of Groote Eylandt, Gulf of Carpentaria, 1948, R. R. Miller, 1 fragmented male; Yirrkala, 1948, Arnhem Land Exped., 2 fragmented males; Umba Kumba, south side of Little Lagoon, northeastern end Groote Eylandt, Gulf of Carpentaria, taken between Apr. 6 and May 18, 1948, R. R. Miller, 1 male, 1 female; Ironstone Reef at Rocky Beach ± 3 mi. S. of the point E. of Yirrkala and NW. of Cape Arnhem, N.T., July 18, 1948, R. R. Miller and F. M. Setzler, 1 male, 1 female (soft and fragmented).

Palau Is.: GVF, High I., Atoll Project, Sta. 12, 1955, H. A. Fehlmann, S. Pierce, R. Harry, 2 males; GVF, High Atoll Project, Sta. 60, W. of Ebadul's Pier, north end of Koror I., sand and eel grass flat, 1011—Crustacea, Aug. 5, 1955, Fehlmann and Harry, 1 male.

Marianas: Ajayan River, Guam, 112X-65, June 19, 1945, D. H. Johnson, 1 male, 2 females; Oca Point, Guam (Alupat I.), July 5, 1945, L. P. McElroy, 1 female; Y114A, from under stones in holes in dead coral blocks, intertidal zone, Tomil Harbor, received June 23, 1952, 2 males, 2 females, 7 juvs.

Samoa Is.: Apia, outer reef, June 22, 1902, *Alb.*, 1 fragmented male; Apia, holes along Vailele River above tidewater, July 1902, *Alb.*, 1 juv; Pago Pago, no. 10, August 1902, *Alb.*, 1 male.

Tuamotus and Societies: Sta. 26-57, Maiai I., Tikahau Atoll, lagoon side, off beach, Apr. 13, 1957, Bredin Exped., 4 males; Sta. 27, Maiai I., Tikahau Atoll, Tuamotu Is., lagoon side, along shore, seining marly clay bottom, Apr. 14, 1957, Bredin Exped., 1 female.

MEASUREMENTS.—Males, 17-91 mm.; females, 19-63 mm.; ovig. females, 40-63 mm.; juvs., 8-16 mm.

REMARKS.—In juveniles narrower than 10 mm., the fourth antero-lateral tooth is smaller than the fifth, and the specimens key out in the wrong direction at couplet 3 in Stephenson and Hudson (1957, p. 316).

In the males "89 mm. Port Uson, West of Pinos I., Dec. 17, 1908, *Alb.*," and "91 mm. Cebu market, Mar. 26, 1909, *Alb.*," the mesogastric ridges are concave anteriorly instead of being straight, and the basal antennal joint is more crestlike than usual. Possibly these features are related to size, these being the largest specimens so far examined by the senior author.

The single *Sacculina* infected male "34 mm, Alimango River, Burias I., Mar. 5, 1909; *Alb.*," in addition to having the characteristically broader abdomen, has an unusually convex carapace.

The male "47 mm, Koh Chang, Siam, Jan. 14, 1924," has the submedian and lateral frontal lobes fused on the left side.

A male "60 mm, Sta. 26-57, Maiai I., Apr. 13, 1957," is abnormal in possessing a small additional frontal lobe between the lateral frontal lobe and the supraorbital angle on the left side.

The right pleopod of a male "67 mm, G.V.F., High I. Atoll Project, Sta. 12; 1955" is grossly malformed, and bears what is probably a crustacean parasite.

DISTRIBUTION.—Durban and Red Sea to Japan, Australia, Hawaii, and Society Is., and now Tuamotus.

Thalamita dakini Montgomery

FIGURE 24

Thalamita dakini Montgomery, 1931, pp. 432-433, pls. 23 (fig. 3), 28 (fig. 4).—Stephenson and Hudson, 1957, pp. 334-335.—Stephenson, 1961a, pp. 118-119, figs. 2D, 3J, pls. 3 (fig. 3), 4I, 5F.

Thalamita medipacifica Edmondson, 1954, pp. 260-262, figs. 34a,b, 35a.

MATERIAL.—Marianas: Ritidian Point, Guam, Sta. 148-R.H.B. 155, July 12, 1945, Baker, 1 male, 1 ovig. female.

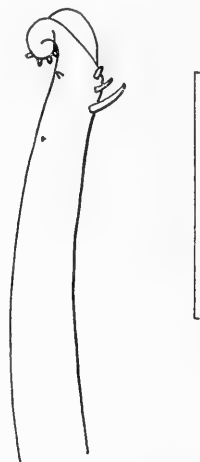


FIGURE 24.—*Thalamita dakini* Montgomery, male, Hawaii, Waikiki Marine Lab., Mar. 28, 1942, Mansfield: pleopod tip, upper surface. (Scale=0.5 mm.)

Gilbert Is.: Howland I., 1926, C. H. Edmondson, 1 male, 1 ovig. female.

Hawaii: Black Point, Haunama Bay, Oahu, 1937, L. R. Woodward, S. F. Light, 1 female, 1 ovig. female, 1 juv; Waikiki Marine Lab., Honolulu, Mar. 28, 1942, G. S. Mansfield, 1 male; coast near Kawailoa, Oahu, under growth of coralline algae, Apr. 4, 1942, G. S. Mansfield, 3 females (2 ovig.); Waikiki Marine Lab. from coral, Apr. 24, 1942, 5 males, 1 ovig. female, 1 juv.

Tuamotus and Societies: Society Is., summer 1925, J. M. Clements, 1 male, 1 ovig. female; Bora Bora, inner edge of outer reef, Sta. 62-57, 2 males, 3 females (2 ovig.), 1 juv; Nuarei Bay, Moorea, Sta. 127-57

coral in shallow, sandy beach, May 11, 1957, Bredin Exped., 1 male, 1 ovig. female.

MEASUREMENTS.—Males, 7–28 mm.; females, 10–15 mm.; ovig. females, 10–21 mm.; juv., 6 mm.

REMARKS.—In previous papers (Stephenson and Hudson, 1957; Stephenson, 1961a) Edmondson's species was included as a queried synonym. Doubt arose from minor differences between the male pleopod as figured by Edmondson (1954, figs. 34g, h) and those of the single male available from Australia. Edmondson showed two terminal spinules on the inner surface, which had no counterpart in the Australian specimen, and five instead of three subterminal spinules on the outer surface.

The present material shows variability in armature of male pleopods (see table 2, p. 114).

DISTRIBUTION.—Western Australia and Hawaii (Edmondson, 1954; Stephenson, 1961a).

Thalamita danae Stimpson

FIGURES 25a–e, 26a–c

Thalamita crenata Dana, 1852a, pp. 282–283, pl. 17 (figs. 7a,b) (not Latreille, 1829).

Thalamita danae Stimpson, 1858, p. 37.—A. Milne Edwards, 1861, pp. 366–367, pl. 36 (figs. 1, 1a–c).—de Man, 1902, pp. 644–645, pl. 21 (fig. 28).—Stimpson, 1907, p. 85, pl. 11 (figs. 1,1a).—Shen, 1934, pp. 52–53, figs. 15, 16a–c.—Sakai, 1939, pp. 413, 415, pl. 85 (fig. 3).—Stephenson and Hudson, 1957, pp. 335–337, figs. 2N, 3N, pls. 3 (fig. 1), 7G, 10D.—Crosnier, 1962, pp. 135–136 (under *T. foresti*), figs. 228, 232–233.

NOTE ON SYNONYMY AND NOMENCLATURE.—Crosnier (1962), in describing *T. foresti*, revised the synonymy of *T. danae*. To his synonymy, Sakai (1939) is now added.

MATERIAL.—Two forms are recognized in adult males, called forms A and B, respectively, distinction being by male abdomens and pleopods. These are listed separately as are females and juveniles.

MALES (FORM A)

Malay Peninsula: Hualap I., Siam, Sept. 26, 1926, H. M. Smith, 1 male.

Philippines: Guijulugan, Negros, shore, seine, Apr. 2, 1908, *Alb.*, 1 male; reefs opposite Cebu, Apr. 7, 1908, *Alb.*, 2 males; Dumurug Point, Masbate, shore, Apr. 19, 1908, *Alb.*, 8 males (1 *Sacculina* infected, 1 with broad abdomen); Busin Harbor, Burias I., between Burias and Luzon, Apr. 23, 1908, *Alb.*, 1 male; Little Santa Cruz I., Zamboanga, Mindanao, soft coral, marginal reefs, May 26, 1908, *Alb.*, 1 male; Masinloc Bay, Tacubales Province, Nov. 22, 1908, *Alb.*, 1 male; Caumahala Bay, Ragay Gulf, mouth small stream, Mar. 11, 1909, *Alb.*, 1 male; Canino I., near Daet, June 15, 1909, *Alb.*, 1 male;

Batan I., July 22, 1909, *Alb.*, 2 males; near Mariveles, Luzon, 1913, Albert M. Reese, 1 male; mangrove swamp, Zamboanga, Mindanao, Mar. 8, 1914, F. Baker, 1 male.

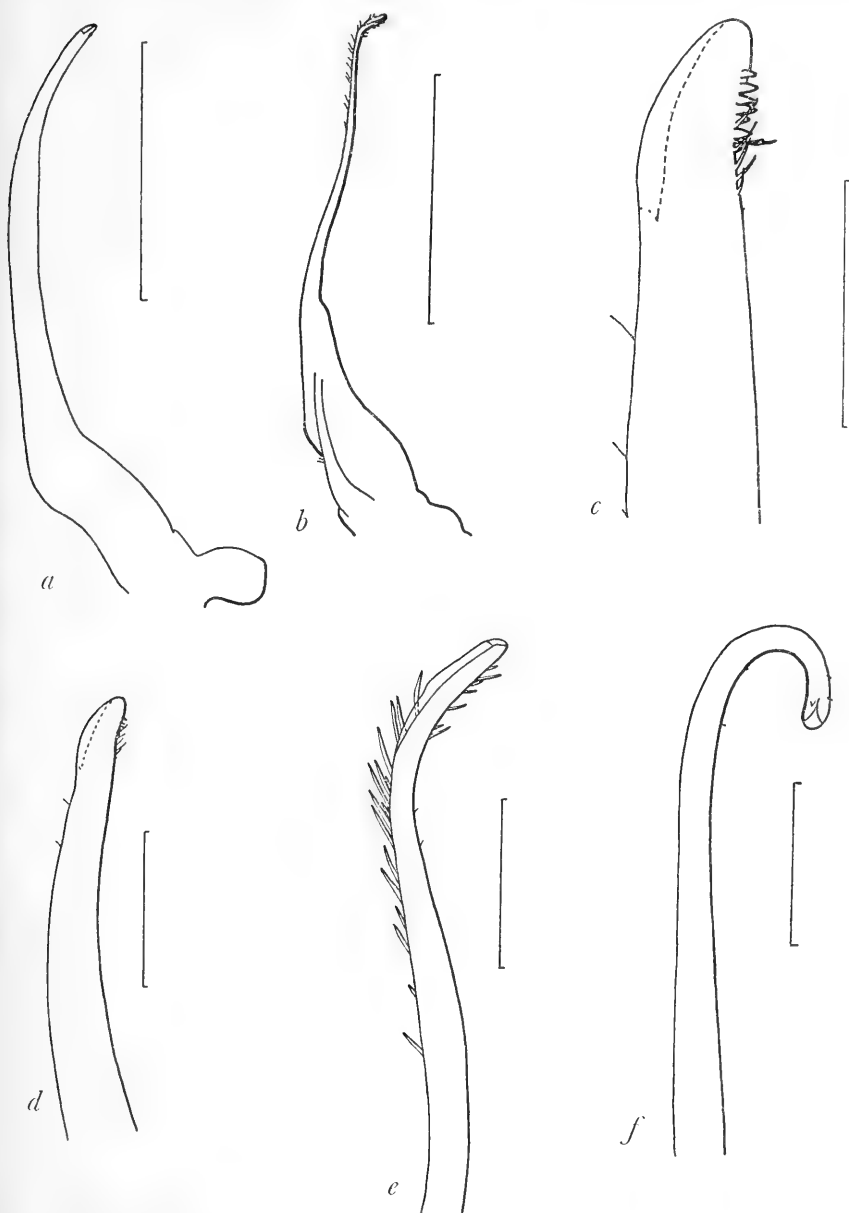


FIGURE 25.—Male pleopods and tips. *Thalamita danae* Stimpson: *a, c, d*, form A, Philippines, Dumurug Pt., *Alb.*; *b, e*, form B, China, Nau Wau, *Alb.* *T. foresti* Crosnier: *f*, China, Sabtan I., *Alb.* (Scales=*a, b*, 5 mm.; *c*, 0.5 mm.; *d-f*, 1 mm.)

Australia: Sta. 11B, Sydney, Mar. 21, 1948, F. D. McCarthy, 1 male; reef at Yirrkala, July 12, 1948, R. R. Miller, 1 male; ironstone reefs (not coral) and rock pools at Yirrkala, NW. of Cape Arnhem, part of M48-21, emulsifiable rotenone, Aug. 6, 1948, R. R. Miller and natives, 1 male; Arnhem Land Exped., M48-21, reef at Yirrkala, NW. of Cape Arnhem, Aug. 12, 1948, R. R. Miller, 1 male.

Palau: No. 10-814 west end Koror I., Madalai district, 1 ft., July 8, 1955, GVF, 1 male.

Marianas: Y-128G from under rocks, tidal flats, Tomil Harbor, received 1952, Hiatt, 1 male.

MALES (FORM B)

China: Nau Wau, Formosa, China Sea, Jan. 27, 1910, *Alb.*, 1 male.

Philippines: Gubat Bay, tide pool, June 23, 1909, *Alb.*, 1 male (right lateral frontal lobe missing).

FEMALES AND JUVENILES

Philippines: Guijulugan, Negros, station shore, sand, gravel, mud, Apr. 2, 1908, *Alb.*, 2 females, 9 juvs; Dumurug Point, Masbate, shore, Apr. 19, 1908, *Alb.*, 6 females, 2 juvs; Busin Harbor, Burias I., between Burias and Luzon, Apr. 23, 1908, *Alb.*, 1 ovig. female; Point Jarnelo, Luzon, 150 ft. seine, July 13, 1908, *Alb.*, 1 ovig. female; Tivanao I., near Palawan Is., reef, Dec. 31, 1908, *Alb.*, 1 ovig. female; San Pascual, Burias I., tide pool, Mar. 8, 1909, *Alb.*, 1 ovig. female; Caumahala Bay, Ragay Gulf, mouth small stream, Mar. 11, 1909, *Alb.*, 2 females; Batan I., July 22, 1909, *Alb.*, 1 female, 3 ovig. females; Nasigit, Mindanao I., tide pools, Aug. 1, 1909, *Alb.*, 1 female; Mactan I., tide pools, Aug. 31, 1909, *Alb.*, 1 female; Great Tobea I., tide pool, sand, coral, Dec. 15, 1909, *Alb.*, 1 female, 1 ovig. female; Dumaguete, Negros Is., July 11, 1931, Herre collection, 1 female.

Australia: Sta. 11B, Sydney, Mar. 21, 1948, F. D. McCarthy, 1 female, 1 ovig. female.

MEASUREMENTS.—Males form A, 22-73 mm.; males form B, 36, 46 mm.; females, 18-53 mm.; ovig. females, 42-56 mm.; juvs., 9-18 mm.

REMARKS.—Form A males have a relatively long ultimate segment of the male abdomen (almost as long as penultimate) with sides straight rather than concave (fig. 26a). In form B the ultimate abdominal segment is shorter (about four-fifths the length of penultimate) with sides markedly concave (fig. 26c). In this concavity it resembles *T. foresti*, but this species is distinguished by the broader, distally swollen penultimate segment, and the more elongate ultimate segment (fig. 26d).

The pleopods of form A males are relatively stout and end abruptly (figs. 25*a*, *c*, *d*). Subterminally on the outer side there are approximately six very short, stout, tubercle-like, laterally directed spines, overlapped and succeeded by about six bristles which are mostly forwardly directed. Subterminally on the inner side there are a few

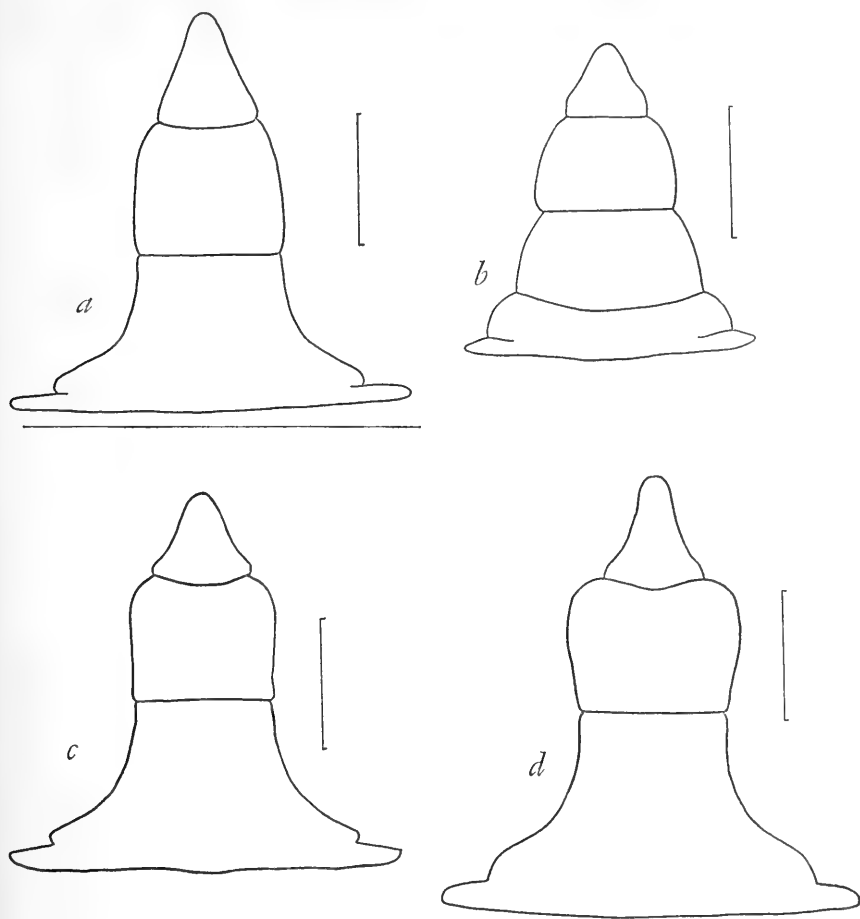


FIGURE 26.—Male abdomens. *Thalamita danai* Stimpson: *a*, form A (normal), Philippines, Dumurug Pt., *Alb.*; *b*, form A (abnormal), Philippines, Dumurug Pt., *Alb.*; *c*, form B, China, Nau Wau, *Alb.* *T. foresti* Crosnier: *d*, China, Sabtan I., *Alb.* (Scale=5 mm.)

sparsely arranged hairs. In form B, the pleopods are thin, gradually tapering, and distinctly curved near the tip. Subterminally on the outer side there are about six stout, elongate, forwardly directed bristles. On the inner side there is an extended row of elongate, forwardly directed spines.

The pleopods of form B differ markedly from those of form A and related species such as *T. coeruleipes*, *T. crenata*, *T. prymna*, and *T. stimpsoni*. But for the similarity in general facies, it would have been placed in a different "group" within the genus (see Stephenson and Hudson, 1957, pp. 320, 362). Form B is very close to *T. foresti* in the form of the male abdomen and in possessing a slender curved pleopod. It differs in having stouter pleopod bristling, in not having a recurved pleopod tip, and in the form of the front.

In one of the form A males (fig. 26b) the abdomen is much broader than long, but the pleopods are normal.

DISTRIBUTION.—Mozambique and Red Sea to Marshalls, Gilberts, and Fiji, including south Japan and north Australia. Recorded from New Zealand by Miers (1876) and by Heller (fide Doflein, 1904) and repeated by later workers, e.g., Stephenson (1961b). As Hutton (1882) has shown, this is almost certainly a mistaken locality.

Thalamita demani Nobili

Thalamita demani Nobili, 1905, p. 402; 1906a, pp. 209–210.—Crosnier, 1962, pp. 124–125, figs. 200, 208–209.

Thalamita invicta de Man, 1895, p. 565, pl. 13, (figs. 11, 11a).

Thalamita cooperi Stephenson and Hudson, 1957, pp. 331–332 (in part).

Thalamita trilineata Stephenson and Hudson, 1957, pp. 359–360, figs. 2E, 3E, pls. 6 (fig. 4), 8S, 10L.—Stephenson, 1961a, p. 124, pl. 4 (fig. 2L).

?*Thalamita invicta* Thallwitz, 1891, pp. 46–47, fig. 11.

Not *Thalamita cooperi* Borradaile, 1902, pp. 206–207, fig. 37.—Sankarankutty, 1961a, p. 122, fig. 113.

MATERIAL.—*Philippines*: Bataan, Simaluc, shore, Feb. 19, 1908, Alb., carapace, two chelae, and one walking leg only of a female (7 mm.).

REMARKS.—Crosnier (1962) has clearly shown that *T. trilineata* Stephenson and Hudson (1957) is a synonym of *T. demani* Nobili. Reexamination of the holotype of *T. trilineata* (Aust. Mus. Reg. No. P.2863) and also specimens from Western Australia (W. Aust. Mus. Reg. No. 84–60) confirms this synonymy.

In addition, two specimens in the Australian Museum (Aust. Mus. Reg. Nos. P.7546 (9 mm. female) and P.12754) reported as *T. cooperi* by Stephenson and Hudson (1957, pp. 331–332) belong to this species, as does a third (Aust. Mus. Reg. No. P.7546, 10 mm. female).

DISTRIBUTION.—Red Sea, Madagascar, and both east and west Australia.

Thalamita foresti Crosnier

FIGURES 25f, 26d

Thalamita danae de Man, 1887b, pp. 78–79, pl. 4 (figs. 8, 9).

Thalamita foresti Crosnier, 1962, pp. 132–136, figs. 221–223, 229–231, pl. 13 (fig. 1).

?*Thalamita danae* Alcock, 1889, pp. 77-78.—Barnard, 1950, p. 174.

Not *Thalamita danae* Stimpson, 1858, p. 39.

MATERIAL.—Malay Peninsula: Koh Pipedon, Pocket Bay, Benjal, Siam, Mar. 10, 1925, Hugh M. Smith, 1 female.

China: Sabtan I., China Sea, vicinity Hong Kong, Nov. 8, 1908, *Alb.*, 1 male.

Philippines: Nogas Point, Panay, shore seine, Feb. 4, 1908, *Alb.*, 1 ovig. female; base reef, Gulf Boni, Dec. 17, 1909, *Alb.*, 1 female.

MEASUREMENTS.—Male, 41 mm.; female, 56 mm.; female, damaged, ca. 37 mm.; ovig. female, 36 mm.

REMARKS.—Crosnier (1962) distinguishes this species from the very similar *T. danae* on the basis partly of adult male features and partly on general facies as follows:

a. Penultimate segment of the male abdomen is much wider than long, diverging in its proximal two-thirds, then narrowing conspicuously toward its end, while the ultimate segment has markedly concave borders. In the single male in the present collection, the penultimate segment (fig. 26*d*) is broader than figured by Crosnier. It should be noted that form B of *T. danae* approaches *T. foresti* in the form of the male abdomen. (Compare figure 26*c* with Crosnier's figure 223.)

b. Male pleopod is elongate, tapering with a recurved tip bearing small spinules and very different from that of *T. danae* (form A). However, forms A and B of *T. danae* differ markedly themselves.

c. According to Crosnier the basal antennal joint in *T. foresti* bears a more prominent crest carrying sharper granules. In the present collection of *T. danae* (form A), there are specimens which cannot be distinguished from *T. foresti* on this feature.

d. Different form of the front. Here again examples of *T. danae* (form A) show some of the points, for example prominence of the median frontal lobes, which Crosnier lists as diagnostic features of *T. foresti*. However, typical specimens do differ, and in all cases the median frontal lobes in *T. foresti* are relatively smaller and more rounded than in *T. danae*.

A further small distinction lies in the infraorbital lobe which is more ventrally inclined in *T. foresti*, the difference being most obvious in ventral view.

DISTRIBUTION.—Previously Madagascar and possibly Andaman I. and Mozambique.

Thalamita gatavakensis Nobili

Thalamita pilumnoides var. *gatavakensis* Nobili, 1906b, p. 262; 1917, p. 334.

Thalamita pilumnoides gatavakensis Nobili.—Forest and Guinot, 1961, pp. 34-36, figs. 23-25.

Thalamita gatavakensis Nobili.—Crosnier, 1962, pp. 106–108, figs. 156 bis a–c, e, 177 bis a–b.

Thalamita granosimana Stephenson, 1961a, pp. 119–121, figs. 2E, 4A, pls. 4J, 5G [not *Thalamita granosimana* Borradaile].

MATERIAL.—Philippines: Sta. 5165, Observation I., Sulu Archipelago, Tawitawi Group, 4°58'20"N., 119°50'30"E., 9 fm., coral, Feb. 24, 1908, *Alb.*, 3 males.

Tuamotus and Societies: Sta. 3–57, Papeete Harbor, Tahiti, anchor chain, Apr. 8, 1957, Bredin Exped., 3 males, 2 females, 2 ovig. females; Sta. 62–57, Bora Bora, inner edge of outer reef, Apr. 25, 1957, Bredin Exped., 3 males.

MEASUREMENTS.—Males, 4–8 mm.; females, 7, 8 mm.; ovig. females, 9, 13 mm.

REMARKS.—The present material greatly resembles that described by Forest and Guinot, including Nobili's, from the Tuamotus. The only differences are that the mesobranchial ridges of the carapace are more distantly separated from the median cardiac, the mesogastric are less interrupted in the midline, and the dactyl of the walking legs is slightly shorter than the propodus.

Minor differences also existed between Crosnier's single specimen and Nobili's type, and between Nobili's syntypes (see Crosnier, 1962, fig. 156 bis a–c, e).

None of the males bore pleopods; these were smaller than the lectotype figured by Forest and Guinot.

Distinctions from *T. pilumnoides* Borradaile are given under that species; a fuller description of the present species, albeit misidentified, is given in Stephenson (1961a).

DISTRIBUTION.—Madagascar, Western Australia, and Tuamotus.

Thalamita gloriensis Crosnier

Thalamita gloriensis Crosnier, 1962, pp. 98–100, 102–103, figs. 155, 156 bis d, 159–160, 165–167, 169.

MATERIAL.—Melanesia: No. 4, Bougainville, Jan. 10, 1945, W. Bartos, 1 ovig. female (10 mm.).

Marianas: Saipan, in coral heads, 1945, A. H. Banner, 1 male (6 mm.).

Marshalls: East Rigili I., Eniwetok Atoll, rock flats, May 30, 1946, J. P. E. Morrison, 1 ovig. female (18 mm.).

Hawaii: Waikiki Marine Lab., from seaweed, Feb. 1, 1942, G. S. Mansfield, 1 juv. (4 mm.).

Tuamotus and Societies: Huahine, off Point Teffaa, Sta. 90a–57, May 2, 1957, Bredin Exped., 1 ovig. female (6 mm.).

REMARKS.—Only the following minor differences with Crosnier's description were noted:

a. Marshall Is. specimen, 3rd anterolateral tooth not much smaller than the other teeth.

b. Above plus Huahine specimen, one or two well-developed spines on wrist behind that at the articulation; wrist more spiniform than in Crosnier's figure 165.

DISTRIBUTION.—Previously only from Glorious Is., Madagascar.



FIGURE 27.—*Thalamita granosimana* Borradaile, male, Philippines, Caiholo R., *Alb.*: a, pleopod; b, pleopod tip, upper surface. (Scales=*a*, 1 mm.; *b*, 0.5 mm.)

***Thalamita granosimana* Borradaile**

FIGURE 27

Thalamita granosimana Borradaile, 1902, pp. 202-203.—Crosnier, 1962, pp. 103-106, figs. 171-172, 175-177, pls. 8 (fig. 2), 13 (fig. 3).

Not *Thalamita granosimana* Stephenson, 1961a, pp. 119-121, figs. 2E, 4A, pls. 3 (fig. 4), 4J, 5G (= *Thalamita gatavakensis* Nobili).

MATERIAL.—Philippines: Sta. 5158, Tinakta I., Sulu Archipelago, Tawitawi Group, 5°12'N., 119°54'30"E., 12 fm., Feb. 21, 1908, *Alb.*,

2 males; Sta. 5159, Tinakta I., Sulu Archipelago, Tawitawi Group, $5^{\circ}11'50''\text{N.}$, $119^{\circ}54'\text{E.}$, Feb. 21, 1908, *Alb.*, 10 males, 6 females, 4 ovig., females, 1 *Sacculina* infected specimen; Sta. 5160, Tinakta I., Sulu Archipelago, Tawitawi Group, $5^{\circ}12'40''\text{N.}$, $119^{\circ}55'10''\text{E.}$, 12 fm., sand, Feb. 22, 1908, *Alb.*, 1 female, 3 ovig. females; Tomindao I., anchorage, electric light, Feb. 26, 1908, *Alb.*, 1 female; Sta. 5169, Sibutu I., $4^{\circ}32'15''\text{N.}$, $119^{\circ}22'45''\text{E.}$, 10 fm., Feb. 27, 1908, *Alb.*, 3 males, 1 ovig. female; San Miguel Harbor, Ticao Is., between Burias and Luzon, Apr. 21, 1908, *Alb.*, 1 male; Sta 5218, Anima Solo Is., between Burias and Luzon, 20 fm., Apr. 22, 1908, *Alb.*, 2 males, 1 ovig. female; Caiholo River, Ulugan Bay, seine, Dec. 29, 1908, *Alb.*, 4 males (1 damaged), 1 female, 1 ovig. female.

MEASUREMENTS.—Males, 8–24 mm.; females, 7–16 mm.; ovig. females, 9–18 mm.; *Sacculina* infected specimen, 13 mm.

REMARKS.—Crosnier's (1962) identification and redescription of this species is based upon comparison with Gordon's refiguring of Borradaile's type, and there are no doubts regarding Stephenson's (1961a) misidentification.

Male pleopods of the present material (fig. 27) bear fewer subterminal spines than those figured by Crosnier (1962, figs. 175–177) but evidently belong to the same species.

DISTRIBUTION.—Madagascar, Maldive-Laccadive Archipelago.

Thalamita imparimana Alcock

FIGURES 28; PLATE 7A

Thalamita imparimanus Alcock, 1899, p. 87.—Alcock and Anderson, 1900, pl. 47 (figs. 3, 3a).

MATERIAL.—China: Sta. 5304, China Sea, vicinity Hong Kong, $21^{\circ}46'\text{N.}$, $114^{\circ}47'\text{E.}$, 34 fm., black mud, Aug. 9, 1908, *Alb.*, 1 male (8 mm.).

Philippines: Sta. 5131, Island off Panabutan Point, 27 fm., Feb. 6, 1908, *Alb.*, 1 male (11 mm.).

REMARKS.—Alcock's brief diagnosis serves to identify this species. It resembles *T. investigatoris* in its long walking legs and in the form of the chelipeds. In these the upper surface bears rounded granules; there are no carinae, and only two spines are present on the upper surface (including the one at the wrist articulation). The species is characterized by the considerable overlap between median and submedian frontal lobes and by the absence of spinules on the posterior borders of the propodite of the fifth leg.

The male abdomen and pleopod appear not to have been described; both are highly characteristic. Penultimate segment of abdomen with markedly convex lateral borders (fig. 28c). Pleopod with re-

markable double curvature: tip flared and swollen, surmounted with a crest of long bristles; overall resembling a crested crane. Beyond basal lobes outer surface bare until just behind tip, here a single row of short hairs. Conspicuous crest on inner surface (which because of curvature becomes directed anteriorly) consisting of single row of about 30 elongate spines merging distally with about 15 short bristles. Tip of appendage bearing four stout bristles.

DISTRIBUTION.—Previously apparently only from Alcock's material from Ganjan Coast, India.

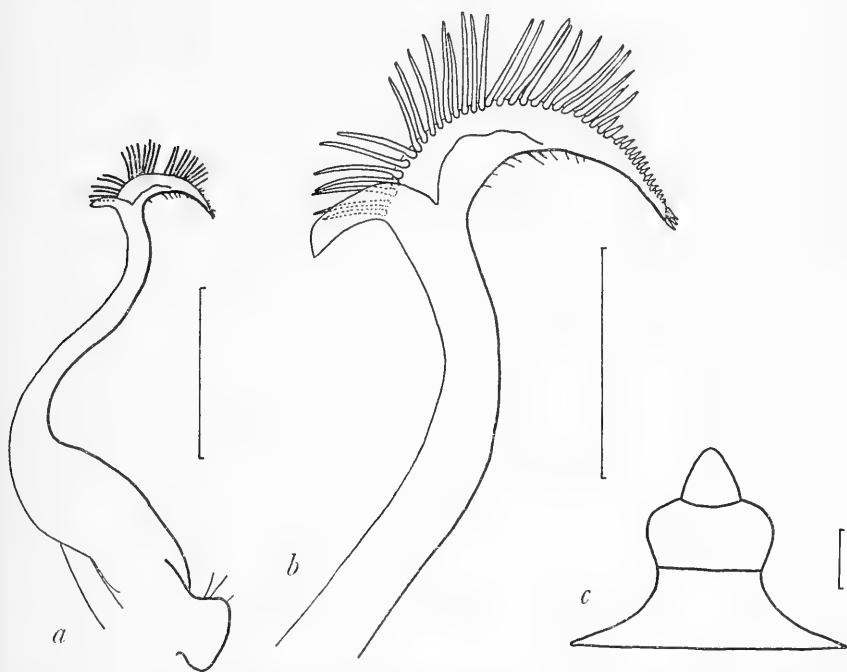


FIGURE 28.—*Thalamita imparimana* Alcock, male, Philippines, Sta. 5131, *Alb.*: a, pleopod; b, pleopod tip, upper surface; c, abdomen. (Scales=*a*, 1 mm.; *b*, 0.5 mm.; *c*, 1 mm.)

Thalamita integra Dana

Thalamita integra Dana, 1852b, p. 85.—Alcock, 1899, p. 85.—Sakai, 1939, pp. 414, 420–421, fig. 15, pl. 84 (fig. 2).—Edmondson, 1954, pp. 252, 253–254, figs. 27a–e, 28a.—Stephenson and Hudson, 1957, pp. 339–341, figs. 2H, 3H, pls. 3 (fig. 3), 7I, 10F.—Sankarankutty, 1961a, p. 105; 1961b, p. 122.—Crosnier, 1962, p. 103, figs. 156, 161, 170.

MATERIAL.—Philippines: *Alb.*, 1 female (no further data); Sta. 5169, Sibutu I., 4°32'15"N., 119°22'45"E., 10 fm., Feb. 27, 1908, *Alb.*, 1 male; Romblon, 150 ft. seine, Mar. 26, 1908, *Alb.*, 1 ovig. female; Tilig, Lubang, beach, July 14, 1908, *Alb.*, 1 ovig. female;

San Pascual, Burias I., tide pool with copper sulphate, Mar. 8, 1909, *Alb.*, 2 males.

Palau Is.: Sta. 12-832, Madalai district, west end Koror I., mangrove shore grading into mud and sand flat, July 9, 1955, GVF, 2 males.

Marianas: Sta. 96/x-49, Oca Point, Guam, June 26, 1945, D. H. Johnson, 2 males.

Japan: Okinawa, received Oct. 22, 1945, Maj. Wm. Thomas, 1 male.

Samoa: Pago Pago, August 1902, 1 male.

Hawaii: Pearl Harbor, Oahu, September 1920, Paul Bartsch, 2 males.

MEASUREMENTS.—Males, 8-32 mm.; female, 18 mm.; ovig. females, 16-24 mm.

REMARKS.—The males from Pearl Harbor have more terminal bristles on the outer side of the pleopod than described and figured by Stephenson and Hudson (1957). The larger specimen (32 mm.) has about 18 bristles.

DISTRIBUTION.—East Africa to Tahiti and Hawaii, including Australia.

Thalamita mitsiensi Crosnier

FIGURE 29

Thalamita mitsiensi Crosnier, 1962, p. 127, figs. 212-213, 216-218.

MATERIAL.—Philippines: Sta. 5159, Tinakta I., Sulu Archipelago, Tavitawi Group, 5°11'50"N., 119°54'E., Feb. 21, 1908, *Alb.*, 2 males (both 12 mm.).

REMARKS.—The first anterolateral tooth is much the stoutest and the second to fourth subequal. Crosnier's description states, "Dents 1-3 subégales, dent 4 de taille légèrement inférieure," although in his figure (fig. 212) the first tooth is shown as the stoutest.

The posterior border of the propodus of the fifth leg bears seven to eight spines, not six.

DISTRIBUTION.—Previously only from Mitsio Is., Madagascar.

Thalamita multispinosa, new species

PLATE 7B

MATERIAL.—Hawaii: Off Waikiki Marine Lab., Honolulu, Apr. 30, 1942, G. S. Mansfield, 1 female (21 mm., holotype, cat no. 112206).

DESCRIPTION: Front: 6-lobed, protruding slightly beyond supra-orbital angles. Median lobes rounded, deeply separated from each other and from the intermediates which are about 1½ times their breadth. Lateral frontal lobes small with shallow separation from intermediates. Supraorbital angles short, sharply arched. Two conspicuous indentations in upper border of orbit.

Anterolateral teeth: Five. First stoutest and bluntest, remainder sharp with fourth the smallest.

Carapace: Relatively long ($B/L=1.3$), covered with fine pile through which coarsely granular ridges are evident. Frontals, small elevated granular patches; protogastrics curved, slightly irregular; mesogastrics concave anteriorly, distinctly separated. Conspicuous patches opposite second and fourth anterolateral teeth. Epibranchials smoothly curving, terminating abruptly with small coarsely granular subterminal patch. Short continuous metagastric. Two broadly separated cardiacs. One pair of mesobranchials slightly in front of cardiacs. Posterior border of carapace apparently smooth, actually microscopically granular.



FIGURE 29.—*Thalamita mitsiensi* Crosnier, male, Philippines, Sta. 5159, *Alb.*: *a*, pleopod; *b*, pleopod tip, upper surface; *c*, abdomen. (Scales=*a*, 1 mm.; *b*, 0.5 mm.; *c*, 1 mm.)

Basal antennal joint: Shorter than width of orbit (0.8 times) and bearing short, steeply elevated crest, covered with small, rounded, close-packed granules.

Chelipeds: Left only present. Spinous, coarsely granular, and hirsute with squamiform markings on under surface of hand. Anterior border of arm with two long distal spines and shorter proximal spine. Wrist with three usual spines on outer surface and longer than usual spine at inner surface. Outer border of hand with two distinct coarsely granular carinae. Upper surface bearing four sharp spines excluding that at wrist articulation, and without obvious carinae. Inner surface with central carina granular, remainder coarsely granular. Fingers long, sharp, strongly carinated.

Fifth leg: Merus about twice as long as broad, with usual sub-terminal spine on hinder surface; posterodistal border also spinous. Propodus with very numerous small spines (ca. 20).

REMARKS.—This specimen keys out in Stephenson and Hudson (1957) as *T. picta*; however, it is neither *T. picta*, the related *T. wakensis*, nor *T. philippinensis*. It differs in the very large number of spines on the posterior border of the propodus of the fifth leg, hence the specific name.

It is probably closest to *T. picta* but differs in the more rounded frontal and inner orbital lobes and in various details of the carapace ridging. The protogastric ridges are shorter than in *T. picta*, the mesogastrics are more distinctly interrupted in the midline and are concave anteriorly. There is a broader interruption between the the metagastric and epibranchial ridges, and the cardiacs are composed of two short, widely separated ridges. The cheliped also differs in having longer and sharper spines on the wrist and hand and in having squamiform markings on the under surface of the hand.

Thalamita oculate Alcock

Thalamita oculate Alcock, 1899, pp. 91-92.—Alcock and Anderson, 1900, pl. 48 (figs. 3, 3a).—Sakai, 1939, pp. 424-425, text-fig., 18.—Crosnier, 1962, pp. 109-111, figs. 173-174, 178-180, 193-194, pl. 9 (fig. 1).

MATERIAL.—Philippines: Sta. 5165, Observation I., Sulu Archipelago, Tawitawi Group, coral, 9 fm., 4°58'20"N., 119°50'30"E., Feb. 24, 1908, *Alb.*, 1 female; Sta. 5561, Tutu Bay (Jolo), coral and sand, Sept. 19, 1909, *Alb.*, 1 female 1 juv. (? female); Labuan, Blanda Is., Buton Strait, marginal coral, Dec. 13, 1909, *Alb.*, 2 males, 1 female.

MEASUREMENTS.—Males, 9, 10 mm.; females, 10-18 mm.; juv. 8 mm.

DISTRIBUTION.—Madagascar, Seychelles, Japan, and Ceylon.

Thalamita parvidens (Rathbun)

FIGURE 30

Thalamonyx parvidens Rathbun, 1907, p. 62, pl. 5 (fig. 9).

Thalamita parvidens (Rathbun).—Sakai, 1939, pp. 425-426, fig. 19.—Stephenson, 1961a, pp. 122-124, figs. 2F, 4B, pls. 4 (fig. 1), 4K, 5H.—Crosnier, 1962, pp. 113-115, figs. 182, 185-187, 190, pl. 9 (fig. 2).

MATERIAL.—Philippines: Sta. 5159, Tinakta I., Sulu Archipelago, Tawitawi Group, 5°11'50"N., 119°54'E., Feb. 21, 1908, *Alb.*, 1 male, 1 female; Tunimdao I. Anchorage, Sulu Archipelago, vicinity Sibutu I., electric light, Feb. 25, 1908, *Alb.*, 1 male, 1 juv; Sta. 5169, Sibutu I., 4°32'15"N., 119°22'45"E., 10 fm., Feb. 27, 1908, *Alb.*, 1 male; Pascao, Ragay Gulf, electric light, Mar. 8, 1909, *Alb.*, 1 male; Mariveles, Luzon, June 27, 1913, A. M. Reese, 3 males.

Japan: Mogi, near Nagasaki, summer of 1900, Dr. D. S. Jordan and Mr. J. O. Snyder, 1 female.

MEASUREMENTS.—Males, 7–25 mm.; females, 8–13 mm.; juv., 8 mm.

REMARKS.—Stephenson (1961a) noted that Sakai's (1939) figure 16 does not show the most distal bristles on the inner side of the male

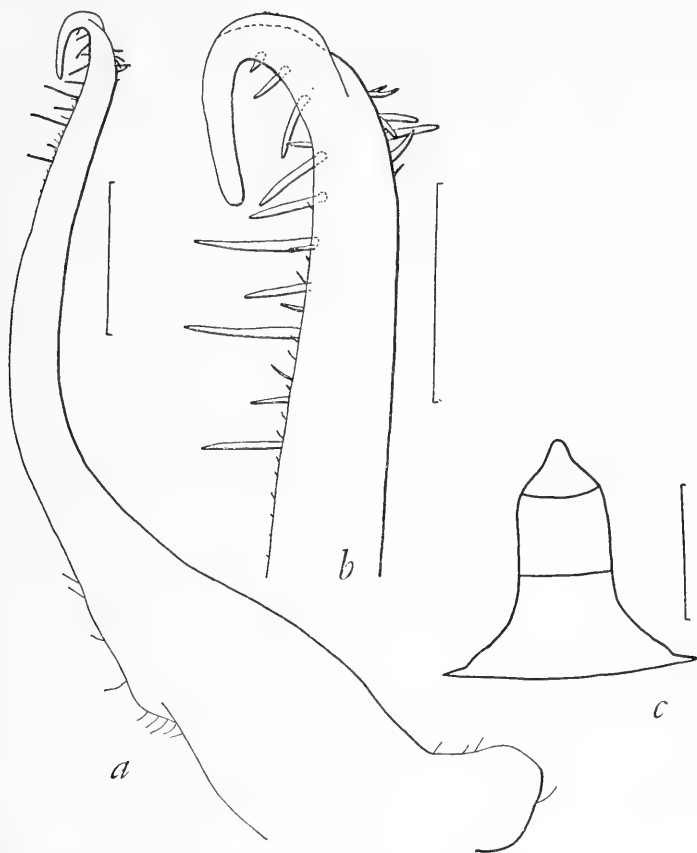


FIGURE 30.—*Thalamita parvidens* (Rathbun), male, Philippines, Mariveles, Reese: *a*, pleopod; *b*, pleopod tip, upper surface; *c*, abdomen. (Scales=*a*, 1 mm.; *b*, 0.5 mm.; *c*, 5 mm.)

pleopod. The specimen here figured is roughly intermediate between Sakai's figure and Stephenson's (1961a) figure 4B. Crosnier's (1962) figures 185 and 186 show numerous long spines on both sides of the tip of the appendage, more than possessed by any of the present specimens.

Crosnier's figure (fig. 190) of the male abdomen shows a straight-sided ultimate segment. In the larger of the present specimens and

in the one figured by Stephenson (1961a, pl. 4, fig. K), the sides are distinctly concave.

Minor differences in general facies as between the descriptions of different authors have been noted by Crosnier. Possibly later study will show the existence of several subspecies.

DISTRIBUTION.—Madagascar, Carolines, Japan, and Western Australia.

Thalamita philippinensis, new species

FIGURE 31; PLATE 8A

MATERIAL.—Philippines: Sta. 5163, Observation I., Sulu Archipelago, Tawitawi Group, 4°59'10"N., 119°51'E., 28 fm., coarse sand, Feb. 24, 1908, *Alb.*, 2 ovig. females; Sta. 5165, Observation I., Sulu Archipelago, Tawitawi Group, 4°58'20"N., 119°50'E., 9 fm., coral, Feb. 24, 1908, *Alb.*, 3 females (1 ovig.); Sta. 5218, Anima Solo I., between Burias and Luzon, 20 fm., Apr. 22, 1908, *Alb.*, 5 males, 5 females (1 ovig.); Davao Bay, from pearl oysters, May 18, 1908, *Alb.*, 1 male; Sta. 5249, Gulf of Davao, Lanang Point, 7°06'06"N., 125°40'08"E., 23 fm., May 18, 1908; *Alb.*, 1 male (holotype—cat. no. 112238); Sta. 5251, Gulf of Davao, Linao Point, 7°05'12"N., 125°39'35"E., 20 fm.; May 18, 1908, *Alb.*, 1 female; Sta. 5252 and Sta. 5253, Linao Point, Gulf of Davao, 7°04'48"N., 125°39'38"E., 28 fm., coral, May 18, 1908, *Alb.*, 3 males, 2 females (1 ovig.); Sta. 5254, Gulf of Davao, Linao Point, 7°05'12"N., 125°39'35"E., 20 fm., May 18, 1908, *Alb.*, 1 male, 2 females; Sta. 5254, Gulf of Davao, Linao Point, 7°05'42"N., 125°39'42"E., 21 fm., sand coral, May 18, 1908, *Alb.*, 2 males.

DESCRIPTION.—Front: Six lobes, all rounded and distinctly separated; medians on lower plane than remainder and approximately two-thirds width of submedians; laterals roundedly triangular. Inner orbital lobes moderately broad, almost straight, sloping slightly backward, and almost the length of submedian lobes.

Anterolateral teeth: Fourth very much smaller than remainder, but still clearly visible and blunt. Remainder all sharp with first the stoutest, followed by second, with third and fifth fairly slender.

Carapace: Covered with short pile and finely granular. All normal ridges present excepting anterior mesobranchial and cardiac. Mesogastrics interrupted in midline, and epibranchial broadly interrupted at cervical grooves.

Basal antennal joint: Shorter than major diameter of orbit (ca. 0.8 times in larger specimens) and bearing short acute ridge with rounded granules.

Chelipeds: Coarsely granular on upper surfaces and smooth below. Right much stouter than left. Anterior border of arm bearing three stout spines and one or more tubercles. Spine at inner angle of wrist

stout and well developed, three spines on outer surface, sometimes reduced to tubercles. Upper surface of hand with inner and outer spine near middle and with two normal distal spines often reduced to rounded tubercles. Outer surface typically with three carinae, lowermost running to immovable finger, distinct granular middle carina and indistinct granular upper carina. In larger chelae of male these carinae indistinct or unrecognizable.

Fifth leg: Merus slender ($L/B = \text{ca. } 3$), smooth posteriorly except for usual spine; posterior border of propodus bearing four to eight spines.

Male abdomen: Penultimate segment much broader than long (ca.

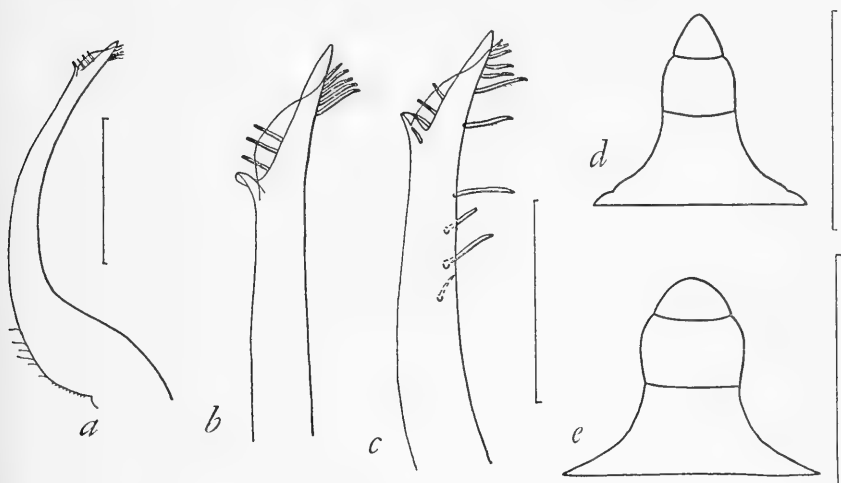


FIGURE 31.—*Thalamita philippinensis*, new species, male holotype: *a*, pleopod; *b*, pleopod tip, upper surface; *d*, abdomen. Philippines, Sta. 5218, *Alb.*: *c*, pleopod tip, upper surface. Philippines, Sta. 5254, *Alb.*, 25 mm. male; *e*, abdomen. (Scales=*a*, 1 mm.; *b*, *c*, 0.5 mm.; *d*, *e*, 5 mm.)

$1\frac{1}{2}$ times) with bulging sides. Ultimate segment rounded equilateral triangle.

Male first pleopod: Fairly stout, smoothly curving to oblique tip bearing flared membrane. Both sides without armature until near tip. Here outer surface typically with five to seven stout subterminal spines directed obliquely forward and decreasing in size toward tip, and usually with two or three thinner bristles widely spaced and lying back from tip. In largest male single subterminal spine present. Inner surface bearing two to four stout spines opposite widest portion of flared membrane; these almost at right angles to appendage.

MEASUREMENTS.—Males, 7–14 mm.; females, 8–12 mm.; ovig. females, 7–12 mm.

REMARKS.—This species keys out with *T. wakensis* Edmondson (1925) and *T. picta* Stimpson (1858). (See Stephenson and Hudson, 1957, p. 316.) It is closest to *T. wakensis*, sharing with it possession of a distinctly granular basal antennal joint and a male pleopod with stout anteriorly directed bristles on the outer side near the tip. It differs from *T. wakensis* in:

a. More rounded median and submedian frontal lobes; see Edmondson (1925, fig. 7a; 1954, fig. 36a) and Sakai (1939, fig. 13a).

b. Longer and less arched inner orbital lobes lying farther behind the front. Only in the two smallest specimens are the lobes relatively arched.

c. Reduction of spines to tubercles upon the wrist and arm; see Edmondson (1925, fig. 7c) and Sakai (1939, fig. 13c).

d. The absence of a distinct cardiac ridge on the carapace.

e. The different shape of the male pleopod. In the present material, there is no subterminal broadening of the appendage as shown in Edmondson (1954, fig. 36c), and the numbers and shapes of the terminal bristles differ conspicuously from those figured either by Edmondson (1954, fig. 36d) or Sakai (1939, fig. 13b).

A male (25 mm., Sta. 5254, May 18, 1908, *Alb.*) has the ultimate segment of its male abdomen much shorter and more rounded than the remainder (see fig. 31e).

Thalamita picta Stimpson

Thalamita picta Stimpson, 1858, p. 39.—Alcock, 1899, p. 79.—Sakai, 1939, pp. 413, 417, pl. 51 (fig. 2).—Edmondson, 1954, pp. 253, 263–264, figs. 35b, 36c–h.—Stephenson and Hudson, 1957, pp. 344–346, figs. 2A, 3A, pls. 4 (fig. 2), 8K, 10I.—Forest and Guinot, 1961, pp. 33–34.—Crosnier, 1962, pp. 138–139, figs. 237–240, pl. 12 (fig. 2).—Miyake, Sakai, and Nishikawa, 1962, p. 128 (record only).—Garth, 1965, pp. 12–14, figs. 7, 11, 12.

Goniosoma lineatum A. Milne Edwards, 1861, p. 377, pl. 35 (figs. 1, 1a–b).—Richters, 1880, p. 153.—Lenz, 1905, pp. 360–361, pl. 48 (figs. 5, 5a–e).

Thalamita gardineri Borradaile, 1902, pp. 205–206, fig. 36.—Rathbun, 1911, p. 209.

Thalamita alcocki de Man, 1902, pp. 646–650.—Edmondson, 1954, pp. 264–265, figs. 37a, b.

Charybdis lineata (A. Milne Edwards).—Balss, 1934, p. 505.

Thalamita roosevelti Schmitt, 1939, p. 16, fig. 2.

?*Thalamita investigatoris* Alcock, 1899, pp. 85–86.—Alcock and Anderson, 1900, p. 8, pl. 47 (figs. 1, 1a).—Barnard, 1954b, p. 124, fig. 4.

MATERIAL.—Philippines: Sta. 5593, Mount Putri, Borneo, 4°02'40"N., 118°11'20"E., 38 fm., fine sand, Sept. 29, 1909, *Alb.*, 1 female.

Marianas: Saipan, coral heads, 1945, coll. A. H. Banner, 1 male.

Marshalls: Eniwetok Reef, low tide, February 1946, F. C. Ziesenhenné, 1 male; Sta. 4442, Yonsyaran I., Bikini Atoll, May 16, 1946,

coll. Johnson, 1 male; Sta. 4449, Eniwetok I., Eniwetok Atoll, under rocks, rock flats, east side of island, May 20, 1946, J. P. E. Morrison, 1 male; E1-121, Arno Atoll, received 1952, 1 female; Jaluit Atoll, October 1960, Rehder, 1 female.

Samoa: U-01015, Schultz, 1 female.

Hawaii: Kilanoa Volcano House, Otto Degener, 1 ovig. female; following from Waikiki Marine Lab., Honolulu, G. S. Mansfield; under stones near shore: Feb. 9, 1942, 1 male; Mar. 13, 1942, 4 males; Mar. 28, 1942, 1 male.

Tuamotus and Societies: Sta. 29a-57, outer reef Tikahau Atoll, Maiai I., near coral rampart, Apr. 14, 1957, Bredin Exped., 1 female.

MEASUREMENTS.—Males, 9-27 mm.; females, 11-20 mm.; ovig. females, 14, 17 mm.

REMARKS.—Crosnier (1962) has examined Milne Edwards' type of *Goniosoma lineatum* and has shown that it belongs to *T. picta*.

DISTRIBUTION.—Examination of specimens from Clipperton I., kindly forwarded by Dr. John S. Garth, confirms that this species extends farther east than others in the genus and that *T. roosevelti* is a synonym (see Garth, 1965). Previously from Madagascar, Mozambique, and Red Sea to Tuamotus, including Japan and Australia (Stephenson and Hudson, 1957; Forest and Guinot, 1961).

Thalamita pilumnoides Borradaile

FIGURE 32

Thalamita pilumnoides Borradaile, 1903, p. 207, figs. 38, 38a.—Holthuis, 1953, p. 8 (record only).—Crosnier, 1962, pp. 150-151, fig. 253-256.

Not *Thalamita pilumnoides* var. *gatavakensis* Nobili, 1906b, p. 262; 1907, p. 384. Not *Thalamita pilumnoides* *gatavakensis* Forest and Guinot, 1961, pp. 34-36, figs. 23-25.

MATERIAL.—Marianas: Saipan, in coral heads, 1945, A. H. Banner, 1 male, 1 ovig. female.

Tuamotus and Societies: Sta. 80-57 Raiatea, Uturoa, off northern end Taoru I., branching coral, depth 2-3 ft., Apr. 29, 1957, Bredin Exped., 1 female; Sta. 90a-57 Huahine, off Point Teffaa, collected from dead coral, May 2, 1957, Bredin Exped., 2 males, 1 female, 3 ovig. females; Sta. 103-57, W. of Waroa Pass, Moorea, reef, May 7, 1957, Bredin Exped., 1 female.

MEASUREMENTS.—Males, 3-5 mm.; females, 4 mm.; ovig. females, 4-5 mm.

REMARKS.—Forest and Guinot (1961) pointed out that *Thalamita pilumnoides* var. *gatavakensis* Nobili differed from Borradaile's species in a number of particulars and left open the question as to whether it really belonged to another species. Two males in the present collection bear pleopods, and their marked difference from those

figured by Forest and Guinot indicates clearly that they were dealing with a different species. Independently Crosnier (1962) came to the same conclusion after reference to Borradaile's type and has re-described the present species.

Apart from the pleopods, the following obvious features separate the present specimens from *T. gatavakensis*: Upper surface of cheliped covered with sharp tubercles instead of small granules; three spines on inner side of upper surface of the hand of the cheliped, instead of two; and relatively shorter basal antennal joint with about four as against six granules.

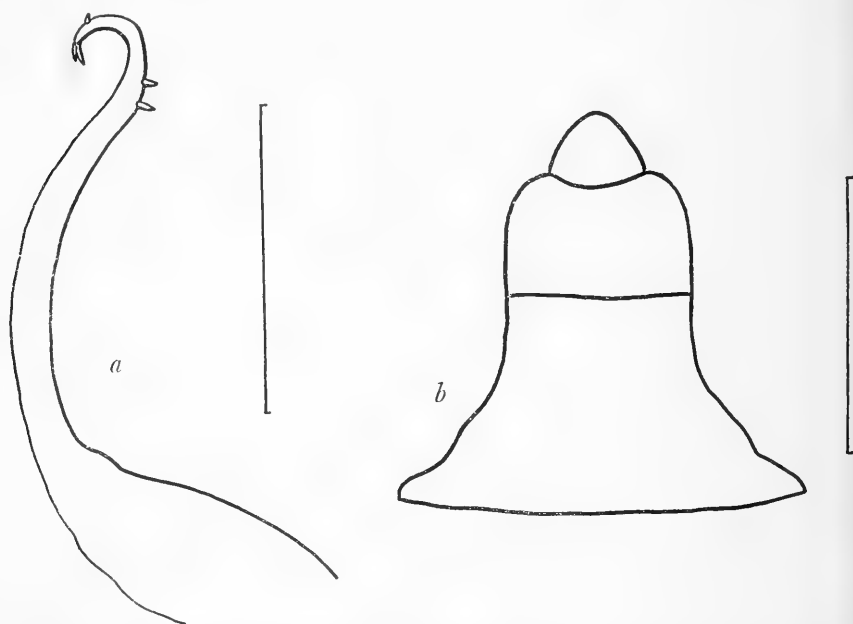


FIGURE 32.—*Thalamita pilumnoides* Borradaile, male, Tuamotus and Societies, Sta. 90a-57, Bredin: *a*, pleopod; *b*, abdomen. (Scales=*a*, 0.5 mm.; *b*, 1 mm.)

The male abdomen (fig. 32*b*) of the present specimen has the penultimate segment much broader than long, and the sides are less sinuous than in Crosnier's figure. The ultimate segment is broader than long in the present specimen, against as long as broad in Crosnier's.

The male pleopod is smoothly curved, with two conspicuous bristles on the outer surface some distance behind the tip. In addition, near the tip there is a small spinule, and on the tip there are two bristles. These additional structures are absent from Crosnier's figure (1962, fig. 256).

The male (5 mm.) from the Marianas has three anterolateral teeth instead of the usual four on each side.

DISTRIBUTION.—Madagascar, Maldive-Laccadive Archipelago, and Marianas.

***Thalamita poissonii* (Audouin and Savigny)**

Portunus poissonii Savigny 1817, pl. 4 (figs. 3 [1-2], 5 [1-2]).—Audouin, 1825, p. 84 [fide Stephensen, 1945, and Crosnier, 1962].

Thalamita poissonii (Audouin and Savigny).—de Man, 1880, p. 181.—Alcock, 1899, p. 81.—Borradaile, 1903, p. 201.—Nobili, 1906b, p. 206.—Rathbun, 1911, p. 208.—Klunzinger, 1913, p. 263, pl. 4 (figs. 12a-b).—Balss, 1924, p. 4.

Thalamita poissoni (Audouin and Savigny).—Crosnier, 1962, pp. 116-117, figs. 183, 188, 192, pl. 10 (fig. 1).

Not *Thalamita poissonii* Sakai, 1939, pp. 423-424, text-fig. 17, pl. 85 (fig. 2) (= *T. pseudopoissoni*, new species).

MATERIAL.—East Africa: Ras Banas, Red Sea, 1950, Sozon Vatikiotis, 2 males (36 mm., 45 mm.).

Marshall: S-46-44, dredged 180-200 ft., Bikini Lagoon, Mar. 29, 1946, L. P. Schultz, 2 females (8 mm., 19 mm.).

REMARKS.—See under *T. pseudopoissoni*.

DISTRIBUTION.—Madagascar, Red Sea and Suez, Laccadive Is., and Ceylon.

***Thalamita prymna* (Herbst)**

Cancer prymna Herbst, 1803, pp. 41-42, pl. 57 (fig. 2).

Thalamita prymna (Herbst).—H. Milne Edwards, 1834, p. 461.—Alcock, 1899, pp. 78-79.—Sakai, 1939, pp. 413, 416, pl. 51 (fig. 1).—Stephenson and Hudson, 1957, pp. 346-349, figs. 2R, 3R, pls. 4 (fig. 3), 8L, 9E.—Sankarankutty, 1961a, p. 107.—Crosnier, 1962, pp. 136-138, figs. 234-236.—Guinot, 1962, p. 3.—Miyake, Sakai, and Nishikawa, 1962, p. 128 (record only).

MATERIAL.—Malay Peninsula: Koh Pipedon, Siam, Mar. 10, 1925, H. M. Smith, 1 male; Kok Gao, Siam, in coral, shoal water, Sept. 24, 1928, H. M. Smith, 1 juv.

Philippines: Near Sta. 5184, between Panay and Negros, surface, Mar. 30, 1908, *Alb.*, 2 males, 1 female; Little Santa Cruz I., Zamboanga, Mindanao, soft coral, marginal reefs, May 26, 1908, *Alb.*, 1 female; Point Jarnelo, Luzon, 150 ft. seine, July 13, 1908, *Alb.*, 1 male, 2 females; Sablayan, Mindanao, shore work collection, tide pool, Dec. 13, 1908, *Alb.*, 1 male, 1 female, 1 ovig. female; Batan I., tide pool, June 5, 1909, *Alb.*, 2 males, 1 female; Canino I., near Daet, June 15, 1909, *Alb.*, 3 males, 1 female, 1 ovig. female; Batan I., July 22, 1909, *Alb.*, 1 male, 1 ovig. female; Pilas I., tide pool, Sept. 12, 1909, *Alb.*, 1 male.

Australia: Arnhem Land Expedition, M48-21, reef at Yirrkala, NW. of Cape Arnhem, Aug. 12, 1948, R. R. Miller, 1 ovig. female.

Melanesia: Vila Efate, New Hebrides, Mar. 27, 1929, Herre collection, 1 male; Waigin, June 6, 1929, Herre collection, 1 female; Can "D," presumably New Guinea, received December 1944, Meyer, 1 ovig. female; as above, Can "K," 1 male.

Palau Is.: Palau I., Sta. 125-1187, about $1\frac{3}{4}$ mi. NE. of Ngabadongu, $7^{\circ}17'36''$ N., $134^{\circ}21'42''$ E., 17 fm., Aug. 24, 1955, GVF, 1 female.

Marianas: Tumon Bay, Guam, Sta. 80/x-30, N.M.R.V. No. 2. June 27, 1945, 1 female; Agfayan Bay, Guam, 145/RHB-150, July 7, 1945, R. H. Baker, 1 male, 1 female; Tumon Bay, Guam, Sta. 147-RHB-153, July 10, 1945, R. H. Baker, 1 male; Tumon Bay, Guam, 174/RHB/153, July 10, 1945, R. H. Baker, 1 male; Guam, December 1945, D. G. Frey, 1 male; Oca Point, Guam, January 1946, D. G. Frey, 1 male.

Japan: Akune, *Alb.*, 1 male, 1 female; Tanego Shima, 1906, *Alb.*, 2 males, 4 females; Okinawa, 1906, *Alb.*, 2 males.

Samoa: No. 14, Apia, outer reef, 1902; *Alb.*, 1 male; Apia, at mouth of river, June 1, 1902, *Alb.*, 1 female; Apia, outer reef, June 27, 1902, *Alb.*, 5 males, 2 females, 2 ovig. females; Apia, outer coral reef at low tide, July 1, 1902, *Alb.*, 1 ovig. female; Apia, outer reef, July 1902, *Alb.*, 2 males, 1 female, 1 ovig. female; Pago Pago, no. 10, August 1902, *Alb.*, 1 male, 1 female.

MEASUREMENTS.—Males, 14-62 mm.; females, 19-51 mm.; ovig. females, 36-54 mm.; juv., 19 mm.

REMARKS.—In unworn specimens, the basal antennal joint bears about five sharp teeth or spines, but with progressive wear these appear to be reduced first to two teeth and eventually to none. The 2-toothed forms key out with Stephenson and Hudson (1957, p. 316, couplet 8) to *T. tenuipes* Borradaile, 1902, which is possibly a synonym. Forms without teeth may key out as *T. picta*, but in this case the basal antennal joint is never acute as in *T. picta* and rarely completely smooth.

The nonovigerous female (42 mm. from Apia, Samoa, outer reef, July 1902) has only four anterolateral teeth on the right side, the second and third of those normally present being fused.

DISTRIBUTION.—Delagoa and Red Sea to Marshalls, including Japan and Australia.

Thalamita pseudopoissoni, new species

FIGURE 33; PLATE 8B

Thalamita poissonii Sakai, 1939, pp. 423-424, fig. 17, pl. 85 (fig. 2).
not *Portunus poissonii* Savigny, 1817, pl. 4 (figs. 3 [1-2], 5 [1-2]).

Audouin, 1825, p. 84 [fide Stephensen, 1945].

Not *Thalamita poissoni* Stephensen, 1945, pp. 131-136, figs. 32A-H.

MATERIAL.—Philippines: Sta. 5159, Tinakta I., Sulu Archipelago, Tawitawi Group, $5^{\circ}11'50''$ N., $119^{\circ}54'$ E., Feb. 21, 1908, *Alb.*, 1 male (8 mm.).

Palau Is.: Sta. 125-1187, about $1\frac{3}{4}$ mi. NE. of Ngabadongu, $7^{\circ}17'36''$ N., $134^{\circ}21'$ E., 17 fm., Aug. 24, 1955, GVF, 1 male (8 mm.—

holotype—cat. no. 112-233), 2 ovig. females (6 mm., 7 mm.), 1 juv. (5 mm.).

Uncertain locality: Bearing two contradictory labels as follows: "Nagasaki" and "Sta. 5254, Gulf of Davao, Linao Point, 7°05'42"N., 125°39'42"E., 21 fm., sand, coral, May 18, 1908, *Alb.*," 1 male (10 mm.), 1 female (18 mm.). The male, which is the figured specimen, would have been selected as a holotype except for locality uncertainty.

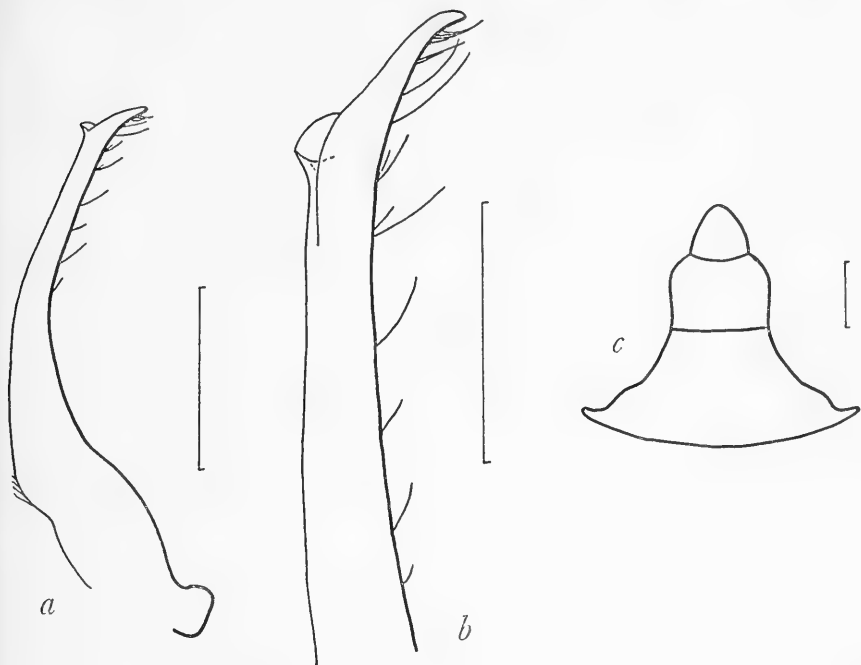


FIGURE 33.—*Thalamita pseudopoissoni*, new species, male paratype, Philippines, Sta. 5254, *Alb.*: *a*, pleopod; *b*, pleopod tip, upper surface; *c*, abdomen. (Scales=*a*, *c*, 1 mm.; *b*, 0.5 mm.)

DESCRIPTION.—Front: Bilobed, median notch varying from small, but distinct (18 mm. female; 7, 6 mm. ovig. females) to barely detectable (10 mm. male, 6 mm. juv.). Near lateral margins each lobe slightly concave, then terminating abruptly. Inner orbital lobes short and barely arched.

Anterolateral teeth: Five. First stoutest, fourth distinctly the smallest, and fifth sharpest and more protruding.

Carapace: Central area typically smooth and shining, lateral and frontal areas pilose. All normal carapace ridges present excepting anterior mesobranchials; no central interruption in mesogastric; an indistinct interruption in cardiac. In 8 mm. male, posterior mesobranchials not visible.

Basal antennal joint: Much shorter than orbit, bearing short inconspicuous crest composed of fused granules.

Chelipeds: Typically equal in females and with right stouter than left in males. Anterior border of arm bearing two spines and tubercle, or three spines. Wrist with usual spines, that on inner margin being unusually long, about two-fifths length of palm.

Hands coarsely granular on upper surface, under surface with squamiform markings (sometimes faint). Upper surface with indistinct inner and outer carinae, each bearing a spine somewhat distal to center and terminal tubercle. Outer surface with indistinct upper and distinct central and lower carinae, uppermost being the most granular. Fingers short, stout.

Fifth leg: Merus short (length about twice breadth). Propodus without posterior spines.

Male first pleopod: Short, stout, tip flared. No subterminal armature on inner side (paratype) or only single sharp bristle showing from under row (holotype). Outer subterminal armature an elongate sparse row of long, thin, forwardly directed bristles concentrated just behind tip. Under surface with transverse row of two to four short sharp bristles just behind membrane, and general but sparse distribution of long forwardly directed bristles continuous with those of outer side.

REMARKS.—Differs from *T. poissonii* markedly in the form of the male pleopods. In *T. poissonii* the tip is recurved, and the outer subterminal armature consists of long stout spines almost at right angles to the appendage.

The differences in the general facies are: Chelipeds are more granular and spinous with clearly recognizable carinae on outer surface of hand; frontal lobes have characteristic sinuous outlines; and propodus of the fifth leg is without spines.

The male pleopod greatly resembles that of *T. sexlobata*, but this species differs obviously in its 4-lobed front.

DISTRIBUTION.—Previously Japan.

Thalamita quadrilobata Miers

Thalamita quadrilobata Miers, 1884, pp. 539–540, pl. 48 (figs. B, b). Alcock, 1899, pp. 84–85.—Stephenson and Hudson, 1957, pp. 349–350, figs. 2G, 3G, pls. 4 (fig. 4), 8M, 9F.

MATERIAL.—Philippines: Nearougas I., shore, coral head, Feb. 10, 1908, *Abb.*, 1 female.

Melanesia: An-ki, Malaita, Solomon Is., Apr. 23, 1929, Herre collection, 1 ovig. female.

Palau Is.: Palau Is., Oct. 13, 1933, Herre collection, 1 ovig. female.

Tuamotus and Societies: Stas. 56-57, 57-57, Bora Bora, dredged, Apr. 25, 1957, Bredin Exped., 1 female.

MEASUREMENTS.—Females, 27-33 mm.; ovig. females, both 20 mm.

DISTRIBUTION.—Although widespread (Seychelles, Andamans, Gilberts, and Australia), apparently not common.

Thalamita sexlobata Miers

Thalamita sexlobata Miers, 1886, pp. 196-197, pl. 16, figs. 2a, b, c.—Henderson, 1893, pp. 373-374.—Alcock, 1899, pp. 87-88.—Stephenson, 1945, pp. 136-137, figs. 32C, D.—Stephenson and Hudson, 1957, pp. 350-352, figs. 2B, 3B, pls. 5 (fig. 1), 8N, 10K.—Crosnier, 1962, pp. 117-118, figs. 195-198.

Thalamita sexlobata var. *plicatirfrons* de Man, 1902, pp. 651-653.

MATERIAL.—Philippines: Sta. 5159, Tinakta I., Sulu Archipelago, Tawitawi Group, 5°11'50"N., 119°54'E., Feb. 21, 1908, *Alb.*, 1 female; Sta. 5595, Zamboanga Light, 6°54'00"N., 122°04'30"E., 9 fm., Oct. 7, 1909, *Alb.*, 1 female.

MEASUREMENTS.—Females 6, 12 mm.

DISTRIBUTION.—Madagascar, Persian Gulf to Tongataba, including Australia.

Thalamita sima H. Milne Edwards

Thalamita sima H. Milne Edwards, 1834, p. 460.—Alcock, 1899, pp. 81-82.—Sakai, 1939, pp. 414, 423, figs. 16a-c, pl. 51 (fig. 3).—Stephenson, 1945, pp. 126-128, figs. 27A-G.—Edmondson, 1954, p. 258, figs. 32e-h.—Stephenson and Hudson, 1957, pp. 352-354, figs. 2C, 3C, pls. 5 (fig. 2), 8O, 9G.—Crosnier, 1962, p. 111, fig. 181.

MATERIAL.—Malay Peninsula: Chumporn, Siam, Sept. 25, 1923, 1 male; Gulf of Siam, Apr. 30, 1934, H. M. Smith, 1 male, 2 females.

Philippines: Subig Bay, China Sea off southern Luzon, shore seine, sand, Jan. 7, 1908, *Alb.*, 1 male; Tataan, Simaluc, shore, Feb. 19, 1908, *Alb.*, 1 juv; Sta. 5158, Tinakta I., Sulu Archipelago, Tawitawi Group, 5°12'N., 119°54'30"E., 12 fm., Feb. 21, 1908, *Alb.*, 1 male; Iloilo, Apr. 20, 1929, Kellers, 1 male, 2 females.

MEASUREMENTS.—Males, 8-39 mm.; females, 12-13 mm.; juv., 9 mm.

DISTRIBUTION.—Madagascar, Mozambique to Red Sea, eastward to Hawaii, including Japan and Australia.

Miers' (1876) record of this species from New Zealand has been cited by later workers including Stephenson and Hudson (1957) and Stephenson (1961b). Hutton (1882) has shown this record is highly questionable.

Thalamita spinifera Borradaile

FIGURE 34

Thalamita exetastica var. *B. spinifera* Borradaile, 1902, p. 203.

Thalamita spinifera Borradaile.—Rathbun, 1906, pp. 874-875.—Edmondson,

1951, p. 221; 1954, pp. 269-270, figs. 41a-d, 42a.—Crosnier, 1962, pp. 125-127, figs. 210-211, 214-215, pl. 11 (fig. 1).

MATERIAL.—Philippines: Sta. 5158, Tinakta I., Sulu Archipelago, Tawitawi Group, $5^{\circ}12'N.$, $119^{\circ}54'30''E.$, 12 fm., Feb. 21, 1908, *Alb.*, 1 ovig. female; Sta. 5159, Tinakta I., Sulu Archipelago, Tawitawi Group, $5^{\circ}11'50''N.$, $119^{\circ}54'E.$, Feb. 21, 1908, *Alb.*, 1 female; Sta. 5218, Anima Solo I., between Burias and Luzon, 20 fm., Apr. 22, 1908, *Alb.*, 1 female; Sta. 5253, Linao Point, Gulf of Davao, $7^{\circ}04'48''N.$, $125^{\circ}39'38''E.$, 28 fm., coral, May 18, 1908, *Alb.*, 1 male,

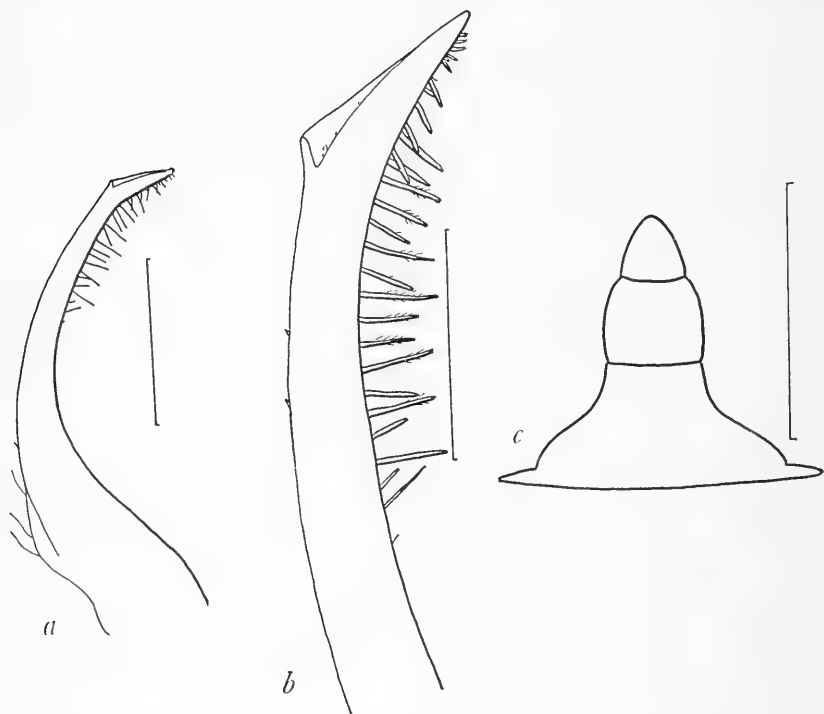


FIGURE 34.—*Thalamita spinifera* Borradaile, male, Philippines, Sta. 5253, *Alb.*: a, pleopod; b, pleopod tip, upper surface; c, abdomen. (Scales = a, 1 mm.; b, 0.5 mm.; c, 5 mm.)

1 female, 4 ovig. females; Sta. 5254, Gulf of Davao, Linao Point, $7^{\circ}05'42''N.$, $125^{\circ}39'42''E.$, 21 fm., sand, coral, May 18, 1908, *Alb.*, 1 fragmented female; Sta. 5401, Tanguingui I., North of Cebu, $11^{\circ}24'45''N.$, $124^{\circ}06'E.$, 30 fm., Mar. 16, 1909, *Alb.*, 1 female.

MEASUREMENTS.—Male, 14 mm.; females, 11-14 mm.; ovig. females, 11-14 mm.

REMARKS.—The male pleopod which has been figured by Edmondson (1954, figs. 41c,d) is here refigured together with the male abdomen (figs. 34a-c).

The pleopod is short, stout, slightly curved, and with flared truncated tip. Subterminal armature on outer side consisting of single well-spaced row of stout bipinnate bristles, about 30 in number and decreasing in size distally. Inner surface with only a few microscopic spinules.

DISTRIBUTION.—Madagascar, Maldivé Archipelago, and Hawaii.

Thalamita spinimana Dana

Thalamita spinimana Dana, 1852a, p. 283, pl. 17 (fig. 8); 1852b, p. 85.—Sakai, 1936, p. 162, pl. 12 (fig. 1).—Shen, 1937, p. 131, fig. 17.—Stephenson and Hudson, 1957, pp. 354–355, figs. 20, 30, pls. 5 (fig. 3), 8P, 9H.

MATERIAL.—Malay Peninsula: Sri Raja, Siam, Feb. 5, 1927, 1 male.

Philippines: Reefs opposite Cebu, Apr. 5, 1908, *Alb.*, 1 male; Reefs off Cebu, Apr. 7, 1908, *Alb.*, 4 males, 1 female; Culion, May 1931, Herre collection, 1 male.

Australia: M48-3, East Poisit Reef, Arnhem Land, ca. 6 mi. NNW. of Darwin, Mar. 26, 1948, coll. R. R. Miller, 1 male.

Palau Is.: Palau Is., Oct. 14, 1933, Herre collection, 1 female; Sta. 60-1011, W. of Ebadul's Pier, north end Koror I., sand and eel grass flats, Aug. 5, 1955, GVF, 1 male.

Marianas: Y-193 B.C., Balabat, Yap I., tidal flats from under rocks, received 1952, coll. Hiatt, 1 male.

MEASUREMENTS.—Males, 17–67 mm.; females, 26, 34 mm.

REMARKS.—The number of spines on the inner border of upper surface of hand is not constant at four, but varies from three (small specimens) to five (large specimens). Sometimes there are four on one hand, but either three or five on the other hand of the same specimen.

DISTRIBUTION.—Viti (Milne Edwards, 1861), Malaya to Palao (Shen, 1937), Australia (Stephenson and Hudson, 1957).

Thalamita spinimera, new species

FIGURE 35; PLATE 9

MATERIAL.—Marianas: Near Agaña, Guam, on alcyonarian, Nov. 12, 1953, Bronson, 1 female (9 mm.—holotype—cat. no. 112/418).

DESCRIPTION.—Front: Protruding, 6-lobed. Medians long, with rounded tips, protruding farthest and separated by deep broad notches from submedians. Submedians broad with slight outward inclination and separated by narrow notches from laterals. Inner orbital lobes erect and with spinous tips. Suborbital lobes also with stout spinous tips.

Anterolateral teeth: Five, all sharp. First three subequal, fourth the smallest, fifth much the longest.

Carapace: Broad, breadth about 1.6 times length with very divergent anterolateral borders and very convergent posterolateral borders. Apart from ridges, covered with long sparsely arranged hairs, beneath which, in frontal region, beaded granules are concealed. Frontal ridges small and rounded; protogastrics short and inconspicuous; mesogastrics well developed, separated in midline, and each concave

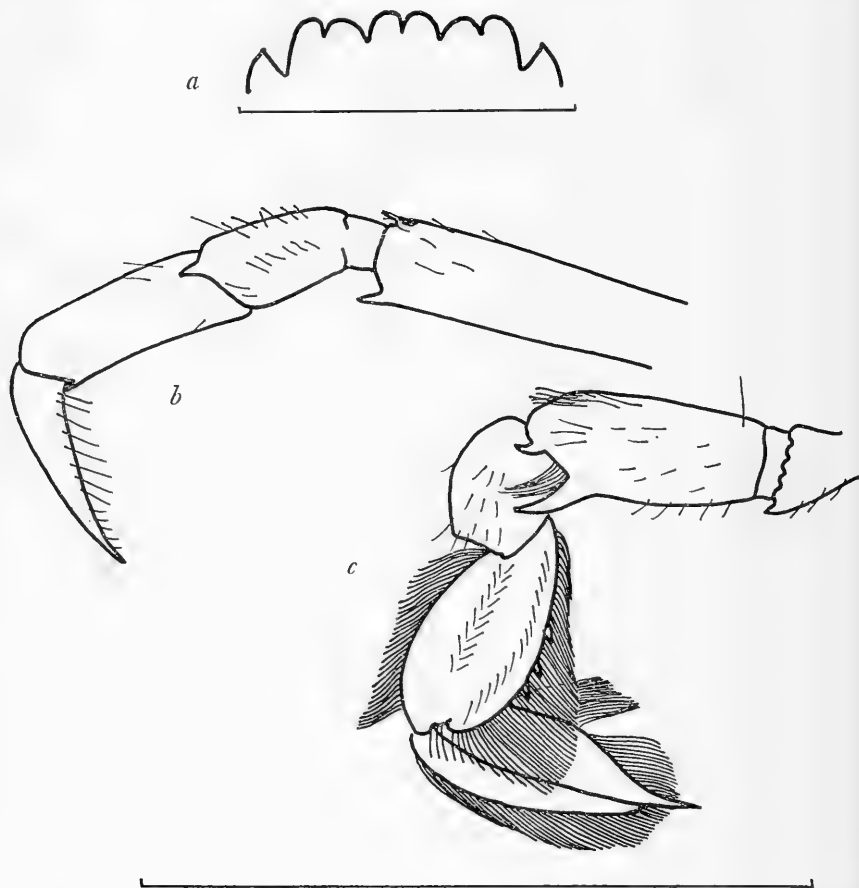


FIGURE 35.—*Thalamita spinimera*, new species, holotype: *a*, front; *b*, left third walking leg, perspective view; *c*, left fifth leg. (Scales=*a*, *b*, *c*, 5 mm.)

anteriorly. Epibranchials well developed and interrupted at cervical grooves but not medially. Two cardials, broadly separated in midline. Two short but conspicuous mesobranchials.

Basal antennal joint: Obliquely inclined, shorter than width of orbit (ca. 0.8 times), and with short but conspicuous crest bearing three spines.

Chelipeds: Equally sized, very spinous, and hirsute. Arm bearing five spines on anterior border, none on posterior border, and one on ventral surface just behind wrist articulation. Wrist with inner spine very well developed, with three usual outer spines and with additional spine on upper surface. Inner and outer carinae of wrist well developed. Hand with upper surface bearing four particularly well-developed spines (apart from one at wrist articulation), but corresponding inner and outer carinae not recognizable. Outer surface of hand peculiarly folded just behind articulation of movable finger, and bearing on lower surface a very conspicuous carina composed of large regularly arranged granules, and terminating just before beginning of immovable finger in a forwardly directed spine. Lower border of outer surface composed of a carina of regularly arranged granules, continuing along immovable finger. Inner surface of hand with coarsely granular subcentral carina. Under surface of hand granular and hairy. Fingers short, sharp, and strongly carinated.

Walking legs: Unique in possessing a spine on ventrodiscal border of merus of each leg. Dorsodiscal border of carpus of first and second legs bearing similar, but less obvious spine. Dactyls of all three legs with sharp spinous tips.

Fifth leg: Merus twice as long as broad and with spine on distal border particularly well developed, and another smaller spine on posterodistal angle. Dactyl sharp tipped.

DISCUSSION.—This specimen is either a most unusual *Thalamita* or alternatively should be referred to a new genus. It resembles the species of the genus *Thalamonyx* A. Milne Edwards, 1873, in possessing inclined anterolateral borders and a protruding front. Stephenson and Hudson (1957, pp. 326–327) have already shown that inclined anterolateral borders are possessed by some species of *Thalamita* and have suggested that *Thalamonyx* should disappear into the synonymy of *Thalamita* (see also Stephenson and Campbell, 1960, p. 107).

It is uniquely spinose on the merus of all walking legs (hence the specific name), on the carpus of the first two legs, on the under surface of the arm of the chelipeds, and on the outer surface of the hand of the chelipeds. In addition the dactyls of the walking and swimming legs are more spinous than usual, and the spine on the posterior border of the merus of the fifth leg is particularly well developed. Presumably these are adaptations for its ectocommensal mode of life and are in the nature of special additions to the basic body plan of a typical *Thalamita*, rather than marked diversions from it. Apart from the spinous dactyls of the fifth legs, none of these adaptations are comparable with those in the genus *Caphyra*, which has presumably evolved separately and farther from *Thalamita*-like ancestors.

The limits of the genus *Thalamita* are already indefinite, and, as Stephenson and Hudson (1957, pp. 361-2) have noted, there is no logical separation from *Charybdis*. The recent discovery of a new species of *Thalamita* with spooned tips on the hands of the chelipeds (*T. stephensoni* Crosnier—see later) complicates the generic picture because it exhibits one of the diagnostic features of the genus *Thalamitoidea*. Another feature, the very spinous upper surface of the hands of the chelipeds, is shown by the present species, although, in other respects (e.g., carapace width), they are not closely related.

Until more species are discovered on the various peripheries of the genus *Thalamita*, and the degrees of intergradation or segregation of such species with the remainder have been determined, it seems preferable to leave the genus with its present wide and indefinite boundaries.

Thalamita stephensoni Crosnier

Thalamita stephensoni Crosnier, 1962, pp. 140-142, figs. 241-248.

MATERIAL.—Melanesia: New Georgia, received Jan. 10, 1945, W. A. Bartos, 1 male—carapace only (7 mm.).

Samoa: Pago Pago, August 1902, *Alb.*, 1 ? male (10 mm.).

REMARKS.—Frontal lobes in the 7 mm. specimen are perfectly straight, and the external angles are sharp instead of rounded.

The male pleopod differs from that figured by Crosnier (figs. 243-245) in possessing only three spines on the outer side, and one instead of two just behind the tip on the inner side.

DISTRIBUTION.—Previously only Madagascar.

Thalamita stimpsoni A. Milne Edwards

FIGURE 36

Thalamita stimpsoni A. Milne Edwards, 1861, pp. 362, 367, pl. 35 (fig. 4).—Alcock, 1899, p. 79.—Sakai, 1939, pp. 413, 416-417.—Stephenson and Hudson, 1957, pp. 356-359, figs. 2M, 3M, pls. 6 (figs. 1-3), 8R, 9I.

MATERIAL.—Malay Peninsula: Koh Pipidon, Mar. 10, 1925, H. M. Smith, 2 males.

China: AT-51, Namru-2, Taipei, Formosa, 12 mi. S. of Tau Hsui, seashore, Lighthouse Beach, 1 male.

Philippines: Sta. 5144, Jolo Lighthouse, 6°05'50"N., 121°02'15"E., 19 fm., coarse sand, Feb. 15, 1908, *Alb.*, 1 male; Sta. 5145, Jolo Light, 6°04'30"N., 120°59'30"E., coarse sand, shells, 23 fm., Feb. 15, 1908, *Alb.*, 1 male, 2 females, 1 ovig. female; Sta. 5147, Sulade I., 5°41'40"N., 120°47'10"E., 21 fm., coarse sand, shells, Feb. 16, 1908, *Alb.*, 2 males; Sta. 5159, Tinakta I., Sulu Archipelago, Tawitawi, 5°11'50"N., 119°54'E., Feb. 21, 1908, *Alb.*, 2 males, 2 ovig. females, 1 *Sacculina* infected female, 2 juvs.; Sta. 5164, Observation

I., Sulu Archipelago, Tawitawi Group, 18 fm., green mud, Feb. 24, 1908, *Alb.*, 1 male; near Sta. 5184 between Panay and Negros, surface, Mar. 30, 1908, *Alb.*, 2 juvs.; reefs opposite Cebu, Apr. 7, 1908, *Alb.*, 1 male; Sablayan Bay, Mindoro, Dec. 12, 1908, *Alb.*,

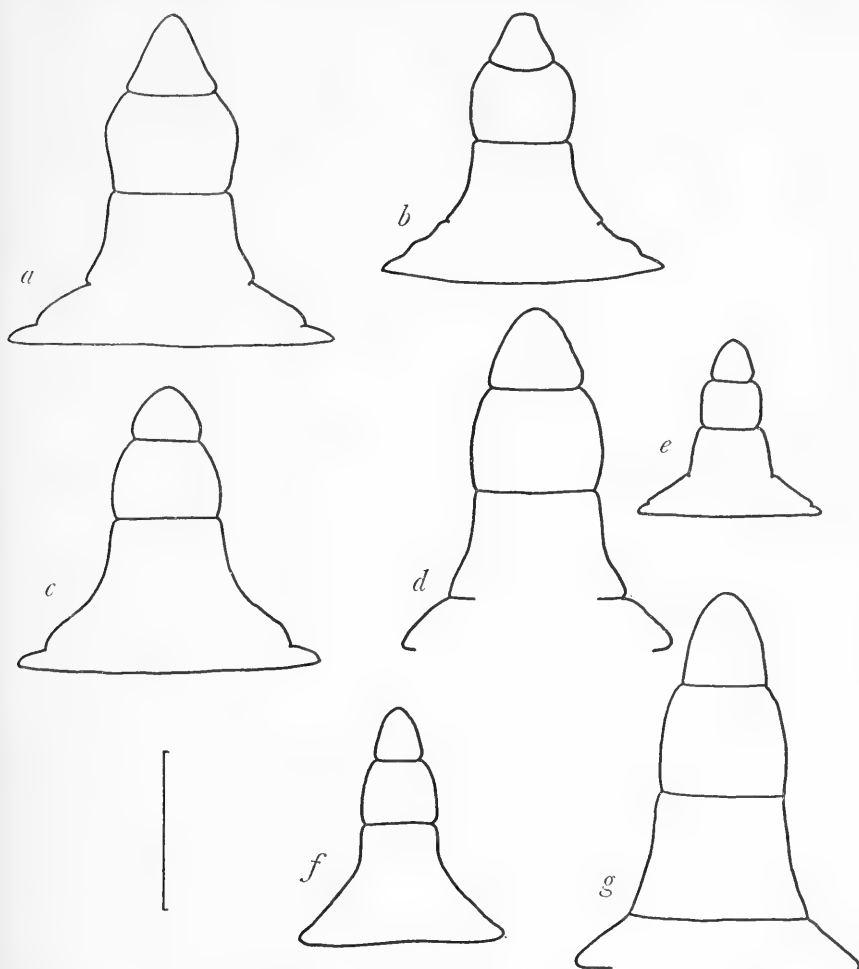


FIGURE 36.—*Thalamita stimpsoni* A. Milne Edwards, male abdomens: *a*, Philippines, Sta. 5147, *Alb.*, larger male; *b*, Philippines, Sta. 5144, *Alb.*; *c*, Philippines, Sta. 5159, *Alb.*; *d*, China, Taipei, AT-51; *e*, Philippines, Sta. 5164, *Alb.*; *f*, Philippines, Ulugan Bay, *Alb.*, 21 mm.; *g*, Philippines, reefs opposite Cebu, *Alb.* (Scale=5 mm.)

1 female; Ulugan Bay near mouth of Bahili River, seine, Dec. 28, 1908, *Alb.*, 2 males; Sta. 5561, Tutu Bay, Jolo, coral and sand, Sept. 19, 1909, *Alb.*, 1 male, 1 juv.

Marianas: Y-1289, Tomil Harbor, from under rocks, tidal flats, received 1952, Hiatt, 4 males, 2 females.

MEASUREMENTS.—Males, 8–35 mm.; females, 14–35 mm.; ovig. females, 19–24 mm.; *Sacculina* infected female, 26 mm.; juvs., 6–9 mm.

REMARKS.—Examination of numerous fresh specimens from Moreton Bay, Queensland, together with those in the present collection, has revealed some divergence from the description by Stephenson and Hudson (1957).

The first concerns the mesobranchial regions of the carapace, which sometimes bear a short, inconspicuous, but distinct ridge. It is not recognizable, presumably due to wear, in smoother hairless specimens and not always so in unworn specimens. When present it upsets the key (Stephenson and Hudson, 1957, p. 316, couplet 12), but this is not serious since the species is clearly distinguishable from *T. wakensis* and *T. picta* which lie on the alternative branch.

The second divergences concern male abdomens and first pleopods. In the present collection there are two groups of males, designated forms A and B respectively. Only the former was described and figured by Stephenson and Hudson.

Form A (figs. 36 *d, f, g*) comprises:

Malay Peninsula: Koh Pipedon, Pocket Bay, Benjal, Siam, Mar. 10, 1925, H. M. Smith, 1 male.

China: AT-51, Namru-2-Taipei, 12 mi. S. of Tau Hsui, seashore, Lighthouse Beach, 1957, R. E. Kuntz, 1 male.

Philippines: Reef opposite Cebu, Apr. 7, 1908, *Alb.*, 1 male; Ulugan Bay near mouth of Bahili River, seine, Dec. 28, 1908, *Alb.*, 1 male.

The outer surface of the pleopod bears many subterminal bristles and from none to five short conical spines, while the inner surface carries few sparsely arranged hairs. The sides of the penultimate segment of the male abdomen are almost straight.

Form B (figs. 36 *a-c, e*) comprises:

Philippines: Sta. 5144, Jolo Lighthouse, 6°05'50"N., 121°02'15"E., 19 fm., coarse sand, Feb. 15, 1908, *Alb.*, 1 male; Sta. 5147, Sulade I. 5°41'40"N., 120°47'10"E., 21 fm., coarse sand, shells, Feb. 16, 1908, *Alb.*, 1 male; Sta. 5159, Tinakta I., Sulu Archipelago, Tawitawi Group, 5°12'N., 119°54'30"E., 12 fm., Feb. 21, 1908, *Alb.*, 1 male; Sta. 5164, Observation I., Sulu Archipelago, Tawitawi Group, 18 fm., green mud, Feb. 24, 1908, *Alb.*, 1 male.

In form B the outer surface of the pleopod bears numerous subterminal robust spines, while the inner surface carries numerous spines or stout bristles, generally continuing some distance proximally. The sides of the penultimate segment of the male abdomen are markedly convex.

Young males of form B differ from the adults in that only few

subterminal spines are present on both sides of the pleopod, and the convexity of the sides of the penultimate abdominal segment is less marked.

A 34 mm. specimen from "Sta. AT-51; 1957; R. E. Kuntz," is somewhat intermediate between the two forms. There are no spines on the inner surface of the pleopod, but the penultimate abdominal segment is markedly convex.

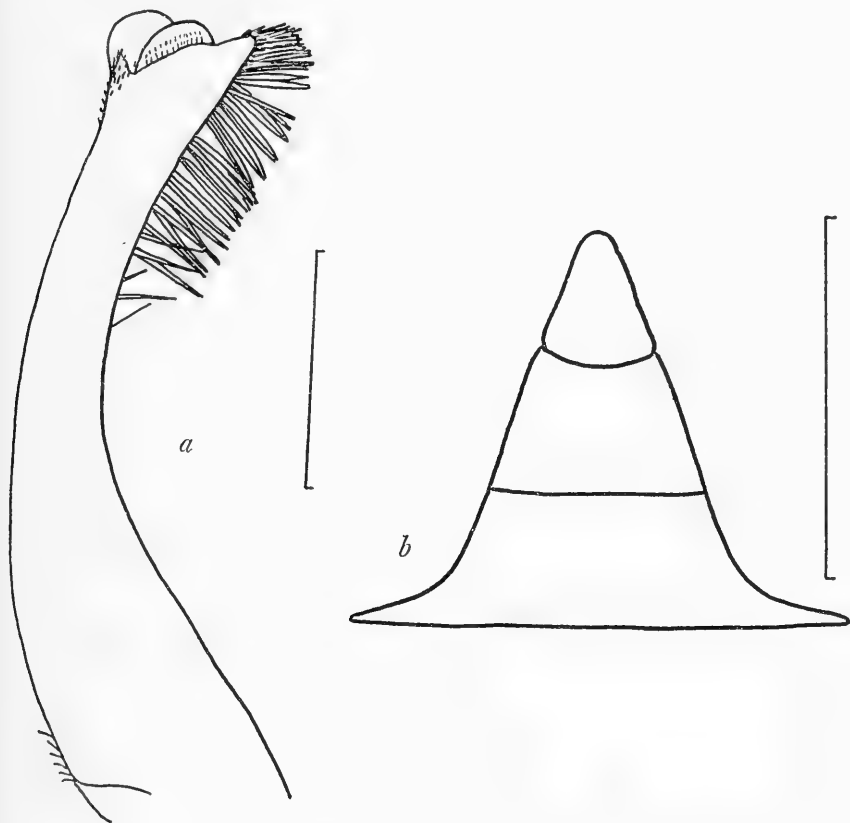


FIGURE 37.—*Thalamitoides quadridens* A. Milne Edwards, male, Marshalls, Latobak I., Sta. 207, Bayer and Zimmerman: *a*, pleopod; *b*, abdomen. (Scales=*a*, 1 mm.; *b*, 5 mm.)

DISTRIBUTION.—India to Samoa, including Japan and Australia.

Genus *Thalamitoides* A. Milne Edwards, 1869

Thalamitoides quadridens A. Milne Edwards

FIGURE 37

Thalamitoides quadridens A. Milne Edwards, 1869, pp. 147-149, pl. 6, figs. 8-15.—de Man, 1887, p. 331.—Nobili, 1906a, p. 212.—Rathbun, 1907, p. 64 (record

only).—Edmondson, 1925, p. 40 (record only).—Gordon, 1934, p. 61.—Balss, 1938, p. 35.—Edmondson, 1954, pp. 270–271, figs. 23a–c, 24b.—Crosnier, 1962, pp. 144–145, figs. 249–251.

Thalamitoides alphonsei Ward, 1939, p. 3, figs. 3, 4.

MATERIAL.—Philippines: Sta. 5108, Corregidor Lt., 15°05'5"N., 120°14'45"E., China Seas, 13 fm., Jan. 15, 1908, *Alb.*, 1 male; Sta. 5109, Corregidor Lt., 14°03'45"N., 120°16'30"E., 10 fm., coral, Jan. 15, 1908, *Alb.*, 1 female.

Marshall: Sta. II, Bikini Lagoon, 15 fm., sandy bottom with *Halimeda*, one-fourth mi. S. of west end, Aug. 7, 1946, J. P. E. Morrison, 1 female; Sta. VI, Bikini I., outer reef, Aug. 8, 1947, F. M. Bayer, 1 male, 1 female; Latobak I., Rongerik, Sta. 207, outer reef, Aug. 18, 1947, F. M. Bayer and F. C. Zimmerman, 1 male; Latobak I., Rongerik, Sta. 262, Aug. 21, 1947, F. M. Bayer and F. C. Zimmerman, 1 male; E2–361, Arno Atoll, received 1952, Hiatt, 3 males, 1 female.

Samoa: Apia, Samoa, at mouth of river, June 1, 1902, *Alb.*, 1 ovig. female.

Hawaii: Sta. 40, Oahu I., C. H. Edmondson, 1 male.

MEASUREMENTS.—Males, 8–24 mm.; females, 19–25 mm.; ovig. female, 27 mm.

REMARKS.—The male pleopod which has been figured by Edmondson (1954, fig. 43b, c) is here refigured and described. Short, stout, gently curved, bearing distally on inner surface two rounded membranous lobes. Subterminal armature on outer side a regular double row of elongate, closely spaced bristles merging into a distal clump of small to large bristles. On inner surface, few short hairs, and a number of recurved spines lying between the membranes.

Crosnier (1962) in redescribing Milne Edwards' type also concludes that *T. alphonsei* Ward is a synonym.

DISTRIBUTION.—Red Sea, Madagascar, Amboina, Samoa, Johnston I., and Jaluit.

Thalamitoides tridens A. Milne Edwards

FIGURES 38

Thalamitoides tridens A. Milne Edwards, 1869, pp. 149–158, pl. 6 (figs. 1–7).—de Man, 1881, p. 99; 1889, pp. 423–424.—Ortmann, 1893, p. 86.—Nobili, 1901, p. 10.—Klunzinger, 1913, pp. 361–363.—Edmondson, 1925, p. 40 (under *T. quadridens*).—Crosnier, 1962, p. 143, fig. 250.

Hedrophthalmus thalamitoides Nauck, 1880, p. 59, pl. 1 (fig. 25) [fide Nobili, 1906a].

Thalamitoides tridens var. *spinigera* Nobili, 1905, p. 403; 1906a, p. 213.

Thalamita (*Thalamitoides*) *tridens* A. Milne Edwards.—Boone, 1934, pp. 79–81 pl. 36.

Thalamitoides tridens typica A. Milne Edwards.—Balss, 1938, p. 35.—Edmondson, 1954, p. 271.

Thalamitoides tridens spinigera Nobili.—Balss, 1924, p. 5; 1938, p. 35 (under *T. tridens typica*).

MATERIAL.—Philippines: Sta. 5159, Tinakta I., Sulu Archipelago, Tawitawi Group, 5°11'50"N., 119°54'E., Feb 21, 1908, *Alb.*, 1 female.

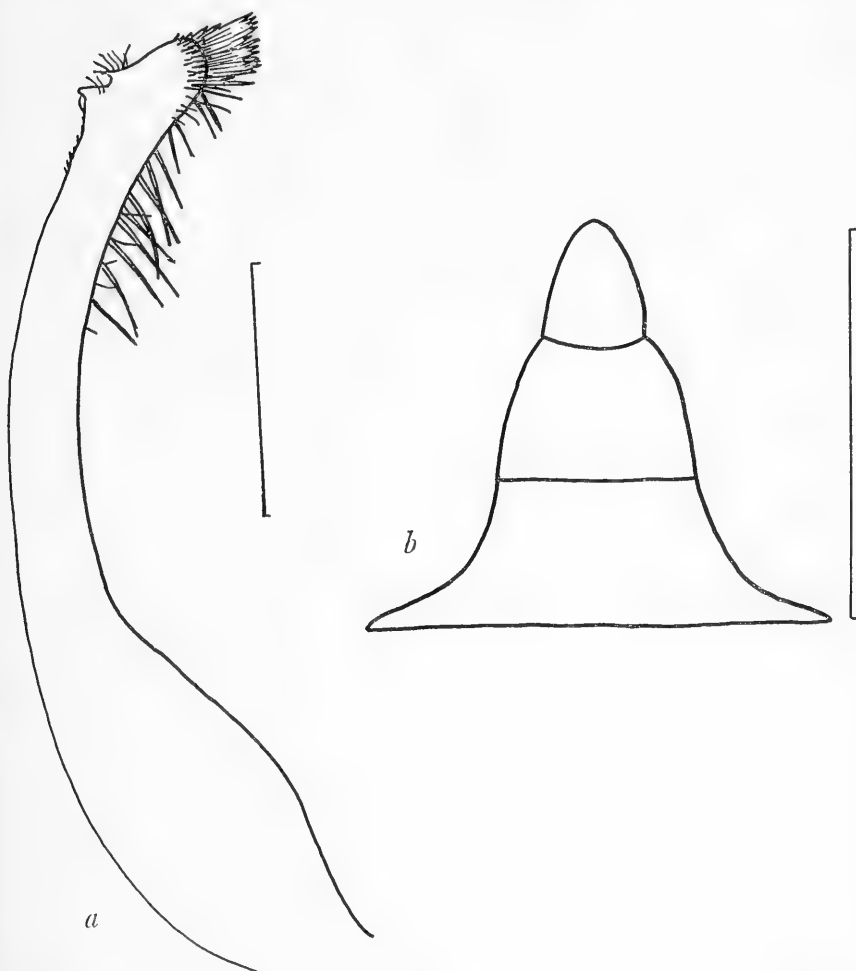


FIGURE 38.—*Thalamitoides tridens* A. Milne Edwards, largest male, Samoa, Apia, July 1902, *Alb.*: a, pleopod; b, abdomen. (Scales=*a*, 1 mm.; *b*, 5 mm.)

Marshalls: Rongelap Lagoon, 1 mi. W. of Rongelap I., 20 fm., June 21, 1946, Taylor, 1 female.

Samoa: Apia, at mouth of river, June 1902, *Alb.*, 4 males, 3 females; Apia, outer coral reef at low tide, July 1, 1902, *Alb.*, 2 females; Apia, coral reef, July 1902, *Alb.*, 3 males, 1 female; Pago Pago, August 1902, *Alb.*, 3 males, 2 females, 2 ovig. females.

Palau: Sta. 333, Kapingamarangi, July 20, 1954, C. Hand, 1 juv.

MEASUREMENTS.—Males, 14–24 mm.; females, 11–22 mm.; ovig. females, 14, 15 mm.; juv. 10 mm.

REMARKS.—The male pleopod, which shows resemblances to that of *T. quadridens*, does not appear to have been figured or described. It is short, stout, gently curved, with a swollen truncate tip. Subterminal armature on outer side consists of a scattered row of elongate bristles followed distally by a tightly packed clump of medium-sized and long bristles. Inner side bears distally four spinules followed by a patch of short curved bristles.

Past authors have disagreed on the status to be given to the Red Sea forms and to the remainder. In some cases (e.g., Edmondson, 1954), subspecific ranks are given with the present form, *Thalamitoides tridens typica*. The most recent author (Crosnier, 1962), while disregarding a varietal heading to the more widely spread forms, refers to those from the Red Sea as variety *spinigera*.

DISTRIBUTION.—Madagascar, Guam, Samoa, and Fiji.

Subfamily PODOPHTHALMINAE Borradaile, 1907

Genus *Podophthalmus* Lamarck, 1801

Podophthalmus vigil (Weber)

Portunus vigil Weber, 1795, p. 93 [fide Forest and Guinot, 1961, p. 36].

Podophthalmus vigil (Weber).—Boone, 1934, pp. 81–85, pls. 37, 38.—Shen, 1937, p. 137, fig. 20.—Leene, 1938, pp. 12–13.—Sakai, 1939, p. 427, pl. 48.—Stephensen, 1945, p. 137, figs. 32a, b.—Edmondson, 1954, pp. 271–272, figs. 43d,e, 44.—Stephenson and Campbell, 1960, pp. 115–116, figs. IL, 2O, pls. 5 (fig. 1), 5O.—Forest and Guinot, 1961, p. 36.—Crosnier, 1962, p. 146, pl. 13 (fig. 1).

Podophthalmus vigil (Fabricius).—Miyake, Sakai, and Nishikawa, 1962, p. 128 (record only).

MATERIAL.—Malay Peninsula: Chantabun River, at Lem Sing, Siam, May 7, 1927, H. M. Smith, 1 male; GVF, Sta. 55, Thailand, open ocean off Aangtong Village, southwest coast of Goh Samui I., 9°31'38"N., 99°51'35"E., Nov. 6, 1957, local fisherman, 1 male.

Philippines: China Sea, off southern Luzon, Subig, electric light, dip net, Jan. 6, 1908, *Alb.*, 2 males, 2 females.

Hawaii: Oahu, Sta. 6, dredge 13.5 m., July 1930, 1 female, 1 juv.

Tuamotus and Societies: Sta. 101 southeastern end of Opunohu Bay (= Papetoai Bay), Moorea I., wire crab trap left down overnight in 10–12 fm., May 6–7, 1957, Bredin Exped., 1 female.

MEASUREMENTS.—Males, 16–123 mm.; females, 19–91 mm.; juv., 10 mm.

DISTRIBUTION.—Red Sea and Madagascar to Hawaii, Samoa and Tahiti, including Japan and Australia.

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TABLE 1.—*Tabulation of Thalamita edwardsi-like characters (-) and T. admete-like characters (+) in 30 male specimens*

General characters				Pleopod characters			Specimen data	Summary
Cardiac ridge present	Post. mesobranch. ridge present	Well-carinated chelae	4th A.L. tooth just present	Uniform size large spines on outside	Fewer large size spines on inside	Inner spines extending short distance backward		
-	-	-	-	-	+	-	Nau Wan Formosa, Jan. 27, 1910 (see fig. 20 f)	General characters near <i>edwardsi</i> , pleopod characters midway
-	-	cheli-peds absent	-	-	+	+	Apia Samoa, June 1902 (see fig. 20e)	
-	-	+	-	-	+	-	Philippine Is., E. A. Mearns	
-	+	-	-	+	-	-	1945 Hawaiian Is.	General characters near <i>edwardsi</i> , pleopod characters midway
-	+	-	-	-	+	-	1945 Honolulu (see fig. 20a)	
-	+	cheli-peds absent	-	+	+	-	Mar. 13, 1942, Honolulu	
-	+	-	+	+	+	-	Apr. 6, 1942, Honolulu	near midway
-	-	-	+	+	+	+	Apr. 12, 1957, Tickatau Atoll, 13 mm.	
-	+	-	-	+	+	+	Apr. 12, 1957, Tickatau Atoll, 10 mm.	General characters midway, pleopod characters <i>admete</i>
-	+	-	-	+	+	+	Mar. 6, 1942, Honolulu	
-	+	-	-	+	+	+	Mar. 23, 1942, Honolulu, 28 mm.	
+	+	-	+	+	+	+	Mar. 23, 1942, Honolulu, 38 mm.	General characters near <i>admete</i> , pleopod characters <i>admete</i>
+	+	-	+	+	+	+	July 13, 1945, Oahu.	
+	+	-	+	+	+	+	1913, 17 mm.	near midway
-	+	+	-	+	-	-	Makiwa Reef, June 19, 1927	

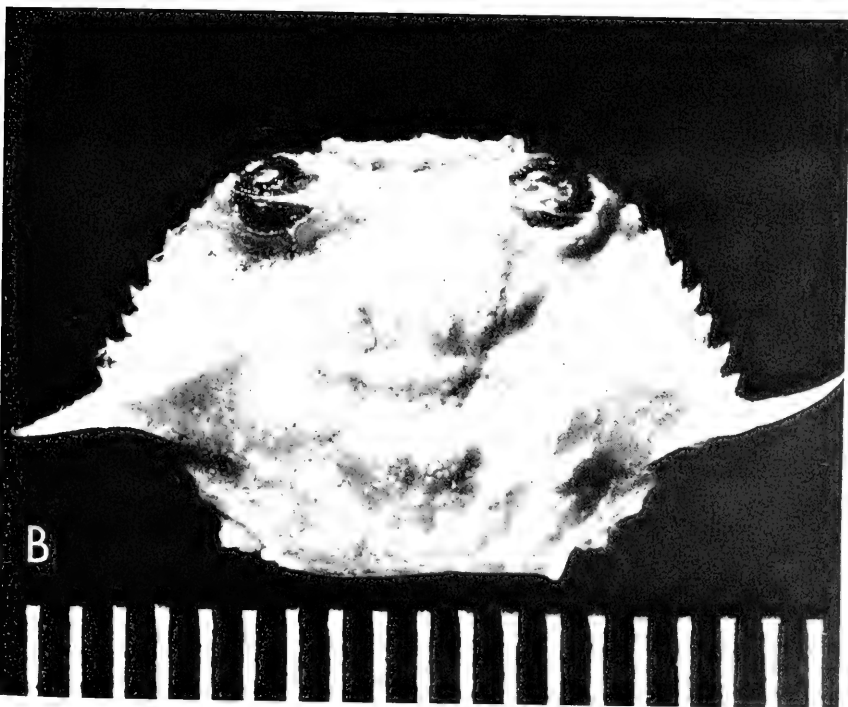
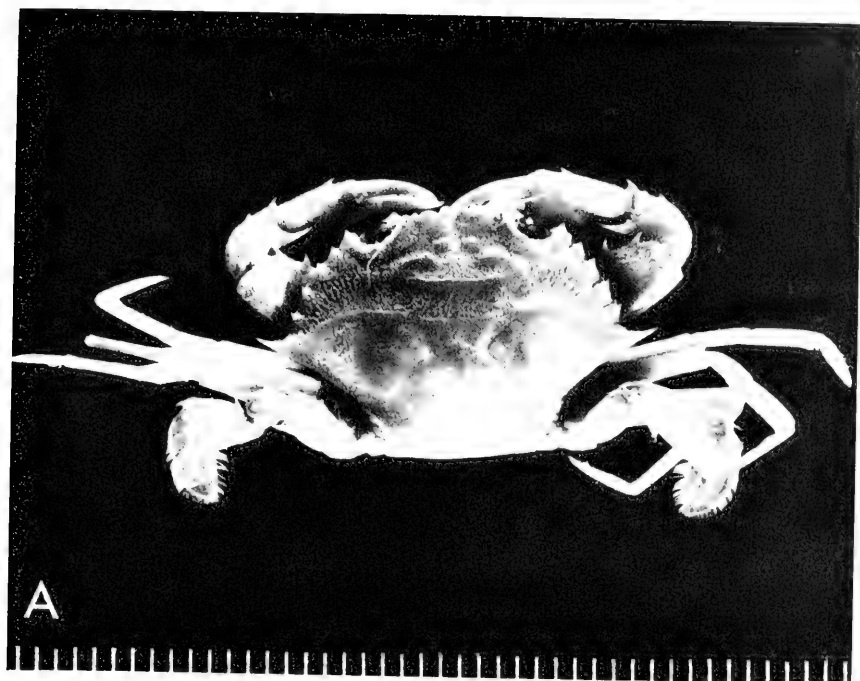
TABLE 1.—Continued.

General characters				Pleopod characters			Specimen data	Summary
Cardiac ridge present	Post. mesobranch. ridge present	Well-carinated chelae	4th A.L. tooth just present	Uniform size large spines on outside	Fewer large size spines on inside	Inner spines extending short distance backward		
+	+	+	+	+	—	—	Makasson I., 1909, <i>Alb</i> (see fig. 20 <i>h</i>)	General characters <i>admete</i> pleopod characters midway
+	+	+	+	+	—	—	Gt. Tobea I., Dec. 15, 1909, <i>Alb.</i> , 18 mm.	
+	+	+	+	—	+	—	Guam, 1945	
+	+	+	+	+	+	—	Samoa, June 27, 1902, 23 mm. (see fig. 20 <i>d</i>)	
+	+	+	+	+	—	—	Samoa, Aug. 1902, 17 mm. (see fig. 20 <i>g</i>)	
+	+	+	?	+	—	+	Gt. Tobea I., Dec. 15, 1909, <i>Alb.</i> , 31 mm.	
+	+	+	+	+	—	+	Gt. Tobea I., Dec. 15, 1909, <i>Alb.</i> , 27 mm.	
+	+	+	+	+	—	—	August 1948, 21 mm. (see fig. 20 <i>b</i>)	
+	+	+	+	+	+	+	Society Is., 1945	
+	+	+	+	+	+	+	Samoa, June 27, 1902, 21 mm. (see fig. 20 <i>c</i>)	
+	+	+	+	+	+	+	1913, 20 mm.	All characters <i>admete</i>
+	+	+	+	+	+	+	1913, 18 mm.	
+	+	+	+	+	+	+	1929, Fiji	
+	+	+	+	+	+	+	Tomil Hbr., 1952	
+	+	+	?	+	+	+	Bikini, 1947	

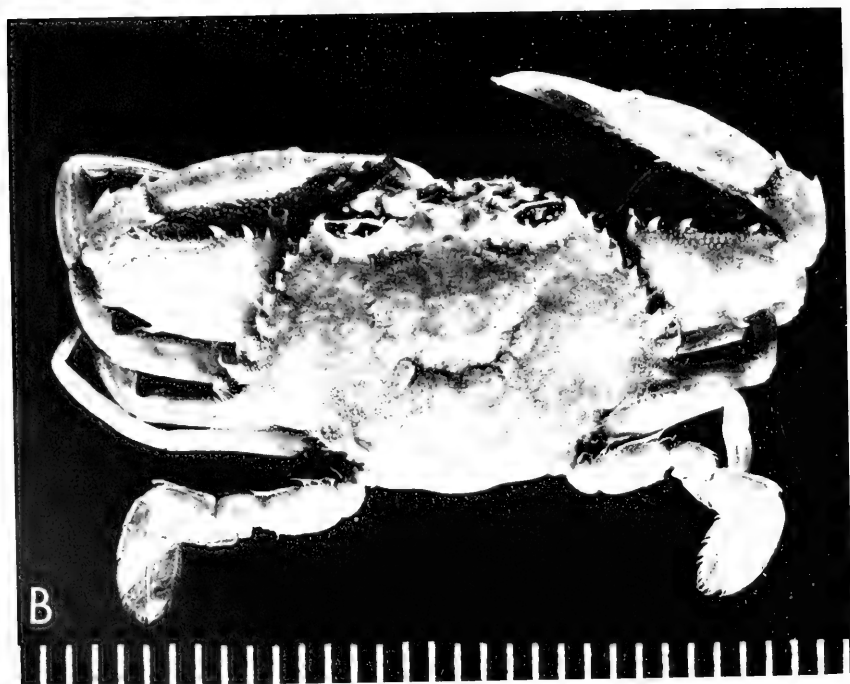
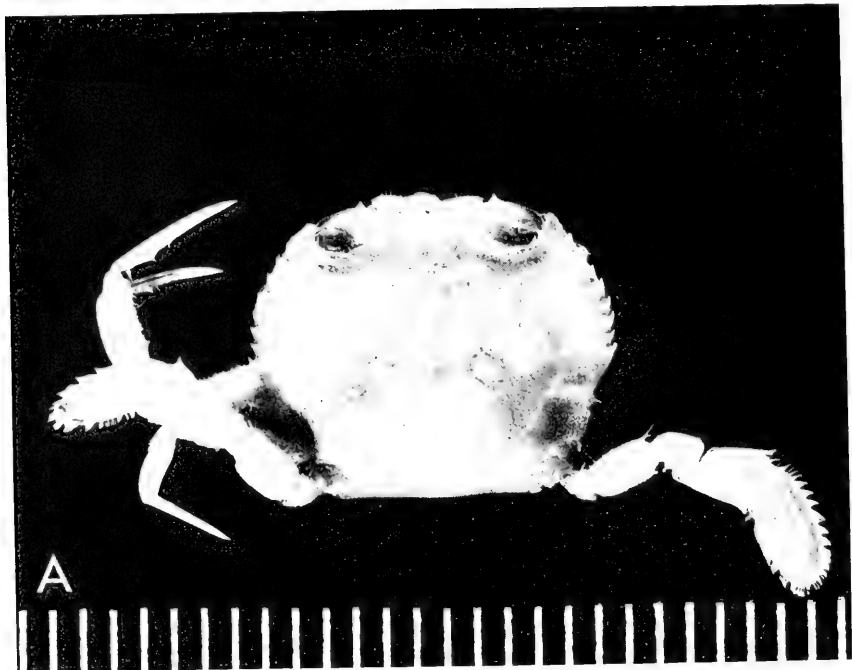
TABLE 2.—Variability in armature of male pleopods in *Thalamita dakini*

Locality	Inner terminal spinules	Outer bristles
Waikiki Marine Lab. (Mar. 28, 1942)	4	3
Locality as above (Apr. 24, 1942)	largest 3	3
	middle-sized 2	4
	smallest 1	2
Sta. 62-57, Bora Bora (9 mm.)	2	3
Howland I.	2	3
Society Is.	1	3
Sta. 62-57, Bora Bora (12 mm.)	0	3

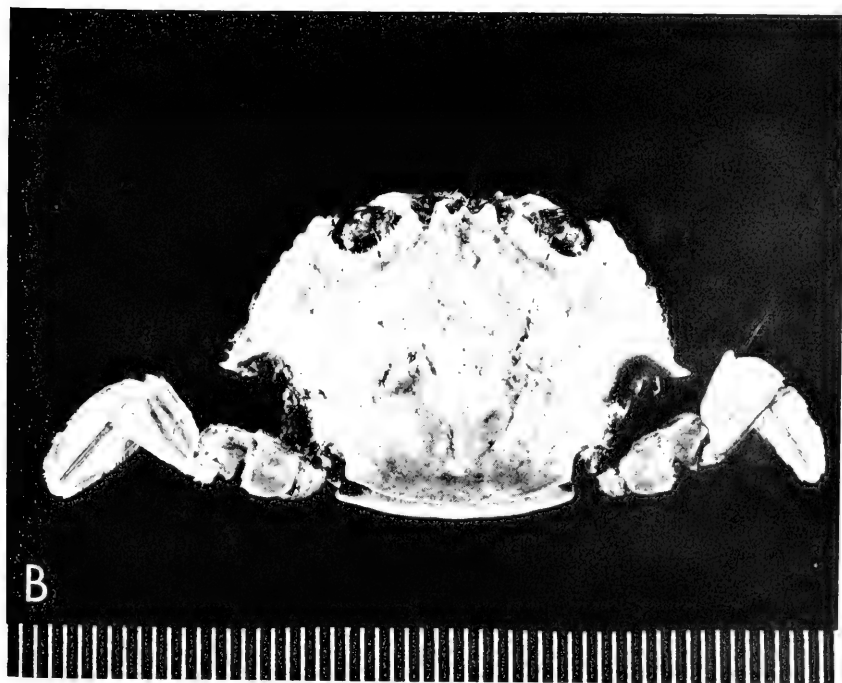
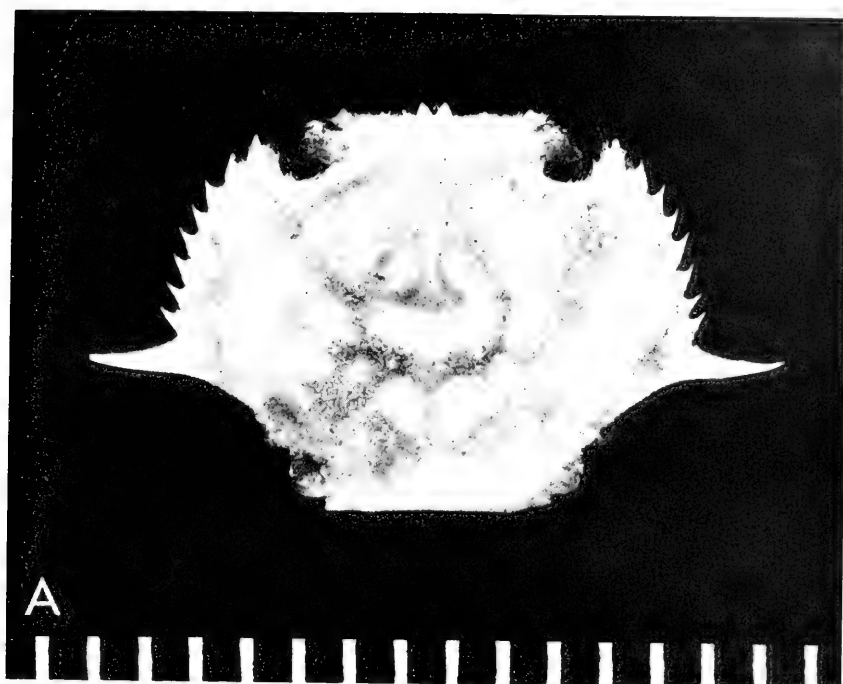
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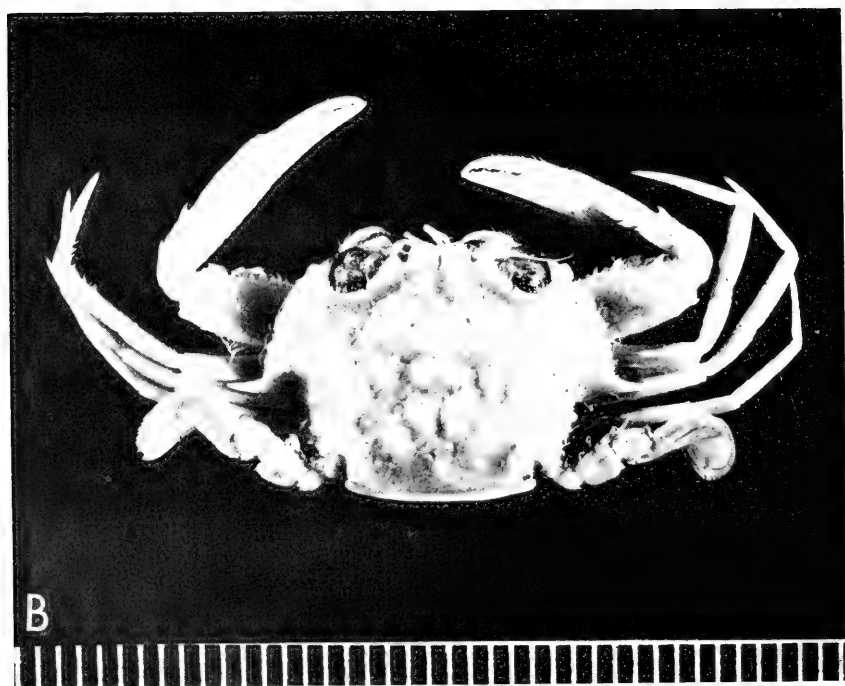
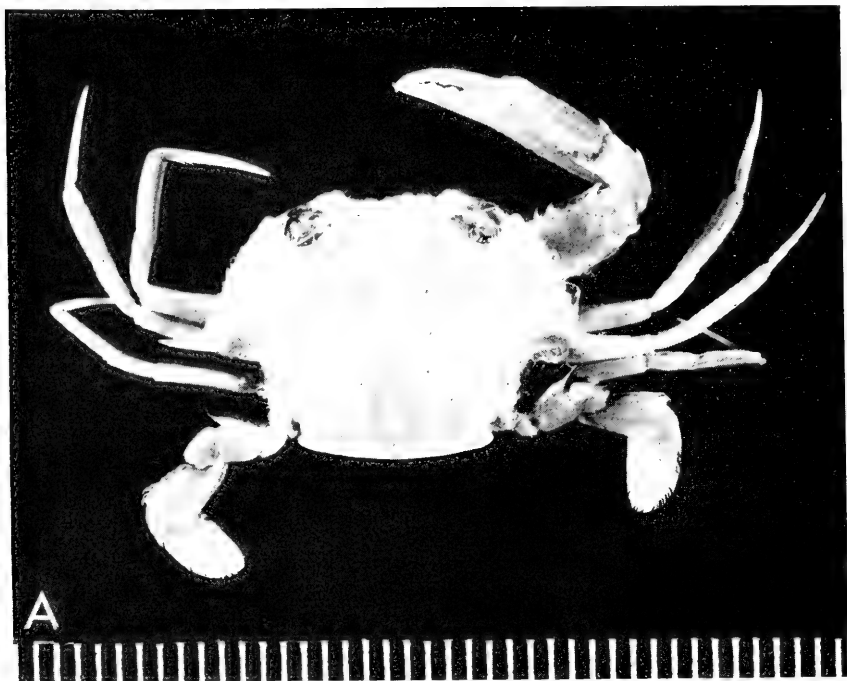
A, *Charybdis curtilobus*, new species, holotype. B, *Portunus acerbiterminalis*, new species, holotype. (Scale 1 mm.)



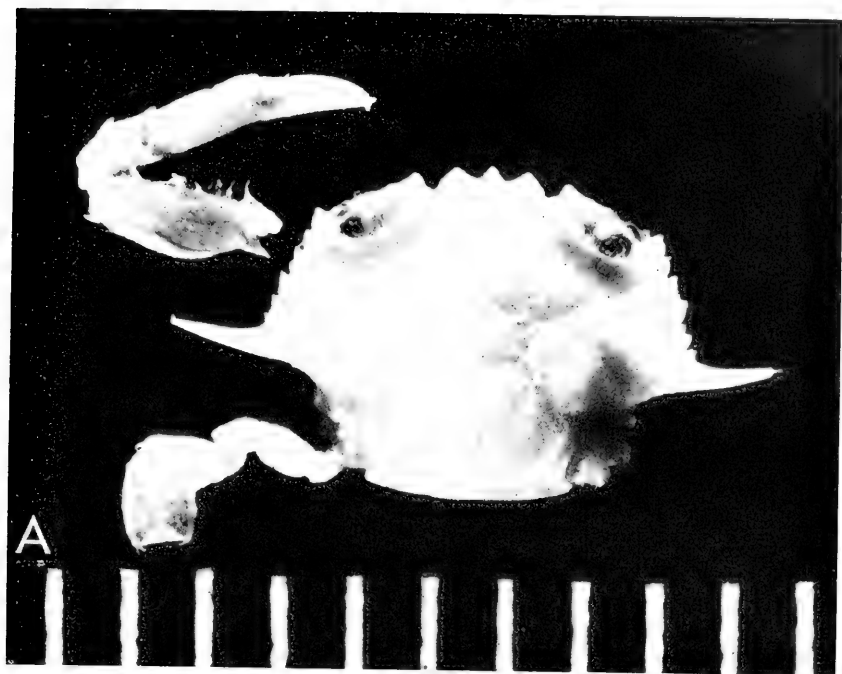
A, *Portunus dubius* (Laurie), male, Philippines, Sta. 5432, *Albatross*. B, *P. euglyphus* (Laurie), male, Philippines, Guijulugan, *Albatross*. (Scale 1 mm.)



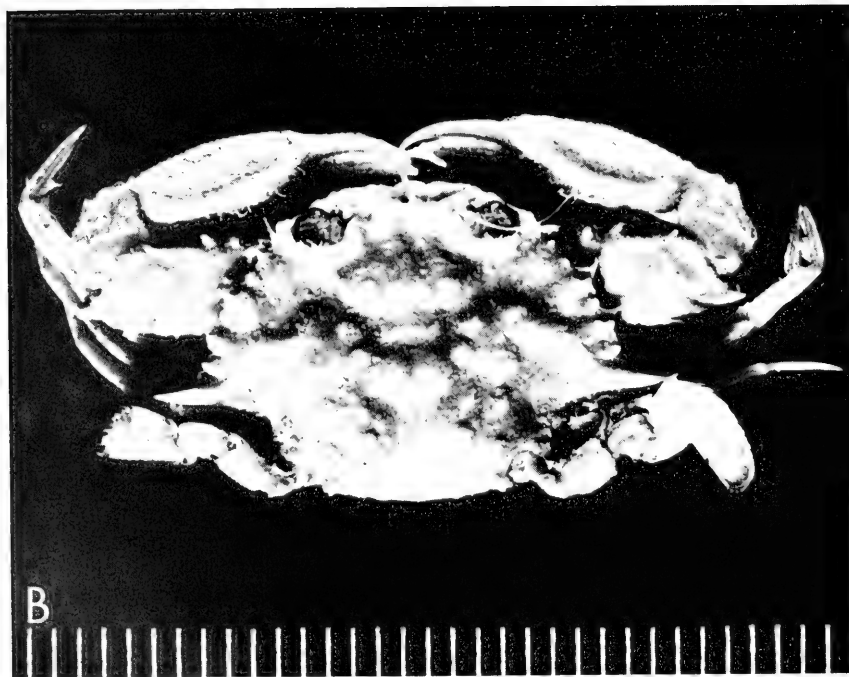
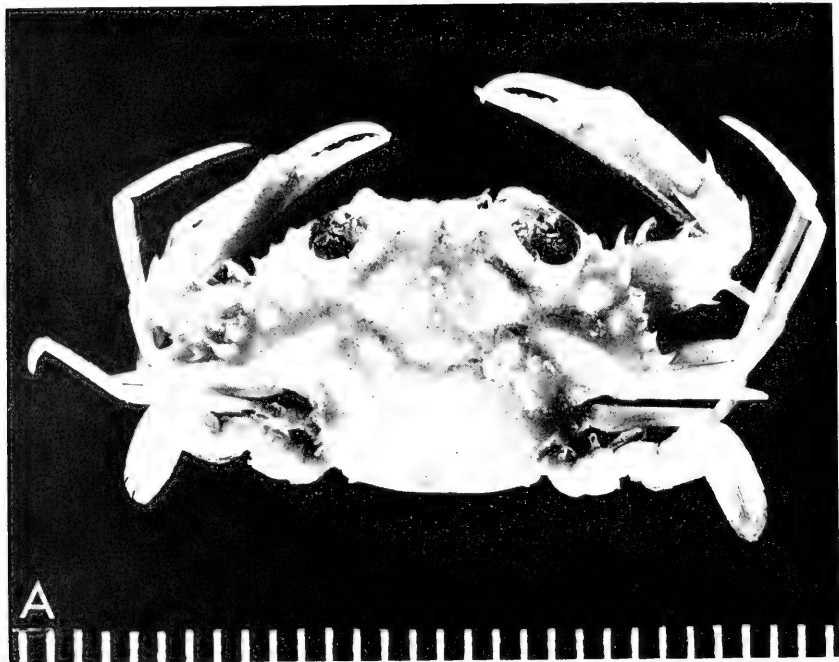
A, *Portunus* cf. *rubromarginatus*, juv., Japan, Sta. 5081, *Albatross*. B, *P. rugosus* (A. Milne Edwards), form I, ovig. female, Philippines, Sta. 5157, *Albatross*. (Scale 1 mm.)



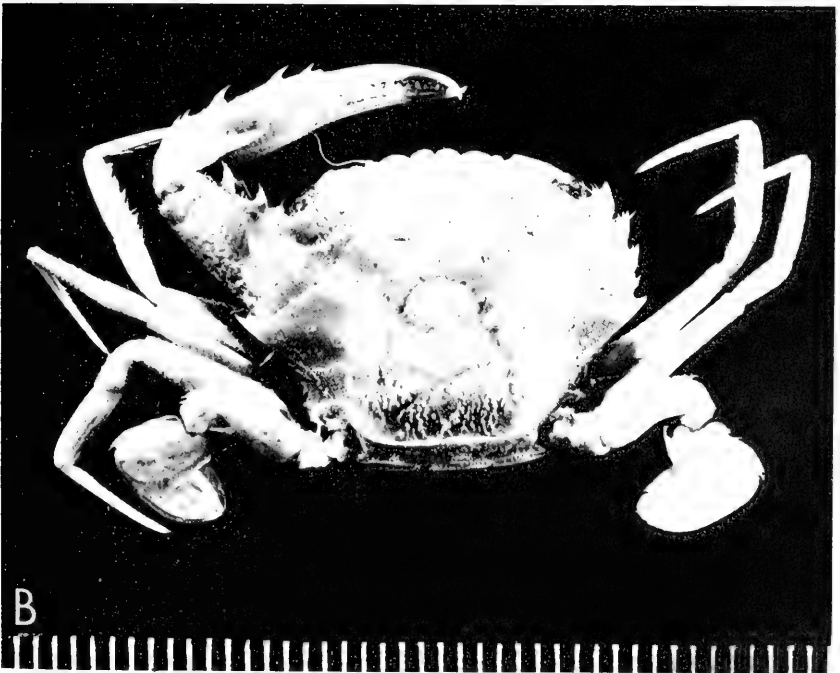
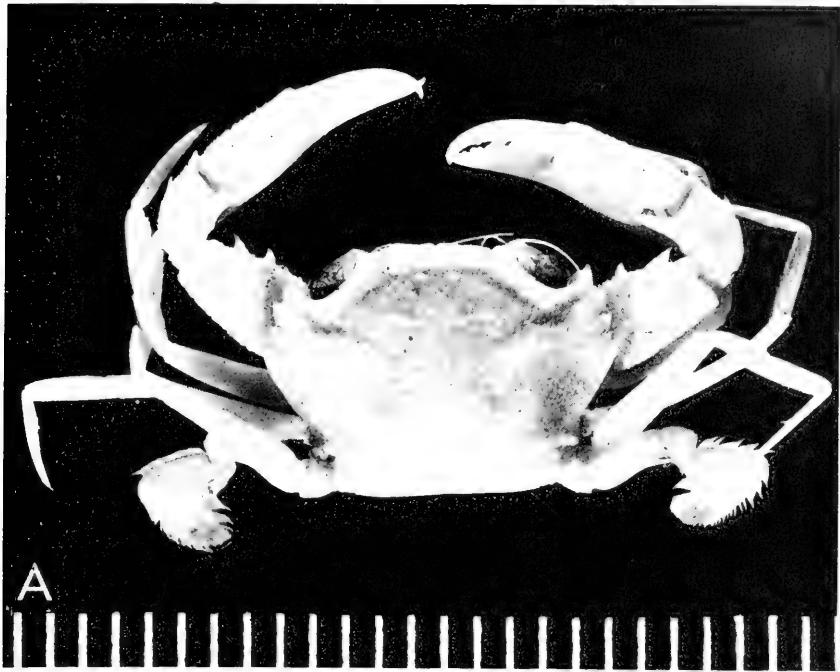
Portunus rugosus (A. Milne Edwards), form I: A, female, Philippines, Sta. 5182, *Albatross*;
B, male, Philippines, Sta. 5159, *Albatross*. (Scale 1 mm.)



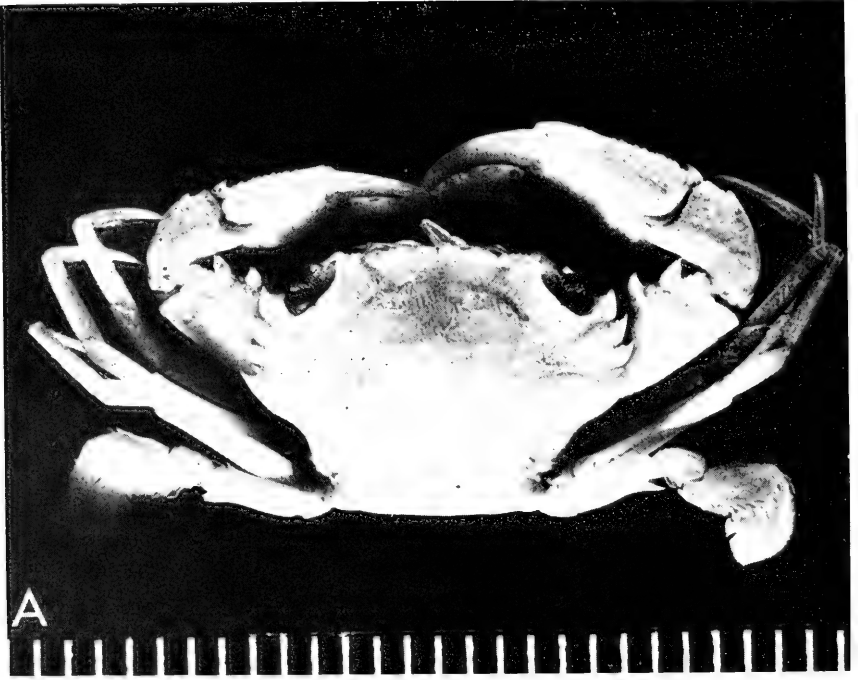
Portunus rugosus (A. Milne Edwards): A, form I, juv., Philippines, Sta. 5158, *Albatross*; B, form II, male, Philippines, Sta. 5159, *Albatross*. (Scale 1 mm.)



A, *Portunus spiniferus*, new species, holotype. B, *P. tuberculosus* (A. Milne Edwards), Philippines, Sta. 5159, *Albatross*. (Scale 1 mm.)



A, *Thalamita imparimana* Alcock, Philippines, Sta. 5131, *Albatross*. B, *T. multispinosa*, new species, holotype. (Scale 1 mm.)



A. *Thalamita philippinensis*, new species, holotype. B. *T. pseudopoisoni*, new species, holotype. (Scale 1 mm.)



Thalamita spinimera, new species, holotype. (Scale 1 mm.)



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CLASSIFICATION OF CULEX SUBGENUS CULEX
IN THE NEW WORLD
(DIPTERA: CULICIDAE)¹

By RALPH A. BRAM
Department of Entomology

A synopsis of the mosquitoes of the world by Stone et al. (1959) with supplements by Stone (1961, 1963) listed 63 species in the *Culex* subgenus *Culex* from the New World. The present study assigns 61 species to the subgenus and lists 3 unrecognized species. In this study four species are described as new, five species are revalidated, one subspecies is elevated to species rank, and 11 species are placed in synonymy.

This study would not have been possible without the enthusiastic guidance and support received from several outstanding culicidologists. I take pleasure in extending most sincere gratitude and thanks to the following persons: Dr. William E. Bickley, Professor and Head, Department of Entomology, University of Maryland; Dr. Alan Stone, Entomology Research Division, Agricultural Research Service, United

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States Department of Agriculture; and Dr. Oswaldo P. Forattini, Professor Associado, Departamento de Parasitologia, Universidade de São Paulo. I am indebted to the following individuals who materially contributed to this study by supplying specimens for examination or generously sharing their knowledge: Dr. P. F. Mattingly, Dr. T. H. G. Aitken, Dr. M. Bates, Dr. T. Belterman, Dr. O. H. Casal, Dr. E. I. Coher, Dr. R. R. Correa, Dr. P. Cova Garcia, Dr. L. Vargas, and Dr. J. F. G. Clarke. I wish to dedicate this study to my wife.

The major portion of material examined during the course of this study is housed in the U.S. National Museum (USNM). Additional specimens from collections in the following institutions were also consulted: Trinidad Regional Virus Laboratory, Trinidad (TRVL); Instituut Voor Tropische Hygiene en Geographische Pathologie, Amsterdam (ITHGP); Instituto Nacional de Microbiologia, Buenos Aires (INM); Serviço De Erradicação da Malária e Profilaxia da Doença de chagas, São Paulo (SEMPDC); Division de Endemias Rurales, Maracay (DER); Universidade de São Paulo, São Paulo (USP); Centro Ecuatoriano de Investigaciones Entomologicas (located in the USNM); and Instituto de Salubridad y Enfermedades Tropicales, Mexico, D. F. (ISET).

Since this manuscript was originally submitted for publication, Forattini (1965) has published a monograph of the culicine mosquitoes of the new world utilizing, in part and with the author's permission, the classification of Bram (1964). Unfortunately, Dr. Forattini was not aware that the present manuscript had not yet been published in accordance with the International Code of Zoological Nomenclature and, therefore, attributed *Culex alani*, *C. bickleyi*, *C. covagarciai*, and *C. oswaldoi* to Bram (1964). Since Forattini (1965) was the first author to publish these species in accordance with the Code, the names must be credited to him. However, since Forattini saw no specimens and did not designate holotypes or type localities for these species, the original material upon which the species were based by Bram (1964) should be recognized as the type series for the species. Similarly, synonymy listed as new in this publication was actually first published by Forattini (1965), but reasons for proposing the synonymy are included in this paper.

New World synonymy is listed under each species. Complete references may be found in Stone et al. (1959) and Stone (1961, 1963).

Zoogeography

Little is known about the zoogeography of the family Culicidae. This is due mainly to reasons enumerated by Bates (1949), who

observed that (a) the few fossil mosquitoes that are known are of little help in understanding the past history of the group; (b) the various taxonomic categories are not sufficiently defined to form a sure foundation for generalization; and (c) a map showing distribution of various species is apt to reflect the distribution of the collectors more than the distribution of the insects. We should also note that, at least in the Neotropical region, sufficient biological data is not available in many instances to permit intelligent interpretations of distributional patterns. Despite these limitations, noteworthy contributions to mosquito zoogeography have been made by Lane (1943, 1944), Bates (1949), Mattingly (1962), and Belkin (1962).

The dominant mosquito genera in the New World, as determined by number of species, are *Culex* and *Aedes*. In the Nearctic region *Aedes* assumes the dominant role with *Culex* being represented by only 26 species (15 of which are both Nearctic and Neotropical). In the Neotropical region *Culex* predominates and is represented by 239 species according to Stone et al. (1959). In no other region is the genus *Culex* so diversified. In the Ethiopian region there are 104 species in the genus. The Oriental region is next in number of species with 88, followed by 33 species in the Palearctic. Within the genus *Culex* the subgenus *Melanoconion* is dominant. It is indigenous to the New World and encompasses 117 species (only eight of which are found in the Nearctic). The subgenus *Culex* is cosmopolitan, but also exhibits a decided concentration in the tropical regions. Only three species of the subgenus, *restuans*, *salinarius*, and *tarsalis*, are indigenous to the Nearctic region. Forty-nine species are indigenous to the Neotropical region, and nine species are found in both Nearctic and Neotropical regions. The following discussion treats zoogeographical patterns of the subgenus *Culex* in the New World.

The three species of *Culex* (*Culex*) native to the Nearctic region present interesting patterns, since they are related to widely distributed Neotropical species. *Culex restuans* is found throughout North America, ranging from the Gulf of Mexico into Canada and from California to the east coast (Carpenter and LaCasse, 1955). Studies of the male terminalia indicate that it has close affinity with *C. laticlasper*, a species described from the Panamanian Isthmus. Another species found in the complex, *C. acharistus* is distributed from Columbia south to Llanquihue, Chile and eastward to Argentina and Brazil.

Culex salinarius, also indigenous to the Nearctic region, occurs in the eastern United States, southeastern Canada, extends westward to Utah, and dips into Mexico (Carpenter and LaCasse, 1955). Studies of male terminalia indicate that it has close affinities with *C. archegus*, which is found on the northwest coast of South America,

and *C. dolosus* and *C. spinosus*, species found in the central portion of South America.

Culex tarsalis ranges from southwestern Canada through the western, central, and southern United States and into Mexico (Carpenter and LaCasse, 1955). This species demonstrates close affinity with *C. abnormalis* which extends from Colombia to central Brazil.

All three of these species, indigenous to the Nearctic region, demonstrate considerable extensions into Mexico but none has been reported from Guatemala southward. Thus, it appears that all three species have close affinities with, and that their ancestors may have been part of, the Neotropical fauna. The affinities of these three Nearctic species with the Neotropical fauna could be explained by Belkin's (1962) hypothesis of the intercontinental origin of new types. This hypothesis suggests that the phylad originated on an island in the intercontinental area, dispersed to both hemispheres initially, and then continued evolving independently.

The two principal intercontinental areas which Belkin (1962) considered as primary centers of origin are the Indo-Pacific area between Eurasia and Australia, and the American Mediterranean between the North and South American continents (ibid., vol. 2, map on p. 18). It was his contention that these areas are the most likely places for the origin and evolution of new major types of mosquitoes. Both are characteristically unstable regions where major orogenic belts of adjacent continents meet, intersect, form arcs, or otherwise have complex relationships. Thus, in the course of island formation, great environmental stress would be imposed on the surviving populations and these would be greatly reduced and isolated. Under such conditions there would be an ideal opportunity for the quick fixation of new adaptive types of organisms. Examination of distributional patterns in the subgenus *Culex* indicates that the American Mediterranean is probably the primary center of origin. Forty-seven of the 61 species considered in this study are found within the boundaries of this area as delimited by Belkin.

Several endemic species are found on the Antillean and Bahamian islands. Both *Culex scimitar* and *C. sphinx* have been reported only from the Bahamas and both show strong affinities in the male terminalia to *C. nigripalpus*, which is distributed throughout the southern Nearctic and American Mediterranean areas. *C. duplicator* is endemic to the island of Hispaniola and demonstrates affinity with *C. saltanensis*, a species with a distribution range from Venezuela to northern Argentina. *C. finlayi* has been reported only from Cuba. Although the male terminalia is somewhat unique, there seems to be some affinity with the more widely distributed *C. chidesteri*. *C. bahamensis*, a unique species demonstrating affinity with the subgenus

Melanoconion, is restricted to the Caribbean Islands and the southern tip of Florida.

The Central American isthmus also possesses endemic species. *Culex delys* and *C. laticlasper* are known only from the Panama Canal Zone. *C. stenolepis* is known from the state of Veracruz, Mexico, and Costa Rica; it exhibits affinities with *C. thriambus*, a species which extends into Colombia. *C. pinarocampa* has been reported from four states in southern Mexico and from Panama; however, considering our present knowledge of distributions, none of these Central American forms can definitely be considered as truly endemic.

In the subgenus *Culex* it appears that the intercontinental islands of the American Mediterranean area did not assume the dominating role as a center of origin but, in general, were the recipients of the South American fauna. Although somewhat reduced in number of species, the Trinidadian fauna is typical of the fauna of the adjacent South American continent. The continental fauna is also reflected to some degree in the fauna of the other Caribbean islands. This tendency towards a South American fauna (in contrast to a Central American, North American, or endemic fauna) is readily explained by consideration of prevailing surface winds of the Atlantic Ocean and typical tracks of tropical storms. Darlington (1957, fig. 8) outlined the course of the prevailing winds. Examination of these figures revealed that the winds and storms originate in the Atlantic Ocean and develop in a circular, clockwise direction, touching the South American continent and proceeding through the Caribbean or towards the Central American isthmus. The winds would have probably served as the primary agents of dispersal.

Lane (1943) reviewed the geographical distribution of the mosquito tribe Sabethini. In this study he recognized five centers of endemism and dispersal in the Neotropical region as well as two negative areas in which no Sabethines were found (ibid., map 8, p. 425). In a subsequent study, Lane (1944) suggested that the tribe Anophelini also adhered to these centers of endemism and dispersal. Belkin's American Mediterranean area encompasses Lane's Central American, Incasic, and Cariba centers as well as the Caribbean islands. This area is considered the primary center of dispersal in the New World. In the subgenus *Culex* the most prominent secondary center of dispersal corresponds generally to the Patagonian area. Species included in this area are: *Culex apicinus*, a highly adapted species with rather independent tendencies; *C. articularis*, also somewhat unique; *C. brethesi* and *C. acharistus*, species showing affinities with the *restuans-laticlasper* complex; *C. lahillei*, which shows affinity with *C. foliaceus*; and *C. tramazayguesi*, a unique species of unknown affinity. Another secondary center of dispersal might well be Lane's negative center 4.

Species which appear to be endemic to this area include *C. foliaceus*, *C. oswaldoi*, and *C. maxi*, which extends through the central plateau to northern Argentina. Lane's center 5 (the Tupi area) is represented by four endemic species: *C. carinoxenus*, *C. lygrus*, *C. renatoi*, and *C. acharistus*; however, each of these species is known only from the type locality. This limited distribution is probably a reflection of the close proximity of this area to culicidologists working at the University of São Paulo. The Central Plateau area (or Lane's center 3) exhibits two endemic species, *C. mauesensis* and *C. airozai*, which are also known only from their type localities. Again, this does not necessarily represent a recognizable center of endemism.

Several species of Neotropical *Culex* (*Culex*) have rather broad areas of distribution which are worthy of consideration. *Culex chidesteri* extends from Mexico southward to northern Argentina, being restricted to the western half of the continent. Interestingly enough, this species has been found on the island of Jamaica but has not been reported from any of the other Caribbean islands. *C. corniger* is distributed from Mexico throughout the northern half of South America and southward to Argentina on the east coast. It is also found throughout the Caribbean. *C. mollis* extends from Mexico south to northern Argentina and is apparently a common species. In the Caribbean, however, it has only been reported from the island of Trinidad which typically exhibits a continental fauna. *C. abnormalis* and *C. saltanensis* seem to be restricted to a central, north-south band on the South American continent. With the exception of Central America and the Caribbean islands, *C. surinamensis* is distributed throughout the American Mediterranean area and extends into the central plateau. *C. declarator* ranges from southern Texas throughout the American Mediterranean, but is limited in the Caribbean to the Lesser Antilles. It also extends eastward to the state of Pernambuco, Brazil. A very closely related species, *C. bidens*, is more southern in distribution ranging from central Argentina northward through the east coast and central plateau areas and extending into Venezuela. It has not been reported from the west coast of South America and is also generally absent from the American Mediterranean. Martinez Palacios (1952) did report this species from six southern and central states of Mexico. The *C. coronator* complex of species presents an interesting distributional pattern, which will be discussed in detail under the various species. In general, however, *C. coronator* and *C. usquatatus* extend from Texas southward to northern Argentina, but are absent from the west coast of South America and the Caribbean islands. *C. usquatissimus*, *C. ousqua*, *C. camposi*, and *C. covagarciai* are distributed in varying degrees within the American Mediterranean.

These patterns, then, do not indicate distinct centers of endemism

and distribution in the subgenus *Culex* as was found by Lane (1943, 1944) for the tribes Sabethini and Anophelini. Rather, the distributional patterns of the various species indicate several broad faunistic areas as suggested by Belkin (1962) for the entire family Culicidae. The American Mediterranean exhibits the greatest number of species of any area, as well as the largest number of endemic species. Although suggestions of subpatterns seem to exist, the general area is considered the primary center of distribution. The Patagonian area was recognized by both Lane and Belkin (in this case as the Patagonian-South Chilean area) and in the subgenus *Culex* demonstrates a distinctively unique fauna. In this subgenus the Patagonian area would seem to represent a compromise between the concept of the areas presented by Lane and Belkin. The remaining area of South America seems best considered under Belkin's broad Neotropical area. In this area suggestions of subpatterns also exist, but sufficient data is not presently available to confirm or delimit these possibilities.

In summary, examination of distributional patterns reveals several broad faunal areas of New World *Culex* (*Culex*). The entire Nearctic region exhibits only three endemic species and possesses nine more species which are also found in the Neotropical region. The Neotropical region may be subdivided into three faunal areas: (1) the American Mediterranean, which is considered the primary center of origin and distribution; (2) the Patagonian, which is confined to the west coast and southern tip of the continent, and which exhibits a unique fauna; and (3) the Neotropical, which includes the rest of the South American continent. These faunal areas, modified after Lane (1943) and Belkin (1962), are outlined in figure 1. Additional subpatterns within these areas are suggestive, but more distributional data is required to confirm and delimit these secondary features.

Terminology

MALE TERMINALIA.—The terminology followed in this study is basically that of Carpenter and LaCasse (1955). The one exception to this is in the male terminalia. A wide variety of terms has been used to describe the structures of the male terminalia and few authors agree on standard terms in the subgenus *Culex*. Table 2 lists the terminology used by eleven different authors to describe the structures of the mesosome in the *Culex* subgenus *Culex*. This table is by no means complete since, as indicated by Freeborn (1924), it is impossible to produce an accurate synonym list for the nomenclature of the different parts without consulting the original descriptions of all species and all monographic works. In respect to male terminalia,

NEW WORLD FAUNAL REGIONS AND AREAS
BASED ON DISTRIBUTION WITHIN THE
CULEX SUBGENUS *CULEX*

Nearctic Region



FIGURE 1.—New World faunal regions and areas based on distribution within the *Culex* subgenus *Culex*.

the nomenclature of Freeborn and Bohart (1951) is utilized throughout this study. Following is a brief discussion of major morphological characters of the male terminalia utilized in this study. Each structure discussed is included in diagrams of each species.

Tenth sternites (XS): These structures were regarded by Christophers and Barraud (1923) as the cerci united with the anal lobe, but in general taxonomic nomenclature they are recognized as sternites. In the subgenus *Culex* the tenth sternites are crowned with a tuft of spines and it is this character that is considered important. Three basic arrangements of tufts are found and can be readily identified: (1) spines sparse and weak; (2) spines dense and rather strong; and (3) spines dense and strong apically, but with the spines on the outer lateral margins spatulate and rather scalelike in appearance. It should be noted that all species exhibiting arrangement "(1)" do not possess a leaf on the apical lobe of the basistyle; however, the reverse is not true.

Ventral cornu (VC): Stone (personal communication, 1962) considered this structure to represent a modification of the apical tooth of the median process of the mesosome. Two rather distinct configurations can be recognized. Most species possess a dentiform ventral cornu, although the structure may assume a variety of shapes and sizes in relation to the teeth of the median process of the mesosome. A second form exists where the ventral cornu is very large, rounded, and exhibits rugulose outer margins.

Median process of the mesosome (MP): The precise number of teeth on the median process of the mesosome varies somewhat, even within a species. Three recognizable situations, however, seem to exist: (1) the teeth are absent or are, at most, one or two in number; (2) the teeth are distinctly separated and range in number from three to approximately 10; and (3) the condition in which a large number of conglomerate teeth is present.

External process (EP): This structure issues from the center of the mesosome and assumes various shapes and sizes in relation to the median process of the mesosome. The structure is present in all species of the subgenus, but is difficult to distinguish when the terminalia is mounted in the everted position.

Basal arm of the mesosome (BA): This structure generally issues from the mesosome as a short, straight, bluntly rounded limb. In some species the structure may be completely absent, and in other species it may be bent at an acute angle so as to be directed posteriorly.

Apical lobe of the basistyle (AL): There is great variation in setal arrangement on the apical lobe, as well as variations in the conformation of the lobe, itself. Lane (1953) conveniently divided the subgenus into two groups, depending on whether or not the apical lobe

possessed a leaf-shaped seta; however, this division seems to represent an oversimplification of the complex interrelationships of terminalic structures. The basic setal arrangement on the apical lobe appears to be: three strong, basal rods followed by a leaf-shaped seta; a straight, pointed seta; and a curved, pointed seta. Variations to this basic pattern range widely from a simple group of straight, pointed setae in *Culex usquatus* to elaborate modifications and setal arrangements in *C. apicinus*.

FEMALE CHARACTERS.—Historically, adult female mosquitoes have been extremely difficult to identify accurately. This is due mainly to the limited number of distinctive characters, intraspecific variation of characters, and similarity of closely related species. In the subgenus *Culex* primary taxonomic characters are concerned with body ornamentation and scale color patterns. In this study 13 different colorational characters have been selected and are listed in table 1. For many of the species, positively determined material was not available (due to lack of associated, individual rearings) and in these cases reference was made to the original descriptions. These characters were not incorporated into a formal key because, for most species, data on intraspecific variation are not available at the present time. Terminology used in describing these colorational characters is that of Carpenter and LaCasse (1955).

LARVAL CHARACTERS.—In the larval stage many stable morphological structures are available for use as taxonomic characters. As in the case of female characters, the terminology utilized in describing these characters is that of Carpenter and LaCasse (1955). Morphological larval characters utilized in this study are as follows:

Antenna: In all but two species examined the antennae are constricted near the outer third, beyond the insertion of the antennal tuft. Degree of spiculation of the antennal shaft is also utilized as a taxonomic character.

Head hairs: The arrangement, length, and condition of the four primary head hairs are characteristic. The following head hairs are utilized as taxonomic characters: postclypeal head hair 4; upper frontal head hair 5; lower frontal head hair 6; and preantennal head hair 7.

Mentum: This structure is the strongly sclerotized and pigmented, toothed plate of the labial-hypopharyngeal complex. It is characteristic in the number and conformation of the lateral teeth.

Integument: The presence or absence of spicules on the thoracic and abdominal integument is frequently diagnostic.

Comb: This structure is a row or patch of enlarged specialized spicules in the middle of each side of the eighth abdominal segment.

The general arrangement of the comb scales is frequently utilized, as well as the number and conformation of the individual scales.

Siphon: The air tube of the typical nonanopheline mosquitoes; morphologically includes part of the abdominal segments VIII and IX. Several features of the siphon are utilized as taxonomic characters.

Siphonal index: The ratio between the length of the siphon and the basal width.

Siphonal tufts: Pairs of setae inserted on the siphon. The number, location, and condition of the siphonal tufts are diagnostic.

Pecten: A paired, comblike row of spiculate teeth along the ventrolateral border of the siphon. The number, arrangement and conformation of individual teeth is diagnostic.

L/S ratio: The ratio of the length of the siphon to the dorsal length of the saddle. This ratio was originally proposed by Colless (1957) and is used as a supplementary character in the larval key.

Keys

In this study emphasis has been placed on characters of the male terminalia because of the scarcity of material, particularly larval skins associated with adults, and because many species are known only from the male terminalia. Of the 61 species recognized in this study, 59 have been included in the key to male terminalia. *Culex delys* is known only from the female and *C. pseudojanthinosoma* is known only from the female and a description of the larval stage. A key to New World subgenera of the genus *Culex* based on the male has been constructed utilizing many of the characters suggested by Foote (1954).

Due to the scarcity of reliable data, the key to larvae is extremely tentative. In 18 species the larval stage is unknown. Descriptions of the larvae in many other species are incomplete or questionable. A thorough understanding of larval morphology and affinities awaits future individual rearings. Only by this technique can correlations between immature and adult stages be conclusively established. A list of larval characters separating the subgenus *Culex* from other New World subgenera of the genus was prepared instead of a formal key, because some difficulty was encountered in separating the subgenera *Carrollia* and *Microculex*.

Morphological and colorational characters of adult females in the subgenus *Culex* are extremely difficult to differentiate. As pointed out by Lane (1953), a key utilizing adult females serves only to approximate species because the characters are variable. In this study few species were represented by a suitable sample of positively determined specimens, and the amount of material obtained from

individual rearings was very limited. Original descriptions of adult females are often vague and different authors emphasize different morphological and colorational aspects. Therefore, no attempt was made to construct a formal key incorporating adult female characters. However, a table of salient female characters has been prepared as table 1.

Key to Subgenera of New World *Culex* Based on the Male

1. Tenth sternite crowned with a tuft of predominantly pointed setae; spatulate setae may be present on the outer lateral margins 2
 Tenth sternite crowned with a row of spatulate setae 4
2. Tenth sternite without a basal arm 3
 Tenth sternite with a basal arm present **Culex**
3. Ventral cornu present on the mesosome **Lutzia**
 Ventral cornu absent **Neoculex**
4. Palpus longer than the length of the proboscis by at least the length of the last palpal segment **Melanoconion**
 Palpus no longer than the length of the proboscis **Mochlostyrax**
5. Abdomen without basolateral metallic spots 6
 Abdomen with basolateral metallic spots **Carrollia**
6. Mesosomal plate without retrorse teeth 7
 Mesosomal plate with a pair of retrorse teeth **Microculex**
7. Apical lobe of the basistyle extended into a single, medially placed, thumb-like projection **Eubonnea**
 Apical lobe of the basistyle not as above, divided into a distal and proximal section **Aedinus**

Key to Species of New World *Culex* (*Culex*) Based on Male Terminalia

1. Apical lobe of the basistyle without a broadened leaf 2
 Apical lobe of the basistyle with at least one broadened leaf 18
2. (1) Tenth sternite crowned with a dense tuft of strong spines 3
 Tenth sternite crowned with a sparse tuft of fine spines 4
3. (2) Dististyle enlarged medially; apical lobe of the basistyle extended into a tuberculiform projection terminating in a strong apical rod and possessing a distal seta and a basal seta **habilitator**
 Dististyle not enlarged medially; apical lobe of the basistyle bearing only three strong, obtuse rods and several normal setae **tramazayguesi**
4. (2) Median process of the mesosome bearing 10 or more conglomerate teeth 5
 Median process of the mesosome bearing less than 10 distinctly separated teeth 9
5. (4) Apical lobe of the basistyle bearing two obtuse and one hooked rod, as well as additional setae; apical third of the dististyle minutely annulate **bahamensis**
 Apical lobe of the basistyle not as above; apical third of the dististyle not annulate 6
6. (5) Ventral cornu pointed, without rugulose outer margins 7
 Ventral cornu rounded, rugulose on outer margins **maracayensis**
7. (6) Tenth sternite with pilosity on the lateral margins 8
 Tenth sternite without pilosity on the lateral margins **bonneae**

8. (7) Ventral cornu pointed and bent at the outer third so as to be directed posterolaterally; external process evenly tapered to an obtuse termination **saltanensis**
 Ventral cornu serrate terminally; external process broad at the basal $\frac{2}{3}$, then sharply indented on the lateral edge and tapered; endemic to the island of Hispaniola **duplicator**
9. (4) Ventral cornu more or less dentiform and short, not distinctly separated from the teeth of the median process 10
 Ventral cornu long and slender, directed laterally, and distinctly separated from the teeth of the median process (*coronator* group) . 13
10. (9) Apical lobe of the basistyle with two sections; the basal section with three rods, the distal section with approximately six setae 11
 Apical lobe of the basistyle with about six subequal setae 12
11. (10) Ventral cornu clavate, located just above the teeth of the median process **brevispinosus**
 Ventral cornu dentiform, located close to the teeth of the median process **surinamensis**
12. (10) Ventral cornu large and distinct; median process bearing about four teeth; basal process directed posteriorly **oswaldoi**
 Ventral cornu small and dentiform; median process bearing about eight teeth; basal process directed anteriorly **maxi**
13. (9) A group of short setae located at the apex of the basistyle 14
 A group of long setae located at the apex of the basistyle; these setae reach to at least the midpoint of the dististyle 16
14. (13) Apical lobe of the basistyle undivided 15
 Apical lobe of the basistyle divided into a large proximal lobe and a small distal tubercle; the proximal lobe possesses a group of approximately 10 subequal setae; the distal tubercle possesses four or five subequal setae **ousqua**
15. (14) Apical lobe of the basistyle possessing two or three rods basally followed by 5 to 15 setae **coronator**
 Apical lobe of the basistyle extended into a thumblike projection possessing the following appendices: one short, very broad rod, two long prominently hooked rods, and several subequal, hooked setae. **covargarciai**
16. (13) Basistyle with a small tubercle located distad of the apical lobe and possessing from one to five setae 17
 Basistyle without a small tubercle distad of the apical lobe; apical lobe of the basistyle possessing from 10 to 15 setae **usquatus**
17. (16) Apical lobe of the basistyle possessing three rods and one seta; small tubercle distad of the apical lobe possessing four or five setae. **usquatissimus**
 Apical lobe of the basistyle possessing approximately 10 setae; small tubercle distad of the apical lobe possessing one or two strong setae **camposi**
18. (1) Median process of the mesosome projected into a strong extension upon which is located a sphincter-form ring **finlayi**
 Median process of the mesosome not as above 19
19. (18) Ventral cornu absent; teeth of the median process absent or greatly reduced in size and number; external process very broad and prominent, slightly curved laterally 20
 Ventral cornu present, dentiform or rugulose and rounded; teeth of the median process not reduced in size; external process normal . . . 24

20. (19) Basal arm of the tenth sternite long and curved 21
 Basal arm or the tenth sternite short and straight **pipiens**
21. (20) Apical lobe of the basistyle with three rods, a leaf, a hooked seta, and a straight seta 22
 Apical lobe of the basistyle with three rods, a leaf, and a straight seta **brethesi**
22. (21) Apical third of the dististyle without minute annulations 23
 Apical third of the dististyle with minute annulations (this character is best seen under oil immersion or phase contrast) . . . **acharistus**
23. (22) Hooked accessory seta on apical lobe of the basistyle unusually strong and curved; median process of the mesosome with about two small, lightly sclerotized denticles **laticlasper**
 Hooked accessory seta on apical lobe of the basistyle not unusually strong, gently curved; median process of the mesosome completely without teeth **restuans**
24. (19) Apical lobe of the basistyle with two leaves present (broadly modified setae are not here considered as leaves) 25
 Apical lobe of the basistyle with only one leaf present 27
25. (24) Dististyle not annulate terminally 26
 Dististyle minutely annulate at the terminal end . . . **diplophyllum**
26. (25) Dististyle with a distinct enlargement at the apex; apical lobe of the basistyle bearing three rods in addition to the two leaves . . **foliaceus**
 Dististyle without a distinct enlargement at the apex; apical lobe of the basistyle bearing three rods and a hooked seta in addition to the two leaves **lahillei**
27. (24) Tenth sternite crowned with short, pointed spines at the apex and short, spatulate spines on the outer lateral margins 28
 Tenth sternite crowned with short, pointed spines; spines on the outer lateral margins not spatulate 33
28. (27) Ventral cornu pointed and dentiform 29
 Ventral cornu rounded and rugulose 30
29. (28) Apical lobe of the basistyle with three blunt rods, a straight, pointed seta, a straight seta, and a narrow leaf **tarsalis**
 Apical lobe of the basistyle with a blunt rod, two hooked rods, a normal oblongo-ovatum leaf, two or three slender hooked setae, and one slender seta **abnormalis**
30. (28) Dististyle not minutely annulate at the terminal end 31
 Dististyle minutely annulate at the terminal end; central portion of the dististyle scimitar-like in shape **scimitar**
31. (30) External process evenly tapered; not rounded apically 32
 External process gradually curved apically so that the point is directed laterally **chidesteri**
32. (31) Apical lobe of the basistyle with a blunt rod, two hooked rods, an accessory seta, and a normal leaf **nigripalpus**
 Apical lobe of the basistyle with a pointed rod, two hooked rods, three setae, and a narrow leaf **sphinx**
33. (27) Ventral cornu rounded, rugulose on outer margins 34
 Ventral cornu pointed and not rugulose 37
34. (33) Apical lobe of the basistyle with five appendices: Three rods, an accessory seta, and a leaf 35
 Apical lobe of the basistyle with six appendices: Three rods, a hooked seta, a straight seta, and a leaf 36

35. (34) External process with a prominent additional sclerite on the inner margin **thriambus**
 External process without an additional sclerite on the inner margin. **stenolepis**
36. (34) External process gradually tapering to a point and bent so as to be directed laterally **interrogator**
 External process not bent so as to be directed laterally; inner edge of the external process sharply angulate at approximately the outer third. **peus**
37. (33) Apical lobe of the basistyle with three rods, a normal, prominently hooked seta, a straight seta, and a normal leaf 46
 Apical lobe of the basistyle without the above number and/or type of appendices 38
38. (37) Apical third of the dististyle minutely annulate 39
 Apical third of the dististyle not minutely annulate 40
39. (38) Tenth sternite robust, the basal process very short and stout; apical lobe of the basistyle with a long, serrate leaf, a cleft, heavily sclerotized rod, and three hooked rods; a densely setose protuberance below the apical lobe **apicinus**
 Tenth sternite normal, the basal process long and curved; apical lobe of the basistyle with an obtuse rod, two hooked rods, a short seta, an unusually hooked spine, and a leaf **articularis**
40. (38) Apical lobe of the basistyle with three rods, two serrate, plumose setae, a hooked seta, a leaf, and a straight seta **levicastilloi**
 Apical lobe of the basistyle not as above 41
41. (40) Apical lobe of the basistyle with three rods, a straight seta, and a leaf 42
 Apical lobe of the basistyle not as above 43
42. (41) External process narrow, pointed, and not reaching posteriorly to the ventral cornu; median process of the mesosome bearing more than 10 conglomerate teeth **corniger**
 External process normal in breadth, reaching posteriorly to at least the ventral cornu; median process of the mesosome bearing less than 10 distinctly separated teeth **carcinoxenus**
43. (41) Apical lobe of the basistyle with one rod, a leaf, and a seta . . . **airosai**
 Apical lobe of the basistyle with more than three appendices . . . 44
44. (43) Apical lobe of the basistyle distinctly divided into two sections, the basal section tuberculiform and possessing three rods, the distal section possessing one seta and a leaf **inflictus**
 Apical lobe of the basistyle not divided into two distinct sections as above 45
45. (44) Apical lobe of the basistyle with three rods, two small setae, a large hooked seta, a leaf, and a straight seta **secutor**
 Apical lobe of the basistyle with one blunt rod, two hooked rods, two setae, and a leaf; a minute seta may also be next to the leaf . **janitor**
46. (37) Ventral cornu not greatly enlarged, not appreciably separated from the teeth of the median process 47
 Ventral cornu T-shaped, greatly enlarged, and distinctly separated from the teeth of the median process **mollis**
47. (46) Basal process bent at an acute angle so as to be directed posteriorly . 48
 Basal process not bent at an acute angle; the basal process may, however, gradually curve posteriorly and terminate in a sharp point . 52

48. (47) External process gradually tapering to a point, with a slight bulge on the middle of the inner surface 49
 External process very broad on the apical fourth **alani**
49. (48) External process evenly tapered to a pointed tip; restricted to the Neotropical region 50
 External process with a prominent knob midway on the inner surface; restricted to the Nearctic region **salinarius**
50. (49) Basal process rather robust, pointed; reaching at most to the middle of the median process of the mesosome 51
 Basal process robust basally, but long and slender apically; reaching almost to the ventral cornu **spinus**
51. (50) Ventral cornu clavate; basal arm of the tenth sternite moderate in length, gently curved **archegus**
 Ventral cornu dentiform; basal arm of the tenth sternite very long, prominently recurved **dolosus**
52. (47) Basal process bluntly rounded distally 53
 Basal process sharply pointed distally, occasionally with an auxiliary point directed posteriorly **bickleyi**
53. (52) Median process of the mesosome with about 10 or more teeth . . . 54
 Median process of the mesosome with about seven or less teeth . . . 55
54. (53) Apical lobe of the basistyle with three hooked rods, a hooked seta, a straight seta, and a leaf **renatoi**
 Apical lobe of the basistyle with one blunt rod, two hooked rods, a hooked seta, a straight seta, and a leaf **mauesensis**
55. (53) External process normal in size or greatly reduced, gradually tapered to a posteriorly directed point 56
 External process large, evenly bent on the outer fourth so that the apical point is directed laterally **lygrus**
56. (55) Apical lobe of the basistyle with three hooked rods, a hooked seta, a straight seta, and a leaf; ventral cornu dentiform 57
 Apical lobe of the basistyle with one blunt rod, two hooked rods, a hooked seta, a straight seta, and a leaf; ventral cornu clavate. **pinarocampa**
57. (56) External process of the mesosome greatly reduced and lightly chitinized; hooked accessory seta on the apical lobe of the basistyle a complex flattened filament 58
 External process of the mesosome normal in size and normally chitinized; hooked accessory seta on the apical lobe of the basistyle a simple, hooked structure **erythrothorax**
58. (57) Individual teeth of the median process slightly curved, robust, and having somewhat convex sides **declarator**
 Individual teeth of the median process not curved, the sides straight and directed to a sharp point **bidens**

Larval Characters Distinguishing the Subgenus *Culex* in the New World

1. Labrum not produced in front; mouthbrushes not thickened and in a compact lateral group (fig. 2*a*).

The predaceous subgenus *Lutzia* is characterized by having the labrum produced in front, strongly developed, and possessing stout denticles; mouthbrushes are thickened and inserted in a compact group laterally (fig. 2*b*).

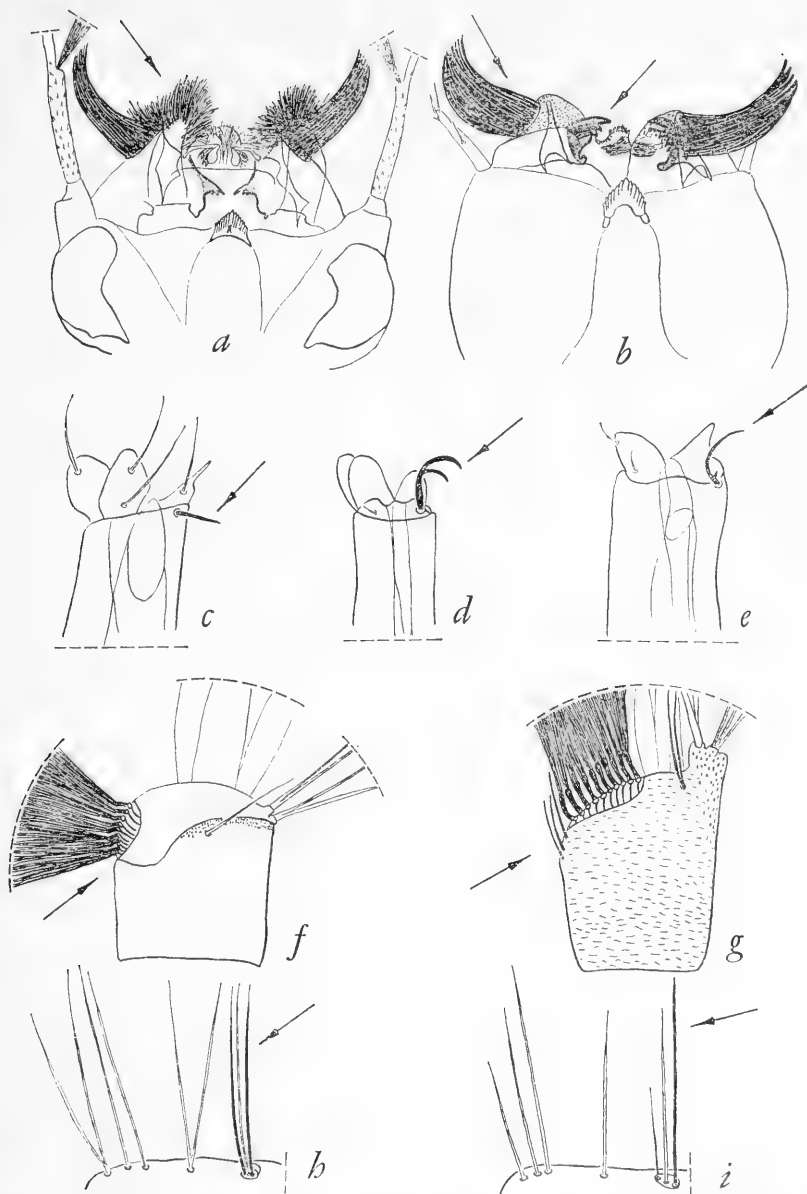


FIGURE 2.—Larval characters distinguishing the subgenus *Culex* in the New World. Head: a, *C. (Culex) declarator* Dyar and Knab, USNM 595; b, *C. (Lutzia) allostigma* Howard, Dyar, and Knab, USNM J92.3. Apex of anal siphon: c, *C. (Culex) declarator*, USNM 595; d, *C. (Melanoconian) mistura* Komp and Rozeboom, USNM Rozeboom 377; e, *C. (Aedinus) americanus* (Neveu-Lamaire), USNM Pratt 1-23-43. Anal segment: f, *C. (Culex) declarator*, USNM 595; g, *C. (Neoculex) derivator* Dyar and Knab. Prothoracic hairs: h, *C. (Culex) declarator*, USNM 595; i, *C. (Microculex) elongatus* Rozeboom and Komp, USNM 407.

2. Apical bristle of air tube absent or, if present, straight and without a basal tooth (fig. 2c).

The subgenera *Melanoconion* and *Mochlostyrax* exhibit a strongly curved or hooked apical bristle which has one or two small teeth or hooks near its base (fig. 2d). The subgenus *Aedinus* possesses a gently curved apical bristle on the air tube which may have one small barb near its base (fig. 2e).

3. Ventral brush of the anal segment without detached hairs proximad of the grid (fig. 2f).

The subgenus *Neoculex* possesses a ventral brush with one or more hairs proximad of the grid, on the saddle or between the saddle and the grid (fig. 2g).

4. Prothoracic hair 3-P of the same order of magnitude and thickness as 1-P (fig. 2h).

In the subgenera *Carrollia* and *Microculex* prothoracic hair 3-P is much thinner and shorter than 1-P, or both 1-P and 3-P may be multiple (fig. 2i).

Key to Species of New World *Culex* (*Culex*) Based on the Larvae

1. Antennae of uniform shape, antennal tuft located near the middle . . . 2
Antennae constricted beyond the antennal tuft; antennal tuft generally inserted near the outer third. 3
2. (1) Siphonal tufts not arranged in a line **corniger**
Siphonal tufts arranged in a line **janitor**
3. (1) Pecten spines exceeding at least the basal half of the siphon. . . . 4
Pecten spines restricted to the basal third of the siphon 5
4. (3) Siphon with all tufts of setae located on the distal half; siphonal tufts very long **bonneae**
Siphon with five siphonal tufts arranged in a row except for the subapical tuft; the siphonal tufts normal in length **interrogator**
5. (3) Siphon without strong apical spines (siphonal spicules may be present). 6
Siphon with strong apical spines **coronator**
6. (5) Siphon pubescent 7
Siphon glabrous or minutely spiculate 9
7. (6) Anal gills four, normal 8
Two thick, bulbous anal gills present **bahamensis**
8. (7) Siphonal index 5.0 or greater; pubescence conspicuously longer and more dense at the apex of the siphon **maracayensis**
Siphonal index less than 5.0; pubescence not conspicuously longer or more dense at the apex of the siphon **saltanensis**
9. (6) Thorax minutely spiculate 10
Thorax glabrous (the thoracic integument may appear granulose) . 21
10. (9) Five or more siphonal tufts beyond the pecten 11
Four or less siphonal tufts beyond the pecten 13
11. (10) Apical and subapical pecten teeth not separated from the other pecten teeth; anal segment clothed with minute spicules 12
Apical and occasionally subapical pecten teeth separated from the other pecten teeth; anal segment clothed with minute setae . . **chidesterei**

12. (11) Siphonal index about 6.0; upper and lower frontal head hairs 5 and 6 with three or four branches **levicastilloi**
Siphonal index about 4.5; upper and lower frontal head hairs 5 and 6 multiple **surinamensis**
13. (10) Four siphonal tufts present 14
Three siphonal tufts present 17
14. (13) Anal gills long and bluntly rounded; apical siphonal tuft single or double 15
Anal gills short and pointed; apical siphonal tuft triple . . **habilitator**
15. (14) Siphonal index 7.5 or less 16
Siphonal index 8.0 or greater **covagarciai**
16. (15) Siphonal index 5.5 to 7.0; preantennal head hair 4 with six or seven branches **nigripalpus**
Siphonal index 5.2 to 5.6; preantennal head hair 4 with eight to 10 branches **scimitar**
17. (13) Siphonal index 6.0 or less 18
Siphonal index 8.0 or greater **brevispinosus**
18. (17) Anal gills longer than the length of the anal segment; less than 15 pecten teeth on the siphon 19
Anal gills shorter than the length of the anal segment; about 16 pecten teeth on the siphon **sphinx**
19. (18) Basal siphonal tuft located well beyond the pecten 20
Basal siphonal tuft located close to, or within the pecten . . **declarator**
20. (19) Lower frontal head hair 6 triple; L/S ratio about 4.5 **bidens**
Lower frontal head hair 6 with four or five branches; L/S ratio about 3.5 **mollis**
21. (9) Siphon with five or more siphonal tufts 22
Siphon with less than five siphonal tufts 29
22. (21) Siphonal tufts inserted in a straight line 23
One or more siphonal tufts inserted laterally out of line 25
23. (22) More than five siphonal tufts present on the siphon 24
Five siphonal tufts present on the siphon **tarsalis**
24. (23) Six siphonal tufts present; upper and lower frontal head hairs 5 and 6 with four branches **secutor**
Eight siphonal tufts present; upper and lower frontal head hairs 5 and 6 with more than four branches **finlayi**
25. (22) Siphonal index 6.0 to 8.0 26
Siphonal index 5.0 or less 27
26. (25) Five siphonal tufts present; pecten with 15 teeth **erythrothorax**
Six siphonal tufts present; pecten with 10 teeth **brethesi**
27. (25) Pecten with 10 or more teeth; subapical siphonal tuft with five or less branches 28
Pecten with less than 10 teeth; subapical siphonal tuft with more than five branches **apicinus**
28. (27) Upper frontal head hair 5 with five branches, lower frontal head hair 6 with four branches; pecten with about 15 teeth . . . **diplophyllum**
Upper frontal head hair 5 with six branches, lower frontal head hair 6 with seven branches; pecten with about 10 teeth **peus**
29. (21) Siphonal index 6.0 or less 31
Siphonal index greater than 6.0 30
30. (29) Postclypeal head hair 4 short, double; pecten restricted to the basal third of the siphon **pinarocampa**

- Postclypeal head hair 4 short, single; pecten restricted to the basal fourth of the siphon **salinarius**
31. (29) Siphonal tufts single, double, or at most with one triple siphonal tuft present 33
Some multiple siphonal tufts present 32
32. (31) Four siphonal tufts present on the siphon; siphonal index about 4.0. **piapiens**
Three siphonal tufts present on the siphon; siphonal index about 3.0. **renatoi**
33. (31) Upper and lower frontal head hairs 5 and 6 three or four branched . . . 34
Upper and lower frontal head hairs 5 and 6 multiple 36
34. (33) Siphonal tufts strong, normal in length 35
Siphonal tufts very short and weak **foliaceus**
35. (34) Upper frontal head hair 5 four branched, lower frontal head hair 6 triple **inflictus**
Upper frontal head hair 5 triple, lower frontal head hair 6 double. **carcinoxenus**
36. (33) Postclypeal head hair 4 with five to seven branches; pecten with about 10 teeth 39
Postclypeal head hair 4 single, double or triple; pecten with about 15 teeth 37
37. (36) Postclypeal head hair 4 short, single 38
Postclypeal head hair 4 short, double or triple **restuans**
38. (37) Apical pecten tooth distinctly removed from the other pecten teeth; siphonal tufts single **thriambus**
Apical pecten tooth not separated from the other pecten teeth; siphonal tufts double or triple **acharistus**
39. (36) Basal and subapical siphonal tufts represented by single setae. **abnormalis**
Basal and subapical siphonal tufts represented by double setae. **archegus**

Larvae of the following species are unknown: *Culex airozai*, *C. alani*, *C. articularis*, *C. bickleyi*, *C. camposi*, *C. delys*, *C. duplicator*, *C. lahillei*, *C. laticlasper*, *C. lygrus*, *C. mauensis*, *C. mari*, *C. oswaldoi*, *C. ousqua*, *C. tramazayguesi*, *C. usquatissimus*, and *C. usquatus*.

The following species have not been included in this key due to insufficient information: *Culex dolosus*, *C. pseudojanthinosoma*, *C. spinosus*, and *C. stenolepis*.

***Culex (Culex) abnormalis* Lane, 1936**

FIGURES 3a, b

Culex (Microculex) abnormalis Lane, 1936, p. 189.

Culex (Culex) scutatus Rozeboom and Komp, 1948, p. 396. [New synonymy.]

SYSTEMATICS.—In the original description by Lane (1936) this species was assigned to the subgenus *Microculex*. Subsequently in his monograph, Lane (1953) placed the species in the subgenus *Culex*. Forattini (pers. comm., 1963) re-examined the holotype male and paratype larvae and discovered that the larval paratypes are actually members of the subgenus *Microculex* and that the holotype male properly belongs in the subgenus *Culex*.

Culex scutatus was originally described as a member of the subgenus *Culex* from male specimens along with their associated larval and pupal skins; however, the technique of completely dissecting the male terminalia utilized by the above authors, made comparison with terminalia mounted in the natural closed position difficult. One male paratype was left unmounted, and during this study the male terminalia of this paratype was mounted in the closed position (USNM RB62 718) and forwarded to Dr. Forattini for comparison with the holotype male terminalia of *C. abnormalis*. A comparison of these type specimens revealed that *C. abnormalis* and *C. scutatus* are conspecific (Forattini, pers. comm., 1963).

Characters of the male terminalia indicate some affinity with *Culex tarsalis*, but the arrangement and number of appendices on the apical lobe of the basistyle are clearly distinctive.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, about twice as long as wide; except for the basal fourth, clothed with fine setae in addition to normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and also clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, straight, and pointed; median rod stout, prominently curved apically, and slightly longer than basal rod; apical rod more slender than median rod, prominently curved apically, and slightly longer than median rod; leaf obovate, moderate in size; accessory setae three in number, two of which are prominently curved, the third being long, straight, and slender. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines apically and approximately five spatulate, scalelike spines on the lateral outer margins; basal arm moderate in length and slightly twisted dorsally; about three cercal setae present in a compact group. External process twisted at the apical third, exceeding the ventral cornu in length. Ventral cornu dentiform, pointed, and close to, but larger than the teeth of the median process. Median process possessing about 10 subequal teeth which become progressively larger apically. Basal process small, straight, and only slightly larger than the teeth of the median process.

Larva: The larva of this species was described by Rozeboom and Komp (1948) as *Culex scutatus*. The paratype larvae described by Lane (1936 and 1953) are actually members of the subgenus *Microculex* and were misassociated with the adult form.

Antennal tuft located in a constriction near the outer third. Pre-clypeal spines long and slender. Frontal head hair 4 unusually large, with five to nine branches; frontal head hairs 5, 6, and 7 large, with four branches. Mentum with teeth equal in size, about 12 on each side. Abdominal integument glabrous. Comb with about 40 scales

in a triangular patch; each scale fringed laterally and at the apex. Siphonal index about 4.0; with three pairs of siphonal tufts. Pecten with about 10 teeth on the basal third of the siphon; each tooth with several barbs along the ventral margin. Anal segment completely ringed by the saddle; ventral brush comprised of about six multiple tufts.

MATERIAL EXAMINED.—The holotype and two paratype males and their associated larval and pupal skins of *Culex scutatus* in the U.S. National Museum collection. As indicated above, one paratype male of *C. scutatus* has been compared with the holotype male of *C. abnormalis*.

DISTRIBUTION.—The states of Mato Grosso and Goiaz, Brazil and Villavicencio, Meta, Colombia.

***Culex (Culex) acharistus* Root, 1927**

FIGURES 3c, d

Culex (Culex) acharistus Root, 1927, p. 578.

SYSTEMATICS.—This species is similar to *Culex brethesi*, *C. restuans*, and *C. latielasper*. All four members of this complex demonstrate a reduced mesosome. *C. acharistus*, however, is readily distinguished by the presence of minute annulations on the apical third of the dististyle. This character is best seen under oil immersion or with phase contrast microscopy, and the dististyle must be observed in profile.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and also clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong and slightly hooked at the apex; median rod longer and broader than the basal rod, terminating in an apical hook; distal rod longer than, but not as broad as the median rod, terminating in an apical hook; leaf moderate in size, obovate; two accessory setae present, one long, gently curved and pointed, the other very strong, about as long as the leaf, and prominently hooked. Dististyle normal in size, but with minute annulations on the crest of the apical third. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderate in length, strongly curved; four cercal setae present in a compact group. External process broad and prominent, gently curved so that the point is directed postero-laterally. Ventral cornu absent. Median process with a suggestion of two lightly sclerotized teeth. Basal process short, straight, and bluntly rounded.

Larva: Antennal tuft located in a constriction near the outer third; spiculose basally. Frontal head hairs 5, 6, and 7 multiple. Mentum with about 25 very long teeth. Abdomen glabrous. Comb with a large number of scales in a broad patch; each scale fringed apically. Siphonal index about 3.5; four pairs of siphonal tufts. Pecten with about 14 teeth on the basal third of the siphon; each tooth with several barbs along the ventral margin. Anal segment completely ringed by the saddle.

MATERIAL EXAMINED.—The lectotype male terminalia, and four adult males and associated terminalia from Argentina, Chile, and Colombia.

DISTRIBUTION.—The type locality of this species is Agua Limpa, Minas Geraes, Brazil. Bachman and Casal (1963) reported the species from the states of Jujuy, Cordoba, Rio Negro, and Neuquen, Argentina. The author has seen specimens in the U.S. National Museum collection from: Tucuman, Argentina; Concepción and Puerto Montt, Chile; and Alban, Colombia.

Culex (Culex) airozai Lane, 1945

FIGURE 5a

Culex (Culex) airozai Lane, 1945, p. 204.

SYSTEMATICS.—This species is easily distinguished from all other members of the subgenus by the reduced number of appendices on the apical lobe of the basistyle.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, about twice as long as basal width. Apical lobe undivided and possessing a basal, pointed rod, a small obovate leaf, and a straight, pointed accessory seta. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm strongly curved. External process gradually tapering to an obtuse tip; exceeding the ventral cornu in length. Ventral cornu dentiform, only slightly larger than the teeth of the median process. Median process possessing 10 or more conglomerate teeth. Basal process small, straight, and bluntly rounded.

Larva: Unknown.

MATERIAL EXAMINED.—None. Known to the author only from the descriptions and figures of Lane (1945 and 1953).

DISTRIBUTION.—That of the type locality, Paruary River, Amazonas, Brazil.

Culex (Culex) alani Forattini, 1965

FIGURE 3e, f

Culex (Culex) alani Bram [sic].—Forattini, 1965, p. 143.

SYSTEMATICS.—This species is a member of the complex of species

in which the basal arm of the mesosome is bent, pointed, and directed posteriorly. It is distinguished by the characteristic and diagnostic external process.

SALIENT CHARACTERS.—Adult female: Unknown.

Male terminalia: Basistyle conical, almost three times as long as the basal width; clothed with fine spicules in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and also clothed with fine spicules. Appendices of the apical lobe as follows: basal rod strong, straight and pointed; median and apical rods broader and longer than the basal rod, and terminating in a gentle hook; leaf moderate in size, obovate and possessing minute longitudinal striations; two accessory setae present, one very strong and prominently hooked at the apex, the other more narrow, slightly longer than the leaf, and gently curved. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderate in size, distinctly curved; three cercal setae present. External process expanded to an extremely broad distal third, with a blunt point directed posterolaterally; reaching to about the ventral cornu in length. Ventral cornu dentiform, considerably larger than the teeth of the median process. Median process with about seven to 10 distinct, sharply pointed teeth. Basal process rather broad, pointed, and bent so as to be directed posteriorly.

Larva: Unknown.

HOLOTYPE.—An adult male and associated slide mounted terminalia with the following data: Colombia, Lot 152, 11–XII–40, Catera a Gachancipa, 2650 m, Bates; USNM RB62 205; USNM 67547. One paratype adult male and associated slide mounted terminalia with the following data: Colombia, Lot 156, 12–XII–40, Catera a Gachancipa, 2650 m, Bates; USNM RB61 303; I take pleasure in naming this species in honor of Dr. Alan Stone.

MATERIAL EXAMINED.—The holotype and paratype male terminalia.

DISTRIBUTION.—That of the type locality.

***Culex (Culex) apicinus* Philippi, 1865**

FIGURE 4

Culex (Culex) apicinus Philippi, 1865, p. 596.

Culex (Culex) escomeli Brethes, 1920, p. 41.

Phalangomyia debilis Dyar and Knab, 1914, p. 58.

Culex (Culex) alticola Martini, 1931, p. 216. [New synonymy.]

SYSTEMATICS.—Lane (1951) synonymized *Culex alticola* with *C. apicinus*. Subsequently Stone (1956 (1957)) revalidated *C. alticola* after studying the lectotype male in the British Museum. Although Stone conceded that the two species are very similar, he pointed out differences in the leaf and the retrorse process on the apical lobe of the

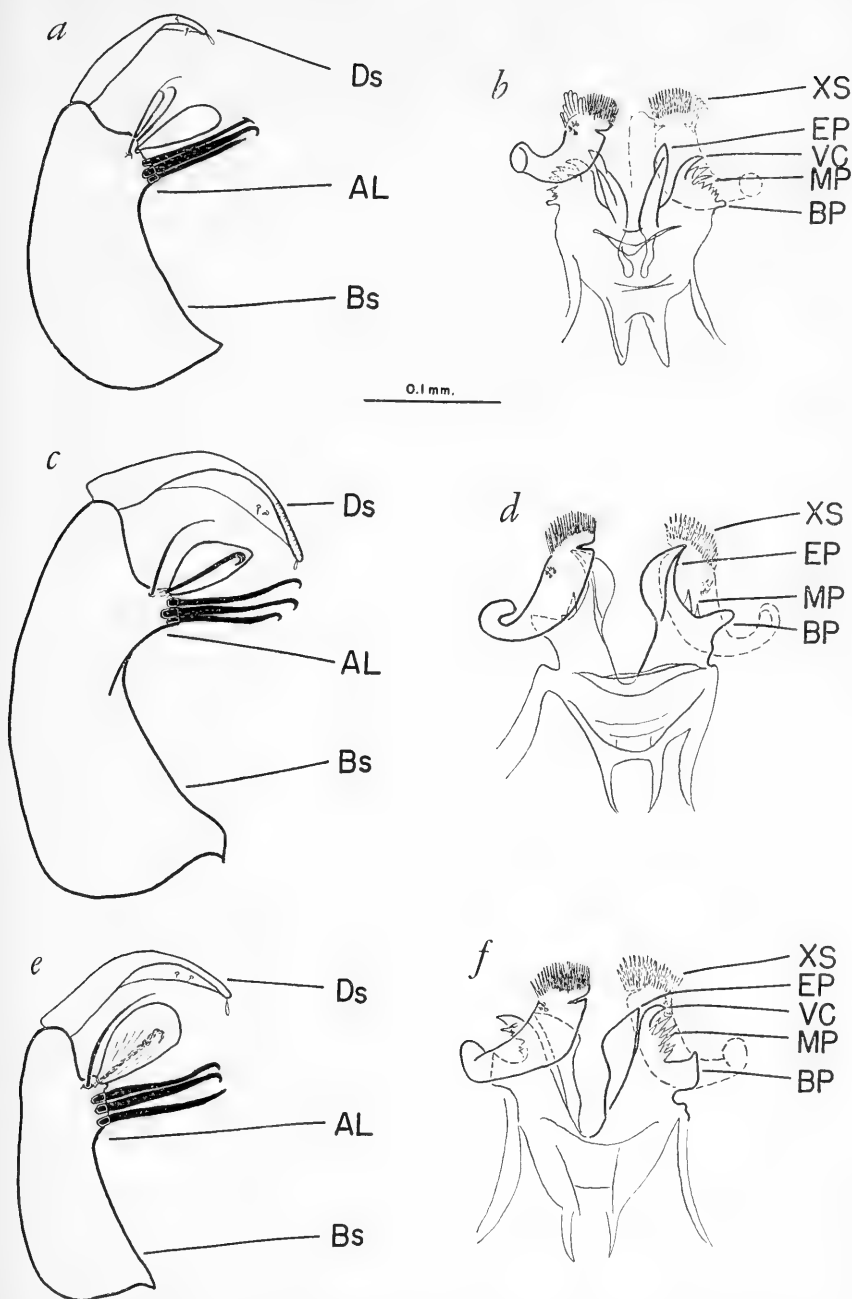


FIGURE 3.—*C. abnormalis*, Villavicencio, Colombia, USNM RB62 718 (paratype of *C. scutatus*): *a*, basistyle and dististyle; *b*, mesosome. *C. acharistus*, Puerto Montt, Chile, USNM RB61 312: *c*, basistyle and dististyle; *d*, mesosome. *C. alani*, Catera a Crachancipa Colombia, USNM RB61 303: *e*, basistyle and dististyle; *f*, mesosome.

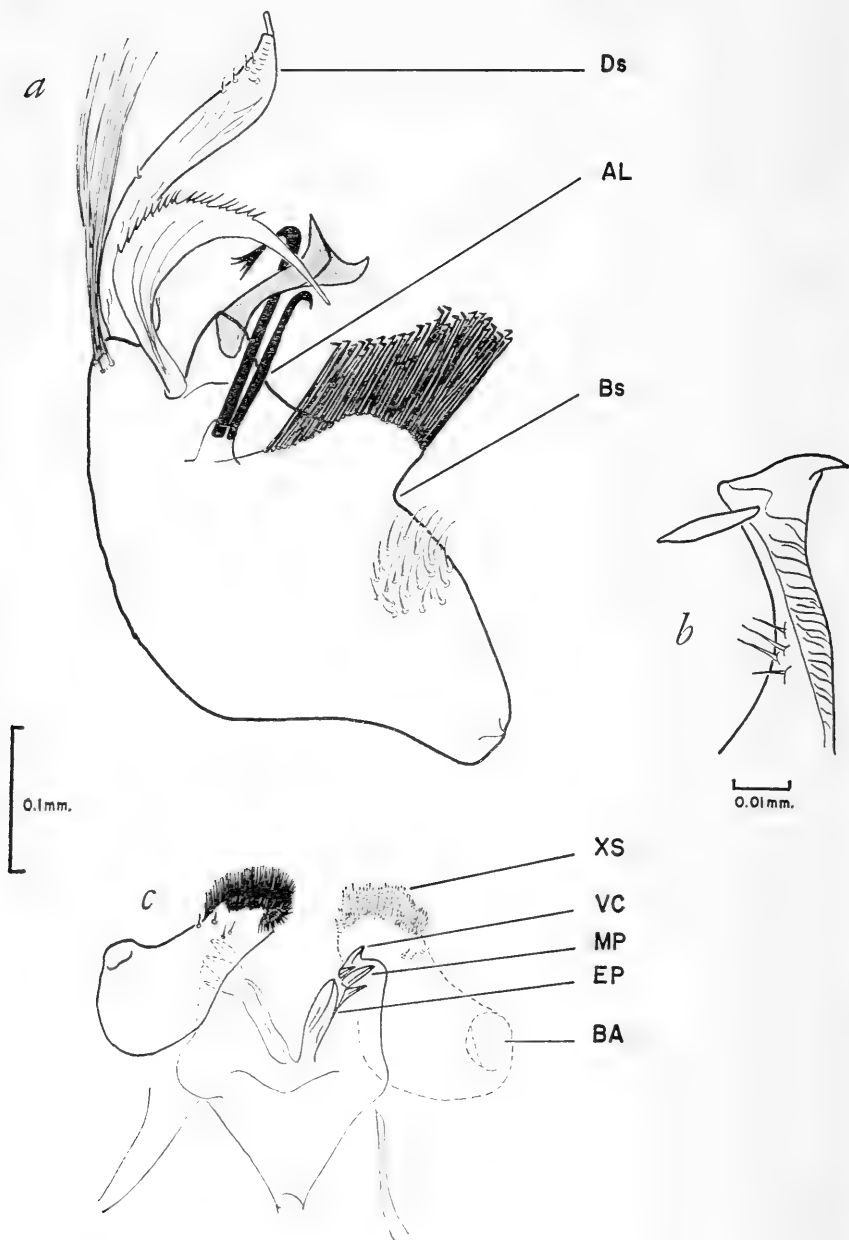


FIGURE 4.—*C. apicinus*, Metucana, Peru, USNM RB62 808 (paratype of *C. debilis*): *a*, basistyle and dististyle; *b*, apex of right dististyle; *c*, mesosome.

basistyle. Mattingly (personal communication, 1962) remounted the male terminalia of the lectotype and sent figures which indicated that the leaves on the apical lobe of the basistyle of both species are identical. Differences in the retrorse process may be attributed to variation within the species (as indicated by variation among other specimens examined). The mesosomes of both species are identical. It is for these reasons that *C. alticola* is here considered a synonym of *C. apicinus*.

Culex apicinus is readily distinguished from other members of the subgenus by the distinctive appendices of the apical lobe of the basistyle and the robust mesosome. The species appears to be somewhat related to *C. articularis*.

SALIENT CHARACTERS.—Female: See table 1.

Male terminalia: Basistyle rather short and stout; not quite twice as long as broad. In addition to normal long setal pattern, basistyle clothed with fine setae; a distinct circular patch of more than 25 long setae on the basal inner surface. Apical lobe of the basistyle divided into two sections; the basal section is characterized by a dense patch of strong, hooked setae, and two very stout, hooked rods (the distal rod being more robust, longer, and with a furcate tip); the distal section of the apical lobe possesses a thick, heavily sclerotized, bi-terminal projection and a large gradually tapering leaf (the basal portion of the leaf is serrate and the apical half tapers gradually to a point). The dististyle is rather stout and tubular; minute annulations ring the apical fourth and the apex is developed into a hooked structure; four to six setae are present on the dististyle in contrast to the normal complement of two. Tenth sternite crowned with a dense tuft of short, pointed spines; the basal arm very short, thick, and slightly curved: three to six cercal setae present, broadly distributed on the tenth sternite. External process robust, gradually tapering apically but not reaching the ventral cornu. Ventral cornu dentiform, indistinguishable from the teeth of the median process. Median process with three or four stout, pointed teeth. Basal process represented only by a slight basal bulge of the median process.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; frontal head hairs 5, 6, and 7 long, multiple. Mentum with about 13 robust teeth; the apical tooth larger than the lateral teeth. Body glabrous. Comb with numerous scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index about 3.0; six multiple siphonal tufts present, the apical tuft short and only double. Pecten with about eight teeth

restricted to the basal third of the siphon; distal teeth larger than proximal teeth; each tooth with about five coarse barbs on one side. Anal segment spiculate, completely ringed by the saddle.

MATERIAL EXAMINED.—Five male specimens from Bolivia, Chile, and Peru.

DISTRIBUTION.—Reported from the mountains of Peru, Chile, and Bolivia.

***Culex (Culex) archegus* Dyar, 1929**

FIGURES 5b, c

Culex (Culex) archegus Dyar, 1929, p. 511.

SYSTEMATICS.—Lane (1951) synonymized *Culex archegus* with *C. articularis*. Although, according to Stone et al. (1959) the type of *C. articularis* is nonexistent, Lane's decision was not entirely arbitrary (Lane's 1953 concept of *C. articularis* and *C. archegus* were synonymous). Dyar (1928), however, considered *C. articularis* as a distinct species from *C. articularis* sensu Lane (= *C. archegus*). Lane (1953) did not even consider *C. articularis* sensu Dyar (1928). Since a neotype will be designated for *C. articularis* Philippi sensu Dyar, *C. archegus* Dyar is here revalidated.

Culex archegus is a member of the *salinarius* complex due to the morphology of the male terminalia, but differs from *C. salinarius*, *C. dolosus*, *C. spinosus*, and *C. alani*, by possessing a clavate ventral cornu. Other characters of the mesosome are also distinctive.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly more than twice as long as the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided and also clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, pointed, and curved at the apical tip; median rod somewhat more robust, prominently curved apically, and slightly longer than basal rod; apical rod more slender than median rod, prominently curved apically, and slightly longer than median rod; leaf obovate, moderate in size; accessory setae two, one short and hooked, the other long and gently curved. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm long and moderately curved; three or four cercal setae present. External process gradually tapering to a pointed tip, exceeding the ventral cornu in length. Ventral cornu dentiform, slightly separated from the teeth of the median process. Median process possessing about six subequal, sharply pointed teeth. Basal process rather stout, acutely bent posteriorly, pointed, and reaching to approximately the middle of the teeth of the median process.

Larva: After Levi-Castillo (1953). Antennal tuft located in a constriction near the outer third; spiculate basally. Head hairs 5, 6,

and 7 long, multiple, barbed. Body spiculate. Comb with numerous scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index about 4.5; four double siphonal tufts present beyond the pecten. Pecten with 13 to 15 teeth on the basal third of the siphon; each tooth with three to five barbs on one side. Anal segment completely ringed by the saddle.

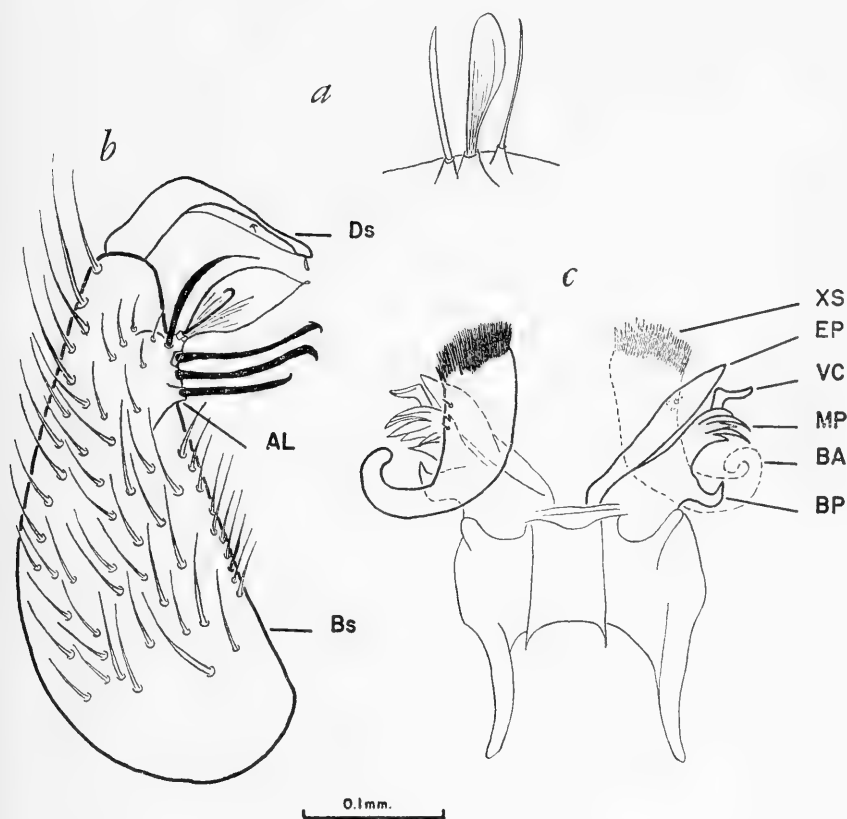


FIGURE 5.—*C. airozai*, Rio Paruari, Brazil (drawn after Lane, 1945): *a*, apical lobe of basistyle. *C. archegus*, Tarma, Peru, USNM RB62 303 (paratype): *b*, basistyle and dististyle; *c*, mesosome.

MATERIAL EXAMINED.—The holotype male and a paratype male from Tarma, Peru; six males from Tinga Maria, Peru, and two males from Bogotá, Colombia.

DISTRIBUTION.—Reported from the type locality, Tarma, Peru, and Quito, Ecuador. Specimens in this study have been examined from Tinga Maria, Peru, and Bogotá, Colombia.

Culex (Culex) articularis Philippi, 1865

FIGURE 6

Culex (Culex) articularis Philippi, 1865, p. 596.

SYSTEMATICS.—Philippi (1865) described *Culex articularis* from Chile. Subsequently Dyar (1928) figured the distinctive male terminalia of this species. Lane (1951) synonymized *C. archgeus* with *C. articularis* and in his monograph (1953) included figures of the male terminalia of what he considered to be *C. articularis*. The terminalia of *C. articularis* sensu Lane, however, do not agree with the terminalia of *C. articularis* sensu Dyar, but are obviously those of *C. archgeus*. Lane, in fact, did not even consider *C. articularis* sensu Dyar in his monograph under any name. Since no type specimen of *Culex (Culex) articularis* Philippi, 1865 exists (Stone et al., 1959), a neotype is hereby designated in accordance with article 75 of the International Code of Zoological Nomenclature (1961) in order to stabilize the nomenclatorial status of this species.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to normal, long setal pattern. Apical lobe of the basistyle rather flattened, undivided and also clothed with fine setae. Appendices of the apical lobe as follows: a dense basal patch of slender setae; basal rod strong, blunt, very slightly curved; median rod stout, curved, and slightly longer than basal rod; apical rod stout, curved, and slightly longer than the median rod; a broad, unusually hooked, rodlike projection; leaf narrow, curved, and pointed apically with minute striations; accessory setae three or four in number, one strong, as long as leaf and gently curved, and two or three short, straight, slender setae. Dististyle normal in size but minutely annulate at the distal third. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm robust and strongly recurved; possessing three to four cercal setae. External process gradually tapering to a point, slightly exceeding the ventral cornu in length. Ventral cornu dentiform, slightly larger than, and close to the teeth of the median process. Median process with about five distinct teeth. Basal process stout, pointed, and sharply bent so as to be directed posteriorly; some specimens have been observed, however, in which the basal process is straight and pointed.

Larva: Unknown.

NEOTYPE.—A male and associated slide mounted terminalia deposited in the U.S. National Museum with the following data: Casa Pangué, Llanquihue, Chile; December 1926; R. and E. Shannon; USNM RB62 554.

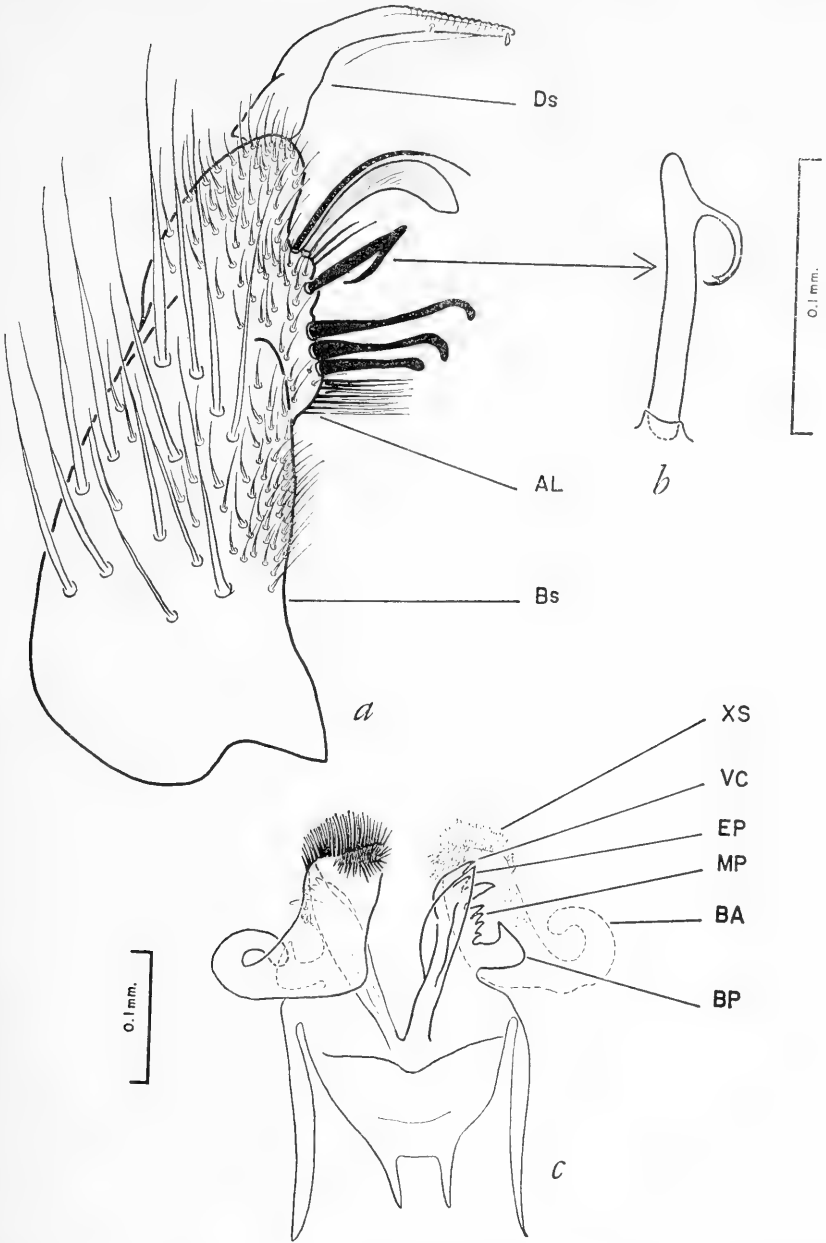


FIGURE 6.—*C. articularis*: *a*, basistyle and dististyle, Casa Pangué, Chile, USNM RB62 554; *b*, seta on apical lobe of basistyle (enlarged), Rio Negro, Argentina, USNM 2321; *c*, mesosome, Bariloche, Rio Negro, Argentina, USNM RB61 66.

MATERIAL EXAMINED.—Five male specimens and their associated terminalia from Argentina, and three male specimens from Chile.

DISTRIBUTION.—This species was described from Corral, Valdivia, Chile. Dyar (1929) reported that it was collected at several localities around Lake Nahuel Huapi, Argentina, and Lake Guiterrez, both Chilean and Argentine sides. The author has seen specimens in the U.S. National Museum from: Bariloche and Corren Tose, Rio Negro, Argentina; Puerto Montt and Casa Pangué, Llanquihue, Chile.

***Culex (Culex) bahamensis* Dyar and Knab, 1906**

FIGURES 7a-c

Culex (Culex) bahamensis Dyar and Knab, 1906b, p. 210.

Culex (Culex) eleuthera Dyar, 1917 (1918), p. 184.

Culex (Culex) petersoni Dyar, 1920, p. 27.

SYSTEMATICS.—This species belongs to the group in which the apical lobe of the basistyle lacks a leaflike appendicle. It is easily distinguished from other members of the subgenus by the distinctive arrangement of appendicles on the apical lobe of the basistyle, the annulate dististyle and the robust mesosome. The larva is characterized by having only two anal gills present.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, less than twice as long as the basal width; clothed with fine setae in addition to normal, long setal pattern. Apical lobe of the basistyle prominent, divided into two sections, and also clothed with fine setae. Appendicles of the apical lobe as follows: basal rod short, narrow (in comparison to median and apical rods), and gently hooked distally; median rod very broad, longer than basal rod, and strongly hooked on the distal fourth; apical rod strong, about twice as long as basal rod, and gently hooked terminally; the distal section of the apical lobe possesses approximately five subequal straight setae, and about three long, strong, rodlike setae; no leaf is present. Dististyle rather narrow, with minute annulations on the apical fourth. Tenth sternite crowned with a sparse tuft of short, pointed spines; basal arm robust, short, and straight; approximately seven cercal setae broadly distributed on the tenth sternite. External process rather broad, straight, and gently tapering to an obtuse tip; about twice as long as the ventral cornu. Ventral cornu very broad, sharply bent at the apical fourth and tapering to a point; distinctly separated from the teeth of the median process. Median process with about 15 to 20 small conglomerate teeth. Basal process absent.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; upper and lower frontal head hairs 5 and 6 long, multiple,

barbed; preantennal head hair 7 multiple. Mentum with about seven bluntly rounded teeth; the apical tooth is broader and longer than the lateral teeth. Body finely and sparsely spiculate. Comb with many scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index 3.5 to 4.5; siphon finely and densely spiculate basally, progressively more coarsely spiculate apically; six or seven multiple siphonal tufts present. Pecten with 10 to 14 teeth reaching a little beyond the basal third of the siphon; each tooth with coarse barbs on one side. Anal segment completely ringed by the saddle; the saddle darkly pigmented dorsally. Anal gills two, short, bulbous.

MATERIAL EXAMINED.—The male terminalia of 17 specimens from the Bahama and Virgin Islands, Puerto Rico, and Cuba; the lectotype larva and 10 other larval specimens.

DISTRIBUTION.—Reported from the Bahama Islands (the type locality), the Antilles, Trinidad, and the southern tip of Florida. A questionable record is from French Guiana.

Culex (Culex) bickleyi Forattini, 1965

FIGURES 7*d, e*

Culex (Culex) bickleyi Bram [sic].—Forattini, 1965, p. 146.

SYSTEMATICS.—The structures of the male terminalia of this species are rather generalized, but it may be readily distinguished from the other members of the subgenus by the pointed and gently curved basal process of the mesosome. Some specimens also exhibit an auxillary point on the basal process.

SALIENT CHARACTERS.—Adult female: Unknown.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and also clothed with fine setae. Appendices of the apical lobe as follows: basal rod straight, strong and rounded terminally; median rod broader and longer than the basal rod, and terminating in a small hook; apical rod not as broad as, but longer than the median rod, also terminating in a small hook; leaf moderate in size, obovate, exhibiting distinct longitudinal striations; two accessory setae present, one about as long as the leaf and prominently hooked terminally, the other very strong, pointed, gently curved, and longer than the leaf. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderate in length, prominently curved at the apex; three or four cercal setae present. External process gradually tapering to a blunt point; exceeding the ventral cornu in length. Ventral cornu dentiform, very similar in size and

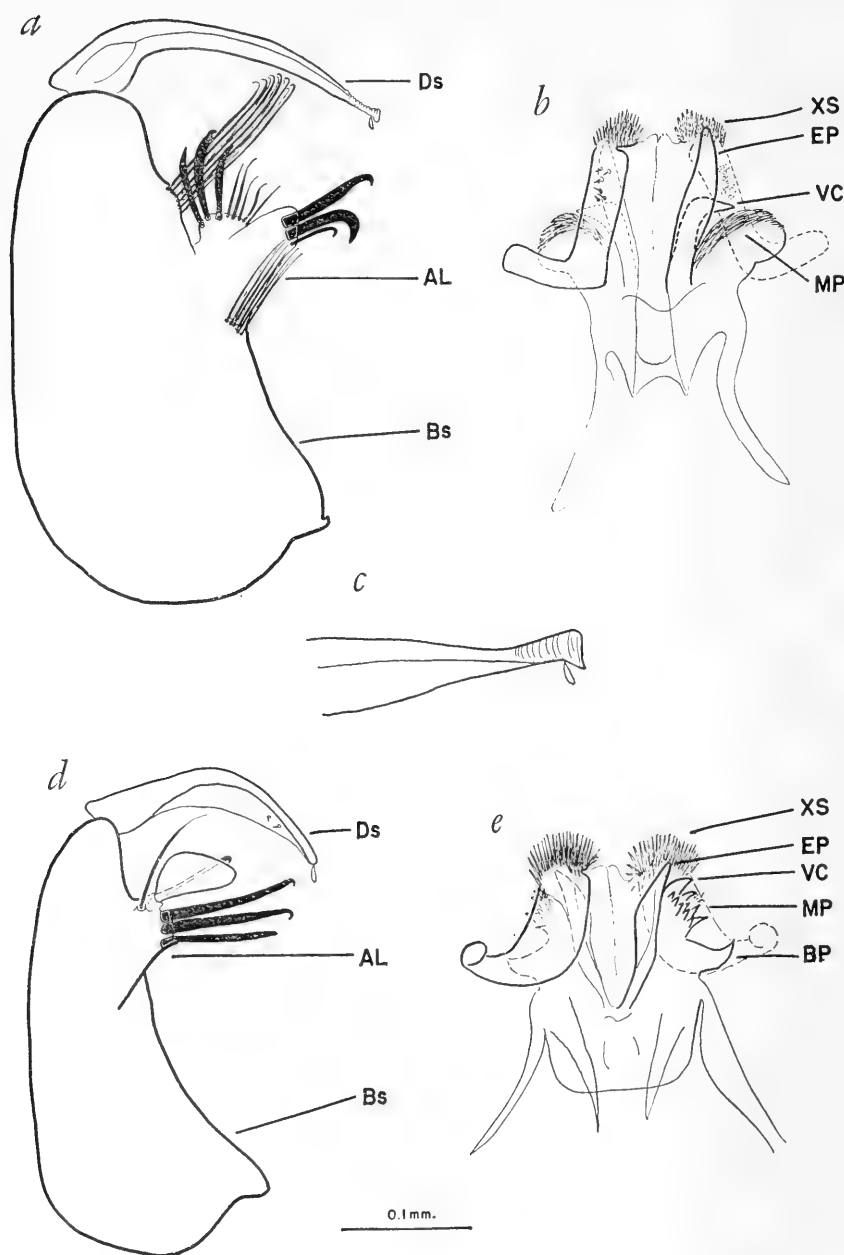


FIGURE 7.—*C. bahamensis*: *a*, basistyle and dististyle, Guanica Lake, P.R., USNM RB62 68; *b*, mesosome, Salmas, P.R., USNM RB62 30; *c*, apex of dististyle (enlarged), Guanica Lake, P.R., USNM RB62 68. *C. bickleyi*, Bogotá, Colombia, USNM RB62 143 (holotype): *d*, basistyle and dististyle; *e*, mesosome.

shape to the teeth of the median process. Median process with about nine sharply pointed, distinct teeth. Basal process sharply pointed distally, gently curved so as to be directed posterolaterally; occasionally with an auxillary point directed posteriorly.

Larva: Unknown.

HOLOTYPE.—An adult male and associated slide mounted terminalia with the following data: Bosque calderon; Bogotá, Colombia; No. Lab. 4161; RB62 143; USNM 67548. Paratypes, six adult males and associated slide mounted terminalia from Bogotá, Colombia with the following data: No. Lab. 4161, RB62 604; No. Lab. 4158, RB62 137; No. Lab. 4159, RB62 115; No. Lab. 4159, RB62 140; No. Lab. 4168, RB62 146; and No. Lab. 4168, RB62 147. I take pleasure in naming this species in honor of Dr. William E. Bickley.

MATERIAL EXAMINED.—The holotype and six paratype males and associated terminalia from Colombia, four specimens from Ecuador, and two specimens from Jamaica.

DISTRIBUTION.—As reported above; Colombia, Ecuador, and Jamaica.

Culex (Culex) bidens Dyar, 1922

FIGURES 8a, b

Culex (Culex) bidens Dyar, 1922b, p. 190.

Culex (Culex) interfor Dyar, 1928, p. 372. [New synonymy.]

Culex (Culex) virgultus (= *C. declarator*) sensu Bachmann and Casal (1962), p. 77. [Misidentification.]

SYSTEMATICS.—Lane (1953) synonymized *Culex bidens* with *C. virgultus* (= *C. declarator*; see Stone, 1956 (1957)). During this study the lectotype male terminalia of both *C. bidens* and *C. declarator* were critically examined, compared, and found to be distinct and valid species. Therefore, *C. bidens* is here revalidated. The lectotype male terminalia of *C. interfor* was also examined and found to be conspecific with *C. bidens*. Thus, *C. interfor* is here synonymized with *C. bidens*.

Culex bidens is very similar to *C. declarator*, the species from which it is here revalidated; however, the teeth on the median process of the mesosome are distinctive and diagnostic. In *C. bidens* the individual teeth are long, straight, laterally directed, and sharply pointed. In *C. declarator* these teeth are robust, curved, have somewhat convex margins, and are rather bluntly rounded. In both species the number of teeth may range from one to six.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and

clothed with fine setae. Appendicles of the apical lobe as follows: basal rod strong, pointed and slightly curved; median and apical rods slightly longer than the basal rod, gently hooked at the distal end; leaf normal, obovate, with minute, longitudinal striations visible; one accessory seta gently curved and about as long as the leaf, the other accessory seta is prominently hooked and flattened apically. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm somewhat flattened and bent at an acute angle; two or three cercal setae present. External process lightly sclerotized (difficult to see without phase contrast), short, straight, and obtuse. Ventral cornu dentiform, equal in size and shape to the teeth of the median process. Median process with one to three strong, straight teeth, which are somewhat extended laterally. Basal process short, pointed, and directed anteriorly.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; upper and lower frontal head hairs 5 and 6 long, triple; pre-antennal head hair 7 multiple. Mentum with about 17 teeth; the apical tooth very broad and longer than lateral teeth; the two basal lateral teeth longer than other lateral teeth. Thorax spiculate. Comb with numerous scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index about 3.5; with three pairs of double or triple siphonal tufts present beyond the pecten. Pecten with about 12 teeth on the basal third of the siphon; each tooth with four to six coarse barbs on one side. Anal segment spiculate, completely ringed by the saddle.

MATERIAL EXAMINED.—The male terminalia of 53 specimens from Argentina, Brazil, Mexico, and Venezuela, as well as the lectotype male from Bolivia; twelve larval specimens from Brazil.

DISTRIBUTION.—It appears that *Culex bidens* has a more southern distribution than its close relative, *C. declarator*. It ranges from central Argentina northward to Venezuela and into southern Mexico. Little reliance can be placed on previous records due to the confusion between this species and the names *declarator*, *interfor*, and *virgultus*.

***Culex (Culex) bonneae* Dyar and Knab, 1919**

FIGURES 8c, d

Culex (Culex) bonneae Dyar and Knab, 1919, p. 3.

SYSTEMATICS.—In the male terminalia this species is very similar to *Culex saltanensis* but can be distinguished by the lack of pilosity on the tenth sternite. The appendices of the apical lobe of the basistyle also differ between these two species.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, less than twice as long as the basal width; clothed with spiculate setae in addition to normal, long setal pattern. Apical lobe of the basistyle somewhat flattened, undivided, and also clothed with spiculate setae. Appendices of the

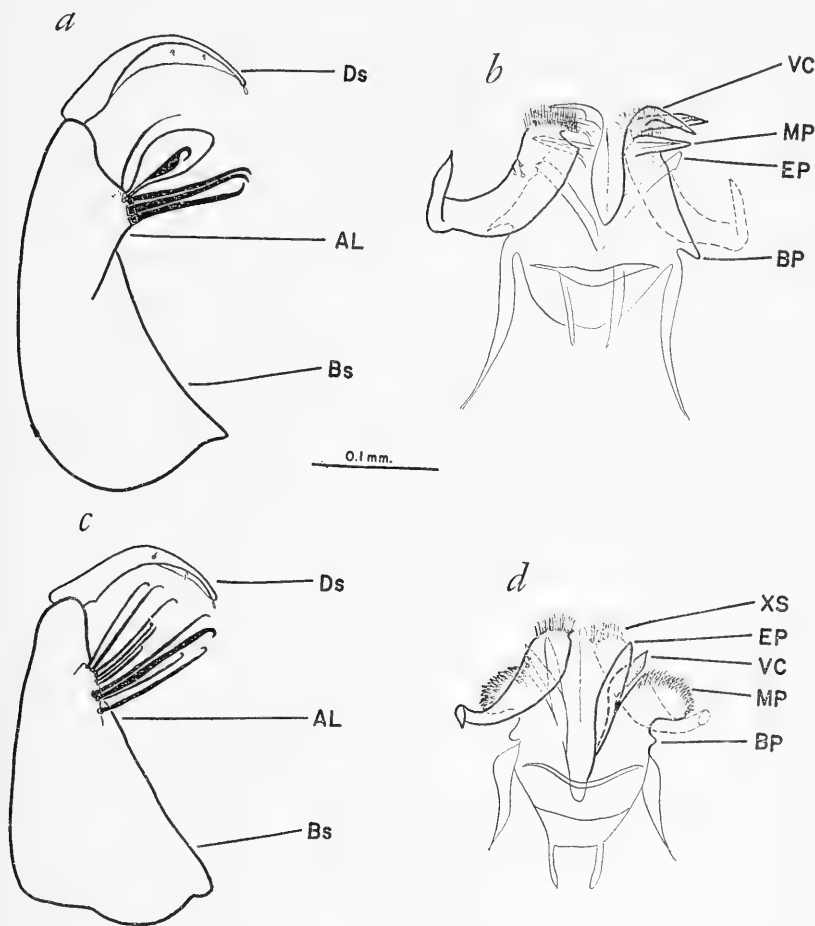


FIGURE 8.—*C. bidens*, Bahia, Brazil: *a*, basistyle and dististyle, USNM RB61 157; *b*, mesosome, USNM RB61 103. *C. bonneae*, Rio Duque, Panama: *c*, basistyle and dististyle, USNM RB62 215; *d*, mesosome, USNM RB61 3.

apical lobe as follows: approximately 10 or more subequal spines and setae distributed on the lobe; leaf absent. Dististyle normal. Tenth sternite crowned with a sparse tuft of short, pointed spines; basal arm short and slightly curved distally; two cercal setae present. External process, strong, straight, and gradually tapering to a blunt point;

exceeding the ventral cornu in length. Ventral cornu dentiform, very strong, and sharply pointed; distinctly separated from the teeth of the median process. Median process with 20 or more small, sharply pointed, conglomerate teeth. Basal process represented by a short, bluntly rounded projection of the mesosome.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; upper and lower frontal head hairs 5 and 6 long, triple; pre-antennal head hair 7 long, multiple. Mentum rather broad with about 17 teeth; apical tooth very broad and larger than the lateral teeth; lateral teeth progressively smaller apically. Comb with numerous scales in a patch; each scale rounded apically and fringed with sub-equal spinules. Siphonal index about 2.5 to 3.0; four multiple siphonal tufts on the distal third of the siphon. Pecten with about 16 teeth extending to the apex of the siphon; each tooth, except for the apical four teeth, with several small barbs on one side; apical four teeth not barbed, strong, straight, and pointed. Anal segment glabrous, completely ringed by the saddle.

MATERIAL EXAMINED.—Six male specimens from Panama, one male from Para, Brazil, and the lectotype male terminalia from Surinam.

DISTRIBUTION.—This species has been reported from Panama, Surinam, French Guiana, and Brazil.

Culex (Culex) brethesi Dyar, 1919

FIGURES 9a, b

Culex (Culex) brethesi Dyar, 1919, p. 86.

SYSTEMATICS.—This species was originally described by Dyar (1919) from a figure of a male terminalia published by Brèthes (1916). The position of this species was questionable until work by Bachmann and Casal (1962) in which the terminalia was redescribed and the immature stages described for the first time.

Culex brethesi is a member of the *restuans-laticlasper-acharistus* complex, all species with a reduced mesosome. It is distinguished by possessing only one accessory seta next to the leaf on the apical lobe of the basistyle.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, less than twice as long as the basal width; clothed with fine setae in addition to normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and also clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, very slightly hooked at apex; median rod broader and slightly longer than basal rod, prominently hooked at apex; apical rod about as broad as basal rod and with a prominent apical curve; leaf

normal in size, tapered to a bluntly rounded apical point, and possessing minute, longitudinal striations; one long, gently curved accessory seta next to the leaf. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderately long, curved, and somewhat flattened distally; three cercal setae present. External process not present. Ventral cornu large, gently curved, and tapering to a point. Median process with two or less small, lightly sclerotized denticles. Basal process absent.

Larva: The larva and pupa of this species were described for the first time by Bachmann and Casal (1962). Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; frontal head hairs 5, 6, and 7 short, multiple. Mentum with about 12 subequal teeth. Comb with many scales in two or three rows; each scale rounded apically and fringed with subequal spinules. Siphonal index about 6.0; with six pairs of double or triple siphonal tufts beyond the pecten. Pecten with 12 to 13 teeth, restricted to the basal fourth of the siphon. Anal segment completely ringed by the saddle, which is covered with very fine spinules.

MATERIAL EXAMINED.—The male terminalia of three specimens from Argentina.

DISTRIBUTION.—Reported from the states of Cordoba, Misiones, Santiago del Estero, Buenos Aires, and Mendoza, Argentina. A questionable record is from Brazil.

***Culex (Culex) brevispinosus* Bonne-Wepster and Bonne, 1919 [1920]**

FIGURES 9c, d

Culex (Culex) brevispinosus Bonne-Wepster and Bonne, 1919 [1920], p. 171.

SYSTEMATICS.—This species is closest to *Culex surinamensis*, but can be distinguished by the clavate ventral cornu. The distinctive teeth of the median plate of the mesosome are also diagnostic.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle tubular, three times as long as the basal width; extremely minute spinules present (seen only with phase contrast) in addition to normal, long setal pattern. Apical lobe of the basistyle rather flattened and undivided. Appendices of the apical lobe as follows: three straight, thin rods which are subequal in length followed by approximately 10 straight, narrow setae; no leaf is present. Dististyle normal. Tenth sternite crowned with a sparse tuft of short, pointed spines; basal arm long and prominently recurved; two cercal setae present. External process moderate, gently incurved, and tapering to a point; not reaching the ventral cornu. Ventral cornu dentiform, close to the teeth of the median process. Median

process with approximately eight pointed and distinctly separated teeth. Basal process short, straight, and bluntly rounded.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; upper and lower frontal head hairs 5 and 6 long, triple and barbed; preantennal head hair 7 long, multiple, barbed. Mentum with about 12 teeth; the apical tooth very broad and larger than the lateral teeth; the subbasal lateral tooth longer than other lateral teeth. Body finely spiculate. Comb with many scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index about 10.0; with three double or single siphonal tufts on the apical half of the siphon. Pecten with about 16 teeth on the basal fourth of the siphon; the apical tooth separated from the other teeth; each tooth with about five coarse barbs on one side. Anal segment completely ringed by the saddle, finely spiculate.

MATERIAL EXAMINED.—Two male specimens and their associated terminalia from Surinam, one of which was a paratype.

DISTRIBUTION.—Reported from Surinam (the type locality), Colombia, Venezuela, and Brazil.

Culex (Culex) carcinoxenus Castro, 1932

FIGURES 10a, b

Culex (Culex) carcinoxenus Castro, 1932, p. 99.

SYSTEMATICS.—In *Culex carcinoxenus* the apical lobe of the basistyle possesses only one accessory seta next to the leaf. This species can be distinguished from *C. corniger* by the normal shape of the external process.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical. Apical lobe somewhat flattened. Appendices of the apical lobe as follows: three subequal, hooked rods; leaf moderate in size, pointed apically; one rather broad accessory seta next to the leaf. Dististyle normal, but with a slight median bulge. Tenth sternite crowned with a dense tuft of short, pointed spines; the basal arm recurved and moderate in length. External process gradually tapering to a point and reaching approximately to the ventral cornu. Ventral cornu dentiform, somewhat larger than the teeth of the median process. Median process with about five distinct teeth. Basal process robust, straight, and pointed.

Larva: Antennal tuft located in a constriction near the outer third. Postclypeal head hair 4 single; upper frontal head hair 5 triple; lower frontal head hair 6 double; preantennal head hair 7 multiple. Comb with over 25 scales in a triangular patch; individual scales not fringed. Siphonal index 5.0 to 5.5; four pairs of siphonal tufts inserted on the

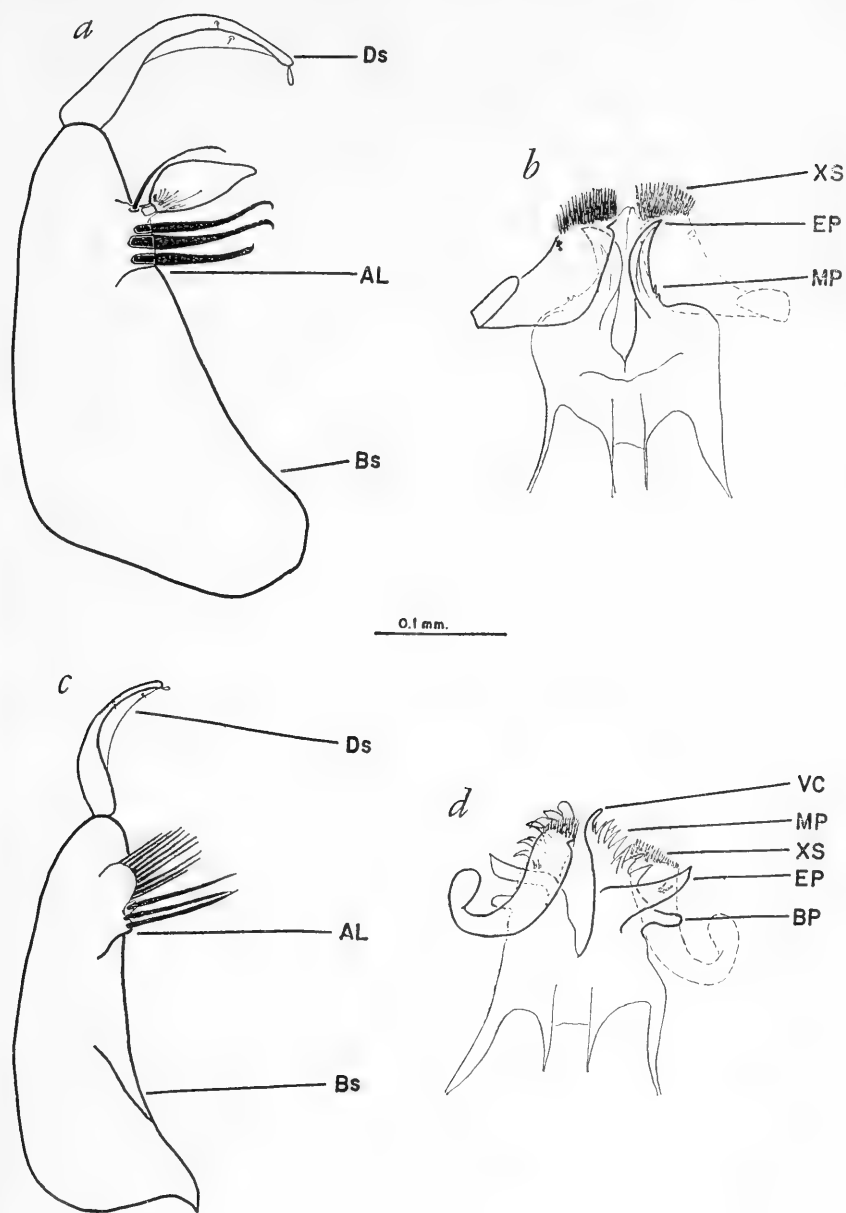


FIGURE 9.—*C. brethesi*: a, basistyle and dististyle, Santiago del Estero, Argentina, USNM Ad. 1683; b, mesosome, Buenos Aires, Argentina, USNM 1918. *C. brevispinosus*, Surinam, USNM RB62 231 (paratype): c, basistyle and dististyle; d, mesosome.

siphon. Pecten with about 11 to 15 teeth on the basal third of the siphon. Anal segment completely ringed by the saddle.

MATERIAL EXAMINED.—None. Known to the author only from descriptions and figures found in the literature.

DISTRIBUTION.—Known only from the type locality, Bertioga, São Paulo, Brazil.

Culex (Culex) chidesteri Dyar, 1921

FIGURE 10c, d

Culex (Culex) chidesteri Dyar, 1921b, p. 117.

Culex (Culex) deanei Correa and Ramalho, 1959, p. 141. [New synonymy].

SYSTEMATICS.—Comparison of the paratype male terminalia of *Culex deanei* (SEMPDC 6.777) with the holotype male terminalia and a series of other specimens of *C. chidesteri* revealed that these two species are conspecific. Therefore, *C. deanei* is here designated a synonym of *C. chidesteri*.

Culex chidesteri is similar to *C. nigripalpus* by possessing broad, spatulate spines on the lateral margins of the tenth sternite; it is similar to *C. peus* in that both possess a large, rounded, and rugulose ventral cornu; however, the broadly curved and laterally directed external process is distinctive.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong and hooked at the apex; median rod longer and broader than the basal rod and with a prominent terminal hook; apical rod about as broad as the basal rod, slightly longer than the median rod, and hooked terminally; leaf small, obovate, with minute longitudinal striations; two subequal accessory setae, one gently curved, the other prominently hooked. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines apically and spatulate, scalelike spines on the lateral outer margins; basal arm moderate in length, slightly curved; two cercal setae present. External process broad and curved so as to be directed to a lateral point; not reaching the ventral cornu. Ventral cornu large, rounded, and rugulose. Median process with 15 or more short, pointed, conglomerate teeth. Basal process absent.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; upper frontal head hair 5 with six to eight branches; lower frontal head hair 6 long, triple; preantennal head hair 7 multiple. Mentum broad, with about 13 teeth; the apical tooth is generally

larger than the lateral teeth; the sub-basal lateral teeth longer than the other lateral teeth. Thorax and abdomen spiculate. Comb with numerous scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index more than 8.0; siphon slender and only slightly tapered; seven to nine pairs of two to four branched siphonal tufts inserted in a straight line. Pecten with nine to 12 teeth on the basal third of the siphon; each tooth with three to five coarse barbs on one side. Anal segment completely ringed by the saddle; gills shorter than the saddle.

MATERIAL EXAMINED.—Three adult males and associated terminalia from Argentina, two from Brazil, two from Ecuador, two from Puerto Rico, one from Venezuela, and one from Texas. The lectotype male from Panama was also studied.

DISTRIBUTION.—Reported from Panama (the type locality), Costa Rica, Mexico, Texas, Puerto Rico, Jamaica, Lesser Antilles, Venezuela, Colombia, Ecuador, Brazil, and a questionable record from Bolivia. The author has seen specimens in the U.S. National Museum collection from Concepción and Medinas, Tucuman, Argentina.

Culex (Culex) corniger Theobald, 1903

FIGURES 10e, f

Culex (Culex) corniger Theobald, 1903a, p. 173.

Culex (Culex) basilicus Dyar and Knab, 1906a, p. 169.

Culex (Culex) hassardii Grabham, 1906, p. 167.

Culex (Culex) lactator Dyar and Knab, 1906b, p. 209.

Culex (Culex) subfuscus Theobald, 1907, p. 403.

Culex (Culex) loquaculus Dyar and Knab, 1909a, p. 254.

Culex (Culex) rigidus Senevet and Abonnenc, 1939, p. 68.

SYSTEMATICS.—*Culex corniger* is distinctive from other members of the subgenus having only one accessory seta next to the leaf on the apical lobe of the basistyle by possessing a short, pointed, distinctive external process.

SALIENT CHARACTERS.—Adult female: See table 1.

Adult male: Basistyle tubular, two and a half times as long as the basal width; clothed with fine setae in addition to normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and clothed with fine setae. Appendices of the apical lobe as follows: basal rod narrow, straight, and pointed; median rod robust, longer than basal rod, and prominently hooked at the apex; apical rod similar in size and shape to the basal rod; leaf short and truncate, with some minute, basal, longitudinal striations; accessory seta long and gently curved. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderate in length, strongly curved at the distal end; two cercal setae present. External process narrow, straight, and sharply pointed; not reaching the ventral cornu.

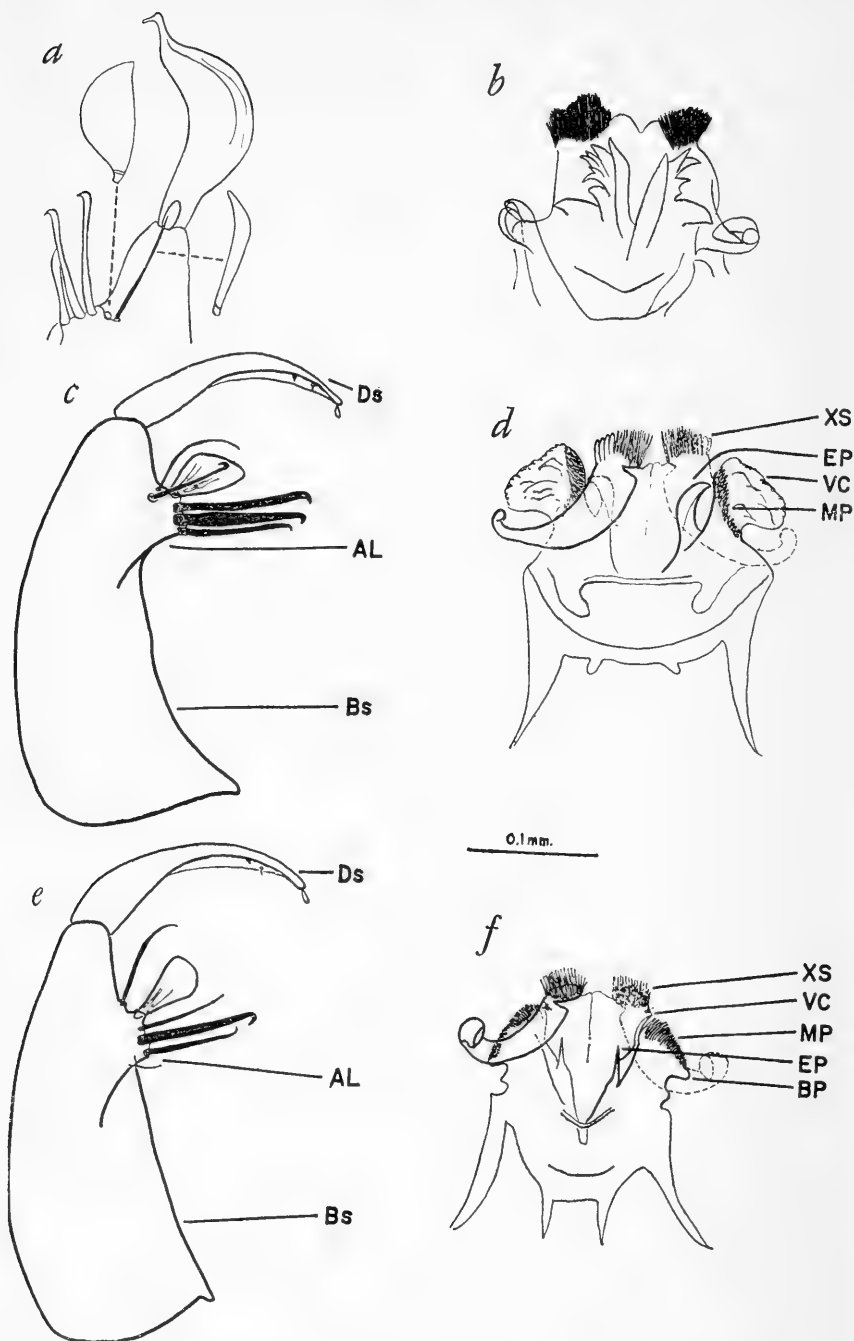


FIGURE 10.—*C. carcinoxenus* (drawn after Castro, 1932): *a*, basistyle and dististyle; *b*, mesosome. *C. chidesteri*: *c*, basistyle and dististyle, Bahia, Brazil, USNM RB61 137; *d*, mesosome, Mayaguez, P.R., USNM RB61 409. *C. corniger*, Para, Brazil: *e*, basistyle and dististyle, USNM RB61 87; *f*, mesosome, USNM RB62 577.

Ventral cornu dentiform, close to the teeth of the median process. Median process with over 15 conglomerate teeth. Basal process represented by only a small, bluntly rounded knob.

Larva: Antenna fusiform, glabrous; antennal tuft short, double, located on about the middle of the antenna. Postclypeal head hair 4 long, double; upper frontal head hair 5 longer than head hair 4, also double; lower frontal head hair 6 long, triple; preantennal head hair 7 long, multiple. Mentum with about 28 very narrow, long teeth; the apical tooth somewhat longer and broader than the lateral teeth. Body glabrous. Comb with about 35 scales in a triangular patch; each scale rounded apically and fringed with subequal spinules. Siphonal index about 2.5; five multiple siphonal tufts randomly placed on the siphon. Pecten with about 10 long, pointed teeth on the basal half of the siphon; basal teeth possessing one or two fine barbs on one side. Anal segment completely ringed by the saddle, with several prominent spicules in a patch at the apex.

MATERIAL EXAMINED.—Twenty-one adult males and associated terminalia from Brazil, four from Ecuador, one from Guatemala, two from Jamaica, four from Mexico, one from Nicaragua, 10 from Panama, three from Peru, one from Venezuela, and one from Trinidad.

DISTRIBUTION.—This species has been reported from Brazil (Para, Brazil, being the type locality), Mexico, El Salvador, British Honduras, Nicaragua, Costa Rica, Panama, Cuba, Haiti, Jamaica, Trinidad, Guianas, Venezuela, Colombia, Ecuador, Peru, Bolivia, and Uruguay. One specimen has been seen by the author in the U.S. National Museum collection from Cayuga, Guatemala.

The *Culex coronator* Complex

FIGURE 11

Culex coronator was described by Dyar and Knab (1906b) from the larval stage. Subsequently Dyar (1918b, 1922a, and 1925) described *C. usquatus*, *C. usquatissimus*, *C. ousqua*, and *C. coronator camposi*. The status of these species was reviewed by Dyar (1922a) and Bonne and Bonne-Wepster (1925). The primary differentiating characters were the arrangement of appendices on the apical lobe of the basistyle and the length of the apical setae on the basistyle. Later Anduze (1943a) described *C. albertoi*, and *C. coronator mooseri* was described by Vargas and Martinez Palacios (1954). Stone et al. (1959) including supplements by Stone (1961 and 1963) listed current synonymy as follows: *C. coronator* maintains species rank and includes the synonyms *C. ousqua*, *C. usquatus*, *C. usquatissimus*, and *C. albertoi*; *C. coronator camposi* and *C. coronator mooseri* retain their original subspecies designation.

During this study the male terminalia of 227 specimens belonging to the *coronator* complex were critically examined and assigned to the various named taxa on the basis of morphological criteria. The areas from which these specimens were collected are delineated in figure 11a. Results of these studies are tabulated in table 3, and probable distribution of each species is plotted on figures 11b-f.

Consideration of the morphological differences and the geographical distribution of each taxon reveals that the various forms are not randomly distributed throughout the areas, but assume discrete distributional patterns. All forms are sympatric in area IV (Colombia), but in no other collection area have all forms been found. Thus, the morphological and distributional data suggest that speciation has occurred, and it is for this reason that the following species are here designated as valid: *Culex coronator*, *C. ousqua*, *C. usquatus*, *C. camposi*, and *C. usquatissimus*. On the basis of morphological similarity in the male terminalia *C. albertoi* is placed in synonymy with *C. ousqua*, and *C. coronator mooseri* is placed in synonymy with *C. coronator*. *C. covagarciai* is described from a specimen sent to Dr. Stone by Dr. Pablo Cova Garcia from Venezuela.

The evidence gleaned from the 227 specimens in no way challenges the hypothesis that speciation has occurred and, in fact, supports this hypothesis. Revalidation of the species in this complex may well stimulate future research in the *C. coronator* group that will elucidate true relationships and contribute to concepts of speciation applicable to the entire family Culicidae. Detailed descriptions of the immature stages of each form are necessary; biological data for the various species must be obtained; hybridization experiments, such as those conducted in the *pipiens-quinquefasciatus* complex, would be invaluable; and cytogenetic studies would be appropriate.

***Culex (Culex) coronator* Dyar and Knab, 1906**

FIGURES 12a, f

Culex (Culex) coronator Dyar and Knab, 1906b, p. 215.

Culex (Culex) coronator mooseri Vargas and Martinez Palacios, 1954, p. 33. [New synonymy.]

SYSTEMATICS.—The male terminalia of six specimens collected at the type locality in 1941 by M. Macias Gomez and determined by Dr. L. Vargas as *C. c. mooseri* were sent to the author (apparently these specimens were part of the original type series, although they were not designated as such in the original description). These specimens were compared with a large series of *C. coronator* and found to be conspecific.

PROBABLE DISTRIBUTION OF SPECIES
IN THE *CULEX CORONATOR* COMPLEX

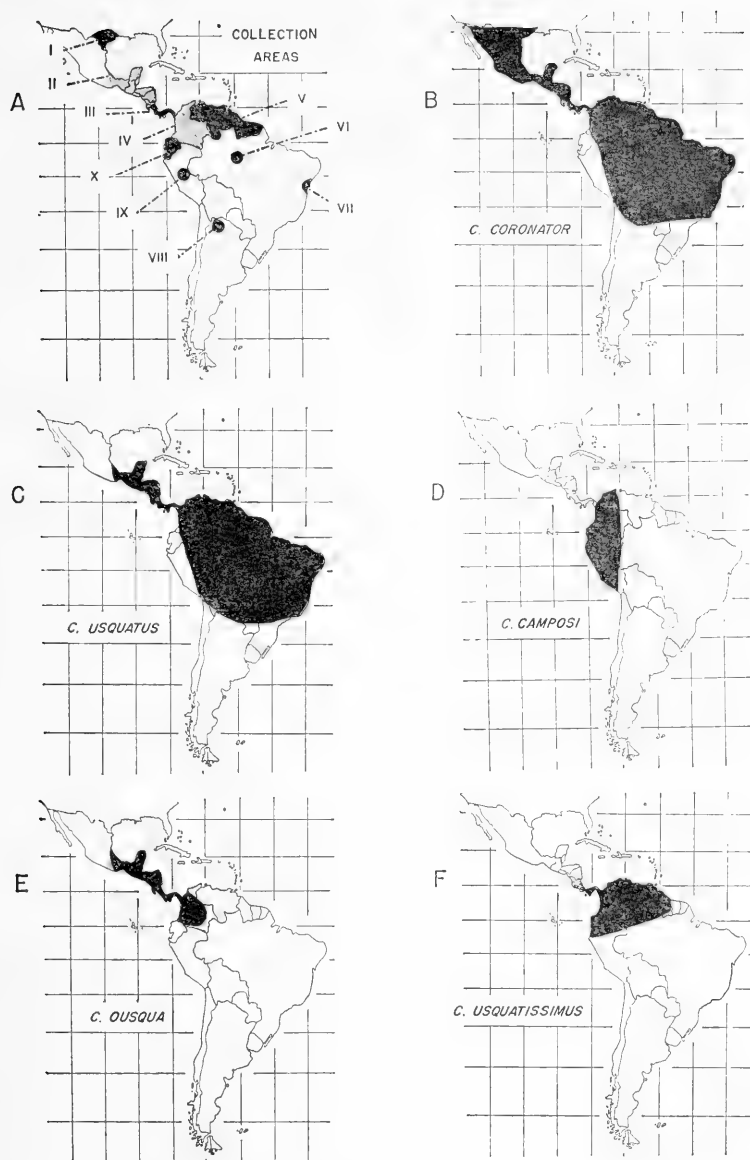


FIGURE 11.—Probable distribution of species in the *Culex coronator* complex: a, collection areas; b, *C. coronator*; c, *C. usquatus*; d, *C. camposi*; e, *C. ousqua*; f, *C. usquatissimus*.

Culex coronator differs from other members of the complex by the arrangement and number of appendices on the apical lobe of the basistyle. In *C. coronator* there are two or three strong rods basally followed by five to 15 subequal setae. A patch of setae is present at the apex of the basistyle, but the setae are short. In *C. usquatus*, *C. camposi*, and *C. usquatissimus*, the setae at the apex of the basistyle are very long and extend to at least the midpoint of the dististyle.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to the normal, long setal pattern; at the apex is a small patch of short setae. Apical lobe of the basistyle prominent, undivided, and also clothed with fine setae. Appendices of the apical lobe as follows: two or three subequal, strong rods, which are gently curved at the apex; a group of five to 13 subequal, gently curved setae distad of the rods; leaf absent. Dististyle normal. Tenth sternite crowned with a sparse tuft of short, pointed spines; basal arm rather long, gently curved; three cercal setae present. External process gradually expanding distally to the midpoint, then tapering to a point; slightly exceeding the ventral cornu in length. Ventral cornu long and slender, distinctly separated from the teeth of the median process, bent so as to be directed laterally; at the crown of the bend, the margin seems to be somewhat rugulose. Median process with five to 11 strong, sharply pointed, subequal teeth. Basal process short, straight, and bluntly rounded.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; upper and lower frontal head hairs 5 and 6 long, three or four branched, and barbed; preantennal head hair 7 long, multiple, and barbed. Mentum with about 15 teeth; the apical tooth is broader and longer than the lateral teeth. Thorax spiculate. Comb with many scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index 8.0 to 9.0; four double siphonal tufts inserted on the siphon beyond the pecten; a crown of prominent spines is present at the apex of the siphon. Pecten with eight to 14 teeth on the basal fourth of the siphon; each tooth with two to five coarse barbs on one side. Anal segment spiculate, completely ringed by the saddle.

MATERIAL EXAMINED.—There are 104 male terminalia from areas indicated in table 3.

DISTRIBUTION.—Probable distribution of this species is plotted on figure 11b.

***Culex (Culex) usquatus* Dyar, 1918**

FIGURE 12b

Culex (Culex) usquatus Dyar, 1918b, p. 122.

SYSTEMATICS.—The appendices on the apical lobe of the basistyle are distinctive. Rods are absent, but a group of 10 to 15 subequal, gently curved setae are evenly distributed on the lobe. A small patch of setae is present at the apex of the basistyle; these setae are very long, reaching to at least the midpoint of the dististyle. The mesosome cannot be distinguished from other members of the complex, except *C. covagarciai*.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to the normal, long setal pattern; at the apex is a small patch of long setae. Apical lobe of the basistyle prominent, undivided, and also clothed with fine setae. Appendices of the apical lobe as follows: rods absent; a group of approximately 10 to 15 subequal, gently curved setae evenly distributed on the lobe; leaf absent. Dististyle normal. Tenth sternite crowned with a sparse tuft of short, pointed spines; basal arm rather long, gently curved; three cercal setae present. External process gradually expanding distally to the midpoint, then tapering to a point; slightly exceeding the ventral cornu in length. Ventral cornu long and slender, distinctly separated from the teeth of the median process, bent so as to be directed laterally; at the crest of the bend the margin seems to be somewhat rugulose. Median process with five to 10 strong, sharply pointed, subequal teeth. Basal process short, straight, and bluntly rounded.

Larva: Similar to *Culex coronator*. Detailed descriptions of the immature stages are not available, and individual rearings of specimens belonging to this species were not examined.

MATERIAL EXAMINED.—Fifty-one male terminalia from areas indicated in table 3.

DISTRIBUTION.—Probable distribution of this species is plotted on figure 11c.

***Culex (Culex) camposi* Dyar, 1925**

FIGURE 12c

Culex (Culex) camposi Dyar, 1925, p. 28.

SYSTEMATICS.—In this species a group of approximately 10 subequal, gently curved setae are evenly distributed on the apical lobe of the basistyle. The diagnostic character is a small tubercle distad of the

apical lobe possessing one or two strong, gently hooked spines. A small patch of setae is present at the apex of the basistyle; these setae are very long, reaching to at least the midpoint of the dististyle. The mesosome cannot be distinguished from other members of the complex, except *Culex covagarciai*.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to the normal, long setal pattern; at the apex is a small patch of long setae. Apical lobe of the basistyle prominent, undivided, and also clothed with fine setae. Appendices of the apical lobe as follows: rods absent; a group of approximately 10 subequal, gently curved setae evenly distributed on the lobe; a small tubercle distad of the apical lobe possessing one or two strong, gently hooked spines; leaf absent. Dististyle normal. Tenth sternite crowned with a sparse tuft of short, pointed spines; basal arm rather long, gently curved; three cercal setae present. External process gradually expanding distally to the midpoint, then tapering to a point; slightly exceeding the ventral cornu in length. Ventral cornu long and slender, distinctly separated from the teeth of the median process, bent so as to be directed laterally; at the crest of the bend, the margin seems to be somewhat granulose. Median process with five to 11 strong, sharply pointed, subequal teeth. Basal process short, straight, and bluntly rounded.

Larva: Similar to *Culex coronator*. Detailed descriptions of the immature stages are not available, and individual rearings of specimens belonging to this species were not examined.

MATERIAL EXAMINED.—Forty-two male terminalia from areas indicated in table 3.

DISTRIBUTION.—Probable distribution of this species is plotted on figure 11*d*.

***Culex (Culex) ousqua* Dyar, 1918**

FIGURE 12*d*

Culex (Culex) ousqua Dyar, 1918a, p. 99.

Culex (Culex) albertoi Anduze, 1943a, p. 193. [New synonymy.]

SYSTEMATICS.—*Culex albertoi* was described from a single male and although the holotype has not been examined, Anduze's detailed original description readily identifies this species with *C. ousqua*.

Culex ousqua is distinguished from other members of the complex by the appendices on the apical lobe of the basistyle. The apical lobe is divided into a large proximal lobe and a small distal tubercle; a group of approximately 10 subequal, gently curved setae are evenly distributed on the proximal lobe; four or five subequal, gently curved setae are

present on the distal tubercle. A patch of setae is present at the apex of the basistyle, but the setae are short.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to the normal, long setal pattern; at the apex is a small patch of short setae. Apical lobe of the basistyle prominent, divided into a large proximal lobe and a small distal tubercle; also clothed with fine setae. Appendices of the apical lobe as follows: rods absent; a group of approximately 10 subequal, gently curved setae evenly distributed on the proximal lobe; four or five subequal, gently curved setae on the distal tubercle; leaf absent. Dististyle normal. Tenth sternite crowned with a sparse tuft of short, pointed spines; basal arm rather long, gently curved; three to five cercal setae present. External process gradually expanding distally to the midpoint, then tapering to a point; slightly exceeding the ventral cornu in length. Ventral cornu long and slender, distinctly separated from the teeth of the median process, bent so as to be directed laterally; at the crest of the bend the margin seems to be somewhat rugulose. Median process with six to 10 strong, sharply pointed, subequal teeth. Basal process short, straight, and bluntly rounded.

Larva: Similar to *Culex coronator*. Detailed descriptions of the immature stages are not available, and individual rearings of specimens belonging to this species were not examined.

MATERIAL EXAMINED.—Twenty male terminalia from areas indicated in table 3.

DISTRIBUTION.—Probable distribution of this species is plotted on figure 11e.

***Culex (Culex) usquatissimus* Dyar, 1922**

FIGURE 12e

Culex (Culex) usquatissimus Dyar, 1922a, p. 19.

SYSTEMATICS.—Appendices on the apical lobe of the basistyle distinguish this species from other members of the complex. The apical lobe is divided into a large, proximal lobe and a small distal tubercle. On the proximal lobe there are three subequal, strong rods, which are gently curved at the apex; on the distal tubercle there are three to five subequal, gently curved setae. A small patch of setae is present at the apex of the basistyle; these setae are very long, reaching to at least the midpoint of the dististyle. The mesosome cannot be distinguished from other members of the complex, except *Culex covagarciai*.

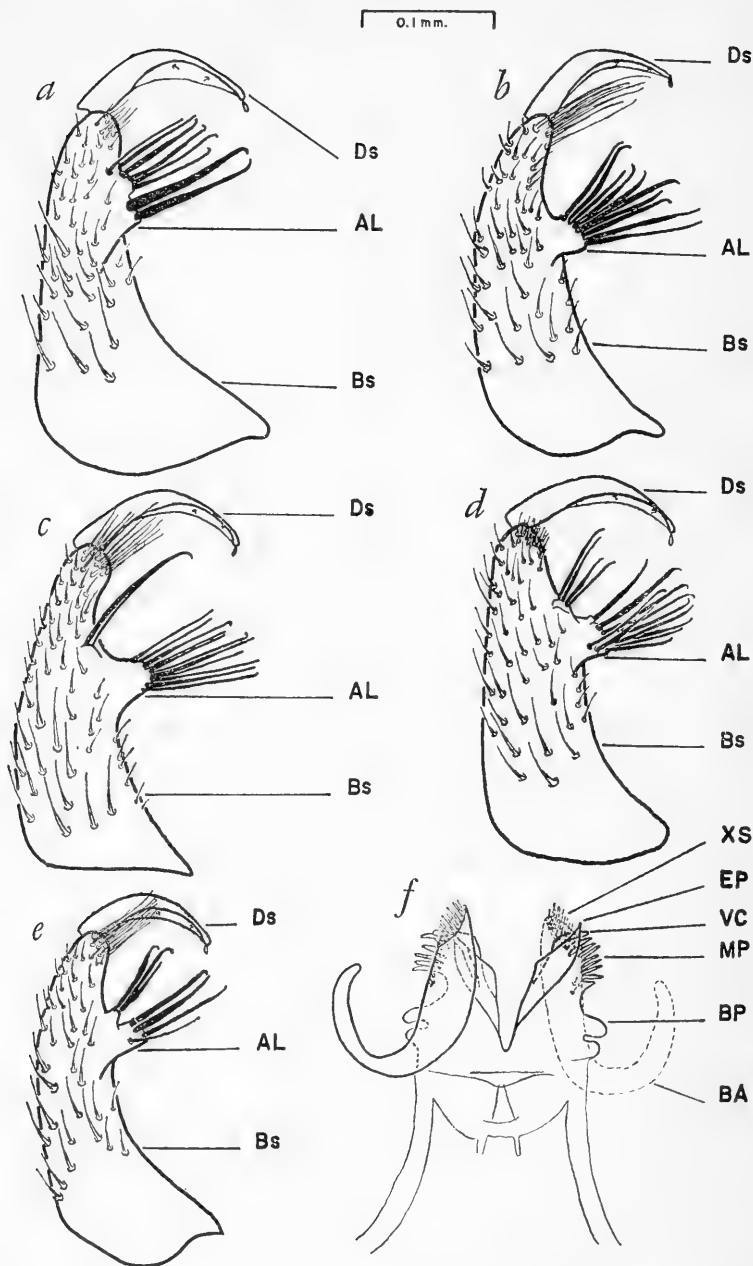


FIGURE 12.—Basistyle and dististyle: *a*, *C. coronator*, San Pedro de, Argentina, USNM RB61 83; *b*, *C. usquatus*, Piraja, Brazil, USNM RB61 275; *c*, *C. camposi*, Fosca, Colombia, USNM RB62 109; *d*, *C. ousqua*, Port Limón, Costa Rica, USNM RB62 80; *e*, *C. usquatis-simus*, Panama, C.Z., USNM RB62 491. Mesosome: *f*, *C. coronator*, San Pedro de, Argentina, USNM RB61 83.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to the normal, long setal pattern; at the apex is a small patch of long setae. Apical lobe of the basistyle prominent, divided into a large, proximal lobe and a small distal tubercle; also clothed with fine setae. Appendices of the apical lobe as follows: three subequal, strong rods which are gently curved at the apex on the proximal lobe; an accessory seta may also be present; distal tubercle with three to five subequal, gently curved setae; leaf absent. Dististyle normal. Tenth sternite crowned with a sparse tuft of short, pointed spines; basal arm rather long, gently curved; three cercal setae present. External process gradually expanding distally to the midpoint, then tapering to a point; slightly exceeding the ventral cornu in length. Ventral cornu long and slender, distinctly separated from the teeth of the median process, bent so as to be directed laterally; at the crest of the bend the margin seems to be somewhat rugulose. Median process with five to 10 strong, sharply pointed, subequal teeth. Basal process short, straight, and bluntly rounded.

Larva: Similar to *Culex coronator*. Detailed descriptions of the immature stages are not available, and individual rearings of specimens belonging to this species were not examined.

MATERIAL EXAMINED.—Ten male terminalia from areas indicated in table 3.

DISTRIBUTION.—Probable distribution of this species is plotted on figure 11f.

Culex (Culex) covagarciai Forattini, 1965

FIGURE 13

Culex (Culex) covagarciai Bram [sic].—Forattini, 1965, p. 128.

SYSTEMATICS.—*Culex covagarciai* is distinguished from other members of the complex by appendices of the apical lobe of the basistyle and the ventral cornu. The apical lobe of the basistyle is extended into a thumblike projection. On this lobe is one short, very broad rod and two long, prominently hooked rods; there are also several subequal hooked setae next to the rods. The setae at the apex of the basistyle are not long. The ventral cornu, although similar in shape to that of other members of the complex, is considerably longer than in the other species. At the crown on the bend of the ventral cornu, the margin appears to be finely spiculate.

SALIENT CHARACTERS.—Adult female: Unknown.

Male terminalia: Basistyle conical, slightly longer than two and a half times the basal width; clothed with fine setae in addition to the normal, long setal pattern; setae at the apex very small and short.

Apical lobe of the basistyle prominent, undivided, and extended into a thumblike projection. Appendices of the apical lobe as follows: one short, very broad rod and two long prominently hooked rods at the terminal end of the apical lobe; several subequal, hooked setae next to the rods; leaf absent. Dististyle normal. Tenth sternite crowned with a sparse tuft of short, pointed spines; basal arm rather long, gently curved; three cercal setae present. External process gradually expanding distally to the midpoint, then tapering to a point; slightly exceeding the ventral cornu in length. Ventral cornu very long and bluntly rounded, slender, distinctly separated from the teeth of the median process, bent so as to be directed laterally; at the crown of the bend, the margin seems somewhat rugulose and even appears to be finely spiculate. Median process with about four strong, subequal teeth. Basal process short, straight, and bluntly rounded.

Larva: Antenna shorter than the head, constricted beyond insertion of antennal tuft, with part before constriction pale and spiculate, part beyond constriction darker and with few spicules; antennal tuft large, multiple, barbed, inserted at outer third of shaft, reaching well beyond the tip. Head hairs: postclypeal 4 short, single; upper and lower frontals 5 and 6 long, triple, barbed; preantennal 7 long, multiple, barbed. Mentum with about 11 teeth; the apical tooth broader and larger than lateral teeth; the subbasal lateral teeth larger than the other lateral teeth. Prothoracic hairs: 1-5 long, single; 6 long, triple; 7 long, double. Thorax and abdomen finely spiculate. Comb with many scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index about 8.5; pecten with about 15 teeth on the basal third of the siphon; each tooth with several coarse barbs on one side; with four single or double siphonal tufts inserted beyond the pecten; a series of small spines are present at the apex of the siphon (these spines are not nearly as numerous or prominent as in other members of the *coronator* complex). Anal segment with prominent spicules, completely ringed by the saddle; lateral hair short, double.

HOLOTYPE.—The male terminalia with its associated larval and pupal skins from San Antonia de Caparo, Municipal Capital, Venezuela, September 1963; P. Cova Garcia; Number 140 D, USNM 67549; deposited in the U.S. National Museum collection. I take pleasure in naming this species in honor of Dr. Pablo Cova Garcia, who sent this specimen to Dr. Alan Stone. According to Cova Garcia (personal communication, 1964) the breeding place of the type specimen was on the bank of a river in a pool of standing, clear, fresh water with some shadow during the rainy season.

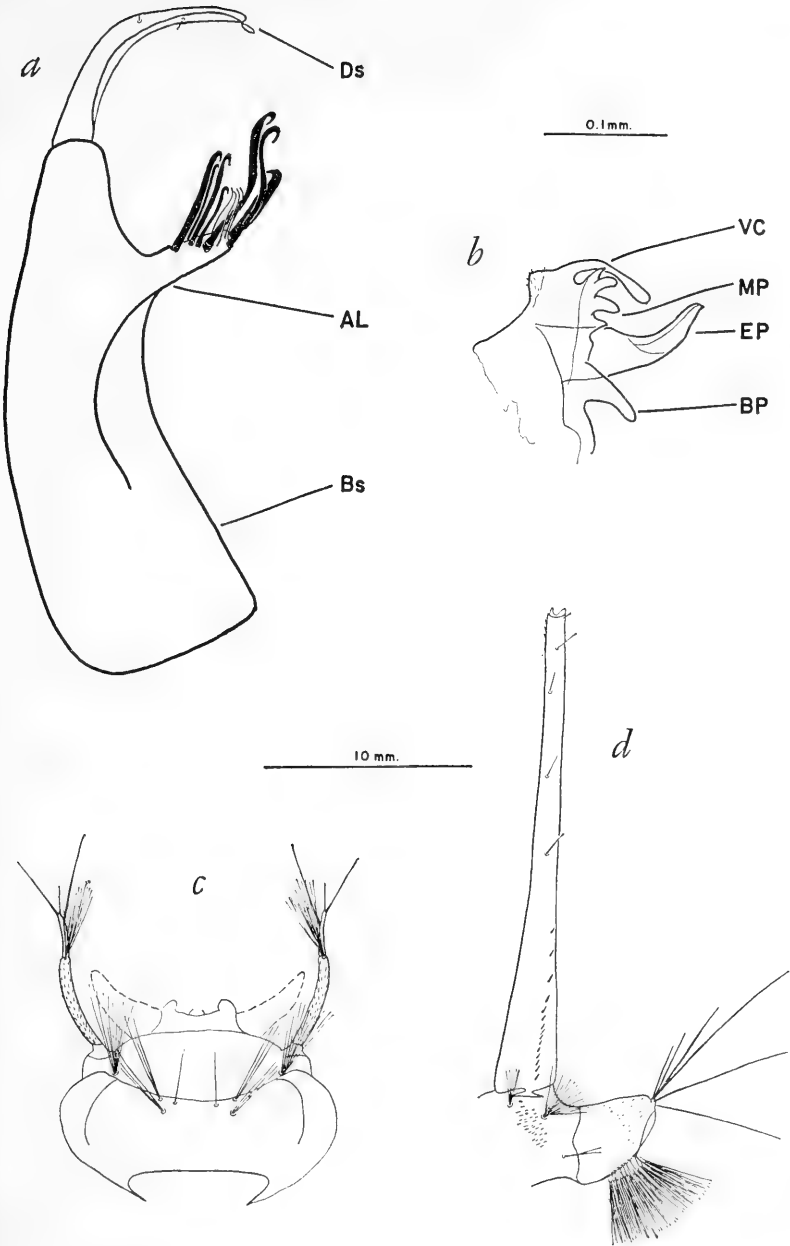


FIGURE 13.—*Culex covagarciai*, Maracay, Venezuela, USNM 140D: *a*, basistyle and dististyle; *b*, mesosome (everted); *c*, larval head; *d*, larval siphon and anal segment.

MATERIAL EXAMINED.—The holotype male terminalia and its associated larval and pupal skins.

DISTRIBUTION.—That of the type locality.

***Culex (Culex) declarator* Dyar and Knab, 1906**

FIGURES 14a, b

Culex (Culex) declarator Dyar and Knab, 1906b, p. 211.

Culex (Culex) inquisitor Dyar and Knab, 1906b, p. 211.

Culex (Culex) proclamator Dyar and Knab, 1906b, p. 211.

Culex (Culex) jubillator Dyar and Knab, 1907a, p. 201.

Culex (Culex) revelator Dyar and Knab, 1907b, p. 202.

Culex (Culex) dictator Dyar and Knab, 1909a, p. 225.

Culex (Culex) vinidicator Dyar and Knab, 1909a, p. 255.

Culex (Culex) forattinii Correa and Ramalho, 1959, p. 55. [New synonymy.]

SYSTEMATICS.—Two male terminalia of *Culex declarator* (RB61 419 and RB62 444) determined by the author and confirmed by comparison with the lectotype male terminalia, were sent to Dr. O. P. Forattini for comparison with the holotype male of *C. forattinii*. Dr. Forattini found that *C. forattinii* was conspecific with the two specimens sent (personal communication, 1963). It is for this reason the *C. forattinii* is here placed in synonymy with *C. declarator*.

Culex declarator is very similar to *C. bidens*. The teeth on the median process of the mesosome are distinctive and diagnostic. In *C. declarator* the individual teeth are robust, curved, have somewhat convex margins, and are rather bluntly rounded apically. In *C. bidens* these teeth are long, straight, laterally directed, and sharply pointed. In both species the number of teeth may range from one to six.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, pointed, and slightly curved; median and apical rods slightly longer than the basal rod, gently hooked at the apex; leaf normal, obovate, with minute longitudinal striations; one accessory seta is gently curved and about as long as the leaf, the other prominently hooked and flattened apically. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm somewhat flattened and bent at an acute angle; two to four cercal setae present. External process lightly sclerotized, short, and straight. Ventral cornu dentiform, equal in size and shape to the teeth of the median process. Median process with one to four strong, curved, robust teeth. Basal process short, pointed, and directed laterally.

Larva: Antennal tuft located in a constriction near the outer third. Postclypeal head hair 4 short, single; upper and lower frontal head hairs 5 and 6 long, triple, and barbed; preantennal head hair 7 large, multiple. Mentum with about 20 teeth; the apical tooth broader and longer than the lateral teeth, the subbasal lateral teeth longer than the other lateral teeth. Thorax spiculate. Comb with numerous scales in a patch; each scale long, broadly expanded apically and fringed with subequal spinules. Siphonal index 5.0 to 6.0; with three pairs of siphonal tufts. Pecten with numerous teeth on the basal third to two-fifths of the siphon; each tooth with two to six barbs on one side. Anal segment completely ringed by the saddle.

MATERIAL EXAMINED.—Ten adult males and associated terminalia from Brazil, five from Colombia, three from Costa Rica, one from Guatemala, two from Mexico, five from Panama, one from Peru, one from Surinam, six from Venezuela, and 11 from the West Indies. The lectotype male terminalia from Trinidad was also examined.

DISTRIBUTION.—This species seems to have a more northern distribution than its close relative, *Culex bidens*. The range extends from Texas southward through the countries listed above and to at least the state of São Paulo, Brazil (the type locality of *C. forattinii*). As indicated for *C. bidens*, a re-evaluation of the distributional patterns of this species must be made due to confusion in the literature of the names *declarator*, *virgultus*, *bidens*, *interfor*, and *forattinii*.

***Culex (Culex) delys* Howard, Dyar, and Knab, 1915**

Culex (Culex) delys Howard, Dyar, and Knab, 1915, p. 317.

SYSTEMATICS.—*Culex delys* was placed in synonymy with *C. mollis* by Dyar (1921b). Subsequently Lane (1951) revalidated the species. Neither author presented evidence to support his decision. The validity of this species seems questionable; however, a final decision must await further study of other adult forms in the subgenus.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Unknown.

Larva: Unknown.

MATERIAL EXAMINED.—The holotype adult female.

DISTRIBUTION.—That of the type locality, Tabernilla, Panama Canal Zone. This species is known only from the holotype adult female.

***Culex (Culex) diplophyllum* Dyar, 1929**

FIGURES 14c, d

Culex (Culex) diplophyllum Dyar, 1929, p. 509.

SYSTEMATICS.—The most characteristic feature of *Culex diplophyllum* is the presence of two distinct leaves on the apical lobe of

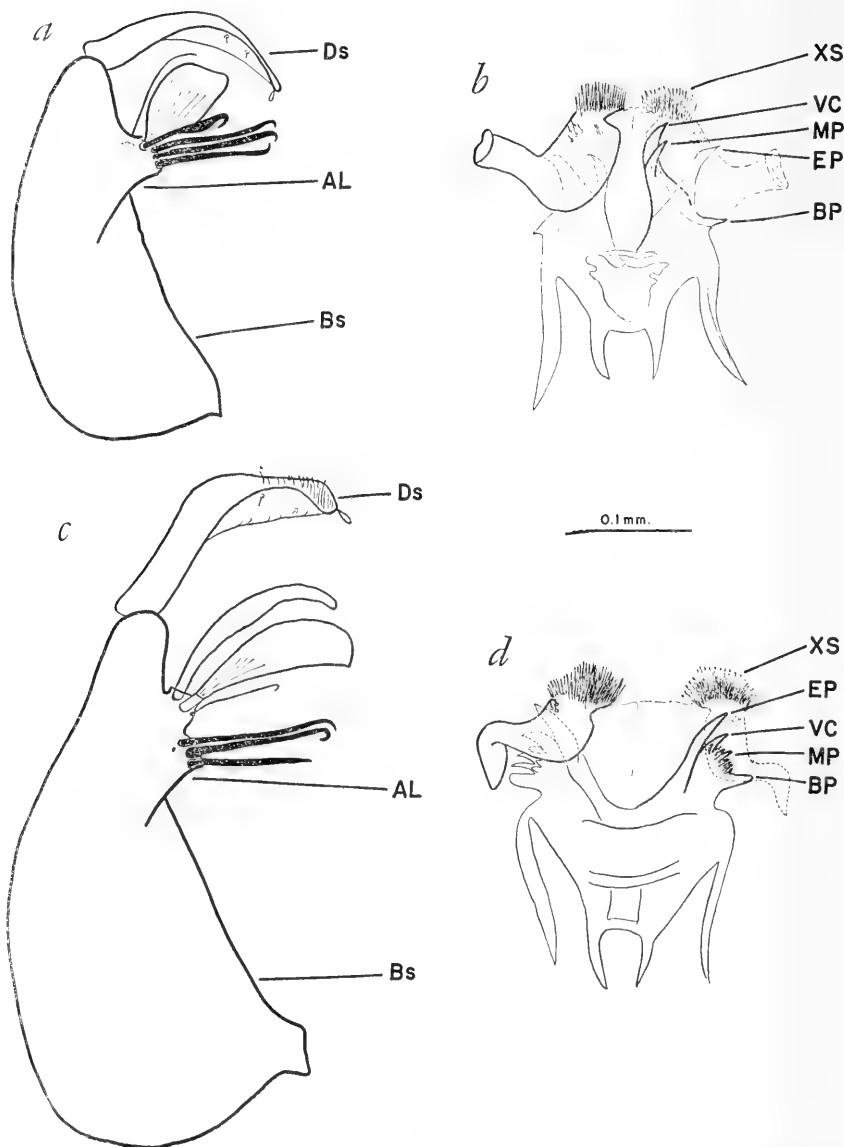


FIGURE 14.—*C. declarator*: a, basistyle and dististyle, Maracay, Venezuela, USNM RB62 444; b, mesosome, Panama, C.Z., USNM RB62 498. *C. diplophyllum*, Lima, Peru, USNM RB62 806: c, basistyle and dististyle; d, mesosome.

the basistyle. Two other species, *C. foliaceus* and *C. lahillei*, also possess two leaves on the apical lobe, but neither exhibits annulations on the apical third of the dististyle as does *C. diplophyllum*.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and clothed with fine setae. Appendices of the apical lobe as follows: basal rod straight and pointed; median and apical rods longer than the basal rod and gently hooked; one fine, prominently hooked, accessory seta present; two leaves present, the proximal leaf large, obovate, and possessing distinct basal, longitudinal striations, the distal leaf very narrow but as long as the proximal leaf and also exhibiting longitudinal striations. Dististyle quite broad, possessing annulations on the apical third. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderate in length and sharply bent; three to four cercal setae present. External process gradually tapering to a point, exceeding the ventral cornu in length. Ventral cornu dentiform, close to the teeth of the median process. Median process with five to nine distinctly separated teeth. Basal process longer than the teeth of the median process, straight, and truncate.

Larva: Antennal tuft located in a constriction near the outer third. Frontal head hairs 4, 5, 6, and 7 multiple. Mentum with about 20 teeth; the apical tooth broader and longer than the lateral teeth. Body glabrous. Comb with many free scales in three or four rows. Siphonal index greater than 4.0. Pecten restricted to the basal third of the siphon followed by four multiple tufts and a single seta before the apex. Anal segment completely ringed by the saddle which is spiculose on the posterior margin.

MATERIAL EXAMINED.—The lectotype male and a paratype male and associated terminalia from Lima, Peru, and another male specimen also from Lima, Peru.

DISTRIBUTION.—Reported only from Lima, Peru.

***Culex (Culex) dolosus* (Lynch Arribálzaga), 1891**

FIGURES 15a, b

Heteronychia dolosus Lynch Arribálzaga, 1891, p. 156.

Culex (Culex) bilineatus Theobald, 1903a, p. 196.

Culex (Culex) bonariensis Bréthes, 1916, p. 213.

SYSTEMATICS.—*Culex dolosus* is a member of the *salinarius* complex. It differs from *C. salinarius* in the conformation of the basal process and the external process; it differs from *C. spinosus* in the length and

shape of the basal process; it differs from *C. archegus* in possessing a ventral cornu which is dentiform and very similar in size and shape to the teeth of the median process.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and also clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, straight, rounded terminally; median rod broader and longer than the basal rod, and terminating in a gentle hook; apical rod not as broad as the median rod, also terminating in a gentle hook; leaf moderate in size, obovate, exhibiting distinct longitudinal striations; two accessory setae present, one shorter than the leaf and prominently hooked terminally, the other very long, pointed, and gently curved. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm very long, prominently recurved; three or four cercal setae present. External process gradually tapering to a blunt point; considerably exceeding the ventral cornu in length. Ventral cornu dentiform, very similar in size and shape to the teeth of the median process. Median process with about six to eight sharply pointed, distinct teeth. Basal process sharply pointed distally, acutely bent so as to be directed posteriorly; reaching, at most, to the middle of the median process.

Larva: After Lane (1953). Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; frontal head hairs 5, 6, and 7 multiple, long, barbed. Body glabrous. Comb with numerous scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index 5.0 to 6.0; four triple siphonal tufts inserted on the siphon beyond the pecten. Pecten with about 13 teeth on the basal third of the siphon; each tooth with coarse barbs on one side. Anal segment completely ringed by the saddle, spiculate dorsally.

MATERIAL EXAMINED.—Six male terminalia from Bolivia, Argentina, and Brazil.

DISTRIBUTION.—Reported from Argentina, Chile, Uruguay, Brazil, Bolivia, and Ecuador.

***Culex (Culex) duplicator* Dyar and Knab, 1909**

FIGURES 15c, d

Culex (Culex) duplicator Dyar and Knab, 1909a, p. 258.

SYSTEMATICS.—This species is similar to *Culex saltanensis* but is distinctive in possessing a serrate ventral cornu and a broad external process.

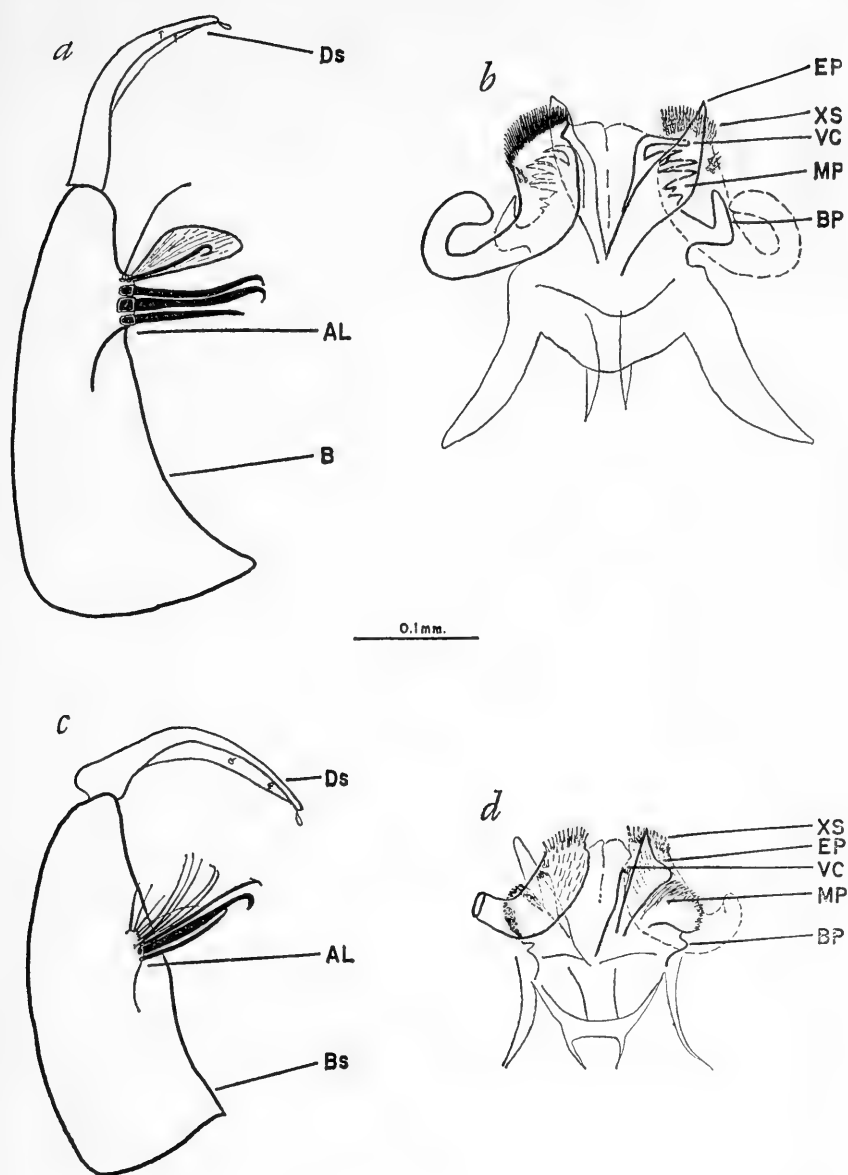


FIGURE 15.—*C. dolorus*, Cohobamba, Bolivia, USNM RB61 8: *a*, basistyle and dististyle; *b*, mesosome. *C. duplicator*, San Francisco Mts., St. Domingo, USNM RB62 101 (paratype): *c*, basistyle and dististyle; *d*, mesosome.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle tubular, two and a half times as long as the basal width; clothed with fine, short setae in addition to normal, long setal pattern. Apical lobe of the basistyle somewhat flattened, undivided, and clothed with fine setae. Appendices of the apical lobe as follows: basal rod fine straight, and pointed; median rod very strong and prominently hooked; apical rod fine, longer than median rod, and gently hooked; six to eight fine subequal setae distad of the rods; leaf absent. Dististyle normal. Tenth sternite crowned with a sparse tuft of short, pointed spines; basal arm short, robust, and gently curved; two cercal setae present; except for the basal arm, the tenth sternite is clothed with fine setae. External process very broad basally, then sharply indented and tapering to a point; exceeding the ventral cornu in length. Ventral cornu distinctly separated from the teeth of the median process; serrate terminally. Median process with more than 10 conglomerate teeth. Basal process represented by a small bluntly rounded knob.

Larva: Unknown.

MATERIAL EXAMINED.—The lectotype male, a paratype male, and three other male specimens from Hispaniola, and their associated terminalia.

DISTRIBUTION.—This species is endemic to the island of Hispaniola.

***Culex (Culex) erythrothorax* Dyar, 1907**

FIGURES 16a, b

Culex (Culex) erythrothorax Dyar, 1907, p. 124.

Culex (Culex) federalis Dyar, 1923a, p. 186.

Culex (Culex) badgeri Dyar, 1924, p. 125.

SYSTEMATICS.—This species is similar to *Culex mauensis* but differs in the conformation of the structures of the mesosome (particularly the teeth), and the shape of the leaf on the apical lobe of the basistyle.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, straight, and pointed; median rod broader and slightly longer than basal rod, hooked distally; apical rod as long as median rod and hooked distally; leaf normal, obovate, and with longitudinal striations; two accessory setae present, one very strong and prominently hooked, the other fine and gently curved. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm long and recurved; two or three cercal setae present.

External process gradually tapering to a blunt tip; exceeding the ventral cornu in length. Ventral cornu dentiform, similar in size and shape to the teeth of the median process. Median process with seven to 10 distinct teeth. Basal process short, straight, and tapering to a point.

Larva: Antennal tuft located in a constriction near the outer third; the basal portion of the antennal shaft spiculate. Postclypeal head hair 4 short, single; upper frontal head hair 5 long, four to seven branched; lower frontal head hair 6 long, three or four branched; preantennal head hair 7 long, multiple. Mentum with approximately 16 subequal teeth. Comb with many scales in a patch; each scale long, broad, and fringed apically with subequal spinules. Siphonal index 6.0 to 7.0; five pairs of small two to four branched siphonal tufts inserted beyond the pecten. Pecten with 11 to 20 teeth on the basal fourth of the siphon; each tooth with three to four coarse barbs on one side. Anal segment completely ringed by the saddle; gills usually about as long as the saddle.

MATERIAL EXAMINED.—Five male specimens and their associated terminalia from Mexico, one from Panama, two from Colombia, and a large series from the United States.

DISTRIBUTION.—Carpenter and LaCasse (1955) reported this species from California, Idaho, and Utah. It has also been reported from Mexico. The author has seen specimens in the U.S. National Museum collection from Panama and Colombia.

Culex (Culex) finlayi Perez Viguera, 1956

FIGURES 16c, d

Culex (Culex) finlayi Perez Viguera, 1956, p. 382.

SYSTEMATICS.—This species differs from all other members of the subgenus by the characteristic shape of the median process of the mesosome.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to normal, long setal pattern. Apical lobe of the basistyle prominent and also clothed with fine setae. Appendices of the apical lobe as follows: three subequal hooked rods: a small, bluntly rounded leaf: a narrow, gently curved seta. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines apically and spatulate, scalelike spines on the lateral outer margins: basal arm moderate in length, prominently curved; two cercal setae present. External process very broad, gently curved so that the tip is pointed laterally. Ventral cornu serrate. Median process projected into a strong extension

upon which is located a sphincter-form ring; teeth absent. Basal process absent.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; upper frontal head hair 5 long, multiple; lower frontal head hair 6 long, triple; preantennal head hair 7 long, multiple. Mentum with six teeth on each side of a large central tooth. Siphonal index about 8.0; eight pairs of two to four branched siphonal tufts present on the siphon. Pecten with eight to 12 teeth on the basal fourth of the siphon; the distal tooth is considerably removed from the other teeth; each tooth is long, thin and with numerous barbs on one side. Anal segment completely ringed by the saddle.

MATERIAL EXAMINED.—None. It is known to the author only from the original description.

DISTRIBUTION.—Known only from the type locality, Casiguas, Province of Havana, Cuba.

***Culex (Culex) foliaceus* Lane, 1945**

FIGURES 17a, b

Culex (Culex) foliaceus Lane, 1945, p. 206.

SYSTEMATICS.—This is one of the three species characterized by possessing two distinct leaves on the apical lobe of the basistyle. It is distinct from *Culex diplophyllum* by not having annulations on the apical third of the dististyle. It differs from *C. lahillei* by possessing a prominent enlargement at the apex of the dististyle.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, about twice as long as the basal width; clothed with fine setae in addition to the normal, long, setal pattern. Apical lobe of the basistyle prominent, undivided, and clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, gently hooked at the apex; median rod broader and longer than the basal rod, and with a prominent distal hook; apical rod longer than the median rod and prominently hooked; two leaves present, the proximal leaf broad and tapering to an apical point, the distal leaf more narrow, equally as long, and also tapering to a point; no accessory setae present. Dististyle normal but distinctly enlarged at the apex. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderate in length, gently curved; about three cercal setae present. External process gradually tapering to a point, slightly exceeding the ventral cornu in length. Ventral cornu dentiform, slightly larger than, and close to the teeth of the median process. Median process with three to five distinctly separated teeth. Basal process short, straight, and bluntly rounded.

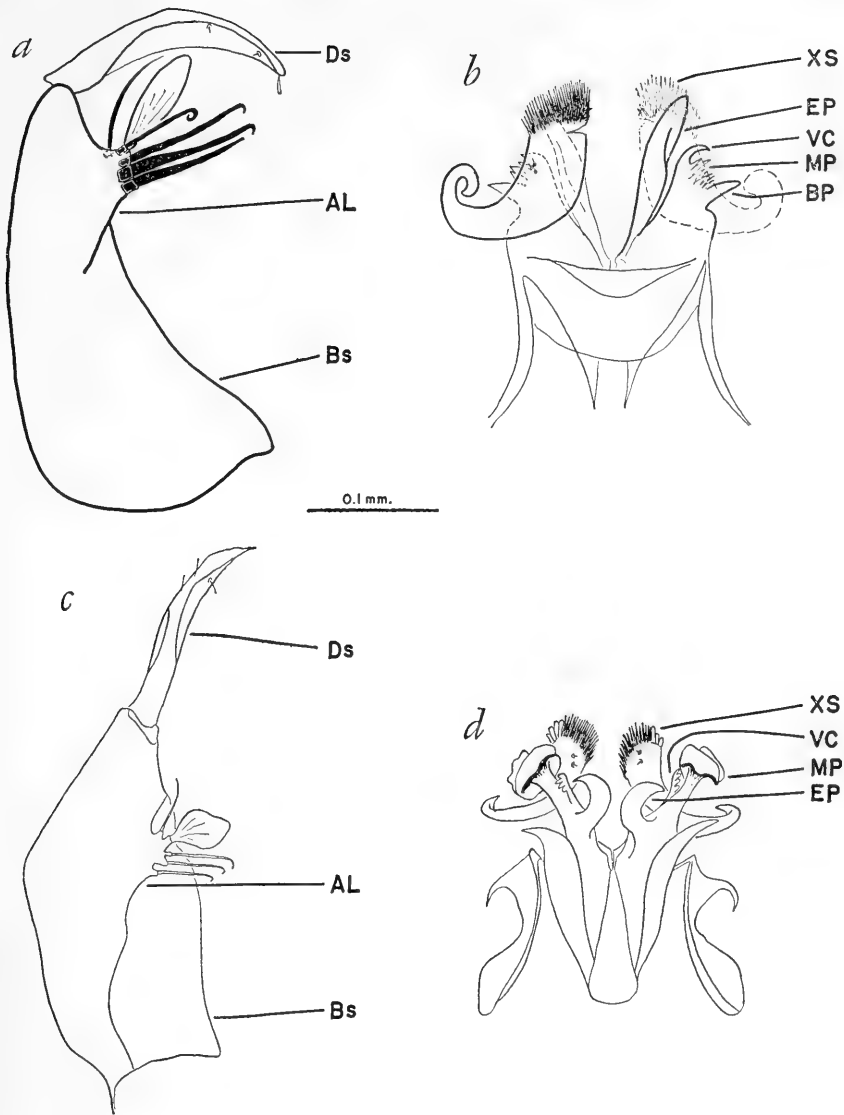


FIGURE 16.—*C. erythrothorax*, Xochimilco, D.F., Mexico, USNM RB62 804: *a*, basistyle and dististyle; *b*, mesosome. *C. finlayi* (drawn after Perez Viguera, 1956): *c*, basistyle and dististyle; *d*, mesosome.

Larva: Antennal tuft located in a constriction near the outer third; basal three-fourths of the antennal shaft sparsely spiculate. Postclypeal head hair 4 single; upper frontal head hair 5 triple; lower frontal head hair 6 double; preantennal head hair 7 multiple. Mentum with a stout central tooth and two or three stout, lateral teeth, the intermediate ones smaller. Abdominal integument glabrous. Comb a patch of about 75 spatulate, fringed scales in about four rows. Siphonal index about 5.0. Siphonal tufts very small and weak and rarely all present, but at most consisting of four pairs of bifid hairs. Pecten with 10 to 14 teeth on the basal third of the siphon; most of the teeth with three lateral barbs, the teeth progressively farther apart distally. Anal segment completely ringed by the saddle.

MATERIAL EXAMINED.—Thirty-three males and their associated terminalia from Brazil.

DISTRIBUTION.—The type locality is in the state of Rio Grande Do Norte, Brazil. The author has seen specimens from the states of Pernambuco, Bahia, and São Paulo, Brazil.

***Culex (Culex) habilitator* Dyar and Knab, 1906**

FIGURES 17c, d

Culex (Culex) habilitator Dyar and Knab, 1906b, p. 212.

Culex (Culex) eremita Howard, Dyar, and Knab, 1912 [1913], p. 331.

SYSTEMATICS.—*Culex habilitator* lacks a leaf on the apical lobe of the basistyle; however, the tenth sternite is crowned with a dense tuft of strong spines. The apical lobe is distinctive, being extended into a tuberculiform projection and terminating in a strong apical rod.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle tubular, two and a half times as long as the basal width; not clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle extended into a thumblike projection, terminating in a strong, stout, blunt, apical rod and possessing three to four straight accessory setae; leaf absent. Dististyle enlarged medially; dististyle claw considerably longer than normal and sharply pointed. Tenth sternite crowned with a dense tuft of short, pointed spines apically and spatulate, scalelike spines on the lateral outer margins; basal arm reduced to a short, knob; three cercal setae present. External process very broad and somewhat twisted in appearance. Ventral cornu absent. Median process with, at most, one or two poorly defined teeth (teeth generally appear to be absent). Basal process absent.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; upper and lower frontal head hairs 5 and 6 long, three

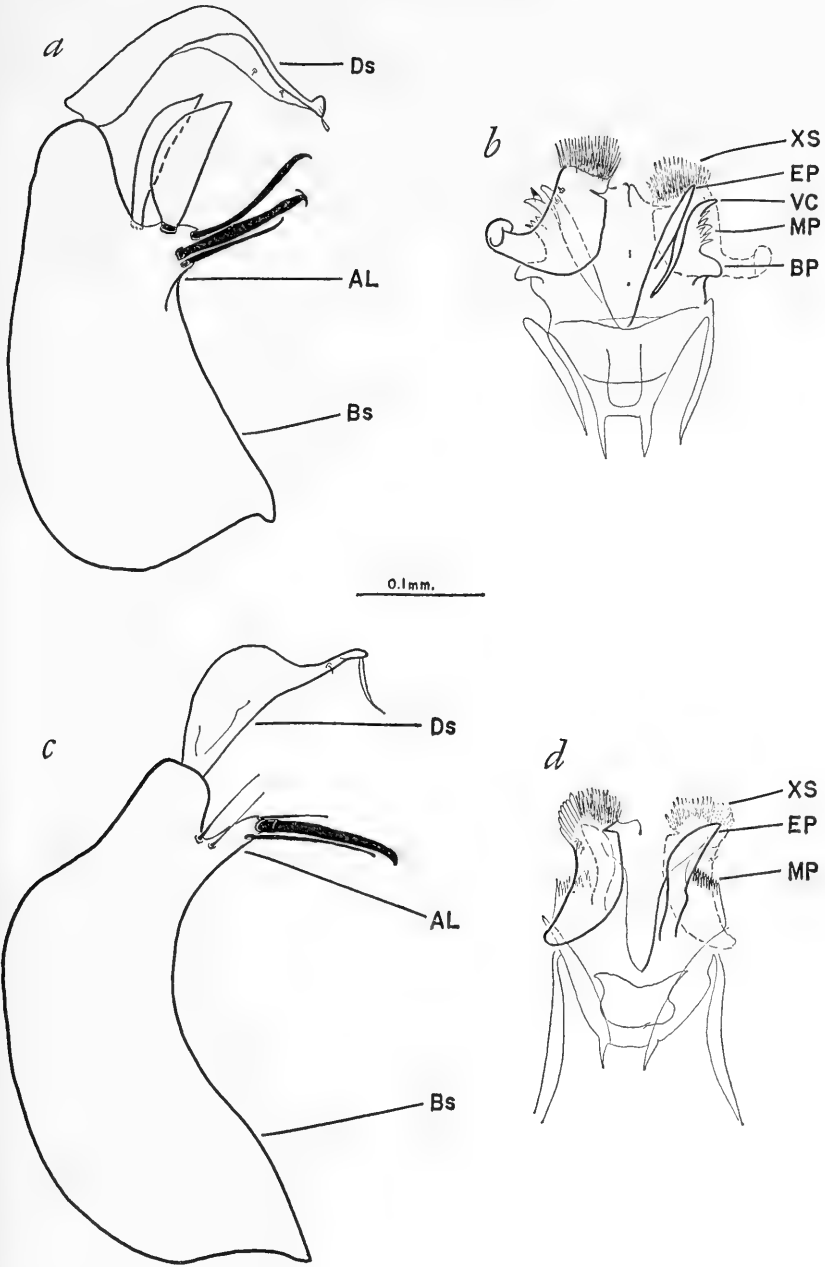


FIGURE 17.—*C. foliaceus*, Bahia, Brazil, USNM RB62 574: *a*, basistyle and dististyle; *b*, mesosome. *C. habilitator*, Guanica, P.R.: *c*, basistyle and dististyle, USNM RB62 22; *d*, mesosome, USNM RB62 14.

or four branched; preantennal head hair 7 multiple. Mentum with about 20 teeth; the apical tooth broader and longer than lateral teeth; subbasal lateral teeth longer than the other lateral teeth. Comb with many scales in a triangular patch. Siphonal index about 8.0; four double or triple siphonal tufts beyond the pecten. Pecten with numerous teeth reaching beyond the basal fourth of the siphon. Anal segment completely ringed by the saddle.

MATERIAL EXAMINED.—Twelve male specimens and their associated terminalia from Puerto Rico, seven from the Antilles, and one from Peru. The lectotype male terminalia from Santo Domingo was also studied.

DISTRIBUTION.—This species has been reported from the Dominican Republic (the type locality), Puerto Rico, the Lesser Antilles, and Trinidad. The author has seen one specimen in the U.S. National Museum collection from Tinga Maria, Peru.

Culex (Culex) inflictus Theobald, 1901

FIGURES 18a, b

Culex (Culex) inflictus Theobald, 1901, p. 115.

Culex (Culex) scholasticus Theobald, 1901, p. 120.

Culex (Culex) extricator Dyar and Knab, 1906b, p. 211.

SYSTEMATICS.—This species is distinct from all other members of the subgenus due to the characteristic division of the apical lobe of the basistyle.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, about two and a half times as long as the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent; distinctly divided into two sections; the proximal section possesses three subequal, gently hooked rods; the distal section exhibits a large, obovate leaf and a long gently curved accessory seta. Dististyle somewhat longer and more narrow than normal. Tenth sternite crowned with a tuft of short, pointed spines apically and spatulate, scalelike spines on the lateral outer margins; basal arm moderate in length, gently curved; cercal setae absent. External process very broad, tapering to a point, and curved so as to be directed laterally; extending in length to about the ventral cornu. Ventral cornu dentiform, slightly larger than, and close to the teeth of the median process. Median process with about nine narrow, sharply pointed teeth. Basal process absent.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; upper frontal head hair 5 long, four branched; lower frontal head hair 6 long, triple; preantennal head hair 7 multiple. Mentum

with about 17 teeth; the apical tooth considerably broader and longer than the lateral teeth. Comb with numerous narrow scales in a patch. Siphonal index about 6.0; three double or triple siphonal tufts beyond the pecten. Pecten with numerous teeth on the basal third of the siphon. Anal segment completely ringed by the saddle.

MATERIAL EXAMINED.—One adult male and associated terminalia from Colombia, four from Costa Rica, nine from Panama, 13 from Venezuela, and three from Trinidad.

DISTRIBUTION.—This species has been reported from the Lesser Antilles, Cuba, Trinidad, Mexico, Costa Rica, Panama, Colombia, and Venezuela.

***Culex (Culex) interrogator* Dyar and Knab, 1906**

FIGURES 18c, d

Culex (Culex) interrogator Dyar and Knab, 1906b, p. 209.

Culex (Culex) reflector Dyar and Knab, 1909a, p. 256.

SYSTEMATICS.—In the male terminalia this species appears to be close to *Culex peus*, *C. stenolepis*, and *C. thriambus*; however, the appendices of the apical lobe of the basistyle and the distinctive ventral cornu are diagnostic.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine spicules in addition to the normal, long setal pattern. Apical lobe of the basistyle rather flattened, undivided, and also clothed with fine spicules. Appendices of the apical lobe as follows: three fine, subequal, gently curved rods; a narrow, bluntly rounded leaf which exhibits minute longitudinal striations; two accessory setae, one straight the other prominently hooked. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderate in length, gently curved; cercal setae absent. External process very broad, tapering to a point, and curved so as to be directed laterally; not reaching the ventral cornu. Ventral cornu large, rounded and rugulose. Median process with five to seven sharply pointed, distinctly separated teeth. Basal process not a distinct arm, but represented by a round bulge of the mesosome.

Larva: Antennal tuft located in a constriction near the outer fourth; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; upper and lower frontal head hairs 5 and 6 long, triple; preantennal head hair 7 long, multiple. Mentum with approximately 17 teeth; the apical tooth broader and longer than the lateral teeth. Thorax sparsely spiculate. Comb with numerous scales in a patch; each scale long, narrow, with apex expanded and fringed with subequal spinules. Siphonal index 3.0 to 3.5; four pairs of

double or triple siphonal tufts present. Pecten with numerous teeth extending to the distal third of the siphon; each tooth with three to five coarse barbs on one side, except for the apical three to six teeth which are large, spinelike and without lateral teeth. Anal segment completely ringed by the saddle.

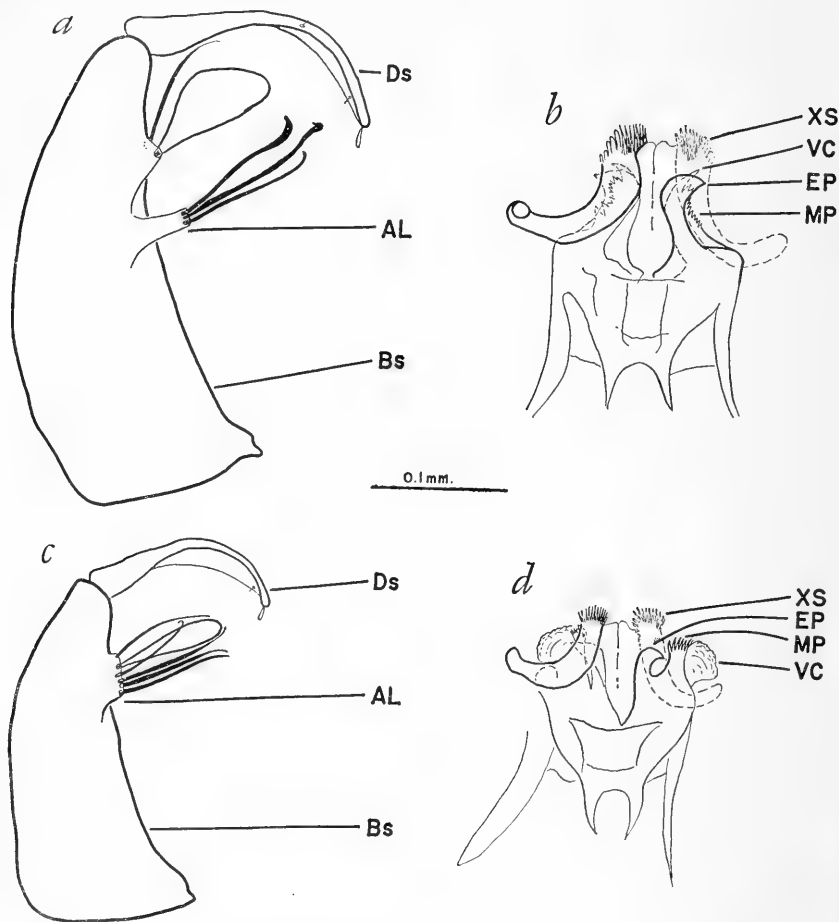


FIGURE 18.—*C. inflictus*, Ocumare de la Costa, Venezuela, USNM RB62 457: *a*, basistyle and dististyle; *b*, mesosome. *C. interrogator*, Panama, C.Z.: *c*, basistyle and dististyle USNM RB61 325; *d*, mesosome, USNM RB62 399.

MATERIAL EXAMINED.—One adult male specimen and associated terminalia from El Salvador, three from Mexico, and 15 from Panama. The lectotype male terminalia from Rincon Antonio, Mexico, was also studied.

DISTRIBUTION.—Reported from Texas, Mexico, El Salvador, Nicaragua, and Panama.

Culex (Culex) janitor Theobald, 1903

FIGURES 19a, b

Culex (Culex) janitor Theobald, 1903a, p. 183.

SYSTEMATICS.—The generalized mesosome of this species makes it rather similar to a large number of species, but the appendices of the apical lobe of the basistyle are distinctive.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided and also clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, straight, and bluntly rounded; median rod more robust, and slightly longer than the basal rod, and with a prominent terminal hook; apical rod more slender than the median or basal rods and with a prominent terminal hook; leaf moderate in size, obovate; two accessory setae present, one straight, the other longer and gently hooked; a small, straight seta may also be next to the leaf. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderate in length, gently curved; one to two cercal setae present. External process gradually tapering to a point, slightly exceeding the ventral cornu in length. Ventral cornu dentiform, slightly larger than, and close to the teeth of the median process. Median process with about five distinct, sharply pointed teeth. Basal process short, straight, and bluntly rounded.

Larva: Antenna fusiform; a short, reduced tuft located near the middle. Postclypeal head hair 4 short, single; frontal head hairs 5, 6, and 7 long, multiple. Mentum with about 21 teeth; the apical tooth broad and large, the lateral teeth progressively smaller apically. Body glabrous. Comb with numerous scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index about 4.0; five siphonal tufts present on the siphon, the apical and subapical tufts being double, the basal tufts multiple and located within the pecten. Pecten with about seven teeth, restricted to the basal third of the siphon; apical tooth considerably separated from the rest of the pecten. Anal segment completely ringed by the saddle.

MATERIAL EXAMINED.—Eight adult males and associated terminalia from Jamaica, six from Puerto Rico, and one from Colombia.

DISTRIBUTION.—This species has been reported from Jamaica and Puerto Rico. The author has seen one specimen in the U.S. National Museum collection from Bogotá, Colombia (RB62 133).

***Culex (Culex) lahillei* Bachmann and Casal, 1962**

FIGURES 19c, d

Culex (Culex) lahillei Bachmann and Casal, 1962, p. 267.

SYSTEMATICS.—This species possesses two leaves on the apical lobe of the basistyle and is, therefore, related to *Culex diplophyllum* and *C. foliaceus*; however, it does not exhibit an apical enlargement or annulations on the dististyle. Other characters of the mesosome are also distinctive.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width. Apical lobe of the basistyle rather flattened, undivided. Appendices of the apical lobe as follows: three subequal, strong, hooked rods; a prominently hooked accessory seta; two leaves, the proximal leaf broad and tapering to an apical point, the distal leaf narrow and bluntly rounded at the apex. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderate in length, gently curved. External process gradually tapering to a point, slightly exceeding the ventral cornu in length. Ventral cornu dentiform, close to the teeth of the median process. Median process with about nine distinct, sharply pointed teeth. Basal process short, straight, and bluntly rounded.

Larva: Unknown.

MATERIAL EXAMINED.—The holotype male terminalia (INM 5219).

DISTRIBUTION.—That of the type locality, Achiras, Cordoba, Argentina.

***Culex (Culex) laticlasper* Galindo and Blanton, 1954**

FIGURE 20a

Culex (Culex) laticlasper Galindo and Blanton, 1954, p. 209.

SYSTEMATICS.—*Culex laticlasper* is very similar to other species which possess a reduced mesosome. It is distinguished from *C. brethesi* and *C. restuans* by the appendices of the apical lobe of the basistyle. It differs from *C. acharistus* by lacking the annulations of the dististyle.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, not quite twice as long as the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided and also clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, straight, and bluntly rounded; median rod more robust, and longer than the basal rod and with a prominent hook at the apex; apical rod longer than the median rod and hooked; leaf moderate in size, obovate; two accessory setae present, one long and gently curved, the other almost as strong as the apical rod and

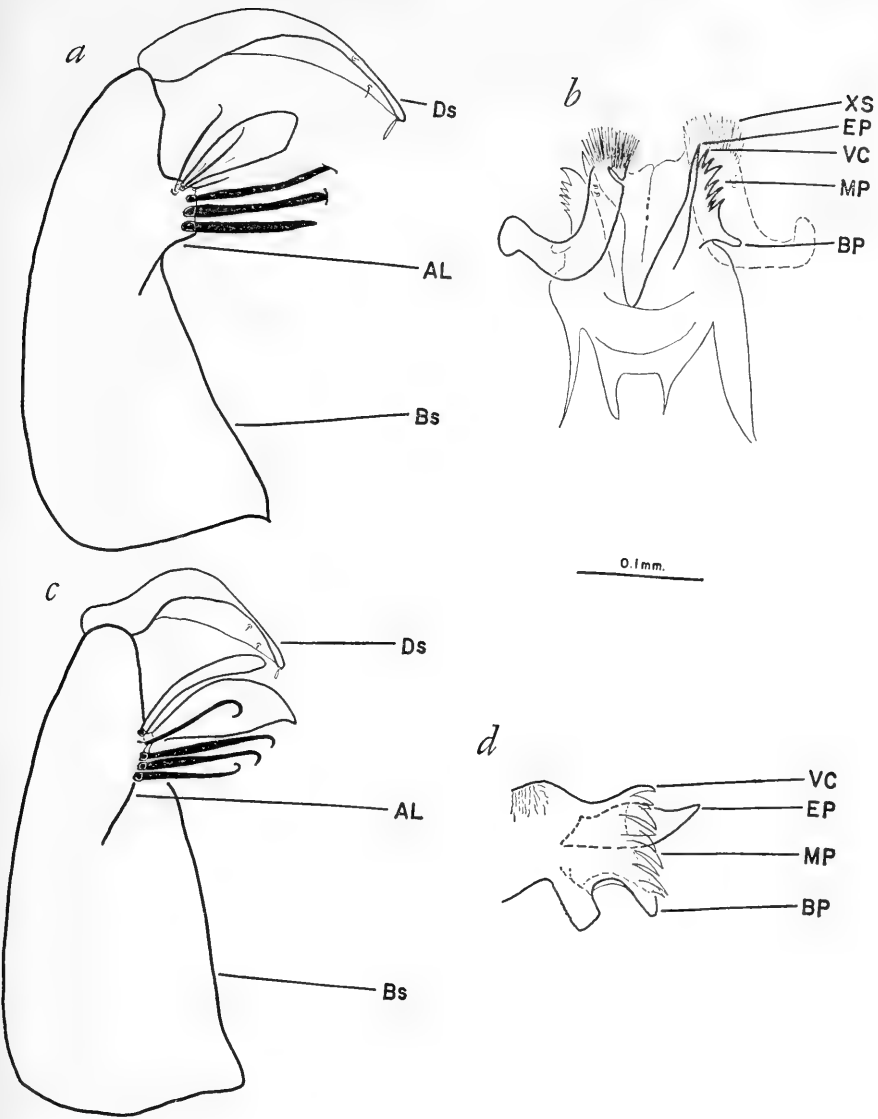


FIGURE 19.—*C. janitor*, Jamaica, USNM RB62 395: *a*, basistyle and dististyle; *b*, mesosome
C. lahillei, Cordoba, Argentina, INM 5219 (holotype): *c*, basistyle and dististyle; *d*,
mesosome (everted).

distinctly recurved at the tip. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderate in length, gently curved; three cercal setae present. External process gradually tapering to a point. Ventral cornu and teeth of the median process absent (in the everted position a slight indication of the ventral cornu may be present). Basal process short, straight, and somewhat pointed at the distal end.

Larva: Unknown.

MATERIAL EXAMINED.—The type series.

DISTRIBUTION.—That of the type locality, Cerro Punta, Panama.

Culex (Culex) levicastilloi Lane, 1945

FIGURES 20b-d

Culex (Culex) levicastilloi Lane, 1945, p. 209.

Culex (Culex) tejera Cova Garcia, 1962, p. 312. [New synonymy.]

SYSTEMATICS.—Two male terminalia slides determined by Cova Garcia as *Culex tejera* were compared with the holotype male terminalia of *C. levicastilloi* and found to be conspecific. Therefore, *C. tejera* is here placed in synonymy with *C. levicastilloi*.

Culex levicastilloi is readily distinguished from all other members of the subgenus by the characteristic appendices on the apical lobe of the basistyle.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided and also clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, straight, and slightly curved at the apex; median rod longer and broader than basal rod, gently hooked terminally; apical rod longer than median rod, with a prominent terminal hook; two strong, short, serrate, plumose setae; a strong, hooked seta and a long, narrow, gently curved seta; leaf moderate in size, obovate. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm short and straight; about four cercal setae present. External process gradually tapering to a point, reaching the ventral cornu in length. Ventral cornu dentiform, very similar in size and shape to the teeth of the median process. Median process with about four distinct teeth. Basal process short, straight, pointed, and directed posteriorly.

Larva: The larval stage was described by Cova Garcia (1962) as *Culex tejera*. Antennal tuft located in a constriction near the outer third. Postclypeal head hair 4 short, single; upper and lower frontal head hairs 5 and 6 long, four branched; preantennal head hair 7 long, multiple. Mentum with about 13 teeth; the apical tooth larger than

the lateral teeth. Thorax and abdomen spiculose. Comb with numerous teeth in a patch. Siphonal index about 6.0; five multiple siphonal tufts beyond the pecten. Pecten with numerous teeth on the basal fourth. Anal segment completely ringed by the saddle.

MATERIAL EXAMINED.—The holotype male and associated terminalia, and the male terminalia of two specimens from Venezuela.

DISTRIBUTION.—Ecuador (the type locality), and Venezuela.

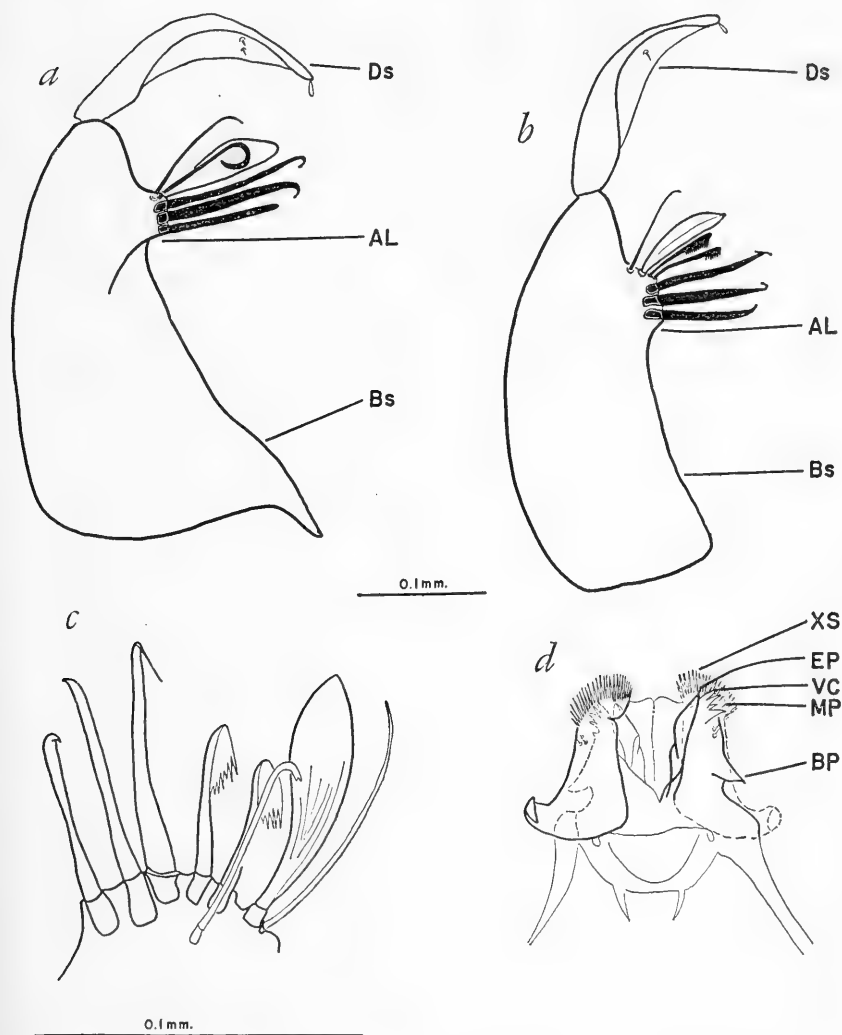


FIGURE 20.—*C. latidasper*, Cerro Punta, USNM MT-00193 (paratype): *a*, basistyle and dististyle. *C. levicastilloi*: *b*, basistyle and dististyle; *c*, apical lobe of basistyle (enlarged); *d*, mesosome.

Culex (Culex) lygrus Root, 1927

FIGURES 21a, b

Culex (Culex) lygrus Root, 1927, p. 579.

SYSTEMATICS.—This species is similar to *Culex renatoi*, *C. mauensis*, and *C. pinarocampa*. It is distinctive by having a reduced number of teeth on the median process of the mesosome and by the characteristic external process.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle tubular, about three times as long as the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided and also clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, gently curved at the apex; median rod longer and broader than basal rod, and strongly hooked terminally; apical rod longer than median rod and prominently hooked; leaf moderate in size, obovate, and possessing minute longitudinal striations; two accessory setae present, one strong and prominently hooked, the other normal, as long as leaf, and gently curved. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm very long and recurved; three to five cercal setae present. External process very large, broad and long, gently curved so as to be directed laterally, and considerably exceeding the ventral cornu. Ventral cornu dentiform, larger than the teeth of the median process. Median process with about four distinct teeth. Basal process short, straight, and bluntly rounded.

Larva: Unknown.

MATERIAL EXAMINED.—The lectotype male terminalia.

DISTRIBUTION.—That of the type locality, Rio de Janeiro, Brazil.

Culex (Culex) maracayensis Evans, 1923

FIGURES 21c, d

Culex (Culex) maracayensis Evans, 1923, p. 102.*Culex (Culex) aglischrus* Dyar, 1924, p. 121.

SYSTEMATICS.—Although related to species lacking a leaf on the apical lobe of the basistyle, *Culex maracayensis* is quite distinctive. It is the only member of this group possessing a rounded, rugulose ventral cornu, and also exhibits characteristic appendices on the apical lobe of the basistyle.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine spicules in addition to the normal long setal pattern. Apical lobe of the basistyle prominent, extended into a thumblike projection. Appendices of the apical lobe as follows:

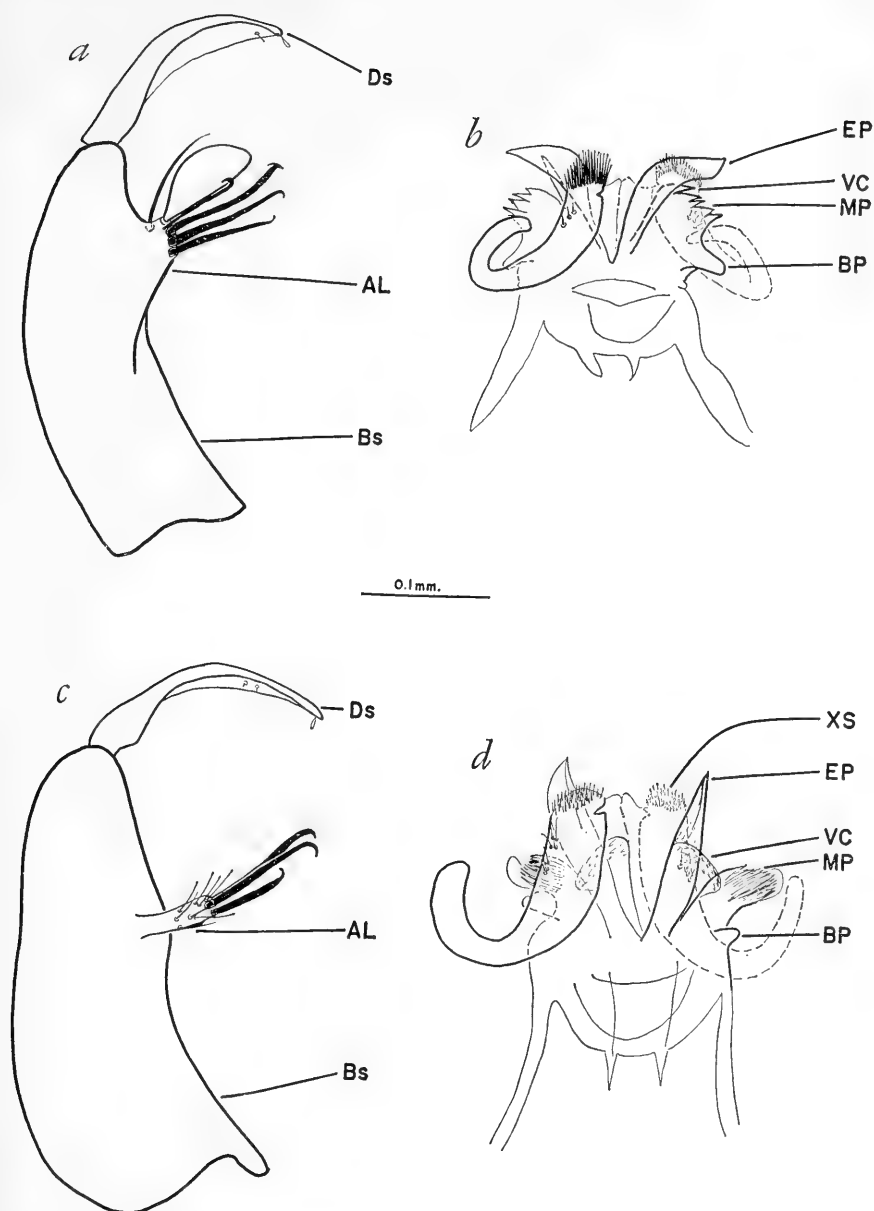


FIGURE 21.—*C. lygrus*, Mage, Brazil, USNM 115-2 (lectotype): *a*, basistyle and dististyle; *b*, mesosome. *C. maracayensis*, Rio Grande Forest, Trinidad, TRVL 19 VI 61-3: *c*, basistyle and dististyle; *d*, mesosome.

basal rod strong, gently hooked at the apex; median and apical rods subequal, longer and broader than basal rod and prominently hooked; leaf and accessory setae absent. Dististyle normal. Tenth sternite crowned with a sparse tuft of short, pointed spines; basal arm long and curved; a group of about nine, unusually long cercal setae present. External process very broad, gradually tapering to a point; about twice the length of the ventral cornu. Ventral cornu large, rounded, and rugulose. Median process with ten or more conglomerate teeth. Basal process represented by a short, rounded knob.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft sparsely spiculate basally. Postclypeal head hair 4 short, single; frontal head hairs 5, 6, and 7 long, multiple. Mentum with about 13 robust, bluntly rounded teeth; the apical tooth broader and longer than the lateral teeth. Thorax sparsely covered with minute spicules; abdomen glabrous. Comb with numerous scales in about four rows; each scale rounded apically and fringed with subequal spinules. Siphonal index about 5.5; five multiple siphonal tufts placed on the siphon, the basal tuft being inserted within the pecten; siphon densely covered with fine setae which are longest and most prominent at the apex. Pecten with about 11 teeth restricted to the basal third of the siphon; each tooth with coarse barbs on one side. Anal segment completely ringed by the saddle.

MATERIAL EXAMINED.—Six males and associated terminalia from Colombia, four from Venezuela, and one from Trinidad.

DISTRIBUTION.—Reported from Venezuela, Colombia, and the Lesser Antilles. One specimen from Macauley Trace, Trinidad has been examined by the author. This is the first record from the island.

Culex (Culex) mauesensis Lane, 1945

FIGURES 22a, b

Culex (Culex) mauesensis Lane, 1945, p. 208.

SYSTEMATICS.—This species is very similar to *Culex renatoi*, but is distinguished by the appendices on the apical lobe of the basistyle.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical. Apical lobe of the basistyle prominent, undivided. Appendices of the apical lobe as follows: basal rod strong, gently curved; median and apical rods subequal, longer than the basal rod, and prominently hooked terminally; leaf broad, obovate, and with minute longitudinal striations; two accessory setae present, one normal and gently curved, the other very strong,

and broadly flattened at the apex. Ventral cornu dentiform, similar in size and shape to the teeth of the median process. Median process with two series of teeth, the first consists of four very large teeth, the second consists of six or seven smaller, sharply pointed teeth. Basal process short, straight, and bluntly rounded.

Larva: Unknown.

MATERIAL EXAMINED.—None. Known to the author from the descriptions of Lane (1945 and 1953).

DISTRIBUTION.—That of the type locality, Maues, Amazonas, Brazil.

***Culex (Culex) maxi* Dyar, 1928**

FIGURES 22c, d

Culex (Culex) maxi Dyar, 1928, p. 386.

SYSTEMATICS.—This species is similar to *Culex brevispinosus*, *C. surinamensis*, and *C. oswaldoi*. It differs in the appendices on the apical lobe of the basistyle and in the conformation of the structures of the mesosome.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle tubular, about three times as long as the basal width; clothed with fine spicules in addition to the normal, long setal pattern. Apical lobe of the basistyle rather flattened, undivided, and also clothed with fine spicules. Appendices of the apical lobe as follows: about six subequal, straight, fine setae present; rods and leaf absent. Dististyle normal. Tenth sternite crowned with a sparse tuft of short, pointed spines; basal arm very long and prominently curved; two cercal setae present. External process gradually tapering to a point; not reaching the ventral cornu in length. Ventral cornu dentiform, very similar in size and shape to the teeth of the median process. Median process with about six short, robust, pointed teeth. Basal process short, straight, and bluntly rounded.

Larva: Unknown.

MATERIAL EXAMINED.—Seven males and their associated terminalia from Brazil, and two from Argentina. The lectotype male terminalia from San Pedro, Argentina was also studied.

DISTRIBUTION.—Reported from the state of Tucuman, Argentina (the type locality), and the states of Bahia and Rio Grande do Norte, Brazil. The author has seen specimens in the U.S. National Museum collection from Recife, Pernambuco, Brazil, and Piedade, São Paulo, Brazil.

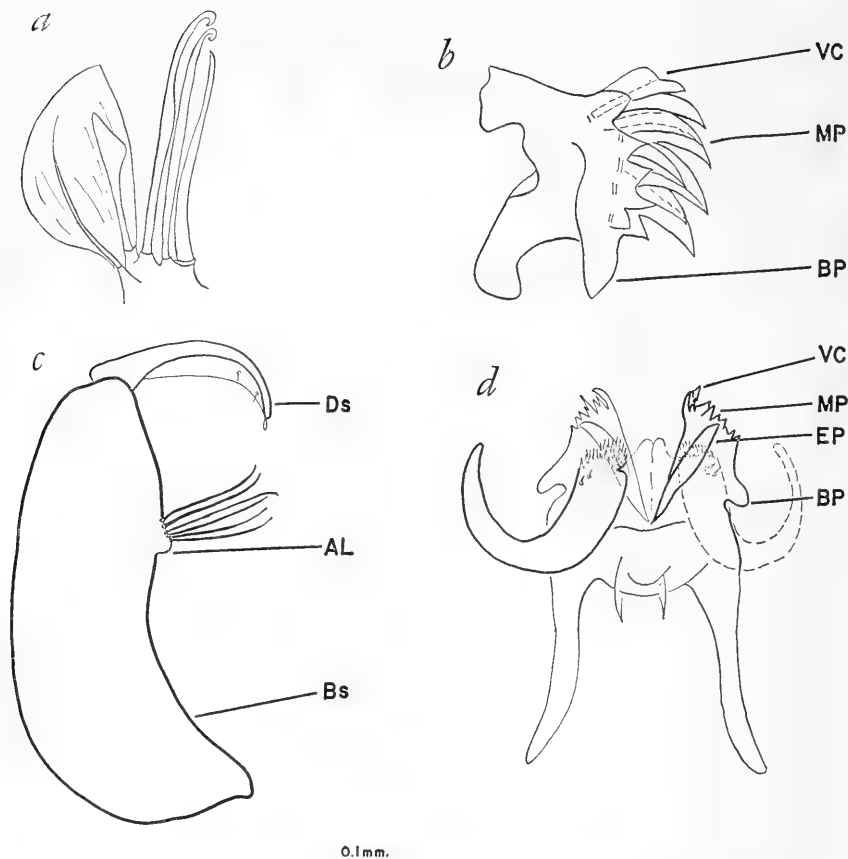


FIGURE 22.—*C. mauesensis* (drawn after Lane, 1945): *a*, apical lobe of basistyle; *b*, mesosoma. *C. maxi*, Bahia, Brazil, USNM RB62 209; *c*, basistyle and dististyle; *d*, mesosoma.

***Culex (Culex) mollis* Dyar and Knab, 1906**

FIGURES 23, 24a-f

Culex (Culex) mollis Dyar and Knab, 1906a, p. 171.

Culex (Culex) lateropunctata Theobald, 1907, p. 458.

Culex (Culex) equivocator Dyar and Knab, 1907, p. 203.

Culex (Culex) elocutilis Dyar and Knab, 1909a, p. 255.

Culex (Culex) lepostenis Dyar, 1923b, p. 70.

Culex (Culex) tisseuilli Senevet, 1937, p. 375. [New synonymy.]

SYSTEMATICS.—Senevet (1937) described *Culex tisseuilli* from French Guiana and recognized that it was extremely close to *C. mollis*. The primary distinguishing character was the reduced number of teeth on the median process of the mesosoma. All available male specimens of *C. mollis* were examined to determine variation in the number of teeth. Figure 23 summarizes data from this investigation. X is the

mean number of teeth; M is the mode; and R is the range in the number of teeth for the given area. N is the number of observations in each sample. Each observation consists of the number of teeth on only one side of the mesosome. Thus, a single individual could contribute two observations to the sample. In 35 of the 97 specimens examined, there was a difference in the number of teeth on each side of the mesosome. Variation in the number of teeth of specimens examined in this study ranged from three to 12 and the number appeared to be larger on the west coast and smaller on the east coast. This indicates that the number of teeth on the median process of the mesosome is not a significant character and since there are no other major differentiating characteristics between these two species, *C. tisseuilli* is here placed in synonymy with *C. mollis*.

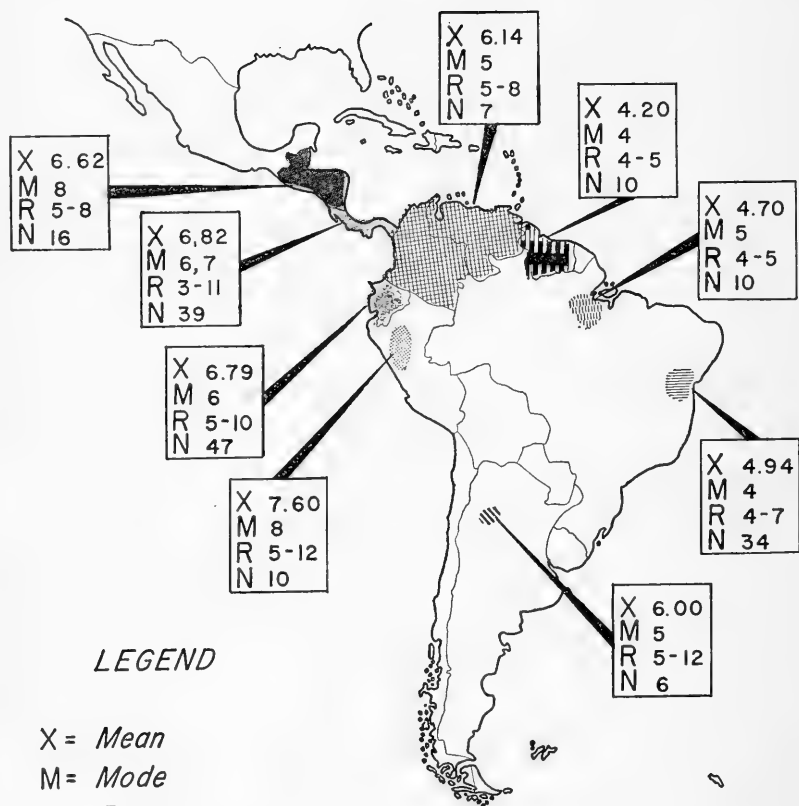
Although a generalized arrangement of appendices on the apical lobe of the basistyle exists, this species is readily distinguished from all other members of the subgenus by the characteristic, extremely large, T-shaped ventral cornu.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and also clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, straight, and pointed at the apex; median rod longer and broader than basal rod, and prominently hooked; apical rod longer than median rod and also prominently hooked; leaf moderate in size, obovate; two accessory setae present, one fine and hooked distally, the other very strong, longer than the leaf, and gently curved. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderate in length and curved; two cercal setae present. External process gradually tapering to a point, reaching slightly farther than the ventral cornu. Ventral cornu extremely large, T-shaped, and distinctly separated from the teeth of the median process. The ventral cornu is quite variable in size and general conformation; figures 24c-f demonstrates some of the variations in shape which this structure may assume. Median process with three to 12 sharply pointed, distinctly separated teeth. Geographical variation in the number of mesosomal teeth may be seen in figure 23. Examination of the mean, mode, and range of collections from various areas indicates that specimens collected on the west coast of South America have considerably more teeth than those collected on the east coast. Basal process short, straight, and bluntly rounded.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft sparsely spiculate basally. Postclypeal head hair 4 long,

GEOGRAPHICAL VARIATION IN THE
NUMBER OF MESOSOMAL TEETH
OF *CULEX MOLLIS* D.&K.



LEGEND

X = Mean
M = Mode
R = Range
N = Sample size

FIGURE 23.—Geographical variation in the number of mesosomal teeth of *Culex mollis* Dyar and Knab.

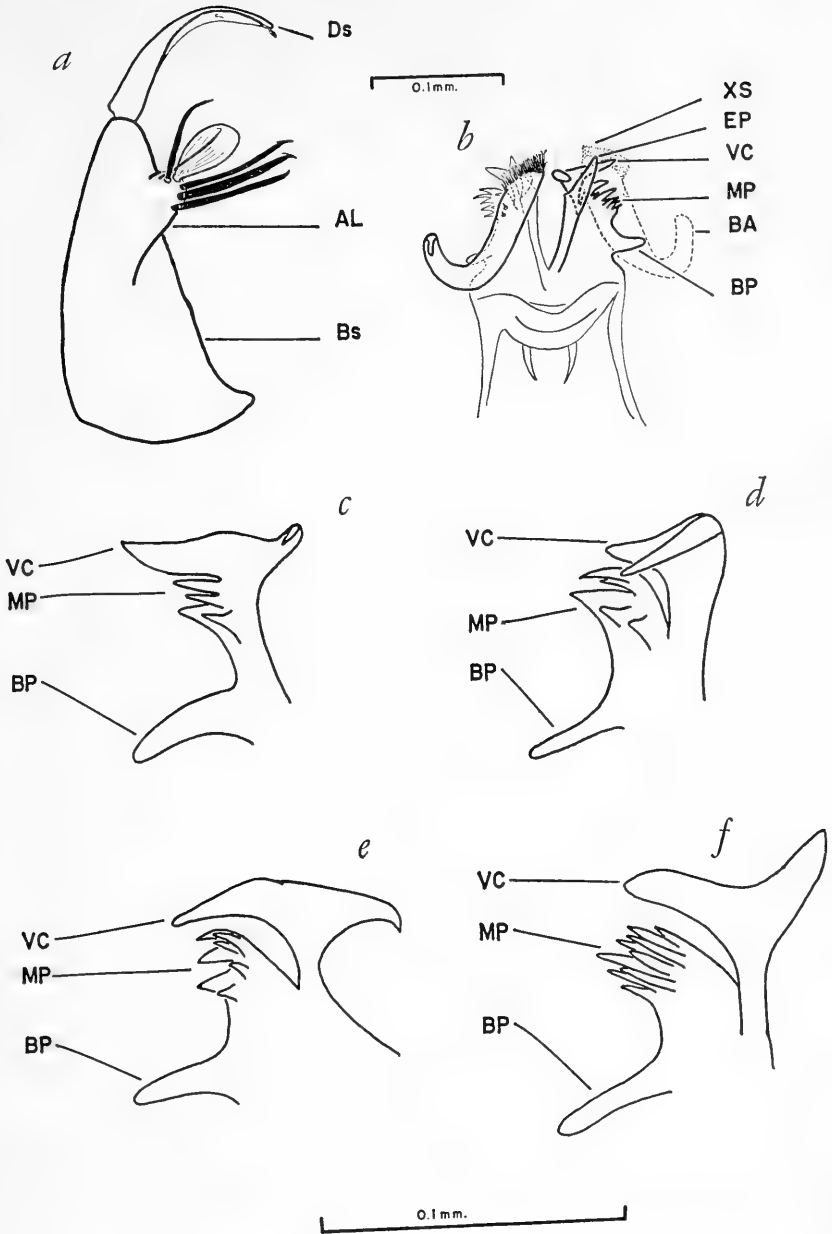


FIGURE 24.—*C. mollis*. Basistyle and dististyle: *a*, USNM RB62 693, El Valle, Panama. Mesosome: *b*, USNM RB62 693, El Valle, Panama; *c*, USNM M87, Surinam; *d*, USNM RB61 243, Bahia, Brazil; *e*, USNM 1650, Panama, C.Z.; *f*, USNM 29 III 28c, Rio Perone, Peru.

fine, single; upper frontal head hair 5 long, five branched, barbed; lower frontal head hair 6 long, triple, barbed; preantennal head hair 7 multiple, long, barbed. Mentum with about 19 teeth; the apical tooth larger and broader than the lateral teeth; the two basal lateral teeth larger than the other lateral teeth. Thorax minutely spiculate; abdomen glabrous. Comb with numerous scales in a triangular patch; each scale rounded apically and fringed with subequal spinules. Siphonal index about 5.0; with three pairs of double siphonal tufts located beyond the pecten. Pecten with about 12 teeth on the basal third of the siphon; each tooth with coarse barbs on one side. Anal segment completely ringed by the saddle, which possesses distinct spicules dorsally.

MATERIAL EXAMINED.—There were 137 adult male specimens and associated terminalia from Argentina, Brazil, British Guiana, Colombia, Costa Rica, Honduras, Panama, Peru, Surinam, Venezuela, and Trinidad.

DISTRIBUTION.—Reported from Trinidad (the type locality), Mexico, Honduras, British Honduras, Costa Rica, Panama, Colombia, Venezuela, Guianas, Ecuador, Peru, and Brazil. The author has examined specimens in the U.S. National Museum collection from Monteros and Concepción, Tucuman, Argentina.

***Culex (Culex) nigripalpus* Theobald, 1901**

FIGURES 25a, b

- Culex (Culex) nigripalpus* Theobald, 1901, p. 322.
Culex (Culex) palus Theobald, 1903a, p. 194.
Culex (Culex) similis Theobald, 1903a, p. 207.
Culex (Culex) biocellatus Theobald, 1903b, p. 224.
Culex (Culex) microsquamosus Theobald, in Grabham, 1905, p. 407.
Culex (Culex) mortificator Dyar and Knab, 1906b, p. 210.
Culex (Culex) carmodyae Dyar and Knab, 1906b, p. 210.
Culex (Culex) factor Dyar and Knab, 1906b, p. 212.
Culex (Culex) regulator Dyar and Knab, 1906b, p. 213.
Culex (Culex) microannulata Theobald, 1907, p. 481.
Culex (Culex) proximus Dyar and Knab, 1909b, p. 38.
Culex (Culex) caraibeus Howard, Dyar, and Knab, 1912 [1913], p. 333.
Culex (Culex) prasinopleurus Martini, 1914, p. 68.
Culex (Culex) azuayus Levi-Castillo, 1954, p. 264. [New synonymy.]

SYSTEMATICS.—A specimen in the U.S. National Museum collection labeled by Levi-Castillo as *Culex azuayus* from the type locality, has been thoroughly studied and appears to be the specimen from which the original figure of *C. azuayus* was made. There is no doubt that this is a specimen of *C. nigripalpus*. Since the type material is improperly labeled and the description of *C. azuayus* is vague and incomplete, *C. azuayus* is here placed into synonymy with *C. nigripalpus*.

Culex nigripalpus is similar to several species possessing a dentiform ventral cornu and spatulate spines on the outer lateral margins of the tenth sternite. It differs, however, in the arrangement and number of appendices on the apical lobe of the basistyle and in the conformation of the structures of the mesosome.

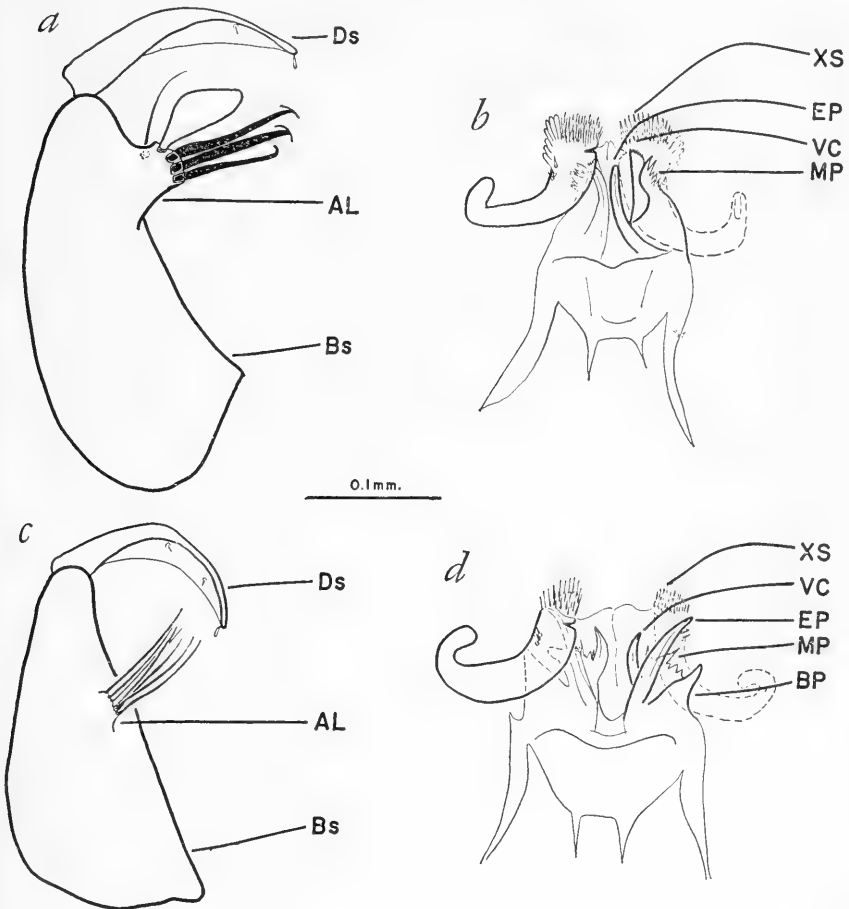


FIGURE 25.—*C. nigripalpus*, Bahia, Brazil, USNM RB62 163; *a*, basistyle and dististyle *b*, mesosome. *C. oswaldoi*, Natal, Brazil, USNM RB62 290 (holotype): *c*, basistyle and dististyle; *d*, mesosome.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine spicules in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and also clothed with fine spicules. Appendices of the apical lobe as follows: basal rod strong, straight, blunt; median rod longer and

broadier than basal rod and terminating in a prominent hook; apical rod longer than median rod, also prominently hooked terminally; leaf moderate in size, obovate; one long, gently curved accessory seta present. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines apically and approximately eight spatulate, scalelike spines on the lateral outer margins; basal arm long and prominently curved; two cercal setae present. External process somewhat curved and bluntly rounded; not reaching the ventral cornu in length. Ventral cornu distinct from the teeth of the median process, truncate and serrate. Median process with three to four strong, pointed teeth. Basal process absent.

Larva: Antennal tuft located in a constriction near the outer third. Postclypeal head hair 4 short, single; upper and lower frontal head hairs 5 and 6 triple, barbed, extending beyond the preclypeus; pre-antennal head hair 7 long, multiple. Mentum with about 23 blunt teeth; the apical tooth longer and broader than the lateral teeth. Thorax densely clothed with fine spicules. Comb with many scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index 6.0 to 7.0; with four pairs of double or triple siphonal tufts. Pecten with nine to 15 teeth on the basal fourth of the siphon; each tooth with two to six coarse barbs on one side. Anal segment completely ringed by the saddle.

MATERIAL EXAMINED.—There were 142 adult males and associated terminalia from the United States, Bahama Islands, Brazil, British Guiana, Colombia, Cuba, Ecuador, Guatemala, Haiti, Honduras, Mexico, Panama, Puerto Rico, Surinam, Venezuela, and the Dominican Republic.

DISTRIBUTION.—Reported from the Antilles, southern United States, Mexico, Central America, Trinidad, Ecuador, Colombia, Venezuela, Guianas, and Brazil.

Culex (Culex) oswaldoi Forattini, 1965

FIGURES 26c, d

Culex (Culex) oswaldoi Bram [sic].—Forattini, 1965, p. 167.

SYSTEMATICS.—This species is a member of the group lacking a leaf on the apical lobe of the basistyle. It is distinct from the other members, however, in the number and conformation of the appendices on the apical lobe of the basistyle and in the structures of the mesosome.

SALIENT CHARACTERS.—Adult female: Unknown.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine spicules in addition to the normal, long setal pattern. Apical lobe of the basistyle somewhat flattened,

undivided, and also clothed with fine spicules. Appendices of the apical lobe as follows: rods absent; a group of about seven long, pointed, gently curved setae evenly distributed; leaf absent. Dististyle normal. Tenth sternite crowned with a sparse tuft of short, pointed spines; basal arm moderate in length, strongly curved; two or three cercal setae present. External process gradually tapering to a blunt point; considerably exceeding the ventral cornu in length. Ventral cornu dentiform, but very large and distinctly separated from the teeth of the median process. Median process with about four, small, sharply pointed, subequal teeth. Basal process moderate in size, tapering to a blunt point, and directed posterolaterally.

Larva: Unknown.

HOLOTYPE.—An adult male and associated slide mounted terminalia with the following data: Natal, Brazil; Macaphyba; VII-23-43; MacCreary, Colr.; reared quarry hole; Serial No. 12; RB62 290. USNM 67550; deposited in the U.S. National Museum. I take great pleasure in naming this species in honor of Dr. Oswaldo P. Forattini.

MATERIAL EXAMINED.—The holotype male.

DISTRIBUTION.—That of the type locality.

***Culex (Culex) peus* Speiser, 1904**

FIGURES 26a, b

Culex (Culex) affinis Adams, 1903, p. 25.

Culex (Culex) peus Speiser, 1904, p. 148. [New name for *affinis* Adams, not Stephens, 1825.]

Culex (Culex) stigmatosoma Dyar, 1907, p. 123.

Culex (Culex) eumimetus Dyar and Knab, 1908, p. 61.

SYSTEMATICS.—This species is similar to *Culex chidesteri* and *C. interrogator* but may be distinguished by the arrangement and number of appendices on the apical lobe of the basistyle and by the conformation of the structures of the mesosome.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with minute spicules in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and also clothed with minute spicules. Appendices of the apical lobe as follows: basal rod strong, straight, and bluntly rounded; median rod longer and broader than basal rod and terminating in a prominent hook; apical rod longer than, but not as broad as median rod, terminating in a gentle hook; leaf small, pointed distally, and possessing distinct longitudinal striations; two accessory setae present, one prominently hooked, the other gently curved and pointed. Dististyle normal. Tenth sternite crowned with a dense tuft of short,

pointed spines; basal arm moderate in length, strongly curved; two cercal setae present. External process very broad medially, gradually tapering to a point; just reaching the ventral cornu in length. Ventral cornu large, round, and rugulose. Median process with four to eight distinct, pointed teeth. Basal process rather broad, straight, and bluntly rounded.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; upper and lower frontal head hairs 5 and 6 four to seven branched, barbed; preantennal head hair 7 multiple. Mentum with about 15 teeth; the apical tooth broader and longer than the lateral teeth; the subbasal teeth longer than the other lateral teeth. Thorax glabrous. Comb with numerous scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index 4.0 to 5.0; with five pairs of siphonal tufts, the subapical pair out of line and double. Pecten with nine to 15 teeth on the basal third of the siphon; each tooth with one to five coarse barbs on one side. Anal segment completely ringed by the saddle.

MATERIAL EXAMINED.—Thirty-nine males and associated terminalia from the United States, Mexico, and Costa Rica.

DISTRIBUTION.—Reported from the western United States, Mexico, Guatemala, El Salvador, Costa Rica, Colombia, and Venezuela.

Culex (Culex) pinarocampa Dyar and Knab, 1908

FIGURES 26c, d

Culex (Culex) pinarocampa Dyar and Knab, 1908, p. 59.

SYSTEMATICS.—The male terminalia indicates that this is a rather generalized species, but characters of the apical lobe of the basistyle and the mesosome distinguish it from other members of the subgenus.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle tubular, slightly longer than three times the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and also clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, straight, and blunt; median rod longer and broader than basal rod, and prominently hooked; apical rod longer than, but not as broad as the median rod, also prominently hooked terminally; leaf moderate in size, obovate; two accessory setae present, one distinctly hooked terminally, the other as long as the leaf, gently curved, and pointed. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderate in length, gently curved; two to four cercal setae present in a compact group. External process gradually tapering

to a point; slightly exceeding the ventral cornu in length. Ventral cornu clavate, tricleft, distinctly separated from the teeth of the median process. Median process with about four strong, pointed teeth. Basal process short, straight, and bluntly rounded.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, double; upper and lower frontal head hairs 5 and 6 three or four branched, long; preantennal head hair 7 long, multiple. Mentum

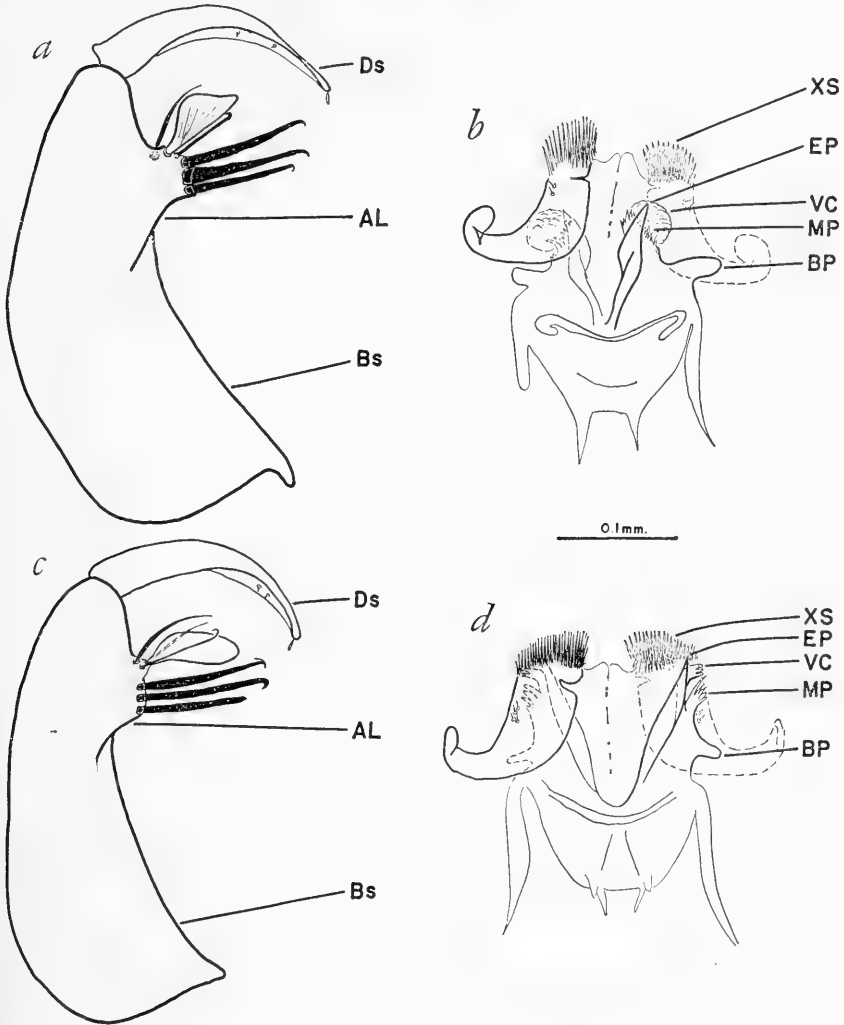


FIGURE 26.—*C. peus*, Montes de Oca, Costa Rica, USNM RB62 387: *a*, basistyle and dististyle; *b*, mesosome. *C. pinarocampa*, Cordoba, Mexico, USNM RB61 53: *c*, basistyle and dististyle; *d*, mesosome.

with about 17 teeth; the apical tooth broader and larger than the lateral teeth; lateral teeth becoming progressively smaller apically. Body glabrous. Comb with numerous scales in a patch. Siphonal index about 6.0; four pairs of double siphonal tufts. Pecten with numerous teeth on the basal third of the siphon. Anal segment completely ringed by the saddle, spiculate dorsally.

MATERIAL EXAMINED.—A paratype adult male and associated terminalia and three other male specimens from the type locality.

DISTRIBUTION.—Reported from Mexico and Panama.

***Culex (Culex) pipiens* Linnaeus, 1758**

FIGURES 27a, b

- Culex (Culex) pipiens* Linnaeus, 1758, p. 602.
Culex (Culex) consobrinus Robineau-Desvoidy, 1827, p. 408.
Culex (Culex) pungens Wiedemann, 1828, p. 9.
Culex (Culex) fatigans Wiedemann, 1828, p. 10.
Culex (Culex) aestuans Wiedemann, 1828, p. 11.
Culex (Culex) ferruginosus Wiedemann, 1828, p. 12.
Culex (Culex) cubensis Bigot, 1857, p. 329.
Culex (Culex) serotinus Philippi, 1865, p. 595.
Culex (Culex) autumnalis Weyenbergh, 1882, p. 23.
Culex (Culex) penafielii Williston, in Sanchez, 1886, p. 213.
Culex (Culex) barbarus Dyar and Knab, 1906b, p. 210.
Culex (Culex) raymondii Tamayo, in Tamayo and Garcia, 1907, p. 37.
Culex (Culex) aikenii Dyar and Knab, 1908, p. 61.
Culex (Culex) revocator Dyar and Knab, 1909a, p. 256.
Culex (Culex) lachrimans Dyar and Knab, 1909a, p. 259.
Culex (Culex) dipseticus Dyar and Knab, 1909b, p. 34.
Culex (Culex) comitatus Dyar and Knab, 1909b, p. 35.
Culex (Culex) aseychae Dyar and Knab, 1915, p. 112.

SYSTEMATICS.—The *Culex pipiens* complex is considered by many authors to consist of two subspecies: *C. pipiens pipiens* in the northern parts of the world and *C. pipiens quinquefasciatus* in the tropics. Another subspecies, *C. pipiens australicus*, has been recognized from Australia, and two infrasubspecific forms, *molestus* and *pallens*, have been described. Mattingly et al. (1951) reviewed the complex in considerable detail, and numerous subsequent papers have discussed distributions and hybridizations among various populations of the complex. Since taxonomic characters utilized in this study are strictly morphological, all members of the complex will be grouped under the broad designation, *C. pipiens*.

Culex pipiens is a very plastic species as evidenced by over 70 synonyms, which are listed by Stone et al. (1959) for members of the complex. The various forms freely hybridize both in nature and in the laboratory and produce fertile intermediates. The male terminalia of members of the complex, however, can be readily distinguished from other species of the subgenus by the characteristic number and

distribution of appendices on the apical lobe of the basistyle, by the short basal arm of the tenth sternite, and by the reduced mesosome.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, about two and a half times as long as the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and also clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, straight, and bluntly rounded; median rod slightly longer than basal rod and gently hooked terminally; apical rod not as broad as median and basal rods, gently hooked terminally; three accessory setae present, the one next to the apical rod is bicleft (one extension being pointed, the other hooked), next to the bicleft seta is a very strong, hooked seta, followed by the leaf; the third accessory seta as long as the leaf and gently curved; leaf moderate in size, obovate, and with distinct longitudinal striations. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm short, straight, and bluntly rounded; three to five cercal setae present. External process straight, somewhat tapered to a bluntly pointed tip; slightly exceeding the ventral cornu in length. Ventral cornu very broad and curved so as to be directed laterally; tapering to a terminal point. Median process without teeth. Basal process reduced to a short, rounded knob.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; frontal head hairs 5, 6, and 7 long, multiple, barbed. Mentum with about 23 sharply pointed teeth; the apical tooth longer and broader than the lateral teeth. Body glabrous. Comb with many scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index about 4.0; four siphonal tufts inserted on the siphon beyond the pecten. Pecten with six to 13 teeth on the basal third of the siphon; each tooth with one to five coarse barbs on one side. Anal segment completely ringed by the saddle.

MATERIAL EXAMINED.—Over 300 male terminalia from throughout the New World.

DISTRIBUTION.—This complex is cosmopolitan.

***Culex (Culex) pseudojanthinosoma* Senevet and Abonnenc, 1946**

Culex (Culex) pseudojanthinosoma Senevet and Abonnenc, 1946, p. 139.

SYSTEMATICS.—Senevet and Abonnenc (1946) described this species from larvae and adult females collected in French Guiana. Without suggesting reasons, Lane (1951) placed *Culex pseudojanthinosoma* in synonymy with *C. corniger*. Subsequently Senevet and Abonnenc (1958) revalidated the species, described the pupa, and provided a

redescription of the larva. Final placement of this species awaits the description of the male terminalia.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Unknown.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft strongly swollen at the basal third, spiculate; spicules more numerous basally. Upper frontal head hair 5 with seven long, barbed branches; lower frontal head hair 6 with eight or nine long, barbed branches; preantennal head hair 7 long, multiple. Mentum with about 21 teeth; apical tooth strong and feebly pointed; basal lateral three teeth more pointed and detached. Body glabrous. Comb with about 20 fringed scales arranged in a triangular patch of three rows. Siphonal index about 3.0; four pairs of siphonal tufts, the basal tuft single and inserted within the pecten, the subbasal tuft single, the subapical tuft single, bifurcated, and the apical tuft short, two or three branched. Pecten with five long, finely pointed teeth; each tooth with fine barbs on one side; restricted to the basal third of the siphon. Anal segment glabrous, completely ringed by the saddle.

MATERIAL EXAMINED.—None. Known to the author only from the descriptions and figures of Senevet and Abonnenc (1946 and 1958).

DISTRIBUTION.—Known only from the type locality, French Guiana.

***Culex (Culex) renatoi* Lane and Ramalho, 1960**

FIGURES 27c, d

Culex (Culex) renatoi Lane and Ramalho, 1960, p. 173.

SYSTEMATICS.—This species is similar to *Culex mauesensis* and *C. secutor*. It is distinctive in the appendices on the apical lobe of the basistyle and in the conformation of structures of the mesosome.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, about three times as long as the basal width. Apical lobe of the basistyle prominent, undivided. Appendices of the apical lobe as follows: basal rod strong, gently curved at the apex; median and apical rods subequal, broader and longer than the basal rod and prominently hooked distally; leaf moderate in size, pointed distally; two accessory setae present, one strong and prominently hooked, the other longer than the leaf and gently curved. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderate in length and curved; cercal setae present. External process gradually tapering to a blunt point; slightly exceeding the ventral cornu in length. Ventral cornu clavate, serrate terminally, distinctly separated from the teeth of the median process. Median process with about 14 strong, pointed teeth. Basal process short, straight, and bluntly rounded.

Larva: Antenna short; antennal hair on mesial portion. Frontal head hairs 4, 5, 6, and 7 long, multiple. Body glabrous. Comb with numerous scales in a patch. Siphonal index about 3.0; three, four, or five branched siphonal tufts beyond the pecten. Pecten with about eight pointed spines, nearly reaching the middle. Anal segment densely spiculate, completely ringed by the saddle.

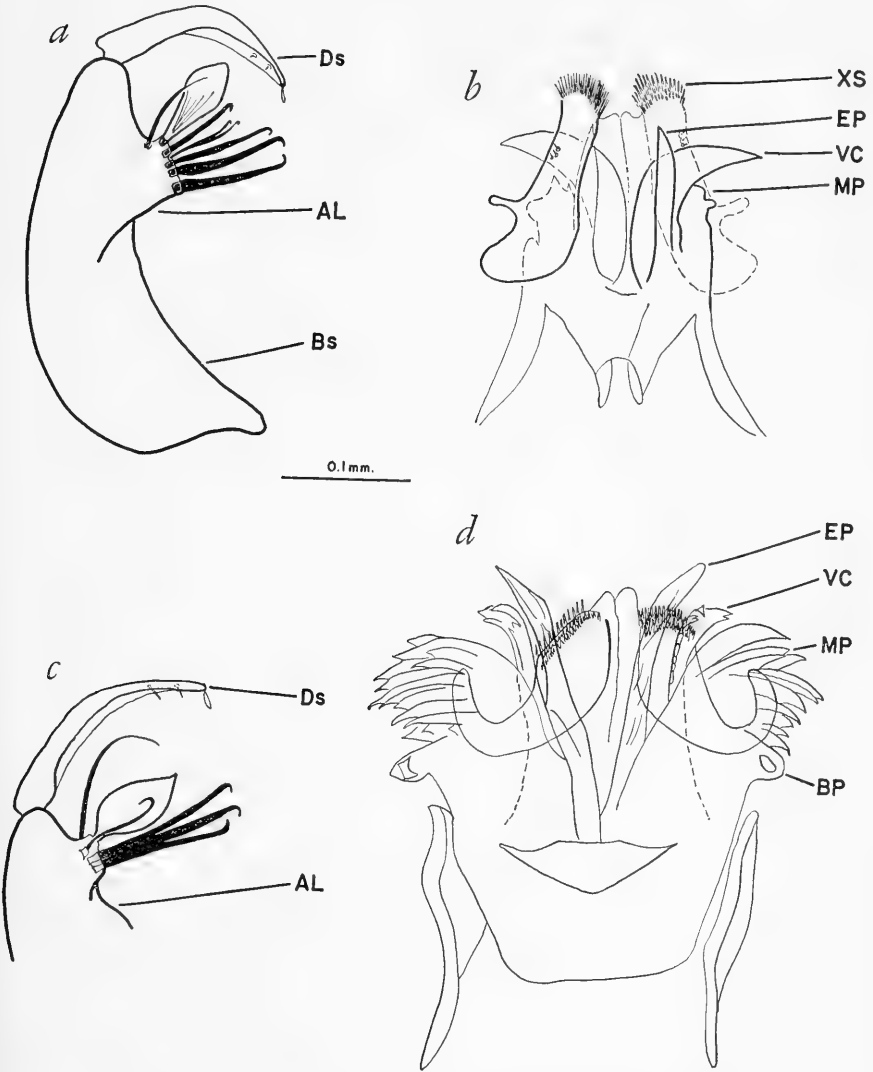


FIGURE 27.—*C. pipiens*, Bahia, Brazil, USNM RB62 166: *a*, basistyle and dististyle; *b*, mesosome. *C. renatoi* (drawn after Lane and Ramalho, 1960): *c*, basistyle and dististyle; *d*, mesosome.

MATERIAL EXAMINED.—One paratype male and associated terminalia.

DISTRIBUTION.—Known only from the type locality, Bairro de São Miguel Paulista, Capital, São Paulo, Brazil.

***Culex (Culex) restuans* Theobald, 1901**

FIGURES 28a, b

Culex (Culex) restuans Theobald, 1901, p. 142.

Culex (Culex) brehmei Knab, 1916, p. 161.

SYSTEMATICS.—This species may be distinguished from *Culex brethesi* by the number of appendices on the apical lobe of the basistyle. It is distinguished from *C. acharistus* by lacking annulations on the dististyle and from *C. laticlasper* by the appendices of the apical lobe of the basistyle and by the median plate of the mesosome.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, about two and a half times as long as the basal width; clothed with fine spicules in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and also clothed with fine spicules. Appendices of the apical lobe as follows: basal rod narrow, terminating in a small hook; median and apical rods subequal, broader and longer than the basal rod, and terminating in a prominent hook; leaf small, not as long as the rods, and obovate; two accessory setae present, both fine, gently curved and longer than the leaf. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderate in length and curved; one or two cercal setae present. External process very broad, somewhat twisted, and tapering to a point. Median process without teeth. Basal process absent.

Larva: Antennal tuft inserted near the middle of the antennal shaft, antennal shaft spiculate, slightly narrowed and darker beyond the antennal tuft. Postclypeal head hair 4 short, double or triple; frontal head hairs 5, 6, and 7 long, multiple, and barbed. Mentum broad, with about 20 very long, subequal, bluntly rounded teeth. Body glabrous. Comb with many scales in a patch; each scale rounded and fringed apically with subequal spinules. Siphonal index 4.0 to 4.5; siphonal tufts represented by three pairs of long, single hairs irregularly placed on the siphon, and a pair of small, subapical, two or three branched tufts inserted beyond the pecten. Pecten with 12 to 20 teeth on the basal third of the siphon; each tooth with one to five coarse barbs on one side. Anal segment completely ringed by the saddle, which is spiculate on the dorso-apical surface.

MATERIAL EXAMINED.—A series of 25 adult males and associated terminalia from the United States.

DISTRIBUTION.—Carpenter and LaCasse (1955) reported this species from southern Canada southward to the Gulf of Mexico. Martinez Palacios (1952) reported *Culex restuans* from five states in Mexico.

***Culex (Culex) salinarius* Coquillett, 1904**

FIGURES 28c, d

Culex (Culex) salinarius Coquillett, 1904, p. 73.

SYSTEMATICS.—*Culex salinarius* is similar to *C. archegus*, *C. dolosus*, and *C. spinosus*, all of which exhibit a basal process, which is pointed, sharply bent, and directed posteriorly. It differs, however, by having a dentiform ventral cornu and by the distinctive and diagnostic external process.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and also clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, straight, and blunt; median rod longer and broader than the basal rod and terminating in a prominent hook; apical rod not as broad as, but longer than the median rod and also hooked apically; leaf moderate in size, obovate; two accessory setae present, one prominently hooked, the other gently curved and pointed. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderate in length, strongly recurved; four cercal setae present in a compact group. External process broad, with a prominent knob midway on the inner surface, then slightly curved and tapering to a point; considerably exceeding the ventral cornu in length. Ventral cornu dentiform, similar in size and shape to the teeth of the median process. Median process with about five strong, sharply pointed teeth. Basal process very broad, sharply pointed, and bent so as to be directed posteriorly and reaching to about the ventral cornu.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; upper frontal head hair 5 long, three to six branched, barbed; lower frontal head hair 6 long, three or four branched, barbed; pre-antennal head hair 7 long, multiple, barbed. Mentum with about 15 teeth; the apical tooth broader and longer than the lateral teeth. Thorax glabrous. Comb with numerous scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index 6.0 to 7.0; four pairs of double or triple siphonal tufts present on the siphon beyond the pecten. Pecten with 10 to 16 teeth on the basal fourth of the siphon; each tooth with two to five coarse barbs on one side. Anal segment completely ringed by the saddle.

MATERIAL EXAMINED.—Fifty-five adult males and associated terminalia from the United States.

DISTRIBUTION.—Reported from Mexico, Bermuda, and the United States and Canada, east of the Rocky Mountains.

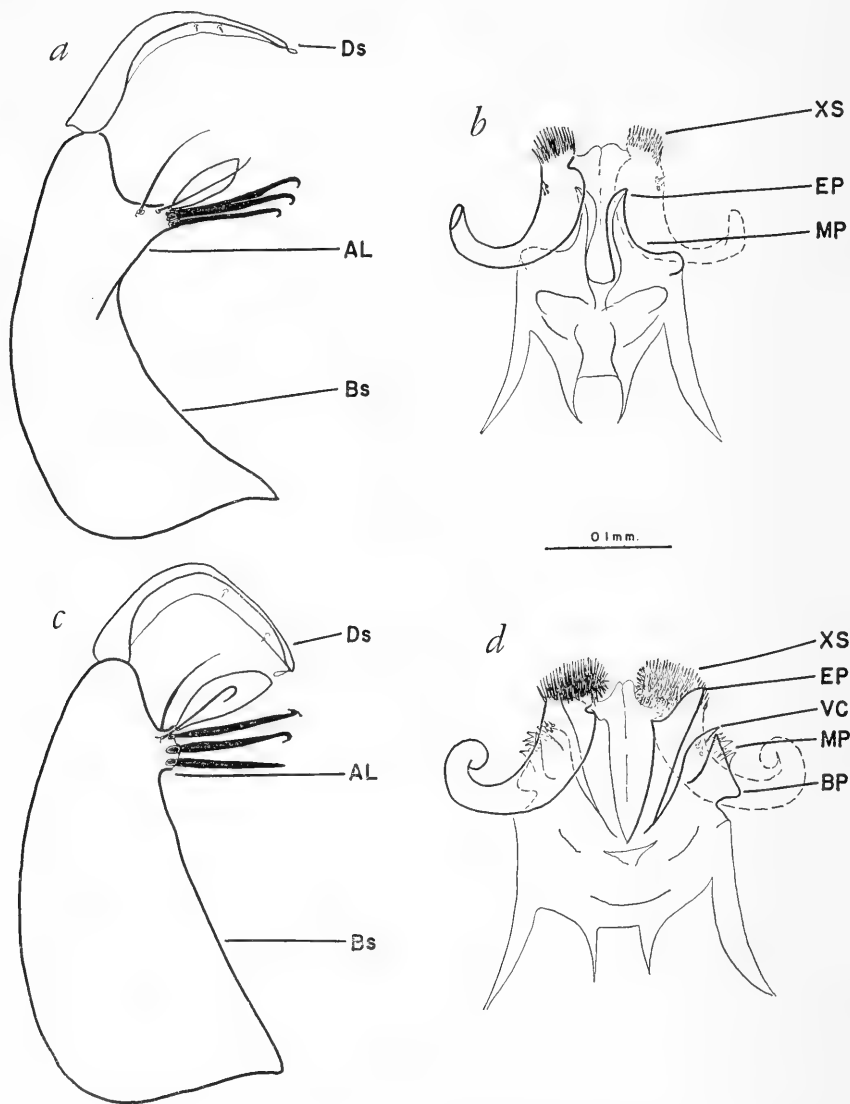


FIGURE 28.—*C. restuans*, Great Falls, Md., USNM HRB2: *a*, basistyle and dististyle; *b*, mesosome. *C. salinarius*, New Orleans, La., USNM RB61 197; *c*, basistyle and dististyle; *d*, mesosome.

Culex (Culex) saltanensis Dyar, 1928

FIGURES 29a, b

Culex (Culex) saltanensis Dyar, 1928, p. 386.*Culex (Culex) beauperthuyi* Anduze, 1943b, p. 459. [New synonymy.]

SYSTEMATICS.—The holotype male terminalia of *Culex beauperthuyi* were compared with the holotype male terminalia of *C. saltanensis* and found to be conspecific. Therefore, *C. beauperthuyi* is here placed in synonymy with *C. saltanensis*.

This species is a member of the group which lacks a leaf on the apical lobe of the basistyle. It is distinguished from *Culex bonneae* by exhibiting dense pilosity on the lateral margins of the tenth sternite; it may be separated from *C. duplicator* by the distinctive ventral cornu and differences in the external process.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine spicules in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent undivided, somewhat thumblike, and also clothed with fine spicules. Appendices of the apical lobe as follows: at the apex of the apical lobe are two subequal, strong rods which terminate in a distinct hook; surrounding these rods is a group of about 15 subequal, pointed setae; leaf absent. Dististyle normal. Tenth sternite crowned with a sparse tuft of short, pointed setae; basal arm moderate in length, prominently curved; cercal setae absent; except for the basal arm, the entire tenth sternite is clothed with fine setae. External process broad, slightly curved and gradually tapering to an obtuse termination; about twice as long as the ventral cornu. Ventral cornu very broad and curved so as to be directed laterally; distinctly separated from the teeth of the median process. Median process with 12 or more conglomerate teeth. Basal process short, straight, and bluntly rounded.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Upper and lower frontal head hairs 5 and 6 long, multiple. Mentum with about 15 teeth; the apical tooth broader and longer than the lateral teeth. Thorax and abdomen densely spiculate. Comb with numerous scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index about 4.5; five or six pairs of multiple siphonal tufts present on the siphon; siphon clothed with dense pilosity. Pecten with about 13 teeth on the basal third of the siphon; each tooth with one or two coarse barbs on one side. Anal segment densely spiculate, completely ringed by the saddle.

MATERIAL EXAMINED.—Four adult males and associated terminalia from Argentina, 10 from Brazil, and 4 from Venezuela. The holotype male was also studied.

DISTRIBUTION.—Reported from the Province of Salta, Argentina (the type locality). The author has seen specimens in the U.S. National Museum collection from: the Province of Tucuman, Argentina; the State of Bahia, Brazil; and the State of Zulia, Venezuela. *Culex beauperthuyi* has been reported from Venezuela, Brazil, and Panama.

***Culex (Culex) scimitar* Branch and Seabrook, 1959**

FIGURES 29c, d

Culex (Culex) scimitar Branch and Seabrook, 1959, p. 217.

SYSTEMATICS.—In the original description Branch and Seabrook (1959) recognized the affinity of this species with *Culex nigripalpus*; however, *C. scimitar* is readily distinguished from all other members of the subgenus by the characteristic shape of the dististyle and by the apical annulations found on the dististyle.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width: clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and also clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, straight, and pointed: median rod broader and longer than the basal rod, terminating in a prominent hook: apical rod longer than, but not as broad as the median rod, also terminating in a prominent hook: leaf moderate in size, obovate: one long, fine gently curved accessory seta present next to the leaf. Dististyle thick at base, widening along the inner margin to near the center where it narrows abruptly, scimitar-like in an unsclerotized area bordering the ragged fringe of the sclerotized integument: the distal third slender to the apex and bearing minute annulations along its crest. Tenth sternite crowned with a dense tuft of short, pointed spines apically and about 10 spatulate, scalelike spines on the lateral outer margins: basal arm moderate in length, gently curved: two cercal setae present. External process somewhat curved and bluntly rounded: exceeding the ventral cornu in length. Ventral cornu distinct from the teeth of the median process, truncate and serrate. Median process with three or four strong, pointed teeth. Basal process broadly spatulate.

Larva: Antennal tuft located in a constriction near the outer third: antennal shaft spiculate basally. Postclypeal head hair 4 short, single: upper frontal head hair 5 four branched, long, and barbed: lower frontal head hair 6 three branched, long, and barbed: pre-

antennal head hair 7 multiple, long, and barbed. Mentum with about 21 teeth, the apical tooth being broader and larger than the lateral teeth. Thorax and abdomen spiculate. Comb with numerous scales in a patch: each scale rounded apically and fringed with subequal spinules. Siphonal index about 5.5: four double siphonal tufts

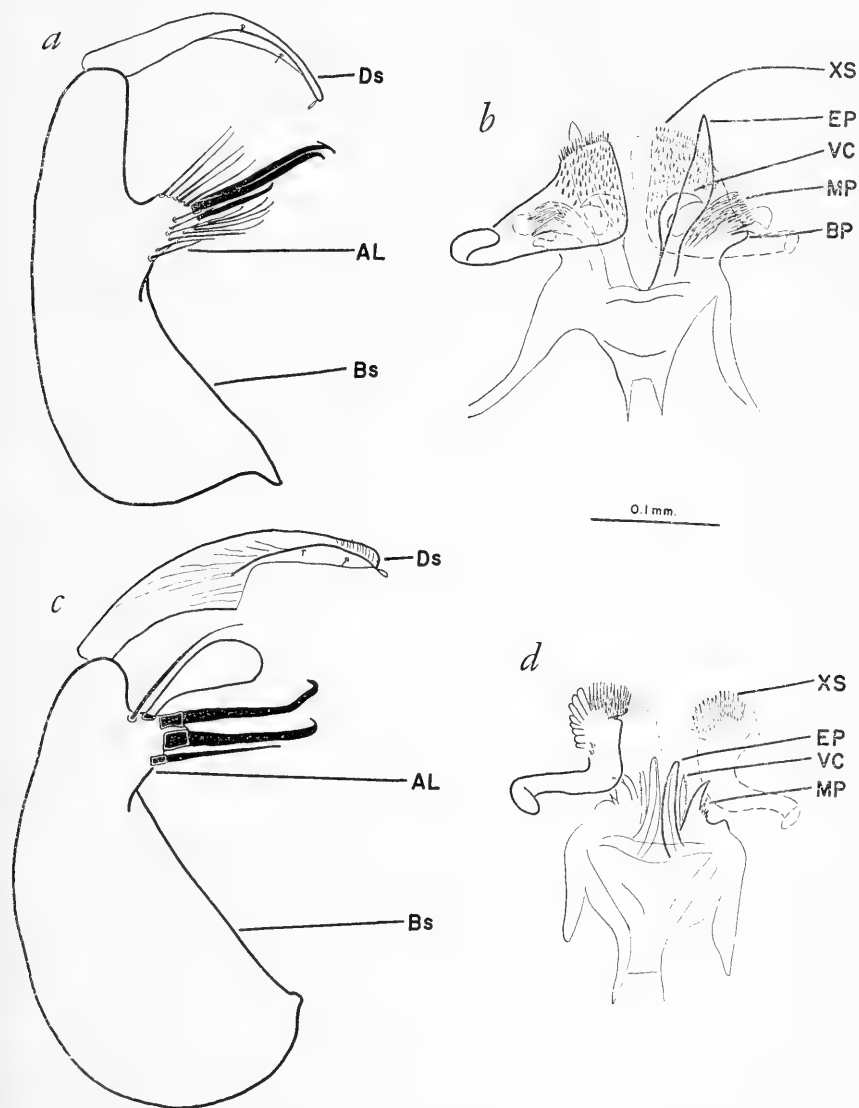


FIGURE 29.—*C. saltanensis*, Bahia, Brazil, USNM RB62 563: *a*, basistyle and dististyle; *b*, mesosome. *C. scimular*, New Providence, Bahama Is., USNM RB62 720: *c*, basistyle and dististyle; *d*, mesosome.

inserted on the siphon beyond the pecten. Pecten with about 12 teeth on the basal third of the siphon: each tooth with coarse barbs on one side. Anal segment completely ringed by the saddle, which is spiculate dorsolaterally.

MATERIAL EXAMINED.—The type series and nine other adult males and associated terminalia from the Bahama Islands.

DISTRIBUTION.—Reported from the Bahama Islands and Cuba.

Culex (Culex) secutor Theobald, 1901

FIGURES 30a, b

Culex (Culex) secutor Theobald, 1901, p. 321.

Culex (Culex) lamentator Dyar and Knab, 1906b, p. 219.

Culex (Culex) quasisecutor Theobald, 1907, p. 398.

Culex (Culex) toweri Dyar and Knab, 1907b, p. 13.

SYSTEMATICS.—This species exhibits a rather generalized mesosome in the male terminalia, but the arrangement and distribution of the appendices on the apical lobe of the basistyle is diagnostic.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and also clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, straight, and with a fine hook at the apex; median rod longer and broader than basal rod, prominently hooked; apical rod longer than, but not as broad as the median rod, also prominently hooked; two short, straight, fine setae next to the apical rod; leaf moderate in size, bluntly rounded, with a few prominent longitudinal striations in the center; two accessory setae present, one strong and prominently hooked, the other more slender, long, and gently curved. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderate in length, strongly curved terminally; three cercal setae present in a compact group. External process gradually tapering to a blunt point; reaching to about the ventral cornu. Ventral cornu dentiform, somewhat larger than the teeth of the median process. Median process with about five distinct, sharply pointed teeth. Basal process broad and sharply bent at the apical third so that the pointed apex is directed posteriorly.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; upper and lower frontal head hairs 5 and 6 4-branched, long, and barbed; preantennal head hair 7 multiple, long, and barbed. Mentum with about 21 teeth, the apical tooth broader and larger than the lateral teeth. Body glabrous. Comb with numerous scales in a patch; each scale rounded apically and fringed with subequal spinules.

Siphonal index about 4.0; six multiple siphonal tufts on the siphon, the basal tuft inserted within the pecten. Pecten with about 13 teeth on the basal third of the siphon, the apical tooth removed from the other pecten teeth; each tooth with coarse barbs on one side. Anal segment completely ringed by the saddle, which is spiculate distally.

MATERIAL EXAMINED.—Three adult males and associated terminalia from Puerto Rico and one from Jamaica.

DISTRIBUTION.—Reported from Jamaica (the type locality), Hispaniola, Puerto Rico, the Lesser Antilles, and Venezuela.

***Culex (Culex) sphinx* Howard, Dyar, and Knab, 1912**

FIGURES 30c, d

Culex (Culex) sphinx Howard, Dyar, and Knab, 1912 [1913], p. 134.

SYSTEMATICS.—This species demonstrates close affinity with *Culex nigripalpus* but is distinctive in the arrangement and conformation of the appendices on the apical lobe of the basistyle.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, about two and a half times longer than the basal width; clothed with fine spicules in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent in the area of the rods, but somewhat flattened in the area of the leaf and accessory setae; also clothed with fine spicules. Appendices of the apical lobe as follows: basal rod straight, strong, and pointed; median rod broader and longer than the basal rod, terminating in a gentle hook; apical rod longer and broader than the median rod, also terminating in a gentle hook; two subequal, strong, straight, pointed accessory setae located between the apical rod and the leaf; leaf rather narrow and truncate, about as long as the accessory setae. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines apically and six to nine spatulate, scalelike spines on the lateral outer margins; basal arm short and gently curved; about six cercal setae present in a compact group. External process somewhat curved and bluntly rounded; not reaching the ventral cornu in length. Ventral cornu distinct from the teeth of the median process, truncate and serrate. Median process with about six distinct, sharply pointed teeth. Basal process reduced to a bulbous expansion of the mesosome; not distinct.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; upper and lower frontal head hairs 5 and 6 three or four branched, long, barbed; preantennal head hair 7 multiple, long, and barbed. Mentum with about 17 teeth, the apical tooth broader and larger than the lateral teeth. Thorax finely spiculate, abdomen glabrous. Comb with numerous scales in a patch; each scale rounded

apically and fringed with subequal spinules. Siphonal index about 3.0 to 3.5; three double or triple siphonal tufts inserted on the siphon. Pecten with about 20 fine teeth, restricted to the basal third of the siphon; each tooth with coarse barbs on one side. Anal segment spiculate, completely ringed by the saddle.

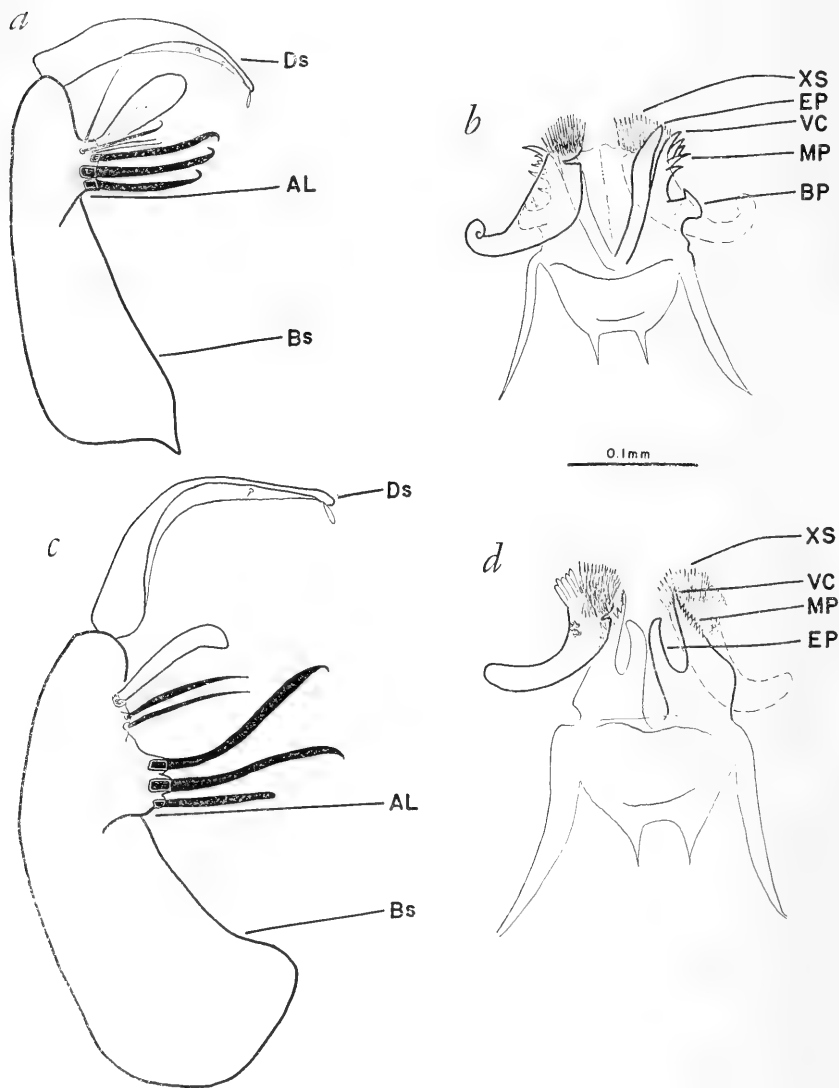


FIGURE 30.—*C. secutor*, Mayaguez, P.R., USNM RB62 356: *a*, basistyle and dististyle; *b*, mesosome. *C. sphinx*, New Providence, Bahama Is., USNM RB62 381: *c*, basistyle and dististyle; *d*, mesosome.

MATERIAL EXAMINED.—The lectotype male terminalia and six other male specimens from the Bahama Islands.

DISTRIBUTION.—Reported only from the Bahama Islands.

***Culex (Culex) spinosus* Lutz, 1905**

FIGURES 31a, b

Culex (Culex) spinosus Lutz, 1905, p. 26.

SYSTEMATICS.—This species is a member of the *salinarius* complex. The primary distinguishing characteristic is the large, distinctive basal process. The ventral cornu and external process are also useful diagnostic characters.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, and also clothed with fine setae. Appendices of the apical lobe as follows: basal rod strong, straight, and rounded terminally; median rod broader and longer than basal rod and terminating in a prominent hook; apical rod not as broad as, but longer than the median rod, also terminating in a prominent hook; leaf moderate in size, obovate, exhibiting distinct longitudinal striations; two accessory setae present, one shorter than the leaf and prominently hooked terminally, the other very long, pointed, and gently curved. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm moderate in length, gently curved; two or three cercal setae present in a compact group. External process gradually tapering to a blunt point; exceeding the ventral cornu in length. Ventral cornu dentiform, very similar in size and shape to the teeth of the median process. Median process with about four to six sharply pointed, distinct teeth. Basal process sharply pointed distally, acutely bent so as to be directed posteriorly; robust basally, but long and slender apically; reaching almost to the ventral cornu.

Larva: After Lane (1953). Antennal tuft located in a constriction near the outer third; antennal shaft spiculate. Postelypeal head hair 4 short, single; frontal head hairs 5, 6, and 7 multiple, long, barbed. Body glabrous. Comb with numerous scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index 4.5 to 6.0; four triple siphonal tufts inserted on the siphon beyond the pecten. Pecten with about 12 teeth on the basal third of the siphon; each tooth without coarse barbs on one side. Anal segment completely ringed by the saddle, which is densely spiculate on the entire surface.

MATERIAL EXAMINED.—Three adult males and associated terminalia from Colombia and Venezuela.

DISTRIBUTION.—Reported from Brazil. The author has seen specimens in the U.S. National Museum collection from Lagunillas, Venezuela, and from Colombia.

Culex (Culex) stenolepis Dyar and Knab, 1908

FIGURES 31c, d

Culex (Culex) stenolepis Dyar and Knab, 1908, p. 60.

SYSTEMATICS.—*Culex stenolepis* demonstrates relationship to *C. interrogator*, *C. peus*, and *C. thriambus*. It may be distinguished from the first two species by the number and arrangement of the appendicles on the apical lobe of the basistyle. It is distinct from *C. thriambus* in the conformation of the external process.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, about twice as long as the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle somewhat flattened, undivided, and also clothed with fine setae. Appendicles of the apical lobe as follows: basal rod strong, straight, and pointed; median rod broader and longer than the basal rod and terminating in a gentle hook; apical rod longer than, but not as broad as the median rod, also terminating in a gentle hook; leaf moderate in size, obovate, with several prominent, longitudinal, centripetal striations; one long, pointed, gently curved accessory seta present. Dististyle normal. External process gradually tapering to a point, reaching to about the ventral cornu in length. Ventral cornu large, rounded, and rugulose. Median process with about seven sharply pointed, subequal teeth. Basal process short, straight, broad, and bluntly rounded.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; frontal head hairs 5, 6, and 7 multiple, long, and barbed. Mentum with about 23 teeth; the apical tooth broader and longer than the lateral teeth; the subbasal lateral teeth longer than the other lateral teeth. Body glabrous. Comb with many scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index about 3.5; five pairs of siphonal tufts inserted beyond the pecten, the basal four tufts double, the apical tuft multiple. Pecten with about 10 teeth, restricted to the basal third of the siphon; each tooth with several coarse barbs on one side. Anal segment completely ringed by the saddle, which is sparsely and finely spiculate distally.

MATERIAL EXAMINED.—Seven adult males and associated terminalia from Mexico. The lectotype male terminalia was also studied.

DISTRIBUTION.—Reported from Mexico and Costa Rica.

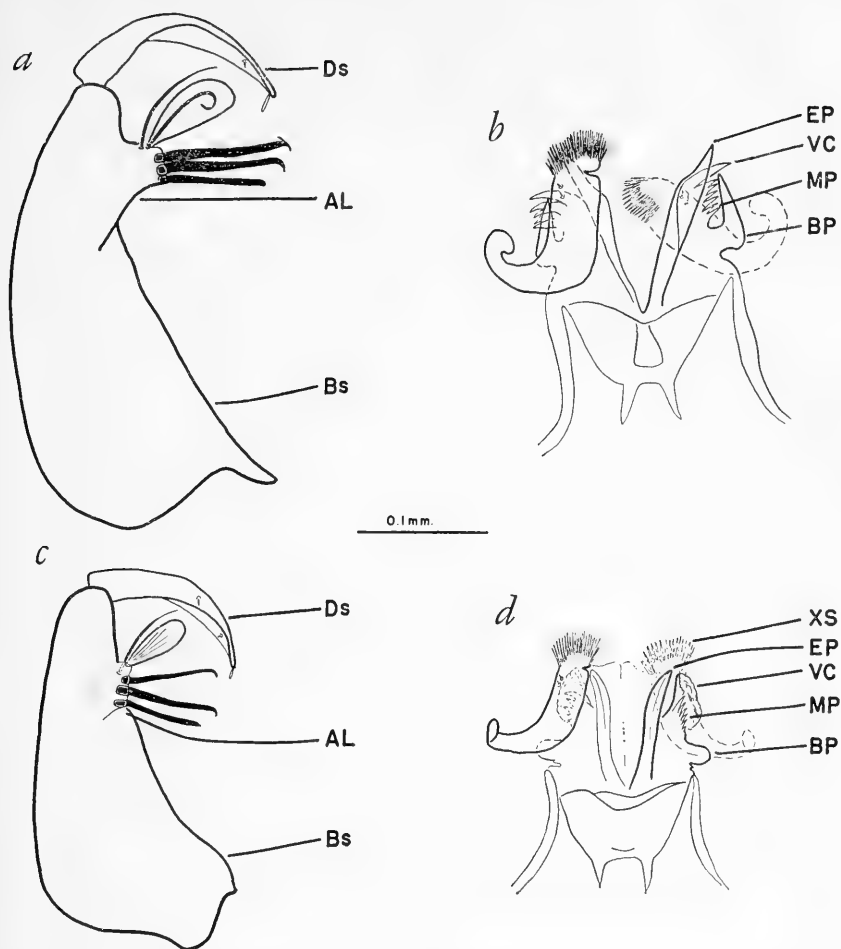


FIGURE 31.—*C. spinosus*, Lagunillas, Venezuela, USNM RB62 428: *a*, basistyle and dististyle; *b*, mesosome. *C. stenolepis*, Cordoba, Mexico, USNM RB62 714: *c*, basistyle and dististyle; *d*, mesosome.

***Culex (Culex) surinamensis* Dyar, 1918**

FIGURES 32*a, b*

Culex (Culex) surinamensis Dyar, 1918b, p. 121.

SYSTEMATICS.—This species belongs to the group which lacks a leaf on the apical lobe of the basistyle. It is distinguished from its nearest relative, *Culex brevispinosus*, by possessing a dentiform ventral cornu.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with a sparse covering of very fine spicules in

addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided, also clothed with fine spicules. Appendices of the apical lobe as follows: basal, median, and apical rods subequal in length, very fine, pointed, and gently curved terminally; beyond the apical rod are three or four fine, straight, and pointed accessory setae; leaf absent. Dististyle normal. Tenth sternite crowned with a sparse tuft of short pointed spines; basal arm moderate in length, distinctly curved; four cercal setae present. External process gradually tapering to a blunt point; reaching to the ventral cornu in length. Ventral cornu dentiform, similar in shape, but slightly larger than the teeth of the median process. Median process with about five distinct, sharply pointed teeth. Basal process short, straight, and bluntly rounded.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; frontal head hairs 5, 6, and 7 multiple, long, and barbed. Mentum with about 11 very broad teeth, the apical tooth larger than the lateral teeth. Thorax and abdomen densely covered with rather long, fine spicules. Comb with numerous scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index about 4.5; five multiple siphonal tufts inserted beyond the pecten. Pecten with about 16 teeth on the basal fourth of the siphon; each tooth with coarse barbs on one side. Anal segment spiculate, completely ringed by the saddle.

MATERIAL EXAMINED.—Four adult males and associated terminalia from Brazil, one from Colombia, and one from Surinam. The lectotype male terminalia has also been studied.

DISTRIBUTION.—Reported from Surinam, French Guiana, Venezuela, Brazil, and Bolivia. One specimen in the U.S. National Museum collection from La Dorada, Colombia has been examined by the author.

Culex (Culex) tarsalis Coquillett, 1896

FIGURES 32c, d

Culex (Culex) tarsalis Coquillett, 1896, p. 43.

Culex (Culex) willistoni Giles, 1900, p. 281.

Culex (Culex) kelloggii Theobald, 1903b, p. 211.

SYSTEMATICS.—*Culex tarsalis* demonstrates close affinity with *C. abnormalis* in structures of the male terminalia, but may be distinguished by the arrangement and number of the appendices on the apical lobe of the basistyle.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided,

and also clothed with fine setae. Appendices of the apical lobe as follows: two strong, straight, subequal, bluntly rounded rods followed by a straight, pointed seta; leaf very narrow, somewhat pointed at apex; two accessory setae present, one as long as leaf, the other broader and longer than the leaf. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines apically and about seven spatulate, scalelike spines on the lateral, outer margins; basal arm rather long, distinctly curved; eight to 10 cercal setae present in a large patch on the lateral margin. External process rather narrow, gradually tapering to a blunt point; slightly exceeding the ventral cornu in length. Ventral cornu long and narrow, similar in size and shape to the external process. Median process with three to five strong, pointed, distinctly separated teeth. Basal process long, thin, straight, and bluntly rounded at the apex.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; frontal head hairs 5, 6, and 7 multiple, long, and barbed. Mentum with about 13 sharply pointed teeth; the apical tooth is longer and broader than the lateral teeth. Thorax glabrous. Comb with many scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index 4.5 to 5.5; five multiple siphonal tufts inserted in a line beyond the pecten. Pecten with 10 to 15 teeth on the basal third of the siphon; each tooth with one to five coarse barbs on one side. Anal segment completely ringed by the saddle, spiculate distally.

MATERIAL EXAMINED.—A series of over 50 specimens from the United States and five adult males and associated terminalia from Mexico.

DISTRIBUTION.—Carpenter and LaCasse (1955) reported that this species ranges from southwestern Canada through the western, central, and southern United States and into Mexico.

Culex (Culex) thriambus Dyar, 1921

FIGURES 33a, b

Culex (Culex) thriambus Dyar, 1921a, p. 33.

SYSTEMATICS.—This species demonstrates affinities with *Culex peus*, *C. interrogator*, and *C. stenolepis*. It may be distinguished by the number and arrangement of appendices on the apical lobe of the basistyle and by its characteristic and diagnostic external process.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, slightly longer than twice the basal width; clothed with fine setae in addition to the normal, long setal pattern. Apical lobe of the basistyle prominent, undivided,

and also clothed with fine setae. Appendicles of the apical lobe as follows: basal rod strong, straight, and pointed; median rod longer and broader than the basal rod and terminating in a gentle hook; apical rod not as broad as, but longer than the median rod, also terminating in a gentle hook; leaf moderate in size, obovate, exhibiting distinct longitudinal striations; one long, pointed, gently curved accessory seta present. Dististyle normal. Tenth sternite crowned

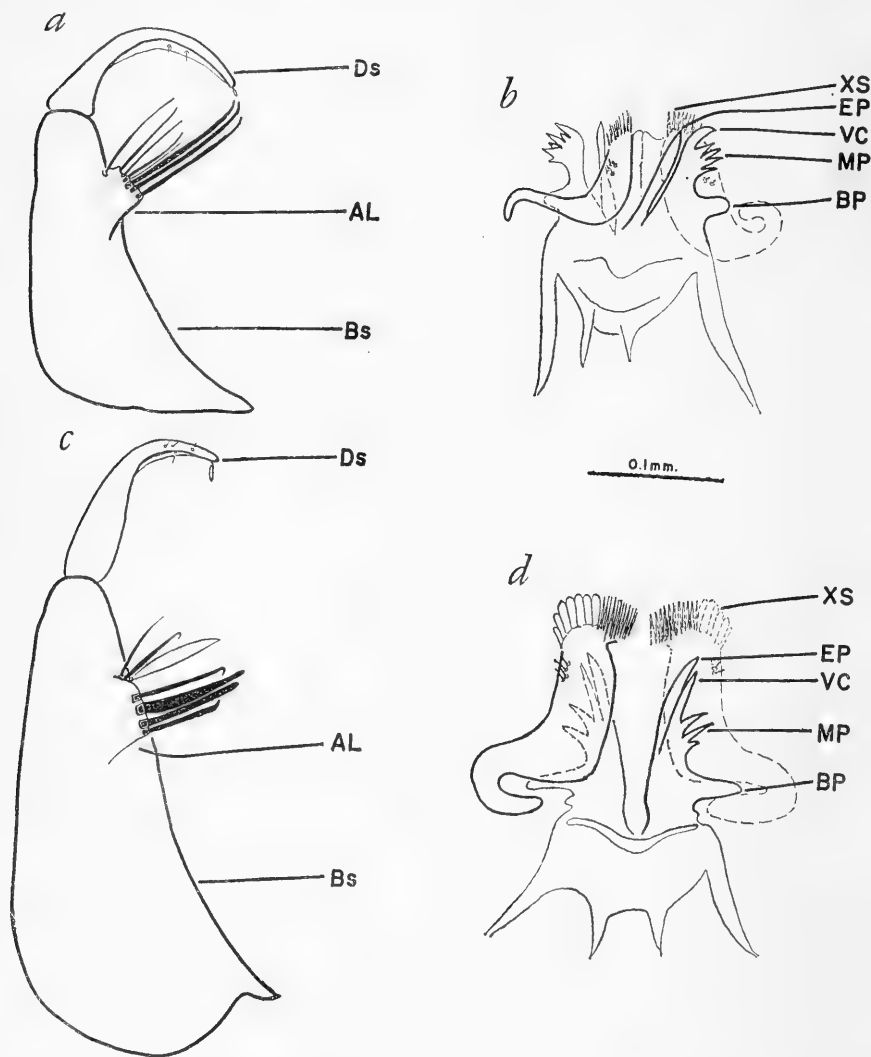


FIGURE 32.—*C. surinamensis*, Bahia, Brazil, USNM RB62 651: *a*, basistyle and dististyle; *b*, mesosome. *C. tarsalis*, Federal District, Mexico, USNM RB62 706: *c*, basistyle and dististyle; *d*, mesosome.

with a dense tuft of short, pointed spines; basal arm moderate in length, prominently curved; three cercal setae present in a compact group. External process broad on the proximal half, then sharply tapering to a point which reaches slightly beyond the ventral cornu; a prominent additional sclerite on the inner margin of the proximal half. Ventral cornu large, rounded and rugulose. Median process with four to six distinct, sharply pointed teeth. Basal process short, straight, and bluntly rounded.

Larva: Antennal tuft located in a constriction near the outer third; antennal shaft spiculate basally. Postclypeal head hair 4 short, single; frontal head hairs 5, 6, and 7 multiple, long, and barbed. Mentum with about 17 teeth; the apical tooth longer and broader than the lateral teeth; subbasal lateral teeth longer than other lateral teeth. Thorax glabrous. Comb with many scales in a patch; each scale rounded apically and fringed with subequal spinules. Siphonal index about 6.0; four siphonal tufts consisting of single setae inserted beyond the pecten. Pecten with about 10 to 14 teeth on the basal third of the siphon; each tooth with one to four coarse barbs on one side. Anal segment completely ringed by the saddle which has several fine spicules distally.

MATERIAL EXAMINED.—Five adult males and associated terminalia from Costa Rica, one from Colombia, one from the Dominican Republic, and three from the United States. The lectotype male terminalia was also studied.

DISTRIBUTION.—Reported from the southwestern United States, Mexico, and Panama. The author has seen specimens in the U.S. National Museum collection from: Santa Anna, Costa Rica; Barahona, Santo Domingo, Dominican Republic; and Cateria al Colegio, Bogotá, Colombia.

***Culex (Culex) tramazayguesi* Duret, 1954**

FIGURE 33c

Culex (Culex) tramazayguesi Duret, 1954, p. 23.

SYSTEMATICS.—Examination of Duret's (1954) original figures and description of this species suggests the possibility that it is not a member of the subgenus *Culex*, however, since actual specimen have not been examined, the species is considered a member of the subgenus for purposes of this study.

Culex tramazayguesi is readily distinguished from all other members of the subgenus by the characteristic shape and number of the appendices on the apical lobe of the basistyle.

SALIENT CHARACTERS.—Adult female: See table 1.

Male terminalia: Basistyle conical, about twice as long as the basal width. Apical lobe of the basistyle prominent, divided into two sec-

tions: the proximal section is conical and possesses two robust, heavily sclerotized, bluntly rounded rods: the distal section is also conical, but possesses only one heavily sclerotized, bluntly rounded rod: numerous setae are also present on the apical lobe. Dististyle normal. Tenth sternite crowned with a dense tuft of short, pointed spines; basal arm short and straight; about eight cercal setae present. Ex-

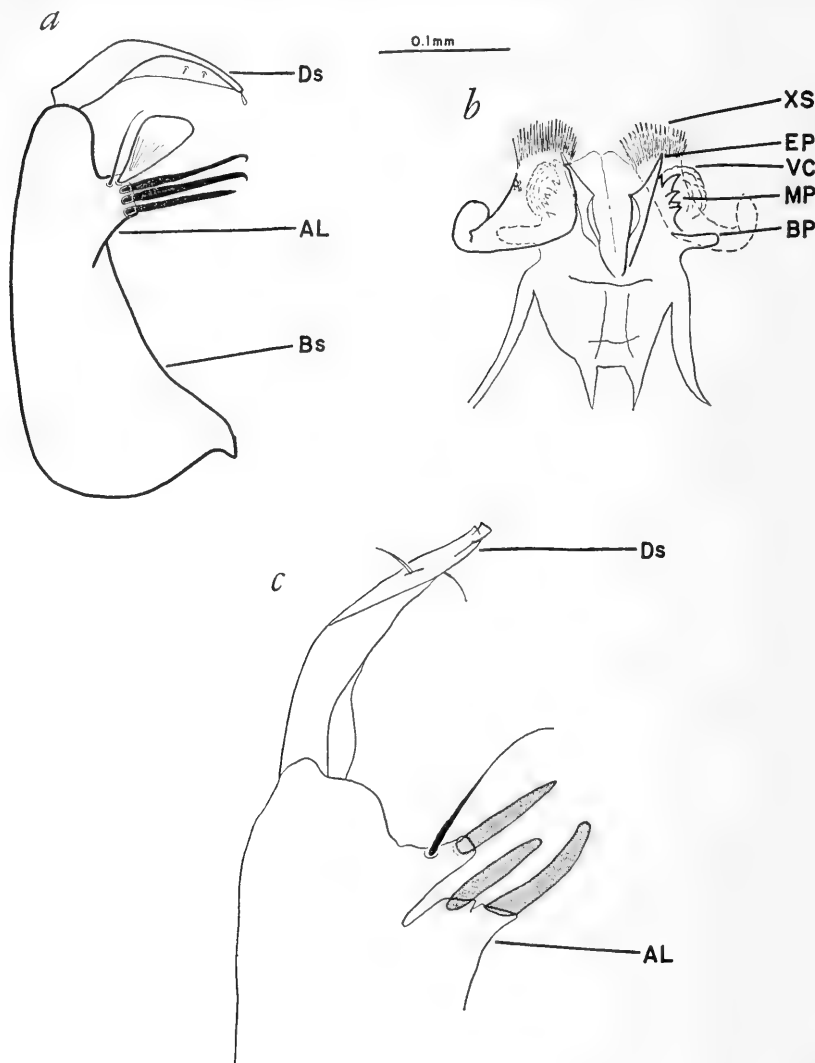


FIGURE 33.—*C. thriambus*, Santa Anna, Costa Rica, USNM RB62 73: *a*, basistyle and dististyle; *b*, mesosome. *C. tramazayguesi* (drawn after Duret, 1954): *c*, apical lobe of basistyle and dististyle.

ternal process gradually tapering to a blunt point. Ventral cornu absent. Median process without teeth. Basal process absent.

Larva: Unknown.

MATERIAL EXAMINED.—None. Known to the author only from the original description.

DISTRIBUTION.—Known only from the type locality, Monte Coman, Mendoza, Argentina.

Unrecognized Species

Culex (Culex) virgultus Theobald, 1901

Culex (Culex) virgultus Theobald, 1901, p. 123.

Following the recommendation of Stone (1956 [1957]), *Culex virgultus* is considered an unrecognized species in the present study.

Culex (Culex) guayasi Levi-Castillo, 1953

Culex (Culex) guayasi Levi-Castillo, 1953, p. 15.

In the original description, Levi-Castillo (1953) described the female and included figures of the male terminalia. I have been unable to utilize the generalized descriptions in keys or otherwise distinguish this species from other members of the subgenus. Since type specimens are not available for study, *Culex guayasi* is here considered as an unrecognized species.

Culex (Culex) quitensis Levi-Castillo, 1953

Culex (Culex) quitensis Levi-Castillo, 1953, p. 190.

As mentioned above for *C. guayasi*, the generalized original description of this species is not sufficient for absolute recognition. Since type specimens are not available for study, *C. quitensis* is here considered as an unrecognized species.

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TABLE 1.—*Salient female characters of New World species of the Culex subgenus Culex*—Continued

	Abdominal bands with caudally directed V	Abdominal segments with broad white basal bands	Abdominal segments with narrow white basal bands	Last hind tarsal segment entirely white	Tarsal segments with white bands	Tibia with pale apical band	Femur with pale apical band	Wings with scattered white scales on costa and subcosta	Scutellum with white scales or setae	Pleura with patches of white scales	Mesonotum with pattern of silver scales	Palpi with white markings	Proboscis ringed with a white band
<i>pinarocampa</i>	O	O	X	X	X	X	X	O	X	X	X	O	O
<i>pipiens</i>	O	O	X	O	O	X	X	O	X	X	O	O	O
<i>pseudojanthinosoma</i>	O	O	X	O	X	O	O	O	X	X	O	X	X
<i>renatoi</i>	O	O	O	O	X	X	X	O	X	X	X	X	X
<i>restuans</i>	O	X	O	O	O	X	X	O	X	X	X	O	O
<i>salinarius</i>	O	O	X	O	O	O	O	O	X	X	O	O	O
<i>scimitar</i>	O	O	X	O	O	X	O	O	O	X	O	O	O
<i>secutor</i>	O	O	X	O	X	X	X	O	X	X	O	O	O
<i>sphinx</i>	O	O	X	O	O	X	X	O	X	X	O	O	O
<i>spinosus</i>	O	O	O	O	O	X	X	O	X	X	O	O	O
<i>stenolepis</i>	O	O	X	X	X	X	X	O	X	X	O	O	O
<i>surinamensis</i>	O	X	O	O	X	X	X	O	?	?	O	O	O
<i>tarsalis</i>	O	O	X	O	X	X	X	X	X	X	X	X	X
<i>thriambus</i>	O	O	X	X	X	X	X	O	O	X	O	O	O
<i>tramazayguesi</i>	O	O	X	X	X	X	X	X	X	X	O	O	X
<i>usquatissimus</i>	O	X	O	O	X	X	X	O	X	X	O	O	O
<i>usquatatus</i>	O	X	O	O	X	X	X	O	X	X	O	O	O

TABLE 2.—*Terminology used in describing structures of the mesosome in Culex (Culex) (*=variation in use of the term within the paper under consideration.)*

Source	Structures				
Freeborn and Bohart (1951)	External process	Ventral cornu	Median process	Basal process	Mesosome
Carpenter and LaCasse (1955)	Dorsal arm *	Ventral arm *	Lateral teeth of phallosome	not named *	Phallosome
	Ventral arm *	not named *	Lateral teeth of phallosome	Dorsal arm *	Phallosome
Lane (1953)	Upper horn *	Upper horn *	Teeth of mesosome	Lateral horn of mesosome	Mesosome
Dyar (1928)	Upper arm	Upper limb	Teeth of mesosome	Lower arm	Mesosome
Martinez Palacios (1950)	Apendice del borde interno	Primer diente apical	Dientes apicales	Apifisis dorsal	Mesosoma
Roth (1943)	Ventral arm	not named	Teeth of mesosome	Dorsal arm	Mesosome
Bohart and Ingram (1946)	External process	Ventral cornu	Median process	Basal angle	Mesosome
Matheson (1944)	Upper arm	Apical tooth of outer plate	Outer plate	Lower arm	Mesosome
Natvig (1948)	Dorsal sclerite	Ventral sclerite	Median sclerite	Median sclerite	Phallosome
Belkin (1962)	Inner division	Tergal arm	Outer division	Lateral arm of the outer division	Phallosome

TABLE 3.—*Distributional analysis of the species in the Culex coronator complex*

Area	Number of Specimens Studied					Total
	<i>c. coronator</i>	<i>c. usquatus</i>	<i>c. camposi</i>	<i>c. ousqua</i>	<i>c. usquatissimus</i>	
I	7	0	0	0	0	7
II	43	3	0	7	0	53
III	11	1	0	12	3	27
IV	2	5	14	1	4	26
V	8	13	0	0	2	23
VI	3	3	0	0	0	6
VII	4	23	0	0	0	27
VIII	26	1	0	0	0	27
IX	0	2	4	0	0	6
X	0	0	24	0	1	25
Total	104	51	42	20	10	227

Addendum

Culex (Culex) fernandezi Casal, Garcia, and Cavalieri (1966, *Physis*, vol. 26, pp. 185-192): In the key to species based on male terminalia, *C. fernandezi* would key to couplet 49, but differs from *C. salinarius* in the development of the external process. In the key to species based on the larva, *C. fernandezi* would key to the vicinity of couplet 16; however, features of the chaetotaxy, particularly the stellate thoracic and abdominal setae, are quite distinctive. This species is known from the Province of Salta, Argentina, and the larvae were collected exclusively from bromeliads.

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AMBLYCERAN MALLOPHAGA (BITING LICE) FOUND ON THE BUCEROTIDAE (HORNBILL)S¹

By ROBERT E. ELBEL²

Mallophaga of the genera *Chapinia* and *Bucerophagus* of the amblyceran family Menoponidae are found only on hornbills. The purpose of this paper is to redescribe and illustrate the known species in these genera, describe new species encountered, and compare the classification of these lice with that of the hornbills. Menoponidae have been examined from 53 species or subspecies of hornbills (table 13). Presented are descriptions and illustrations of 22 species of Menoponidae of which 17, including 12 new, are species of *Chapinia*, 3 are species of *Bucerophagus*, and 2 are new species in a new genus, *Bucerocolpocephalum*.

No previous attempt has been made to examine all the Menoponidae from the hornbills. Clay (1947) included *Chapinia* and *Bucerophagus* in her key to the genera of the Menoponidae, but her figures 8 and 9 of the antennae of these genera were transposed accidentally. The genus *Chapinia* was described by Ewing (1927) for his species *C. robusta*; later it was described by Bedford (1930) for *Menopon bucerotis*

¹ Modified from a doctoral dissertation submitted to the University of Oklahoma, Norman.

² E. and E. Branch, Dugway Proving Ground, Dugway, Utah.

Kellogg, 1908, and *M. lophocerus* Bedford, 1920. Hopkins and Clay (1952) included in the genus *Chapinia* the additional species, *Colpocephalum hirtum* Rudow, 1866, *Menopon acutovulvatum* Piaget, 1881, and *Allomenopon mjöbergi* Eichler, 1947, but they considered the generic position of *C. hirtum* doubtful. In the present study *C. hirtum* is shown to be a *Chapinia*, and a neotype is designated; *A. mjöbergi* is shown to be a synonym of *M. acutovulvatum*. Hopkins (1941) designated a lectotype for *Chapinia lophocerus* (Bedford), Clay (1949a) designated a lectotype for *C. acutovulvata* (Piaget), and a lectotype is designated here for *C. bucerotis* (Kellogg). Piaget (1880) identified a female from *Rhyticeros cassidix* (Temminck, 1823) as *C. hirtum*, but Piaget's specimen is shown here to be the new species *Chapinia lydae*. The genus *Bucerophagus* was described by Bedford (1929) for his species *B. africanus* and for *Colpocephalum productum* Burmeister, 1838. For the latter species a neotype was erected by Conci (1950), and a lectotype was designated by Clay (1951a). Eichler (1947) described a new genus for *Menopon forcipatum* Nitzsch, 1874, but Hopkins and Clay (1952) put *M. forcipatum* in the genus *Bucerophagus*. A neotype for *B. forcipatus* (Nitzsch) is designated here from Eichler's material. Clay (1951a) stated that *Bucerophagus africanus* and *B. productus* both infest the two hosts, *Bucorvus abyssinicus* (Boddaert, 1783) and *B. leadbeateri* (Vigors, 1825). No morphological or statistical means were found in the present study to separate the populations of each species on each host so that only the two species, *Bucerophagus productus* and *B. africanus*, could be recognized.

The phylogenetic arrangement of the hornbills (Peters, 1945) shows scant regard for the geographical regions, and the list winds back and forth between the Ethiopian, Oriental, and Australasian regions (table 13). The mallophagan genera studied here, however, fall into definite species-groups confined to the Ethiopian region or to the Oriental and Australasian regions. It is believed, therefore, that the arrangement of the Mallophaga gives more insight into the origin of the hornbills than study of the host skins.

Classification of the hosts is that proposed by Deignan (1963) except for species not discussed by him, for which Peters (1945) has been followed. Skins of the hosts collected in Thailand are in the U.S. National Museum and were identified by Mr. H. G. Deignan. Collections were made possible by assistance from the U.S. Operations Mission to Thailand and the U.S. National Museum.

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Explanation of Terms

The terminology used in this paper agrees with that of Clay (1947) except as noted below.

“Combs of setae” are rows of short, stout setae, each with the alveoli lying close together and approximately in a straight line, on the venter of the third femora and the posterolateral areas of one or more abdominal sternites (figs. 64, 65).

“Brushes of setae” are concentrations of setae on the venter of the third femora and the posterolateral areas of one or more abdominal sternites. These may take the form of a few widely spaced setae called “small scattered brushes” (figs. 23, 24) or a large number of closely set setae called “large thick brushes” (figs. 68, 69). The setae of the brushes are “normal” if approximately the same length and thickness as the surrounding setae or “small” if the majority are considerably smaller than the surrounding setae.

The "preocular slit" is an emargination with approximately equal and parallel margins in the dorsal-lateral margin of the head immediately anterior to the eye (figs. 23, 24).

The "preocular notch" is a similar emargination with triangular or semicircular margins (figs. 25, 26, 64-69).

The "metasternal plate" on the metasternum was first described by Bedford (1920) as a 4-sided plate which was normally expanded anteriorly (figs. 26c, 64c, 66c, 68c, 70).

The male and female each possess a complete complement of abdominal segments from the first to the tenth (Cope, 1941).

The "pleurites" ("paratergal plates" of some authors) are sclerites which pass around the lateral margin of the abdomen and are separated from the tergites and sternites by clear divisions (Clay, 1954) (figs. 23, 24).

The "postspiracular seta" on each side of abdominal tergites III-VIII is posterior to the spiracle and is always associated with two small setae, the alveoli of the three setae being contiguous (Clay, 1954). A similar group of three setae is present on abdominal tergite II, although there is no functional spiracle on this tergite. In most Amblycera the postspiracular setae are the most laterad setae of the posterior marginal row (fig. 25p).

The "male terminal abdominal tergites" IX and X are almost completely fused. "Abdominal sternite VIII" is fragmented into two parts which have moved laterad. "Abdominal sternite IX" strengthens the anterior lip of the genital and anal opening (cloaca), and there is no apparent tenth sternite (Cope, 1941).

The "basal plate" ("basal apodeme" of Clay, 1956) of the "male genitalia" supports posteriorly the slender "parameres" laterally and the "endomeres" centrally (Ewing, 1927).

The "sclerite of the male genital sac" is the sclerite on the walls of the genital sac which is articulated to the basal plate (Clay, 1956) (figs. 18s, 19s).

The "lateral horns" of the "male genitalia" are structures on each side of the large, curved, platelike "endomeres" (Ewing, 1927) (figs. 1-3, 6, 7).

The "female terminal abdominal tergites" IX and X are single plates. "Abdominal sternite VIII" has a pair of gonopods, lying side by side medially, which are fused at their apices to cover the genital opening (vulva) between segments VIII and IX, and on each lateral side of the gonopods is a fragment of sternite VIII (Cope, 1941).

The "internal sclerite of female abdominal sternite VIII" appears to be the sclerite that Clay (1961) calls the internal structure of the female genital chamber (figs. 35i, 38i, 39i, 49i).

"Sclerital hooks" are hooklike processes in the female arising on

either side of the midline of the "ventral sclerite between the vulva and anus" (fig. 27h).

The "anal fringe" ("anal corona" of Ferris, 1923) surrounds the female anus on abdominal segment X (figs. 28, 45, 52).

"Species-groups" are groups of similar species within a genus.

"Fresh material" indicates that Mallophaga were obtained from the host that was collected in the field as contrasted to mallophagan "dried material" which was obtained from dried museum skins either personally (REE) or by my wife, Lyda.

Methods

Dried material was obtained from museum skins by lightly fluffing the bird feathers, particularly around the neck and lower belly, over a white surface. Emerson (1954) stated that contamination that occurred on museum skins was well known and that records of Mallophaga so obtained should be considered questionable. Mallophaga that were obtained from museum skins were considered here to be stragglers unless they belonged to recognized hornbill genera and unless they were represented by other specimens obtained from additional skins or fresh material of the same host species. Correspondingly, about 20 percent of the dried material was considered to be stragglers. The mounting procedure was suggested by Dr. K. C. Emerson (in litt.): Mallophaga were placed in 10 percent potassium hydroxide overnight, transferred to distilled water, and after one hour the body contents were teased out. Specimens were placed in fresh 10 percent potassium hydroxide for 6-12 hours, after which they again were transferred to distilled water. Approximately one-half hour later specimens were put into 40 percent ethyl alcohol. Fifteen minutes later several drops of carbol fuchsin (Ziehl Nielson) were added and allowed to act for one-half hour. Specimens were placed in 70 percent ethyl alcohol for one-half hour, followed by 95 percent ethyl alcohol for 15 minutes. Next, specimens were washed in 100 percent ethyl alcohol for a few minutes and placed in Beechwood Creosote for one hour to overnight, after which they were mounted in Gum Damar or other dried resin media.

Drawings were prepared from holotypes and allotypes except as noted in the text. All drawings were prepared with the aid of a 300-watt, 35-mm. slide projector as suggested by Dr. K. C. Emerson (in litt.). The monocular microscope with the mounted Mallophaga was turned on its side, the ocular and mirror removed, and the slide projector placed at the lower end of the microscope so that the light projected the image onto a vertical surface, from which the outline was traced on Bristol board or drawing velum. Measurements were obtained by projecting a millimeter scale from a stage micrometer

onto the surface. Details of the Mallophaga were added after the microscope was uprighted.

Measurements for the tables are in millimeters and were made with the aid of an ocular micrometer.

Because of variation in setal number, setae recorded in species descriptions represent the range in numbers of setae from representative specimens from the material examined.

Characters described under genera or species-groups have not been repeated for individual specific descriptions. In each genus or species-group the arrangement of the species is based first on morphological similarity and second on the phylogenetic arrangement of their hosts.

Key to Species of *Chapinia*, *Buceroocolpocephalum* and *Bucerocephalus*

1. Terminal segment of antenna showing definite signs of division either by transverse line or marginal indentation (figs. 64a, 66a, 68a) 19
Terminal segment of antenna without signs of division (figs. 23a, 25a).
(Genus *Chapinia* Ewing). 2
2. Dorsal-lateral margins of head with a preocular slit (figs. 23, 24).
(*lophocerus* species-group) 3
Dorsal-lateral margins of head with a preocular notch (figs. 25, 26). 7
3. Each lateral margin of abdominal tergites III–VI with a short seta between the spiracle and postspiracular seta (fig. 64 l) 4
Abdominal tergites without such short setae (figs. 23, 24).
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4. Abdominal sternite II with three median rows of setae.
C. bucerotis (Kellogg), p. 15.
Abdominal sternite II with one median row of setae on posterior margin 5
5. Male genitalia with each lateral horn possessing two sharp posterior points; female anal fringe with fewer than 58 setae (figs. 2, 28).
C. lophocerus (Bedford), p. 13.
Male genitalia with each lateral horn possessing one or two rounded posterior points; female anal fringe with more than 58 setae 6
6. Male genitalia with each lateral horn possessing two rounded posterior points; female anal fringe with more than 70 setae (fig. 1).
C. fasciati, new species, p. 12.
Male genitalia with each lateral horn possessing one rounded posterior point; female anal fringe with 60–64 setae (fig. 3) **C. camuri**, new species, p. 15.
7. Each lateral margin of abdominal tergites III–VI with a short seta between the spiracle and postspiracular seta (fig. 64 l) 8
Abdominal tergites without such short setae 11
8. Male genitalia with endomeres possessing small inner plate and paired outer rims, each with serrulations on posterior inner margin; female with each lateral projection of ventral sclerite between vulva and anus possessing more than eight thick, posteriorly directed setae (figs. 71, 72sp).
C. waniti, new species, p. 22.
Male genitalia with endomeres possessing small or large inner plate and paired outer rims without serrulations; female with each lateral projection of ventral sclerite between vulva and anus possessing fewer than eight thick, posteriorly directed setae (fig. 43sp) 9

9. Male genitalia with endomeres possessing paired outer rims and large shieldlike inner plate with paired lateral flanges and central terminal point; female abdominal sternite VIII with more than 32 setae on posterior margin (figs. 12, 37) **C. malayensis**, new species, p. 25.
Male genitalia with endomeres possessing paired outer rims and small inner plate that is not shieldlike; female abdominal sternite VIII with fewer than 32 setae on posterior margin 10
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Male genitalia with endomeres consisting only of paired outer rims which are straight and nearly parallel; female abdominal sternite VIII with internal sclerite much longer than wide (figs. 14, 39i).
C. boonsongi, new species, p. 27.
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C. wenzeli, new species, p. 28.
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Bucerophagus africanus Bedford, p. 46.

Genus *Chapinia* Ewing

FIGURES 23-26

Chapinia Ewing, 1927, p. 88. [Genotype: *Chapinia robusta* Ewing, 1927.]
Allomenopon Bedford, 1930, p. 153. [Genotype: *Menopon bucerotis* Kellogg, 1908.]

Head triangular, width $1\frac{1}{2}$ to 2 times that of length. Forehead much narrower anteriorly. Temples expanded. Antennae 4-jointed, third segment constricted at base, and terminal segment capitate without signs of division. Antennary fossa deep, covered above by expansion of lateral margin of head, posterior margin of which bears eye with double cornea. Dorsal-lateral margin of forehead anterior to eye with preocular slit or shallow notch. Gular region with 3-7 setae varying in length on each lateral margin. Pronotum expanded anteriorly with posterior marginal row of long setae. Metanotum expanded posteriorly with posterior marginal row of long setae and two short setae on each lateral margin. Metanotum separated from mesonotum and from pleurites. Thoracic sternal plates as shown in figures 23b, 25b, and 26c. Metasternal plate trapezoidal, expanded anteriorly, with 6-22 setae. Venter of third femora and posterolateral margins of abdominal sternites IV-VI, each with or without brushes of normal setae. Abdominal segments consist of tergites, sternites, and pleurites, the latter without prolongation of posteroventral angles.

Abdominal tergites each with a posterior marginal row of setae, the most laterad being the postspiracular seta. Each lateral margin of abdominal tergites II–VI with or without a short seta between the spiracle and postspiracular seta. Sternites and pleurites each with a posterior marginal row of long setae and with numerous shorter setae. Male terminal abdominal sternites VIII and IX fused with partial division only from sternite VII (figs. 4, 10, 22, 24, 26). Male genitalia as illustrated for each species, with parameres either expanded anteriorly or split posteriorly or both. Female terminal abdominal segments as illustrated for each species, with lateral processes arising from ventral sclerite between vulva and anus, with long stout setae but never strong spines. Females larger than males, usually with more abdominal sternal setae, but general shape and chaetotaxy similar to that of males except for terminal abdominal segments.

Both Ewing (1927) and Bedford (1930) stated that the pterothorax was undivided. As noted by Cope (1941), the sclerotized median button behind the prothorax (fig. 25m) is a vestige of the mesonotum; the supposed mesonotum, the narrow sclerotized band posterior to this button, is a mere extension of the subcoxae. Ewing (1927) stated that the abdomen consisted of 9 segments in the female and 10 segments in the male, but as shown by Cope (1941), the abdomen of both the male and female has 10 segments each.

Chapinia resembles most closely *Bucerophagus* (figs. 66–69) but differs in several characters: The terminal segment of the antenna shows no sign of division in *Chapinia*, but there are definite signs of division into two parts either by transverse line or marginal indentation in *Bucerophagus*. The venter of the third femora may have brushes of normal setae in *Chapinia* and *Bucerophagus*; similar brushes are present on posterolateral margins of abdominal sternites IV–VI in *Chapinia* but abdominal sternites IV and V in *Bucerophagus*. Each lateral margin of abdominal tergites II–VI may have a short seta between the spiracle and postspiracular seta in *Chapinia*, but 1–5 short setae may be present on margins of abdominal tergites II–VIII in *Bucerophagus*. Male terminal abdominal sternites VIII and IX are fused in *Chapinia* with partial division only from abdominal sternite VII, but abdominal sternites VIII and IX may be fused in *Bucerophagus* with a complete division from abdominal sternite VII. Male genitalia have parameres slender or expanded anteriorly in *Chapinia* but branched anteriorly in *Bucerophagus*. Lateral processes arising from the ventral sclerite between the female vulva and anus have long stout setae in *Chapinia* but long stout setae and strong spines in *Bucerophagus*.

The male genitalia and details of the male and female terminal abdominal segments are the best characters for separating species

of *Chapinia*. Other characters useful in species separation are: The presence or absence of brushes of normal setae on the venter of the third femora and posterolateral margins of abdominal sternites IV–VI; the presence or absence of a short seta on each lateral margin of abdominal tergites III–VI between the spiracle and postspiracular seta; the number of median rows of setae, and the total number of setae on abdominal sternite II. The number and length of setae on the lateral margins of the gular region are too variable to be of much use in separating species.

For convenience of classification the species of *Chapinia* have been arranged into species-groups.

Hosts: Species of *Chapinia* have been found on the genera *Tockus*, *Anorrhinus*, *Penelopides*, *Rhyticeros*, *Anthracerus*, *Bycanistes*, *Ceratogymna*, and *Buceros* of the avian family Bucerotidae.

The *lophocerus* Species-Group

Species similar in shape to *Chapinia robusta* (figs. 23, 24). Differing from other species-groups in the following combination of characters: Dorsal-lateral margins of head with preocular slit; venter of third femora and posterolateral margins of abdominal sternites IV–VI each with brushes of normal setae; each lateral margin of abdominal tergites II–VI with or without a short seta between the spiracle and postspiracular seta; females with more abdominal sternal setae than males; abdominal sternite II with either one or three median rows of setae; male genitalia with lateral horns on each side of endomeres and with parameres enlarged anteriorly, not split posteriorly; females with sclerital hooks on each side of midline of ventral sclerite between vulva and anus; female abdominal sternite VIII with most of setae similar in size to setae on posterior margin.

Hosts: Species of the *lophocerus* species-group have been found on the genera *Tockus*, *Bycanistes*, and *Ceratogymna* of the avian family Bucerotidae.

Species of the *lophocerus* species-group are all similar in size except that both sexes of *Chapinia camuri* are smaller than corresponding sexes of other species, and males of *C. robusta* are larger than other males. The small size of *C. camuri* might be expected since its host, the 15-inch *Tockus camurus*, is the smallest known hornbill. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have large thick brushes of normal setae in *C. bucerotis* but small scattered brushes of normal setae in other species of the *lophocerus* species-group, although the brushes are slightly thicker in *C. robusta*. Each lateral margin of abdominal tergites II–VI has a short seta between the spiracle and postspiracular seta in

all species except in *C. robusta*. Abdominal sternite II has more total setae in both sexes of *C. bucerotis* and *C. robusta* than in corresponding sexes of *C. fasciati*, *C. lophocerus*, and *C. camuri*; this sternite has one median row of setae in all species except *C. bucerotis*, which has three median rows. The male genitalia have each lateral horn possessing posterior points in all species except *C. robusta*, which has one sharp median point crossing the broad endomeres; the posterior points are sharp in *C. bucerotis* and *C. lophocerus* but rounded in *C. fasciati* and *C. camuri*; *C. camuri* has only one posterior point instead of two as in the other species; the two points do not reach the slender endomeres in *C. lophocerus*, but one point crosses the broad endomeres in *C. bucerotis* (figs. 1-7). In the female the ventral sclerite between the vulva and anus is elevated medially between the sclerital hooks in *C. fasciati*, *C. bucerotis*, and *C. robusta*, is elevated only slightly in *C. camuri*, and is not elevated in *C. lophocerus*. The female anal fringe has the most setae in *C. fasciati* and the fewest in *C. lophocerus*.

Clay (1958) treated populations of the ischnoceran genus *Degeeriella* as subspecies when the male genitalia were apparently identical or differed only in a minor degree and when there were other minor morphological differences. Because of similarity of the genitalia, *Chapinia fasciati* and *C. camuri* could be considered subspecies of *C. lophocerus*. This would express the similarity of their six host species, which are all members of the Ethiopian genus *Tockus*. Clay (1958) pointed out that the genitalia, particularly in the Amblycera, might show only minor differences throughout a genus or species-group and great differences in other groups. She therefore concluded that differentiation of the genitalia has taken place at different rates in different groups. Similarly, Johnson (1960) stated that evolution and morphological divergence would not be expected to proceed at the same rate for all free-living species. It would seem that the similarity in the genitalia of *C. fasciati*, *C. lophocerus*, and *C. camuri* would indicate either that evolution has not proceeded as rapidly in these species or that they have not been isolated as long as other species of *Chapinia*. Clay (1958) stated that if subspecies were populations that would interbreed under natural conditions if they occurred sympatrically, any morphological differences which might prevent interbreeding should be considered as specific characters. Johnson (1960) believes that there is little possibility of finding interbreeding populations among lice which are isolated on their hosts. She stated that it would be desirable to treat all stable recognizable forms of Anoplura and Mallophaga as species. Clay (1962) consequently stated that the subspecific category might be useful in some of the ischnoceran genera, but its application in the Amblycera is less satisfactory and

should not be used until more is known about the relationships between populations in this superfamily.

The members of the *lophocerus* species-group are arranged according to the phylogeny of their hosts, since this order agrees with the morphological similarities or the parasites.

Chapinia fasciati, new species

FIGURE 1

Male: Smaller than *Chapinia robusta* in all measurements; smaller than *C. lophocerus* in all measurements except width of metathorax (table 1). Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae. Each lateral margin of abdominal tergites II–VI with a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 32–42 total setae and one median row of setae on posterior margin. Terminal abdominal segments similar to those of *C. lophocerus*. Genitalia as shown in figure 1, each lateral horn with two rounded posterior points.

Female: Larger than *Chapinia robusta* in all measurements except width of metathorax; smaller than *C. lophocerus* in all measurements except total length and width of prothorax (table 2). Resembles the male except that abdominal sternite II has 54 total setae. Terminal abdominal segments similar to those of *C. lophocerus*. Ventral sclerite between vulva and anus elevated medially between sclerital hooks. Anal fringe with 72–86 setae.

Discussion: *Chapinia fasciati* resembles most closely *C. lophocerus*. The male genitalia have each lateral horn possessing two posterior points which are rounded in *C. fasciati* but sharp in *C. lophocerus*. The ventral sclerite between female vulva and anus is elevated medially between the sclerital hooks in *C. fasciati* but not elevated in *C. lophocerus*. The female anal fringe has more than 70 setae in *C. fasciati* but fewer than 58 setae in *C. lophocerus*.

Material examined: 27 males and 34 females from fresh and dried material collected in the Ethiopian region.

Type host: *Tockus fasciatus fasciatus* (Shaw, 1811).

Type material: Holotype male and allotype female from Eden, French Cameroons, Africa, collected by J. Mouchet, BMNH. Paratypes: 18 males and 15 females from French Cameroons, Africa, collected by J. Mouchet, BMNH; 1 male from Kasongo, Belgian Congo, Africa, Nov. 13, 1959, collected by P. L. G. Benuit, JT; 3 males and 10 females from CNHM skins from Entebbe, Uganda, Africa, 1895–1916, collected by F. J. Jackson and others, REE; 2 males and 1 female from CNHM skins from Bitya, Cameroons,

Africa, 1924–1927, collected by O. L. Bates, REE; 1 female from CNHM skin from Yokadouma, French Cameroons, Africa, Oct. 19, 1946, collected by A. I. Good, REE; 1 female from CNHM skins from Bwamba, Ruwenzori, Uganda, Africa, 1944–1946, collected by V. Someren, REE; 1 male from CNHM skins from Ebolowa, French Cameroons, Africa, 1952–1953, collected by A. I. Good, REE; 1 male and 3 females from USNM skins from Congo, Africa, 1917, collected by C. R. Aschemeier, REE; from *Tockus alboterminatus suahelicus* (Neumann, 1905): 1 female from CNHM skins from Sokoke Forest, Kenya, Africa, June 1932, collected by V. Someren, REE; 1 female from USNM skins from Nairobi, Kenya, Africa, 1909, collected by Loring and Mearns, REE.

***Chapinia lophocerus* (Bedford)**

FIGURES 2, 4, 27, 28

Menopon lophocerus Bedford, 1920, p. 717, pls. 1 (fig. 1), 3 (fig. 1). [Type host: *Lophoceros leucomelas* = *Tockus flavirostris leucomelas* (Lichtenstein, 1842).]
Chapinia lophocerus (Bedford)—Hopkins and Clay, 1952, p. 67.

Bedford did not designate a type from his material which contained a pair of Mallophaga from *Lophoceros leucomelas* = *Tockus flavirostris leucomelas* (Lichtenstein, 1842), a pair from *L. epirhinus* = *Tockus nasutus caffer* (Sundevall, 1851), and two males and one female from *L. erythrorhynchus* = *Tockus e. erythrorhynchus* (Temminck, 1823). A lectotype was designated by Hopkins (1941) from the host, *Lophoceros leucomelas*, since the male from that host agreed best with Bedford's figure of the male genitalia.

Male: Smaller than *Chapinia robusta* in all measurements (table 1). Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae. Each lateral margin of abdominal tergites II–VI with a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 28–42 total setae and one median row of setae on posterior margin. Terminal abdominal segments as shown in figure 4. Genitalia as shown in figure 2, each lateral horn with two sharp posterior points which do not reach the slender endomeres.

Female: Larger than *Chapinia robusta* in all measurements except width of prothorax and width of metathorax (table 2). Resembles the male except that abdominal sternite II has 34–54 total setae. Terminal abdominal tergite with 22–30 setae, short setae alternating with long, on posterior margin; ventral sclerite between vulva and anus not elevated medially between sclerital hooks (fig. 27). Anal fringe with 42–56 setae (fig. 28).

Discussion: Bedford (1920) gave the following measurements (in mm).

	male	female
length of head	0.25	0.33
width of head	0.53	0.60
width of prothorax	0.38	0.43
width of metathorax	0.55	0.71
width of abdomen	0.85	1.15
total length	1.74	2.36

Except for females being larger in abdominal width and total length, these measurements fall within the ranges of *Chapinia lophocerus* (tables 1, 2). *C. lophocerus* resembles most closely *C. fasciati*. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have small scattered brushes of normal setae in *C. lophocerus*, *C. fasciati*, and *C. camuri* but large thick brushes of normal setae in *C. bucerotis*. Abdominal sternite II of both sexes has fewer than 58 total setae and one median row of setae in *C. lophocerus*, *C. fasciati*, and *C. camuri* but more than 58 total setae and three median rows of setae in *C. bucerotis*. The male genitalia have each lateral horn possessing posterior points that do not reach the slender endomeres in *C. lophocerus*, *C. fasciati*, and *C. camuri* but one sharp point that crosses the broad endomeres in *C. bucerotis*; the posterior two points are sharp in *C. lophocerus* but rounded in *C. fasciati*, and there is only one rounded posterior point in *C. camuri*. The ventral sclerite between female vulva and anus is not elevated medially between the sclerital hooks in *C. lophocerus*, is elevated slightly in *C. camuri*, but is more elevated in *C. fasciati* and *C. bucerotis*. The female anal fringe has fewer than 58 setae in *C. lophocerus*, at least 72 setae in *C. fasciati*, and 58–72 setae in *C. camuri* and *C. bucerotis*.

Material examined: 6 males and 19 females from fresh and dried material collected in the Ethiopian region; lectotype male and syntype female from Transvaal, South Africa, September 1917, collected by G. A. H. Bedford, GHEH; from the type host: 1 male and 4 females from Pretoria Zoo, South Africa, Feb. 10, 1938, collected by G. A. H. Bedford, GHEH; from *Tockus n. nasutus* (Linnaeus, 1766): 1 male and 1 female from Maroua, North French Cameroons, Africa, 1959, collected by J. Mouchet, BMNH 1960–105; 1 male and 2 females from Mansôa, Portuguese Guinea, Africa, Feb. 14, 1951, collected by J. Tendeiro, JT; from *Tockus e. erythrorhynchus* (Temminck, 1823): 1 male and 4 females from Somaliland, Africa, February 1949, Meinertzhagen 18708, BMNH; 1 male from USNM skins from Ethiopia, Africa, 1912, collected by Childs Frick, REE; from *Tockus f. flavivestris* (Rüppell, 1835): 1 female from USNM skins from Ethiopia, Africa, 1912, collected by Childs Frick, REE; from *Tockus deckeni* (Cabanis, 1869): 6 females from Koka, Ethiopia, Africa, Dec. 13, 1960, collected by Savo Brelih, PMS.

Drawings were made of the lectotype male and a female collected in the Pretoria Zoo. Specimens in GHEH.

Chapinia camuri, new species

FIGURE 3

Male: Smaller than *Chapinia robusta* in all measurements; smaller than *C. lophocerus* in all measurements except length of head and width of prothorax (table 1). Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae. Each lateral margin of abdominal tergites II–VI with a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 37 or 38 total setae and one median row of setae on posterior margin. Terminal abdominal segments similar to those of *C. lophocerus*. Genitalia as shown in figure 3, each lateral horn with one rounded posterior point.

Female: Smaller than other *Chapinia* in all measurements except length of head and width of abdomen (table 2). Resembles the male except that abdominal sternite II has 44–56 total setae. Terminal abdominal segments similar to those of *C. lophocerus*. Ventral sclerite between vulva and anus slightly elevated medially between sclerital hooks. Anal fringe with 60–64 setae.

Discussion: Although smaller in size, *Chapinia camuri* resembles most closely *C. lophocerus*. The male genitalia have each lateral horn possessing one rounded posterior point in *C. camuri* but two sharp posterior points in *C. lophocerus*. The ventral sclerite between female vulva and anus is elevated medially only slightly between the sclerital hooks in *C. camuri* and is not elevated in *C. lophocerus*. The female anal fringe has more than 58 setae in *C. camuri* but fewer than 58 setae in *C. lophocerus*.

Material examined: 2 males and 2 females from fresh material collected in the Ethiopian region.

Type host: *Tockus camurus camurus* Cassin, 1857.

Type material: Holotype male and allotype female from Ambam, French Cameroons, Africa, 1955, collected by J. Mouchet, BMNH. Paratypes: 1 male and 1 female with same data.

Chapinia bucerotis (Kellogg)

FIGURES 5, 6, 29, 30

Menopon bucerotis Kellogg, 1908, p. 54, pl. 7 (fig. 12).—Bedford, 1920, pl. 3 (fig. 2) (male genitalia). [Type host: *Bycanistes cristatus*=*Bycanistes brevis omissus* Peters, 1945.]

Chapinia bucerotis (Kellogg).—Hopkins and Clay, 1952, p. 67.

Kellogg did not designate a type from his material, which contained 1 male and 1 female syntypes on slides and about 40 syntypes in

alcohol. The slide specimens were remounted and the male is designated hereby as a lectotype; the slide has been so labeled. Approximately one-half of the syntype material formerly in alcohol was mounted.

Male: Smaller than *Chapinia robusta* in all measurements (table 1). Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with large thick brushes of normal setae. Each lateral margin of abdominal tergites II–VI with a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 60–82 setae and three median rows of setae. Terminal abdominal segments as shown in figure 5. Genitalia as shown in figure 6, each lateral horn with two sharp posterior points, one of which crosses the broad endomeres.

Female: Approximately the same size as *Chapinia robusta* (table 2). Resembles the male except that abdominal sternite II has 68–104 total setae. Terminal abdominal tergite with 22–32 setae, short setae alternating with long, on posterior margin; ventral sclerite between vulva and anus elevated medially between sclerital hooks (fig. 29). Anal fringe with 58–72 setae (fig. 30).

Discussion: Kellogg (1908) gave the following measurements (in mm).

	male	female
length of head	0.33	0.40
width of head	0.65	0.72
width of abdomen	0.80	1.10
total length	2.00	2.80

These measurements are slightly larger than those given here for *Chapinia bucerotis* (tables 1, 2). *C. bucerotis* resembles most closely *C. lophocerus*. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have large thick brushes of normal setae in *C. bucerotis* but small scattered brushes of normal setae in other species of the *lophocerus* species-group. Each lateral margin of abdominal tergites II–VI has a short seta between the spiracle and postspiracular seta in *C. bucerotis* but not in *C. robusta*. Abdominal sternite II of both sexes has more than 58 total setae in *C. bucerotis* but fewer than 58 total setae in *C. lophocerus*; this sternite has three median rows of setae in *C. bucerotis* but one median row of setae on posterior margin in other species of the *lophocerus* species-group. The male genitalia have each lateral horn possessing two sharp posterior points in *C. bucerotis* and *C. lophocerus*, but one point crosses the broad endomeres in *C. bucerotis*, and the points do not reach the slender endomeres in *C. lophocerus*; each lateral horn in *C. robusta* has one sharp median point that crosses the broad endomeres. The ventral sclerite between female vulva and anus is elevated medially between the sclerital hooks in *C. bucerotis* almost

as much as in *C. robusta* but is not elevated in *C. lophocerus*. The female anal fringe has at least 58 setae in *C. bucerotis* but at most 56 setae in *C. lophocerus*.

Material examined: 34 males, 29 females, and approximately 20 specimens in alcohol from fresh and dried material collected in the Ethiopian region; lectotype male and syntypes, 12 males, 13 females, and about 20 syntypes in alcohol from Kilimanjaro, Tanganyika, Africa, collected by Sjöstedt, SMNH; from *Bycanistes bucinator sharpii* (Elliot, 1873): 1 female from CNHM skin from Mount Tandan, Mouila, Gabon, Africa, June 9, 1951, collected by H. A. Beatty, REE; 1 female from USNM skins from Congo, Africa, 1917–1918, collected by C. R. Aschemeier, REE; from *Bycanistes bucinator duboisi x sharpii*: 1 female from CNHM skin from Yaounde, French Cameroons, Africa, July 12, 1948, collected by A. I. Good, REE; from *Bycanistes bucinator duboisi* W. Sclater, 1884: 1 male from CNHM skins from Elat, French Cameroons, Africa, collected by Rev. M. Fraser, REE; from *Bycanistes b. bucinator* (Temminck, 1824): 1 male and 1 female from Pietermaritzburg, South Africa, 1917, GHEH; 3 males and 2 females from CNHM skins from Kenya, Africa, 1918–1922, collected by V. Someren, REE; from *Bycanistes c. cylindricus* (Temminck, 1831): 1 male and 1 female from CNHM skins from Liberia, Africa, February–June 1948, collected by H. A. Beatty, REE; from *Bycanistes cylindricus albotibialis* (Cabanis and Reichenow, 1877): 2 males and 1 female from Mbalmayo, French Cameroons, Africa, collected by J. Mouchet, BMNH; 1 male from CNHM skin from French Cameroons, Africa, July 8, 1907, REE; 1 male from CNHM skin from French Cameroons, Africa, June 25, 1940, collected by A. I. Good, REE; 1 male from CNHM skin from Uganda, Africa, July 15, 1945, collected by V. Someren, REE; from *Bycanistes subcylindricus subquadratus* Cabanis, 1880: 6 males and 6 females from Uganda, Africa, April 1936, Meinertzhagen 7674, 7708, 7709, BMNH; 1 male from CNHM skin from Kampala, Uganda, Africa, Sept. 2, 1918, collected by V. Someren, REE; 1 male and 2 females from USNM skins from Uganda, Africa, June 1920, collected by H. C. Raven, REE; from *Bycanistes b. brevis* Friedmann, 1929: 2 males from CNHM skin from Mount Kenya, Kenya, Africa, November 1946, collected by V. Someren, REE.

Drawings were made of the lectotype male and the syntype female mounted on the same slide. Specimens in SMNH.

***Chapinia robusta* Ewing**

FIGURES 7, 23, 24, 31, 32

Chapinia robusta Ewing, 1927, p. 89. [Type host: *Ceratogymna atrata* (Temminck, 1835).]

Chapinia robusta Ewing,—Hopkins and Clay, 1952, p. 68.

Through the courtesy of Dr. K. C. Emerson, BMNH specimens from the type host, here examined, were determined to be conspecific with the USNM holotype and allotype (USNM 40137, Nytonga, Congo, Africa, Nov. 3, 1917, collected by E. A. Chapin).

Male: As illustrated in figure 24. Larger than other species of the *lophocerus* species-group in all measurements except width of abdomen; approximately the same size as *Chapinia traylori* (table 1). Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae. Each lateral margin of abdominal tergites II–VI without a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 48–66 total setae and one median row of setae on posterior margin. Terminal abdominal segments as shown in figure 24c. Genitalia as shown in figure 7, each lateral horn with one large sharp point which crosses the broad endomeres.

Female: As illustrated in figure 23. Larger than *Chapinia camuri* in all measurements except length of head; approximately the same size as other species of the *lophocerus* species-group; slightly smaller than *C. traylori* in all measurements except length of head (table 2). Resembles the male except that abdominal sternite II has 56–68 total setae. Terminal abdominal tergite with 20–24 setae, short setae alternating with long, on posterior margin; ventral sclerite between vulva and anus elevated medially between sclerital hooks (fig. 31). Anal fringe with 56–62 setae (fig. 32).

Discussion: Ewing (1927) gave the following measurements (in mm).

	male	female
width of abdomen	0.70	0.95
total length	1.59	2.00

These measurements are not as great as those given here for *Chapinia robusta* (tables 1, 2). *C. robusta* resembles most closely *C. bucerotis*. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have small scattered brushes of normal setae in *C. robusta*, slightly more numerous than for other species of the *lophocerus* species-group, except *C. bucerotis*, which has large thick brushes of normal setae. Each lateral margin of abdominal tergites II–VI in *C. robusta* lacks the short seta between the spiracle and postspiracular seta that is present in all other species of the *lophocerus* species-group. Abdominal sternite II has one median row of setae in *C. robusta* but three median rows of setae in *C. bucerotis*. Male genitalia have each lateral horn possessing one sharp median point that crosses the broad endomeres in *C. robusta* but two sharp posterior points, one of which crosses the broad endomeres, in *C. bucerotis*. The ventral sclerite between female vulva and anus is elevated

medially between the sclerital hooks slightly more in *C. robusta* than in *C. bucerotis*.

Material examined: 4 males and 5 females from fresh and dried material collected in the Ethiopian region; from the type host: 3 males and 3 females from Ambam, French Cameroons, Africa, 1955, collected by J. Mouchet, BMNH; 1 female from CNHM skin from Fougamou, Gabon, Africa, Aug. 4, 1951, collected by H. A. Beatty, REE; from *Ceratogymna elata* (Temminck, 1831): 1 male and 1 female from Konn, French Cameroons, Africa, Apr. 26, 1947, collected by V. Aellen, BMNH 1954-487.

Drawings were made of a male and a female from the type host collected in Ambam, French Cameroons, Africa. Specimens in BMNH.

The *acutovulvata* Species-Group

Species similar in shape to *Chapinia traylori* (figs. 25, 26). Differing from other species-groups in the following combination of characters: Dorsal-lateral margins of head with a preocular notch; venter of third femora and posterolateral margins of abdominal sternites IV-VI each with or without brushes of normal setae; each lateral margin of abdominal tergites II-VI with or without a short seta between the spiracle and postspiracular seta; females usually with more abdominal sternal setae than males; abdominal sternite II usually with one median row of setae on posterior margin; male genitalia without lateral horns on each side of endomeres and with parameres enlarged anteriorly, split posteriorly; females without sclerital hooks on each side of midline of ventral sclerite between vulva and anus; female abdominal sternite VIII with most of setae much shorter than those on the posterior margin.

Hosts: Species of the *acutovulvata* species-group have been found on the genera *Tockus*, *Anorhynchus*, *Penelopides*, *Rhyticeros*, *Anthraceros*, and *Buceros* of the avian family Bucerotidae.

Species of the *acutovulvata* species-group are all similar in size except that males of *Chapinia wenzeli* are smaller than other males, and females of *C. traylori* are larger than other females. The venter of the third femora and posterolateral margins of abdominal sternites IV-VI each have large thick brushes of normal setae in both sexes of *C. waniti*, *C. acutovulvata*, *C. malayensis*, and *C. hoplasi*; small scattered brushes of normal setae in females of *C. blakei* and in both sexes of *C. clayae*, *C. boonsongi*, *C. wenzeli*, and *C. lydae*; brushes are absent in the male of *C. blakei* and in both sexes of *C. traylori*. Each lateral margin of abdominal tergites II-VI has a short seta between the spiracle and postspiracular seta in *C. clayae*, *C. waniti*, *C. acutovulvata*,

and *C. malayensis*. Abdominal sternite II has more total setae in both sexes of *C. waniti*, *C. acutovulvata*, and *C. hoplai* than in corresponding sexes of *C. malayensis*, *C. wenzeli*, *C. blakei*, and *C. traylori*; more total setae in females than in males except in *C. lydae*; and setae are arranged in one median row except for one or two median rows in *C. waniti*, two median rows in *C. traylori*, and three median rows in *C. lydae*. The male genitalia have endomeres with an inner plate and paired outer rims in *C. clayae*, *C. waniti*, *C. acutovulvata*, *C. malayensis*, and *C. lydae*, the paired outer rims possessing internal knobs only in *C. clayae* and *C. acutovulvata* and serrulations only in *C. waniti*; the inner plate possessing paired lateral flanges and central terminal point only in *C. malayensis*; only paired outer rims in *C. hoplai*, *C. boonsongi*, and *C. wenzeli*, the posterolateral margin being split in *C. wenzeli*; and only paired plates in *C. blakei* and *C. traylori*. The female terminal abdominal tergite has on the posterior margin at most 24 setae except for *C. waniti*, *C. acutovulvata*, and *C. hoplai* with at least 24 setae; of these setae approximately two-thirds are long and one-third are short in *C. waniti*, *C. acutovulvata*, *C. malayensis*, *C. boonsongi*, and *C. lydae*; approximately one-half are long and one-half are short in *C. clayae*, and *C. hoplai*; these setae are arranged with at least five long setae on each side of the midline in *C. acutovulvata* and *C. malayensis* but at most six setae in all other species of the *acutovulvata* species-group. In the female the ventral sclerite between the vulva and anus is curved sharply on the anterior margin in *C. clayae* and *C. acutovulvata* but is only slightly curved in the other species of the group; on each lateral projection of this sclerite there are 4-6 thick, posteriorly directed setae except in *C. waniti* which has 10 or 11 and in *C. traylori* which has 2 or 3 (figs. 43 sp, 44 sp, and 72 sp). The female abdominal sternite VIII has on the posterior margin the most setae in *C. malayensis* with more than 34 and the fewest in *C. blakei* with at most 18. The female anal fringe has at least 44 setae in *C. waniti*, *C. acutovulvata*, *C. malayensis*, *C. hoplai*, *C. boonsongi*, and *C. lydae* but at most 44 setae in *C. clayae*, *C. wenzeli*, *C. blakei*, and *C. traylori*.

Were the species of the *acutovulvata* species-group arranged according to the phylogeny of their hosts (Peters, 1945), the order would be: *C. clayae*, *C. waniti*, *C. wenzeli*, *C. blakei*, *C. lydae*, *C. boonsongi*, *C. malayensis*, *C. acutovulvata*, *C. hoplai*, and *C. traylori*, rather than *C. clayae*, *C. waniti*, *C. acutovulvata*, *C. malayensis*, *C. hoplai*, *C. boonsongi*, *C. wenzeli*, *C. blakei*, *C. traylori*, and *C. lydae*, which is based on morphological similarities of the lice.

Chapinia clayae, new species

FIGURES 8, 33, 34

Both sexes are smaller than corresponding sexes of *Chapinia traylori* in all measurements except length of head (tables 1, 2).

Male: Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae. Each lateral margin of abdominal tergites II–VI with a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 38–50 total setae and one median row of setae on posterior margin. Terminal abdominal segments similar to those of *C. acutovulvata*. Genitalia as shown in figure 8, endomeres with small inner plate and paired outer rims.

Female: Resembles the male except that abdominal sternite II has 66–76 total setae. Terminal abdominal tergite with 12 long and 12 short setae on posterior margin; abdominal sternite VIII with 22–30 setae on posterior margin (fig. 33). Anal fringe with 38–44 setae (fig. 34).

Discussion: Although smaller in size, *Chapinia clayae* resembles most closely *C. acutovulvata*. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have small scattered brushes of normal setae in *C. clayae* but large thick brushes of normal setae in *C. acutovulvata*. The male genitalia have endomeres possessing on each outer rim a triangular internal knob that is wider than long in *C. clayae* but longer than wide in *C. acutovulvata*. The female terminal abdominal tergite has on the posterior margin at most 24 setae, of which approximately one-half are long and one-half are short, in *C. clayae*, but at least 26 setae, of which approximately two-thirds are long and one-third are short, in *C. acutovulvata*. In addition this margin has on each side of the midline at most four long setae in *C. clayae* but at least six long setae in *C. acutovulvata*. The female anal fringe has at most 44 setae in *C. clayae* but at least 44 setae in *C. acutovulvata*.

Material examined: 19 males and 29 females from fresh and dried material collected in India and Nepal.

Type host: *Tockus birostris* (Scopoli, 1786).

Type material: Holotype male, allotype female, and 2 male and 4 female paratypes on same slide from Rajputana, India, March 1937, Meinertzhagen 8855–8856, BMNH. The holotype and allotype are each the second from the right in the rows of males and females as seen under the microscope. Paratypes: 5 males and 12 females with same data except Meinertzhagen 8932; 1 male from Nepal,

December 1935, Meinertzhagen 4859, BMNH; 4 males and 5 females from Nepal, February 1936, Meinertzhagen 4858, BMNH; 1 female from CNHM skins from Kotla, Kangra, East Punjab, India, 1946 and 1948, collected by W. Koelz, REE; 1 male and 1 female from CNHM skins from Bheraghat, Central Provinces, India, March–April 1946, collected by W. Koelz and R. Chand, REE; 1 male from CNHM skins from Belwani, Kisli, Central Provinces, India, July–August 1946, collected by W. Koelz, REE; 1 female from CNHM skin from Kanha, Central Provinces, India, Aug. 29, 1946, collected by R. Chand, REE; 2 males from CNHM skins from Kalnali, United Provinces, India, February 1947, collected by W. Koelz, REE; 1 male and 1 female from CNHM skins from Nichland, United Provinces, India, February 1947, collected by W. Koelz, REE; 1 female from CNHM skins from Simra, Nepal, Mar. 4, 1947, collected by W. Koelz and R. Chand, REE; 1 female from CNHM skins from Baihar, Balaghat, India, January–February 1949, collected by R. L. Flemming, REE; 1 female from USNM skins from India, 1898, 1946–1948, REE; from *Tockus g. griseus* (Latham, 1790): 1 male from CNHM skins from Nilambus, Madras, India, February–March 1937, collected by W. Koelz, REE.

Chapinia clayae is named for Dr. Theresa Clay of the British Museum (Natural History) in appreciation for her continuous assistance throughout the study, for the loan of hornbill Menoponidae from the BMNH, and for helping to obtain the loan of hornbill Menoponidae from other museums.

Chapinia waniti, new species

FIGURES 71, 72

Male: Larger than *Chapinia traylori* in all measurements except width of prothorax and width of metathorax (table 1). Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with large thick brushes of normal setae. Each lateral margin of abdominal tergites II–VI with a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 68–78 total setae and one or two median rows of setae. Terminal abdominal segments similar to those of *C. acutovulvata*. Genitalia as shown in figure 71, endomeres with small inner plate and paired outer rims.

Female: Smaller than *Chapinia traylori* in all measurements except length and width of head (table 2). Resembles the male except that abdominal sternite II has 92–104 total setae. Terminal abdominal tergite with 14–18 long and 10–12 short setae on posterior margin; abdominal sternite VIII with 28–34 setae on posterior margin (fig. 72); each lateral projection of the ventral sclerite between vulva and anus

with 10–11 thick, posteriorly directed setae (fig. 72 sp). Anal fringe similar to that of *C. acutovulvata*, with 56–64 setae.

Discussion: *Chapinia waniti* resembles most closely *C. acutovulvata*. Abdominal sternite II of both sexes has more total setae in *C. waniti* than in corresponding sexes of *C. acutovulvata*. The male genitalia have endomeres possessing on each outer rim serrulations on the posterior inner margin in *C. waniti* but a triangular internal knob in *C. acutovulvata*. Each lateral projection of the ventral sclerite between female vulva and anus has more than eight thick, posteriorly directed setae in *C. waniti* but fewer than eight in all other *Chapinia*. The female anal fringe has at least 56 setae in *C. waniti* but at most 54 setae in *C. acutovulvata*.

Material examined: 8 males and 7 females from fresh material collected in Thailand.

Type host: *Anorrhinus galeritus carinatus* (Blyth, 1845).

Type material: Holotype male and allotype female from Chong, Muang, Trang, Thailand, Mar. 4, 1963, collected by Wichit Suwan Laong, USNM. Paratypes: 6 males and 3 females with same data; 1 male and 1 female from Lamo, Muang, Trang, Thailand, Mar. 3, 1963, collected by Wichit Suwan Laong, USNM; 2 females from Na Wong, Muang, Phatthalung, Thailand, Mar. 6, 1963, collected by Wichit Suwan Laong, USNM.

Chapinia waniti is named for Mr. Wanit Songprakob, Songkhla, Thailand, in appreciation for mounting Mallophaga and for directing the activities of the field collector, Wichit Suwan Laong. After my departure from Thailand in April 1963, both boys collected for the Bernice P. Bishop Museum.

Chapinia acutovulvata (Piaget)

FIGURES 9, 10, 35, 36

Menopon acutovulvatum Piaget, 1881, p. 5, pl. 1 (fig. 4). [Type host: *Buceros malabaricus*=*Anthracoceros a. albirostris* (Shaw, 1808).]

Menopon acutovulvatum Piaget, 1885, p. 106, pl. 11 (fig. 8).

Allomenopon mjobergi Eichler, 1947, pp. 2, 20, figs. 1, 2 (new synonym). [Type host: *Anthracoceros convexus* (Temminck, 1831).]

Chapinia mjobergi (Eichler)—Hopkins and Clay, 1952, p. 68.

Chapinia acutovulvata (Piaget)—Hopkins and Clay, 1952, p. 67.

Dr. Eichler's specimens of *Chapinia mjobergi* from *Anthracoceros convexus* in the Zoological Museum, Humboldt University, Berlin, were loaned through the courtesy of Dr. von Kéler. Comparison of these lice with specimens of *Chapinia acutovulvata* from the type host discloses no morphological differences between the two series.

A lectotype male for *Chapinia acutovulvata* was designated by Clay (1949a) from the Piaget collection, now in BMNH, BM 777, with 6 syntype females, BM 774 and 776.

Both sexes are smaller than corresponding sexes of *Chapinia traylori* in all measurements except length and width of head (tables 1, 2).

Male: Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with large thick brushes of normal setae. Each lateral margin of abdominal tergites II–VI with a short setae between the spiracle and postspiracular seta. Abdominal sternite II with 42–54 total setae and one median row of setae on posterior margin. Terminal abdominal segments as shown in figure 10. Genitalia as shown in figure 9, endomeres with small inner plate and paired outer rims.

Female: Resembles the male except that abdominal sternite II has 76–86 total setae. Terminal abdominal tergite with 16–22 long and 10–12 short setae on posterior margin; abdominal sternite VIII with 18–30 setae on posterior margin (fig. 35). Anal fringe with 44–54 setae (fig. 36).

Discussion: Although larger in size, *Chapinia acutovulvata* resembles most closely *C. clayae*. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have large thick brushes of normal setae in *C. acutovulvata* but small scattered brushes of normal setae in *C. clayae*. Abdominal sternite II of both sexes of *C. acutovulvata* has fewer total setae than in corresponding sexes of *C. waniti* but has more total setae than in corresponding sexes of *C. malayensis*. The male genitalia have endomeres possessing on each outer rim a triangular internal knob that is longer than wide in *C. acutovulvata* but wider than long in *C. clayae*. These internal knobs are absent in other *Chapinia*. The female terminal abdominal tergite has on the posterior margin at least 26 setae in *C. acutovulvata*, of which approximately two-thirds are long and one-third are short, but at most 24 setae in *C. clayae* and *C. malayensis*, of which approximately one-half are long and one-half are short in *C. clayae*, but approximately two-thirds are long and one-third are short in *C. malayensis*. In addition this margin has on each side of midline at least six long setae in *C. acutovulvata* but at most five long setae in *C. clayae*. The female abdominal sternite VIII has on the posterior margin fewer than 32 setae in *C. acutovulvata* but more than 34 setae in *C. malayensis*. Each lateral projection of the ventral sclerite between female vulva and anus has fewer than eight thick, posteriorly directed setae in *C. acutovulvata*, but more than eight in *C. waniti* (fig. 72 sp.). The female anal fringe has 44–54 setae in *C. acutovulvata*, at most 44 setae in *C. clayae*, and at least 56 setae in *C. waniti*.

Material examined: 33 males and 35 females from fresh and dried material collected in the Oriental region; from the type host: 2 females, Piaget, BMNH 1953–21; 2 males and 2 females from Nepal,

December 1935, Meinertzhagen 4872, BMNH; from *Anthracoceros albirostris leucogaster* (Blyth, 1841): 2 males and 2 females from Myitkyina, Burma, Mar. 26, 1945, collected by the U.S. Typhus Commission, BMNH; 3 males, 1 female with same data, USNM; 2 males and 1 female from Stillwell Road, Myitkyina, Burma, Sept. 26, 1945, collected by H. S. Fuller, BMNH 1947-321 (164); 2 males, 2 females with same data, USNM; 2 males from Hin Laem, Tha Khanun, Kanchanaburi, Thailand, Nov. 27, 1952, collected by Robert E. Elbel and H. G. Deignan, USNM; 2 males from Ban Khlua Klang, Prachuap Khiri Khan, Thailand, December 1952, collected by Robert E. Elbel and H. G. Deignan, USNM; 2 males and 1 female from Ban Nam Phu, Phu Khieo, Chaiyaphum, Thailand, Dec. 22, 1952, collected by Robert E. Elbel, USNM; 1 male and 1 female from Ban Thung Chuak, Salok Bat, Khanu, Kamphaeng Phet, Thailand, June 25, 1953, collected by Robert E. Elbel, USNM; 1 female from Tha Din Daeng, Pa Bon, Pak Pha Yun, Phatthalung, Thailand, July 30, 1962, collected by Wichit Suwan Laong, USNM; 6 males and 6 females from Muang Kluang, Kapoe, Ranong, Thailand, 1962-1963, collected by Wichit Suwan Laong, USNM; 6 males and 11 females from Pa Dong Lan, Chumphae, Khon Kaen, Thailand, Dec. 2, 1962, collected by Kitti Thonglongya, SMRL; from *Anthracoceros coronatus* (Boddaert, 1783): 2 females from CNHM skins from Kanha, Central Provinces, India, August 1946, collected by Rup Chand, REE; 2 females from CNHM skins from Nawadeh, Bihars, India, Nov. 11, 1947, collected by W. Koelz, REE; 1 male from USNM skins from India and Ceylon, 1874 and 1944, collected by B. H. Swales and S. D. Ripley, REE; from *Anthracoceros convexus* (Temminck, 1831): 1 male and 1 female from lot 1584 (TMRN), Zoological Museum, Humboldt University, Berlin; according to Eichler (1947) the Mallophaga WEC 2268 from this later named host were collected in Sumatra by E. Mjöberg; from *Anthracoceros marchei* Oustalet, 1885: 1 male from Puerto Princesa, Palawan, Philippines, May 12, 1962, collected by Max Thompson, USNM BPM-PI 2313.

Drawings were made of a male and a female from *Anthracoceros albirostris leucogaster* collected in Myitkyina, Burma. Specimens in BMNH.

Chapinia malayensis, new species

FIGURES 12, 37

Male: Smaller than *Chapinia traylori* in all measurements except width of abdomen (table 1). Venter of third femora and postero-lateral margins of abdominal sternites IV-VI each with large thick brushes of normal setae which are not as numerous on abdominal sternite VI. Each lateral margin of abdominal tergites II-VI with a short seta between the spiracle and postspiracular seta. Abdominal

sternite II with 34 total setae and one median row of setae on posterior margin. Terminal abdominal segments similar to those of *C. acutovulvata*. Genitalia as shown in figure 12, endomeres with large inner plate and paired outer rims.

Female: Slightly smaller than *Chapinia traylori* in all measurements except length of head (table 2). Resembles the male except that abdominal sternite II has 64 total setae. Terminal abdominal tergite with 20 long and 4 short setae on posterior margin; abdominal sternite VIII with 24 long and 12 short setae on posterior margin (fig. 37). Anal fringe similar to that of *C. acutovulvata* with 50 setae.

Discussion: *Chapinia malayensis* resembles most closely *C. acutovulvata*. Abdominal sternite II of both sexes has fewer total setae in *C. malayensis* than in corresponding sexes of *C. acutovulvata*. Male genitalia have endomeres possessing a large inner plate with paired lateral flanges and a central terminal point in *C. malayensis* but a small inner plate in *C. acutovulvata*. The female terminal abdominal tergite has on the posterior margin at most 24 setae in *C. malayensis* but at least 26 setae in *C. acutovulvata*. The female abdominal sternite VIII has on the posterior margin more than 34 setae in *C. malayensis* but fewer than 32 setae in *C. acutovulvata*.

Material examined: 1 male and 1 female from fresh material collected in Borneo.

Type host: *Anthracoceros malayanus* (Raffles, 1822).

Type material: Holotype male and allotype female from Borneo, Meinertzhagen 10910, BMNH.

Chapinia hoplai, new species

FIGURES 13, 38

Both sexes are slightly smaller than corresponding sexes of *Chapinia traylori* in all measurements except length of head (tables 1, 2).

Male: Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with large thick brushes of normal setae. Each lateral margin of abdominal tergites II–VI without a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 66–68 total setae and one median row of setae on posterior margin. Terminal abdominal segments similar to those of *C. acutovulvata*. Genitalia as shown in figure 13, endomeres with paired outer rims only.

Female: Resembles the male except that abdominal sternite II has 80–88 total setae. Terminal abdominal tergite with 14 long and 12 short setae on posterior margin; abdominal sternite VIII with 16 long and 4 short setae on posterior margin (fig. 38). Anal fringe similar to that of *C. acutovulvata* with 50–54 setae.

Discussion: Although slightly larger in size, *Chapinia hoplai* re-

sembles most closely *C. boonsongi*. The venter of the third femora and posterolateral margins of abdominal sternite IV–VI each have large thick brushes of normal setae in *C. hoplari* but small scattered brushes of normal setae in *C. boonsongi*. Abdominal sternite II of both sexes has more total setae in *C. hoplari* than in corresponding sexes of *C. boonsongi*. The male genitalia have endomeres with paired outer rims that are curved inwardly in *C. hoplari* but straight and nearly parallel in *C. boonsongi*. The female terminal abdominal tergite has on the posterior margin more than 24 setae of which approximately one-half are long and one-half are short in *C. hoplari* but fewer than 22 setae of which approximately two-thirds are long and one-third are short in *C. boonsongi*.

Material examined: 3 males and 2 females from dried material collected in the Philippines.

Type host: *Anthracoseros montani* (Oustalet, 1880).

Type material: Holotype male and allotype female from USNM skins from Sulu, and Tawitawi, Philippines, 1891, collected by D. C. Worchester and F. S. Bourns, REE in USNM. Paratypes: 2 males and 1 female with same data.

Chapinia hoplari is named for Dr. Cluff E. Hopla, Department of Zoology, University of Oklahoma, in appreciation for his thoughtful advice while directing this study.

***Chapinia boonsongi*, new species**

FIGURES 11, 14, 39

Both sexes are smaller than corresponding sexes of *Chapinia traylori* in all measurements except length of head (tables 1, 2).

Male: Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae which are not as numerous on abdominal sternite VI. Each lateral margin of abdominal tergites II–VI without a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 48–62 total setae and one median row of setae on posterior margin. Terminal abdominal segments as shown in figure 11. Genitalia as shown in figure 14, endomeres with paired outer rims only.

Female: Resembles the male except that abdominal sternite II has 62–70 total setae. Terminal abdominal tergite with 14–16 long and 4 short setae on posterior margin; abdominal sternite VIII with 18–20 setae on posterior margin (fig. 39). Anal fringe similar to that of *C. acutovulvata* with 50–56 setae.

Discussion: Although slightly smaller in size, *Chapinia boonsongi* resembles most closely *C. hoplari*. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have

small scattered brushes of normal setae in *C. boonsongi* but large thick brushes of normal setae in *C. hoplai*. Abdominal sternite II of both sexes has fewer total setae in *C. boonsongi* than in corresponding sexes of *C. hoplai*. The male genitalia have endomeres with paired outer rims that are straight and nearly parallel in *C. boonsongi* but curved inwardly in *C. hoplai*. The female terminal abdominal tergite has on the posterior margin fewer than 22 setae of which approximately two-thirds are long and one-third are short in *C. boonsongi* but more than 24 setae of which approximately one-half are long and one-half are short in *C. hoplai*.

Material examined: 5 males and 8 females from fresh and dried material collected in Thailand.

Type host: *Rhyticeros undulatus ticehursti* Deignan, 1941.

Type material: Holotype male from USNM skin from Ban Hai Huai, Thailand, June 15, 1936, collected by H. G. Deignan, REE in USNM. Additional types from *Rhyticeros u. undulatus* (Shaw, 1811): Allotype female from Khao Phap Pha Mt., Ban Na, Muang, Phatthalung, Thailand, Feb. 7, 1955, collected by Boonsong Lekagul, USNM. Paratypes: 3 males and 3 females with same data; 1 male from BL skin from Nong Ko, Siracha, Chon Buri, Thailand, August 1953, collected by Boonsong Lekagul, REE; 4 females from Lamo, Muang, Trang, Thailand, Mar. 5, 1963, collected by Wichit Suwan Laong, USNM.

Chapinia boonsongi is named for Dr. Boonsong Lekagul, Bangkok physician and naturalist, in appreciation for the fresh material he collected from Thailand and for permission to examine his hornbill skins for Mallophaga.

Chapinia wenzeli, new species

FIGURES 15, 40, 41

Both sexes are smaller than corresponding sexes of *Chapinia traylori* in all measurements except length of head in females (tables 1, 2).

Male: Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae which are not as numerous on abdominal sternite VI. Each lateral margin of abdominal tergites II–VI without a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 30–36 total setae and one median row of setae on posterior margin. Terminal abdominal segments similar to those of *C. boonsongi*. Genitalia as shown in figure 15, endomeres with paired outer rims only, the posterolateral margins of which are split.

Female: Resembles the male except that abdominal sternite II has 50–60 total setae. Terminal abdominal tergite with 12–14 long and 6–8 short setae on posterior margin; abdominal sternite VIII

with 18–24 setae on posterior margin (fig. 40). Anal fringe with 40–44 setae (fig. 41).

Discussion: *Chapinia wenzeli* resembles most closely *C. blakei*. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have small scattered brushes of normal setae in both sexes of *C. wenzeli* but only in the female of *C. blakei*. The male genitalia have endomeres with paired outer rims in *C. wenzeli* but paired plates in *C. blakei*. However, the paired plates may be split in *C. blakei*, giving the appearance of paired outer rims and inner plate, but the inner plate in this case is unsymmetrical. The female abdominal sternite VIII has on the posterior margin at least 18 setae in *C. wenzeli* but at most 18 setae in *C. blakei*, and the internal sclerite, absent in *C. wenzeli*, is present in *C. blakei*. The female anal fringe has at least 40 setae in *C. wenzeli* and at most 40 setae in *C. blakei*.

Material examined: 20 males and 23 females from fresh and dried material collected in the Philippines.

Type host: *Penelopides panini samarensis* Steere, 1890.

Type material: Holotype male and allotype female from CNHM skins from Sandayong, Sierra Bullones, Bohol Island, Philippines, April 1955, collected by D. S. Rabor, REE in CNHM. Paratypes: 2 females with same data; 2 males from CNHM skins from Matuguinao, Samar Island, Philippines, April 1957, collected by D. S. Rabor, REE; from *Penelopides panini manilloe* (Boddaert, 1783): 1 male and 1 female from CNHM skin from Bataan, Luzon Island, Philippines, Jan. 17, 1905, collected by Celestino and Canton, REE; from *Penelopides panini mindorensis* Steere, 1890: 1 male from CNHM skin from Balete, Rio Baca, Mindanao, Philippines, Apr. 1, 1905, collected by McGregor, Celestino, and Canton, REE; from *Penelopides panini affinis* Tweeddale, 1877: 8 males and 2 females from CNHM skins from Mindanao, Philippines, 1946 and 1947, collected by Werner and Alcasid, REE; 3 males and 8 females from Davao, Mindanao, Philippines, Jan. 18, 1947, KCE; 4 males and 9 females from Mindanao, Philippines.

Chapinia wenzeli is named for Dr. Rupert L. Wenzel, Curator of Insects, Chicago Natural History Museum, in appreciation for the loan of hornbill Menoponidae from that museum.

Chapinia blakei, new species

FIGURES 16, 42, 43

Male: Slightly smaller than *Chapinia traylori* in all measurements except length of head and width of metathorax (table 1). Venter of third femora and abdominal sternites IV–VI each without brushes. Each lateral margin of abdominal tergites II–VI without a short

seta between the spiracle and postspiracular seta. Abdominal sternite II with 32–42 total setae and one median row of setae on posterior margin. Terminal abdominal segments similar to those of *C. boonsongi*. Genitalia as shown in figure 16, endomeres with paired plates.

Female: Smaller than *Chapinia traylori* in all measurements except length of head (table 2). Resembles the male except that the venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have small scattered brushes of normal setae which are not as numerous on abdominal sternite VI. Abdominal sternite II with 52–64 total setae. Terminal abdominal tergite with 10–16 long and 8–14 short setae on posterior margin; abdominal sternite VIII with 14–18 setae on posterior margin (fig. 43) and with internal sclerite having slender posteriorly divergent margins. Anal fringe with 34–40 setae (fig. 42).

Discussion: *Chapinia blakei* resembles most closely *C. wenzeli*. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have small scattered brushes of normal setae in females of *C. blakei* and in both sexes of *C. wenzeli*. The male genitalia have endomeres with paired plates in *C. blakei* but paired outer rims in *C. wenzeli*. However, the paired plates may be split in *C. blakei*, giving the appearance of paired outer rims and inner plate, but the inner plate in this case is unsymmetrical. The male genitalia of *C. traylori* also have endomeres with paired plates, but the posterior extension of the endomeres is split in *C. traylori* and not split in *C. blakei*. The female abdominal sternite VIII has on the posterior margin at most 18 setae in *C. blakei* but at least 18 setae in *C. wenzeli*, and the internal sclerite with slender posteriorly divergent margins, present in *C. blakei*, is absent in both *C. wenzeli* and *C. traylori*. The female anal fringe has at most 40 setae in *C. blakei* and at least 40 setae in *C. wenzeli*.

Material examined: 13 males and 16 females from fresh and dried material collected in the Philippines.

Type host: *Rhyticeros l. leucocephalus* (Vieillot, 1816).

Type material: Holotype male and allotype female from CNHM skins from Zamboanga, Mindanao Island, Philippines, 1948 and 1956, collected by D. S. Rabor, REE in CNHM. Paratypes: 11 males and 12 females from Mutya, Canon, Mindanao Island, Philippines, December 1961, collected by Rabor and Gonzales, BPBM; 1 female from Davao, Tagum, Mindanao Island, Philippines, Oct. 13, 1946, collected by H. Hoogstraal, CNHM; from *Rhyticeros leucocephalus waldeni* (Sharpe, 1877): 1 male and 2 females from CNHM skins from Tolong, Negros Island, Philippines, November–December 1948, collected by D. S. Rabor, REE.

Chapinia blakei is named for Dr. Emmet R. Blake, Curator of Birds, Chicago Natural History Museum, in appreciation for permission to examine hornbill skins for Mallophaga in that museum.

***Chapinia traylori*, new species**

FIGURES 17, 25, 26, 44, 45

Male: As illustrated in figure 26. Slightly larger than *Chapinia clayae*, *C. acutovulvata*, *C. malayensis*, *C. hoplai*, *C. boonsongi*, *C. wenzeli*, *C. blakei*, and *C. lydae* in all measurements except length of head in *C. clayae*, *C. acutovulvata*, *C. hoplai*, *C. boonsongi*, *C. blakei*, and *C. lydae*, width of head in *C. acutovulvata*, width of metathorax in *C. blakei*, and width of abdomen in *C. malayensis*; smaller than *C. waniti* in all measurements except width of prothorax and width of metathorax; approximately the same size as *C. robusta* (table 1). Venter of third femora and abdominal sternites IV–VI each without brushes. Each lateral margin of abdominal tergites II–VI without a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 24–42 total setae and two median rows of setae although the anterior row has widely separated setae. Terminal abdominal segments as shown in figure 26e. Genitalia as shown in figure 17, endomeres with paired plates.

Female: As illustrated in figure 25. Larger than *Chapinia waniti* and *Chapinia acutovulvata* in all measurements except length and width of head; slightly larger than other *Chapinia* in all measurements except length of head (table 2). Resembles the male except that abdominal sternite II has 38–58 total setae. Terminal abdominal tergite with 10 long and 6–10 short setae on posterior margin; abdominal sternite VIII with 14–20 setae on posterior margin and with small triangular internal sclerite (fig. 44); each lateral projection of the ventral sclerite between vulva and anus with 2 or 3 thick, posteriorly directed setae (fig. 44sp). Anal fringe with 34–40 setae (fig. 45).

Discussion: *Chapinia traylori* resembles most closely *C. blakei*. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI lack brushes in both sexes of *C. traylori* and in the male of *C. blakei*, but these margins have small scattered brushes of normal setae in females of *C. blakei*. The male genitalia have endomeres with paired plates in both *C. traylori* and *C. blakei*, but the posterior extension of the endomeres is split in *C. traylori* and not split in *C. blakei*; the paired plates may be split in *C. blakei*, giving the appearance of paired outer rims and inner plate, but the inner plate in this case is unsymmetrical. The female abdominal sternite VIII has a small triangular internal sclerite in *C. traylori* but a much larger sclerite with slender posteriorly divergent margins in *C. blakei*. Each lateral projection of the ventral sclerite between female vulva

and anus has fewer than four thick, posteriorly directed setae in *C. traylori* but more than four in all other *Chapinia*.

Material examined: 73 males and 52 females from fresh and dried material collected in the Philippines.

Type host: *Buceros hydrocorax semigaleatus* Tweeddale, 1878.

Type material: Holotype male, allotype female, and paratype female on same slide from CNHM skins from San Isidro, Samar Island, Philippines, April–May 1957, collected by D. S. Rabor, REE in CNHM. The allotype female is the largest female and is next to the male. Paratypes: 1 male and 1 female from CNHM skins from Cantaub, Sierra Bullones, Bohol Island, Philippines, April–May 1955, collected by D. S. Rabor, REE; 2 males from CNHM skins from Matuguinao, Samar Island, Philippines, April 1957, collected by D. S. Rabor, REE; 15 males and 9 females from CNHM skins from Mount Capato-an, Samar Island, Philippines, May 1957, collected by D. S. Rabor, REE; from *Buceros hydrocorax mindanensis* Tweeddale, 1877: 11 males and 12 females from Mutya, Canon, Mindanao Island, Philippines, Dec. 23, 1961, collected by Rabor and Gonzales, BPBM; 9 males and 7 females from Mount McKinley, Davao, Mindanao Island, Philippines, August 1946, collected by H. Hoogstraal, CNHM; 2 males and 3 females from CNHM skins from Taglawig, Tagum, Davao, Mindanao Island, Philippines, October 1946, collected by Celestino, REE; 13 males and 7 females from Mount Apo, Todaya, Mindanao Island, Philippines, Oct. 25, 1946, collected by Hoogstraal and Hey, CNHM; 2 males and 1 female from CNHM skins from Kidapawan, Cotabata, Mindanao Island, Philippines, Dec. 2, 1946, collected by Alcasid, REE; 1 male and 1 female from CNHM skins from Burungkot Upi, Cotabata, Mindanao Island, January 1947, collected by Werner and Alcasid, REE; 9 males and 4 females from CNHM skins from Mount Malindang, Zamboanga, Mindanao Island, Philippines, March–May 1956, collected by D. S. Rabor, REE; 2 males and 1 female from USNM skins from Mindanao Island, Philippines, August–September 1903, collected by E. A. Mearns, REE; 5 males and 4 females from Mindanao Island, Philippines.

Chapinia traylori is named for Dr. M. A. Traylor, Division of Birds, Chicago Natural History Museum, in appreciation for assistance in examination of hornbill skins for Mallophaga in that museum.

Chapinia lydae, new species

FIGURES 20, 46

"*Colpocephalum hirtum* Rudow, 1866."—Piaget, 1880, p. 530, pl. 44 (fig. 3).

[Not Rudow, 1866; type host: *Buceros cassidix*=*Rhyticeros cassidix* (Temminck, 1823).]

Clay (1951b) stated that it was impossible to say whether or not

Piaget's specimens of a headless female and 2 nymphs from *Buceros cassidix*=*Rhyticeros cassidix* (Temminck, 1823) were conspecific with Rudow's *hirtum* from *Buceros ruficollis*=*Rhyticeros plicatus ruficollis* (Vieillot, 1816). Through the courtesy of Dr. Clay, Piaget's specimens have been examined, and they do not appear to be conspecific with *Chapinia hirta* (Rudow, 1866). They are described herewith as part of the type material from *Rhyticeros cassidix*.

Both sexes are smaller than corresponding sexes of *Chapinia traylori* in all measurements except length of head, but this measurement in the male is larger than in males of other *Chapinia* (tables 1, 2).

Male: Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae which are not as numerous on abdominal sternite VI. Each lateral margin of abdominal tergites II–VI without a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 62–64 total setae and three median rows of setae. Terminal abdominal segments similar to those of *C. boonsongi*. Genitalia as shown in figure 20, endomeres with inner plate and paired outer rims.

Female: Resembles the male except that abdominal sternite II has 54–68 total setae. Terminal abdominal tergite with 14 long and 8 short setae on posterior margin; abdominal sternite VIII with 20–24 setae on posterior margin (fig. 46). Anal fringe similar to that of *C. hirta*, with 46–50 setae.

Discussion: *Chapinia lydae* superficially resembles *C. hirta*. Abdominal sternite II in both species has approximately the same number of total setae in females as in males and three median rows of setae. Abdominal sternite II of other members of the *acutovulvata* species-group has more setae in the females than in the males and 1 or 2 median rows of setae. The male genitalia in *C. lydae* are wider than in *C. hirta*, and the parameres are enlarged anteriorly only in *C. lydae*; the endomeres have an inner plate and paired outer rims in *C. lydae*, but endomeres apparently are absent in *C. hirta*. The female terminal abdominal tergite has on the posterior margin in *C. lydae* 3 or 4 long setae on each side of the midline, the two median setae being as widely spaced as four times the distance between each of the 3 or 4 long setae, but in *C. hirta* 5 long setae on each side of the midline yield a total of 10 setae that are evenly spaced.

Material examined: 3 males and 5 females from dried skins collected in the Celebes.

Type material: Holotype male and allotype female from USNM skins from Palaleh River, Celebes, Aug. 9, 1914, collected by H. C. Raven, LE in USNM. Paratypes: 2 males and 3 females with same data; 1 female, Piaget, BMNH, 1928–325.

Chapinia lydae is named for my wife, Lyda, in appreciation for the

dried material that she obtained from *Rhyticeros cassidix* and other hosts in the USNM and for much help in preparation of the manuscript.

The *hirta* Species-Group

Species similar in shape to *Chapinia traylori* (figs. 25, 26). Differing from other species-groups in the following combination of characters: Dorsal-lateral margins of head with a preocular notch; venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae which are not as numerous on abdominal sternite VI; each lateral margin of abdominal tergites II–VI without a short seta between the spiracle and postspiracular seta; females with approximately the same number of abdominal sternal setae as males; abdominal sternite II with three median rows of setae; male genitalia much narrower than for other species-groups, without lateral horns on each side of endomeres, and with parameres not enlarged anteriorly but split posteriorly; females without sclerital hooks on each side of midline of ventral sclerite between vulva and anus; female abdominal sternite VIII with most of setae much shorter than those on posterior margin.

Hosts: Species of the *hirta* species-group have been found only on the genera *Penelopides* and *Rhyticeros* of the avian family Bucerotidae.

Chapinia muesebecki, new species

FIGURES 18, 21

Male: Smaller than *Chapinia traylori* in all measurements except length of head (table 1). Abdominal sternite II with 58–62 total setae. Terminal abdominal segments as shown in figure 21. Genitalia as shown in figure 18.

Female: Unknown.

Discussion: *Chapinia muesebecki* resembles most closely *C. hirta*. Male terminal abdominal segments are shorter in *C. muesebecki* than in *C. hirta*, and the partial division between abdominal sternites VII and VIII is not as pronounced in *C. muesebecki* as in *C. hirta*. The sclerite of male genital sac is nearly twice as long as wide in *C. muesebecki* but approximately as wide as long in *C. hirta*, and this sclerite is approximately three times as long in *C. muesebecki* as in *C. hirta*.

Material examined: 2 males from dried skins collected in the Celebes.

Type host: *Penelopides e. exarhatus* (Temminck, 1823).

Type material: Holotype male from USNM skins from Celebes, 1914–1916, collected by H. C. Raven, REE in USNM. Paratype male with same data.

Chapinia muesebecki is named for Mr. C. F. W. Muesebeck, Division of Insects, U.S. National Museum, in appreciation for the loan of Mallophaga from that museum.

Chapinia hirta (Rudow)

FIGURES 19, 22, 47, 48

Colpocephalum hirtum Rudow, 1866, p. 474. [Type host: *Buceros ruficollis* = *Rhyticeros plicatus ruficollis* (Vieillot, 1816).]

Colpocephalum hirtum Rudow, 1869, p. 399.

Chapinia hirta (Rudow).—Hopkins and Clay, 1952, p. 67.

Hopkins and Clay state that the generic position of *hirtum* is doubtful. Examination of specimens from the type host shows them to be *Chapinia*. Therefore, the male, BM 13376, is designated hereby as neotype of *C. hirta*. The slide has been so labeled.

Both sexes are smaller than corresponding sexes of *Chapinia traylori* in all measurements except length of head (tables 1, 2).

Male: Abdominal sternite II with 60–64 total setae. Terminal abdominal segments as shown in figure 22. Genitalia as shown in figure 19.

Female: Resembles the male except that terminal abdominal segments have a tergite with 12 long and 10 short setae on posterior margin; abdominal sternite VIII has 18–22 setae on posterior margin (fig. 48). Anal fringe with 46–48 setae (fig. 47).

Discussion: *Chapinia hirta* resembles most closely *C. muesebecki*. Also, *C. hirta* superficially resembles *C. lydae*. Abdominal sternite II in these three species has approximately the same number of total setae in females as in males, and three median rows of setae. Male terminal abdominal segments are longer in *C. hirta* than in *C. muesebecki*, and the partial division between abdominal sternites VII and VIII is more pronounced in *C. hirta* than in *C. muesebecki*. The sclerite of male genital sac is approximately as wide as long in *C. hirta* but nearly twice as long as wide in *C. muesebecki*, and this sclerite is approximately one-third as long in *C. hirta* as in *C. muesebecki*. The male genitalia in *C. hirta* are narrower than in *C. lydae*; the parameres, straight-sided in *C. hirta*, are enlarged anteriorly in *C. lydae*; the endomeres apparently are absent in *C. hirta*, but have an inner plate and paired outer rims in *C. lydae*. The female terminal abdominal tergite has on the posterior margin in *C. hirta* 5 long setae on each side of the midline, these 10 setae being evenly spaced; however, in *C. lydae* 3 or 4 long setae on each side of the midline have the two median setae as widely spaced as four times the distance between each of the 3 or 4 long setae.

Material examined: 3 males and 2 females from fresh and dried material collected in the Oriental and Australasian regions; neotype male, BM 13376, and female, BM 13375, from New Guinea, BMNH;

from *Rhyticeros plicatus subruficollis* (Blyth, 1843): 1 female from USNM skins from Domel Island, Mergui Archipelago, 1904, collected by W. L. Abbott, REE; from *Rhyticeros plicatus mendanae* (Hartert, 1924): 1 male from CNHM skins from Guadalcanal, Solomon Islands, August–October 1944, collected by W. J. Beecher, REE; 1 male from MMZ skin from Guadalcanal, Solomon Islands, Jan. 20, 1944, collected by K. W. Prescott, REE.

Drawings were made of the neotype male and the female, BM 13375. Specimens in BMNH.

***Bucero-colpocephalum*, new genus**

FIGURES 64, 65

Head triangular, width $1\frac{1}{4}$ to $1\frac{3}{4}$ times that of length. Forehead slightly narrower anteriorly. Temples expanded. Antennae 4-jointed, third segment constricted at base, and terminal segment capitate with definite signs of division into two parts, either by transverse line or marginal indentation. Antennary fossa deep, covered above by expansion of lateral margin of head, posterior margin of which lacks an eye. Dorsal-lateral margin of forehead above antennary fossa with shallow notch. Gular region narrow with a ridge on each lateral margin from which 8–11 setae extend. Pronotum expanded anteriorly with posterior marginal row of long setae. Metanotum expanded posteriorly with posterior marginal row of long setae and 4–7 short setae on each lateral margin. Metanotum separated from mesonotum and from pleurites. The sclerotized median button behind the prothorax (fig. 25m) is a vestige of the mesonotum; the supposed mesonotum, the narrow sclerotized band posterior to this button, is a mere extension of the subcoxae (Cope, 1941). Thoracic sternal plates as shown in figures 64b and 64c. Metasternal plate oval with 14–24 setae. Venter of third femora and postero-lateral margins of abdominal sternite IV each with combs of setae. Abdominal segments consist of tergites, sternites, and pleurites, the latter without prolongation of posteroventral angles. Abdominal tergites each with a posterior marginal row of setae, the most laterad being the postspiracular seta. Each lateral margin of abdominal tergites II–VIII with 1–4 short setae between the spiracle and postspiracular seta. Sternites and pleurites each with a posterior marginal row of long and short setae and with numerous short, usually thick setae. Male terminal abdominal sternites VIII and IX fused with complete division from sternite VII (fig. 65). Male genitalia as illustrated for each species with parameres anteriorly either enlarged or curved inwardly. Female terminal abdominal segments as illustrated for each species, with lateral processes arising from ventral

sclerite between vulva and anus, with long stout setae and strong spines. Females similar to males in size, general shape, and chaetotaxy except for terminal abdominal segments.

Bucerocolpocephalum resembles most closely *Bucerophagus* (figs. 66–69) but differs in several characters: The posterior margin of the expansion of the lateral margin of the head covering the antennary fossa lacks an eye in *Bucerocolpocephalum*, but an eye with a double cornea is present in *Bucerophagus*. The gular region has on each lateral ridge 8–11 setae in *Bucerocolpocephalum*, but the ridge is absent, and each lateral margin has at most eight setae in *Bucerophagus*. The metasternal plate is oval in *Bucerocolpocephalum* but trapezoidal or triangular in *Bucerophagus*. The venter of the third femora has combs of setae in *Bucerocolpocephalum* but may have large thick brushes of normal setae in *Bucerophagus*; similar combs are present on posterolateral margins of abdominal sternite IV in *Bucerocolpocephalum*, and similar brushes are present on posterolateral margins of abdominal sternites IV and V in *Bucerophagus*. Male genitalia of *Bucerocolpocephalum* are shorter than in *Bucerophagus*. The female anal fringe is weak in *Bucerocolpocephalum* and prominent in *Bucerophagus*.

The male genitalia and details of the male and female terminal abdominal segments are the best characters for separating species of *Bucerocolpocephalum*.

Hosts: Species of *Bucerocolpocephalum* have been found only on the genera *Ptilolaemus* and *Anorrhinus* of the avian family Bucerotidae. [Genotype: *Bucerocolpocephalum emersoni*, new species.]

***Bucerocolpocephalum emersoni*, new species**

FIGURES 49, 57, 64, 65

Both sexes are approximately the same size as corresponding sexes of *Bucerocolpocephalum deignani* (table 3).

Male: As illustrated in figure 65. Metasternal plate with 16–20 setae. Abdominal sternite II with 40–48 total setae. Terminal abdominal segments as shown in figure 65e. Genitalia as shown in figure 57.

Female: As illustrated in figure 64. Resembles the male except that metasternal plate has 16–24 setae. Terminal abdominal tergite with 30–36 setae on posterior margin; abdominal sternite VIII with 32–42 setae on posterior margin and with internal triangular sclerite; anal fringe with 44–48 weak setae (fig. 49).

Discussion: *Bucerocolpocephalum emersoni* resembles most closely *B. deignani*. Male terminal abdominal sternites VIII and IX have a lateral notch in *B. emersoni* but not in *B. deignani*. Male genitalia have parameres anteriorly slender, curved inwardly with each lateral

point reaching endomeres in *B. emersoni* and anteriorly enlarged, not curved inwardly, in *B. deignani*; endomeres have a pair of posterior points in *B. emersoni* which are absent in *B. deignani*. The female terminal abdominal tergite has thick setae along the entire posterior margin in *B. emersoni*, but thick setae are absent medially in *B. deignani*. The female abdominal sternite VIII has an internal triangular sclerite in *B. emersoni* that is absent in *B. deignani*.

Material examined: 13 males and 19 females from fresh and dried material collected in the Oriental region.

Type host: *Ptilolaemus tickelli austeni* (Jerdon, 1872).

Type material: Holotype male and allotype female from Phu Lom Lo Mt., Kok Sathon, Dan Sai, Loei, Thailand, Mar. 23, 1954, collected by Robert E. Elbel, USNM. Paratypes: 8 males and 15 females with same data; from *Ptilolaemus tickelli indochinensis* Delacour and Jabouille, 1928: 4 males and 3 females from CNHM skins from Muong Yo, Laos, and Muong Maun, Tonkin, Indochina, March–May 1929, collected by Van Tyne, REE.

Bucerocolpocephalum emersoni is named for Dr. K. C. Emerson, Stillwater, Okla., in appreciation for his untiring help and advice throughout this study, particularly in the preparation of the manuscript and illustrations, and in other studies on Oriental Mallophaga.

***Bucerocolpocephalum deignani*, new species**

FIGURES 50, 58, 59

Both sexes are approximately the same size as corresponding sexes of *Bucerocolpocephalum emersoni* (table 3).

Male: Metasternal plate with 14–18 setae. Abdominal sternite II with 44–46 total setae. Terminal abdominal segments as shown in figure 59. Genitalia as shown in figure 58.

Female: Resembles the male except that abdominal sternite II has 42–58 total setae. Terminal abdominal tergite with 28–34 setae on posterior margin; abdominal sternite VIII with 34–42 setae on posterior margin; anal fringe with 24–40 weak setae (fig. 50).

Discussion: *Bucerocolpocephalum deignani* resembles most closely *B. emersoni*. Male terminal abdominal sternites VIII and IX lack the lateral notch in *B. deignani* that is present in *B. emersoni*. Male genitalia have parameres anteriorly enlarged, not curved inwardly, in *B. deignani* and anteriorly slender, curved inwardly with each lateral point reaching endomeres in *B. emersoni*; endomeres lack the pair of posterior points in *B. deignani* that are present in *B. emersoni*. The female terminal abdominal tergite lacks thick setae medially on the posterior margin in *B. deignani*, but thick setae are present along this entire margin in *B. emersoni*. The female abdominal sternite

VIII lacks the internal triangular sclerite in *B. deignani* that is present in *B. emersoni*.

Material examined: 39 males and 28 females from fresh and dried material collected in the Oriental region.

Type host: *Anorrhinus g. galeritus* (Temminck, 1831).

Type material: Holotype male from CNHM skin from Kinabatangan, North Borneo, May 18, 1950, collected by D. D. Davis, REE in CNHM. Paratypes: 2 males with same data. Additional types from *Anorrhinus g. carinatus* (Blyth, 1845): Allotype female from USNM skins from Trang, Thailand, 1896 and 1899, collected by W. L. Abbott, REE in USNM. Paratypes: 1 male and 1 female with same data; 27 males and 18 females from Lamo and Chong, Muang, Trang, Thailand, March 1963, collected by Wichit Suwan Laong, USNM; 8 males and 7 females from Na Wong, Ban Na, Muang, Phatthalung, Thailand, Mar. 6, 1963, collected by Wichit Suwan Laong, USNM: 1 female from BL skin from Khao Phap Pha Mt., Ban Na, Muang, Phatthalung, Thailand, Sept. 4, 1954, collected by B. Lekagul, REE.

Bucerocolpocephalum deignani is named for Mr. H. G. Deignan, Division of Birds, U.S. National Museum, in appreciation for the fresh material he collected in Thailand, for supplying identifications and information on hosts, and for permission to examine hornbill skins for Mallophaga in the USNM.

Genus *Bucerophagus* Bedford

FIGURES 66-69

Bucerophagus Bedford, 1929, p. 509, figs. 11, 12. [Genotype: *Bucerophagus africanus* Bedford, 1929.]

Antimenopon Eichler, 1947, p. 3, figs. 3-5. [Genotype: *Menopon forcipatum* Nitzsch, 1874.]

Head triangular, width $1\frac{1}{4}$ to $1\frac{3}{4}$ times that of length. Forehead narrower anteriorly. Temples expanded. Antenna 4-jointed, third segment constricted at base, and terminal segment capitate with definite signs of division into two parts, either by transverse line or marginal indentation. Antennary fossa deep, covered above by expansion of lateral margin of head, posterior margin of which bears eye with double cornea. Dorsal-lateral margin of forehead anterior to eye with shallow notch, Gular region with 2-8 setae varying in length on each lateral margin. Pronotum expanded anteriorly with posterior marginal row of long setae. Metanotum expanded posteriorly with posterior marginal row of long setae and 2-5 short setae on each lateral margin. Metanotum separated from mesonotum and from pleurites. The sclerotized median button behind the prothorax (fig. 25m) is a

vestige of the mesonotum; the supposed mesonotum, the narrow sclerotized band posterior to this button, is a mere extension of the subcoxae (Cope, 1941). Thoracic sternal plates as shown in figures 66b, 66c, 68b, 68c, and 70. Metasternal plate trapezoidal or triangular, expanded anteriorly, with 6-34 setae. Venter of third femora and posterolateral margins of abdominal sternites IV and V each with or without large thick brushes of normal setae. Abdominal segments consist of tergites, sternites, and pleurites, the latter without prolongation of posteroventral angles. Abdominal tergites each with a posterior marginal row of setae, the most laterad being the postspiracular seta. Each lateral margin of abdominal tergites II-VIII with or without 1-5 short setae between the spiracle and postspiracular seta. Sternites and pleurites each with a posterior marginal row of long setae and with numerous shorter setae. Male terminal abdominal sternites VIII and IX either fused or not but with complete division from abdominal sternite VII (figs. 67, 69). Male genitalia as illustrated for each species with parameres branched anteriorly and either split or unsplit posteriorly. Female terminal abdominal segments as illustrated for each species with lateral processes arising from ventral sclerite between vulva and anus with long stout setae and strong spines. Females larger than males, usually with more abdominal sternal setae but general shape and chaetotaxy similar to that of males except for terminal abdominal segments.

Bucerophagus resembles both *Chapinia* (figs. 23-26) and *Bucerocolpocephalum* (figs. 64, 65) but differs in several characters: The terminal segment of the antenna shows definite signs of division into two parts either by transverse line or marginal indentation in *Bucerophagus* and *Bucerocolpocephalum*, but there is no sign of division in *Chapinia*. The posterior margin of the expansion of the lateral margin of the head covering the antennary fossa has an eye with a double cornea in *Bucerophagus* and *Chapinia*, but an eye is absent in *Bucerocolpocephalum*. The gular region lacks a lateral ridge and each lateral margin has at most 8 setae in *Bucerophagus* and *Chapinia*, but each lateral ridge has 8-11 setae in *Bucerocolpocephalum*. The metasternal plate is trapezoidal or triangular in *Bucerophagus* and *Chapinia* but oval in *Bucerocolpocephalum*. The venter of the third femora may have brushes of normal setae in *Bucerophagus* and *Chapinia* but has combs of setae in *Bucerocolpocephalum*; similar brushes are present on posterolateral margins of abdominal sternites IV and V in *Bucerophagus* and abdominal sternites IV-VI in *Chapinia*, but combs of setae are present on posterolateral margins of abdominal sternite IV in *Bucerocolpocephalum*. Each lateral margin of abdominal tergites II-VIII may have 1-5 short setae between the spiracle and postspiracular seta in *Bucerophagus* and *Bucerocolpocephalum*, but one

short seta may be present on margins of abdominal tergites II–VI in *Chapinia*. Male terminal abdominal sternites VIII and IX may be fused in *Bucerophagus* and *Bucerocolpocephalum* with a complete division from abdominal sternite VII, but abdominal sternites VIII and IX are fused in *Chapinia* with a partial division only from abdominal sternite VII. Male genitalia of *Bucerophagus* are longer than in *Bucerocolpocephalum*; parameres are branched anteriorly in *Bucerophagus* but are slender or expanded anteriorly in *Chapinia*. Lateral processes arising from the ventral sclerite between the female vulva and anus have long stout setae and strong spines in *Bucerophagus* and *Bucerocolpocephalum* but only long stout setae in *Chapinia*. The female anal fringe prominent in *Bucerophagus* and *Chapinia* is weak in *Bucerocolpocephalum*.

The male genitalia and details of the male and female terminal abdominal segments are the best characters for separating species of *Bucerophagus*. Other characters useful in species separation are: The shape of the metasternal plate and the number of setae present; the presence or absence of brushes of normal setae on the venter of the third femora and posterolateral margins of abdominal sternites IV and V; the number present or absent of short setae on each lateral margin of abdominal tergites III–VIII between the spiracle and postspiracular seta; the total number of setae on each of abdominal sternites I and II. The number and length of setae on the lateral margins of the gular region are too variable to be of much use in separating species.

Eichler (1947) believed that the lack of brushes, the rounded projected lobe on the posterior end of the male abdomen, the specific male genital apparatus, and the female anal ring of setae were enough to place *Menopon forcipatum* Nitzsch in a separate genus. Hopkins and Clay (1952) correctly placed *M. forcipatum* in the genus *Bucerophagus*. Since there are several characters separating *B. forcipatus* from the complex *B. productus* and *B. africanus*, it is believed here that the relationship can be shown best by species-groups.

Hosts: Species of *Bucerophagus* have been found only on the genera *Buceros*, *Rhinoplax*, and *Bucorvus* of the avian family Bucerotidae.

The *forcipatus* Species-Group

As illustrated in figures 66, 67. Differing from the *productus* species-group in the following combination of characters: Head width $1\frac{1}{2}$ to $1\frac{3}{4}$ times that of length; metanotum with two short setae on each lateral margin and without setae on anterior margin; metasternal plate with less than 14 setae; venter of third femora and abdominal sternites IV and V without brushes; each lateral margin of abdominal tergites II–VIII without short setae between the spiracle

and postspiracular seta; females with approximately the same number of abdominal sternal setae as males; both sexes having abdominal sternite I with fewer than 20 total setae and abdominal sternite II with fewer than 44 total setae; male terminal abdominal sternite IX projecting posteriorly as rounded lobe and with complete division from abdominal sternite VIII; male genitalia with parameres posteriorly split and curved inwardly; female terminal abdominal tergite with fewer than 12 setae on posterior margin; female abdominal sternite VIII with fewer than 24 setae on posterior margin.

Hosts: *Bucerophagus forcipatus* has been found only on the genera *Buceros* and *Rhinoplax* of the avian family Bucerotidae.

Bucerophagus forcipatus (Nitzsch)

FIGURES 51, 52, 60, 66, 67

Menopon forcipatum "Nitzsch."—Giebel, 1874, p. 289, pl. 15 (figs. 7, 8.) [Type host: *Buceros rhinoceros*=*Buceros rhinoceros sumatranus* Schlegel and Müller, 1840.]

Antimenopon forcipatum "Nitzsch in Giebel."—Eichler, 1947, pp. 3, 20, figs. 3-5.
Bucerophagus forcipatus (Nitzsch).—Hopkins and Clay, 1952, p. 64.

Eichler's description and figures are not recognizable. He designated specimens from *Buceros rhinoceros* from Sumatra as neotype material, but he did not select a neotype. His slide specimens have been remounted and examined; the male, 2275 ji, is designated hereby as neotype. The slide has been so labeled. The female, 2275 jf, is mounted on the same slide with the neotype.

Male: As illustrated in figure 67. Smaller than *Bucerophagus africanus* in all measurements except length of head and width of metathorax (table 12). Metasternal plate trapezoidal, expanded anteriorly, with 6-12 setae (fig. 66c). Abdominal sternite I with 6-18 total setae and abdominal sternite II with 30-36 total setae. Terminal abdominal segments as shown in figure 67d. Genitalia as shown in figure 60.

Female: As illustrated in figure 66. Smaller than *Bucerophagus africanus* in all measurements except width of metathorax (table 12). Resembles the male except that abdominal sternite II has 34-42 total setae. Terminal abdominal tergite with 8 long and 2 short setae on posterior margin; abdominal sternite VIII with 18-22 long and 4 short setae on posterior margin (fig. 51). Anal fringe with 44-54 setae (fig. 52).

Material examined: 49 males and 66 females from fresh and dried material collected in the Oriental region; neotype male and specimens from the same series, 1 male and 4 females, from WEC 2275, SMNH. According to Eichler (1947), WEC 2275 was collected in Sumatra by E. Mjöberg; from the type host: 23 males and 29 females from

USNM skins from Tarussan Bay, West Sumatra, 1904–1905, collected by W. L. Abbott, REE; from *Buceros rhinoceros borneoensis* Schlegel and Müller, 1840: 1 male and 6 females from Serabang Bay, Sarawak, Borneo, Jan. 11, 1958, BMNH 1958-737; 4 females from Borneo, Meinertzhagen 10890, BMNH; 2 males and 5 females from CNHM skin from Sapagayo Forest Reservation, Sandakan, North Borneo, July 27, 1950, collected by R. F. Inger and D. D. Davis, REE; from *Buceros bicornis homrai* Hodgson, 1832: 7 males and 5 females from Ban Khlua Klang, Prachuap Khiri Khan, Thailand, December 1952, collected by Robert E. Elbel, and H. G. Deignan, USNM; 11 males and 8 females from Khlong Khlung, Kamphaeng Phet, Thailand, Apr. 7, 1953, collected by Robert E. Elbel and H. G. Deignan, USNM; 1 male and 3 females from Ban Muang Khai, Tha Li, Loei, Thailand, Dec. 7, 1953, collected by Robert E. Elbel, USNM; 2 males and 1 female from Banghin, Kapoe, Ranong, Thailand, Feb. 6, 1963, collected by Wichit Suwan Laong, USNM; from *Rhinoplax vigil* (J. R. Forster, 1781): 1 female from Borneo, Meinertzhagen 10888, BMNH.

Drawings were made of a male and a female from *Buceros bicornis homrai* collected in Khlong Khlung, Thailand. Specimens in USNM.

The *productus* Species-Group

Species similar in shape to *Bucerophagus africanus* (figs. 68, 69). Differing from the *forcipatus* species-group in the following combination of characters: Head width $1\frac{1}{4}$ to $1\frac{1}{2}$ times that of length; metanotum with 3–5 short setae on each lateral margin and with 6–8 setae on anterior margin; metasternal plate with more than 20 setae; venter of third femora and posterolateral margins of abdominal sternites IV and V each with thick brushes of normal setae; each lateral margin of abdominal tergites II–VIII with 1–5 short setae between the spiracle and postspiracular seta; females with more abdominal sternal setae than males; both sexes having abdominal sternite I with more than 20 total setae and abdominal sternite II with more than 60 total setae; male terminal abdominal sternites VIII and IX neither projecting posteriorly as rounded lobe nor with division but with complete division from abdominal sternite VII; male genitalia with parameres straight and not split posteriorly; female terminal abdominal tergite with more than 24 setae on posterior margin; female abdominal sternite VIII with more than 28 setae on posterior margin.

Hosts: Species of the *productus* species-group have been found only on the genus *Bucorvus* of the avian family Bucerotidae.

***Bucerophagus productus* (Burmeister)**

FIGURES 53, 54, 61, 62, 70

Colpocephalum productum Burmeister, 1838, p. 439. [Type host: *Buceros abyssinicus*=*Bucorvus abyssinicus* (Boddaert, 1783).]

Colpocephalum vittatus Giebel, 1866, p. 394 (nomen nudum).

Colpocephalum productum "Nitzsch."—Giebel, 1874, p. 266, pl. 14 (figs. 2, 3).

Colpocephalum eurygaster Piaget, 1888, p. 162, pl. 4 (fig. 5). [Type host: *Lep-toptilus argala* error=*Bucorvus abyssinicus*.]

Bucerophagus productus "Nitzsch in Burmeister"—Conci, 1950, p. 78, figs. 1-7.

Bucerophagus productus (Burmeister).—Hopkins and Clay, 1952, p. 64.

A neotype, in the Zoologischen Institute der Universität Halle, Germany, was erected by Conci, who redescribed and figured *Bucerophagus productus* from *Bucorvus abyssinicus* collected in east Africa by Prof. E. Zavattari. A male from the same series is in the collection of Mr. G. H. E. Hopkins, Zoological Museum, Tring, Hertsfordshire, England.

A lectotype male was designated by Clay (1951a) from the *Colpocephalum eurygaster* syntypes in the Piaget collection, and it is now in the British Museum (Natural History), BM 1157a, with 3 syntype males and 1 syntype female, BM 1157 and 1158.

Clay (1951a) stated that *Bucerophagus productus* also seemed to occur naturally on *Bucorvus leadbeateri* (Vigors).

Male: Smaller than *Bucerophagus africanus* in all measurements except length of head; approximately the same size as *B. forcipatus* (table 12). Metasternal plate triangular, expanded anteriorly, with 22-26 setae (fig. 70). Each lateral margin of abdominal tergites III-VIII with 2-4 short setae between the spiracle and postspiracular seta except for tergite VII with 1 or 2 setae and tergite VIII with one seta. Abdominal sternite I with 22-24 total setae and abdominal sternite II with 66-68 total setae. Terminal abdominal segments as shown in figure 61. Genitalia as shown in figure 62, with branch connecting parameres posterior to endomeres pointed medially.

Female: Approximately the same size as *Bucerophagus africanus*; larger than *B. forcipatus* in all measurements except width of head and width of metathorax (table 12). Resembles the male except that metasternal plate has 26-34 setae. Abdominal sternite I with 28 total setae and abdominal sternite II with 74-76 total setae. Terminal abdominal tergite with 26-38 setae on posterior margin; abdominal sternite VIII with 30-36 setae on posterior margin (fig. 53). Anal fringe with 42-56 setae (fig. 54).

Discussion: *Bucerophagus productus* resembles most closely *B. africanus* which, however, is much more pigmented than *B. productus*. Males of *B. productus* are much smaller than females, but males of *B. africanus* are only slightly smaller than females. The metasternal plate is triangular in *B. productus* and trapezoidal in *B. africanus*;

this plate has fewer setae in both sexes of *B. productus* than in corresponding sexes of *B. africanus*. Each lateral margin of abdominal tergites III-VI between the spiracle and postspiracular seta has more short setae in males and fewer in females of *B. productus* than in corresponding sexes of *B. africanus*. Abdominal sternite I has approximately one-half the number of setae in both sexes of *B. productus* as in corresponding sexes of *B. africanus*; abdominal sternite II has slightly more setae in males and slightly fewer setae in females of *B. productus* than of *B. africanus*. The male abdominal sternite VIII lacks the central T-shaped plate in *B. productus* which is present in *B. africanus* (fig. 69d). The male genitalia has the internal branch connecting the parameres posterior to the endomeres pointed medially in *B. productus* but rounded in *B. africanus*. The female anal fringe has fewer than 58 setae in *B. productus* but more than 58 setae in *B. africanus*.

Comparison on different hosts: No morphological differences were found between specimens of *Bucerothrips productus* found on the two hosts, *Bucorvus abyssinicus* and *B. leadbeateri*, so standard measurements were tested against the null hypothesis that there were no differences in measurements (tables 4-7).

Terminology and formulae are as follows:

\bar{x}_1 = mean measurement of *B. productus* specimens on host 1, *Bucorvus abyssinicus*

\bar{x}_2 = mean measurement of *B. productus* specimens on host 2, *Bucorvus leadbeateri*

D = difference in mean measurements, $(\bar{x}_1 - \bar{x}_2)$ or $(\bar{x}_2 - \bar{x}_1)$

s^2 = variance = $\frac{S(x - \bar{x})^2}{N - 1} = \frac{Sx^2 - (Sx)^2/N}{N - 1}$

s_1^2 = variance of measurements of *B. productus* specimens on host 1, *B. abyssinicus*

s_2^2 = variance of measurements of *B. productus* specimens on host 2, *B. leadbeateri*

F = the ratio of the larger variance divided by the smaller = $\frac{s_1^2}{s_2^2}$ or $\frac{s_2^2}{s_1^2} = \frac{N_n}{N_d}$

SE = Standard Error of D = $\sqrt{\frac{S(x - \bar{x}_1)^2 + S(x - \bar{x}_2)^2}{N_n + N_d - 2} \left(\frac{1}{N_n} + \frac{1}{N_d} \right)}$

CL = Confidence Limits for D = $D \pm (SE) (t_{.05})$

Since it is not possible by measurements alone to decide from which host specimens came, populations from two hosts are considered conspecific.

Material examined: 39 males and 44 females from fresh and dried material collected in the Ethiopian region; from the type host: 4 males and 2 females from Gula, Uganda, Africa, July 10, 1936, collected by G. H. E. Hopkins, GHEH; 6 females from Ethiopia, Africa, March 1909, BMNH 3673; 1 female from CNHM skin from Africa, Jan. 30, 1946, REE; 3 males and 1 female from USNM skins from Sirre, Ethiopia, Africa, Feb. 13, 1912, collected by Childs Frick, REE; 3 males from USNM skins from Uganda, Africa, January-

February 1910, collected by E. A. Mearns, REE; from *Bucorvus leadbeateri* (Vigors, 1825): 9 males and 18 females from CNHM skins from Chitau, Bihe, Angola, Africa, 1932-1934, collected by Jean Bodaly, REE; 15 males and 14 females from CNHM skin from Pondi, Benguela, Angola, Africa, Sept. 14, 1936, collected by K. H. Prior, REE; 5 males and 2 females from CNHM skins from Kari Pan, Makari, Bechuanaland, Africa, August 1930, collected by Vernay, Lang, and Roberts, REE.

Drawings were made of a male and a female from the type host collected in Gula, Uganda, Africa. Specimens in GHEH.

***Bucrophagus africanus* Bedford**

FIGURES 55, 56, 63, 68, 69

Bucrophagus africanus Bedford, 1929, p. 509, figs. 11, 12. [Type host: *Bucorvus schlegeli* Roberts=*Bucorvus leadbeateri* (Vigors, 1825).]

Bucrophagus africanus Bedford—Hopkins and Clay, 1952, p. 64.

Clay (1951a) stated that according to Mr. G. H. E. Hopkins *Bucrophagus africanus* also occurred on *Bucorvus abyssinicus*.

Male: As illustrated in figure 69. Larger than either *Bucrophagus forcipatus* or *B. productus* except for length of head (table 12). Metasternal plate trapezoidal, expanded anteriorly, with 30-34 setae (fig. 68c). Each lateral margin of abdominal tergites III-VIII with two short setae between the spiracle and postspiracular seta except for tergites III and VIII each with one short seta. Abdominal sternite I with 40 total setae and abdominal sternite II with 62 total setae. Abdominal sternite VIII with central T-shaped plate (fig. 69d). Genitalia as shown in figure 63.

Female: As illustrated in figure 68. Approximately the same size as *Bucrophagus productus*: larger than *B. forcipatus* in all measurements except width of metathorax (table 12). Resembles the male except that metasternal plate has 36-42 setae. Each lateral margin of abdominal tergites III-VIII with 3-5 short setae between the spiracle and postspiracular seta except for tergite VIII with one seta. Abdominal sternite I with 50 total setae and abdominal sternite II with 86 total setae. Terminal abdominal tergite with 32-40 setae on posterior margin; abdominal sternite VIII with 28-38 setae on posterior margin (fig. 55). Anal fringe with 60-66 setae (fig. 56).

Discussion: *Bucrophagus africanus* resembles most closely *B. productus* which, however, is not as pigmented as *B. africanus*. Males of *B. africanus* are only slightly smaller than females, but males of *B. productus* are much smaller than females. The metasternal plate is trapezoidal in *B. africanus* and triangular in *B. productus*; this plate has more setae in both sexes of *B. africanus* than in corresponding

sexes of *B. productus*. Each lateral margin of abdominal tergites III–VI between the spiracle and postspiracular seta has fewer short setae in males and more in females of *B. africanus* than in corresponding sexes of *B. productus*. Abdominal sternite I has approximately twice the number of setae in both sexes of *B. africanus* as in corresponding sexes of *B. productus*; abdominal sternite II has slightly fewer setae in males and slightly more setae in females of *B. africanus* than of *B. productus*. The male abdominal sternite VIII has a central T-shaped plate in *B. africanus* which is absent in *B. productus*. The male genitalia has the internal branch connecting the parameres posterior to the endomeres rounded medially in *B. africanus* but pointed in *B. productus*. The female anal fringe has more than 58 setae in *B. africanus* but fewer than 58 setae in *B. productus*.

Comparison on different hosts: No morphological differences were found between specimens of *Bucerophagus africanus* found on the two hosts, *Bucorvus abyssinicus* and *B. leadbeateri*, so standard measurements were tested against the null hypothesis that there were no differences in measurements (tables 8–11).

Terminology and formulae were the same as those used for *Bucerophagus productus* except as follows:

- \bar{x}_1 = mean measurement of *B. africanus* specimens on host 1, *Bucorvus abyssinicus*
- \bar{x}_2 = mean measurement of *B. africanus* specimens on host 2, *Bucorvus leadbeateri*
- s_1^2 = variance of measurements of *B. africanus* specimens on host 1, *Bucorvus abyssinicus*
- s_2^2 = variance of measurements of *B. africanus* specimens on host 2, *Bucorvus leadbeateri*

Since it is not possible by measurements alone to decide from which host specimens came, populations from two hosts are considered conspecific.

Material examined: 13 males and 13 females from fresh and dried material collected in the Ethiopian region; from the type host: 1 female from Mafa, South-West Africa, February 1923, BMNH; 9 males and 7 females from Cameroons Zoo, Africa, November 1936, BMNH 8127; 1 female from CNHM skins from Kari Pan, Makari, Bechuanaland, Africa, August 1930, collected by Vernay, Lang, and Roberts, REE; from *Bucorvus abyssinicus* (Boddaert, 1783): 1 male and 1 female from Koubadge, French Cameroons, Africa, July 1947, collected by V. Aellen, BMNH 1954–487; 2 males and 2 females from USNM skins from Sirre, Ethiopia, Africa, Feb. 13, 1912, collected by Childs Frick, REE; 1 male and 1 female from Nyala, Sudan, Africa, Feb. 12, 1949, KCE.

Drawings were made of a male and a female from the type host collected in the Cameroons Zoo. Specimens in BMNH.

Aviparasitological Relationships

Since Mallophaga are obligatory, usually highly host-specific, external parasites, their distribution is dependent on the distribution of their hosts (Emerson and Ward, 1958). The arrangement of the Mallophaga based on morphological similarities does not follow exactly Peters' (1945) phylogenetic arrangement of the hornbill hosts (table 13). In the genus *Chapinia*, species of the *lophocerus* species-group infest hosts in the genera *Tockus*, *Bycanistes*, and *Ceratogymna* of the Ethiopian region, but species of the *acutovulvata* and *hirta* species-groups infest hosts in the genera *Tockus*, *Anorrhinus*, *Penelopides*, *Rhyticeros*, *Anthracoceros*, and *Buceros* of the Oriental and Australasian regions. Species of *Bucerocolpocephalum* infest hosts in the genera *Ptilolaemus* and *Anorrhinus* of the Oriental region. In the genus *Bucerophagus*, the species *B. forcipatus* of the *forcipatus* species-group infests hosts in the genera *Buceros* and *Rhinoplax* of the Oriental region, but species of the *productus* species-group infest hosts in the genus *Bucorvus* of the Ethiopian region.

Tockus is the only hornbill genus with amblyceran lice that has members in both the Ethiopian and Oriental regions (table 13). Yet the amblyceran, *Chapinia clayae*, from the Oriental species, *Tockus birostris* and *Tockus g. griseus*, does not resemble members of the *lophocerus* species-group which infest other species of *Tockus*. Instead, *C. clayae* resembles most closely *C. acutovulvata* from the Oriental species of *Anthracoceros*. It would appear that there has been more recent contact between the Indian *Tockus* and *Anthracoceros* whose ranges overlap than between the more nearly related Indian *Tockus* and African *Tockus*. Kellogg (1896) was the first to mention that Mallophaga live their entire lives on the host bird and that infestation of new hosts is accomplished by the actual migration of individuals from one bird to another, during copulation, nesting, or roosting. Clay (1949b) stated that normally birds of different species did not come into close enough contact for lice to be transferred from host to host but that interchange of lice could take place between predator and prey, nestling and foster parent in brood parasites, by the use of common dust baths (according to Hoyle, 1938), and by phoresy, which is the transfer of lice by Hippoboscid flies. In the case of brood parasites she stated that for the European Cuckoo, *Cuculus canorus*, lice of the foster parents had never been established on the cuckoo. She further stated that establishment on the new host might be prevented by competition of the already adapted resident louse population, by the host specificity of the immigrant louse making feeding and development on the new host impossible, or by the fact that only males or unfertilized females had been introduced. Clay (1962) described natural straggling as

occurring between hosts that happened to be nesting in close proximity; she stated that establishment on the new host might be facilitated by the absence of a resident louse.

It would appear that both *lophocerus* and *acutovulvata* species-groups shared a common ancestor of *Chapinia* on *Tockus* before the Indian and African *Tockus* became separated. Once separated, the *Chapinia* evolved as did the birds to the recognized species within each species-group. Natural straggling may have accounted for establishment on some of the hosts.

Clay (1949b) mentioned that the chief factor influencing the production of allopatric species and genera of Mallophaga has been the successive splitting of the host populations during the evolution of the birds, thus leaving isolated louse populations. The louse population is considered as comprising all individuals that can interbreed because their hosts can interbreed (Clay, 1958). Kellogg (1896) stated that with the spreading of the ancestral bird species, geographical races arose within the limits of the species. With time and isolation, these races became distinct species which were often distinguished only by superficial differences in color, etc. The Mallophaga remained practically unaffected since their environment was essentially unchanged. The environment of the Mallophaga, the physical and chemical composition of the feathers and blood, changes more slowly than do other factors leading toward speciation of the bird; until this environment changes, the Mallophaga would remain unchanged (Clay, 1949b). For example, in the *acutovulvata* species-group, the hosts *Anthracoceros coronatus* and *A. converus* are now considered to be full species distinct from *A. a. albirostris*, *A. a. leucogaster*, and *A. marchei*, yet all these hosts bear the same species of Mallophaga, *Chapinia acutovulvata*. Similarly, in the *lophocerus* species-group, *Chapinia bucerotis* infests eight subspecies in four species of *Bycanistes*, and *C. lothocerus* infests six subspecies in four species of *Tockus*. In the *forcipatus* species-group, *Bucrophagus forcipatus* infests three subspecies in three species and two genera.

Although *Anthracoceros marchei* is restricted to the Philippines, it is host to *Chapinia acutovulvata* which infests other *Anthracoceros* species with wider distribution in the Oriental region. *A. montani* also is restricted to the Philippines, but its amblyceran parasite, *C. hoplai*, resembles most closely *C. boonsongi* from *Rhyticeros undulatus*, which is distributed elsewhere in the Oriental region. *Chapinia wenzeli* from *Penelopides panini* and *C. traylori* from *Buceros hydrocorax* both resemble most closely *C. blakei* from *Rhyticeros leucocephalus*. Although the host genus *Buceros* is not considered to be as related to *Rhyticeros* as is *Penelopides*, the host species from which *C. wenzeli*, *C. blakei*, and *C. traylori* were obtained are all restricted

to the Philippines. Thus, *C. traylori* may have evolved as a result of natural straggling from the stock that gave rise to *C. wenzeli* and *C. blakei* and subsequently became established on the host *B. hydrocorax*.

Chapinia lydae from *Rhyticeros cassidix* has the characters of the *acutovulvata* species-group but superficially resembles members of the *hirta* species-group of which *C. muesebecki*, from *Penelopides e. exarhatus*, like *C. lydae*, is restricted to the Australasian region (table 13). *Chapinia hirta*, the other member of the *hirta* species-group, infests subspecies of *Rhyticeros plicatus* in both the Oriental and Australasian regions.

The hornbill genus *Buceros* is host to both *Chapinia* and *Bucrophagus* (table 13); however, these Mallophaga do not infest the same hosts. *Buceros hydrocorax*, the host of *Chapinia traylori*, is restricted to the Philippines, but *B. rhinoceros* and *B. bicornis*, the hosts of *Bucrophagus forcipatus*, are distributed elsewhere in the Oriental region. On the other hand, the mallophagan species, *Chapinia waniti* and *Bucrocolpocephalum deignani*, do infest the same host, *Anorrhinus galeritus carinatus*.

In the *productus* species-group both *Bucrophagus productus* and *B. africanus* infest the two hosts, *Bucorvus abyssinicus* and *B. leadbeateri*. The population of each mallophagan species on each host could not be separated morphologically or statistically. Thus, only the two species, *Bucrophagus productus* and *B. africanus*, could be recognized. Similarly, Clay (1955) recognized only the one species, *Bucorvellus docophorus*, although specimens from *Bucorvus leadbeateri* showed a tendency to be smaller in size than specimens from *B. abyssinicus*. She further stated that it would be expected from Harrison's rule (1915) that specimens from *B. leadbeateri*, the smaller host, would be smaller than specimens from the larger *B. abyssinicus*. However, Mackworth-Praed and Grant (1952) stated that *B. leadbeateri* was the largest of the Hornbills; they gave wing measurements for *B. leadbeateri* as 509–595 mm. and for *B. abyssinicus* as 495–595 mm.

Harrison (1915) stated the rule that bears his name: that in general, when a mallophagan genus is well distributed over a considerable number of nearly related hosts, the size of the parasite is roughly proportional to the size of the host. *Chapinia camuri*, the smallest species of *Chapinia*, infests the smallest hornbill, *Tockus camurus*, but *Chapinia traylori*, the largest species of *Chapinia*, does not infest *Rhyticeros undulatus*, the largest host for species of *Chapinia*.

Summary

Amblyceran Mallophaga of the family Menoponidae were examined from 53 species or subspecies of hornbills. Descriptions and illustrations are presented for 22 species in three genera of hornbill Menoponidae of which 14 species are new. The genus *Chapinia* now contains three species-groups and 17 species of which 12 are new. The genus *Bucerophagus* now contains two species-groups and three species. The new genus *Bucerocolpocephalum* type *emersoni* is erected here for two new comb-bearing species. The new species are as follows: *Chapinia fasciati*, *C. camuri*, *C. clayae*, *C. waniti*, *C. malayensis*, *C. hoplasi*, *C. boonsongi*, *C. wenzeli*, *C. blakei*, *C. traylori*, *C. lydae*, *C. muesebecki*, *Bucerocolpocephalum emersoni*, and *B. deignani*. New synonymy is *C. acutovulvata* (Piaget, 1881) (= *C. mjöbergi* (Eichler, 1947)). New type designations are: A neotype for *Chapinia hirta* (Rudow, 1866), a neotype for *Bucerophagus forcipatus* (Nitzsch, 1874), and a lectotype for *C. bucerotis* (Kellogg, 1908). Differential characters are listed for genera, species-groups, and species, and a key is provided for separating the species.

The amblyceran species-groups are confined to the Ethiopian region or to the Oriental and Australasian regions as shown in a table of the hornbill hosts, their distribution, and amblyceran parasites. *Tockus* is the only hornbill genus with amblyceran lice that is present in both the Ethiopian and Oriental regions; however, *Chapinia clayae* of the *acutovulvata* species-group from the Oriental species of *Tockus* resembles *C. acutovulvata* from Oriental species of *Anthracoceros* more closely than species of the *lophoceros* species-group from Ethiopian species of *Tockus*. It would appear, that there has been more recent contact between the Oriental species of *Tockus* and *Anthracoceros*, whose ranges overlap, than between the more closely related Oriental and Ethiopian species of *Tockus*.

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TABLE 1.—Measurements in mm. of *Chapinia* males (from specimens from which drawings were made and from hosts, in parentheses, other than type hosts)

	Length		Width			
	Head	Total	Head	Prothorax	Metathorax	Abdomen
<i>fasciati</i>	0. 283	1. 655	0. 544	0. 391	0. 588	0. 786
<i>lophocerus</i>	. 276	1. 764	. 529	. 384	. 565	. 895
(<i>T. nasutus</i>)	. 304		. 551	. 398	. 558	
(<i>T. e. erythrorhynchus</i>)	. 290		. 536	. 362	. 522	
<i>camuri</i>	. 304	1. 302	. 485	. 370	. 464	. 732
<i>bucerotis</i>	. 304	2. 010	. 581	. 435	. 602	. 786
(<i>B. b. bucinator</i>)	. 304		. 565	. 413	. 588	
(<i>B. c. cylindricus</i>)	. 290		. 558	. 406	. 544	
(<i>B. c. albotibialis</i>)	. 286		. 544	. 398	. 540	
(<i>B. sc. subquadratus</i>)	. 290		. 572	. 413	. 551	
(<i>B. b. brevis</i>)	. 308		. 559	. 409	. 576	
<i>robusta</i>	. 348	2. 222	. 602	. 471	. 682	. 868
(<i>C. elata</i>)	. 326		. 595	. 450	. 652	
<i>clayae</i>	. 312	1. 600	. 544	. 370	. 551	. 760
<i>waniti</i>	. 355	2. 170	. 638	. 398	. 688	1. 000
<i>acutovulvata</i>	. 333	1. 818	. 616	. 427	. 652	. 840
(<i>A. coronatus</i>)	. 348		. 623	. 442	. 616	
<i>malayensis</i>	. 312	1. 655	. 602	. 478	. 630	. 950
<i>hoplai</i>	. 362	1. 845	. 572	. 442	. 623	. 868
<i>boonsongi</i>	. 355	1. 764	. 544	. 435	. 581	. 840
<i>wenzeli</i>	. 304	1. 410	. 529	. 391	. 551	. 705
(<i>P. p. manilloe</i>)	. 297		. 478	. 370	. 485	
(<i>P. p. mindorensis</i>)	. 304		. 478	. 362	. 492	
(<i>P. p. affinis</i>)	. 283		. 515	. 355	. 522	
<i>blakei</i>	. 333	1. 790	. 572	. 450	. 652	. 786
(<i>R. l. waldeni</i>)	. 355		. 544	. 420	. 572	
<i>traylori</i>	. 340	1. 980	. 609	. 492	. 689	. 868
(<i>B. h. mindanensis</i>)	. 312		. 595	. 464	. 630	
<i>lydae</i>	. 375	1. 850	. 531	. 437	. 625	. 825
<i>muesebecki</i>	. 333	1. 790	. 536	. 398	. 572	. 814
<i>hirta</i>	. 348	1. 710	. 529	. 427	. 609	. 868
(<i>R. p. mendanae</i>)	. 344		. 522	. 435	. 605	

TABLE 2.—Measurements in mm. of *Chapinia* females (from specimens from which drawings were made and from hosts, in parentheses, other than type hosts)

	Length		Width			
	Head	Total	Head	Prothorax	Metathorax	Abdomen
<i>fasciati</i>	0.340	2.222	0.630	0.485	0.689	1.004
(<i>T. alboterminatus</i>)	.333		.609	.478	.674	
<i>lophocerus</i>	.304	2.170	.623	.450	.689	1.085
(<i>T. nasutus</i>)	.348		.630	.471	.738	
(<i>T. e. erythrorhynchus</i>)	.318		.602	.427	.667	
<i>camuri</i>	.333	1.926	.544	.406	.602	0.950
<i>bucerotis</i>	.362	2.715	.660	.522	.811	1.112
(<i>B. b. bucinator</i>)	.340		.630	.478	.745	
(<i>B. c. cylindricus</i>)	.326		.630	.478	.745	
(<i>B. c. albotibialis</i>)	.377		.623	.492	.768	
(<i>B. sc. subquadratus</i>)	.311		.623	.450	.768	
<i>robusta</i>	.362	2.550	.652	.508	.803	1.112
(<i>C. elata</i>)	.333		.630	.485	.775	
<i>clayae</i>	.326	2.118	.602	.435	.717	1.085
<i>waniti</i>	.390	2.550	.720	.496	.822	1.190
<i>acutovulvata</i>	.406	2.550	.703	.492	.782	1.250
(<i>A. coronatus</i>)	.362		.717	.529	.761	
<i>malayensis</i>	.333	2.010	.652	.515	.789	1.085
<i>hoplai</i>	.333	2.280	.595	.464	.745	0.976
<i>boonsongi</i>	.376	2.150	.563	.469	.719	1.006
<i>wenzeli</i>	.311	1.980	.581	.450	.660	1.004
(<i>P. p. manilloe</i>)	.333		.551	.435	.660	
(<i>P. p. affinis</i>)	.304		.581	.420	.696	
<i>blakei</i>	.362	2.010	.595	.485	.689	0.976
(<i>R. l. waldeni</i>)	.355		.599	.486	.711	
<i>traylori</i>	.333	2.770	.696	.551	.861	1.194
(<i>B. h. mindanensis</i>)	.318		.667	.544	.854	
<i>lydae</i>	.375	2.155	.544	.482	.712	1.006
<i>hirta</i>	.377	2.035	.551	.464	.674	0.976
(<i>R. p. subruficollis</i>)	.348		.565	.427	.667	

TABLE 3.—Measurements in mm. of *Bucrocotpocephalum* (from specimens from which drawings were made and from hosts, in parentheses, other than type hosts)

Male	Length		Width			
	Head	Total	Head	Prothorax	Metathorax	Abdomen
<i>emersoni</i>	0.304	1.954	0.435	0.384	0.471	0.548
(<i>P. t. indochinensis</i>)	.318		.435	.398	.485	
<i>deignani</i>	.312	1.800	.437	.362	.444	.581
(<i>A. g. carinatus</i>)	.304		.464	.398	.471	
Female						
<i>emersoni</i>	.318	2.010	.450	.406	.544	.786
(<i>P. t. indochinensis</i>)	.300		.442	.399	.519	
<i>deignani</i>	.318	1.960	.481	.418	.531	.800

TABLE 4.—Measurements in mm. and computations for *Bucrophagus productus* males on host 1, *Bucorvus abyssinicus* (see p. 45 for explanation of formulae)

	Head		Width			Total length
	Length	Width	Prothorax	Metathorax	Abdomen	
N=8	0.350	0.507	0.436	0.586	0.707	1.914
	.371	.5285	.457	.586	.771	2.071
	.371	.514	.457	.586	.714	1.914
	.386	.5285	.464	.543	.771	2.0785
	.436	.550	.464	.543	.750	2.0785
	.486	.550	.486	.5785	.750	2.100
	.400	.514	.414	.571	.721	2.114
	.400	.507	.414	.571	.7285	2.057
$Sx_1 =$	3.200	4.199	3.592	4.5645	5.9125	16.327
$\bar{x}_1 =$	0.400	0.525	0.449	0.5705	0.739	2.041
$Sx_1^2 =$	1.293	2.206	1.617	2.607	4.374	33.366
$(Sx_1)^2 =$	10.240	17.632	12.902	20.835	34.958	266.571
$(Sx_1)^2/N =$	1.280	2.204	1.613	2.604	4.370	33.321
$S(x-\bar{x}_1)^2 =$	0.0130	0.0020	0.0040	0.0030	0.0040	0.0450
$s_1^2 =$	.00186	.000286	.000571	.000428	.000571	.00643

TABLE 5.—*Measurements in mm. and computations for Bucrophagus productus males on host 2, Bucorvus leadbeateri* (see p. 45 for explanation of formulae)

	Head		Width			Total length
	Length	Width	Prothorax	Metathorax	Abdomen	
N=28	0.414	0.521	0.443	0.521	0.7285	1.750
	.414	.521	.443	.521	.7285	1.700
	.414	.521	.443	.521	.7285	1.743
	.414	.5285	.443	.471	.7285	1.743
	.414	.5285	.443	.5285	.7285	1.714
	.414	.5285	.443	.5285	.686	1.850
	.414	.5285	.443	.5285	.707	1.929
	.414	.5285	.457	.5285	.707	2.029
	.414	.5285	.457	.5285	.707	1.700
	.414	.5285	.457	.557	.764	1.807
	.400	.5285	.457	.557	.764	1.821
	.400	.536	.457	.557	.714	1.979
	.400	.536	.457	.557	.714	2.136
	.386	.536	.457	.557	.736	2.129
	.386	.536	.457	.557	.743	2.271
	.3785	.536	.457	.514	.771	2.171
	.393	.514	.421	.543	.757	1.857
	.407	.514	.450	.543	.757	1.857
	.4285	.550	.450	.543	.786	2.243
	.4285	.550	.450	.543	.786	1.579
	.4285	.550	.436	.564	.800	2.021
	.4285	.543	.436	.564	.750	1.964
	.443	.543	.471	.536	.750	2.079
	.443	.543	.471	.536	.750	1.900
	.421	.543	.471	.536	.750	1.900
	.457	.557	.464	.500	.814	1.814
	.371	.500	.464	.550	.821	1.786
	.3285	.500	.414	.571	.700	1.914
$Sx_2 =$	11.468	14.878	12.612	15.0615	20.8765	53.386
$\bar{x}_2 =$	0.4095	0.531	0.450	0.538	0.746	1.907
$Sx_2^2 =$	4.714	7.911	5.686	8.114	15.597	102.629
$(Sx_2)^2 =$	131.515	221.355	159.063	226.849	435.828	2850.065
$(Sx_2)^2/N =$	4.697	7.906	5.681	8.102	15.565	101.788
$S(x - \bar{x}_2)^2 =$	0.0170	0.0050	0.0050	0.0120	0.0320	0.841
$s_2^2 =$	.00060	.000180	.000180	.000444	.001185	.0311

TABLE 6.—*Measurements in mm. and computations for Bucrophagus productus females on host 1, Bucorvus abyssinicus* (see p. 45 for explanation of formulae)

	Head		Width			Total length
	Length	Width	Prothorax	Metathorax	Abdomen	
N=8	0.464	0.636	0.536	0.714	1.036	3.250
	.443	.614	.5285	.714	1.050	3.171
	.507	.650	.543	.686	1.043	2.607
	.443	.657	.543	.686	1.136	2.736
	.4785	.657	.543	.6785	1.143	3.100
	.493	.657	.543	.6785	1.193	3.114
	.500	.671	.543	.6785	1.100	2.621
	.457	.614	.543	.693	1.0785	3.171
$Sx_1 =$	3.7855	5.156	4.3225	5.5285	8.7795	23.770
$\bar{x}_1 =$	0.473	0.6445	0.540	0.691	1.097	2.971
$Sx_1^2 =$	1.796	3.326	2.336	3.822	9.657	71.132
$(Sx_1)^2 =$	14.330	26.584	18.684	30.564	77.080	565.013
$(Sx_1)^2/N =$	1.791	3.323	2.3355	3.820	9.635	70.627
$S(x - \bar{x}_1)^2 =$	0.0050	0.0030	0.0050	0.0020	0.0220	0.505
$s_1^2 =$	.000714	.000428	.0000714	.000286	.00714	.0721

TABLE 7.—Measurements in mm. and computations for *Bucerophagus productus* (see p. 45 for explanation of formulae)

Females on host <i>2, Bucorvus leadbeateri</i>	Head		Width			Total length
	Length	Width	Prothorax	Metathorax	Abdomen	
N=34	0.471	0.600	0.500	0.621	0.914	2.843
	.471	.600	.500	.621	.914	3.000
	.471	.600	.500	.636	.957	3.229
	.500	.600	.500	.636	.957	3.229
	.500	.600	.500	.636	.957	2.793
	.500	.600	.500	.636	.971	3.164
	.500	.614	.529	.671	.971	3.250
	.500	.614	.529	.671	.979	3.250
	.500	.614	.529	.671	.979	2.957
	.500	.614	.529	.671	.986	2.521
	.500	.614	.529	.671	.986	2.500
	.500	.614	.529	.671	.986	3.057
	.500	.571	.529	.600	.986	3.136
	.500	.607	.486	.600	1.007	2.393
	.514	.607	.486	.614	0.893	3.086
	.514	.607	.493	.614	.900	2.329
	.486	.607	.479	.614	.900	3.171
	.486	.593	.479	.614	.886	2.971
	.486	.593	.521	.657	.857	2.729
	.486	.621	.521	.657	1.086	2.914
	.486	.621	.521	.657	1.029	2.771
	.486	.621	.521	.657	0.964	3.264
	.486	.621	.514	.657	1.014	2.950
	.464	.621	.514	.643	1.036	2.857
	.464	.621	.514	.643	1.036	2.857
	.457	.579	.514	.643	0.907	2.507
	.457	.629	.507	.629	.950	2.821
	.493	.629	.507	.607	.921	2.650
	.493	.629	.543	.607	1.100	3.257
	.529	.629	.543	.593	1.021	3.393
	.529	.629	.543	.686	1.071	3.093
	.529	.629	.536	.686	1.057	3.379
	.479	.650	.536	.664	1.079	3.007
	.479	.636	.536	.664	1.043	2.521
$Sx_2 =$	16.716	20.834	17.517	21.818	33.300	99.849
$\bar{x}_2 =$	0.492	0.613	0.515	0.642	0.979	2.937
$Sx_2^2 =$	8.230	12.775	9.036	14.024	32.745	29.602
$(Sx_2)^2 =$	279.425	434.056	306.845	476.025	1108.890	9969.823
$(Sx_2)^2/N =$	8.218	12.766	9.025	14.001	32.614	29.323
$S(x-\bar{x}_2)^2 =$	0.0120	0.0090	0.0110	0.023	0.131	0.279
$s_2^2 =$	.000364	.000273	.000330	.000697	.00397	.00845
Males on two hosts						
SE =	.0070	.00317	.00374	.00490	.00762	.0381
D =	.0095	.006	.001	.0325	.007	.134
CL =		.006±.0064		.0325±.010	.007±.015	
Females on two hosts						
SE =	.00447	.00374	.00436	.00538	.0135	0.0306
D =	.019	.031	.025	.049	.095	.034
CL =	.019±.009	.031±.0076		.049±.011	.095±.027	

TABLE 8.—*Measurements in mm. and computations for Bucerophagus africanus males on host 1, Bucorvus abyssinicus* (see p. 47 for explanation of formulae)

	Head		Width			Total length
	Length	Width	Prothorax	Metathorax	Abdomen	
N=3	0.457	0.628	0.528	0.693	0.957	2.528
	.471	.593	.507	.678	1.057	2.500
	.493	.586	.500	.728	1.050	2.557
$Sx_1 =$	1.421	1.807	1.535	2.099	3.064	7.585
$\bar{x}_1 =$	0.474	0.602	0.512	0.700	1.021	2.528
$Sx_1^2 =$	0.674	1.089	0.786	1.470	3.136	19.179
$(Sx_1)^2 =$	2.019	3.265	2.356	4.406	9.388	57.532
$(Sx_1)^2/N =$	0.673	1.088	0.785	1.468	3.129	19.177
$S(x - \bar{x}_1)^2 =$	0.0010	0.0010	0.0010	0.0020	0.0070	0.0020
$s_1^2 =$	0.00050	0.00050	0.00050	0.0010	0.00350	0.0010

TABLE 9.—*Measurements in mm. and computations for Bucerophagus africanus males on host 2, Bucorvus leadbeateri* (see p. 47 for explanation of formulae)

	Head		Width			Total length
	Length	Width	Prothorax	Metathorax	Abdomen	
N=6	0.393	0.557	0.500	0.650	0.943	2.371
	.400	.557	.500	.650	1.028	2.478
	.400	.586	.500	.650	0.971	2.428
	.443	.571	.485	.686	1.043	2.443
	.457	.586	.514	.686	1.050	2.486
	.371	.564	.521	.671	1.064	2.386
$Sx_2 =$	2.464	3.421	3.020	3.993	6.099	14.592
$\bar{x}_2 =$	0.411	0.570	0.503	0.666	1.016	2.432
$Sx_2^2 =$	1.017	1.951	1.521	2.659	6.211	35.499
$(Sx_2)^2 =$	6.071	11.703	9.120	15.944	37.198	212.926
$(Sx_2)^2/N =$	1.0120	1.950	1.520	2.657	6.200	35.488
$S(x - \bar{x}_2)^2 =$	0.0050	0.0010	0.0010	0.0020	0.0110	0.0110
$s_2^2 =$	0.0010	0.00020	0.00020	0.00040	0.00220	0.00220

TABLE 10.—*Measurements in mm. and computations for Bucerophagus africanus females on host 1, Bucorvus abyssinicus* (see p. 47 for explanation of formulae)

	Head		Width			Total length
	Length	Width	Prothorax	Metathorax	Abdomen	
N=4	0.493	0.664	0.564	0.728	1.214	3.300
	.514	.628	.543	.693	1.236	3.271
	.443	.628	.543	.786	1.300	3.428
	.486	.643	.586	.714	1.110	2.700
$Sx_1 =$	1.936	2.563	2.236	2.921	4.860	12.699
$\bar{x}_1 =$	0.484	0.641	0.559	0.730	1.215	3.175
$Sx_1^2 =$	0.940	1.643	1.251	2.138	5.924	40.631
$(Sx_1)^2 =$	3.748	6.569	5.000	8.532	23.620	161.265
$(Sx_1)^2/N =$	0.937	1.642	1.250	2.133	5.905	40.316
$S(x - \bar{x}_1)^2 =$	0.0030	0.0010	0.0010	0.0050	0.0190	0.315
$s_1^2 =$	0.0010	0.000333	0.000333	0.00166	0.00633	0.104

TABLE 11.—Measurements in mm. and computations for *Bucrophagus africanus* (see p.47 for explanation of formulae)

Females on host 2, <i>Bucornus</i> <i>leadbeateri</i>	Head		Width			Total length
	Length	Width	Prothorax	Metathorax	Abdomen	
N=4	0.471	0.621	0.557	0.714	1.328	3.243
	.457	.593	.557	.678	1.143	3.000
	.457	.636	.514	.764	1.393	3.321
	.471	.628	.536	.743	1.321	3.386
$Sx_2 =$	1.856	2.478	2.164	2.899	5.185	12.950
$\bar{x}_2 =$	0.464	0.620	0.541	0.725	1.296	3.238
$Sx_2^2 =$	0.861	1.536	1.172	2.105	6.756	42.011
$(Sx_2)^2 =$	3.445	6.140	4.683	8.404	26.884	167.702
$(Sx_2)^2/N =$	0.861	1.535	1.171	2.101	6.721	41.926
$S(x - \bar{x}_2)^2 =$	0.000	0.0010	0.0010	0.0040	0.0350	0.0850
$s_2^2 =$	0.000	0.000333	0.000333	0.00133	0.0117	0.0283
Males on two hosts						
SE =	.0138	.00797	.00797	.0127	.0239	.0203
D =	.063	.032	.009	.034	.005	.096
CL =	.063±.033	.032±.019	.009±.019	.034±.030	.005±.056	.096±.048
Females on two hosts						
SE =	.0112	.00913	.00913	.0194	.0478	.1290
D =	.020	.021	.018	.005	.081	.063
CL =	.020±.027	.021±.022	.018±.022	.005±.047	.081±.116	.063±.316

TABLE 12.—Measurements in mm. of *Bucrophagus* (from specimens from which drawings were made and from hosts, in parentheses, other than those from which drawings were made)

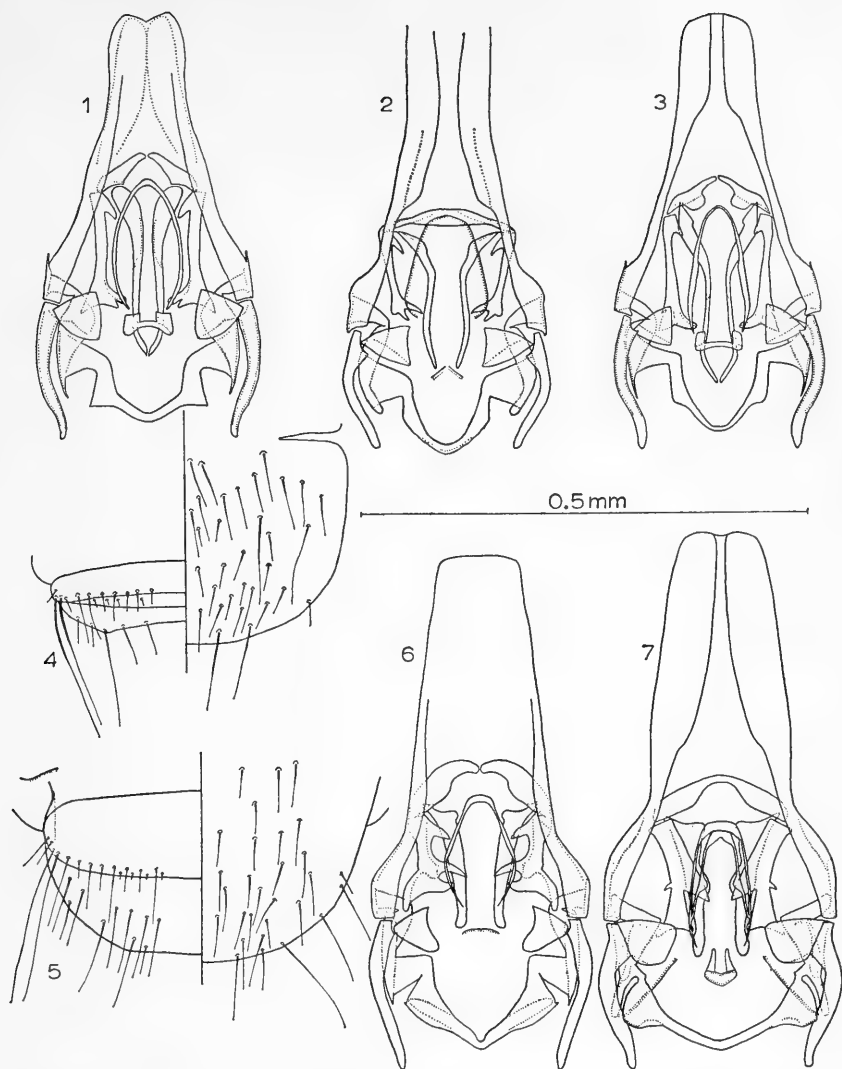
Male	Length		Width			
	Head	Total	Head	Prothorax	Metathorax	Abdomen
<i>forcipatus</i>	0.318	1.725	0.492	0.413	0.565	0.625
(<i>B. r. sumatranus</i>)	.322		.522	.438	.570	
(<i>B. r. borneoensis</i>)	.351		.515	.431	.652	
<i>productus</i>	.386	2.080	.528	.464	.578	.750
<i>africanus</i>	.457	2.488	.586	.500	.686	1.050
Female						
<i>forcipatus</i>	.370	1.125	.544	.435	.667	0.950
(<i>B. r. sumatranus</i>)	.355		.584	.464	.677	
(<i>B. r. borneoensis</i>)	.344		.580	.467	.678	
<i>productus</i>	.464	3.172	.636	.536	.714	1.035
<i>africanus</i>	.471	3.325	.636	.557	.764	1.390

TABLE 13.—*Bucerotidae* arranged phylogenetically (Peters, 1945) with geographical distribution and amblyceran parasites (blank indicates no lice found on host)

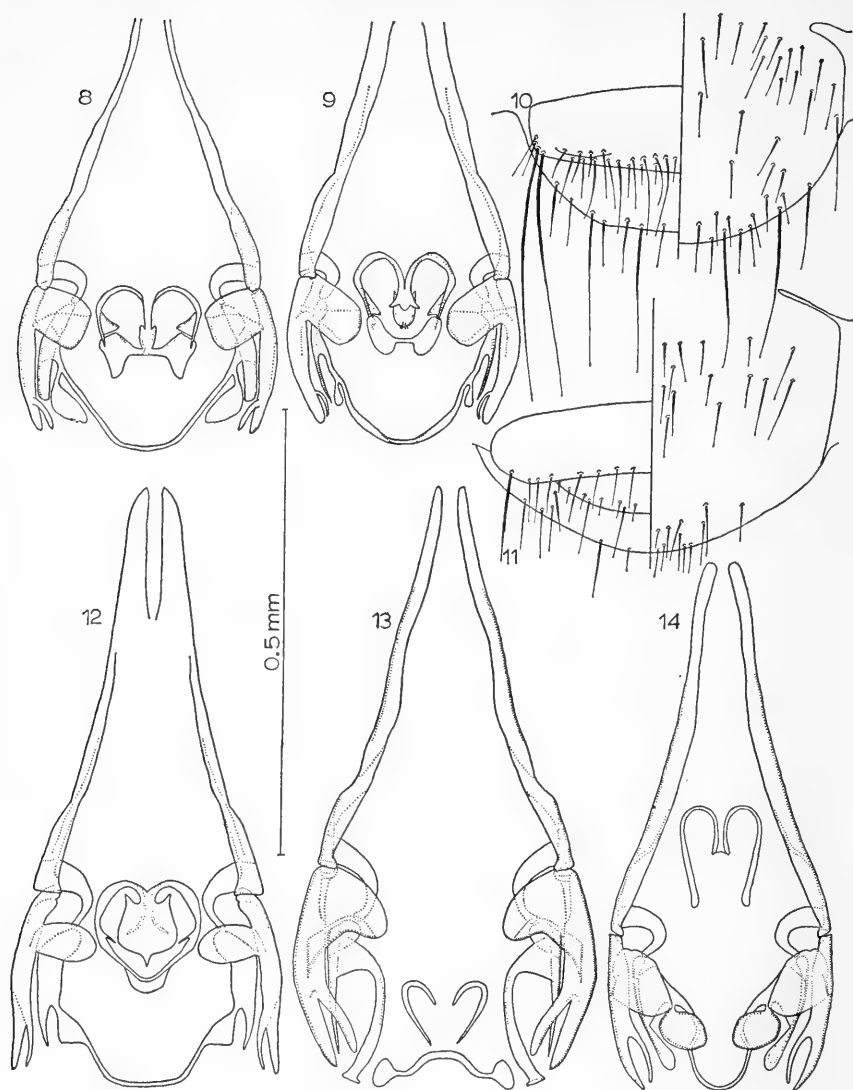
Host	Geographical region	Parasite	Species-group
<i>Tockus birostris</i>	Oriental	<i>Chapinia clayae</i>	<i>acutovulvata</i>
<i>T. f. semifasciatus</i>	Ethiopian		
<i>T. f. fasciatus</i>	"	<i>C. fasciati</i>	<i>lophocerus</i>
<i>T. alboterminatus geloensis</i>	"		
<i>T. a. stegmanni</i>	"		
<i>T. a. suahelicus</i>	"	<i>C. fasciati</i>	<i>lophocerus</i>
<i>T. a. angolensis</i>	"		
<i>T. a. alboterminatus</i>	"		
<i>T. a. australis</i>	"		
<i>T. b. bradfieldi</i>	"		
<i>T. b. williaminae</i>	"		
<i>T. p. pallidirostris</i>	"		
<i>T. p. neumanni</i>	"		
<i>T. n. nasutus</i>	"	<i>C. lophocerus</i>	<i>lophocerus</i>
<i>T. n. forskdlii</i>	"		
<i>T. n. caffer</i>	"	<i>C. lophocerus</i>	<i>lophocerus</i>
<i>T. h. hemprichii</i>	"		
<i>T. h. ezsul</i>	"		
<i>T. monteiri marjoriae</i>	"		
<i>T. m. monteiri</i>	"		
<i>T. g. griseus</i>	Oriental	<i>C. clayae</i>	<i>acutovulvata</i>
<i>T. g. gingalensis</i>	"		
<i>T. h. hartlaubi</i>	Ethiopian		
<i>T. h. granti</i>	"		
<i>T. c. pulchritrostris</i>	"		
<i>T. c. camurus</i>	"	<i>C. camuri</i>	<i>lophocerus</i>
<i>T. e. erythrorhynchus</i>	"	<i>C. lophocerus</i>	<i>lophocerus</i>
<i>T. e. rufirostris</i>	"		
<i>T. e. damarensis</i>	"		
<i>T. e. ngamiensis</i>	"		
<i>T. f. flavirostris</i>	"	<i>C. lophocerus</i>	<i>lophocerus</i>
<i>T. f. somaliensis</i>	"		
<i>T. f. leucomelas</i>	"	<i>C. lophocerus</i>	<i>lophocerus</i>
<i>T. f. elegans</i>	"		
<i>T. deckeni</i>	"	<i>C. lophocerus</i>	<i>lophocerus</i>
<i>Berenicornis comatus</i>	Oriental		
<i>B. a. albo-cristatus</i>	Ethiopian		
<i>B. a. macrourus</i>	"		
<i>B. a. cassini</i>	"		
<i>Ptilolaemus t. austeni</i>	Oriental	<i>Bucerocolpocephalum emersoni</i>	
<i>P. t. tickelli</i>	"		
<i>P. t. indochinensis</i>	"	<i>B. emersoni</i>	
<i>Anorrhinus g. carinatus</i>	"	<i>C. waniti</i> and <i>B. deignani</i>	<i>acutovulvata</i>
<i>A. g. galeritus</i>	"	<i>B. deignani</i>	
<i>A. g. minor</i>	"		
<i>Penelopides p. manilloe</i>	"	<i>C. wenzeli</i>	<i>acutovulvata</i>
<i>P. p. subnigra</i>	"		
<i>P. p. mindorensis</i>	"	<i>C. wenzeli</i>	<i>acutovulvata</i>
<i>P. p. ticaensis</i>	"		
<i>P. p. panini</i>	"		
<i>P. p. samarensis</i>	"	<i>C. wenzeli</i>	<i>acutovulvata</i>
<i>P. p. affinis</i>	"	<i>C. wenzeli</i>	<i>acutovulvata</i>
<i>P. p. basilanica</i>	"		
<i>P. e. exarhatus</i>	Australasian	<i>C. musebecki</i>	<i>hirta</i>
<i>P. e. sanfordi</i>	"		

TABLE 13.—*Bucerotidae arranged phylogenetically (Peters, 1945) with geographical distribution and amblyceran parasites (blank indicates no lice found on host)—Continued*

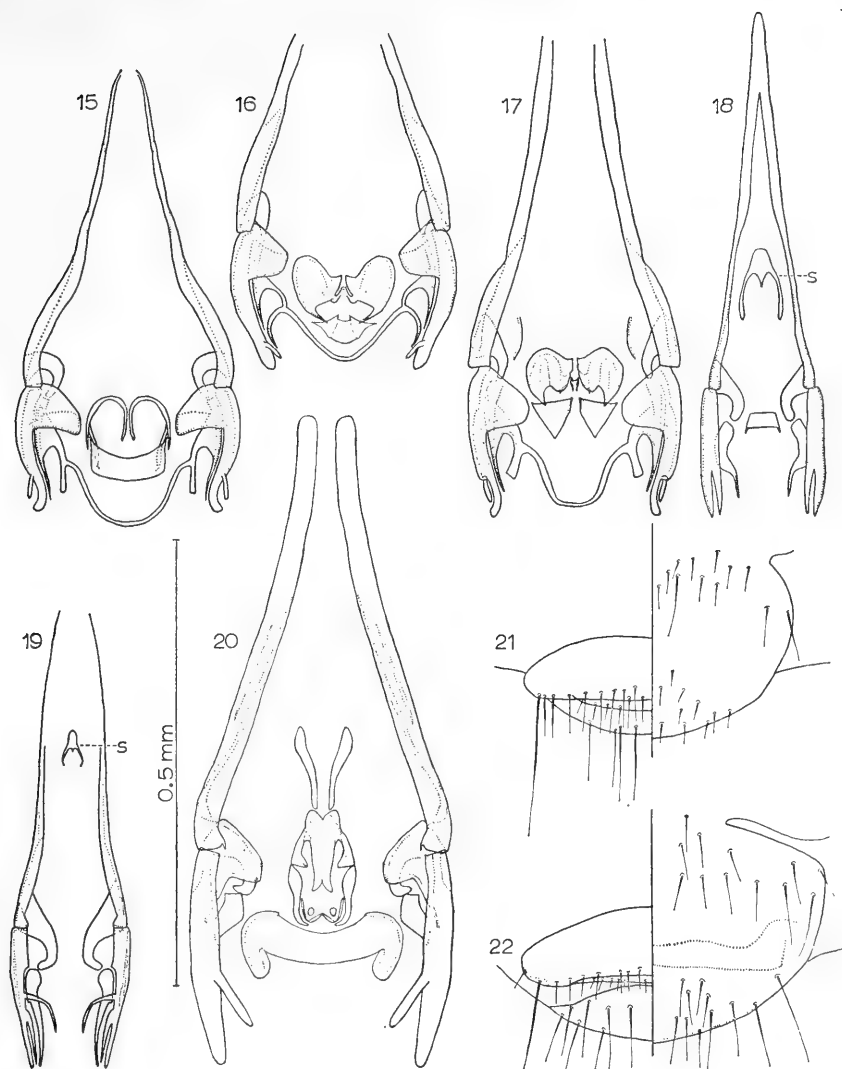
Host	Geographical region	Parasite	Species-group
<i>Rhyticeros nipalensis</i>	Oriental		
<i>R. c. corrugatus</i>	"		
<i>R. c. megistus</i>	"		
<i>R. l. waldeni</i>	"	<i>C. blakei</i>	<i>acutovulvata</i>
<i>R. l. leucocephalus</i>	"	<i>C. blakei</i>	<i>acutovulvata</i>
<i>R. cassidix</i>	Australasian	<i>C. lydae</i>	<i>acutovulvata</i>
<i>R. u. ticehursti</i>	Oriental	<i>C. boonsongi</i>	<i>acutovulvata</i>
<i>R. u. undulatus</i>	"	<i>C. boonsongi</i>	<i>acutovulvata</i>
<i>R. p. subruficollis</i>	"	<i>C. hirta</i>	<i>hirta</i>
<i>R. p. plicatus</i>	Australasian		
<i>R. p. ruficollis</i>	"	<i>C. hirta</i>	<i>hirta</i>
<i>R. p. jungei</i>	"		
<i>R. p. dampieri</i>	"		
<i>R. p. harterti</i>	"		
<i>R. p. mendanae</i>	"	<i>C. hirta</i>	<i>hirta</i>
<i>R. everetti</i>	"		
<i>R. narcondami</i>	Oriental		
<i>Anthracoecerus malayanus</i>	"	<i>C. malayensis</i>	<i>acutovulvata</i>
<i>A. a. albirostris</i>	"	<i>C. acutovulvata</i>	<i>acutovulvata</i>
<i>A. a. leucogaster</i>	"	<i>C. acutovulvata</i>	<i>acutovulvata</i>
<i>A. coronatus</i>	"	<i>C. acutovulvata</i>	<i>acutovulvata</i>
<i>A. convexus</i>	"	<i>C. acutovulvata</i>	<i>acutovulvata</i>
<i>A. montani</i>	"	<i>C. hoplasi</i>	<i>acutovulvata</i>
<i>A. marchei</i>	"	<i>C. acutovulvata</i>	<i>acutovulvata</i>
<i>Bycanistes b. fistulator</i>	Ethiopian		
<i>B. b. sharpii</i>	"	<i>C. bucerotis</i>	<i>lophocerus</i>
<i>B. b. duboisi</i>	"	<i>C. bucerotis</i>	<i>lophocerus</i>
<i>B. b. bucinator</i>	"	<i>C. bucerotis</i>	<i>lophocerus</i>
<i>B. c. cylindricus</i>	"	<i>C. bucerotis</i>	<i>lophocerus</i>
<i>B. c. albotibialis</i>	"	<i>C. bucerotis</i>	<i>lophocerus</i>
<i>B. s. subcylindricus</i>	"		
<i>B. s. subquadratus</i>	"	<i>C. bucerotis</i>	<i>lophocerus</i>
<i>B. b. omissus</i>	"	<i>C. bucerotis</i>	<i>lophocerus</i>
<i>B. b. brevis</i>	"	<i>C. bucerotis</i>	<i>lophocerus</i>
<i>Ceratogymna atrata</i>	"	<i>C. robusta</i>	<i>lophocerus</i>
<i>C. elata</i>	"	<i>C. robusta</i>	<i>lophocerus</i>
<i>Buceros r. rhinoceros</i>	Oriental		
<i>B. r. sumatranus</i>	"	<i>Bucerophagus forcipatus</i>	<i>forcipatus</i>
<i>B. r. silvestris</i>	"		
<i>B. r. borneoensis</i>	"	<i>B. forcipatus</i>	<i>forcipatus</i>
<i>B. b. bicornis</i>	"		
<i>B. b. homrai</i>	"	<i>B. forcipatus</i>	<i>forcipatus</i>
<i>B. h. hydrocorax</i>	"		
<i>B. h. semigaleatus</i>	"	<i>C. traylori</i>	<i>acutovulvata</i>
<i>B. h. mindanensis</i>	"	<i>C. traylori</i>	<i>acutovulvata</i>
<i>B. h. bastlanicus</i>	"		
<i>Rhinoplax vigil</i>	"	<i>Bucerophagus forcipatus</i>	<i>forcipatus</i>
<i>Bucorvus abyssinicus</i>	Ethiopian	<i>B. productus</i> and <i>B. africanus</i>	<i>productus</i>
<i>B. leadbeateri</i>	"	<i>B. africanus</i> and <i>B. productus</i>	<i>productus</i>



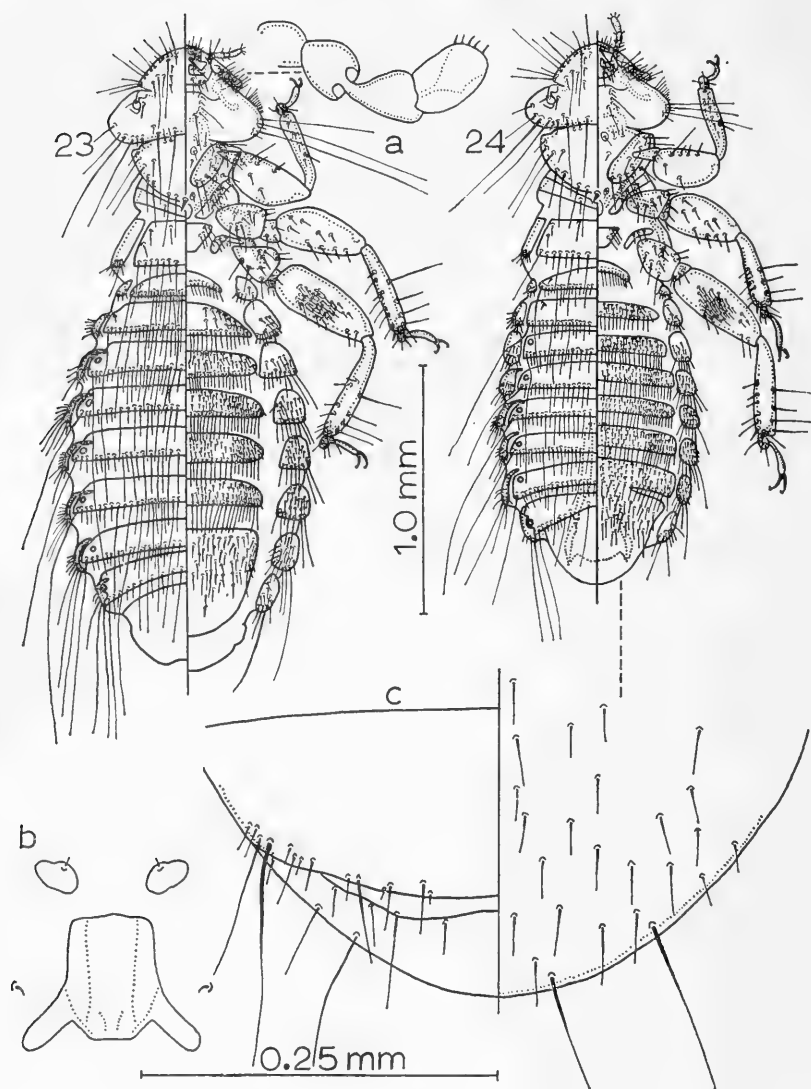
FIGURES 1-7.—The *lophocerus* species-group. Male genitalia, ventral view: 1, *Chapinia fasciati*, new species, holotype; 2, *C. lophocerus* (Bedford), lectotype; 3, *C. camuri*, new species, holotype; 6, *C. bucerotis* (Kellogg), lectotype; 7, *C. robusta* Ewing. Male terminal abdominal segments, dorsal-ventral view: 4, *C. lophocerus* (Bedford), lectotype; 5, *C. bucerotis* (Kellogg), lectotype.



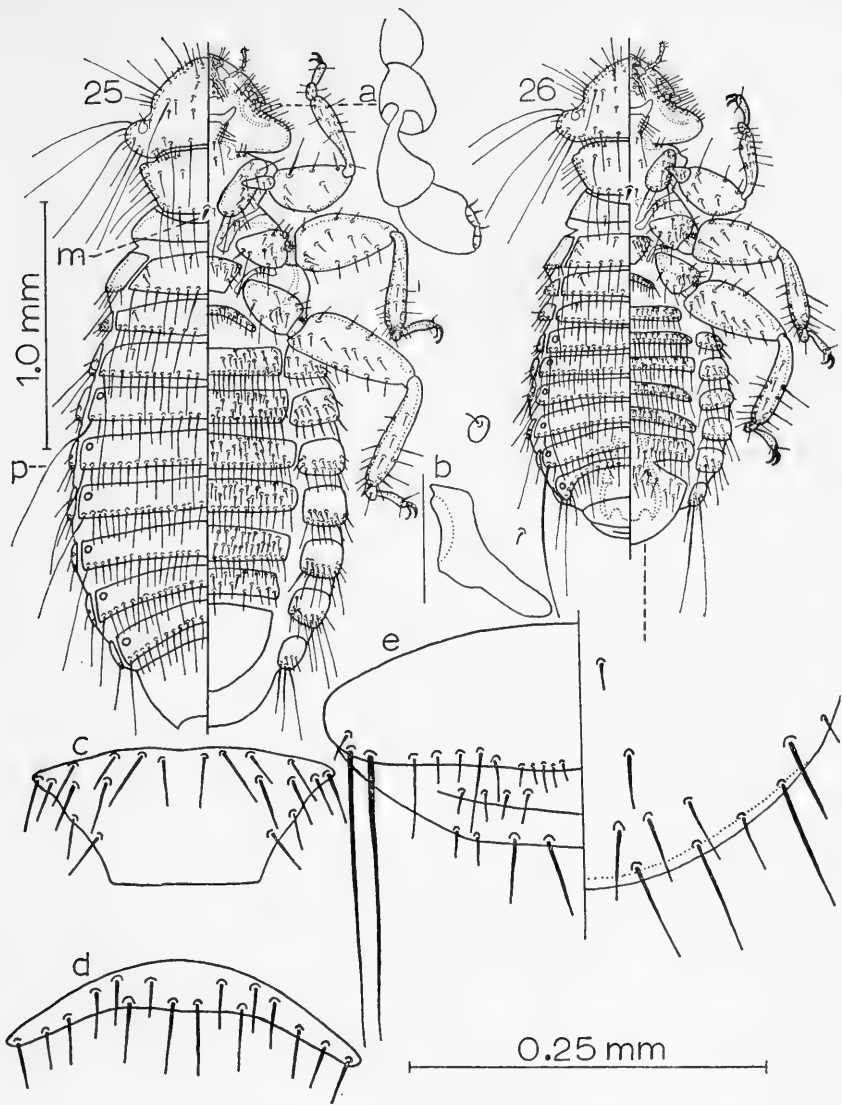
FIGURES 8-14.—The *acutovulvata* species-group. Male genitalia, ventral view: 8, *Chapinia clayae*, new species, holotype; 9, *C. acutovulvata* (Piaget); 12, *C. malayensis*, new species, holotype; 13, *C. hoplai*, new species, holotype; 14, *C. boonsongi*, new species, holotype. Male terminal abdominal segments, dorsal-ventral view: 10, *C. acutovulvata* (Piaget); 11, *C. boonsongi*, new species, holotype.



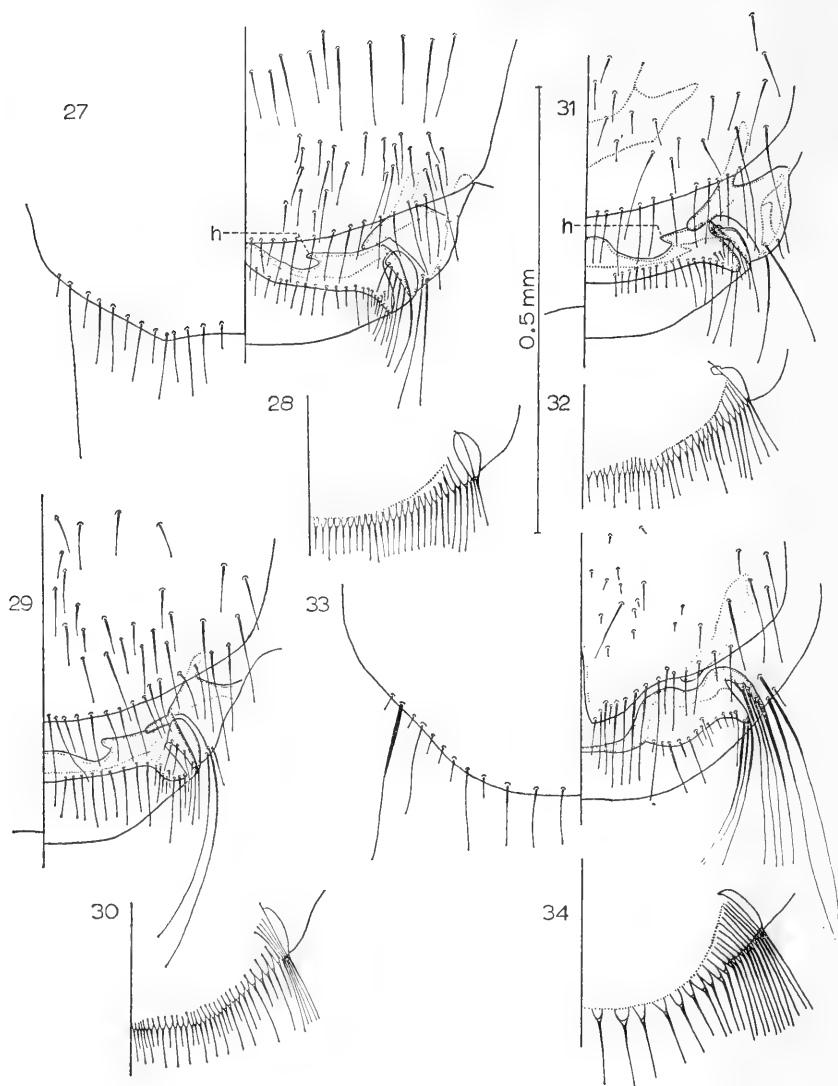
FIGURES 15-22.—The *acutovulvata* and *hirta* species-groups. Male genitalia, ventral view: 15, *Chapinia wenzeli*, new species, holotype; 16, *C. blakei*, new species, holotype; 17, *C. traylori*, new species, holotype; 18, *C. muesebecki*, new species, holotype; 19, *C. hirta* (Rudow), neotype; 20, *C. lydae*, new species, holotype. Male terminal abdominal segments, dorsal-ventral view: 21, *C. muesebecki*, new species, holotype; 22, *C. hirta* (Rudow), neotype. (s=sclerite of genital sac.)



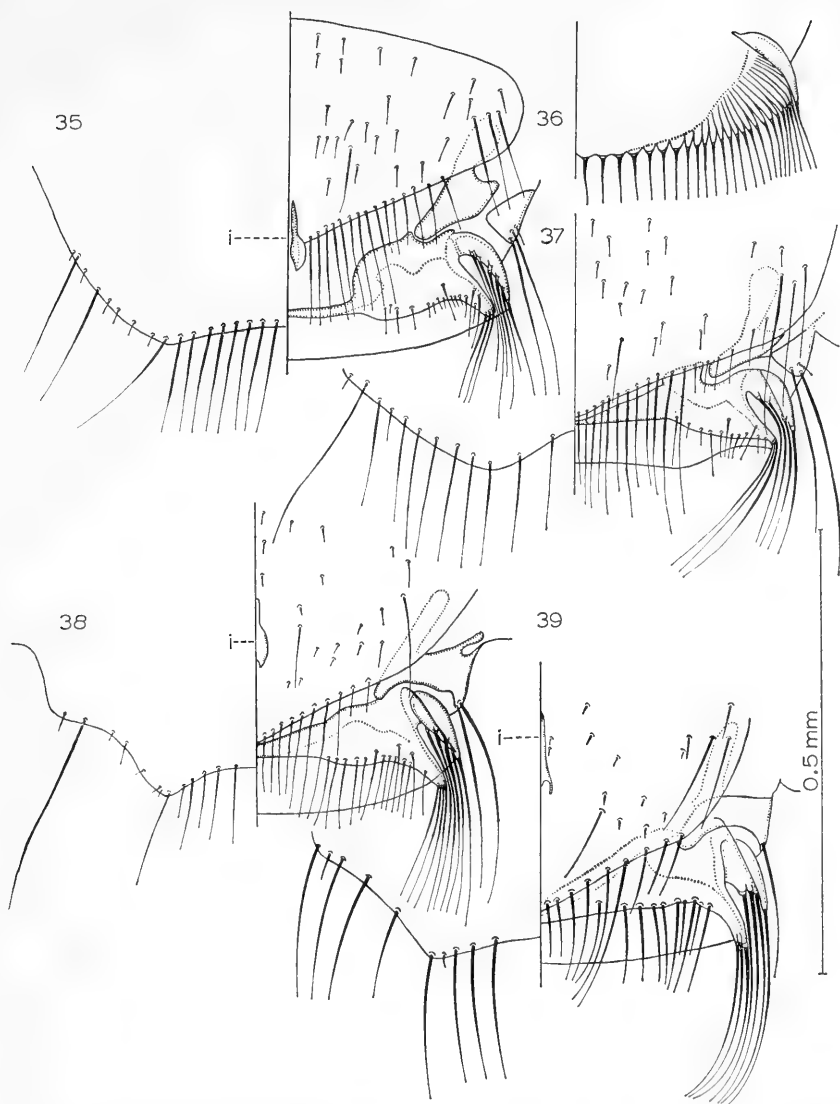
FIGURES 23, 24.—*Chapinia robusta* Ewing, dorsal-ventral view: 23, female; 24, male. (a=antenna of female; b=prosternal plate of female; c=terminal abdominal segments of male.)



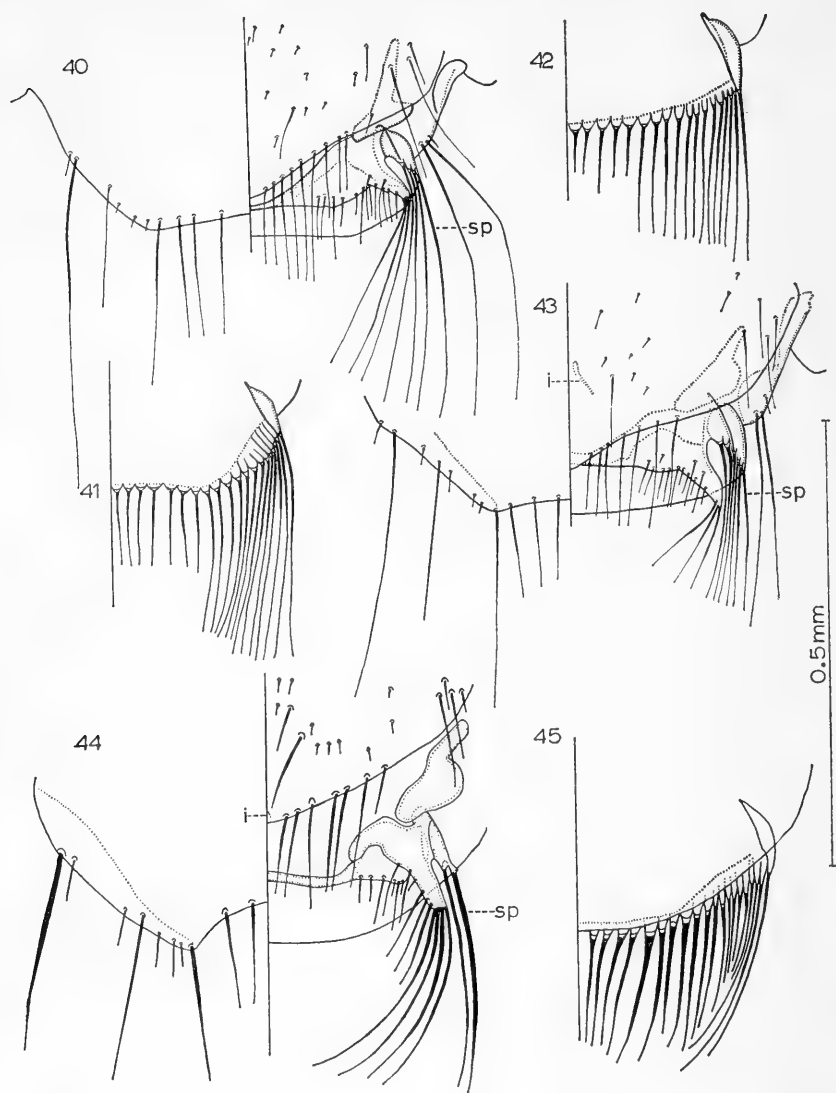
FIGURES 25, 26.—*Chapinia traylori*, new species, dorsal-ventral view: 25, allotype female; 26, holotype male. (a=antenna of female; b=prosternal plate of female; c=metasternal plate of male; d=first abdominal sternite of male; e=terminal abdominal segments of male; m=mesonotum; p=postspiracular seta.)



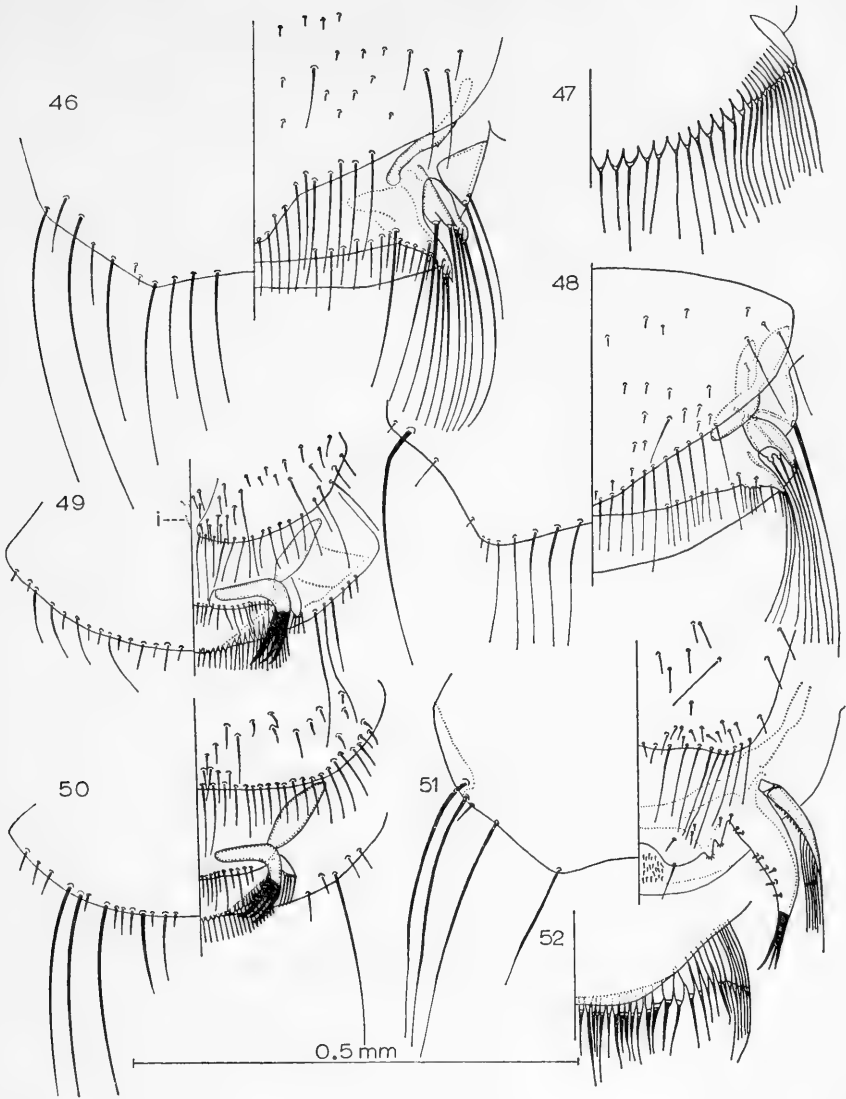
FIGURES 27-34.—The *lophocerus* and *acutovulvata* species-groups. Female terminal abdominal segments, dorsal-ventral view: 27, *Chapinia lophocerus* (Bedford); 29, *C. bucerotis* (Kellogg); 31, *C. robusta* Ewing; 33, *C. clayae*, new species, allotype. Female anal fringes, ventral view: 28, *C. lophocerus* (Bedford); 30, *C. bucerotis* (Kellogg); 32, *C. robusta* Ewing; 34, *C. clayae*, new species, allotype. (h=sclerital hooks.)



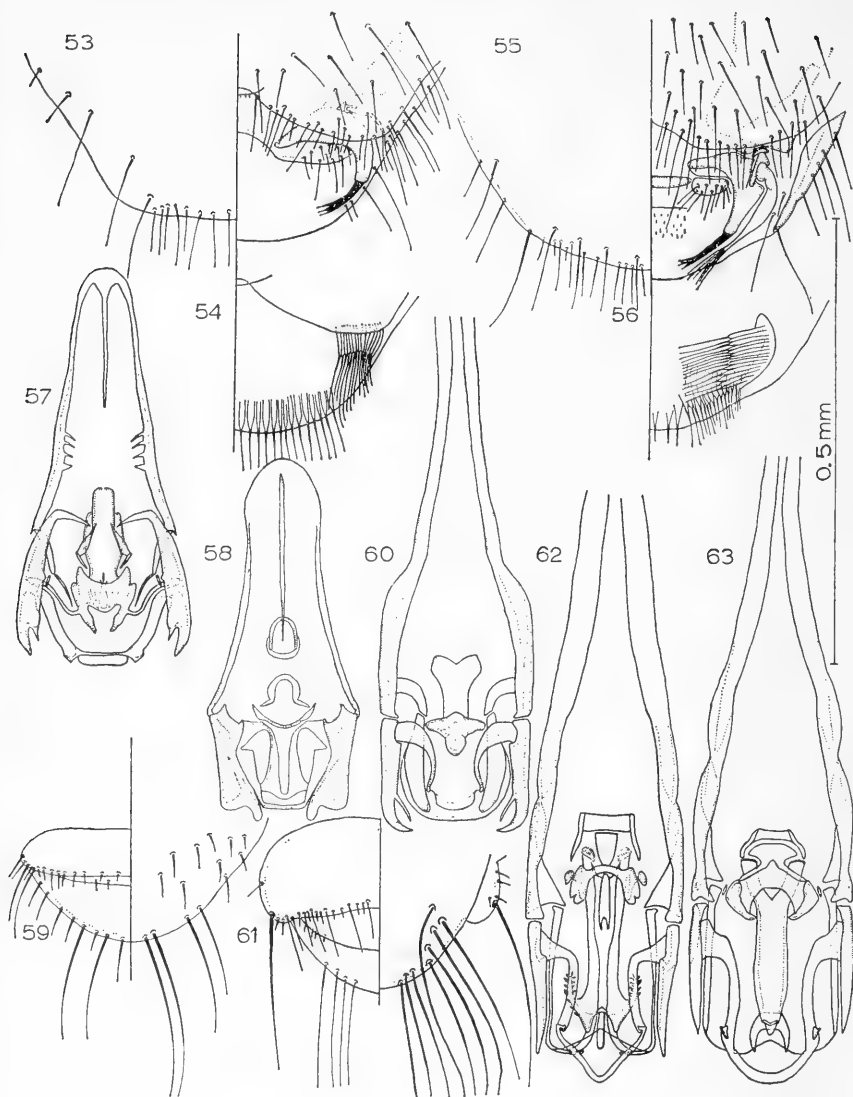
FIGURES 35-39.—The *acutovulvata* species-group. Female terminal abdominal segments, dorsal-ventral view: 35, *Chapinia acutovulvata* (Piaget); 37, *C. malayensis*, new species, allotype; 38, *C. hoplai*, new species, allotype; 39, *C. boonsongi*, new species, allotype. Female anal fringes, ventral view: 36, *C. acutovulvata* (Piaget). (i=internal sclerite of abdominal sternite VIII.)



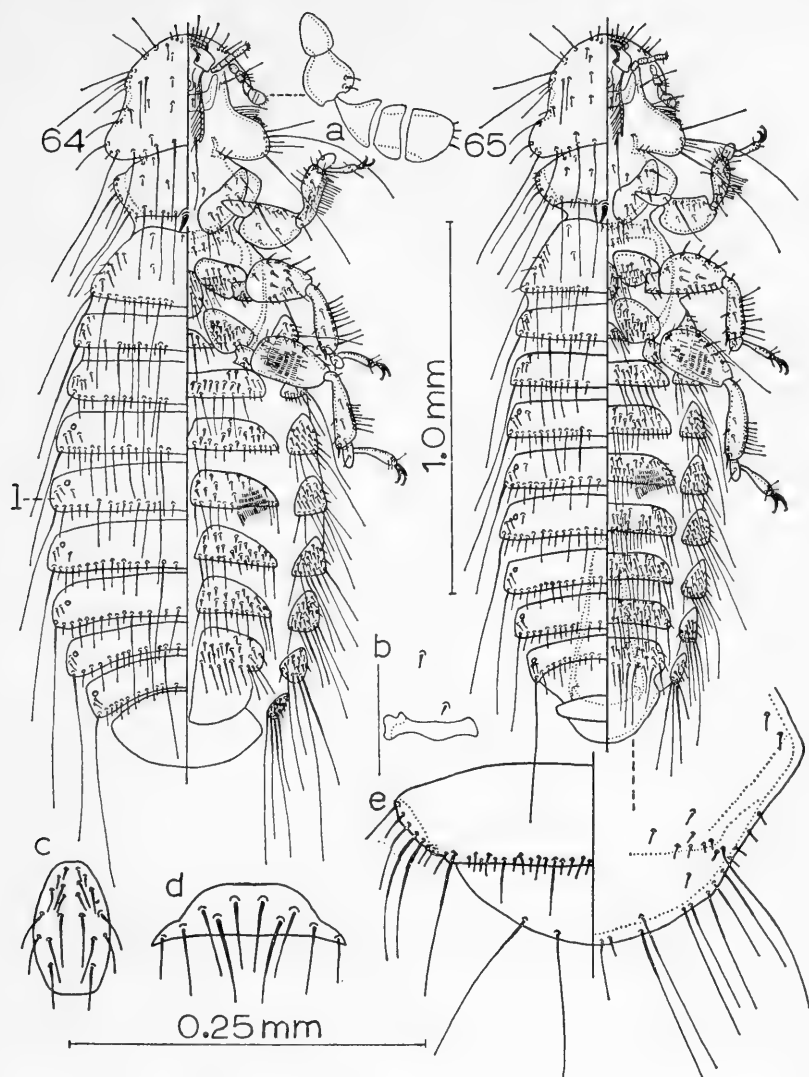
FIGURES 40-45.—The *acutoovulvata* species-group. Female terminal abdominal segments, dorsal-ventral view: 40, *Chapinia wenzeli*, new species, allotype; 43, *C. blakei*, new species, allotype; 44, *C. traylori*, new species, allotype. Female anal fringes, ventral view: 41, *C. wenzeli*, new species, allotype; 42, *C. blakei*, new species, allotype; 45, *C. traylori*, new species, allotype. (i=internal sclerite of abdominal sternite VIII; sp= posteriorly directed setae on lateral projection of ventral sclerite between vulva and anus.)



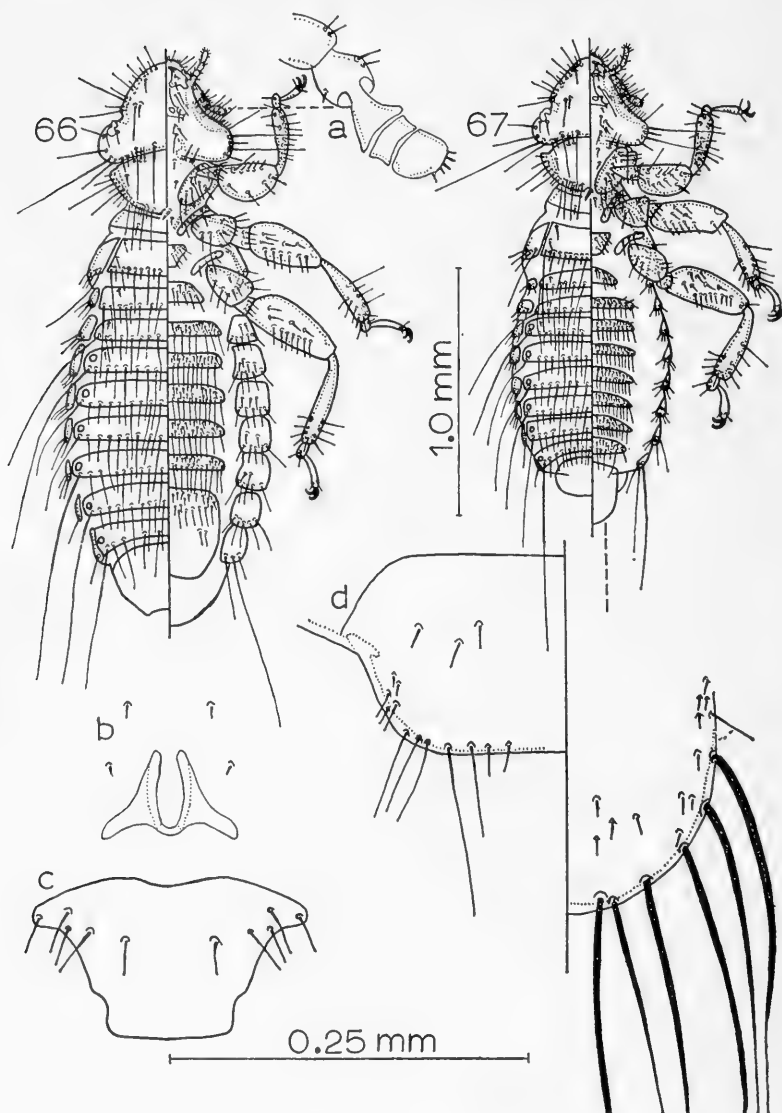
FIGURES 46-52.—Female terminal abdominal segments, dorsal-ventral view: 46, *Chapinia lydae*, new species, allotype; 48, *C. hirta* (Rudow); 49, *Bucerocolpocephalum emersoni*, new species, allotype; 50, *B. deignani*, new species, allotype; 51, *Bucerophagus forcipatus* (Nitzsch). Female anal fringes, ventral view: 47, *C. hirta* (Rudow); 52, *Bucerophagus forcipatus* (Nitzsch). (i=internal sclerite of abdominal sternite VIII.)



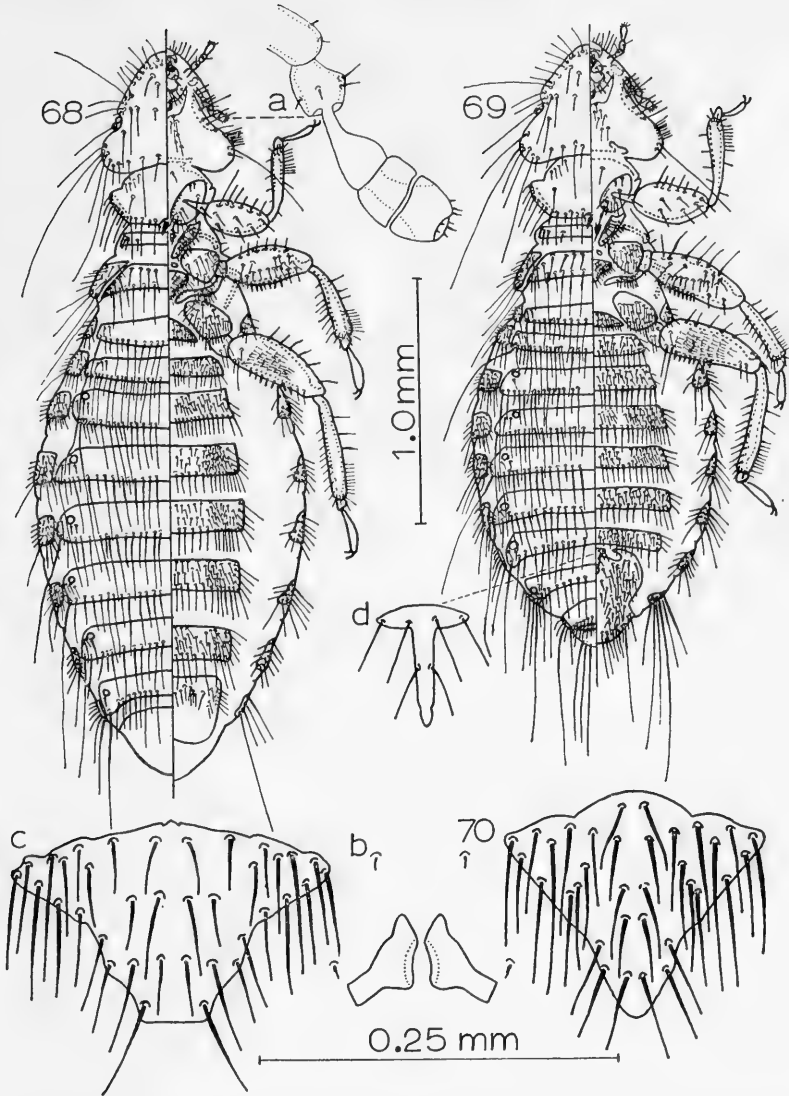
FIGURES 53-63.—Female terminal abdominal segments, dorsal-ventral view: 53, *Bucero-phagus productus* (Burmeister); 55, *B. africanus* Bedford. Female anal fringe, ventral view: 54, *B. productus* (Burmeister); 56, *B. africanus* Bedford. Male genitalia, ventral view: 57, *Bucero-colpocephalum emersoni*, new species, holotype; 58, *B. deignani*, new species, holotype; 60, *Bucero-phagus forcipatus* (Nitzsch); 62, *B. productus* (Burmeister); 63, *B. africanus* Bedford. Male terminal abdominal segments, dorsal-ventral view: 59, *Bucero-colpocephalum deignani*, new species, holotype; 61, *Bucero-phagus productus* (Burmeister).



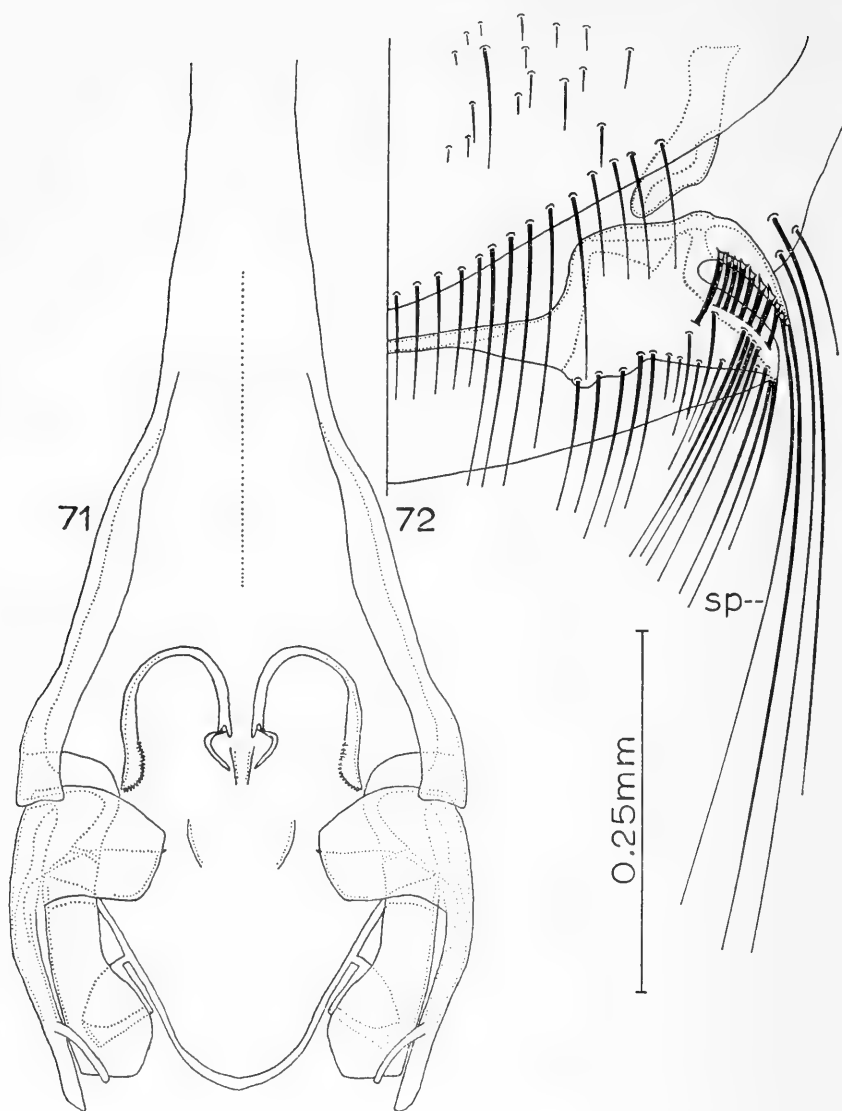
FIGURES 64, 65.—*Bucerocolpocephalum emersoni*, new species, dorsal-ventral view: 64 allotype female; 65, holotype male. (a=antenna of female; b=prosternal plate of female; c=metasternal plate of female; d=first abdominal sternite of female; e=terminal abdominal segments of male; l=short lateral setae between spiracle and postspiracular seta.)



FIGURES 66, 67.—*Bucerophagus forcipatus* (Nitzsch), dorsal-ventral view: 66, female; 67, male. (a=antenna of female; b=prosternal plate of female; c=metasternal plate of female; d=terminal abdominal segments of male.)



FIGURES 68-70.—*Bucerophagus africanus* Bedford, dorsal-ventral view: 68, female; 69, male, (a=antenna of female; b=prosternal plate of female; c=metasternal plate of female; d=central T-shaped plate of male sternite VIII.) *B. productus* (Burmeister): 70. metasternal plate of female.



FIGURES 71, 72.—*Chapinia waniti*, new species, ventral view: 71, genitalia of holotype; 72, terminal abdominal segments of allotype. (sp=posteriorly directed setae on lateral projection of ventral sclerite between vulva and anus.)

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STUDIES OF NEOTROPICAL CADDIS FLIES, III

TYPES OF SOME SPECIES DESCRIBED BY ULMER AND BRAUER

By OLIVER S. FLINT, JR.
Curator, Division of Neuropteroids

Georg Ulmer described 67 species of Trichoptera from South and Central America and the West Indies during the years 1905 to 1913. His work, which established a basis for subsequent studies on this fauna, was excellent by standards of his day. By present-day standards, however, most of his illustrations of the genitalia are inadequate because he did not clear these important structures before figuring them.

Friedrich Brauer described only two species of caddis flies from this region—one from Mexico, the other from Brazil. The latter species, the type of which has been redescribed, presents no particular problems. The former, for which he proposed a new genus, has been neither redescribed nor rediscovered subsequently.

During the past few years I have been able to borrow the types of nearly half of Ulmer's species and of both of Brauer's species. Many of these species were described from series, which in a few

cases appear to be mixed. To avoid any future ambiguity, lectotypes are here designated for all species described from a series. The genitalia of the borrowed holotypes or lectotypes have been cleared and figures prepared from these preparations for species that have not been redescribed recently. In addition, photographs have been made of the wings of species in certain genera. The final drawings were prepared by Mr. André D. Pizzini from sketches made by the author.

The work was made possible through the excellent cooperation of Dr. Cezary Tomaszewski, Zoological Museum of the University of Lodz, Lodz, Poland, who arranged for the loan of the types in the collection of the Institute of Zoology of the Polish Academy of Science in Warsaw and to Prof. Dr. Max Beier, Zoological Division of the Natural History Museum in Vienna, who lent the types in the collection of that museum.

Rhyacophilidae

Atopsyche longipennis (Ulmer)

Psilochorema longipenne Ulmer, 1905a, pp. 110-112.—Tomaszewski, 1961, p. 4.
Atopsyche longipennis (Ulmer).—Ulmer, 1907b, p. 205; 1913, p. 384.—Ross, 1947, p. 128.—Ross and King, 1952, p. 202.—Fischer, 1960, p. 161.
Atopsyche brasiliiana Ulmer, 1909a, p. 73. [Lapsus for *longipennis*.]

The collection from Warsaw contains two female syntypes. Apparently, Dr. Ulmer had retained a male syntype which should be designated lectotype.

I have seen a series of males and females of the species from Nova Teutonia, Santa Catarina, Brazil. The genitalia of the female from this series are identical with those of the female syntypes. The males from the series are identical with the male type figured by Ross and King, giving additional evidence that the species is being correctly recognized.

Glossosomatidae

Mexitrichia albolineata (Ulmer), new combination

FIGURE 1d

Mortoniella species Ulmer, 1906, pp. 98, 99.
Mortoniella albolineata Ulmer, 1907a, pp. 44, 45; 1907b, p. 219; 1913, p. 385.—Jorgensen, 1919, p. 394.—Tomaszewski, 1961, p. 4.—Fischer, 1961, p. 83.
 ?*Antoptila albolineata* (Ulmer).—Mosely, 1939a, p. 218.
Mexitrichia teutonia Mosely, 1939a, p. 223.—Flint, 1963, pp. 474, 475. [New synonymy.]

Lectotype, male: "S. Catarina Lüderwaldt," "Type," "Inst. Zool. P.A.N. Warszawa Syntypus Nr. 1751," "*Mortoniella albolineata* Ulmer Typus!" "Lectotype *Mortoniella albolineata* Ulmer By Flint." In Warsaw.

Ulmer was mistaken in his belief that the original series was all female because there was one male in the series from Warsaw. This specimen has been designated lectotype.

Although there are several small differences between the lectotype and topotypic examples of *M. teutonia*, I am synonymizing the two species. The differences in *albolineata* are in the ventral lobe of the tenth tergum which is much narrower, the lateral processes of the aedeagus which are narrower, and the ventralmost spine which is stouter. All of these differences, however, are quantitative in nature and rather minor considering the overall similarity of the genitalia.

Philopotamidae

Chimarra mexicana (Ulmer)

Wormaldia mexicana Ulmer, 1905b, p. 89.

Chimarra mexicana (Ulmer).—Ulmer 1907b, p. 200; 1913, p. 405.

Chimarra mexicana (Ulmer).—Fischer, 1961, p. 66.

Lectotype: "Bilimek Mexico 1871 Stadt," "pulchra? det. Brauer," "mexicana det. Ulmer," "Lectotype *Wormaldia mexicana* Ulmer Designated Flint." In Vienna.

This species, originally described in *Wormaldia*, is definitely a species of *Chimarra* (subgenus *Curgia*). Unfortunately the type series is in very poor condition since each specimen lacks its abdomen. The lectotype is in the best condition and is brown with yellow hair on the head and in patches on the forewings. The original figure of the venation appears correct, but the figure of the genitalia is undoubtedly upside down.

Chimarra brasiliiana (Ulmer)

FIGURES 1a-c

Chimarra brasiliiana Ulmer, 1905a, pp. 96, 97; 1907b, p. 200; 1909b, p. 308; 1913, p. 405—Lestage, 1925, p. 38.—Tomaszewski, 1961, p. 2.

Wormaldia brasiliiana (Ulmer).—Ulmer, 1905b, p. 91.

Chimarra brasiliiana (Ulmer).—Fischer, 1961, p. 58.

Wormaldia parva Ulmer, 1905b, p. 90. [New synonymy.]

Chimarra parva (Ulmer).—Ulmer, 1907b, p. 200; 1913, p. 405—Lestage, 1925, p. 39.

Chimarra parva (Ulmer).—Fischer, 1961, p. 68.

Lectotype, male: "S. Catarina Lüderwaldt," "Type," "St. Ztg. 1905, p. 97 N. 81," "Inst. Zool. P.A.N. Warszawa Syntypus Nr. 1713," "Chimarra brasiliiana Ulm. Typus!" "Lectotype *Chimarra brasiliiana* Ulmer By Flint." In Warsaw.

Lectotype, male: "Blumenau," "Brasil 1885 Hetschko," "parva det. Ulmer," "Lectotype *Wormaldia parva* Ulmer Designated Flint." In Vienna.

The lectotypes of *brasiliانا* and *parva* have been compared side by side and, with the exception of a few small quantitative differences, have been found identical. The figures here presented were made from the lectotype of *parva*.

Psychomyiidae

Polyplectropus annulicornis Ulmer

FIGURES 1g,h

Polyplectropus annulicornis Ulmer, 1905b, p. 91; 1907b, p. 185; 1913, p. 406.—Fischer, 1962, p. 92.

Lectotype, female: "Rio Gr. do Sul Stieglmayr," "annulicornis det. Ulmer," "Lectotype *Polyplectropus annulicornis* Ulmer Designated Flint." In Vienna.

The type series of the species consists only of females, one of which is here selected as lectotype and figured. In addition, a series of males and females, carefully compared with the lectotype, from Plaumann in Santa Catarina has been studied and the male genitalia of one figured.

Polyplectropus flavicornis Ulmer

FIGURES 1e,f

Polyplectropus flavicornis Ulmer, 1905a, pp. 103, 104; 1907b, p. 185; 1913, p. 406.—Tomaszewski, 1961, p. 4.—Fischer, 1962, pp. 92, 93.

Lectotype, male: "S. Catarina Lüderwaldt," "Type," "St. Zt. 1905, p. 104 N. 87," "Polyplectropus flavicornis Ulm. Type." "Lectotype *Polyplectropus flavicornis* Ulmer By Flint." In Warsaw.

The figure of the male genitalia was made from the lectotype and that of the female from one of the paralectotypes.

Xiphocentron bilimeki Brauer

FIGURES 1i,j

Xiphocentron bilimeki Brauer, 1870, p. 66; 1871, p. 103.—Ulmer, 1907b, p. 176; 1913, p. 407.—Ross, 1949, pp. 3, 4.—Fischer, 1963, p. 138.

Lectotype, male: "Bilimek Mexico 1871," "Bilimeki det. Brauer," "Bilimeki det. Ulmer," "Xiphocentron Bilimeki Brauer," "Lectotype *Xiphocentron bilimeki* Brauer Designated Flint." In Vienna.

The figures of the genitalia were made from the lectotype. This species has a very long, broad spur on the hind tibia as mentioned in the original description.

Hydropsychidae

Blepharopus diaphanus reticulatus Ulmer

FIGURES 2e-g; PLATE 2c

Blepharopus reticulatus Ulmer, 1905a, pp. 52, 53; 1907b, p. 162.—Tomaszewski, 1961, p. 2.

Blepharopus diaphanus reticulatus Ulmer.—Ulmer 1907c, pp. 43, 44.—Navas, 1918, p. 503; 1920a, p. 40; 1926, p. 113; 1932, p. 83.—Fischer, 1963, pp. 164, 165.

The photograph of the wings and the drawings of the male genitalia were made from the holotype male in the collection from Warsaw.

Leptonema cinctum Ulmer

FIGURES 2j-m

Leptonema cinctum Ulmer, 1905a, pp. 64, 65; 1907b, p. 163; 1907c, p. 54; 1913, pp. 393, 407.—Mosely, 1933, pp. 19, 20.—Tomaszewski, 1961, p. 3.—Fischer, 1963, pp. 167-168.

The wings of the holotype male seem to have the same pattern as those of the specimen figured by Mosely (1933, frontisp.). The genitalia, however, show several distinct differences, especially in the structure of the tenth tergum. I have not seen enough material of the species to determine whether these differences are of specific value.

The drawings of the genitalia were made from the holotype male in the collection from Warsaw.

Leptonema columbianum Ulmer

Leptonema columbianum Ulmer, 1905a, pp. 61, 62; 1907b, p. 163; 1907c, p. 51; 1913, pp. 394, 407.—Banks, 1913a, p. 89.—Navas, 1917, p. 404; 1920a, p. 40; 1920b, p. 64; 1930, p. 132.—Mosely, 1933, pp. 13, 14.—Tomaszewski, 1961, p. 3.—Fischer, 1963, p. 168.

Leptonema externum Banks, 1913a, p. 87.—Mosely, 1933, pp. 8, 13 (synonymizes *externum*).

Lectotype, female: "Columbia Pehlke," "Type," "St. Z. 1905 p. 62 N. 43," "Inst. Zool. P.A.N. Warszawa Syntypus Nr. 1735," "Leptonema columbianum Ulmer Typus!" "Lectotype Leptonema columbianum Ulmer By Flint." In Warsaw.

The type specimens are all females with dilated mesothoracic legs as stated by Ulmer. There is no reason to believe that Mosely associated the wrong male with the species. His action is substantiated by several series I have seen which contain both sexes.

Leptonema furcatum Ulmer

Leptonema furcatum Ulmer, 1905a, pp. 50, 51; 1907b, p. 161; 1907c, pp. 48, 49; 1913, p. 407.—Navas, 1916, p. 30.—Mosley, 1933, pp. 42, 43; 1939b, pp. 310-314 (as a synonym of *pallidum* Guer).—Tomaszewski 1961, p. 3.—Fischer, 1963, p. 169.

Lectotype, male: "Esprito-Santo Brasil ex Coll. Fruhstorfer," "Co-Typus," "St. Z. 1905 p. 58 N. 38," "Inst. Zool. P.A.N. Warszawa Syntypus Nr. 7736," "Leptonema furcatum Ulmer Typus!" "Lectotype Leptonema furcatum Ulmer By Flint." In Warsaw.

The lectotype of the species agrees closely with Mosely's figures and is therefore not refigured. Although Mosely's action (1939b)

synonymizing *furcatum* with *L. pallidum* Guerin may ultimately prove correct, I feel that his reasons of pale color and locality make this synonymy too tenuous to accept at this time.

***Leptonema stigmatosum* Ulmer**

FIGURES 2*n*-*q*

Leptonema stigmatosum Ulmer, 1905a, p. 60; 1907b, p. 163; 1907c, pp. 57, 58; 1913, pp. 394, 407.—Campos, 1922, p. 74.—Mosely, 1933, p. 140.—Fischer, 1947, pp. 313, 315.—Tomaszewski, 1961, p. 3.—Fischer, 1963, p. 173.—Schmid, 1964, pp. 317, 318.

Lectotype, male: "Balzapamba (Ecuad.) R. Haensch S," "Type," "St. Z. 1905 p. 61. N. 41," "Inst. Zool. P.A.N. Warszawa Syntypus Nr. 1736," "*Leptonema stigmatosum* Ulmer Typus!" "Lectotype *Leptonema stigmatosum* Ulmer By Flint." In Warsaw.

Mosely's illustrations (1933) do not agree very closely with the lectotype. The tenth tergum of the lectotype is not as extended, especially the dorsal lobe, and the apical processes of the aedeagus are different, although of the same general plan. It is not known whether these differences are specific, because considerable variation has been found whenever specimens from different localities identified as *stigmatosum* have been looked at critically.

The figures of the genitalia were made from the lectotype.

***Centromacronema excisum* (Ulmer)**

PLATE 1E

Macronema excisum Ulmer, 1905a, pp. 85, 86.—Tomaszewski, 1961, p. 4.
Centromacronema excisum (Ulmer).—Ulmer, 1905b, p. 87; 1907b, p. 116; 1907c, p. 117; 1913, p. 408.—Fischer, 1968, p. 204.

The holotype female is from Santa Inez, Ecuador, "R. Haensch S." The photograph of the wings was made from the type which is in the collection in Warsaw.

***Macronema argentilineatum* Ulmer**

FIGURES 3*g*-*i*; PLATE 1D

Macronema argentilineatum Ulmer, 1905a, pp. 77, 78; 1907b, p. 164; 1907c, pp. 68, 69; 1913, p. 408.—Banks 1924, p. 453.—Tomaszewski, 1961, p. 4.—Fischer, 1963, p. 177.

The photograph of the wings and the drawings of the genitalia were prepared from the holotype male from Warsaw. The mesal rodlike process of the eighth sternum has not been found in any other Neotropical species of the genus.

***Macronema bicolor* Ulmer**

FIGURES 3*d*-*f*; PLATE 1C

Macronema bicolor Ulmer, 1905a, pp. 75, 76; 1907b, p. 164; 1907c, pp. 71, 72; 1913, pp. 395, 408.—Tomaszewski, 1961, p. 4.—Fischer, 1963, p. 178.

Lectotype, male: "S. Catarina Lüderwaldt," "Type," "St. Z.

1905 p. 76 N 56," "Inst. Zool. P.A.N. Warszawa Syntypus Nr. 1743," "Macronema bicolor Ulmer Typus!" "Lectotype *Macronema bicolor* Ulmer By Flint." In Warsaw.

The photograph of the wings was made from the lectoparatype; the drawings of the genitalia were made from the lectotype. The two specimens are identical in all details.

***Macronema parvum* Ulmer**

FIGURES 3 a-c; PLATE 1F

Macronema parvum Ulmer, 1905a, pp. 73, 74; 1907b, p. 165; 1907c, pp. 69, 70; 1913, p. 408.—Tomaszewski, 1961, p. 4.—Fischer, 1963, p. 193.

Lectotype, male: "Süd Amerika," "Type," "St. Z. 1905, p. 74. N 55," "Inst. Zool. P.A.N. Warszawa Syntypus Nr. 1749," "Macronema parvum Ulmer Typus!" "Lectotype *Macronema parvum* Ulmer By Flint." In Warsaw.

The photograph of the wings and the drawings of the genitalia were made from the lectotype.

***Macronema santaeritae* Ulmer**

PLATE 1B

Macronema Santae Ritae Ulmer, 1905b, p. 85; 1907b, p. 165; 1907c, pp. 79, 80; 1913, pp. 397, 408.—Jorgensen, 1919, p. 396.—Fischer, 1963, p. 196.

The unique type of the species in the Vienna Museum is a female, the wings of which are figured.

***Macronema tuberosum* Ulmer**

FIGURES 3 j,k; PLATE 1A

Macronema tuberosum Ulmer, 1905b, p. 82; 1907b, p. 165; 1907c, pp. 78, 79; 1913, p. 408.—Fischer, 1963, p. 199.

Lectotype, male: "Bahia Brasilia Fruhstorfer," "tuberosum det. Ulmer," "Lectotype *Macronema tuberosum* Ulmer Designated Flint." In Vienna.

The accompanying figures of the wings and male genitalia were prepared from the lectotype.

***Rhyacophylax columbianus* Ulmer**

FIGURES 2c,d

Rhyacophylax columbianus Ulmer, 1905a, pp. 106, 107; 1907b, p. 175; 1909b, p. 306; 1913, pp. 390, 391, 407.—Jorgensen, 1919, p. 395.—Tomaszewski, 1961, p. 4.—Fischer, 1963, p. 136.

Lectotype, male: "Columbia Pehlke," "Type," "Type 11795," "Rhyacophylax columbianus Ulm.," "Lectotype *Rhyacophylax columbianus* Ulm, By Flint '64." In the collection of the Museum of Comparative Zoology, Cambridge, Mass.

Although there is a male in the series from Warsaw, it appears to be a different species from that figured by Ulmer (1913). For this reason

I am designating as lectotype a syntypic male in the collection of the Museum of Comparative Zoology which agrees with Ulmer's figures.

The figures of the species were prepared from the lectotype.

Rhyacophylax brasilianus Ulmer

FIGURES 2a,b

Rhyacophylax brasilianus Ulmer, 1905a, p. 108; 1907b, p. 176; 1913, pp. 391, 392, 407.—Banks, 1913a, p. 88.—Tomaszewski, 1961, p. 4.—Fischer, 1963, pp. 135, 136.

Lectotype, male: "S. Catarina Lüderwaldt," "Type," "St. zg. 1905, p. 108, N. 91," "Inst. Zool. P.A.N. Warszawa Syntypus Nr. 1758," "Rhyacophylax brasilianus Ulm. Typus!" "Lectotype Rhyacophylax brasilianus Ulmer By Flint." In Warsaw.

The eye of the male of this species is about one-half as wide as the distance between the eyes. The forewings, which are badly damaged, appear to be pale on their basal half, dark especially toward the costal margin, a narrow pale band at the cord, followed by a dark apex. The male genitalia are also damaged; the tip of the aedeagus is lacking. The figures of the male were made from the lectotype.

Synoestropsis obliqua Ulmer

FIGURE 2h; PLATE 2A

Synoestropsis obliqua Ulmer, 1905a, pp. 45-47; 1907b, p. 158; 1907c, pp. 28, 29; 1913, pp. 392, 407.—Tomaszewski, 1961, p. 5.—Fischer, 1963, p. 210.

Lectotype, male: "Rio Grande do Sul," "Type," "St. Z. 1905. p. 46 N. 27," "Inst. Zool. P.A.N. Warszawa Syntypus Nr. 1760," "Synoestropsis obliqua Ulmer Typus!" "Lectotype Synoestropsis obliqua Ulmer By Flint." In Warsaw.

The drawings of the genitalia and the photograph of the wings were made from the lectotype.

Synoestropsis pedicillata Ulmer

FIGURE 2i, PLATE 2B

Synoestropsis pedicillata Ulmer, 1905a, pp. 43-45; 1907b, p. 158; 1907c, pp. 26, 27; 1913, pp. 392, 407.—Jorgensen, 1919, p. 396.—Tomaszewski, 1961, p. 5.—Fischer, 1963, p. 210.

Lectotype, male: "S. Catarina Lüderwaldt," "Type," "Inst. Zool. P.A.N. Warszawa Syntypus Nr. 1761," "Lectotype Synoestropsis pedicillata Ulmer By Flint." In Warsaw.

The photograph of the wings and the drawings of the genitalia were made from the lectotype. The type series varies somewhat in the extent of dark spots around the crossveins.

Leptoceridae

Leptocella flavofasciata Ulmer

FIGURES 4c,d; PLATE 2E

Leptocella flavofasciata Ulmer, 1907a, pp. 18–20; 1907b, p. 138; 1913, p. 410.—

Tomaszewski, 1961, p. 3.—Fischer, 1966, pp. 55, 56.

Leptocella sparsa Banks, 1920, p. 353. [New synonymy.]

The holotype of the species is rather mutilated; both the hindwings and the abdomen are missing. However, the forewings still show enough of their color pattern to permit recognition of the species. The photograph of the forewing is made from the holotype which is in Warsaw. The figure of the male genitalia was prepared from a syntype of *sparsa* in the Museum of Comparative Zoology.

Leptocella mulleri Ulmer

FIGURES 4a,b; PLATE 2D

Leptocella mulleri Ulmer, 1905a, pp. 29, 30; 1907b, p. 138; 1913, p. 410.—Tomaszewski, 1961, p. 3.—Fischer, 1966, p. 58.

The species was described from a single male, which has now lost the wings on the right side. The forewing of the species is buff, with black spots on the veins. The figures of the wings and genitalia were made from the holotype which is in Warsaw.

Leptocella punctata Ulmer

FIGURE 4e–g; PLATE 2F

Leptocella punctata Ulmer, 1905b, p. 75; 1907b, p. 138; 1913, pp. 402, 410.—Fischer, 1966, p. 60.

Leptocella fenestra Banks, 1913 b, p. 237. [New synonymy.]

Leptocella mixta Navas 1920b, p. 67; 1923, p. 200; 1929, p. 225.—Schmid, 1949, pp. 386, 387. [New synonymy.]

Leptocella ambitiosa Navas, 1933, p. 118.—Schmid, 1949, p. 386. [New synonymy.]

Lectotype, male: “Rio Preto, zw. Boquero u. Sta. Rita. Bras. Exped. Penher '03,” “23.4,” “punctata det. Ulmer,” “Lectotype *Leptocella punctata* Ulmer By Flint.” In Vienna.

The two type specimens of *punctata* are rather rubbed, but enough of the pattern remains to help with the recognition of the species. The wings are covered with white scales and marked with irregular yellowish to brownish patches frequently outlined in dark brown. The figures of the genitalia and photograph of the wings were made from the lectotype.

The types of *punctata* and *fenestra* have been compared side by side and found to be similar in all essential respects. Schmid (1949) synonymized *ambitiosa* with *mixta* and provided figures which enable me to synonymize them with *punctata*.

Atanatolica brasiliana (Brauer)

Mystacides brasilianus Brauer, 1865, p. 256; 1866, p. 14.

Notanatolica brasiliana (Brauer).—Ulmer, 1905b, p. 72; 1906, pp. 31-34; 1907b, p. 131; 1913, pp. 402, 409.

Atanatolica brasiliana (Brauer).—Mosely, 1936, p. 123.—Fischer, 1965, p. 71.

Lectotype, male: "Novara-R. Rio de Janeiro," "Novara 1857-59 Reise," "brasiliana det Brauer," "brasiliana det. Ulmer," "Atanatolica brasiliana Brauer ♂ Novara Reise Rio Janeiro 1857-59 Type M.E.M.," "Lectotype *Mystacides brasilianus* Brauer By Flint." In Vienna.

The type is mounted on two slides, one pair of wings dry on one slide, the other pair of wings, one set of legs, head, and abdomen in Canada balsam on the other. The species was well figured by Mosely (1936) and therefore is not figured here.

Genus *Oecetis* McLachlan

Oecetis McLachlan, 1877, p. 329. [Type species: *Leptocerus ochraceus* Curtis, designated Ross 1944.]

Pseudosetodes Ulmer 1905b, p. 76. [New synonymy. Type species: *Pseudosetodes punctipennis* Ulmer, monobasic.]

Ulmer separated his genus *Pseudosetodes* from *Oecetis* primarily on the reduced number of veins in the hindwings. This characteristic does vary considerably in the genus *Oecetis*, and *punctipennis* can be considered to represent the most reduced condition yet found. Males of this species now have been found so that additional evidence from the genitalia may be considered. This structure in both sexes also conforms closely to the pattern found in *Oecetis*. I am therefore synonymizing *Pseudosetodes* with *Oecetis*.

Oecetis punctipennis (Ulmer), new combination

FIGURES 4 h, i

Pseudosetodes punctipennis Ulmer, 1905b, p. 77; 1907b, p. 147; 1913, p. 410.—Fischer, 1966, p. 104.

Oecetina parishii Banks 1915, p. 631. [New synonymy.]

Lectotype, female: "Sta. Rita," "1.5," "Bras. Exped, Penther '03," "punctipennis det. Ulmer," "Lectotype *Pseudosetodes punctipennis* By Flint." In Vienna.

The types of *punctipennis* have been compared with the type of *parishi* and have been found to be identical in maculation and venation. The figure of the female was prepared from the lectotype of *punctipennis*, that of the male from the type of *parishi*.

Triaenodes columbica Ulmer

Triaenodes columbica Ulmer, 1909c, pp. 141, 142; 1913, p. 410.—Tomaszewski, 1961, p. 5.—Fischer, 1966, p. 90.

This species is known only from the male holotype in the collection from Warsaw. Unfortunately the abdomen and right forewing are

missing. The original figures of the genitalia of the species appear to be quite good and probably are adequate for recognition of the species.

Calamoceratidae

Phylloicus major Müller

FIGURES 5d-f

Phylloicus major Müller, 1880, p. 131; 1881, p. 81; 1921, pp. 523-542.—Flint, 1964, p. 65.—Fischer, 1965, pp. 22, 23.

Homeoplectron assimile Ulmer, 1905a, pp. 36, 37.—Tomaszewski, 1961, p. 3.

Phylloicus assimilis (Ulmer).—Ulmer 1905b, pp. 77, 78; 1907b, p. 120; 1913, pp. 398, 409.—Lestage 1925, p. 43.

Lectotype, male: "S. Catarina Lüderwaldt," "Type," "St. Z. 1905; p. 37 N 21," "Inst. Zool. P.A.N. Warszawa Syntypus Nr. 1723," "Phylloicus (*Homeoplectron*) *assimilis* Ulmer Typus!" "Lectotype *Homeoplectron assimilis* Ulmer By Flint." In Warsaw.

Ulmer (1905b) synonymized *major* and *assimilis*, retaining *assimilis* as the valid name because he felt that *major* was a nomen nudum. However, *major* had been validated as a name for the larval cases; thus, *assimilis* is the synonym.

In addition to the types of *assimilis*, I have studied material at the MCZ and from Vienna labelled *major* by Müller. The genitalia of the males of *major* and *assimilis* differ only in the possession of a small process above the cercus in *assimilis*. The coloration of *assimilis* is difficult to ascertain because the types are nearly denuded, but what remains of the pattern is reconcilable with the pattern of the specimens of *major*. Undoubtedly, Ulmer was correct in synonymizing the two.

The figures of the male genitalia were prepared from the lectotype of *assimilis*.

Phylloicus angustior Ulmer

Figures 5a-c

Phylloicus angustior Ulmer, 1905b, pp. 78, 79; 1907b, p. 120; 1913, pp. 399, 409.—Jorgensen 1919, p. 197.—Lestage 1925, p. 44.—Fischer, 1965, p. 21.

Lectotype, male: "Stieglmayr. Rio Gr. do Sul," "angustior det. Ulmer," "Lectotype *Phylloicus angustior* Ulmer By Flint." In Vienna.

The wings of this species are covered with fuscus hairs, with a few white ones scattered in the region of the anastomosis and again nearer the wing base. The genitalia of the lectotype are figured.

Sericostomatidae

Grumicha flavipes (Ulmer)

FIGURES 5*g, h*

Dicentropus flavipes Ulmer, 1905a, pp. 16, 17.—Tomaszewski 1961, p. 2.

Grumicha flavipes (Ulmer).—Ulmer, 1905b, p. 97; 1907b, p. 96; 1913, p. 404.—Jorgensen 1919, p. 399.

Lectotype, male: "S. Catarina Lüderwaldt," "Co-Typus," "Inst. Zool. P.A.N. Warszawa Syntypus Nr. 1716," "Lectotype *Dicentropus flavipes* Ulmer By Flint." In Warsaw.

The figures of the genitalia were made from the lectotype.

Helicopsychidae

Tetanonema clarum Ulmer

FIGURES 5*i-k*

Tetanonema clarum Ulmer, 1905a, pp. 17, 18; 1907b, pp. 95, 96; 1913, p. 404.—Jorgensen, 1919, p. 398.—Tomaszewski, 1961, p. 5.

Lectotype, male: "S. Catarina Lüderwaldt," "Co-Typus," "Inst. Zool. P.A.N. Warszawa Syntypus Nr. 1762," "Lectotype *Tetanonema clarum* Ulmer By Flint." In Warsaw.

The lectotype lacks the left forewing and one antenna but is otherwise complete. The figures of the male genitalia were made from the lectotype.

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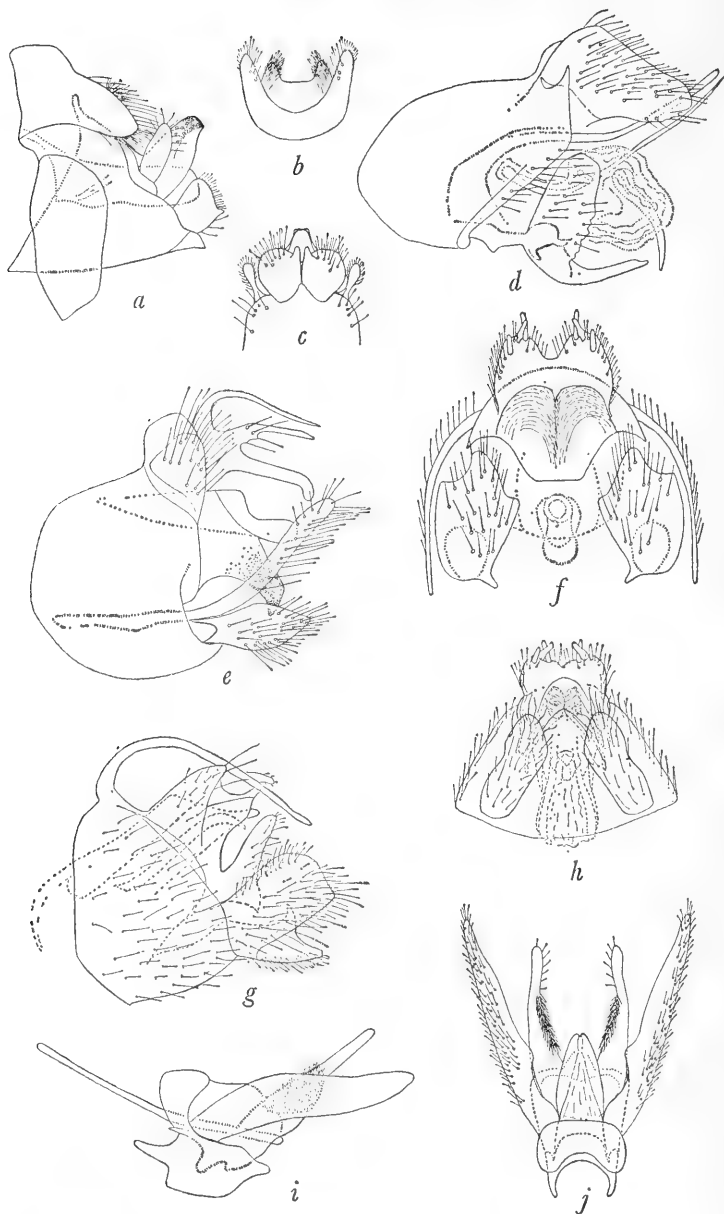


FIGURE 1.—*Chimarra brasiliiana*: *a*, male genitalia, lateral; *b*, eighth tergum, dorsal; *c*, genitalia, ventral. *Mexitrichia albolineata*: *d*, male genitalia, lateral. *Polyplectropus flavicornis*: *e*, male genitalia, lateral; *f*, female genitalia, ventral. *P. annulicornis*: *g*, male genitalia, lateral; *h*, female genitalia, ventral. *Xiphocentron bilimeki*: *i*, male genitalia, lateral; *j*, male, dorsal.

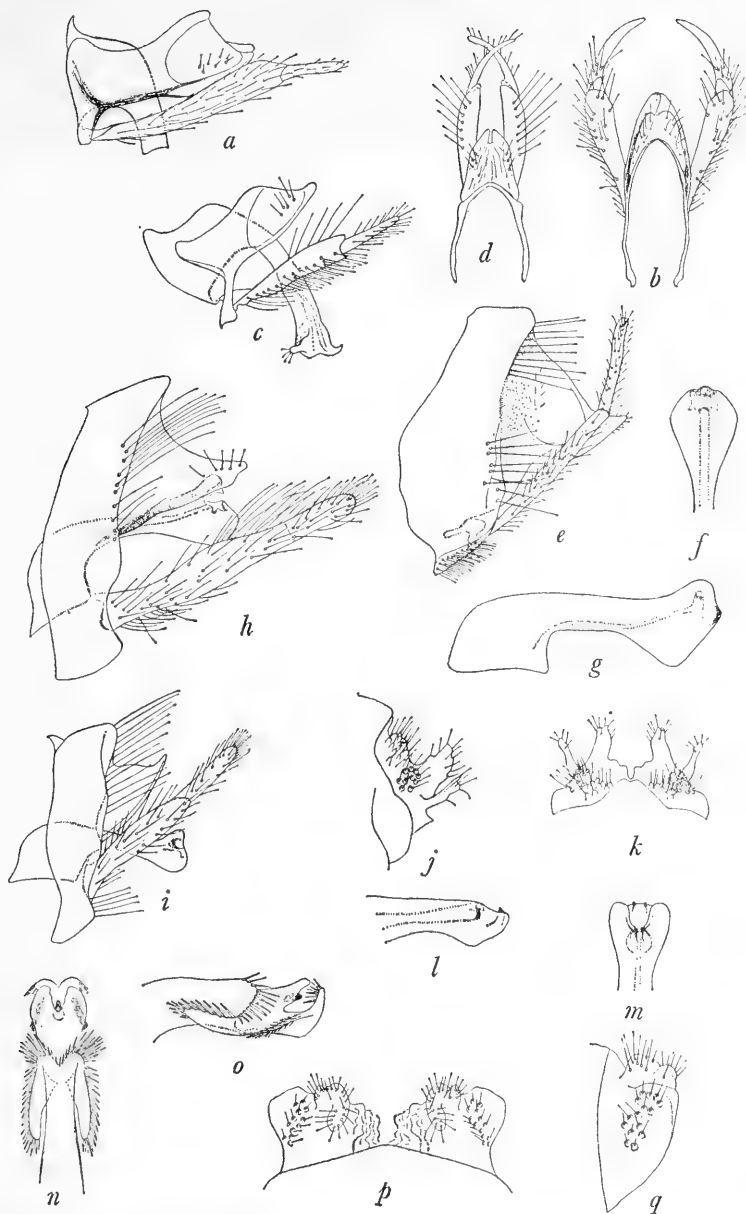


FIGURE 2.—*Rhyacophylax brasilianus*: a, male genitalia, lateral; b, male, dorsal. *R. columbianus*: c, male genitalia, lateral; d, male, dorsal. *Blepharopus diaphanus reticulatus*: e, male genitalia, lateral; f, tip of aedeagus, dorsal; g, aedeagus, lateral. *Synoestropsis obliqua*: h, male genitalia, lateral. *S. pedicillata*: i, male genitalia, lateral. *Lep-tonema cinctum*: j, male tenth tergum, lateral; k, male tenth tergum, dorsal; l, tip of aedeagus, lateral; m, tip of aedeagus, dorsal. *L. stigmatum*: n, tip of aedeagus, dorsal; o, tip of aedeagus, lateral; p, male tenth tergum, dorsal; q, male tenth tergum, lateral.

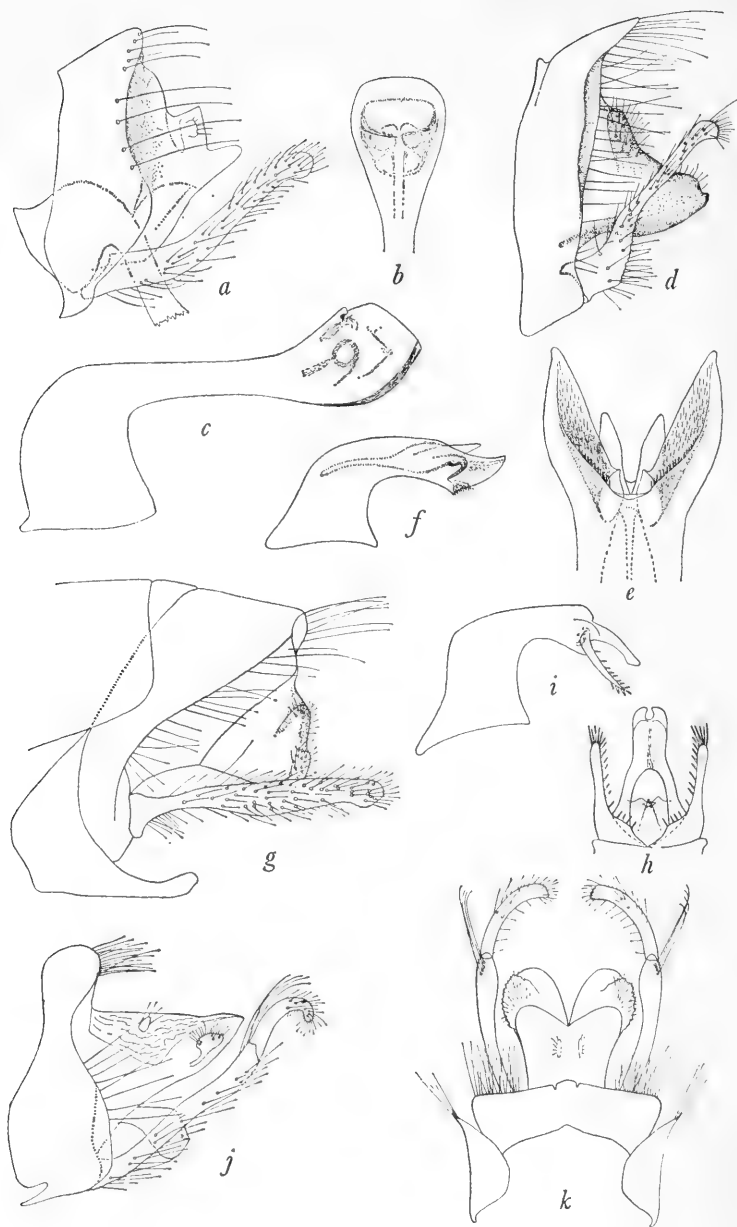


FIGURE 3.—*Macronema parvum*: a, male genitalia, lateral; b, tip of aedeagus, dorsal; c, aedeagus, lateral. *M. bicolor*: d, male genitalia, lateral; e, tip of aedeagus, ventral; f, aedeagus, lateral. *M. argenteolineatum*: g, male genitalia, lateral; h, tip of aedeagus, ventral; i, aedeagus, lateral. *M. tuberosum*: j, male genitalia, lateral; k, male, dorsal.

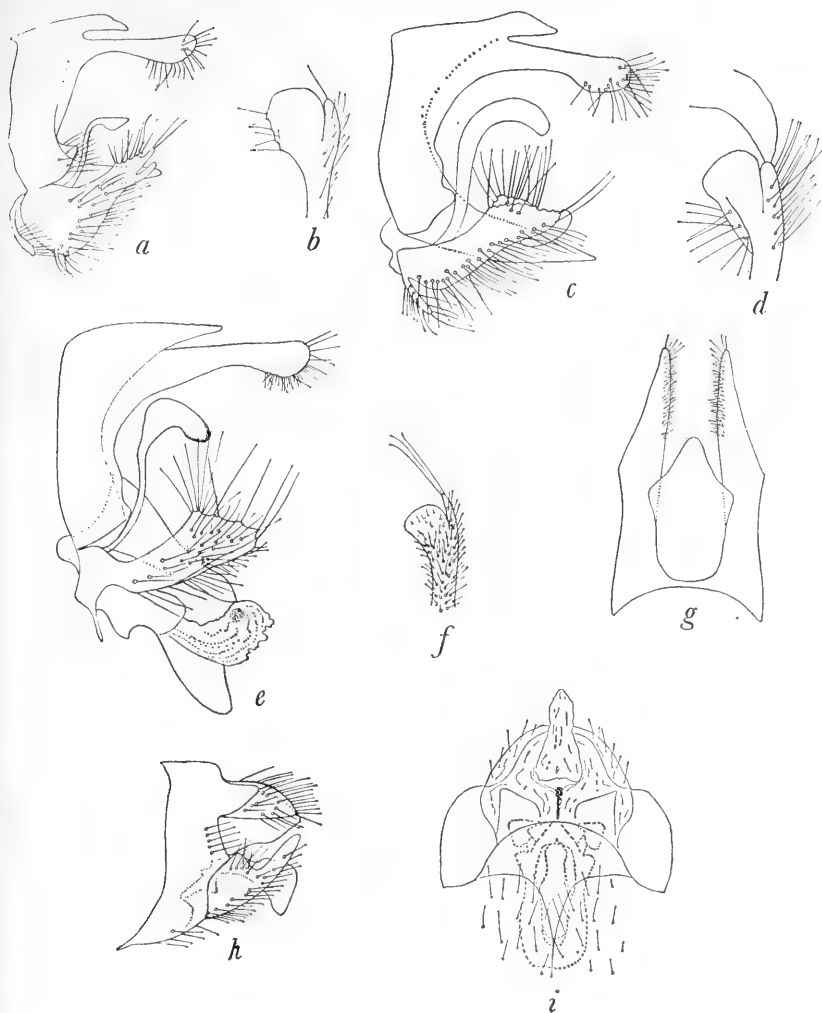


FIGURE 4.—*Leptocella mulleri*: *a*, male genitalia, lateral; *b*, tip of clasper, ventral. *L. flavofasciata*: *c*, male genitalia, lateral; *d*, tip of clasper, ventral. *L. punctata*: *e*, male genitalia, lateral; *f*, tip of clasper, ventral; *g*, male, dorsal. *Oecetis punctipennis*: *h*, male genitalia, lateral; *i*, female genitalia, ventral.

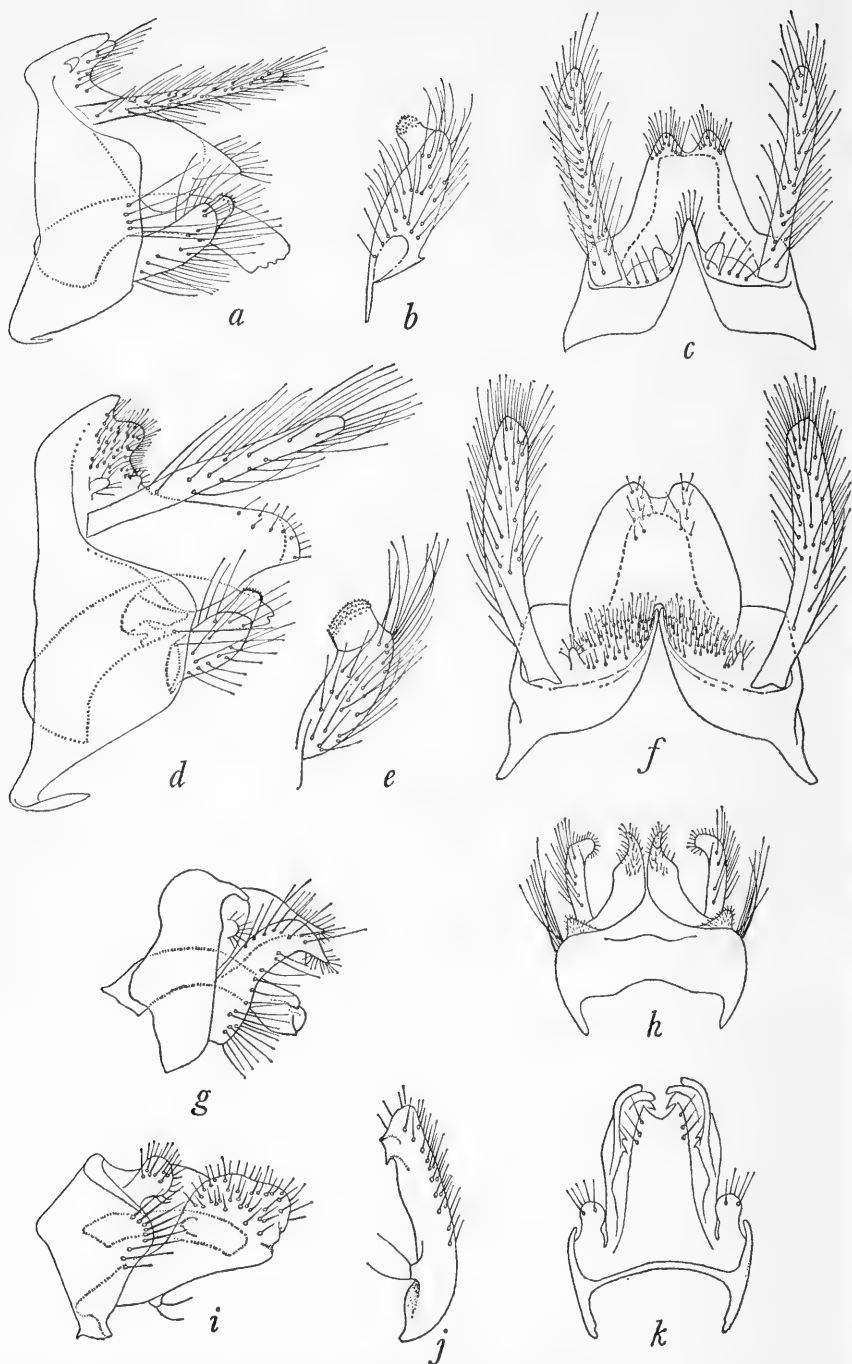
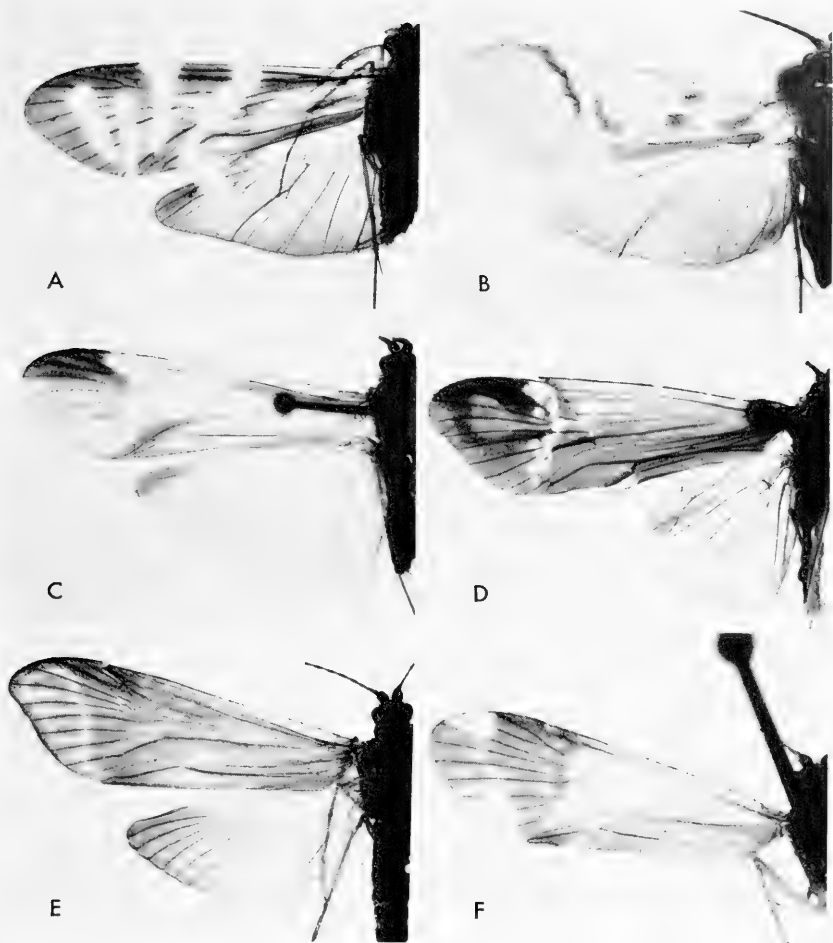


FIGURE 5.—*Phylloicus angustior*: *a*, male genitalia, lateral; *b*, clasper, ventral; *c*, male, dorsal. *P. major*: *d*, male genitalia, lateral; *e*, clasper, ventral; *f*, male, dorsal. *Grumicha flavipes*: *g*, male genitalia, lateral; *h*, male, dorsal. *Tetanonema clarum*: *i*, male genitalia, lateral; *j*, clasper, ventral; *k*, male, dorsal.



FIGURES A-F.—A, *Macronema tuberosum*; B, *M. santaeritae*; C, *M. bicolor*; D, *M. argentilineatum*; E, *Centromacronema excisum*; F, *M. parvum*.



FIGURES A-F.—A, *Synoesdropsis obliqua*; B, *S. pedicillata*; C, *Blepharopus diaphanus reticulatus*; D, *Leptocella mulleri*; E, *L. flavofasciata*; F, *L. punctata*.

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NOTES AND DESCRIPTIONS OF SOME AMERICAN AGARISTINE MOTHS (LEPIDOPTERA: NOCTUIDAE)

By E. L. Todd¹

The following notes on and descriptions of agaristine moths are primarily the result of studies of the noctuid fauna of Cuba but include comments on specimens from other areas of America. The studies have been based mainly on specimens in the collection of the U.S. National Museum, supplemented by material from the collections of C. P. Kimball, Barnstable, Mass., Ing. Fernando de Zayas Munoz and Dr. Pastor Alayo Dalmau, Habana, Cuba, and photographs of types in the British Museum (Natural History), supplied through the courtesy of D. S. Fletcher and the authorities of that institution.

Euthisanotia unio Hübner

Euthisanotia unio Hübner [1827–1831], *Zuträge zur Sammlung exotischer Schmetterlinge*, Drittes Hundert, p. 12, figs. 431, 432.

A single specimen labeled "Havana, Cuba, Baker" is in the collection of the U.S. National Museum. It undoubtedly represents a stray from the north, an introduced specimen, or one that has been

¹ Entomology Research Division, U.S. Department of Agriculture, Washington, D.C.

incorrectly labeled. To my knowledge, the species has not been collected in Cuba by any of the Cuban lepidopterists.

Caularis undulans Walker

Caularis undulans Walker, 1857, List of the specimens of lepidopterous insects in the collection of the British Museum, pt. 12, p. 801.

Eudryas bartholomaei Boisduval, 1874, Rev. Mag. Zool., ser. 3, vol. 2, p. 59.

This species (fig. 18) may be separated from *C. lunata* Hampson (fig. 16) by the absence of the discal spot in the hindwing. *C. undulans* Walker differs from *C. jamaicensis*, new species (fig. 17), in that the white scales near the tornus of the forewing form a short longitudinal bar as in *lunata*, and the basal tuft of the abdomen is white medially, not a uniformly black transverse patch.

The original description was based on a male from Santo Domingo [Dominican Republic]. The type of the synonym, *E. bartholomaei* Boisduval, is a female from Saint-Barthélemy Island. In addition to the types, there are three specimens in the British Museum (Natural History). The additional specimens are an unlabeled female, a male from Jamaica, and another male from Puerto Rico. Seven specimens from Puerto Rico and one specimen from Cruz Bay, Saint John, Virgin Islands are in the collection of the U.S. National Museum.

Caularis lunata Hampson

Caularis lunata Hampson, 1904, Ann. Mag. Nat. Hist., ser. 7, vol. 14, p. 169.

Hampson described this species from two females from Nassau, Bahamas. In the British Museum the only specimens are the two syntypes. Both are labeled "Bahamas, Sir. G. Carter [accession number], 1904-200." One specimen marked as type has rather faded hindwings. It has been selected and labeled as lectotype because it was marked type, and because it obviously was the specimen figured by Hampson, 1910 (Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 9, p. 406, pl. 145, fig. 31). Three males in the collection of the U.S. National Museum (two received as a gift from Ing. Zayas) from localities in Oriente Province of Cuba are referable to this species. Both sexes possess a moderately heavy, terminal, fuscous band between veins Sc+R₁ and M₃ of the hindwing.

This species is easily recognized by the presence of a large dark discal spot in the hindwing (fig. 16).

Caularis jamaicensis, new species

Caularis undulans Walker.—Hampson, 1910, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 9, p. 406, fig. 191.

Description: Eyes large, hemispherical, naked; ocelli small, located above margin of eye immediately caudad of base of antenna; antenna

pectinate in male, weakly serrate in female; frons provided with a slender, conical prominence, the apex rounded and minutely depressed as in *undulans*, diameter of apex smaller than in *lunata*; labial palpi nearly correct, first and second segments mostly black except loose ventral fringe mixed black and white and apical fourth of second segment with some white scales, third segment small, clothed with appressed, mixed dark and light scales. Vestiture mostly of hair and hairlike scales, head gray in appearance, a mixture of dark and white scales; collar mixed brown and white; tegulae and thorax red brown becoming darker toward posterior; abdomen pale yellow with a transverse tuft of blue-black iridescent scales on first segment; pectus pale yellow or white. Legs moderately long; forelegs dark, scaling mixed brown, black and white, middle legs much paler but of mixed dark and light scales, hindlegs pale; all legs with a moderate fringe of scales on femora.

Pattern of maculation as illustrated (fig. 17). Forewing with post-medial line dark reddish brown; basal spot along inner margin, area around reniform and orbicular spots, and subterminal area distad of postmedial line dull olive green; anterior half of subterminal area suffused with darker red-brown scales; median area including ordinary spots and terminal area suffused with dark gray, metallic scales that tend toward a violet iridescence; a narrow V formed by two vague white lines above tornus; fringe brown, darker at tornus. Hindwing mostly yellow orange; a vague salmon-colored marginal band from apex to Cu_1 ; cell Cu_1 with a black spot covering half or more of the salmon spot; cell Cu_2 with an extensive broad salmon spot bordered or partially bordered with black; fringe yellow or whitish from apex to middle of cell Cu_1 , then metallic black to anal angle. Wings ventrally dull yellow with some salmon suffusion toward apex of forewing and margin of hindwing; reniform and sometimes orbicular spots of forewing weakly indicated. Length of forewing: Male 18 to 19 mm., female 19 to 21 mm.

Type male, Jamaica, USNM 64644 and two male paratypes, Jamaica, in the U.S. National Museum, Washington, D.C. Two male paratypes, Runaway Bay, Jamaica, April 1905, Walsingham; one male paratype, Jamaica; one male paratype, Moneague, Jamaica, April 9, 1928, 1200 ft., Dr. F. W. Jackson; one male paratype, Jamaica, Yates; one male paratype, Jamaica, Dr. Jackson; one female paratype, Sturridge, Jamaica; one female paratype, Saint Ann, Jamaica, Martin, in the British Museum (Natural History), London, England.

This species was erroneously figured by Hampson (1910, fig. 191) as *undulans*. It differs from that species in that white lines near the tornus of the forewing form a V, and the tuft of scales on the first abdominal segment form a uniformly black transverse patch.

It lacks the large black discal spot of the hindwing that is present in *lunata*.

Euscirrhopterus Grote

- Euscirrhopterus* Grote, 1866 (July), Proc. Ent. Soc. Philadelphia, vol. 6, p. 176; 1867, Proc. Ent. Soc. Philadelphia, vol. 6, pp. 310, 329.—Gundlach, 1881, Contribución á la Entomología Cubana, Lepidopteros, vol. 1, p. 234.—Möschler, 1890, Abh. Senckenberg Naturf. Ges., vol. 16, p. 349. [Type-species: *Euscirrhopterus poeyi* Grote, monobasic.]
- Euscirrhopterus* [sic] Grote—Kirby, 1892, A synonymic catalogue of Lepidoptera Heterocera, vol. 1, p. 40. [A misspelling.]
- Euschirropterus* [sic] Grote—Hampson, 1901, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 3, p. 619.—Jordan, 1908, Nov. Zool., vol. 15, no. 1, p. 254.—Strand, 1912, Lepidopterorum catalogus, pt. 5, p. 28.—Draudt, 1919, in Seitz, Gross-Schmetterlinge der Erde, vol. 7, p. 4.—Hampson, 1920, Catalogue of the Lepidoptera Phalaenae in the British Museum, Supplement, vol. 2, pp. 583–584.—Forbes, 1939, Bull. Mus. Comp. Zool., vol. 85, no. 4, p. 230.—Bruner, Scaramuzza, and Otero, 1945, Cuba Estac. Expt. Agron. Bol. 63, p. 141. [A misspelling.]
- Heterandra* Herrich-Schäffer, 1866 (September), Corresp. Blatt Zool.-Min. Verein. Regensburg (Naturw. Ver. Regensburg), vol. 20, p. 134. [Type-species: *Heterandra disparilis* Herrich-Schäffer, monobasic.]
- Laquea* Jordan, 1896, Nov. Zool. vol. 3, p. 41.—Druce, 1896, in Godman and Salvin, Biologia Centrali-Americana, Insecta, Lepidoptera, Heterocera, vol. 2, p. 329. [Type-species: *Euthisanotia argentata* Druce, original designation and monobasic.]

In 1867 Grote ("Notes on the Zygaenidae of Cuba, Part II," loc. cit.) treated *Heterandra disparilis* Herrich-Schäffer as generic and specific synonyms of his own *Euscirrhopterus poeyi*. He cited his names as published in July 1866 and Herrich-Schäffer's in September of that year. Since that time most authors have utilized *Euscirrhopterus* Grote or one of two misspellings of the name and also the specific name *poeyi*. Grote did submit part I of the paper for publication on February 12, 1866. Grote's cited date of publication was apparently based on the printer's date on the lower right corner of the first page of each signature of the paper. Brown (1964, Trans. Amer. Ent. Soc., vol. 89, nos. 3, 4, p. 308, a paper on the dates of publication of the parts of the six volumes of the "Proceedings of the Entomological Society of Philadelphia") states that the earliest date of publication of number 2 of volume 6 (pp. 153–252) was March 4, 1867. According to Brown (1964, p. 306), the authors of articles published in this journal received 50 author's copies as each separate was printed. When the author had received all of the signatures containing his article, he was at liberty to distribute them. On the other hand, the society did not distribute such articles to the members and subscribers until all the signatures of a number had been printed, collated, and stitched. Brown considers that "the earlier dissemination by the

author is distribution of a 'pre-print' with no bibliographic standing." "The International Code of Zoological Nomenclature of 1961" does not exclude preprints. Preprints conform to the requirements of article 8, "What Constitutes Publication." Furthermore, they are not excluded under article 9, "What Does Not Constitute Publication." Recommendation 21D states: "Preprints should be definitely identified as such." This is, however, only a recommendation, and it was obviously not intended that the recommendation be retroactive.

The resolution of the problem of publication dates for these particular papers of Grote and Herrich-Schäffer is dependent upon answers to the following questions: Is the printer's date "July 1866" for Grote's paper accurate? If so, did Grote receive author's copies at that time or at some time prior to the distribution of the number by the society? Did he distribute copies prior to the society's distribution of the paper (*Proc. Ent. Soc. Philadelphia*, vol. 6, no. 2, pp. 153-252)? Is the date of publication for number 2 of volume 6 ("March 4, 1867") as Brown indicated? Were numbers of the yearbook (*Corresp. Blatt Zool.-Min. Verein. Regensburg*) that contained Herrich-Schäffer's paper published in July, August, and September of 1866?

In the absence of evidence to the contrary, the printer's date "July 1866" must be considered to be accurate. This date of printing does not seem unreasonable considering the fact that Grote had submitted the paper for publication 5 months previously.

We do not have any direct evidence that Grote did, in fact, receive author's copies prior to distribution of the number by the society. Brown (1964, p. 306) has indicated that receipt of author's copies was the usual practice, but, in the absence of definite evidence, we cannot conclude that Grote received such copies of the paper in question. Grote did have separates because the *Proceedings* (*Proc. Acad. Nat. Sci. Philadelphia*, vol. 19, p. 269, under "Donations to the Library") reported receiving a copy from Grote sometime in 1867. That Grote considered his paper to have been published in July 1866 may, but does not necessarily, indicate that he had received author's copies by that date. It would be helpful if we knew what Grote considered to constitute publication. Some authors of the past thought that the date manuscripts were accepted for publication was the publication date or at least utilized such dates in claiming priority over papers accepted at later dates by other publications. Grote may have considered the date printed to be the date of publication.

A search of the literature has produced the following information supporting Brown's cited year of publication, but no additional actual dates within the year are known. The *Zoological Record* (1867, vol. 4, p. 335) cited the date of the Grote paper as 1867. The receipt in 1867

(Proc. Ent. Soc. Philadelphia, vol. 6, 1866-1867) and Grote's separate are recorded under "Donations to the Library" (Proc. Acad. Nat. Sci. Philadelphia, 1867, vol. 19, pp. 259, 269). Dyar (1903, Bull. U.S. Nat. Mus., no. 52, p. 77) cites the description of *Horama texana* Grote (p. 184) as 1867. But on p. 43 Dyar cites *Nomiades antiacis mertila* Edwards (Proc. Ent. Soc. Philadelphia, vol. 6, p. 206) as 1866.

The date of publication for the part of the paper by Herrich-Schäffer appearing in volume 20 (Corresp. Blatt Zool.-Min. Verein. Regensburg) is cited as 1866 by all authorities known to me. In my search of the literature I have discovered no positive information as to the month of appearance of the different numbers of the volume. If the printer's date "January 1867" on the signatures containing part II of Grote's paper is correct, it is certain that Herrich-Schäffer's paper was published in 1866. Grote had a copy and cited the species described by Herrich-Schäffer. This action by Grote would not have been possible then unless the publication date was well before January 1867.

On the basis of our present information, it is not possible to state with certainty whether Grote's "Notes on the Zygaenidae of Cuba, Part I" appeared before or after the paper by Herrich-Schäffer. In the absence of conclusive evidence, it is undoubtedly best for the present to continue the usage of the Grote names. If the names of Herrich-Schäffer should subsequently be applied, it would be necessary to point out that four species of Ctenuchidae (Syntomidae) treated in the two works would also require a change in name.

The other generic synonym, *Laquea* Jordan, was based on a female and compared with a male of *Euschirropterus* [sic] Grote. Jordan noted a difference in the venation but was unaware that he was comparing the two sexes of the same species. *E. poeyi* Grote males have vein R_2 stalked with vein R_3 beyond R_4 ; in the female R_3 and R_4 are stalked beyond R_2 . In 1901 Hampson placed *Laquea* Jordan in the synonymy of *Euschirropterus* [sic] Grote.

Euschirropterus poeyi Grote

Euschirropterus poeyi Grote, 1866 (July), Proc. Ent. Soc. Philadelphia, vol. 6, p. 176.

Heterandra disparilis Herrich-Schäffer, 1866 (September), Corresp.-Blatt Zool.-Min. Verein Regensburg (Naturw. Verein Regensburg), vol. 20, p. 134.

Euthisanotia argentata Druce, 1894, Ann. Mag. Nat. Hist., ser. 6, vol. 13, p. 352.

In females of the populations in Mexico and Guatemala (fig. 7), the orbicular spot of the forewing is slightly larger and darker than that in the specimens of the same sex from the typical Cuban population. In females from Cuba the orbicular spot may be completely lacking or indicated only by a minute spot (fig. 6).

Euscirropterus klagesi Jordan

- Euschirropterus* [sic] *klagesi* Jordan, 1908, Nov. Zool., vol. 15, p. 254, pl. 11, fig. 9.—Strand, 1912, Lepidopterorum catalogus, pt. 5, p. 28.—Draudt, 1919, in Seitz, Gross-Schmetterlinge der Erde, vol. 7, p. 4, pl. 1, row e.—Hampson, 1920, Catalogue of the Lepidoptera Phalaenae in the British Museum, Supplement, vol. 2, p. 583 (in error as synonym of *E. valkeri* [sic] Hampson).
- Euschirropterus* [sic] *poeyi pulverosa* Dyar, 1914, Proc. U.S. Nat. Mus., vol. 47, no. 2050, p. 175. [New synonymy.]

This species was placed in the synonymy of *E. valkeri* Hampson by Hampson in 1920, but that synonymy is erroneous for typical *klagesi*. Jordan had only females for study and considered the differences observed as subspecific when he described *E. klagesi* and *E. klagesi tucumanus*. The two names do not apply to the same species. The differences in maculation between the two species are greater for the males than for the females (figs. 1-4). The females of *klagesi* differ from those of *valkeri tucumanus* as follows: The distal part of the forewing from the tornus to the middle of the termen is suffused with white scales; the inner edge of the dark marginal band of the hindwing is rather dentate before the terminal orange spot, the width of the marginal band is about one-fourth the length of the wing, the fringe whitish from the apex to the terminal orange spot; the yellow of the undersurface of the hindwing usually extends across vein Sc+R₁ toward the costa in the postmedial area. In females of *valkeri tucumanus* the distal part of the forewing is nearly uniformly dark except the small white area basad of the dark terminal spot before the tornus; the marginal band of the hindwing is smoother along the inner edge, wider, the width about one-third the length of the wing, the fringe dark; the yellowish orange of the lower surface of the hindwing usually does not cross vein Sc+R₁ in the postmedial area. The male of *klagesi* differs considerably from that of *valkeri tucumanus*; in fact, it resembles that sex of *poeyi*, but the hindwing does not possess a dark marginal band, and it has but a single, well-developed, orange terminal spot. The male of *valkeri tucumanus* is smaller and resembles the females more in maculation.

The illustration of the female of *klagesi* provided by Jordan agrees with the females of the type series of *E. poeyi pulverosa* Dyar. Accordingly, I do not hesitate to place *pulverosa* in the synonymy of *klagesi*. Dyar indicated some of the differences between the females of *pulverosa* and *poeyi*; for example, the dark line separating the white area of the forewing from the dark area in *poeyi* is absent in *pulverosa*, and the reniform and orbicular spots of the forewing are shaped differently (figs. 4, 6, 7). In addition, the females of *pulverosa* (= *klagesi*) have only a single, distinct, marginal, black point on the termen of the forewing, a single yellow spot in the dark marginal band of the hind-

wing, and they have the apical part of the antenna flattened, appearing to be clubbed in a lateral view. The corresponding markings of females are different in *poeyi*, and the antenna is simple and filiform; in *klagesi* the length of the forewing of the male is 17 mm., that of the females 17 to 21 mm.

Jordan described *klagesi* from three females from Ciudad Bolívar, Orinoco [Ciudad Bolívar, Bolívar, Venezuela], July 1898, S. M. Klages. I select the specimen he illustrated, plate 11, figure 9, as the lectotype. The specimen is in the British Museum (Natural History) via the Rothschild collection and has been labeled as lectotype. Dyar's original series of *pulverosa* was composed of one male and six female cotypes from La Chorrera, Panama. The specimens are in the collection of the U.S. National Museum. I have selected and labeled one of the females as the lectotype. The genitalia of the lectotype have been mounted on slide number 294 by J. G. Franclemont, and the specimen is so labeled.

E. klagesi Jordan is known mainly from the type localities. Jordan discusses a specimen from Guayaquil, Ecuador, that is either referable to this species or to *walkeri tucumanus*. It will be necessary to restudy the specimen to determine the correct placement. Two females from Pernambuco, Brazil, in the U.S. National Museum presumably belong to this species but differ slightly as the brown postmedial marking of the forewing does not extend as far basad as it does in the females from Panama and Venezuela. Obviously more material of *klagesi* is needed to determine its distribution and the extent of its individual and population variability.

Euscirropterus walkeri Hampson

Euschiropterus [sic] *walkeri* Hampson, 1901, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 3, pp. 619, 620, fig. 270.—Strand, 1912, *Lepidopterorum catalogus*, pt. 5, p. 28.—Draudt, 1919, in Seitz, *Die Gross-Schmetterlinge der Erde*, vol. 7, p. 4, pl. 1, row b.—Hampson, 1920, Catalogue of the Lepidoptera Phalaenae in the British Museum, Supplement, vol. 2, p. 583.

Hampson obviously named this species after the collector of the type series, J. J. Walker, but he deliberately changed the "w" to a "v" as was his usual practice in latinizing scientific names. He usually also changed "k" to "c" but did not do so in this instance. Strand (1912, *Lepidopterorum catalogus*, pt. 5, p. 28) suggested that the name should be "*walkeri*." I agree with Strand and have emended the name accordingly.

Typical *walkeri* is known to me only from the description and illustration of Hampson. The species was described from a male and female from Valparaiso, Chile. Hampson did not indicate which specimen was the type and noted no differences in size or



FIGURES 1-6.—Adults of species of *Euscirrhopterus* Grote, dorsal view: 1, 2, *E. walker, tucumanus* Jordan, ♂ and ♀, Tucumán, Argentina; 3, 4, *E. klagesi* Jordan, ♂ and ♀, La Chorrera, Panama; 5, 6, *E. poeyi* Grote, ♂ and ♀, Cuba.



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FIGURES 7-12.—Adults of Neotropical agaristids: 7, *Euscirrhopterus poeyi* Grote, ♂, Mexico; 8, *Tuerta hemicycla* Hampson, ♂, Las Villas, Cuba; 9, 10, *T. hemicycla* Hampson, ♂, Pinar del Rio, Cuba, dorsal and ventral views; 11, *Gisaucula peruviana* (Druce), ♂, Incahaca, Cochabamba, Bolivia; 12, *Schalifrontia furcifer* Hampson, ♂, Santa Catarina, Brazil.



13



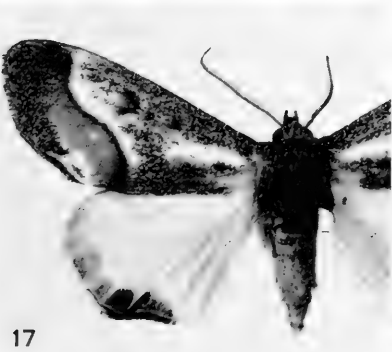
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FIGURES 13-18.—Adults of Neotropical agaristids: 13, *Tuerta sabulosa* (Felder), ♀, Jalapa, Mexico; 14, 15, *T. sabulosa collectiora* new subspecies, type ♂, Baracoa, Cuba and para-type ♀, C. ortl. de Zapata Aguada, Las Villas, Cuba; 16, *Caularis lunata* Hampson, ♂, Santiago de Cuba, Oriente, Cuba; 17, *C. jamaicensis*, new species, ♂, Jamaica; 18, *C. undulans* Walker, ♀, Parguera, Isla Maguey, Puerto Rico.



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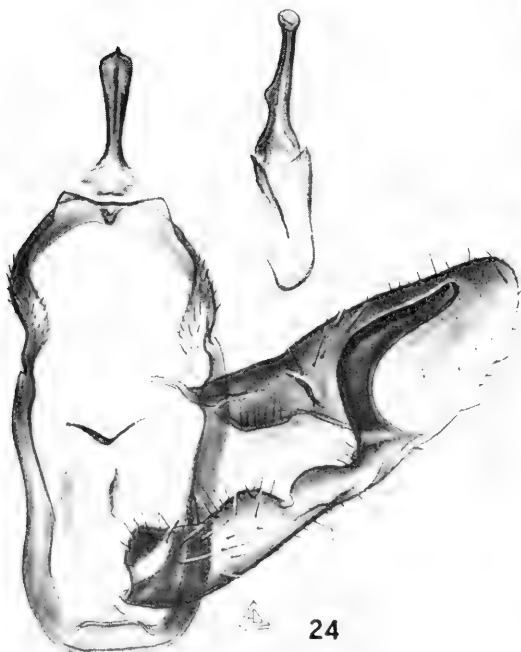
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FIGURES 19-25.—Adults and genitalia of Neotropical agaristids: 19, 20, *Tuerta hemicycla* Hampson, dorsal and ventral views, type ♂, Abaco, Bahama Islands; 21, *Cisaucula peruviana* (Druce), lectotype ♂, Santo Domingo, southeast Peru; 22, 23, *Tuerta sabulosa* (Felder), ♂ type *T. insulica* Hampson, Trinidad, dorsal and ventral views; 24, *Cisaucula peruviana* (Druce), ♂ genitalia, aedeagus removed and shown to the right; 25, *C. peruviana* (Druce), ♀ genitalia.

maculation of the two sexes. It is possible that he described only the male. The male was labeled as type by Hampson. That specimen is selected as lectotype, and it has been so labeled in the British Museum (Natural History).

***Euscirrhopterus walkeri tucumanus* Jordan**

Euschirropterus [sic] *klagesi tucumanus* Jordan, 1908, Nov. Zool., vol. 15, p. 254.

Euschirropterus [sic] *klagesi* var. *tucumanus* Jordan.—Strand, 1912, Lepidopterorum catalogus, pt. 5, p. 28.

Euschirropterus [sic] *klagesi* form *tucumana* Jordan.—Draudt, 1919, in Seitz, Die Gross-Schmetterlinge der Erde, vol. 7, p. 4.

Euschirropterus [sic] *walkeri tucumanus* Jordan.—Hampson, 1920, Catalogue of the Lepidoptera Phalaenae in the British Museum, Supplement, vol. 2, p. 583.

Hampson (1920) placed *klagesi* Jordan as a synonym of *walkeri* and treated *tucumanus* as a subspecies of it. I have already indicated that *klagesi* is a species distinct from *walkeri* and *tucumanus*. For the present it seems best to leave *tucumanus* as a subspecies of *walkeri*. The forewing of the known males of *tucumanus* have much more white than is indicated for *walkeri*. The determination of the actual status of *tucumanus* undoubtedly will require additional material and further revisional and biological studies. Length of the forewing: male, 14 mm.; female, 18 to 23 mm. Male and female are illustrated in figures 1 and 2.

The type series is in the British Museum (Natural History) via the Rothschild collection. The specimen labeled type is selected as lectotype and has been so labeled. There are 2 males and 18 females in the collection of the U.S. National Museum. Eight of the females in this collection belong to the dark form named *fusca* by Jordan. All known specimens are from Tucumán, Argentina.

***Euscirrhopterus discifera* Hampson**

Euschirropterus [sic] *discifera* Hampson, 1901, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 3, p. 621, pl. 51, fig. 9.—Strand, 1912, Lepidopterorum catalogus, pt. 5, p. 28.—Draudt, 1919, in Seitz, Die Gross-Schmetterlinge der Erde, vol. 7, p. 4, pl. 1, row a.

The illustrations provided by Hampson and Draudt will permit the identification of this species. The forewing has the basal dark mark and the reniform spot nearly black, darker than the dark distal part of the wing; the orbicular spot may be present or absent; the collar dark brown, nearly black, contrasting with the white head and gray thoracic scaling. Males are unknown. Length of the forewing female, 20 to 23 mm.

The type, a female from Santa Catarina, Brazil, is in the British Museum (Natural History). There are nine females, all from the type locality, in the U.S. National Museum.

Tuerta hemicycla Hampson

Tuerta hemicycla Hampson, 1904, Ann. Mag. Nat. Hist., ser. 7, vol. 14, p. 166; 1920, Catalogue of the Lepidoptera Phalaenae in the British Museum, Supplement, vol. 2, p. 588, pl. 71, fig. 10 [sic].

Hampson described this species from a unique male from Abaco, Bahama Islands. He figured the type in his second treatment (pl. 71, fig. 11). In the text of that paper (p. 588, and on the page of explanation of pl. 71), he erroneously refers the name *Tuerta hemicycla* Hampson to figure 10. There is a very definite misapplication of names to figures 9, 10, and 11 of that plate. The figure citations for *xenia* (p. 590, fig. 11) and for *insulica* (p. 585, fig. 9) are also incorrect and should be changed. The correct assignment should be as follows:

9. <i>Massagidia xenia</i> , ♂	Suppl. II, p. 590	Cameroons
10. <i>Tuerta insulica</i> , ♂	" " p. 585	Trinidad
11. <i>Tuerta hemicycla</i> , ♂	" " p. 588	Bahamas

A pair of *hemicycla* is now in the collection of the U.S. National Museum through the kindness of Ing. F. de Zayas, Habana, Cuba. The male is from "C. ortl. de Zapata Aguada," Las Villas, Cuba, May 1956; the female from Viñales, Pinar del Rio, Cuba, July 1955. Both were collected by Zayas, who has other specimens. A female collected on Key Largo, Florida, July 20, 1962, by H. V. Weems, Jr., has also been studied. The species is sexually dimorphic. Both sexes from Cuba and the type from Abaco, Bahamas, are illustrated in this paper (figs. 8-10, 19, 20). The female is described as follows:

Slightly larger than male (length of forewing of male, 13 mm., that of female, 14 to 16 mm.); forewing broader, apex less acute. Eyes globoid, moderately large, smaller than in male, accordingly frons wider, white, entirely lacking long, black hairs that ornament frons of male. Antenna simple, filiform, rather stout, but not clubbed as in male. Maculation of upper surface of wings as illustrated (fig. 9). Ground color white, the area distad of the postmedial line dusted with fuscous scaling, small triangular patches of fuscous scales at apices of cells M_2 and Cu_1 ; some gray green in the ordinary spots, median part of costa, and distad of the postmedial line; all the transverse lines (the fine terminal line, short dentate subterminal line, postmedial line, and antemedial line) black; area between postmedial and antemedial lines from fold to inner margin metallic gray. Hindwing mostly yellow orange; a dark, marginal, fuscous band tapering toward anal angle, the band subterminal between Cu_2 and anal angle; some pale scales on apices of veins M_1 , Cu_1 and Cu_2 in the marginal band; a small indistinct fuscous discal spot present; terminal line fine, black in color. Maculation of lower surface of wings as illustrated (fig. 10); basal area of hindwing yellow orange, remainder of wing white or fuscous as indicated in the illustration.

In general habitus, the female resembles *Tuerta sabulosa* (Felder), especially the form *albidisca* Draudt, but may be easily distinguished by the shape of the postmedial line (bent basad in posterior half of forewing as far as outer margin of orbicular spot, then parallel to antemedial line to inner margin), by the presence of a fine, black, terminal line in both wings, by the black triangular patches at the apices of cells M_2 and Cu_1 of the forewing, and by the narrower, fuscous, marginal band of the hindwing.

Judging from the pattern of maculation and the sexual dimorphism, this species appears to be intermediate to the other American species placed in *Tuerta* Walker and species of the genus *Euscirrhopterus* Grote. I do not believe that the American species should be placed in *Tuerta* or in the subgenus *Misa* Karsch, but as I do not have examples of *Tuerta chrysochlora* Walker or *Misa memnonia* Karsch, the two type-species from Africa, it seems best for the present to follow previous workers in the generic placement of *hemicycla* and to include the following species.

Tuerta sabulosa (Felder)

Agarista sabulosa Felder, 1874, in Felder, Felder, and Rogenhofer, Zoologischer Theil, vol. 2, no. 2, Lepidoptera, in Reise der Österreichischen Fregatte Novara um die Erde . . . , table 107, fig. 11; 1875, *ibid.*, explanation for tables 75 bis 107, p. 1.

?*Eusemia sabulosa* (Felder).—Boisduval, 1874, Rev. Mag. Zool., ser. 3, vol. 2, p. 106.

Metagarista sabulosa (Felder).—Butler, 1875, Ann. Mag. Nat. Hist., ser. 4, vol. 15, p. 139.

Seudytia sabulosa (Felder).—Neumoegen and Dyar, 1894, Journ. New York Ent. Soc., vol. 2, p. 19.

Copidryas sabulosa (Felder).—Druce, 1896, in Godman and Salvin, Biologia Centrali-Americana, Insecta, Lepidoptera, Heterocera, vol. 2, p. 329.

Tuerta (*Misa*) *sabulosa* (Boisduval).—Hampson, 1901, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 3, p. 625.

Tuerta sabulosa (Boisduval).—Holland, 1903, The moth book, p. 143, fig. 81.—Hampson, 1920, Catalogue of the Lepidoptera Phalaenae in the British Museum, Supplement, vol. 2, p. 588.—Forbes, 1930, Scientific survey of Porto Rico and the Virgin Islands, vol. 12, pt. 1, p. 43.

Tuerta sabulosa (Felder).—Strand, 1912, Lepidopterorum catalogus, pt. 5, p. 29.—Draudt, 1919, in Seitz, Die Gross-Schmetterlinge der Erde, vol. 7, p. 5, pl. 1, row b, row a (forms *albidisca* and *albiplaga*).

Misa sabulosa (Boisduval).—Dyar, 1903, Bull. 52, U.S. Nat. Mus., p. 96, no. 942.—Barnes and McDunnough, 1917, Check List of the Lepidoptera of Boreal America, p. 36, no. 1037.—McDunnough, 1938, Mem. So. California Acad. Sci., vol. 1, p. 53, no. 1107.—Wolcott (1948) 1951, Puerto Rico Univ. Journ. Agric., vol. 32, p. 581.

Agarista noctuiformis Möschler, 1890, Abh. Senck. Naturf. Ges., vol. 16, p. 112.—Gundlach, 1891, Soc. Españ. de Hist. Nat. Ann., vol. 20, p. 153.—Hampson, 1901, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 3, p. 625 (as synonym of *sabulosa*).

Tuerta noctuiformis (Möschler).—Wolcott, 1924, Porto Rico Dept. Agric. Journ., vol. 7, p. 160.

Tuerta insulica Hampson, 1909, Ann. Mag. Nat. Hist., ser. 8, vol. 4, p. 365.—Strand, 1912, Lepidopterorum catalogus, pt. 5, p. 29.—Hampson, 1920, Catalogue of the Lepidoptera Phalaenae in the British Museum, Supplement, vol. 2, p. 585, pl. 71, fig. 9 [sic, recte fig. 10]. [New synonymy.]

A complete synonymy has been presented to indicate the incorrect author citations for this species. All the American lepidopterists have been in error in following Hampson's citation of Boisduval as author of *sabulosa*. Boisduval gives a complete, accurate reference to the Felder plate and figure and credits the name to Felder. Hampson gave no reason for his use of Boisduval as author. It is possible that he did not consider the Felder treatment to constitute a description. The original description by Felder consists of only a colored illustration of the moth and the name "*A. sabulosa* F." Felder figured 25 moths on table 107 including 10 species assigned to *Agarista*. He used the complete generic name for the first species of the genus but used only the abbreviation "*A.*" for the remainder.

This species is recorded in the literature from San Francisco, Calif. (Felder, Felder, and Rogenhofer, 1875), New Mexico (Hampson, 1901), Arizona (Neumoegen and Dyar, 1894), Mexico and Guatemala (Druce, 1896) and Porto Rico (Möschler, 1890, *noctuiformis*). It is doubtful that this species occurs in the United States. The records from Arizona and New Mexico are undoubtedly referable to *Gerra sevorsa* (Grote). *G. sevorsa* (Grote) does occur in those States and was treated as a synonym of *sabulosa* by Neumoegen and Dyar (1894) and by Hampson (1901). Hampson (1920) corrected the erroneous synonym, but he did not change the recorded distribution for *sabulosa*. The type locality "San Francisco, California" must certainly be an error. *Tuerta sabulosa* (Felder) is known to occur in Mexico, Guatemala, El Salvador, and Porto Rico. *Tuerta insulica* Hampson from Trinidad is referred to the synonymy of *sabulosa* in the present paper so that locality may be added to the known distribution. Figures 22 and 23 illustrate the upper and lower surfaces of the wings of the type of *insulica* in the British Museum (Natural History). It is a battered example of *sabulosa* in which the white areas of the right forewing are aberrant. There is one specimen in the collection of the U.S. National Museum, via the Dognin collection, labeled "Paraguay, Pouillon." I do not know whether this locality record is authentic.

There is considerable variation in amount and position of white coloration on the forewings of *sabulosa*. Draudt (1919) named two forms, *albiplaga* (a white spot present distad of reniform spot, median area otherwise dark gray) and *albidisca* (a white spot present distad of reniform spot, but median area around ordinary spots and to the

fold white). Draudt considered the typical form to be that in which the area between the postmedial and antemedial lines is gray, the area distad of the reniform spot not white. In the series of the species in the U.S. National Museum there are all degrees of intermediates between the "forms" of Draudt. Therefore, I do not believe these names are representative of distinct seasonal or population entities.

***Tuerta sabulosa collectiora*, new subspecies**

All of the known specimens of *sabulosa* from Cuba differ from those of other areas as follows: The inner margin of the dark marginal band of the hindwing is excavate in cells M_3 and Cu_1 (figs. 14, 15), whereas the dark marginal band of the hindwing of typical *sabulosa* (fig. 13) is not conspicuously reduced in width in that part of the wing. The genitalia of the Cuban specimens do not differ from those of typical *sabulosa*. The Cuban population is treated as a subspecies because of the different phenotype and the geographic isolation.

Type male, Baracoa, Oriente, Cuba, William Schaus, male genitalia slide number 301, J. G. Franclemont; one male paratype, same place and collector, male genitalia slide number 300, J. G. Franclemont; one male paratype, Tanamo, Oriente, Cuba, Dec., William Schaus; one male and one female paratypes, C. orl. de Zapata Aguada, Las Villas, Cuba, May 1956, F. de Zayas, in the U.S. National Museum, Washington, D.C.

***Gerra radicalis* Walker**

Gerra radicalis Walker, 1864, List of the specimens of lepidopterous insects in the collection of the British Museum, pt. 31, p. 141.

Diamuna adrasta Druce, 1889, in Godman and Salvin, *Biologia Centrali-Americana*, Insecta, Lepidoptera, Heterocera, vol. 1, p. 334, pl. 30, fig. 20.

Three specimens of *Gerra radicalis* Walker from Arizona have been discovered standing in the series of *Gerra sevorsa* (Grote). Two are labeled "Huachuca Mts.," the other is from Palmerly, Cochise County. This species was previously known only from Mexico.

***Schalifrontia furcifer* Hampson**

Schalifrontia furcifer Hampson, 1901, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 3, p. 654, fig. 288.—Strand, 1912, *Lepidopterorum catalogus*, pt. 5, p. 38.—Draudt, 1919, in Seitz, *Die Gross-Schmetterlinge der Erde*, vol. 7, p. 7, pl. 1, row c.

This genus and species were described from a unique female from Santa Catarina, Brazil. The type is in the collection of the British Museum (Natural History). In the collection of the U.S. National Museum there is another female also from Santa Catarina, Brazil, and five males from Espirito Santo, Rio [Rio de Janeiro?], St. Catherines [Santa Catarina], and Joinville, Santa Catarina, Brazil.

Hampson described the color of the pale areas of the wings as "orange-yellow." The female specimen in the U.S. National Museum is deep yellow with a slight orange tinge. It is not nearly as orange as indicated by the figure provided by Draudt (1919). The males (fig. 12) resemble the female, except the pale markings of the wings are slightly smaller, pale yellow, nearly white in color, and the ventral surface of the body is nearly uniformly dark brown or black. There is a lateral line of yellow on abdominal segments 4-7. One male has a few yellow scales on abdominal sternite 3 and some of the males have some yellow scales and hair between the bases of the forelegs. Hampson stated that the type has a broad ventral yellow stripe in addition to the lateral abdominal stripes. In the female in the U.S. National Museum the abdomen has been removed and the genitalia have been prepared on a slide; thus, the coloration of the abdomen is not determinable. The orange-yellow, lateral spots of the patagia of the male are like those of the female.

Cisaucula, new genus

Type-species: *Copidryas peruviana* Druce, 1910=*Cisaucula peruviana* (Druce).

The species on which this genus is based is not congeneric with the species of *Copidryas* Grote. The modification of the aedeagus (apical half greatly reduced in diameter and very strongly sclerotized) indicates it belongs with the complex of genera including *Rhosus* Walker, *Erocha* Walker, and *Aucula* Walker. This complex contains remarkably similar groups that are badly mixed and that differ mainly in general pattern of maculation and in characters of the male genitalia. *Copidryas peruviana* Druce differs from all of the species assigned to the three previously mentioned genera in the pattern of maculation of the wings (figs. 11, 21) and in having simple antennae in the male (bipectinate in the other genera). The male genitalia are also distinct although some characters do agree with one or another of the other genera.

Description: Eyes large, hemispherical, naked; ocelli small, adnate to upper margin of eye immediately caudad of base of antenna; antenna simple, pubescent ventrally; frons produced into a blunt, rounded prominence with slightly raised rim, the latter rounded ventrally and convergent dorsally, prominence exceeding anterior margin of eye by half length of eye; labial palpus small, slightly exceeding frons, slightly oblique, third segment slightly decumbent, clothed with appressed scales, slightly shorter than second segment, second and third segments fringed ventrally with long, loose, hairlike scales. Vestiture of head and thorax of hair or hairlike scales, without crests. Abdomen with a prominent dorsal tuft of hairs on first seg-

ment; a pair of coremata and grooves on sternum of first abdominal segment. Legs with large tufts and fringes of long, white hair. Pectus also clothed with hair. Forewing triangular, broad, termen evenly rounded; inner margin nearly straight. Hindwing broad, with termen evenly rounded. Pattern of maculation as illustrated (figs. 11, 21). Venation of wings uncomplicated. Forewing with R_1 and Cu_2 from outer third of either side of discal cell; R_3 from R_2 adnate with R_{4+5} and R_4 to form accessory cell; R_3+R_{4+5} shortly stalked; R_3+R_4 also shortly stalked; M_1 from upper angle of discal cell; M_2 from below middle of discocellulars, base slightly curved, convergent with M_3 ; M_3 from just above lower angle of discal cell; Cu_1 from lower angle of cell. Hindwing with $Sc+R_1$ fused with cell near base only; Rs and M_1 shortly stalked from upper angle of discal cell; M_2 weak, from near middle of discocellulars; M_3 and Cu_1 connate from lower angle of discal cell; Cu_2 from outer third of cell. Male genitalia as illustrated (fig. 24), uncus explanate distally, apex hooked, a thin dorsal, longitudinal carina present; tergumen simple; vinculum with elongate dorsal arms, saccus scarcely developed; juxta large, triangularly emarginate dorsally; valves symmetrical, moderately broad, apex rounded, corona nearly absent, clasper large, curved toward apex of valve, sacculus emarginate at apical third; apical half of aedeagus reduced in diameter, strongly sclerotized, extreme apex a rounded knob. Female genitalia as illustrated (fig. 25), simple, a slight irregular sclerotization around ostium; ductus bursae extremely small, elongate, membranous; bursa copulatrix an oval membranous sac; ductus seminalis about as large as ductus bursae, originating from caudal end of bursa copulatrix.

Cisaucula peruviana (Druce), new combination

Copidryas peruviana Druce, 1910, Ann. Mag. Nat. Hist., ser. 8, vol. 6, p. 168.—Strand, 1912, Lepidopterorum catalogus, pt. 5, p. 28.—Draudt, 1919, in Seitz, Die Gross-Schmetterlinge der Erde, vol. 7, p. 4.

According to the original description, Druce had at least a male and a female from Santo Domingo, southeast Peru, 6000 feet, wet season, G. Ockenden, but he failed to indicate which was the type. The male illustrated in the present paper (fig. 21) is labeled type, and it is selected as lectotype. It is in the collection of the British Museum (Natural History). There are five males and one female from Incachaca, Cochabamba, Bolivia, J. Steinbach, in the collection of the U.S. National Museum.

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REVIEW OF SOME SPECIES OF *LOXOSTEGE* HÜBNER AND DESCRIPTIONS OF NEW SPECIES (LEPIDOPTERA, PYRAUSTIDAE: PYRAUSTINAE)

By HAHN W. CAPPS¹

The purpose of this paper is to provide means for reliable identification of the species of *Loxostege* Hübner, to correct invalid synonymy and nomenclature, and to provide names for undescribed species.

Some nomenclature, following Hampson's (1899, p. 207) error in treating *Loxostege* as a nomen nudum and synonym of *Phlyctaenodes* Guenée (1864, p. 173), needs correction. Although Hampson (1918, p. 189) corrected the error, the generic placement has not been corrected for those new species described in the interim from Mexico, Central and South America because there has been no subsequent revision involving them and because lists of American Lepidoptera published in that period have been restricted to North American species.

In addition to the nomenclatural aspect, zoology is also involved. The type-species of *Loxostege* and *Phlyctaenodes* are not congeneric. *Pyrallis aeruginalis* Hübner, the type of *Loxostege* (Hampson, 1918, p. 189), differs from *Pyrallis pustulalis* Hübner, the type of *Phlyctaenodes* (Hampson, 1899, p. 211), in maculation and genitalia as indicated below.

¹ Retired, September 1964, Entomology Research Division, Agriculture Research Service, U.S. Department of Agriculture, Washington, D.C.

VENATION.—*Loxostege aeruginalis*: Forewing (fig. 2) with vein 6 distinctly closer to vein 7 than to middle of cell; veins 8 and 9 long stalked, 10 approximate to 8+9 at cell and parallel for almost half the length of stem; vein 11 subparallel with 10 to costa; terminus of vein 1a upturned, obsolescent distally or if discernible, forming a loop with 1b. Hindwing (fig. 2a) essentially the same as in *P. pustulalis*.

Phlyctaenodes pustulalis: Forewing (fig. 3) with origin of vein 6 closer to middle of cell than to vein 7; stalking of veins 8 and 9 much shorter than in *L. aeruginalis*; vein 10 strongly divergent from stalk of 8 and 9 a short distance from cell; vein 1a acutely divergent from vein 1b from base and terminating on inner margin of wing. Hindwing (fig. 3a).

MALE GENITALIA (see figs. 14 and 18 for terminology).—*L. aeruginalis*: Harpe with a well-developed, hooklike clasper; transtilla with ventrodistal extension conspicuous, narrow and extending to near base of anellus. Uncus with apex rounded distally. Gnathos absent.

Phlyctaenodes pustulalis (fig. 5): Harpe unarmed; transtilla without ventrodistal extension. Uncus somewhat bilobed at apex. Gnathos well developed.

This study is based, in part, upon more than 1800 dissections of genitalia prepared during the investigation.

FEMALE GENITALIA (see fig. 7 for terminology).—*L. aeruginalis* (fig. 7): Bursa copulatrix with an accessory pouchlike appendage; signum well developed.

P. pustulalis (fig. 4): Bursa copulatrix simple, without an accessory pouchlike appendage; signum absent.

The *Loxostege* species *helvialis* (Walker), *manalis* (Lederer), *similalis* (Guenée), *rantalalis* (Guenée), *occidentalis* (Packard), and a species described as *Botys oblitalis* Walker and heretofore assigned to *Loxostege* and *Phlyctaenodes*, are so similar to each other or closely related species in color, maculation, and other characters that examination of the genitalia is often necessary for reliable identification.

The delineations were prepared by Mr. A. D. Cushman, scientific illustrator, Entomology Research Division, Agric. Res. Serv., U.S. Department of Agriculture, and are not drawn to scale. The genitalia are in ventral view and those of the males are drawn with one harpe omitted and the aedeagus removed.

All photos of adults, except one, are by J. Scott, staff photographer, U.S. National Museum; figure 146 is used through courtesy of British Museum (Nat. Hist.). Photos are about three times natural size.

Loxostege Hübner

Loxostege Hübner, 1827, Verzeichniss bekannter Schmettlinge [sic], p. 352. [Type: *Pyralis aeruginalis* Hübner, designation Hampson, 1918, Ann. Mag. Nat. Hist., ser. 9, vol. 2, p. 189.]

Characters common to the *Loxostege* species treated here are discussed below.

ADULT.—Antenna simple. Frons usually pointed or conically produced, the modification sometimes limited to the lower margin and more discernible from dorsal view. Midtibia normal and without a hair-pencil, or incrassate and with a hair-pencil, often concealed in a groove. Hind tibia with two pairs of spurs (the relative lengths referred to herein are those of the upper pair of spurs on the hind tibia of the male).

LARVA.—Chaetotaxy and crochets are typical pyraustid. Prothorax with two setae on the prespiracular shield; group VI bisetose. Meso- and metathorax with VI unisetose. Abdominal setments 3–6 with seta IV approximate to seta V, and under spiracle on same pinaculum. Ninth abdominal segment with seta I approximate to seta III and on same pinaculum; setae IV and V absent, only seta VI of this group present. Crochets on abdominal prolegs of triordinal length and arranged in a penellipse. Anal fork absent.

Distribution, food plant, and flight data reported in this paper are taken entirely from labels accompanying the specimens examined.

Loxostege helvialis (Walker)

FIGURES 8, 62, 105

Spilodes helvialis Walker, 1859, List of the lepidopterous insects in the British Museum (Nat. Hist.), pt. 18, p. 772.

Botys thycealis Walker, 1859, *ibid.*, pt. 19, p. 981.

Botys apertalis Walker, 1865, *ibid.*, pt. 34, suppl. 4, p. 1393.

Botys citrina Grote, 1867, Trans. American Ent. Soc., vol. 1, p. 23.

Loxostege helvialis (Walker) authors.—Fernald, 1903, in Dyar, U.S. Nat. Mus. Bull. 52, p. 382.—Barnes and McDunnough, 1917, Check list of the Lepidoptera of boreal America, p. 131.—Forbes, 1920, Cornell Univ. Agric. Exp. Sta. Mem. 68, p. 556 [as *helvalis*.]—McDunnough, 1939, Mem. Southern California Acad. Sci., vol. 2, p. 12.

MALE.—Alar expanse 18–20 mm. Frons with conical production strong. Antenna somewhat pubescent, cilia dense, very short, length of cilia less than one-half width of shaft. Midtibia slightly incrassate, hair-pencil obsolescent. Outer spur less than one-half as long as inner spur. Labial palpus length less than two times width of eye; first segment white; second segment slightly upturned, luteous

dorsally and laterally, white ventrally; third segment short, porrect or slightly downturned, luteous dorsally and laterally, white below. Head, thorax, and abdomen pale ochreous above, whitish below. Forewing: Upper surface pale yellow, somewhat shiny; area along costa, the reniform, discal dot, and two transverse lines luteous; subterminal line absent. Transverse lines smooth, transverse anterior line bent outwardly, concave or weakly angulate. Posterior transverse line directly posterior from costa to about vein 7, slightly concave outwardly to vein 3, angled inward to vein 2, outward to fold between veins 1b and 2, thence slightly inward to inner margin of wing. Hindwing: Upper surface ground color similar to that of forewing but paler from cell to costa; postmedial line appearing as a continuation of transverse line of forewing and terminating at about vein 2; subterminal line absent.

Fringe of fore- and hindwings concolorous with ground color of wings. Under surface of wings paler than upper, with markings evident but weaker.

Genitalia (fig. 8): Uncus with apex bluntly pointed. Harpe with simple hairlike scales; the sclerotized hooklike structure short, stout, bifid. Vinculum rather broadly concave midventrally. Aedeagus with an irregular, elongate patch of numerous spinelike cornuti and distally, a strong, single spine and a tapered, subcylindrical structure, the latter with circular grooves; basal keel absent or obsolescent.

FEMALE (fig. 105).—Alar expanse 16–20 mm. Color and maculation like that of male. Genitalia (fig. 62) with sclerotization of ventral margin of ostium weak or absent; ductus bursae broad between ostium and origin of ductus seminalis; accessory pouch small.

LARVA.—Mature, 22 mm long. Head sordid white, with reticulate amber markings; fuscous pigmentation of lateral incision of hind margin inconspicuous or absent. Prothoracic shield sordid white, middorsal markings weak, pale amber; area adjacent to lateral margin darker and extending almost to base of seta 1b. Pinacula bearing setae Ia–Ib and IIa–IIb of mesothorax separate, but slightly elevated. Pinacula bearing setae IIa–IIb of the meso- and meta-thorax and abdominal segments 1–8 with the sclerotization stronger and the brownish or fuscous pigmentation more extensive than those pinacula above or below. Ninth abdominal segment with pigmented area of pinaculum of seta II small and adjacent to base of the seta; pigmentation of pinaculum bearing setae I and III extensive, covering almost the entire area; pinaculum of seta VI nonpigmented.

TYPES.—British Museum (Nat. Hist.): *helvialis*, female; *thycealis*, male; *apertalis*, male and female. American Museum of Natural History: *citrina*, female, hereby designated lectotype.

TYPE-LOCALITIES.—United States: *helvialis* and *thycealis*. North America: *apertalis*. "Phil." [Philadelphia, Pa.]; *citrina*.

FOOD PLANTS.—*Amaranthus*, beets.

DISTRIBUTION.—UNITED STATES: Massachusetts: Barnstable, Martha's Vineyard. New York: Long Island (Bellfort, Orient). New Jersey: Lakehurst, Oakland. District of Columbia. Florida: Miami, Sarasota, Siesta Key, Tavernier, Craig. Texas: Brownsville, Black Jack Springs, Mercedes, San Antonio, San Benito, Big Bend Nat. Park, and Montague Co. Oklahoma: Norman. CANADA: Ontario: Chatham.

SPECIMENS EXAMINED.—72.

IN FLIGHT.—March to October.

REMARKS.—Several species have heretofore been confused with *helvialis* in collections. Six of these species are described as new herein, and some are reliably distinguished from *helvialis* only by examination of the genitalia.

I am indebted to W. H. Tams and E. L. Martin of the British Museum (Nat. Hist.) for comparison of material with the Walker types; and to F. H. Rindge of the American Museum of Natural History for information relative to the cotype of *citrina*. The male cotype of *citrina* could not be located in the material at the Philadelphia Academy of Sciences and appears to be lost; therefore, the female cotype at the American Museum of Natural History is designated lectotype of the species.

***Loxostege pseudohelvialis*, new species**

FIGURES 9, 63, 106

MALE (fig. 106).—Alar expanse 17–20 mm. Frons and antenna as in *helvialis*, but male differs otherwise as follows: Midtibia more incrassate, hair-pencil well developed. Outer spur of hind tibia shorter, about one-third as long as inner. Outer margin of fore- and hindwing darker, concolorous with markings of wings (in *helvialis*, concolorous with ground color of wings).

Genitalia (fig. 9): Similar to those of *helvialis* but with apex of uncus more sharply pointed; arms of bifid hook slenderer and more angulate distally; vinculum narrower and more attenuate midventrally. Aedeagus similar to that of *helvialis* but more slender.

FEMALE.—Alar expanse 17–21 mm. Similar to male in color and maculation. Outer spur one-half as long as inner spur. Genitalia (fig. 63) similar to those of *helvialis* but with ventral margin of ostium a narrow, somewhat crinkled sclerotized band; sclerotized portion of ductus bursae between ostium and origin of ductus seminalis shorter, narrower, lateral margins subparallel.

TYPE.—Male, U.S. National Museum, USNM 67595, genitalia slide OBP 290.

TYPE-LOCALITY.—Baboquivari Mts., Pima Co., Ariz.

PARATYPES.—UNITED STATES: Arizona: type-locality, 8 ♂, 4 ♀; Brown Canyon, Baboquivari Mts., 7 ♀; Madera Canyon, Santa Rita Mts., 33 ♂, 28 ♀; Madera Canyon, Pima Co., 1 ♀; Paradise, Cochise Co., 1 ♂; Tempe, 1 ♂, 1 ♀; Tucson, 1 ♂, 1 ♀; Scottsdale, Maricopa Co., 1 ♂; Southwestern Res. Sta., Chiricahua Mts., 2 ♂, 1 ♀; Chiricahua Mts., 2 ♂, 1 ♀; White Mts., 1 ♀; Huachuca Mts., 2 ♀; Yavapai Co., 1 ♀; "Arizona" [no additional locality], 2 ♂, 3 ♀. California: San Diego, 7 ♂, 4 ♀; La Puerta Valley, 2 ♂, 3 ♀. Utah: Beaver, 1 ♂. New Mexico: Mesilla, 1 ♀. Texas: Limpia Canyon, Jeff Davis Co., 1 ♀. MEXICO: Sonora: Nainari, 1 ♂, 5 ♀. Paratypes in the U.S. National Museum, Los Angeles County Museum, American Museum of Natural History, the collection of C. P. Kimball, the Canadian National Collection, and the British Museum (Nat. Hist.).

FOOD PLANT.—Unknown.

IN FLIGHT.—June to September.

REMARKS.—The *L. pseudohelvialis* series contains specimens with labels of both *helvialis* and *citrina*. If specimens are in good condition, the luteous suffusion along the outer margin of the fore- and hindwing distinguishes specimens of *pseudohelvialis* from those of *helvialis*. The more incrassate midtibia and hair-pencil of *pseudohelvialis* also distinguish its males from those of *helvialis*, but examination of the genitalia is necessary for reliable identification of worn females.

Loxostege arizonensis, new species

FIGURES 11, 64, 112

MALE (fig. 112).—Alar expanse 20–24 mm. Frons conical. Antenna ciliate, length of cilia about one-half width of shaft. Midtibia distinctly incrassate, hair-pencil well developed. Outer spur slightly less than one-third as long as inner spur. Similar to *pseudohelvialis* in color and maculation, but the average size of *arizonensis* is larger and luteous suffusion along outer margin of fore- and hindwing is more extensive.

Genitalia (fig. 11): Uncus pointed. Harpe with hairlike scales simple; padlike production above base of hook narrow, nonscobinate, but with a few simple setae, hooklike structure strong, curved; sacculus normally with a single spine about midway between cluster of spines and base of anellus. Vinculum narrowly attenuate midventrally. Aedeagus with a conspicuous, thin, rounded basal keel and a dense cluster of spinelike cornuti distally.

FEMALE.—Alar expanse 19–24 mm. Similar to male in color and maculation. Genitalia (fig. 64) with midventral invagination of

ostium divided and rather broad; ductus bursae narrow at origin of ductus seminalis.

TYPE.—Male, U.S. National Museum, USNM 67596, genitalia slide HWC 7725.

TYPE-LOCALITY.—Oracle, Ariz.

PARATYPES.—UNITED STATES: Arizona: Baboquivari Mts., Pima Co., 9 ♂, 4 ♀; Sabino Canyon, Santa Catalina Mts., Pima Co., 6 ♂, 8 ♀; Madera Canyon, Santa Rita Mts., 42 ♂, 55 ♀; Santa Rita Mts., 1 ♂; Nogales, 4 ♂, 2 ♀; Palmerlee, 1 ♂; Patagonia, 1 ♂; Southwestern Res. Sta., Chiricahua Mts., Cochise Co., 1 ♂; "SWS" [Southwestern Res. Sta.], 1 ♀. MEXICO: Chiapas, 1 ♂. Oaxaca, 1 ♀. Mesquititlan, 1 ♀. Guerrero: Iguala, 1 ♀. Puebla: Tehuacan, 2 ♀. Sonora: Nainari, 1 ♂, 4 ♀. Paratypes in U.S. National Museum, American Museum of Natural History, Los Angeles County Museum, and the Canadian National Collection.

FOOD PLANT.—Unknown.

IN FLIGHT.—July to September in Arizona; May to June in Mexico.

REMARKS.—Labels on some specimens indicate that *arizonensis* has also been confused with *helvialis*.

Loxostege neohelvialis, new species

FIGURES 12, 66, 111

MALE (fig. 111).—Alar expanse 18–23 mm. With characters of *arizonensis* and reliably distinguished from it only by examination of genitalia. Genitalia (fig. 12) resemble those of both *arizonensis* and *helvialis*; but the aedeagus of *neohelvialis* has, in addition to dense distal patch of slender spines, a small cluster of strong spinelike cornuti from a narrow, straplike sclerotization which distinguishes the species from all others of the group.

FEMALE.—Alar expanse, 20–23 mm. Similar to male in color and maculation. Genitalia (fig. 66): configuration of ductus bursae from ostium to origin of ductus seminalis as illustrated; sclerotization of ventral margin of ostium interrupted medially; ductus bursae distinctly sclerotized and longitudinally rugose at origin of ductus seminalis.

TYPE.—Male, U.S. National Museum, USNM 67597, genitalia slide HWC 7729.

TYPE-LOCALITY.—Plano, Tex.

PARATYPES.—UNITED STATES: Georgia: Milledgeville, 1 ♀; Tifton, 1 ♂. Florida: Quincy, 2 ♂, 5 ♀; Cassadaga, 1 ♀. Louisiana: 1 ♂, 1 ♀. Mississippi: Bolton, 3 ♀; Starkville, 1 ♀; Vicksburg, 1 ♂. Missouri: Charleston, 4 ♂, 2 ♀. Texas: Brownsville, 1 ♂, 1 ♀; Dallas, 1 ♀; Plano, 1 ♀. Arizona: Box Canyon, Santa Rita Mts., 2 ♂; Madera Canyon, Pima Co., 3 ♀; Madera Canyon, Santa Rita Mts.,

2 ♂, 1 ♀; Santa Rita Mts., 2 ♀; Baboquivari Mts., Pima Co., 1 ♂; Redington, 2 ♂, 1 ♀. CUBA: Santiago, 15 ♂, 10 ♀. JAMAICA: 1 ♀. MEXICO: Vera Cruz: La Gloria Cardel, 1 ♀; Coatepec, 1 ♀. Yucatan: Chichen Itza, 1 ♂. Jalisco: Guadalajara, 1 ♀. Sonora: Nainari, 3 ♂, 8 ♀. GUATEMALA: Cayuga, 1 ♂. COSTA RICA: Avangarez, 1 ♀. PANAMA: Corozal, 3 ♂. Paratypes in the U.S. National Museum, Los Angeles County Museum, C. P. Kimball collection, and the Canadian National Collection.

FOOD PLANT.—Unknown.

IN FLIGHT.—June to September.

REMARKS.—Labels on some specimens indicate that *neohelvalis* has been confused with both *manalis* and *helvalis*. The lack of a subterminal line on the fore- and hindwings of *neohelvalis* distinguishes it from *manalis*. The sparser cilia of the antenna and incrassate midtibia with a hair-pencil distinguishes the males of *neohelvalis* from those of *helvalis*. If the specimens are in good condition, the coloration along the outer margin of the fore- and hindwings is darker in *neohelvalis* than in *helvalis*; in the former, it is concolorous with the markings of the wings and in the latter, concolorous with the ground color of the wings. Worn females of *neohelvalis*, however, are reliably distinguished from those of *helvalis* only by examination of the genitalia.

Loxostege nayaritensis, new species

FIGURES 10, 65, 117

MALE.—Alar expanse 25 mm. Frons conical. Antenna weakly ciliate, cilia one-half or less than one-half as long as width of shaft. Midtibia incrassate, hair-pencil present. Outer spur about one-third as long as inner one. Resembles both *pseudohelvalis* and *arizonensis* in color and maculation; in *nayaritensis*, markings darker and browner with indentation of transverse posterior line of forewing more directly inward at vein 3 and coloration of reniform extending somewhat beyond lower angle of cell between veins 3 and 4; hindwing with a similar but smaller patch.

Genitalia (fig. 10): Like those of *arizonensis* but with padlike production broader, more rounded, and setae more numerous; sacculus without a spine midway between outer cluster of spines and base of anellus; vinculum more broadly concave midventrally.

FEMALE (fig. 117).—Alar expanse 22 mm. Similar to male in color and maculation except that transverse posterior line of forewing is somewhat straighter from costa to vein 3 and small brownish patch between veins 3 and 4 at lower angle of cell stronger; these differences are not likely to be constant in a larger series. Genitalia (fig. 65) with midventral modification of ostium narrow, not interrupted; ductus bursae conspicuously enlarged at origin of ductus seminalis.

TYPE.—Male, American Museum of Natural History, genitalia slide HWC 10,644.

TYPE-LOCALITY.—Compostela, Nayarit, Mexico.

PARATYPE.—Type-locality, 1 ♀. In collection of Cornell University.

FOOD PLANT.—Unknown.

IN FLIGHT.—August.

REMARKS.—The rather obscure brownish patch at the lower angle of the cell between veins 3 and 4 of the fore- and hindwings distinguishes *nayaritensis* from all other species of the genus that lack a subterminal line.

Loxostege polingi, new species

FIGURES 14, 67, 109

MALE (fig. 109).—Alar expanse 18–23 mm. Frons conical. Antenna with cilia short, somewhat pubescent. Midtibia moderately incrassate, hair-pencil present. Outer spur less than one-half as long as inner. Maculation similar to that of *arizonensis* but with shading along outer margin of fore- and hindwings usually not as sharply defined as in *arizonensis*.

Genitalia (fig. 14): Harpe without digitate setae; pad small, nonscobinate but with a few simple setae; clasper broadly rounded and fimbriate distally. Aedeagus with a distal patch of slender cornuti of irregular length; basal keel very small.

FEMALE.—Alar expanse 19–23 mm. Similar to male in color and maculation. Genitalia (fig. 67): configuration of ductus bursae from ostium to origin of ductus seminalis as illustrated; ductus bursae not sclerotized and without longitudinal grooves at origin of ductus seminalis; ductus seminalis somewhat scobinate adjacent to origin.

TYPE.—Male, U.S. National Museum, USNM 67598, genitalia slide HWC 7828.

TYPE-LOCALITY.—Lakeland, Fla.

PARATYPES.—UNITED STATES: Florida: Cassadaga 1 ♀; Gainesville, 2 ♂, 2 ♀; Lakeland, 3 ♀; Lake Placid, 1 ♀; Lake Placid [Archbold Biol. Sta.], 1 ♂, 2 ♀; Warrington, 1 ♀; Winter Park, 6 ♀. Texas: Black Jack Springs, 1 ♀; Kerrville, 1 ♂; San Diego, 1 ♂; San Antonio, 3 ♀; "Texas" [no additional locality], 1 ♀. Arizona: Madera Canyon, Santa Rita Mts., 1 ♀. MEXICO: Guerrero: Iguala, 2 ♀; Puebla: Tehuacan, 2 ♀; Zapotitlan, 1 ♀; Oaxaca: Oaxaca, 1 ♀; Totolapam, 1 ♀. Paratypes in the U.S. National Museum, American Museum of Natural History, Los Angeles County Museum, the collection of C. P. Kimball, and the Canadian National Collection.

FOOD PLANT.—Unknown.

IN FLIGHT.—April to September in the United States; June to October in Mexico.

REMARKS.—The type of *polingi* bears a label indicating that it had been compared with the cotype of *citrina* and regarded as conspecific with it, prior to dissection of the genitalia. Other labels also indicate confusion with *helvialis* and with a more remotely related species, *Pionea eupalusalis* Walker. The rather broad, fimbriate clasper distinguishes the male genitalia of *polingi* from those of *helvialis* and *eupalusalis*; the configuration of the sclerotization of the ductus bursae between the ostium and collarlike structure at origin of the ductus seminalis is diagnostic for the females of *polingi*.

***Loxostege pelotasalis*, new species**

FIGURES 15, 113

MALE (fig. 113).—Alar expanse 18 mm. Frons conical. Antenna somewhat pubescent, cilia very short. Midtibia slightly incrassate, hair-pencil weak. Outer spur one-half as long as inner. Similar to *polingi* in maculation. Genitalia (fig. 15) similar to those of *polingi* but with uncus broader, stouter; fimbriate clasper of harpe narrower; aedeagus with a narrow, curved, hooklike cornutus in addition to distal patch of slender spinules.

FEMALE.—Unknown.

TYPE.—Male, Cornell University, genitalia slide HWC 10,642.

TYPE-LOCALITY.—Pelotas, Rio Gran do Sul, Brazil.

FOOD PLANT.—Unknown.

IN FLIGHT.—May.

REMARKS.—Efforts to obtain females of *pelotasalis* were unsuccessful. No other closely related species was noted in the South American material examined; there should be no difficulty in association of the sexes when the females become available.

***Loxostege boliviensis*, new species**

FIGURES 16, 110

MALE (fig. 110).—Alar expanse 19 mm. Frons conical. Antenna pubescent. Similar to *pelotasalis* in color but with markings much weaker, barely discernible. Genitalia (fig. 16) resemble those of *pelotasalis* but with uncus more pointed, the fimbriate clasper of the harpe distinctly narrower and more extenuate basally, and with a conspicuous, strong, hooklike production from near middle of dorsal margin of sacculus.

FEMALE.—Unknown.

TYPE.—Male, Canadian National Collection, genitalia slide CNC 3765 MS.

TYPE-LOCALITY.—Puerto Suarez, Bolivia.

FOOD PLANT.—Unknown.

IN FLIGHT.—December.

REMARKS.—Although no females of *boliviensis* are available, no other closely related species was noted in the material examined from Bolivia. There should be no difficulty in associating the sexes when females become available.

Loxostege saltensis, new species

FIGURES 69, 114

FEMALE (fig. 114).—Alar expanse 23 mm. Frons conical. Similar in color and maculation to *pelotasalis*, but *saltensis* is larger and termination of posterior transverse line is farther inward on inner margin. Genitalia (fig. 69): ductus bursae with a rather broad, collarlike expansion between constriction near middle and origin of the ductus seminalis.

TYPE.—Female, U.S. National Museum, USNM 67599, genitalia slide HWC 10,041.

TYPE-LOCALITY.—Salta, Argentina.

FOOD PLANT.—Unknown.

REMARKS.—The species is known only from the type; configuration of the ductus bursae between the ostium and the origin of the ductus seminalis is diagnostic for the female. There is no date of collection on the label to indicate time of flight.

Loxostege fordii, new species

FIGURES 18, 84, 107

MALE (fig. 107).—Alar expanse 18–20 mm. Frons conical. Antenna with cilia short, length one-half or less than one-half as long as width of shaft. Midtibia incrassate, hair-pencil present. Outer spur minute, about one-fifth as long as inner spur. Color and maculation like that of *helvialis*.

Genitalia (fig. 18): Harpe with a small cluster of digitate setae arising from oblique, ridgelike modification near middle of harpe; distal termination of modification broadly rounded, padlike, and scobinate; sacculus with two groups of spines, the outer composed of a rather dense patch of subequal spines, inner of one to three rather stout spines. Aedeagus without cornutus.

FEMALE.—Alar expanse 17–20 mm. Similar to male in color and maculation. Outer spur distinctly less than one-half as long as inner spur. Genitalia (fig. 84) with sclerotization below ventral margin of ostium crinkled, median production narrow.

TYPE.—Male, U.S. National Museum, USNM 67600, genitalia slide HWC 7731.

TYPE-LOCALITY.—Tucson, Ariz.

PARATYPES.—UNITED STATES: Arizona: Christmas, 1 ♂; Redington, 3 ♂; Yuma, 1 ♂, 1 ♀; Kingman, 1 ♀; Madera Canyon, Santa Rita Mts., 4 ♂, 5 ♀; Madera Canyon, Pima Co., 1 ♂, 5 ♀; Picacho State Park,

Pinal Co., 1 ♂; Santa Rita Mts., Pima Co., 1 ♂. California: Ibanpah Mts., 3 ♂, 2 ♀; Providence Mts., San Bernardino Co., 1 ♂, 1 ♀; Furnace Creek, Death Valley, 1 ♀; Chino Canyon, Palm Springs, 1 ♂; Borrego 1 ♀. MEXICO: Sonora: Carbo [Copete Mine, 30 mi. E.], 1 ♂. Paratypes in U.S. National Museum, American Museum of Natural History, Los Angeles County Museum, and the Canadian National Collection.

FOOD PLANT.—Unknown.

IN FLIGHT.—April to October.

REMARKS.—*L. fordii* resembles *helvialis* and *polingi* in color and maculation, but in well-marked specimens of *fordii*, a faint subterminal line, absent in both *helvialis* and *polingi*, is discernible on the forewing. Differences in the lengths of the outer spurs distinguish the males of these species from each other; in *helvialis*, the outer is one-half as long as the inner; in *polingi*, it is about one-third as long as the inner; and in *fordii*, it is much shorter, only about one-fifth as long as the inner one. The females are reliably distinguished only by examination of the genitalia.

Loxostege alpinensis, new species

FIGURES 19, 83, 108

MALE (fig. 108).—Alar expanse 20–23 mm. Frons conical. Antenna weakly ciliate. Outer spur slightly less than one-half as long as inner spur. Color and maculation as in *fordii* but with markings often more obscure.

Genitalia (fig. 19) resemble those of *fordii* but with outer group of spines smaller and spinules weaker; inner group in a linear arrangement, extending from near base of outer group to middle of sacculus.

FEMALE.—Alar expanse 21–23 mm. Color and maculation as in male. Genitalia (fig. 83) somewhat similar to those of *fordii* but with median production of ventral margin of ostium broader, not crinkled laterad; origin of ductus seminalis more remote from ostium.

TYPE.—Male, U.S. National Museum, USNM 67601, genitalia slide HWC 7842.

TYPE-LOCALITY.—Paradise, Ariz.

PARATYPES.—UNITED STATES: Arizona: 3 ♂, 3 ♀; White Mts., 15 ♂, 1 ♀; Huachuca Mts., 1 ♀. Texas: Brownsville, 1 ♂, 1 ♀; San Benito, 3 ♂, 4 ♀; Brewster Co., 1 ♂; Montague Co., 1 ♀. Paratypes in the U.S. National Museum and the Canadian National Collection.

FOOD PLANT.—Unknown.

IN FLIGHT.—March to September.

REMARKS.—Specimens of this species are likely to be identified in collections as *helvialis* and *Loxostege oblitalis* of authors, not Walker.

Loxostege marculenta (Grote and Robinson)

FIGURES 20, 70, 130

Botys marculenta Grote and Robinson, 1867, Trans. American Ent. Soc., vol. 1, p. 23, pl. 2, fig. 21.—Klots, 1942, Bull. American Mus. Nat. Hist., vol. 79, p. 420 [lectotype designation].

Loxostege marculenta (Grote and Robinson).—Forbes, 1920, Cornell Univ. Agric. Exp. Sta. Mem., no. 68, p. 557.

Phlyctaenodes oblitalis (Walker).—Hampson, 1899, Proc. Zool. Soc. London p. 280.

Loxostege oblitalis (Walker) of authors.—Fernald, 1903, in Dyar, U.S. Nat. Mus. Bull. 52, p. 382.—Barnes and McDunnough, 1917, Checklist of the Lepidoptera of boreal America, p. 13.—McDunnough, 1939, Mem. Southern California Acad. Sci., vol. 2, p. 12.

MALE (fig. 130).—Alar expanse 18–24 mm. Frons conical. Antenna weakly ciliate, cilia about one-half as long as width of shaft. Midtibia slightly thicker than hind tibia, hair-pencil weak. Outer spur about one-fifth as long as inner. Head, thorax, and abdomen pale ochreous above, whitish below. Labial palpus upturned, with third segment short, porrect, concealed by scales; palpus twice as long as width of eye; first segment white, second segment luteous above and laterally, white below, all of third segment luteous.

Forewing: Upper surface pale yellow, somewhat subhyaline; area along costa and markings luteous; with three transverse lines, transverse anterior and posterior lines narrow, somewhat denticulate, subterminal line smooth, somewhat diffuse and broader than anterior and posterior lines. Anterior transverse line bent obliquely outward from costa to vein 1b, thence zig-zag inward and outward to hindwing margin, posterior transverse line bent slightly inward from origin on costa to vein 7, weakly crenulate and broadly concave outwardly to slightly below vein 3, almost directly inward to vein 2, slightly concave outwardly to vein 1b, thence directly posterior to hindwing margin. Subterminal line nearly straight, about midway between outer margin of wing and loop of transverse posterior line at end of cell, subparallel to outer wing margin.

Hindwing: Upper surface coloration similar to that of forewing but paler, with two rather diffuse transverse lines appearing as continuations of transverse posterior and subterminal lines of forewing. Postmedial line occasionally weakly crenulate, extending from costa to slightly below vein 2. The subterminal line smooth, parallel to outer margin and distinctly closer to outer wing margin than to postmedial line. Fringe of both fore- and hindwing concolorous with ground color of wing. Under surface of fore- and hindwing whitish with ochreous tinge; markings stronger on forewing but weaker on both wings than above.

Genitalia (fig. 20): Uncus stout. Harpe with cluster of digitate setae; pad broadly rounded and scobinate distally; sacculus with a long, slender, curved spine and two subequal strongly sclerotized productions, the outer bluntly conical, the inner slender, fingerlike, sometimes sharply pointed distally. Aedeagus stout, without cornutus.

FEMALE.—Alar expanse 21–26 mm. Similar to male in color and maculation. Genitalia (fig. 70) with ventral margin of ostium distinctly concave medially.

LECTOTYPE.—Female, American Museum of Natural History, Grote and Robinson no. 22995.

TYPE LOCALITY.—“Atlantic District (Penna.).”

FOOD PLANTS.—*Ambrosia trifida* and *Solidago*.

DISTRIBUTION.—UNITED STATES: Maine, Connecticut, Massachusetts, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia, North Carolina, Alabama, Mississippi, Ohio, Illinois, Missouri, Michigan, Iowa, Texas, and New Mexico. CANADA: Ontario, Quebec.

SPECIMENS EXAMINED.—117.

IN FLIGHT.—May to September.

REMARKS.—Labels in collections indicate confusion of *marculenta* with *helvialis*, *obliteralis*, and *mancalis*. The presence of subterminal lines on the fore- and hindwings distinguishes *marculenta* from *helvialis* and others of that group. The markings on the wings of *marculenta* are somewhat diffuse, often obscure, usually more brownish and with the definition weaker than in *mancalis*, and the subterminal line of the hindwing is closer to the outer margin in *mancalis* than in *marculenta*. The frons is conical in *marculenta* and round in *obliteralis*.

Loxostege neomarculeta, new species

FIGURES 21, 71, 131

MALE.—Alar expanse 22–24 mm. With characters of *marculenta* and reliably distinguished from it only by examination of the genitalia. Genitalia (fig. 21): harpe with digitate setae; scobinate area of pad rather narrow; sacculus with a strong subequal bifid spine and a stout, conical production slightly beyond base of spine. Aedeagus without cornutus.

FEMALE (fig. 131).—Alar expanse 22–23 mm. Similar to male in color and maculation. Genitalia (fig. 71) with two conspicuous, pronglike elements from median area of ventral margin of ostium, margins of prongs occasionally somewhat serrate; ductus bursae distinctly angulate at constriction above origin of ductus seminalis.

TYPE.—Male, U.S. National Museum, USNM 67602, genitalia slide HWC 7825.

TYPE-LOCALITY.—Decatur, Ill.

PARATYPES.—Type-locality, 1 ♂. Maryland: Plummers Island, 1 ♂, 1 ♀. Virginia: Skyland, 1 ♀. "West Virginia" [no additional locality], 1 ♀.

FOOD PLANT.—Unknown.

IN FLIGHT.—May to July.

REMARKS.—The male genitalia of *marculenta* and *neomarculenta* differ chiefly in the armature of the sacculus; the bifurcate spine, shorter outer conical production, and narrower pad distinguish the males of *neomarculenta* from those of *marculenta*. The presence of two median prongs arising from the ventral margin of the ostium distinguishes *neomarculenta* females from those of *marculenta*.

Loxostege pseudoblitalis, new species

FIGURES 25, 88, 135

MALE (fig. 135).—Alar expanse 21–24 mm. Frons conical, production moderate. Antenna weakly ciliate. Midtibia incrassate, hair-pencil distinct. Outer spur minute, about one-sixth as long as inner. Color and maculation as in *marculenta* and *neomarculenta* but forewing usually with an indentation of subterminal line evident at vein 2.

Genitalia (fig. 25): Harpe with a cluster of digitate setae; sacculus with spine short, somewhat modified, with one or two spinules basad; subconical production at base of spine bearing several slender setae. Aedeagus attenuate distally and with a small patch of coarse, subconical granules.

FEMALE.—Alar expanse 22–26 mm. Color and maculation like that of male. Genitalia (fig. 88): ductus bursae rather strongly sclerotized at ostium dorsally and ventrally; ventral margin of ostium strongly convex, somewhat crinkled.

LARVA.—Mature, 24 mm long. Head sordid white, with reticulate pale amber markings; a conspicuous small fuscous patch at lateral incision of hind margin. Prothoracic shield sordid white or with a yellowish tinge, narrowly margined with brown or brownish fuscous, the pigmentation slightly interrupted middorsally. Body pinacula of similar brownish pigmentation. Abdominal segments 1–8: Pinacula of seta I and seta II transversely elongate, several times longer than wide; pinacula of seta III subquadrangular longitudinally; pinacula below level of spiracle oval shaped, with pigmentation weaker and less extensive than those dorsad. Ninth abdominal segment: posterior half of pinaculum of paired setae II pigmented; pinaculum bearing setae I–III pigmented; pinaculum of seta VI pigmented. Anal shield with a small, pigmented patch at base of anterior lateral seta.

TYPE.—Male, U.S. National Museum, USNM 67605, genitalia slide OBP 149.

TYPE-LOCALITY.—Paradise, Ariz.

PARATYPES.—UNITED STATES: Arizona: type-locality, 3 ♀; Nogales, 1 ♀; Baboquivari Mts., Pima Co., 1 ♂, 3 ♀; Huachuca Mts., 5 ♂, 1 ♀; Santa Rita Mts., Madera Canyon, 10 ♂, 6 ♀; Santa Rita Mts., 1 ♀; Madera Canyon, Pima Co., 1 ♀; White Mts., 2 ♀; "Arizona" [no additional locality], 1 ♂. Texas: Kerrville, 1 ♂, 1 ♀; San Antonio, 1 ♀; Brewster Co., 2 ♀. MEXICO: Morelos: Cuernavaca, 1 ♀. Paratypes in the U.S. National Museum and the Canadian National Collection.

FOOD PLANT.—Morning glory.

IN FLIGHT.—July to September in the United States, May in Mexico.

REMARKS.—Differences in character of the spine and subconical production of the sacculus distinguish the males of *pseudobliteralis* from those of *marculenta* and *neomarculenta*. The shape and character of sclerotization of the ductus bursae at the ostium is diagnostic for the females of *pseudobliteralis*.

Loxostege neobliteralis, new species

FIGURES 26, 87, 132

MALE (fig. 132).—Alar expanse 18–24 mm. Antenna, frons, tibial character, color, and maculation essentially the same as in *marculenta* and *neomarculenta* but reliably distinguished from them by examination of the genitalia. Genitalia (fig. 26): harpe with digitate setae; a short, sharp, spinelike projection from near middle of oblique modification bearing cluster of digitate setae; pad moderately developed, scobination extensive, rounded or somewhat truncate distally; clasper conspicuously expanded distally and strongly denticulate. Aedeagus without cornutus.

FEMALE.—Alar expanse 22–23 mm. Similar to male in color and maculation. Genitalia (fig. 87): ostium subcircular; margin rather strongly sclerotized; ventral margin straight or nearly so.

LARVA.—Mature, 25 mm long. Similar to larva of *pseudobliteralis* but with marginal fuscous pigmentation of prothoracic shield interrupted on lateral margin; pinacula nonpigmented below level of spiracles on abdominal segments. Ninth abdominal segment with pigmentation of pinaculum bearing paired setae II interrupted on dorsum; pinaculum of setae I–III and that of seta VI nonpigmented, concolorous with adjacent body area. Anterior lateral seta of anal shield without a fuscous patch at its base.

TYPE.—Male, U.S. National Museum, USNM 67604, genitalia slide HWC 10,609.

TYPE-LOCALITY.—Hubberton, Vt.

PARATYPES (16).—UNITED STATES: type-locality, 2 ♂, 1 ♀; Pennsylvania: Pittsburgh, 1 ♂; Oak Station, 2 ♂. New Jersey: Lakehurst, 1 ♀. Maryland: Plummerville Island, 1 ♂, 2 ♀. District of Columbia: Washington, 1 ♂. West Virginia: 1 ♀. Mississippi: "Agr. College" [sic] 1 ♀. Indiana: Lafayette, 1 ♂. Iowa: Soldier [near] 1 ♂. CANADA: Quebec: Hummingford, 1 ♀. Paratypes in the U.S. National Museum and the Canadian National Collection.

FOOD PLANT.—*Ipomoea*.

IN FLIGHT.—May to September.

REMARKS.—The short, spinelike projection from near the middle of the lower margin of the harpe, in combination with the denticulate character of the clasper, is diagnostic for males of *neoblitalis*. The female genitalia resemble those of *pseudoblitalis*, but the straight ventral margin of the ostium distinguishes females of *neoblitalis* from those of *pseudoblitalis*.

***Loxostege potosiensis*, new species**

FIGURE 22

MALE.—Alar expanse 22 mm. Frons conical. Antenna ciliate, length of cilia slightly less than width of shaft. Midtibia incrassate; hair-pencil present. Outer spur short, about one-fifth as long as inner spur. Color and maculation as in *neomarculenta*.

Genitalia (fig. 22): Harpe with spine from sacculus simple, rather long and slender; distal margin of pad medially angulate, the lower element with fine spinules, slightly bifurcate distally. Aedeagus somewhat attenuate distally, with a patch of short, stout spinules.

FEMALE.—Unknown.

TYPE.—Male, U.S. National Museum, USNM 67603, genitalia slide HWC 12,018.

TYPE-LOCALITY.—Tamazunchale, San Luis Potosi, Mexico.

FOOD PLANT.—Unknown.

IN FLIGHT.—May to August.

REMARKS.—*L. potosiensis* is reliably distinguished from *pseudoblitalis* and several other species only by examination of the genitalia. The medially angulate distal margin of the pad, in combination with the fine spinulation and distal subequal bifurcation of the ventral element, distinguishes *potosiensis* males from all others of the group.

***Loxostege cayugalis*, new species**

FIGURES 35, 85, 136

MALE.—Alar expanse 21–25 mm. Frons conical. Antenna ciliate, cilia about as long as width of shaft. Midtibia incrassate; hair-pencil weak. Outer spur one-fifth as long as inner spur. Similar to *pseudoblitalis* in color and maculation.

Genitalia (fig. 35): Harpe with distal termination of oblique ridge-like modification pointed, curved, hooklike, and nonscabinated; a similar hook at base of cluster of digitate setae; sacculus with two conspicuous spines, one to several small, short spines often associated with outer. Aedeagus with distal patch of subconical granules.

FEMALE (fig. 136).—Alar expanse 26–28 mm. Color and maculation as in male. Genitalia (fig. 85): shape of ostium and character of its ventral margin is diagnostic for females; ostium somewhat variable, nearly round to distinctly oval, ventral margin smooth.

TYPE.—Male, U.S. National Museum, USNM 67606, genitalia slide HWC 7912.

TYPE-LOCALITY.—Cayuga, Guatemala.

PARATYPES.—GUATEMALA: type-locality, 2 ♂; Quirigua, 1 ♂; San Geronimo, 1 ♀. COSTA RICA: Tuis, 1 ♂, 1 ♀; Cachi, 2 ♀. MEXICO: San Luis Potosi, 1 ♀; Tamazunchale, 1 ♀; Morelos: Cuernavaca, 1 ♀; Chiapas: Soconusco (Finca la Violeta), 38 ♂, 15 ♀; Veracruz: Cordoba, 1 ♀. Paratypes in U.S. National Museum, British Museum (Nat. Hist.), and the Canadian National Collection.

FOOD PLANT.—Unknown.

IN FLIGHT.—April to October.

REMARKS.—*L. cayugalis* is likely to be confused in collections with the species described as *Pachyzancla cynoalis* Druce, which is treated next herein. One of the *cayugalis* paratypes from Cachi, and those from San Geronimo and Cuernavaca, are from the syntypes of *cynoalis*.

***Loxostege cynoalis* (Druce), new combination**

FIGURES 36, 72, 137

Pachyzancla cynoalis Druce, 1895, in Godman and Salvin, *Biologia Centrali-Americana*, Zoology, Lepidoptera, Heterocera, vol. 2, p. 221 [in part].

MALE (fig. 137).—Alar expanse 23 mm. Frons conical. Antenna ciliate, cilia about as long as width of shaft. Upper spur about one-fourth as long as inner spur. Color and maculation similar to that of *cayugalis*.

Genitalia (fig. 36): Harpe with production from base of digitate setae strongly denticulate; dorsal margin of sacculus with two conspicuous, stout spines. Anellus stout. Aedeagus with distal patch of small conical granules.

FEMALE.—Alar expanse 20–21 mm. Similar to male in color and maculation. Genitalia (fig. 72) resemble those of *neomarculenta* but with contour of ductus bursae undulate between ostium and origin of ductus seminalis.

LECTOTYPE.—Male, British Museum (Nat. Hist.), genitalia slide HWC 17,454, present designation.

TYPE-LOCALITY.—Volcan de Chiriqui, Panama.

FOOD PLANT.—Unknown.

DISTRIBUTION.—Guatemala and Panama.

SPECIMENS EXAMINED.—3.

IN FLIGHT.—May.

REMARKS.—Differences in genitalia and length of the upper spurs distinguish the males of *cynoalis* and *cayugalis*, but examination of the genitalia is necessary for reliable identification of the females of these two species.

Druce did not indicate the number of specimens in the type series of *cynoalis* but stated that he had specimens from Mexico (Cuernavaca, Morelos), Guatemala (San Geronimo), Costa Rica (Cachi), and Panama (Chiriqui, Volcan de Chiriqui). Of the five syntypes in the British Museum, the specimen from Volcan de Chiriqui (2000–3000 ft, Champion), a male, was labelled type by Druce and is the one selected herein as lectotype of *cynoalis*. The male and female from Cuernavaca and the female from Cachi are not conspecific with the type and represent a new species treated herein. The abdomen is missing from the female from Geronimo; the placement of that specimen is uncertain.

Loxostege ecuadoralis, new species

FIGURES 37, 138

MALE (fig. 138).—Alar expanse 24–26 mm. Frons weakly conical. Antenna ciliate, cilia about one-half as long as width of shaft. Mid-tibia somewhat incrassate; hair-pencil weak. Outer spur one-fifth as long as inner spur. Similar to *cayugalis* in color and maculation.

Genitalia (fig. 37) resemble those of *cayugalis* but with dorsal element of extenuation of oblique ridgelike modification of harpe somewhat truncate and with a few slender setae; hook at base of cluster of digitate setae stronger and more pointed than in *cayugalis*.

FEMALE.—Alar expanse 26 mm. Similar to male in color and maculation. Genitalia resemble those of both *cayugalis* and the next species; distinguished from *cayugalis* by the much wider nonpigmented, membranous median area dorsad of ostium and the somewhat narrower and less constricted ductus bursae between ostium and origin of ductus seminalis. Distinguished from the next species by the smooth, concave, ventral margin of ostium and the narrower and much shorter ductus bursae between ostium and origin of ductus seminalis.

TYPE.—Male, U.S. National Museum, USNM 67607, genitalia slide HWC 7848.

TYPE-LOCALITY.—“Environs de Loja Equateur.”

PARATYPES.—ECUADOR: type-locality, 1 ♂. PERU: Huanuco, 1 ♂. BOLIVIA: Bajo Palmar, Chapare Cochamba, 1 ♀. Paratypes in U.S. National Museum and the Canadian National Collection.

FOOD PLANT.—Unknown.

IN FLIGHT.—November to January.

REMARKS.—Labels on some specimens of *ecuadoralis* indicate they have been confused in collections with *cynoalis* and *obliteralis*.

Loxostege neotropicalis, new species

FIGURES 24, 86, 133

MALE (fig. 133).—Alar expanse 22–25 mm. Antenna ciliate, cilia about one-half as long as width of shaft. Midtibia incrassate; hair-pencil present. Outer spur short, one-fifth as long as inner spur. Similar to *cayugalis* in color and maculation but distinguished from it by genitalic differences.

Genitalia (fig. 24): Harpe with distal termination of oblique ridge-like modification padlike, spinulation coarse; width of pad and extent of spinulation variable; sacculus with a single, stout spine arising from dorsal margin. Aedeagus robust, with a distal patch of subconical granules.

FEMALE.—Alar expanse 25–28 mm. Similar to male in color and maculation. Genitalia (fig. 86) somewhat like those of *cayugalis* but ostium of different shape and ventral margin of ostium crinkled.

TYPE.—Male, U.S. National Museum, USNM 67608, genitalia slide 7871.

TYPE LOCALITY.—Jalapa, Mexico.

PARATYPES.—MEXICO: Puebla: Zapotitlan de las Salinas, 3 ♂; Guanajuato: Irapuato, 1 ♀. GUATEMALA: Volcan Santa Maria, 1 ♀. COSTA RICA: Juan Vinas, 1 ♀. VENEZUELA: Rancho Grande [Near Maracay], 1 ♂, 1 ♀. Paratypes in U.S. National Museum, American Museum of Natural History, and the Canadian National Collection.

FOOD PLANT.—Unknown.

IN FLIGHT.—May to October.

Loxostege jaralis (Schaus), new combination

FIGURES 33, 78, 139

Phlyctaenodes jaralis Schaus, 1920, Proc. Ent. Soc. Washington, vol. 22, p. 220.

MALE.—Alar expanse 23 mm. Frons conical. Antenna pubescent. Midtibia incrassate, hair-pencil well developed. Outer spur one-third as long as inner. Similar to *pseudobliteralis* in color and maculation, but with ground color and markings slightly darker and subterminal line of hindwing closer to outer margin.

Genitalia (fig. 33): Sacculus with one to three short, stout spines in outer group; inner group of two to four similar but somewhat larger spines; a larger spine about midway between the two groups. Pad narrow and rather densely spinulate.

FEMALE (fig. 139).—Alar expanse 23–25 mm. Similar to male in color and maculation. Genitalia (fig. 78): configuration of genital plate diagnostic.

TYPE.—Female, U.S. National Museum, USNM 23829, genitalia slide HWC 6008.

TYPE-LOCALITY.—Guadalajara, Jalisco, Mexico.

FOOD PLANT.—Unknown.

DISTRIBUTION.—MEXICO: Oaxaca. Puebla: Zapotitlan de las Salinas. San Luis Potosi: Tamazunchale. Jalisco: Guadalajara. UNITED STATES: Arizona: Redington; Baboquivari Mts., Pima Co.; Madera Canyon, Santa Rita Mts. [The U.S. records are new for the species.]

SPECIMENS EXAMINED.—11.

IN FLIGHT.—May to September.

REMARKS.—The Arizona specimens were confused with *helvialis* in the U.S. National Museum collection, but the presence of a subterminal line on the forewing of *jaralis* distinguishes it from *helvialis*.

The male heretofore has not been associated with females of the species.

Loxostege sacculalis Amsel

FIGURES 31, 118

Loxostege sacculalis Amsel, 1956 (1954), Bol. Ent. Venezuela, vol. 10, p. 250.

MALE (fig. 118).—Alar expanse 19–22 mm. Frons conical. Antenna ciliate, cilia slightly shorter than width of shaft. Midtibia incrassate, hair-pencil weak. Outer spur about one-third as long as inner spur. Similar to *jaralis* in color and maculation.

Genitalia (fig. 31): Essentially like those of *jaralis* but with differences in character of outer termination of dorsal margin of sacculus and contour of ventral margin of oblique ridge of harpe.

TYPE.—Male, Amsel collection.

TYPE-LOCALITY.—Maracay, Venezuela.

FOOD PLANT.—Unknown.

DISTRIBUTION.—Known only from type-locality.

SPECIMENS EXAMINED.—1.

IN FLIGHT.—August.

REMARKS.—No females of *sacculalis* were available for study; the description of the female genitalia was omitted in Amsel's treatment of the species. The differences in the male genitalia of *jaralis* and *sacculalis* may not be constant; a larger series of males and comparison of the female genitalia of both species is needed to determine the status of the two names.

Loxostege mancalis (Lederer)

FIGURES 27, 89, 119

Botys mancalis Lederer, 1863, Weiner Ent. Monatschr., vol. 7, p. 464, table 9, fig. 4.—Munroe, 1958, Canadian Ent., vol. 90, no. 9, p. 511.

Phlyctaenodes mancalis (Lederer).—Hampson, 1899, Proc. Zool. Soc. London, p. 208.

Loxostege mancalis (Lederer).—Fernald, 1903, in Dyar, U.S. Nat. Mus. Bull. 52, p. 382.—Forbes, 1920, Cornell Agric. Exp. Sta. Mem., no. 68, p. 557.—Barnes and McDunnough, 1917, Checklist of the Lepidoptera of boreal America, p. 131.—McDunnough, 1939, Mem. Southern California Acad. Sci. vol. 2, p. 12.

MALE (fig. 119).—Alar expanse 20–24 mm. Frons conical. Antenna ciliate, cilia about one-half as long as width of shaft. Midtibia incrassate, hair-pencil well developed. Outer spur one-third as long as inner. Similar to *marculenta* in color and maculation, but specimens of *mancalis* are somewhat duller and less ochreous, with definition of markings sharper, subterminal band of forewing usually broader anteriorly, and subterminal line of hindwing closer to outer margin (pale ochreous area between line and outer margin of wing narrower than subterminal line).

Genitalia (fig. 27): Harpe without digitate setae; with two conspicuous subequal hooklike structures; the small one downcurved, arising from near middle of harpe and extending below ventral margin; the large one from sacculus, rather broad basally, distal termination a sharp point; pad moderately broad, rounded, scobinate. Aedeagus somewhat attenuate distally, bluntly pointed and with a patch of small spinules.

FEMALE.—Alar expanse 22–24 mm. Similar to male in color and maculation. Genitalia (fig. 89): ductus bursae rather strongly sclerotized from ostium to junction with ductus seminalis and somewhat incrassate near middle; ostium with lateral production short, spurlike.

LARVA.—Mature, 28–30 mm long. Head pale amber, reticulation weak. Body color sordid white. Pigmentation of markings on prothoracic shield and body pinacula brown or blackish. Prothoracic shield with pigmentation restricted to lateral margin. Pinacula of seta Ia–Ib and IIa–IIb of meso- and metathorax moderately convex, irregularly ovoid or round in shape, pigmentation strong. On abdominal segments 1–8: Pinacula of seta I and seta II conspicuously large, round and flat; pinaculum of seta III reniform and smaller than those of setae I and II; pigmentation of setae I, II, and III strong; pinacula of setae below level of spiracles not pigmented or the pigmentation obsolescent centrally. Ninth abdominal segment with pinacula not pigmented.

LECTOTYPE.—Male, Naturhistorische Museum, Vienna, genitalia slide HWC 17,238.

TYPE-LOCALITY.—North America.

PARALECTOTYPE.—Female, British Museum (Nat. Hist.), genitalia slide HWC 17,327.

FOOD PLANTS.—*Amaranthus retroflexus*, mint, morning glory, tobacco, and *Rumex*.

DISTRIBUTION.—UNITED STATES: Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Tennessee, Florida, Louisiana, Mississippi, Texas, Oklahoma, Nebraska, Missouri, Illinois, Arizona. MEXICO: Sonora, Jalisco, Morelos, Puebla, Oaxaca. COSTA RICA: Avangarez.

SPECIMENS EXAMINED.—169.

IN FLIGHT.—March to September.

REMARKS.—In describing *mancalis*, Lederer indicated that the type series consisted of nine specimens, which were from North America and Brazil "Ex Mus. Caesar, Felder." Only two of these could be located, a male, by Dr. Kasy of the Vienna Museum, and the other, a female, by Mr. Whalley, at the British Museum. I hereby designate the male as lectotype and the female as paralectotype of the species. It is not likely that the syntypes from Brazil are the same species as those from North America, for I have found no specimens of *mancalis* in the considerable amount of material from Brazil and other South American countries that I have examined.

The lack of digitate setae, in combination with the character of the spine arising from near the middle of the ventral margin of the harpe and the hook arising from the sacculus, is diagnostic for the male genitalia of *mancalis*. The rather smooth, straight, ventral margin and short lateral, spurlike production of the ostium, in combination with the incrassate character of the ductus bursae between the ostium and ductus seminalis, distinguish the females of *mancalis* from all others of the genus.

***Loxostege ramsdenalis* (Schaus), new combination**

FIGURES 28, 74, 120

Phlyctaenodes ramsdenalis Schaus, 1920, Proc. Ent. Soc. Washington, vol. 22, p. 219.

MALE.—Alar expanse 20–23 mm. Frons conical. Midtibia incrassate, hair-pencil distinct. Similar to *mancalis* in color and maculation but with indentation of transverse posterior line deeper and more acute between veins 1b and 2 of forewing.

Genitalia (fig. 28): Somewhat similar to those of *mancalis* but differing as follows: harpe with a cluster of digitate setae; sclerotized production from near middle of ventral margin bluntly rounded,

spatulate; distal pad narrow, spinules rather stout; sacculus with hook more oblique inwardly and a small spine basad.

FEMALE (fig. 120).—Alar expanse 17–20 mm. Color and maculation as in male. Genitalia (fig. 74): ostium with ventral median emargination deep and broadly concave.

TYPE.—Female, U.S. National Museum, USNM 23827, genitalia slide HWC 6012.

TYPE-LOCALITY.—Santiago, Cuba.

FOOD PLANT.—Unknown.

DISTRIBUTION.—CUBA: Santiago. CAYMAN ISLANDS: Grand Cayman. MEXICO: Jalapa and Oaxaca. GUATEMALA: Volcan Santa Maria. VENEZUELA: Rancho Grande [near Maracay]. BRAZIL: Pernambuco. BOLIVIA: Corioco.

SPECIMENS EXAMINED.—27.

IN FLIGHT.—April to June.

REMARKS.—As there were no examples of *mancalis* in the South American material studied, and as *ramsdenalis* is so similar to *mancalis* in size, color, and maculation, it seems likely that at least part of the Brazilian syntypes apparently misidentified as *mancalis* (q.v.) are in fact *ramsdenalis*. In collections, *ramsdenalis* has also been confused with *Phlyctaenodes conisphora* Hampson.

Loxostege pergivalis (Hulst)

FIGURES 30, 79, 122

Botis pergivalis Hulst, 1886, Trans. American Ent. Soc., vol. 13, p. 151.—Klots, 1942, Bull. American Mus. Nat. Hist., vol. 79, art. 6, p. 421 [lectotype designation].

Botys pergivalis Hulst.—Hampson, 1899, Proc. Zool. Soc. London, p. 208. [A synonym of *Phlyctaenodes coloradensis* (Grote and Robinson) in error.]

Loxostege pergivalis (Hulst).—Fernald, 1903, in Dyar, U.S. Nat. Mus. Bull. 52, p. 382.—Barnes and McDunnough, 1916, Contr. Nat. Hist. Lepid., vol. 3, no. 3, p. 191 [type restricted to female of the Henry Edwards collection].—Barnes and McDunnough, 1917, Checklist of the Lepidoptera of boreal America, p. 131.—McDunnough, 1939, Mem. Southern California Acad. Sci., vol. 2, p. 12. [As synonym of *coloradensis* (Grote and Robinson) in error.]

MALE (fig. 122).—Alar expanse 20–26 mm. Frons conical. Antenna weakly ciliate. Midtibia weakly incrassate, hair-pencil absent or obsolescent. Outer spur slightly less than one-half as long as inner. Resembles *mancalis* in color and maculation but differs as follows: Transverse lines narrower and weaker; subterminal line of forewing little, if any, broader anteriorly; hindwing with postmedial line concave outwardly, postmedial and subterminal lines often obsolescent, interrupted, dotlike.

Genitalia (fig. 30): Harpe with cluster of digitate setae; pad rounded distally, the spinulation fine, dense; sacculus with two rather large conspicuous spines and a group of small spines adjacent to

base of the large outer spine; dorsal margin of sacculus with median subtriangular production.

FEMALE.—Alar expanse 18–28 mm. Color and maculation as in male. Genitalia (fig. 79): rugose character of postgenital plate diagnostic.

LECTOTYPE.—Female, American Museum of Natural History, genitalia slide FHR 4634.

TYPE-LOCALITY.—Arizona.

FOOD PLANT.—Corn?

DISTRIBUTION.—UNITED STATES: Arizona, New Mexico, Texas, Iowa, Illinois, and Delaware. CANADA: Ontario. MEXICO: Federal District, Puebla, and Jalisco.

SPECIMENS EXAMINED.—220.

IN FLIGHT.—May to September.

REMARKS.—Hulst (1886) stated that the type series of *pergilvalis* consisted of three females from Arizona. Hampson (1899), followed by authors of subsequent check lists of American Lepidoptera, erred in his treatment of *pergilvalis* as a synonym of *coloradensis*. The male specimen from Arizona in the Neumoegen collection that bears a *pergilvalis* type label of Hulst (to which reference was made by Barnes and McDunnough (1916)), agrees with *coloradensis* in color, maculation, and genitalia and is definitely conspecific with *coloradensis*; however, the female type designated by (Barnes and McDunnough, 1916), and also subsequently designated lectotype by Klots (1942), is distinct from *coloradensis* and is a valid species.

L. pergilvalis and *coloradensis* differ in both maculation and genitalia. Postmedial and subterminal lines are present on the hindwing of *pergilvalis* and are absent in *coloradensis* (fig. 123). The harpe of *pergilvalis* has a cluster of digitate setae; that of *coloradensis* (fig. 17) is without digitate setae. Differences in the character of the sclerotization adjacent to the ostium readily distinguish the female genitalia of *pergilvalis* from those of *coloradensis* (fig. 77).

Of the rather large series at hand, only one specimen had a plant association; it is labelled "on corn" and is from Coapa, D. F., Mexico. Whether it was collected as an adult on corn or reared from a larva feeding on corn is not definitely ascertainable.

***Loxostege coloradensis* (Grote and Robinson)**

FIGURES 17, 77, 123

Botis coloradensis Grote and Robinson, 1867, Trans. American Ent. Soc., vol. 1, p. 25.

Botys coloradensis Grote and Robinson.—Klots, 1942, Bull. American Mus. Nat. Hist., vol. 79, art. 6, p. 419.

Phlyctaenodes coloradensis (Grote and Robinson).—Hampson, 1899, Proc. Zool. Soc. London, p. 208.

Loxostege coloradensis (Grote and Robinson).—Fernald, 1903, in Dyar, U.S. Nat. Mus. Bull. 52, p. 382.—Barnes and McDunnough, 1916, Contr. Nat. Hist. Lepid., vol. 3, no. 3, p. 191; 1917, Checklist of the Lepidoptera of boreal America, p. 131.—McDunnough, 1939, Mem. Southern California Acad. Sci., vol. 2, p. 12.

MALE.—Alar expanse 23–31 mm. Frons conical. Antenna weakly ciliate. Midtibia incrassate, hair-pencil present, buff. Outer spur minute, about one-sixth as long as inner. Color whitish, with a slight ochreous tinge. Markings of forewing similar to those of *pergilvalis* but somewhat more ochreous and weaker. Hindwing whitish, subhyaline, without postmedial and subterminal lines, or the postmedial barely discernible.

Genitalia (fig. 17): Harpe without digitate setae; sacculus with two conspicuous subequal spines and an outer cluster of small, subequal spines. Aedeagus with distal patch of short, sharp, spinules.

FEMALE (fig. 123).—Alar expanse 27–31 mm. Color and maculation as in male. Genitalia (fig. 77): ventral margin of ostium broadly concave, shallow; sclerotization laterad of ostium concave, granulose. Spinulation of bursa copulatrix conspicuous from origin of accessory pouch to junction with ductus bursae.

LARVA.—Penultimate stage, 18 mm. Head pale amber, reticulation weak; a small fuscous patch at lateral incision on hind margin. Body sordid white. Pigmentation of markings of prothoracic shield and body pinacula brownish. Thorax: anterior and lateral margin of prothoracic shield with a brownish patch at bases of setae Ia, Ib, Ic, and IIc; pigmentation discontinuous on dorsum and between setae Ia and Ib; posterior margin concolorous with adjacent body area, without dark markings; prespiracular shield and pinaculum of group VI conspicuously pigmented. Meso- and metathorax with pinacula of setae Ia–Ib, IIa–IIb, IV, V, and VI rather large, pigmentation strong; pinaculum of seta III smaller, pigmentation weaker. Abdominal segments: pinacula of setae I and II of first and eighth segments more strongly pigmented than on second to seventh segments; pinacula of setae III darkly pigmented and of approximately equal size on segments 1–8. Pinacula below level of spiracles not pigmented on segments 1–8. Pinacula of ninth segment not pigmented. Anal shield without conspicuous markings.

LECTOTYPE.—Female, American Museum of Natural History, slide no. 22998 Grote and Robinson, present designation.

TYPE-LOCALITY.—Colorado.

FOOD PLANT.—Wild sunflower.

DISTRIBUTION.—Arizona, Utah, Colorado, Iowa, Kansas, Missouri, Oklahoma, and Texas.

SPECIMENS EXAMINED.—51.

IN FLIGHT.—April to September.

REMARKS.—See the discussion of *pergilvalis* (p. 24).

Loxostege cochisensis, new species

FIGURES 39, 82, 121

MALE.—Alar expanse 21–26 mm. Frons conical. Antenna weakly ciliate. Midtibia slightly more incrassate than hind tibia; hair-pencil obsolescent or absent. Outer spur one-half as long as inner. Resembles *pergilvalis* but with ground color usually more ochreous and transverse lines of forewing slightly smoother: postmedial line of hindwing absent, or if evident, smooth, somewhat diffuse, termen concolorous with fringe.

Genitalia (fig. 39): Uncus somewhat narrower apically. Harpe with digitate setae; outer half of dorsal margin of sacculus somewhat produced, with numerous, short inwardly directed spines. Aedeagus without cornuti.

FEMALE (fig. 121).—Alar expanse 19–26 mm. Similar to male in color and maculation. Genitalia (fig. 82): postgenital plate strongly sclerotized, concave, with distinct transverse ridges.

TYPE.—Male, U.S. National Museum, USNM 67609, genitalia slide OBP 147.

TYPE-LOCALITY.—Palmerlee, Ariz.

PARATYPES.—Arizona: type-locality, 1 ♀; [no additional locality], 2 ♀; Santa Rita Mts. 1 ♂, 1 ♀; Southwestern Res. Sta., Chiricahua Mts., Cochise Co., 1 ♂, 2 ♀; Madera Canyon, Santa Rita Mts., 2 ♂, 3 ♀; Madera Canyon, Santa Rita Mts., Pima Co., 4 ♀; Huachuca Mts., 1 ♀. Texas: The Basin, Chisos Mts., Brewster Co., 2 ♂, 1 ♀. Paratypes in the U.S. National Museum, Los Angeles County Museum, and the collection of Mr. C. P. Kimball.

FOOD PLANT.—Unknown.

IN FLIGHT.—June to September.

REMARKS.—The narrower uncus, in combination with the character of the spinulation on the dorsal margin of the sacculus, is diagnostic for the male genitalia of *cochisensis*. The character of the postgenital plate (concave with transverse ridges) distinguishes the female genitalia of *cochisensis* from all others of the genus.

Loxostege jacalensis, new species

FIGURES 38, 134

MALE (fig. 134).—Alar expanse 21 mm. Frons conical. Antenna weakly ciliate, cilia about one-half as long as width of shaft. Midtibia weakly incrassate; hair-pencil absent or obsolescent. Outer spur slightly less than one-half as long as inner. Similar to *cochisensis* in

color and markings. Genitalia (fig. 38) similar to those of *cochisensis* but with uncus stouter, fewer spines on dorsal margin of sacculus, spines coarser, anellus broader basally, outer margins of lateral arms parallel or nearly so.

FEMALE.—Unknown.

TYPE.—Male, Canadian National Collection, genitalia slide HWC 17,616.

TYPE-LOCALITY.—Jacala, Hidalgo, Mexico.

FOOD PLANT.—Unknown.

REMARKS.—The species is known only from the type specimen.

Loxostege yucatanalis, new species

FIGURE 48

MALE.—Alar expanse 20 mm. Frons conical. Antenna weakly ciliate, cilia about one-half as long as width of shaft. Outer spur one-fourth as long as inner. Similar to *jacalensis* in color and maculation, but somewhat paler. Genitalia (fig. 48) resemble those of *pseudobliteralis* but harpe without digitate setae, pad broader with spinulation finer, aedeagus more robust, cornutus stronger.

FEMALE.—Unknown.

TYPE.—Male, Canadian National Collection, genitalia slide HWC 17,620.

TYPE-LOCALITY.—Chichen Itza, Yucatan, Mexico.

FOOD PLANT.—Unknown.

REMARKS.—The species is known only from the type-specimen.

Loxostege autocratoralis Dyar

FIGURES 41, 93, 115

Loxostege autocratoralis Dyar, 1912, Pomona College Journ. Ent., vol. 4, no. 2, p. 747.

Phlyctaenodes autocratoralis (Dyar).—Dyar, 1914, Proc. U.S. Nat. Mus., vol. 47, p. 281.

MALE.—Alar expanse 20–24 mm. Frons conical. Midtibia incrassate, hair-pencil distinct. Outer spur one-third as long as inner. Resembles *nayaritensis* in color and maculation but somewhat paler, subterminal line present on forewing.

Genitalia (fig. 41): Harpe without digitate setae; dorsal margin of sacculus straight or nearly so, extending almost to middle of harpe. Aedeagus with a rather large patch of spinelike cornuti.

FEMALE (fig. 115).—Alar expanse 18–25 mm. Similar to male in color and maculation. Genitalia (fig. 93): postgenital plate strongly sclerotized, concave, scobinate. Sclerotized part of ductus bursae between ostium and origin of the ductus seminalis about as wide as long; ductus bursae rather conspicuously enlarged adjacent to origin of ductus seminalis, with longitudinal grooves.

TYPE.—Female, U.S. National Museum, USNM 14432, genitalia slide HWC 6002.

TYPE-LOCALITY.—Cuernavaca, Mexico.

FOOD PLANT.—Unknown.

DISTRIBUTION.—MEXICO: Federal District: Mexico City. Morelos: Cuernavaca. Vera Cruz: Jalapa. San Luis Potosi: Tamazunchale. Michoacan: Zitacuaro. Chiapas: Soconusco. Colima.

SPECIMENS EXAMINED.—13.

IN FLIGHT.—May and June.

REMARKS.—In collections, specimens of *autocratoralis* have been confused with those of *helvialis* and *Phlyctaenodes cupreicostalis* Dyar, but the presence of a subterminal line on the forewing of *autocratoralis* readily distinguishes it from those two species. Heretofore, *autocratoralis* has been known only by females.

Loxostege corozalis, new species

FIGURES 40, 92, 116

Phlyctaenodes helvialis (Walker).—Dyar, 1914, Proc. U.S. Nat. Mus., vol. 47, p. 281.

MALE (fig. 116).—Alar expanse 18–23 mm. Frons conical. Antenna weakly ciliate. Midtibia incrassate; hair-pencil present. Outer spur less than one-half as long as inner. Resembles *autocratoralis* in color and maculation but with subterminal line of forewing weaker, often obsolete posteriorly; hindwing usually with an obscure, very narrow ochreous area between subterminal line and termen.

Genitalia (fig. 40): Similar to those of *autocratoralis* but harpe with a cluster of digitate setae; dorsal margin of sacculus shorter, terminating distinctly before middle of harpe; cornuti of aedeagus much weaker, the patch scobinate or obsolescent.

FEMALE.—Alar expanse 17–23 mm. Similar to male in color and maculation. Genitalia (fig. 92): somewhat like those of *autocratoralis* but with sclerotization of postgenital plate weaker; ductus bursae between ostium and origin of ductus seminalis narrower, the sclerotization longer, about two times as long as wide and without conspicuous longitudinal grooves or enlargement adjacent to origin of ductus bursae.

TYPE.—Male, U.S. National Museum, USNM 67610, genitalia slide HWC 7864.

TYPE-LOCALITY.—Corozal, Panama Canal Zone.

PARATYPES.—PANAMA CANAL ZONE: type-locality, 3 ♂, 8 ♀; Barro Colorado Is., Gatun Lake, 3 ♂, 2 ♀; Tabernilla, 1 ♀. PANAMA: La Chorrera, 3 ♀. COSTA RICA: Avangarez, 1 ♂; Juan Vinas, 2 ♂, 1 ♀. GUATEMALA: Cayuga, 1 ♀. MEXICO: Vera Cruz: Jalapa, 1 ♀; San Luis

Potosi: Tamazunchale, 1 ♀; Chiapas: Santa Anita, 1 ♂, 1 ♀; Soconusco (Finca la Violeta), 2 ♂, 2 ♀; Tepechual, 1 ♀. Yucatan: Chichen Itza, 21 ♂, 30 ♀; Oaxaca: Tuxtepec, 1 ♂, 1 ♀. Morelos: Cuernavaca, 2 ♀. Nayarit: El Pautanal, 1 ♀. Zacualpan: 1 ♀. Paratypes in collections of the U.S. National Museum, American Museum of Natural History, Cornell University, and the Canadian National Collection.

FOOD PLANT.—Unknown.

IN FLIGHT.—April to November.

REMARKS.—Labels in collections indicate confusion of *corozalis* with both *helvialis* and *mancalis*. The presence of a subterminal line on the forewing of *corozalis* distinguishes it from *helvialis*, and the transverse posterior line on the forewing of *mancalis* is more denticulate than that of *corozalis*.

Loxostege huachucalis, new species

FIGURES 46, 75, 124

MALE (fig. 124).—Alar expanse 21–24 mm. Frons conical. Antenna weakly ciliate. Midtibia incrassate, hair-pencil weak. Outer spur one-fourth as long as inner spur. Resembles *mancalis* in color and maculation but with markings somewhat more ferruginous, lines more denticulate, definition sharper, and postmedial line of hindwing broadly concave.

Genitalia (fig. 46): Harpe without digitate setae; sacculus with two conspicuous, subequal spines and an outer cluster of small spines; pad with distal margin concave or somewhat angulate medially, lower element densely spinulate, spinules moderately long and slender. Aedeagus stout, somewhat bifid distally; the attenuate sclerotizations subequal, with the dorsal one denticulate.

FEMALE.—Alar expanse 21–24 mm. Similar to male in color and maculation. Genitalia (fig. 75): eighth sternum conspicuously pigmented and strongly scobinate, midventral configuration as illustrated. Ductus bursae strongly sclerotized from ostium to origin of ductus seminalis and conspicuously reduced in size from midway between ostium and origin of ductus seminalis.

TYPE.—Male, U.S. National Museum, USNM 67611, genitalia slide HWC 7834.

TYPE-LOCALITY.—Paradise, Cochise Co., Ariz.

PARATYPES.—Arizona: type-locality, 1 ♂, 2 ♀; so. Arizona, 3 ♂, 3 ♀; Palmerlee, 6 ♂, 6 ♀; Redington, 1 ♀; Huachuca Mts., 1 ♂, 4 ♀; Madera Canyon, Santa Rita Mts, 3 ♂, 4 ♀. Paratypes in collections of the U.S. National Museum and the Los Angeles County Museum.

FOOD PLANT.—Unknown.

IN FLIGHT.—June to August.

REMARKS.—*L. huachucalis* resembles *coloradensis* much more closely in genitalia than in habitus. In the male genitalia of *huachucalis* the pad is narrower and more extenuate and the aedeagus is stouter, with distal bifid elements more strongly developed than in *coloradensis*. The female genitalia of *coloradensis* are distinguished from those of *huachucalis* by a difference in the midventral configuration of the eighth sternum, the inconspicuous reduction in width of the ductus bursae from midway between the ostium and the origin of the ductus seminalis, and the stronger spinulation adjacent to junction of the ductus bursae and bursa copulatrix.

Loxostege marialis, new species

FIGURES 47, 76, 125

MALE (fig. 125).—Alar expanse 24 mm. Frons conical. Antenna weakly ciliate. Midtibia incrassate; hair-pencil distinct, white. Outer spur one-fourth as long as inner. Similar to *huachucalis* but with ground color less ochreous, markings somewhat finer, wings slightly more hyaline.

Genitalia (fig. 47): Harpe without digitate setae; pad moderately broad, spinulate; sacculus with two conspicuous subequal spines. Aedeagus stout, median constriction conspicuous, bifid distally, the dorsal element strongly sclerotized, narrow, spinulate.

FEMALE.—Alar expanse 24–26 mm. Similar to male in color and maculation. Genitalia (fig. 76): ductus bursae of approximately same width from ostium to origin of ductus seminalis; midventral configuration of eighth sternum widest at ostium, lateral margins subparallel, pigmentation and granulation ending before ostium.

TYPE.—Male, U.S. National Museum, USNM 67612, genitalia slide HWC 7903.

TYPE-LOCALITY.—Volcan Santa Maria, Guatemala.

PARATYPES.—Guatemala: type-locality, 3 ♂, 3 ♀; Duenas, 1 ♀; Calderas, 1 ♂. Paratypes in the U.S. National Museum, British Museum (Nat. Hist.), and Canadian National Collection.

FOOD PLANT.—Unknown.

IN FLIGHT.—June.

REMARKS.—The lack of an outer cluster of small spines on the sacculus, the broader pad, and stouter aedeagus of *marialis* distinguishes its males from those of *huachucalis*. The nonpigmented, smooth, membranous, concave area at the base of the midventral configuration, in combination with the rather inconspicuous constriction of the ductus bursae midway between the ostium and the origin of the ductus seminalis, is diagnostic of the females of *marialis*.

The paratypes from Calderas and Duenas are from the syntype series of *Phlyctaenodes conisporea* Hampson.

Loxostege purulhalis, new species

FIGURES 45, 126

MALE (fig. 126).—Alar expanse 20–21 mm. Frons conical. Antenna weakly ciliate. Midtibia weakly incrassate, hair-pencil obsolescent. Similar to *marialis* in color and maculation, but somewhat smaller than that species.

Genitalia (fig. 45): Harpe without digitate setae; pad broad, ventral half spinulate; dorsal margin of sacculus with a single spine from near middle and an outer cluster of short, stout spinules. Aedeagus slightly bifid distally, the dorsal element short, attenuate, and with short, stout spinules.

FEMALE.—Unknown.

TYPE.—Male, U.S. National Museum, USNM 67613, genitalia slide HWC 7905.

TYPE-LOCALITY.—Purulha, Guatemala.

PARATYPE.—Type-locality, 1 ♂; in collection of the U.S. National Museum.

FOOD PLANT.—Unknown.

IN FLIGHT.—July.

REMARKS.—No reliable differences in color and maculation were noted to distinguish *purulhalis* from *marialis*; however, in *purulhalis* the outer spur is longer and the hair-pencil is weaker than in *marialis*.

The genitalia of *purulhalis* are more like those of *huachucalis* than of *marialis*, but the presence of only one median spine from the sacculus and the wider pad distinguish the males of *purulhalis* from those of *huachucalis*.

Loxostege conisphoralis, new species

FIGURES 44, 80, 127

MALE (fig. 127).—Alar expanse 22–23 mm. Frons conical. Antenna weakly ciliate. Midtibia incrassate; hair-pencil present, white. Outer spur one-fifth as long as inner spur. Color and maculation similar to that of *marialis* but hindwing with brownish or fuscous accentuation of veins 3 and 4 adjacent to cell and postmedial line not as broadly concave.

Genitalia (fig. 44): Harpe without digitate setae; pad rather elongate and of uniform width, densely spinulate distally; sacculus with a conspicuous scalpel-like spine arising from near middle of dorsal margin and a rather large outer cluster of subequal spines. Aedeagus with an inconspicuous patch of minute spinules as cornuti.

FEMALE.—Alar expanse 22–26 mm. Similar to male in color and maculation. Genitalia (fig. 80): ductus bursae strongly sclerotized from ostium to origin of ductus seminalis, the sclerotization about as wide as long; median ventral configuration of eighth sternum below

ostium as figured; granulation strong at junction of ductus bursae and bursa copulatrix.

TYPE.—Male, U.S. National Museum, USNM 67614, genitalia slide HWC 7901.

TYPE-LOCALITY.—Chiapas, Mexico.

PARATYPES.—MEXICO: Chiapas: "Santa Anita," 1 ♂; La Granja, 1 ♂; Soconusco (Finca La Violeta), 33 ♂, 5 ♀. Vera Cruz: Santa Lucrecia, 1 ♀. Yucatan: Chichen Itza, 1 ♀. GUATEMALA: Chejel, 1 ♀; Volcan Santa Maria, 1 ♂. COSTA RICA: Juan Vinas, 1 ♀. Paratypes in the U.S. National Museum, American Museum of Natural History, and the Canadian National Collection.

FOOD PLANT.—Unknown.

IN FLIGHT.—June to November.

REMARKS.—The scalpel-like spine arising from the dorsal margin of the sacculus and the character of the outer cluster of spinules are diagnostic for the males of *conisphoralis*, and the midventral configuration of the eighth sternum, in combination with the short, broad sclerotization of the ductus bursae between the ostium and origin of the ductus seminalis, distinguish the females of *conisphoralis* from all others in the genus.

***Loxostege conisphora* (Hampson), new combination**

FIGURES 23, 73, 128

Phlyctaenodes conisphora Hampson, 1913, Ann. Mag. Nat. Hist., ser. 8, vol. 11, p. 517.

MALE (fig. 128).—Alar expanse 22 mm. Frons conical. Antenna weakly ciliate. Midtibia incrassate, hair-pencil present, white. Outer spur about one-fifth as long as inner spur. Resembles *marialis* in color and maculation but wings with brownish irroration and definition of subterminal lines stronger, and veins 3 and 4 of hindwing with fuscous accentuation adjacent to cell.

Genitalia (fig. 23): Harpe with digitate setae; medial spine long, slender, bifid distally; dorsal margin of sacculus with outer half broadly convex.

FEMALE.—Alar expanse 24 mm. Color and maculation as in male. Genitalia (fig. 73) similar to those of *neomarculenta* but with ventral margin of ostium deeply incised medially and lateral margins of the two pronglike projections strongly denticulate.

LECTOTYPE.—Male, British Museum (Nat. Hist.), genitalia slide BM no. 9588, present designation.

TYPE-LOCALITY.—Calderas, Guatemala.

PARALECTOTYPE.—Irazu, Costa Rica, 1 ♂, British Museum (Nat. Hist.), genitalia slide HWC 17,451, present designation.

DISTRIBUTION.—Guatemala, Costa Rica, and Mexico.

FOOD PLANT.—Unknown.

SPECIMENS EXAMINED.—3.

REMARKS.—Dissection of the syntypes of *conisphora* revealed the presence not only of *conisphora* and *marialis*, but another undescribed species, the discussion of which follows that of the next species.

Loxostege jaliscalis, new species

MALE.—Alar expanse 25 mm. Frons conical. Antenna weakly ciliate. Midtibia incrassate; hair-pencil present. Outer spur about one-fifth as long as inner spur. Resembles *conisphoralis* but differs from it as follows: wings more ochreous, pale straw yellow, and without irroration, markings pale buff; transverse and postmedial lines wider and smoother; subterminal and terminal lines weaker and more diffuse; fringe pale buff; hindwing with accentuation of veins 3 and 4 adjacent to cell absent or obsolescent.

Genitalia: Like those of *conisphoralis* but with uncus somewhat narrower, spine and distal bifurcation stronger, and distal convex production of sacculus much reduced.

FEMALE.—Alar expanse 25 mm. Similar to male in color and maculation, except accentuation of veins 3 and 4 of hindwing at cell is stronger. Genitalia similar to those of *conisphoralis* but with sclerotization of ductus bursae from ostium to origin of ductus seminalis shorter, conspicuously constricted about midway between ostium and angulate lateral production; and median incision of ventral margin of ostium concave and not as deep as in *conisphoralis*.

TYPE.—Male, Canadian National Collection, genitalia slide HWC 17,617.

TYPE-LOCALITY.—San Luis Potosi, Mexico [46 mi. N.].

PARATYPE.—Tepititlan, Jalisco, Mexico, 1 ♀. Canadian National Collection.

FOOD PLANT.—Unknown.

IN FLIGHT.—August and September.

Loxostege volcanensis, new species

FIGURES 49, 81, 129

MALE (fig. 129).—Alar expanse 12–22 mm. Frons conical. Antenna pubescent, cilia very short. Midtibia incrassate, hair-pencil brownish. Outer spur one-sixth as long as inner spur. Resembles *conisphoralis* in color and maculation but hindwing with postmedial line smoother, not conspicuously bent inward at vein 3, origins of veins 3 and 4 without adjacent brownish accentuation.

Genitalia (fig. 49): Uncus conspicuously narrower apically. Harpe without digitate setae; pad narrow, densely spinulate distally; sacculus with large spine, greatly expanded basally, arising from near middle

of dorsal margin. Aedeagus stout, cornutus an elongate, serrate, sclerotized patch.

FEMALE.—Alar expanse 19–21 mm. Similar to male in color and maculation. Genitalia (fig. 81): production of ductus bursae ventrad of the ostium with conspicuous medial emargination.

TYPE.—Male, U.S. National Museum, USNM 67615, genitalia slide HWC 6004.

TYPE-LOCALITY.—Volcan Santa Maria, Guatemala.

PARATYPES.—GUATEMALA: type-locality, 2 ♂. MEXICO: Cordoba, 1 ♀; Orizaba, 1 ♀; Jalapa, 2 ♀; Oaxaca, 1 ♂; Chiapas: La Granja, 1 ♀; Soconusco (Finca La Violeta), 5 ♂. COSTA RICA: Juan Vinas, 2 ♀, Irazu, 1 ♀. VENEZUELA: Rancho Grande (near Maracay), 1 ♀. Paratypes in the U.S. National Museum, American Museum of Natural History, Canadian National Collection, and British Museum (Nat. Hist.).

FOOD PLANT.—Unknown.

IN FLIGHT.—January to October.

REMARKS.—The attenuate character of the uncus distinguishes the males of *volcanensis* from all others of the genus, and the conspicuous median emargination of the production of the ductus bursae below the ostium is diagnostic for the females of the species. The female from Irazu is from the syntype series of *conisphora*.

***Loxostege mellinialis* (Druce), new combination**

FIGURES 42, 91, 143

Epichronistis mellinialis Druce, 1899, in Godman and Salvin, *Biologia Centrali-Americana*, Zoology, Lepidoptera, Heterocera, vol. 2, p. 559.

Phlyctaenodes phrixalis Dyar, 1914, Proc. U.S. Nat. Mus., vol. 47, no. 2059, p. 395. [New synonymy.]

MALE.—Alar expanse 28–32 mm. Frons conical. Antenna weakly ciliate. Midtibia incrassate; hair-pencil well developed, white. Outer spur one-third as long as inner spur. Forewing straw-yellow, slightly irrorated with buff. Markings as in female (fig. 42). Hindwing somewhat paler than forewing, without buff irroration; post-medial line terminating at fold between veins 1c and 2; brownish patch adjacent to base of vein 2 variable in size and intensity; wedge-like brownish accentuation of veins at termen variable in intensity, occasionally absent or obsolescent.

Genitalia (fig. 42): Harpe with digitate setae; a conspicuous denticulate production arising from dorsal margin of sacculus; pad spinulate ventrally, brushlike. Aedeagus bifid distally, elements subequal, the dorsal one attenuate and spinulate.

FEMALE (fig. 143).—Alar expanse 27–31 mm. Similar to male in color and maculation. Genitalia (fig. 91): eighth sternum finely

spinulate, rather smooth in appearance but with a few transverse folds or ridges and a pair of pouchlike receptacles laterad of the ostium, their long axes transverse.

TYPES.—British Museum (Nat. Hist.): *mellinialis*. U.S. National Museum: *phrixalis*, USNM 16510, genitalia slide HWC 6014.

TYPE-LOCALITIES.—Duenas, Guatemala (*mellinialis*); Zacualpan, Mexico (*phrixalis*).

DISTRIBUTION.—GUATEMALA: Duenas. MEXICO: Zacualpan. UNITED STATES: Arizona [new record for the United States].

FOOD PLANT.—Unknown.

SPECIMENS EXAMINED.—25.

IN FLIGHT.—July to September.

REMARKS.—*L. mellinialis* and *phrixalis* were previously known only from the types, and I am indebted to Mr. Whalley for comparison of my material with that of *mellinialis* in the British Museum (Nat. Hist.).

Loxostege venadialis, new species

FIGURES 43, 90, 145

MALE.—Alar expanse 32 mm. Frons conical. Antenna ciliate, length of cilia equal to width of shaft. Midtibia incrassate; hair-pencil well developed, white. Outer spur slightly less than one-half as long as inner spur. Color and maculation as in *mellinialis* but with definition of markings weaker, without wedgelike buff or brownish accentuation of veins at termen, and second and third segments of labial palpus paler.

Genitalia (fig. 43): Similar to those of *mellinialis* but with uncus stouter, sacculus wider with dorsal margin somewhat undulate, aedeagus more robust and longer.

FEMALE (fig. 145).—Alar expanse 27–31 mm. Similar to male in color and maculation. Genitalia (fig. 90) resemble those of *mellinialis* but with eighth sternum more strongly spinulose, with conspicuous undulate furrows, and with pouchlike receptacles much larger.

TYPE.—Male, U.S. National Museum, USNM 67616, genitalia slide HWC 6013.

TYPE-LOCALITY.—Venadio, Sinaloa, Mexico.

PARATYPES.—Type-locality, 1 ♂, 3 ♀.

FOOD PLANT.—Unknown.

IN FLIGHT.—No date of collection.

REMARKS.—The slightly longer cilia and outer spur distinguish the males of *venadialis* from those of *mellinialis*. The absence of the

wedgelike accentuation of the veins at the termen in *venadialis* distinguishes its females from those of well marked specimens of *melinialis*; if specimens are worn, the genitalia must be examined for the reliable separation of those two species.

***Loxostege labeculalis* (Hulst)**

FIGURES 58, 102, 140

Botis labeculalis Hulst, 1886, Trans. American Ent. Soc., vol. 13, p. 152.

Loxostege labeculalis (Hulst).—Fernald, 1903, in Dyar, U.S. Nat. Mus. Bull. 52, p. 384.—Barnes and McDunnough, 1917, Checklist of the Lepidoptera of boreal America, p. 132.—McDunnough, 1939, Southern California Acad. Sci. Mem., vol. 2, no. 1, p. 13.

MALE.—Alar expanse 16–20 mm. Conical production of frons obsolescent or absent. Antenna weakly ciliate. Midtibia weakly incrassate; hair-pencil weak. Outer spur one-fourth as long as inner spur. Head, thorax, and abdomen ochreous. Ground color of wings pale ochreous, markings dark brown with reddish tinge.

Genitalia (fig. 58): Uncus triangulate, apex pointed, slightly blunt. Harpe rather narrow, with digitate setae, clasper short, stout, curved, spinulate distally; sacculus with conspicuous upturned slender spine arising from dorsal margin. Anellus stout. Aedeagus with subequal bifurcate sclerotization and patch of deciduous spines. Large element of bifurcation elongate, somewhat concave, dilated distally; small element a short, spurlike projection from near base of larger.

FEMALE (fig. 140).—Alar expanse 20–23 mm. Color and maculation as in male. Genitalia (fig. 102): ostial pouch large, width about equal to depth; ductus bursae extending beyond anterior margin of pouch.

TYPE.—Female, American Museum of Natural History.

TYPE-LOCALITY.—Arizona.

FOOD PLANT.—Unknown.

DISTRIBUTION.—Arizona: Cochise Co.: Palmerlee, Paradise; Huachuca Mts., Chiricahua Mts.; Pima Co.: Baboquivari Mts. (Carr Canyon, Pepper Sauce Canyon); Santa Rita Mts., Madera Canyon. Texas: Brewster Co.

SPECIMENS EXAMINED.—39.

IN FLIGHT.—July to September.

REMARKS.—The spurlike projection of the aedeagus varies from obsolescent to well developed, and the serration of the margins of the larger element ranges from nearly smooth to distinctly serrate. The ostial pouch is also somewhat variable in shape, particularly adjacent to the origin of the ductus seminalis.

Loxostege intinctalis (Dyar), new combination

FIGURE 141

Pachyzancla intinctalis Dyar, 1920, Insec. Insc. Menstr., vol. 8, p. 34.

MALE (fig. 141).—Alar expanse 21 mm. Conical production of frons obsolescent or absent. Antenna weakly ciliate. Midtibia incrassate, hair-pencil distinct. Color and maculation as in *labeculalis* but with brownish accentuation of veins at termen more wedgelike. Genitalia like those of *labeculalis* but with uncus broader.

FEMALE.—Alar expanse 20 mm. Similar to male in color and maculation. Genitalia similar to those of *labeculalis* but larger, with ductus bursae wider and ostial pouch somewhat differently shaped.

TYPE.—Male, U.S. National Museum, USNM 22762, genitalia slide HWC 17,241.

TYPE-LOCALITY.—Zacualpan, Mexico.

PARATYPE.—Female, U.S. National Museum, Guadalajara, Mexico, via Schaus collection, genitalia slide HWC 17,242.

FOOD PLANT.—Unknown.

REMARKS.—*L. intinctalis* is known only from the type and paratype, so the differences distinguishing them from specimens of *labeculalis* may be individual rather than of specific value. Until this can be determined by examination of additional material of *intinctalis*, however, it seems best to treat it as a distinct species.

Loxostege federalis, new species

FIGURES 60, 103, 148

MALE (fig. 148).—Alar expanse 22–24 mm. Frons round. Antenna ciliate, length of cilia about equal to width of shaft. Midtibia weakly incrassate; hair-pencil obsolescent or absent. Outer spur about one-third as long as inner. Ground color of wings straw yellow, markings brownish.

Genitalia (fig. 60) similar to those of *labeculalis* but with uncus longer and more extenuate distally.

FEMALE.—Alar expanse 23 mm. Similar to male in color and maculation. Genitalia (fig. 103) similar to those of *labeculalis* but with posterior apophyses longer and a conspicuous constriction of eighth sternum adjacent to ostial opening.

TYPE.—Male, U.S. National Museum, USNM 67623, genitalia slide HWC 10,005.

TYPE-LOCALITY.—Popocatepetl Park, Mexico, D.F.

PARATYPES.—Type locality, 3 ♂, 2 ♀; in collection of U.S. National Museum.

FOOD PLANT.—Unknown.

IN FLIGHT.—June and July.

***Loxostege entephrialis* (Schaus), new combination**

FIGURES 29, 147

Pyrausta entephrialis Schaus, 1912, Ann. Mag. Nat. Hist., ser. 8, vol. 9, p. 311.

MALE (fig. 147).—Alar expanse 25 mm. Frons conical. Antenna ciliate, cilia slightly longer than width of shaft. Midtibia weakly incrassate; hair-pencil obsolescent or absent. Wings: ground color sordid white with an ochreous tinge; irrorated with light brown; markings brownish fuscous.

Genitalia (fig. 29): Uncus about as broad as long. Harpe with digitate setae; pad folded, spinulation dense and fine; a conspicuous broad, concave, spurlike projection arising from near middle of harpe and extending below lower margin; sacculus with small distal triangular production on dorsal margin. Aedeagus with patch of slender, spinelike cornuti and small finlike basal keel.

FEMALE.—Unknown.

TYPE.—Male, U.S. National Museum, USNM 17596, genitalia slide HWC 7952.

TYPE-LOCALITY.—Juan Vinas, Costa Rica.

FOOD PLANT.—Unknown.

IN FLIGHT.—October.

REMARKS.—*L. entephrialis* is known only from the type.

***Loxostege cupreicostalis* (Dyar), new combination**

FIGURES 60, 104, 142

Phlyctaenodes cupreicostalis Dyar, 1913, Proc. U.S. Nat. Mus., vol. 44, no. 1951, p. 318.

MALE (fig. 142).—Alar expanse 21–27 mm. Conical production of frons obsolescent or absent. Antenna somewhat pubescent, cilia very short. Midtibia incrassate, hair-pencil well developed, white. Wings pale yellow, somewhat lustrous and subhyaline, markings brownish; subterminal line absent.

Genitalia (fig. 60): Harpe without digitate setae; pad somewhat modified, with distal cluster of rather strong spinules; dorsal margin of sacculus with a short spinelike projection adjacent to emargination, near middle. Aedeagus with a patch of deciduous spinelike cornuti, spinules strongly dilated basally.

FEMALE.—Alar expanse 25 mm. Similar to male in color and the maculation. Genitalia (fig. 104): the character of sclerotization of the ductus bursae from ostium to origin of the ductus seminalis, in combination with the conspicuously narrow, elongate elements of signum, is diagnostic.

LECTOTYPE.—Male, U.S. National Museum, USNM 14449, genitalia slide HWC 6009.

TYPE-LOCALITY.—Guadalajara, Jalisco, Mexico.

PARALECTOTYPE.—Female, U.S. National Museum, genitalia slide HWC 6010.

FOOD PLANT.—Unknown.

DISTRIBUTION.—MEXICO: Guerrero: Sierra de Guerrero; Iguala. Puebla: Tehuacan. Jalisco: Guadalajara. Chiapas: Soconusco. Sonora: Mainari. VENEZUELA: Aroa. UNITED STATES: Arizona: Baboquivari Mts. [new record for the United States].

SPECIMENS EXAMINED.—9.

IN FLIGHT.—May to October.

REMARKS.—According to the original description, the species was based on two cotypes, a male and a female. The male, labeled type in Dyar's script, and the female are hereby designated lectotype and paralectotype, respectively.

Although *cupreicostalis* may eventually require placement elsewhere, it is best placed in *Loxostege* pending a revision of the subfamily.

***Loxostege subcostalis* (Dyar), new combination**

FIGURE 149

Lygropia subcostalis Dyar, 1912, Proc. U.S. Nat. Mus., vol. 42, no. 1885, p. 104.

—Klima, 1939, in Junk, Lepidopterorum catalogus, pt. 94, p. 233.

MALE (fig. 149).—Alar expanse 15–18 mm. Frons conical. Antenna weakly ciliate, somewhat pubescent, black with tip white. Midtibia weakly incrassate; hair-pencil obsolescent or absent. Outer spur one-half as long as inner spur. Upper surface of wings brownish yellow, unicolorous; under surface as above, except costa of forewing margined with black. Labial palpus with first and second segments brownish yellow; third segment black. Fore-, mid-, and hindtarsi blackish fuscous.

Genitalia similar to those of the species treated next but with the aedeagus of *subcostalis* lacking the conspicuous, strong, rather long, hooklike distal cornutus.

FEMALE.—Unknown.

TYPE.—Male, U.S. National Museum, USNM 14208, genitalia slide HWC 7995.

TYPE-LOCALITY.—Orizaba, Mexico.

FOOD PLANT.—Unknown.

DISTRIBUTION.—MEXICO: Vera Cruz: Orizaba and Santa Tosa. GUATEMALA: Chejel. COSTA RICA: Avangarez. UNITED STATES: Texas: Dallas [new record for the United States].

SPECIMENS EXAMINED.—8.

IN FLIGHT.—May to August.

REMARKS.—The Texas specimen is labeled "*Botis obauratalis*

Hulst, Type," but this appears to be a manuscript name since no record of its description was found in the literature.

Dyar erred in referring to the tibiae and tarsi as black; only the tarsi are blackish. The tibiae are brownish yellow.

Loxostege sinaloensis, new species

FIGURES 13, 150

MALE (fig. 150).—Alar expanse 15–17 mm. Frons conical. Antenna weakly ciliate, somewhat pubescent, brownish yellow with tip white. Midtibia weakly incrassate; hair-pencil obsolescent or absent. Outer spur one-half as long as inner spur. Upper surface of wings brownish yellow, unicolorous; under surface same as upper, except costa of forewing narrowly margined with black. Labial palpus with all segments brownish yellow. Entire foretarsus fuscous; first segment of mid- and hind tarsi pale fuscous, remainder of segments brownish yellow.

Genitalia (fig. 13): Uncus bluntly pointed. Harpe without digitate setae; clasper bifid. Aedeagus with one large, conspicuous, hooklike distal cornutus and a few patches of small, slender spines; basal keel well developed.

FEMALE.—Unknown.

TYPE.—Male, U.S. National Museum, USNM 67617, genitalia slide HWC 7997.

TYPE-LOCALITY.—Venadio, Sinaloa, Mexico.

PARATYPES.—Type locality, 4 ♂.

FOOD PLANT.—Unknown.

REMARKS.—*L. sinaloensis* and *subcostalis* are closely related; but the differences in coloration of the antenna, third segment of the labial palpus, and tarsi readily distinguish them from each other. The genitalia of both *sinaloensis* and *subcostalis* resemble those of *helvialis* and *pseudohelvialis*, but the former two species have stouter bifid claspers of the harpe and a different aedeagal armature.

Loxostege chiapasalis, new species

FIGURES 34, 151

MALE (fig. 151).—Alar expanse 22 mm. Frons conical. Antenna ciliate, cilia slightly shorter than width of shaft. Midtibia incrassate; hair-pencil present. Outer spur minute, about one-eighth as long as inner spur. Head, thorax, and abdomen brownish yellow; frons margined with white; thorax and abdomen paler below. Upper and under surfaces of fore- and hindwings brownish yellow, without markings. Labial palpus: first segment with basal half white, remainder blackish above, fringe fuscous intermixed with white; second

segment blackish above and laterally, fringe white; third segment blackish. Inner surface of foretibia fuscous, outer surface pale ochreous. Midtibia with a brownish dorsal band, remainder ochreous; hind tibia ochreous. All tarsi pale, smoky fuscous.

Genitalia (fig. 34): Uncus stout. Harpe with digitate setae; pad bifurcate distally, the elements subequal; a crenulate production anterior to median angle of bifurcation; spinulation restricted to area below crenulate production; sacculus with two widely separated spines. Aedeagus without cornuti.

FEMALE.—Unknown.

TYPE.—Male, U.S. National Museum, USNM 67618, genitalia slide HWC 17,092.

TYPE-LOCALITY.—Chiapas, Mexico.

FOOD PLANT.—Unknown.

REMARKS.—The species, known only from the type, resembles *Psara nigripes* Schaus, but *chiapasalis* is smaller and somewhat more brownish yellow, and the midtibia is brownish fuscous dorsally. The genitalia of *chiapasalis* are similar to those of *cayugalis*, differing chiefly in the modification of the pad.

***Loxostege nigripes* (Schaus), new combination**

FIGURES 32, 68, 152

Psara nigripes Schaus, 1920, Proc. Ent. Soc. Washington, vol. 22, p. 190.

MALE (fig. 152).—Alar expanse 28–30 mm. Frons conical. Antenna ciliate, cilia one-half as long as width of shaft. Midtibia incrassate, hair-pencil weak. Outer spur one-fifth as long as inner spur. Wings above and below orange, without markings. Labial palpus: first segment whitish at base, remainder fuscous; dorsal half of second segment fuscous, remainder whitish; third segment fuscous. Foretibia with some fuscous, more extensive on inner side; mid- and hind tibia orange. All tarsi blackish.

Genitalia (fig. 32): Uncus stout. Harpe with digitate setae; pad moderately narrow, spinulation rather coarse; a conspicuous spine arising from sacculus, with distal portion bent horizontally. Aedeagus without cornutus.

FEMALE.—Alar expanse 27–30 mm. Similar to male in color and maculation. Genitalia (fig. 68): ostium rather broad; ductus bursae gradually tapered from ostium to constriction adjacent to origin of ductus seminalis.

TYPE.—Male, U.S. National Museum, USNM 23552, genitalia slide HWC 17,090.

TYPE-LOCALITY.—“Cayuga, Guatemala”?

FOOD PLANT.—Unknown.

DISTRIBUTION.—GUATEMALA: Volcan Santa Maria. MEXICO: Vera

Cruz: Jalapa, Orizaba; Chiapas: Soconusco.

SPECIMENS EXAMINED.—14.

IN FLIGHT.—June to October.

REMARKS.—Schaus cited only Cayuga, Guatemala as habitat for the species, but none of the material in the collection is labeled Cayuga. The type and all of the other specimens in the series from Guatemala are labeled Volcan Santa Maria.

Loxostege subcuprea (Dognin), new combination

FIGURES 61, 174

Lygropia subcuprea Dognin, 1906, Ann. Mag. Ent. Belgique, vol. 50, p. 121.—

Klima, 1939, in Junk, Lepidopterorum catalogus, pt. 94, p. 233.

MALE (fig. 174).—Alar expanse 20 mm. Frons conical. Antenna somewhat pubescent. Midtibia incrassate; hair-pencil weak. Outer spur slightly less than one-third as long as inner spur. Fore- and hindwings orange, without markings except for fuscous margins. Labial palpus: first segment and most of second segment orange; distal part of second and all of third segment pale fuscous.

Genitalia (fig. 61): Uncus pointed. Harpe without digitate setae; clasper strong, hooklike, arising from near middle of harpe; dorsal margin of sacculus with a cluster of coarse, slender spinules near base and a distal group of finer spinules. Aedeagus with a narrow, straplike ventral sclerotization and a distal group of slender spines; basal keel thin, finlike.

FEMALE.—Unknown.

TYPE.—Male, U.S. National Museum, USNM 29562, genitalia slide HWC 17,237.

TYPE-LOCALITY.—Metan, Salta, Argentina.

FOOD PLANT.—Unknown.

DISTRIBUTION.—ARGENTINA: Type-locality and Tucuman.

SPECIMENS EXAMINED.—3.

IN FLIGHT.—February.

REMARKS.—The species is definitely not congeneric with *Lygropia unicoloralis* (Guenée), type of the genus *Lygropia* Lederer.

Loxostege clarissalis (Schaus), new combination

FIGURE 176

Nomophila clarissalis Schaus, 1920, Proc. Ent. Soc. Washington, vol. 22, no. 8, p. 217.—Klima, 1939, in Junk, Lepidopterorum catalogus, pt. 94, p. 382.

MALE (fig. 176).—Alar expanse 24 mm. Frons conical. Antenna weakly ciliate. Midtibia incrassate; hair-pencil well developed. Outer spur slightly less than one-half as long as inner spur. Head, thorax, and abdomen pale fuscous; patagia pale orange. Forewing ground color fuscous with orange tinge; orange accentuation of veins

terminating before attaining termen. Hindwing orange, margined with fuscous.

Genitalia very similar to those of *subcuprea* but larger and with uncus somewhat longer and more slender.

FEMALE.—Unknown.

TYPE.—Male, U.S. National Museum, USNM 23822, genitalia slide HWC 17,239.

TYPE-LOCALITY.—Peru.

FOOD PLANT.—Unknown.

DISTRIBUTION.—Peru.

SPECIMENS EXAMINED.—2.

REMARKS.—The frons, venation, genitalia, and tibial characters of *clarissalis* exclude it from the genus *Nomophila*.

***Loxostege aemulalis* (Dognin), new combination**

FIGURE 171

Phlyctaenodes aemulalis Dognin, 1905, Ann. Ent. Soc. Belgique, vol. 49, p. 77.

MALE (fig. 171).—Alar expanse 23 mm. Frons conical. Antenna weakly ciliate, cilia about one-half as long as width of shaft. Midtibia incrassate; hair-pencil present. Outer spur one-third as long as inner spur. Forewing smoky fuscous, without markings. Hindwing ochreous orange with smoky fuscous border on costa and outer margin. Genitalia essentially like those of *clarissalis* but with uncus narrower and more attenuate.

FEMALE.—Unknown.

TYPE.—Male, U.S. National Museum, USNM 29584, genitalia slide HWC 7949.

TYPE-LOCALITY.—Charuplaya, Bolivia.

FOOD PLANT.—Unknown.

SPECIMENS EXAMINED.—1 (known only from the type).

IN FLIGHT.—June.

REMARKS.—Although the genitalia of *aemulalis* and *clarissalis* are very similar, the lack of orange accentuation of the forewing veins of *aemulalis* readily distinguishes it from *clarissalis*.

***Loxostege naranjalis* (Schaus), new combination**

FIGURE 173

Lygropia naranjalis Schaus, 1920, Proc. Ent. Soc. Washington, vol. 22, no. 8, p. 213.—Klima, 1939, in Junk, Lepidopterorum catalogus, pt. 94, p. 232.

FEMALE (fig. 173).—Alar expanse 23 mm. Frons conical. Antenna pubescent. Head fuscous, frons margined with orange. Collar, thorax, and patagia orange. Abdomen orange with a black dorsal stripe from second to anal segment. Fore- and hindwings orange, margins black.

Genitalia with ostium broad; ductus bursae long, coiled, with a collarlike sclerotization near origin of ductus seminalis; bursa copulatrix somewhat granulose.

MALE.—Unknown.

TYPE.—Female, U.S. National Museum, USNM 23810, genitalia slide HWC 17,240.

TYPE-LOCALITY.—São Paulo, Brazil.

FOOD PLANT.—Unknown.

REMARKS.—*L. naranjalis* is known only from the type, and without the male, its generic placement is somewhat uncertain; however, its affinity with *Lygropia* is remote and, although the signum lacks the carina of typical *Loxostege*, its other characters indicate close relationship to that genus.

***Loxostege mojavealis*, new species**

FIGURES 172, 175

FEMALE (fig. 172).—Alar expanse 22 mm. Frons conical. Antenna simple. Forewing: ground color of upper surface whitish, strongly irrorated with smoky fuscous, markings blackish; definition of transverse anterior and posterior lines rather weak, with that of the latter strongest; area between transverse anterior line and base of wing paler than that between transverse anterior and posterior lines; angulation of transverse posterior line sharp and acute on vein 2. Hindwing yellowish orange, postmedial and subterminal lines fuscous, weak but discernible; terminal line black, thin; fringe blackish. Genitalia somewhat similar to those of *nigripes* but with lateral margins of ductus bursae at ostium straplike, ductus bursae with a conspicuous, narrow sclerotization below origin of ductus seminalis.

MALE.—Unknown.

TYPE.—Female, U.S. National Museum, USNM 67619, genitalia slide HWC 8027.

TYPE-LOCALITY.—Mojave Desert, near Phelan, Calif.

FOOD PLANT.—Unknown.

IN FLIGHT.—April.

REMARKS.—The species is known only from the type. Although *mojavealis* is somewhat similar to *Loxostege annaphilalis* (Grote), of which no females were available for study, it does not seem likely that they are conspecific, since the wings of *mojavealis* are narrower than those of *annaphilalis* and the markings different on both the fore- and hindwing. Definition of the markings is sharper on the forewing of *mojavealis*, with the transverse posterior line much more angulate and acute on vein 2 than in *annaphilalis*. The hindwing of *annaphilalis* is without markings except for the terminal dots and fringe.

***Loxostege fuscivenalis* (Schaus), new combination**

FIGURE 177

Lygropia fuscivenalis Schaus, 1920, Proc. Ent. Soc. Washington, vol. 22, no. 8, p. 213.—Klima, 1939, in Junk, Lepidopterorum catalogus, pt. 94, p. 233.

MALE (fig. 177).—Alar expanse 23 mm. Frons conical. Antenna somewhat pubescent, cilia very short. Outer spur one-third as long as inner spur. Head and collar orange; patagia orange anteriorly, fuscous posteriorly; abdomen fuscous. Forewing dull grayish brown, without markings except for brownish fuscous accentuation of veins. Hindwing brownish fuscous, accentuation of veins black. Labial palpus: first segment orange; upper half and distal portion of second segment fuscous, remainder orange; third segment fuscous.

Genitalia similar to those of the species treated next but with vinculum narrower and anterior production longer.

FEMALE.—Unknown.

TYPE.—Male, U.S. National Museum, USNM 23811, genitalia slide HWC 17,305.

TYPE-LOCALITY.—Peru.

FOOD PLANT.—Unknown.

DISTRIBUTION.—Peru.

SPECIMENS EXAMINED.—2.

REMARKS.—*L. fuscivenalis* is definitely misplaced in *Lygropia* and its affinity to this group is remote. Although the genitalia of *fuscivenalis* are somewhat aberrant, all other characters indicate that it is closely related to *Loxostege*.

***Loxostege peruensis*, new species**

FIGURE 178

MALE (fig. 178).—Alar expanse 24 mm. Frons conical. Antenna somewhat pubescent, cilia very short. Outer spur one-third as long as inner spur. Head, collar, palpi, and abdomen entirely fuscous. Fore- and hindwings as in *fuscivenalis*.

Genitalia: Uncus short, broad at base, distal termination a sharp point. Harpe without digitate setae; two slender fingerlike projections dorsad of outer end of sacculus, one directed dorsad, the other ventrad; sacculus with a conspicuous medial production bearing a cluster of strong spines. Aedeagus with two subequal sclerotizations; the long one narrow, straplike, with distal termination a long, slender, curved hook, the other short, bluntly pointed distally.

FEMALE.—Unknown.

TYPE.—Male, U.S. National Museum, USNM 67620, genitalia slide HWC 17,306.

TYPE-LOCALITY.—Peru.

FOOD PLANT.—Unknown.

REMARKS.—The species is known only from the type and is distinguished from *fuscivenalis* by its fuscous head, collar, and palpi. Because the genitalia of *peruensis* and *fuscivenalis* are so similar, the former may eventually prove to be a Mendelian color variant of the latter; but until its status can be definitely determined, it is desirable that a name be available for it.

Loxostege rantalis (Guenée)

FIGURES 51, 94, 153, 154

Nymphula rantalis Guenée, 1854, in Boisduval and Guenée, Histoire naturelle des insectes: Species général des lépidoptères, vol. 8, p. 405.—Hampson, 1899, Proc. Zool. Soc. London, p. 210 [cited as synonym of *Phlyctaenodes similalis* (Guenée) in error].

Eurycreon rantalis (Möschler).—von Hedemann, 1894, Stettiner Ent. Zeit., vol. 55, p. 286. [Incorrect citation.]

Loxostege similalis var. *rantalis* (Guenée).—Fernald, 1903, in Dyar, U.S. Nat. Mus. Bull. 52, p. 383.

Loxostege similalis form *rantalis* (Guenée).—Barnes and McDunnough, 1917, Checklist of the Lepidoptera of boreal America, p. 132.—McDunnough, 1939, Mem. Southern California Acad. Sci., vol. 2, no. 1, p. 12.

Loxostege similalis of authors.—Fernald, 1903, in Dyar, U.S. Nat. Mus. Bull. 52, p. 383.—Barnes and McDunnough, 1917, Checklist of the Lepidoptera of boreal America, p. 132.—Forbes, 1920, Cornell Univ. Agric. Exp. Sta. Mem. 68, p. 556.—McDunnough, 1939, Southern California Acad. Sci. Mem., vol. 2, no. 1, p. 12.—Schaus, 1940, Scientific survey of Porto Rico and the Virgin Islands, vol. 12, pt. 3, p. 367.—Smith and Franklin, 1954, Kansas Ent. Soc. Journ., vol. 27, no. 1, p. 27.—Okumura [in part], 1961, California Dept. Agric. Spec. Publ., no. 282, p. 48. [Misidentification.]

Phlyctaenodes similalis of authors.—Hampson [in part], 1899, Proc. Zool. Soc. London, p. 210. [Misidentification.]

Phlyctaenodes similalis of authors.—Wolcott, 1923, Journ. Dept. Agric. Puerto Rico, vol. 7, p. 192; 1936, Journ. Agric. Univ. Puerto Rico, vol. 20, p. 466. [Misidentification.]

Botis siriualis Walker, 1859, List of the lepidopterous insects in the British Museum (Nat. Hist.), pt. 18, p. 563.

Botis licealis Walker, 1859, *ibid.*, p. 563.

Ebulea murcialis Walker, 1859, *ibid.*, p. 746.

Scopula nestusalis Walker, 1859, *ibid.*, p. 784.

Scopula diotimealis Walker, 1859, *ibid.*, p. 785.

Scopula crinialis Walker, 1859, *ibid.*, p. 798.

Nephopteryx intractella Walker, 1863, *ibid.*, pt. 27, p. 55.

Eurycreon crinitalis (Walker).—Lederer, 1863, Weiner Ent. Monat., vol. 7, p. 376 [invalid emendation].—von Hedemann, 1894, Stettiner Ent. Zeit., vol. 55, p. 286.

Botys posticata Grote and Robinson, 1867, Trans. American Ent. Soc., vol. 1, p. 22.

Botys subfulvalis Herrich-Schäffer, 1871, Corr.-Blatt. Zool. Min. Ges. Regensburg, vol. 25, p. 20.

Eurycreon communis Grote, 1876, Canadian Ent., vol. 8, p. 99.

- Eurycreon collucidalis* Möschler, 1890, Abh. Senck. Ges., 16, p. 290.—Gundlach, 1891, Ann. Soc. Española Hist. Nat., vol. 20, p. 248.
- Phlyctaenodes collucidalis* (Möschler).—Wolcott, 1923, Journ. Dept. Agric. Puerto Rico, vol. 7, p. 192; 1936, Journ. Agric. Univ. Puerto Rico, vol. 20, p. 466.
- Pyrausta caffrei* Flint and Malloch, 1920, Bull. Illinois Dept. Reg. Educ. (Nat. Hist. Surv.), vol. 13, art. 10, pp. 304.
- Loxostege caffrei* (Flint and Malloch).—Heinrich [in part,] 1921, Ent. News, vol. 32, p. 57.

MALE (fig. 153).—Alar expanse 17–22 mm. Frons conical. Antenna pubescent. Midtibia little, if any, incrassate; hair-pencil absent. Outer spur one-half as long as inner spur. Forewing: ground color dull ochreous or somewhat brownish with markings slightly darker; transverse anterior line rather smooth, irregularly angulated; transverse posterior line denticulate; both lines often weak, diffuse; discocellular patch conspicuous, discal dot weaker. Hindwing often paler than forewing; postmedial line, if evident, diffuse.

Genitalia (fig. 51): Uncus narrowing gradually from base to tip. Harpe with cluster of setae arising from ridgelike modification, long, slender, nondigitate; pad somewhat modified, downcurved, hooklike, spinulate; dorsal margin of sacculus with three conspicuous spines; ventral spine of basal pair distinctly more than half as long as dorsal; dorsal spine upright from base for about one-third its length, thence somewhat outwardly oblique and weakly undulate; outer spine approximately parallel to dorsal margin of sacculus and terminating near middle. Aedeagus with a spinulate, irregular, elongate patch.

FEMALE (fig. 154).—Alar expanse 17–43 mm. Coloration usually somewhat darker than that of male, more brownish or occasionally somewhat grayish fuscous, markings stronger. Genitalia (fig. 94) with sclerotization of ductus bursae broadly interrupted between ostium and collarlike structure; lateral margins of sclerotized portion of ductus bursae between ostium and collar-like structure parallel or turning but slightly inward adjacent to ostium; an elongate, spinulate sclerotization on dorsum of ductus bursae midway between collar and ostium. Two signa, subequal; the small one connate, spinulate.

LARVA (fig. 1).—Mature, 24 mm. long. Head sordid white with reticulate pale amber markings and a small fuscous patch at lateral incision of hind margin. Prothoracic shield sordid white with brownish or blackish markings; elongate, or a series of small spots on dorsum and a narrow, interrupted pigmentation posterior to seta 1b, suffusion present along lateral margin; posterolateral margin extenuated, passing behind and under spiracle and fusing with prespiracular shield. Pinacula brown or blackish. Pinacula above level of spiracles uniformly concolorous, or with but a small area at base of seta paler; those below level of spiracles with a reduction or absence of pigmenta-

tion in central area much larger, often appearing ringlike. Meso- and metathorax with pinacula of setae Ia–Ib and IIa–IIb longitudinally elongate. Abdominal segments 1–8 with pinacula of setae I and II large, flat, round; pinaculum of seta III somewhat elongate or triangular. Abdominal segment 9 with pinaculum bearing paired setae II, that of setae I–III strongly pigmented; setae VI, VII, and VIII also on well-defined pinacula but with central areas paler.

Types.—U.S. National Museum: *rantalis*, female, USNM 67625, genitalia slide HWC 17,401. British Museum (Nat Hist.): *siriusalis*, male with head and abdomen missing; *lycealis*, male, genitalia slide BM 9683; *murcialis*, female, genitalia slide BM 9680; *nestusalis*, male with abdomen missing; *diotimealis*, female, genitalia slide BM 9679, hereby designated lectotype; *crinisalis*, male, genitalia slide BM 9681, hereby designated lectotype; *intractella*, male, genitalia slide BM 9678; *communis*, male, genitalia slide BM 9682, hereby designated lectotype. Museum der Humboldt-Universität: *collucidalis*, male, genitalia slide HWC 17,636. American Museum Natural History: *posticata*, male, lectotype. Illinois Natural History Survey Collection: *caffreii*, male. Location unknown: *subfulvalis*.

TYPE-LOCALITIES.—Probably “Amérique Septentrionale, Am. bor.,” or, “Cuba”: *rantalis*. United States: *siriusalis*, *lycealis*, *nestusalis*, and *intractella*. New York: *communis*. Pennsylvania: *posticata*. Illinois: *caffreii*. Santo Domingo: *murcialis*, *diotimealis*. Puerto Rico: *collucidalis*. Unknown: *crinisalis*, *subfulvalis*.

FOOD PLANTS.—Alfalfa, *Ambrosia trifida*, *A. artemisifolia retroflexus*, *Amaranthus* sp., *Atriplex patula*, *Batis maritima*, beans, clover, corn, cotton, cowpeas, lambsquarters, *Parthenium argentatum*, peas, pigweed, radish, ragweed, *Rumex* spp., smartweed, soybeans, strawberry, sugarbeets, sunflower, Swiss chard, and thistle.

DISTRIBUTION.—UNITED STATES: Maine, Connecticut, New York, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Louisiana, Arkansas, Texas, Ohio, Indiana, Illinois, Missouri, Iowa, Kansas, Oklahoma, Colorado, New Mexico, Arizona, and California. WEST INDIES: Bermuda, Bahamas, Cuba, Puerto Rico, St. Croix, and St. Domingo. MEXICO: Vera Cruz, Puebla, Oaxaca, and Jalisco.

SPECIMENS EXAMINED.—335.

IN FLIGHT.—April to November.

REMARKS.—After examining over one hundred genitalia dissections, I believe that the origins cited by Guenée for *rantalis* (Montevideo) and *similalis* (Amérique Septentrionale) were confused. The genitalia of the type of *rantalis*, a female, are unlike any of those of South American specimens but typical of material from North America, Mexico, and the West Indies. Similarly, the genitalia of the type of

similalis, a male, are unlike those of North American, Mexican, and West Indies material but are like those of South American specimens, some of which were collected at Montevideo, Uruguay.

Furthermore, "Amerique Septentrionale" does not appear on the type label of *similalis*; the only localities on it are "Am. bor. Cuba." A line appears to have been drawn through "Cuba" indicating cancellation.

I am much indebted to Mr. Whalley for examining, dissecting, and furnishing data on the type material in the British Museum essential for verification of synonymy and selection of lectotypes. The types of *siriusalis* and *intractella* were found to be males, not females as indicated by Walker, and *Scopula thoonalis* Walker proved to be not congeneric with *Loxostege*. *S. thoonalis* is, therefore, removed from the synonymy but, owing to lack of genitalia, it cannot be assigned elsewhere at present.

I am also indebted to Dr. H. J. Hannemann of the Humboldt-Universität Museum for making available the type of *collucidalis* for dissection and verification of its synonymy.

***Loxostege occidentalis* (Packard)**

FIGURES 52, 96, 155, 156

Scopula occidentalis Packard, 1873, Ann. Lyc. Nat. Hist. New York, vol. 10, p. 260.

Eurycreon occidentalis (Packard).—Hampson, 1899, Proc. Zool. Soc. London, p. 210 [cited as a synonym of *Phlyctaenodes similalis* (Guenée) in error].

Loxostege occidentalis (Packard).—Fernald, 1903, in Dyar, U.S. Nat. Mus. Bull. 52, p. 383 (cited as synonym of *Loxostege similalis* var. *rantalís* (Guenée) in error).—Barnes and McDunnough, 1917, Checklist of the Lepidoptera of boreal America, p. 132.—McDunnough, 1939, Southern California Acad. Sci. Mem., vol. 2, no. 1, p. 12 [cited as synonym of *Loxostege similalis* form *rantalís* (Guenée) in error].

MALE (fig. 155).—Alar expanse 18–26 mm. Frons conical. Antenna pubescent. Midtibia little, if any, thicker than the hind tibia; hair-pencil absent. Typical specimens similar to darker specimens of *rantalís* in color and maculation, those of *occidentalis* more grayish fuscous and with definition of narrow, sordid white or ochreous shading along inner side of transverse anterior and outer side of transverse posterior lines of forewing more distinct, terminal dots stronger. Examination of the genitalia, however, is necessary to reliably distinguish occasional pale brownish specimens of *occidentalis* from those of *rantalís*.

Genitalia (fig. 52) similar to those of *rantalís* but with uncus stouter and the two basal spines of sacculus stouter, subequal; ventral spine one-half or less as long as dorsal.

FEMALE (fig. 156).—Alar expanse 20–23 mm. Similar to male in color and maculation. Genitalia (fig. 96) similar to those of *rantalís*

but ductus bursae distinctly expanded at ostium and lateral margins somewhat angulate.

LECTOTYPE.—Female, Museum of Comparative Zoology, MCZ 14264, genitalia slide HWC 17,459.

TYPE-LOCALITY.—California.

FOOD PLANT.—Unknown.

DISTRIBUTION.—California: Soda Springs, Navarro, San Francisco, Claremont, San Diego, Loma Linda, Fair Oaks, Fresno, Yosemite, and Inyo Co. [no additional locality].

SPECIMENS EXAMINED —47.

IN FLIGHT.—April to October.

REMARKS.—*L. occidentalis* was based on two males and two females from California received by Packard from the collections of Edwards and Behrens. Of the three specimens (two males and one female) of *occidentalis* now in the collection of the MCZ, only the female can be definitely associated with the type series; it is labeled "*Scopula occidentalis* Packard, California, Edwards" and is hereby designated lectotype of the species. One of the males has no locality label; the other is from California, but there are no indications that either was Edwards' or Behrens' material.

Differences in the genitalia, both male and female, distinguish *occidentalis* from *rantalis* and *similalis* and clearly indicate that it is a distinct species.

The adults of *occidentalis* have not yet been associated with larvae.

Loxostege similalis (Guenée)

FIGURES 50, 95, 157, 158

Nymphula similalis Guenée, 1854, in Boisduval and Guenée, Histoire naturelle insects: Species général des Lépidoptères, vol. 8, p. 403.

Phlyctaenodes similalis (Guenée).—Hampson [in part,] 1899, Proc. Zool. Soc. London, p. 210.

Tritea ferruginea Warren, 1892, Ann. Mag. Nat. Hist., ser. 6, vol. 9, p. 179. [New synonymy.]

Phlyctaenodes ferruginea (Warren).—Hampson, 1899, Proc. Zool. Soc. London, p. 210.

Pyralis garalis Schaus, 1906, Proc. U.S. Nat. Mus., vol. 30, no. 1444, p. 141. [New synonymy.]

MALE (fig. 157).—Alar expanse 17–20 mm. Frons conical. Antenna pubescent. Midtibia little, if any, incrassate; hair-pencil absent. Outer spur about one-half as long as inner spur. Resembles *rantalis* but duller in appearance, with ochreous tinge lacking; posterior transverse line of forewing usually with pale edging along outer margin.

Genitalia (fig. 50): Uncus distinctly extenuate; distal third cylindrical, hairlike scales short, one-half or less as long as proximal ones.

Harpe with basal pair of spines on dorsal margin of sacculus of equal length, or ventral spine slightly longer than dorsal.

FEMALE (fig. 158).—Alar expanse 16–20 mm. Usually somewhat darker than male but otherwise similar in color and maculation. Genitalia (fig. 95) similar to those of *rantalis* but with dorsum of ductus bursae between collarlike structure and ostium without a platelike sclerotization, or if discernible, obsolescent and nonscobinate.

TYPES.—U.S. National Museum: *similalis*, male, USNM 67626, genitalia slide HWC 7754; *garalis*, male, USNM 9624, genitalia slide HWC 10,032. British Museum (Nat. Hist.): *ferruginea*, male.

TYPE-LOCALITIES.—Probably Montevideo, Uruguay: *similalis* (see discussion under *rantalis*). Coquimbo, Chile: *ferruginea*. São Paulo, Brazil: *garalis*.

Food plant and larval stage unknown.

DISTRIBUTION.—BRAZIL: Rio Grande do Sul: Pelotas, Guarani; Mato Grosso: Corumba; Minas Gerais: Lassance; São Paulo: Rio de Janeiro, Campinas; Castro Parana. URUGUAY: Montevideo. PARAGUAY: Villarica. ARGENTINA: Santa Fe: San Cristobal; Tucuman: Tucuman, Los Vasquez; Cordoba: Pilar; Jujuy: Ledesma; La Rioja: La Rioja. CHILE: Santiago, Cajon Rio Maipo; Malleco: Angol. PERU: no additional locality. BOLIVIA: no additional locality. ECUADOR: Loja.

SPECIMENS EXAMINED.—109.

IN FLIGHT.—January to December.

REMARKS.—In addition to the differences in genitalic structures, the distributions of *similalis* and *rantalis* are different, the former being restricted to South America and the latter to the United States, Mexico, and the West Indies.

Schaus' *Pyralis garalis* agrees with *similalis* in both maculation and genitalia and is definitely conspecific. I am indebted to Mr. Whalley of the British Museum for comparing material with the type of *Tritea ferruginea*, which also agrees with *similalis* in maculation and genitalia and is doubtless conspecific.

Although *similalis* replaces *rantalis* in South America and appears to be common, it has not attracted attention as a pest there; this may be due to some confusion of its larvae with those of *Loxostege bifidalis* (Fabricius), which has been reported as a pest of considerable importance.

Loxostege bifidalis (Fabricius)

FIGURES 54, 98, 164, 165

Phalaena bifidalis Fabricius, 1794, Ent. Syst., vol. 3, pt. 2, p. 232.

Phlyctaenodes inornatalis Walker, 1865, List of the lepidopterous insects in the British Museum (Nat. Hist.), pt. 34, p. 1456.

Eurycreon evanidalis Berg, 1875, Deutsche Ent. Zeit., vol. 19, p. 134.—Gundlach, 1890, Ann. Soc. Española Hist. Nat., vol. 20, p. 348.

Eurycreon obsoletalis Berg, 1875, op. cit., p. 135.

Eurycreon evanadalis [sic] Berg.—Möschler, 1890, Abh. Senck. Ges., vol. 16, p. 290.

Eurycreon bifidalis (Fabricius).—von Hedemann, 1894, Stettiner Ent. Zeit., vol. 55, p. 286; 1896, *ibid.*, vol. 57, p. 3.

Phlyctaenodes bifidalis (Fabricius).—Hampson, 1899, Proc. Zool. Soc. London, p. 210.—Wolcott, 1923, Journ. Dept. Agric. Puerto Rico, vol. 7, p. 192.

Loxostege bifidalis (Fabricius).—Fernald, 1903, in Dyar, U.S. Nat. Mus. Bull. 52, p. 383.—Barnes and McDunnough, 1917, Checklist of the Lepidoptera of boreal America, p. 131.—McDunnough, 1939, Southern California Acad. Sci. Mem., vol. 2, no. 1, p. 12.—Schaus, 1940, Scientific survey of Porto Rico and the Virgin Islands, vol. 12, pt. 3, p. 368.—Amsel, 1956 (1954), Bol. Ent. Venezolana, vol. 10, p. 249.

Loxostege stolidalis Schaus, 1940, Scientific survey of Porto Rico and the Virgin Islands, vol. 12, pt. 3, p. 368. [New synonymy.]

MALE (fig. 164).—Alar expanse 20–24 mm. Frons conical. Antenna pubescent. Midtibia but slightly thicker than hind tibia; hair-pencil absent. Outer spur one-half as long as inner spur. Forewing: ground color pale buff, somewhat glossy; markings brownish, obsolescent, diffuse. Hindwing slightly paler than forewing, without markings except for thin terminal line. Fringe of both fore- and hindwings pale buff.

Genitalia (fig. 54): Uncus terminating in a sharp point. Harpe with cluster of strong, slender, nondigitate setae from oblique modification; hooklike sclerotization spinulate distally; production of dorsal margin of sacculus truncate. Aedeagus with numerous strong, spinelike cornuti, variable in number and shape.

FEMALE (fig. 165).—Alar expanse 20–23 mm. Similar to male in color and maculation but with the markings stronger and often more fuscous. **Genitalia** (fig. 98): ostial margins membranous; ductus bursae strongly sclerotized from slightly below ostium to slightly beyond midpoint between ostium and origin of ductus seminalis, somewhat constricted near middle, with upper element spinulate, lower element smooth, broad, collarlike; ductus bursae membranous, nonpigmented from collar to origin of ductus seminalis; ductus seminalis strongly sclerotized and curved, hooklike at origin.

LARVA.—Mature, 24–27 mm. long. Resembles *rantalalis* but differs from it as follows: posterolateral extension of prothoracic shield behind and under spiracle, and fusion with prespiracular shield weaker, usually discernible only in specimens treated with KOH. Pigmentation of pinacula weaker, interrupted. Meso- and metathorax: pigmentation of pinaculum of setae Ia–Ib weak, restricted to a small patch anterior to base of setae or occasionally with an additional

posterior patch; pinaculum of setae IIa-IIb with pigmentation stronger and more extensive, restricted to lower portion of pinaculum, crescent shaped; pinacula of setae III, IV-V, and VI nonpigmented or pigmented at margin only. Abdominal segments 1-7: pigmentation of pinaculum of setae I similar to that of setae IA-IB of meso- and metathorax; pigmentation of pinaculum of seta II stronger than that of seta I, constricted at middle; pigmentation of seta II similar to that of setae IIa-IIb of meso- and metathorax; pinacula below level of spiracle with pigmentation restricted to marginal area or absent. Abdominal segment 8: pigmentation of pinacula of setae I and II more extensive than on anterior segments, usually not interrupted on margins but with large central area not pigmented; pinaculum of seta III complete, except for small area at base of seta. Abdominal segment 9: pigmentation of pinaculum of paired setae II stronger on anterior and lateral margins, central area and posterior margin with pigmentation obsolescent or absent; pinaculum of setae I-III with pigmentation complete, except for small area at base of setae; pinacula of setae VI, VII and VIII nonpigmented. Anal shield with pigmentation of pattern variable.

TYPES.—Location uncertain: *bifidalis*. British Museum (Nat. Hist.): *inornatalis*. Museum Natural Sciences Argentina: *evanidalis*, *obsoletalis*. U.S. National Museum: *stolidalis*, USNM 34632.

TYPE-LOCALITIES.—“Americae Insulis,” *bifidalis*. St. Domingo: *inornatalis*. Argentina, Buenos Aires: *evanidalis*, *obsoletalis*. Puerto Rico, Ensenada: *stolidalis*.

FOOD PLANTS.—Cotton, purslane.

DISTRIBUTION.—CANADA: Alberta. UNITED STATES: Arizona, New Mexico, Texas. MEXICO: Colima, Oaxaca, Vera Cruz, Morelos. GUATEMALA: Cayuga. PANAMA: La Chorrera. VENEZUELA: Aroa. COLOMBIA: Tolima. PERU: Lima. BRAZIL: Rio Grande do Sul. ARGENTINA: Santa Fe, Tucuman. PARAGUAY: Villarica. WEST INDIES: St. Croix, Jamaica, Puerto Rico.

SPECIMENS EXAMINED.—179.

IN FLIGHT.—February to December.

REMARKS.—The inwardly oblique brownish or somewhat fuscous diffuse bandlike marking which extends from the apex of the forewing to the outer angle of the cell, thence fused with the posterior transverse line to the inner margin of the wing, distinguishes *bifidalis* from the other species heretofore treated herein; it is usually weaker in the males, and is often obsolescent but with remnants discernible.

The genitalia of *stolidalis* Schaus were dissected and they are within the range of interspecific variation of *bifidalis*.

Loxostege brasiliensis, new species

FIGURES 55, 99, 166, 167

MALE (fig. 166).—Alar expanse 22 mm. Frons conical. Antenna pubescent. Midtibia slightly more incrassate than hind tibia; hair-pencil obsolescent or absent. Outer spur about one-third as long as inner spur. Resembles *bifidalis* but somewhat darker, definition of markings of forewing stronger, and fuscous suffusion adjacent to outer margin of hindwing more extensive.

Genitalia (fig. 55): Similar to those of *bifidalis* but with uncus stouter and lateral margins more convex; sacculus without a somewhat extenuate, truncate production from dorsal margin.

FEMALE (fig. 167).—Alar expanse 22 mm. Similar to male in color and maculation but with markings stronger. Genitalia (fig. 99) similar to those of *bifidalis* but collarlike structure narrower, with dorsal and ventral margins parallel.

TYPE.—Male, U.S. National Museum, USNM 67621, genitalia slide HWC 8022.

TYPE LOCALITY.—Campinas, São Paulo, Brazil.

PARATYPES.—From type locality 2 ♀, genitalia slide HWC 8023, in U.S. National Museum.

FOOD PLANT.—Unknown.

IN FLIGHT.—December.

Loxostege piuralis, new species

FIGURES 57, 100, 168, 169

MALE (fig. 168).—Alar expanse 21 mm. Frons conical. Antenna pubescent. Midtibia slightly more incrassate than hind tibia; hair-pencil absent or obsolescent. Outer spur about one-third as long as inner spur. Similar to *brasiliensis* in color and maculation but forewing with veins accentuated with fuscous, hindwing with less suffusion adjacent to outer margin.

Genitalia (fig. 57): Similar to those of *brasiliensis* but with uncus somewhat extenuate from near middle to apex; dorsal margin of sacculus more rounded distally; aedeagus with cornuti spinules much weaker.

FEMALE (fig. 169).—Alar expanse 16–20 mm. Similar to male in color and maculation. Genitalia (fig. 100) similar to those of *brasiliensis* but with sclerotization at origin of ductus seminalis greatly reduced.

TYPE.—Male, U.S. National Museum, USNM 67622, genitalia slide HWC 8029.

TYPE-LOCALITY.—Piura, Peru.

PARATYPES.—From type-locality, 2 ♀, genitalia slide HWC 8030, in U.S. National Museum.

FOOD PLANT.—Unknown.

IN FLIGHT.—February.

***Loxostege protealis* (Warren), new combination**

FIGURES 56, 97, 162

Tritaea protealis Warren, 1892, Ann. Mag. Nat. Hist., ser. 6, vol. 9, p. 178.

Phlyctaenodes protealis (Warren).—Hampson, 1899, Proc. Zool. Soc. London, p. 211.

MALE.—Alar expanse 21 mm. Frons conical. Midtibia not incrassate; hair-pencil absent. Outer spur about one-half as long as inner spur. Resembles *eneanalis* in color and maculation but upper surface of forewing somewhat duller; area in cell between discal dot and reniform ochreous; terminal dots black, conspicuous; hindwing with post-medial line diffuse but evident.

Genitalia (fig. 56): Similar to those of the species described as *Pyrausta eneanalis* Schaus and treated next, but distinguished from them by the stronger ampulla, longer spine from dorsal margin of sacculus, and character of the cornuti of the aedeagus.

FEMALE (fig. 162).—Alar expanse 20–21 mm. Similar to male in color and maculation but with ochreous patch between discal dot and reniform stronger. Genitalia (fig. 97) similar to those of *eneanalis* but distinguished from them by difference in character of sclerotization adjacent to ostium, in length of ductus bursae from ostium to origin of ductus seminalis, and degree of sclerotization at origin of ductus seminalis.

LECTOTYPE.—Male, British Museum (Nat. Hist.).

TYPE-LOCALITY.—San Lorenzo Is., Callao, Peru.

FOOD PLANT.—Unknown.

DISTRIBUTION.—PERU: Trujillo and Angamarca.

SPECIMENS EXAMINED.—3.

IN FLIGHT.—No dates of collection on labels.

REMARKS.—The species was based on two males and one female, all from the same locality. The male, with genitalia dissected, is hereby designated lectotype of *protealis*.

***Loxostege eneanalis* (Schaus), new combination**

FIGURES 53, 101, 160, 161

Pyrausta eneanalis Schaus, 1923, Zoologica, Sci. Contr. New York Zool. Soc., vol. 5, p. 45.

MALE (fig. 160).—Alar expanse 18 mm. Frons conical. Antenna pubescent. Midtibia slightly thicker than hind tibia; hair-pencil obsolescent or absent. Outer spur about one-half as long as inner spur. Resembles darker specimens of *occidentalis* in color and maculation.

Genitalia (fig. 53): Similar to those of *occidentalis*, harpe with a single spine arising from dorsal margin of sacculus; an obscure ampulla dorsad of cluster of long, slender setae; spinelike cornuti of aedeagus stronger.

FEMALE (fig. 161).—Alar expanse 17–20 mm. Similar to male in color and maculation. Genitalia (fig. 101): the conspicuous dilation of ductus seminalis in combination with character of sclerotization adjacent to ostium, ductus bursae between ostium and origin of ductus seminalis, and ductus seminalis at origin, are diagnostic for females.

TYPE.—Male, U.S. National Museum, USNM 26524, genitalia slide HWC 17,693.

TYPE-LOCALITY.—Conway Bay, Indefatigable Island, Galapagos Archipelago.

FOOD PLANT.—Unknown.

DISTRIBUTION.—Indefatigable and South Seymour Islands, Galapagos Archipelago.

SPECIMENS EXAMINED.—4.

IN FLIGHT.—April.

REMARKS.—Examination of the type revealed that it is a male, not a female as stated by Schaus.

Ostrinia oblitalis (Walker), new combination

FIGURE 146

Botys oblitalis Walker, 1865, List of the lepidopterous insects in the British Museum (Nat. Hist.), pt. 34, p. 1392.

Loxostege oblitalis (Walker).—Barnes and McDunnough, 1917, Checklist of the Lepidoptera of boreal America, p. 131.

Pyrausta ainsliei Heinrich, 1919, Journ. Agric. Res., vol. 18, p. 175. [New synonymy.]

TYPES.—British Museum (Nat. Hist.): *oblitalis*, female; U.S. National Museum: *ainsliei*, male, USNM 22544.

TYPE-LOCALITIES.—North America: *oblitalis*; Knoxville, Tennessee: *ainsliei*.

REMARKS.—F. H. Benjamin was the first to note discrepancies in the sex of the type of *oblitalis* and the application of the name. In his unpublished notes, compiled about forty years ago during his examination of types of American species in the British Museum, he noted that the type of *oblitalis* was a female and not a male (as stated in the original description), and that the species to which the name was applied in collections in the United States was probably a *Pyrausta* instead of a *Loxostege*.

It was not until recently, however, that Walker's *oblitalis* was definitely determined to be conspecific with *ainsliei* by the comparison of females and genitalia of that species with the type of *oblitalis*.

Hence, *ainsliei* falls as a synonym of *obliteralis*. I am indebted to Mr. Whalley of the British Museum and to Dr. Duckworth of the U.S. National Museum for comparison of the material and verification of the suspected synonymy.

***Ostrinia penitalis* (Grote), new combination**

Botis penitalis Grote, 1876, Canadian Ent., vol. 8, p. 98.

Pyrausta penitalis (Grote).—Fernald, 1903, in Dyar, U.S. Nat. Mus. Bull. 52, p. 391.

Marion's (1957) paper transferring *nubilalis* (Hübner), commonly referred to as the European corn borer, from the genus *Pyrausta* Schrank to *Ostrinia* Hübner was restricted to species occurring in Europe. Because of that fact, treatment of its contemporary American congeners, *Pyrausta ainsliei* and *Pyrausta penitalis* (Grote), was omitted. *P. ainsliei* is placed in synonymy under *obliteralis* herein, but *penitalis* is not a *Loxostege* or *Phlyctaenodes* species and has never been assigned to either of them; in a strict sense it is not an essential part of this study. Due to its association with *ainsliei* and *nubilalis*, however, there is considerable economic literature involved. *P. penitalis* is also hereby assigned to *Ostrinia* for its correct placement and uniformity of nomenclature in references to *obliteralis*, *ainsliei*, and *penitalis*.

***Phlyctaenodes parvipicta* (Barnes and McDunnough), new combination**

FIGURE 170

Loxostege parvipicta Barnes and McDunnough, 1918, Contr. Nat. Hist. Lepid. North America, vol. 4, p. 161.—McDunnough, 1939, Southern California Acad. Sci. Mem., vol. 2, no. 1, p. 13.

MALE (fig. 170).—Alar expanse 13 mm. Frons conical. Antenna ciliate, cilia longer than width of shaft. Midtibia not incrassate; hair-pencil absent. Upper surface of forewing ochreous, markings pinkish. Hindwing white, without markings.

Genitalia like those of *pustulalis* but with uncus and vinculum narrower, gnathos stouter, and aedeagus longer and more slender.

FEMALE.—Alar expanse 14 mm. Similar to male in color and maculation. Genitalia like those of *pustulalis* but with anterior and posterior apophyses shorter and collarlike structure of ductus bursae more strongly sclerotized.

LECTOTYPE.—Male, U.S. National Museum, USNM 67627, genitalia slide HWC 7815.

TYPE-LOCALITY.—Olancho, Inyo Co., Calif.

FOOD PLANT.—Unknown.

DISTRIBUTION.—Arizona: Mojave Co. California: type-locality. Nevada: Clarke Co.

SPECIMENS EXAMINED.—17.

IN FLIGHT.—March to June.

REMARKS.—Of the American species studied, only *parvipicta* has the characters of *Phlyctaenodes*, to which it is hereby transferred; it is not closely related to the *vibicalis* group as indicated in the original description.

The species was based on three males and two females. Two of the specimens were labeled as type male and type female and the remainder paratypes. The specimen labeled "*Loxostege parvipicta* B. & McD., male type" is hereby designated lectotype of the species.

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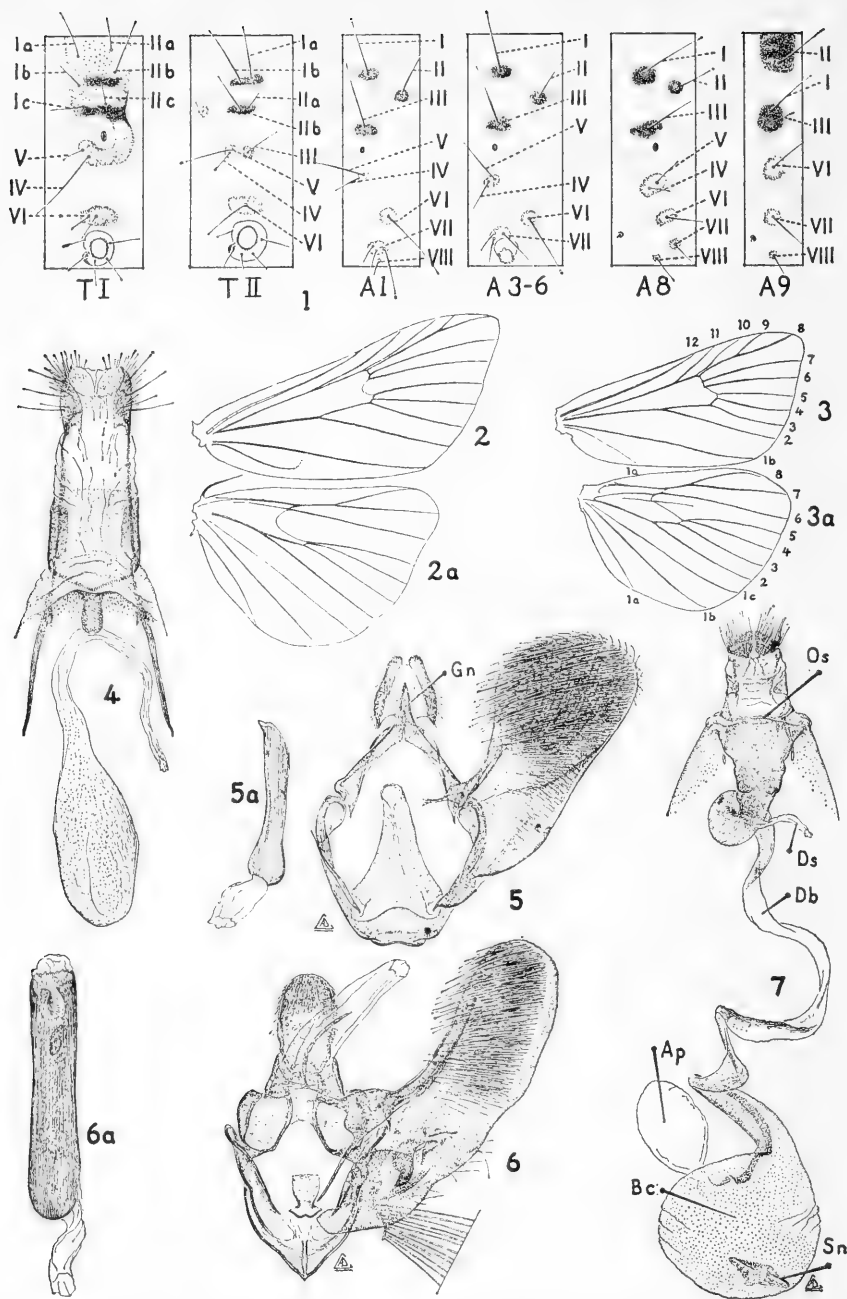
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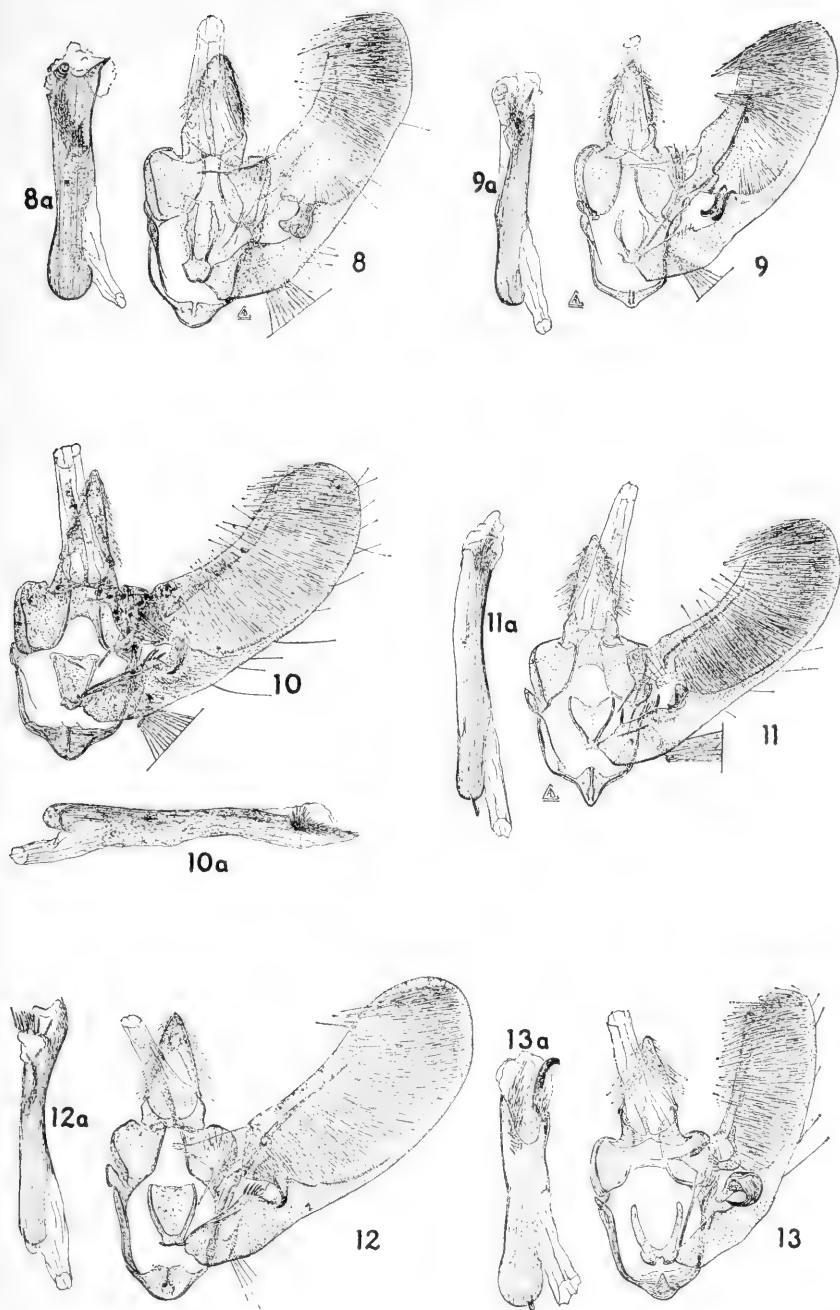
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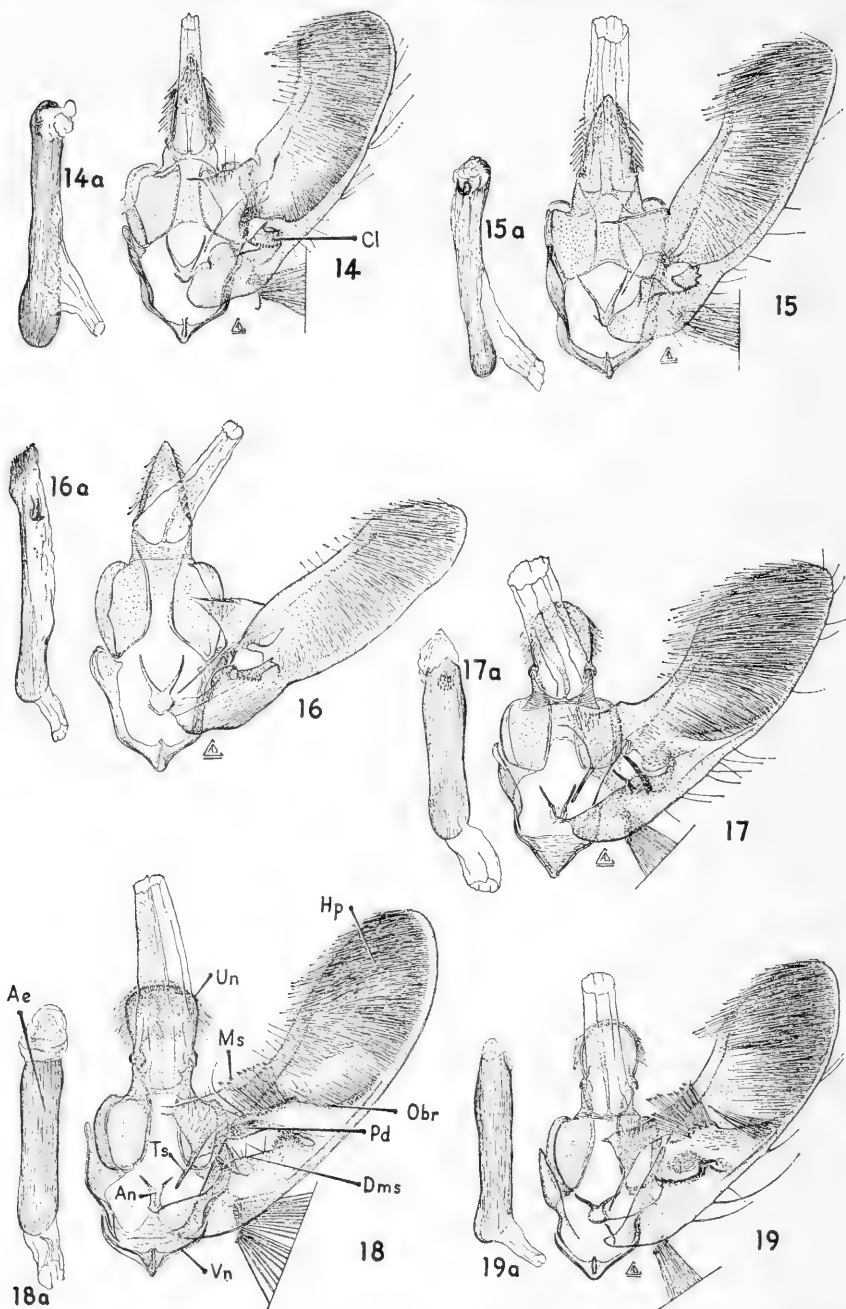
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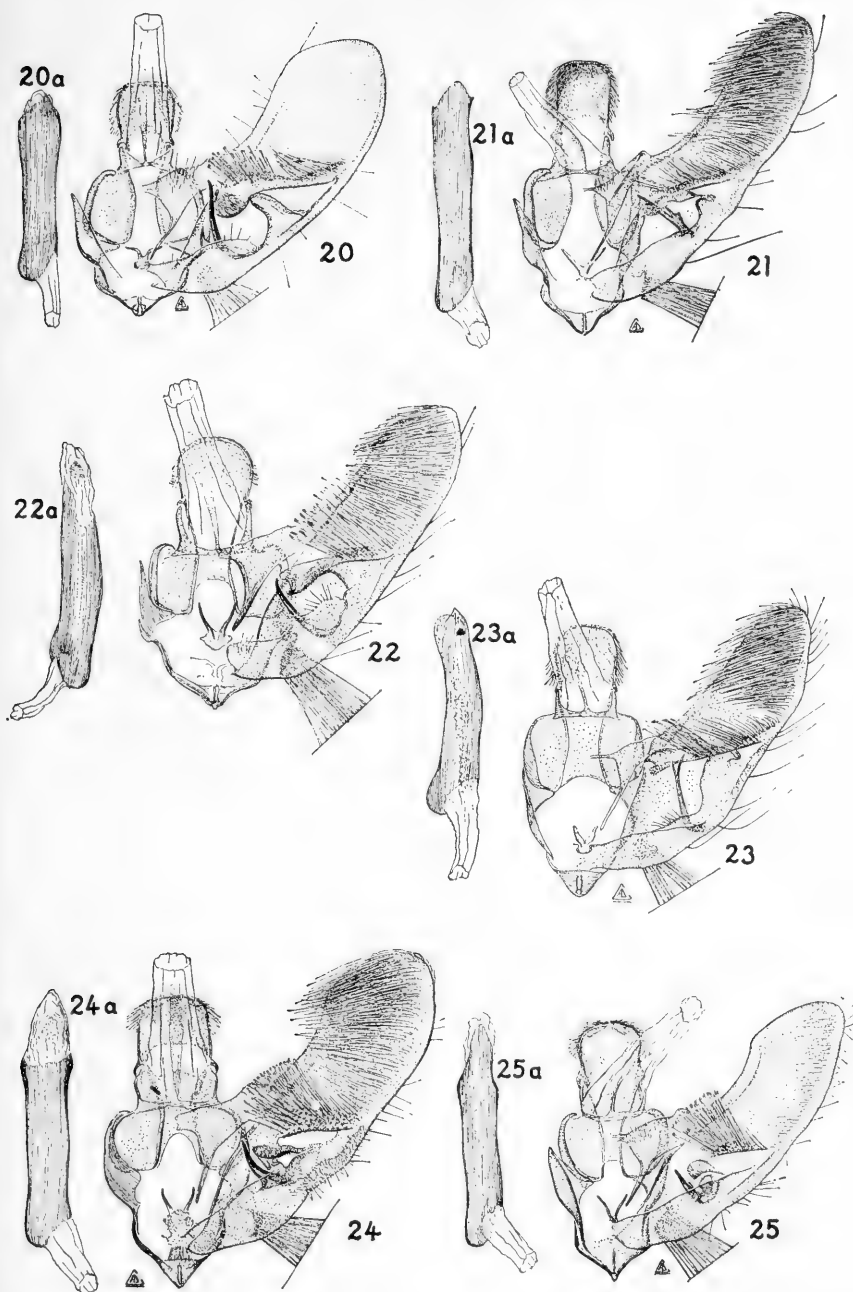
FIGURES 1-7.—*Loxostege ratalis* (Guenée): 1, larval setal arrangement of prothorax, mesothorax, and abdominal segments 1, 3-6, 8, 9, using Dyar and Heinrich system of terminology (TI=prothorax, TII=mesothorax, AI=1st abdominal segment, A3-6=3rd to 6th abdominal segments, A8=8th abdominal segment, A9=9th abdominal segment). *Loxostege aeruginalis* (Hübner): 2, forewing; 2a, hindwing. *Phlyctaenodes pustulalis* (Hübner): 3, forewing; 3a, hindwing. 4, female genitalia; 5, male genitalia; 5a, aedeagus *Loxostege aeruginalis* (Hübner): 6, male genitalia; 6a, aedeagus; 7, female genitalia (Ap=accessory pouch, Bc=bursa copulatrix, Db=ductus bursae, Ds=ductus seminalis, Os=ostium, Sn=signum).



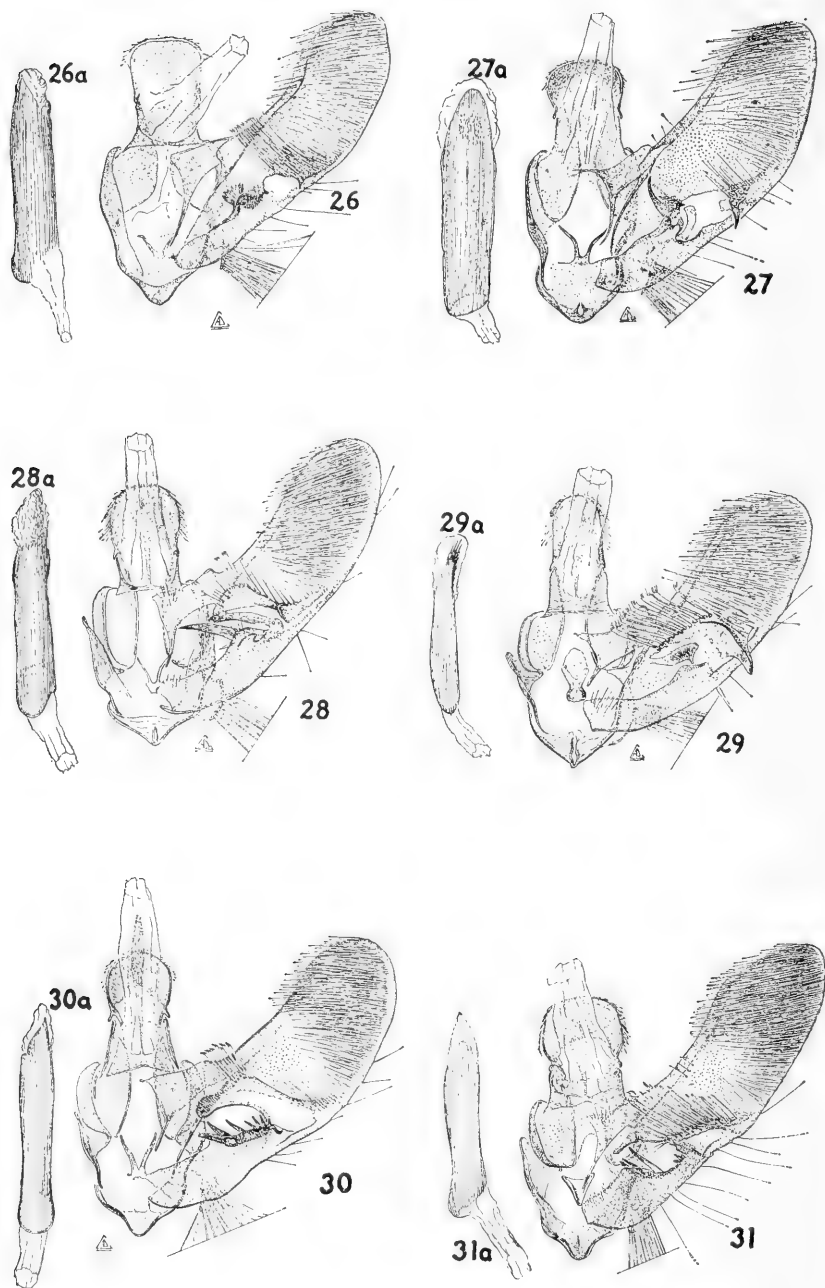
FIGURES 8-13.—*Loxostege*, male genitalia: 8, 8a, *helvialis* (Walker); 9, 9a, *pseudohelvialis*, new species; 10, 10a, *nayaritensis*, new species; 11, 11a, *arizonensis*, new species; 12, 12a, *neohelvialis*, new species; 13, 13a, *sinaloensis*, new species.



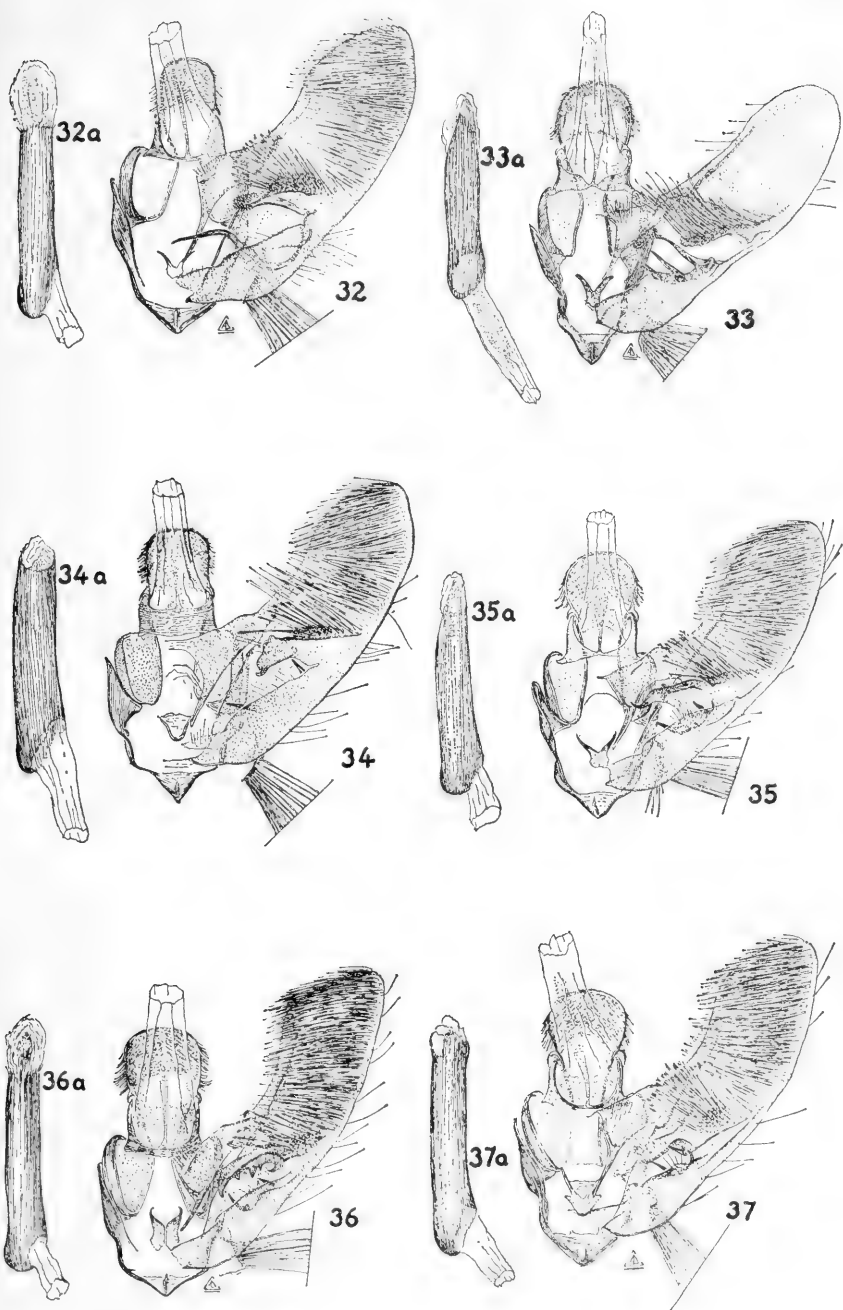
FIGURES 14-19.—*Loxostege*, male genitalia: 14, 14a, *polingi*, new species; 15, 15a, *pelotasalis*, new species; 16, 16a, *boliviensis*, new species; 17, 17a, *coloradensis* (Grote and Robinson); 18, 18a, *fordi*, new species; 19, 19a, *alpinensis*, new species. (Ae=aedeagus, An=anellus, Cl=clasper, Dms=dorsal margin of saccus, Gn=gnathos, Hp=harpe, Ms=modified setae, Obr=oblique ridge, Pd=pad, Ts=transtilla, Un=uncus, Vn=vinculum.)



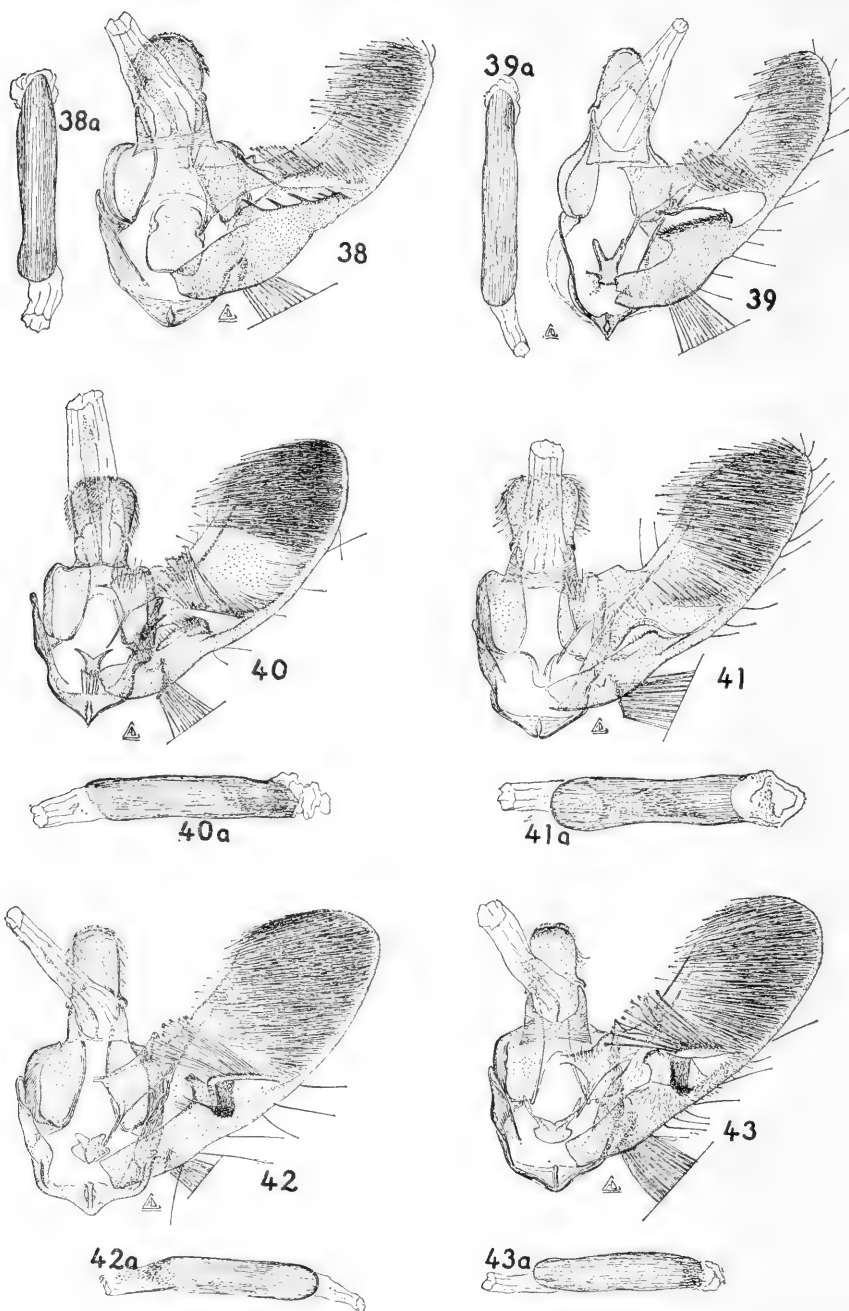
FIGURES 20-25.—*Loxostege*, male genitalia: 20, 20a, *marculenta* (Grote and Robinson); 21, 21a, *neomarculeta*, new species; 22, 22a, *potosiensis*, new species; 23, 23a, *conisphora* (Hampson); 24, 24a, *neotropicalis*, new species; 25, 25a, *pseudobliteralis*, new species.



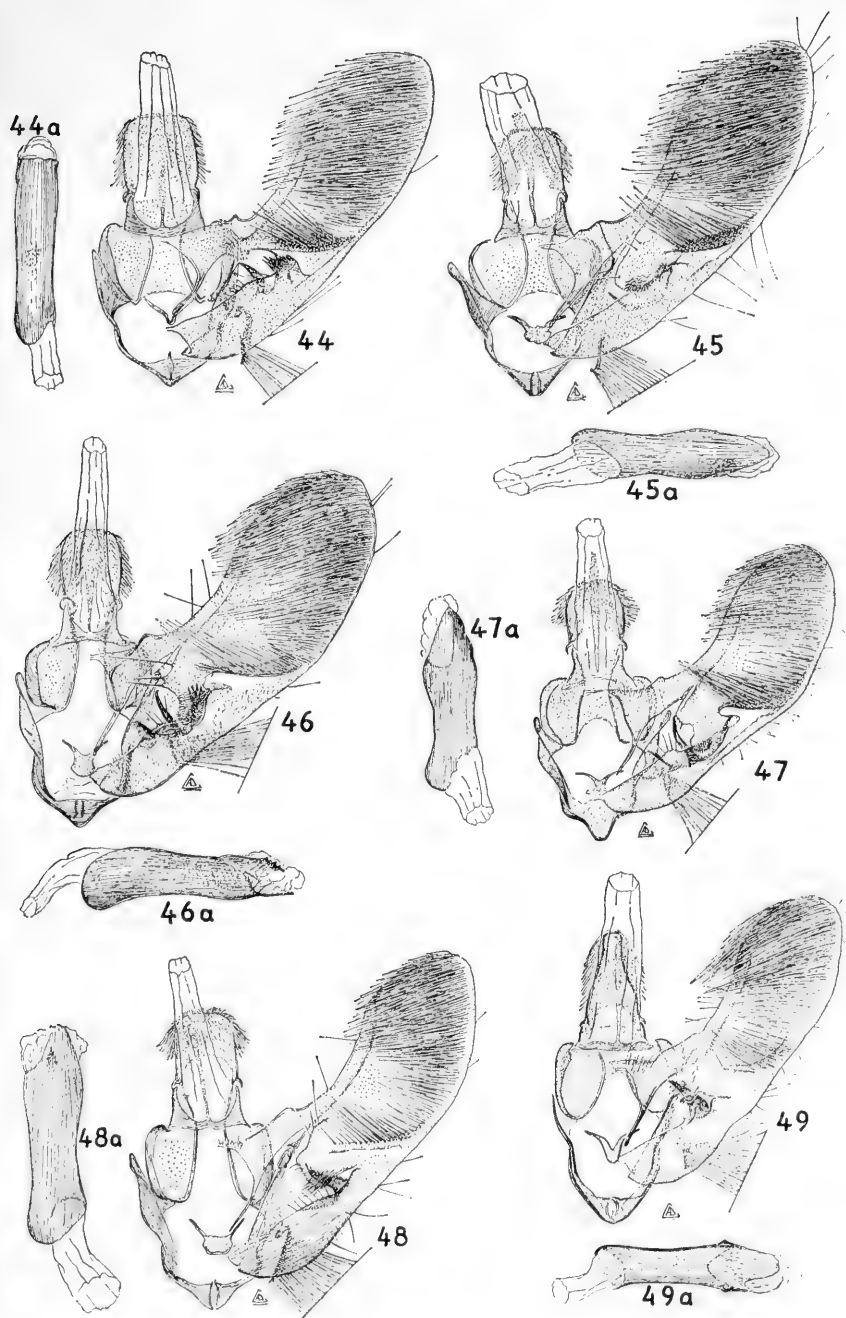
FIGURES 26-31.—*Loxostege*, male genitalia: 26, 26a, *neoblitalis*, new species; 27, 27a, *mancalis* (Lederer); 28, 28a, *ramsdenalis* (Schaus); 29, 29a, *entephrialis* (Schaus); 30, 30a, *pergivalis* (Hulst); 31, 31a, *sacculalis* Amsel.



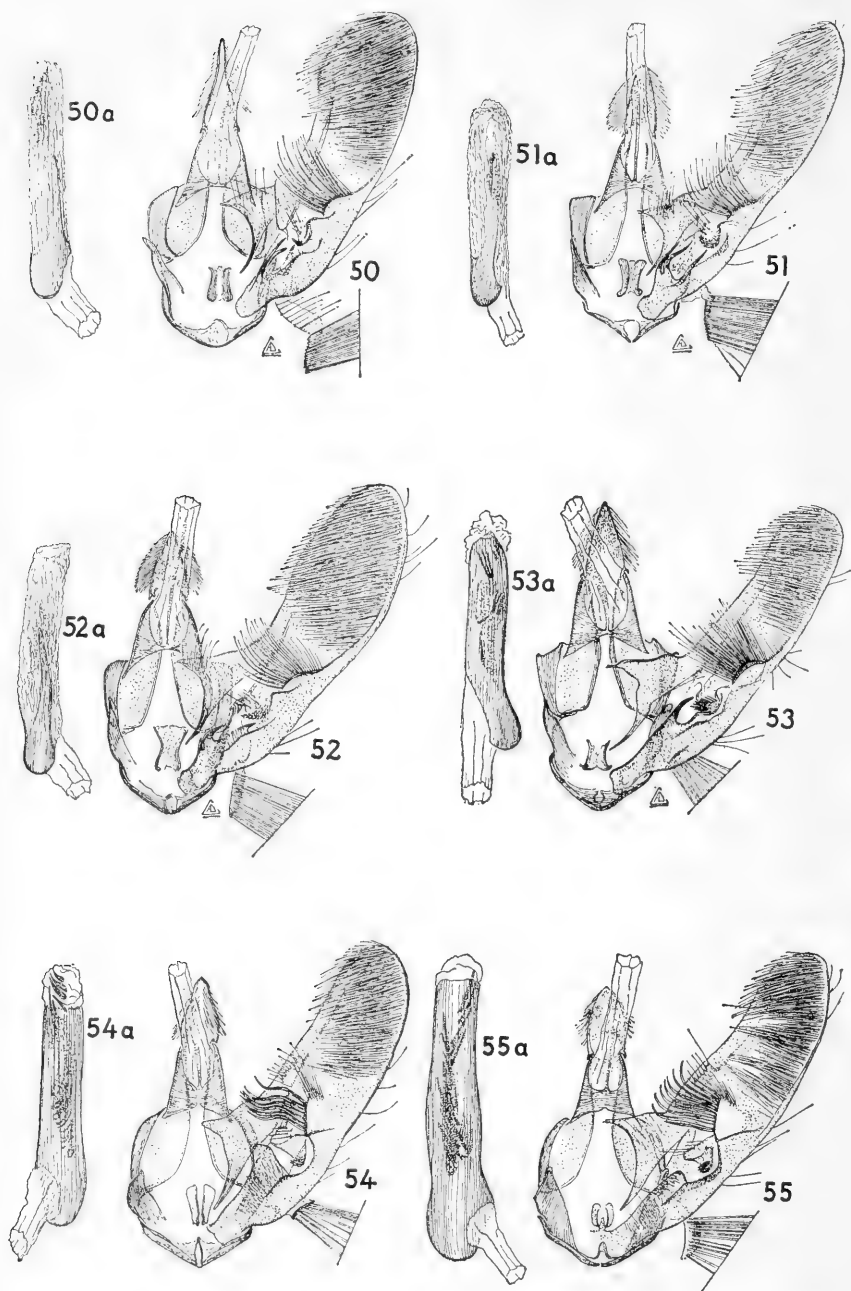
FIGURES 32-37.—*Loxostege*, male genitalia: 32, 32a, *nigripes* (Schaus); 33, 33a, *faralis* (Schaus); 34, 34a, *chiapasalis*, new species; 35, 35a, *cayugalis*, new species; 36, 36a, *cynoalis* (Druce); 37, 37a, *ecuadoralis*, new species.



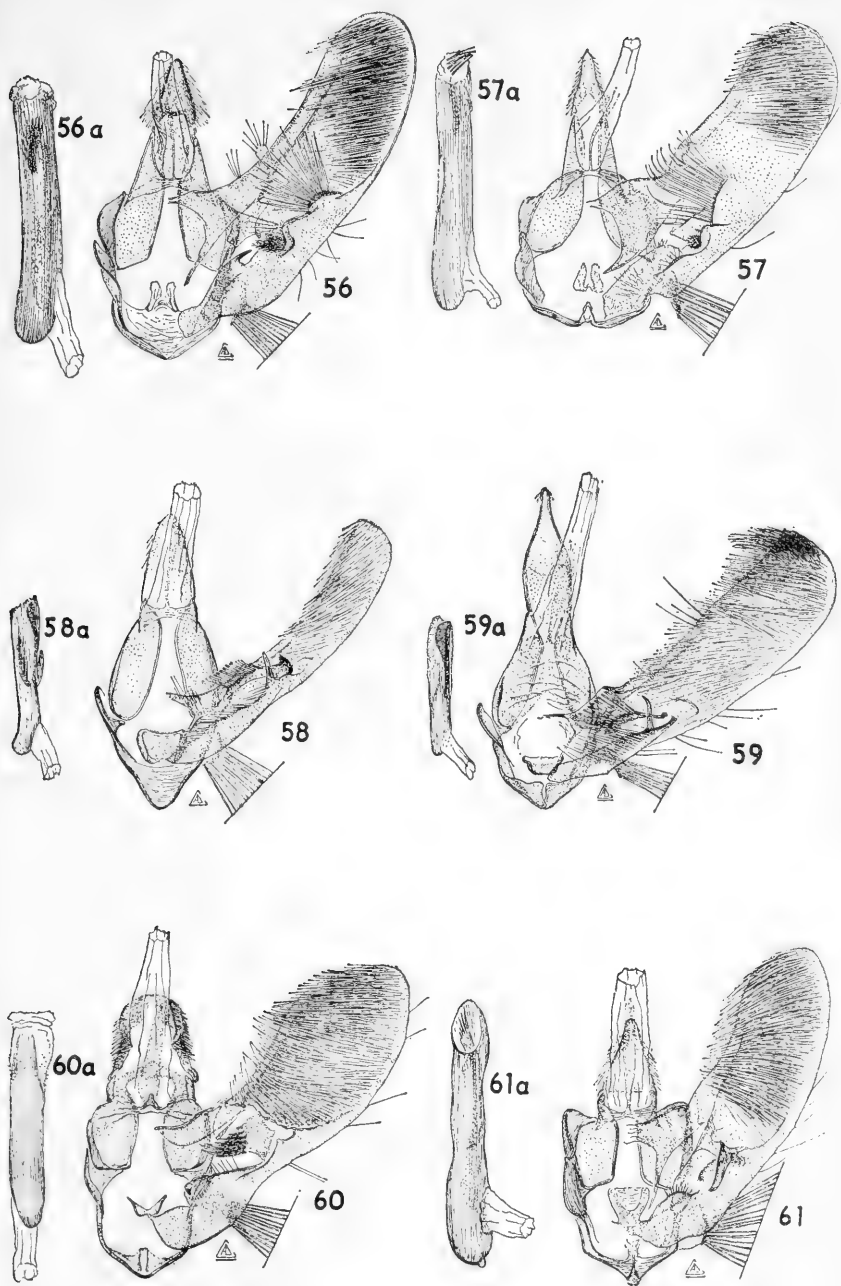
FIGURES 38-43.—*Loxostege*, male genitalia: 38, 38a, *jacalensis*, new species; 39, 39a, *cochisensis*, new species; 40, 40a, *corozalis*, new species; 41, 41a, *aulocratoralis* (Dyar); 42, 42a, *mellinialis* (Druce); 43, 43a, *venadialis*, new species.



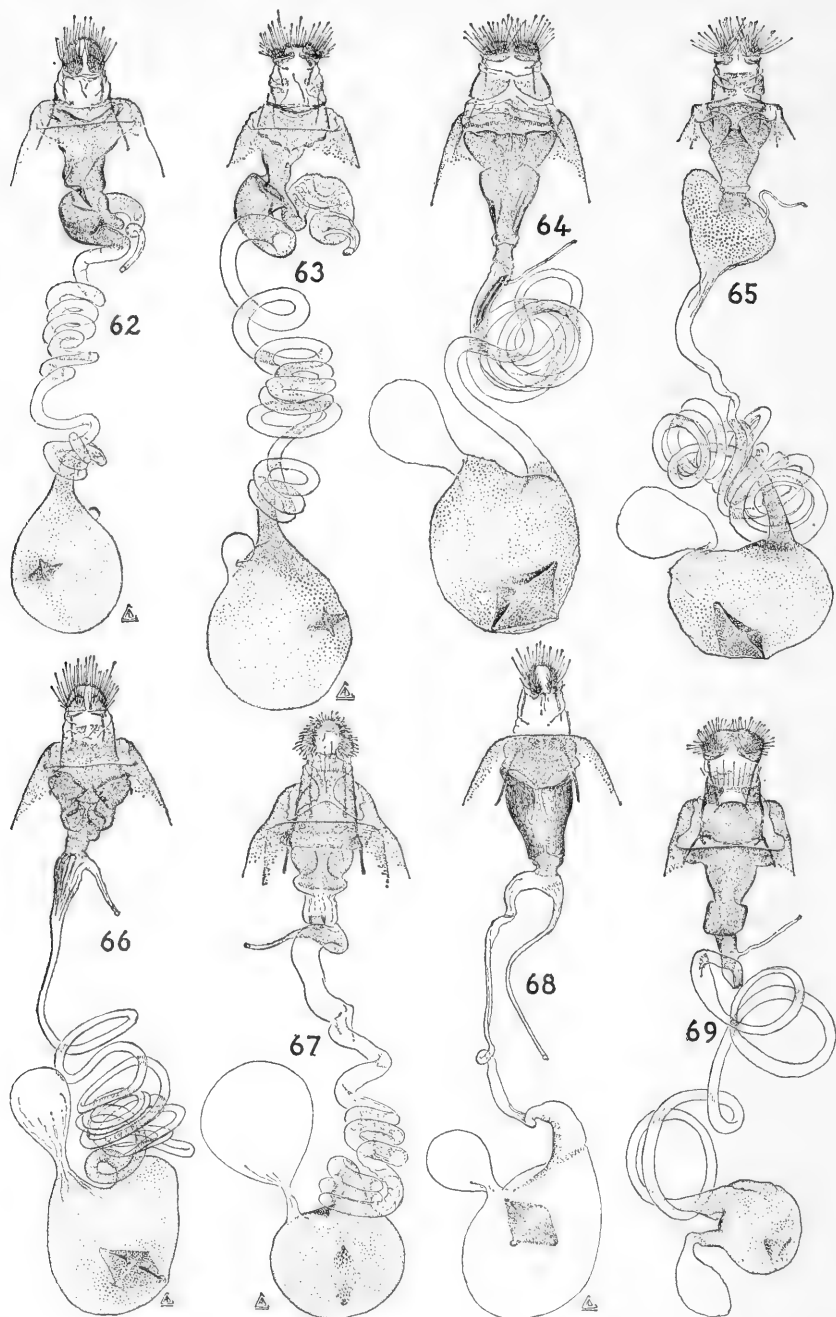
FIGURES 44-49.—*Loxostege*, male genitalia: 44, 44a, *conisphoralis*, new species; 45, 45a, *purulhalis*, new species; 46, 46a, *huachucalis*, new species; 47, 47a, *marialis*, new species; 48, 48a, *yucatanalis*, new species; 49, 49a, *volcanensis*, new species.



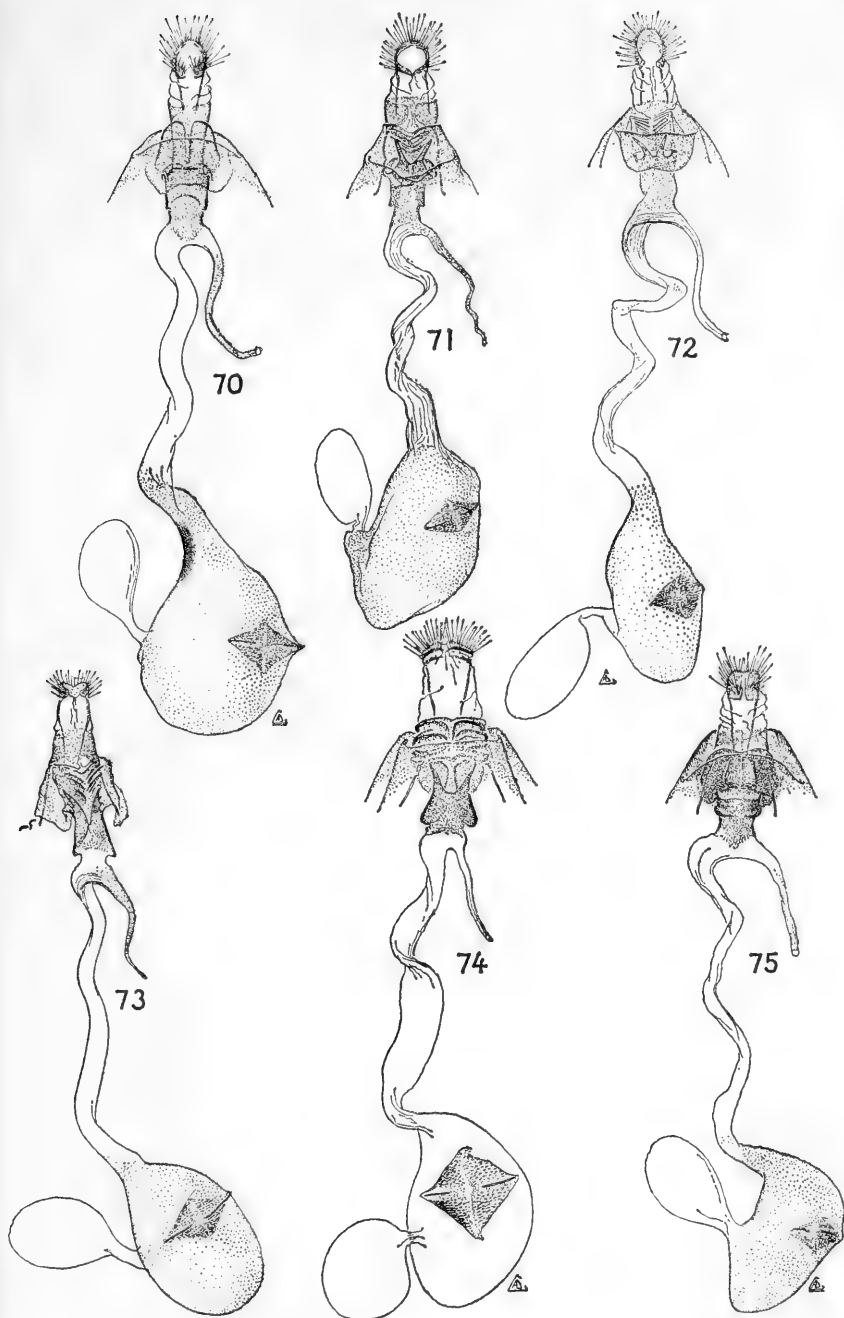
FIGURES 50-55.—*Loxostege*, Male genitalia: 50, 50a, *similalis* (Guenée); 51, 51a, *ratalis* (Guenée); 52, 52a, *occidentalis* (Packard); 53, 53a, *eneanalis* (Schaus); 54, 54a, *bifidalis* (Fabricius); 55, 55a, *brasiliensis*, new species.



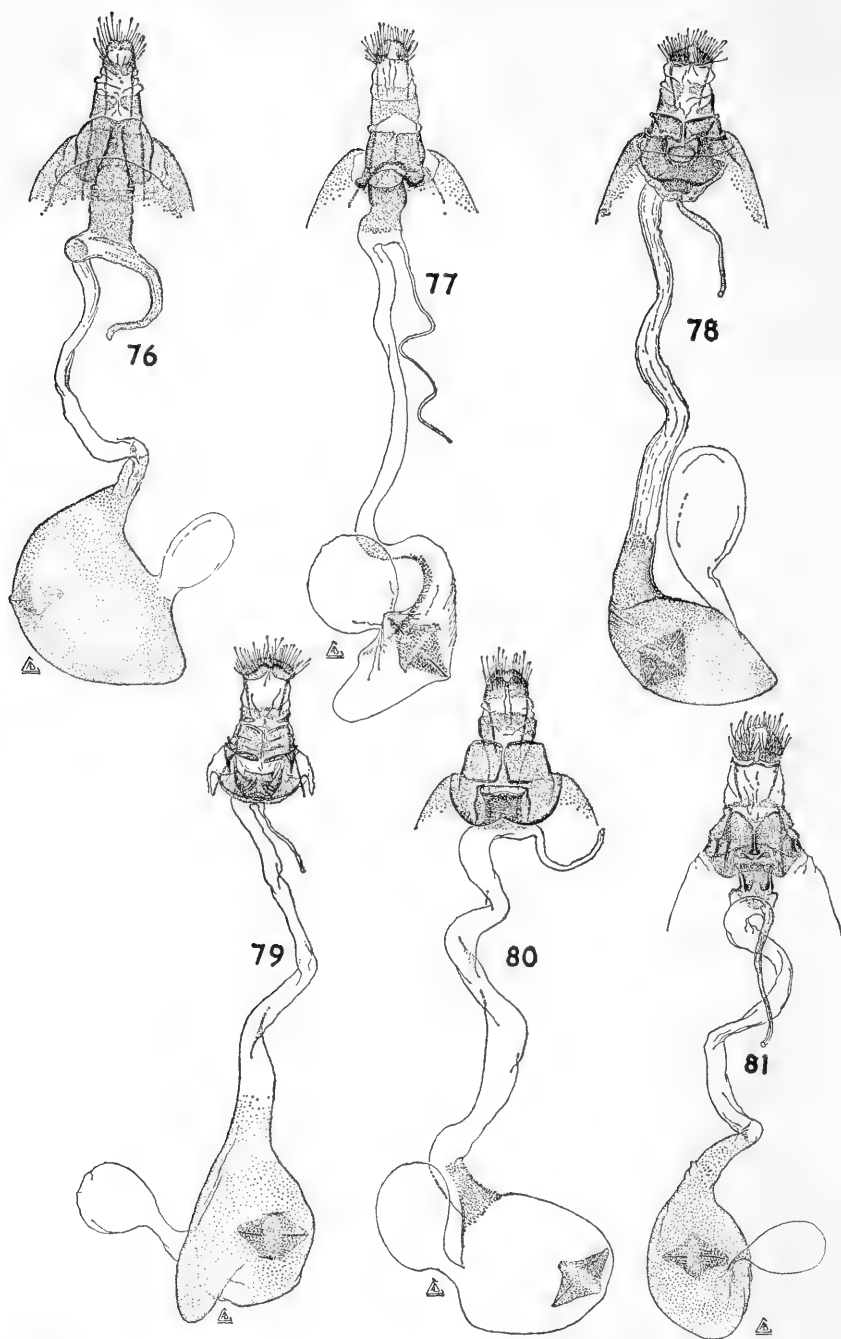
FIGURES 56-61.—*Loxostege*, male genitalia: 56, 56a, *protealis* (Warren); 57, 57a, *piuralis*, new species; 58, 58a, *labeculalis* (Hulst); 59, 59a, *federalis*, new species; 60, 60a, *cupreicostalis* (Dyar); 61, 61a, *subcuprea* (Dognin).



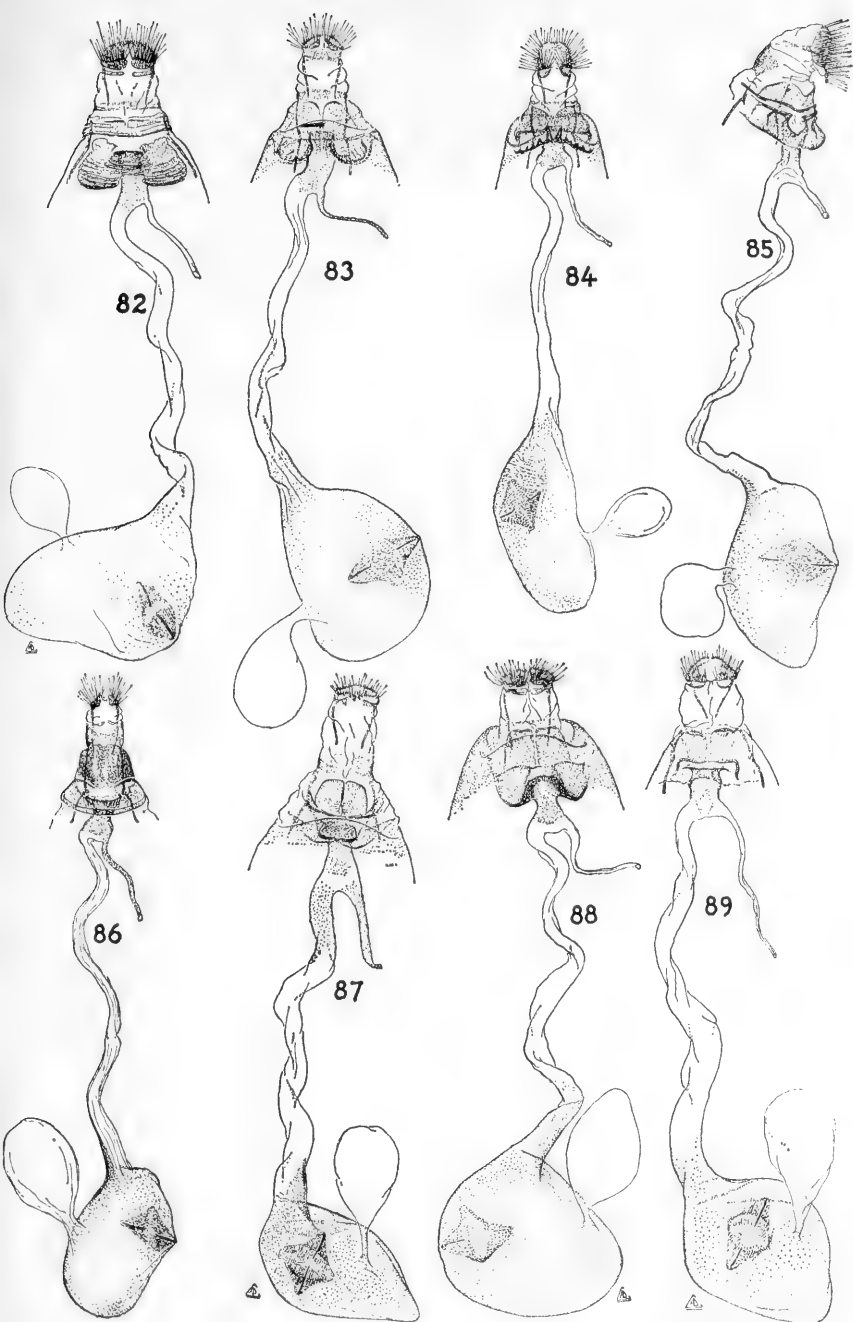
FIGURES 62-69.—*Loxostege*, female genitalia: 62, *helvialis* (Walker); 63, *pseudohelvialis*, new species; 64, *arizonensis*, new species; 65, *nayaritensis*, new species; 66, *neohelvialis*, new species; 67, *polingi*, new species; 68, *nigripes* (Schaus); 69, *saltensis*, new species.



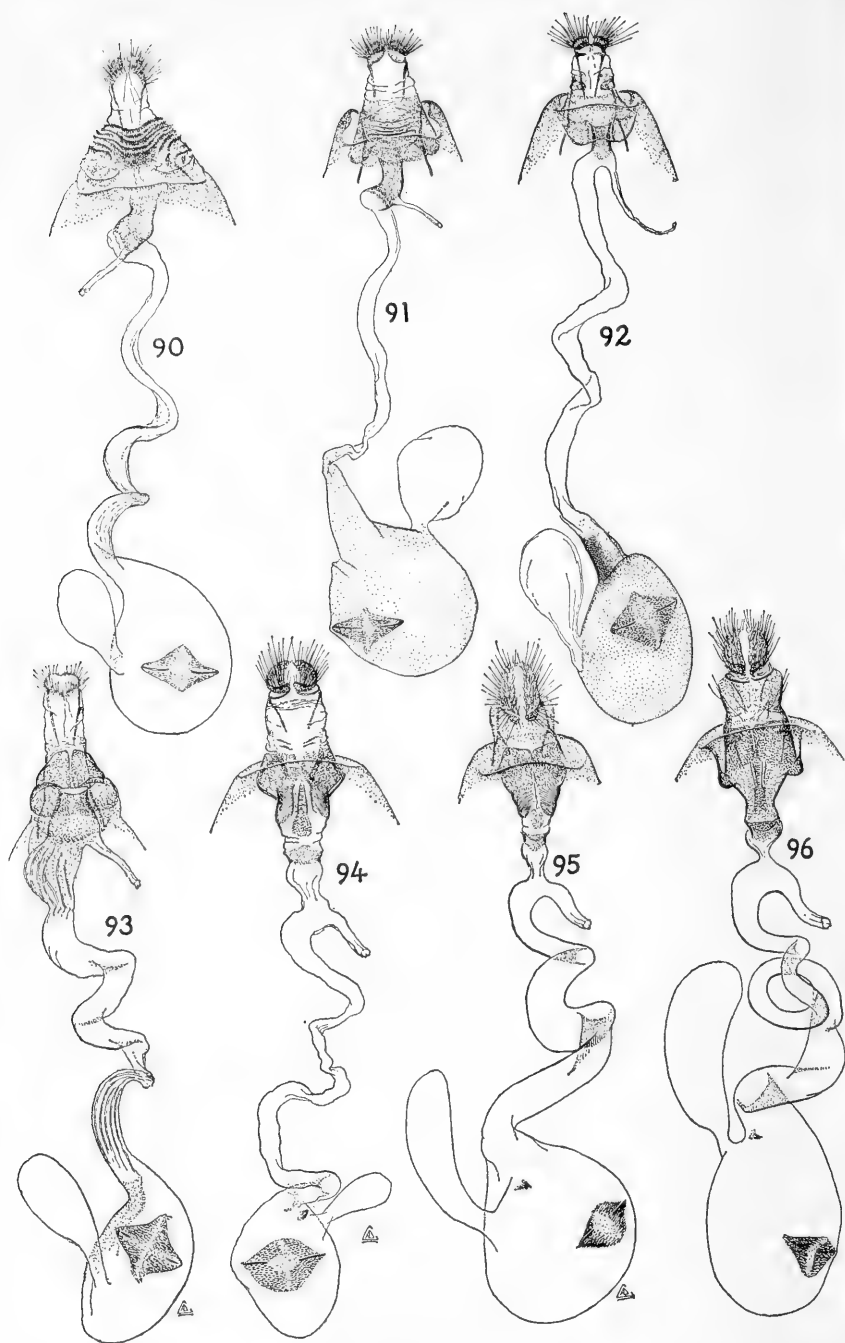
FIGURES 70-75.—*Loxostege*, female genitalia: 70, *marculenta* (Grote & Robinson); 71, *neomarculeta*, new species; 72, *cynoalis* (Druce); 73, *conisphora* (Hampson) 74, *ramsdenalis* (Schaus); 75 *huachucalis*, new species.



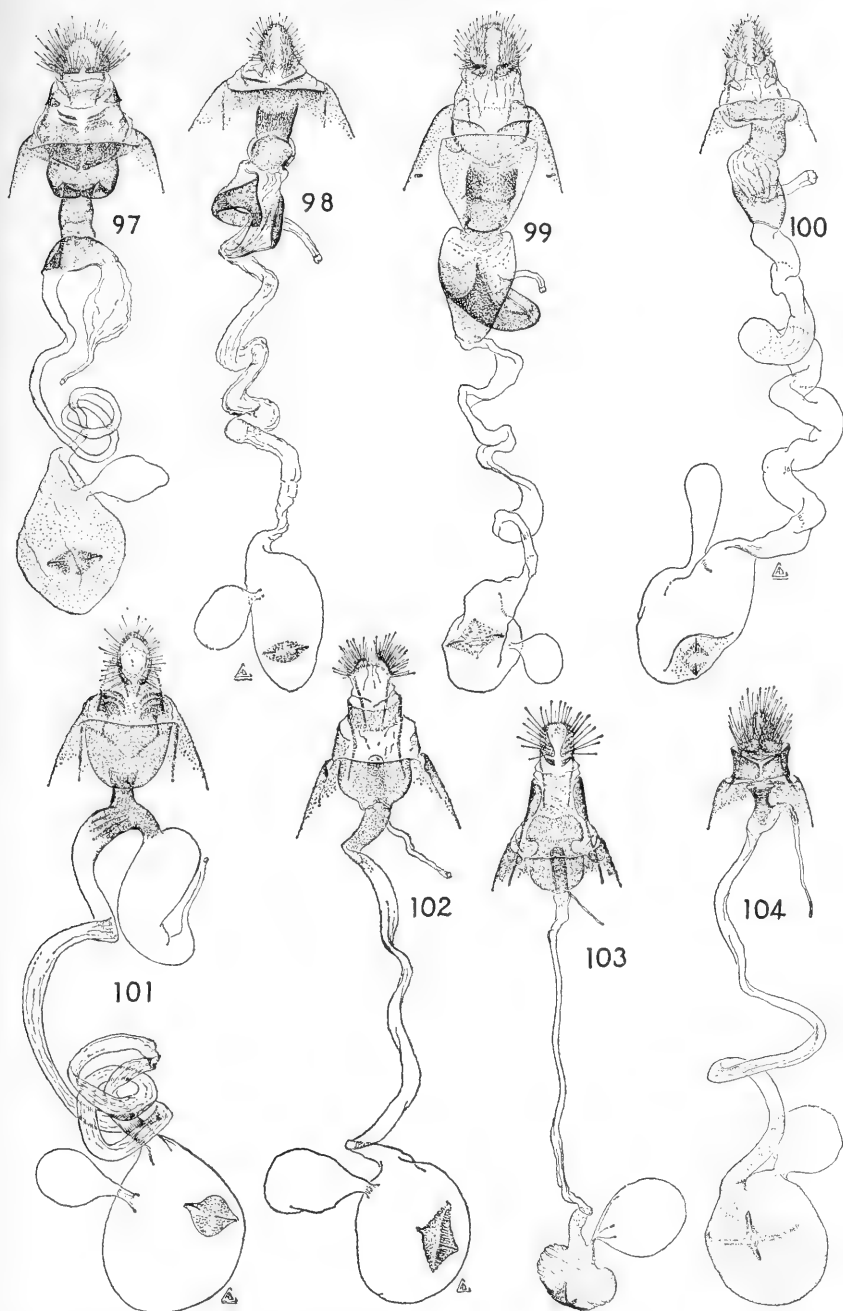
FIGURES 76-81.—*Loxostege*, female genitalia: 76, *marialis*, new species; 77, *coloradensis* (Grote & Robinson); 78, *jaralis* (Schaus); 79, *pergivalis* (Hulst); 80, *conisphoralis*, new species; 81, *volcanensis*, new species.



FIGURES 82-89.—*Loxostege*, female genitalia: 82, *cochisensis*, new species; 83, *alpinensis*, new species; 84, *fordi*, new species; 85, *cayugalis*, new species; 86, *neotropicalis*, new species; 87, *neoblitalis*, new species; 88, *pseudoblitalis*, new species; 89, *mancalis* (Lederer).



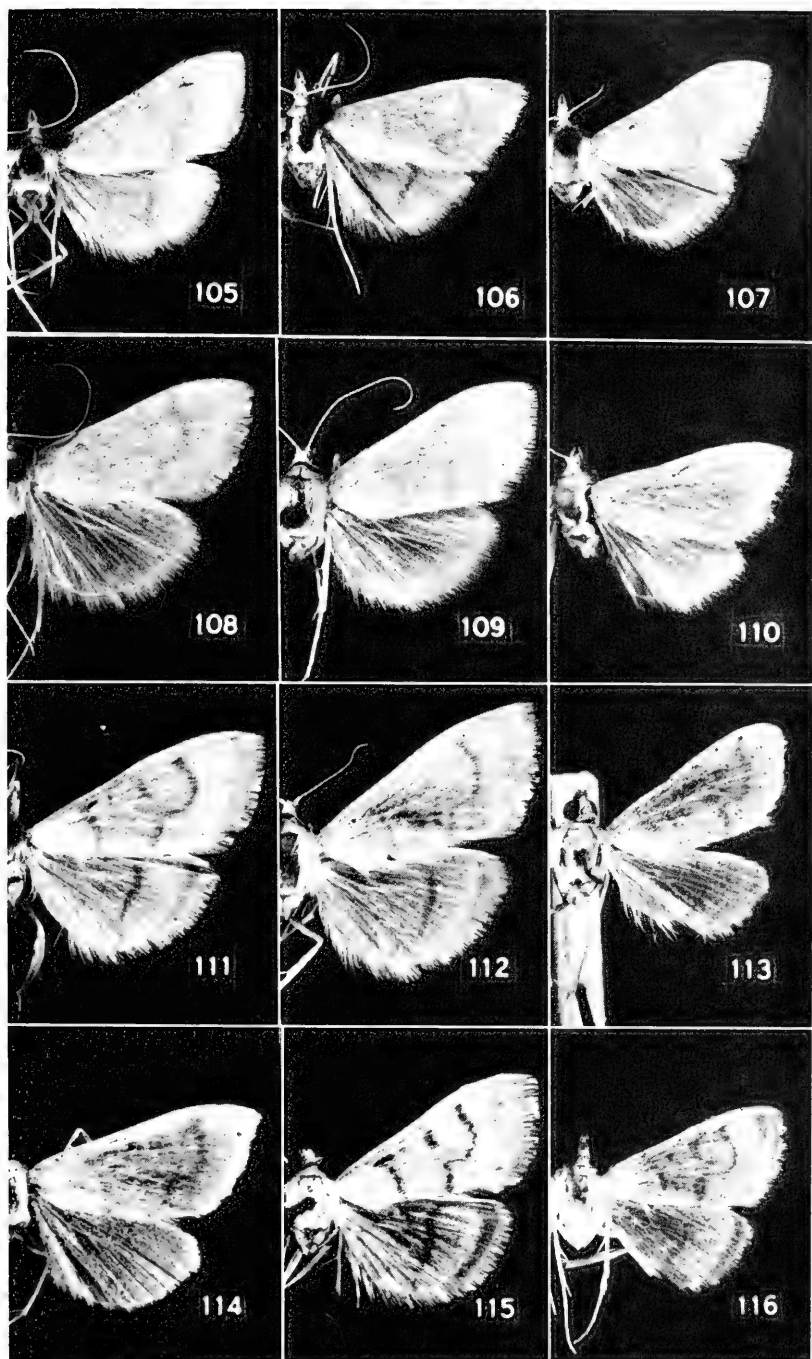
FIGURES 90-96.—*Loxostege*, female genitalia: 90, *venadialis*, new species; 91, *mellinialis* (Druce); 92, *corozalis*, new species; 93, *autocratoralis* (Dyar); 94, *rantalalis* (Guenée); 95, *similalis* (Guenée); 96, *occidentalis* (Packard).



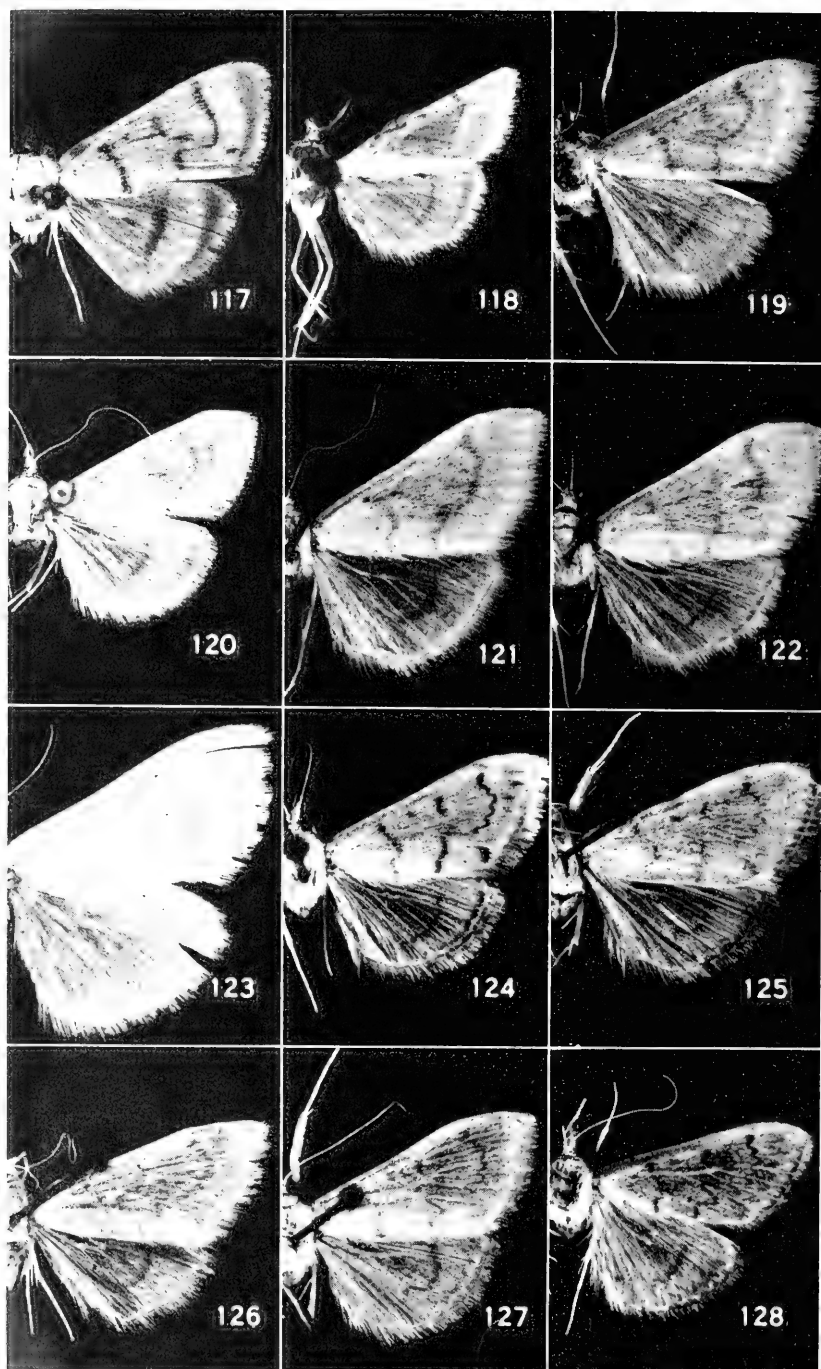
FIGURES 97-104.—*Loxostege*, female genitalia: 97, *protealis* (Warren); 98, *bifidalis* (Fabricius); 99, *brasiliensis*, new species; 100, *piuralis*, new species; 101, *eneanalis* (Schaus); 102, *labeculalis* (Hulst); 103, *federalis*, new species; 104, *cupreicostalis* (Dyar).

PLATES

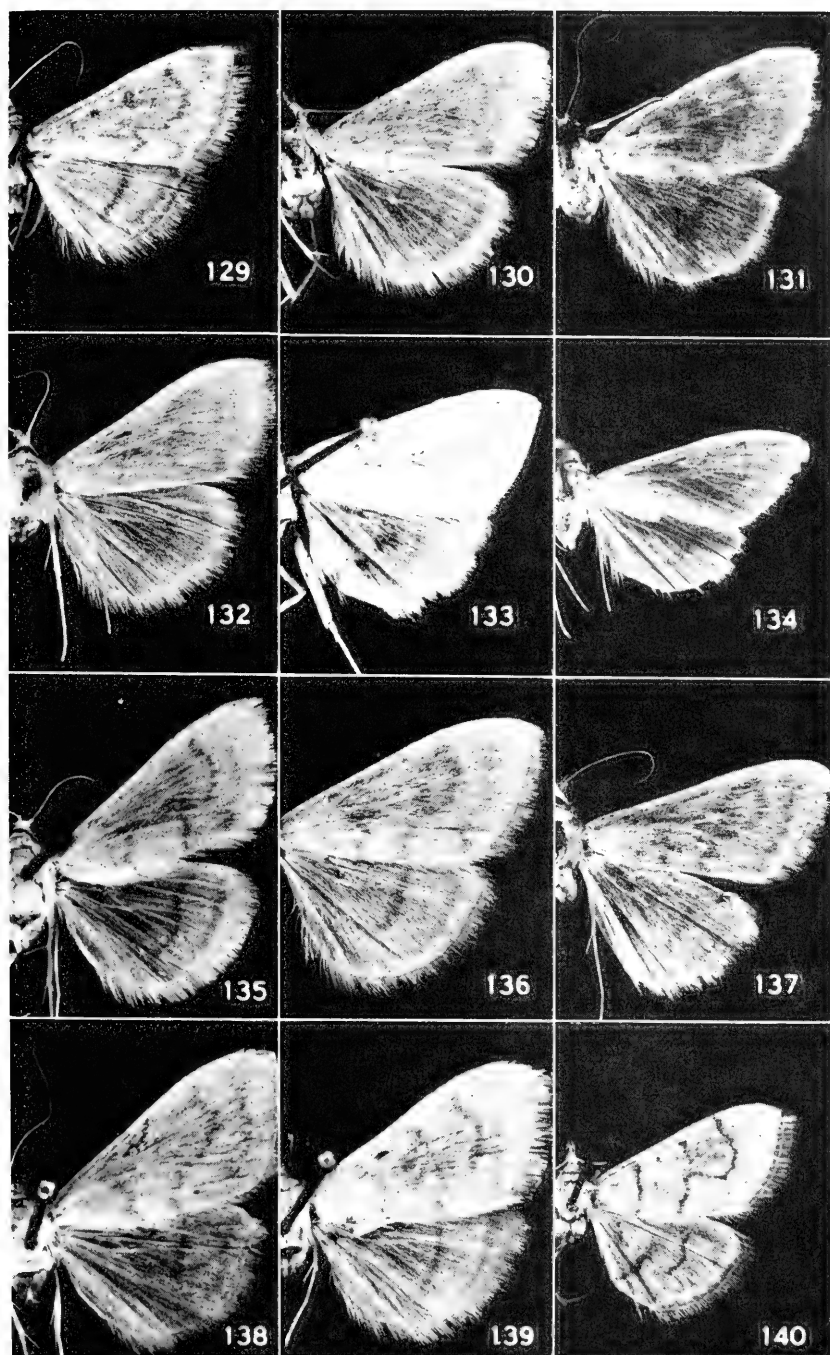
(Figures 105–178)



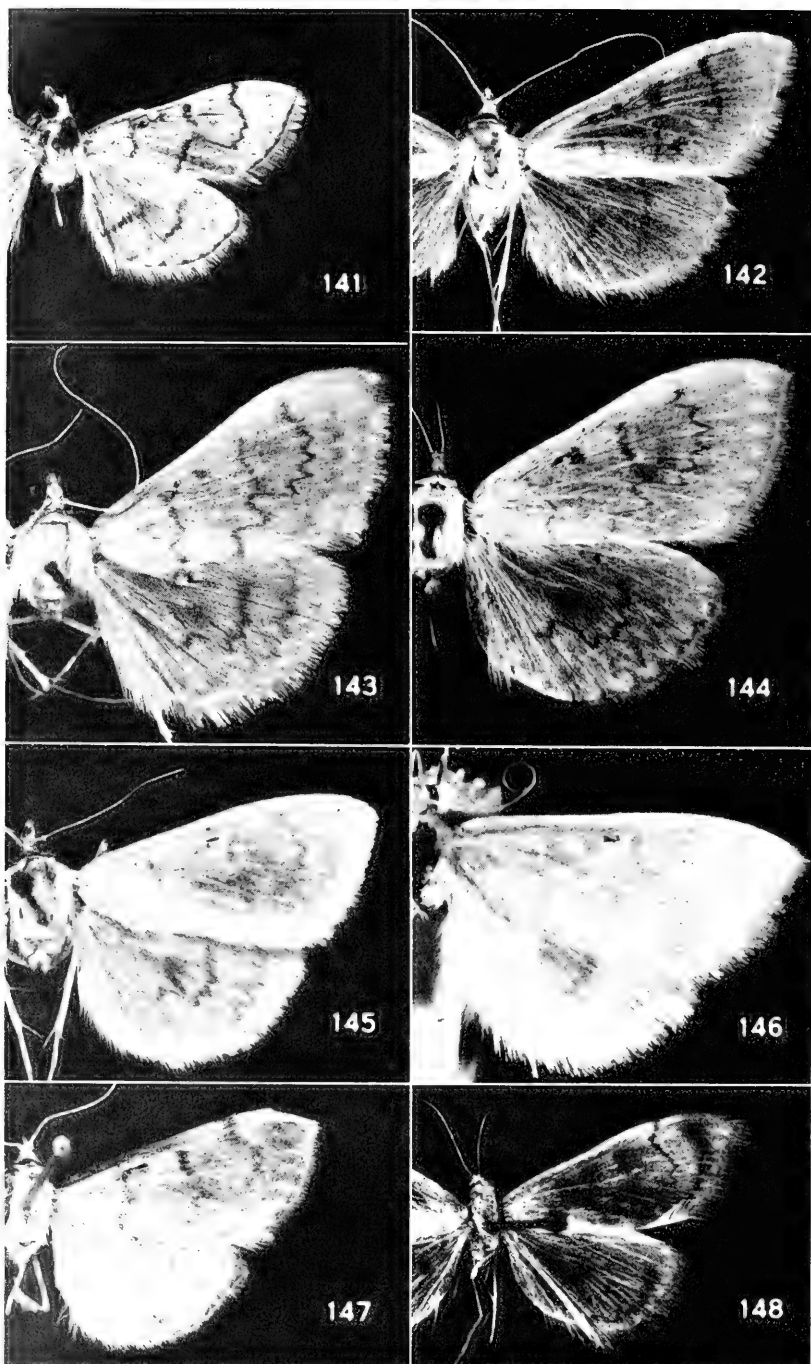
FIGURES 105-116.—*Loxostege*, right wings: 105, *helvialis* (Walker), ♀; 106, *pseudohelvialis*, new species, ♂ paratype; 107, *fordi*, new species, ♂ paratype; 108, *alpinensis*, new species, ♂ type; 109, *polingi*, new species, ♂ type; 110, *boliviensis*, new species, ♂ type; 111, *nechevialis*, new species, ♂ paratype; 112, *arizonensis*, new species, ♂ paratype; 113, *pelotasalis*, new species, ♂ type; 114, *saltensis*, new species, ♀ type; 115, *autocratoralis* (Dyar), ♀ type; 116, *corozalis*, new species, ♂ type.



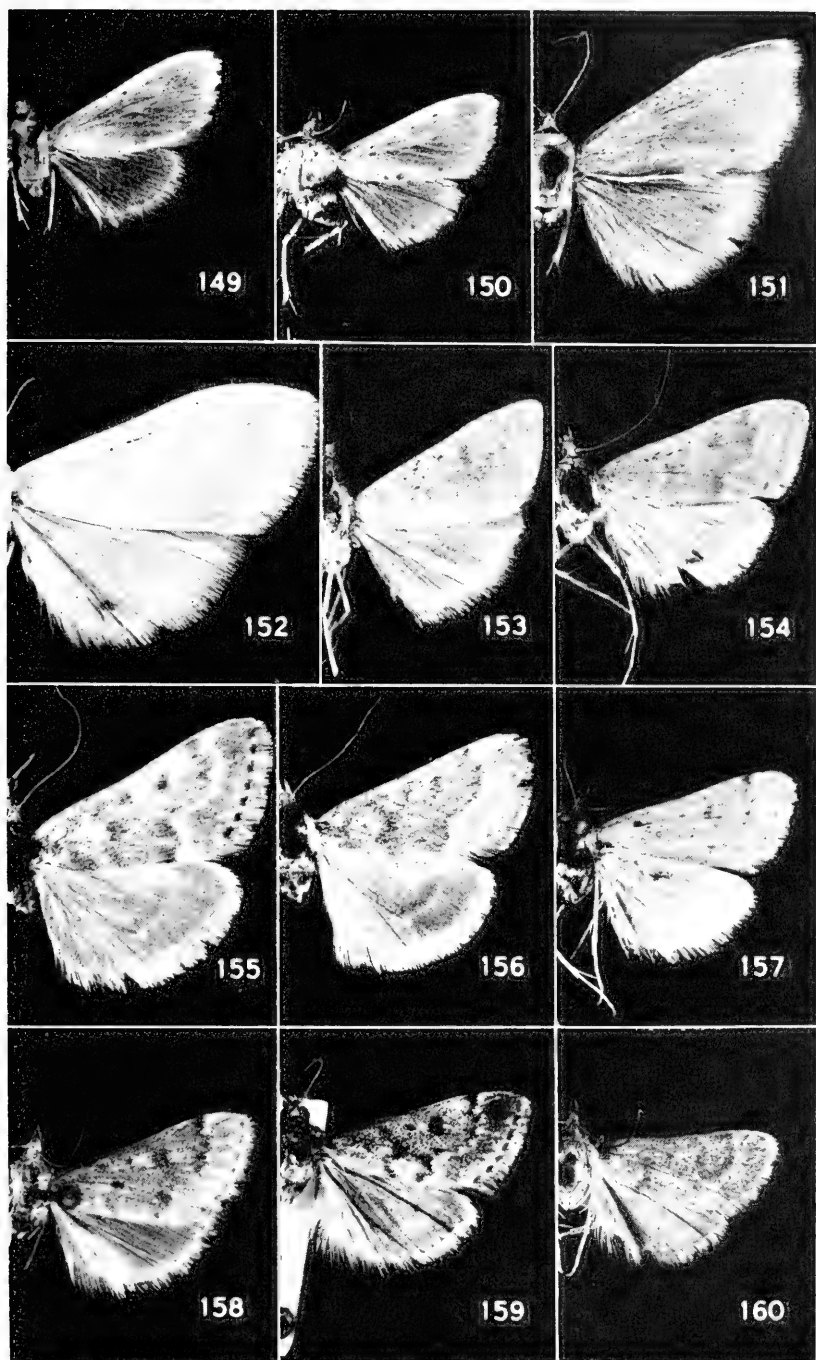
FIGURES 117-128.—*Loxostege*, right wings: 117, *nayaritensis*, new species, ♀ paratype; 118, *sacculalis* Amsel, ♂; 119, *mancalis* (Lederer), ♂ lectotype; 120, *ramsdenalis* (Schaus), ♂ type; 121, *cochisensis*, new species, ♀ paratype; 122, *pergikalis* (Hulst), ♂; 123, *coloradensis* (Grote and Robinson), ♀; 124, *huachucalis*, new species, ♂ type; 125, *marialis*, new species, ♂ type; 126, *purulthalis*, new species, ♂ type; 127, *conisphoralis*, new species, ♂ paratype; 128, *conisphora* (Hampson), ♂ paralectotype.



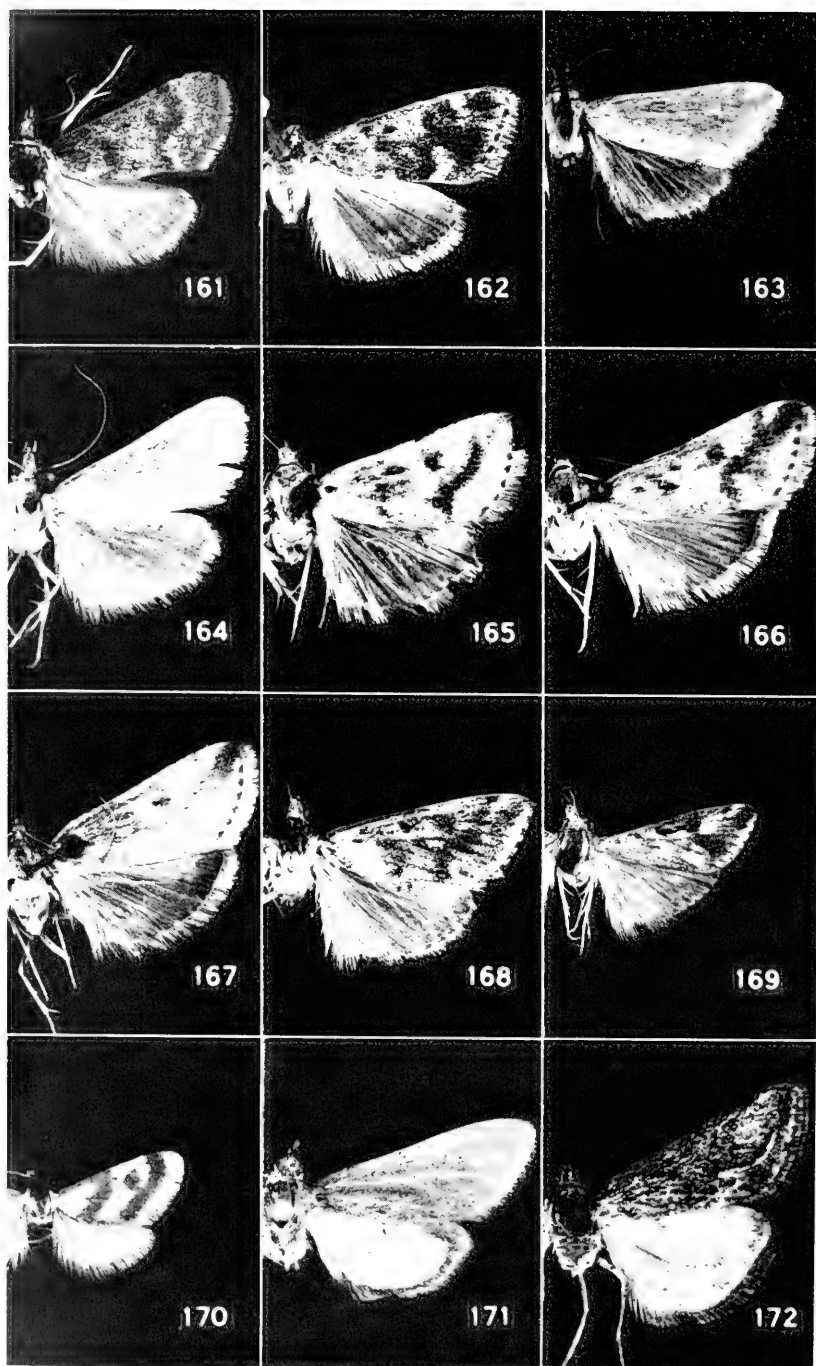
FIGURES 129-140.—*Loxostege*, right wings: 129, *volcanensis*, new species, ♂ type; 130, *marculenta* (Grote and Robinson), ♂; 131, *neomarculeta*, new species, ♀ paratype; 132, *neobliteralis*, new species, ♂ paratype; 133, *neotropicalis*, new species, ♂ type; 134, *jacalensis*, new species, ♂ type; 135, *pseudobliteralis*, new species, ♂ paratype; 136, *cayugalis*, new species, ♀ paratype; 137, *cynoalis* (Druce), ♂ lectotype; 138, *ecuadoralis*, new species, ♂ type; 139, *jaralis* (Schaus), ♀ type; 140, *labeculalis* (Hulst), ♀.



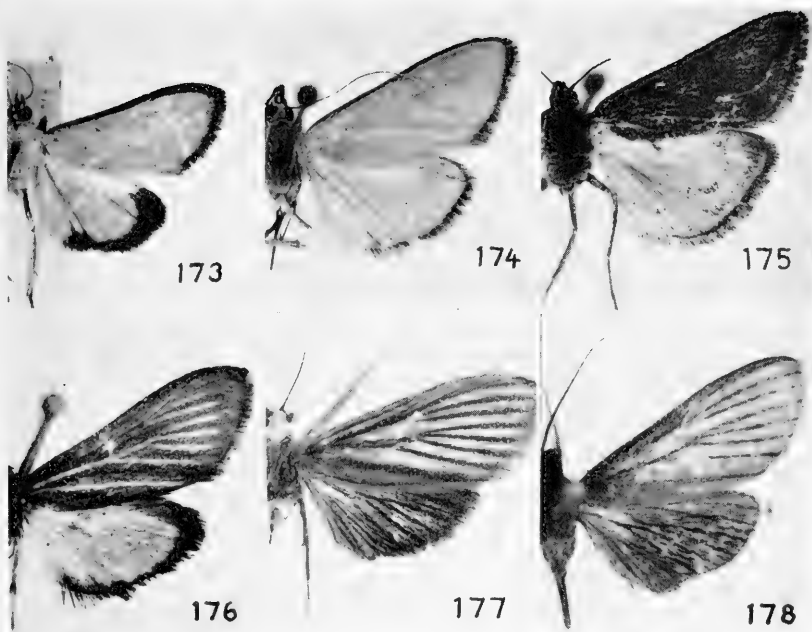
FIGURES 141-148.—*Loxostege* and *Ostrinia*, right wings: 141, *L. intinctalis* (Dyar), ♂ type; 142, *L. cupreicostalis* (Dyar), ♂ type; 143, *L. mellinialis* (Druce), ♀; 144, *L. phrivalis* (Dyar), ♀ type; 145, *L. zenadialis*, new species, ♀ paratype; 146, *O. obliteralis* (Walker), ♀ type; 147, *L. entephrialis* (Schaus), ♂ type; 148, *L. federalis*, new species, ♂ type.



FIGURES 149-160.—*Loxostege*, right wings: 149, *subcostalis* (Dyar), ♂ type; 150, *sinaloensis*, new species, ♂ paratype; 151, *chiapasalis*, new species, ♂ type; 152, *nigripes* (Schaus), ♂ type; 153, *rantalis* (Guenée), ♂; 154, *rantalis* (Guenée), ♀ type; 155, *occidentalis* (Packard), ♂; 156, *occidentalis* (Packard), ♀; 157, *similalis* (Guenée), ♂ type; 158, *similalis* (Guenée), ♀; 159, *garalis* (Schaus), ♂ type; 160, *eneanalis* (Schaus), ♂ type.



FIGURES 161-172.—*Loxostege* and *Phlyctaenodes*, right wings: 161, *L. eneanalis* (Schaus), ♀; 162, *L. protealis* (Warren), ♀; 163, *L. stolidalis* (Schaus), ♂ type; 164, *L. bifidalis* (Fabricius), ♂; 165, *L. bifidalis* (Fabricius), ♀; 166, *L. brasiliensis*, new species, ♂ type; 167, *L. brasiliensis*, new species, ♀ paratype; 168, *L. piuralis*, new species, ♂ type; 169, *L. piuralis*, new species, ♀ paratype; 170, *P. parvipicta* (Barnes and McDunnough), ♂ lectotype; 171, *L. aemulalis* (Dognin), ♂ type; 172, *L. mojavaealis*, new species, ♀ type.



FIGURES 173-178.—*Loxostege*, right wings: 173, *naranjalis* (Schaus), ♀ type; 174, *subcuprea* (Dognin), ♂ type; 175, *mojavealis*, new species, ♀ type; 176, *clarissalis* (Schaus), ♂ type; 177, *fuscivenalis* (Schaus) ♂ type; 178, *peruensis*, new species, ♂ type.

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NOTES ON FLIES CAPTURED IN TREETOPS IN MALAYA (DIPTERA: EMPIDIDAE, NERIIDAE, PLATYSTOMATIDAE, SEPSIDAE, MUSCIDAE)

By GEORGE C. STEYSKAL¹

An unusually interesting lot of Diptera captured on treetop platforms in the Selangor Gombak Forest Reserve, Malaya, by Dr. H. Elliott McClure, of the U.S. Armed Forces Institute of Pathology, was presented to this author for determination. The following notes are the result. All specimens are deposited in the collections of the United States National Museum (USNM).

The following abbreviations, referring to leg parts, chaetotaxy, and wing veins, have been used throughout: *a*=anterior, *acr*=acrostichal, *ad*=anterodorsal, *av*=anteroventral, *cx*=coxa or coxae (*cx*₁=forecoxa, etc.), *d*=dorsal, *dc*=dorsocentral, *f*=femur or femora (*f*₁=forefemur, etc.), *fo*=fronto-orbital, *h*=humeral, *mspl*=mesopleural, *ntpl*=notopleural, *p*=posterior, *pa*=postalar, *pd*=postero-dorsal, *ppl*=propleural, *pra*=prealar, *prs*=presutural, *prsc*=prescutellar, *pv*=posteroventral, *sa*=supra-alar, *sc*=scutellar, *sl*=sublateral, *stpl*=sternopleural, *t*=tibia or tibiae (*t*₁=foretibia, etc.), *ta*=anterior crossvein, *tp*=posterior crossvein, *v*=ventral, *vti*=inner vertical.

¹ Entomology Research Division, Agriculture Research Service, U.S. Department of Agriculture, Washington, D.C.

Family Empididae

Hybos melanauges, new species

FIGURES 1a-e

MALE.—Length of body 3 mm; wing 3.25 mm.

Color black, only basitarsi brownish. Sides of thorax, posterior part of mesonotum, and coxae, with thin white pruinosity; middle of mesonotum shining with very little microsetation; bristles black; hairs of coxae, dorsal side of f_1 and f_3 , and abdomen white.

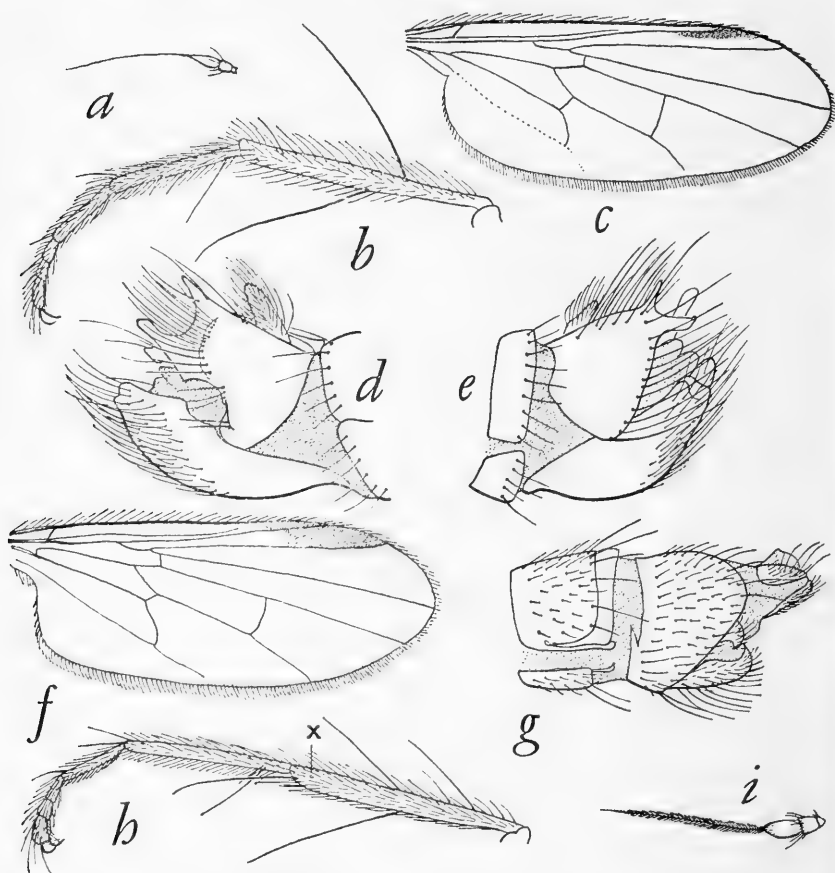


FIGURE 1.—*Hybos melanauges*, new species: a, antenna; b, right middle tibia and tarsus, anterior view; c, wing; d, postabdomen, right side; e, postabdomen, left side. *Hybos meracrus*, new species: f, wing; g, tip of abdomen; h, right middle tibia and tarsus, anterior view (x=position of bristle on posterior side); i, antenna.

Head with eyes contiguous above, ommatidia of upper half approximately twice as large as lower ones; antenna as in figure 1a, arista

bare; proboscis slightly shorter than height of head; palpi a little shorter than proboscis, very slender, with only one rather small apical bristle.

Thoracic chaetotaxy: 2 *ntpl*, 1 *pa*, 1 *dc* (also a few small anterior dorsocentral hairs), 1 *acr*, 1 *sc*; *pa*, *dc*, *acr* in transverse line some distance anterad of scutellum.

Wing (fig. 1*c*) hyaline, with poorly developed brown stigma; halter pale yellowish.

Legs slender; *f*₃ somewhat clavate, at apical third 0.15 as wide as long. Bristles of legs as follows: *t*₁ with one short median *d* and one long preapical *ad*; *t*₂ as in figure 1*b*; *f*₃ with complete row of 16–17 staggered *av*, mostly approximately as long as femoral diameter, in apical half with 3–4 *pv*; *t*₃ with one long median *ad*, followed a short distance apicad by a smaller *d*, one *ad* at apical 1/7, and one each *ad* and *pd* preapicals; *t*₁ with basiventral basitarsal bristle and each tarsal segment of all tarsi with more or less distinct preapical *ad* and *pd*; basitarsus₂ with a secondary basiventral and 2 median *pv*; basitarsus₃ slightly enlarged.

Abdomen with sparse whitish hairs of moderate length; postabdomen (fig. 1*d–e*) scarcely greater in diameter than preabdomen, dorsal valves each with 2 apical processes and rows of black bristly hairs.

HOLOTYPE.—Male, Malaya, Selangor Gombak Forest Reserve, tree platform, February 24, 1962 (H.E. McClure), USNM 67631.

This species runs in Frey's key (1953, pp. 57–71) to *H. nigronitidus* Brunetti, described from northern India and recorded by Frey from northeast Burma; it differs therefrom by its lack of "stiff hairs" on the humerus, narrowly brown knees (except possibly on middle legs), pale hairs on the under side of the tarsi, and "wollig weissliche Behaarung" [wooly whitish hairs].

Hybos meracrus, new species

FIGURES 1*f–i*

FEMALE.—Length of body 3 mm; wing 3.25 mm.

Head, thorax, and abdomen shining black; legs, including coxae, yellowish, all knees narrowly piceous; *t*₁ dark brown dorsally; *f*₃ blackish above in apical 0.15; apical tarsal segments brown.

Head with eyes contiguous above, ommatidia of upper half twice as large as lower ones; antenna (fig. 1*i*) black, arista short plumose; proboscis brown, slightly shorter than height of head; palpi nearly as long as proboscis, slender, black, bearing a few small bristles at and near apex.

Thorax with pale gray pruinosity on sides and in humeral grooves; mesonotum with scanty grayish pruinosity laterally; mesonotum posteriorly and scutellum and metanotum with somewhat denser

yellowish microsetation; middle of mesonotum with very scant and minute microsetation; strong blackish bristles as follows: 1 *ntpl*, 1 *sa*, 1 *dc*, 1 *acr* (prescutellar); all other thoracic setae hairlike, yellowish.

Wings (fig. 1*f*) pale brownish with deep brown stigma; venation as shown; halter pale yellowish.

Legs slender, f_3 somewhat clavate, at apical fourth 0.12 as wide as long; coxae and most of legs with pale yellowish hairs; *f* and *t* with bristles as follows: t_1 with one long median *d* and one long preapical *ad*, also with nearly erect fine ventral hairs nearly as long as tibial diameter; t_2 (fig. 1*h*) including one *p* of moderate length at position indicated by *x*; f_3 with complete row of 9 *av*, longest (median) somewhat longer than greatest diameter of femur; also 2 *ad*, one slightly apicad of middle and one at apical $\frac{1}{2}$; t_3 with one *d* shortly apicad of middle and one each *a* and *pd* preapicals; tarsi with moderately long hairs, one basiventral bristle on basitarsus₁ and basitarsus₂, each segment of all tarsi with more or less distinct preapical *ad* and *pd*; basitarsus₃ slightly enlarged.

Abdomen with sclerites black, lightly grayish pruinose and with sparse whitish hairs of moderate length; terminal segments (fig. 1*g*) with bristles black.

HOLOTYPE.—Female, Malaya, Selangor Gombak Forest Reserve, tree platform, February 24, 1962 (H. E. McClure), USNM 67632.

This species runs in Frey's key (1953) to *H. apicalis* Frey, but differs by having f_3 with less black apically and the upper ommatidia enlarged, or to *H. annulipes* Frey, from which it differs also in its differently colored f_3 and the differently bristled t_2 . Both of those species are from Burma. If one considers the 2nd wing vein sufficiently bowed apically to place this species in Frey's subgenus *Pseudosyneches*, it would run to *H. palawanus* Frey, differing therefrom by its hairy arista and by the presence of only 2 bristles on f_3 .

Family Neriidae

The following key is offered in the hope that it will be found an improvement over the one by Aczél (1954, p. 511).

Key to Asiatic Genera of Subfamily Neriinae

- 1 (4). Antennal socket largely unpolished, matt or at most with slightly greasy appearance; only 1 *ntpl*.
- 2 (3). Third antennal segment short oval with acute tip blending directly into apical, densely white-felted arista; tips of t_1 and all *f* of ♂ distinctly clavate; large species **Rhoptrum** Enderlein
- 3 (2). Third antennal segment oval to long oval, with rounded tip; tip of t_1 and all *f* of ♂ ordinary, never clavate or swollen; *vti* usually weakly developed, short and hairlike; smaller species . . **Telostylinus** Enderlein
- 4 (1). Antennal socket polished, strongly shining.

- 5 (8). Two strong equal *fo*; anterior *ntpl* strong; 4th wing vein strongly bowed downward before *ta*, 1st basal cell at widest part therefore nearly twice as wide as length of *ta*; occiput and prothorax weakly developed.
- 6 (7). Stump veins on 3rd and 4th veins; anterior *dc* strong; *f*₁ of ♂ with small spinules below **Stypocladius** Enderlein
- 7 (6). Stump veins lacking; anterior *dc* very small; *f*₁ of ♂ with very heavy spines on small tubercles **Nipponerius** Coquillett
- 8 (5). Only one weak *fo* and sometimes anterior thereto another rudimentary one; anterior *ntpl* usually very weak; 4th wing vein only gently bowed basad of *ta*, 1st basal cell therefore only slightly wider than length of *ta*.
- 9 (10). Occiput and prothorax greatly lengthened, occiput nearly or quite as long as eye **Gymnonerius** Hendel
- 10 (9). Occiput and prothorax little lengthened, occiput much shorter than eye.
Paranerius Bigot

Neither Aczél nor I have been able to place *Protonerius* Meijere (1924, p. 29) in our keys.

Subfamily Telostyliinae

This subfamily is distinguished from the Neriinae by the lack of a distinct dorsal expansion of the facial plate at the bases of the antennae. The genus *Telostylus* Bigot, 1859 (type: *T. binotatus* Bigot, 1859) is distinguished from the two other known genera by having only 1 *ntpl* and 1 (prescutellar) *dc*, a long and pointed 3rd antennal segment, and by the basitarsus₁ of the ♂ sometimes being swollen.

Nobody so far has had the temerity to offer a key to *Telostylus*. The following one is offered as a preliminary contribution since it is constructed largely from descriptions—although *T. philippinensis* Cresson has been placed from examination of the type specimen in the USNM, and *T. niger* Bezzi, from material in the USNM collected by Baker and apparently part of the original lot. Aczél's statement (1955, p. 32) that *T. binotatus* Bigot is known only from Borneo is erroneous, since the original description cites Celebes only, and Aczél's redescription from Borneo specimens must therefore be suspect. Specimens of *T. binotatus* that agree well with Bigot's description and the concept here presented were taken in the Selangor Gombak Reserve by McClure on October 21, 1961 and October 27, 1962.

Key to Species of *Telostylus* Bigot

- 1 (4). Mesofrons between the eyes dull black all the way across; mesonotum, scutellum, and pleura largely or wholly black; halter yellow.
- 2 (3). Legs yellow with preapical dark bands; 3rd antennal segment largely yellowish; dull black supra-alar spot present; wing length 3.75 mm; basitarsus₁ of ♂ not broadened (Philippine Islands) . . **T. niger** Bezzi
- 3 (2). Legs black; 3rd antennal segment black; mesonotum wholly shining black; wing length 5.5 mm; ? ♂ basitarsus₁ broadened (type ♀, Sumatra and Thailand) **T. apicatus** Edwards

- 4 (1). Mesofrons between the eyes more or less yellowish or reddish medially; halter yellow (except in *T. remipes*).
- 5 (6). Mesonotum and pleura wholly blackish; f_1 yellow brown, f_2 missing in type; 3rd antennal segment black, except at base; wing length 5 mm (Thailand) ***T. inversus*** Hennig
- 6 (5). Mesonotum variegated with brownish or blackish stripes or spots or largely yellowish; pleura with considerable yellowish color.
- 7 (8). Wing span 5.5 lines (=11.5 mm); body length 3.5 mm; halter black; f yellowish with black tips; ♂ basitarsus₁ broadened (Macassar).
T. remipes (Walker)²
- 8 (7). Wings 4–4.5 mm. long; legs yellowish, f with black tips and sometimes dark preapical bands.
- 9 (12). Mesonotum yellowish without median marks, only intrahumeral and supra-alar black marks; f_2 with blackish tips; 3rd antennal segment with extreme tip blackish; scutellum yellow; abdomen yellowish or reddish.
- 10 (11). Pleura with large blackish mark above cx_1 ; mesonotum with large intrahumeral spot and posterior thereto a small presutural spot (Philippine Islands) ***T. philippinensis*** Cresson
- 11 (10). Pleura with 3 blackish marks (Taiwan) . . ***T. decemnotatus*** Hendel
- 12 (9). Mesonotum with median dark marking and often other stripes and spots.
- 13 (14). Mesonotum with median stripe only; f_1 blackish in apical third, f_2 of type missing (Ceylon) ***T. latibrachium*** Enderlein
- 14 (13). Mesonotum with dark markings besides median stripe.
- 15 (16). Black supra-alar spot lacking; f_2 dark brownish, base and preapical band yellow; mesonotum yellowish with pair of presutural black spots; wing length 4 mm (Celebes; Malaya; ?Borneo) . . ***T. binotatus*** Bigot
- 16 (15). Black supra-alar spot present.
- 17 (18). Pleura yellowish in anterior half, dark brown posteriorly; abdomen blackish brown; scutellum wholly black, lateral pair of bristles very small; f_1 with apicodorsal blackish mark (islands off Sumatra).
T. babilensis Meijere
- 18 (17). Pleura wholly yellowish or with 1–3 black spots; scutellum more or less reddish medially; 3rd antennal segment black.
- 19 (20). Pleura with 3 distinct black spots; f without preapical dark marks; 3rd antennal segment black in apical half; abdomen with blackish central stripe (Philippine Islands) . . . ***T. maccus*** Osten-Sacken
- 20 (19). Pleura wholly yellowish or with one indistinct blackish mark between cx_1 and cx_2 ; at least f_2 with preapical dark band; abdomen blackish brown (Krakatoa; Java; so. India) . . . ***T. trilineatus*** Meijere

Family Platystomatidae

Plagiostenopterina Hendel

Subgenus *Meringomeria* Enderlein

Meringomeria Enderlein, 1924, Mitteil. Zool. Mus. Berlin, vol. 11, p. 108.—Bezzi, 1928, Dipt. Fiji Is. (Brit. Mus.), p. 98.—Heunig, 1941, Arb. Morphol. Taxon.

² These are the only differentiating characters I can glean from Walker's short description as *Coenurgia remipes* (1859, p. 164).

Entom. Berlin-Dahlem, vol. 8, p. 21.—Frey, 1964, Notulac Ent., vol. 44, p. 19.

Stenopterella Malloch, 1931, Proc. U.S. Nat. Mus., vol. 78, no. 15, pp. 13, 16.

Enderlein designated *Plagiostenopterina trivittata* (Walker) as type of *Meringomeria*, although he also included *P. aenea* (Wiedemann), which is the type of *Plagiostenopterina*. Malloch cited *P. trivittata* also as the type of *Stenopterella*, distinguishing it from other segregates of *Plagiostenopterina* in a key and included therewith also *P. marginata* (Wulp) and a new species, *P. trivittigera* Malloch. Hennig and Frey have indicated the synonymy of *Stenopterella*. The nature of the "spiracles" of the 4th and 5th tergites of the female, well within the sclerotic margins, would seem doubtful, but a macerated specimen of *P. trivittata* does indeed show large ramose tracheae connected with them. I prefer to maintain *Meringomeria* as a subgenus and offer the following key to include all of the species that can be brought into it at this time, although information on the position of spiracles of the ultimate preabdominal segments is not available for *P. neurostigma* Bezzi, *P. pallidipes* Frey, and *P. olivacea* Hendel.

Key to Species of *Plagiostenopterina* Subgenus *Meringomeria*

- 1 (2). Wing with cloud about *tp* and isolated spot anterad thereof dark brown; costal cell hyaline ***P. neurostigma*** Bezzi
- 2 (1). Wing without such markings.
- 3 (8). Mesonotum lightly clayey-yellow pruinose without shining longitudinal vittae.
- 4 (5). *Cz* and *f* dark brown; ♀: spiracles of 5th tergite far mesad of lateral margins, but somewhat closer thereto than to each other and near posterior margin ***P. marginata*** (Wulp)
- 5 (4). Femora nearly wholly yellow.
- 6 (7). Mesonotum with distinct blackish *dc* lines interrupted at suture; abdomen wholly greenish ***P. olivacea*** Hendel
- 7 (6). Mesonotum without such lines, with only faint traces of brownish *dc* lines; abdomen with yellowish transverse bands; ♀: spiracles of 5th tergite close to lateral margins . . . ***P. leytensis***, new species
- 8 (3). Mesonotum with pair of longitudinal shining stripes.
- 9 (10). Pruinosity of mesonotum whitish, rather light; *cx* and *f* blackish; ♀: spiracles of 5th tergite distant from lateral margins, twice as far from each other as from posterior margin . . . ***P. planidorsum*** (Walker)
- 10 (9). Pruinosity of mesonotum yellowish, heavy; at least *f*₂ largely yellowish.
- 11 (14). Costal cell hyaline.
- 12 (13). Base of abdomen wholly greenish; costal wing margin from stigma to end of 4th vein with continuous brown seam; ♀: spiracles of 5th tergite? ***P. pallidipes*** Frey
- 13 (12). Base of abdomen yellowish; wings with apical spot isolated from dark brown stigma by hyaline space; ♀: spiracles of 5th tergite only their diameter from each other and from posterior margin.

P. hebes Hendel

- 14 (11). Entire costal margin of wing from root to end of 4th vein with brown seam; abdomen wholly greenish.
- 15 (16). Shining mesonotal vittae gradually tapered posteriorly; abdomen with dense, yellow pruinose anterior tergal margins; ♀: spiracles of 5th tergite near anterior margin, only twice their diameter from each other, surface of tergite dull **P. trivittata** (Walker)
- 16 (15). Shining mesonotal vittae tapered rather suddenly at posterior end; pruinose tergal margins of abdomen faint; ♀: spiracles of 5th tergite near posterior corners, widely separated, surface of tergite shining.

P. trivittigera Malloch

***Plagiostenoptera (Meringomeria) hebes* Hendel**

Plagiostenoptera hebes Hendel, 1914, Abhandl. Zool.-Bot. Ges. Wien, vol. 8, p. 70.

The type and only described specimen is a male from Singapore. McClure captured a female on the Selangor Gombak tree platform, on May 7, 1961, which agrees very well with Hendel's description. Spiracles of 5th tergite as in preceding key, those of 4th tergite near posterior corners; front dull blackish with very narrow shining median longitudinal stripe and many black hairs; abdomen shining, lightly transversely carinulate, and with black hairs on all dark parts, whitish hairs at the yellowish base.

***Plagiostenoptera (Meringomeria) leyensis*, new species**

FEMALE.—Length of wing 6.5 mm.

Head brownish yellow; antennal grooves and pair of ill-defined occipital spots piceous; 3rd antennal segment, palpus, and front brown. Hairs of front whitish to yellowish. Medifrons wholly dull.

Thorax largely brownish; middle of mesonotum, mesopleuron, and sternopleuron metallic greenish; nearly entire thorax covered with moderately dense whitish tomentum or coarse pruinescence, that on mesonotum uniform and not showing shining stripes, but with a trace of brownish dorsocentral lines; all hairs whitish to yellowish, except a few black ones on anterodorsal corner of mesopleuron and adjacent humerus; all bristles black.

Legs with all *cx* and *f* yellowish, only *f*₃ with small black antero-apical spot; *t* black, only basitarsus₃ brown. Bristles of *cx*, *d* and *v* rows of *f*₁, and 6–8 bristles and several hairs on dorsal third of *f*₃ black; all other vestiture of *f* (hairs) whitish.

Wings light yellowish hyaline, entire costal margin from root to tip of 4th vein with dark brown seam, broadest near tip of wing. Basal 4/5 of 2nd basal cell and basal half, except narrow strip along anterior edge, of anal cell bare. Squamae and their fringes whitish. Halter blackish.

Abdomen metallic greenish black; compound 1st dorsal segment with transverse pruinose yellowish band in 3rd quarter; basal 2/5

of next 2 segments and diffuse basal part of last (5th) preabdominal segment yellowish; entire 5th tergite pruinose; yellowish parts and entire 5th tergite covered with whitish pile; apical part of basal tergite and dark apical parts of 3rd and 4th tergites covered with moderately dense and long, recumbent rufous hairs; spiracles of 4th tergite narrowly within apical corners of tergite; those of 5th tergite narrowly within lateral margins of tergite opposite base of ovipositor; basal segment of ovipositor piceous, with many erect whitish hairs.

HOLOTYPE.—Female, Tacloban, Leyte, Philippine Is. (Baker), USNM 67978.

This species, as shown in the preceding key, is apparently most closely related to *Plagiostenopterina marginata* (Wulp) and to *P. olivacea* Hendel, should the latter be found definitely to belong to *Meringomeria*.

Plagiostenopterina (Meringomeria) planidorsum (Walker)

Charax planidorsum Walker, 1860, Trans. Ent. Soc. London (new series), vol. 5, p. 325.—Hendel, 1914, Genera Insectorum, fasc. 157, p. 50; 1914, Abhandl. Zool.-Bot. Ges. Wien, vol. 8, p. 53.

Plagiostenopterina (M.) planidorsum (Walker).—Frey, 1930, Notulae Ent., vol. 10, p. 51.

One pair, Selangor Gombak Forest Reserve, tree platform, ♀ Nov. 10, 1962, ♂ Jan. 19, 1963. Walker described a female from Burma, Hendel expressed an opinion that the species might be related to *P. trivittata* (Walker), and Frey made the combination and recorded the species from Palawan. The Malayan specimens agree well with Walker's description and are indeed close to *P. trivittata* (see key, p. 7).

Plagiostenopterina (Meringomeria) trivittigera Malloch

Plagiostenopterina (Stenopterella) trivittigera Malloch, 1931, Proc. U.S. Nat. Mus., vol. 78, no. 15, p. 17.

Selangor Gombak Forest Reserve, tree platform, 2 ♂, 1 ♀, May 7, 1961; 2 ♀, May 13, 1961; 1 ♀, Sept. 29, 1962. These are apparently the second recorded captures. The specimens agree well with the type from Singapore in the USNM.

Family Sepsidae

Dicranosepsis coryphea, new species

FIGURES 2a-f

MALE.—Length of body 3.4 mm; wing 2.5 mm.

General color metallic purplish black; propleura reddish brown; labellae and most of legs yellowish; f_2 and f_3 becoming dark brown apically; base and apex of t_3 brown; apical swollen part of t_2 black;

apical 2 or 3 segments of all tarsi brown; basimesal spot on 3rd antennal segment reddish brown.

Head (fig. 2e): front shining, at antennae 0.66 as broad as at level of anterior ocellus; cheeks very narrow, without outstanding posterior bristle; 3 moderately developed vibrissae.

Thorax with mesonotum very lightly brownish pruinose; with the following white pruinose areas: anterior part of humeral grooves,

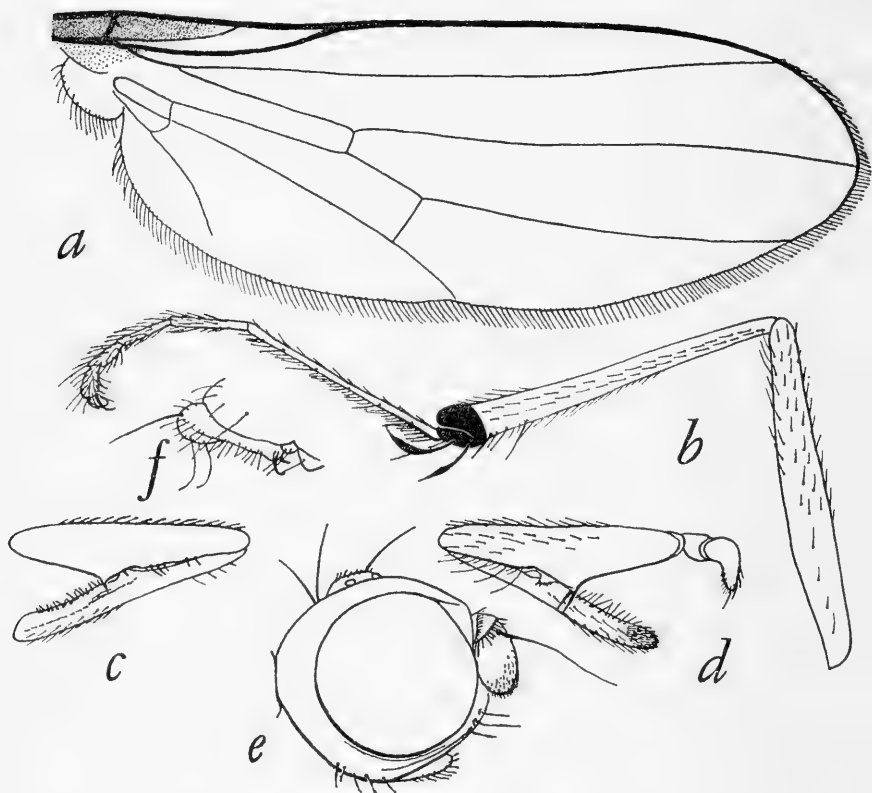


FIGURE 2.—*Dicranosepsis coryphea*, new species: a, wing; b, middle leg, posterior view; c, forefemur and tibia, anterior view; d, foreleg, less tarsus, posterior view; e, head, profile view; f, male abdomen, apex.

lateral stripe on notopleuron, stripe above cx_1 on propleuron and for only a short distance on sternopleuron, posterior half of sternopleuron, entire hypopleuron (lightly). Chaetotaxy: 1 *h*, 2 *ntpl*, 1 *sa*, 2 *dc*, 2 *sc*, 1 *mspl*.

Wing pale brownish hyaline, at root and in humeral and larger part of costal cell dark brown; venation as in figure 2a; halter yellowish; squama and its long cilia yellowish.

Legs (figs. 2*b-d*): cx_1 C-shaped, with heavy pilose ventral projection (fig. 2*d*); f_1 with strong triangular median projection and without basal hairs or bristles (figs. 2*c, d*); f_2 and f_3 with bristles; f_3 moderately swollen (fig. 2*b*); t_2 with ventral bristle near tip, latter shining black, dilated into 2 roundish tubercles and with 3 curved, preapically compressed and broadened bristles (fig. 2*b*).

Abdomen smooth and shining; segment 3 strongly constricted basally; segment 2 without strong bristles; segment 3 and posterior segments with well-developed bristles, most of which are approximately half as long as apical epandrial pair (fig. 2*f*). Postabdomen black, processes of epandrium each ending in pair of slender, mesally directed prongs.

HOLOTYPE.—Male, Malaya, Selangor Gombak Forest Reserve, tree platform, Oct. 20, 1962 (H.E. McClure), USNM 67579.

This species is evidently close to *Dicranosepsis bicolor* (Wiedemann), a taxon including a number of entities that Hennig has considered to be members of a "Formengruppe." The peculiar modification of t_2 in *D. coryphea* has not been mentioned in connection with any of the other forms or related species.

The genus *Dicranosepsis* Duda has been placed by Hennig as a synonym or possible subgenus of the neotropical genus *Palaeosepsis* Duda, but the relationships and rank of these taxa need further study and at present I prefer to consider them as distinct genera.

Family Muscidae

Dichaetomyia prolixa (Walker), new combination

Aricia prolixa Walker, 1864, Journ. Proc. Linn. Soc. London, vol. 7, p. 218.

Spilogaster prolixa (Walker).—Stein, 1901, Zeits. Hym. Dipt., vol. 4, p. 205.

Mydaea prolixa (Walker).—Stein, 1918, Ann. Mus. Nat. Hung., vol. 16, p. 185.—

Séguy, 1937, Genera insectorum, fasc. 205, p. 289 (in list of "species dubiae vel incerti generis").

One female, Selangor Gombak Forest Reserve, tree platform, Dec. 23, 1962, agrees well with Walker's description. The species is rather characteristically colored, mesonotum reddish with broad central blackish stripe stopping at yellowish scutellum, abdomen largely yellowish with posterior margins of tergites 3 and 4 rather broadly blackish, and tergite 5 with a pair of well-developed, oval, black lateral spots, legs with all f and t_1 and t_2 yellowish, and all tarsi blackish; 4 postsutural dc bristles.

Although clearly a *Dichaetomyia*, the species is not to be found in Malloch's keys (1925a, p. 324; 1925b, p. 323) nor in his key of 1929 (p. 401), where it runs to *D. rufa* (Stein), a species with a wholly reddish mesonotum.

Genus *Fraserella*, new name

Fraseria Malloch, 1932, Ann. Mag. Nat. Hist., vol. 10, no. 10, p. 309 [type by original designation: *F. fulvomaculata* Malloch]—Séguy, 1937, Genera insectorum, fasc. 205, p. 378. [Preoccupied by *Fraseria* Bonaparte, 1854 (Aves).]

Both Malloch and Séguy have referred this genus to the Muscinae, although it is not very conformable therein. The thoracic squama, being in close contact with the base of the scutellum and with straightish apical margin, would seem to indicate such a reference. In Séguy's key (1937, p. 370), the type species traces easily by its hairy eyes; the two additional species I am including at this time, however, have eyes that are scarcely hairy at all and will therefore run to *Mesembrina* or *Muscina*. Malloch, in his unpublished key to world genera of Muscidae (now on file in USNM), compares *Fraseria* to *Mesembrina* and distinguishes the former by its bare pteropleuron. Malloch, however, also brings out *Fraseria* in two other places, comparing it in the first instance with *Bryantina* and *Balioglutum* (distinguished from those genera by its wholly hairy arista, lack of any seta on wing veins except costa, and 4 postsutural *dc*) and in the other instance with *Gymnodia* (distinguished by plumose arista and strong presutural *acr*). *Fraserella* resembles *Muscina* in many respects, but the flattish abdomen and quite differently bristled *t*₃, including a distinct calcar, of *Muscina* separate it from *Fraserella*.

The new species described below is not very similar to *F. fulvomaculata*, but it fits no better with any other genus than *Fraserella* and hardly seems distinct enough to require a new genus. I am indebted to Roger W. Crosskey, Commonwealth Institute of Entomology, London, for notes on the type of *F. fulvomaculata* and for pointing out that *Phaonia corbeti* Malloch should also be referred to *Fraserella*. The development of the latter species was described by J. S. Sewill (1931, pp. 233–235) as taking place in the inflorescence of nipa palms and it is possible that the new species has a similar habitat.

***Fraserella altivolans*, new species**

FIGURES 3, 4

MALE.—Length of wing 8.25–8.5 mm.

Color generally black; 1st, 2nd, and base of 3rd antennal segments reddish; oral margin between vibrissae reddish; infraocular bare area brownish; all bristles and hairs black, except very short whitish marginal cilia of thoracic squama.

Head proportions (fig. 3c): front at narrowest part 0.115 of total width of head; medifacies strongly narrowed at insertion of vibrissae; arista as in figure 3d, long plumose; anterior ommatidia approximately twice as great in diameter as posterior ones; bristles and hairs similar

to those of female (fig. 3*b*); occipital ocular margin bare, whitish pruinose.

Thorax with changeable pruinosity, when viewed from rear with central stripe, stripes in lines of *dc* bristles, and broad lateral areas, grayish. Chaetotaxy: 4 *h* in row; 2 *ntpl*; 1 *sl*; 1 *prs*; 1 small *pra* and 3 strong *sa*, 3 *pa*; 2 small posterior *ia*; 2+4 *dc*; 3 strong presutural *acr* and several much smaller and finer pairs of postsutural *acr* ending in row of 6 strong *prsc*; 6 marginal *sc*; 1 *ppl* and 1 strong stigmatal, each accompanied by a group of long strong bristly hairs, 1+2 *stpl*, the posterior 2 close together; complete row of about 18

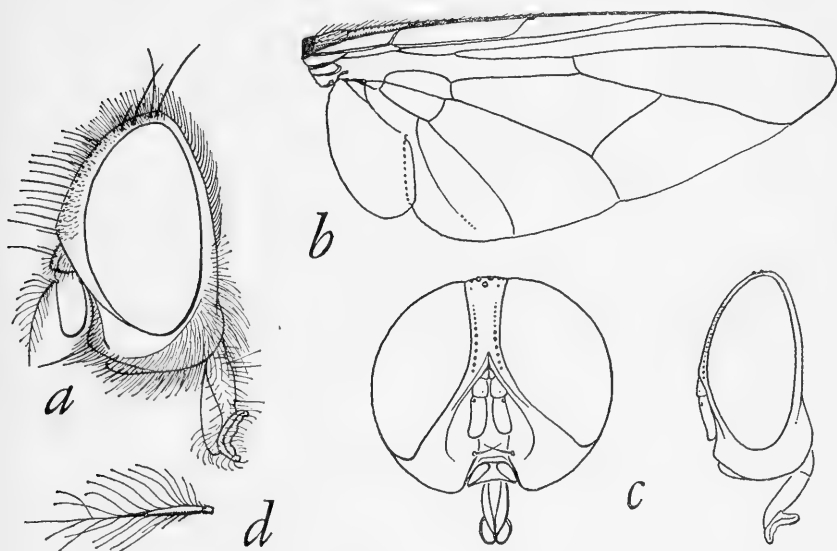


FIGURE 3.—*Fraserella altivolans*, new species: *a*, female head, profile; *b*, male wing; *c*, diagrammatic male head, anterior and lateral views; *d*, male arista.

posterior *mspl*. All thoracic hairs long and coarse, only the following areas bare: prosternum, center of propleuron, oblique stripe from center of mesopleuron to just posterad of *cx*₁, pteropleuron, hypopleuron, supra-alar and postalar declivities (except a few small hairs just below *pa*), suprasquamal ridge, lower surface of scutellum, metanotum. Sides of scutellum with many coarse hairs.

Legs simple, only *f*₂ quite slender in apical fourth; claws and pulvilli moderate in size. Chaetotaxy: *f*₁ with 2 complete rows of *pd*, 1 complete row of long *pv*; *t*₁ with short median *p* and many short *ad*; *f*₂ with 5 *pv* shorter than femoral diameter, about as many *av* only half as long as *pv*, and 3 closely adjacent preapical *pd*; *t*₂ with 2 *p* in apical half, 1 *d* and 4 *v* preapicals; *f*₃ with complete comb of densely placed disticline bristly *ad* hairs about as long as femoral

diameter, complete row of about 20 *av* (about 5 of which definitely bristles, others hairlike), a series of *pv* bristly hairs in basal half similar to *av* series; t_3 with 5 median *av* somewhat shorter than tibial diameter, some bristly *pd* hairs (a slightly larger one at apical third might be called calcar), distinct apical *d* and *av*, other apicals no larger than surrounding bristly setae. T_3 is distinctly compressed on apical half of posterior surface and is furnished with a narrow but deep sulcus in *pd* middle half. Cx_3 bare at apex above.

Wing (fig. 3a) hyaline; veins brown to black, only swollen base of costa as far as humeral crossvein yellowish; tegula and basicostal scale black; alar squama with blackish margin; thoracic squama closely adjacent to base of scutellum, with nearly straight apical margin, white and with very short whitish marginal cilia; costal vein at swollen base with rather long bristles, otherwise with very short depressed spinules; all other veins bare; halter with dark brown knob.

Abdomen rotund, swollen, covered dorsally with yellow pruinosity in somewhat changeable pattern, giving it a finely peppered appearance, except on basal 2/3 of 1st apparent tergite. Whole surface of abdomen covered with fairly dense decumbent hairs, marginal segmental hairs somewhat longer and more bristle-like; 1st ventral segment hairy. Postabdomen as in figures 4a-c; 5th sternite with broad, V-shaped emargination and 2 digitate apical protuberances (fig. 4b).

FEMALE.—Wing length 7.9–8.6 mm. Similar to male, except as follows.

Head (fig. 3b): front slightly broader anteriorly, 0.38 of total width of head; anterior ommatidia 1.25 times as large as posterior ones.

Legs with f_1 bearing complete rows of long *pd* and *pv* and small group of medial *a*; t_1 with 1–2 *pd* in apical half, nearly complete row of 9–10 rather short *ad*, long apical *ad*, *pd*, and *pv*; t_3 lacking the regular palisade of *ad* of male, but with a number of irregular bristles, of which 2 near middle stand out; t_3 also with *pd* bristles a little coarser than in male, but calcar no more distinct; posterior compression and sulcus as in male.

Abdomen in general appearance much as in male; postabdomen as in figure 4d (ovipositor), 8th sternite consisting of 2 elongate cuneiform sclerites; spermathecae not seen.

HOLOTYPE.—Male, Malaya, Selangor Gombak Forest Reserve, tree platform, Dec. 9, 1961 (H. E. McClure); allotype, same data, Dec. 17, 1961; paratypes, same data, 1 ♂, Nov. 10, 1962, bait trap 2000'; 1 ♂, May 20, 1961; 1 ♀, Mar. 3, 1961; 1 ♀, Apr. 1, 1961; 1 ♀, June 3, 1961; 1 ♀, June 10, 1961; 1 ♀, Oct. 21, 1961; 2 ♀, Sept. 1, 1962; USNM 67824.

The relationships of this species may be gathered from the discussion preceding the description and from the following key.

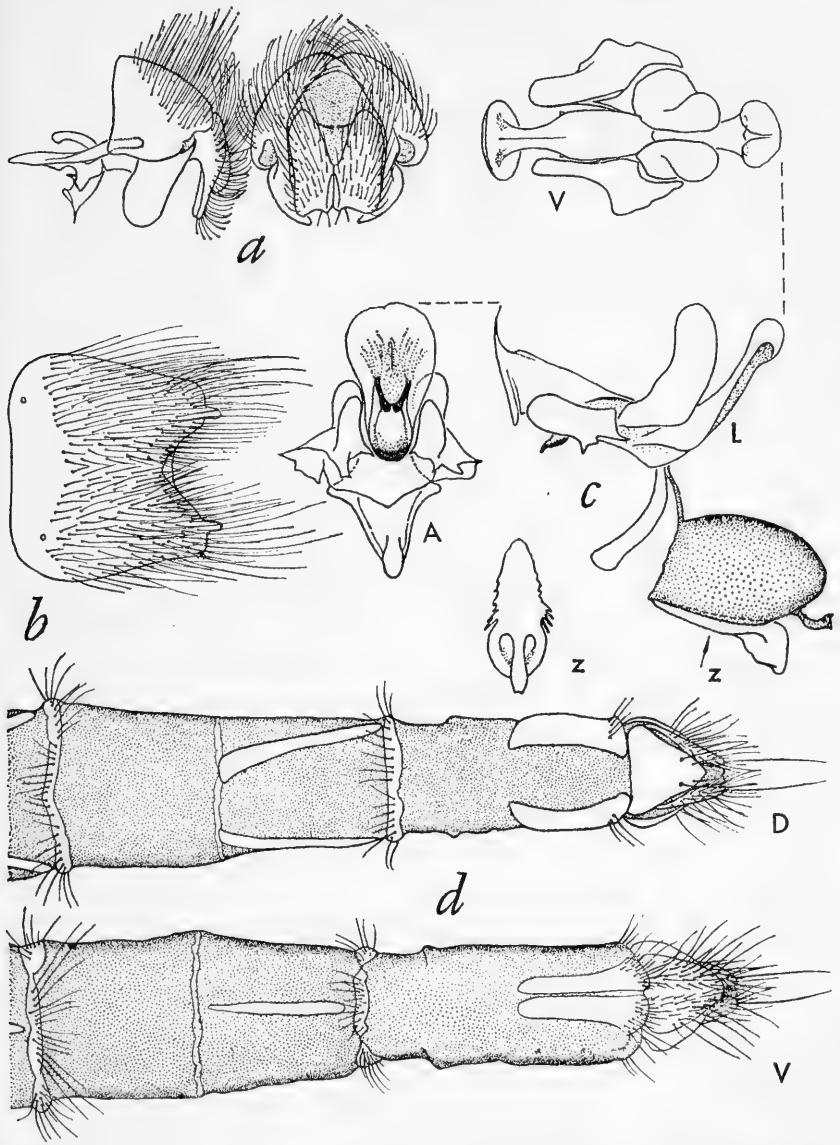


FIGURE 4.—*Fraserella altivolans*, new species: a, male postabdomen, lateral and posterior views; b, last preabdominal sternite; c, inner copulatory apparatus; d, female postabdomen (ovipositor). (Views: A=anterior, D=dorsal L=lateral, V=ventral, z=ejaculatory apodeme.)

Key to Species of *Fraserella*

- 1 (2). Eyes hairy; legs fulvous or orange yellow; 4th wing vein strongly bent forward apically; 4 *sc*.
F. fulvomaculata (Malloch), new combination
- 2 (1). Eyes practically bare; legs black; 4th wing vein very weakly bent forward apically.
- 3 (4). 3 *sc* (plus bristle-like posterior discal hairs); antenna black; abdomen gray pruinose *F. corbetti* (Malloch),³ new combination
- 4 (3). 5-6 *sc*; antenna basally reddish; abdomen yellowish-pruinose.
F. altivolans, new species

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³ Described as *Phaonia corbetti* Malloch (1931, p. 187).

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EUPHILOMEDES AROSTRATA,
A NEW MYODOCOPID OSTRACOD
FROM MALDIVE ISLANDS, INDIAN OCEAN

By LOUIS S. KORNIKER

Associate Curator, Division of Crustacea

While participating in the U.S. Program in Biology, International Indian Ocean Expedition, aboard the Stanford University Research Vessel *Te Vega*, the author obtained marine Ostracoda from the waters along the southwest coast of Ceylon and from among atolls forming the Maldive Islands. This paper describes a new species collected in the Maldives.

Field collecting was sponsored by the National Science Foundation through the Woods Hole Oceanographic Institution. I wish to thank Miss Caroline Bartlett and William Risley for preparing the illustrations. Through the courtesy of Dr. Gerhard Pretzmann of the Natural History Museum in Berlin, I was able to examine for comparative purposes specimens of *Philomedes polae* Graf from the Gulf of Suez.

Subfamily Philomedinae G. W. Müller, 1912

Genus *Euphilomedes* Poulsen, 1962

Philomedes (part), Müller, 1912.

Philomedes (part) Skogsberg, 1920.

Euphilomedes Poulsen, 1962.

Type-species: *Euphilomedes nodosa* Poulsen, 1962, by present designation.

GENERIC CHARACTERS.—Only a few additions need to be added to Poulsen's diagnosis of the genus (1962, pp. 359–361) to include the new species described herein.

Shell hingement of the genus was not discussed by Poulsen. *Euphilomedes arostrata* bears a tripartite hinge with strongly sclerotized posterior elements. Whether this character is present in all members of the genus is not known. Muscle scars consist of numerous oval or polygonal individual muscle scars located near, or anterior to, the middle of each valve.

Second antenna: Basal spines are not always present on exopodite. They are not present on *E. arostrata* and were also reported to be absent on *Euphilomedes oblonga* (Juday, 1907, p. 145) and *Euphilomedes multichelata* (Kornicker, 1959, p. 230).

Sixth limb: The end joint of *E. arostrata* is unusual because it is not produced posteriorly.

Frontal organ: Not noticeably widened at middle and with some surface spines near tip on appendage of male of *E. arostrata*. Surface spines also were reported on *Euphilomedes polae* (Graf, 1931, p. 37. fig. h).

OCCURRENCE.—Species of *Euphilomedes* have been reported from subtropical, tropical, and warm temperate regions (Poulsen, 1962, p. 359). The new species is the second reported from the Indian Ocean. *Euphilomedes debilis* (Brady, 1902) was previously reported from Trincomali on the northeast coast of Ceylon facing the Bay of Bengal.

Euphilomedes arostrata, new species

FIGURES 1–10

HOLOTYPE.—Gravid female described in this paper, USNM 112658 (figs. 1–4).

PARATYPE.—Male described in this paper, USNM 112659 (figs. 5–10).

TYPE LOCALITY.—A male and female were collected about 100 meters apart between Imma and Hura Islands, Male Atoll, Maldive Islands on March 20, 1964. Specimens were in sand obtained from upper surface of bottom in a patch of marine grass in one-third to one-half meters of water.

DIAGNOSIS.—*Euphilomedes* with four primary claws and seven to nine (possibly more) secondary claws. Second joint of exopodite of sixth limb not produced posteriorly. Hinge of shell terminating posteriorly in sclerotized angular process on each valve. Shell surface with irregular polygons and without lateral or posterior processes.

DESCRIPTION OF FEMALE.—Shell (figs. 1, 2): Oval in lateral view with greatest height near middle (fig. 1A); prominent rostrum; broad rostral incisure, with compressed posterior edge (fig. 1C). Anterior

margin of rostrum and anteroventral margin of shell with scalloped outline formed by crescent-like marginal denticulations. Shell surface with irregular polygons and normal pore canals; polygons containing pore canals smaller than average; about 23 polygons larger than average, hyaline, slightly in front of valve middle, representing locations of muscle attachments; hyaline, large, oval spot, with polygon border lies dorsal to hyaline polygons (fig. 2F). Anterior two-thirds of dorsal margin of valves hinged by transparent ligament following arcuate curvature of shell outline; posterior one-third with tripartite straight hinge. Hinge not affecting arcuate shell outline, but clearly visible in dorsal view and in lateral view when light is passed through closed shell. Posterior elements on each valve an angular sclerotized process (figs. 2A-E); left valve process containing a small forward-facing recess which apparently receives backward-projecting process of right valve (figs. 2B, C). Thin flap behind posterior process of left valve projecting medially, apparently resting on smooth, slightly depressed surface behind posterior process of right valve when shell is closed; upper surface of flap containing polygons similar to those on lateral surface of valves. Anterior hinge element less prominent than posterior; no tooth-and-socket arrangement observed. Medial hinge element of each valve consisting of straight bar without teeth. Surface of each valve above medial hinge element bearing two rows of minute tubercles or crenulations. Left valve broadly overlapping right along anterodorsal margin.

Thin sclerotized septum projecting downward from dorsal margin of each valve, starting near middle in front of anterior hinge element and terminating just behind posterior hinge element. Septum clearly visible in medial view at anterior and posterior hinge elements where it is set back from contact plane of valves; septum striated at anterior hinge elements. Several septa seem to be present in vicinity of anterior hinge element, especially on left valve.

Inner lamella (inner lamella, as used here, is peripheral part of chitin lining of epidermis) broad with vestibule, terminating at each end of dorsal ligament. Line of concrescence lies about halfway between inner and outer margin of inner lamella, closer to inner margin in anteroventral section, closer to outer margin in postero-dorsal section. Marginal zone with simple, fairly closely spaced true and false radial pore canals. Selvage narrow, with wide, corrugated, lamellar prolongation having serrate outer edge and terminal spines (figs. 1F, 2G). List midway between selvage and inner margin of inner lamella; about ten striations between list and inner margin of anterior part of inner lamella (figs. 1G, H).

Hairs, flaring distally and with concave, cuplike ends abundant, protruding from normal pore canals (figs. 2G, H); short, tapered hairs

sparsely distributed over shell surface; long, tapered hairs, as well as flared hairs on lateral surface of shell near outer margins, appear to protrude from false radial pore canals. About 11 long, bifurcating hairs bearing secondary hairs form row on inner lamella behind rostrum (figs. 1D, E); a small tapered hair, immediately below rostral incisure, is followed by a space and then a bare hair on left valve, and three bare and two brushlike hairs on right valve; these are followed by a space and then 16 or 17 brushlike hairs, all having bases on or near list (figs. 1G, H); short, bare hairs are distributed between list and inner margin of posterior and posteroventral parts of inner lamella (figs. 2A, E).

DIMENSIONS.—Length 1.37 mm., height 0.92 mm.

First antenna (fig. 3A): First joint elongate with clusters of fine hairs on broad surface. Second joint about three-fourths length of first, with numerous fine hairs; annulated bristle near middle of dorsal margin; slightly shorter bristle near anteroventral corner; short bristle near middle of distal margin. Third joint about one-half length of second; anterodorsal margin with short, bare bristle and long plumose bristle; anteroventral margin with bare bristle about length of third joint; short spines on ventral margin. Fourth joint about twice length of third; anterodorsal margin with two long, slender bristles about length of joint, both bristles with short, fine hairs; anteroventral corner with about four bristles, two long, two short; ventral margin with short spines. Fifth joint slightly longer than third; anterodorsal corner bears slender bristle with short hairs. End joint (or joints) fused, with numerous bristles (ventral bristle may be attached to end of fifth joint).

Second antenna (figs. 3B-E): Exopodite: first joint about twice length of following joints combined; second to ninth joints trapezoidal, each joint smaller than preceding, all without basal spines; mediodistal margin of second to eighth joints with comb of slender spines; second to ninth joints with long bristles; bristles on second and third joints without natatory hairs, bristles on fourth to ninth joints with natatory hairs; bristles on second and third joints with short marginal spines, some spines also observed on bristles of fifth to ninth joints. End joint with five or six bristles; two long with natatory hairs, three or four short without hairs. Endopodite: two jointed; first joint with long bristle wreathed by long hairs and five short, bare bristles; second joint bears long bristle with two wreaths of long hairs, minute spine at distal end of joint.

Mandible (figs. 3F, H, I): Coxale endite bifurcate, with rows of slender spines. Basale: ventral margin with seven bristles; two long, distal bristles with wreaths of long hairs; five short, proximal bristles with short hairs. Dorsal margin with three bristles: two at distal corner;

one with long hairs, proximal to middle. Medial surface with six short bristles and spines proximal to middle. Exopodite reaches about middle of first endopodite joint; tip with point; two terminal bristles of about equal length, both with short hairs, but slightly longer hairs on proximal bristle. Endopodite: distoventral corner of first joint with one short, bare bristle and three long bristles with wreaths of long hairs. Second joint: dorsal margin with ten bristles; two long and two short proximal to middle; six at about middle, one of latter much shorter than rest. Ventral margin with five bristles: two bristles distal to middle; three bristles at distal corner, clawlike, with sharp secondary spines. End joint with two claws of about equal length and about three bare bristles. Medial surfaces of basale and second endopodite joint provided with hairs.

Maxilla (figs. 3G, J, K): Dorsal margins of precoxale and coxale with thin, transparent epipodial appendages fringed with long, fine hairs. Coxale with short, bare bristle on distal, dorsal margin. Basale: distal dorsal margin with long, stout bristle with wreaths of long hairs; distal ventral margin with shorter bristle with hairs; narrow, elongate lobe with terminal bristle with base on distal medial margin near posteroventral corner, terminal bristle reaching end of endopodite; base of exopodite on distal lateral margin. Exopodite bears three bristles: proximal short, bare; two terminal bristles extend past end of endopodite, one with long, other with short hairs distally. Endopodite: first joint elongate, with clusters of stiff hairs along anterior margin and medial surface; distal anterior margin bears long bristle with wreaths of long hairs; distal lateral margin bears three (?) bristles with short hairs. End joint with numerous bristles, all with secondary hairs or spines, some clawlike. Precoxale bears three endites: first with about nine bristles; second about seven; third about nine plus one short proximal bristle.

Fifth limb (figs. 4A-C): First exopodite joint: middle, distal, anterior margin with two bristles, both bear long hairs; distal, medial corner with short, bare bristle; triangular process in front of main tooth extends almost to tip of tooth. Main tooth composed of four constituent teeth: distal tooth, large, bifurcate; following tooth slender, with four secondary teeth; next tooth slender, with about nine secondary teeth; fourth tooth small, without secondary teeth. Bristle with hairs, proximal to fourth tooth. Second exopodite joint has large curved tooth with small marginal teeth on inner curvature, small spine near distal lateral corner.

Sixth limb (fig. 4D): Protopodite: first endite with long bristle bearing long, stiff hairs and two short bristles with fine hairs; second endite with one proximal and three distal bristles; third endite with eight distal bristles, all except shortest bristle bear stiff hairs, fourth endite

with one medial and eight distal bristles; epipodial appendage represented by two short bristles. Second joint of exopodite twice as broad as long; distal margin bears 17 bristles, 4 with long, thin hairs, remainder with one or two wreaths of stiff hairs; medial surface with fine hairs; unlike others in genus, joint not produced posteriorly.

Seventh limb (fig. 4E): Cleaning bristles: five in distal group, three dorsally, two ventrally; two (?) proximal bristles; each bristle with three or four bells; distal surface with short, closely spaced hairs. Terminal comb: simple distal tooth with three or four teeth on either side; these teeth have secondary teeth at base. Terminal pegs: two, one or both with short, marginal spines.

Furca (figs. 4F, G): Each lamella has 13 claws: primary claws number 1, 2, 7, 12; secondary claws 3, 4, 5, 6, 8, 9, 10, 11, 13. Primary claws 1 and 2 separated from lamella, 7 and 12 joined to lamella; secondary claws all separated from lamella. Primary claws decrease in length proximally on lamella; claw 12 unusually broad at base. Secondary claws 3, 4, 5, 6 about same length, shorter than claw 7, longer than claw 8; claws 8, 9, 10, 11 decrease in size proximally. Primary claw 12 shorter than secondary claw 11, longer than claw 13. Lamella near basis of claws 1 and 2 bears cluster of long hairs.

Claw number 1, right lamella: Posterolateral margin has row of about 24 teeth arranged in sets of two to four; teeth at distal part of claw generally shorter than teeth at midclaw. Central portion of medial surface bears two large teeth followed by about eight smaller teeth. Claw number 1, left lamella: posteromedial margin has row of about 24 teeth similar to row on posterolateral margin of claw number 1 of right lamella; similar row of about 29 teeth on posterolateral margin. Primary claws 2 and 7 have two rows of teeth, claw 12 has single row. Secondary claws: broad base; spines along anterior and posterior margins become progressively finer and longer on distal half.

Eyes: Medial eye with brown pigment in preserved material. Lateral eyes absent.

Frontal organ (fig. 4H): Two jointed, with suture proximal to middle; construction with faint suture, near proximal end; tip rounded, without hairs.

Upper lip (figs. 4I-K): Small, helmet shaped, with small, unpaired conical process on anterior part; lip and process bear hairs. Irregular protuberances occur between upper lip and frontal organ.

Eggs: Specimen contained about 10 oval eggs.

DESCRIPTION OF MALE.—Shell (figs. 5-7): Oval in lateral view with greatest height near middle, more elongate than shell of female (figs. 5A-E). Prominent rostrum and broad rostral incisure similar to female. Rostral anterior margin and shell anteroventral margin

have scalloped outline formed by crescent-like marginal denticulations. Shell surface with irregular polygons and normal pore canals (fig. 6D). Polygons having pore canals are smaller than average. Distribution of pore canals differs in males and females; males have fewer large canals through which large hairs pass and more small canals containing minute hairs. Large hyaline polygons interpreted as areas of muscle attachment on the female valve, less distinct on male valve. Oval hyaline area with polygon border distinct, located dorsal to hyaline polygons. Hinge elements of male identical to those of female (fig. 7).

Inner lamella broad with vestibule as in female, but narrower along ventral margin. Radial canals not observed in male. Line of concrescence not identified with certainty on male, but may lie just within inner margin of selvage. If so, marginal zone of male is much narrower than that of female. Selvage of male similar to that of female. List as well as striations on anteroventral part of inner lamella not observed on male.

Distribution of hairs differs on male and female: Hairs that flare distally and have concave tips less abundant than on female, restricted to anterior one-third of valve surface and to ventral margin (fig. 6C); minute tapered hairs apparently more abundant, more or less evenly distributed over valve surface. Long tapered hairs more abundant on posterior one-third, especially along posterior margin; also present along ventral and anterodorsal margins interspersed with flaring hairs. Single tapered hair located behind posterior hinge elements of left and right valves on both male and female. Normal pore canals from which hairs protrude located in polygons smaller than surrounding polygons. Polygons containing flared hairs generally bordered by five polygons; polygons with long tapered hairs by six polygons; polygons containing minute tapered hairs by only four polygons. Pore canals containing minute tapered hairs apparently smaller in diameter than pore canals with long tapered or flared hairs.

Ten long hairs on left valve and nine on right form row on inner lamella behind rostrum; not bifurcate like hairs similarly located on female shell (figs. 5F, G). Small bare hair located below rostral sinus in same position as on female. Row of 19 bare hairs on right valve and 21 on left on anterior part of ventral inner lamella; not brushlike as are similarly located hairs on female (figs. 5G, J). About 32 short, tapered hairs, more or less in two rows, on inner lamella extending from its posteroventral part to posterior hinge element (fig. 5H).

DIMENSIONS.—Length 1.00 mm., height 0.60 mm.

First antenna (fig. 8A): First joint without bristles; second joint with transverse rows of hairs along ventral margin and three bare bristles; third joint with one bare bristle on ventral margin and two bristles on dorsal margin; of these the shorter is bare, the longer has

wreaths of long hairs. Fourth joint weakly separated from third; dorsal margin with two long bristles, each with wreath of long hairs; distoventral corner with four long, bare bristles. Fifth joint small, inserted ventrally between fourth and sixth joints; sensory bristle with numerous thin filaments on broad base, two or three more distal short filaments and about four short terminal filaments. Sixth joint with one bare bristle distally. End joints bearing five slender bristles and two long, stout c- and f-bristles, each with about 12 short filaments. Broad surfaces of third joint and distal part of second joint with hairs.

Second antenna (figs. 8B-G): Exopodite: first joint elongate with small mediodistal spine; second joint about one-fourth length of first; third joint about twice length of second; distal margins of second to eighth joints with comb of short spines. First joint without bristle; bristle of second joint with marginal spines, reaching end of third joint; on left appendage only, second bristle provided with marginal spines on proximal part, natatory hairs on distal one-half (second bristle at this location atypical for family, and probably not present on all males of species). Bristles on joints 3-8 with natatory hairs, without marginal spines. End joint with one short, and three long, stout bristles, all with natatory hairs, and two short, slender bristles, the longer of these having hairs. Endopodite: 3-jointed; first joint with five short, bare bristles and one long, stout bristle having short hairs on distal one-half and wreath of long hairs near middle; second joint elongate with two long, slender bristles on margin near middle; third joint elongate, arcuate, with broadest part proximal to middle; two short, annulated bristles along convex margin, one near distal, other near proximal end; tip of third joint with short, curved nonannulate bristle and four or five serrate transverse ridges.

Mandible (figs. 9A, B): Coxale endite not observed. Basale: ventral margin with five short, slender, bare bristles and two long, stout bristles with wreaths of long hair; one of the slender bristles farther in from margin than others. Dorsal margin with two bristles at distal corner and one near middle, all bare. Medial surface with about five short bristles near proximoventral corner. Exopodite reaches middle of first endopodite joint; with two subequal bare terminal bristles, proximal bristle with few short hairs; tip of joint with blunt process provided with hairs. Endopodite: distoventral corner of first joint with one short, bare bristle and three long bristles with wreaths of long hairs. Second joint: Dorsal margin with proximal group of two and distal group of six bristles; one short bristle located on medial side between proximal and distal groups. Ventral margin with two bristles proximal to middle and three

bristles near distal corner. End joint with two claws of about equal length, one short claw, and three bare bristles. Medial surfaces of basale and second endopodite joint provided with hairs.

Maxilla (fig. 9c): About two-thirds size of female maxilla. Bristles seem more weakly developed than on female. Dorsal margin of precoxale and coxale with epipodial appendage fringed with long hair. Precoxale with several short bristles along distal margin. Long, stout bristle on dorsodistal margin of female not observed on male. Endopodite first joint elongate, with hairs along anterior margin. End joint with numerous bristles. Precoxale bears three endites provided with numerous bristles.

Fifth limb (figs. 9D, G, H): Endites and exopodite joints provided with numerous bristles; first and second exopodite joint with elongate, triangular process; outer lobe of third exopodite joint with two plumose bristles.

Sixth limb (fig. 9E): Protopodite: first endite with long, bare distal bristle and three short, medial bristles provided with hairs; second endite with one proximal and three distal bristles; third endite with two stout, plumose bristles and about five short, bare bristles; fourth endite with plumose proximal bristle and eight distal bristles; epipodial appendage represented by three short, bare bristles, bristles are followed by small bifurcated process. Second joint of exopodite not produced posteriorly; distal margin bears 15 bristles, all with hairs; medial surface, anterior and posterior margins with fine hairs.

Seventh limb (figs. 9F, H, I): Cleaning bristles: four in distal group, two dorsally, two ventrally; three proximal bristles; each bristle with one to four bells; surface hairs not observed on bristles. Terminal comb contains about nine teeth; some have short, marginal spines. Terminal pegs: two, one or both with short, marginal spines. Diameter of seventh limb about one-half that of female limb.

Furca (figs. 10A-E): Each lamella has 11 claws: primary claws 1, 2, 6, 10; secondary claws 3, 4, 5, 7, 8, 9, 11. Medial and lateral row of teeth on all primary claws. Claw number 1 contains 50 to 60 teeth on each side arranged in sets containing 4 to 7 teeth arranged on echelon. Secondary claws have spines along anterior and posterior edges. Medial side of lamella near bases of primary claws 1, 2, 6 bears clusters of hair.

Copulatory limb (figs. 10E, F): Long, slender, divided into three lobes having bristles; one lobe has large curved tooth.

Eyes (figs. 10G, H): Medial eye with brown pigment in preserved material. Large lateral eyes, each with about 19 ommatophores visible in lateral view; suture divides ommatophores into two parts.

Frontal organ: 2-jointed with minute spines or hairs at tip.

Upper lip: Small, helmet shaped. Irregular protuberances occur between upper lip and frontal organ.

COMPARISONS.—Other species of *Euphilomedes* having a furca with more than one secondary claw placed between two distally located primary claws and a third primary claw are *Euphilomedes multichelata* (Kornicker) (1959, p. 230), *Euphilomedes oblonga* (Juday) (1907, p. 145), *Euphilomedes polae* (Graf) (1931, p. 37).

Each furcal lamella of *E. arostrata* has four primary claws, but each lamella of both *E. multichelata* and *E. oblonga* has five. Polygons forming the shells of *E. arostrata* do not have the shingle-like texture of shells of *E. multichelata* and *E. oblonga*. The seventh limbs of the male of *E. arostrata* have three proximal bristles compared to only one on *E. multichelata* and *E. oblonga*.

Euphilomedes polae is closely related to *E. arostrata*. The two bristles on the second joint of the endopodite of the male of *E. arostrata* are longer and are located more proximally on the joint than the bristles on *E. polae*; the third joint of the endopodite of *E. arostrata* has one bristle at the distal end, whereas *E. polae* has two.

Graf designated two specimens, both females, captured in plankton of the Red Sea, as *Philomedes* species. Only the furca was described and illustrated. The distribution of primary and secondary claws on that appendage suggests close relationship with *E. arostrata*, but lack of knowledge of other appendages prevents further comparison. Specimens of *Euphilomedes polae* and *Philomedes* species were found in the same sample, so it is possible that *Philomedes* species is the female of *E. polae*.

The second exopodite joint of the sixth limb of *E. arostrata* differs from species of *Euphilomedes*, *Philomedes*, *Scleroconcha*, and *Paraphilomedes* in which that appendage has been described in not being produced posteriorly. Sixth limbs of species of *Euphilomedes* having a distribution of furcal claws similar to *E. arostrata* have not been described.

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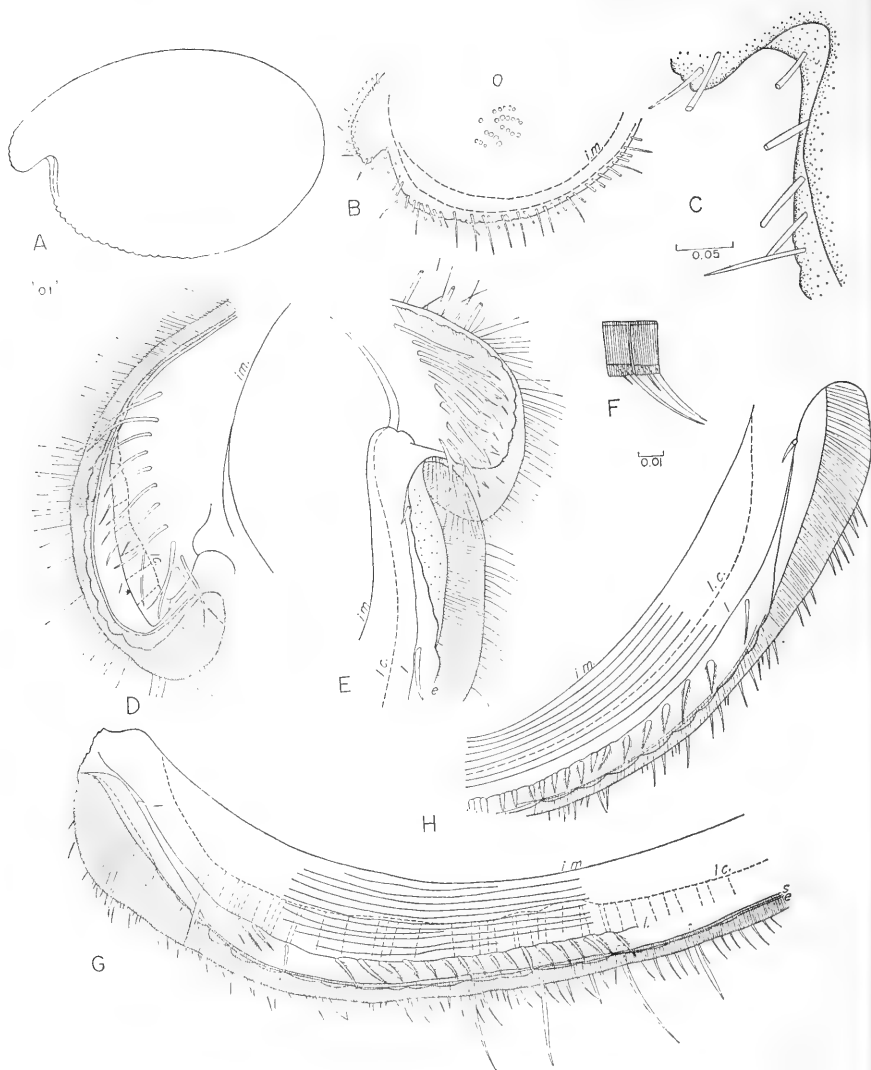


FIGURE 1.—*Euphilomedes arostrata*, new species, female: A, left lateral outline of complete specimen; B, lateral view left valve showing muscle spots and marginal hairs; C, lateral view left valve showing depressed area below antennal sinus; D, medial view rostrum right valve; E, medial view anterior left valve; F, detail posteroventral selvage right valve; G, medial view anteroventral part right valve margin; H, medial view anteroventral part left valve margin. (Same scale, in mm.: A, B; C, D, G, H; E, F. Key: i. m. = inner margin of lamella; l. c. = line of concrescence; l. = list; e = edge of valve; s = selvage.)

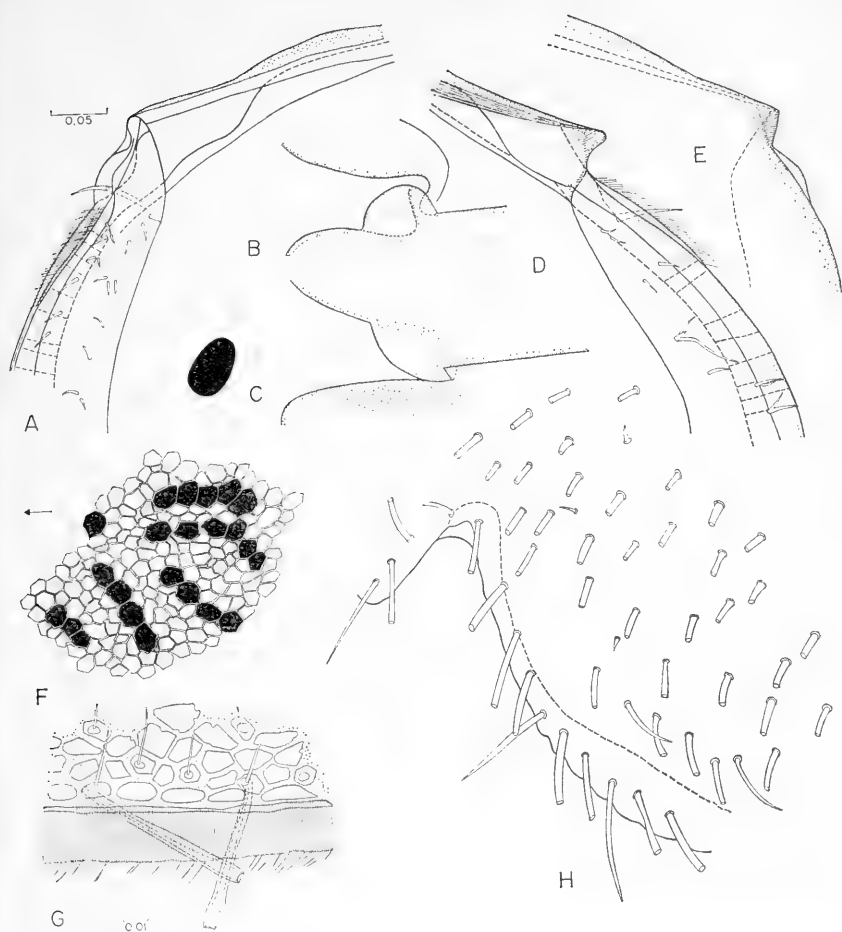


FIGURE 2.—*Euphilomedes arostrata*, new species, female: A, medial view left valve posterior hinge element; B, ventral view posterior hinge elements of partly open connected valves (posterior end of valves to left); C, dorsal view posterior hinge element of partly open connected valves (posterior end of valves to left); D, medial right valve posterior hinge element; E, lateral view left valve posterior hinge element; F, lateral view left valve muscle scars (anterior to left); G, medial view part of valve margin with calcium carbonate removed by dilute acid; H, lateral view anteroventral part of left valve showing distribution of surface hairs. (Same scale, in mm.: A–F, H; G.)



FIGURE 3.—*Euphilomedes arostrata*, new species, female: A, lateral view left 1st antenna with frontal organ and medial eye; B, medial view right second antenna; C, 2nd antenna endopodite; D, section of bristle on 3rd joint second antenna, outer edge on bottom; E, medial view end joints right second antenna; F, medial view left mandible exopodite; G, medial view distal end right maxilla; H, lateral view right mandible; I, medial view left mandible (marginal bristle of basal not shown); J, lateral view right maxilla (all bristles not shown); K, lateral view left maxilla exopodite, anterior to left. (Same scale, in mm.: A, B; C-G, I, K; H, J. Key: pco=precoxale; CO=coxale; Ba.=basale; Ex.=exopodite; E.=endopodite; I-III=endite joints.)

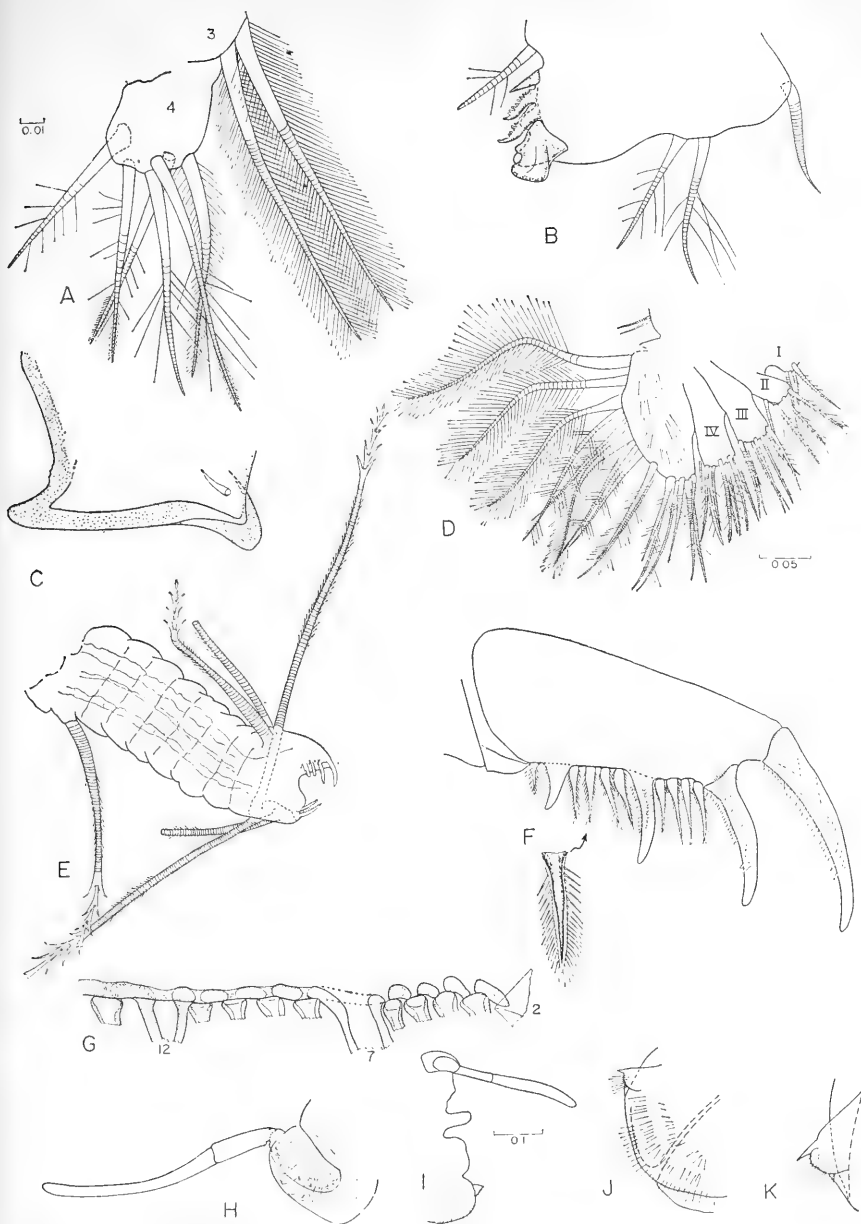


FIGURE 4.—*Euphilomedes arostrata*, new species, female: A, posterior view 4th joint and two lateral bristles of 3rd joint in 5th limb; B, posterior view 1st joint of left 5th limb (looking through part of 2nd joint); C, posterior view 2nd joint of right 5th limb (all bristles not shown); D, medial view left 6th limb; E, distal end 7th limb; F, lateral view right furca; G, detail of where claws 2-13 join lamella of right furca; H, frontal organ and median eye; I, profile from frontal organ to upper lip; J, profile of upper lip; K, detail of projecting process on upper lip. (Same scale, in mm.: A-C, E, G, K; D, F, H, J; I. Key: I-IV=endite joints.)

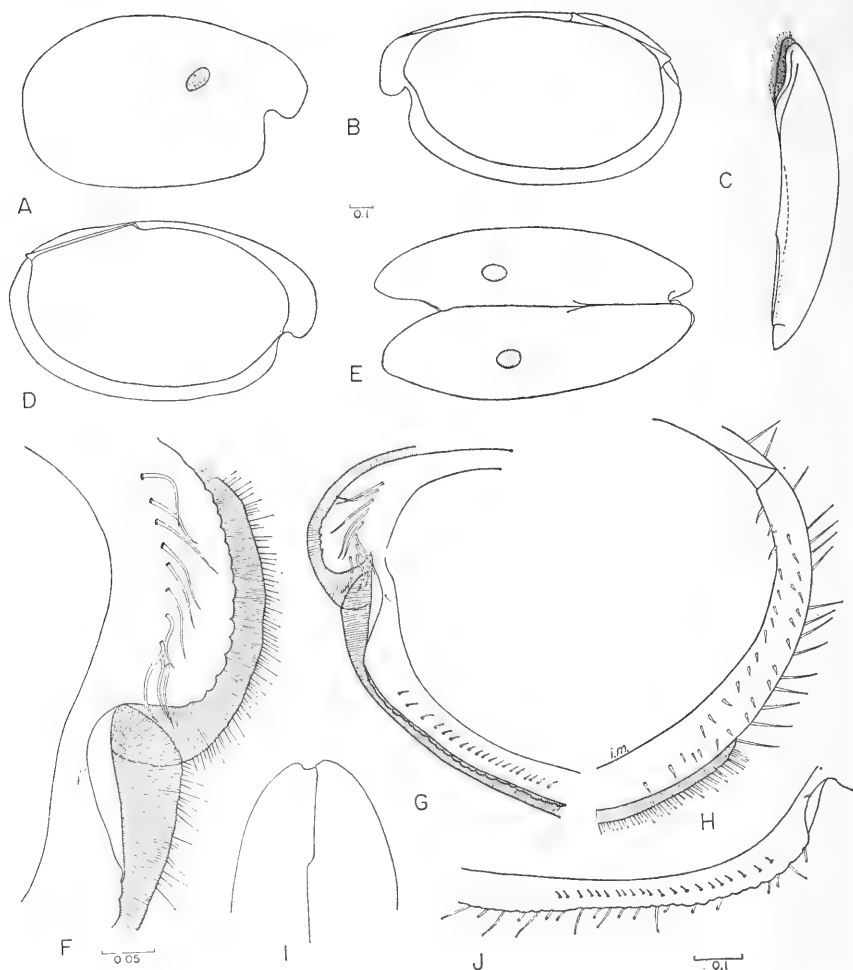


FIGURE 5.—*Euphilomedes arostrata*, new species, male: A, right lateral view of complete specimen showing right lateral eye; B, medial view right valve; C, dorsal view right valve; D, medial view left valve; E, dorsal view of partly open complete specimen; showing lateral eyes; F, anterior part left valve; G, anterior part right valve; H, posterior part right valve; I, dorsal view posterior part complete specimen; J, anterior ventral part left valve. (Same scale, in mm.: A-E, I, F; G, H, J. Key: i. m.=inner margin of lamella.)

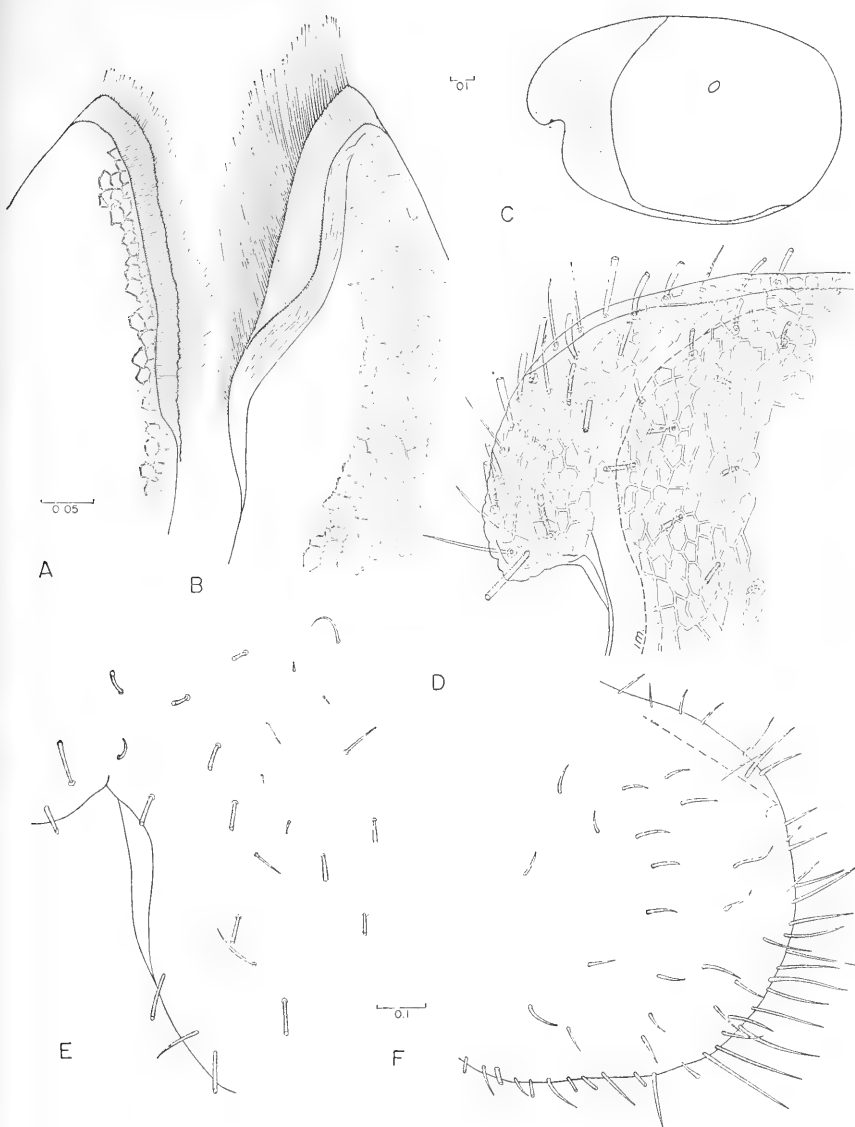


FIGURE 6.—*Euphilomedes arostrata*, new species, male: A, dorsal view anterior part left valve; B, dorsal view anterior part right valve; C, lateral view left valve with area bearing flared hairs stipled; small oval outlines lucid spot; D, medial view anterior dorsal part right valve showing distribution of hairs and polygons; E, lateral view anterior part left valve showing distribution of hairs; F, lateral view posterior part left valve showing distribution of hairs. (Same scale, in mm.: A, B, D, E; C; F.)

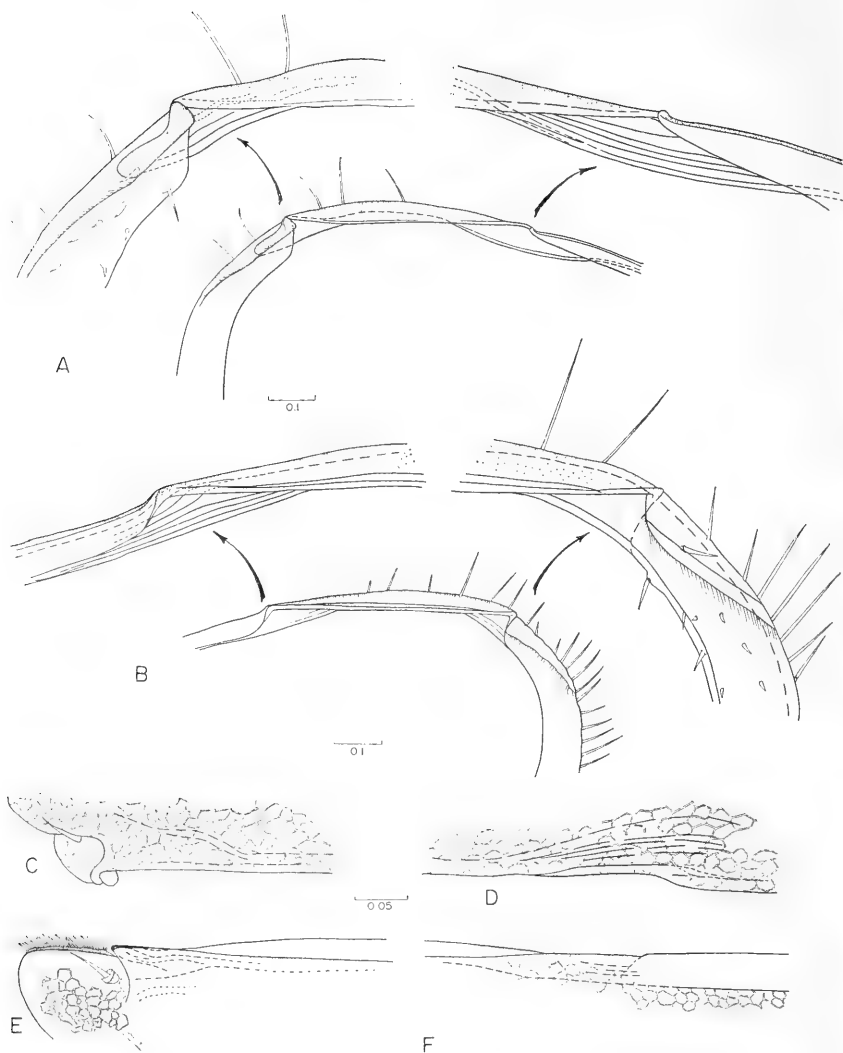


FIGURE 7.—*Euphilomedes arostrata*, new species, male: A, medial view dorsal hinge left valve with details of anterior and posterior elements; B, medial view dorsal hinge right valve with details of anterior and posterior elements; C, dorsal view posterior hinge element left valve; D, dorsal view anterior hinge element left valve; E, dorsal view posterior hinge element right valve; F, dorsal view anterior hinge element right valve. (Scale in mm.: A; B; C-F.)

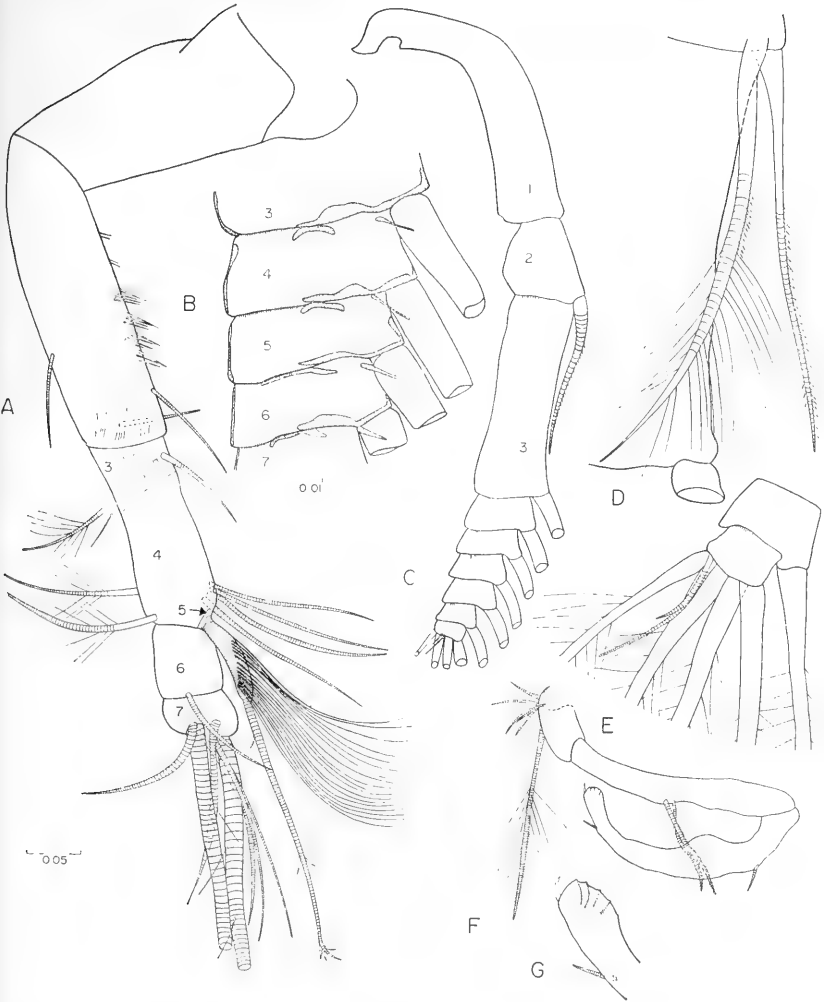


FIGURE 8.—*Euphilomedes arostrata*, new species, male: A, medial view right first antenna; B, lateral view joints 3-7 left second antenna exopodite showing sclerotized areas; C, lateral view joints 1-9 right second antenna exopodite; D, detail showing double bristle on distal corner of joint 2 left 2nd antenna; E, detail showing bristles on joints 8-9 right 2nd antenna; F, 2nd antenna endopodite; G, detail of tip of 2nd antenna endopodite. (Same scale, in mm.: A, C, F; B, D, E, G.)



FIGURE 9.—*Euphilomedes arostrata*, new species, male: A, lateral view left mandible; B, lateral view exopodite and first endopodite joint left mandible; C, maxilla (all bristles not shown); D, distal part 5th limb (all bristles not shown); E, medial view left 6th limb; F, tip of 7th limb; G, detail of bristle of 5th limb epipodial appendage; H, 7th limb and epipodial appendage of fifth limb; I, left (above) and right (below) 7th limbs. (Same scale, in mm.: A, C, E, G, I; B, D, F; H. Key: Pco=precoxale; Co=coxale; Ba=basale; E=endopodite; I-IV=endite joints.)

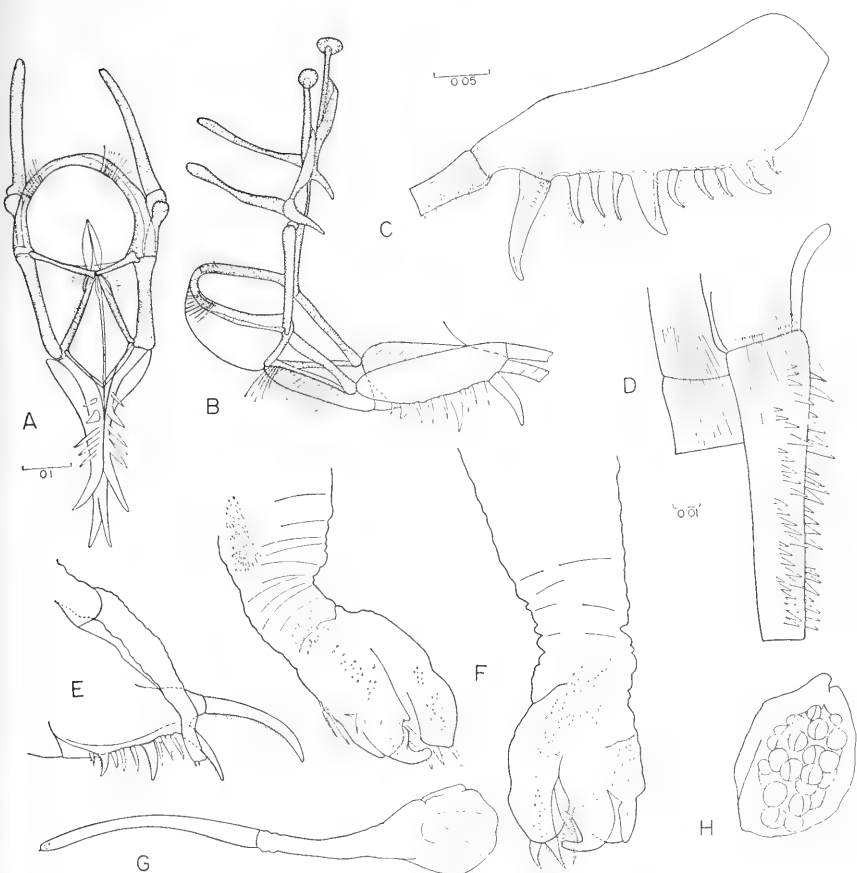


FIGURE 10.—*Euphilomedes arostrata*, new species, male: A, ventral view furca and sclerotized connectives; B, furca and sclerotized connectives viewed from slightly above lateral; C, lateral view left lamella of furca; D, part of distal tooth on left and right lamella of furca showing distribution of secondary teeth and hairs at base; E, lateral view of right lamella of furca and copulatory limb; F, distal ends of copulatory limbs; G, lateral view frontal organ and median eye; H, lateral eye. (Same scale, in mm.: A, B, E; C, G, H; D, F.)

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A COMPARISON OF AUSTRALASIAN AND AMERICAN SPECIMENS OF *HEMISQUILLA ENSIGERA* (OWEN, 1832) (CRUSTACEA: STOMATOPODA)

By WILLIAM STEPHENSON¹

Drs. Raymond B. Manning, John C. Yaldwyn, and the present author each decided independently and simultaneously that the status of the Australian specimens of *Hemisquilla* merited reconsideration. Drs. Manning and Yaldwyn graciously consented to this author's undertaking the main investigation while at the Allan Hancock Foundation. Here, California material was available mostly from the Hancock Foundation collections. Australian material has been obtained from various museums in Australia (particularly the Australian Museum, Sydney). Chilean material was limited to the small, complete collection of the Smithsonian Institution; unfortunately no recent collections from Chile have been obtained. Dr. John C. Yaldwyn has kindly loaned me the only known New Zealand specimen.

Institutions referred to by abbreviations are: Allan Hancock Foundation (AHF); Australian Museum, Sydney (AM); Dominion Museum, Wellington (DM); Scripps Institution of Oceanography (SIO); United States National Museum, Smithsonian Institution (USNM).

Measurements throughout are in millimeters. Carapace lengths were measured with dial calipers, and other dimensions with the

¹ Department of Zoology, University of Queensland, St. Lucia, Brisbane, Australia.

calibrated eyepiece of a stereomicroscope. Both are accurate to ca. 0.1 mm.

Two considerations are involved: first, whether the material from Australia and New Zealand (i.e. Australasia) is identical with the American, and secondly, what names to apply to the different populations.

The author is deeply grateful to Drs. Raymond B. Manning and John C. Yaldwyn for helpful suggestions, to Miss May Rees for assistance in computations, and to Mr. I. F. Horton for advice on statistical matters. Thanks are also due to the directors and curators of Crustacea of the above-mentioned institutions for allowing me to examine their *Hemisquilla* collections. I also wish to thank the directors and curators of Crustacea of institutions not mentioned: Johns Hopkins Marine Laboratory, the Queensland Museum, Brisbane, and the Tasmanian Museum, Hobart.

Names of Chilean Material

At the generic level the following names have been employed: *Gonodactylus* Latreille, 1825 (e.g., by H. M. Edwards, 1837; Nicolet, 1849; Miers, 1880; and Bigelow, 1894); *Pseudosquilla* Dana, 1852 (e.g., by Rathbun, 1910; Kemp, 1913) and *Hemisquilla* Hansen, 1895 (e.g., by Schmitt, 1940; and Manning, 1963b).

Most workers have used the specific epithets *styliferus* or *stylifera*, following H. M. Edwards' (1837) description of *Gonodactylus styliferus*. Rathbun (1910) showed that *G. styliferus* H. M. Edwards is a homonym of *G. styliferus* (Lamarck, 1818), now *Pseudosquilla ciliata* (Fabricius, 1787). She substituted the specific epithet *bigelowi*, and *Gonodactylus styliferus* H. M. Edwards became *Pseudosquilla bigelowi* Rathbun. This name has been used by a number of American workers for Californian material (e.g., Hilton, 1915a, 1915b; Buchsbaum and Milne, 1960).

Meanwhile Australian records have been under *P. stylifera* (H. M. Edwards) by Whitelegge (1900) and Kemp (1913); and under *H. stylifera* (H. M. Edwards) (following Schmitt, 1940) by Stephenson (1953, 1954) and Stephenson and McNeill (1955).

Manning (1963b) has shown that *Gonodactylus ensiger* Owen, 1832, from Chile is clearly the *Hemisquilla* that H. M. Edwards described as *G. styliferus*. Manning stressed the color similarities between Owen's description and preserved Chilean material, which leaves no doubt that *Hemisquilla ensigera* (Owen, 1832) has priority as the name for the Chilean form. He is also using this name for Australian material (Manning, 1967).

Distribution

Randall's (1839) Hawaiian record, suggesting continuous pan-Pacific distribution has been shown by Manning (1963b) to have been based upon an incorrectly labelled American specimen. Evidently Australasian and American populations are geographically distinct.

Past American records show a discontinuous antitropical distribution, with distinct Californian and Chilean records, the latter including Juan Fernandez (see Schmitt, 1940). One specimen, collected by the Allan Hancock Foundation, links these populations by the following measurements: juvenile, anterior half of body only, carapace length 6.0 mm, rostral length 1.7 mm, rostral breadth 1.7 mm, length eye 3.0 mm, length eyestalk 2.3 mm, length cornea 2.5 mm, breadth cornea 2.3 mm, no mandibular palps visible. Other data are: Jicarita Is., Panama, dredging east side, 24 fms, shelly gravel, coll. W. L. Schmitt, Hancock Galapagos Exped., *Velero* Sta. 240-34, Feb. 20, 1934, USNM 76381. This specimen is obviously a *Hemisquilla* as evidenced by (1) the raptorial claw having a single terminal tooth and not being swollen basally, (2) the articulation between the merus and ischium being terminal, (3) the carapace lacking carinae, and (4) the detailed structure of the narrowest part of the cornea (see p. 10) being identical with that of specimens of *H. ensigera*. Apart from the unlikely event of the first specimen of an undescribed species being a damaged juvenile, it must belong to *H. ensigera*.

Although only 37 specimens have been available for study, it is evident that the species is common in the Californian region. The California Department of Fisheries and Game advise that it is frequently caught on rod and line (one was so caught in the author's presence) and by skin divers. Verbal confirmation has been received from various unofficial sources. The contrast between apparent abundance and numbers available for study from this region suggests the possibility that additional specimens may be recovered from Central American waters in future years. Present records certainly extend the known southern limit of the Californian population, as evidenced by the following specimens all recently obtained from Mexican waters:

(1) ♂, east side of North Coronados Is., lower Calif., fishing line at 100 ft (33 m), Aug. 20, 1949, coll. John L. Perkins, RI 6.2-6 (SIO).

(2) ♂, Ensenada, lower Calif., Feb. 10, 1958, RI 6.2-11 (SIO).

(3) 2 ♂♂, 5.4 mi E Morro Redondo Pt., Cedros Is., 41 fms (74 m), trawl, Apr. 20, 1951, *Velero* Sta. 2030-51 (AHF).

(4) ♂, Sebastian Vizcaino Bay, lower Calif., coll. Jack Littlepage, acc. no. 153 (AHF).

(5) 2 ♂♂, 3 ♀♀, San Cristobal Bay, lower Calif., 41 fms (74 m), trawl, Apr. 27, 1950, *Velero* Sta. 1949-50 (AHF).

(6) ♂, ♀, 1 juvenile, 27°24' N, 114°40' W, San Cristobal Bay, lower Calif., 40 fms (72 m), Aug. 20, 1960 (1800-1820 hrs.), otter trawl, 6008B, 123.37, coll. Fred Berry (SIO).

(7) ♂, Turtle Bay, lower Calif., in purse seine inside bay during daytime, *Stella Maris*, coll. Ben Fukuzaki (AHF).

(8) ♀, 6.25 mi SSW San Hipolito Pt., 36 fms (65 m), trawl, Apr. 29, 1950, *Velero* Sta. 1952-50 (AHF).

The following specimen, kindly loaned by Dr. John C. Yaldwyn, is the first recorded from New Zealand: ♀, New Zealand waters, DM reg. no. Z.Cr.1493.

Morphological Differences—Initial Study

Only four possible distinguishing features were noted on preserved specimens from different areas. In each case there was considerable variability and such overlap between the series that statistical analyses were deemed necessary.

Initially, comparisons were made between Australasian and American material. Chilean and Californian collections were pooled for the following reasons: (1) the single Panamanian specimen tends to bridge the biogeographic gap; (2) probably the northern population extends in strength beyond the known southern limit as evidenced by the fact that 15 of the 37 "Californian" specimens have been collected in recent years in Mexican waters; and (3) the small number of Chilean specimens (9 only) available for study.

In each case a quantitative study of a feature was made and group means were computed. In most cases deviations from means exhibited by each of the individuals in a group were plotted as frequency distribution histograms; in other cases raw data were plotted similarly. These histograms sometimes indicate differences in the constitution of populations from the two areas (figs. 1-3). Histograms showing normal distributions are not given.

Variabilities of populations were computed in terms of standard deviations divided by means; these again indicate some population differences.

Finally, *t* tests of the significance of differences between group means were carried out (Lacey, 1953, p. 114; Fisher and Yates, 1957). It is appreciated that the applicability of this test is affected by abnormal frequency distributions; however, the low *p* values obtained

in all relevant cases ($p \ll 0.001$) leave no doubt of the significance of the differences.

In certain cases inspection of raw data indicated the possibility of sexual dimorphism. Means for Australasian males and females and for American males and females, respectively, were computed and t tests carried out in "promising" cases within the locality groupings.

In other cases it was suspected that the measured ratios depended upon specimen size. Using all specimens from a given area, correlation coefficients were computed between ratios and carapace length (i.e., the measure of specimen size) and were tested for significance (Fisher and Yates, 1957). Regression coefficients were computed in several cases.

MANDIBULAR PALP.—Kemp (1913) noted two-segmented palps in an Australian specimen and from one to three segments in Chilean specimens. Schmitt (1940) noted three segments on the right and two on the left side of a single Southern Californian specimen.

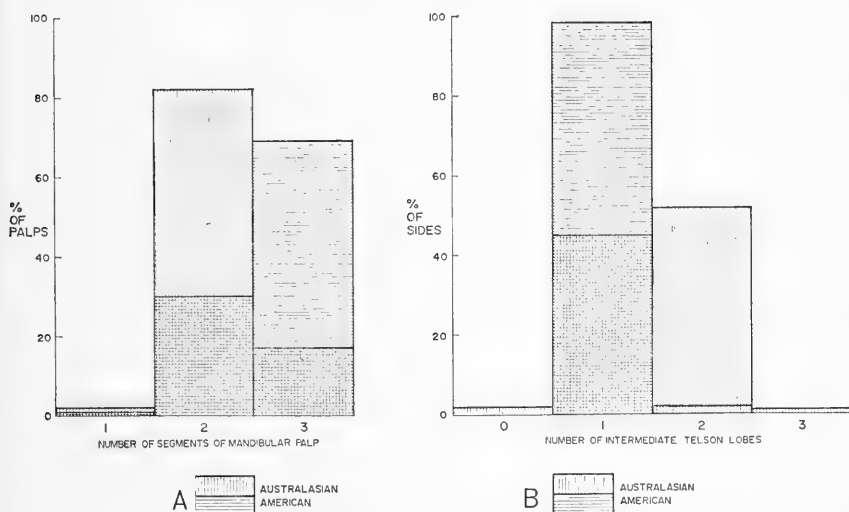


FIGURE 1.—Frequency distribution histogram showing percentages of specimens with varying numbers of: A, segments of mandibular palp; B, intermediate telson lobes.

Figure 1A shows that the Australasian population gives an approximately normal distribution curve with a mode of about two segments, but the American is strongly skewed to the right. Table 1 indicates approximately equal variability in the two populations. On the difference between means, t tests give $p \ll 0.001$. There is no doubt that the specimens belong to populations that are statistically separate.

Inspection of raw data gave no indications of differences between sizes or sexes of specimens, and analyses were not attempted. A minor cause of variation is related to loss and regrowth of palps. While many of the palps missing from the specimens may have been removed during collection and preservation, the occasional presence of unusually small palps, typically weakly segmented, suggests that natural loss and regrowth can occur. This could reflect varying environmental stresses, apart from any genetical differences.

TABLE 1.—*Comparative data of Australasian and American specimens*

	No. of segments of mandibular palp		Intermediate telson lobes		L/B rostrum	
	Aust.	Amer.	Aust.	Amer.	Aust.	Amer.
Mean	2. 3558	2. 6777	1. 3559	1. 0220	1. 1021	1. 3037
<i>n</i>	104	90	118	91	59	44
Range	1-3	1-3	0-3	1-2	0.88-1.26	1.10-1.54
Standard deviation	0. 473	0. 491	0. 612	0. 147	0. 0821	0. 134
<u>Standard deviation</u> mean	0. 201	0. 183	0. 451	0. 143	0. 0745	0. 103
Probability of differences (<i>t</i> test)	<<0. 001		<<0. 001		<<0. 001	

	<u>L carapace</u> L rostrum		L/B cornea		<u>L eye</u> B cornea	
	Aust.	Amer.	Aust.	Amer.	Aust.	Amer.
Mean	4. 7746	4. 1534	1. 2013	1. 3090	1. 3230	1. 4679
<i>n</i>	59	44	55	41	54	42
Range	4. 0-6. 0	3. 50-5. 0	1. 08-1. 36	1. 04-1. 55	1. 08-1. 46	1. 12-1. 92
Standard deviation	0. 442	0. 371	0. 0589	0. 340	0. 0733	0. 283
<u>Standard deviation</u> mean	0. 0926	0. 0893	0. 0490	0. 260	0. 0554	0. 193
Probability of differences (<i>t</i> test)	<<0. 001		<<0. 001		<<0. 001	

INTERMEDIATE LOBES OF TELSON.—Kemp (1913) noted that an Australian specimen had two lobes on each side but the then known Chilean specimens had single lobes. Schmitt (1940, p. 181) noted single lobes on Southern California specimens and suggested that these differences might be "of more significance than may seem justified at present."

In counting numbers of lobes, difficulties were encountered over two American and one Australian specimen. These possessed on each side one normal lobe and one very small lobe just lateral to it; the latter were regarded as vestigial and were not counted. In addition, one side of an American specimen had a malformed telson, and this was excluded from the count.

Figure 1B shows that the Australasian population gives a skewed curve but the American an approximately normal curve. (This is the opposite of results shown in figure 1A). Table 1 shows that the Australasian data vary more than the American. Differences between means are again significant with $p \ll 0.001$, and the populations are again statistically distinct.

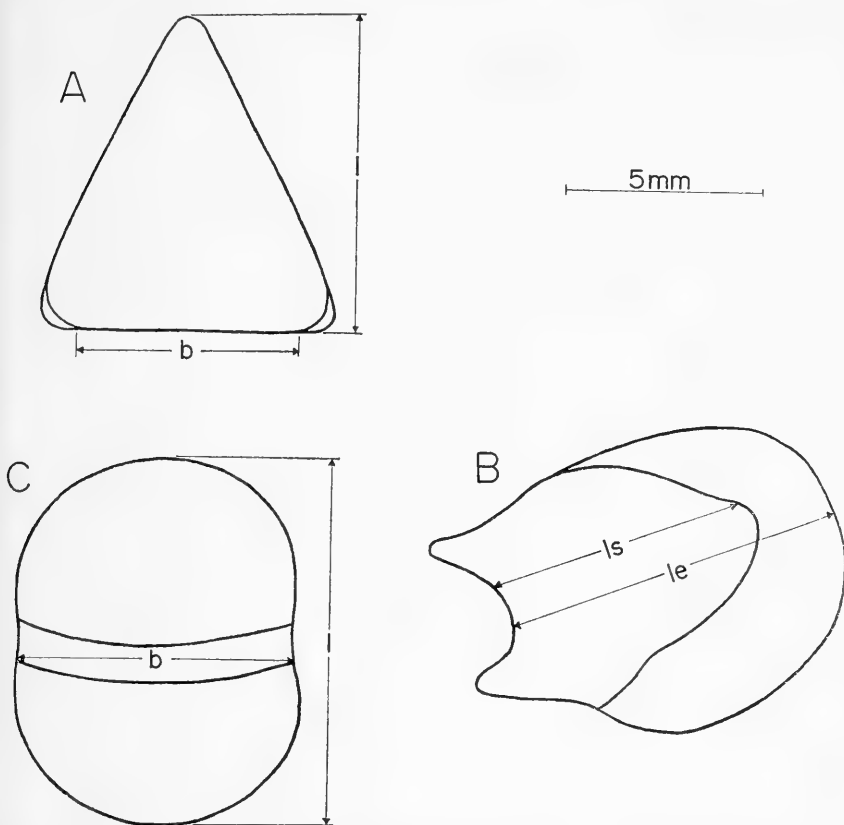


FIGURE 2.—Dimensions of *Hemisquilla ensigera*: A, rostrum; B, eye, lateral view; C, cornea, anteroventral view (l=length, b=breadth, le=length of eye, ls=length of eyestalk; drawn from male, Queensland Mus. reg. no. W1779).

ROSTRAL PROPORTIONS.—This distinction was suggested initially by comparison of Australian specimens with Kemp's figure (1913, pl. 7, fig. 84) of a Chilean specimen.

All specimens were measured for lengths and breadths of rostrum and carapace lengths. Measuring rostral breadths caused occasional difficulty and basal breadths on the upper surface of the line of articulation with the carapace were measured in preference to maxi-

mum breadth (fig. 2A). From these measurements, the ratios L/B rostrum and L carapace/L rostrum were computed.

Selected data show a hint of bimodality in the Australasian data (fig. 3A) and a much less definite hint in the American (fig. 3B). The

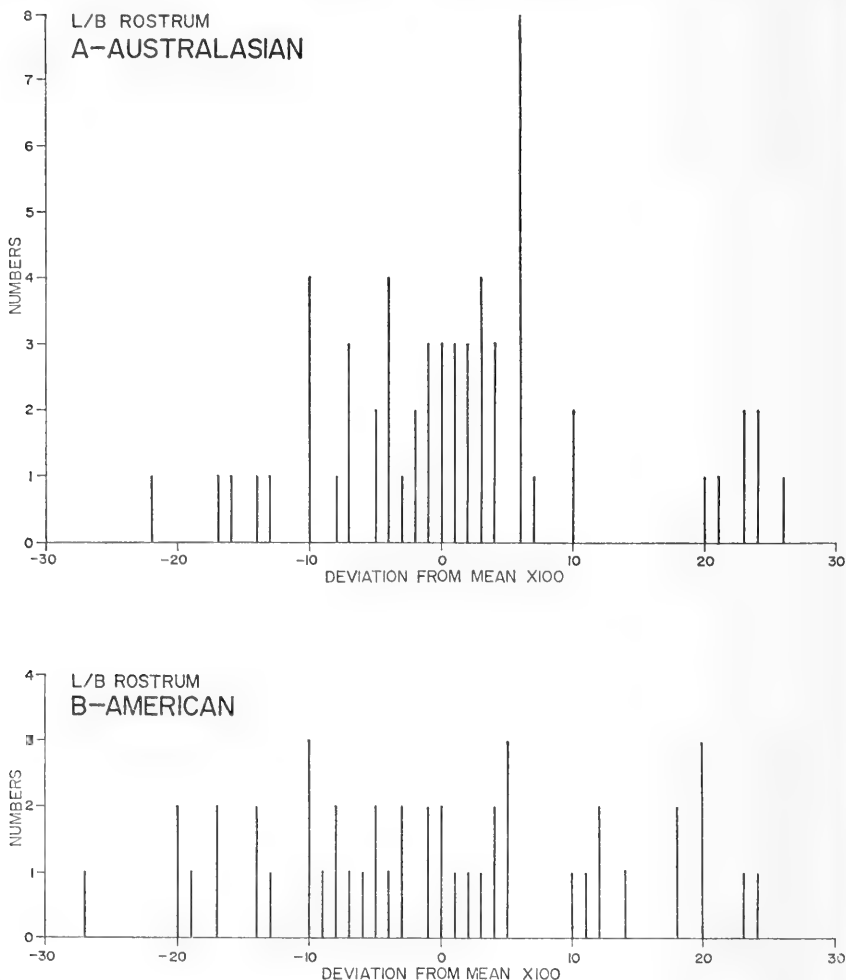


FIGURE 3.—Frequency distribution histograms showing numbers of Australasian and American specimens with varying deviations from group mean L/B ratios.

small "separate" groups with higher deviations are not distinctive as regards sex ratio or size; to simplify analyses, hints of polymorphism in L/B rostrum data were ignored. There are no comparable hints in L carapace/L rostrum data.

Table 1 shows that there is equivalent variability in Australasian and American material and that the rostra of American specimens are significantly longer than that of the Australasian ($p. \ll 0.001$).

Inspection of data indicated possible sexual dimorphism and size effects. Relevant data on sexual differences are shown below.

L/B rostrum			
	no.	mean	weighted mean
Australasia	36 ♂ ♂	1.1017	1.1021
	23 ♀ ♀	1.1026	
America	28 ♂ ♂	1.3086	1.3027
	16 ♀ ♀	1.2925	

L carapace/L rostrum			
	no.	mean	weighted mean
Australasia	36 ♂ ♂	4.7292	4.7746
	23 ♀ ♀	4.8457	
America	28 ♂ ♂	4.1289	4.1534
	16 ♀ ♀	4.1963	

For L carapace/L rostrum data the differences between male and female means is significant almost at the 0.02 level on Australasian material but not significant on American (p ca. 0.3). No tests were carried out on L/B rostrum data because of the small differences between means of Australasian males and females, respectively, and the reversed tendency of Australasian versus Californian data.

The effects of size upon the ratios were only investigated upon L/B rostrum data, which appeared to offer the more "promising" indications. Correlation coefficients between carapace length and L/B rostrum for Australasian and American material are -0.070 and $+0.330$, respectively. The former is not significant ($p > 0.1$), while the latter is significant at about the 0.03 level. Regression coefficients between carapace length and L/B rostrum are -0.00156 and $+0.00479$, respectively.

Summarizing these analyses, the American and Australasian specimens clearly belong to different populations with shorter rostra on the Australasian material. There are indications of sexual dimorphism, with a smaller L carapace/L rostrum ratio in males, but this is significant only on Australasian material. There are also indications of a slight size effect, which is significant only on American material.

EYES AND EYESTALKS.—This possible distinction, like the last, arose initially by comparison of Australasian specimens with Kemp's figure (1913, pl. 7, fig. 84) of a Chilean specimen.

Measurements were made on all undamaged eyes of length of eyestalk from lateral view, length of entire eye from lateral view,

length of cornea from anteroventral view (looking at cornea "end on"), and breadth of cornea in similar view (see figs. 3B, C). Choice of the portions of the eye to be measured was conditioned partly by ease of precise recognition on successive occasions. Thus minimal corneal breadth was measured because recognition is aided by slight concave curvatures in the centers of the corneas, by the presence of larger facets in this area, and by transverse pigment lines in pigmented specimens. In all measurements there are subjective errors, and the accuracy of results decreases, possibly to ± 0.2 mm. From these measurements L/B cornea and L eye/B cornea were computed as the most accurate and meaningful of the possible ratios.

Histograms of deviations from means give normal frequency distributions in each case. Values of standard deviation/mean (table 1) indicate that for L/B cornea data only the American material varies more than the Australasian. For both L/B cornea and L eye/B cornea data American specimens give higher values than Australasian, with the differences significant at values of $p \ll 0.001$.

Inspection of data indicated possible sexual dimorphism and possible size effects. Relevant data on sexual differences are shown below.

L/B cornea

	no.	mean	weighted mean
Australasia	32 ♂ ♂	1.2028	1.2013
	23 ♀ ♀	1.1991	
American	25 ♂ ♂	1.3092	1.3090
	16 ♀ ♀	1.3088	

L eye/B cornea

	no.	mean	weighted mean
Australasia	31 ♂ ♂	1.3277	1.3230
	23 ♀ ♀	1.3143	
American	25 ♂ ♂	1.4772	1.4679
	17 ♀ ♀	1.4512	

For L/B cornea data, differences between the means of males and females are not significant either upon Australian material (p ca. 0.6) or American ($p \gg 0.9$ level). For L eye/B cornea Australian data significance is at the 0.1 level but American data are not significantly different ($p \gg 0.9$).

Size effects were investigated only on L/B cornea data. The correlation coefficient between carapace length and L/B cornea for Australasian specimens is 0.296 (p ca. 0.02) and for American 0.476 ($p \ll 0.001$). Regression coefficients are 0.00145 and 0.00562, respectively.

Summarizing these analyses, the American and Australasian specimens clearly belong to different populations as indicated by the

dimensions of eyes and eyestalks (broader cornea in Australasian material). Of four possibilities of sexual dimorphism, only one is significant—L eye/B cornea in Australasian males, greater than in females. The ratio L/B cornea increases significantly with specimen size.

The general summation of the results of the present section is that Australasian and American material are significantly different in all features selected for examination. In the six sets of data, differences between means are significant at p levels of $\ll 0.001$. Apart from differences in means there are also differences in the form of frequency distributions of deviations from mean (e.g., skewness) and in heterogeneity within groups. There are indications of sexual dimorphism in certain features and stronger indications of proportions changing with specimen size. Since none of these effects are as noteworthy as those depending upon locality, they were neglected in further analyses.

Comparisons Between Californian, Chilean, and Australasian Material

Because differences between American and Australasian populations had proved so highly significant and because in many respects mean values for Chilean material lay between Californian and Australasian extremes, data were reconsidered under the three main locality groupings. Results, given in tables 2 and 3, show that differences between Californian and Australasian data are highly significant throughout. Further consideration is restricted to Australasian/Chilean and Chilean/Californian comparisons.

MANDIBULAR PALP.—The mean Chilean value is roughly midway between Australasian and Californian means, with an approximately equal probability of the differences being significant (p ca. 0.1 and 0.2 – 0.1, respectively). The three populations have approximately equivalent variability. The Californian data is more skewed than the Chilean data.

INTERMEDIATE LOBES OF TELSON.—The mean Chilean value lies further from the Australasian than the Californian and differs significantly from the Australasian (p ca. 0.01) but not from the Californian (p 0.4 – 0.3). The Chilean data resembles the Californian in the form of its frequency distribution; both differ from the skewed curve for Australasian data. Variability in the Australasian data is much higher than in the Chilean, which resembles more that of the Californian.

ROSTRAL PROPORTIONS.—L/B rostrum: The mean Chilean value is closer to the Australasian than to the Californian. It is not significantly different from the former (p ca. 0.2) but is from the latter ($p \ll 0.001$). The variability of the Chilean values is of the same

order of magnitude as for the Australasian and is considerably smaller than the Californian.

L carapace/L rostrum: Again the mean Chilean value is closer to the Australasian than to the Californian. It is just significantly different from the former (p ca. 0.1) but is highly significantly different from the latter ($p \ll 0.001$). Variability is approximately the same throughout.

EYES AND EYESTALKS.—L/B cornea: The mean Chilean value is midway between Australasian and Californian values, with differences significant in both cases (p ca. 0.001 and < 0.05 , respectively). Varia-

TABLE 2.—Comparative data of Australasian, Chilean, and Californian specimens

	No. of segments of mandibular palp			Intermediate telson lobes			L/B rostrum		
	Aust.	Chile	Calif.	Aust.	Chile	Calif.	Aust.	Chile	Calif.
Mean	2.3558	2.5500	2.7083	1.3559	1.0	1.0274	1.1021	1.1744	1.3357
<i>n</i>	104	18	72	118	18	73	59	9	35
Range	1-3	2-3	1-3	0-3	1	1-2	0.88- 1.26	1.10- 1.29	1.10- 1.54
Standard deviation	0.473	0.497	0.484	0.612	0	0.163	0.0821	0.0678	0.112
Standard deviation mean	0.201	0.194	0.179	0.451	0	0.159	0.0745	0.0577	0.0839

	<u>L carapace</u> <u>L rostrum</u>			L/B cornea			<u>L eye</u> <u>B cornea</u>		
	Aust.	Chile	Calif.	Aust.	Chile	Calif.	Aust.	Chile	Calif.
Mean	4.7746	4.5388	4.0543	1.2013	1.2689	1.3203	1.3220	1.5056	1.4576
<i>n</i>	59	9	35	55	9	32	54	9	33
Range	4.0- 6.0	4.1- 5.15	3.50- 4.57	1.08- 1.36	1.18- 1.38	0.95- 1.55	1.08- 1.46	1.41- 1.65	1.12- 1.92
Standard deviation	0.442	0.3376	0.3040	0.0589	0.0617	0.0931	0.0733	0.0782	0.3123
Standard deviation mean	0.0926	0.0744	0.0750	0.0490	0.0486	0.0705	0.0554	0.0519	0.2140

bilities of Australasian and Chilean material are roughly the same and lower than Californian.

L eye/B cornea: The Chilean mean is further from the Australasian than is the Californian; p values emphasize the difference between Chilean and Australasian material ($p \ll 0.001$) and the similarity between Chilean and Californian (p 0.6 - 0.5). The variability of the Californian population is much greater than that of either of the others.

Summarizing these results, of the six determinations upon the four selected structural features, in four the mean Chilean values lie between the extremes of the Australasian and the Californian, and in the other two they lie further from the Australasian than do the

Californian. In significance tests in 5/6 cases, differences between Chilean and Australasian means are significant, and in one case (L/B rostrum) they just fail to be significant (p ca. 0.2). In 2/6 cases differences between Chilean and Californian means are not significant, in one case the difference just fails to be significant, and in two cases differences are highly significant.

Comparisons Between *H. ensigera* and *H. braziliensis*

In deciding the status to be given to the three populations of *H. ensigera*, two considerations are relevant:

(1) Distinctions between stomatopod taxa are becoming finer from the generic level downward (Serène, 1962; Manning, 1963a).

(2) *H. ensigera* is very close to *H. braziliensis* (Moreira, 1903a, b), the only other species of the genus. The only conspicuous difference in preserved material is that in *H. braziliensis* the lobes of the telson

TABLE 3.—Significance of differences among three populations of *H. ensigera*

		No. of segments of man- dibular palp	Inter- mediate telson lobes	L/B rostrum	L carapace L rostrum	L/B cornea	L eye B cornea
Australasia	<i>t</i>	1.784	2.870	1.377	1.651	3.674	8.088
v. Chile	<i>p</i>	c. 0.1	c. 0.01	c. 0.2	c. 0.1	c. 0.001	<<0.001
Chile v.	<i>t</i>	1.527	0.932	5.220	5.295	2.032	0.591
California	<i>p</i>	0.2-0.1	0.4-0.3	<<0.001	<<0.001	<0.05	0.6-0.5
California	<i>t</i>	11.226	9.176	22.680	15.727	13.538	6.164
v. Australasia	<i>p</i>	<<0.001	<<0.001	<<0.001	<<0.001	<<0.001	<<0.001

are spinous (see Schmitt, 1940, figs. 18a, b). There are also possible differences in the form of the basal process of the uropods, in the color of live specimens, and in rostral shape (Moreira, 1905; Lemos de Castro, 1955). Because rostral shape is variable in *H. ensigera* and because there may be other statistical differences in variable features, most of the measurements upon *H. ensigera* were repeated upon the nine specimens of *H. braziliensis* in the USNM.

The ranges of values show complete overlap with *H. ensigera* data, but comparison of mean values gives data as shown below.

Number of segments of mandibular palp: 2.8889, cf. 2.7083 for nearest and largest *H. ensigera* value (Californian), difference highly significant ($p \ll 0.001$).

Intermediate lobes of telson: On the criteria adopted above, the number of lobes is identical with *H. ensigera* from Chile, being unity throughout; however, most or all specimens of *H. braziliensis* possess small lobes just lateral to the intermediates, similar to those here

regarded as "vestigial" (see p. 6; also Schmitt, 1940, fig. 18b). These were only observed in three specimens of *H. ensigera*.

L/B rostrum: 1.1088, cf. 1.1021 for nearest *H. ensigera* value (Australasian), difference not significant (p 0.8).

L carapace/L rostrum: 3.9650, cf. 4.0543 for nearest and lowest *H. ensigera* value (Californian), difference not significant (p 0.4–0.3).

L/B cornea: 1.0556, cf. 1.2013 for nearest and lowest *H. ensigera* value (Australasian), difference just not significant (p 0.2–0.1).

L eye/B cornea: 1.1544, cf. 1.3220 for nearest and lowest *H. ensigera* value (Australasian), difference highly significant ($p \ll 0.001$).

Summarizing these differences, *H. braziliensis* differs from *H. ensigera* in having (1) in all cases, more spinous telson teeth and (probably) differently shaped basal processes of uropods; and (2) statistically significant differences as follows: a larger number of segments in the mandibular palp, a higher proportion of individuals with "vestigial" intermediate lobes of telson, a relatively broader cornea as indicated by lower L eye/B cornea ratios (and possibly by lower L/B cornea ratios).

Discussion

There are three populations of *Hemisquilla* in the Pacific—one Australasian and two American. The latter are geographically separate (apart from a single juvenile from Panama).

Four possible morphological differences between the populations have been noted: number of segments in the mandibular palp, number of intermediate lobes on the telson, relative length of rostrum, and relative breadth of cornea. In each case there is considerable variability and overlap between populations.

An initial analysis showed that American and Australasian populations are morphologically distinguishable by statistical tests at a highly significant level. (These analyses also show hints of sexual dimorphism in some features and slight alterations of proportions with increasing specimen size.) At this stage one might conclude that the American and Australasian forms belong to two subspecies.

In further analyses a three-way comparison has been made, American material being treated under Chilean and Californian headings and compared with the Australasian. Of six features measured (two being different measurements of rostral proportions and two being eye proportions), the numbers of dissimilarities among the three populations are shown below.

	highly significant	just or doubtfully significant	not significant
Australasian v. Californian	6	0	0
Chilean v. Australasian	3	3	0
Chilean v. Californian	3	1	2

It is evident on the basis of present data that Chilean material is almost as distinct from the Californian as it is from the Australasian. The best schema to meet this situation is to regard each population as a subspecies. This conclusion is influenced by three factors:

(1) Only nine Chilean specimens were available for study. When additional material is measured, it seems likely that differences between Chilean and other material will become more significant.

(2) There is the possibility that detailed examination of colors of living specimens may afford further diagnostic criteria. Manning (pers. comm.) stresses the importance of color differences in other genera of stomatopods. In the present case it is possible that Chilean specimens may differ from Californian in having less yellow color on various appendages. Thus Nicolet's plate (1854, pl. 2, fig. 3) shows the following as green or bluish green: antennal scales, propodus of raptorial claws, and endopodites of uropods. They are canary yellow on living and recently preserved Californian specimens. To determine whether the differences are real or are artifacts, requires observations on fresh Chilean material.

(3) Distinctions between stomatopods at all levels are becoming increasingly fine, and subspecific distinctions must be finer still. This is emphasized by a comparison between *H. braziliensis* and the different groups of *H. ensigera*. Apart from two "firm" features the differences are of the same order as those between the different groups of *H. ensigera*. In these respects the Brazilian form shows no closer relationship to any one group of *H. ensigera* than to any other.

In view of the above, three subspecies of *H. ensigera* are therefore designated:

Chilean: *Hemisquilla ensigera ensigera*

Californian: *H. ensigera californiensis*, new subspecies

Australasian: *H. ensigera australiensis*, new subspecies

The distinguishing features, on the basis of present knowledge are as follows:

Mandibular palps: In *H.e. australiensis* 80% of the palps are two segmented and 20% three segmented. In *H.e. californiensis* the values are 25% and ca. 75%, respectively, and in *H.e. ensigera* they are 45% and 55%, respectively.

Intermediate lobes of telson: In *H.e. australiensis* about half the telsons have single lobes (45%) and about half (52%) two lobes. In *H.e. californiensis* over 95% have single lobes, and in *H.e. ensigera* all specimens examined have single lobes. On this basis *H.e. californiensis* and *H.e. ensigera* are indistinguishable.

Length/breadth ratio of rostrum: In *H.e. australiensis* the ratio is low (mean 1.10), in *H.e. californiensis* high (mean 1.34), and in *H.e.*

ensigera intermediate (mean 1.17). On this basis *H.e. australiensis* and *H.e. ensigera* are doubtfully distinguishable.

Length carapace/length rostrum ratio: In *H.e. australiensis* the ratio is high (mean 4.77), in *H.e. californiensis* low (mean 4.05), and in *H.e. ensigera* intermediate (mean 4.54).

Length/breadth ratio of cornea: In *H.e. australiensis* the ratio is low (mean 1.20), in *H.e. californiensis* high (mean 1.32), and in *H.e. ensigera* intermediate (mean 1.27).

Length of eye/breadth of cornea: In *H.e. australiensis* the ratio is low (mean 1.32), in *H.e. californiensis* intermediate (mean 1.46), and in *H.e. ensigera* high (mean 1.51). On this basis *H.e. californiensis* and *H.e. ensigera* are indistinguishable.

Type specimens of the three subspecies are designated as follows:

H.e. australiensis, male, carapace length, 28.5 mm, 12 miles E. Broken Bay, NSW, Australia, presented by H. Arnold, November 1946, AM reg. no. P.11695.

H.e. californiensis male, carapace length, 41.1 mm, Southern California, Anton Dohn coll., gift Venice Mar. Biol. Sta. 1909, USNM 50016.

H.e. ensigera Manning (pers. comm.) has informed me that the type of *H. ensigera* is a dry specimen in the collection of the British Museum (Natural History). I have not had an opportunity to study the specimen.

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THE BENTHIC POLYCHAETA AND AMPHIPODA OF MORRO BAY, CALIFORNIA

By DONALD J. REISH AND J. LAURENS BARNARD¹

This paper records the present fauna of polychaete worms and amphipod crustaceans of Morro Bay, California, and reports upon their zoogeographic relationships to areas previously studied by the authors. Prior work in Morro Bay includes a study of the distribution of the wood-boring isopod *Limnoria* and the Nebaliacea (Menzies and Mohr, 1952) and amphipods (Barnard, 1952).

Although altered by dredging, the installation of wharfs, and the establishment of oyster farming, the environment of Morro Bay is of interest because of the sparsity of other embayments on the long coastline of central California. Previous studies on the benthic invertebrates of Californian bays and harbors include the following: Tomales Bay (Pitelka and Paulson, 1962), San Francisco Bay (Packard, 1918; Hartman, 1954a; Filice, 1954, 1958, 1959; Jones, 1961), Elkhorn Slough (MacGinitie, 1935), Los Angeles—Long Beach Harbors (Reish, 1959b), Alamitos Bay (Reish and Winter, 1954; Reish, 1961, 1963a), Newport Bay (Barnard and Reish, 1959), San Diego Bay (Anon., 1952), and Catalina Harbor, Santa Catalina

¹ Reish: Department of Biology, California State College, Long Beach, California; Barnard: Associate Curator, Division of Crustacea, Smithsonian Institution. Barnard's work completed at Beaudette Foundation, Moss Landing, California.

Island (Reish, 1964). All of these Californian embayments have been altered to some extent by man so that the aboriginal faunas are unknown; presumably the biotas have been modified by the introduction of cosmopolitan bay forms (Barnard, 1961), by means of shipping, oyster culture, and other transmitting agents.

DESCRIPTION OF MORRO BAY.—Morro Bay (fig. 1) lies on the southern middle portion of the California coast, just north of the

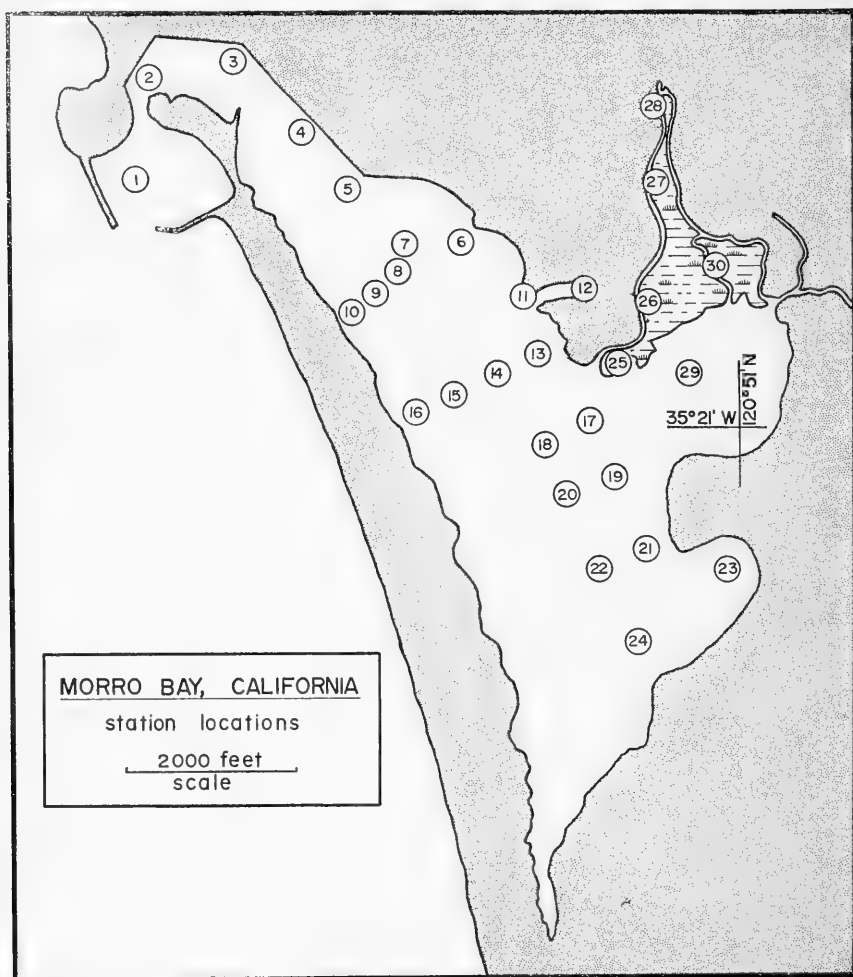


FIGURE 1.—Station locations of benthic survey, August 25, 1960.

zoogeographical boundary of Point Conception. Open-sea water temperatures approximate the southernmost extension of cold-temperate conditions and the rainfall is sufficient to permit a slight dilution of bay waters. This situation is in contrast to the embay-

ments south of Point Conception that belong with the warm-temperate, low-rainfall regime.

Except where dredging has deepened some channels, Morro Bay is exceedingly shallow; much of the bay floor is exposed during minus tides. Two streams drain into the bay: Chorro Creek enters the Bay through a channel in the marshland (Stations 28 to 25) and Los Osos Creek enters near Station 29. The triangular marshland, extending from Stations 28 to 25 and then landward to the right in figure 1, constitutes the Morro Bay State Park Bird Reserve. Changes by man in Morro Bay include the dredging of channels, the construction of a small boat harbor at Stations 11 and 12, dock facilities along the shore extending from about Stations 3 to 11, jetties at the Bay entrance, and fencing for oyster beds. Small docks have been built at other localities of the bay. No pollution is known to exist (Barrett, 1963). A steam-generating plant near Station 3 takes in sea water from this area for use in cooling condensers, but the water is discharged by a channel into the open sea north of the Bay.

Although Morro Bay is important as a port for both commercial and sport fisheries, only the oyster, accounting for a value of \$24,467 in 1961, is harvested directly from the bay. The total value of commercial landings for 1961 (Anon., 1963) was \$632,324, with abalone accounting for over one-third of the total. The history of oyster farming in Morro Bay has been summarized by Barrett (1963). The Pacific oyster, *Crassostrea gigas* (Thunberg), was first introduced from Japan to Morro Bay in 1932. The beds extend throughout much of the middle part of the bay from about the region of Station 5 to Stations 21, 22, and 29 (fig. 1).

MATERIALS AND METHODS.—Bottom samples, taken on August 25, 1960, from a small skiff using a size one Hayward orange-peel bucket (taking an area of $\frac{1}{16}$ sq. meter), were obtained from all stations indicated in figure 1 with the exception of Stations 1, 2, 5, and 6 where the substrate was a hard-packed sand. The samples were washed on shore through a size 24 screen (0.7 mm openings) and preserved in formalin diluted with seawater. The polychaetes and amphipods were separated from the other organisms by Mr. Harold Pope. The polychaetes were identified by Reish and the amphipods by Barnard. The dissolved oxygen, salinity, and water temperature were determined on August 26, 1960, from 14 representative stations at surface and deeper levels; each varied according to depth of water. The modified Winkler method was used for dissolved oxygen measurement (Barnes, 1959), and the chlorinity was determined by the Mohr method (Barnes, 1959). Water temperature was measured with a thermistor-type thermometer.

CHEMICAL AND PHYSICAL DATA.—Chlorinity was that of normal sea water throughout the sampled areas of Morro Bay. The chlorinity probably is lowered in the vicinities of Chorro and Los Osos Creeks during the winter rainy season.

Dissolved oxygen of the water ranged from 4.2 to 7.1 ppm with the lowest value measured at Station 10 and the highest at Station 25. The oxygen values of the deeper waters were generally slightly higher than those of the surface readings.

Temperature of the water ranged from 13.4° to 17.8° C on August 26, 1960. The lower measurements were recorded at the entrance of Morro Bay and the higher values at Stations 23, 25, and 26.

Sediments were not analyzed for particle size, but their condition was noted at the time of collection. In general, the sedimentary characteristics of Morro Bay may be divided into three categories. Sands predominate at the entrance of the bay and extend to about the region of stations 7 and 8. Fine sediments and extensive patches of eel-grass, *Zostera marina*, and sea lettuce, *Ulva* sp., occur throughout much of the rest of the bay. The sediments of Chorro Creek, especially at Stations 27 and 28, consisted primarily of gravels with a thin layer of silts and fine sands on top.

THE POLYCHAETE FAUNA

The polychaetes collected from the benthos of Morro Bay are listed in table 1 and are compared with those of other embayments of California and Baja California for which data are available. Of the 34 species taken, 18% or 55% also occur in San Francisco Bay. Less than 50% of the species are common with areas studied south of Morro Bay.

New distributional data are recorded for seven species. The northern distribution is herein extended for three species from southern California, namely, *Prionospio pygmaeus*, *Spiophanes missionensis* and *Pista alata*. *Cossura longocirrata* is extended southward from Vancouver. *Pseudopolydora kemp*i is reported from the eastern Pacific Ocean for the first time. With reservation, *Magelona papillicornis* is reported from the Pacific Ocean for the first time. *Chone infundibuliformis* was reported from Elkhorn Slough by Berkeley and Berkeley (1935). No endemic polychaete was found in Morro Bay. *Sphaerosyllis hystrix*, *Typosyllis fasciata*, *Boccardia polybranchia*, and *Spirorbinae* have not been reported previously from the bay environments in the eastern Pacific Ocean.

Four species account for over 70% of the 9127 specimens of polychaetes collected from the bay: *Capitella capitata* (2434), *Streblospio benedicti* (1999), *Heteromastus filiformis* (1078), and *Exogone lourei*

TABLE 1.—Comparison of the polychaetes from Morro Bay with those from other California bays

Species	San Francisco Bay ¹	Los Angeles Long Beach Harbors ²	Alamitos Bay ³	Newport Bay ⁴	Catalina Harbor ⁵	San Quintin Bay ⁶
<i>Anatides williamsi</i>	X	X	X	X		X
<i>Eteone californica</i>	X	X				
<i>E. dilatata</i>			X	X	X	X
<i>Hypocaulalia bilineata</i>		X				X
<i>Exogone lourei</i>				X	X	
<i>Sphaerosyllis hystrix</i>						
<i>Typosyllis fasciata</i>						
<i>Nereis latescens</i>	X	X				
<i>N. procera</i>	X	X	X	X	X	
<i>Platynereis bicanaliculata</i>	X	X	X	X	X	X
<i>Nephtys caecoides</i>	X	X	X	X		X
<i>Lumbrineris zonata</i>	X					
<i>Stauronereis articulata</i>		X	X	X	X	X
<i>Haploscoloplos pugettensis</i>	X	X	X	X	X	X
<i>Scoloplos acmeceps</i>	X				X	X
<i>Nerinides acuta</i>	X		X	X		
<i>Boccardia polybranchia</i>						
<i>P. ligni</i>	X		X		X	
<i>Prionospio cirrifera</i>	X	X	X	X	X	
<i>P. pygmaeus</i>						X
<i>Pseudopolydora kemp</i>						
<i>Streblospio benedicti</i>	X		X	X		
<i>Spiophanes missionensis</i>		X	X	X	X	X
<i>Magelona ? papillicornis</i>						
<i>Cossura longocirrata</i>						
<i>Ctenodrilus serratus</i>		X				
<i>Armandia bioculata</i>	X	X	X	X		X
<i>Capitella capitata</i>	X	X	X	X		X
<i>Heteromastus filiformis</i>	X					
<i>Axiiothella rubrocincta</i>	X	X		X	X	X
<i>Pista alata</i>			X	X	X	X
<i>Chone infundibuliformis</i>						
Spirorbinae						
Number of species in common	18	15	16	16	12	15
Percent in common	55	45	48	48	35	45

¹ Hartman, 1954a; Jones, 1961. ² Reish, 1959b, 1961. ³ Reish, 1961, 1963a. ⁴ Reish, 1959a. ⁵ Reish, 1964.⁶ Reish, 1963b.

(886). Of the 26 stations from which polychaetes were taken, *E. lourei* was present at 19, *H. filiformis* at 17, *C. capitata* at 15, and *S. benedicti* at 14.

The community structure of the polychaetes follows the general pattern of the sediment characteristics discussed above. The sandy

fauna is nearest the channel entrance and is dominated numerically by *Armandia bioculata*. The central part of the bay consists of fine sediments and is dominated numerically by *Heteromastus filiformis* and *Exogone lourei*. At individual stations *C. capitata* and *Pista alata* may occur in large numbers and thus alter the community structure. The Chorro and Los Osos Creeks fauna is dominated numerically by *S. benedicti* and *C. capitata*; these two species are known to be tolerant of brackish waters elsewhere (Woodwick, 1953).

Dr. Keith H. Woodwick, Fresno State College, identified the specimens of the genus *Polydora*, sensu lato, for which aid we are grateful.

Family Phyllodocidae

Anaitides williamsi Hartman

Anaitides williamsi Hartman, 1936, p. 126, figs. 33-35.—Reish, 1963b, p. 408.

MATERIAL.—Stations 9(1), 10(6), 11(3), 17(1), 19(1).

DISTRIBUTION.—Oregon to Baja California.

Eteone californica Hartman

Eteone californica Hartman, 1936, p. 131, figs. 43-46; 1961, p. 12.

MATERIAL.—Station 29(11).

DISTRIBUTION.—Central and southern California.

Eteone dilatata Hartman

Eteone dilatata Hartman, 1936, pp. 130-131, figs. 40-42.—Reish, 1963b, p. 408.

MATERIAL.—Stations 8(1), 12(1), 14(4), 16(1), 22(8), 25(14), 26(8), 30(2).

DISTRIBUTION.—Central California to Baja California.

Hypoeulalia bilineata (Johnston)

Phyllodoce bilineata Johnston, 1840, p. 227.

Eulalia bilineata (Johnston).—Pettibone, 1963, pp. 86-88, fig. 20.

Hypoeulalia bilineata (Johnston).—Hartman, 1961, p. 13.—Reish, 1963b, p. 423.

MATERIAL.—Stations 8(1), 11(4).

DISTRIBUTION.—British Columbia to southern California, Nova Scotia to North Carolina, Arctic Ocean, Europe, Japan, and South Africa.

Family Syllidae

Exogone lourei Berkeley and Berkeley

Exogone lourei Berkeley and Berkeley, 1938, pp. 44-47, figs. 6-10.—Reish, 1959b, p. 80.

MATERIAL.—Stations 7(1), 8(1), 9(31), 10(102), 11(7), 12(4), 13(1), 15(17), 16(260), 17(1), 18(18), 19(1), 21(1), 22(308), 23(22), 24(5), 26(2), 29(102), 30(2).

DISTRIBUTION.—British Columbia, California, and Acapulco, Mexico.

Sphaerosyllis hystrix Claparède

Sphaerosyllis hystrix Claparède, 1863, p. 45, pl. 13, figs. 36-37.—Berkeley and Berkeley, 1948, p. 80, fig. 119.—Hartman, 1961, p. 16.—Pettibone, 1963, pp. 136-137, fig. 35g.

MATERIAL.—Stations 9(6), 12(15), 16(12), 19(2), 20(1), 21(1), 22(150), 27(1).

DISTRIBUTION.—British Columbia to southern California, Connecticut, Europe.

Typosyllis fasciata (Malmgren)

Syllis fasciata Malmgren, 1867, p. 43, pl. 8, fig. 47.—Berkeley and Berkeley, 1948, pp. 74-75, figs. 109-110.

Syllis (*Typosyllis*) *fasciata*.—Pettibone, 1954, pp. 254-255, figs. 28 c-e.

Typosyllis fasciata (Malmgren).—Imajima and Hartman, 1964, pp. 135-136, pl. 33, figs. j-o.

MATERIAL.—Station 11(3).

DISTRIBUTION.—North Atlantic Arctic, Japan, China, Alaska south to southern California.

Family Nereidae

Nereis latescens Chamberlin

Nereis latescens Chamberlin, 1919, pp. 10-11.—Hartman, 1961, p.18.

MATERIAL.—Station 11(1).

DISTRIBUTION.—Central and southern California.

Nereis procera Ehlers

Nereis procera Ehlers, 1868, p. 557-559, pl. 23, fig. 2.—Reish, 1959b, pp. 81-82.

MATERIAL.—Station 24(2).

DISTRIBUTION.—Alaska to southern California.

Platynereis bicanaliculata (Baird)

Nereis bicanaliculata Baird, 1863, p. 109.

Platynereis bicanaliculata.—Hartman, 1954b, pp. 36-39, figs. 38-39.—Reish, 1963b, p. 424.

MATERIAL.—Stations 7(6), 8(6), 9(9), 10(3), 11(25), 12(1), 15(53), 18(7), 21(46), 22(6), 24(24), 26(9), 27(1), 29(1).

DISTRIBUTION.—Northeast Pacific Ocean from British Columbia to Baja California, Hawaii, Australia.

Family Nephtyidae

Nephtys caecoides Hartman

Nephtys caecoides Hartman, 1938b, pp. 148-149, fig. 63; 1950, pp. 101-102.

MATERIAL.—Stations 13(4), 17(1), 20(3), 22(2).

DISTRIBUTION.—British Columbia to Baja California.

Family Lumbrineridae

Lumbrineris zonata (Johnson)

Lumbriconereis zonata Johnson, 1901, pp. 408-409, pl. 9, figs. 93-100.

Lumbrineris zonata (Johnson).—Hartman, 1944a, pp. 146-147.

MATERIAL.—Stations 7(3), 8(1), 9(11), 10(21), 11(8), 12(1), 16(8), 17(2).

DISTRIBUTION.—Washington to Baja California.

Family Dorvilleidae

Stauronereis articulatus Hartman

Stauronereis articulatus Hartman, 1938a, pp. 101-102.

Dorvillea articulata Hartman, 1944a, p. 189.—Reish, 1963b, p. 426.

MATERIAL.—Stations 9(1), 10(3), 15(3), 16(2), 18(3), 21(1), 22(6), 24(4).

DISTRIBUTION.—Central California to Baja California.

REMARKS.—*Stauronereis* Verrill (1900) was re-established by Pettibone (1961). Pettibone (1963) placed *S. articulatus* in synonymy with *S. rudolphi* (Delle Chiaje), but we are retaining the name *S. articulatus* for the eastern Pacific population until detailed comparisons can be made with collections from European waters.

Family Orbiniidae

Haploscoloplos pugettensis (Pettibone)

Scoloplos elongata Johnson, 1901, pp. 412-413, pl. 10, figs. 105-110.

Haploscoloplos elongatus (Johnson).—Hartman, 1944b, p. 257; 1957, pp. 273-275, pl. 26, figs. 1-11.—Reish, 1963b, p. 426.

Scoloplos (*Scoloplos*) *pugettensis* Pettibone, 1957, p. 162.

MATERIAL.—Stations 11(3), 16(1), 17(2), 20(2).

DISTRIBUTION.—Alaska to Baja California.

REMARKS.—*Scoloplos elongata* Johnson, 1901, is a junior homonym of *S. elongata* Quatrefages, 1866. Pettibone (1957) renamed Johnson's species as *S. (Scoloplos) pugettensis*. Earlier Hartman (1944b) referred *S. elongata* Johnson to the genus *Haploscoloplos* Monro, 1933, because of the absence of thoracic uncini in this genus. Pettibone, in 1954 (p. 279) and again in 1957 (p. 160) indicated the difficulty in separating worn thoracic capillary setae in the genus *Haploscoloplos* from the thoracic uncini of the genus *Scoloplos*. This viewpoint was not followed by Hartman (1957) nor Berkeley and Berkeley (1958). We are therefore retaining the new name given by Pettibone, as required by the rules of nomenclature, and placing the species in the genus *Haploscoloplos*.

***Scoloplos acmeceps* Chamberlin**

Scoloplos acmeceps Chamberlin, 1919, pp. 15-16.—Hartman, 1957, pp. 282-283, pl. 30, figs. 1-7.

MATERIAL.—Stations 7(1), 8(1), 9(13), 10(81), 11(2), 19(2).

DISTRIBUTION.—Alaska south to Mazatlán, Mexico.

Family Spionidae

***Nerinides acuta* (Treadwell)**

Spio acuta Treadwell, 1914, pp. 199-201, pl. 11, figs. 14-20.

Nerinides acuta (Treadwell).—Hartman, 1941, pp. 294-296, pl. 45, figs. 1-8; pl. 47, fig. 29; 1954a, p. 10.

MATERIAL.—Stations 9(3), 10(45), 11(4), 12(1), 19(2), 22(15), 23(2), 27(6), 29(1).

DISTRIBUTION.—Central and southern California.

***Boccardia uncata* Berkeley**

Boccardia uncata Berkeley, 1927, p. 418, pl. 1, figs. 9-13.—Hartman, 1961, p. 28.

Polydora (*Boccardia*) *uncata*.—Berkeley and Berkeley, 1952, pp. 14-15, figs. 18-21.—Reish, 1963b, p. 427.

MATERIAL.—Stations 15(1), 16(23), 23(14), 24(10), 27(2).

DISTRIBUTION.—British Columbia to Baja California.

***Boccardia polybranchia* (Haswell)**

Polydora polybranchia Haswell, 1885, p. 275.

Polydora (*Boccardia*) *polybranchia*.—Berkeley and Berkeley, 1952, pp. 16-17, figs. 24-25.—Reish, 1959b, p. 38.

Boccardia polybranchia (Haswell).—Hartman, 1959, p. 375.

MATERIAL.—Station 25(130).

DISTRIBUTION.—Europe, Japan, Australia, British Columbia, and central and southern California.

***Polydora ligni* Webster**

Polydora ligni Webster, 1879, p. 119.—Hartman, 1941, pp. 309-310, pl. 48, figs. 47-49.—Berkeley and Berkeley, 1952, p. 19, figs. 31-33.

MATERIAL.—Stations 15(3), 21(2), 25(3), 27(14), 28(192), 30(33).

DISTRIBUTION.—Both sides of United States, British Columbia, Mexico.

***Prionospio cirrifera* Wiren**

Prionospio cirrifera Wiren, 1883, p. 409.—Berkeley and Berkeley, 1952, pp. 28-29, figs. 52-53.

MATERIAL.—Stations 23(1), 25(1).

DISTRIBUTION.—Europe, Arctic, India, Bering Sea to southern California.

***Prionospio pygmaeus* Hartman**

Prionospio pygmaeus Hartman, 1961, pp. 93-95.—Reish, 1963b, p. 427.

MATERIAL.—Stations 10(1), 15(1).

DISTRIBUTION.—This species was known previously only from southern California and Baja California.

Pseudopolydora kemp (Southern)

Polydora (*Carazzia*) *kemp* Southern, 1921 p. 636, pl. 28, fig. 20.—Fauvel, 1953, pp. 317–318, fig. 167 a-c.—Chlebovitch, 1961, pp. 199–200.

Polydora kemp.—Day, 1957, pp. 99–100.

Pseudopolydora kemp (Southern).—Hartman, 1959, p. 387.

MATERIAL.—Stations 10(44), 13(1), 17(1), 18(3), 19(2), 22(74), 25(1), 26(25), 27(29), 29(84), 30(2).

DISTRIBUTION.—India, Japan, Kurile Islands, and South Africa. This is the first report of the species from the eastern Pacific Ocean.

Spiophanes missionensis Hartman

Spiophanes missionensis Hartman, 1941, pp. 296–298, pl. 46, figs. 17–21.—Reish, 1963b, p. 427.

MATERIAL.—Station 12(1).

DISTRIBUTION.—Known previously from southern California to Baja California.

Streblospio benedicti Webster

Streblospio benedicti Webster, 1879, pp. 120–121.—Hartman, 1944b, p. 260; 1945, p. 34, pl. 6, fig. 4.

MATERIAL.—Stations 11(2), 12(45), 13(33), 14(3), 19(6), 21(5), 22(216), 23(2), 25(1), 26(437), 27(740), 28(43), 29(255), 30(211).

DISTRIBUTION.—New Jersey, Massachusetts, North Carolina, central and southern California.

Family Magelonidae

Magelona ?papillicornis (Müller)

?*Magelona papillicornis* (Müller).—fide Fauvel, 1927, pp. 64–65, fig. 22 a–k.

MATERIAL.—Station 4(1).

REMARKS.—This specimen comes closest to *M. papillicornis* (fide Fauvel, 1927), but since only one worm in poor condition was collected and since it has not been reported previously from the Pacific Ocean, it is referred to this species with reservation.

Family Cirratulidae

Cossura longocirrata Webster and Benedict

Cossura longocirrata Webster and Benedict, 1887, p. 743.—Berkeley and Berkeley, 1956, pp. 544–545.—Reish, 1965, p. 145.

MATERIAL.—Stations 12(41), 13(30), 26(1).

DISTRIBUTION.—North Atlantic, Maine, Russian Pacific, Bering and Chukchi Seas, and Washington. This record of the species from Morro Bay is a southern extension of its distribution in the eastern Pacific Ocean.

Family Ctenodrilidae

Ctenodrilus serratus (Schmidt)

Parthenope serratus Schmidt, 1857, p. 363, pl. 5, fig. 13.

Ctenodrilus serratus (Schmidt).—Fauvel, 1927, pp. 108–109, figs. 38a-e.—Hartman, 1961, p. 32.

MATERIAL.—Stations 11(2), 26(2).

DISTRIBUTION.—Cosmopolitan.

Family Ophelidae

Armandia bioculata Hartman

Armandia bioculata Hartman, 1938a, pp. 105–106, figs. 51–54.—Reish, 1963b, p. 428.

MATERIAL.—Stations 3(1), 7(62), 8(29), 9(78), 10(4), 11(9), 18(3), 19(1), 20(2), 21(1), 22(12), 26(11).

DISTRIBUTION.—Northern California to Baja California.

Family Capitellidae

Capitella capitata (Fabricius)

Lumbricus capitatus Fabricius, 1780, p. 279.

Capitella capitata (Fabricius).—Hartman, 1947, pp. 404–405, pl. 43, figs. 1–2.

MATERIALS.—Stations 7(166), 8(149), 10(1), 13(3), 18(179), 21(5), 22(25), 23(11), 24(2), 25(27), 26(190), 27(1628), 28(14), 29(5), 30(29).

DISTRIBUTION.—Cosmopolitan.

Heteromastus filiformis (Claparède)

Capitella filiformis Claparède, 1864, p. 509, pl. 4, fig. 10.

Heteromastus filiformis (Claparède).—Hartman, 1947, pp. 427–428, pl. 52, figs. 1–4.

MATERIAL.—Stations 8(42), 9(32), 10(181), 11(89), 12(23), 13(34), 14(1), 16(3), 17(44), 18(34), 19(101), 21(1), 22(173), 23(1), 25(5), 26(26), 29(288).

DISTRIBUTION.—Widely distributed in both hemispheres.

Family Maldanidae

Axiiothella rubrocincta (Johnson)

Clymenella rubrocincta Johnson, 1901, pp. 418–419, pl. 13, figs. 128–133.

Axiiothella rubrocincta (Johnson).—Berkeley and Berkeley, 1952, pp. 51–52, figs. 105–106.—Reish, 1963b, p. 429.

MATERIAL.—Stations 18(1), 20(1), 22(89).

DISTRIBUTION.—British Columbia to Baja California.

Family Terebellidae

Pista alata Moore

Pista (*Scionopsis*) *alata* Moore, 1909, pp. 273–275, pl. 9, figs. 48–51.

Pista alata.—Reish, 1963b, p. 430.

MATERIAL.—Stations 9(2), 12(1), 13(1), 15(15), 18(125), 20(1), 21(6), 22(31).

DISTRIBUTION.—Heretofore known only from southern California and San Quintin Bay, Baja California.

Family Sabellidae

Chone infundibuliformis Kröyer

Chone infundibuliformis Kröyer, 1856, p. 33.—Berkeley and Berkeley, 1952, p. 133, figs. 252–253.—Pettibone, 1954, pp. 338–339, figs. 39a–j.

MATERIAL.—Stations 7(7), 10(38), 11(29), 12(1), 14(2), 17(7), 18(1), 19(39), 20(69), 22(4).

DISTRIBUTION.—North Atlantic, Arctic, British Columbia, California.

Family Serpulidae

Subfamily Spirorbinae

MATERIAL.—Stations 12(3), 15(512), 16(3).

REMARKS.—No attempt was made to identify these specimens. Many were observed attached to blades of the eel grass *Zostera marina*.

THE AMPHIPOD FAUNA

In contrast to the other well-known bays of the Californias, Bahía de San Quintín and Newport Bay, the amphipod fauna of Morro Bay is characterized by several boreal elements and by a few species associated with brackish water. Although the waters of Morro Bay were not brackish at the time of this survey, the presence of *Corophium spinicorne* and the abundance of *C. uenoi* and *C. acherusicum* suggest a history of dilution. Of course these species may also be linked with environments which are abnormal in factors other than dilution, such as natural and artificial pollution and wide ranges in thermal regime. The boreal elements known to occur in the Morro Bay fauna, such as *Ampithoe lacertosa*, *Allorchestes angustus*, *Aoroides columbiae*, *Pontogeneia rostrata*, *Ampithoe valida*, and possibly *Eohaustorius washingtonianus*, which are lost or diminished in Newport Bay (Barnard, 1959) and Bahía de San Quintín (Barnard, 1964), may not be due so much to the supposed increase in average temperatures of the southern bays as they are to the greater yearly range of temperatures there.

An analysis of the ecological and zoogeographical distribution of the amphipod species encountered showed that all of the species have been derived from the open sea, or have had to find a pathway through it. Of all species encountered, *Corophium spinicorne* is the most firmly bound to estuarine conditions. Those species that are considered as primarily of estuarine habit, because of the absence or near absence of

their populations in the open sea at these latitudes, include *Corophium uenoi*, *Allorchestes angustus*, *Elasmopus rapax* (sensu stricto), *Ampithoe valida*, *Pontogeneia minuta*, and *Ampithoe longimana*. These are primarily confined to the innermost reaches of the bay, in or near marshland channels. Generally, they are also among the most abundant species of any of the samples, as the following ranked list of species and numbers of individuals in 26 samples shows: *Corophium uenoi* (1131), *Aoroides columbiae* (808), *Corophium spinicorne* (333), *Ampithoe lacertosa* (242), *Microdeutopus schmitti* (205), *Pontogeneia rostrata* (194), *Corophium acherusicum* (187), *Allorchestes angustus* (116). Note, however, that *Elasmopus rapax*, *Ampithoe valida*, *Pontogeneia minuta*, and *Ampithoe longimana* are rare in these samples. The discontinuity of many of the typical open-sea species from the sea to the inner reaches of Morro Bay is probably due to the unsuitable, coarse, sandy substrates, rapid tidal currents and lack of benthic algae at the seaward stations.

Species and genera known to occur in Bahía de San Quintín (table 2) that were not discovered in Morro Bay and that are considered to be absent because of geographic thermal differences are: *Acumino-deutopus*, *Rudilemboides*, *Lembos macromanus*, *Amphideutopus*, *Orchomene magdalenensis*, and *Pontogeneia quinsana*.

Other San Quintin species that, in the open sea, extend to the north of Morro Bay and probably are excluded from the estuary for reasons other than thermal structure are *Ampelisca compressa* and *Hyale frequens*. The absence of both species is striking and unexplainable.

The most unusual difference between Bahía de San Quintín and Morro Bay is in the species of *Ampelisca* that dominate the benthos; in San Quintin *Ampelisca compressa* is the dominant; this species occurs northward in the open sea to Puget Sound, Washington, but in Morro Bay (and in Tomales Bay, material at hand), the principal species is *A. cristata*. Both *A. compressa* and *A. cristata*, however, are known to occur in tropical Pacific and tropical Atlantic America, so that neither can be considered a warm or a cool-sea species. Other species of *Ampelisca* occur only incidentally in Newport Bay.

Although the plant is widespread in Morro Bay, stands of the eel-grass, *Zostera marina*, do not seem as dense in Morro Bay as in Bahía de San Quintín. That eel-grass is not so prominent in Morro Bay as in San Quintin is shown by the absence or low rank of *Hyale*, *Pontogeneia*, and *Erichthonius*, genera of amphipods which characterize the San Quintin eel-grass beds (Barnard, 1964). On the other hand, a relatively higher incidence of algae is indicated in Morro Bay by the high rankings of *Corophium*, *Aoroides*, and *Ampithoe*.

The influence of the dense populations associated with pilings in Newport Bay is now confirmed in comparing the fauna of that bay

with that of San Quintin Bay and Morro Bay. The bottom fauna at Newport has a number of highly ranked species (table 2) that apparently represent extravagants from the piling fauna: *Leucothoides pacifica*, *Colomastix pusilla*, *Jassa falcata*, and both species of *Podocerus*.

TABLE 2.—Dominant amphipods listed by rank according to their frequencies in Morro Bay, Newport Bay, and Bahía de San Quintín

Morro Bay (herein)	Newport Bay (Barnard, 1959, 1961)	Bahía de San Quintín (Barnard, 1964)
<i>Corophium uenoi</i>	<i>Elasmopus rapax</i>	<i>Ampelisca compressa</i>
<i>Aoroides columbiae</i>	<i>Acuminodeutopus heterurops</i>	<i>Erichthonius brasiliensis</i>
<i>Corophium spinicorne</i>	<i>Rudilemboides stenopropodus</i>	<i>Rudilemboides stenopropodus</i>
<i>Ampithoe lacertosa</i>	<i>Ampithoe plumulosa</i> ¹	<i>Acuminodeutopus heterurops</i>
<i>Microdeutopus schmitti</i>	<i>Ampithoe pollex</i>	<i>Hyale frequens</i> (as <i>nigra</i>)
<i>Pontogeneia rostrata</i>	<i>Leucothoides pacifica</i>	<i>Aruga holmesi</i>
<i>Corophium acherusicum</i>	<i>Corophium acherusicum</i>	<i>Microdeutopus schmitti</i>
<i>Allorchestes angustus</i>	<i>Corophium baconi</i>	<i>Paraphoxus obtusidens</i>
<i>Heterophoxus oculatus</i>	<i>Hyale frequens</i>	<i>Lembos macromanus</i>
<i>Ampelisca cristata</i>	<i>Paraphoxus spinosus</i>	<i>Amphideutopus oculatus</i>
<i>Photis brevipes</i>	<i>Erichthonius brasiliensis</i>	<i>Orchomene magdalenensis</i>
<i>Synchelidium shoemakeri</i>	<i>Colomastix pusilla</i>	<i>Corophium uenoi</i>
<i>Elasmopus rapax</i>	<i>Amphideutopus oculatus</i>	<i>Listriella melanica</i>
<i>Ampithoe valida</i>	<i>Corophium uenoi</i>	<i>Elasmopus rapax</i>
<i>Synchelidium rectipalmmum</i>	<i>Amphilochus neapolitanus</i>	<i>Uristes entalladurus</i>
<i>Batea transversa</i>	<i>Maera simile</i>	<i>Corophium baconi</i>
<i>Paraphoxus stenodes</i>	<i>Microdeutopus schmitti</i>	<i>Pontogeneia quinsana</i>
<i>Pontogeneia minuta</i>	<i>Jassa falcata</i>	<i>Corophium acherusicum</i>
<i>Ampithoe longimana</i>	<i>Podocerus brasiliensis</i>	<i>Paraphoxus heterocuspis</i>
<i>Corophium baconi</i>	<i>Podocerus fulanus</i>	<i>Ampithoe plumulosa</i>

¹ Table 1 of Barnard (1961) entry "4" should read *Ampithoe plumulosa* not *A. pollex*.

Family Ampeliscidae

Ampelisca cristata Holmes

Ampelisca cristata Holmes, 1908, pp. 507–508, figs. 16, 17.—Barnard, 1954a, pp. 26–29, pls. 17–18; 1959, p. 18.

MATERIAL.—Stations 10(1), 12(14), 20(5), 21(10), 22(2), 25(3).

DISTRIBUTION.—Caribbean Sea; eastern Pacific from Ecuador to Tomales Bay, Calif.

Family Ampithoidae

Ampithoe lacertosa Bate

Ampithoe lacertosa Bate, 1858, p. 362.—Gurjanova, 1951, pp. 895–897, fig. 622.—Barnard, 1954b, pp. 31–33, pls. 29–30.—Nagata, 1960, pp. 175–176, pl. 16, figs. 95–96.

MATERIAL.—Stations 9(29), 16(206), 18(7).

DISTRIBUTION.—Japan; Kodiak, Alaska to Magdalena Bay, Baja California.

Ampithoe longimana Smith

Ampithoe longimana Smith, 1873, pp. 563–564.—Barnard, 1959, pp. 36–37, pl. 12; 1964, p. 111.

MATERIAL.—Stations 9(1), 21(4).

DISTRIBUTION.—Atlantic coast of the United States and Bermuda; eastern Pacific Ocean only in bays (Morro Bay, Newport Bay, Bahía de San Quintín).

Ampithoe valida Smith

Ampithoe valida Smith, 1873, p. 563.—Barnard, 1954b, pp. 34–35, pl. 31.—Nagata, 1960, p. 176, pl. 16, figs. 97, 98.

MATERIAL.—Stations 26(6), 28(4).

DISTRIBUTION.—Atlantic coast of United States; Japan; eastern Pacific Ocean from Coos Bay, Oreg., to Morro Bay.

Family Aoridae

Aoroides columbiae Walker

Aoroides columbiae Walker, 1898, p. 285, pl. 16, figs. 7–10.—Barnard, 1954b, pp. 24–26, pl. 22; 1959, p. 33.—Nagata, 1960, p. 175, pl. 16, fig. 94.—Barnard, 1961, p. 180; 1964, p. 110.

MATERIAL.—Stations 7(15), 8(10), 9(473), 10(34), 15(8), 18(266), 21(1), 23(1).

DISTRIBUTION.—Puget Sound to Bahía de San Quintín, Baja California.

Microdeutopus schmitti Shoemaker

Microdeutopus schmitti Shoemaker, 1942, pp. 18–21, fig. 6.—Barnard 1959, pp. 32–33, pl. 9; 1961, p. 180; 1964, p. 110, chart 13.

MATERIAL.—Stations 15(114), 21(52), 24(39).

DISTRIBUTION.—Monterey Bay to Cape San Lucas, Baja California.

Family Bateidae

Batea transversa Shoemaker

Batea transversa Shoemaker, 1926, pp. 13–18, figs. 8–11.

MATERIAL.—Stations 15(5), 18(1).

DISTRIBUTION.—Southern California at Morro Bay, Catalina Island, and Point Loma.

Family Corophiidae

Corophium acherusicum Costa

Corophium acherusicum Costa, 1857, p. 232.—Shoemaker, 1947, p. 53, figs. 2, 3; 1949, p. 76.—Barnard, 1954b, p. 36; 1959, p. 38; 1961, p. 182; 1964, p. 111, chart 5.

MATERIAL.—Stations 9(1), 15(5), 16(143), 21(1), 23(37).

DISTRIBUTION.—Cosmopolitan in temperate and tropical waters, especially in bays and harbors.

Corophium baconi Shoemaker

Corophium baconi Shoemaker, 1934, pp. 356–359, fig. 1; 1949, p. 82.—Barnard, 1959, p. 38; 1961, p. 182; 1964, pp. 111–112, chart 16.

MATERIAL.—Station 15(4).

DISTRIBUTION.—Peru to the Bering Sea.

Corophium spinicorne Stimpson

Corophium spinicorne Stimpson, 1857, pp. 514–515.—Shoemaker, 1949, pp. 74–76, fig. 6.—Barnard, 1952, p. 33; 1954b, pp. 36–37.

MATERIAL.—Stations 26(327), 27(5), 28(1).

DISTRIBUTION.—Alaska to Morro Bay, Calif.

Corophium uenoi Stephensen

Corophium uenoi Stephensen, 1932, pp. 494–498, figs. 3, 4.—Barnard, 1952, pp. 28–32, pls. 8, 9; 1959, p. 39.—Nagata, 1960, p. 178.—Barnard, 1961, p. 183; 1964, p. 112, chart 16.

MATERIAL.—Stations 16(260), 17(3), 21(2), 22(1), 23(31), 26(18), 27(291), 28(517), 29(4), 30(4).

DISTRIBUTION.—Japan; Morro Bay to Bahía de San Quintín in the Californias.

Ericthonius sp. [cf. *brasiliensis* (Dana)]

MATERIAL.—Station 27 (1 juv.). Probably this specimen is the juvenile of *E. brasiliensis*. See Sars (1895, pl. 215) for illustration and Barnard (1959 and 1964) for references and distribution of this species.

DISTRIBUTION.—Cosmopolitan (except in polar regions) in bays and harbors and the open-coast intertidal.

Family Eusiridae

Pontogeneia minuta Chevreux

Pontogeneia minuta Chevreux, 1908, pp. 1–3, fig. 1.—Barnard, 1959, p. 23, pl. 3; 1964, p. 106, figs. 21 B, C.

MATERIAL.—Stations 26(4), 27(1).

DISTRIBUTION.—In the Pacific found in Morro Bay, Newport Bay, and Bahía de San Quintín, Baja California. The identification of the Pacific forms with Chevreux's species is open to question.

Pontogeneia rostrata Gurjanova

Pontogeneia rostrata Gurjanova, 1938, p. 330, fig. 39.—Barnard, 1962b, p. 81.

MATERIAL.—Stations 4(1), 9(87), 10(21), 15(5), 18(79).

DISTRIBUTION.—Bering Sea, Okhotsk Sea, Japan Sea to Bahía de San Quintín, Baja California.

Family Gammaridae

Elasmopus rapax Costa

Elasmopus rapax Costa, 1853, p. 175.—Sars, 1895, pp. 521–522, pl. 183.—Shoemaker, 1942, p. 12.—Barnard, 1959, pp. 23–24; 1962b, pp. 94–96, figs. 16, 17, 1964, p. 108, chart 9.

MATERIAL.—Stations 27(9), 28(1).

DISTRIBUTION.—Pantropical with penetration to warm-temperate and rarely cold-temperate waters in the northeastern Atlantic. This is a bay form; however, an open-sea Californian form has been described by Barnard (1962b).

Family Haustoriidae

Eohaustorius washingtonianus (Thorsteinson)

Haustorius washingtonianus Thorsteinson, 1941, pp. 61–62, pl. 4, figs. 39–51.

Eohaustorius washingtonianus Barnard, 1957, p. 82, pl. 16.—Gurjanova, 1962, pp. 404–405, fig. 135.

MATERIAL.—Station 4(2).

DISTRIBUTION.—Puget Sound to just southeast of Point Conception, Calif.

Family Hyalidae

Allorchestes angustus Dana

Allorchestes angustus Dana, 1856, p. 177.—Barnard, 1952, pp. 20–23, pl. 5, figs. 2–6; 1954b, pp. 21–23, pl. 21; 1959, p. 28.

MATERIAL.—Stations 16(33), 26(77), 28(6).

DISTRIBUTION.—Japan; Coos Bay, Oreg., to Newport Bay, Calif.

Family Ischyroceridae

Jassa falcata (Montagu)

Jassa falcata (Montagu).—Sexton and Reid, 1951, pp. 30–47, pls. 4–30 (with synonymy).—Barnard, 1959, p. 37; 1964, p. 118.

MATERIAL.—Station 9(1).

DISTRIBUTION.—Cosmopolitan in cold-temperate and tropical waters, especially in bays and harbors.

Family Oedicerotidae

Synchelidium rectipalmum Mills

Synchelidium rectipalmum Mills, 1962, pp. 17-19, fig. 5.

MATERIAL.—Stations 15(3), 21(4), 22(1).

DISTRIBUTION.—British Columbia to middle Baja California.

Synchelidium shoemakeri Mills

Synchelidium shoemakeri Mills, 1962, pp. 15-17, fig. 4.

MATERIAL.—Stations 7(1), 14(1), 20(10).

DISTRIBUTION.—British Columbia to middle Baja California.

Family Photidae

Photis brevipes Shoemaker

Photis brevipes Shoemaker, 1942, pp. 25-27, fig. 9.—Barnard, 1962a, pp. 31-33, fig. 11.

MATERIAL.—Stations 7(1), 8(2), 9(24), 12(3), 18(3).

DISTRIBUTION.—Coos Bay, Oreg., to Magdalena Bay, Baja California.

Family Phoxocephalidae

Heterophoxus oculus (Holmes)

Harpinia oculata Holmes, 1908, pp. 521-523, fig. 28.

Heterophoxus oculus (Holmes).—Barnard, 1960, pp. 320-324, pls. 59-61; 1964, p. 102.

MATERIAL.—Stations 12(5), 15(66), 16(2), 24(25).

DISTRIBUTION.—Puget Sound to Panama, an open-sea deep-water species, 13-1785 meters, occasionally penetrating shallow bays such as Morro Bay and San Quintin Bay.

Paraphoxus epistomus (Shoemaker)

Pontharpinia epistoma Shoemaker, 1938, pp. 326-329, fig. 1.

Paraphoxus epistomus (Shoemaker).—Barnard, 1960, pp. 205-209, pls. 6-8.

MATERIAL.—Station 14(1).

DISTRIBUTION.—Mendocino County, Calif., to Panama; Atlantic Ocean from New Hampshire to South Carolina.

Paraphoxus spinosus Holmes

Paraphoxus spinosus Holmes, 1905, pp. 477-478, fig. 12.—Barnard, 1959, p. 18; 1960, pp. 243-249, pls. 29-31; 1964, p. 105.

MATERIAL.—Station 14(1).

DISTRIBUTION.—Western Atlantic Ocean; Pacific Ocean from Puget Sound to the Gulf of California.

Paraphoxus stenodes Barnard

Paraphoxus stenodes Barnard, 1960, pp. 221-224, pls. 17, 18.

MATERIAL.—Stations 4(2), 14(1), 20(2).

DISTRIBUTION.—Point Conception, Calif., to San Cristobal Bay, Baja California.

Miscellaneous Amphipod Specimens

Ampithoe species, juveniles

MATERIAL.—Stations 9(9), 10(1), 15(5), 17(1), 23(1), 24(1), 27(2).

Corophium species, juveniles

MATERIAL.—Stations 7(2), 9(1), 16(10), 18(1), 21(1), 23(3), 24(1), 27(32), 28(36).

Erichthonius species, juveniles

MATERIAL.—Station 27(1).

Photis species, juveniles

MATERIAL.—Stations 10(2), 15(3).

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SUPPLEMENTARY DESCRIPTION OF THE MYODOCOPID OSTRACOD *EUPHILOMEDES MULTICHELATA* FROM THE GREAT BAHAMA BANK

By LOUIS S. KORNIKER

Associate Curator, Division of Crustacea

The original description of *Philomedes multichelata* Kornicker, 1959, was based solely on males collected in the vicinity of the Bimini Islands, Great Bahama Bank. Some details of the carapace and appendages, of value in taxonomic classification, were not included in the original description. To remedy these omissions, the holotype and paratypes have been restudied and described more completely in this paper. In addition, a female of the species, obtained from sediment in the Bimini area, is described and illustrated.

E. M. Poulsen (1962, p. 343) proposed the genus *Euphilomedes* for species of the subfamily Philomedinae having the following diagnostic characters: Maxilla with three endites; some of the secondary claws of the furca alternating with main claws; frontal organ not ringed, and shell without small horns at dorsal margin. *Philomedes multichelata* Kornicker, 1959, which agrees with the above diagnosis, is herein referred to *Euphilomedes*.

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Family Cypridinidae Baird, 1850

Subfamily Philomedinae G. W. Müller, 1912

Genus *Euphilomedes* Poulsen, 1962

Philomedes (part).—Müller, 1912.—Skogsberg, 1920.
Euphilomedes Poulsen, 1962.

TYPE SPECIES.—*Euphilomedes nodosa* Poulsen, 1962, by subsequent designation, Kornicker (1967).

GENERIC CHARACTERS.—Only a few additions are needed to Poulsen's diagnosis of the genus (1962, pp. 359–361) as amended by Kornicker (1967) to include *E. multichelata*.

Sixth limb: The end joint of *E. multichelata* is comprised of two lobes; the proximal lobe bears a short, slender, hirsute bristle followed by three stout, plumose bristles.

Seventh limb: The male of *E. multichelata* bears only five bristles on the seventh limb (4 distal, 1 lateral), the same number as reported on *E. oblonga* (Juday, 1907).

Euphilomedes multichelata (Kornicker, 1959)

FIGURES 1–6

Philomedes multichelata Kornicker, 1959, pp. 230–232, figs. 46, 3A, B; 50, A–E; 51, A–D.

HOLOTYPE.—Specimen no. 686Z–6, Columbia University, Department of Geology. Gender: male.

PARATYPES.—USNM 112940, 10 males.

HYPOTYPE.—USNM 112985, 1 female.

TYPE LOCALITY.—Holotype and paratypes were collected at night off the end of the Lerner Marine Laboratory on North Bimini, B.W.I. The female described in this paper (USNM 112985) was from sediment approximately a mile east of the Bimini Islands.

DIAGNOSIS (revised).—*Euphilomedes* with five primary claws and six to nine (usually eight) secondary claws. Second joint of exopodite of sixth limb bilobed, with small bristle followed by three large bristles on proximal lobe. Seventh limb of male with one lateral and four distal bristles. Anterior surface of valves with irregular polygons distributed in shingle-like pattern.

DESCRIPTION OF MALE.—Shell (figs. 1, 3*l*): oval, elongate with greatest height near middle, prominent rostrum and broad rostral incisure (figs. 1*a*, *b*); anterior margin of rostrum and anteroventral margin of shell with scalloped outline formed by crescent-like marginal denticulations. Anterior surface of valves with irregular polygons distributed in shingle-like pattern (fig. 1*c*). Posterior dorsal margin with linear hinge depressed below outline of shell; hinge not visible

in lateral view except by transmitted light. Posterior hinge element of each valve consisting of angular sclerotized process (figs. 1e, h); medial hinge element straight; anterior hinge element not prominent. Left valve broadly overlapping right valve along anterodorsal margin (fig. 1b). Fifteen or more individual muscle scars clustered near middle of valve (fig. 1a); large scar situated some distance above others.

Inner lamella broad, terminating at each end of dorsal hinge. Line of concrescence about half-way between middle and outer margin of inner lamella. Selvage with wide, corrugated, lamellar prolongation, having fringe of slender spines along outer margin; no parallel striations observed on inner lamella. Six or seven long hairs, some bearing secondary spines, forming row on inner lamella behind rostrum (figs. 1d, i); inner lamella below rostrum with small hair followed by wide space and then about four hairs (fig. 1f); about 16 hairs on posteroventral part of inner lamella (figs. 1e, h).

Marginal pore canal with minute tapered hair between first and second crescent-like denticulation on anteroventral margin of rostrum; another pore canal with minute hair near 12th to 15th denticle (figs. 1d, i). Additional marginal pore canals more or less evenly spaced along ventral and posteroventral margin. Hairs with either pointed or blunt ends distributed on rostral surface (fig. 1g), some forming row near margin of shell; long slender hairs with pointed ends forming row that is closer to edge posteriorly and is near ventral and posteroventral margins of valves; additional hairs coming from normal pore canals; a long tapered hair projects backward from base immediately behind posterior hinge element of each valve (figs. 1e, h).

Dimensions: Holotype length 1.04 mm, height 0.60 mm, width 0.57 mm. Length of specimens ranges between 0.96–1.04 mm (Kornicker, 1959, p. 231).

First antenna (fig. 2a): First joint with about seven clusters of short hairs on lateral surface. Second joint with clusters of long hairs on medial surface; spines projecting from ventral margin and distally with a dorsal and lateral bristle; a distal ventral bristle observed only on one of five specimens examined; all bristles bare or with short hairs distally, none with wreaths of long hairs. Third joint with one ventral and two dorsal bristles, the longer dorsal bristle provided with wreath of long hairs near middle and short hairs distally; other dorsal bristle bare or with short hairs distally; ventral bristle with short hairs on most specimens. Fourth joint with two dorsal bristles, each with wreaths of long hairs, and one short and three long ventral bristles subdistally; bristles bare or with short hairs distally. Fifth joint inferred to be inserted ventrally between

fourth and sixth joints, bearing sensory bristle with broad base and provided with numerous filaments. Sixth joint bears distally a long dorsal bristle, which is bare or with short hairs distally. End joints with five slender bristles and two long stout c- and f-bristles.

Second antenna (figs. 2*b*, *c*): Exopodite: first joint elongate with small medial spine distally; second joint about one-third length of first; third joint about twice length of second; distal margins of second to eighth joints with medial comb of short spines; basal spines not observed. First joint without bristle; bristle of second joint about three-fourths length of joint, bearing short marginal spines. Bristles on joints three to eight bearing natatory hairs, without marginal spines. End joint provided with four stout bristles with natatory hairs, and two short slender bristles without hairs. Endopodite 3-jointed; first joint with five short basal bristles and one long distal bristle, all bare, except for single spine observed near middle of long bristle on some specimens; second joint elongate, with two bristles provided with short spines (one specimen had three bristles on one appendage only); third joint elongate, arcuate, with two short bare annulate bristles and about five serrated ridges near tip (appendage which had three bristles on second joint had only one short bristle near tip of third joint).

Mandible (figs. 2*d-f*): No coxale endite. Basale: ventral margin with four short slender bristles with short spines, and two long bristles with wreaths of long hairs. Dorsal margin with three bristles, one near middle and two at distal corner, middle bristle and one of two at distal corner bearing short spines distally. Medial surface with five short bristles proximally near ventral corner and one short bristle at middle near ventral margin. Exopodite (fig. 2*e*) almost reaching middle of first endopodite joint with two terminal bristles, distal about one-half length of proximal bristle, both with short hairs distally on some specimens; tip of joint with blunt hirsute process. Endopodite: first joint with one bare short bristle and three long hirsute ventral bristles distally. Second joint dorsal margin with proximal group of two, and distal group of six bare bristles; ventral margin with two bare bristles distal to middle, one short annulate bristle, and two clawlike bristles subdistally. End joint (fig. 2*f*) with two large subequal claws, one short dorsal claw, and three bare annulate bristles. Medial surfaces of basale and first and second joints of endopodite provided with groups of hairs.

Maxilla (figs. 2*g*, *h*): Very small. Exopodite with one proximal and two distal bristles; proximal bristle bare, annulate, about one-third length of longest distal bristle; longest distal bristle with hairs, annulate, longer than combined length of second and third joints of endopodite; second distal bristle nonannulate, semitransparent, with

few stiff spinelike hairs, about one-half length of other distal bristle. Coxale with bare, annulate anterior bristle distally. Three small endites, each with about five bare, nonannulate, semitransparent bristles (crowding of bristles makes accurate count difficult); one bare, annulate bristle about same length as proximal bristle of exopodite, located near base of third endite. Anterodistal end of basale with long, stout, annulate bristle with long hairs; posterodistal end with bare, nonannulate, semitransparent bristle. Distal ends of first and second endopodite joints with about 14 bare, nonannulate semitransparent bristles; one bare, nonannulate, semitransparent bristle located medially near middle of first endopodite joint; second semitransparent bristle located medially on distal margin. Surface of endopodite and basale with long hairs; precoxal with fringe of long hairs along anterior margin; endopodite surface with short spines.

Fifth limb (figs. 3*a*, *b*): Epipodial appendage with about 39 plumose bristles. First endite with two bare bristles, one long; second endite with one long, stout bristle and about four shorter, semitransparent bristles of varying length, all bare; third endite with one long, stout, annulate bristle provided with short hairs, and about eight bare, shorter, semitransparent bristles. First exopodite joint with about seven bare, semitransparent bristles; second exopodite joint with one broad bladelike and three or four stubby, semitransparent bristles, all bare; third exopodite joint with long, annulate, plumose bristles on outer lobe and about three bare, semitransparent bristles of unequal lengths on inner lobe; end joints with about six bristles, two longest bristles hirsute, annulate, one stout bristle also annulate, but without hairs, remaining three bare and semitransparent.

Sixth limb (fig. 3*c*): Protopodite: first endite with one bristle, bare or with short spines; second endite with one bare, proximal bristle and three terminal bristles; third endite with six terminal bristles, three medial, three lateral; fourth endite with five bristles. Second joint of exopodite narrow with two lobes, distal lobe provided with five stout plumose bristles, proximal lobe with three stout, plumose bristles followed by one short bristle; no bristles in place of epipodial appendage. Surface with clusters of short hairs; joint separations not well marked.

Seventh limb (figs. 3*d*, *e*): Cleaning bristles: four in distal group, two ventral, two dorsal, each with two to four bells; one proximal bristle with two or three bells; bristles bare or with short marginal spines. Terminal comb: fan shaped with marginal teeth (in side view teeth difficult to see, and fan gives false appearance of being single large tooth). One small fan-shaped comb with slender marginal spines on each side of terminal comb. Long slender peg with rounded end, and sharp spine opposite terminal comb.

Copulatory organ (fig. 3*i*): Long, slender, divided into three lobes, each hirsute with two annulate bristles; one lobe with large curved tooth.

Furca (figs. 3*f-h*): Each lamella with 12 to 14 (usually 13) claws consisting of 5 primary and 7 to 9 secondary claws; primary claws numbers 1 and 2 followed by 3 to 5 (usually 4) secondary claws, 1 primary claw, 3 to 5 (usually 4) secondary claws, and finally 2 small primary claws; medial and lateral rows of teeth on first 3 primary claws; lateral sides of proximal 2 primary claws each with comb of

TABLE 1.—*Distribution of primary (P) and secondary (S) claws on furcal lamellae*

Specimen	Claw														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
686Z-A Left	P	P	S	S	S	S	P	S	S	S	S	P	P		13
Right	P	P	S	S	S	S	P	S	S	S	S	P	P		13
686Z-12 Left	P	P	S	S	S	S	P	S	S	S	S	P	P		13
686Z-13 Left	P	P	S	S	S	S	P	S	S	S	S	P	P		13
Right	P	P	S	S	S	S	S	P	S	S	S	S	P	P	14
686Z-14 Left	P	P	S	S	S	S	P	S	S	S	P	P			12
Right	P	P	S	S	S	P	S	S	S	S	P	P			12
686Z-4 ?	P	P	S	S	S	S	P	S	S	S	S	S	P	P	14
686Z-B Left	P	P	S	S	S	S	P	S	S	S	S	P	P		13
Right	P	P	S	S	S	S	P	S	S	S	S	P	P		13
686Z-R Left	P	P	S	S	S	S	P	S	S	S	S	P	P		13
Right	P	P	S	S	S	S	P	S	S	S	S	P	P		13
686Z-J Left	P	P	S	S	S	S	P	S	S	S	S	P	P		13
Right	P	P	S	S	S	S	P	S	S	S	S	P	P		13
686Z-H Left	P	P	S	S	S	S	P	S	S	S	S	P	P		13
Right	P	P	S	S	S	S	P	S	S	S	S	P	P		13
686Z-K Left	P	P	S	S	S	S	P	S	S	S	S	P	P		13
Right	P	P	S	S	S	S	S	P	S	S	S	S	P	P	14
686Z-L Left	P	P	S	S	S	S	P	S	S	S	S	P	P		13
Right	P	P	S	S	S	S	P	S	S	S	S	P	P		13

short spines extending obliquely onto lamella; secondary claws with spines along anterior and posterior margins. Primary claw number 1 with cluster of long hairs near base; lateral surface of each lamella with numerous clusters of short hairs. The distribution of primary and secondary claws on several specimens is shown in table 1.

Eyes: Lateral eyes large; about 17 ommatophores visible in side view, each weakly divided by a suture into two parts (fig. 3*k*). Medial eye pigmented (fig. 3*j*).

Frontal organ (fig. 3*j*): Elongate, two jointed; short spines on surface of end joint and distal end of basal joint.

DESCRIPTION OF FEMALE.—Shell (figs. 4, 5*a,b*): oval in lateral view, highest near middle, widest behind middle; prominent rostrum, broad rostral incisure (figs. 4*a-c*). Rostrum anterior margin and shell anteroventral margin with scalloped outline formed by crescent-like marginal denticulations of flange (figs. 4*f*, 5*b*). Posterior one-third of dorsal margin with linear hinge depressed below outline of shell (fig. 4*i*); posterior hinge element of each valve with angular sclerotized process; straight medial hinge element; anterior hinge element not prominent. Left valve broadly overlaps right valve along antero-dorsal margin (fig. 4*b*). Numerous muscle scars in front of middle of valve, located more anterior than on male (figs. 4*a*, *e*). Shell surface with irregular polygons distributed in shingle-like pattern, anterior to muscle scars (figs. 4*e*, 5*a*).

Inner lamella broad, with vestibule; line of concrescence (identified as inner margin of clear zone of inner lamella) near middle of inner lamella anteriorly and ventrally, coming closer to outer margin posteriorly (figs. 4*f-h*). Selvage with wide, corrugated, lamella prolongation with fringe of slender spines along margin. Faint striations along anteroventral inner lamella. About six long hairs, bearing secondary spines, in row on inner lamella behind rostrum (figs. 4*f*, 5*b*). Small tapered hair on inner lamella below rostrum (figs. 4*f*, 5*b*) followed by four hairs with secondary spines. Numerous tapered hairs on posteroventral part of inner lamella (fig. 4*g*). Numerous radial pore canals and false radial pore canals along anterior, ventral, and posterior margins (figs. 4*f-h*). Hairs with blunt and pointed ends (fig. 4*d*), scattered on rostral surface; tapered hairs of various lengths in row along ventral and posteroventral margins; additional hairs in normal pore canals, scattered over shell surface. Long tapered hair projecting backward from behind posterior hinge element of each valve (fig. 4*g*).

Dimensions: Length 1.07 mm, height 0.66 mm, width 0.51 mm.

First antenna (fig. 5*c*): First and second joints with surface hairs. Second joint with distal bristles, one dorsal, one lateral bristle. Third joint with one ventral and one dorsal bristle, dorsal bristle with short hairs. Fourth joint with two dorsal bristles and one short and two long bristles near ventrodistal corner. End joints with eight bristles.

Second antenna (figs. 5*d-h*): Exopodite with nine joints (fig. 5*e*); first joint elongate without bristle; second to ninth joints trapezoidal decreasing in width distally, without basal spines. Distal margin of second joint only with comb of long spines or stiff hairs (fig. 5*h*). Second and third joints each with bristles with denticulation along ventral margin, no natatory hairs (fig. 5*g*); fourth to eighth joints with long bristles with natatory hairs; ninth joint with four bristles (fig. 5*f*): long bristle with natatory hairs; shorter bristles bare, one about one-

third length of long bristles, two extremely short. Endopodite with two joints (fig. 5*d*): basal joint with a long stout bristle with wreath of hairs and a short, bare annulated bristle (additional bristles normally present on this joint in subfamily were not observed); distal joint elongate with stout terminal bristle with wreath of long hairs near middle.

Mandible (figs. 5*i*, *j*): Coxal endite large, bifurcate, with rows of spines. Basale: ventral margin of left appendage with four short bristles followed by one long bristle near distal end; right appendage with two additional bristles near middle (fig. 5*j*), one with base on medial side, other on lateral side; dorsal margin of both appendages with three bristles, one near middle and two at distal corner; medial surface with one bristle at middle near ventral margin and four shorter bristles near proximoventral corner; short spines and long hairs on ventral margin near proximal end. Exopodite short with two bristles and hairy process at tip, inner bristle with short marginal hairs. Endopodite: distal end of first joint with two long and two short bristles ventrally; dorsal margin of second joint with proximal group of two and distal group of about five bristles; ventral margin with two subdistal bristles and distally with one short, annulate bristle and two clawlike bristles; distal joint with two long, stout claws of subequal length and three bare, annulate bristles. Medial surface of basale and second joint of endopodite with hairs.

Maxilla (figs. 5*k*, 6*a-c*): Precoxa and coxa with marginal fringe of fine hair, anterior margin of coxa with one short, bare, annulate bristle. Basale with three distal bristles: anterior bristle with wreaths of long hairs, medial bristle bare, posterior bristle broken off at base of specimen examined. Anteroventral margin of first endopodite joint with annulate bristle with wreath of hairs near middle and marginal hairs. Terminal end of endopodite with 13 bristles (fig. 6*b*). Exopodite with two long bristles and one short bristle (fig. 5*k*). Three endites (fig. 6*c*): first endite with six bristles; second endite with four bristles; third endite with six distal bristles and one proximal bristle.

Fifth limb (figs. 6*d-f*): Main tooth of first joint of exopodite comprised of several constituent teeth (fig. 6*d*): distal tooth rectangular; following tooth longer, slender with few low secondary teeth; next tooth shorter than distal tooth, slender, pointed with few secondary teeth proximally; next tooth short, bare. Spine with row of secondary spines along dorsal margin following fourth tooth. Triangular tooth anterior to rectangular distal tooth low, curving upward. Distal margin of first joint with two centrally located bristles with wreath of stiff hairs near middle; lateral margin with low node, bearing short bristle with wreath of stiff hairs near middle (fig. 6*d*). Second joint with large tooth with low crenulations along inner curvature; two

bristles on base near posteroproximal margin, one spinose, one bare (fig. 6e). Third joint with two long, plumose bristles on outer margin and two or three on inner margin. End joints with about seven bristles. Endites with numerous bristles.

Sixth limb (figs. 6g-h): Protopodite: first endite with one short, annulated, bare bristle; second endite with three terminal bristles with wreath of stiff hairs near middle, and one short, annulated, bare bristle on posterior margin; third endite with six terminal bristles, all with wreath of stiff hairs near middle; fourth endite of left sixth limb with five bristles, all with wreath of stiff hairs near middle, right sixth limb with bifurcating bristle resulting in total of six bristles on endite (fig. 6h). Second joint of exopodite with two distinct lobes; distal lobe with five bristles on left sixth limb, six on right, all with wreaths of stiff hairs; proximal lobes on both limbs with three long, stout, plumose bristles followed closely by one short, bare, annulate bristle.

Seventh limb (fig. 6i): Quite similar to male. Terminal comb consisting of fan with marginal teeth, in side view appearing as large single tooth. Small fan with marginal teeth located on each side of terminal comb. Slender peg and sharp spine opposite comb. Four of five distal bristles and one proximal bristle; bristles bare or with short marginal spines distally.

Frontal organ (fig. 6j): 2-jointed; apparent additional joints near proximal end probably resulting from wrinkles and folds.

Eyes (fig. 6j): Median eye well developed, pigmented; lateral eyes absent.

Furca: Missing from specimen.

Eggs: About five oval eggs in brood pouch.

REMARKS.—*Euphilomedes multichelata* is closely related to *Euphilomedes oblonga* (Juday, 1907). Specimens of the latter were unavailable for study. According to the description and figure by Juday (1907, p. 145, pl. 20, fig. 6), *E. oblonga* has fewer secondary claws (5 claws) on the caudal furca than *E. multichelata* has. In order to determine whether the difference in number of secondary claws could be due to variability in that character, the number of secondary claws on the furca was counted on 11 specimens of *E. multichelata* (table 1). No specimen examined had fewer than seven secondary claws, most had eight, a few nine; consequently it is concluded that *E. multichelata* and *E. oblonga* are distinct.

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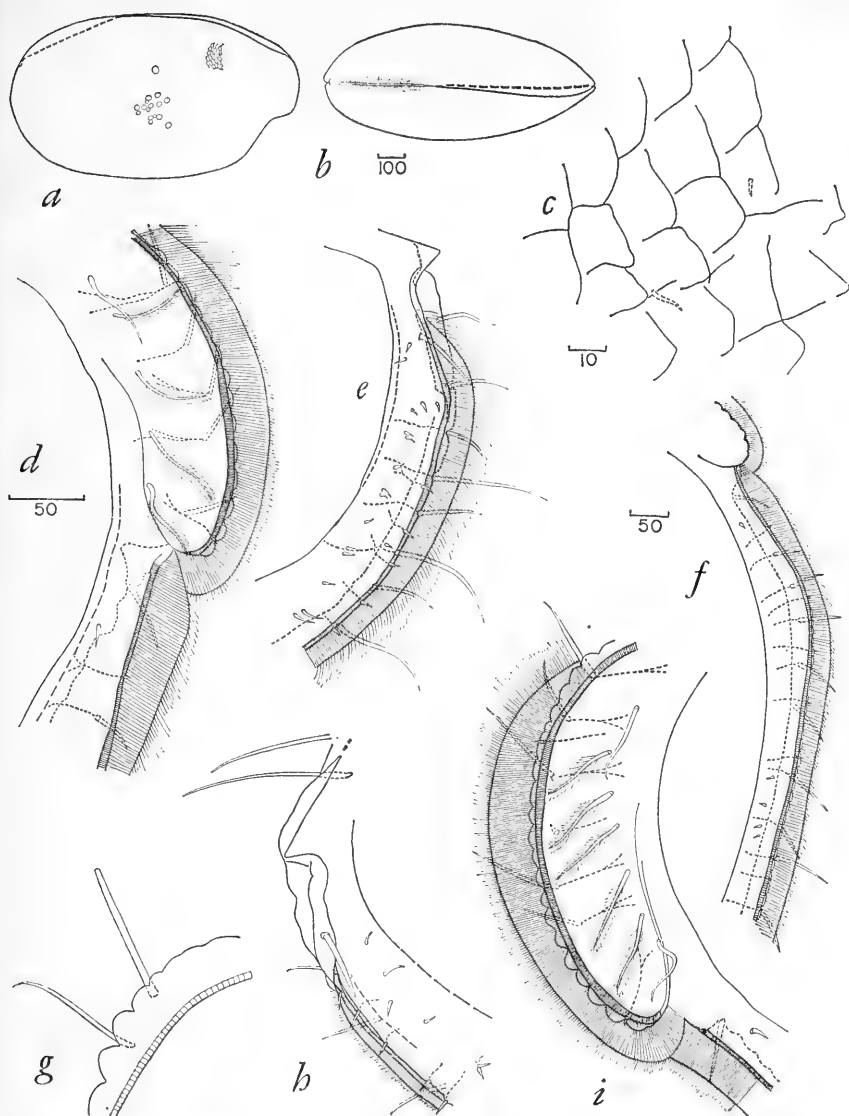


FIGURE 1.—*Euphilomedes multichelata*, male: *a*, right lateral view, showing position of muscle spots and scalelike appearance of reticulations on anterior part of shell (holotype); *b*, dorsal view of shell, anterior on right (holotype); *c*, detail of surface pattern, anterior part, right valve from inside (686Z-12); *d*, medial view, anterior extremity, left valve (686Z-13); *e*, medial view, posterior extremity, right valve (686Z-12); *f*, medial view, anteroventral margin, left valve (686Z-13); *g*, detail of blunt, tapered hair on rostrum of right valve from inside (686Z-12); *h*, medial view, posterodorsal part, left valve (686Z-13); *i*, medial view rostrum, right valve (686Z-13). (Same scale, in microns: *a*, *b*; *c*, *g*; *d*, *e*, *h*, *i*; *f*.)

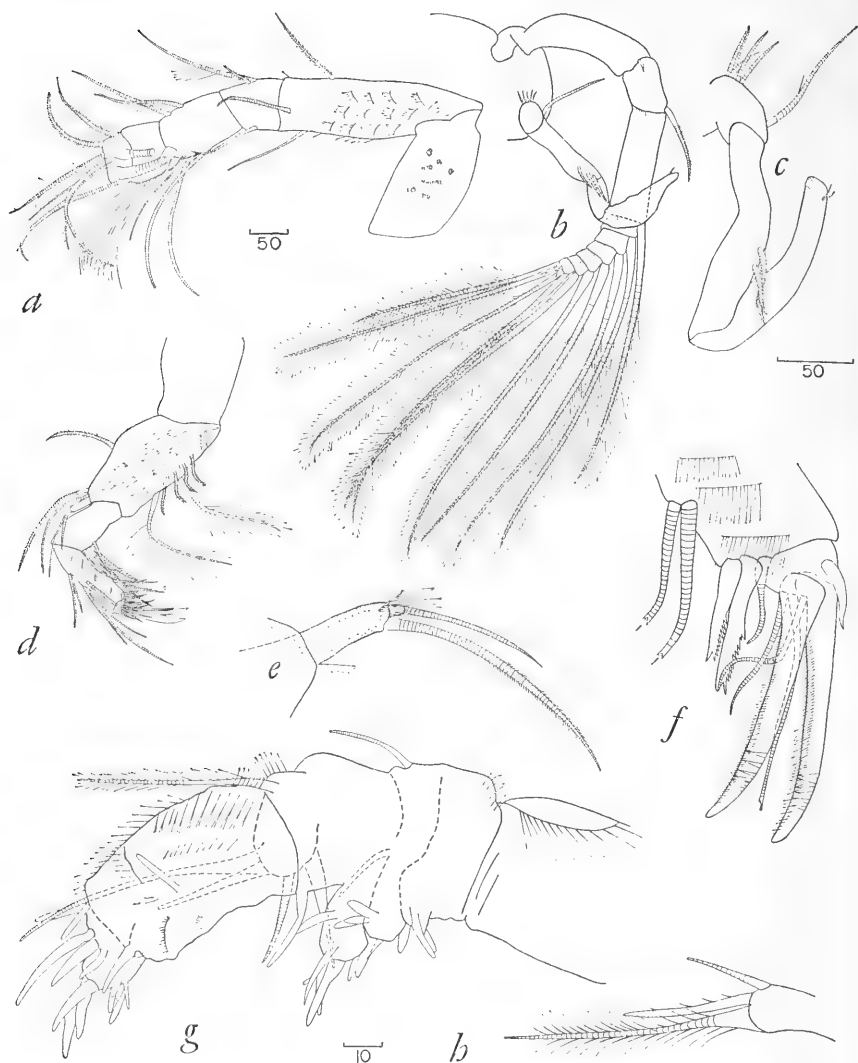


FIGURE 2.—*Euphilomedes multichelata*, male: *a*, lateral view, left first antenna (686Z-12); *b*, medial view, right second antenna (686Z-14); *c*, medial view endopodite, right first antenna (686Z-13); *d*, lateral view, left mandible (686Z-12); *e*, medial view exopodite, left mandible (686Z-13); *f*, medial view, distal end, left mandible (686Z-14); *g*, medial view, right maxilla (686Z-13); *h*, medial view, exopodite of left maxilla (686Z-13). (Same scale, in microns: *a*, *b*, *d*; *c*; *e*–*h*.)

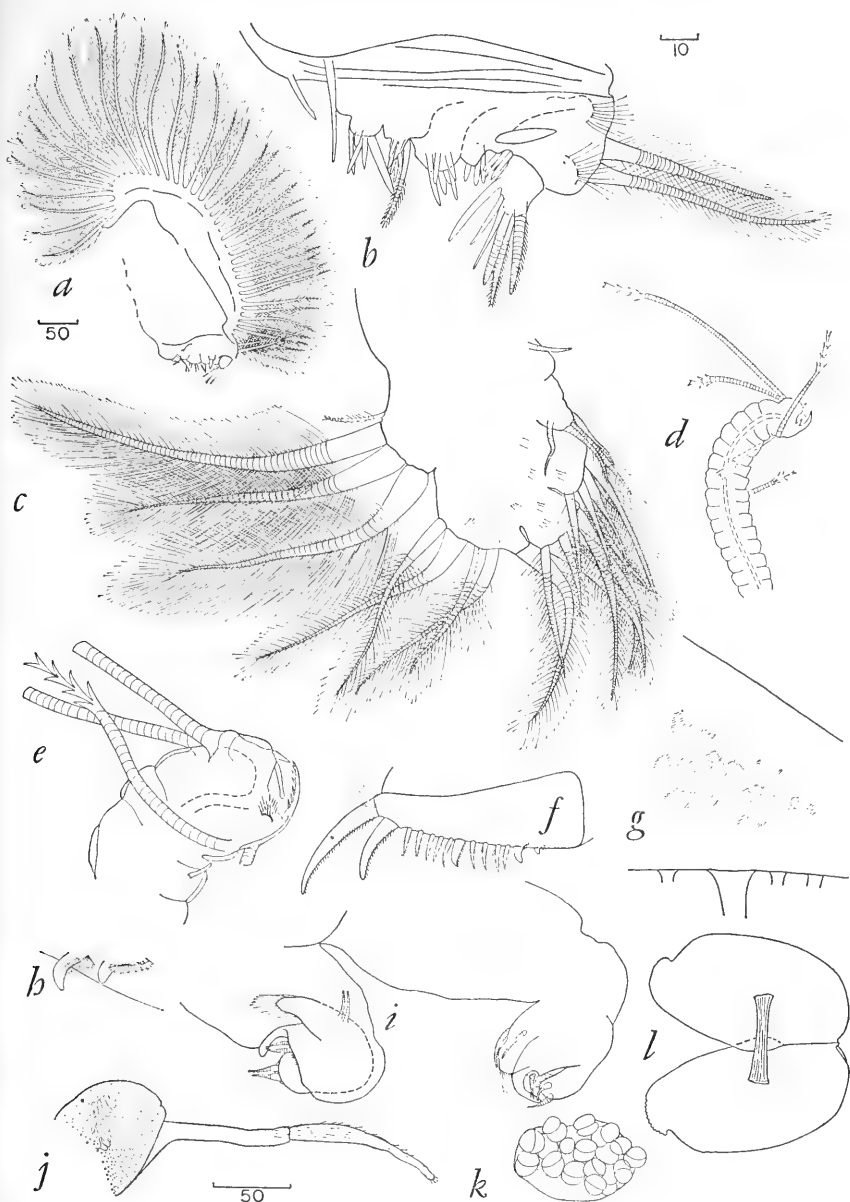


FIGURE 3.—*Euphilomedes multichelata*, male: *a*, 5th limb (686Z-14); *b*, distal end, 5th limb (686Z-13); *c*, medial view, left 6th limb (686Z-12); *d*, distal part, 7th limb (686Z-14); *e*, distal end, 7th limb (686Z-13); *f*, medial view, right lamella of furca (686Z-13); *g*, lateral view, right lamella of furca showing surface hairs (686Z-13); *h*, lateral view, two proximal primary claws on left lamella of furca (686Z-13); *i*, copulatory organ (686Z-13); *j*, frontal organ and medial eye (686Z-13); *k*, lateral eye (686Z-14); *l*, opened valves showing position of adductor muscles, left valve at top (686Z-12). (Same scale, in microns: *a,f,k*; *b,c,e,g-i*; *d,j*; *l*.)

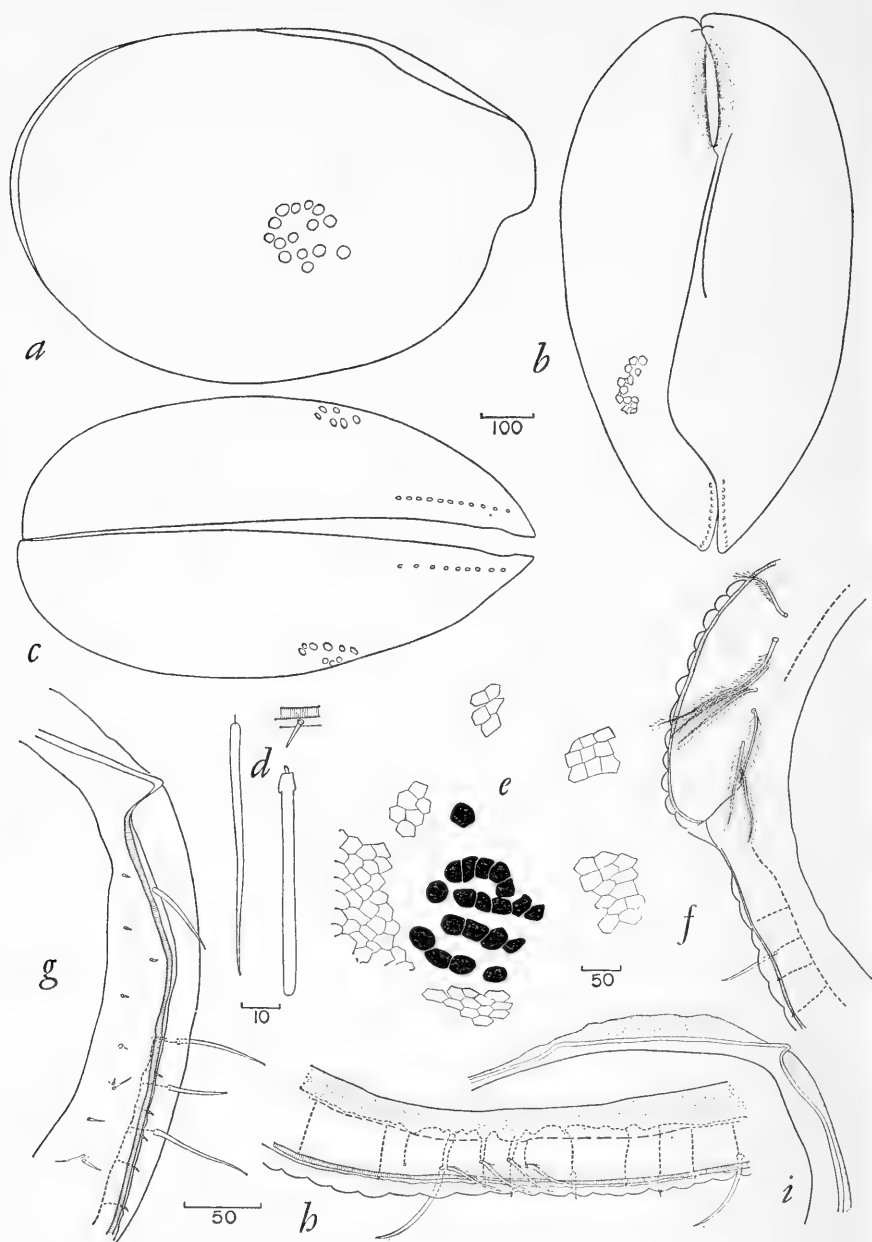


FIGURE 4.—*Euphilomedes multichelata*, female (USNM 112985): *a*, lateral view, showing muscle scars; *b*, dorsal view with polygons shown on right valve; *c*, ventral view, anterior to right; *d*, three hairs from shell: long tapered hair from posterior margin, short tapered hair from radial pore canal on posterior margin, blunt hair from rostrum; *e*, muscle scars and portions of ornamentation in vicinity of scars, right valve from inside, anterior to left; *f*, medial view, anterior right valve; *g*, medial view, posterior right valve; *h*, medial view, ventral section, right valve; *i*, medial view, hinge section, right valve. (Same scale, in microns: *a-c*; *d*; *e,i*; *f-h*.)

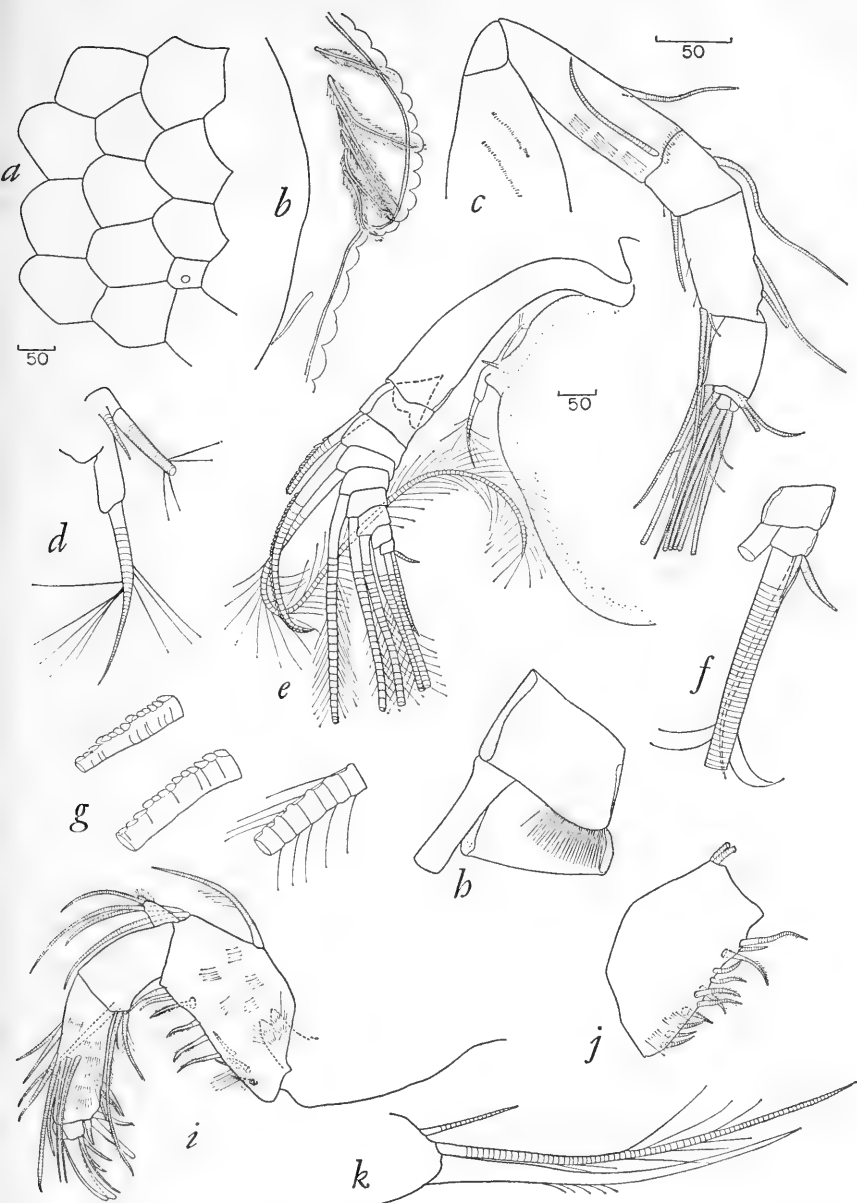


FIGURE 5.—*Euphilomedes multichelata*, female (USNM 112985): *a*, medial view, polygons of left valve anterior to adductor muscle attachment, anterior of valve to right; *b*, medial view, anterior left valve; *c*, lateral view, right first antenna; *d*, endopodite, second antenna; *e*, medial view, right second antenna; *f*, detail of 8th and 9th joints of second antenna; *g*, detail of sections of bristles on 2nd, 3rd, and 4th joints of 2nd antenna; *h*, detail showing comb of stiff hairs or spines on distal margin of 2nd joint of second antenna; *i*, lateral view, left mandible; *j*, lateral view of basale of right mandible; *k*, medial view, exopodite of maxilla. (Same scale, in microns: *a, d, f-h, k*; *b, c, i, j*; *e*.)

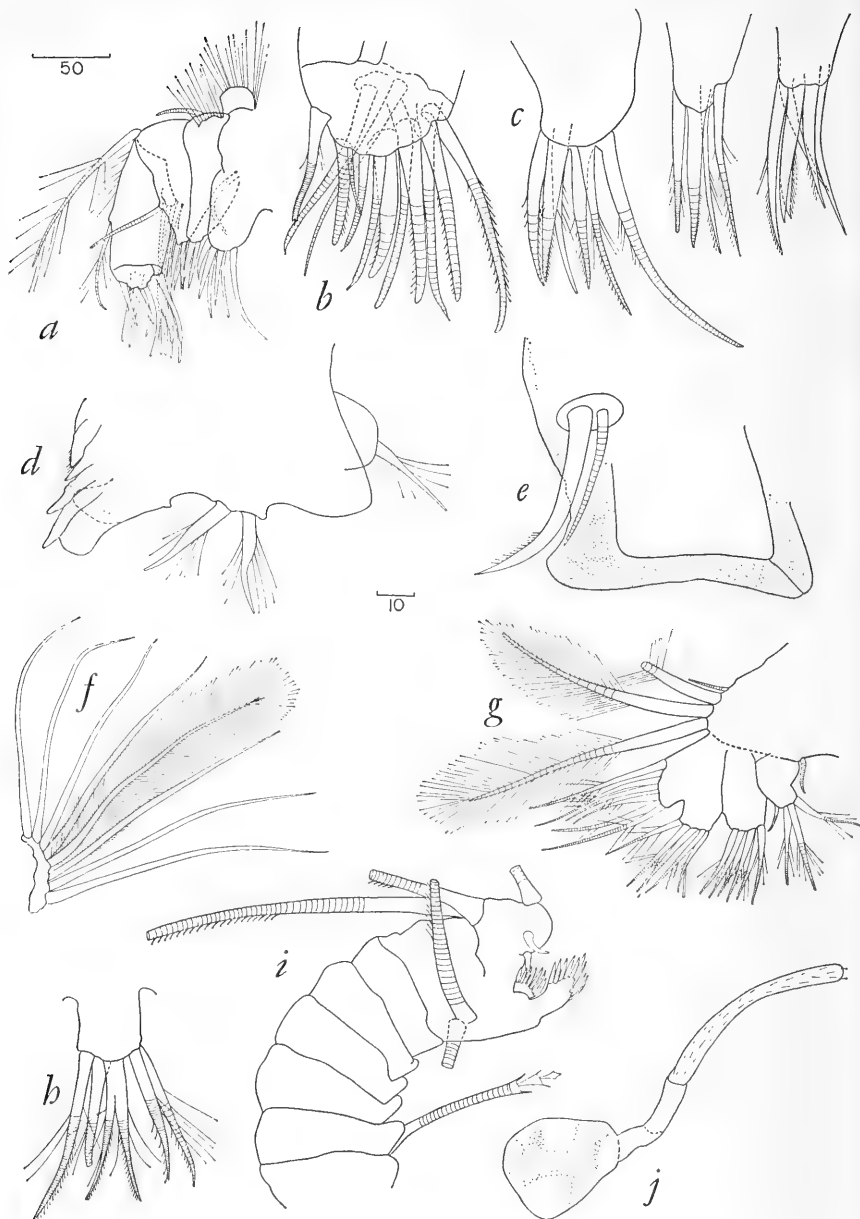


FIGURE 6.—*Euphilomedes multichelata*, female (USNM 112985): *a*, medial view, right maxilla; *b*, medial view, distal end, endopodite of maxilla; *c*, medial view, endites I, II, III of maxilla; *d*, posterior view, 1st joint of right 5th limb; *e*, posterior view, 2nd joint of right 5th limb; *f*, part of epipodial appendage of 5th limb, fine hairs shown on one bristle, other bristles similar; *g*, lateral view, left 6th limb; *h*, medial view, 4th endite, right 6th limb; *i*, distal end, 7th limb; *j*, medial eye and frontal organ. (Same scale, in microns: *a, f, g, j*; *b-e, h, i*.)

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TAXONOMY, DISTRIBUTION, AND POLYMORPHISM IN THE LABIDOCERA JOLLAE GROUP WITH REMARKS ON EVOLUTION WITHIN THE GROUP (COPEPODA: CALANOIDA)

By ABRAHAM FLEMINGER ¹

Introduction

Acceptance of the idea that the prevailing mode of speciation in sexually reproducing animals begins with genetic divergence of spatially separated stocks is widespread and rightly so. With regard to the pelagic biotope of the oceans, however, this concept is based more on faith than on documentation, although several noteworthy efforts have been published (e.g., Bowman, 1955; Brinton, 1962; Ebeling, 1962; Davies, 1963).

Study of evolution in pelagic metazoans is impeded by a combination of factors, including (1) confluence of oceans and the relative obscurity of isolating barriers; (2) uncharted variability of major current systems with climatic changes over time; (3) general lack of detailed knowledge regarding the biology and range of pelagic organisms; (4) scarcity of information on the kinds and extent of morphological variation within and between populations; (5) extensive economic and logistic requirements for collecting oceanic species; (6) continuing prevalence of

¹ Scripps Institution of Oceanography, University of California, San Diego, Calif.

typology in taxonomic accounts of pelagic invertebrates (cf. Simpson, 1961, pp. 45-50); and (7) paucity or absence of a fossil record for most taxa.

Many of these obstacles can be lessened materially by concentrating upon predominantly neritic taxa. Among the planktonic copepods there are a number of large, essentially neritic genera from which to select. One of these, the genus *Labidocera* (family Pontellidae), offers several notable advantages for examining ecological, distributional, and morphological relationships between closely related congeners. Species are relatively large in size and can be collected in abundance. Sexually modified anatomical features are species-specific and remarkably well developed.

Ranges, which are limited to warm-temperate to tropical latitudes, are sharply defined and tend to coincide with major zoogeographic as well as inshore-offshore boundaries (Fleminger 1957, 1959; Heinrich, 1960; Voronina, 1962, 1964; Sherman, 1963, 1964). Range limits conforming to oceanic barriers on the one hand and latitudinal zonation on the other are relatively simple to determine and monitor for an extended period of time. This lattermost feature confers added advantages to the study of neritic *Labidocera* in the Western Hemisphere, where several distinctive species groups are found. These species groups are adapted to coastal waters. Within a group, the distribution and taxonomic relationships of its species constitute a series of succeeding ranges like successive links in a chain. Taxonomic, morphological, and distributional relationships within and between species groups of *Labidocera* found in the Western Hemisphere are under study, one objective being to disclose patterns of evolutionary consequence operating interspecifically on planktonic copepods.

Seven species of *Labidocera* are known to occur on the Pacific Coast of the Americas (Giesbrecht, 1892; Esterly, 1905, 1906; Johnson, 1935; Wilson, 1942, 1950; Sherman, 1963; Fleminger, 1964a).² Of these, *L. acutifrons* and *L. detruncata* are typically oceanic, whereas *L. acuta* is more closely associated with continental and insular land masses. Three, *L. trispinosa*, *L. johnsoni*, and *L. jollae*, have been found chiefly in inshore waters off California and northern Mexico while the remaining species, *L. lubbockii*, is known only from the type locality, Golfo de Guayaquil, Ecuador. In the present study two additional species have been found.

The two new species are closely related to *L. jollae*, and the three together comprise the subject of this paper. One of the new species is especially noteworthy in that it is conspicuously dimorphic in the

² Some of the records of *Labidocera* published by Wilson (1950) have been omitted for reasons discussed elsewhere (Fleminger, 1965).

male sex. Following description of the three species, ranges and interspecific relationships are discussed with special regard to their bearing on evolution within the group.

The genus *Labidocera* was established by Lubbock (1853) for a new species, *L. darwini* Lubbock, collected off Argentina at latitude 38°5' S. More than 40 species have subsequently been described. Although substantial revision of this complex is necessary, it must be delayed due to the lack of appropriate collections for study. In this report the genus *Labidocera* is used in the sense of Giesbrecht (1892) and refers to those pontellids with (1) one pair of dorsal subcuticular lenses in forehead; (2) rostrum deeply bifurcated and lacking a lense; (3) medioventral eye protuberant and extending antero-ventrad between rostral prongs; (4) first pair of swimming legs with two-segmented endopod; (5) male right antennule with at least four separate segments distal to hinge between segment 18 and fusion segment 19–21; (6) maxillule with basipod about twice the length of endite 2, maxilliped with six distinct segments.

Roughly 20 percent of the species of *Labidocera*, including the *jollae* group, bear lateral head-hooks, which are obscure structures best seen in dorsal view. All are coastal in habitat. Most are restricted to the Indian and western Pacific Oceans although one is found in the northeast Atlantic and the *jollae* group occurs along the west coast of North America. Their phylogenetic relationships are not yet established; however, zoogeographically reasonable groups can be sorted out using segmentation of the antennule, sexually modified appendages, and female urosome segmentation. On this basis the *jollae* group can be regarded as being monophyletic and widely separated from the other head-hooked species. Extrapolating from present day ranges, no other head-hooked *Labidocera* has occupied any portion of the Western Hemisphere—at least since late Pleistocene.

This research was partially supported by National Science Foundation Grants G 19417 and GB 2861. A large number of plankton samples used in this study were obtained through the generous cooperation of colleagues with Scripps Institution of Oceanography, the Bureau of Commercial Fisheries, La Jolla Laboratory, and the Inter-American Tropical Tuna Commission. Especially notable contributions of coastal plankton were made by T. Matsui, S. Kato, R. H. Rosenblatt, F. H. Berry, B. Zahuranec, W. Klawe, and M. Gilmartin. I have been greatly helped with preparation of the manuscript by the thoughtful council of C. R. Stasek, who read an early draft, and by T. E. Bowman and several members of the curatorial staff of the U.S. National Museum, who read the final draft.

Methods

MEASUREMENTS.—In general, the procedures of Fleminger (1957) were followed. All measurements were taken with an ocular micrometer from specimens mounted in glycerine; prosome and urosome were measured at $62.5\times$ magnification using a stereoscopic microscope; individual segments were measured at $80\times$ magnification using a compound microscope. No allowance for telescoping or expansion at joints has been made, but damaged specimens have been omitted. Total length (TL) was routinely measured and the prosome-urosome length ratio (PUR) was calculated. Details of special measurements are presented in the text. All figures were drawn with the aid of a camera lucida.

COLLECTIONS.—Plankton samples used in this study were obtained by three kinds of tow. Most collections were CalCOFI (California Cooperative Oceanic Fisheries Investigations standard plankton tow) oblique tows (140 meters to the surface), taken with a one-meter net (1m/O; cf. Berner and Reid, 1961, or Fleminger, 1964b, for more extensive description). Some collections were obtained from a series of vertically stratified horizontal net tows taken at various depths by one-meter, Leavitt-type, opening-closing nets (1m/H; cf. Ahlstrom, 1959, for description). Much of the coastal material from the Gulf of California was collected by standard conical nets (no. 333 Nytex mesh) roughly $\frac{1}{2}$ m in diameter ($\frac{1}{2}$ m). A $\frac{1}{2}$ m conical net constructed of monel mesh ($\frac{1}{2}$ m/HS) and patterned after the cone of the Gulf-III Sampler (Gehringer, 1952) was used at some stations off southern Baja California. The $\frac{1}{2}$ m and $\frac{1}{2}$ m/HS nets were towed within five miles of the intertidal between the surface and five meters for periods of 5 to 15 minutes depending on locality. Some collections were taken by vertical tows and are referred to in the tables by "V" placed after net type. Station locations are shown in figure 2.

Morphological Terminology

The abbreviations of Giesbrecht and Schmeil (1898), later repeated by Rose (1933), afford a practical means for dealing with calanoid morphology in the light of the unresolved problem of homologizing it with malacostracan morphology (Illg, 1958). With widespread usage these abbreviations would simplify descriptive sections, but, unfortunately, they have not been utilized as frequently as their merits warrant. To reduce copepod morphological ambiguities, Gooding (1957, 1960) has tabulated and carefully defined terms and abbreviations frequently misused. His definitions are followed in the present paper.

It seems useful to review briefly the terminology used in this and future papers of this series on *Labidocera*. The calanoid body is

divisible into three primary tagmata, the cephalosome, the metasome, and the urosome. The cephalosome consists of the cephalic somites bearing the antennules (A1), the antennae (A2), the mandibles (Mnd), the maxillules (Mx₁), and the maxillae (Mx₂), and the first true thoracic somite bearing the maxillipeds (Mxp). The metasome contains the five thoracic somites (TI-V) that bear the swimming legs (P1-5), the last pair (P5) at least being sexually modified. The cephalosome and metasome jointly make up the prosome, i.e., all body segments anterior to the major articulation between TV and the genital segment. The urosome begins with the genital segment and contains four or less abdominal segments, the last one being the anal (perianal) segment bearing the caudal rami.

The swimming legs consist of two basal segments, B1 proximal and B2 distal, together referred to as the protopodite, and two distal rami, the lateral exopod (Re) and the medial endopod (Ri). The segments of the rami are numbered in sequence from proximal to distal joint; e.g., second segment of the exopod of the fourth pair of legs would be referred to as Re2 of P4. The larger articulating elements on the segments of appendages are lateral (Se), medial (Si), or terminal (St), and are numbered proximal to distal, a new sequence beginning with each segment. Spinules and hairs (cilia) also articulate or arise from sockets. Nonarticulating structures, or those imperfectly separated from the parent element by a weak line of constriction but lacking an apparent line of flexure, are treated as a general class of processes with appropriate descriptive adjectives to denote form.

The genital pore or antrum (Fahrenbach, 1962) is a cuticular-lined depression on the sternum of the genital segment into which the oviducts (gonopores) open. The gonopores are incompletely shielded by a genital plate articulating along its anterior margin and possibly free along its posterior margin.

Dentition of the mandibular gnathobase appears to be a useful phylogenetic tool, at least for the higher taxa of calanoid copepods. Relationships have been noted between shape and arrangement of the teeth and the kind and condition of the food observed in gut analyses of a number of different species (Fleminger, 1956; Beklemishev, 1959; Anaraku and Omori, 1963).

Giesbrecht (1892, pl. 8, figs. 4, 8, 11) did not propose a formal nomenclature but sometimes numbered the teeth in a ventral to dorsal sequence. Beklemishev (1959) has employed a similar system of letters and numbers. Interfamily homologies in dentition are not established, but an empirical system for Pontellidae has been derived from a survey of pontellid genera (Fleminger, unpubl.) and is used in the descriptions that follow. For the subfamily Eupontellinae, three groups of teeth can be distinguished. Group 1 consists of the two

ventralmost teeth, the apical and subapical, which are the largest, usually unicuspidate, and widely separated by a deeply cut, rounded notch. Group 2 includes the three medial teeth, which are usually bicuspidate and separated by narrower, shallower notches, and a minute intercalary tooth, which may occur between medials 1 and 2 and medials 2 and 3. Group 3, the dorsalmost teeth, are referred to as basals. They extend dorsomedial into the mouth field instead of medial like the others. Basal teeth are usually acuminate, unicuspidate, and closely spaced; they vary in number from one to four and often present useful specific characters. A seta is also present in the subfamily Eupontellinae and is located dorsal to the basals. Several rows of scalelike accessory spines and patches of spinules occur adjacent to the dentition, but they have not been used in this system.

Holotypes, allotypes, and reference specimens have been deposited in the U.S. National Museum (USNM). Reference specimens have also been deposited in the Marine Invertebrate Collections of Scripps Institution of Oceanography (SMIC).

Labidocera jollae Esterly

FIGURES 1, 10

Labidocera jollae Esterly, 1906, p. 74, pls. 9 (figs. 22, 23), 12 (figs. 50-53), 14 (figs. 89, 91).—Johnson, 1935, p. 411, pls. 3 (figs. 1-3), 4 (figs. 1, 3, 11, 13, 17-19, 20-21), 5 (figs. 3-8) [moult stages described].

LOCALITIES, MATERIALS.—See table 1.

LENGTH AND BODY PROPORTIONS.—Adult and stage V copepodite measurements, excluding caudal setae, of specimens selected at random are as follows:

	no.	Total Length (mm)			Prosome-Urosome Length Ratio	
		mean	range	st. dev.	median	range
adult ♀	63	2.69	2.07-3.07	0.152	4.1:1	3.6-4.9:1
adult ♂	60	2.26	1.93-2.61	0.121	2.9:1	2.5-3.3:1
stage V cop. ♀	14	2.02	1.81-2.23		4.2:1	4.0-4.6:1
stage V cop. ♂	15	1.80	1.72-1.92		3.3:1	3.0-3.5:1

DESCRIPTION.—Adult female: Overall appearance stocky, urosome short relative to prosome, latter roughly four times length of former, forehead armed with pair of lateral hooks. A1 short relative to prosome, when extended posteriad reaching articulation between TIII and TIV. Urosome two segmented; genital segment large, asymmetrical, anal segment exceedingly short. In dorsal view (fig. 1d) genital segment with two anterolateral swellings: one on right side larger, knoblike, one on left side a low boss; genital pore lateral, opening on right side. Caudal rami asymmetrical, right ramus

larger, inflated, left ramus somewhat reduced, setation concentrated at distal end; setae of both rami relatively short, less than length of urosome, proximal portions not expanded.

TIV and TV separated by a distinct suture. In dorsal view TV asymmetrical, left posterior corner larger than right, both corners strongly flared, maximum width between apex of left and right TV corners about 1.2 times larger than maximum width of preceding segment (fig. 1*d*).

P5 with exopod bearing two lateral denticles and one short apical spine; endopod small, imperfectly separated from B2 by weak constriction (fig. 1*h*).

Spermatophore, in general, resembles that found in *Labidocera mirabilis* (Fleminger, 1957). Coupler ("Koppler," Heberer, 1932= accessory ornamentation, Fleminger, 1957) relatively large, cemented to ventral side of urosome; in ventral view (fig. 1*f*) appearing as large, somewhat rectangular plate obscuring the urosome. Left and right sides of coupler extending laterodorsad in ovate lobes that flank right and left sides of urosome (fig. 1*e*). Left lobe longer and higher than right lobe, both extending dorsad well above uppermost limit of genital segment (fig. 1*g*); occasionally, lobe tending to flare laterally, decreasing height relative to genital segment. Spermatophore sac short, about as long as, and located ventral to, right caudal ramus (fig. 1*g*).

Adult male: Head-hooks present. TIV and TV separate. TV corners symmetrical, not expanded, each side ending in a minute denticle; caudal rami comparatively long, equal to combined lengths of preceding four segments (fig. 1*b*); rostrum asymmetrical, right prong reduced, left prong as in female (figs. 1*l*, 10).

Hinged right A1 (fig. 1*a*), in dorsal view, with segment 17 expanded anteriorly in an arched ridge lightly sculptured with irregular ribbing; ridge lacking denticles. Segment 17 wider (anterior-posterior limits) than long (proximal-distal limits), mean of ratio $W/L=1.190$, range 1.0–1.5 (22 specimens selected at random). Segment 18 with two parallel rows of slender, closely spaced denticles; fusion segment 19–21 with single row of blunter, shorter denticles, row extending three-quarters length of segment; fusion segment 19–21 roughly twice length of segment 18.

P1 with unusual asymmetry in external spines on exopod of right leg; Se1 of Re1, Re2, and Re3 elongate, distal portion swollen; same spines on exopod of left leg normal (fig. 1*m*).

Right P5 (fig. 1*c*) with large chela; both segments comprising chela elongate, slender, crescent shaped and lacking pronounced lamelliform ridges; straight line distance between origin and apex of distal segment about equal to length of right protopodite; proximal and distal

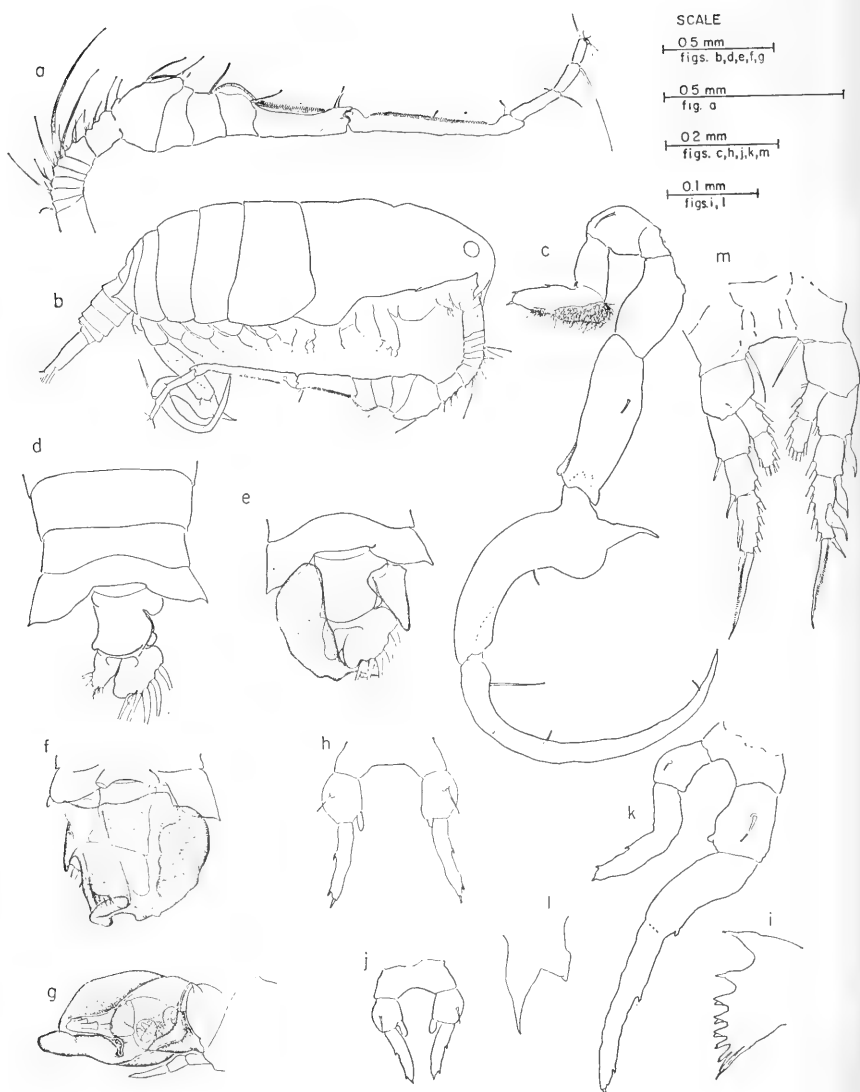


FIGURE 1.—*Labidocera jollae* Esterly, adult male: *a*, right A1, setation incomplete; *b*, right lateral view, appendages incomplete; *c*, P5, posterior view; *l*, rostrum, posterior view; *m*, P1, posterior view. Adult female: *d*, posterior half of body, dorsal view; *e*, posterior half of body with spermatophore, dorsal view; *f*, posterior half of body with spermatophore, ventral view (terminal segments of P5 omitted); *g*, posterior half of body with spermatophore, right lateral view; *h*, P5, posterior view; *i*, right mandibular gnathobase, anterior view. Penultimate stage, P5, posterior view: *j*, female; *k*, male.

segments articulate at medialmost extension of chela; when chela closed, apex of distal segment crosses proximal segment near articulation with B2 between prominent ovate swelling and lateral attenuated prong. Left P5 (fig. 1c) relatively short, pediform; apical segment hirsute on medial face, bearing two short distal spines, one lateral spine at midlength.

No appreciable variation was observed in the proportions of the spermatophore, the flaring of the TV corners in the female, the male P5 and the male right A1.

ADDITIONAL DESCRIPTION.—Right A1 of adult male with partial to complete tagmosis of the following segments: 8–9, 10–12, 13–14, 19–21, 24–25 (based on numbering system of Giesbrecht, 1892). A1 of adult female and left A1 of adult male with 23 perfectly separated segments; segments 8–9 imperfectly fused, segments 24–25 perfectly fused.

Gnathobase of Mnd (fig. 1i) with apical and subapical teeth acuminate; median teeth 1–3 bicuspidate, each cusp pointed. Three large basal teeth present, basals 1 and 2 usually bifid, basal 3 simple, acuminate.

Johnson (1935, pl. 4, fig. 11) noted only seven teeth on the mandibular gnathobase of *jollae*; his illustration lacks one of the three basals found in the present study. He has suggested (personal communication) that the third basal tooth may have been overlooked since he used relatively low magnifications to examine the mandible.

Adult female with symmetrical rostrum (fig. 10b), prongs robust, proximal portion expanded, in frontal view prongs separated by angular notch. Diameter of subcuticular dorsal eye lenses similar in both sexes, not exhibiting the strong sexual dimorphism common to most other species of the genus.

Penultimate stage female: Urosome with three segments. Corners of TV not expanded, similar to penultimate stage male. P5 in general resembles that in adult but with relatively smaller processes (fig. 1j). A1 extends to posterior end of TII. Genital segment occasionally with precocious, more or less incompletely developed genital pore.

Penultimate stage male: Urosome with four segments. Right A1 with middle segments moderately expanded proximal to site of subsequent hinge. Right P5 (fig. 1k) with B2 bearing mediobasal, knoblike protuberance regarded as the endopod precursor. Left B2 with smaller, less distinct protuberance. Right and left B1 fused, ventral margin with asymmetrical notch closer to left leg. Right exopod unisegmented with constriction just distal to proximalmost spinous process. Left exopod unisegmented, shorter, width in posterior view essentially constant from origin to first lateral denticle. Johnson (1935, pl. 4, fig. 20) shows endopods of penultimate stage male P5 separated from

B2 by suture or marked constriction. This condition was not found in the material examined during the present study.

COLORATION.—Two sets of prominent carmine-colored bodies in the prosome and the red pigment cup of the ventral eye generally persist for some time in material kept in 5 percent solution of formaldehyde in sea water. The carmine-colored bodies occur in pairs lateral to the midline, the anterior pair being straplike and lying between TI and TII immediately dorsal to the sternum. The posterior pair vary in shape and in the number of lobes or particles. One clump is found on each side of the gut usually at midlength of TIII. In the adult male the left member of the TIII pair is typically absent. The cuticle is generally colorless except for a faint blue tint in the swimming legs.

Alive, adults are blue green, the intensity of the hue over the entire body varying from light to heavy. The blue-green color is located under the cuticle. It is not restricted to the epidermis but appears diffused throughout the outermost muscle layers. Lateral pairs of reddish-orange chromatophores to the right and left of the midline were observed in the prosome. The chromatophores are uniformly distributed, there being in general two pairs per pair of prosomal appendages. One pair is ventrolateral and can be observed in lateral view where it is seen near the ventral margin of the pleuron. The other pair seen in ventral view is associated with the appendage's B1.

Movement of pigment in these chromatophores was observed to be slow. About one minute was required for a chromatophore to change from the reticulate stage of total pigment dispersion to the punctate state of extreme concentration. I have observed somewhat similar chromatophores in *Pontellopsis occidentalis* and *Labidocera acuta*. There is reason to believe that pigmentation will play a useful role in studies of habitat and mate selection in Pontellidae and such data should be systematically gathered and made available.

TYPES.—Esterly (1906, p. 75) refers to two specimens of *jollae*, a female "taken on the surface three and one-half miles from La Jolla, June 26, 1905," and a male collected "in the cove of La Jolla, January 2, 1906," as the types that he deposited in the collections of the University of California.

None of the specimens of *jollae* that I found in the Esterly Collection held in the Scripps Marine Invertebrate Collections were designated by label as a type specimen. Collecting data on the label of one male, however, matches the collecting details presented in the original description. Some of the appendages are missing (right A1, P1-5). The same kind and number of appendages are mounted

on a slide in the Esterly Collection that bears the name of the species, but lacks other distinguishing remarks. The close similarity of Esterly's figures of the male P5 with the position of the P5 on the slide suggests that the slide and the tubed specimen comprise the male component of Esterly's original specimens.

One of the two females found in the Esterly Collection may be the other syntype. The two females were together in the same vial, labeled "*Labidocera jollae* Esterly, ♀ ad., 1158." Tow number 1158 refers to a surface tow taken on June 29, 1906 between 0505–0520 hrs. at latitude 32°52.3' N, longitude 117°16.4' W (off San Diego). It is possible and even likely that only one of the two females was taken at station 1158, and that the other specimen is the missing syntype from La Jolla cove (3.5 miles off La Jolla, June 26, 1905); but there is no way of distinguishing one from the other. The male specimen is, therefore, designated the lectotype.

The lectotype and one of the females are deposited in the USNM, 110762. The other female and a male specimen collected by Esterly at a later date (tow 2104, Mar. 17, 1910, 1934 hrs., lat. 32°50.6' N, long. 117°29.2' W) are deposited in the SMIC, XVIII-3012 and XVIII-3011, respectively.

DISTRIBUTION.—Localities and collecting data are presented in table 1. These records comprise all of the captures observed in examination of several hundred plankton samples taken in the California Current, the eastern-equatorial Pacific Ocean, and the Gulf of California (fig. 2). *L. jollae* occurred chiefly in inshore samples characterized by a coastal-neritic assemblage of zooplankton.

The species has not been reported from any region outside of the range established by the records in table 1. It was not found in earlier coastal water studies undertaken north of Point Conception (Esterly, 1924; Campbell, 1929a, 1929b, 1930; Johnson, 1932; Davis, 1949; Le Brasseur, 1955, 1956a, 1956b; Legare, 1957; Cameron, 1957). It is not in the Aleutians list (Anraku, 1954) nor has it been reported from the northwest Pacific (Brodsky, 1950). Turning to the eastern equatorial Pacific it is absent from both Giesbrecht's (1895) and Wilson's (1942, 1950) lists.

The present range of *L. jollae*, then, apparently does not extend north of Cape Mendocino, California, nor south of Cabo San Lucas, Baja California. Within these limits it is confined to near-shore waters. Most of the geographical records fall between Point Conception and Sebastian Viscaïno Bay (table 1, fig. 11). North of Point Conception, and extending west along the Aleutians to Asia, *jollae* is replaced by *Epilabidocera longipedata* (Sato) [= *E. amphitrites*

(McMurrich)]. South of Magdalena Bay, Baja California, *jollae* is replaced by *Labidocera diandra*, new species, which is described below.

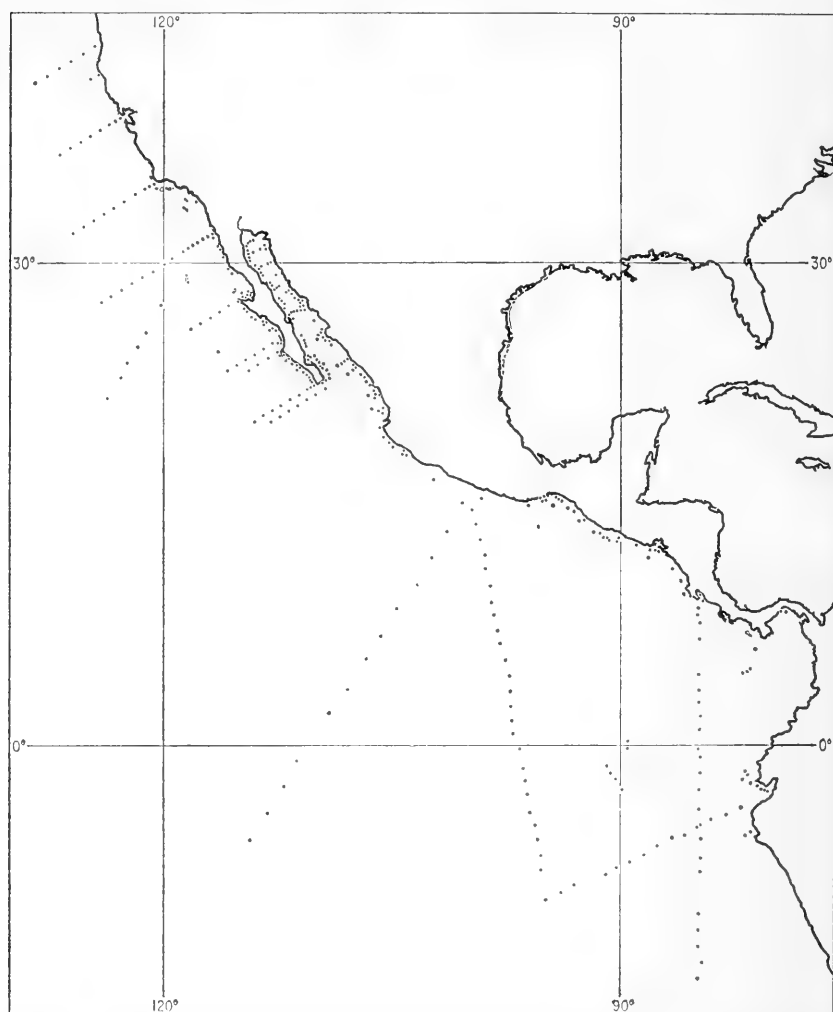


FIGURE 2.—Location of plankton samples examined for *Labidocera*. CalCOFI stations (parallel lines perpendicular to the coasts of California and Baja California) have been occupied regularly since 1950; from them one or more samples from each seasonal quarter of one year were examined.

***Labidocera kolpos*, new species**

FIGURES 3–5, 10

LOCALITIES, MATERIALS.—See table 2.

LENGTH AND BODY PROPORTIONS.—Adult and stage V copepodite

measurements, excluding caudal setae, of specimens selected at random are as follows:

	no.	Total Length (mm)			Prosome-Urosome Length Ratio	
		mean	range	st. dev.	median	range
adult ♀	54	2.66	2.18-2.97	0.152	4.3:1	3.6-5.0:1
adult ♂	61	2.10	1.91-2.30	0.089	3.0:1	2.8-3.6:1
st. V cop. ♀	6	1.99	1.90-2.07		4.2:1	4.0-4.6:1
st. V cop. ♂	7	1.75	1.63-1.88		3.4:1	3.2-3.6:1

DIAGNOSIS.—An allopatric twin species of *L. jollae*, morphologically similar in general features, but showing several constant differences in sexual structure. The name *kolpos* [Greek] refers to the geographical region (Gulf of California) inhabited by the new species.

Adult female: Greatest width of TV, in dorsal view, approximately equal to greatest width of preceding segment (fig. 3f). TV corners weakly flared, maximum width between corners about 15 percent less than that in *jollae* of equal prosome length (fig. 4d). P5 with vestigial endopod perfectly fused to B2 (figs. 3j, l). Mandibular gnathobase with cusps of median teeth rounded at apex (fig. 3k). Spermatophore, in lateral view, with left and right lobes low, closely appressed to dorsolateral portions of genital segment, lobes not extending beyond dorsal limit of genital segment (figs. 3g-i); in *jollae* lobes larger and not flattened but extending conspicuously above genital segment. Rostrum as in *jollae* (fig. 10c).

Adult male: Chela of right P5 similar in form but smaller in proportion to protopodite and left ramus than in *jollae*; shortest length of distal segment, measured along imaginary straight line between proximal and distal ends, excluding spine, equal to lengths of B2 plus half of B1 (fig. 3c); in *jollae* this width equal to total length of both segments of protopodite. Inner circumference of chela about half the length of that in *jollae*, although protopodite only slightly smaller (fig. 5). In closed chela, apex of distal segment crosses proximal segment near articulation with B2 between weak swelling and stout lateral prong. Rostrum as in *jollae* (figs. 3n, 10c).

Right A1 (fig. 3a) in dorsal view with segment 17 almost twice as long as wide, mean of ratio W/L=0.57, range .50-.64 (22 specimens), anterior edge produced in shallow ridge; ridge more weakly sculptured than in *jollae*; segment 18 with two rows of teeth as in *jollae*; fusion segment 19-21 with row of small denticles extending about half length of total segment; segment 19-21 about one and one-half times length of segment 18. Compared with *jollae*, length of segment 17 is slightly greater, length of segment 18 is slightly less, length of segment 19-21 is considerably less (figs. 4a-c).

ADDITIONAL DESCRIPTION.—*L. jollae* and *kolpos* share the following characters: Female A1 and male left A1 with 23 perfectly

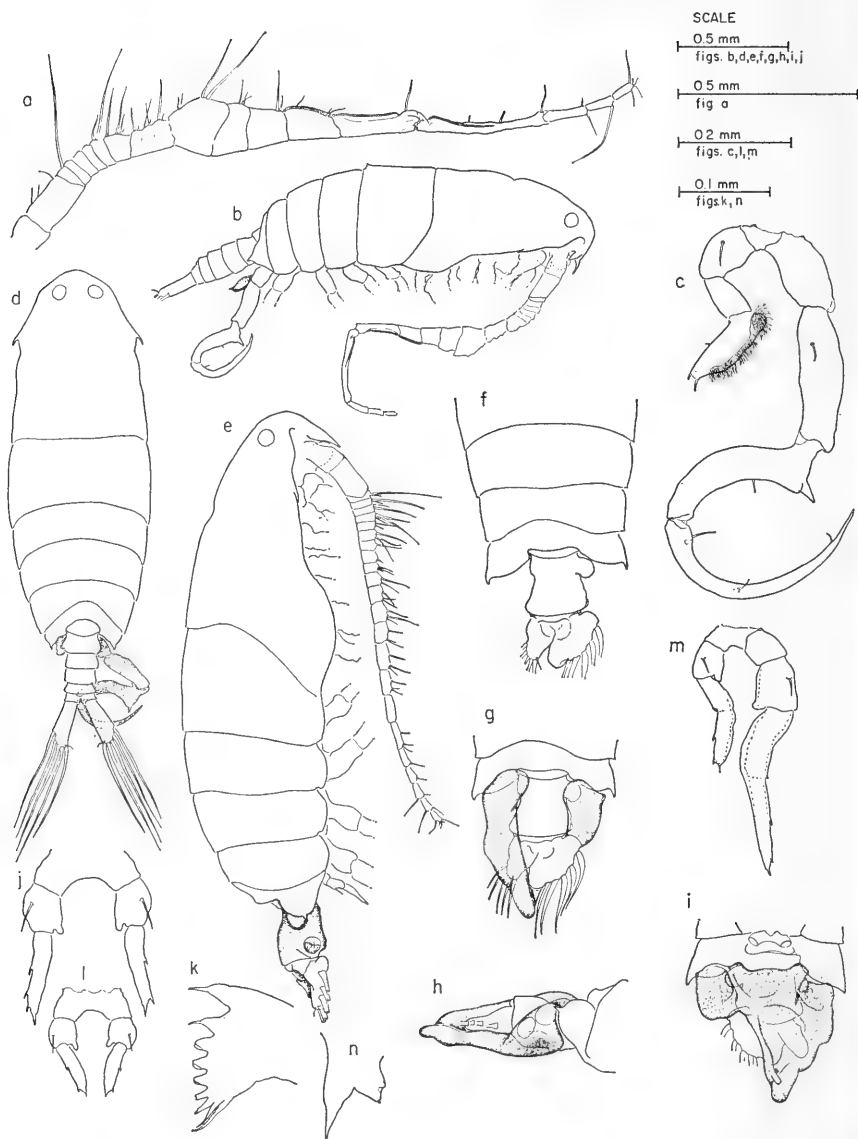


FIGURE 3.—*Labidocera kolpos*, new species, adult male: *a*, right A1, setation and dentition approximated; *b*, right lateral view, appendages incomplete; *c*, P5, posterior view; *d*, dorsal view; *n*, rostrum, posterior view. Adult female: *e*, right lateral view, appendages incomplete; *f*, posterior half of body, dorsal view; *g*, posterior half of body, dorsal view, with spermatophore; *h*, posterior half of body, right lateral view, with spermatophore; *i*, posterior half of body, ventral view, with spermatophore; *j*, P5, posterior view; *k*, right mandible, gnathobase, anterior view. Penultimate stage, P5, posterior view: *l*, female; *m*, male.

separated segments, segments 8-9 imperfectly fused, segments 24-25 perfectly fused; right A1 of adult male with partial to complete fusion of the following segments: 8-9, 10-12, 13-14, 19-21, 24-25.

Exopod of P5 in adult female occasionally with extra lateral spinous prong as in figure 3j.

Right P1 of adult male with Se2 of Re3 not swollen, Se1 of Re1-3 swollen as in *jollae*.

Penultimate stage male with right leg of P5 (fig. 3m) bearing 2-3 minute, lateral denticles and one terminal prong. P5 of penultimate stage female resembles that of adult except for proportional relationships of segments (fig. 3l).

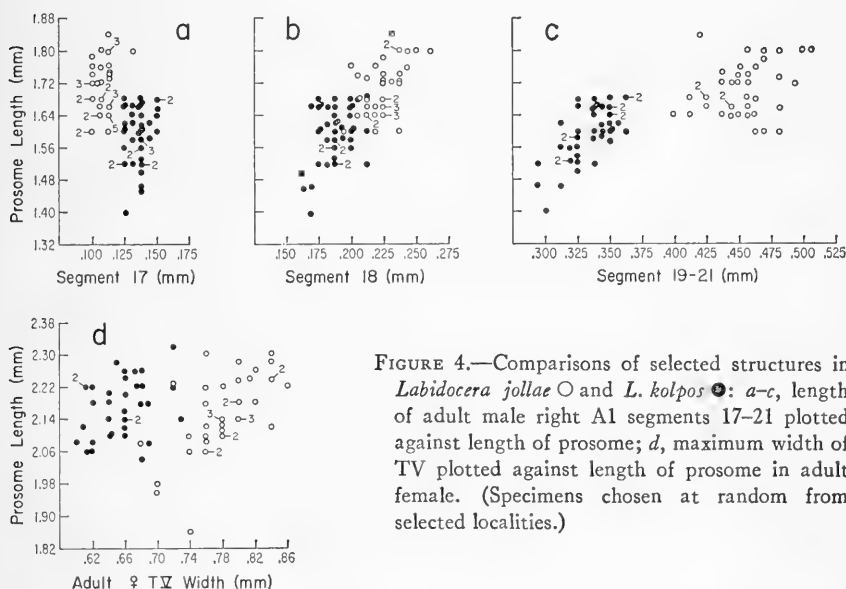


FIGURE 4.—Comparisons of selected structures in *Labidocera jollae* ○ and *L. kolpos* ●: a-c, length of adult male right A1 segments 17-21 plotted against length of prosome; d, maximum width of TV plotted against length of prosome in adult female. (Specimens chosen at random from selected localities.)

COLORATION.—Preserved specimens (5 percent formaldehyde solution in sea water) exhibit two sets of carmine-colored structures, one between TI and TII, the other in TIII, as described above for *jollae*. The swimming legs also show a faint tint of blue in the cuticle. Living specimens were found to be uniformly blue-green as in *jollae*. Examination for chromatophores was carried out only on preserved material. The results suggest a chromatophore array similar to that in *jollae* but, due to fading of pigments, this should be confirmed by examination of living material.

TYPES.—Female holotype, USNM 110747, allotype, USNM 110748, selected from material collected at station II-1 (lat. 28°03' N, long. 111°16.5' W), located a few yards offshore of a steeply sloped sand beach in a small cove, roughly 20 miles north of Guaymas,

Sonora, Mexico. About 100 adult specimens collected with the holotype are deposited in the USNM, 110749. A series of reference specimens representing the known range in the Gulf of California has been deposited with SMIC XVIII-3.

DISTRIBUTION.—Along the Mexican mainland the species has been taken from Puerto Peñasco to Isla Macapule, just south of Topolobampo. On the Baja California shore of the Gulf the species has been collected from San Felipe south to Bahía San Carlos, located just north of Santa Rosalia. Within these geographical limits (fig. 11) *kolpos* has been found most frequently and in the greatest abundance in near-shore waters. The species has not appeared in samples from the southernmost third of Baja California. It is also absent in the tows taken between Mazatlán and Ecuador. A related species, described next below, replaces *kolpos* in southern Baja California and along the mainland coast, at least as far south as Puerto Vallarto, Mexico.

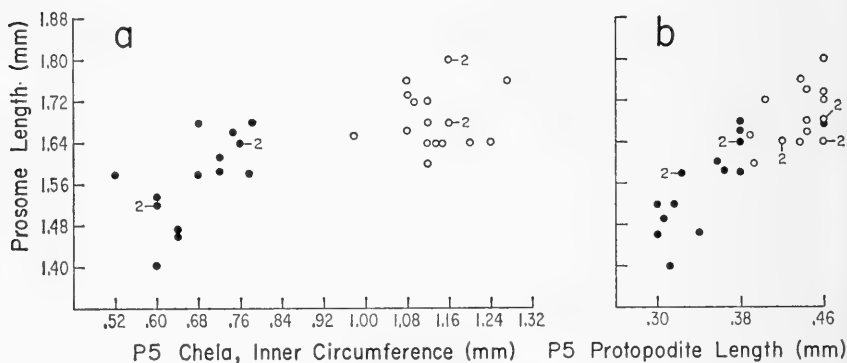


FIGURE 5.—Comparison of P5 in adult males of *Labidocera jollae* ○ and *L. kolpos* ● chosen at random: *a*, length of inner circumference of chela plotted against prosome length (measurements of chela made with planimeter from camera lucida sketches of posterior view, 80× magnification; circumference limits are from apex of distal segment to apex of lateral prong of proximal segment); *b*, length of protopodite plotted against prosome length (protopodite measured along lateral margin at 80× magnification).

Labidocera diandra, new species

FIGURES 6-10

LOCALITIES, MATERIALS.—See table 3.

LENGTH AND BODY PROPORTIONS.—Adult and stage V copepodite measurements, excluding caudal setae, of specimens selected at random are as follows:

	no.	Total Length (mm)			Prosome-Urosome Length Ratio	
		mean	range	st. dev.	median	range
adult ♀	144	2.95	2.57–3.49	0.140	3.5:1	3.1–4.0:1
adult ♂ A	135	2.95	2.53–3.25	0.148	3.3:1	3.0–3.8:1
adult ♂ B	122	2.89	2.51–3.25	0.152	3.4:1	2.9–4.1:1
st. V cop. ♀	25	2.13	2.00–2.32		3.6:1	3.4–3.9:1
st. V cop. A ♂	25	2.12	1.93–2.31		3.4:1	3.2–3.7:1
st. V cop. B ♂	25	2.09	1.91–2.24		3.4:1	3.0–3.6:1

DIAGNOSIS.—Distinguished from other species by (1) details of sexually modified structures, (2) secondary loss of head-hooks in the mature stage of both sexes, and (3) occurrence of two morphologically different kinds of adult male (morph A and morph B), the differences being concentrated in sexually modified appendages. The name *diandra* [Greek] refers to the two morphologically distinct kinds of males comprising this new species.

Adult A1 segments 24–25 fused as in genus (fig. 6*d*), segments 8–9 imperfectly fused as in *jollae* and *kolpos*; segments 6 and 7 perfectly separate. Forehead rounded, no head-hooks in adult, dorsal subcuticular eye lenses large in male, left and right lenses touching (fig. 8*k*); dorsal eye lenses in female small, well separated (fig. 6*d*). TIV and TV not fused. Rostrum as in *jollae* except lacking asymmetry in male (fig. 10*a*).

Adult female: TV in dorsal view produced posteriad in subequal lobes; in lateral view lobes flanking proximal end of genital segment (figs. 6*e,f*), reminiscent of *detruncata*; robust prong ventral to right lobe and extending posterolaterad (figs. 6*d,f*), left side of TV without prong. Urosome asymmetrical, in dorsal view with relatively long genital segment curving to right; anal segment small; caudal rami asymmetrical, left ramus larger, second innermost seta moderately expanded in proximal portion (fig. 6*d*). Genital segment with robust hooked process extending from anterior portion of left side (figs. 6*d,e*); posterodorsal portion of genital segment with swollen dorsal surface lightly sculptured. Genital pore displaced to right of mid-longitudinal axis (fig. 6*f*).

P5 with apex of exopod deeply bifurcated, weakly asymmetrical, right exopod longer; one or two small, lateral denticles occasionally present on exopod; endopods asymmetrical, left endopod apically bifurcated, right endopod spinelike with minute lateral prong (fig. 6*b*).

Adult male: Both male forms essentially identical in prosome and urosome; TV corners symmetrical with simple rounded margins not flaring outward (fig. 7*c*). Caudal rami elongate, length exceeding combined lengths of preceding three urosomal segments (fig. 8*j*). Forehead rounded, lacking head-hooks and crest (fig. 8*k*).

Right A1 in dorsal view with segment 17 lacking denticulated ridge, anterior surface rounded, not flattened, and bearing small, low protuberance just proximal to midlength of segment. Segment 18 with prominent denticulated ridge; ridge extended proximad, projecting along axis of antennule and in dorsal view overlapping

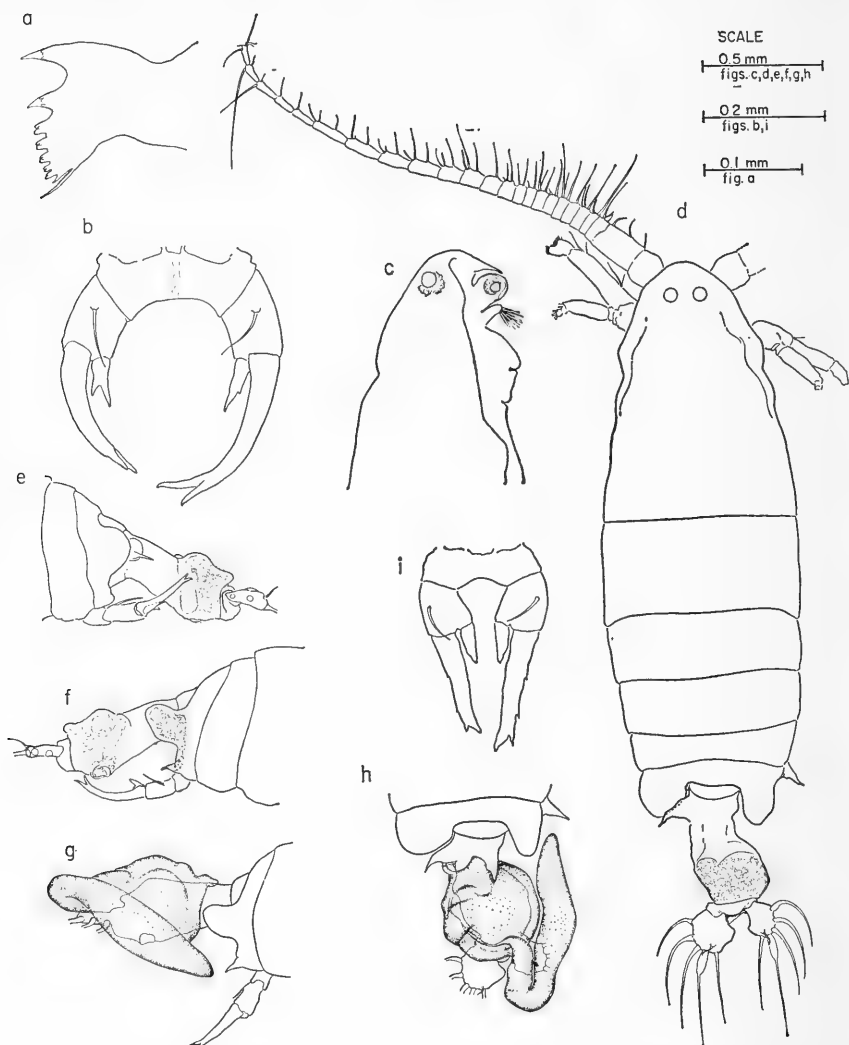


FIGURE 6.—*Labidocera diandra*, new species, adult female: *a*, right mandible, gnathopod 1, anterior view; *b*, P5, posterior view; *c*, cephalosome, right lateral view; *d*, prosome and urosome, dorsal view; *e*, posterior half of body, left side; *f*, posterior half of body, right side; *g*, posterior half of body, right side, with spermatophore; *h*, posterior half of body, dorsal view, with spermatophore. Penultimate copepodite: *i*, P5, posterior view.

anterior edge of preceding segment, surface abutting segment 17 not flattened. Fusion segment 19–21 with well-developed denticulated ridge extending length of segment. Segment 22 with distal spiniform process about as long as segment 23, in dorsal view process somewhat appressed to front edge of segment 23.

P3 and P4 asymmetrical, right leg with Se1 of Re1 and Re2 enlarged and extending perpendicular to axis of leg (figs. 7*g*, 8*i*); in right lateral view enlarged spines (Se1) of P3 and P4 projecting obliquely posteriad (fig. 7*c*); P3 with Se1 of Re2 bearing large irregular lamella on distal border, Se1 usually coated with amber colored material resembling resinous (cement-like) secretion occurring on females where spermatophore is fixed to urosome.

Basic characteristics of P5, as in *jollae* and *kolpos*, are short left leg; long, robust right leg bearing large, ovate chela; left leg with terminal segment lacking prominent spines and processes, terminal segment roughly perpendicular to protopodite; ventral face hirsute; in general, left P5 also reminiscent of that in *L. mirabilis* (Fleminger, 1957, figs. 32, 33).

Morph A differs from morph B in details of the right A1 and chela of right P5.

Morph A: Right A1 with denticulated ridge of segment 18 extending proximad on an elongated process that reaches distal half of fusion segment 13–14 (fig. 7*a*). Segments of chela slender, elongated; proximal segment with perpendicular digitiform process extending from proximal end; process bearing knob on posterior face, ridge on anterior face. Slender distal segment (finger) opposes proximal segment (thumb), and closure of chela provided by finger crossing digitiform process of thumb (figs. 7*d–h*). Proximal segment of chela with large proximal seta; distal segment with three setae, one approximately one-third distance from origin of segment, second at midlength, third nearer apex.

Morph B: Segment 18 of right A1 with ridge extending proximad to suture between segments 16 and 17 (fig. 8*a*). Chela ovate, compact (figs. 8*d*, *e*, *h*), proximal segment roughly semicircular in lateral view and bearing a flaccid lamella with distal margin broadly notched; angle of lamella relative to segment varying from acute to perpendicular. Large seta originating at base of lamella resembling similarly positioned seta in male A and suggesting that lamella homologous to rigid digitiform process on proximal segment of chela in male A. Spinule located adjacent to distal side of lamella. Distal segment in ventral view somewhat lanceolate, with concave palmar surface opposing proximal segment; apex of distal segment terminating in small denticle; three setae on distal segment, one located close to

origin of segment, one about one-fourth of length from origin, and one at midlength; number similar to those in male A.

Terminal segment of left P5 differing slightly in proportions from male A but similar in organization and armament (figs. 8*f*, *g*).

ADDITIONAL DESCRIPTION.—Cephalic appendages similar in most respects to Giesbrecht's (1892) account of *L. wollastoni* but showing several noteworthy differences. A2 with exopod almost as robust as endopod.

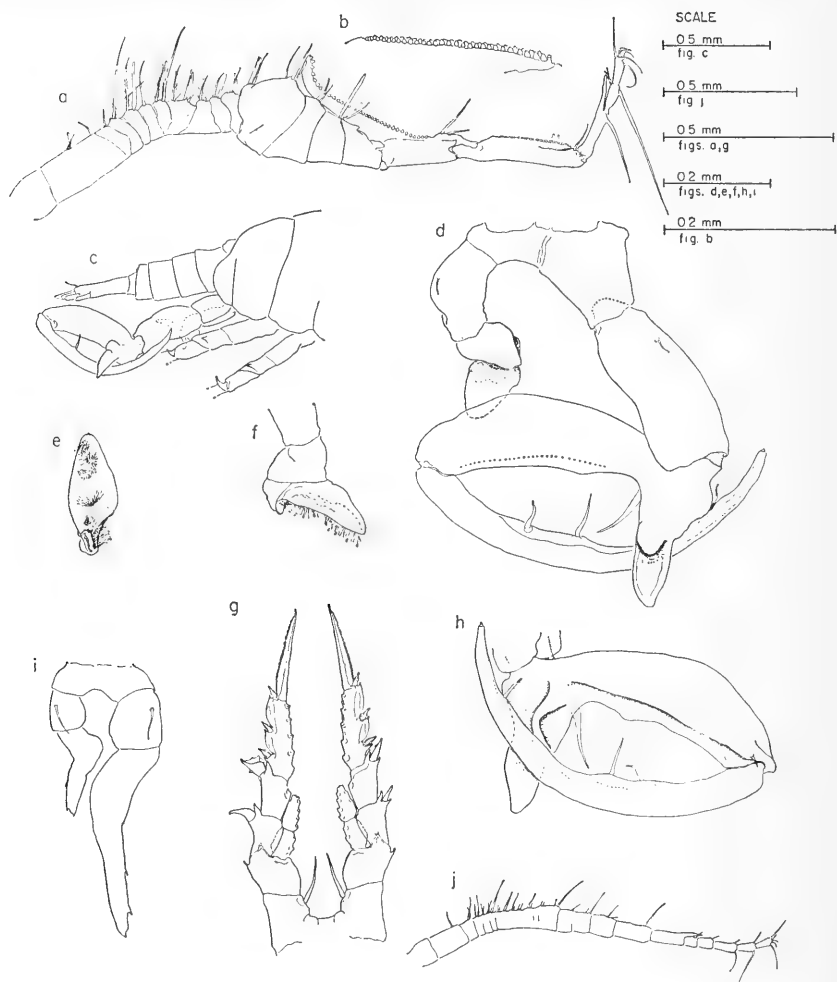


Figure 7.—*Labidocera diandra*, new species, adult male, morph A: *a*, right A1; *b*, dentition of fusion segment 19-21, right A1; *c*, posterior half of body, right side; *d*, P5, posterior view; *e*, P5, terminal segment of left leg, ventral surface; *f*, P5, terminal segment of left leg, lateral view; *g*, P3, posterior view; *h*, P5, chela, anterior view. Penultimate male: *i*, P5, posterior view (male B); *j*, right A1, dorsal view (typical of both male forms).

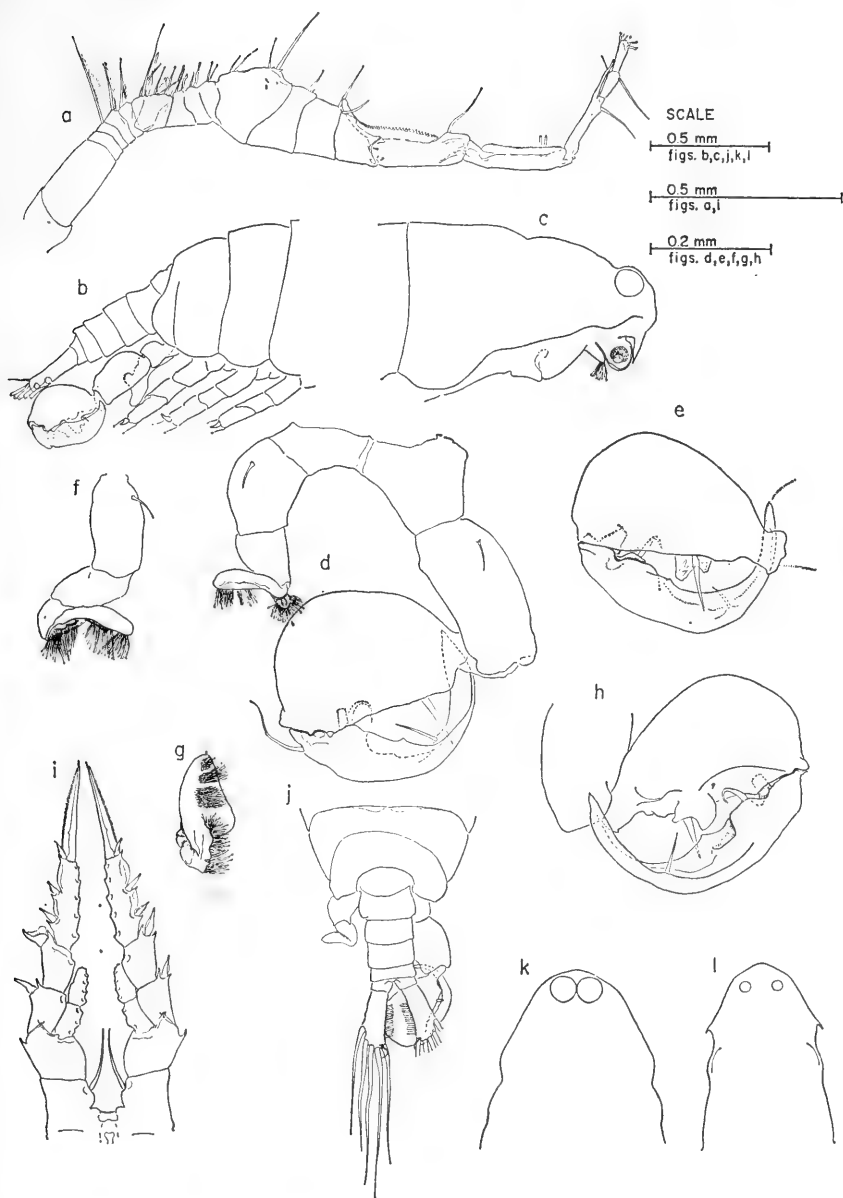


FIGURE 8.—*Labidocera diandra*, new species, adult male, morph B: *a*, right A1, dorsal view; *b*, posterior half of body, right side; *c*, cephalosome, right side; *d*, P5, posterior view; *e*, P5, chela, lateral view; *f*, P5, left leg, lateral view; *g*, P5, terminal segment of left leg, ventral surface; *h*, P5, chela, medial view; *i*, P3, posterior view; *j*, posterior half of body, dorsal view; *k*, forehead, dorsal view. Penultimate stage: *l*, forehead, dorsal view.

Mandibular gnathobase with eight teeth, apical and subapical teeth typical, median teeth 1-3 bicuspidate, basal teeth 1 and 2 usually bicuspidate, occasionally with single cusp as in basal 3; basal seta well developed (fig. 6a). Mx_1 with B2 bearing clump of three setae followed by clump of two setae on inner margin (*wollastoni* has two setae in each clump), lobe 3 with four setae. Large, spinelike setae of Mx_2 bearing about $1\frac{1}{2}$ times more pairs of perpendicular spinules, distance between spinules less than in *wollastoni*. Mxp with B2 bearing row of denticles as in all species of *Labidocera* examined.

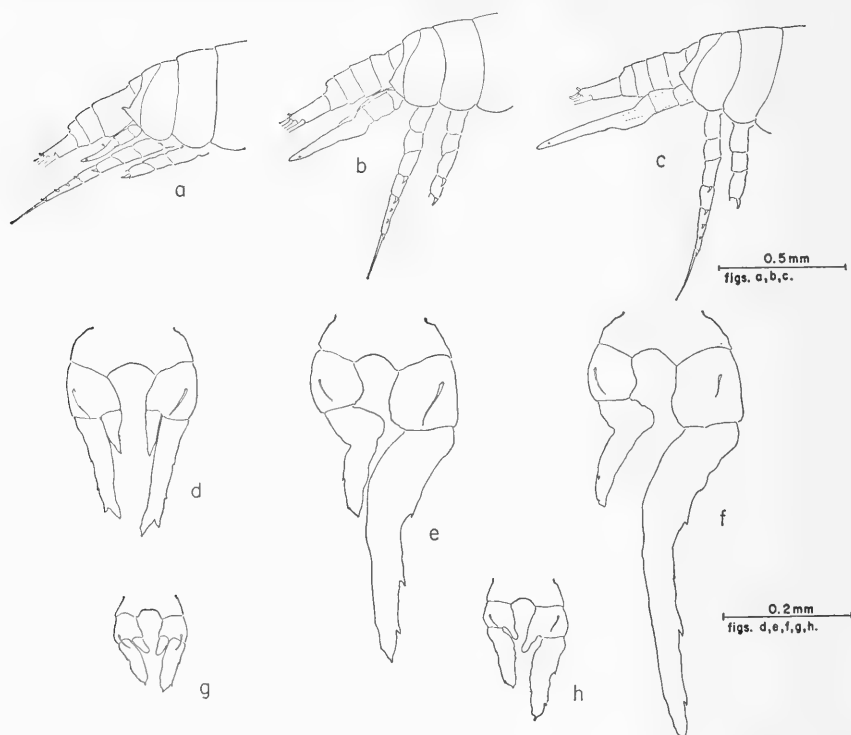


FIGURE 9.—*Labidocera diandra*, stage V copepodites: *a*, female, posterior half of body, right lateral view; *b*, male, morph B, posterior half of body, right lateral view; *c*, male, morph A, posterior half of body, right lateral view; *d*, female, P5, posterior view; *e*, male, morph B, P5, posterior view; *f*, male, morph A, P5, posterior view. Stage IV copepodites, P5, posterior view: *g*, female; *h*, male.

In adult female, tissue within right TV corner and ventral prong granular; lobe flanking genital segment with large clear space. Tissues underlying tergum of genital segment also glandular in appearance.

Spermatophore in *diandra* essentially similar to that in *jollae* and *kolpos* but differing in several fundamental characteristics from that in other coastal species of east Pacific *Labidocera* (Fleminger, 1964a).

Coupler in *jollae* and *kolpos* consists of shield ventral to urosome; right and left portions of shield turned dorsad flanking urosome and extending upward as more or less free, curved, lobiform or lamelliform processes. In *diandra*, right and left portions of shield appressed to genital segment. Sac in *jollae* and *kolpos* remarkably short and arising from left side of coupler; separation of coupler and sac poorly demarcated; beginning at genital pore, neck extending to left, ventral to genital segment, and posterior along left side of coupler before expanding into short sac. In *diandra*, beginning at genital pore, neck extending to left side ventral to genital segment and turning posteriad, as in *jollae* and *kolpos*, but then extending dorsad and to

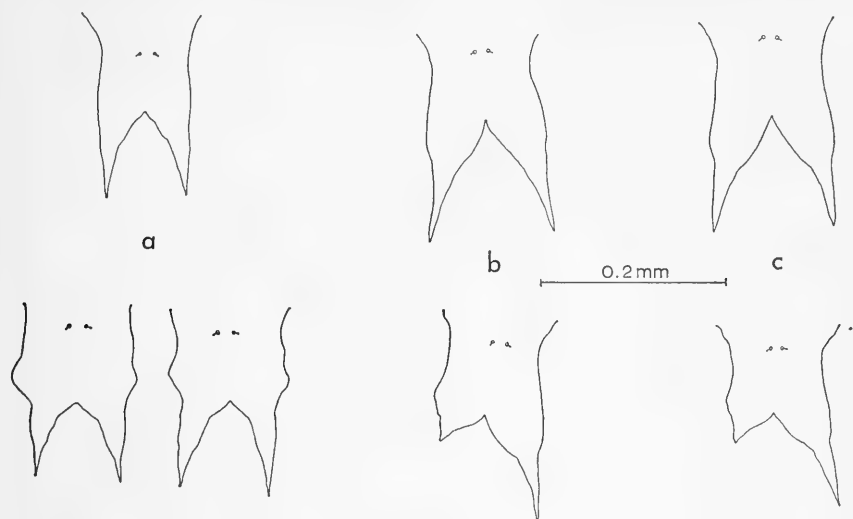


FIGURE 10.—Front view of rostrum (top, females; bottom, males): a, *Labidocera diandra* (A, B); b, *L. jollae*; c, *L. kolpos*.

right above anal segment; elongated sac appearing over right caudal ramus, and extending posteriad before abruptly turning about 180° in horizontal plane and extending toward prosome (figs. 6g,h); about three-fourths of sac length projecting forward toward right corner of TV.

Flexure of spermatophore sac projecting it away from usual posteriorly directed attitude occurs in several other species of *Labidocera*. In *detruncata*, neck leaves coupler middorsal on genital segment, broadening into sac and turning horizontally counter-clockwise about 150° , distal portion of sac extending to right more or less perpendicular to longitudinal axis of urosome. In *acutifrons*, neck bending abruptly about 180° under left caudal ramus and sac projecting anteroventrad to left of urosome. In *minuta*, neck extending to left of midventral

genital pore, turning posteriad and crossing ventral to anal segment to right side of urosome; portion of sac free of coupler extending anterolaterad.

Two types of spermatophore placement observed in *diandra*: type 1 placement considered normal; type 2 placement less common and appears to be nonfunctional. In type 1, described above (figs. 6*g*, *h*), coupler envelops genital segment posterior to hook on left side and extends back to cover anal segment. Actual site of attachment of neck not observed but appears to emanate from genital pore.

Type 2 placement with spermatophore similar to that in type 1, but coupler cemented to left corner of TV, 180° bend in sac anterior to terminal portion of sac which extends posteriad; resulting orientation of spermatophore sac and coupler 180° out of phase with type 1 placement. Neck cemented to left corner of TV, totally lacking contact with genital pore.

COLORATION.—Living and preserved specimens (5 percent formaldehyde solution in sea water) exhibit the same sets of carmine structures between TI and TII and in TIII as described above for *jollae*. The cuticle on the ventral side of the prosome and on the swimming legs is tinted blue. Otherwise the species is translucent and shows no pronounced coloration.

TYPES.—Female holotype, USNM 110758, allotype, USNM 110759, selected from material collected at station F-5 (lat. 24°14' N, long. 111°18' W), bottom depth about 20 m, located roughly 1 mile offshore of Boca Flor de Malba, Baja California, an estero flanked on either side by moderately sloping sandy beach coastline. Additional reference specimens are USNM 110760 and SMIC XVIII-2.

DISTRIBUTION.—Plankton samples containing *L. diandra* (table 3) were collected in coastal waters usually within 1 mile of shore. The northernmost positive station (F-5) is located on the Pacific coast of Baja California just south of Almejas Bay (24°20' N). Along the Gulf of California coast of Baja California, the species occurred as far north as Santa Rosalia (27°19' N). From the eastern shore on the Mexican mainland we have four records, all coastal and from the region between Banderas Bay (20°26' N) and Tenacatita Bay (19°15.3' N). The distribution of *L. diandra* is shown in figure 11. During portions of the year the range will probably be found to extend farther north (approximately a hundred miles) on both shores of the Gulf. The only remaining broad question of range concerns how far south the species extends along the Central American coast.

In general, the calanoids found in samples containing *diandra* were a mixed assemblage of coastal, neritic, and oceanic species which have a wide distribution in the eastern Equatorial Pacific. Samples rich in *diandra* were also rich in the coastal and neritic species of this

assemblage, but the actual composition varied somewhat from tow to tow. Perhaps the only consistent feature is the relatively high abundance of inshore coastal species such as *Acartia tonsa*. Most interesting is the observed trend in the occurrence of other species of

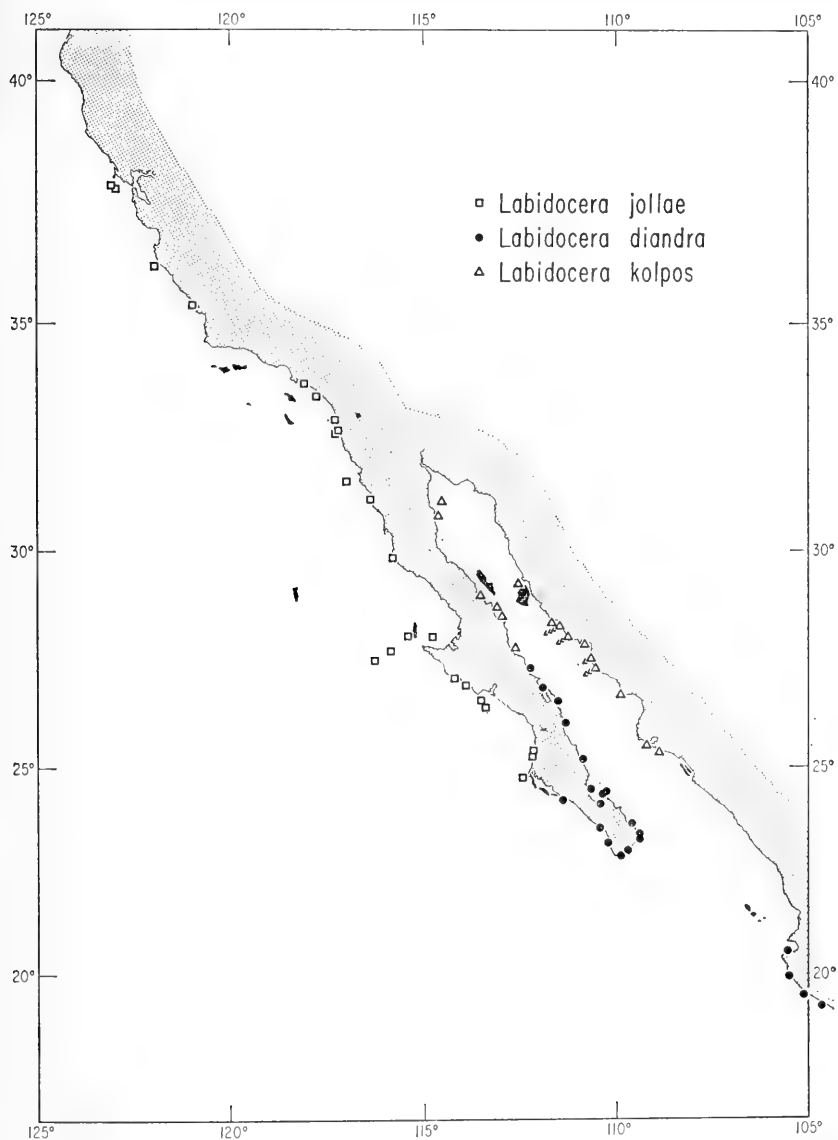


FIGURE 11.—Location of plankton samples containing species of the *jollae* group; no sample yielded more than one species.

Labidocera. Within north-south limits of the *diandra* range, *L. detruncata* was very rare and decidedly offshore; *L. acutifrons* was abundant chiefly in the more offshore tows from blue, highly transparent water; and *L. acuta* was the numerically dominant species of the genus in blue to bluish-green water especially within 10–20 miles of the coast. Wherever the latter two species were abundant, *diandra* was rare or absent. The abundant catches of *diandra* were made in green to greenish-blue, relatively turbid water.

REMARKS ON IDENTIFICATION.—Adults of *diandra* are distinguished from other species, except *jollae* and *kolpos*, by (1) partial fusion of segments 8 and 9 and separation of 6 and 7 in the nongeniculated A1; and (2) the short robust rostrum in which the base of each prong is swollen in lateral and frontal views.

Adult *diandra* are easily separated from *kolpos* and *jollae* by the absence of head-hooks.

The male is further characterized by (1) the terminal segment of the left P5 lacking prominent spines, hooks, or modified setae; (2) the right A1 with segment 18 bearing a proximal process overlapping at least the entire length of segment 17, superficially as in *L. aestiva*, but differing in that abutting surfaces of the process and segment 17 are rounded and the joint separating segment 17 from 18 is not hinged as in *aestiva* superspecies (for *aestiva* superspecies, see Giesbrecht, 1892, pl. 23, figs. 3, 4); and (3) the asymmetry in P3 and P4 of Sel on Re2.

In the female, excellent identifying features are found in dorsal view in (1) the combination of the lateral spinous process extending laterad from the right side of TV; and (2) the lateral, hooklike process extending from the left side of the genital segment.

Remarks on Spermatophore Placement and Mating

About 36 percent of adult females carried spermatophores (table 4). A number of females carried more than one, arranged in a variety of combinations of type 1 and type 2 placements. Some carried more than one spermatophore of the same placement, the couplers being arranged in sequence, one on top of the other, the sacs lying parallel to one another.

Type 1 was the most frequent and geographically widespread spermatophore placement observed. In this position the neck is in close proximity to the genital pore although the actual point of contact is obscured by the sheath. The less frequent type 2 occurred sporadically and the mouth of the neck is not in contact or even in close proximity to the segment, the coupler and neck being cemented to the left corner of TV.

In the material at hand, the frequency of type 1 spermatophore placement was more than three times that of type 2, and the latter,

when present, usually occurred in conjunction with a type 1; i.e., most specimens with a type 2 placement also carried another spermatophore in the type 1 position. Type 1 is, therefore, considered to be normal placement on the basis of higher frequency, more widespread occurrence, and the reasonable assumption that the opening to the neck of the spermatophore must be closely associated with the genital pore to provide the female with sperm.

The Punta Frailes sample (table 5) is distinguished by a high proportion of females bearing more than one spermatophore. In this sample, examined in toto, males outnumbered females 1.2 to 1 and 80 percent of females carried one or more spermatophores. This percentage is unusually high in my experience and suggests the time of sampling coincided with a local mating swarm. Sexual swarming, if this in fact occurred, and an excess of males over females, could be the basis for the large number of misplaced spermatophores. In any event, comparison of placement types 1 and 2 provides some insight into the question of sexual behavior in the genus *Labidocera*.

Of primary significance in spermatophore attachment in the Punta Frailes sample is the suggestion of instinctive ritualistic behavior which seems to have a high degree of species-specificity. The complexly arranged coupler is cemented to the female genital segment with such precision that spermatophore position, in addition to form, provides a valid criterion for identifying the species. The fact that type 2 placement is the reciprocal of type 1 can be interpreted as evidence that the male accomplishes coupler placement relative to his position on the female. Since the normal type 1 placement is much more frequent and since only one type of alternative placement has been seen, it can be inferred that the male positions himself in a specific manner relative to the orientation of the female. The predominant co-occurrence of type 1 placements on females bearing type 2 placements suggests further that the former type either deters subsequent males from assuming a type 1 orientation or that a second male grasped a female on the side opposite the normal position already occupied by another male. Instances of two or more spermatophores of one placement type superimposed on one another could be the product of a single male that fails to release the female after cementing the first spermatophore or the outcome of subsequent matings by other males. Abnormal placement of spermatophores in other species of the *jollae* group were not observed.

In all, spermatophores have been examined in 15 species found in the Western Hemisphere and an additional number from Africa and Asian coastal waters (Fleminger, unpubl.). Each species was found to have its own characteristic coupler—sac morphology and placement. One notable point of interest is the fact that the greater the extent of

range overlap between species, the stronger the interspecific differences in spermatophore morphology. For example in the *jollae* group, *diandra*, potentially in contact with both *jollae* and *kolpos*, has a surprisingly unique spermatophore, whereas the latter two are allopatric and show only weak differences in spermatophore morphology.

Complexity and species-specificity in spermatophore morphology and constancy in its orientation with respect to the female urosome are compelling reasons to anticipate ritualistic mating behavior in the genus. *Labidocera jollae* has been observed briefly in copula on two occasions, once in January 1962 (pers. comm., Dr. Bui Thi Lang, SIO) and again in April 1964 (by the author). At first the two individuals were side by side. They quickly changed positions, pivoting about the region of the genital segment like the hands of a clock and causing the prosomes to be pointed in opposing directions while the urosomes crossed at about the level of the genital segments. Claspings lasted for at least 10 minutes. In both instances the observers were unable to note whether a spermatophore was deposited. More extensive observations on copepod mating behavior, however, are available for other genera.

Hill and Coker (1930) provide considerable evidence of ritual associated with copulation as well as a critical time for spermatophore deposition derived from observations on mating in several species of freshwater cyclopoids. They found that, regardless of which female structure was initially grasped, the male would later shift its position until it had secured itself to the female's fourth pair of swimming legs; furthermore, in several species, adult males remained close to or clasped a late stage V female and waited for ecdysis, thus guaranteeing that the spermatophore would be implanted on unhardened cuticle. Fahrenbach (1962) found a pronounced mating ritual in the algal-dwelling harpacticoid *Diarthrodes cystoecus*, while Gauld's (1957) brief notes on mating in some estuarine-coastal planktonic calanoids (*Centropages*, *Temora*, *Eurytemora*, and *Acartia*) also suggest ritual prior to attachment of spermatophore and uniformity of orientation of the male during attachment.

In *Pseudodiaptomus euryhalinus* and *P. coronatus*, copula persists for hours and even days, whereas in *Acartia tonsa* the act is apparently accomplished in less than a minute (Johnson, 1948; Jacobs, 1961). Jacobs (ibid., p. 445) observed that males were more prone to attack "when they chanced to become situated some 5 mm obliquely behind a female, leaving the impression that the attack might be triggered by the female feeding current." Johnson (op. cit.) noted that when isolated *Pseudodiaptomus* males and females are brought together a high percentage of the animals may copulate within a few minutes.

The suggestion that the female feeding current triggers clasping by the *Pseudodiaptomus* male is not without merit; however, cephalic appendages appear to beat at relatively low frequencies. Underwater, low-frequency signals are probably subject to serious limitations for directionality and for separation from background noise. Such signals could be effective only over relatively short distances. Furthermore, no special organs of hearing are known in Crustacea (Cohen and Dijkgraaf, 1961).

Taking note of the commonness of cuticular pores overlying small epidermal glands, the abundance of aesthetascs on the A1 and the more extensive development of the latter in adult males of many families, it seems likely that mate recognition, pursuit and receptivity, the mating attack and locating of the female genital pore, etc., are mediated by chemical trail substances, i.e., pheromones. Feeding and swimming currents would serve to disperse these substances. Parker (1902), working on *Labidocera aestiva*, discusses several simple experiments which support the idea that the male finds the female by means of pheromones.

Polymorphism in *Labidocera diandra*

IMMATURE COPEPODITE STAGES

HEAD-HOOKS.—Head-hooks of the usual form were seen in all immature copepodites (fig. 8*l*) from stages II to V. In copepodite stage I, found only in collections in and around La Paz Harbor, Baja California, in April 1962, both head-hooks and rostrum were absent. Except for the absence of head-hooks in adult *diandra* these findings agree with Johnson's (1935) account of rostrum and head-hooks in the ontogeny of *L. jollae*.

Regarding the ontogeny of other species of *Labidocera*, head-hooks are lacking in all stages of *L. trispinosa*, a fact established by Johnson (1935) and verified during the present study. For comparative purposes, I have also examined immature copepodite stages of other species of *Labidocera* at my disposal (table 6). No instance was found that paralleled the secondary loss of head-hooks³ seen in

³ I have found two specimens of *Labidocera* in collections from Mombasa, Kenya (Lusiad Expedition, lat. 4°04' S, long. 39°39' E, VII-24-1962, tow 1, 1824-1829 hrs., tow 2, 1852-1859 hrs., ½ m net, 3-0 m depth) that agree in all particulars with *L. kroyeri* except that head-hooks are lacking. No younger copepodites, males or normal *kroyeri* females were present in the two samples. I have seen normal *kroyeri* in a collection from Ceylon (Lusiad Expedition, VIII-28-1962, 1807-1817 hrs., 1 m net, 3-0 m depth, in Colombo, Ceylon Harbor). Brady (1915) included *kroyeri* in a list of copepods from Durban Bay, South Africa, but failed to include notes on its appearance.

diandra, but it should be pointed out that the list in table 6 represents less than half of the described species.

The presence or absence of head-hooks in pontellids, and especially in *Labidocera*, has been widely regarded as a feature of considerable taxonomic significance. Obviously, if head-hooks can vary in occurrence intraspecifically, their usefulness to phylogeny hinges upon a thorough survey of all species in the genus. Head-hooks are found in other pontellid genera (*Anomalocera*, *Pontella*, *Calanopia*, *Ivellopsis*, *Epilabidocera*) but not necessarily in all species of these genera. They are characteristically absent in two other genera (*Pontellopsis*, *Pontellina*). Based on this distribution, head-hooks may be regarded as an older generalized feature that is losing adaptive value in some of the younger phyletic lines. Certainly, revision of *Labidocera* is

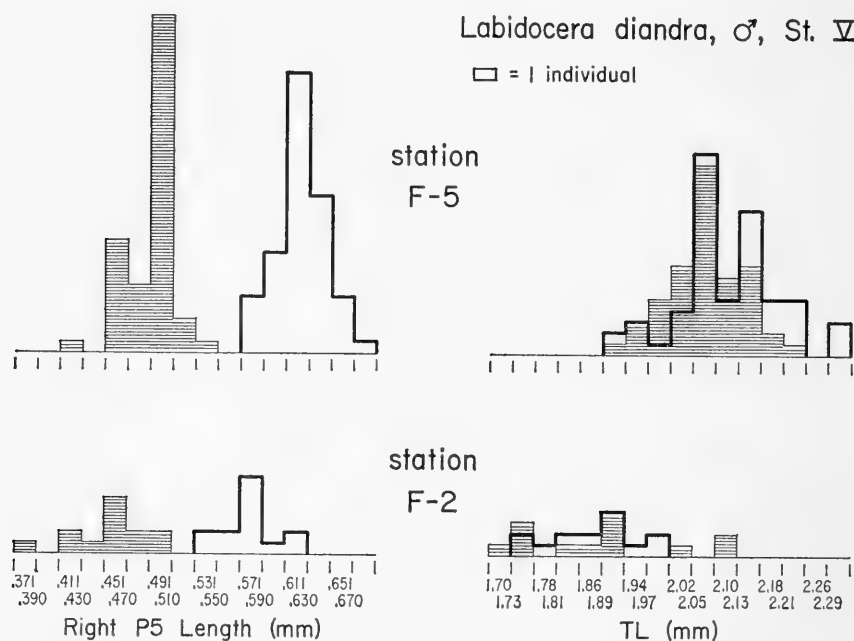


FIGURE 12.—Size distribution of right leg 5 (P5) and total length (TL) in male *Labidocera diandra*, stage V copepodites, collected at stations F2 and F5 (horizontal hatching=morph B males; heavy line=morph A males; specimens selected at random and measured at 60X magnification).

not merely a matter of grouping species according to (1) the presence or absence of head-hooks in adults and (2) urosomal segmentation in adult females, as suggested by Sewell (1956). Not only are head-hooks undependable but the urosome is variously two and three segmented in head-hooked and nonhead-hooked species alike.

P5.—In the stage V female the P5 exopod (figs. 6*i*, 9*d*) bears three short, lateral, spinulose processes. The apex is spiniform and the left leg is slightly smaller than the right. The female P5 increases uniformly with subsequent moults, following appearance of the appendage in stage IV (figs. 9*g*, 14); lateral spinous processes on the exopod disappear in stage VI (fig. 6*b*).

LABIDOCERA DIANDRA STAGE V ♂

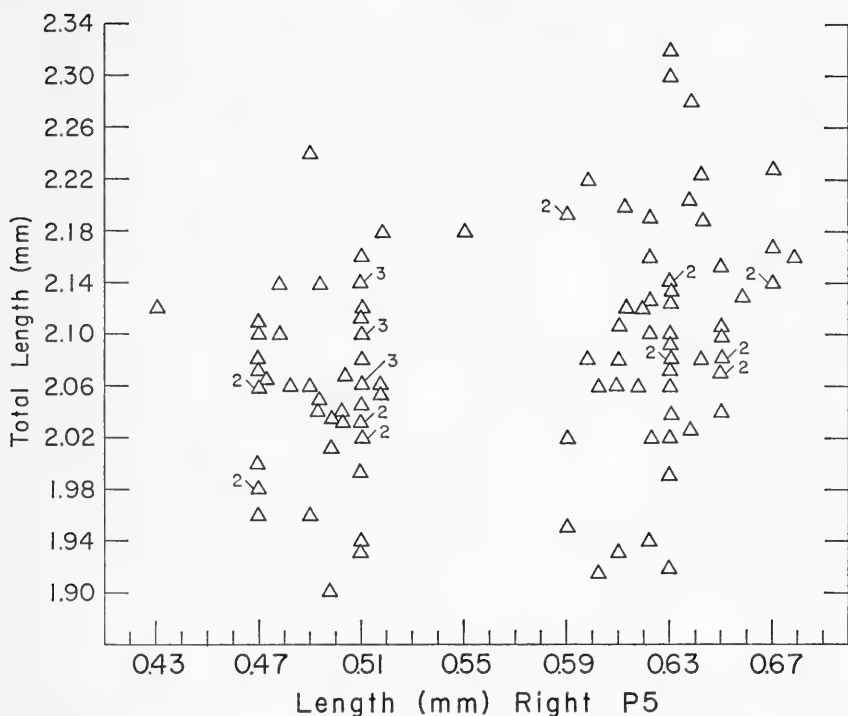


FIGURE 13.—Scatter diagram comparing length of right leg 5 and total length in male *Labidocera diandra*, stage V copepodites (measurements taken from lateral view at 62.5× magnification, using undissected specimens, appendage length extending from line of articulation of protopodite with tergite to apex of ramus; specimens selected at random from sample F5).

The stage V male P5 (fig. 7*i*) resembles that found in *jollae* in the arrangement of spinous processes and basic proportions. It differs in lacking rudimentary endopodal lobes and in having a knoblike protrusion on the median side of the left ramus.

Stage V males can be separated into two groups (morph 1 and morph 2) based on length of P5 (figs. 9*e,f*). This division, into a longer and

a shorter length, occurs irrespective of the individual's TL (figs. 12, 13, table 7). TL distribution among the two morphs differ only slightly and in the same direction and degree as morph A differs from morph B in adult males (table 8). P5 size distribution in stage IV males does not appear to be bimodal (fig. 14).

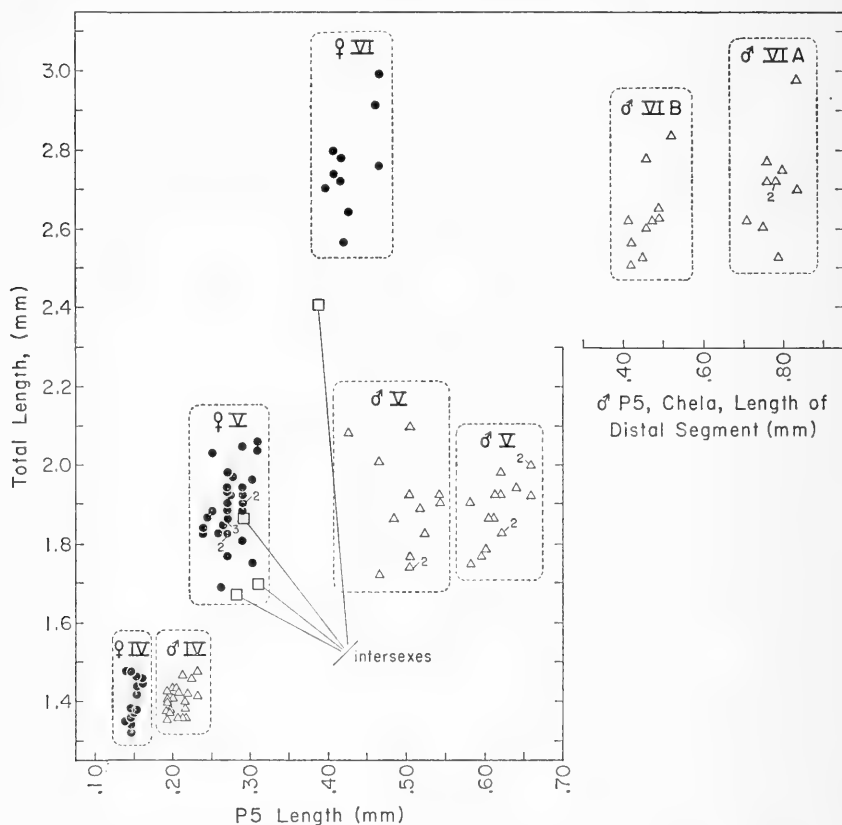


FIGURE 14.—*Labidocera diandra*: at left scatter diagram comparing length of right leg 5 to total length in male Δ and female \bullet , stages IV and V copepodites and stage VI female; in upper right, scatter diagram comparing length of distal segments of chela with total length in stage VI male (chela measured by planimeter from camera lucida drawing of posterior view; segment length determined along inner perimeter relative to mouth of chela; specimens selected at random from station F2).

In the moult to stage VI, the terminal segment of right P5 divides to form the chela, the proximal segment becoming the thumb, the distal segment the finger. Assuming that the lateral spinous processes on this leg in stage V are homologous to setous-like spines in the adult chela, the proximal segment in the adult appears to be a fusion of Re1 and Re2, while the distal segment comprises Re3. Immature stages of female and male P5 are compared in figure 9.

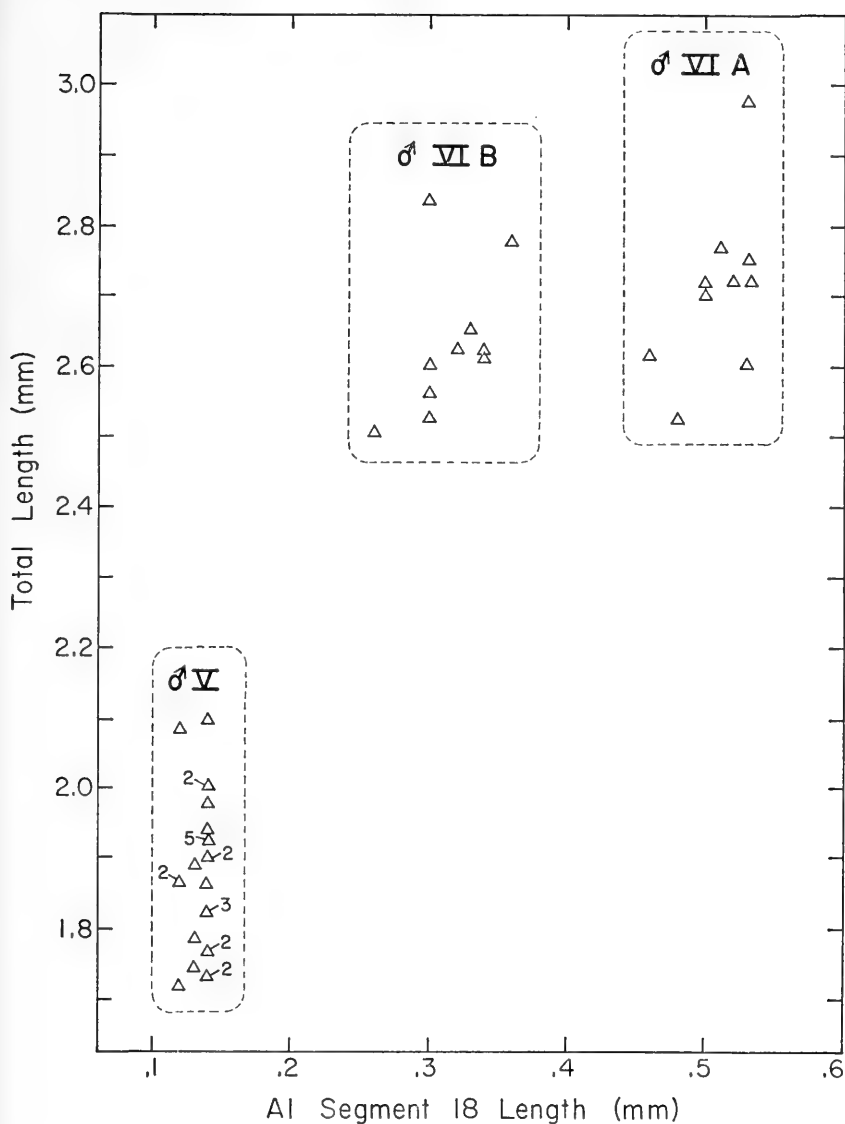


FIGURE 15.—*Labidocera diandra*: scatter diagram comparing total length to length of segment 18 of right antennule in male stages V and VI (length of segment 18 taken with planimeter from camera lucida drawings along anterior perimeter from apex of proximal process to distal limit of segment; specimens chosen at random from sample F2).

MALE RIGHT ANTENNULE.—In the penultimate male the right A1 is similar in morphs 1 and 2 (fig. 7j). This appendage is distinguished from that in *jollae* and *kolpos* by the presence of a prominent spur extending distad on the sixth from the last segment. Based on clusters of two-three setae and intersegmental sutures, the terminal segment represents fused segments 24 and 25 in the adult, and the spur emanates from segment 19. The process on segment 19 extends distad overlapping segment 20. In the adult stage segment 19 is fused with segments 20 and 21, the fused unit bearing a denticulated ridge (friction plate). It would appear that the spur on segment 19 in the penultimate stage is the precursor of the denticulated ridge in the adult. A similar spur has been observed in stage V males of the *mirabilis* group found in the Gulf of Mexico, Bahamas Islands region (Fleminger and Tan, 1966).

In the stage V copepodite there is no indication of bimodality in the length of segment 18 (fig. 15). The mean length of segment 18 is 0.1360 mm in morph 1 and 0.1358 mm in morph 2; the difference is not significant. The proximal extension of the denticulated ridge on segment 18, or its precursor, is not present prior to stage VI (fig. 7j).

RELATIONSHIP BETWEEN STAGE V AND STAGE VI MALES

Both stage V and stage VI males are dimorphic; i.e., each is bimodal in some morphological aspect and one or more of the involved structures differ discontinuously and are nonoverlapping. In stage V, morph 1 differs from morph 2 in the length of the right P5 exopod, the anlage of the chela. Also, the mean TL of morph 1 is slightly larger than that of morph 2. In stage VI, morph A differs from morph B in details of the right A1, the size and shape of the chela, and in the mean TL being slightly larger than that of morph B. In the right A1, segment 18 does not exhibit bimodality prior to stage VI (fig. 15). Pursuing the chela relationships one more step, the longer, slenderer exopod of right P5 in morph 1 would be expected to produce the larger, slenderer chela of morph A, while the shorter, stockier right P5 exopod of morph 2 is more likely to yield the smaller, stocky chela of morph B (fig. 14). Other things being equal, these parallel relationships and size similarities (table 8) provide a reasonable basis for postulating that at maturity morph 1 yields morph A adults and morph 2 produces morph B adults.

There is no obvious agreement in the relative abundance of the morphs between stages V and VI (table 9). The ratio of stage V and stage VI morphs vary widely in individual samples and in the summed totals as well. This may not constitute a denial of the postulated relationship of the four morphs since genetic polymorphism provides the species with a rapid process for resolving adaptation

to recurrent environmental fluctuations (see Ford, 1964, for examples and discussion). Evidence that the male morphs of *diandra* have a genetic origin is presented below.

Polymorphism of sexual structures in marine Calanoida is not a familiar phenomenon. One case presented in an unpublished thesis by Fleminger (1956) involves *Pontella meadii*, a surface species inhabiting transitional warm-temperate coastal waters of the eastern United States. In this area the offshore climate provides a year-round warming influence that is overcome to varying degrees in winter by the continental climate. The resulting seasonal changes are probably not too dissimilar to the variable conditions experienced by populations of *L. diandra* in the northern segment of its range and in areas of seasonal upwelling. Two forms of the adult male of *P. meadii* are known, one described by Wheeler (1900) and the other described as *P. pennata* by Wilson (1932). Regarding the female, Wheeler worked only with stage V copepodites and apparently assumed they were adult. Wilson described the adult female as *pennata* along with the larger sized male morph. More recently, Haq (1960, 1965) reported finding genetic polymorphism in laboratory-bred *Euterpina acutifrons* (Harpacticoida). Two morphologically different kinds of adult male are described. Johnson (1964) found two kinds of male of *Pseudodiaptomus wrighti* which differ in several structural features including the size of the fifth pair of legs; however, only three examples of the morph with the larger fifth legs were observed in the hundreds of male specimens examined. In *L. diandra* and *P. meadii* both morphs are relatively common and occur throughout the range of the species.

DEVIATION IN THE SEX RATIO IN *LABIDOCERA DIANDRA*

Comparison of the relative abundance of males and females in *diandra* revealed a conspicuous deviation in the adult stage from an expected 1:1 ratio (table 9). Abundance estimates were obtained by tabulating the species in the entire sample, excepting tow F-5; for the latter a large subsample was counted.

Using pooled data stage V males and females do not differ significantly from a 1:1 ratio ($\chi^2=7.58$, $p=0.025-0.020$). In the adult stage, however, males exceed females by 1.0:0.69, the deviation from 1:1 being highly significant ($\chi^2=157.5$, $p=<0.001$). These relationships apply to summed data but not necessarily to values obtained from any single collection.

Despite extensive variation in the numbers of adults, males exceeded females appreciably in six of the seven large collections of the species. In the seventh (El Golfo station 24), males are too rare for the sample to be regarded as representative. Considerable variation in the rel-

ative numbers of A and B males should also be noted since they conflict with the alternative that only one of the two males is conspecific with the female. If we assume that the two males are not conspecific and that the probable sex ratio approaches 1:1, to account for the quantitative data on hand requires an additional complicating assumption, namely, that there are two kinds of females that are morphologically indistinguishable (i.e., in the characters that have been examined). The two species alternative would have to provide for the co-occurrence of the two species over the same limited geographical range, when as a rule closely related species of *Labidocera* do not overlap extensively (Fleminger, unpubl.). Thus, this line of reasoning becomes burdensome without necessarily contributing to a better understanding of the extant data.

Assuming the *diandra* population as described above is conspecific, three facts stand in evidence that the dimorphism is under relatively simple and direct genetic control, namely: (1) dimorphism occurs throughout the range; (2) there is no intergrading of dimorphic characters; and (3) dimorphism is sex linked. These three points also prevail in the case of *Pontella meadii* referred to in the preceding section.

One hypothesis can account for both the basic features and variability of the unusual sex ratio in adults and the polymorphism in males. It requires the following assumptions: that the male is the heterogametic sex, that the gene (or polygene) controlling morph type is on the X chromosome, and that one class of homozygote females fails to achieve sexual maturity; hence, the frequency of adult males in a deme would reflect the local frequency of the A and B alleles and this, in turn, should agree with the ratio of adult females to males on the basis of the Hardy-Weinberg equilibrium.

The hypothesis also accounts for a 1:1 sex ratio in stage V copepodites. Presumably, the polymorphism is adaptive in that the heterozygote female conserves both alleles and the local population benefits in having the ability to rapidly shift its genotype to meet crucial changes in local environmental conditions. In some aspects the available data fit this model surprisingly well (table 9); however, the lack of concordance between adult and stage V morph frequencies and the overall sparseness of the data emphasize the need for more intensive collections representative of both range and seasonal fluctuations. Obviously, ultimate confirmation that genetic polymorphism is the basis for the observed facts will require breeding experiments.

Relationship of the *jollae* Group to the Genus

The three species described above are considered a species group, in the sense of Mayr (1963), as a consequence of sharing essential morphological similarities and occupying successive geographical

ranges. Adults of this group show two characteristics which set them apart from the remainder of the genus, namely: (1) antennules with segments 8 and 9 partially fused; and (2) mandibular gnathobase with basal teeth 1 and 2 usually bicuspidate. The *jollae* group is further distinguished from their closest relatives, the *mirabilis* group (Fleminger and Tan, 1966) in the retention of head-hooks (except in adult *diandra*).

A large number of morphological features are shared exclusively by the *mirabilis* and *jollae* groups. This and their endemism in the Americas constitute a firm basis for combining them in the *wilsoni* superspecies as proposed by Fleminger and Tan, (1966). This superspecies is characterized by (1) short rostral prongs, which have a swollen proximal portion and are separated in frontal view by a triangular notch (fig. 10); (2) separation of TIV and TV; (3) two-segmented, asymmetrical urosome and usually asymmetrical caudal rami in the female; (4) male left leg 5 usually short, terminal segment padlike, densely pilose and bearing three minute spines or setae or none at all; (5) male lacking specialized outgrowths on right corner of TV; and (6) male with asymmetrical exopodal spines on one or more pairs of swimming legs. Also noteworthy is the strong overall similarity of immature stages, especially in such critical features as the fifth legs and rostrum and the crimson bodies in the thorax.

Other head-hooked species differ from the *jollae* group in having (based on various sources including unpublished observations of the author) (1) relatively long, slender rostral prongs; (2) nongeniculated antennule segmentation numbering 24(24-25 fused) or, if 23, with 6-7 and 24-25 fused; (3) female with three-segmented urosome; (4) male left leg 5 more than one half the length of right leg 5, terminal segment of former with several robust spiniform or setiform processes, conspicuous and often incompletely fused to segment; (5) male TV usually asymmetrical, right posterior corner being variously modified; and (6) male right antennule with segment 17 bearing modified seta antieriad, more or less ridgelike.

The *wilsoni* superspecies shows morphological affinities with another assemblage of predominantly Indo-Pacific species of which *L. detruncata* is characteristic. This resemblance is restricted to a few structures modified by secondary sexual development and lacks the support of similarities in rostrum configuration and A1 segmentation. In reviewing the genus, division of the species among groups and superspecies has proven most helpful and provisional monophyletic aggregations are given below.

Superspecies *wilsoni* (coastal, temperate to subtropical).

jollae group: *L. jollae* Esterly, *diandra*, new species, *kolpos*, new species (west coast, North America).

mirabilis group: *L. mirabilis* Fleminger, *wilsoni* Fleminger and Tan (southern Florida, Bahama Islands).

Superspecies *detruncata* (mostly tropical, neritic or island forms of Indo-Pacific): *L. detruncata* (Dana) (Indo-Pacific, oceanic), *orsinii* Giesbrecht, *gangetica* Sewell, *cervi* Krämer, *caudata* Nicolls, *bataviae* Scott, *madurae* Scott, *pavo* Giesbrecht, species Farran (1936) (Indo-Pacific, neritic-island forms), *nerii* Kröyer (Atlantic, oceanic).

Superspecies *darwinii* (predominantly neritic):

trispinosa group: *L. trispinosa* Esterly, *johnsoni* Fleminger, *lubbockii* Giesbrecht (western American coast).

ungrouped species: *L. darwinii* Lubbock (southeastern South America), *fluvialitus* Dahl (eastern South and Central America), *aestiva* Wheeler (eastern North America), species (in preparation, subtropical-tropical America), *scotti* Giesbrecht (west Africa), *brunescens* Czerniavski (Mediterranean, west Africa), *acutifrons* (Dana) (subtropical panoeceanic).

Superspecies *kroyeri* (predominantly neritic, Indo-Pacific): *L. kroyeri* (Brady), *pectinata* Thompson and Scott, *bipinnata* Tanaka, *japonica* Mori, *minuta* Giesbrecht, *bengalensis* Krishnaswamy, *rotunda* Mori, species Dakin and Colefax (1940).

Unassigned species (predominantly neritic): *L. glauca* Smith (Philippines), *laevidentata* (Brady) (Indo-Pacific), *euchaeta* Giesbrecht (Indo-Pacific), *wollastonii* (Lubbock) (western European coast, Mediterranean), *acuta* (Dana) (Indo-Pacific).

Species based on immature stages, or otherwise doubtful: *L. simplex* (Dana), *crispata* (Dana), *exigua* (Dana), *frivola* (Dana), *media* (Dana), *hebes* (Dana), *inermis* Brady, *chubbi* Brady, *agilis* (Dana).

Relationships Within the *jollae* Group

The *jollae* group is geographically isolated from the *mirabilis* group as well as from other head-hooked species of the genus. As shown above, the group is indigenous to coastal waters of western North America. The three species of the group succeed each other geographically, each occupying a biogeographically distinct portion of the coastline from California to Mexico. *L. jollae* is found in temperate waters off California and northern Baja California. *L. diandra* occurs in the subtropical waters of southern Baja California and further south along the Mexican mainland. *L. kolpos* is isolated in the upper half of the Gulf of California where conditions are often unusually warm but must be regarded as temperate for year-round residents (Hubbs, 1948; Roden, 1958, 1964; Roden and Groves, 1959); hence, the two temperate species are allopatric, but, independently, the range of each extends south to the northern limits of *diandra*.

Considering range relationships, character differences (Schoener, 1965) in TL (fig. 16) and PUR (fig. 17) deserve closer examination. Turning first to the allopatric pair, *jollae* and *kolpos*, TL and PUR values are remarkably similar. In the male sex, *jollae* exceeds *kolpos* in TL by about 7 percent (difference between means, Student *t* test,

$p < .001$). Differences between the sexes, however, are much more conspicuous (table 10). In fact, using mean TL values, males are 16 percent (*jollae*) and 21 percent (*kolpos*) smaller than their respective females. In PUR the median ratio in males is about 30 percent smaller than in females in both species. The urosome is, in general,

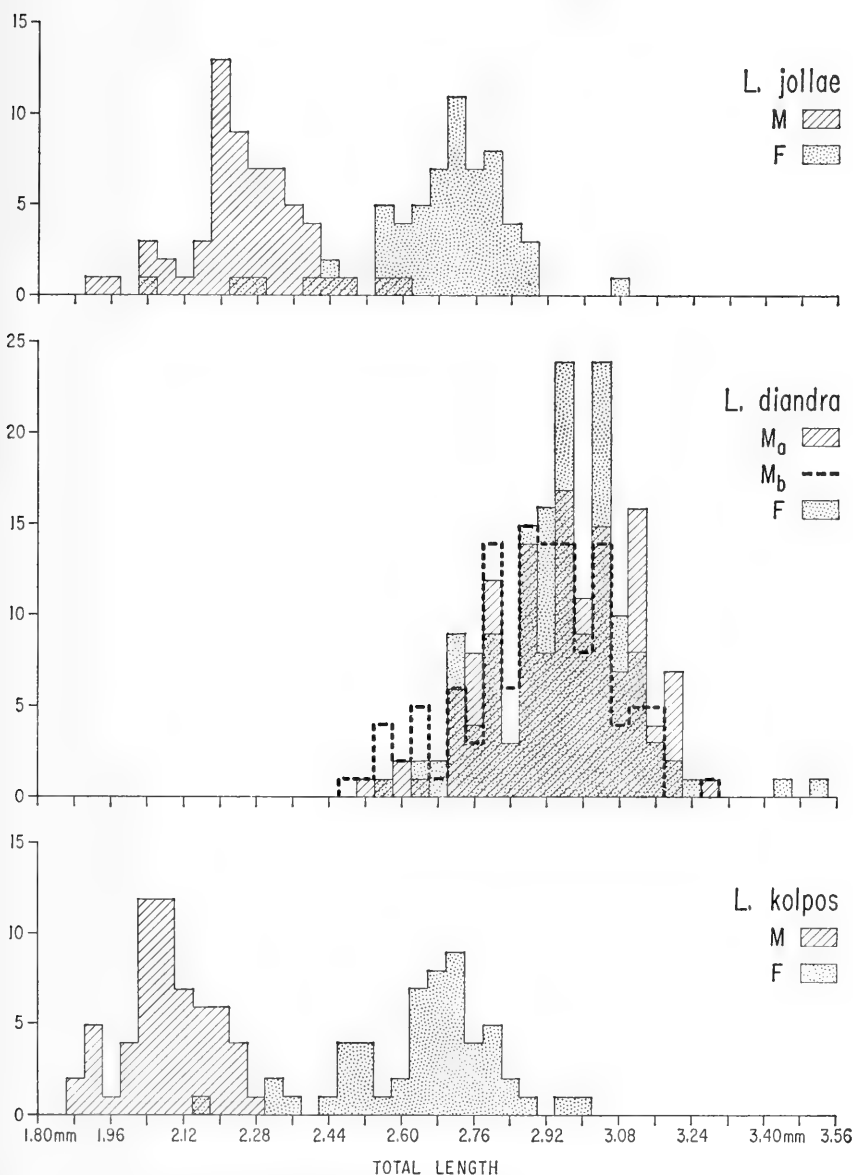


FIGURE 16.—Distribution of total length in the *jollae* group.

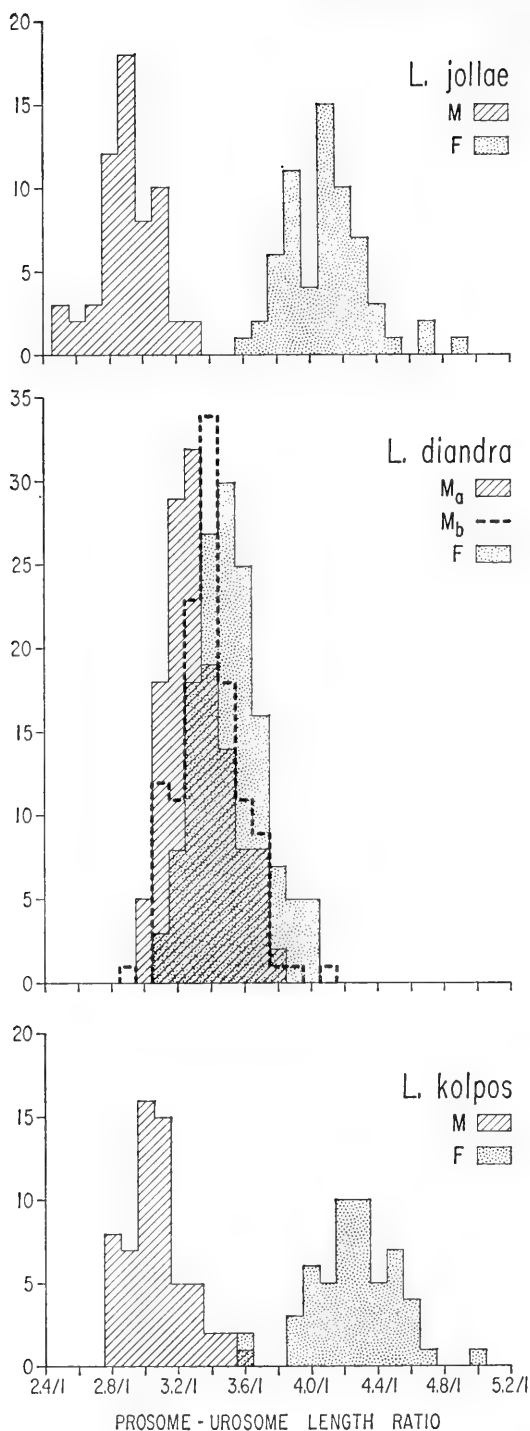


FIGURE 17.—Distribution of prosome-urosome length ratio in the *jollae* group.

slightly larger in males (ca. 0.04 mm) despite the larger TL in females. On the other hand, the prosome is about 0.5 mm smaller in the male.

TL-PUR relationships in *diandra* are surprisingly different from those in *jollae* and *kolpos*. Males and females not only fail to differ appreciably, but have essentially the same ranges, means and medians. There are other notable differences as well. Both sexes of *diandra* tend to be considerably larger than their counterparts in *jollae* and *kolpos*. In the male sex there is virtually no overlap in TL range between *diandra* and the other two species (fig. 16). In the female sex the smallest sized *diandra* occur near the middle of the range for *jollae* and *kolpos*. On the other hand, the entire distribution of PUR in *diandra* falls midway between the gap separating the two sexes in *jollae* and *kolpos*.

In other words, these data show that for each species of the *jollae* group, males and females either barely overlap or completely overlap in the distribution of TL and PUR; furthermore, the geographical arrangement is such that only unlike pairs of species have a measure of geographical contact—that is, the pair of species with the same TL and PUR characteristics, *jollae* and *kolpos*, are geographically isolated from one another. In contrast, *diandra*, bordering on the geographical range of each of the other two, differs not only in the distribution of TL and PUR ranges, but also in having males and females sharing the same values.

Bayly (1962, table 9) working with a fresh water calanoid, *Boeckella propinqua*, presents evidence that the proportional relationship of female length to male length remains fairly constant despite seasonal changes in absolute length of adults. Using his values, the ratio $\bar{q} \times \text{length} / \bar{\sigma} \times \text{length}$ in *B. propinqua* varies from 1.09 to 1.24 with a median of 1.12. He later (1964) expressed the opinion that this ratio tends to vary significantly among different species of *Boeckella*.

The significance of sexual and interspecific differences in TL and PUR should become more apparent after more is known about the behavior of species in the *jollae* group; however, the probability that they came about by chance alone seems most unlikely. For one thing, if mating is instinctive and ritualistic as previously discussed (pp. 27–29), the range limits of certain body proportions should prove to be critical. Successful mating requires the male to eject, position, and cement a complicated coupling device about one-third of TL while limited in movement because it must hold the female with its clasping appendages and maintain a position from which accurate spermatophore placement is feasible. On the basis of the differences in TL and PUR shown above, one or more details of copulatory behavior of *diandra* may differ appreciably from that of *jollae* or *kolpos*. On the other hand, there is no reason to anticipate such a difference

among the morphologically similar but allopatric species, *jollae* and *kolpos*.

We can only speculate as to the mechanics of a key-lock mechanism for inhibiting hybrid mating in the *jollae* group. The existence of such a mechanism at this time rests on the absence of hybrids and the fact that no *Labidocera* adult female of any species has been seen bearing the spermatophore of another species. In general, copulation in crustaceans occurs soon after the female moults and before the cuticle has hardened. If this is true in pontellids, the possibility of damage makes it unlikely that female secondary sexual characters are subjected to great pressure during clasping or when used as sites for leverage. As noted earlier, the *jollae* male has been observed holding the female about the urosome with its chela. To avoid injury to the recently moulted female and to permit whatever maneuverability is needed for manipulating and cementing the spermatophore, the chela could serve as a ring loosely encircling the female urosome. The urosome in turn should have the means to prevent both interference with prosome-urosome articulation and separation of the mating pair, i.e., suitably placed anterior and posterior mechanical stops.

In the *jollae* group the female genital segment anteriorly bears one or more conspicuous swellings and posteriorly it expands gradually in circumference somewhat like a plug. In *diandra*, a strong shoulder abruptly increases the posterior girth of the elongated genital segment while in *jollae* and *kolpos* the right caudal ramus is greatly expanded beyond the lateral limit of the urosome. These otherwise peculiar asymmetries appear to fulfill the requirements for mechanical stops limiting the extent of slippage of an encircling chela. In fact, the arrangement in *diandra* appears to be equally effective for both male morphs.

Evolution of Specific Characters in the *jollae* Group

Comparison of the three species described above reveals one outstanding feature. Despite predominantly allopatric ranges, morphological separation of these species is concentrated in secondary sexual characters. On the other hand, no apparent differences were seen in either feeding or swimming structures unaffected by sexual maturity; that is, the three species show unmistakable evidence of strong selection pressure for diversification of copulatory structures but little to no modification from basic morphology of other adaptive structures.

The possibility that copulatory adaptations differentiated as such in totally allopatric daughter populations cannot be ruled out at this time; however, the likelihood of achieving by chance the orderly

arrangement of morphology and morphometry seen in the *jollae* group seems remote indeed.

A more likely alternative is suggested by comparing differences among the geographically contiguous pairs of species with those of the one totally allopatric pair. In contiguous species conspicuous differences appear in both morphology and morphometry. The allopatric pair, *jollae* and *kolpos*, are spatially separated by a broad, biogeographically inimical, zone. Morphological distinctions are weak and the two species share the same morphometry.

Turning to the eastern American cognates, Fleminger and Engchow (1966) show that morphological and morphometrical differences among the geographically contiguous species, *L. mirabilis* and *L. wilsoni*, closely parallel differences between contiguous pairs of the *jollae* group (table 11). In *wilsoni* the two sexes are similar in TL and PUR, in *mirabilis* they differ conspicuously in both features and to about the same degree as in *kolpos* and *jollae*. Some of the more notable morphological differences among the eastern species are the position of the female genital pore, the length of the male's left leg 5, and the position and extent of development of specialized exopodal spines on male swimming legs.

Table 11 also reveals another surprising feature. Males of the *mirabilis* group have a median PUR in excess of 5:1, while males of the *jollae* group have a median PUR of less than 3.5:1. Could this difference reflect the evolutionary imprint of earlier interactions when sea passages connected the eastern and western American coasts—or did they, too, arise by chance in isolation?

Repetition of the pattern in contiguous species on both coasts and the deviation in the one totally allopatric pair within a group are compelling reasons for exploring further into the argument for interaction. We may assume with Mayr (1963) that incipient reproductive barriers arise in isolated daughter populations as a byproduct of provincial adaptation. In the case of incipient species, the provincialism would impose a selective disadvantage on hybrid mating after geographical isolation breaks down. This in turn would increase selection for strengthening copulation barriers among newly overlapping daughter populations (see reviews of Brown and Wilson, 1956; Blair, 1958; Sibley, 1961; and discussion of Brown, 1957, 1958). Selection for reproductive barriers to reduce hybridization in response to this interaction is usually termed reinforcement. It is akin to character displacement, both being a product of sympatry of closely related species. Reinforcement leads to reproductive incompatibility while character displacement permits ecological compatibility.

Natural selection against interactions that waste gametes can be expected to act upon the ethology of mating as well as on the copulatory mechanism. Evidence of ritualization and species-specificity in copepod copulation has already been discussed above. Lacking direct observations, mating ethology, morphology, and morphometry in the *jollae* and *mirabilis* groups can be related only by inference. Another necessary assumption is that sympatry of the contiguous species has been more extensive in the past than is indicated by the known distributions. In support of more extensive sympatry is substantial evidence that the California-Mexico coastline has continuously experienced both large and small-scale climatic and hydrographic flux.

The development of the *jollae* group as a distinct evolutionary unit probably begins with complete emergence of the Panamanian Isthmus and we can safely assume that the group is the outcome of a Quaternary history. Alternating periods of extensive sympatry and allopatry could have followed the familiar pattern of successive warming and cooling trends during North American Pleistocene. Zeuner (1959) points out that biotope replacement occurred about 10 times or more on the continent. Paleontological-geological evidence of the extensive changes that occurred along the Pacific coast has been reviewed by Durham and Allison (1960), Hubbs (1960), and Allison (1964).

Opportunities for variation in range relationships within the *jollae* group are not necessarily tied to the more or less 10,000-year intervals of glacial and interglacial stages. Within geological epochs we have evidence of more provincial warming and cooling trends that can shift hydrographic and faunal properties hundreds of miles off California and Baja California (Hubbs, 1948; Brinton, 1960; Berner, 1960; Reid, 1960; Berner and Reid, 1961); moreover, on an annual basis seasonal countercurrents flowing from the south alternate with periods of upwelling and concomitant strengthening of California Current flow from the north (Reid, Roden, and Wyllie, 1958; Reid, 1960; Schwartzlose, 1963) provide the pathways for range extensions and intermingling of *diandra* and *jollae*. In the Gulf of California monsoonal wind conditions (Roden, 1964) provide *diandra* and *kolpos* with similar opportunities. The polymorphism observed in *diandra* can be regarded as evidence that the species is regularly subjected to extensive environmental changes (Ford, 1964).

Considering their morphological affinities *jollae* and *kolpos* were separated recently, perhaps in connection with Wisconsin and post-Wisconsin events. The cooler phase would have extended the range of the ancestral population south beyond Cabo San Lucas. A northward shift in the range could be expected to follow diminution of the

cool period. This in effect would trap one segment in the upper Gulf of California while the Pacific coast population retreated north of Magdalena Bay. Parallels have been noted in the temperate fishes of the two regions and accounted for by the same reasoning (Hubbs, 1948; Walker, 1960). Following isolation of the daughter populations, it is likely that the initial adaptations were physiological since the chemical, physical, and climatic properties of the two regions show notable differences. The distinguishing morphological features, centered in sexual structures, could have come about by reinforcement, in response to subsequent genetic exchange between the two populations during especially cold periods.

In the above discussion the action of reinforcement has been proposed as the basis for explaining the extant patterns of morphology with respect to range. Examination of other closely related complexes should be made to obtain more direct evidence that reinforcement occurs in planktonic populations; that is, we should determine whether species-specific differences in an area of overlap between closely related species would be more pronounced than in the allopatric portions of the range of each. Study of Fleminger's (1964) *trispinosa* group (genus *Labidocera*) has yielded evidence of reinforcement in several morphological features and will be presented elsewhere in the near future.

Assuming that reinforcement of reproductive isolation is the basis for the extant morphological patterns in the *jollae* group, why is it that no pair of species has successfully adapted to some degree of sympatry? In the *trispinosa* group, each pair of adjacent species share several hundred miles of common range but each species' range also includes a more extensive nonoverlapping segment. Another point to consider is whether reinforcement is evidence that the *trispinosa* group is in an earlier stage of development than that attained by the *jollae* group. Further study of the biology and distribution of these groups should prove enlightening as to the mechanics of dispersion, gene flow, and competition among planktonic Crustacea.

Summary

Three closely related species inhabiting coastal waters of western North America and referable to the genus *Labidocera* are described. Two of the species are new. Geographical relationships among the three species are established and morphological differences compared between allopatric and incompletely sympatric pairs. The location and strength of character differences in the light of geographical relationships is noted and the likelihood that reinforcement of secondary sexual characters has played a major role in evolution within the group is discussed. Mating behavior within the group is also considered.

A genetic model consistent with varying sex ratios and proportions of polymorphic forms in field collections is proposed to account for the widespread polymorphism discovered in males of one of the new species. The relationship of the *jollae* group to the remainder of the genus is discussed.

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TABLE 1.—*Labidocera jollae*: collecting data and measurements ($1m/O = \text{CalCOFI plankton net}$, $1m$ = mouth diameter, oblique tow; $1m/H = \text{opening-closing plankton net}$, $1m$ = mouth diameter, horizontal tow; $1/2m = \text{standard plankton net}$, $1/2m$ = mouth diameter)

Position			Locality or station no.	Net/tow/ depth (m)	Date	Time (PST)	Temp. °C at 10 m	Sal. ‰ at 10 m	No. specimens	TL (mm)			PUR	No. Ad./Tow
Lat. N	Long. W									Range	Mean	Range		
37°54'	123°02'		5901	60.52	I-18-59	0050			1 ♀ ad.	2.76		3.8:1		1
37°54'	123°02'		6210	60.52	X-18-62	0853	13.03	33.40	1 ♀ ad.	2.68		4.3:1		2
									1 ♀ V	2.10		4.4:1		
36°05'	122°00'		6201	70.55	I-17-62	1415	12.16	33.59	1 ♂ V	1.77		3.3:1		1
34°18'	120°48'		6201	80.55	I-14-62	0533	13.13	33.52	1 ♂ ad.	2.29		2.9:1		3
									1 ♀ ad.	3.07		3.9:1		
33°28'	117°47'		5206	90.28	IV-13-52	0918	18.2		1 ♂ ad.	2.61		2.7:1		10
33°40'	118°02'		San Pedro Harbor	$1/2m/H/1$	V-60/IX-61		(Observed regularly in 16 month series of daily samples)							
32°52'	117°16'		Scripps pier	$1/2m/V/3-0$	VIII-9-62	2000			1 ♀ ad.	2.48		3.9:1		nq
									1 ♀ V	1.83		4.2:1		nq
									2 ♂ ad.	2.16-2.18		3.1:1		
32°38'	117°14'		San Diego Harbor	$1m/H/1$	III-9-64	1000			23 ♀	2.58-2.88	2.74	3.6-4.4:1	4.1:1	nq
									23 ♂	2.10-2.47	2.30	2.5-3.3:1	2.9:1	
31°31'	117°07'		6210	100.35	XI-4-62	0005	17.88	33.67	1 ♂ ad.	2.20		3.0:1		1
31°05'	116°25'		5804	103.30	IV-23-58	0453	17.42	33.58	1 ♀ ad.	2.63		4.2:1		1
29°50'	115°52'		6207	110.32	III-19-62	0225	15.06		1 ♀ ad.	2.66		4.4:1		<50
									1 ♂ ad.	2.32		2.9:1		
28°00'	114°47'		5808	120.34	VIII-18-58	0315			2 ♀ ad.	2.07-2.24		4.2:1		nq
									1 ♀ V	1.62		4.5:1		
									2 ♂ ad.	1.93-2.07		3.0-3.3:1		
28°02'	115°18'		Cedros Harbor	$1m/V/5-0$	VI-16-61	2000			1 ♂ ad.	2.37		2.8:1		nq
27°43'	115°33'		6106	120.45	VI-14-61	2045	16.36	33.76	10 ♀ ad.	2.57-2.80	2.68	3.7-4.2:1	3.9:1	400
									3 ♀ V	2.11-2.22	2.17	4.2-4.6:1		
									1 ♂ ad.	2.56		3.2:1		1
									1 ♂ V	1.73		3.2:1		

27°33'	115°52'	5504	120.50	1m/H/1	IV-21-55	2015	15.30	3 ♀ ad. 1 ♂ ad.	2.80-2.84 2.22	2.82	3.9-4.2:1 3.1:1	10 nq
27°08'	114°10'	Asuncion Bay		1m/H/1	VIII-14-58	0810	21.50					nq
26°56'	113°50'	Hipolito Bay		1m/H/1	VIII-13-58	1210	23.20					nq
26°29'	113°29'	6207	130.30	1m/H/1	VII-29-62	0715	18.29	34.11	2.57-2.81	2.65	4.1-4.9:1	550
26°26'	113°29'	6204	130.30	1m/H/1	IV-27-62	1600	14.53	33.86	2.68-2.85	2.77	4.0-4.5:1	21
									16 ♂ ad.	2.27	2.8-3.1:1	
									8 ♀ V	2.00	4.0-4.4:1	
									12 ♂ V	1.81	3.0-3.5:1	nq
25°20.5'	112°06.3'	Boca de Soledad		½m/H/1	II-5-64	1200			2.07	3.0:1		nq
25°16.5'	112°07.5'	Boca de Soledad		½m/H/1	II-7-64	1100			2.00-2.15	2.8-2.9:1		nq
24°46'	112°24'	6204	140.30	1m/H/1	IV-30-62	0700	16.32	33.98	2.29-2.45	4.4-4.7:1		2
<i>Esterly's specimens</i>												
32°52.3'	117°16.4'	1168	San Diego	surface	VI-29-06	0505-0520			2.39-2.57	3.9-4.1:1		
32°50.6'	117°29.2'	2104	San Diego	46-18	III-17-10	1934			2.29	2.9:1		
		La Jolla Cove			I-2-06	1900			2.27	2.8:1		

* Lectotype, USNM 110762.

TABLE 2.—*Labidocera kolpos*: collecting data and measurements (1m/0=CalCOFI plankton net, 1 m. mouth diameter, oblique tow; 1m/H= opening-closing plankton net, 1 m. mouth diameter, horizontal tow; ½m=standard plankton net, ½m. mouth diameter)

Position			Locality or station no.	Net/tow/ depth (m)	Date	Temp.		Sal.	No. specimens	TL (mm)		PUR		No. Ad./Tow
Lat. N	Long. W					°C at 10 m	°C at 10 m			Range	Mean	Range	Median	
31°03'	114°30'		5704 99G25	1m/0/<30-0	IV-17-57	18.61		35.62	4 ♂ ad.	2.08-2.24	2.15	2.8-3.3:1		nq
30°47.5'	114°38'		5704 100G11	1m/0/<30-0	IV-17-57	19.55		35.74	1 ♂ ad.	1.95		3.2:1		nq
29°16'	112°24'		6003 Tiburon	dipnet/0	III-7-60				1 ♀ ad.	2.33		3.6:1		nq
			Anchorage											
28°58'	113°32'		Bahia de Los Angeles	1m/H/1	IV-24-62	15.00			7 ♀ ad.	2.45-2.71	2.59	4.3-4.6:1	4.5:1	nq
28°42'	113°04.5'		5604 115G20	1m/0/140-0	IV-16-56	14.48		35.10	3 ♂ ad.	1.95-2.12	2.05	3.2-3.5:1		500
									8 ♀ ad.	2.18-2.80	2.51	4.0-4.5:1	4.3:1	
28°33.5'	112°59'		5604 116G20	1m/0/140-0	IV-21-56	14.12		35.14	7 ♂ ad.	1.95-2.18	2.04	3.0-3.3:1	3.1:1	nq
27°46.5'	112°37.5'		5604 121G13	1m/0/140-0	IV-21-56	17.22		35.23						500
28°17'	111°38'		5604 121G74	1m/0/<30-0	VI-15-56	17.78		35.23	7 ♀ ad.	2.48-2.94	2.65	3.6-4.6:1	4.2:1	rare
28°48.5'	110°02'		5604 133G105	1m/0/<50-0	VI-14-56	20.18		35.26	1 ♀ ad.	2.48		4.1:1		500
28°18'	111°27.5'		Guaymas I-1	½m/H/1	III-28-62	18.0*		35.0*						350
28°17.5'	111°28'		Guaymas I-2	½m/H/1	III-28-62	18.0*		35.0*						50
28°17'	111°30'		Guaymas I-3	½m/H/1	III-28-62	17.0*		35.0*						50
28°16'	111°32'		Guaymas I-4	½m/H/1	III-28-62	17.5*		35.0*						50
28°03'	111°16.5'		Guaymas II-1	½m/H/1	III-28-62	18.15		35.5*	14 ♀ ad.	2.53-2.87	2.72	3.9-4.7:1	4.2:1	>2000
						15.5*			15 ♂ ad.	1.96-2.26	2.13	2.9-3.6:1	3.2:1	
									1 ♀ V	1.90		4.5:1		
									1 ♂ V	1.38		3.6:1		
28°02.7'	111°17'		Guaymas II-2	½m/H/1	III-28-62	18.00		35.0*						37
28°02'	111°18'		Guaymas II-3	½m/H/1	III-28-62	17.40		36.0*						3
28°01'	111°18.7'		Guaymas II-4	½m/H/1	III-28-62	17.15		36.0*						1
27°54'	110°53'		Guaymas Harbor	½m/H/1	III-27-62	16.00		35.5*						nq
27°55'	110°54.5'		Guaymas Harbor	½m/H/1	III-27-62	17.30		35.0*						nq

TABLE 3.—*Labidocera diandra*: collecting data and measurements ($1m/0 = CalCOFI$ plankton net, 1 m. mouth diameter, oblique tow; $1m/H =$ opening-closing plankton net, 1 m. mouth diameter, horizontal tow; $\frac{1}{2}m =$ standard plankton net, $\frac{1}{2}m$. mouth diameter; $\frac{1}{2}m/HS =$ monel mesh plankton net, $\frac{1}{2}m$. mouth diameter)

Lat. N	Long. W	Locality or station no.	Net/tow/ depth(m)	Date	Time (PST)	Temp. °C at 10 m	Sal. ‰ at 10 m	No. specimens	TL (mm)		PUR		No. Ad./Tow
									Range	Mean	Range	Median	
24°14'	111°18'	F5 Boca Flor de Malba	$\frac{1}{2}mHS/0/5-0$	IX-7-62	2036	26.0		10 ♀ ad. 10 ♂ A ad. 10 ♂ B ad. 30 ♀ V 60 ♂ A V 50 ♂ B V	2.69-2.92 2.57-2.96 2.65-2.90 1.93-2.32 1.93-2.31 1.91-2.42	2.79 2.79 2.76 2.12 2.12 2.07	3.1-3.5:1 3.1-3.4:1 3.1-3.7:1	3.3:1 3.2:1 3.3:1	8700
23°37'	110°26.5'	F4 Boca de Canisal	$\frac{1}{2}mHS/0/13-0$	IX-7-62	1437	26.0							50
23°06.5'	110°07.5'	F3 Boca de Las Mantancitas	$\frac{1}{2}mHS/0/13-0$	IX-6-62	1630	24.0							30
22°53'	109°53.6'	El Golfo Sta. 17-1 Cape San Lucas	$\frac{1}{2}m/H/1-3$	XI-12-63	0915								74
22°53'	109°53.6'	El Golfo Sta. 17-3 Cape San Lucas	$\frac{1}{2}m/H/1-3$	XI-12-63	1000								1
23°03'	109°39'	F2 Bahia San Jose del Cabo	$\frac{1}{2}mHS/0/13-0$	IX-6-62	1211			10 ♀ ad. 10 ♂ A ad. 10 ♂ B ad. 32 ♀ V 14 ♂ A V 13 ♂ B V 14 ♀ IV 21 ♂ IV	2.57-2.99 2.53-2.98 2.51-2.84 1.69-2.06 1.76-2.00 1.72-2.10 1.32-1.48 1.35-1.48	2.77 2.72 2.62 1.90 1.88 1.89 1.41 1.41	3.1-3.4:1 3.1-3.6:1 3.1-3.7:1	3.3:1 3.1:1 3.2:1	400
23°24.8'	109°24.5'	El Golfo Sta. 18	$1m/0/20-0$	XI-12-63	1802	27.8*	35.0*						1

23°39'	109°40.5'	Punta Buena Vista	1m/H/1	VI-19-61	1142	1 ♀ ad.	2.80	3.2:1	1
23°25'	109°25'	Punta Frailes	½m/H/1	VI-19-61	1142	59 ♀ ad.	2.68-3.07	3.2-4.0:1	146
						54 ♂ A ad.	2.77-3.99	3.0-3.7:1	3.5:1
						33 ♂ B ad.	2.65-2.99	3.1-3.5:1	3.3:1
24°19'	110°19.5'	La Paz No. 3	½m/H/1-3	IV-4-62	0855	1 ♀ V	2.25	4.0:1	1
24°20'	110°20.5'	La Paz No. 3A	½m/H/1-3	IV-4-62	0940	2 ♀ V	1.90-2.04	3.5-3.6:1	1
24°20'	110°21.5'	La Paz No. 3BN	½m/H/1-3	IV-5-62	1750				2
24°21'	110°13.5'	La Paz No. 4	½m/H/1-3	IV-4-62	1040				1
24°19'	110°12.5'	La Paz No. 4B	½m/H/1-3	IV-4-62	1120				2
24°19'	110°12.5'	La Paz No. 4C	½m/H/1-3	IV-4-62	1140				(juv.)
24°10'	110°19'	La Paz No. 6N	½m/H/1-3	IV-5-62	2015				(juv.)
24°28'	110°28'	5708 144G15	1m/0/140-0	VIII-24-58	1405	2 ♀ ad.	2.70-2.80	3.5-3.8:1	18
						9 ♂ A ad.	2.78-2.99	3.3-3.8:1	3.5:1
25°08'	110°45'	6708 140G20	1m/0/140-0	VIII-24-58	0730	7 ♂ B ad.	2.74-2.91	3.3-3.6:1	3.5:1
						2 ♀ ad.	2.84-2.96	3.5-3.6:1	6
						1 ♂ A ad.	2.82	3.3:1	
						2 ♂ B ad.	2.75-2.84	3.3-3.4:1	
26°00.5'	111°00'	El Golfo Sta. 23	1m/0/20-0	XI-18-63	1058				2
26°34'	111°32'	El Golfo Sta. 24D	½m/H/1-3	XI-18-63	1608	20 ♀ ad.	2.66-3.10	3.1-3.6:1	70
26°54.2'	111°07.6'	El Golfo Sta. 25	½m/H/1-3	XI-20-63	2200	20 ♂ A ad.	2.57-3.13	3.0-3.7:1	257
		Mulege				20 ♂ B ad.	2.57-3.14	2.9-3.7:1	3.4:1
27°19'	112°16'	El Golfo Sta. 26B	½m/H/1-3	XI-22-63	0849				1
27°19'	112°16'	El Golfo Sta. 26C	½m/H/1-3	XI-22-63	0900	20 ♂ A ad.	2.97-3.25	3.1-3.7:1	3
20°36.2'	105°16.1'	El Golfo Sta. 38	½m/H/1-3	XII-2-63	0912	20 ♂ B ad.	2.94-3.15	3.1-3.8:1	20
19°57.9'	105°29.6'	El Golfo Sta. 40	½m/H/1-3	XII-2-63	1619	20 ♀ ad.	2.90-3.21	3.3-4.0:1	1
19°31.8'	105°08.2'	El Golfo Sta. 41	½m/H/1-3	XII-2-63	2052	20 ♀ ad.	2.93-3.49	3.4-4.0:1	776
						20 ♂ A ad.	2.97-3.25	3.1-3.7:1	3.5:1
						20 ♂ B ad.	2.94-3.15	3.1-3.8:1	3.4:1
						20 ♀ ad.	2.90-3.21	3.3-4.0:1	3.6:1
						11 ♂ A ad.	2.94-3.20	3.2-3.7:1	3.4:1
						20 ♂ B ad.	2.91-3.25	3.2-4.1:1	3.5:1
19°15.3'	104°50.3'	El Golfo Sta. 42	½m/H/1-3	XII-3-63	0038				110

* Temperature or salinity at surface.

TABLE 4.—*Frequency of spermatophore placement in Labidocera diandra (counts based on examination of total sample or on subsamples selected at random, depending upon abundance of the species)*

Station	No. adult females observed	No. with spermatophore	No. with type 1 placement	No. with type 1 and 2 placements	No. with type 2 placement
Punta Frailes	86	65	25	34	6
F2	3	2	2		
F3	3	1	1		
F4	1	1	1		
F5	124	19	18		1
5708 140G20	2	1	1		
5708 144G15	2				
El Golfo 17-1	22	18	11	6	1
El Golfo 24D	66	61	47	12	2
El Golfo 25	54	29	29		
El Golfo 41	353	72	67	4	1
El Golfo 42	38	5	5		
Totals (12)	754	274	207	56	11
Percent		36	76	20	4

TABLE 5.—*Spermatophore placement in Labidocera diandra from Punta Frailes, June 19, 1961*

No. and position of spermatophores	No. individuals	Percent
0	21	24
1—Type 1	25	28
2—Type 1	2	2
3—Type 1	1	1
1—Type 2	4	5
2—Type 2	1	1
4—Type 2	1	1
1—Type 1, 1—Type 2	22	25
1—Type 1, 2—Type 2	9	10
1—Type 1, 3—Type 2	1	1
2—Type 1, 1—Type 2	2	2
Totals	89	100

TABLE 6.—Presence of head-hooks

<i>Labidocera</i> species	Copepodite stages observed	Head-hooks	
		Immature stages	Adults
<i>acuta</i>	II, III, IV, V, VI	absent	absent
<i>acutifrons</i>	III, IV, V, VI	absent	absent
<i>aestiva</i>	II, III, IV, V, VI	absent	absent
<i>bataviae</i>	V, VI	absent	absent
<i>fluviatilis</i>	IV, V, VI	absent	absent
<i>detruncata</i>	IV, V, VI	absent	absent
<i>lubbockii</i>	II, III, IV, V, VI	absent	absent
<i>mirabilis</i>	II, III, IV, V, VI	absent	absent
<i>nerii</i>	III, IV, V, VI	absent	absent
<i>johnsoni</i>	III, IV, V, VI	absent	absent
<i>wilsoni</i>	III, IV, V, VI	absent	absent
<i>scotti</i>	III, IV, V, VI	absent	absent
<i>trispinosa</i>	I, II, III, IV, V, VI	absent	absent
<i>diandra</i>	I, II, III, IV, V, VI	present*	absent
<i>madurae</i>	V, VI	absent	absent
<i>pectinata</i>	VI		present
<i>jollae</i>	I, II, III, IV, V, VI	present*	present
<i>kolpos</i>	IV, V, VI	present	present
<i>kröyeri</i>	IV, V, VI	present	usually present
<i>minuta</i>	IV, V, VI	present	present

*Head-hooks absent in stage 1.

TABLE 7.—*Labidocera diandra*, TL : P5, ♂ stage V, A and B

Sample	Class	No.	P5			TL		
			Range (mm)	Mean (mm)	St. Dev.	Range (mm)	Mean (mm)	St. Dev.
F5	♂ V-1	59	0.59-0.68	0.658	.0217	1.91-2.32	2.12	.083
F5	♂ V-2	51	0.47-0.55	0.529	.0065	1.90-2.24	2.07	.063
F2	♂ V-1	14	0.58-0.66	0.621	.0244	1.72-2.01	1.885	.074
F2	♂ V-2	13	0.43-0.55	0.504	.0324	1.72-2.10	1.889	.123
Pooled data:								
	♂ VI-A	74				2.56-3.11	2.91	.1017
	♂ VI-B	52				2.52-2.99	2.83	.1009

TABLE 10.—*TL-PUR in jollae group*

<i>Labidocera</i> species	Sex	No.	TL			PUR	
			Range (mm)	Mean (mm)	St. Dev.	Range	Median
<i>jollae</i>	♀	63	2.07-3.07	2.69	.152	3.6-4.9:1	4.1:1
	♂	60	1.93-2.61	2.26	.121	2.5-3.3:1	2.9:1
<i>kolpos</i>	♀	54	2.18-2.97	2.66	.152	3.6-5.0:1	4.3:1
	♂	61	1.91-2.30	2.10	.089	2.8-3.6:1	3.0:1
<i>diandra</i>	♀	144	2.57-3.49	2.95	.140	3.1-4.0:1	3.5:1
	♂ A	135	2.53-3.25	2.95	.148	3.0-3.8:1	3.3:1
	♂ B	122	2.51-3.25	2.89	.152	2.9-4.1:1	3.4:1

TABLE 11.—*Sexual differences in TL and PUR in the wilsoni superspecies*

<i>Labidocera</i> species	TL, Mean (mm)			PUR, median		
	♂	♀	♀:♂ ratio	♂	♀	♂:♀ difference
Eastern species*						
<i>wilsoni</i>	2.41	2.54	1.05:1	5.2:1	5.2:1	0
<i>mirabilis</i>	2.37	2.80	1.18:1	5.1:1	3.8:1	1.3:1
Western species						
<i>jollae</i>	2.26	2.69	1.19:1	2.9:1	4.1:1	1.2:1
<i>diandra</i>	2.95	2.95	1.00:1	3.3:1	3.5:1	0.2:1
	2.89		1.02:1	3.4:1		0.1:1
<i>kolpos</i>	2.10	2.66	1.27:1	3.0:1	4.3:1	1.3:1

*Data from Fleminger and Tan (1966).





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