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Frank A. Taylor,
Director, United States National Museum.

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Proceedings of the United States National Museum

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ADDITIONAL INFORMATION ON THE MORPHOLOGY OF AN EMBRYO WHALE SHARK

By J. A. F. Garrick[1]

An embryo whale shark, *Rhincodon typus* Smith, kindly loaned by the Marine Laboratory, Texas Game and Fish Commission, Rockport, shows several notable differences in proportional dimensions and other features as compared with accounts of adult specimens. To describe these differences is the purpose of this paper.

The embryo, 350 mm. in total length, is one that has been removed from an egg-case trawled from 31 fathoms in the Gulf of Mexico about 130 miles south of Port Isabel, Texas, on June 29, 1953. This specimen, believed to be the only embryo whale shark available, has been reported previously by Breuer (1954), Baughman (1955), and Reid (1957), who published dimensions of it and discussed its trunk ridges and oronasal groove. Reid also presented a figure of the underside of the head, while Breuer's and Baughman's accounts each included a photograph of the specimen and its egg-case. To supplement these already published figures, I submit here five additional illustrations of the embryo whale shark and its dermal denticles. For these drawings I am greatly indebted to the skill of Mrs. Fanny Phillips.

[1] Division of Fishes, U.S. National Museum. This research was supported by contracts between the Smithsonian Institution and the Atomic Energy Commission (AEC (30–1) 2409) and the Office of Naval Research (NONR 1354 (09)).

Proportional differences.—In the following account the features of the embryo whale shark are compared for the most part with those of the adult (total length 17′ 3″) from Acapulco, Mexico, figured in Bigelow and Schroeder (1948). As dimensions of both these specimens are already available in their respective accounts, there is no need to reproduce such measurements here. Instead, I shall give, in general terms, the major differences between the embryo and adult, followed in each case by a figure in parentheses which is the proportional difference expressed as a percentage of total length.

The differences are: the adult is slightly broader headed (0.5), longer headed (1.4), and noticeably shorter tailed (6.3); the adult eye is strikingly smaller (0.9), but the gill-openings are longer (0.3 to 2.2); the first dorsal (2.6), second dorsal (8.4), anal (7.8), and pelvic fins (3.2) are further rearward in the adult; the first dorsal fin is proportionately higher (1.2), but its base is shorter (0.9) in the adult (however, the reverse is the case for both height and base length—about 2.0 and 0.3 respectively—in the second dorsal and anal fins); the distance between the first and second dorsal fins and between the anal fin and subcaudal origin are longer in the adult (4.8 and 3.4 respectively); the pectoral fin of the adult has a much longer distal margin (5.5) than that of the embryo, though the anterior margins are comparable; the lengths of the upper and lower lobes of the caudal fin are considerably shorter (7.3 and 4.2 respectively) in the adult than in the embryo.

The above differences are indicative of the growth change which the whale shark undergoes. Understanding such growth change is important in studying sharks because of the frequent need to rely on proportional dimensions to distinguish species. The pattern of growth change is by no means identical in all sharks, but there do appear to be common features (Beebe and Tee-Van, 1941, p. 107; Maschlanka, 1955, p. 12; S. Springer, 1960, p. 9; Garrick, 1960, p. 546), such as accelerated growth in the trunk region, as compared to the head and tail, which thus proportionately decrease with increasing total length; a tendency for the pectoral fin to increase its relative length or at least remain stable (though *Carcharhinus longimanus* (Poey) shows a relative shortening of pectoral fin from juvenile to adult, as noted by S. Springer, 1960, p. 9); a broadening of the head region; and a noticeable decrease in eye diameter. Dorsal fin heights tend to increase relatively in the galeoid sharks (but *C. longimanus* is again an exception), while in the squaloid sharks the reverse generally holds true (Garrick, 1960, p. 548).

The indicated growth change of the embryo whale shark fits the above pattern reasonably well except that the head length in the embryo is relatively shorter than that of the adult. This may be only an apparent difference for the following reason. The dorsal lobe of the caudal fin of the embryo is raised only slightly from the horizontal axis of the body; hence, the posterior margin between the dorsal and ventral lobes is deeply notched, the angle being less than 90°. In the adult the caudal fin is lunate, the dorsal lobe being raised steeply from the horizontal axis, with the result that the posterior margin is only slightly concave. It follows that the change leading from the slightly raised dorsal lobe in the embryo to the steeply raised lobe in the adult would yield relative total lengths which are not strictly comparable, and thus this difference would provide bias in proportional lengths of structures, such as head length, if calculated in terms of the total length. Accordingly, one would expect the head length of the embryo to have a lower relative value in terms of total length than is the case for the adult. Better comparison is afforded by examining the head length in terms of the length to the upper caudal origin—this shows the relative head length in embryo and adult to be the same, which is nearer to the actual situation in most other sharks.

The need for caution in extrapolating proportional dimensions of small specimens is demonstrated by the different growth rates operating on the first dorsal fin of the embryo as compared with the second dorsal and anal. Dimensions of the first dorsal fin in the embryo and in the adult indicate that the rate of vertical growth is proportionately faster than that of horizontal, whereas in the second dorsal and anal fins the horizontal growth is faster. A similar situation has been described for *Etmopterus baxteri* Garrick (Garrick, 1960, p. 548) and it may be relatively common. The lengths of the free rear tips of the dorsal and anal fins compared with their bases also show considerable change with growth. In the embryo, these free tips are relatively short (about 4.0 in base in the first dorsal fin) but in the adult they are much longer (about 1.4 in base in the first dorsal). Another change affecting the comparison of all fins is the usual tendency for fin tips to become relatively pointed in the adult, whereas in the embryo they are more rounded or blunt tipped (V. G. Springer, 1961, p. 480, gives an example of this in *Mustelus norrisi* Springer). The tip of the dorsal lobe of the caudal fin in the embryo is distinctly notched, presumably representing the subterminal notch, which is not evident in the adult.

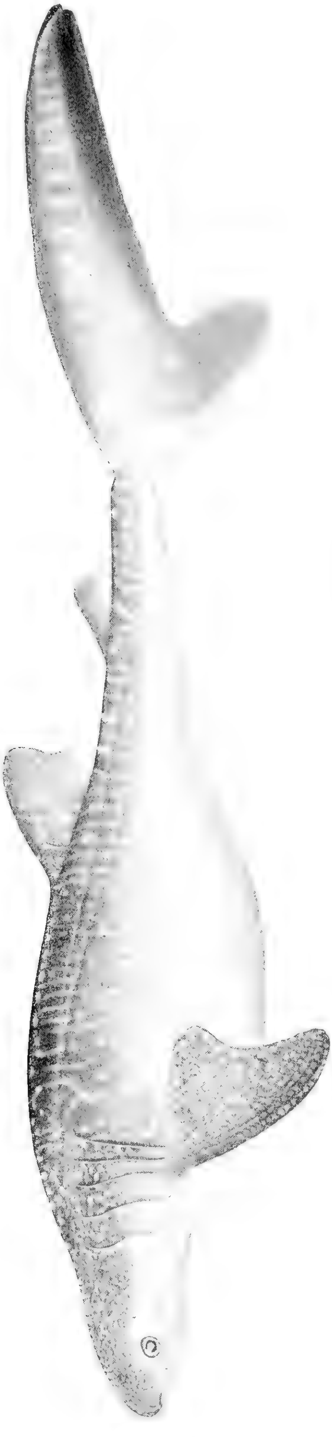
Dermal ridges.—As noted by Reid (1957, p. 158), the embryo whale shark has a longitudinal dermal ridge originating on each side of the head and dividing, above the end of the pectoral fin, into two ridges which continue posteriorly. Reid identified this ridge as one corresponding to an upper divided ridge in the adult. The adult has, in addition, a lower ridge which extends the whole length of its body and forms a keel on the peduncle and anterior part of the caudal fin. I interpret the lower half of the divided ridge in the embryo to be the same as the lowermost ridge in the adult, since posteriorly the lower ridge forms the keel on the peduncle and caudal fin. This means that, at a later date, a third ridge must appear above the lower one in the embryo. Similar longitudinal ridges occur in some members of the family Orectolobidae. The embryo also has a mid-dorsal ridge which extends from the level of the first gill-opening to the origin of the first dorsal fin and possibly is present between the first and second dorsal fins. Adults have been described with and without a middorsal ridge.

Precaudal pits.—The embryo has a prominent upper precaudal pit, with a notably wide, transverse front margin. There is also a small but distinct lower precaudal pit. Adults are described as having the upper pit but lacking the lower.

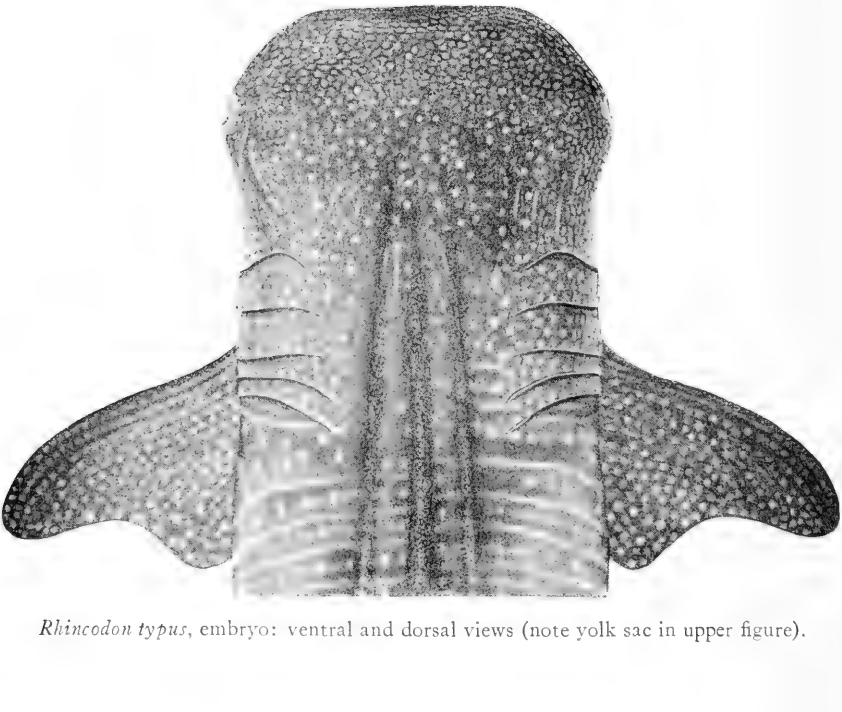
Nostrils.—Reid (1957, p. 158) reported that each nostril in the embryo is connected to the mouth by a distinct furrow—a character frequently used to support the view that the whale shark is closely related to, or belongs in, the family Orectolobidae.

On the basis of an adult specimen, Barnard (1935, p. 649) disputed this view. Without wishing to enter the controversy, I confirm Reid's description that, in the embryo, there is no doubt that the nostril is joined to the mouth by a naked or nearly naked furrow (pl. 4). However, in view of the close proximity of the nostril to the mouth, I wonder if any significance can be placed upon this connection. Also, in passing, I would mention that, in the embryo, the distance (in percentage of total length) from snout tip to outer nostril (0.6) is about half that of snout tip to mouth (1.0). Bigelow and Schroeder (1948, p. 189) give the reverse of these figures for the adult they describe.

Dermal denticles.—The dermal denticles of the embryo (pl. 3) closely resemble those of the adult in having ovoid blades, each with three posterior marginal teeth and a strong median longitudinal keel. Some denticles from the lower longitudinal dermal trunk ridge, however, are distinctly larger and are arranged in longitudinal pairs, with the anterior denticle overlapping the one posterior to it. These pairs are clearly visible not only because of their larger size, but also because of their darker pigmentation. The posterior denticle of each pair is similar in shape to the surrounding body denticles, but usually it has a broader topped longitudinal ridge. The anterior denticle is of the same size, but it is more nearly oval in shape, with only a median posterior tooth; its longitudinal ridge is broadly expanded and round topped, and usually it bears several minor ridges which converge posteriorly to form a single ridge.



Rhincodon typus, embryo whale shark, 350 mm. total length, from Gulf of Mexico.



Rhincodon typus, embryo: ventral and dorsal views (note yolk sac in upper figure).

Rhincodon typus, embryo: dermal denticles from in front of, and a little below, first dorsal fin. The two pairs of enlarged denticles, overlapping lengthwise (left center and upper right), are on the lower dermal ridge.

Rhincodon typus, embryo: left nostril with nasal flap reflected to show naked furrow leading from nostril to mouth.

I do not know if similar pairs of enlarged denticles occur on the longitudinal dermal ridges of adults. However, Ford (1921, p. 493) described the first denticles to erupt in *Scyliorhinus canicula, S. stellaris,* and *Galeus melanostomus* as being conspicuously larger than the normal body denticles and "symmetrically arranged in a sequence of transverse pairs forming two longitudinal rows, one on either side of the midline in a dorsolateral position." At a later stage, these larger denticles "lose their individuality eventually owing to the presence of equally large and similar scales which have grown up around them" (p. 494).

Teeth.—In the embryo, the teeth are for the most part still covered by membrane, but those that are visible show little difference from the teeth of adults.

Gill-rakers.—The plankton-sieving apparatus of the adult whale shark consists of transverse cartilaginous bars (representing gill-rakers) which join one gill-arch to the next; these transverse bars are further connected, one to the other, by a secondary grid of slenderer cross members. The entire structure is covered on its internal (pharyngeal) surface by a fine, spongelike lattice or veil derived from dermal denticles. This structure forms the sieving apparatus, with interstices 1 to 3 mm. in diameter.

In the embryo the sieve is still in a very early stage of development, comprising only the gill-raker elements. These project forward from each arch to the next, but their tips are still free. On the first arch there are about 26 rakers on the upper limb and 34 on the lower. The rakers are comparatively stout rods, closely arranged, with virtually no space between them. Each raker shows faint indications of being bipinnate, having very short processes developing along the sides. These processes are presumably the rudiments of the secondary grid members. There is as yet no obvious sign of the spongy tissue which will later line their inner surface.

Reid (1957, p. 157) suggests that the relatively advanced stage of development of the embryo whale shark and the extent to which its external yolk sac has been absorbed are indications that it is approaching the size at which it would hatch. This is probably correct. On the other hand, the abdomen is filled almost completely with yolk, forming an oval mass about 80 mm. long, 50 mm. wide, and 40 mm. deep. This yolk supply seemingly would allow sufficient reserve to complete development of the pharyngeal sieve either before or after hatching. Only further specimens will establish whether the juvenile whale shark feeds from the beginning in the same manner as the adults.

Color and pattern.—The color of the embryo when first removed from the egg-case was "bluish grey with white spots, the undersurface white" (Breuer, 1954, p. 29). After preservation, the embryo is brownish rather than bluish grey, but with the dermal ridges dusky. Adults have been described as being variously dark grey to reddish or greenish brown above and white or yellow below. The color pattern of small spots and narrow transverse bars on the embryo (pls. 1–2) is remarkably similar to that of adults.

Vertebrae.—Radiographs of the embryo whale shark show vertebral centra very clearly in the body region and the anterior four-fifths of the tail. The centra are widely spaced, presumably from incomplete calcification. In the body region anterior to the level of the origin of the upper caudal lobe, there are 81 vertebrae, while posteriorly on the caudal axis there are 72 countable vertebrae. The total number of caudal vertebrae is probably much higher, but those in the terminal fifth of the caudal axis are calcified or developed insufficiently to show on the radiographs.

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NOTES ON NEW AND OLD SPECIES OF ALTICINAE (COLEOPTERA) FROM THE WEST INDIES

By Doris H. Blake

The present paper describes 17 new species of beetles of the subfamily Alticinae: 8 collected in Puerto Rico by R. G. Oakley, 4 in Jamaica by T. H. Farr, and 5 from other sources. Notes on other species are given, and the proper placing of species hitherto wrongly ascribed to *Pseudoepitrix* is discussed.

Aphthona crucifera, new species

Figure 4

About 1.5 mm. in length, oblong oval, shining, the prothorax and elytra lightly punctate, striate rows of punctures on elytra becoming faint near apex, pale yellow brown, occiput of head deeper in color, margins of prothorax usually dark brown and on elytra a brown humeral spot connecting narrowly along base with a sutural darkening, slightly below the middle a brown fascia, lateral margin more or less dark.

Head with interocular space a little more than half width of head, occiput rounded, few punctures near eye, frontal tubercles distinctly marked, narrow carina down lower front; top of head deeper brown, pale in lower front. Antennae pale yellow brown with outer four joints slightly darker and wider, not extending much below humeri, fifth joint longer than fourth. Prothorax with rounded lateral sides, having oblique angle anteriorly, disc somewhat rounded, shining, finely punctate, pale yellow with lateral margin usually dark brown. Scutellum brownish. Elytra moderately convex, without depressions, shining, with rows of fine punctures becoming fainter near apex; pale yellow brown with dark reddish brown humeral spot connecting with brown sutural vitta more or less widely across base, sutural vitta extending to apex and sometimes connecting with dark lateral margin in darker specimens; in paler specimens only sutural edge darkened; slightly below middle a brown fascia usually connected at suture. Body beneath in darker specimens with middle of prosternum and breast chestnut brown, abdomen and legs pale yellow brown. Hind femora thickened, hind tibiae with short spur. Length 1.3–1.5 mm.; width .8 mm.

Type, female, USNM 66194, and 11 paratypes, taken on *Myrica cerifera* at Guanica, Puerto Rico, by R. G. Oakley, September 14, 1934.

Remarks.—Dr. E. A. Schwarz originally identified this as *Aphthona maculipennis* Jacoby, a Central American species, but that species as described possesses a very different coloration.

Aphthona lepta, new species

Figure 5

Approximately 1.5 mm. in length, oblong oval, shining, prothorax very finely punctate, elytra somewhat more distinctly striate punctate, entirely pale reddish brown with outer antennal joints slightly darker.

Head with interocular space approximately half width of head, occiput polished, a group of punctures near eye, frontal tubercles clearly marked, carina down lower front, lower front paler, occiput and mouth parts deeper brown. Antennae extending below humeri, fifth joint longer than fourth; joints two, three, and four paler; outer joints broader and hairier. Prothorax with arcuate sides, oblique angles anteriorly and tooth at basal angle, smoothly convex, without depressions, shining, very finely punctate. Scutellum brownish. Elytra smoothly convex, without depressions, with fine striate punctures; in male specimen more indistinct than in female; entirely reddish brown. Body beneath and legs reddish brown. Length 1.5 mm.; width .7 mm.

Type, male, USNM 66193, and one female paratype, collected at Guanica, Puerto Rico, by R. G. Oakley, September 27, 1934.

Remarks.—This is approximately the same size as *Aphthona crucifera*, which was also collected at Guanica. It lacks the elytral dark markings and has a narrower aedeagus with a more tapering point. The striate punctation on the elytra is also less distinct.

Aphthona inornata Blake

Figure 8

Aphthona inornata Blake, Journ. Wash. Acad. Sci., vol. 39, no. 11, p. 308, 1949.

Numerous specimens of this species, which was described from a single female collected at Río Piedras, Puerto Rico, have been taken by R. G. Oakley at Ponce, Puerto Rico. Because of the similarity in the yellow brown coloration of several species of West Indian *Aphthona*, a drawing of the aedeagus is given here for the first time.

Aphthona insularis, new species

Figure 1

About 2 mm. in length, oblong oval, shining, pronotum very finely punctate, elytra somewhat more coarsely and striately punctate, with slight depression below basal callosity, deep black with faint bluish lustre, antennae pale at base, deeper brown towards apex, femora piceous, tibiae and tarsi sometimes slightly paler.

Head with interocular space a little less than half width of head, frontal tubercles clearly marked but not swollen, occiput smooth, impunctate, a short carina, slightly produced between antennal sockets and down lower front, entirely dark. Antennae not reaching middle of elytra, basal two joints swollen, third joint slightly shorter than fourth, remainder subequal, becoming somewhat wider and darker in color. Prothorax moderately convex with arcuate sides and oblique angles anteriorly, disc without depressions, polished and finely punctate, entirely dark. Scutellum entirely dark. Elytra convex, lateral margin almost invisible from above, a slight depression below basal callosity, lines of fine striate punctures slightly irregular near suture, between these a line of very fine striate punctures; entirely dark with faint deep bluish lustre. Body beneath entirely dark, hind femora enlarged, hind tibiae with short apical sulcus and spur at apex. Length 2–2.4 mm.; width 1–1.3 mm.

Type, male, USNM 66202, and 9 paratypes from Dominica, West Indies, collected by H. W. Foote of the Yale 1913 Expedition in June and July, 1913.

Remarks.—The dark bluish black coloration of this species distinguishes it from the smaller yellowish brown species of *Aphthona* from the West Indies.

Aphthona lamprocyanea, new species

Figure 9

Between 2 and 3 mm. in length, oblong oval, polished, dark violaceous blue, nearly impunctate, a remnant of striate punctation on elytra in transverse depression below basal callosity and along suture at base.

Head with interocular space more than half width of head, occiput polished, rounded, impunctate, groove from eye to frontal tubercles with punctures along it, carina short and distinct, head entirely dark. Antennae extending below humeri, entirely dark, basal joints with metallic blue sheen, third joint about same length as fourth, remainder subequal and hairy. Prothorax slightly wider than long, with arcuate sides and oblique anterior angles, moderately convex, without depressions, polished, impunctate, entirely dark. Scutellum dark. Elytra moderately convex, below basal callosity a transverse depression in which are remnants of striate punctation, rest of surface with very fine confused punctation visible only under high magnification; surface polished, dark blue. Body beneath and legs shining, entirely dark blue. Length 2.3–2.9 mm.; width 1.3–1.5 mm.

Type, male, USNM 66195, and 13 paratypes, from Ponce and Aibonito, Puerto Rico, collected on *Croton* species by R. G. Oakley, September 7, 1933, August 1933, and July 10, 1934.

REMARKS.—It is interesting to note that many species of *Aphthona* occur on the Euphorbiaceae.

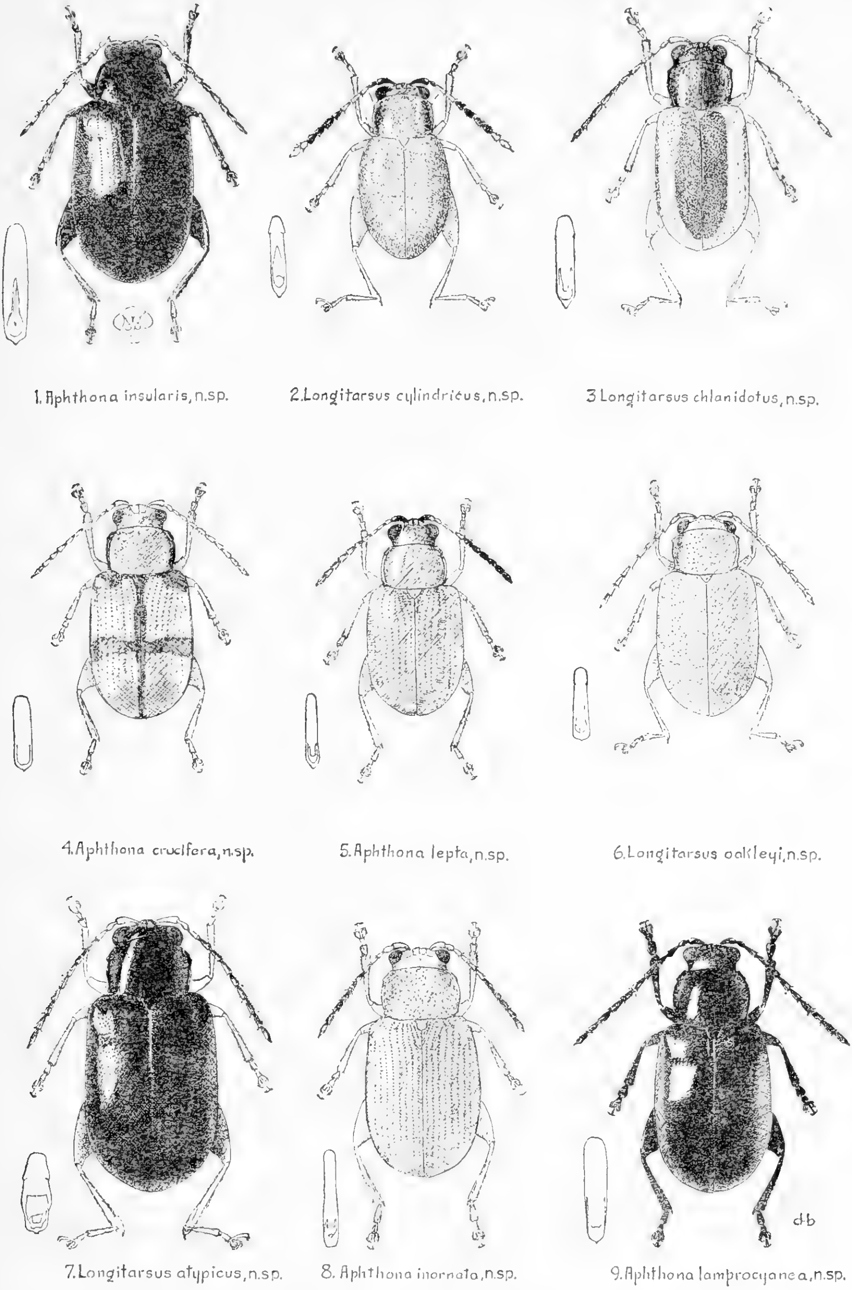
Longitarsus cylindricus, new species

FIGURE 2

About 1.5 mm. in length, elongate oval, shining, very finely punctate, elytra without wings or humeral prominences, widest at middle, yellowish brown, sides of pronotum darker brown; antennae dark with joints three, four, ten, and eleven pale; outer joints thicker and hairier.

Head with interocular space approximately half width of head, occiput polished, deeper brown than lower front, a group of punctures near eye, frontal tubercles clearly marked, carina down lower front. Antennae fully half length of body; third, fourth, tenth, and eleventh joints pale; outer joints slightly longer and thicker. Prothorax convex, somewhat wider than long, sides slightly arcuate with oblique angles anteriorly and tooth at base, a long hair at each corner; very finely punctate, surface polished, yellow brown with sides deeper brown. Scutellum brownish. Elytra convex with rounded sides and no humeral prominences, without wings, surface polished, more distinctly punctate than prothorax, entirely yellowish brown. Body beneath with breast and prosternum usually slightly deeper brown than abdomen and legs, shining, anterior coxal cavities open, hind femora enlarged, hind tibiae shallowly channelled with spur at end, first tarsal joint very long. Length 1.2–1.6 mm.; width .6 mm.

Type, male, USNM 66190, and three paratypes, collected on weeds at Adjuntas, Puerto Rico, by R. G. Oakley, October 11, 1934.



FIGURES 1–9.—1, *Aphthona insularis*, new species; 2, *Longitarsus cylindricus*, new species; 3, *Longitarsus chlanidotus*, new species; 4, *Aphthona crucifera*, new species; 5, *Aphthona lepta*, new species; 6, *Longitarsus oakleyi*, new species; 7, *Longitarsus atypicus*, new species; 8, *Aphthona inornata* Blake; 9, *Aphthona lamprocyanea*, new species.

Remarks.—This tiny flealike beetle is distinguished from other species of *Longitarsus* in the West Indies by its wingless elytra lacking humeral prominences and by its black and white antennae. It is closely related to *L. oopterus* Harold, another wingless species, from Colombia, which has an impunctate prothorax, and *L. intermedius* Jacoby from Panama, which is also impunctate but has similarly colored antennae. In *L. angusticollis* Jacoby the antennae are longer than the body. *L. impuncticollis* Blatchley from Florida, another wingless species, is dark chocolate brown with fuscous antennae.

Longitarsus chlanidotus, new species

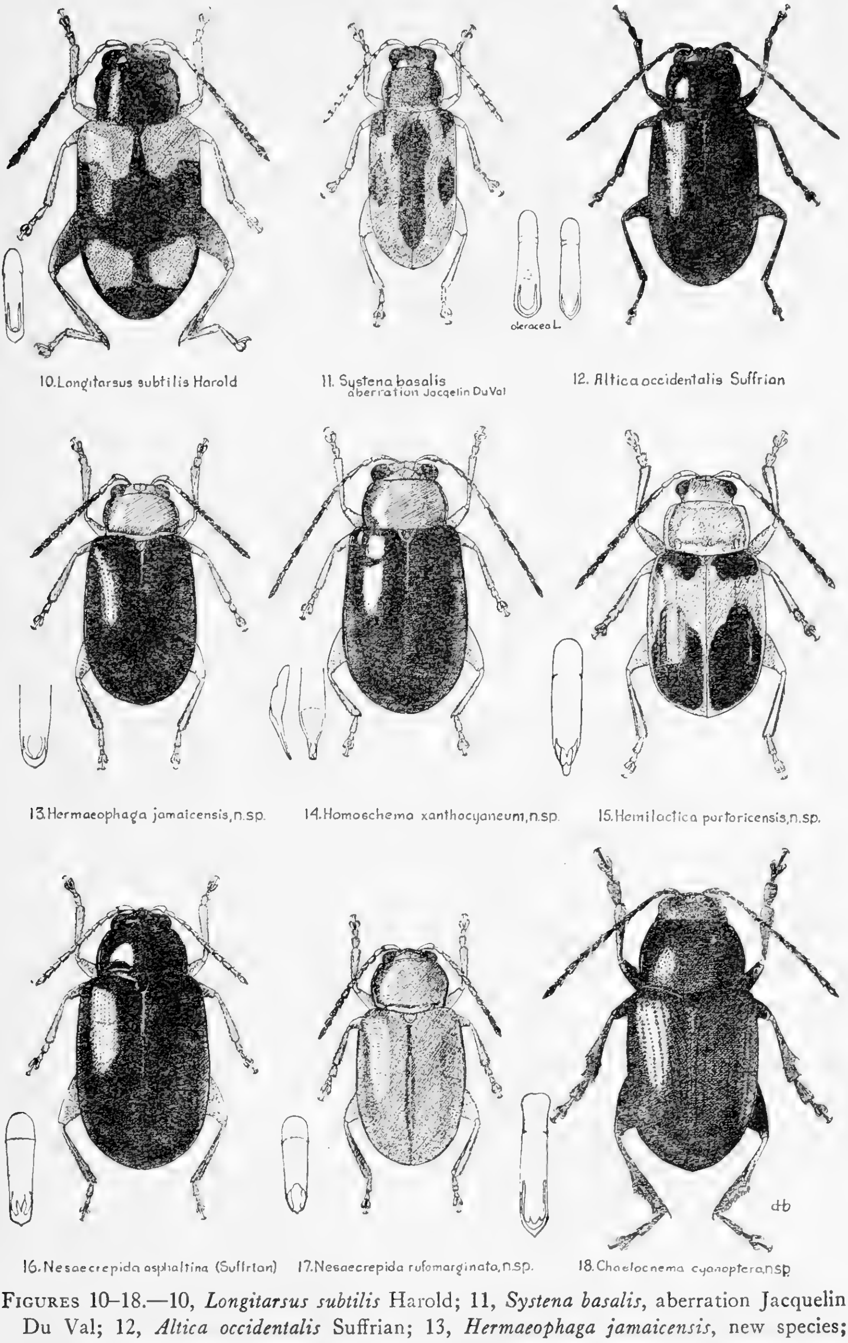
Figure 3

About 2 mm. in length, oblong oval, shining, pronotum finely punctate, elytra more coarsely punctate, yellow brown with a brown head, pronotum and broad brown sutural vitta, and often brown along sides of elytra.

Head with interocular space approximately half width of head, occiput polished, a group of punctures near eye, frontal tubercles slightly swollen, interantennal area somewhat produced, a carina down front, shining dark brown, slightly paler in lower front. Antennae brown with four basal joints paler, extending to middle of elytra, third joint shorter than fourth, remainder subequal. Prothorax with slightly curved sides, oblique anterior angles and small tooth at basal angle, disc smooth, without depressions, polished, dark brown, or in pale specimens paler, distinctly punctate. Elytra without depressions, humeri not prominent, more coarsely and densely punctate than pronotum, yellow brown, usually with a wide sutural vitta covering half the elytra, not reaching apex, usually a brown lateral vitta between humerus and apex, in paler specimens only sutural and marginal edges brown. Body beneath brownish with legs yellowish brown, hind femora enlarged, first hind tarsal joint very long, hind tibiae grooved, a spur at end, claws appendiculate. Length 1.6–2 mm.; width .8–.9 mm.

Type, male, USNM 66191, and 23 paratypes collected on weeds in Boringuen Forest, at Guanica, Puerto Rico, by R. G. Oakley, September 14, 1934. One specimen taken at St. Thomas, 14½ miles east of Kingston, Jamaica, by T. H. Farr.

Remarks.—This distinctive little beetle with its brown mantle was also taken on *Tournefortia gnaphalodes* on Lower Matecumbe Key, Florida, by Paul W. Oman, July 20, 1939.



FIGURES 10–18.—10, *Longitarsus subtilis* Harold; 11, *Systena basalis*, aberration Jacquelin Du Val; 12, *Altica occidentalis* Suffrian; 13, *Hermaeophaga jamaicensis*, new species; 14, *Homoschema xanthocyaneum*, new species; 15, *Hemilactica portoricensis*, new species; 16, *Nesaecrepida asphaltina* (Suffrian); 17, *Nesaecrepida rufomarginata*, new species; 18, *Chaetocnema cyanoptera*, new species.

Longitarsus oakleyi, new species

FIGURE 6

About 1.5 mm. in length, oblong oval, shining, elytra moderately densely and strongly punctate, entirely yellow brown.

Head with interocular space slightly more than half width of head, occiput smoothly rounded, polished, a group of punctures near eye, interantennal area broad, somewhat produced, this rather flat carina broadening below, entire head pale yellow brown. Antennae extending to middle of elytra, fifth joint longer than third or fourth, entirely pale. Prothorax moderately convex with arcuate sides, oblique angles anteriorly and small tooth at basal angle, surface shining, without depressions, very finely punctate, entirely pale yellow brown. Scutellum brownish. Elytra moderately convex, without depressions, shining, strongly and coarsely punctate, yellow brown. Body beneath and legs entirely pale, shining, hind legs enlarged, hind tibiae grooved, spur at end, first hind tarsal joint very long. Length 1.3–1.8 mm.; width .7–.8 mm.

Type, male, USNM 66192, from Ponce, Puerto Rico, collected on weeds, and also one specimen taken at Guanica, Puerto Rico, both collected by R. G. Oakley, September 27, 1934.

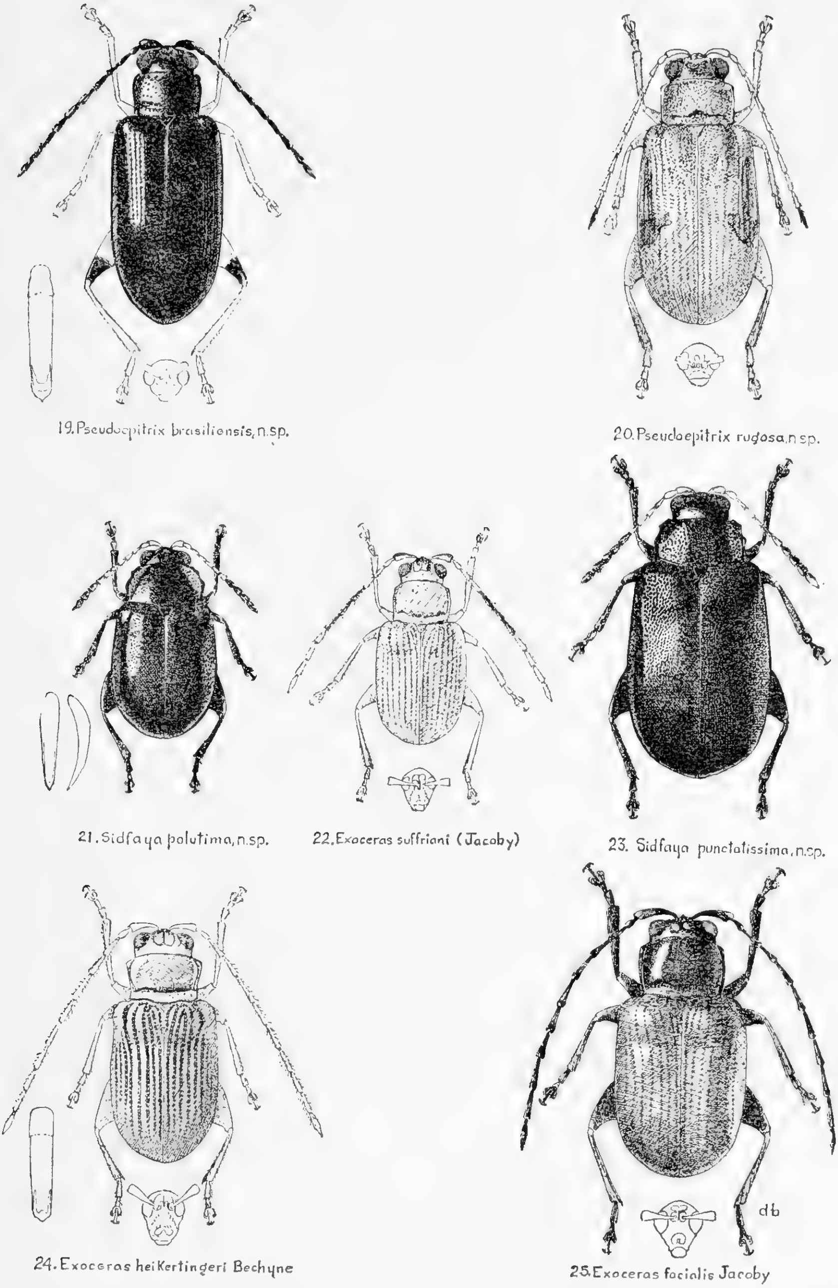
REMARKS.—This tiny pale species differs from both *L. cylindricus* and *L. chlanidotus* by being entirely pale and having rather coarsely punctate elytra.

Longitarsus atypicus, new species

FIGURE 7

About 2 mm. in length, oblong oval, very shining, prothorax finely and elytra more coarsely punctate, elytra with distinct basal callosity and depression below, black with four basal joints of antennae pale and legs pale, posterior femora and lower front of face brownish.

Head with interocular space slightly more than half width of head, occiput polished, a group of punctures near eye, frontal tubercles slightly swollen, interantennal area produced, well-marked carina down lower front, lower front rather long and paler brown. Antennae about half as long as body, three basal joints pale, fourth slightly darker, remainder dark, third joint shorter than fourth. Prothorax moderately convex, smoothly rounded, without depressions, sides slightly arcuate, an oblique anterior angle and small tooth at base, surface polished black with distinct punctation. Scutellum dark. Elytra wider than prothorax, with distinct humeri, a basal callosity, below this a transverse depression, surface very shiny, with coarser



FIGURES 19–25.—19, *Pseudoepitrix brasiliensis*, new species; 20, *Pseudoepitrix rugosa*, new species; 21, *Sidfaya polutima*, new species; 22, *Exoceras suffriani* (Jacoby); 23, *Sidfaya punctatissima*, new species; 24, *Exoceras heikertingeri* Bechyne; 25, *Exoceras facialis* Jacoby.

punctation than on pronotum, entirely dark. Body beneath dark brown or piceous with legs pale yellow brown except hind femora, which are brownish. Hind femora thickened, hind tibiae slightly channelled, spur at end, first tarsal joint very long, claws appendiculate. Length 1.8–2.5 mm; width 1–1.2 mm.

Type, male, USNM 66189, and 18 paratypes, collected on an "unknown vine," at Matrullas, Puerto Rico, October 22, 1934, by R. G. Oakley.

Remarks.—H. S. Barber has labelled this "?*Longitarsus* sp." with the further note that "this is probably a new genus and new species." It does not resemble the usual species of *Longitarsus:* first, in its coloring, which is dark piceous or black instead of brownish or yellowish; second, in the shape of the elytra, which are considerably wider than the prothorax and with well-developed humeri and basal callosities and a transverse depression below them; and lastly, in the shape of the aedeagus, which is different from any of the species of *Longitarsus* that I have ever examined. On the other hand, the channelled tibiae and the very long first tarsal joint of the hind legs are typical of a species of *Longitarsus*, and for the present, until similar species appear, it seems better to assign the present species to this genus.

Longitarsus subtilis **Harold**

Figure 10

Longitarsus subtilis Harold, Coleopterologische Hefte, vol. 15, p. 31, 1876.

Two specimens collected at Aguirre, Puerto Rico, by H. E. Box in May 1925, resemble a series from El Valle, Venezuela, taken by C. H. Ballou September 4, 1939, on *Heliotropum indicum*, and a series from Pichilingue, Ecuador, taken by E. J. Hambleton, October 15, 1944. Harold's description of *Longitarsus subtilis* from Venezuela appears to fit these beetles. He describes the species as a beetle with a rufous head, a piceous thorax, and smooth rufotestaceous elytra, having the apex and a wide median fascia more dilute at the suture, rufopiceous, the feet testaceous, the posterior femora rufous, the four basal antennal joints as testaceous, and the remainder fuscous. Although there are minor differences, this description appears to apply fairly well to the present species, which now is found to occur in Puerto Rico.

Systena basalis **Jacquelin Du Val, aberration**

Figure 11

Systena basalis Jacquelin Du Val, *in* Ramon de la Sagra, Historia física, politica y natural de la Isla de Cuba, vol. 7, p. 129, 1856.

A single female beetle from Cuba in the Wickham collection has an unusual coloration. Instead of being almost entirely piceous with a bronze lustre, with the elytra having only a trace of a pale vitta near the base, as is uniformly found in the female of *Systena basalis*, this specimen has pale elytra with a humeral dark spot and a median lateral short vitta, as well as a wide sutural dark vitta, widening below the scutellum for a short way, then narrowing and extending down the suture but not reaching the apex. The legs are entirely pale, the antennae also pale, with a slight darkening at the apex of each joint. The breast and abdomen are brownish piceous. If it were a male, in which the usual elytral markings are paler, with a full-length pale vitta, this would not appear so unusual. Structurally, however, the specimen does not seem to differ from *Systena basalis*, being of the same size and dimensions and possessing the same sort of punctation. Thus, it seems highly unlikely that this is a different species.

Altica occidentalis **Suffrian**

Figure 12

Haltica occidentalis Suffrian, Arch. Naturg., vol. 34, p. 197, 1868.

In describing this species Suffrian was somewhat in doubt as to whether or not it might be the European *A. oleracea* L., which it strongly resembles and which he thought might have been introduced into Cuba with vegetables. The present species is very similar in outward appearance to the European species but the aedeagus is different. This species appears to be endemic in the West Indies and occurs not only in Cuba but also in Hispaniola, Puerto Rico, the Virgin Islands, Jamaica, Dominica, and St. Lucia. It is of the same elongate shape as *A. ludoviciana* Fall, another Caribbean species found on the same food plant, *Jussiaea*, and a species distinguished by its pale yellow legs.

Hermaeophaga jamaicensis**, new species**

Figure 13

About 2 mm. in length, oblong oval, shining, prothorax with basal sulcus not limited at ends, elytra faintly striate punctate, pale yellowish brown with elytra shining metallic green, breast and abdomen dark brown and outer joints of antennae dark brown.

Head with interocular space about half width of head, occiput smoothly rounded, impunctate, frontal tubercles clearly marked, a narrow carina down front, entirely pale yellow brown. Antennae extending slightly below humeri, first four basal joints pale, without much pubescence, remainder thicker, dark and very hairy. Prothorax moderately convex, shining, impunctate, pale yellow brown with basal sulcus across pronotum not limited at ends. Scutellum pale. Elytra faintly striate punctate, punctures evanescent at apex, a slight transverse depression below basal callosity, shining, metallic green. Body beneath with breast and abdomen dark brown, legs entirely pale. Length 2–2.3 mm.; width 1–1.1 mm.

Type, male, USNM 66199, one female paratype, and one male paratype, in Institute of Jamaica, collected at St. James, about 4 miles northeast of Montego Bay, Jamaica, September 12, 1958, by T. H. Farr.

Remarks.—This is the second species of *Hermaeophaga* to be described from Jamaica, the other being *H. cupraea* Blake.

Hemilactica portoricensis, new species

Figure 15

Between 3 and 4 mm. in length, oblong oval, shining, finely punctate, prothorax with remnants of basal sulcus apparent at limiting ends and middle, elytra in female conspicuously costate, less so in male, pale yellow brown, with outer joints of antennae deeper brown, on elytra a basal dark blue or green spot not reaching suture, from middle almost to apex a larger metallic blue or blue green area.

Head with interocular space more than half width of head, occiput distinctly punctate with a median depression over well-markedfrontal tubercles, interantennal area broad and somewhat produced but not extending down lower front, lower front short. Antennae scarcely reaching middle of elytra, basal two or three joints paler th an deep brown outer ones, third joint shorter than fourth, remainder subequal. Prothorax almost rectangular with only slightly arcuate sides, disc convex in middle, a poorly developed basal sulcus with limiting ends clearly marked, a depression in middle of base, surface distinctly punctate, shining yellow brown. Scutellum pale. Elytra in female with three distinct costae, outer one from humerus to apical angle, two inner ones shorter, in male these costae less distinct but apparent, surface finely punctate. Epipleura wide and extending nearly to apex, anterior coxal cavities open, legs robust, hind femora enlarged, tibiae all faintly channelled, a short spur at end of hind tibiae, claws appendiculate. Length 3–3.8 mm.; width 1.5–1.8 mm.

Type, male, USNM 66196, and 27 paratypes, from Matrullas, Puerto Rico, collected on *Micropholis curvata* by R. G. Oakley, October 15, 1934. Other specimens were taken at Villalba on a tree by R. G. Oakley, June 18, 1934.

Remarks.—This is the first species of the genus to be described outside of Cuba. It has the characters of the group: the rather indistinct basal sulcus on the prothorax, the costate elytra (more distinct in the female), and the coloring, which is pale yellow brown with metallic blue or green markings on the elytra.

Nesaecrepida, new genus

Small (2–3 mm. in length), oblong oval beetles, similar in appearance to species of *Crepidodera* but with basal sulcus across the entire base of prothorax, elytra very finely punctate, punctures tending to be striate but not entirely so.

Head with groove from large puncture near eye running down and cutting around frontal tubercles, carina down lower front slightly produced, as in *Crepidodera.* Antennae not extending to middle of elytra; first two joints swollen, third scarcely as long as second, fourth and fifth subequal; from fifth on, joints wider but not longer. Prothorax moderately convex, with rounded sides, an oblique angle anteriorly and a small tooth at basal angle, a somewhat sinuate basal sulcus extending completely across base, not distinctly limited at ends but with inconspicuous line going downward not upward on prothorax slightly before lateral margin. Elytra moderately convex, without depressions, with very fine inconspicuous punctation obsolete at apex, tending to be striate, but not always so. (In one of the two species are traces of more than a dozen striae, in the second species the striations tend to be geminate and become confused in places, but in neither species are the striations clear cut and impressed as in others of the *Crepidodera.*) Epipleura wide until apical curve, then vanishing, anterior coxal cavities closed, hind femora enlarged, hind tibiae shallowly sulcate near apex, a very short spur at tip, claws appendiculate.

Type of genus, *Haltica asphaltina* Suffrian.

The generic name is derived from the Greek *νησαῖος* (nesaios = insular) + crepida.

Remarks.—The two West Indian species of this genus, *Nesaecrepida,* which is allied to *Crepidodera,* differ from the other New World Crepidoderini in having inconspicuous elytral punctation that consists of very fine punctures in many (over 12) striae. In *Nesaecrepida asphaltina* (fig. 16) these striae are slightly confused, but in both species the punctation becomes obsolete near the apex. In addition, these two West Indian species have a basal groove that extends completely across the prothorax to the lateral margins, without the usual limiting lines perpendicular to the base; these lines are represented by a very short and inconspicuous line from the sulcus down to the basal margin, but not extending upward from the groove. *Nesaecrepida asphaltina* was described by Suffrian from Cuba as *Haltica asphaltina* and was recorded in the Junk Catalogue as a species of *Crepidodera;* it occurs also in Puerto Rico and Jamaica. The other species, which has been collected by T. H. Farr in Jamaica, is known also from Cuba, where it was collected on rice; it is described below.

Nesaecrepida rufomarginata, new species

FIGURE 17

Between 2 and 3 mm. in length, oblong oval, shining, prothorax large, with basal sulcus not distinctly limited at ends; elytra very densely, feebly, and finely striate punctate; anterior coxal cavities closed, pale yellow brown, with suture narrowly reddish brown.

Head with interocular space approximately half width of head, a large fovea near eye with finer punctures about it, a deep groove extending down from fovea over frontal tubercles, which are slightly swollen, frontal carina pronounced, pale yellow brown with mouth parts deeper in color. Antennae extending approximately to middle of elytra, pale yellowish brown, two basal joints swollen, third joint somewhat shorter than second or fourth, fourth and fifth subequal, remainder slightly wider, longer, and deeper brown in color. Prothorax about one-third wider than long, somewhat convex, with rounded sides, anterior angles oblique, a small tooth at basal angles, sulcus extending across base, not very distinctly limited at ends, a feeble line at end extending downward only from sulcus to base, surface very finely punctate, shiny yellow brown, lateral margin reddish brown. Scutellum pale. Elytra smoothly and moderately convex, without depressions, punctation slightly coarser than on prothorax, but not conspicuous, very densely and feebly striate, pale yellow brown with suture and lateral margin narrowly reddish brown. Epipleura wide to apical curve, then disappearing. Body beneath reddish brown, anterior coxal cavities closed, legs short, posterior femora enlarged, posterior tibiae channelled, a small spur at end. Length 2.2 mm.; width 1.2 mm.

Type, male, USNM 66197, and one paratype, one female paratype in Institute of Jamaica, collected at St. Elizabeth, Luana, Jamaica, July 21, 1961, by T. H. Farr. Other specimens collected at Jababa, Cuba, December 2, 1957, on rice.

REMARKS.—This species, like *N. asphaltina*, occurs both in Cuba and Jamaica.

Homoschema xanthocyaneum, new species

FIGURE 14

About 2.5 mm. in length, oblong oval, shining, nearly impunctate, head with a group of punctures on each side near eye, prothorax with a slightly pinched-in depression at basal angle, pale yellow with darker antennae, elytra shining dark blue or purplish.

Head with interocular space about half width of head, a group of coarse punctures on either side near eye, rendering surface uneven, frontal tubercles clearly marked, a short carina not extending down rather flat lower front, pale yellow. Antennae extending to middle of elytra, first two joints swollen, third joint not as long as fourth, remainder subequal, diminishing slightly toward end, basal joints pale, outer joints becoming dark brown. Prothorax not twice as wide as long, with rounded sides, oblique anterior angles and a small tooth at basal angle, a small pinched-in depression near this basal angle, surface very shiny and very finely punctate, pale yellow. Scutellum reddish brown. Elytra moderately convex with transverse depression below basal callosity, polished dark violaceous blue and very finely punctate. Body beneath and legs pale yellow, anterior coxal cavities open, legs short, hind tibiae with short spur, claws appendiculate. Length 2.2–2.7 mm.; width 1–1.2 mm.

Type, male, USNM 66198, collected at Clarendon, Portland Ridge, north side, July 23, 1958, by T. H. Farr; one female collected at Hanover, Bloody Bay, February 15–24, 1952, by F. A. McDermott.

Remarks.—This is the second species of *Homoschema* to be found on Jamaica. It differs from *H. jamaicense* in having a more transverse prothorax with a little depression on each side near the basal angle. The aedeagus also is different and, in its long narrow point, suggests that of *H. hoffmani* from Haiti.

Chaetocnema cyanoptera, new species

Figure 18

About 2.5 mm. in length, oblong oval, shining, pronotum and head densely punctate, elytra striately punctate, greenish blue with brown tibiae and tarsi, and darker femora.

Head with interocular space more than half width of head, occiput rounded, strongly alutaceous and punctate, tubercles not defined, lower front flat and wrinkled and with pale pubescence, entirely dark with metallic blue-green lustre. Antennae extending below humeri, basal joints reddish brown, outer ones piceous. Prothorax convex, with arcuate sides, sinuous basal margin, shining although alutaceous, strongly punctate, bluish green. Scutellum dark. Elytra shiny, alutaceous, strongly striate punctate, dark blue. Body beneath dark shiny piceous, punctures anteriorly on metasternum and abdomen densely punctate. Hind femora enlarged, dark with faint greenish lustre, middle and hind tibiae deeply emarginate near apex, hind tibiae with spur, all tibiae somewhat brownish, darker toward apex, claws appendiculate. Length 2.5 mm.; width 1.3 mm.

Type, male, USNM 66188, taken on an avocado from Cuba, July 7, 1930.

Remarks.—This is about the size of *C. plicipennis* Blake and is one of the larger species of *Chaetocnema* from the West Indies. It is distinguished by its blue-green color.

Pseudoepitrix rugosa, new species

Figure 20

About 3 mm. in length, elongate oblong, faintly shining, pronotum densely and coarsely punctate with basal sulcus very distinct in middle of base, elytral punctation irregularly striate, somewhat confusedly punctate in depression below basal callosity, pale yellowish brown, prothorax more reddish, a reddish brown irregular marking along side of elytra, legs and antennae pale yellow.

Head with interocular space half its width, front of head coarsely punctate down middle from occiput to somewhat swollen frontal tubercles, carina between antennal sockets short and broad, lower front short. Antennae long and slender, extending below middle of elytra, pale yellow with terminal joint brownish, third joint shorter than fourth. Prothorax wider than long with oblique anterior angles and tooth at basal angle, sides straight, basal sulcus very distinct in middle, marked at sides by depression, surface coarsely and contiguously punctate, pale reddish brown. Scutellum reddish brown. Elytra long, with well-marked basal callosity and a slight depression below this, rows of striate punctures irregular, almost geminate at times, especially confused in depression below basal callosity and about scutellum, along sides feebly costate, yellowish brown with irregular brown areas on sides between humerus and middle. Body beneath reddish brown, legs pale yellow brown, anterior coxal cavities closed. Length 2.9 mm.; width 1.3 mm.

Type, female, USNM 66201, collected at Hardwar Gap, Portland, Jamaica, June 28, 1959, by T. H. Farr.

Remarks.—The characters of this Jamaican species resemble more the characters of the genus that Jacoby described as *Pseudoepitrix* from Central America than the species that have been described from the West Indies under the same genus. Like the Central American species, this Jamaican species is more elongate, with long elytra and with a shorter face than in the West Indian species, and the anterior coxal cavities are closed.

Pseudoepitrix brasiliensis, new species

Figure 19

About 3 mm. in length, elongate oblong, shining, prothorax with inconspicuous basal sulcus not distinctly limited at ends, strongly punctate, elytra elongate with striate punctation, shining black with yellow legs, hind femora with dark apex.

Head with interocular space half width of head, a row of punctures near eye, frontal tubercles somewhat swollen, with distinct carina down lower front, entirely dark piceous, shining. Antennae extending nearly to middle of elytra, third joint shorter than fourth, rest subequal, entirely dark. Prothorax almost rectangular with nearly straight sides, anterior oblique angles thickened, a faint basal sulcus, slightly more distinct at ends, disc somewhat flat, with scattered not dense coarse punctures, shining black. Scutellum black. Elytra elongate, tapering at apex, strongly striate punctate, punctures becoming weaker at apex, shining black. Body beneath black with legs pale yellow except apex of hind femora, which are dark. Anterior coxal cavities closed, tibiae not channelled, hind ones with short spur, claws appendiculate. Length 2.8–3 mm.; width 1.2–1.4 mm.

Type, male, USNM 66200, and three paratypes, from São Paulo, Brazil, collected by H. L. Parker on a "labiate plant." Two other specimens were collected by W. M. Mann in the Baturites Mountains, Brazil. One of these, which may be immature, has yellow brown elytra; the head and prothorax are brownish.

Remarks.—This South American beetle has been included among the West Indian species to show how the West Indian species assigned (up to this time) to the genus *Pseudoepitrix* differ from the Central and South American species of *Pseudoepitrix*.

Exoceras facialis Jacoby

Figure 25

Exoceras facialis Jacoby, *in* Biologia Centrali-Americana, Coleoptera vol. 6, pt. 1, suppl., p. 273, 1891.

Exoceras facialis Jacoby was described from a single male specimen from Volcan de Chiriqui, Panama. In 1897 Jacoby described a closely related species from St. Vincent as *Pseudoepitrix suffriani*. Mr. Bryant has followed Jacoby in describing, as species of *Pseudoepitrix*, two others closely related to *suffriani*, one from Trinidad, *P. trinitatis*, the other from Puerto Rico, *P. hoffmani*. The present writer has followed them in ascribing to the genus *Pseudoepitrix: hispaniolae* from the Dominican Republic, *punctatissima* and *hottensis* from Haiti, *jamaicensis* from Jamaica, *tetraspilota* and *longicornis* from Cuba. In all these species the strongly marked sex characters described in the male *Exoceras facialis* are either very much reduced or not at all apparent, with the result that there is little to relate these species to *Exoceras facialis*, which is a much larger beetle, with very long antennae, much enlarged frontal tubercles, and a prominent enlargement in the lower front of the face in the male. Recently, Bechyne [1] has described several species of *Exoceras* from Central and South America in which the characters found in *E. facialis* are more apparent. In addition to these he described one species from Guadeloupe, *E.*

[1] Bechyne, Ent. Arb., Band 6, Heft. 1, 1955, pp. 145–148

heikertingeri. The present writer recently has examined specimens from Dominica and St. Lucia that are probably this species. The writer at once recognized the relationship of these specimens to the other West Indian species described under *Pseudoepitrix* although, in *E. heikertingeri* (also a larger species), the male characters are very long antennae, very swollen frontal tubercles, and two well-developed tubercles in the lower front of the face—all characters to be found in *E. facialis.*

In all the West Indian species the head is long, as in *E. facialis.* In *P. longicornis,* described from a male only, the antennae approximate those of *facialis.* In *P. suffriani* the frontal tubercles over the antennae are very swollen, as in *facialis.* To a slightly less extent this may also be true in *P. trinitatis,* as shown in Mr. Bryant's drawing (the present writer has not examined the type). In the remainder of the West Indian species (*hoffmani, hispaniolae, punctatissima, hottensis, jamaicensis,* and *tetraspilota*) none of these striking male characters so far has been observed, but it is evident that all of these species belong to the genus *Exoceras,* rather than to *Pseudoepitrix.*

The West Indian species are all smaller than *E. facialis,* and all very similar, forming a homogeneous group. Several have been collected on tree ferns. Mr. Bryant records *trinitatis* as destroying young fronds of the fern *Adiantum tenerum.* These species do not have the long elytra common to *Pseudoepitrix* and, unlike this genus, the anterior coxal cavities are open. The head in *Pseudoepitrix* is normal, not elongate, and there are no traces of tubercles on the lower front nor enlarged tubercles over the antennal sockets.

Two new species of *Pseudoepitrix* are included in this paper to illustrate the differences in the two genera. Drawings have been made of *Exoceras facialis* Jacoby (fig. 25), *E. suffriani* (Jacoby) (fig. 22), and what is probably *E. heikertingeri* Bechyne (fig. 24).

***Sidfaya,* new genus**

Small, between 2 and 4 mm. in length, ovate, convex, shining black, with coarsely and confusedly punctate prothorax and elytra, head with groove extending down from eye to frontal tubercles, interantennal area broad, somewhat produced, front below slightly declivous. Antennae not extending much below humeri, first two joints swollen, third to sixth slender and subequal, joints seven to eleven much thicker but not much longer. Prothorax twice as wide as long with lateral sides slightly angulate, with anteriorly a prominent oblique angle, middle of margin sharply rounded and at basal angle a well-developed tooth, disc without basal depression and strongly punctate. Elytra widened slightly behind, convex, with prominent basal callosities and transverse depression below them, surface coarsely and confusedly punctate. Body beneath with prosternum extending down widely between anterior coxae, hind femora enlarged, hind tibiae not channelled but rounded, spur at end, claws appendiculate.

Type of genus, *Sidfaya polutima*, new species.

Remarks.—The beetles are somewhat similar in shape to those of the genus *Heikertingerella* but are not so smoothly convex, the elytra having basal callosities and a transverse depression. In addition, the strong, even coarse, punctation is unlike any found in *Heikertingerella*.

The genus is named in memory of Dr. Sidney Fay Blake. This name also has an interesting parallel in Greek: σίδαρος (sidaros=iron) and φάω (phao=shining).

Sidfaya polutima, new species

Figure 21

About 2 mm. in length, ovate, convex, shining, with dense and somewhat confused punctation, dark piceous black with tibiae and tarsi yellowish brown and basal seven joints of antennae pale yellow, four terminal joints thickened and dark, hind femora enlarged, hind tibiae rounded with small spur at end, claws appendiculate.

Head with interocular space half width of head, smoothly rounded, polished and impunctate over occiput, a groove on each side extending from fovea near eye down to frontal tubercles with several punctures along it, frontal tubercles small and distinct, interantennal area slightly produced, flat, with no definite carina and somewhat declivous below. Antennae reaching below humeri, the two basal joints swollen, joints three to six pale yellow, subequal, joints seven to eleven gradually becoming wider and last four joints piceous. Prothorax approximately twice as wide as long with sinuate, almost angulate, lateral margin, a broad oblique angle anteriorly ending in prominent tooth at lower end and another tooth at basal angle, moderately convex, without depressions, surface shining black, with strong punctation. Scutellum dark. Elytra moderately convex, with small humeral prominences and short intrahumeral depression, distinct depression below basal callosities, surface shiny with strong and not too dense punctation becoming somewhat less distinct at apex, punctation with tendency to being striate but not actually so, epipleura vanishing at apical angle. Body beneath having prosternum extending down widely between anterior coxae and closing anterior coxal cavities. Hind femora much enlarged, hind tibiae entire, rounded, a spur at end, claws appendiculate. Length 1.8–2 mm.; width 1.1 mm.

Type, male, MCZ 30491, and one female paratype in the U.S. National Museum collection, taken at Buenos Aires, Trinidad Mountains, Cuba, by P. J. Darlington, Jr.

REMARKS.—In shape this species approaches the species of the genus *Heikertingerella*, being ovate, moderately convex, with a prothorax about twice as wide as long and without a basal sulcus of any sort. The species differs from that genus, however, in the less sinuate basal margin of the prothorax, which does not dip down as much over the scutellum, and in the lateral margin, which is very sinuate, even angulate, and with a more distinctive oblique angle anteriorly and a larger tooth basally. The elytra, too, are not as smoothly convex but have a transverse depression below the basal callosity. The terminal joints of the antennae are much more enlarged than in *Heikertingerella*, and the head has wider interantennal space. The punctation of this and the species below is much coarser than that of any species of *Heikertingerella*.

Sidfaya punctatissima, new series

FIGURE 23

Between 2 and 3 mm. in length, oblong ovate, shining piceous black, pronotum and elytra densely and moderately coarsely punctate, prothorax twice as wide as long with prominent oblique angles anteriorly and somewhat angulate lateral margin, elytra with transverse depression below basal callosities, antennae yellowish brown with four terminal joints wider and darker, not extending much below humeri.

Head with interocular space approximately half width of head, occiput rounded, impunctate, polished, a groove with several punctures along it from eye to frontal tubercles, frontal tubercles small and clearly cut, a broad and somewhat produced interantennal area widening below, lower front slightly concave. Antennae not extending far below humeri, joints one and two swollen, joints three to six slender and subequal, joints seven to eleven gradually wider, but not much longer, hairier and darker. Prothorax twice as wide as long with prominent oblique anterior angles having tooth at lower end, at midpoint margin sharply rounded, at base a small tooth, disc not very convex, shiny piceous black with numerous moderately coarse and deep punctures, not too closely placed in all parts. Scutellum dark and shiny. Elytra slightly wider in apical half, moderately convex, with prominent basal callosities and transverse depression below them, surface shining black, coarsely and almost contiguously punctate, epipleura vanishing at apical curve. Body beneath entirely dark, prosternum extending down widely between anterior coxae, hind femora enlarged, hind tibiae not channelled, but rounded, with spur at apex, claws appendiculate. Length 2.8 mm.; width 1.4 mm.

Type, female, MCZ 30492, collected on Main Range, Blue Mountains, Jamaica, 5000–7388 ft., August 17–19, 1934, by P. J. Darlington, Jr.

Remarks.—Although somewhat larger than *Sidfaya polutima*, the structure of the head, with the incised line from the eye to the frontal tubercles, the somewhat declivous face, the wide prothorax, with the prominent angles, the elytra, with the basal callosities and transverse depression, and the coarse punctation over all the surface—all cause this species to resemble *S. polutima*.

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ASTEROIDEA OF THE BLUE DOLPHIN EXPEDITIONS TO LABRADOR

By E. H. Grainger

Introduction

During the four summer field seasons of 1949 to 1952 the *Blue Dolphin* expeditions, commanded by David C. Nutt, collected 321 specimens of sea stars at 57 stations along the coast of Labrador. Eleven species were taken.

Few collections of marine invertebrates from the Labrador coast preceded the *Blue Dolphin* voyages, and little information exists on the invertebrate fauna of the region. Only three publications on asteroid collections from Labrador are available, and they refer to six species in all. Packard (1867) reported from several locations in southern Labrador *Solaster papposus* (Linnaeus), *S. endeca* (Linnaeus), *Henricia sanguinolenta* (O. F. Müller), *Leptasterias groenlandica* (Steenstrup), and *L. polaris* (Müller and Troschel), the latter taken also at Hopedale, about half way along the Labrador coast. Bush (1884) recorded *Solaster papposus*, *Henricia sanguinolenta*, *Leptasterias littoralis* (Stimpson), and *L. polaris*, and Rankin (1901) *L. polaris* only, all from southern Labrador. Packard (1863, 1867) listed *Asterias vulgaris* Verrill from the north shore of the Gulf of St. Lawrence near the Quebec-Labrador boundary. The species, however, has not yet been reported from the Strait of Belle Isle or north of there, and therefore it is not properly a member of the Labrador fauna. The

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Blue Dolphin collection raised the number of Labrador species to 13 and extended the range of collections over nearly the full length of the coast.

Two species, *Solaster endeca* (Linnaeus) and *Leptasterias littoralis* (Stimpson), recorded formerly from Labrador, were not included in the *Blue Dolphin* collections. The first is an Arctic, Subarctic, and Boreal species of rock, mud, and sand bottoms, recorded from eastern North America to the Kara Sea and from the Bering Sea and northern Alaska. The second is a Subarctic eastern North American species.

Of the 13 Labrador species considered here, 6 are circumpolar, 5 extend from North America eastward to the northern U.S.S.R. but apparently are absent from the Pacific and from areas immediately on either side of Bering Strait, 1 (in several forms) extends from the North Pacific to western Greenland, and 1 occurs in eastern North America only. Five of the 13 species are Arctic to Boreal in distribution and 8 are Arctic and/or Subarctic.

Species Collected

The waters of the Labrador Current, which flow southward off the Labrador coast, are of mixed origin, coming partly from west Greenland and partly from east Baffin Island and Hudson Strait. They contain both Arctic and Atlantic elements. Labrador Current water of 50 m. and greater depth shows a temperature range of about $-1.70°$ to nearly $3°$ C., and a salinity range of 32 to more than 34.5 (Dunbar, 1951). Waters of the coastal inlets of Labrador come primarily from the Labrador Current and may be modified by coastal drainage, according to Nutt (1953). Most of the inlets, including Seven Islands Bay, Hebron Fjord, Kaipokok Inlet, and St. Lewis Inlet, show temperature-salinity characteristics of the lowest temperature and the lowest salinity portion of the Labrador Current, that is, of essentially Arctic-type water with, it appears, relatively little west Greenland influence. Lake Melville and, to a lesser degree, Hamilton Inlet represent more specialized local conditions. Nutt's observations in Hamilton Inlet showed water near the coldest, least saline Labrador Current water in July, but much warmer (more than $0°$ to more than $2°$ C.) and slightly reduced in salinity (to less than $31.5‰$) in August. Lake Melville was shown to be much less saline (less than $29‰$) than Hamilton Inlet and about the same temperature.

The echinoderms of the *Blue Dolphin* collection come from two rather different types of environment. One, including all but 2 of the species (*Poraniomorpha tumida* and *Urasterias lincki*) and occurring at the majority of stations, is relatively cold (usually less than $0°$ C.) below 50 m. but up to about $4°$ C. at the shallow stations, and not less than

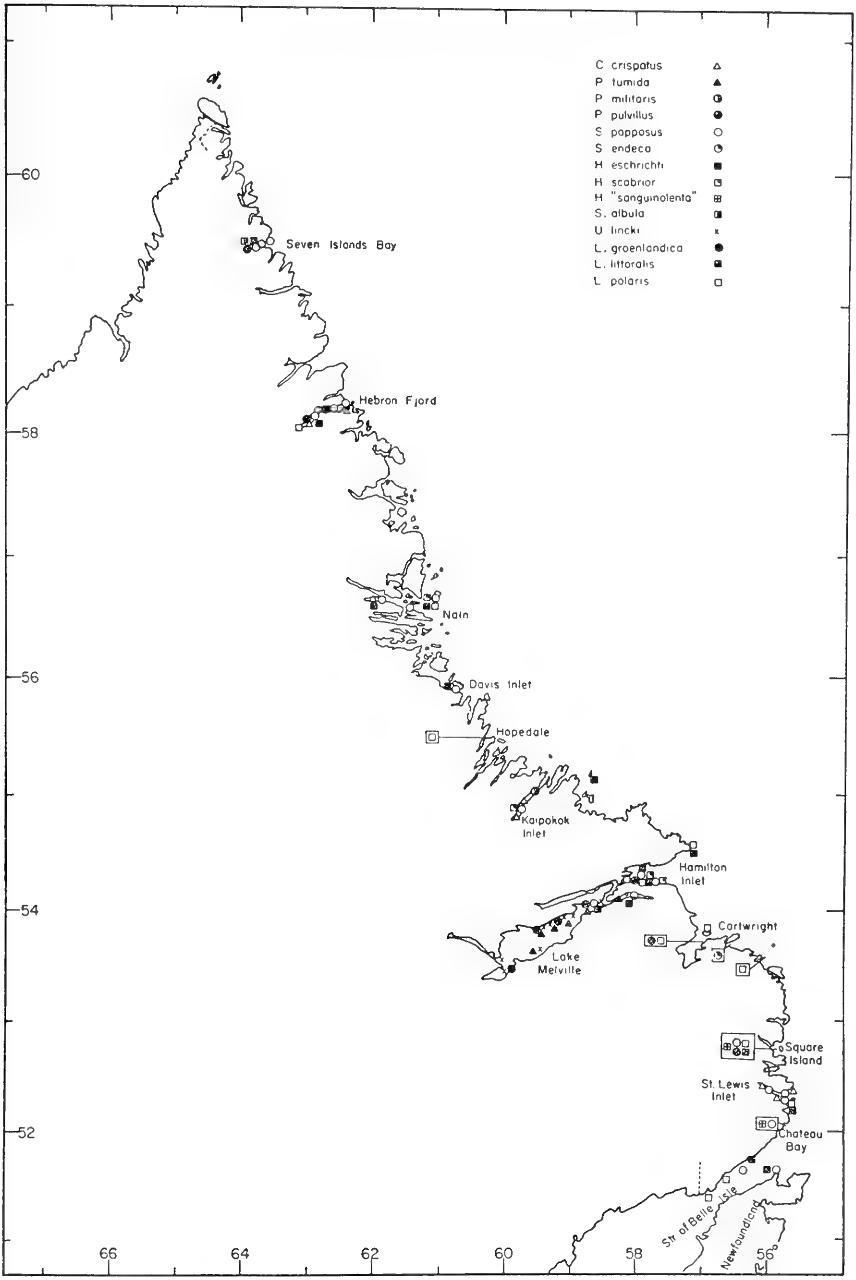

FIGURE 1.—Coast of Labrador, showing *Blue Dolphin* and earlier sea star collection points. Symbols for the latter are enclosed in squares; the other symbols represent *Blue Dolphin* material.

30°/₀₀ at the bottom of the shallowest stations. This is more or less typical inshore Labrador Current water, apparently little modified by local conditions. It is mixed water with a preponderance of Arctic influence. The other, including all representatives of 2 of the species (*P. tumida* and *U. lincki*) and a small proportion only of 3

TABLE 1.—Blue Dolphin *sea star collection stations.*

No.	Date	Depth (meters)	Bottom	North latitude	West longitude	Location
			1949			
BD4	7- 1	45	rock	51°41′	56°20′	Str. of Belle Isle
BD5	7- 1	54	do	51°39.7′	55°57.7′	do
BD16	7-12	72	mud	52°20.1′	55°49.4′	St. Lewis Inlet
BD17	7-12	64	soft mud	52°22.3′	55°56.7′	do
BD19	7-29	82	silt	54°56.7′	59°43.2′	Kaipokok Inlet
BD20	7-29	82	do	55°01.5′	59°33.3′	do
BD21	7-29	27	do	54°52.4′	59°50.3′	do
BD24	8- 3	40	rubble	55°51′	60°15′	do
BD24/37	7- 8	0		51°16′ [1]	55°40′ [1]	Indian Island
BD27	8- 8	174	mud	58°11.4′	62°34.2′	Hebron Fjord
BD28	8- 8	225	do	58°09′	62°45.7′	do
BD30	8-12	90	mud, rock	58°05.6′	63°03.9′	do
BD31/32	8-12	9	sand, pebble	50° [1]	63°20′ [1]	do
	6-25	Along shore		51°28′ [1]	56°54′ [1]	Forteau Bay
	6-30	55		51°44′ [1]	56°25′ [1]	Red Bay
	7-25	15		53°51′ [1]	57° [1]	Packs Harbor
	7-19	9-11	sand, mud, rock	53°42′ [1]	57°04′ [1]	Cartwright
	8- 1	82	silt	54°56′	59°38′	Kaipokok Inlet
	8- 3	20	rubble	55°51′	60°48′	Davis Inlet
			1950			
BLD1	7-11	54-63	mud	53°52′	59°19′	Lake Melville
BLD2	7-13	126	do	54°01.3′	58°41.7′	do
BLD3	8-10	18-22	stone, mud	59°23.4′	64°03.2′	Seven Islands Bay
BLD4	8- 8	54	mud, rock	59°24′	64°01′	Kangalaksiorvik
BLD5	7-25	36	sand, mud, rock	53°50′	59°25′	Lake Melville
BLD6	8- 8	90	mud, rock	59°24′	63°51′	Seven Islands Bay
BLD7	7-23	63	mud	53°56.5′	58°58′	Lake Melville
BLD8	7-12	81	do	53°56′	59°03′	do
BLD11	8-19	27		53°28.8′	59°59.5′	do
BLD12	8-19	113	mud	53°32′	60°03′	do
BLD14	8-10	90	stone	59°25′	63°47′	Seven Islands Bay
BLD15	8-27	81	do	54°14.9′	58°01′	Hamilton Inlet
BLD16	8-27	54	mud, stone	54°15′	57°45′	do
BLD18	8-30	36-63	do	52°20′	55°51′	St. Lewis Inlet
BLD19	8-30	63-72	mud	52°21′	55°56.5′	do
BLD20	7-28	16-20	do	53°29′	59°58′	Lake Melville
BLD22	8-30	18	mud, stone, shell	52°20′ [1]	56° [1]	St. Lewis Inlet

TABLE 1.—Blue Dolphin *sea star collection stations*—Continued

No.	Date	Depth (meters)	Bottom	North latitude	West longitude	Location
1951						
BLD1, 11, 34	8- 7	63	mud	56°36′ [1]	61°50′ [1]	Nain Bay
BLD2	8- 7	81	do	56°36′ [1]	61°50′ [1]	do
BLD3	8- 5	99–108	sandy mud, stone	56°33′ [1]	61°40′ [1]	off Nain
BLD4	7–29	18	mud, rock	54°33′ [1]	57°12′ [1]	Hamilton Inlet
BLD5	7–22	88		54°14.8′	57°59′.5	do
BLD7	8–24	63	hard (?rock)	54°22′	57°39′	do
BLD8	7- 2	27–36	mud, rock	52°12.5′	55°43′	Niger Sound
BLD10	7- 5	27	rock	54°20′ [1]	57°30′ [1]	Hamilton Inlet
BLD23	8–26	31–34		53°40′ [1]	59°30′ [1]	Lake Melville
BLD35	7–29	18–27		54°33′	57°10′	Brig Harbour Isle
BLD36	8- 8	110		56°33′ [1]	61°40′ [1]	Nain
BLD37	7–10	72	mud	53°30.8′	59°59.6′	Lake Melville
BLD19/39	7–22	36		54°15.8′	58°01.5′	Hamilton Inlet
BLD40	8- 8	110		56°33′ [1]	61°40′ [1]	off Nain
BLD41	8–25	146		53°39′	59°30′	Lake Melville
BLD44	8- 6	73		56°33′ [1]	61°40′ [1]	Nain
1952						
I–2a, b	7- 4	27–29		54°6.3′	58°01.1′	Lake Melville
I–4	7–13	85		55°7′	58°45′	Ironbound Sound
I–11	7–31	13–15	mud, sand, stones	58°10′ [1]	62°40′ [1]	Hebron Fjord
I–16	8–24	30–36		53°40′ [1]	59°30′ [1]	Lake Melville
I–17	8–25	29–36		54°6.3 ′	58°01.1′	do

[1] Approximate.

others (*Solaster papposus, Henricia eschrichti,* and *Leptasterias groenlandica*) occurs in Lake Melville in generally warmer and much less saline water (not higher than 29°/₀₀). These two situations are bridged, in part, by Hamilton Inlet which shows intermediate characteristics.

The Asteroidea of Labrador are therefore primarily a cold water (mixed Arctic-Atlantic) fauna characteristic of the North Atlantic region, closely resembling, although considerably less rich than, that of the warmer waters of western Greenland. All but one of the species occur in Canadian waters to the north of Labrador (Grainger, 1955). The exception is *Leptasterias littoralis*, the northern limit of which appears to be the Labrador coast. *Asterias vulgaris* may be shown to reach southernmost Labrador in the Strait of Belle Isle, but it is doubtful that it reaches farther northward. All but one of the species also occur to the south of Labrador in the cold inshore waters of the Canadian Atlantic provinces and New England. *Poraniomorpha tumida* appears not to have been recorded south of the Labrador location given here. Others, like *Pteraster pulvillus* and *Henricia scabrior,* are evidently rare south of Labrador.

Comparison of this material with Pettibone's (1956) report on the *Blue Dolphin* polychaetes from Labrador illustrates interesting distributional differences between the generally widely dispersed polychaete species and the more restricted sea stars. Of 68 species of polychaetes, only 9% (compared with 62% of the asteroids) are Arctic-Subarctic and 37% (38% of the asteroids) are Arctic-to-Boreal; the remainder, including 25% with "cosmopolitan" distribution, show no counterpart among the sea stars.

I am grateful to Dr. F. M. Bayer of the United States National Museum for making the *Blue Dolphin* collection available for study and to Mr. D. C. Nutt for providing station data.

Locations of all collection stations are shown in figure 1. The *Blue Dolphin* station list is given in table 1.

Ctenodiscus crispatus (Retzius)

Asterias crispata Retzius, 1805, p. 17.
Ctenodiscus crispatus (Retzius).—Fisher, 1911, p. 31, pls. 3 (figs. 1–4), 4 (figs 1–6).

Collected at 9 stations; 27 to 174 m.; mud, silt, rock; 1949: BD16 (47 specimens), BD17 (1), BD19 (14), BD21 (4), BD27 (4), BD30 (1); 1950: BLD18 (10), BLD19 (23); 1951: BLD1, 11, 34 (13).

All but 4 individuals have the usual 5 rays; 3 from BD16 and 1 from BD21 have only 4. Two 5-rayed individuals show apparently regenerating rays, 1 with a single new ray, the other with 2. Diameters range from 6 to 78 mm., the majority being larger than 30 mm.

These specimens were collected (fig. 1) between Hebron and St. Lewis Inlet, and the species may be expected to occur along the full length of the Labrador coast. It is limited here to cold water of high salinity (fig. 2), to water of $-1°$ C. and less, and of a little less than 31‰ to 33‰. Typically a mud-bottom form, it occurred almost exclusively on mud in these collections. It is a circumpolar species, ranging from Arctic to Boreal seas.

Poraniomorpha tumida (Stuxberg)

Solaster tumida Stuxberg, 1878, p. 31, pl. 6.
Asterina tumida tuberculata Danielssen and Koren, 1884, p. 63, pls. 10 (figs. 5–7), 15 (fig. 3).
Paraniomorpha tumida (Stuxberg).—Mortenson, 1910, pp. 257–258, pl. 16 (figs. 6, 7).

Collected at 8 stations: 27–146 m.; mud, sand, rock; 1950: BLD1 (4 specimens), BLD2 (3), BLD5 (4), BLD7 (2), BLD8 (2); 1951: BLD41 (2); 1952: I–2a, b (3), I–17 (2).

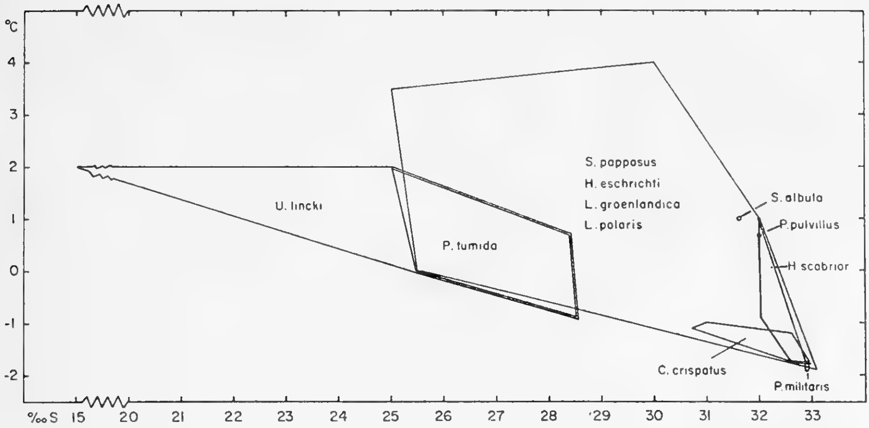

FIGURE 2.—Temperature-salinity ranges of the *Blue Dolphin* sea star specimens.

All the specimens show at least some characteristics of the form *tuberculata* Danielssen and Koren, described as differing from *tumida* in having relatively longer rays, in possessing dorsal tubercles, and in having only single rather than double rows of adambulacral spines. Arm radii are from 9 to 36 mm., R:r from 1.7:1 to 2.7:1. Dorsal tubercles, present in all, vary greatly in their degree of development, from only faint bulges to strongly developed protuberances spread conspicuously over the dorsal surface. There is some evidence of correlation between size and tubercle development, the largest sea stars frequently showing the most highly developed tubercles. Adambulacral spines show a rather bewildering range of variation, most being arranged in only a single row but many occurring in 2 rows per plate. One-row series range from 3 to 5, having most frequently 4 or 5 per plate. The majority of specimens show both 1-row and 2-row adambulacral plates, usually irregularly arranged, the latter with up to 8 spines per plate. While there appears to be some correlation between size and degree of development (above), there is none apparent between either size and R:r values or between size and adambulacral spine arrangement; that is, large specimens with well-developed dorsal tubercles (characteristic of form *tuberculata*) may have low R:r values and frequent occurrence of 2 rows of spines per adambulacral plate (characteristic of *tumida*). Little work on variation within either form has been done to date. It appears from this collection that form *tuberculata* must be defined much more widely than was done by Danielssen and Koren, and that its differences from the stem form are far less distinct than they were formerly thought to be. Possession of dorsal tubercles and presence of only a single row of spines on the majority of adambulacral plates are the two criteria used here to place specimens, at least tentatively, in form *tuberculata*.

Occurrence in this collection was limited to Lake Melville (fig. 1), that is, to relatively warm water, mostly above 0° C., of fairly low salinity, 25 to 28.5 (fig. 2). This is a curious circumstance, the species being known from North America eastward to the Kara Sea, in Arctic and Subarctic waters. Its apparent total absence from the outer coastal waters may be a result of insufficient collecting. If present, however, it may be assumed that numbers are small. Large concentrations in Lake Melville are undeniable, and indications of preference by the species for low salinity conditions are fairly clear.

Solaster papposus (Linnaeus)

Asterias papposa Linnaeus, 1767, p. 1098.
Solaster papposus (Linnaeus).—Fisher, 1911, p. 325, pl. 94 (figs. 1–6).

Collected at 24 stations; 13 to 225 m.; mud, rock, rubble; 1949: BD4 (1 specimen), BD5 (2), BD16 (8), BD24 (1), BD28 (1), BD30 (7), Davis Inlet (4); 1950: BLD3 (2), BLD4 (1), BLD14 (1), BLD15 (1), BLD16 (3), BLD18 (2), BLD19 (1), BLD22 (2); 1951: BLD1, 11, 34 (2), BLD3 (2), BLD5 (1), BLD19/39 (3), BLD40 (1), BLD44 (2); 1952: I–2a, b (1), I–11 (1), I–16 (2).

These specimens range in diameter from 7 to 176 mm. and have from 9 to 13 rays. More than half (53%) have 12 rays. It is the most abundantly collected asteroid on the Labrador coast (fig. 1), as indeed it appears to be throughout most of the eastern Arctic-Subarctic part of the North American coast. Temperature-salinity tolerance is wide (fig. 2), from nearly −2° to 4° C., and from about 25‰ to 33‰. Most collections are from the outer Labrador coast; a few specimens were taken, however, in the outermost reaches of Lake Melville. It is a circumpolar species, ranging from Arctic to Boreal waters.

Pteraster militaris (O. F. Müller)

Asterias militaris O. F. Müller, 1776, p. 234.
Pteraster militaris (O. F. Müller).—M. Sars, 1861, p. 48, pls. 3 (figs. 8, 9) 4, 5, 6 (figs. 1–13).

Collected at 3 stations; 82 to 108 m.; silt, sandy mud, stone. 1949: BD20 (1 specimen), Kaipokok Inlet (1); 1951: BLD3 (1).

The 3 individuals, 148, 118, and 70 mm. in diameter, show R:r values of 2.4:1, 2.6:1, and 2.3:1 respectively. They are rather unexceptional members of this widely distributed nearly circumpolar, Arctic, Subarctic and Boreal species. Occurrence here (fig. 1) is limited to two locations which (fig. 2) have high salinity of nearly 33 and low temperature of near −2° C.

Pteraster pulvillus M. Sars

Pteraster pulvillus M. Sars, 1861, p. 62, pls. 6 (figs. 4–18), 7, 8.

Collected at 1 station; 81 m.; stone; 1950: BLD15 (1 specimen). The single individual collected was 44 mm. in diameter, with R:r of 1.7:1. It occurred (fig. 1) in Hamilton Inlet, at 0.7° C. and 32°/oo (fig. 2). This too is an almost circumpolar species, extending from Arctic to Boreal Waters.

Henricia eschrichti eschrichti (Müller and Troschel)

FIGURE 3

Eschinaster eschrichtii Müller and Troschel, 1842, p. 25.
Henricia eschrichti eschrichti (Müller and Troschel).—Heding, 1935, p. 26, figs. 8, 12(2), 13(7, 8, 12–14).

Collected at 14 stations; 18 to 146 m.; mud, rock, rubble; 1949: BD5 (2 specimens), BD30 (1), Red Bay (2), Davis Inlet (1); 1950: BLD15 (1); 1951: BLD1,11,34 (1), BLD4 (1), BLD5 (1), BLD7 (1), BLD8 (1), BLD40 (1); 1952: I–2a, b (2), I–4 (1), I–16 (2).

Several of these 18 specimens are placed with some doubt in the form *eschrichti*. Inconsistencies among the deviating forms and the suggestion of gradations between typical *eschrichti* and the most variable specimens, however, prompt inclusion of all within the *eschrichti* group. The majority fulfill requirements of the form according to the criteria of Heding (1935) and Djakonov (1950) and agree well with specimens from farther north in Arctic-Subarctic Canada (Grainger, 1955). One individual, from BLD4 (1951), taken by itself, however, shows several marked differences from typical *eschrichti*. The diameter is 60 mm., the R:r 4.3:1. Dorsal paxillae are more widely separated than in the typical form, often by spaces equal to their width or larger. A few paxillae have up to 12 to 14 spines; others have as few as 3. Many have 4 to 6. The madreporite shows conspicuous rows of spines. Most important are the adambulacral spines, generally in only a single row, or sometimes in irregular zigzag series suggesting 2 rows, with always a single spine larger than the others at the edge of the groove (figs. 3*c*,*d*). These spines usually number 5 or 6 per plate. Marginal paxillae differ from typical *eschrichti* in their shape. Instead of being roughly circular to oval, they are clearly elongate and form obvious, rather comblike structures transversely along the marginal area (fig. 3*d*).

This subspecies brings to mind Verrill's (1894) *Cribrella pectinata* from Eastport, Maine, later (Verrill, 1914) placed as a variety of *Henricia sanguinolenta* following the finding of intermediate forms. This specimen resembles *pectinata* in having dorsal paxillae separated

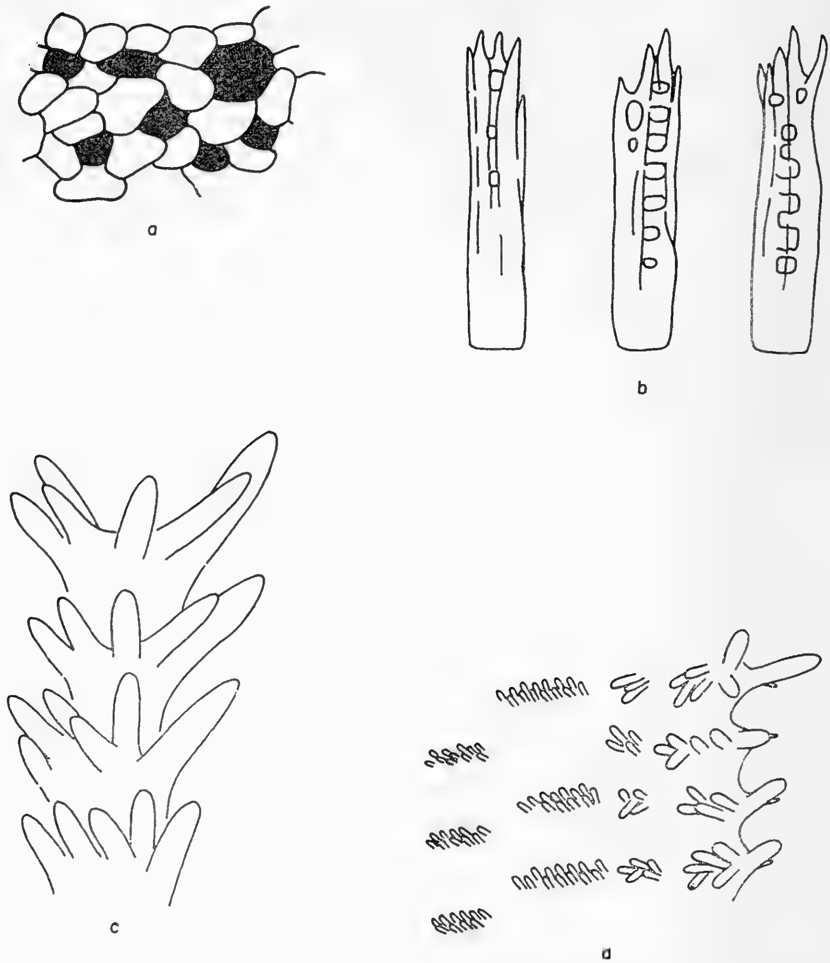

FIGURE 3.—*Henricia eschrichti:* *a*, aboral ray plates; *b*, aboral ray spines; *c*, adambulacral spines, showing variable 1-row pattern; *d*, adambulacral and marginal spines, showing comblike arrangement of the marginals.

by spaces equal to their own diameter or larger, transverse combs of spines on the marginal plates, with the inframarginals the larger, madreporite with obvious rows of spines, occasionally 2 rows of blunt adambulacral spines per plate, and almost always a single spine (the largest one of the series) at the upper edge of the adambulacral groove. It differs from *pectinata* in having some dorsal paxillae with as many as 12 to 14 spines, most inframarginal plates with fewer than 20 spines, and adambulacral plates usually with only 5 or 6 (rather than 8 to 12) spines in only 1 row or in irregular zigzag rows. The last feature probably is the most important—compare figure 3 with Verrill (1914, pl. 49, fig. 1a). This specimen closely resembles *Cribrella pectinata* but is not identical with it, nor does the specimen seem to be a distinct form by itself. Examination of other specimens shows wide variation in marginal comb structure, with forms intermediate between the advanced comb noted above and the typical *eschrichti* comb. Spacing of the dorsal paxillae varies between the open pattern above and the fairly close arrangement characteristic of *eschrichti*. Adambulacral spines frequently show 2 rows per plate, with either a single large spine at the upper edge of the groove or, as in typical *eschrichti*, 2 more or less equally large spines at the groove margin. One specimen shows all structures except the marginal combs closely resembling the extreme form described above. The marginal spines are typical for *eschrichti*. In others the characteristics are blended differently. It seems impossible, therefore, to set these specimens up as a distinct form; rather they must be considered merely as variations of the form *eschrichti*.

Specimens in this collection (fig. 1) were taken all along the Labrador coast from Seven Islands Bay to the Strait of Belle Isle and from the outermost portion of Lake Melville. The ranges of temperature and salinity (nearly −2° to 4° C. and 25 to 33°/₀₀) are wide. The range of form *eschrichti* cannot yet be described because of the doubtful identity of many former records of *Henricia sanguinolenta*, including two from southern Labrador shown in figure 1. The form *eschrichti* appears to be primarily Subarctic and Arctic, and it extends from the Barents Sea westward at least to eastern North America and southward at least to the coast of New England.

Henricia scabrior (Mikhaĭlovskiĭ)

FIGURE 4

Cribella sanguinolenta forma *scabrior* Mikhaĭlovskiĭ, 1902, pp. 478–480.
Henricia scabrior (Mikhaĭlovskiĭ).—Heding, 1935, p. 31, fig. 11, 12(5, 6), 13 (9–11).—Djakonov, 1950, p. 92, pls. 44, 45.

Collected at 6 stations; 36 to 110 m.; silt, mud, rock; 1949: BD19 (3 specimens), Kaipokok Inlet (1); 1950: BLD15 (1), BLD16 (1); 1951: BLD19/39 (1), BLD40 (1).

Among only 8 individuals there is considerable structural variation. This species is obviously one of the more plastic of this extremely variable genus. Heding (1935) expanded somewhat on Mikhaĭlovskiĭ's (1903) original description of the species. Much greater variability was shown by Djakonov (1950), and it is on the basis of his concept of the species that the individuals of the present collection are placed in *H. scabrior*; this assignment is made with awareness that further collecting may show subspecific separations which present material is not sufficiently extensive to reveal.

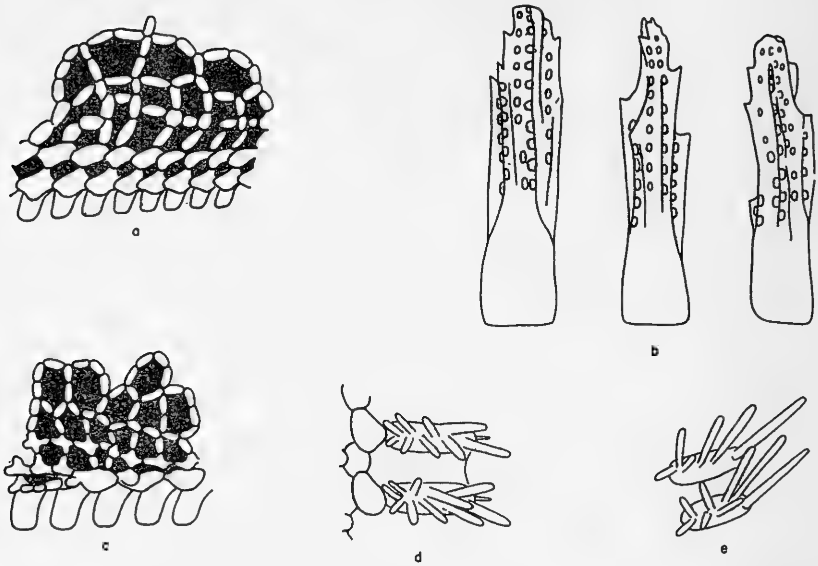

FIGURE 4.—*Henricia scabrior:* *a*, lateral ray plates; *b*, aboral ray spines; *c*, lateral ray plates; *d* and *e*, adambulacral spines.

The most variable features of the species are the arrangement of the plates on the side of the ray adjacent to the adambulacrals and the adambulacral spines. Frequently 1 or 2 longitudinal rows of plates occur fairly regularly along the ventrolateral surface of of the ray, parallel to the adambulacral plates. Dorsal to these, quite irregular papular spaces are enclosed by a variable arrangement of plates, and occasionally single isolated plates occur within the papular areas (figs. 4*a*,*c*). Adambulacral spines are frequently present as a single row of about 6 per plate (fig. 4*e*), but may be more numerous (up to 12 per plate), may occur in an irregular zigzag pattern, and may often resemble 2 rows per plate (fig. 4*d*). Both patterns may occur in single individuals. Dorsally, a membrane characteristically covers single spines per plate, but there may be at least 4 per plate. Spines lack the terminal crown of points characteristic of *H. eschrichti;* lateral ridges do not extend higher than the central portion of the spine (fig. 4*b*). One specimen with exceptionally slender rays showed unusually small papular areas and relatively more slender spines than do other individuals.

Specimens were collected (fig. 1) from Nain to Hamilton Inlet; these are the first published records of the species from Canadian waters. With a temperature range of nearly −1.8° to 1° C. and a salinity range of 32 to nearly 33 (fig. 2), the species is limited here to an environment of high salinity, and relatively low temperature. It appears to be an Arctic and Subarctic species. From Labrador and Foxe Basin in eastern Canada, it is known as far to the east as the New Siberian Islands. Additional specimens of the species have been identified by the author from the Gulf of St. Lawrence and south of Newfoundland.

Stephanasterias albula (Stimpson)

Asteracanthion albulus Stimpson, 1853, p. 14, pl. 1, fig. 5.
Stichaster albilus (Stimpson).—Mortensen, 1910, p. 267, pls. 13 (figs. 1–6), 14 (fig. 8), 15 (figs. 8–10), 17 (fig. 12).
Stephanasterias albula (Stimpson).—Fisher, 1930, pp. 157–159, pls. 70 (figs. 1–5), 71 (figs. 1, 1a–g), 72 (fig. 5).

Collected at 1 station; 18 to 22 m.; rock, mud; 1950: BLD3 (2 specimens).

The 2 individuals collected in Seven Islands Bay (fig. 1) are 42 and 31 mm. in diameter, the larger having 6 unequal rays, the smaller 3 equal rays. Temperature was 1° C., salinity 31.6 (fig. 2). Arctic and Subarctic in distribution, the species is recorded from eastern Canada eastward to the Kara Sea, and in the Bering Sea, Sea of Okhotsk, and Sea of Japan. It is not known in North America from west of Foxe Basin and Jones Sound nor in northern Asia from between the Bering and Kara Seas.

Urasterias linckii (Müller and Troschel)

Asteracanthion linckii Müller and Troschel, 1842, p. 18.
Asterias gunneri Danielssen and Koren, 1884, p. 7, pls. 2, 3 (figs. 8, 9).
Asterias stellionura Danielssen and Koren, 1884, p. 14, pl. 4 (figs. 1–9).
Urasterias linckii (Müller and Troschel).—Fisher, 1930, p. 211.

Collected at 12 stations; 27 to 146 m.; mud, rock; 1950: BLD1 (16 specimens), BLD2 (3), BLD5 (7), BLD7 (4), BLD8 (2), BLD12 (2), BLD20 (2); 1951: BLD23 (1), BLD37 (3), BLD41 (4); 1952: I–2a, b (6), I–17 (2).

These individuals range in diameter from 20 to 330 mm., in R:r from 4.3:1 to 8.5:1. The specimens in this collection were taken only from Lake Melville (fig. 1); none were taken along the outer coast. Figure 2 shows temperatures mostly above 0° C. and reaching 2° C., and salinities from 15 to only 28.5. In this collection the species is restricted to low salinity and intermediate temperatures.

Almost circumpolar, although not recorded from between Herschel Island (near the Alaskan-Yukon boundary) and the eastern Siberian Sea, it is an Arctic-Subarctic species. Because the species occurs elsewhere in higher salinity than here, its apparent absence from the outer Labrador coast is difficult to explain. It appears to be a species of wide salinity tolerance, perhaps especially well adapted to low salinity where it occurs in greatest abundance, at least in eastern North America.

Leptasterias groenlandica (Steenstrup)

Asteracanthion groenlandicus Steenstrup, 1857, p. 228.
Leptasterias groenlandica (Lütkin).—Fisher, 1930, pp. 45–47, pls. 8 (figs. 1–3), 21–23, 24 (figs. 1, 2).

Collected at 9 stations; 9 to 225 m.; mud, sand, rock; 1949: BD28 (17 specimens), BD30 (1), Cartwright (1); 1950: BLD3 (5), BLD5 (2), BLD8 (?1), BLD11 (2); 1951: BLD4 (1); 1952: I–16 (1).

Diameter range is from (?10) 20 to 110 mm., R:r from 3.1:1 to 5.8:1. The majority at least appear to be of the form *groenlandica* (Steenstrup). Distinction between the forms *groenlandica* and *cribraria* (Stimpson) is frequently not clear in individual specimens, and generally is not indicated in publications. Range of the 2 forms, therefore, is not known in detail. It is possibly significant, however, that the majority of specimens reported by Grainger (1955) from the eastern Arctic area immediately to the north of Labrador were called *cribraria*.

One small individual of diameter 10 mm., R:r 5.5:1 could not be identified with certainty. Another specimen of diameter 41 mm., R:r 3.5:1 (station BLD4, July 29, 1951), enclosed 62 young stars beneath its rays held in the brooding position.

The species was collected at stations along the whole length of the Labrador coast (fig. 1), including 2 stations just within Lake Melville. It was found (fig. 2) over a wide temperature range (less than −1° to 4° C.) and a fairly wide salinity range (about 25‰ to 33‰). It is a circumpolar species of Arctic and Subarctic waters.

Leptasterias polaris (Müller and Troschel)

Asteracanthion polaris Müller and Troschel, 1842, p. 16.
Leptasterias polaris (Müller and Troschel).—Fisher, 1930, p. 60, pls. 30 (figs. 1, 2), 32 (fig. 3), 35.

Collected at 10 stations; intertidal zone to 110 m.; rock, pebble sand, mud; 1949: BD24/37 (1 specimen), BD31/32 (1), Forteau Bay (1), Packs Harbour (1), Cartwright (3); 1951: BLD4 (1), BLD10 (1), BLD19/39 (1), BLD35 (1), BLD36 (1).

Diameters are from 25 to 270 mm., R:r from 3.7:1 to 5.2:1. Specimens were taken from Hebron to the Strait of Belle Isle (fig. 1), under temperature and salinity conditions similar to those of *L. groenlandica* (fig. 2). The species was not taken within Lake Melville but was found immediately outside. An inhabitant of Arctic and Subarctic waters, it is reported (in its various subspecific forms) from the New Siberian Islands eastward only to West Greenland.

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MOTHS OF THE GENUS RHABDATOMIS DYAR (ARCTIIDAE: LITHOSIINAE)

By William D. Field

The genus of moths treated in this paper is neotropical in distribution and contains 13 species, 5 of which are described as new. One of these species was included formerly in a second genus, for which a type designation needs to be made. The following discussion will clarify the nomenclature.

Hampson (1900, pp. 517, 518) described as new the genus *Diarhabdosia* with two included species: *Eustixis minima* Butler and *Lithosia laudamia* Druce. Although Hampson usually selected a type species for his genera, he failed to do so for this genus. Hampson's second included species, *Lithosia laudamia* Druce, is congeneric with *Rhabdatomis zaba* Dyar, the sole species included in *Rhabdatomis* by Dyar (1907, p. 227).

In order to preserve both names, *Diarhabdosia* and *Rhabdatomis*, and also because Hampson used the "first species rule" in selecting types for the genera of other authors, I designate as type species of the genus *Diarhabdosia* the first species listed and treated by Hampson, *Eustixis minima* Butler=*Diarhabdosia minima* (Butler).

I am not further concerned here with *Diarhabdosia* except to say that it appears to be more closely related to *Clemensia* Packard and *Talara* Walker than to *Rhabdatomis* and *Haematomis* Hampson.

The species included in *Rhabdatomis* differ from those included in *Haematomis* in possessing a well-developed proboscis and in having narrower forewings strongly marked by two fasciae. In *Haematomis* the proboscis is developed very weakly and on the forewing the dark ground color is divided weakly into two fasciae with a third one sometimes faintly indicated. In venation *Rhabdatomis* differs from *Haematomis* in having the origins of veins 3, 4, and 5 on the forewing much farther apart and in having the origin of vein 10 closer to the stem of 7, 8, and 9.

The venation of *Rhabdatomis* is as follows: Forewing with vein 2 from past middle of cell and from near outer third; vein 3 from just before lower angle of cell; 4 and 5 separate; 4 from lower angle and 5 from above lower angle of cell; 6 from well below upper angle; 7 from stalk of 8 and 9; veins 10 and 11 free; 10 from nearer stem 7, 8, and 9 than 11; 11 from near middle of cell and curved toward 12, sometimes distally coincident with 12. Hindwing with vein 2 from about outer third of cell; 3 stalked with 4 from lower angle of cell; 5 from near middle of cell; 6 and 7 stalked from upper angle of cell and 8 from just before middle of cell.

Key to the Species of Rhabdatomis

BASED ON EXTERNAL CHARACTERS

1. Antennae annulate 2
   Antennae evenly colored fuscous or gray 3
2. Hind tarsus fuscous; large species, length of forewing 11 mm. (figs. 18, 19) . . . . **mandana**
   Hind tarsus straw yellow; small species, length of forewing usually between 7.5 and 8.6 mm., never more than 10 mm. (figs. 26, 27) . . . . **cora**
3. Fuscous color covering nearly two-thirds of hindwing above (fig. 17) . **dognini**
   Fuscous color covering only one-half or less of hindwing above 4
4. Submarginal fuscous fascia in upper half of forewing above nearly divided in the middle by the yellow ground color of costa (fig. 20) . . . . **melinda**
   Submarginal fuscous fascia entire 5
5. Abdomen fuscous above . . . . **pueblae**
   Abdomen straw yellow above 6
6. Costal margin of hindwing below entirely fuscous 7
   Costal margin of hindwing below with at least basal half straw yellow . 10
7. Hind tarsi straw yellow (fig. 16). . . . . **zaba**
   Hind tarsi fuscous 8
8. Fuscous color of apex of hindwing above not extended along margin below area opposite discal cell (figs. 32, 33) . . . . **pusa**
   Fuscous color of apex of hindwing above extended to vein 2d A 9

9. Abdomen straw yellow above, fuscous below (fig. 23). . . . . . . **draudti**
Abdomen with terminal segments entirely fuscous (fig. 30). . . . . **fasseli**
10. Abdomen entirely straw yellow. 11
Abdomen straw yellow with a lateral patch of fuscous near middle [see key based on genital characters] (figs. 21, 22, 24) . . . . . **laudamia, knabi**
11. Submarginal fuscous band along costa of forewing above extending to edge of wing; fuscous on apex of hindwing above reduced to the margin (fig. 31). **peruviana**
Submarginal fuscous band along costa of forewing above outlined around apex by yellow; fuscous on apex of hindwing above covering apical area (fig. 25). **extensa**

BASED ON GENITAL CHARACTERS

1. Males 2
Females (those of only four species are known) 13
2. Anellus with two separate small dorsal plates as well as a single large ventral plate (juxta) 3
Anellus with a single large hoodlike dorsal plate in addition to the large ventral plate (juxta) 11
3. Saccus greatly produced anteriorly, nearly twice as long as broad; juxta lacking mesially placed finger or spinelike process (fig. 1) . . . . . **zaba**
Saccus not greatly produced anteriorly; juxta with mesially placed finger or spinelike process 4
4. Harpe bilobed at apex; juxta with a mesially placed spinelike process . . 5
Harpe trilobed at apex; juxta with a mesially placed fingerlike process . 10
5. Dorsal plates of anellus slightly scobinate (fig. 3) . . . . **mandana**
Dorsal plates of anellus smooth 6
6. Harpe with apex at costa only slightly produced (fig. 2) . . . . . **dognini**
Harpe with apical lobe from costa, greatly produced and curved forming a fingerlike process 7
7. Harpe with apical lobe from costa sharply curved inward and with cuiller slightly curved downward in lateral view (fig. 7) . . . . **knabi**
Harpe with apical lobe from costa gradually curved inward and upward and with cuiller curved upward in lateral view 8
8. Spinelike process of juxta appearing to arise from its anterior margin (fig. 5). **draudti**
Spinelike process of juxta appearing to arise from its posterior margin . . . 9
9. Aedeagus almost as broad distally as it is at base . . . . **laudamia**
Aedeagus distinctly narrower distally than at its base (fig. 4) . . . **melinda**
10. Aedeagus flattened dorsoventrally; harpe with apical lobe from costa sharply pointed and beaklike (fig. 8) . . . . **extensa**
Aedeagus not flattened dorsoventrally; harpe with apical lobe from costa broad and rounded (fig. 6) . . . . **cora**
11. Dorsal plate of anellus with large distinctly hooded posterior projection; harpe with apical lobe from costa large, much longer than broad 12
Dorsal plate of anellus with posterior projection small, not distinctly hooded; harpe with apical lobe from costa small and at least as broad as long (fig. 11). **pusa**
12. Aedeagus with at least three large cornuti (fig. 9) . . . . **fasseli**
Aedeagus lacking cornuti (fig. 10) . . . . **peruviana**
13. Signum very small, consisting of a very narrow and weakly sclerotized and slightly scobinate area 14
Signum larger, consisting of a ribbonlike or pouchlike area 15

14. Ductus bursae short, as wide as long and cuplike (fig. 15) . . . . . **cora**
 Ductus bursae long, much narrower than its length, and tubelike (fig. 12). **mandana**
15. Signum ribbonlike (fig. 14) . . . . **pusa**
 Signum pouchlike (fig. 13) . . . . **laudamia**

Rhabdatomis zaba Dyar

Figures 1, 16

Rhabdatomis zaba Dyar, Journ. N.Y. Ent. Soc., vol. 15, p. 227, December 1907.—Hampson, Catalogue of the Lepidoptera Phalaenae in the British Museum, suppl., vol. 1, p. 796, fig. 260 (♂), 1914.—Draudt, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 6, p. 244, pl. 34, fig. m1 (♂), 1919.—Strand, *in* Wagner, Lepidopterorum catalogus, pars 26, p. 837, 1922.

Male.—Figure 16. Head yellow above with palpi, frons and antennae fuscous. Thorax yellow tinged with pink. Abdomen entirely straw yellow. Forewing above straw yellow in color with two large parallel fuscous bands or fasciae extending length of wing from base to apex. Forewing below similar with fuscous fasciae larger, covering almost entire wing. Hindwing on both surfaces whitish, tinged with yellow along inner margin and with fuscous on costal and outer margin.

Length of forewing 9.5 mm.

Male genitalia as characterized in key and as illustrated by figure 1, with unusually large saccus, largest in genus and without mesially placed finger or spinelike process on juxta.

Female.—Unknown.

Type locality.—"Orizaba, Mexico."

Additional type data.—Originally described from single male specimen, holotype (USNM Type 11020, collection, William Schaus, ♂ genitalia slide WDF 1304).

Location of type.—United States National Museum.

Distribution and material studied.—This species is still known solely from the holotype specimen.

Rhabdatomis dognini, new species

Figures 2, 17

Male.—Figure 17. Head and thorax as in *Rhabdatomis zaba.* Abdomen fuscous except for straw yellow on basal four segments above. Forewing above and below similar to *R. zaba,* having on upper surface two parallel fuscous fasciae narrower, with yellow ground color more extensive. Yellow also has lustrous quality not present in *zaba.* Hindwing on both surfaces entirely dark fuscous except for yellow band along inner margin.

Length of forewing 9–10 mm. (average 9.5 mm.).

Male genitalia as characterized in key and as illustrated by figure 2, somewhat similar to *mandana* but dorsal plates of anellus smooth, not scobinate as in that species; short and broad aedeagus and cuiller much narrower apically.

Female.—Unknown.

Type locality.—Micay, department of Cauca, Colombia.

Additional type data.—Described from holotype, male (August 1896; USNM Type 34855; Dognin Collection; ♂ genitalia slide WDF 1541), and one paratype, male (♂ genitalia slide WDF 1568; other data as in holotype).

Location of type.—United States National Museum.

Distribution and material studied.—This species is known solely from the holotype and paratype.

Remarks.—Species named for the late Paul Dognin.

Rhabdatomis mandana (Dyar), new combination

Figures 3, 12, 18, 19

Diarhabdosia mandana Dyar, Journ. N.Y. Ent. Soc., vol. 15, p. 228, December 1907.—Hampson, Catalogue of the Lepidoptera Phalaenae in the British Museum, suppl., vol. 1, p. 795, pl. 41, fig. 22 (♂), 1914.—Draudt, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 6, p. 244, pl. 33, fig. h7 (♂), 1919.—Strand, *in* Wagner, Lepidopterorum catalogus, pars 26, p. 837, 1922.

Male.—Figure 18. Head and thorax as in *R. zaba.* Abdomen straw yellow, paler below. Forewing above and below similar to *zaba,* except that fasciae enlarged with fuscous color extending along both base and apex of costa and to inner margin near anal angle. Hindwing on both surfaces whitish, tinged with yellow, even on costal margin below and with small cloud of fuscous at apex much smaller on undersurface than above.

Length of forewing 9.5–11 mm. (average 10.1 mm.).

Male genitalia as characterized in key and as illustrated by figure 3. As already mentioned, it is characterized by dorsal plates of anellus slightly scobinate, by aedeagus greatly narrowed distally, and by very broad cuiller from harpe.

Female.—Figure 19. Very similar to male, differing chiefly in having hindwings entirely fuscous except for yellow in middle of outer margin above and below and on costal margin below. Adbomen yellowish brown.

Length of forewing 11 mm.

Female genitalia as characterized in key and as illustrated by figure 12. This species has a signum similar in shape to that of *cora* but it is transverse rather than longitudinal in position. Otherwise it differs greatly from *cora* in the length and shape of the ductus bursae.

Type locality.—"Castro, Parana, Brazil."

Additional type data.—Originally described from three males and two females, no single specimen of which was stated to be "the type" in the original description. All five of these specimens are therefore syntypes (article 73, paragraphs b and c, International Code of Zoological Nomenclature, adopted by XV International Congress of Zoology, London, 1961). Two of these syntypes bear the USNM type number assigned by Dyar: 10921. In addition, one of these two specimens bears a written label containing the word "type" in Dyar's handwriting. I hereby designate this specimen as the lectotype and have so labeled it (USNM type 10921; collection, William Schaus; ♂ genitalia slide WDF 1533).

Location of type.—United States National Museum.

Distribution.—Brazil: Castro, State of Paraná, and Rio de Janeiro.

Material studied.—Three males and two females.

Rhabdatomis melinda (Schaus), new combination

Figures 4, 20

Diarhabdosia melinda Schaus, Ann. Mag. Nat. Hist., ser. 8, vol. 7, p. 369, April 1911.—Hampson, Catalogue of the Lepidoptera Phalaenae in the British Museum, suppl., vol. 1, p. 795, pl. 41, fig. 21 (♂), 1914.—Draudt, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 6, p. 244, pl. 33, fig. h6 (♂), 1919.—Strand, *in* Wagner, Lepidopterorum catalogus, pars 26, p. 837, 1922.

Male.—Figure 20. Head straw yellow with faint fuscous spot between antennae, which are also fuscous. Thorax yellow, tinged with pink. Abdomen entirely straw yellow. Forewing above and below with fuscous in upper half of wing greatly reduced, entirely lacking in base of wing but extended toward costa near middle and also at apex. Hindwing on both surfaces pale straw yellow with small dark shade near apex and small faint spot on outer margin of upper surface near anal angle.

Length of forewing 9 mm.

Male genitalia as characterized in key and as illustrated by figure 4, shows close relationship to *draudti* and *laudamia*. From both species it differs greatly in form and shape of cuiller and aedeagus.

Female.—Unknown.

Type locality.—"Banana River, Costa Rica."

Additional type data.—Originally described from single male specimen, holotype (March 1907; USNM Type 17258; collection, William Schaus; ♂ genitalia slide WDF 1532).

Location of type.—United States National Museum.

Distribution and material studied.—This species is still known solely from the holotype specimen.

Rhabdatomis pueblae (Draudt), new combination

Diarhabdosia pueblae Draudt, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 6, p. 243, pl. 33, fig. h3 (♂), h4 (♀), 1919.—Strand, *in* Wagner, Lepidopterorum catalogus, pars 26, p. 837, 1922.

Discussion.—This species is unknown to me and, since the types have been destroyed (see below), its true status and taxonomic position will have to remain in question for the present. The original description from the English edition of Seitz is as follows: "*D. pueblae spec. nov.* (33 h) is very similar [compared with *laudamia* Druce, a discussion of which preceded this description], with longer, more slender wings, and a more pointed apex; the costal-marginal and discal stripes are finer, more distinct, not faded, the inner-marginal stripe somewhat narrower, more uniform. Hindwing at the proximal angle in the ♂ less extended, lighter yellow, the whole costal area grey as far as down to the lower median vein; anal tuft rosy. ♀ much darker, hindwings quite unicolorously blackish-grey. Expanse of wings: 28 to 30 mm. Described according to several couples from Tehuacan (Mexico [Puebla])." The illustration of the male shows this sex as having the forewings very much as in *R. laudamia* but with hindwings very dark and more like those of *R. dognini*. The illustration of the female shows no characters that would differentiate it from females of *laudamia*.

Type locality and distribution.—Tehuacán, Puebla, Mexico.

Additional type data and location of type.—Originally described from several pairs, holotype not selected. Unfortunately, these specimens were destroyed along with the Draudt Collection, which was located in Darmstadt, Germany.

Rhabdatomis laudamia (Druce), new combination

Figures 13, 21, 22

Lithosia laudamia Druce, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 39 (Lepidoptera-Heterocera, vol. 1), p. 131; vol. 41 (vol. 3), pl. 13, fig. 4 (♂), 1885.

Crambidia laudamia (Druce), Kirby, A synonymic catalogue of Lepidoptera Heterocera, p. 338, 1892.

Diarhabdosia laudamia (Druce), Hampson, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 2, pp. 517, 518, fig. 370 (♂), 1900.—Draudt, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 6, p. 243, pl. 33, fig. h1 (♂), h2 (♀), 1919.—Strand, *in* Wagner, Lepidopterorum catalogus, pars 26, p. 837, 1922.

Lithosia pusa Dognin, Hampson *not* Dognin, Catalogue of the Lepidoptera Heterocera in the British Museum, vol. 2, p. 518, 1900.—Draudt *not* Dognin, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 6, p. 243, 1919.—Strand *not* Dognin, *in* Wagner, Lepidopterorum catalogus, pars 26, p. 837, 1922.

Lithosia peruviana Schaus, Hampson *not* Schaus, Catalogue of the Lepidoptera Phalaenae in the British Museum, vol. 2, p. 518, 1900.—Draudt *not* Schaus, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 6, p. 243, 1919.—Strand *not* Schaus, *in* Wagner, Lepidopterorum catalogus, pars 26, p. 837, 1922.

Male.—Figure 21. Head yellow above with palpi, frons and antennae fuscous. Thorax yellow tinged with pink. Abdomen entirely straw yellow except for large black lateral spots (more or less square in shape) on segments 3 and 4. Forewing above straw yellow with two large parallel fuscous fasciae extending length of wing from base to apex. This species has more yellow along the hind margin than does *zaba*. Forewing below similar to uppersurface with thin yellow line dividing two fasciae almost obliterated. Hindwing on both surfaces with basal half, including costal margin, straw yellow, and with outer portion, including apex down to middle of wing, fuscous.

Length of forewing 9–11 mm. (average 11 mm.).

Male genitalia (not illustrated) as characterized in key and differing from close relative *draudti*, with spinelike process of juxta appearing to arise from posterior instead of anterior margin.

Female.—Figure 22. Very similar to male, differing chiefly in having hindwings and abdomen entirely fuscous.

Female genitalia as characterized in key and as illustrated by figure 13, differing from all other species in genus by shape of signum.

Type locality.—Volcán de Chiriquí, Panama.

Additional type data.—Originally described from unspecified number of males. Hampson (1900, p. 370) selected a type (=lectotype); (collected by Champion; Godman-Salvin Collection).

Location of type.—In the collection of the British Museum (Natural History).

Distribution.—Mexico south through Central America into Colombia:

Mexico.—State of Vera Cruz, Córdoba (January, February, May), Jalapa, Orizaba. Guatemala.—Department of Baja Verapaz, Purulha (July); Department of Izabel, Cayuga (October); Department of Quezaltenango, Volcán Santa Maria (June, July, August, November). Costa Rica.—Province of Cartago, Cachí (October), Juan Vinas (March, August, December); Province of San José, La Uruca, San José (January, November), San Pedro de Montes de Oca (November). Panama.—Province of Chiriquí, Volcán de Chiriquí. Colombia.—Intendencia de Chocó, La Cumbre (Valle Siato, Río Siato, slopes of Chocó, September).

Material studied.—14 males, 17 females.

***Rhabdatomis draudti*, new species**

Figures 5, 23

Male.—Figure 23. Head and thorax as in *R. laudamia*. Abdomen entirely straw yellow except apex of harpe and terminal four segments underneath, which are fuscous. Forewing above very similar to *R. laudamia*, with parallel fuscous fasciae separated by slightly more distinct yellow line. Forewing below as in *laudamia*. Hindwing on both surfaces with costal margin and apical half of outer margin fuscous, thus differing from *laudamia* which has basal half of costal margin straw yellow.

Length of forewing 11–12.5 mm. (average, 11.6 mm.).

Male genitalia as characterized in key and as illustrated by figure 5. See remarks under *R. laudamia*.

FEMALE.—Unknown.

TYPE LOCALITY.—Tuis, Province of Cartago, Costa Rica.

ADDITIONAL TYPE DATA.—Described from holotype, male (Aug. 28, 1908; USNM type 34856; Schaus Collection; ♂ genitalia slide WDF 1318), from five male paratypes (same locality as holotype; Sept. 1, 1908, Aug. 29, 31, 1908; Schaus Collection), and a sixth male paratype (Cartago, Costa Rica; ♂ genitalia slide WDF 1558; Schaus Collection).

LOCATION OF TYPE.—United States National Museum.

DISTRIBUTION AND MATERIAL STUDIED.—This species is known solely from the holotype and paratypes listed above.

REMARKS.—Species named for Dr. Max Draudt.

Rhabdatomis knabi, new species

FIGURES 7, 24

MALE.—Figure 24. Head and thorax as in *R. laudamia* and *R. draudti*. Abdomen entirely straw yellow except for lateral oblong patches of fuscous on segments 3 and 4. Both forewing and hindwing, above and below, entirely like *laudamia*.

Length of forewing 9.5–10.5 mm.

Male genitalia as characterized in key and as illustrated by figure 7 differs from all other species in genus in form of harpe, aedeagus, and juxta. Harpe has apical lobe from costa sharply curved inward and cuiller slightly curved downward. Juxta has sharp spinelike projection from posterior margin. Aedeagus has distal lobe projecting from middle of left lateral surface.

FEMALE.—Unknown.

TYPE LOCALITY.—Córdoba, State of Vera Cruz, Mexico.

ADDITIONAL TYPE DATA.—Described from holotype, male (Jan. 5, 1908; USNM Type 34857; Frederick Knab, collector; ♂ genitalia slide WDF 1550), and from one paratype, male (locality as given for holotype; Feb. 8, 1908; Frederick Knab, collector; ♂ genitalia slide WDF 1549).

LOCATION OF TYPE.—United States National Museum.

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Distribution and material studied.—This species is known solely from the holotype and paratype listed above.

Remarks.—Species named for Mr. Frederick Knab.

Rhabdatomis extensa, new species

Figures 8, 25

Male.—Figure 25. Head and thorax as in *R. laudamia*. Abdomen entirely straw yellow with few fuscous scales covering apices of harpes. Forewing above and below entirely like *R. laudamia*. Hindwing on both surfaces with basal area and entire costal margin yellow, even at apex (especially noticeable on undersurface). In *laudamia* only the basal half of costal margin is yellow. Apex of hindwing (except for costal margin) fuscous as in *laudamia*.

Length of forewing 9–10 mm.

Male genitalia as characterized in key and as illustrated by figure 25. This is the only species in the genus with a beaklike apical lobe on the costa of the harpe, with an aedeagus that is distinctly flattened dorsoventrally, and with a uniquely shaped juxta.

Female.—Unknown.

Type locality.—Yuntas (near Cali), Department of Valle del Cauca, Colombia.

Additional type data.—Described from holotype, male (USNM type 34848; ♂ genitalia slide WDF 1554), from one paratype, male (Esperanza, Guanacaste, Costa Rica; May; ♂ genitalia slide WDF 1556), and second paratype, male (Cayuga, Izabal, Guatemala; April; Schaus and Barnes, collectors; genitalia slide WDF 1555).

Location of type.—United States National Museum.

Distribution and material studied.—Guatemala, Costa Rica, and Colombia. This species is known solely from the holotype and paratypes.

Rhabdatomis cora (Dyar), new combination

Figures 6, 26, 27

Diarhabdosia cora Dyar, Journ. N.Y. Ent. Soc., vol. 15, p. 227, December 1907.—Hampson, Catalogue of the Lepidoptera Phalaenae in the British Museum, suppl., vol. 1, p. 794, pl. 41, fig. 19 (♂), 1914.—Draudt, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 6, p. 243, pl. 33, fig. g8 (♂), 1919.—Strand, *in* Wagner, Lepidopterorum catalogus, pars 26, p. 836, 1922.

Male.—Figure 26. Head yellow above with palpi and frons fuscous. Thorax yellow, tinged with pink. Antenna annulate. Abdomen entirely straw yellow. Forewing above and below very similar to *R. laudamia* except that fuscous-colored fasciae have more lilaceous cast. Hindwing straw yellow with outer border fuscous, this color broken in middle by straw yellow ground color.

Length of forewing 6.5–7.5 mm. (average 6.8 mm.).

Male genitalia as characterized in key and as illustrated by figure 6. This species, along with *extensa*, has a harpe that is trilobed at its apex; it differs from *extensa* in the shape of all three of these lobes as well as in the shape of the juxta and aedeagus.

Female.—Figure 27. Very similar to male, differing chiefly in having hindwing and abdomen entirely fuscous, except for narrow yellow border on costal margin of hindwing below.

Length of forewing 8.5–9 mm. (average 8.8 mm.).

Female genitalia as characterized in key, having very small signum, consisting of very narrow and weakly sclerotized and slightly scobinate area and with short cuplike ductus bursae.

Type locality.—St. Jean, Maroni River, French Guiana.

Additional type data.—Originally described from 15 males and 3 females, no single specimen of which was stated to be "the type" in the original description. All 18 of these specimens are therefore syntypes (article 73, paragraphs b and c, International Code of Zoological Nomenclature, adopted by XV International Congress of Zoology, London, 1961). Two of these syntypes bear the USNM type number 10920 assigned by Dyar. In addition, one of these two specimens bears a written label containing the word "type" in Dyar's handwriting. I hereby designate this specimen as the lectotype and have so labeled it (USNM Type 10920; collection, William Schaus; ♂ genitalia slide WDF 1526).

Location of type.—United States National Museum.

Distribution.—French Guiana and Brazil:

French guiana.—Maroni District, St. Jean, Maroni River. Brazil.—Pará.

Material studied.—14 males and 4 females.

Rhabdatomis cora coroides (Schaus), new combination and new status

Figures 28, 29

Diarhabdosia coroides Schaus, Ann. Mag. Nat. His., ser. 8, vol. 7, p. 368, April 1911.—Hampson, Catalogue of the Lepidoptera Phalaenae in the British Museum, suppl., vol. 1, pp. 794, 795, pl. 41, fig. 20 (♂), 1914.—Dyar, Proc. U.S. Nat. Mus., vol. 47, p. 168 (♂), May 20, 1914.—Draudt, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 6, p. 243, pl. 33, fig. h5 (♂), 1919.—Strand, *in* Wagner, Lepidopterorum catalogus, pars 26, p. 836, 1922.

Male.—Figure 28. The name *coroides* can be retained to represent a northern subspecies. It is very similar to *Rhabdatomis cora cora* (Dyar), differing slightly in size (see below) and in having a great deal more fuscous on the hindwings.

Length of forewing 7–8 mm. (average 7.5 mm.).

Male genitalia entirely like that of typical subspecies illustrated by figure 6.

Female.—Figure 29. There appears to be no difference between the females of this subspecies and those of typical *R. cora.*

Length of forewing 7.5–10 mm. (average 8.6 mm.).

Female genitalia not illustrated and not different from genitalia of *R. cora cora.*

Type locality.—Guapiles, province of Limón, Costa Rica.

Additional type data.—Originally described from both sexes, number of specimens not stated. Single male specimen labeled "type" by Schaus and here designated lectotype (850 ft. alt., USNM Type 17257; collection, William Schaus; genitalia slide WDF 1528).

Location of type.—United States National Museum.

Distribution.—Guatemala south through Costa Rica and Panama into Venezuela:

Guatemala.—Department of Izabal, Cayuga (April, May). Costa Rica.—Province of Limón, Guápiles, Sixola River (August); Province of Cartago, Tuis (June). Panama.—Province of Colón, Rió Trinidad (June, September). Canal Zone.—Barro Colorado Island (April, October), Cabima [now submerged in Lake Gatun near Barro Colorado Island] (May). Venezuela.—State of Carabobo, Las Quiguas, San Esteban Valley (July).

Material studied.—5 males and 18 females.

Rhabdatomis fasseli, new species

Figures 9, 30

Male.—Figure 30. Head and thorax as in *R. laudamia* and *R. draudti.* Abdomen straw yellow above and fuscous below. Terminal segments entirely dark brown. Uncus covered with straw-colored scales and harpes covered with similar scales mixed with darker ones. Forewing above and below similar to *laudamia* with fuscous fasciae broader, covering more of wing, especially noticeable below. Hindwing on upper surfaces similar to *draudti* in having costal margin and apical and outer areas of wing fuscous. Hindwing below with costal margin and extreme apex of wing fuscous and differing from *draudti* in lacking fuscous on outer margin.

Length of forewing 11 mm.

Male genitalia as characterized in key and as illustrated by figure 9. This species, along with *R. pusa* and *R. peruviana,* form a separate group of *Rhabdatomis,* characterized by each having an anellus that consists of a single large, hoodlike dorsal plate. *R. fasseli* differs from *peruviana,* particularly in the shape of the harpe, and from *pusa* not only in the shape of the harpe but also in the differently shaped anellus.

Female.—Unknown.

Type locality.—Alto de las Cruces, Department of Norte de Santander, Colombia.

ADDITIONAL TYPE DATA.—Described from holotype, male (March; A. H. Fassel, collector; Dognin Collection; ♂ genitalia slide WDF 1551; USNM Type 34859), and one male paratype (San Antonio, Department of Valle del Cauca, Colombia; November; M. G. Palmer, collector; 5,800 ft.; Dognin Collection; ♂ genitalia slide WDF 1552).

LOCATION OF TYPE.—United States National Museum.

DISTRIBUTION AND MATERIAL STUDIED.—This species is known solely from the holotype and paratype listed above.

REMARKS.—Species named for the collector, Mr. A. H. Fassel.

Rhabdatomis peruviana (Schaus), new combination

FIGURES 10, 31

Lithosia peruviana Schaus, Proc. Zool. Soc. London, p. 239, March 6, 1894.

MALE.—Figure 31. Thorax yellow, tinged with pink. Head missing in holotype (sole specimen available for study) but reported by Schaus in his original description as "yellow, with a transverse grey band." This statement undoubtedly can be interpreted to mean that the specimen had a fuscous or gray frons. Abdomen entirely straw yellow in color. Forewing above most like that of *R. extensa* below with fasciae larger than in that species. In hindwing *peruviana* differs from all other species in genus by costal margin colored differently above than below, upperside yellow and underside fuscous. In this species also the fuscous on the apical area is more reduced than that in any other species.

Length of forewing 10 mm.

Male genitalia as characterized in key and as illustrated by figure 10. See remarks under *R. fasseli*.

FEMALE.—Unknown.

ADDITIONAL TYPE DATA.—Originally described from single male specimen, holotype (USNM Type 10922; collection, William Schaus; ♂ genitalia slide WDF 1530).

LOCATION OF TYPE.—United States National Museum.

DISTRIBUTION AND MATERIAL STUDIED.—This species is still known solely from the holotype specimen.

Rhabdatomis pusa (Dognin), new combination

FIGURES 11, 14, 32, 33

Crambidia pusa Dognin, Le Naturaliste, ser. 2, no. 130, p. 185, Aug. 1, 1892; Lépidoptères de Loja et environs (Equateur), descriptions d'èspeces nouvelles, livr. 3, p. 88, pl. 9, fig. 7 (♂), 1894.

MALE.—Figure 32. Head, thorax, and wings entirely like *R. fasseli*. *R. pusa* differs from that species in coloration by having the abdomen straw yellow above and fuscous below.

Length of forewing 11 mm.

Male genitalia as characterized in key and as illustrated by figure 11. See remarks under *R. fasseli*.

Female.—Figure 33. Very similar to male, differing chiefly in hindwing and abdomen being entirely fuscous. *R. pusa* entirely like female of *laudamia* in color and pattern.

Length of forewing 12 mm.

Female genitalia as characterized in key and as illustrated by figure 14. *R. pusa* has long ribbon-like signum lengthwise in position.

Type locality.—Loja, province of Loja, Ecuador.

Additional type data.—Originally described from two female specimens. One of these females bears a red, numbered USNM type label and I designate this specimen the lectotype ("Environs de Loja, Equateur"; November 1887; USNM Type 30580; Dognin Collection; ♀ genitalia slide WDF 1531).

Location of type.—United States National Museum.

Distribution.—Ecuador.

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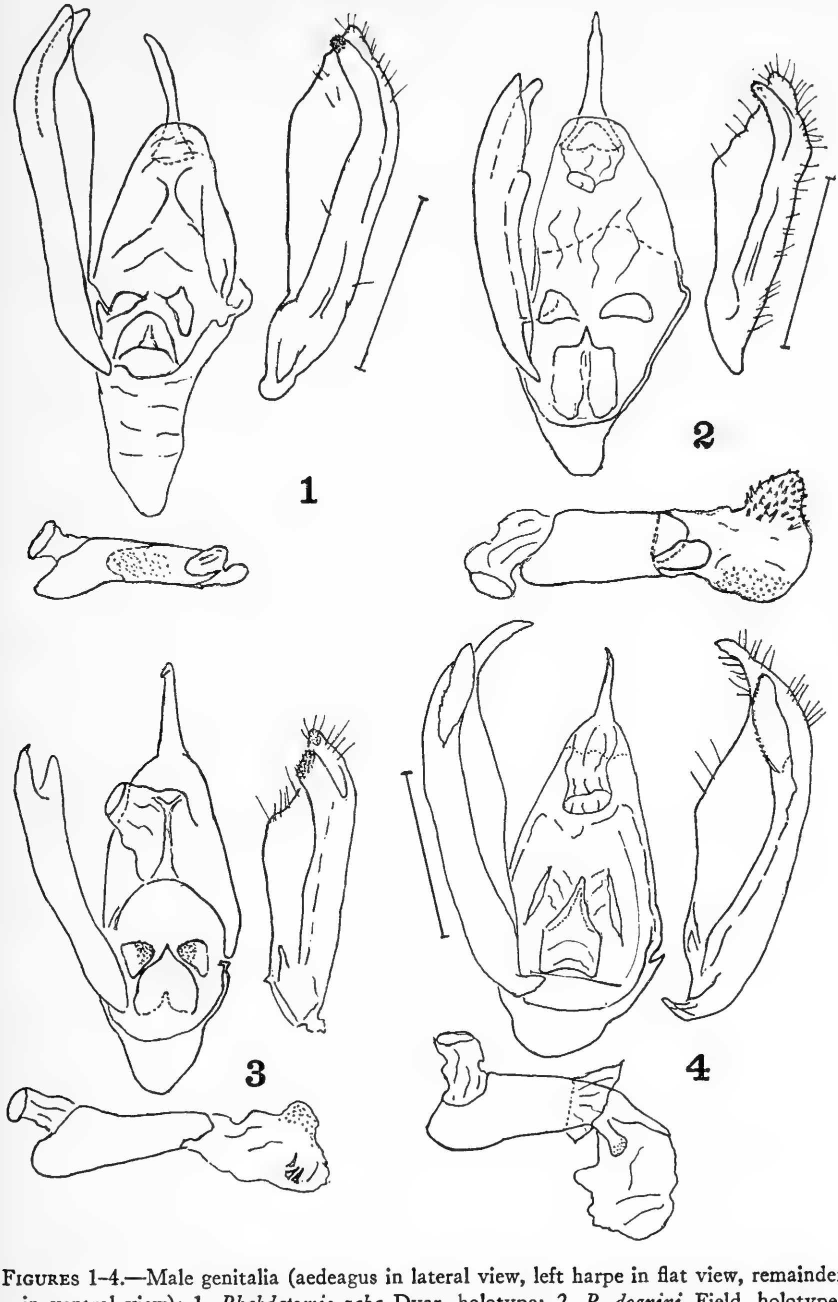
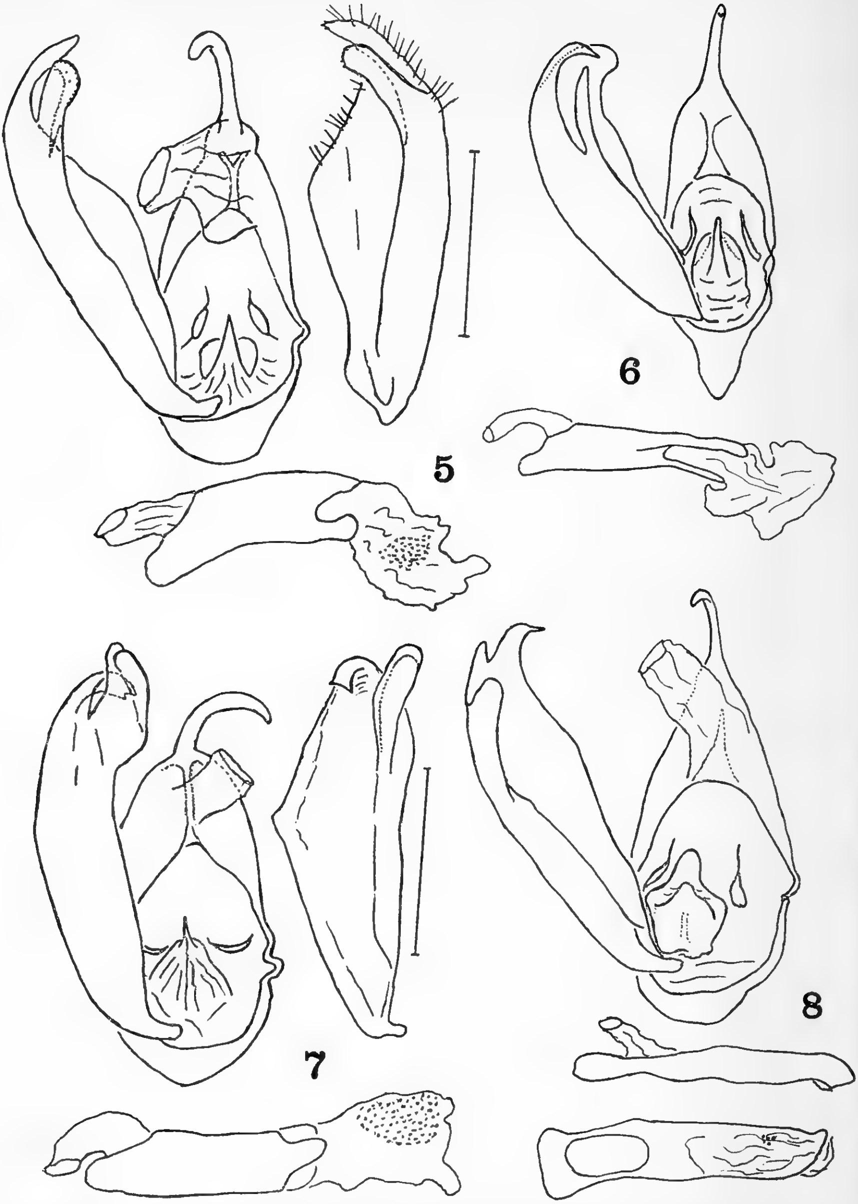
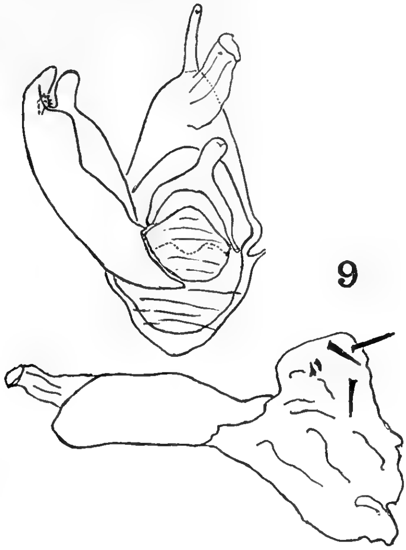


FIGURES 1–4.—Male genitalia (aedeagus in lateral view, left harpe in flat view, remainder in ventral view): 1, *Rhabdatomis zaba* Dyar, holotype; 2, *R. dognini* Field, holotype; 3, *R. mandana* (Dyar), lectotype; 4, *R. melinda* (Schaus), holotype.



FIGURES 5–8.—Male genitalia (aedeagus in lateral view and also in dorsal view in figure 8, left harpe in flat view when included, remainder in ventral view): 5, *Rhabdatomis draudti* Field, holotype; 6, *R. cora* (Dyar), lectotype; 7, *R. knabi* Field, holotype; 8, *R. extensa* Field, holotype.



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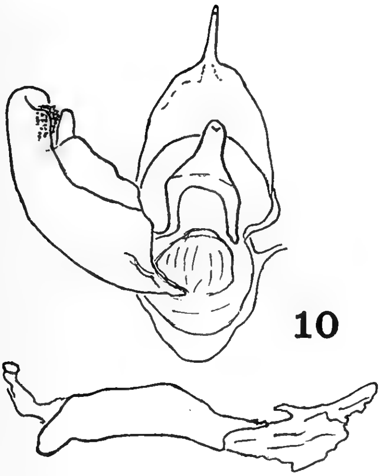

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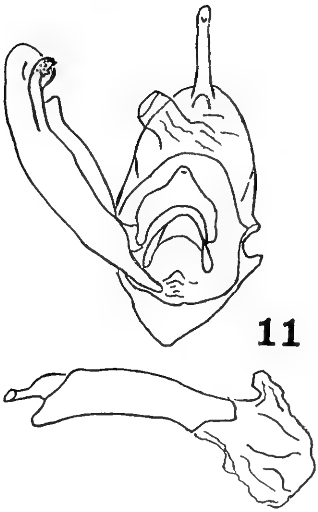

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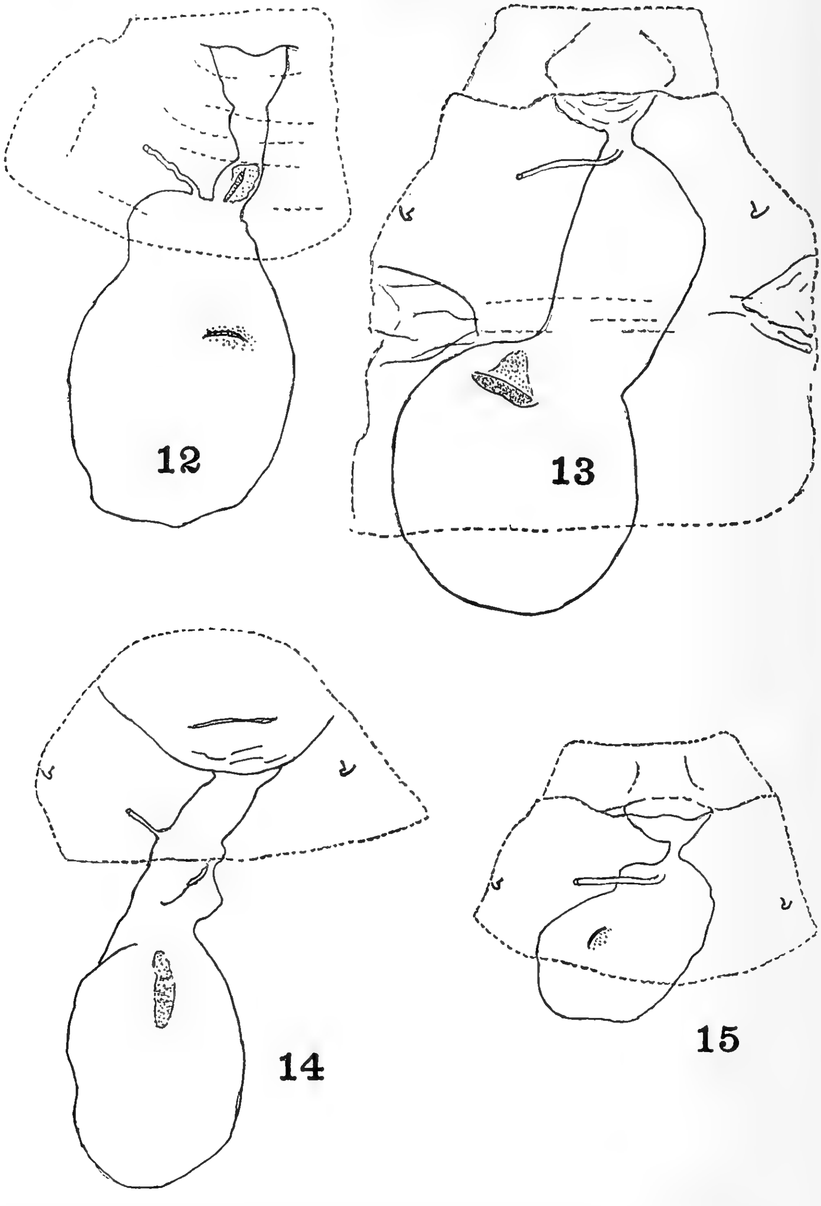
FIGURES 9–11.—Male genitalia (aedeagus in lateral view, left harpe not shown, genital capsule in ventral view): 9, *Rhabdatomis fasseli* Field, holotype; 10, *R. peruviana* (Schaus), holotype; 11, *R. pusa* (Dognin), drawn from preparation WDF 1553.



FIGURES 12–15.—Female genitalia (exclusive of ovipositors): 12, *Rhabdatomis mandana* (Dyar), drawn from preparation WDF 1650; 13, *R. laudamia* (Druce), drawn from preparation WDF 1646; 14, *R. pusa* (Dognin), lectotype; 15, *R. cora* (Dyar), drawn from preparation WDF 1531.

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NEOTROPICAL MICROLEPIDOPTERA, III

RESTRICTION OF GONIONOTA MELOBAPHES WALSINGHAM WITH DESCRIPTIONS OF NEW SPECIES (LEPIDOPTERA: OECOPHORIDAE)

By J. F. Gates Clarke

Since the description of *Gonionota melobaphes* Walsingham, a considerable number of species of small moths has been placed under that name in collections and, indeed, it seems entirely likely that Walsingham's original series consisted of several species. Larger series from widespread localities indicate that *melobaphes* is actually confined to a relatively small geographical area and that other similarly colored species of this complex are likewise restricted in their ranges.

In the U.S. National Museum there are specimens, determined as *melobaphes* by Durrant and Meyrick, which are not referable to Walsingham's species; moreover, Meyrick suppressed his own *vexillata* in favor of *melobaphes*, yet *vexillata* is one of the most distinct species of the group. All of these taxa need reconsideration.

In treating these and other South American forms, Meyrick placed all of them in the European genus *Hypercallia* Stephens. *Hypercallia* Stephens is based on *Phalaena tortrix christiernana* Linnaeus, a synonym of *H. citrinalis* (Scopoli), which is abundantly distinct from any of the South American species, and none of the latter are referable to *Hypercallia*.

The genus *Gonionota* was proposed by Zeller [1] for *G. notodontella* Zeller.

Meyrick [2] recognized the genus and stated: "I give the characters of this genus, which was incompletely described by Zeller, who regarded it as a group of *Hypercallia*, from which it is in fact very distinct. . . ." Later, in the same paragraph, he stated: "I am informed by Mr. Busck that the typical species of *Gonionota*, *G. notodontella*, Zell., has vein 9 of fore-wings rising from the stalk of 7 and 8. . . ." Walsingham [3] has pointed out: "Some error has occurred here—the neuration of the Type of *Gonionota notodontella* Z. is: FW: 12 veins; 7–8 stalked, 7 to termen; 9 and other veins separate; 2 twice as remote from 3 as 3 is from 4. HW: 8 veins; 3–4 connate; 5–7 parallel.—Drnt." Obviously Busck was not familiar with *notodontella* (there are no specimens in the U.S. National Museum) because he would not have overlooked such a clear character as the relation of vein 9 in the forewing to 7 and 8. In 1922 [4] Meyrick suppressed *Gonionota* in favor of *Hypercallia* and placed all the species of this group in the latter genus.

Gonionota is a distinct genus, as pointed out by Meyrick in 1909, and may be distinguished from *Hypercallia* by the upturned palpus, the third segment roughened posteriorly, the pubescent or short-ciliated antenna of the male, the smooth antenna of the female, the bifurcate uncus, and the presence of a clasper or other ornamentation on the harpe. *Gonionota* is most nearly related to the South American genus *Coptotelia*, from which it is distinguished by the strong posterior thoracic scale-tuft, by vein 9 of the forewing being widely separated from the stalk of 7 and 8, and by the termen being convex. In the hind wing, veins 3 and 4 are usually connate, but all species provide examples with veins 3 and 4 stalked.

Gonionota melobaphes **Walsingham**

Figure 1; Plates 1 (Fig. 6), 2 (Fig. 1)

Gonionota melobaphes Walsingham, 1912, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 42 (Lepidoptera-Heterocera, vol. 4), p. 129, pl. 4, fig. 27.—Amsel, 1956, Bol. Ent. Venezolana, vol. 10 (nos. 1 and 2), p. 294, pl. 64 (fig. 5), pl. 108 (fig. 10).

Hypercallia melobaphes (Walsingham), Meyrick, 1922, *in* Wytsman, Genera insectorum, fasc. 180, p. 162, no. 22; 1926, Exotic Microlepidoptera, vol. 3, p. 314; 1930, Ann. Naturhist. Mus. Wien, vol. 44, p. 233.—Gaede, 1939, *in* Bryk, Lepidopterorum catalogus, part 92, p. 261.

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[1] 1877, Hor. Soc. Ent. Ross., vol. 13, p. 379.

[2] 1909, Trans. Ent. Soc. London, 1909, p. 24.

[3] 1912, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 42 (Lepidoptera-Heterocera, vol. 4), p. 128.

[4] 1922, *in* Wytsman, Genera insectorum, fasc. 180, p. 161.

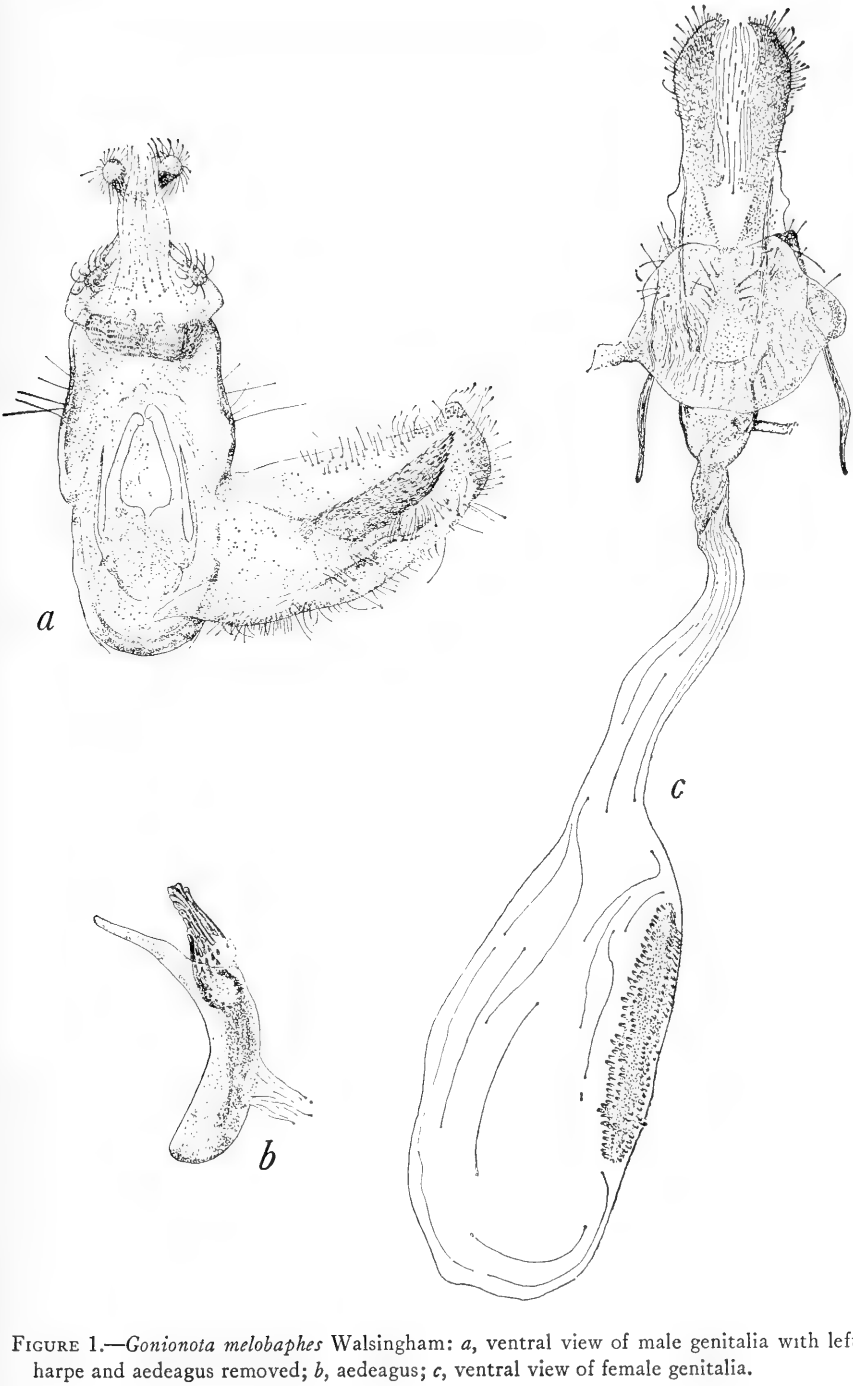

FIGURE 1.—*Gonionota melobaphes* Walsingham: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus; *c*, ventral view of female genitalia.

Type: In the British Museum (Natural History).

Type locality: Chiriqui, Panama.

Abdomen with strong, median, eversible scale-tuft from first sternum of male.

Male genitalia: Harpe broadest about middle, tapering abruptly to a bluntly pointed cucullus; sacculus with short distal protuberance, the latter with strong cluster of hairlike setae; from center of harpe a stout clasper extends toward cucullus for about half the length of harpe; clasper clothed with very strong setae for almost its whole length. Anellus subquadrate, posteriorly divided into two long, digitate processes, and with a long, slender, pointed process arising on each side from about middle. Aedeagus stout, curved, with distal end depressed, spatulate; vesica armed with strong cluster of cornuti. Vinculum rounded. Gnathos terminating in a wide, curved plate clothed with fine setae. Socii small, elongate lobes. Uncus terminating in widely divergent curved processes.

Female genitalia: Posterior third of ductus bursae sclerotized and dilated before ostium; inception of ductus seminalis dorsal, at point of constriction of ductus bursae before ostium. Signum an elongate dentate plate.

Slides examined: ♂♂, AB 25.ii.1920; JFGC nos. 4232, 10122, 10123, 5096 (paratype in BM); ♀♀, JFGC nos. 4233, 10125, 10126, 10127.

Although recorded from several widespread localities by Walsingham and from Venezuela by Amsel, *melobaphes* appears to be restricted to Central America. The distribution, according to specimens in the U.S. National Museum, is as follows:

Costa Rica: Juan Vinas, 3 ♂♂, 2 ♀♀; Sixola River, 3 ♀♀ (Wm. Schaus); Panama: Cabima, 3 ♂♂, 2 ♀♀ (May, 1911; August Busck).

One of the specimens from the Sixola River is labeled "*Gonionota melobaphes* Wlsm." in Walsingham's handwriting.

Gonionota contrasta, new species

Figures 2*a–d*; Plate 1 (Fig. 4), 2 (Fig. 2)

Alar expanse 19–21 mm.

Labial palpus buff yellow; second segment strongly overlaid with reddish ocherous anteriorly and on outer side; third segment tinged with reddish ocherous and with a cluster of black scales subapically. Antennal scape silvery white ventrally, reddish ocherous dorsally; remainder of antenna reddish ocherous basally shading to fuscous apically. Proboscis silvery white. Head and thorax buff yellow heavily overlaid with reddish ocherous; posterior thoracic tuft tipped fuscous. Forewing ground color sayal brown blotched and suffused with fuscous; from base of wing broad, elongate, oblique reddish

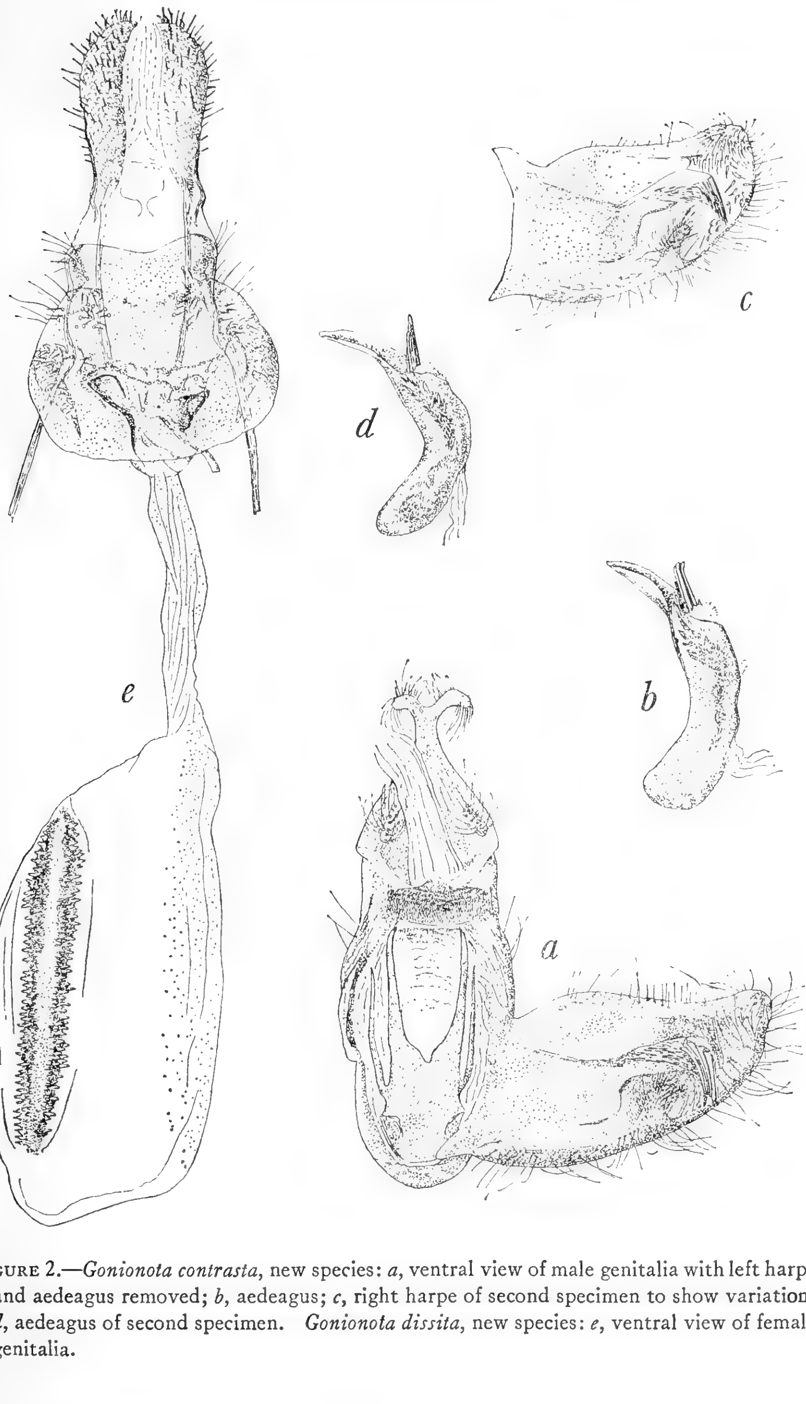

FIGURE 2.—*Gonionota contrasta*, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus; *c*, right harpe of second specimen to show variation; *d*, aedeagus of second specimen. *Gonionota dissita*, new species: *e*, ventral view of female genitalia.

ocherous blotch, mixed with buff yellow, nearly reaching costa and separated from a smaller similarly colored outwardly oblique patch by an arm of ground color; in outer patch, which extends to cell, two blackish spots; in cell, at two-fifths, a black spot and at end of cell a small white dot; at apical third of costa an elongate triangular white spot edged with pink along inner margin; beyond this spot a few whitish scales; cilia grayish fuscous except those along apical third white with faint pink tinge. Hind wing fuscous; cilia grayish fuscous except those around apical half of wing tipped with pink-tinged white. Legs silvery white; forefemur brown on inner side; foretibia and first tarsal segment tinged with reddish ocherous; midtibia blotched with brown; hind tibia tinged ocherous white. Abdomen fuscous dorsally, white ventrally; anal tuft with violaceous tint; first sternum with strong, median, eversible scale tuft in male.

Male genitalia: Harpe broadest slightly before middle, costal margin slightly excavate before cucullus; saccular margin with slightly curved digitate process extending about one-third distance across harpe; clasper a long arm from middle of harpe, terminating in a cluster of strong setae directed toward and reaching saccular margin. Anellus rectangular, deeply incised posteriorly forming two long, pointed processes; on each side an additional long, slender process. Aedeagus stout, curved, distally depressed, tonguelike; cornuti numerous, consisting of closely appressed elongate group and stout dentate series. Vinculum narrow, rounded. Gnathos transverse, oval, spined knob. Socii small fleshy lobes clothed with long fine setae. Uncus bifurcate, base as long as lateral arms.

Slides examined: ♂♂, JFGC nos. 4630, 5098, 10116, 10121.

Type: Peru, Tingo Maria (Nov. 25, 1949, H. A. Allard), USNM 66373.

Described from the male type and three male paratypes as follows:

PERU: 2♂♂, Callao (Mrs. M. J. Pusey); ♂, Chanchamayo (Dognin Coll.).

The Chanchamayo specimen bears a label "*Hypercallia melobaphes* Wals." in Meyrick's handwriting.

The superficial similarity between *contrasta* and *vexillata* is striking, but the genitalia at once distinguish the two. The anellus of *contrasta* exhibits long, slender lateral and terminal processes but *vexillata* lacks them. Moreover, midway on the saccular margin of *contrasta* there is a pronounced digitate process that is absent in *vexillata*.

The anellus and aedeagus of *contrasta* place it nearer *melobaphes* than to any other species of this group but the digitate saccular process of *contrasta*, absent in *melobaphes*, and the arrangement of the cornuti immediately distinguish the two.

Females of *contrasta* and *vexillata* are unknown and no comparison with *melobaphes* can be made.

Gonionota dissita, new species

FIGURE 2*e*; PLATE 3 (FIG. 5)

Alar expanse 20–22 mm.

Labial palpus missing. Antennal scape reddish ocherous dorsally, silvery white ventrally; remainder of antenna buff yellow proximally shading to brownish distally. Head and thorax buff yellow, the former with sparse, scattered reddish ocherous scales, the latter with abundant reddish ocherous scaling; posterior tuft brown. Forewing ground color brown, blotched dorsally with fuscous; base, to two-fifths of costa and dorsal fourth, buff yellow strongly mixed with reddish ocherous; outer margin of basal patch irregularly oblique, costal margin shaded with brown; from costal two-fifths an oblique, narrow blotch, the same color as basal patch, extends to end of cell and terminates in a small white dot; basal and outer light areas separated by an arm of ground color; in cell, at about two-fifths, a fuscous spot; from costa to tornus, at about outer fifth, an indistinct row of fuscous spots parallel to termen; at apical fourth, on costa, a prominent, narrow triangular white streak bordered on its inner margin with reddish ocherous and followed by white scaling to apex; cilia brown except those in apical third tipped white. Hind wings brownish but much paler basally; cilia ocherous white shaded brownish around apex. Legs silvery white; forefemur overlaid with brownish on outer side; foretibia and first tarsal segment reddish ocherous on outer side; midfemur and tibia shaded with pale brown on outer side. Abdomen brownish dorsally, white ventrally.

Female genitalia: Ostium broad, opening into broadly funicular sclerotized posterior portion of ductus bursae; inception of ductus seminalis dorsal, approximately at junction of membranous and sclerotized parts of ductus bursae. Signum a long, slender, sclerotized, dentate plate.

Slides examined: ♀♀, JFGC nos. 4235, 11104.

Type: Trinidad, Port of Spain (no date, F. W. Urich), USNM 66372.

Described from the type and one female paratype as follows:

TRINIDAD: ♀, "Mt. St. B." (Bro. Maur, 1923).

Under *determinata* I have discussed the apparent relationships of this species. In *dissita* the basal patch is bordered outwardly by a less irregular margin than the other species, and the basal patch is separated from the costal blotch by a broad triangular arm of ground color.

Unfortunately, both specimens from which this species is described are damaged, but the species is distinct and is the basis for the first record of this group from the West Indies.

Gonionota determinata, new species

FIGURE 3; PLATES 1 (FIG. 5), 2 (FIG. 3)

Alar expanse 19–27 mm.

Labial palpus bright buff yellow; second segment strongly suffused with brown anteriorly and laterally, with considerable reddish ocherous scaling on outer side; third segment edged with reddish ocherous anteriorly and with a few black scales subapically on inner side. Antennal scape reddish ocherous dorsally, silvery white ventrally; remainder of antenna reddish ocherous proximally shading to fuscous distally. Head and thorax bright buff yellow mixed with reddish ocherous; posterior tuft brown. Ground color brown blotched and suffused with fuscous; basal patch buff yellow to costal two-fifths, heavily overlaid with reddish ocherous in females and divided near middle by an angulate line of ground color; costal edge of basal patch broadly brown in female and narrowly edged with fuscous in male; beyond basal patch, and separated from it by an arm of ground color, an outwardly oblique buff yellow blotch reaching vein three; beyond this outer blotch subcostally a few scattered black scales; in cell at two-fifths a fuscous spot; at end of cell a white dot bordered outwardly by a few fuscous scales; at apical third of costa a narrow white dash bordered inwardly with reddish ocherous and followed on costa by a few white scales; apical fourth of wing lightly streaked with gray scales; cilia brown apically deepening to leaden gray around termen to tornus. Hind wing brownish ocherous in female, considerably lighter in male, with conspicuous brown or fuscous scaling in anal area; cilia leaden gray apically becoming lighter toward anal section. Legs silvery white; forefemur suffused brownish on outer side; foretibia and first tarsal segment overlaid reddish ocherous; midtibia and tarsi suffused brownish and tibia with some reddish ocherous; posterior tibia and tarsi lightly shaded with brownish. Abdomen ocherous white ventrally, brown dorsally; from first sternum a strong eversible scaletuft in male.

Male genitalia: Harpe broadest about middle, then tapering somewhat abruptly to a bluntly pointed cucullus; sacculus bearing a small triangular protuberance; clasper a moderately long arm from middle of harpe terminating in cluster of rather short stout setae directed toward sacculus. Anellus subrectangular, deeply cleft posteriorly forming two long, narrow, divergent arms; from each side of anellus a long, curved, pointed process. Aedeagus stout, curved, tonguelike distally; vesica armed with a narrow band of strong cornuti. Vinculum narrow, rounded. Gnathos a transverse oval knob. Socii small, fleshy lobes sparsely clothed with fine setae. Uncus furcate, rather thick basally.

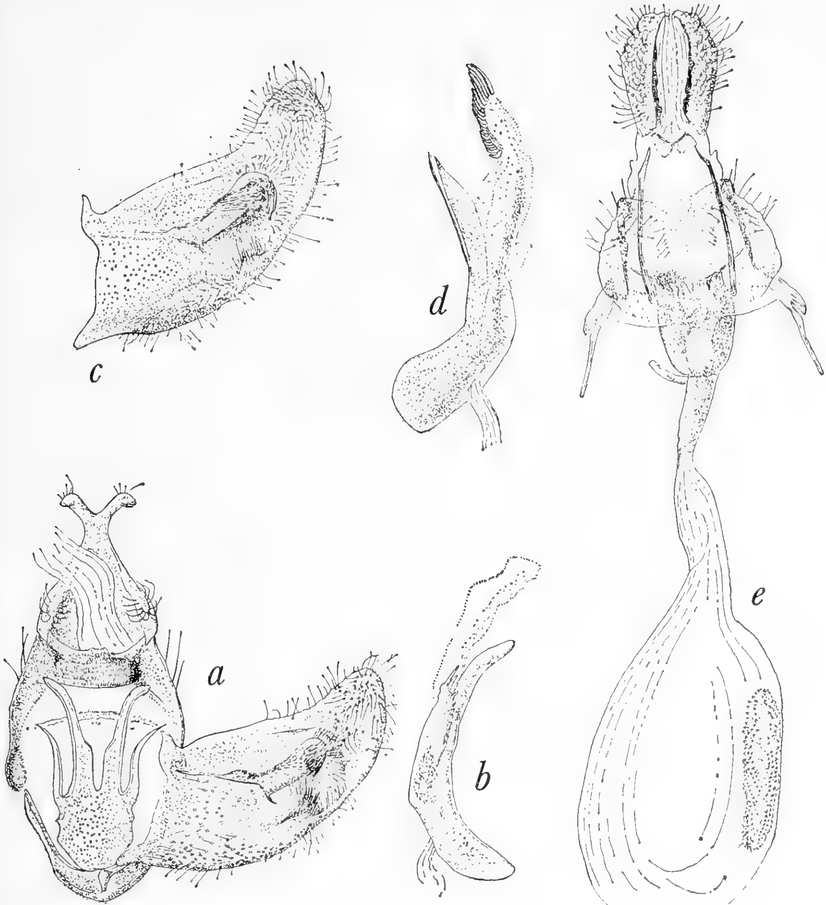

FIGURE 3.—*Gonionota determinata*, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus; *c*, right harpe of second specimen illustrating variation; *d*, aedeagus of second specimen; *e*, ventral view of female genitalia.

Female genitalia: Posterior half of ductus bursae sclerotized, dilated before ostium; inception of ductus seminalis dorsal and anterior to dilated portion of ductus bursae. Signum an elongate dentate plate.

Slides examined: ♂♂, JFGC nos. 5096, 10128; ♀♀, JFGC nos. 4234, 10120.

Type: British Guiana, Mallali (no date or collector), USNM 66374. There is a white label attached to this specimen bearing the inscription "*Hypercallia melobaphes* Wals." in Meyrick's handwriting.

681–521—64——2

Described from male type, one male and four female paratypes as follows:

VENEZUELA: ♂, Aroa (Schaus, 1895) [this specimen was paratype ♂ 6444 of *Gonionota melobaphes* Walsingham]; 4 ♀ ♀, Valera (no date, E. P. deBellard).

In the males of this species the coloring appears to be generally lighter than in the females.

The five species *melobaphes*, *contrasta*, *dissita*, *incontigua*, and *determinata* form a group with similar pattern and coloration, and with genitalia of the same general type. On superficial appearance the five can easily be confused, especially if the specimens are worn. The genitalia, however, exhibit excellent points of distinction. Both *contrasta* and *determinata* have a saccular process, but that of *contrasta* is about three times as long as that of *determinata; melobaphes* lacks this process; the males of *dissita* and *incontigua* are unknown. The claspers of *contrasta* and *determinata* are similar but the terminal setae of *determinata* are short and do not attain the saccular margin as they do in *contrasta*. The aedeagi of all three show a very definite relationship, but all differ as may be seen from a comparison of the figures. The females (that of *contrasta* unknown) also show close relationship in this group. All have the same type of signum although the length varies. The details of the posterior part of the ductus bursae differ and perhaps give the only reliable characters in the females for distinguishing the species. In *dissita* the sclerotized part of the ductus is short and funicular; in *determinata* and *melobaphes* it is rather long and the ostium opens into a deep cuplike section; the signum of *determinata* is much shorter (about three-fifths) than that of *melobaphes*, *incontigua*, and *dissita* and is not so heavily sclerotized. In *incontigua* the sclerotized portion of the ductus bursae is very short and broad in marked contrast to the other species.

Gonionota bourquini, new species

FIGURE 4; PLATE 2 (FIGS. 4, 5)

Hypercallia melobaphes (Walsingham) Bourquin, not Walsingham, 1945, De Acta Zool. Lilloana, vol. 3, p. 135, figs. 1, 2, 1 pl.

Alar expanse 16–24 mm.

Labial palpus pale maize yellow; second segment pale brown on anterior edge shading to reddish ocherous laterally; at apex and on outer side a few carmine scales mixed, and with a jet black spot slightly below apex on outer side. Antenna pale maize yellow shading to fuscous distally, basally strongly overlaid with reddish ocherous; scape silvery white beneath, reddish ocherous above. Proboscis silvery white. Head and thorax darker yellow than palpus with strong mixture of carmine scales; tegula sometimes sparsely irrorate with

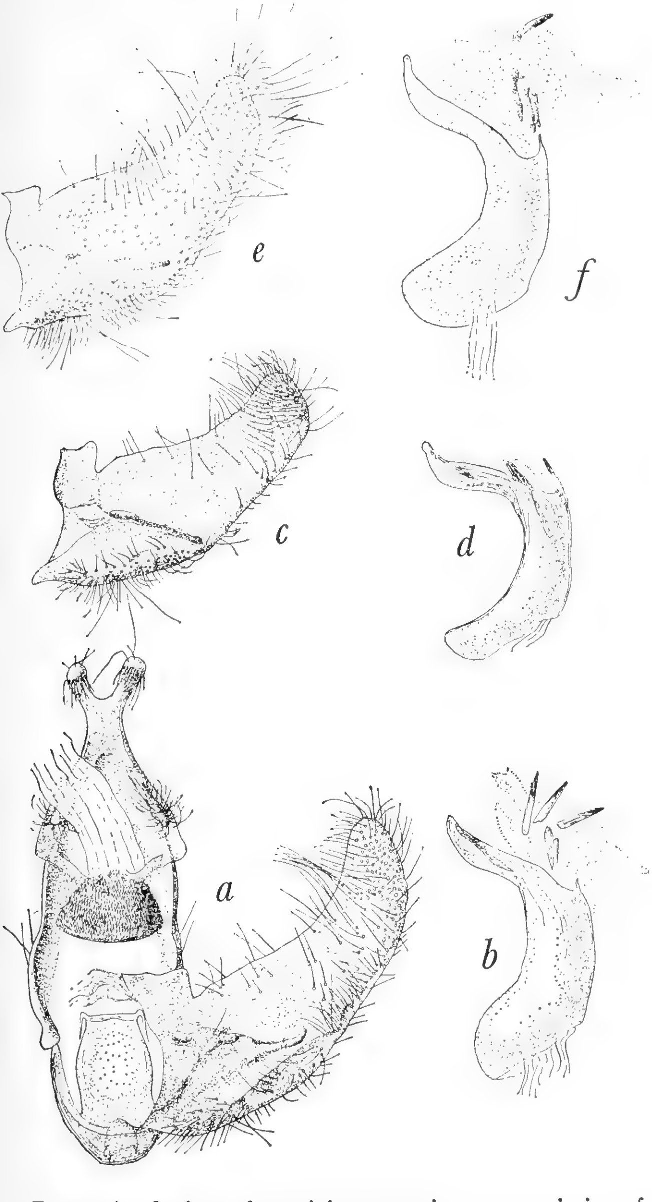

FIGURE 4.—*Gonionota bourquini*, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus with five cornuti; *c*, right harpe, variation; *d*, aedeagus with three cornuti; *e*, right harpe of third variation; *f*, aedeagus with four cornuti; *g*, ventral view of female genitalia.

black scales; anterodorsally a black spot near edge of tegula; posterior tuft fuscous. Forewing ground color light brown with slight pinkish cast and with some ill-defined fuscous blotches; base of forewing buff yellow, outer edge lobed obliquely to costa at one-third; an outwardly oblique blotch of the same color separated from basal patch by an arm of the ground color; costal edge of light basal patch brownish ocherous; basal patch and costal blotch overlaid with reddish ocherous and sparsely irrorate with scattered jet black scales; outer third of costa broadly edged with white, pink, and fuscous scales intermixed; at end of cell a tiny white spot; around termen a series of blackish spots; cilia fuscous. Hind wing buff to ocherous fuscous, veins outlined darker; anal area with darker scaling parallel to first anal vein; cilia concolorous with hind wing but with some darker scales mixed. Legs silvery white; femur and tibia of foreleg strongly overlaid reddish ocherous; midtibia overlaid ocherous and hind tibia faintly ocherous dorsally.

Abdomen fuscous dorsally, silvery white ventrally, latter with slight buff tinge posteriorly; first sternum with strong, median, eversible scale-tuft in male.

Male genitalia: Harpe widest before middle, gently tapered to the bluntly rounded cucullus; from base of harpe a broadly sclerotized area extending almost to sacculus before middle and terminating in a small pointed process; at middle of the sclerotized area, and arising from it, there is a short, high ridge; from this ridge to costa, and beyond base of harpe, there is a sclerotized subrectangular extension. Anellus rectangular, slightly convex laterally. Aedeagus broadly U-shaped, stout, terminating in a point bent dorsad; vesica armed with three to five stout cornuti. Vinculum with well-developed dorsoanterior process. Gnathos broad, transverse. Socii small hairy lobes. Arms of uncus long, rather stout, somewhat dilated distally, connate at base.

It should be noted that there is considerable variation in the harpes and in the more strongly sclerotized areas of the inner surfaces; but I do not believe that these apparent differences are specific.

Female genitalia: Posterior third of ductus bursae strongly sclerotized. Inception of ductus seminalis dorsal, well before ostium. Signum a rather small dentate, elongate-ovate plate.

Slides examined: ♂♂, JFGC nos. 4217, 4227, 4230, 5097, 6929, 10117, 10131, 10132; ♀♀, JFGC nos. 4218, 4219, 4231, 6931.

Type: Brazil, New Bremen (Oct. 5, 1936, Fritz Hoffmann), USNM 66371.

Described from the male type, 40 male and 4 female paratypes as follows:

ARGENTINA: 26 ♂♂, 2 ♀♀, La Tacuarita, Tigre (II.1932 and III.1947, Fernando Bourquin); BRAZIL: 7 ♂♂, Nova Teutonia (V.1938, IV to 30.VIII.

PLATE 1.—1, *Gonionota extima*, new species; 2, *Gonionota excavata*, new species; 3, *Gonionota fimbriata*, new species; 4, *Gonionota contrasta*, new species; 5, *Gonionota determinata*, new species; 6, *Gonionota melobaphes* Walsingham.

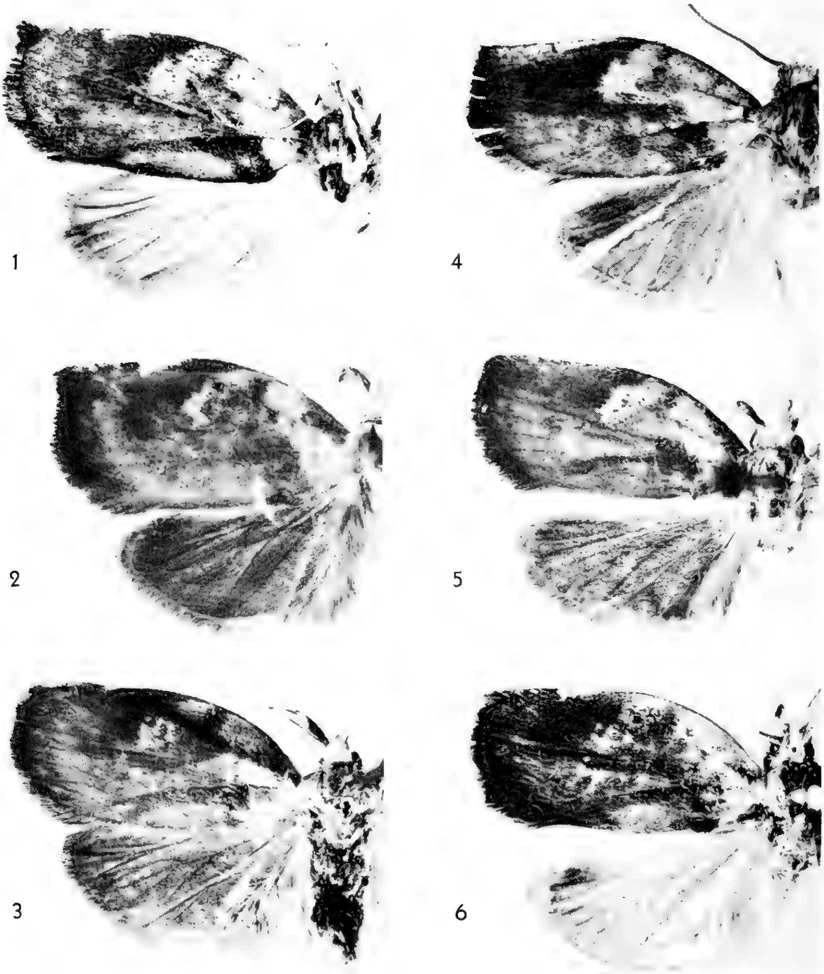

PLATE 2.—1, *Gonionota melobaphes* Walsingham; 2, *Gonionota contrasta*, new species; 3, *Gonionota determinata*, new species; 4, *Gonionota bourquini*, new species; 5, *Gonionota bourquini*, new species (dark winged form); 6, *Gonionota incontigua*, new species.

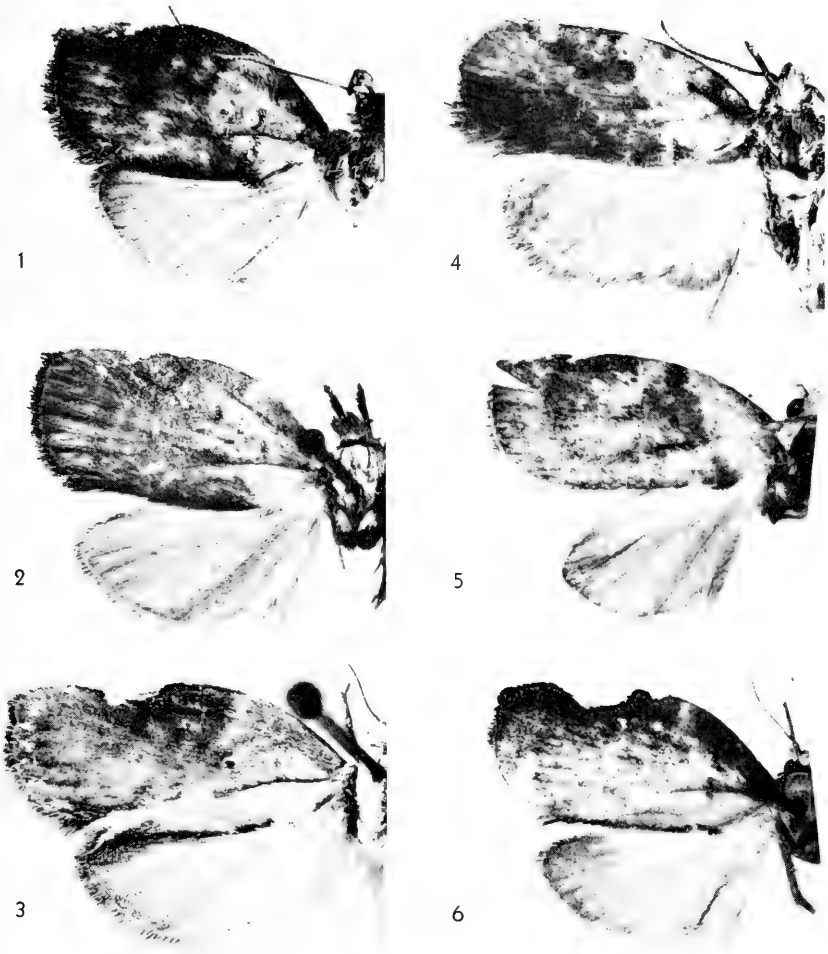

Plate 3.—1, *Gonionota fimbriata*, new species; 2, *Gonionota extima*, new species; 3, *Gonionota excavata*, new species; 4, *Gonionota periphereia*, new species; 5, *Gonionota dissita*, new species; 6, *Gonionota hyptiotes*, new species.

1948; one with no date, Fritz Plaumann); 3 ♂♂, ♀, New Bremen (V–XI.1936, I.1937, Fritz Hoffmann); 4 ♂♂, ♀, Santa Catarina (VI.1935, V.1936, Fritz Hoffmann).

This is the species treated by Fernando Bourquin in De Acta Zoologica Lilloana, in which he described the life history and figured the larva, pupa, and adult. He also illustrated an example of the damage caused by the larva. Bourquin's use of the name "*Hypercallia melobaphes*" was based on a misdetermination by Meyrick.

Because of the considerable intraspecific variation exhibited by the genitalia, as well as exhibited superficially it is not surprising that the species was misdetermined. In the long series before me there is variation in the intensity of the color of the forewings, although the pattern appears to be constant, and in some specimens, regardless of locality, the hindwings are as dark as those of *vexillata*. In the males the number of cornuti varies from three to five but there is no suggestion that this variation reflects the locality. The signa also vary to some extent but this also is not connected with locality. I am unable to separate the various color forms.

I am pleased to name this species for my friend Fernando Bourquin, who has contributed so much to our knowledge of the life histories of Argentine Microlepidoptera.

Gonionota vexillata **(Meyrick)**

Coptotelia vexillata Meyrick, 1913, Trans. Ent. Soc. London, 1913, p. 179.

Hypercallia vexillata (Meyrick), 1922, *in* Wytsman, Genera insectorum, fasc. 180, p. 163, no. 42; 1930, Ann. Naturhist. Mus. Wien, vol. 44, p. 233 (as synonym of *melobaphes*).

Hypercallia melobaphes vexillata (Meyrick), 1926, Exotic Microlepidoptera, vol. 3, p. 314.—Gaede, 1939, *in* Bryk, Lepidopterorum catalogus, part 92, p. 261.

Gonionota vexillata (Meyrick), Clarke, 1963, Catalogue of the type specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick, vol. 4, p. 246, pl. 120, figs. 3–3*b*.

Meyrick described this species from two males and accorded it full specific rank. In 1926 he wrote, under *Hypercallia melobaphes* Walsingham: "I find . . . that *vexillata* Meyr. should be regarded as a mountain form of this." The dark hind wing and genitalia readily distinguish *vexillata* from *melobaphes*, and I have raised *vexillata* to its appropriate specific status (Clarke, 1963).

The abundant differences between the male genitalia of *melobaphes* and *vexillata* are revealed by a comparison of figure 1*a* of this paper with that of figure 3*b*, plate 120, in the Meyrick work cited above. The anellus of *melobaphes* has four pointed processes but that of *vexillata* has none; the anellus of *vexillata* is similar to that of *bourquini*. The clasper of *vexillata* is naked for most of its length and terminates in a cluster of thick, long setae, sharply turned back toward the base of the harpe. The clasper of *melobaphes* is nearly straight, stout, and clothed for almost its entire length by short setae.

Gonionota incontigua, new species

FIGURE 5*a*; PLATE 2 (FIG. 6)

Alar expanse 26 mm.

Labial palpus yellow; basal half of second segment white posteriorly; anterior edge brown shading to reddish ocherous laterally, with some blackish scaling on outer side and at apex; third segment edged narrowly reddish ocherous anteriorly; rather dense black scaling subapically and apex white. Antennal scape reddish ocherous mixed with a few blackish scales dorsally, white ventrally; remainder of both antennae missing. Proboscis white, slightly infuscated. Head yellow mixed with reddish ocherous. Thorax buff yellow mixed with reddish ocherous and some pale fuscous scales; posterior tuft fuscous. Forewing ground color brown strongly suffused with fuscous; basal patch buff yellow mixed with reddish ocherous and with several small groups of fuscous scales; costal edge of basal patch brown; from costa, beyond basal patch and separated from it by a band of ground color, an outwardly oblique buff yellow and reddish ocherous blotch extends to end of cell, where it terminates in a white spot; surface of blotch marked with considerable fuscous scaling; in cell, beyond edge of basal patch, a fuscous spot; dorsum strongly suffused fuscous; at apical third of costa a narrow triangular white dash followed on apical part of costa by white scaling; costal dash edged inwardly reddish ocherous; subterminally, grayish scales form ill-defined streaks and spots; cilia grayish fuscous, those near apex tipped whitish. Hind wing ocherous shading to brownish apically; cilia pale grayish ocherous, darker apically; apical cilia whitish tipped. Legs silvery white; forefemur brown outwardly; foretibia and first tarsal segment reddish ocherous on outer side; midtibia lightly marked dull ocherous on outer side; posterior tibia dull ocherous white. Abdomen brownish dorsally, whitish ventrally.

Female genitalia: Ostium crescentic opening into a broad, short, sclerotized posterior section of ductus bursae; inception of ductus seminalis dorsal, at anterior edge of sclerotized part of ductus bursae. Signum an elongate, sclerotized dentate plate.

Slide examined: ♀, JFGC no. 10124.

Type: Venezuela, Caracas (no date or collector), USNM 66375.

Described from the unique female type.

Superficially strikingly similar to *melobaphes*, *determinata*, and *bourquini*, but the brilliance of coloring is subdued by abundant fuscous

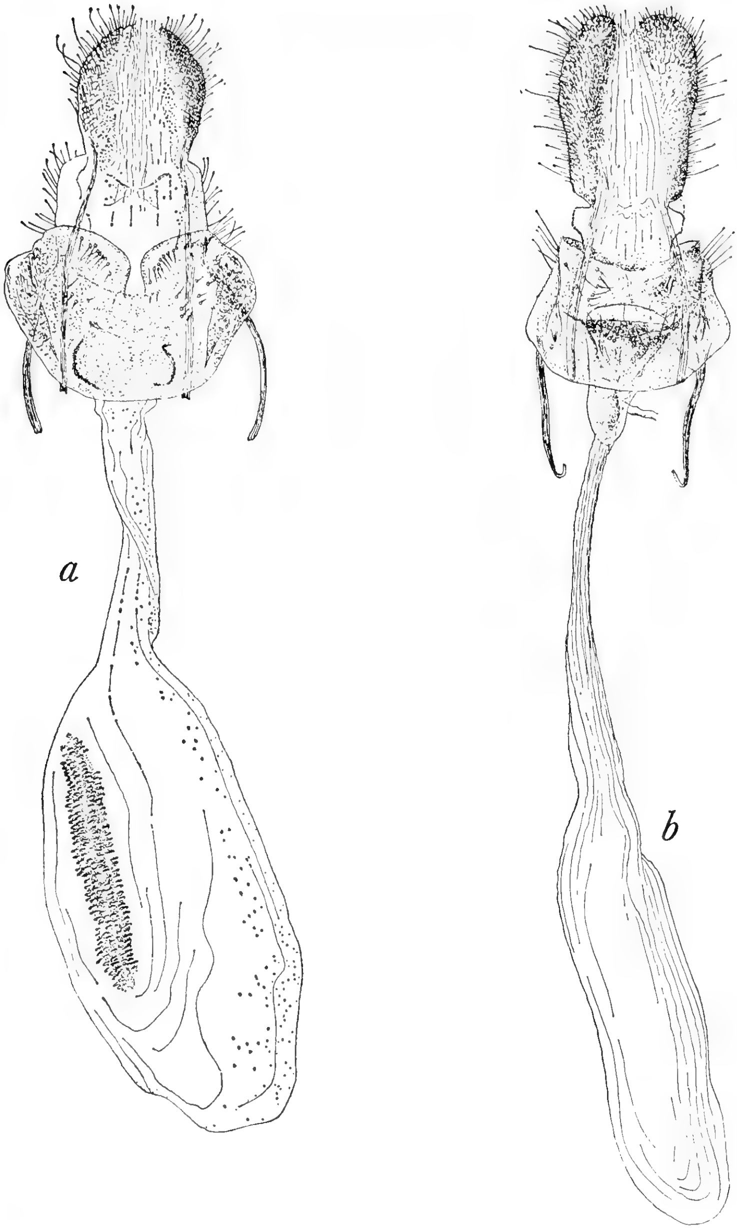

FIGURE 5.—*Gonionota incontigua*, new species: *a*, ventral view of female genitalia. *Gonionota extima*, new species: *b*, ventral view of female genitalia.

irroration. The genitalia, however, provide ample characters to distinguish *incontigua* from its nearest relatives as discussed under *determinata.*

Gonionota extima, new species

FIGURE 5*b*; PLATES 1 (FIG. 1), 3 (FIG. 2)

Alar expanse 22 mm.

Labial palpus sayal brown; second segment irrorate with black on outer side, basal half of posterior edge white; third segment spotted with blackish fuscous subapically and on inner side; apex ocherous white. Antennal scape silvery white ventrally, sayal brown dorsally; remainder of antenna sayal brown shading to fuscous apically. Head sayal brown mixed with some reddish scales anteriorly and ocherous posteriorly. Thorax buff yellow mixed with reddish ocherous; dorsally several black spots; posterior tuft brown; tegula sayal brown basally and sparsely irrorate with black. Forewing ground color sayal brown; basal patch buff yellow mixed with reddish ocherous and irrorate with blackish fuscous, from basal third of costa outwardly oblique to middle of cell, then inwardly oblique to basal fourth of dorsum; costal part of basal patch broadly suffused sayal brown; in basal patch, near outer margin, two black discal spots; at end of cell a white dot followed by a few black scales; fold conspicuously indicated by black scales; dorsum broadly suffused fuscous with purplish tinge; at apical fourth of costa a prominent white triangular spot followed outwardly and obliquely toward termen by a series of irregular, alternating white and blackish spots; cilia fuscous. Hind wing clay color with conspicuous fuscous scaling in anal area; cilia grayish fuscous mixed with ocherous white. Legs silvery white suffused and spotted with sayal brown and grayish fuscous; foretibia and first tarsal segment reddish ocherous on outer side. Abdomen whitish ventrally, brown dorsally.

Female genitalia: Ostium broad, opening into the sclerotized, funicular posterior portion of ductus bursae; inception of ductus seminalis dorsal, at junction of sclerotized and membranous parts of ductus bursae. Signum absent.

Slide examined: ♀, JFGC no. 4236.

Type: Costa Rica, Tuis (May 28–June 4, Wm. Schaus), USNM 66376.

Described from unique female type.

The most characteristic feature of the female is the absence of the signum by which it can be distinguished from all other species of this group.

Gonionota incalescens (Meyrick)

Figures 6*a,b*

Hypercallia incalescens Meyrick, 1914, Exotic Microlepidoptera, vol. 1, p. 192; 1922, *in* Wytsman, Genera insectorum, fasc. 180, p. 160, no. 41.—Gaede, 1939, *in* Bryk, Lepidopterorum catalogus, part 92, p. 260.

Gonionota incalescens (Meyrick), Clarke, 1963, Catalogue of the type specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick, vol. 4, p. 237, pl. 115, figs. 1–1*b*.

Meyrick described this species from two males, the only two known. Although the basal patch of forewing is greatly reduced, *incalescens* unquestionably belongs in this group. The small basal patch, the conspicuous white, triangular costal spot, and the genitalia at once distinguish *incalescens* from *melobaphes*.

Gonionota periphereia, new species

Figures 6*c,d*; Plate 3 (Fig. 4)

Alar expanse 20 mm.

Labial palpus russet, the bases of the scales somewhat lighter, producing finely speckled effect; posterior edge of second segment white basally; third segment pale ocherous with a few scattered reddish scales. Antennal scape ocherous white ventrally, russet dorsally; remainder of antenna fuscous with few reddish ocherous scales dorsally. Head and thorax ocherous mixed with reddish ocherous; tegula reddish ocherous basally. Forewing ground color sayal brown shading to russet in apical third; from basal fifth, to about middle of costa, an outwardly oblique band of buff yellow crossed by transverse brown bars and marked with ill-defined reddish ocherous spots; extreme edge of basal third of costa brown; on costa, beyond basal patch, triangular group of black scales; on apical fourth of costa a buff yellow quadrate spot containing some reddish ocherous scales; cilia russet, strongly suffused fuscous from middle of termen to apex. Hind wing ocherous white, somewhat darker toward apex; cilia pale pink, those at apex mixed with gray. Legs ocherous white; forelegs and midlegs overlaid with reddish ocherous and pale ocherous; posterior tibia finely irrorate with pink and gray scales; posterior tarsi light ocherous. Abdomen brownish dorsally, buff tinged with reddish ocherous ventrally; first sternum without strong, eversible scale-tuft; anal tuft dull ocherous.

Male genitalia: Harpe very wide at base, abruptly narrowed beyond middle; saccular and costal margins parallel beyond middle; cucullus truncate; clasper a disc with a whorl of strong setae around its periphery. Anellus subrectangular, about twice as long as broad, narrowed posteriorly. Aedeagus stout, curved; vesica unarmed (at least in type). Vinculum very narrow, rounded. Gnathos a transverse, oval

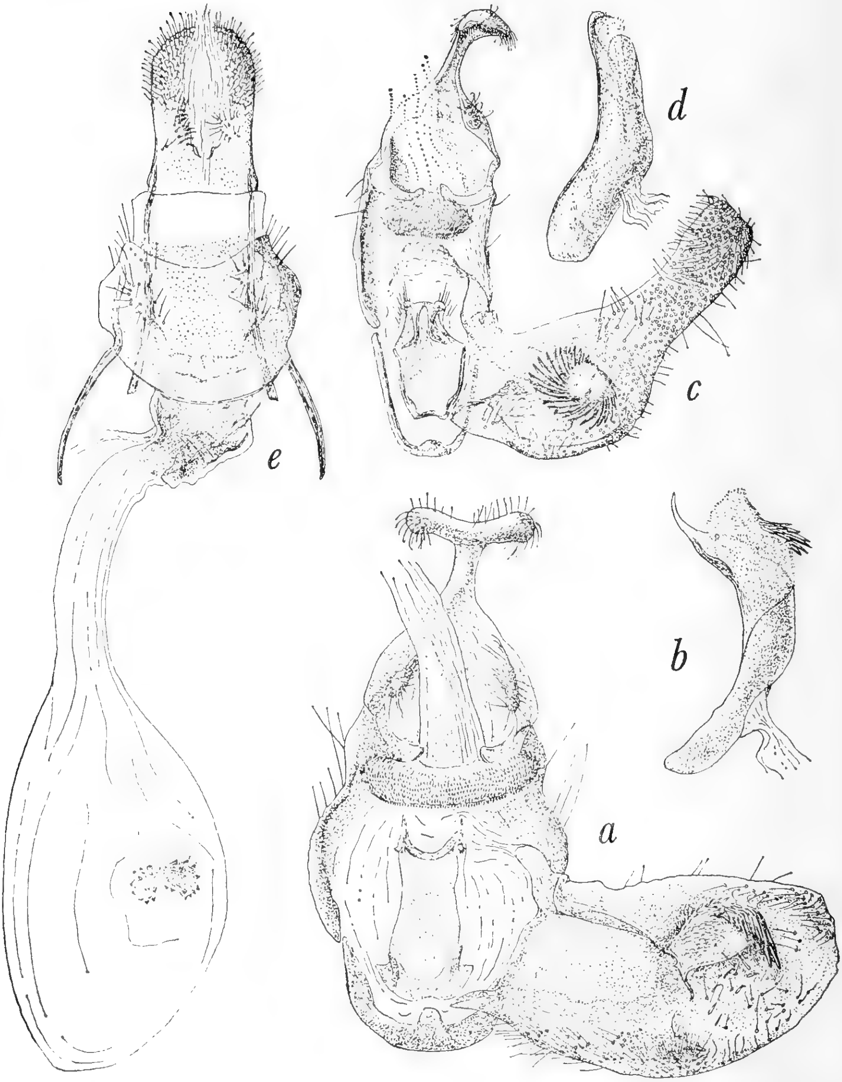

FIGURE 6.—*Gonionota incalescens* (Meyrick): *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus. *Gonionota periphereia*, new species: *c*, ventral view of male genitalia with left harpe and aedeagus removed; *d*, aedeagus. *Gonionota excavata*, new species: *e*, ventral view of female genitalia.

spined knob. Socii small, papillate, clothed with fine setae. Uncus furcate, basal stalk long, slender; divergent distal arms short.

Slide examined: ♂, JFGC no. 11101.

Type: Ecuador, Environs de Loja (no date, Dognin collection), USNM 66377.

Described from unique male type.

This specimen, among others, was sent to Meyrick for determination, presumably by Busck. Attached to it is a note in Meyrick's handwriting which reads: "Sent as second specimen of *H. melobaphes* with ocherous h.w., but is new, I therefore return. h.w. of *melobaphes* vary from ocherous to dark fuscous, but never white." I would not describe the hindwing of this specimen as white but it is certainly lighter than that of any of the other species considered here.

There is some doubt in my mind about placing *periphereia* in *Gonionota*. Although the genitalia are not dissimilar to those of other species associated with *melobaphes* and the venation easily permits its retention here, the fact remains that the labial palpus of *periphereia* differs from those of the other species. Moreover, the third segment is short, about one-third the length of the second, and devoid of any long scaling on the posterior edge. Finally, this is the only species lacking the eversible tuft from the first sternum, but this can, and may, be only a specific character.

Gonionota excavata, new species

FIGURE 6*e*; PLATES 1 (FIG. 2), 3 (FIG. 3)

Alar expanse 22 mm.

Labial palpus ocherous white overlaid with brown, especially on outer side of second segment, sparsely irrorate with fuscous and reddish ocherous; third segment similarly colored, apex whitish. Antenna ocherous white ventrally, grayish fuscous dorsally. Head buff yellow mixed with brown and reddish ocherous. Thorax ocherous mixed with brown; tegula brown basally. Forewing ground color light brown shaded with fuscous costad and with a faint violaceous tinge in tornal area; basal patch buff yellow mixed with reddish ocherous, extending to two-fifths; costal margin of basal patch broadly edged with ground color for nearly its entire length; in cell, at outer edge of basal patch, a blackish spot; several reddish ocherous blotches in center of wing; at apical third costa excised, bordered white; around termen a series of white scale patches preceded by ill-defined fuscous spots; dorsal margin edged with fuscous and with a group of blackish scales at base of dorsum. Hind wing ocherous white shading to brownish ocherous apically; in anal area scattered fuscous scales; cilia grayish fuscous, paler basally. Legs ocherous white lightly infuscated; tarsi white with a few fuscous spots. Abdomen brownish dorsally, ocherous white ventrally.

Female genitalia: Ostium broad, crescentic. Posterior two-fifths of ductus bursae sclerotized and bent anteriorly; inception of ductus seminalis dorsal, near junction of membranous and sclerotized parts of ductus bursae. Signum a small, bilobed, sclerotized dentate plate.

Slide examined: ♀, JFGC no. 4003.

Type: Mexico, Orizaba (no date, Wm. Schaus), USNM 66378.

The structure of the genitalia suggests that *excavata, fimbriata* and *hyptiotes* are closely related, but *fimbriata* lacks the excised costa of forewing of the other two. The unusually broad ostium and the signum of *hyptiotes* distinguish it from *excavata.* In superficial appearance *excavata* most nearly resembles *G. rhacina* Walsingham, which, however, lacks the row of white subterminal dashes characteristic of the former species. Also, the hind wing of *excavata* is paler than that of *rhacina.*

Gonionota hyptiotes, new species

Figure 7*f*; Plate 3 (Fig. 6)

Alan expanse 24 mm.

Labial palpus buckthorn brown; outer side of second segment sparsely irrorate with fuscous, inner side with some white scaling and tinged with pink; posterior edge white basally; third segment white posteriorly, subapical tuft fuscous. Antennal scape buckthorn brown dorsally, white ventrally; remainder of antenna brown dorsally shading to grayish fuscous distally. Head and thorax dull ocherous; tegula brownish basally. Forewing ground color buckthorn brown; basal fifth to costal edge of cell at two-fifths dull ocherous; from two-fifths of costa a transverse bar of dull ocherous extends toward outer extremity of basal patch but is interrupted by ground color; basal patch divided at middle by a transverse line of ground color; on outer margin of basal patch, in cell, two small clusters of fuscous scales; at end of cell a fuscous spot surrounded by ocherous; costa deeply excised at outer third, edged with white; inner margin of white edge very narrowly ocherous; costa fuscous before and after white-edged excision; dorsum broadly edged with fuscous; in terminal third scattered, ill-defined fuscous spots; cilia grayish fuscous. Hind wing ocherous white basally, shading to brown apically; in anal area considerable grayish fuscous scaling; cilia ocherous white shading to grayish fuscous around termen to apex. Legs ocherous white irrorate with brown and fuscous. Abdomen ocherous white with sparse fuscous irroration ventrally; dorsally brownish buff.

Female genitalia: Ostium extremely broad, opening into the sclerotized portion of ductus bursae on left side. Ductus bursae very short, sclerotized for about half its length, the sclerotized part dilated and convoluted; inception of ductus seminalis on right side. Signum approximately diamond-shaped.

Slide examined: ♀, JFGC no. 11103.

Type: Mexico, Orizaba (Sept. 10, R. Muller), USNM 66380.

Described from the unique female type.

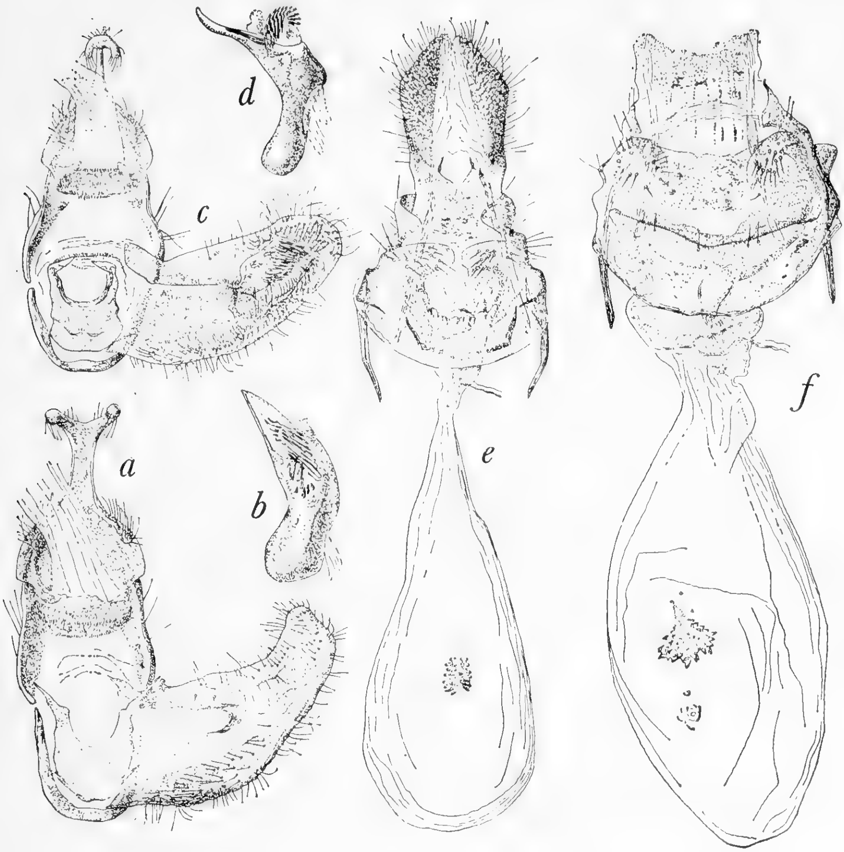

FIGURE 7.—*Gonionota cristata* Walsingham: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus. *Gonionota fimbriata*, new species: *c*, ventral view of male genitalia with left harpe and aedeagus removed; *d*, aedeagus; *e*, ventral view of female genitalia. *Gonionota hyptiotes*, new species: *f*, ventral view of female genitalia (ovipositor lobes missing).

In wing shape *hyptiotes* is similar to *excavata*, but the costal excision of the former is deeper than that of the latter. The forewing of *hyptiotes* shows no trace of the white subterminal dashes found in *excavata*, and the reddish ocherous scaling of the forewing of the latter is also lacking in the former. The two can be distinguished further by the genitalia, particularly with respect to the shapes of the signa. The signum of *hyptiotes* is roughly diamond-shaped but that of *excavata* has a definite median constriction.

The type of *hyptiotes* bears a label ("*Goniota* [sic] *incisa* Wlsh."), but there is no indication of who made the determination. Moreover, there is no close relationship between Walsingham's *incisa* and this specimen labeled as that species.

Gonionota cristata Walsingham

Figures 7*a,b*

Gonionota cristata Walsingham, 1912, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 42 (Lepidoptera-Heterocera, vol. 4), p. 129.

The male genitalia of *cristata* have not been figured previously; they are shown here for comparative reasons.

Slide examined: ♂, JFGC no. 3394. No female available.

Male genitalia: Harpe rather abruptly narrowed in distal half; cucullus truncate; clasper a very small curved ridge about middle of harpe. Anellus subquadrate, deeply excavated on posterior edge. Aedeagus very stout, bent slightly before middle; vesica armed with two groups of strong cornuti, the four or five of the proximal and smaller group short, dentiform, those of the distal group longer and more numerous. Vinculum rather narrow, rounded. Gnathos a narrowly oval spined knob. Uncus with long, slender, proximal stalk and widely divergent, moderately slender distal arms.

Gonionota fimbriata, new species

Figures 7*c–e*; Plates 1 (Fig. 3), 3 (Fig. 1)

Alar expanse 17–21 mm.

Labial palpus amber brown; second segment ocherous white on inner side with pale ocherous toward tip; third segment fuscous on posterior margin subapically; apex white. Antennal scape amber brown dorsally, silvery white ventrally; remainder of antenna amber brown dorsally at base shading to grayish fuscous; dull pale ocherous ventrally. Head russet, the scales narrowly tipped with white; proboscis white. Thorax deep chrome mixed with scattered reddish ocherous scales; anteriorly heavily overlaid with russet; posterior tuft brown; anterior two-thirds of tegula russet. Forewing ground color sayal brown faintly blotched with darker brown, basal patch deep chrome mixed with reddish ocherous and extending to about basal third of wing; outer margin convex; costal edge of basal patch sayal brown and across middle of patch a narrow outwardly curved line of the same color; in cell near outer margin of basal patch two small black spots, one obliquely above the other; at end of cell a few white scales, preceded and followed by scattered fuscous scaling, indicate an outer discal spot; at apical third of costa a conspicuous triangular white dash followed by some white scales; dorsum narrowly edged with fuscous; cilia grayish fuscous, those below apex faintly tipped whitish. Hind wing brownish ocherous, cilia slightly darker. Legs silvery white; forefemur shaded with grayish fuscous on outer side; foretibia and first tarsal segment russet on outer side; midtibia shaded with brown on outer side; midtarsi irrorate brown; posterior tibia and tarsi shaded with pale brown. Abdomen slightly darker than hind wing, brownish dorsally, white ventrally; anal tuft cinereous mixed with ocherous; first sternum with strong, eversible, median scale-tuft in male.

Male genitalia: Harpe broadest near base, tapering gently to the rounded cucullus; clasper arising slightly beyond middle, stout, distally armed with strong, sharp setae; sacculus thickened but without appreciable prominence. Anellus rectangular, deeply concave posteriorly. Aedeagus stout, curved, sharply pointed; vesica armed with cluster of strong setae. Vinculum narrow, rounded. Gnathos an oval transverse spined knob. Socii small, fleshy lobes clothed with fine setae. Uncus furcate, proximal stalk long, slender; distal arms slender.

Female genitalia: Ostium moderately small, ventral lip ridged, opening into a cup-shaped posterior sclerotized portion of ductus bursae. Inception of ductus seminalis approximately at junction of sclerotized and membranous parts of ductus bursae. Signum a small rectangular dentate plate.

Slides examined: ♂♂, JFGC nos. 3391, 3395, 10791; ♀, JFGC no. 11102.

Type: Panama, Porto Bello (April 1912, August Busck), USNM 66379.

Described from male type, one male and two female paratypes as follows:

PANAMA: Barro Colorado Island (♂, Sept. 1940, James Zetek; 2 ♀♀, 11.x and 3.xi, M. Bates coll.).

Superficially, *fimbriata* and *cristata* are similar, but the hind wing of *cristata* is considerably darker than that of *fimbriata*. In the forewing of *fimbriata* the white costal spot is more pronounced and the ground color is much lighter than in *cristata*. The male genitalia also show marked differences. Although the anneli of both species are of the same type and are, for practical purposes, indistinguishable, the clasper, as in the apical half of the harpe of *fimbriata*, is absent in the harpe of *cristata*. Other obvious differences will be seen by a comparison of the figures. Unfortunately, no female of *cristata* is available for comparison.

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CHIRONOMID MIDGES OF CALIFORNIA
II. TANYPODINAE, PODONOMINAE, AND DIAMESINAE

By James E. Sublette[1]

Subsequent to publication of Part I of this series (Proc. U.S. Nat. Mus., vol. 112, no. 3435, 1960), I have received several additional collections. Rather than delay publication until all the remaining subfamilies can be treated, I am presenting here the results of study of three subfamilies. A projected third part will treat the Orthocladiinae and addenda to Parts I and II.

For making the additional collections available to me I should like to thank George W. Byers, Snow Entomological Museum, University of Kansas, Lawrence, Kansas; Gail Grodhaus, California Department of Public Health, Berkeley, California; Ernest C. Bay and E. I. Schlinger, University of California, Riverside, California.

Names of collections and collectors which are abbreviated in the text of this paper are as follows: U.S. National Museum (USNM); British Museum (Natural History) (BMNH); University of California at Davis (UCD); University of California at Los Angeles (UCLA); University of California at Riverside (UCR); California Department of Public Health, Berkeley (CDPH); University of Kansas (KU); Illinois Natural History Survey (INHS); Willis W. Wirth (W); R. E. Darby (D); J. N. Belkin (B); Gail Grodhaus (G); Ernest C. Bay (Bay); E. I. Schlinger (S); James E. Sublette (JES).

[1] Eastern New Mexico University, Portales, New Mexico.

All localities mentioned are in California unless otherwise noted. The deposition of material is indicated immediately before locality data of the specimens studied.

I should like again to thank my wife Mary Smith Sublette for her assistance in preparation of the manuscript and Dr. Willis W. Wirth for reading and constructively criticizing the manuscript.

Subfamily Tanypodinae

Pentaneura (Ablabesmyia) monilis (Linnaeus) Johannsen

Tipula monilis Linnaeus, Systema naturae, ed. 10, p. 587, 1758.

Males: Wing length, range 2.29–3.15; mean 2.85 mm. (14); fore leg ratio, range 0.77–0.83; mean 0.79 (9); antennal ratio, range 1.50–2.17; mean 1.95 (9); venarum ratio, range 0.80–0.87; mean 0.84 (13); aedeagus blade length, range 0.72–0.090; mean 0.081 (10). Prealar bristles 19 to 23; dorsolateral bristles mostly in single row; occasionally doubled for 1 or 2 bristles; anterolateral bristles 9 to 13.

Females: Wing length, range 2.29–3.00; mean 2.66 mm. (4); fore leg ratio, range 0.75–0.85; mean 0.80 (4); venarum ratio, range 0.84–0.86; mean 0.85 (3).

Material examined: In USNM: 1 male, 1 female, Berkeley, May 1, 1948, W; 2 males, 2 females, Shafter, Kern Co., June, 1946, B. Brookman; 1 male, King's River Bridge, Stratford, July 15, 1947, W. In KU: 3 males, Mammoth Lakes, July 29, 1940, D. E. Hardy; 1 male, Mammoth Lakes, July 29, 1940, R. H. Beamer; 1 female, Tioga Pass, July 31, 1940, R. H. Beamer. In UCLA: 1 male, Arcata, Humboldt Co., Sept. 9, 1950, B. In UCD: 1 male, Cobb's P.O., Forest Lake, June 22, 1953, D; 1 male, Pope Valley, Duvall Lake, June 22, 1953, D. In CDPH: 1 male, Puddingstone Reservoir, Los Angeles Co., June 22, 1952, G; 18 males, Lake Tenaya, Mariposa Co., Aug. 20, 1960, L. L. Lewallen; 2 males, 3 miles south of Woodside, San Mateo Co., Apr. 20, 1960, G. In UCR: 3 males, Whittier, Rio Hondo, May 15, 20, 1960, Bay.

Pentaneura (Ablabesmyia) mallochi (Walley)

Tanypus mallochi Walley, Canadian Ent., vol. 57, p. 273, 1925; Ann. Ent. Soc. Amer., vol. 21, p. 589, 1928.

Males: Wing length, range 2.11–2.52; mean 2.37 mm. (7); antennal ratio, range 2.00–2.28; mean 2.14 (7); fore leg ratio, range 0.78–0.82; mean 0.79 (6); venarum ratio, range 0.79–0.83; mean 0.83 (7); anterolateral bristles, range 13–19; mean 16 (4).

Female: Wing length 2.26 mm.; fore leg ratio 0.74; venarum ratio 0.90; anterolateral bristles 19.

Material examined: In USNM: 2 males, 1 female, Stratford, July 8, 1947, W; 1 male, Corcoran, Aug. 22, 1947, W. In D: 3 males, Rio

Linda, July 25, 27, 31, 1957. In CDPH: 1 male, 2 miles east, 4 miles north of Manteca, San Joaquin Co., June 3, 1957, G.

I have examined five specimens, four of them paratypes from the Canadian National Collections, through the kindness of Dr. J. R. Vockeroth, Entomology Research Institute, Canadian Department of Agriculture, Ottawa. He also has sent me notes on the holotype. Measurements for these specimens are:

Males: Wing length, range 2.52–2.85; mean 2.65 mm. (4); fore leg ratio 0.77–0.85; mean 2.65 (4); antennal ratio, range 2.11–2.22; mean 2.15 (4).

Female: Wing length 2.26 mm.; fore leg ratio 0.85.

Material examined in Canadian National Collections: 3 males, paratypes, 1 male, Aylmer, Ont., Aug. 8, 1924, C. H. Curran; 1 male, Aylmer, Ont., Sept. 7, 1924, C. H. Curran; 1 male, Ottawa, Ont., June 31, 1924, C. H. Curran; 1 male, Ottawa, Ont., July 14, 1926, G. S. Walley; 1 female, locality not recorded.

Measurement data for this species (male) is summarized as follows (those for the Georgia and New York specimens, fide Roback, 1959, p. 123):

	Wing length (mm.)	*Antennal ratio*	*Fore leg ratio*	*Anterolateral bristles*
Type series	2.52–2.85	2.11–2.22	0.77–0.85	18–20
Georgia	2.10–2.40			
New York	2.20–2.70	1.85	0.79	
California	2.11–2.52	2.00–2.28	0.78–0.82	13–19

Previous California records: Fallen Leaf, Lake Tahoe, Sept. 13, 1915 (USNM), Roback, 1959, p. 123.

Pentaneura (Ablabesmyia) peleensis (Walley)

Tanypus peleensis Walley, Canadian Ent., vol. 58, p. 64, 1926.

Through the courtesy of Dr. J. R. Vockeroth I have examined paratypes of *Tanypus peleensis* Walley. Dr. Vockeroth also kindly provided me with the notes on the holotype.

The California material that I am referring to this species differs from the type series by having the scutellum concolorous with the dark reddish-brown vittae and postnotum, and by having the blade of the aedeagus more strongly curved.

Male: Wing length 3.00 mm.; fore leg ratio 0.76; antennal ratio 2.30; fore tibia: tarsals 1+2, 52:52; venarum ratio 0.75; anterolateral bristles 13.

Female: Wing length 2.59 mm.; venarum ratio 0.87.

Material examined: In UCD: 1 male, Cobb's P.O., Forest Lake, June 22, 1953, D; 1 female, Pope Valley, Duvall Lake, June 22, 1953, D.

Pentaneura (Pentaneura) fluminalis, new species

FIGURES 1*a,b*

Pentaneura carnea (Fabricius) Johannsen, Journ. New York Ent. Soc., vol. 54, p. 279, 280, 1946. Misidentification?

Holotype male: In USNM 65503, Mad River Beach, Humboldt Co., Aug. 12, 1948, Coll. No. 104, reared, W.

Head reddish-brown, mouthparts and antennae darkened. Eyes with thin dorsal extension. Antennal ratio 1.84.

Thorax yellowish to reddish-brown. Anterior portion of lateral vittae darkest reddish-brown; pollinose, especially on dorsomedial and dorsolateral bristle rows and on prescutellar area. Supra-alar bristles 2; prealar bristles 12; dorsomedial bristles in single staggered row, becoming 2 rows posterior to tubercle at anterior edge of prescutellar area. Dorsolateral bristles in single staggered row, becoming doubled at edge of prescutellar area and extending back to scutellum. Dorsomedial and dorsolateral bristles erect, divergent, yellow. Scutellar bristles numerous; anterior ones strewn; 4 posterior erect bristles. Halteres white.

Fore leg proportions 60:80:60:34:24:15:8. Fore leg ratio 0.75. Fore leg with beard 7 times as long as diameter of tarsus; legs uniformly stramineous. Seven spines in comb on hind tibia; spurs sinuate, ratio 58:24 (long spur subsequently broken off at tip); side bristles not clearly discernible for counting on short spur; on long spur, 3 on one side only. Middle leg ratio 0.72; hind leg ratio 0.63.

Wings very heavily haired; R_{2+3} scarcely discernible. R_{4+5} only slightly proximal to termination of M, very far distal to Cu_1. R_1 distal to Cu_2; anal lobe rounded. Wing length 2.89 mm.; venarum ratio 0.85. Ratio of arculus to m–cu:m–cu to wing tip 0.43.

Abdomen yellowish-brown with reddish-brown fascia on basal part of each segment, faint on segment I becoming progressively wider and heavier until segment VI is almost entirely dark.

Allotype: In USNM, reared with holotype.

Wing length 2.70 mm.; fore leg ratio 0.77; middle leg ratio 0.68; hind leg ratio 0.64; venarum ratio 0.90; ratio of arculus to m–cu:m–cu to wing tip 0.36.

Paratype: In USNM: 1 female, reared with the holotype and allotype.

Wing length 2.66 mm.; fore leg ratio 0.74; middle leg ratio 0.67; hind leg ratio 0.65; venarum ratio 0.85; ratio of arculus to m–cu:m–cu to wing tip 0.37.

This species belongs to Edwards' Group C of *Pentaneura*. It further belongs to that portion of the group that was not named when Fittkau (1957) erected *Thienemannimyia*.

In Johannsen (1946) *P fluminalis*, new species, keys in Group C to *P. carnea* (Fabricius) and may well be the species that Johannsen identified as *P. carnea* (Fabricius). However, the wings and genitalia of this species are distinctly different from those illustrated by Goetghebuer (1936a, pl. 2, fig. 18; 1936b, pl. 5, fig. 71) for *P. carnea* (Fabricius), and so I am considering it as new. I have not examined Johannsen's material identified as *P. carnea.*

Previous California records: ?Johannsen, 1946, p. 278.

Pentaneura (Pentaneura) goniodes, new species

Figure 1*c*

Holotype male: USNM 65504, Berkeley, Oct. 3, 1947, W.

Head yellow; antennal pedicel and flagellum brown; mouthparts blackish. Eyes with long narrow dorsal extension. Antennal ratio 2.00.

Thorax stramineous, including legs; pollinose on prescutellar area and on dorsolateral bristle row. Vittae orange-yellow. Prealar bristles 14; dorsomedial bristles in staggered single row, which divides around tubercle, then extends laterally as row on each side of prescutellar area to join single dorsolateral row, thus forming cluster of bristles on either side of midline just in front of scutellum. Sternopleuron reddish-brown.

Fore leg proportions: 75:92:70:35:25:16:8. Fore leg ratio 0.76; middle leg ratio 0.50; hind leg ratio 0.65. Sparse hairs on fore tarsus 3 times as long as tarsal diameter.

Wings hyaline, weakly haired on basal half. Ratio of arculus to m–cu:m–cu to wing tip 0.46. R_1 distal to Cu_2; R_{2+3} proximal to Cu_1; R_{4+5} distal to Cu_1. Squama well haired with small triangular spot on distal margin. Wing length 3.29 mm.; venarum ratio 0.91.

Abdomen with middorsal brown stripe. Segments II to V with basal brown fascia; remainder of segments yellow.

Female: Unknown.

Paratype: Collected with holotype. Wing length 3.03 mm.; fore leg ratio 0.71; middle leg ratio 0.54; hind leg ratio 0.65; antennal ratio 2.00; venarum ratio 0.87; ratio of arculus to m–cu:m–cu to wing tip 0.42. Both hind legs slide mounted. Both spurs sinuate; longer spur with 5 lateral spines; shorter spur with 6 lateral spines, ratio 42:70; comb of 7 long pale bristles.

This species falls in Edwards' Group D of *Pentaneura* and in the restricted group which Fittkau (1957) erected as genus *Conchapelopia.* It closely resembles *P. flavifrons* Johannsen, *P. alba* Roback, *P. rurika* Roback, and *P. vitellina* Johannsen, not Kieffer.[2]

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[2] Fittkau (1957, p. 320) clarified the status of *vitellina* Kieffer and pointed out that Johannsen (1946) had misidentified the species. Fittkau then proceeded to propose a new name *americana* for *vitellina* Johannsen, not Kieffer, based on Johannsen's figure 13. The propriety of Fittkau's action is questionable since, according to my understanding of the rules of nomenclature, a new name is to be proposed only in the case of homonomy.

While these species differ in details of color, size, etc., they can be differentiated for certainty only by the structure of the male genitalia. The shape of the basal organ of the male genitalia is diagnostic for this species; the dististyle also appears to be more strongly angulate than in the related Nearctic species.

Pentaneura (Pentaneura) chrysos, new species

FIGURE 1*d*

Holotype male: USNM 65505, Pollock Pines, Eldorado Co., June 14, 1948, at light, W.

Entirely pale stramineous except antennal pedicels, vittae, and abdominal fascia pale yellowish-brown. Eyes with long narrow dorsal extension. Antennal ratio 2.26.

Prothorax broadly notched. Prealar bristles about 8; dorsomedial and dorsolateral bristles long and pale; dorsolateral bristles in single row; dorsomedial bristles in single row, elevated on slight elongated tubercle on prescutellar area, with about 3 bristles on each side of tubercle.

Fore leg proportions: 70:80:62:30:20:15:10. Fore leg ratio 0.77; middle leg ratio 0.60. Fore tarsal beard length 6 times tarsal diameter.

Wings entirely pale except darkened and thickened arculus. R_{4+5} distal to Cu_1. Ratio of arculus to m–cu:m–cu to wing tip 0.44. Wing length 2.96 mm.; venarum ratio 0.87.

Abdominal tergites with basal pale yellowish-brown fascia, indistinct on segment I, segments II to V on basal one-third, segments VI to VIII with most of tergite darkened.

Female: Unknown.

Paratype: In USNM: 1 male collected with type.

Wing length 2.74 mm.; fore leg ratio 0.75; antennal ratio 2.17; venarum ratio 0.83.

This species is placed in Edwards' Group D of *Pentaneura* and in the group which Fittkau (1957) established as genus *Thienemannimyia*. In Johannsen (1946, p. 297) the species runs to couplet 8 where it can be distinguished from *P. okoboji* (Walley) and *P. vitellina* (Kieffer) (cf. discussion under *P. goniodes*, new species) by the distinctive male genitalia.

Pentaneura (Pentaneura) barberi (Coquillett)

FIGURES 1*e,f*

Tanypus barberi Coquillett, Proc. U.S. Nat. Mus., vol. 25, p. 90, 1902.

The specimens before me agree well with Coquillett's original description and, although I have not studied the type material, I have no hesitation as to the specific placement. I am offering the following

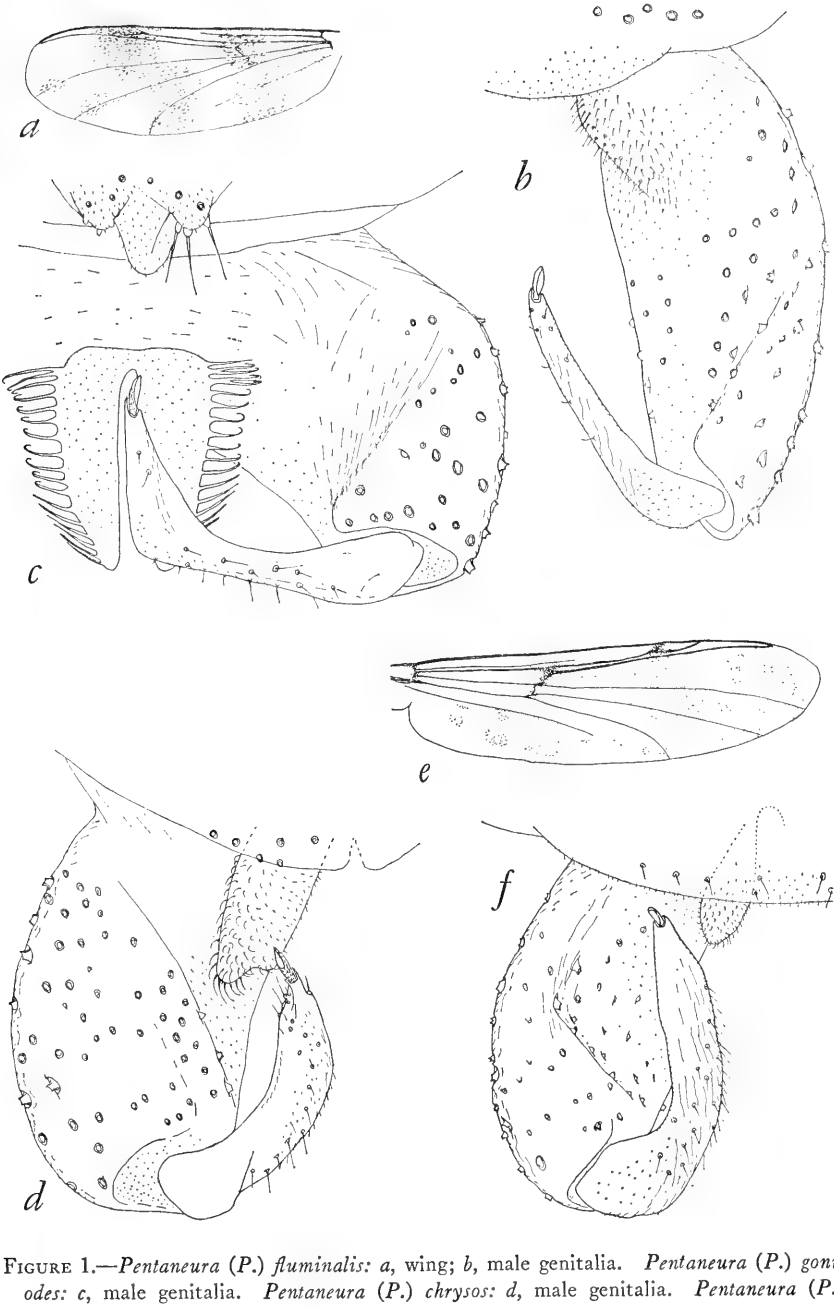

FIGURE 1.—*Pentaneura* (*P.*) *fluminalis: a*, wing; *b*, male genitalia. *Pentaneura* (*P.*) *goniodes: c*, male genitalia. *Pentaneura* (*P.*) *chrysos: d*, male genitalia. *Pentaneura* (*P.*) *barberi* (Coquillett): *e*, wing; *f*, male genitalia.

as a more complete description of the species, based on a male specimen in USNM: Mono Lake, Mono Co., June 6, 1948, W.

Head yellowish-brown, except antennal pedicels and mouthparts which are blackish-brown. Antenna yellowish with tip infuscate and with fuscous band near middle. Antennal ratio 1.64. Eyes with conspicuous narrow dorsal extension.

Thorax, except for yellowish pronotum, humeri, and scutellum, dark brown; middle and lateral vittae separated by paler line along dorsolateral bristle row; medial vittae separated by reddish-brown line along dorsomedial bristle row; dorsum heavily pollinose. Prothorax narrowed medially, evanescent, considerably inferior to mesonotum; with 6 to 8 very fine lateral bristles. Prealar bristles about 15; dorsolateral and dorsomedial bristles in single rows with dorsomedial bristles doubled for about 6 hairs posteriorly, terminating before scutellum; anterolateral bristles about 15. Halteres stramineous. Scutellum rubbed. Sternopleuron dark reddish-brown.

Fore leg proportions: 68:87:58:32:23:14:9. Fore leg ratio 0.67. Legs stramineous; dark brown annulus at distal end of femur and proximal end of tibia, separated from joint by distance equal to width of bands; tips of tibiae and tarsal joints 1 to 3 dark brown; distal half of fourth and all of fifth dark brown. Fore tarsi with beard slightly less than 3 times tarsal diameter; middle and hind legs with long pale hairs.

Wings with numerous spots on hyaline background; R_{4+5} terminates slightly distal to Cu_1; Cu_2 sharply bent downward, terminating half way between R_1 and R_{2+3}. Wing length 3.15 mm. Venarum ratio 0.90.

Each abdominal segment with basal dark brown, rather mottled, fascia, inconspicuous and narrow on segments I and II, progressively broadens until segment VII almost completely dark. Each abdominal segment with apical pollinose, mottled white fascia; prominent on segments I and II, decreasing apically.

Males: Wing length, range 2.32–3.18; mean 2.88 mm. (8); fore leg ratio, range 0.64–0.73; mean 0.69 (6); antennal ratio, range, 1.52–2.08; mean 1.81 (8); venarum ratio, range 0.80–0.92; mean 0.87 (8).

Females: Wing length, range 2.52–3.07; mean 2.73 mm. (3); fore leg ratio 0.58, 0.66 (2); venarum ratio, range 0.88–0.92; mean 0.90 (3).

Material examined: In USNM: 1 male, Mono Lake, June 7, 1948, W; 1 male, 1 female, Deer Creek Hot Springs, Tulare Co., Aug. 6, 1947, W; 2 males, 2 females, Wheeler's Springs, Ventura Co., June 16, 1948, W; 1 male, Grangeville, Kings Co., July 31, 1947, W; 1 male, Sanger, Fresno Co., Oct. 14, 1947; 1 male, Reedley, Fresno Co., Oct., 1947; 1 female, Visalia, June 30, 1947, W; 1 female, Shafter, Kern Co., June, 1946, B. Brookman. In UCD: 1 male, Bear-Cache Creek Junction, Yolo Co., Apr. 19, 1957, S.

The genus *Thienemannimyia* Fittkau, 1957, was established for Edwards' Group C, in part. Fittkau's generic diagnosis (freely translated) includes a "leg with a brown ring at the end of the femur and on the base of the tibia; the last 2 or 3 tarsal segments brownish. Wing mostly with darkened cross veins and dark flecks or bands. . . . Hypopygium of a very uniform structure" (Fittkau, 1957, figs. 3, 4).

Of the described North American species only *P. barberi* (Coquillett), *P. marmorata* Johannsen, *P. apicalis* (Walley), *P. ornata* (Meigen) Johannsen, and *P. pulchripennis* (Lundbeck) definitely belong to this restricted genus as indicated by characteristics described by Johannsen (1946).

Roback (1957) has described *Pentaneura norena*, a species obviously belonging to *Thienemannimyia*, as evidenced by the structure of the male genitalia and by the banded wings; however, the species lacks leg fasciae. *Thienemannimyia* must thus be emended to include both species with fasciate legs and those without fasciae. The remaining species treated by Johannsen (1946) as members of Group C—that is, those with unbanded legs—possibly may include also species that properly should be placed in *Thienemannimyia;* however, in the absence of hypopygial illustrations in the literature, none of these can be verified at this time. These species of uncertain position include *P. bifasciata* (Coquillett), *P. fragilis* (Walley), *P. futilis* (Wulp), *P. carnea* (Fabricius) Johannsen, and *P. sinuousa* (Coquillett). Because of lack of precise knowledge of many North American types of this group, I am not using *Thienemannimyia* at this time but am using a much more inclusive *Pentaneura* (*Pentaneura*) (=Groups B–F, sensu Edwards.)

***Pentaneura* (*Pentaneura*) *comosa*, new species**

FIGURE 2*a*

Holotype male: USNM 65506, Alum Rock Park, Santa Clara Co., July 8, 1948, W.

Head pale yellowish-white; posteriorly infuscate. Antennal pedicel and flagellum dark brown. Eyes with long narrow dorsal extensions. Palpi long, pale brown, ratio 35:43:45:70. Antennal ratio 1.52.

Thorax brown overlaid with strong white pruinescence; vittae dark brown, overlaid with conspicuous greenish pruinescence. Pronotum infuscate yellowish-white with broad notch completely interrupted on midline; with 4 fine lateral bristles. Scutellum infuscate yellow. Postnotum dark brown. Sternopleuron dark brown marked with infuscate yellow on pleura. Halteres yellow. Supra-alar bristles 2, 1 long, 1 short; prealar bristles 11; dorsomedial bristles staggered in single row, anteriorly with tuft of fine appressed bristles; dorsolateral bristles in 2 staggered rows, converging almost to midline just anterior to scutellum where the 2 rows are much broadened and staggered; anterolateral bristles 5, much finer and paler than dorsolateral bristles; scutellum with single posterior row of 12 long black bristles, anteriorly 16 scattered near midline.

Femora with apical faint brown band, remainder infuscate stramineous. Fore tarsi with long beard 8 times as long as diameter of tarsus; middle leg and hind leg densely pilose. Fore tibia with single lyrate spur (similar to that illustrated for *P. lyra*, new species), composed of 6 spines; main spur spine only slightly heavier than lateral bristles; middle tibial spurs lyrate, each with 6 spines, main spur spine heavier than remainder of side bristles; spurs of approximately equal length. Hind tibial spurs very similar to those of middle leg, lyrate form not quite so pronounced; comb of 6 spines.

Leg proportions:

	F	*Ti*	Ta_1	Ta_2	Ta_3	Ta_4	Ta_5	*Leg Ratio*
Fore	57	65	56	29	22	15	7	0.86
Middle	65	78	57	27	21	18	12	0.73
Hind	57	96	55	33	23	14	8	0.57

Wings densely hairy; R_{4+5} terminates distal to Cu_1; M terminates behind apex of wing; ratio of arculus to m–cu:m–cu to wing tip 0.41; cross veins not darkened. Length of first basal cell beyond end of second basal cell greater than length of m–cu cross vein. Wing length 2.85 mm.; venarum ratio 0.84.

Abdominal segments I to V with basal brown fascia, middorsal portion elongated posteriorly forming roughly shaped T; remainder of segment pruinose white; brown fascia progressively enlarged posteriorly with corresponding decrease in amount of white shown; segment VI to tip of abdomen almost entirely dark brown.

Female: Unknown.

Paratypes: In UCLA: 4 males, Resting Springs, Inyo Co., May 29, 30, 1955. In UCD: 1 male, Benton Station, Mono Co., July 20, 1950, H. A. Hunt.

Males: Wing length, range 2.15–2.74; mean 2.30 mm. (4); fore leg ratio, range 0.78–0.85; mean 0.81 (3); antennal ratio, range 1.25–1.54; mean 1.37 (4); venarum ratio, range 0.82–0.86; mean 0.84 (5); ratio of arculus to m–cu:m–cu to wing tip, range 0.37–0.43; mean 0.40 (4); prealar bristles 9 (1); anterolateral bristles 9 (1). Middle tibia with 2 equal, lyrate spurs, 4 side spines almost as long as main spur. Hind tibia with 2 subequal (24:21) lyrate spurs, each with 4 side spines about two-thirds as long as main spine; comb of 4 bristles.

This species is differentiated from related species in the key (p. 102).

Pentaneura (Pentaneura) thryptica, new species

FIGURE 2*b*

Holotype male: USNM 65507, 5 miles west of Gilroy, Santa Clara Co., Sept. 18, 1955 G.

Clypeus longer than wide, with 14 fine bristles. Dorsal extension of eyes much longer than wide. Palpi 4-segmented; ratio 38:47:58:108. Postocular bristles in single row median to eyes, becoming two rows behind eyes, one row lateral to eyes. Antennal ratio 1.80.

Head and thorax medium brown, scutellum yellowish-brown, stained with black on posterior surface; scutellar bristles about 22, 12 in posterior straight transverse row, and 10 anterior strewn ones. Prealar bristles 9; dorsomedial bristles staggered in 2 rows; dorsolateral bristles in single staggered row; scutellum with 11 large bristles in single posterior row; anterolateral bristles about 7.

Fore tarsal beard 4 times diameter of tarsus; legs stramineous. Fore tibia with single lyrate spur of 8 bristles (similar to that illustrated for *P. lyra,* new species), outer bristle on each side somewhat heavier. Middle tibia with one lyrate spur composed of 7 bristles and 1 ordinary somewhat sinuate spur with 6 side teeth. Length of lyrate to normal spur 20:38. Hind tibia with 2 spurs, shorter one sinuate with 5 side teeth almost as long as tip of spur; longer spur very slender with side teeth obscured; ratio of length of spurs 26:55; comb of 5 bristles.

Leg proportions:

	F	*Ti*	*Ta_1*	*Ta_2*	*Ta_3*	*Ta_4*	*Ta_5*	*Leg Ratio*
Fore	43	56	41	24	16	10	5	0.73
Middle	52	55	35	20	14	8	5	0.63
Hind	45	65	42	22	16	10	6	0.65

Wings well haired; ratio of arculus to m–cu:m–cu to wing tip 0.43. R_1 terminates above Cu_2; R_{4+5} ends distal to termination of Cu_1 and proximal to termination of M. Wing length 2.18 mm.; venarum ratio 0.89.

Abdominal segments blotched with black speckled brown; irregular whitish patch on each side of tergite.

Allotype: In USNM: Colored as male except abdomen, almost entirely brown. Dorsal extension of eye almost as wide as long. Clypeal bristles 21.

Prothorax with 3 fine lateral bristles. Prealar bristles 15; anterolateral bristles about 18, both large and small bristles.

This species is distinguished from related North American species in the key (p. 102).

***Pentaneura* (*Pentaneura*) *lyra*, new species**

FIGURES 2*c,d*

Holotype male: USNM 65508, Wheeler's Springs, Ventura Co., June 16, 1948, light trap, W.

Head infuscate yellow; antennal pedicels dark reddish-brown; flagellum infuscate. Palpi infuscate; ratio 38:45:55:95. Clypeus slightly longer than broad, with 13 bristles. Postocular bristles reaching point medial to long narrow dorsal extensions of eyes; in single row.

Thorax reddish-brown; pleura, spaces between vittae, humeri and scutellum pale yellowish-white. Prothorax infuscate yellow; completely divided by rather narrow notch; 2 lateral fine bristles. Postnotum reddish-brown. Halteres white. Prealar bristles 13; dorsomedial bristles in staggered single row; dorsolateral bristles in double staggered row, posterior rows dilated medially, almost reaching midline; scutellum with 12 long, pale bristles in posterior single row; anteriorly several fine pale strewn bristles near midline; anterolateral bristles 9.

Fore legs without beard; middle and hind legs heavily pilose. Single spur of fore tibia somewhat lyrate with 8 side teeth being almost as large as main spur continuation; both spurs of middle and hind tibiae lyrate, very similar to that of fore leg, about equal length, each with 7 to 9 side teeth; comb of hind tibia of 5 bristles.

Leg proportions:

	F	*Ti*	Ta_1	Ta_2	Ta_3	Ta_4	Ta_5	*Leg Ratio*
Fore	45	50	37	20	14	19	6	0.74
Middle	47	47	31	15	10	6	5	0.66
Hind	46	63	40	21	16	10	6	0.63

Ratio of arculus to m–cu:m–cu to wing tip 0.44. R_{4+5} terminates distal to Cu_1; M terminates slightly below apex of wing; membrane rather heavily haired; cross veins not darkened; length of first basal cell beyond distal end of second basal cell greater than length of m–cu. Wing length 2.00 mm.; venarum ratio 0.91.

Abdominal segments I to V whitish with basal one-third to one-half covered by blotchy black fascia; segment VI and beyond largely blackish-brown.

Genitalia with pale bristles on ninth tergite.

Female: Unknown.

Paratypes: In USNM: 1 male, Springville, July 10, 1947, W. In UCLA: 1 male, China Ranch, Inyo Co., May 29, 1955; 4 males, Resting Springs, Inyo Co., May 29, 30, 1955. In UCD: 1 male, 4 miles west of Quincy, Plumas Co., July 16, 1949, W. E. Ehrhardt.

Males: Wing length, range 1.74–2.04; mean 1.87 mm. (6); fore leg ratio 0.66–0.71 (2); antennal ratio, range 1.40–1.54; mean 1.45 (3);

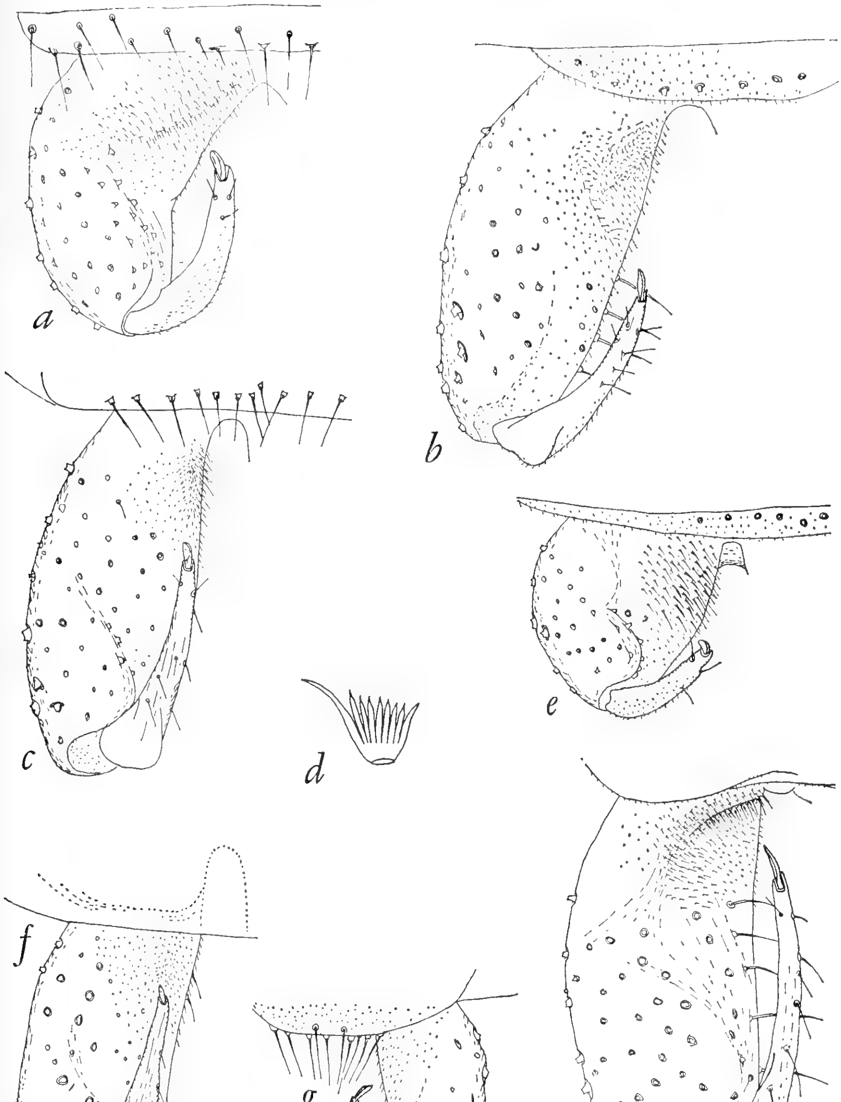

FIGURE 2.—*Pentaneura* (*P.*) *comosa*: *a*, male genitalia. *Pentaneura* (*P.*) *thryptica*: *b*, male genitalia. *Pentaneura* (*P.*) *lyra*: *c*, male genitalia; *d*, tibial spur of middle leg. *Pentaneura* (*P.*) *inyoensis*: *e*, male genitalia. *Pentaneura* (*P.*) *sequoiaensis*: *f*, male genitalia. *Pentaneura* (*P.*) *pilosella* (Loew): *g*, male genitalia. *Pentaneura* (*P.*) *smithae*: *h*, male genitalia.

venarum ratio, range 0.86–0.93; mean 0.88 (6); arculus to m–cu:m–cu to wing tip, range 0.42–0.45; mean 0.43 (6).

This species is distinguished from closely related forms in the key (p. 102).

Pentaneura (*Pentaneura*) *inyoensis*, new species

FIGURE 2e

Holotype male: USNM 65509, Resting Springs, Inyo Co., May 29, 1955.

Head pale brown; antennal pedicels darker brown. Postocular bristles in single row reaching medial to dorsal extensions of eyes. Clypeus longer than broad with 17 bristles. Palpi 35:50:70:62. Antennal ratio 1.70.

Thorax pale brown overlaid with conspicuous golden green pruinescence; vittae and postnotum darker brown. Halteres white. Pronotum with 4 lateral bristles. Supra-alar bristles 2, 1 large, 1 small; prealar bristles 8; dorsolateral bristles in 2 staggered rows; anterolateral bristles about 6; scutellum with 8 posterior bristles in transverse row, anteriorly about 10 smaller strewn bristles.

Legs stramineous; fore tarsal beard 3 times as long as diameter of tarsus. Fore leg with very short sinuate spur with 2 lateral barbs; spur length:tibial apical diameter 20:38. Middle leg with two unusual spurs of about equal length, each composed of 3 long filaments. Hind leg with only one visible trifid spur as middle leg; with comb of only 4 spines.

Leg proportions:

	F	*Ti*	Ta_1	Ta_2	Ta_3	Ta_4	Ta_5	*Leg Ratio*
Fore	35	40	39	18	15	9	5	0.98
Middle	42	51						
Hind	35	57	45	20				0.79

Arculus to m–cu:m–cu to wing tip 0.37. R_{4+5} terminates slightly distal to Cu_1; M terminates almost at wing apex, slightly below. Wing length 1.89 mm.; venarum ratio 0.86.

First abdominal segment largely pale with slight lateral infuscation; segments II to V pale brown (to dark brown, paratype) with posterolateral pruinose white areas that almost meet on posterior middorsal line; remainder of abdomen largely brown.

Female: Unknown.

Paratypes: In UCLA: 2 males, Resting Springs, Inyo Co., May 30, 1955; 3 males, China Ranch, Inyo Co., May 30, 1955; 1 male, 1000 Palm Canyon, Riverside Co., March 20, 1954, B; 1 male, Saratoga Springs, May 28, 1955.

Males: Wing length, range 1.77–2.29; mean 1.95 mm. (6); fore leg ratio 0.89 (1); antennal ratio, range 1.60–1.76; mean 1.70 (3); venarum ratio, range 0.86–0.93; mean 0.91 (3); arculus to m–cu:m–cu to wing tip, range 0.37–0.41; mean 0.39 (4); hind leg ratio 0.68 (1).

This species is distinguished from related forms in the key (p. 102).

Pentaneura (Pentaneura) sequoiaensis, new species

FIGURE 2*f*

Holotype male: USNM 65510, Stony Creek, Sequoia National Park, July 13, 1947, W.

Postocular bristles 15, in single row which begins at point medial to long dorsal extension of eyes. Eye extension with posteromedial border angulate; the anteromedial border rounded. About 12 clypeal bristles. Antennal ratio 2.00.

Thoracic vittae, postnotum, and sternopleuron pale brown; remainder of thorax whitish pollinose. Prothorax with 5 fine lateral bristles. Halteres white. One supra-alar bristle; prealar bristles 10; dorsolateral bristles in single staggered row; scutellum with 3 transverse rows of bristles, 12 in posterior row, 8 in median row, 3 in anterior row.

Fore tibial spur lyrate, closely resembling that of *P. lyra*, new species; lateral bristles spatulate, almost as long as spine of spur, giving appearance of comb. Middle leg with spurs short, subequal, each with apparently 3 lateral somewhat spatulate bristles. Hind leg with comb of 5 spines; spurs short, each with apparently 2 lateral bristles almost as long as spur.

Leg proportions:

	F	*Ti*	Ta_1	Ta_2	Ta_3	Ta_4	Ta_5	*Leg Ratio*
Fore	44	57	43	22	16	10	6	0.75
Middle	46	49	39	15	10	7	5	0.80
Hind	45	67	50	19	17	10	5	0.75

Ratio of arculus to m–cu:m–cu to wing tip 0.42. R_{4+5} terminates distal to Cu_1; M terminates below wing tip. Wing membrane densely haired; cross veins colorless; length of first basal cell beyond distal end of second basal cell greater than length of m–cu.

Abdomen whitish; segments II to VI with basal one-third covered with pale brown fascia. The elongate dististyle and the absence of bristles on the posterior margin of the ninth tergite serve to distinguish this species. The key which follows serves to separate this species from closely related Nearctic forms.

Female: Unknown.

Paratype: Collected with holotype.

Wing length 2.22 mm.; fore leg ratio 0.76; antennal ratio 2.00; venarum ratio 0.89; prealar bristles 9; ratio of arculus to m–cu:m–cu to wing tip 0.42.

Pentaneura (Pentaneura) pilosella (Loew)

FIGURE 2*g*

Tanypus pilosellus Loew, Berlin Ent. Zeitschr., vol. 10, p. 5, 1866.

The description that follows is given to supplement the original description and the one given by Johannsen (1946). It is based on a male specimen in UCLA: Lee's Lake, Chatsworth, Los Angeles Co., July 25, 1950, B.

Head yellowish-white except antennal pedicels reddish-brown and palpi and antennal flagella infuscate. Postocular bristles in single row; reaching point medial to dorsal extension of eyes. Eye extension angulate posteriorly, rounded anteriorly. About 15 clypeal bristles. Antennal ratio 1.30.

Thorax yellowish-white except for vittae, postnotum, and sternopleuron which are reddish-brown. Mesothoracic vittae with greenish pruinosity. Halteres yellowish-white. Supra-alar bristles 2, prealar bristles 8; dorsomedial bristles in 2 rows, diverging posteriorly; dorsolateral bristles in 2 staggered rows, composed of large and small bristles, rows diverge posteriorly to join dorsomedial bristles; scutellum with 8 large bristles in transverse posterior row, anteriorly with many fine strewn bristles; anterolateral bristles about 8.

Legs infuscate stramineous; beard 3.6 times fore tarsal diameter.

Leg proportions:

	F	*Ti*	*Ta*$_1$	*Ta*$_2$	*Ta*$_3$	*Ta*$_4$	*Ta*$_5$	*Leg Ratio*
Fore	25	30	19	12	8	5	4	0.63
Middle	32	27	33	15	4	5	5	1.22
Hind	29	38	30	14	11	6	4	0.79

Wing with ratio of arculus to m–cu:m–cu to wing tip 0.37. R_1 terminates proximal to Cu_1; wing densely haired. Wing length 1.55 mm.; venarum ratio 0.75.

Abdomen with segments I, II, and IV yellowish-white with narrow basal brown band; segments III, V, and VI largely brown, with narrow apical white fascia; segments VII and VIII mounted with genitalia.

Males: Wing length, range 1.04–1.52; mean 1.26 mm. (7); fore leg ratio, range 0.56–0.72; mean 0.66 (5); antennal ratio, range 0.64–1.26; mean 0.91 (7); middle leg ratio, range 1.10–1.28; mean 1.18 (5); hind leg ratio, range 0.82–1.09; mean 0.89 (4).

Material studied: In USNM: 4 males, Orosi, Tulare Co., June 5, 1947, W. In UCLA: 9 males, Lee's Lake, Chatsworth, Los Angeles Co., July 25, 1950, B; 7 males, same locality, Aug. 10, 1950.

Pentaneura (Pentaneura) smithae, new species

FIGURE 2*h*

Holotype male: USNM 65511, Saratoga Springs, March 20, 1955, B.

Head yellowish, occiput and mouthparts infuscate; antennal pedicel, thoracic vittae, postnotum, and sternopleuron reddish-brown. Postocular bristles in single row continuing medially to vertex between dorsal extensions of eyes. Palpi ratio 13:28:35:20. Antennal ratio 1.59.

Prothorax with 1 large, 2 small lateral bristles. Pronotum, humeri, small pleural area and scutellum yellowish. Halteres white. Prealar bristles 12; dorsolateral bristles mostly in double row, posteriorly expanded, becoming multiserial; 12 scutellar bristles in posterior transverse row, about 16 anterior strewn ones; anterolateral bristles about 12.

Fore legs with longest hairs 3.5 times diameter of tarsus, mostly with short hairs.

Leg proportions:

	F	Ti	Ta_1	Ta_2	Ta_3	Ta_4	Ta_5	*Leg Ratio*
Fore	45	53	38	22	15	10	6	0.71
Middle	55	46						
Hind	45	62	41	25	16	10	5	0.68

Wings with ratio of arculus to m–cu:m–cu to wing tip 0.38. Wing length 2.22 mm.; venarum ratio 0.83.

Abdomen with basal segment largely brown with only dorsal disc pale white; segments II to IV with basal half brown, apical half white; segment V with only narrow faint apical band; remainder of segments largely brown.

Allotype: In USNM: Whitmore Tub, Mono Co., Aug. 3, 1952, McDonald. Wing length 2.37 mm.; fore leg ratio 0.65; venarum ratio 0.82; ratio of arculus to m–cu:m–cu to wing tip 0.34.

Paratypes: In USNM: 3 males, Shafter, Kern Co., June, 1946, B. Brookman; 1 male, Independence, Inyo Co., Aug. 22, 1952, B. In KU: 1 male, Mono Lake, July 31, 1940, D. E. Hardy. In INHS: 1 male, Palo Alto, May 1, 1906. In UCLA: 4 males, Saratoga Springs, March 20, 1955, B; 3 males, Saratoga Springs, May 20, 1955; 1 male, Santa Monica Creek, Los Angeles Co., July 22, 1952; 7 males, collected with allotype. In UCD: 3 males, Benton Station, Mono Co., July 20, 1950, H. A. Hunt.

Males: Wing length, range 1.74–2.70; mean 2.33 mm. (17); fore leg ratio, range 0.66–0.73; mean 0.70 (12); antennal ratio, range 1.36–2.00; mean 1.66 (13); venarum ratio, range 0.77–0.93; mean 0.83 (17); arculus to m–cu:m–cu to wing tip, range 0.36–0.46; mean 0.39 (12); middle leg ratio 0.71, 0.75 (2).

This species is distinguished from the remainder of the North American species of this group in the key below.

I take pleasure in naming this species for my wife Mary Smith Sublette, an able zoologist whose patience, understanding, and assistance made this work possible.

680–447—63——2

Key to Species of *Pentaneura* (*Pentaneura*) Group E of Edwards

Based on key given by Johannsen (1946)

1. Small species; body length 1 mm.; wing length 1 mm.; body brownish with pale halteres and legs . . . . **P. fimbriata** (Walker)
   Larger species; wing length 1.40 mm. or greater 2
2. Thorax light brown with greenish pruinescence; abdomen yellow with brown fasciae; basistyle yellow; halteres yellow with black knob; tibiae yellow with narrow dark apices. Length 2.5 to 3 mm. . . . **P. brooksi** (Gerry)
   Thorax without greenish pruinescence, or otherwise differing 3
3. Basitarsus of middle legs longer (1.1) than corresponding tibia; thorax yellow, vittae brown; abdomen yellow with brown basal fasciae. **P. pilosella** (Loew)
   Mesothoracic leg ratio less than 1.0 4
4. Antennal ratio about 0.5; fore leg ratio about 0.75; yellow species with buff-colored thoracic vittae. . . . . . . **P. flaveola** (Williston) Johannsen
   Antennal ratio 1.0 or greater. 5
5. Cross veins darkened; arculus to m–cu:m–cu to wing tip about 0.5; R_{4+5} terminates noticeably distal to Cu_1; thorax pale with buff yellow vittae; abdomen yellow with brownish fasciae . . . . **P. planensis** Johannsen
   Cross veins not darker than adjacent veins; arculus to m–cu:m–cu to wing tip 0.45 or less 6
6. Cross vein m–cu lies proximad of base of Rs by distance less than length of m–cu; thorax reddish-yellow with dark brown vittae; abdomen fasciate; antennal ratio 1.33; middle leg ratio 0.88; arculus to m–cu:m–cu to wing tip 0.43; wing length 1.7 mm. . . . . . **P. indecisa** (Williston)
   Distance between m–cu and Rs greater than length of m–cu 7
7. Fore tarsi with long beard (hairs 5 to 8 times diameter of tarsus); thoracic markings dark brown; fore leg ratio 0.78–0.86; middle leg ratio 0.55–0.60; antennal ratio 1.52 . . . . **P. comosa,** new species
   Fore tarsi with short beard (about 4 times) or bare 8
8. Basistyle of male genitalia subovate (fig. 2*e*) . . **P. inyoensis,** new specie
   Basistyle of male genitalia subcylindrical, elongate 9
9. Ninth tergite with conspicuous row of posteriorly directed bristles . . . 10
   Ninth tergite with only fine hairs 11
10. Fore tarsi with short beard 4.4 times tarsal diameter; thorax marked with brown; each abdominal segment blotched with black speckled brown; irregular white patch on each side . . . . . **P. thryptica,** new species
    Fore tarsi with hairs only slightly longer than tarsal diameter; thorax marked with reddish-brown; basal one-third to one-half of each abdominal segment with blotchy black fascia, remainder of segment pale. **P. lyra,** new species
11. Thoracic markings reddish-brown; dorsolateral bristles mostly in 2 rows; some multiserial just anterior to scutellum; middle leg ratio 0.71–0.75; hind leg ratio 0.66; basistyle of male genitalia with prominent basal diagonal fold . . . . **P. smithae,** new species
    Thoracic markings pale brown; dorsolateral bristles in single staggered row; middle leg ratio 0.80; hind leg ratio 0.75; basitarsus without prominent fold, only slightly wrinkled . . . . . . **P. sequoiaensis,** new species

The groups of *Pentaneura* used by Edwards (1929) and followed by Johannsen (1946) appear to be at least subgenerically distinct. Freeman (1955) has split off Group A as *Pentaneura* subgenus

Ablabesmyia Johannsen, 1905, while retaining Edwards' Groups B to F as *Pentaneura* sensu stricto. Fittkau (1957) has named two new genera, *Thienemannimyia* and *Conchapelopia*, which include parts of Groups C and D of Edwards. There are other species groups within Edwards' Groups C and D that were not named. Group F appears to be the equivalent of *Nilotanypus* Kieffer, 1923. Group E contains the type-species, *Pentaneura grisea* Phillipi, sensu Edwards, and is thus *Pentaneura* in the strict sense. The remaining Group B is unnamed. Since the status of several types of North American *Pentaneura* are described inadequately as yet, I am refraining at this time from establishing or using subgeneric units for Edwards' Groups B to F.

Anatopynia (Anatopynia) submarginella, new species

FIGURE 3*a*

Holotype male: USNM 65512, Modoc Co., Fandango Pass, May 15, 1948, W.

Postocular bristles in double and triple rows reaching from below eyes up to point medial to dorsal extension of eyes. Clypeus wider than long, with about 16 bristles. Palpi ratio 15:25:20:30. Antennal ratio 1.64.

Head, thorax, and abdomen dark brown overlaid with greenish-white pollen; pronotum, pleural areas, and posterolateral area on each abdominal segment lighter brown; pollen on abdomen concentrated on posterior half of each segment, giving, in certain light, vittate appearance; incisures of abdomen somewhat lighter; pollen absent between vittae on thorax. Prothorax with 13 fine lateral bristles, covered all over with fine microtrichae. Sternopleuron with 3 fine lateral bristles above and 2 below anepisternal suture. Halteres yellowish, stalk basally infuscate. Prealar bristles 26; dorsolateral bristles multiserial; scutellum with 26 large staggered bristles in posterior transverse row; anteriorly about 14 fine strewn bristles; anterolateral bristles about 18.

Fore legs with few long hairs 3 times diameter of tarsus; legs paler brown than body. Fore tibia with almost straight spur with 9 side teeth; spur 0.8 as long as apical tibial diameter. Middle tibial spurs straight with 10 side teeth; spurs of equal length. Spurs of hind leg straight with 8 teeth on longer, 10 on shorter. Spur ratio 55:45. Comb of 9 bristles.

Leg proportions:

	F	*Ti*	Ta_1	Ta_2	Ta_3	Ta_4	Ta_5	*Leg Ratio*
Fore	75	85	53	28	20	11	6	0.62
Middle	77	84	41	22	17	10	7	0.49
Hind	70	100	63	33	24	15	10	0.63

Wings well haired only on distal half; anterior wing veins including m–cu cross vein brown; posterior veins pale; membrane not darkened. Wing length 3.37 mm.; venarum ratio 0.88.

The rather short, straight, parallel-sided dististyle of the genitalia is distinctive, separating this species from *A. marginella* (Malloch), in which the dististyle is longer and evenly tapered to the tip (Malloch, 1915, pl. 27, fig. 10).

Allotype: In USNM: Alturas, Modoc Co., July 14, 1948, W.

Colored as male except abdomen more solidly blackish-brown; antennal pedicel and first segment pale brown. Prealar bristles 28; anterolateral bristles about 30; dorsolateral bristles multiserial; dorsomedial bristles in two rows, dividing anterior to prescutellar area, extending laterally to join dorsolateral bristles.

Anterior wing veins dark brown; posterior paler; heavy hairs over entire wing; with oblique lighting macrotrichia produces irregular dark fascia on posterior basal half of wing and second fascia extending along distal part of M, Cu_1, and Cu_2; scutellum somewhat translucent and slightly paler brown.

Comb of hind tibia with 7 bristles; spurs subequal.

Paratypes: In CBPH: 1 female, 5.3 miles south of Manteca, San Joaquin Co., May 6, 1957. In UCLA: 1 male, Bradley, Aug. 28, 1949, B.

Male: Wing length 2.66 mm.; fore leg ratio 0.66; antennal ratio 1.78; venarum ratio 0.92; middle leg ratio 0.54; fore tarsal beard 4 times tarsal diameter.

Female: Wing length, 3.18 mm.; fore leg ratio 0.59; venarum ratio 0.82; middle leg ratio 0.49, hind leg ratio 0.58.

This species is differentiated from North American species in the key (p. 109).

Anatopynia (*Macropelopia*) *aclines*, new species

FIGURE 3*b*

Holotype male: USNM 65513, Alturas, Modoc Co., July 14, 1948, W.

Dorsal surface of head yellowish-brown; mouthparts black. Antennal pedicel and flagellum black; postocular bristles in double row below eye, becoming single row for short distance behind eye, then 3 rows at base of dorsal extension of eye; rows extend almost to midline of vertex. About 30 clypeal bristles. Palpi ratio 15:32:38:57. Antennal ratio 2.25.

Thorax and basal four-fifths of abdominal segments marked with blackish-brown. Ground color of thorax and apices of abdominal segments yellowish-white, somewhat infuscate on thorax except for spot of clear yellow on humeri and pleura. Pronotum completely

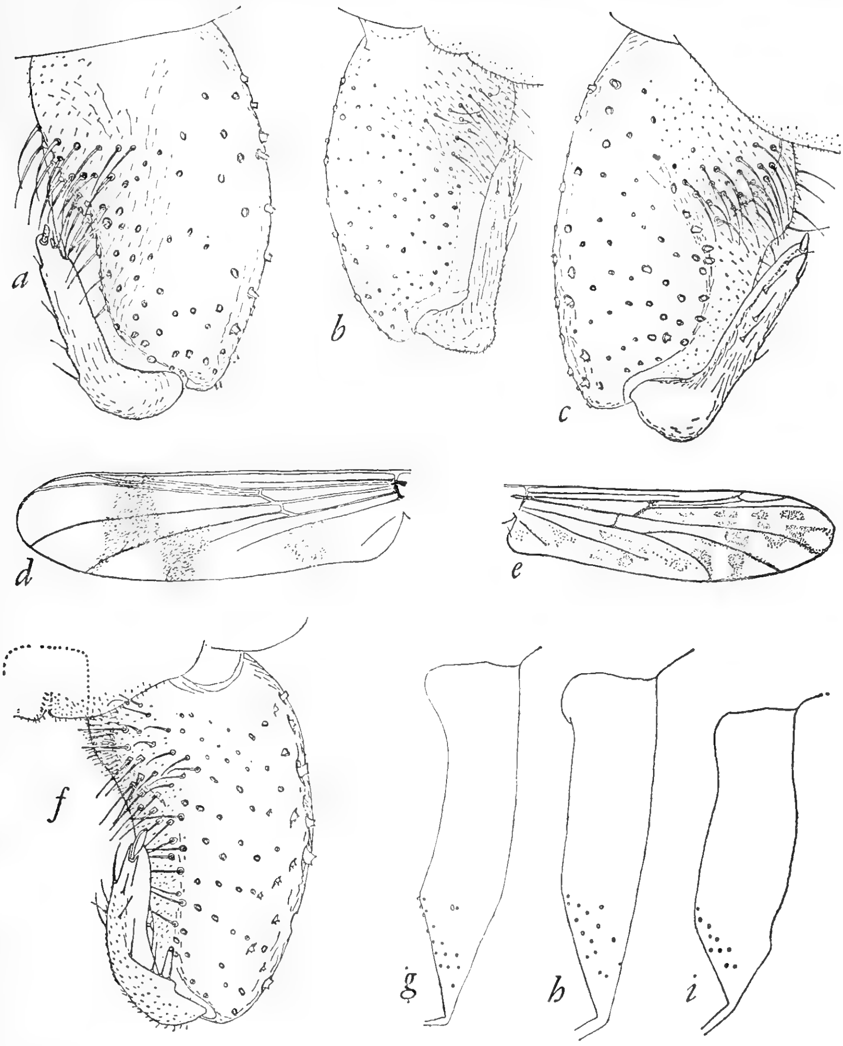

FIGURE 3.—*Anatopynia* (*A.*) *submarginella: a*, male genitalia. *Anatopynia* (*Macropelopia*) *actines: b*, male genitalia. *Anatopynia* (*Psectrotanypus*) *eumorpha: c*, male genitalia: *d*, wing. *Tanypus carinatus: e*, wing; *f*, male genitalia; lateral view of pronotum: *g*, holotype, male; *h*, paratype from Michigan; *i*, paratype from Louisiana.

interrupted in middle, with 38 fine lateral bristles. Sternopleuron with 7 bristles above and 9 below anepisternal suture. Halteres yellowish-white. Prealar bristles 39; dorsomedial bristles in 2 rows becoming multiserial at anterior edge of prescutellar area where rows extend laterally to join dorsolateral bristle rows. Dorsolateral bristles in 3 staggered rows, becoming multiserial on prescutellar area. Scutellum with posterior row of about 38 bristles, 14 staggered on each side of apex, becoming somewhat scattered medially with about 10 bristles; anteriorly on scutellum about 20 strewn bristles. Anterolateral bristles about 27.

Beard of fore legs 6 times diameter of tarsus; legs stramineous; narrow apical brown band on femora, extreme base and apex of tibiae and apex of Ta_1 and $_2$; Ta_3 to $_5$ largely dark. Fore tibia with triangular spur that bears 16 side barbs; ratio of spur length to apical tibial diameter 43:40. Middle tibia with 2 spurs more linear than that of fore tibia; longer spur with 17 side barbs; shorter spur more triangular, but less so than fore leg. Ratio of length of middle spurs 34:45. Hind tibia with 15 side teeth on longer spur; 3 bristles in comb. Ratio of length of hind spurs 32:45.

Leg proportions:

	F	*Ti*	*Ta_1*	*Ta_2*	*Ta_3*	*Ta_4*	*Ta_5*	*Leg Ratio*
Fore	42	56	30	20	15	9	5	0.53
Middle	45	55	25	14	9	6	4	0.45
Hind	42	64	38	22	17	10	6	0.50

Cross veins of wings brown with surrounding membrane narrowly darkened; R_{2+3} directly above Cu_1; Cu_2 sharply bent downward at wing margin; anal vein reaches to middle of Cu_2; anal lobe well developed. Wing length 4.51 mm.; venarum ratio 0.89.

Allotype: In USNM: Collected with holotype male.

Lighter colored than male with vittae yellowish-orange and abdominal fasciae pale brown. Wing length 4.59 mm.; fore leg ratio 0.46; venarum ratio 0.93; body length 3.89 mm.; ratio of last 3 tarsal segments of middle leg, 54:37:32.

Paratypes: In USNM: 3 females, Alturas, Modoc Co., July 14, 1948, W; 2 females, Stronghold, Modoc Co., July 17, 1948, W. In UCLA: 1 female, Los Angeles Co., March 22, 1933, W. Grisel.

Females: Wing length, range 3.33–4.81; mean 4.42 mm. (5); fore leg ratio, range 0.46–0.71; mean 0.56 (5); venarum ratio, range 0.90–1.54; mean 1.03 (5); body length, range 3.33–4.20; mean 3.63 (4).

This species most closely resembles *A. hirtipennis* (Loew), fide Malloch (1915), which is distinguished, however, by its short-haired fore legs and the curved dististyle of the male genitalia.

Anatopynia (Psectrotanypus) dyari (Coquillett)

Tanypus dyari Coquillett, Ent. News, vol. 13, p. 85, 1902.

Males: Wing length, range 3.78–4.37; mean 4.14 mm. (5); fore leg ratio 0.63–0.67; mean 0.65 (5); antennal ratio, range 1.96–2.30; mean 2.13 (5); venarum ratio, range 0.90–0.97; mean 0.92 (5); prealar bristles about 36 (1).

Females: Wing length, range 3.70–3.85; mean 3.79 mm. (3); fore leg ratio 0.56, 0.56 (2); venarum ratio 0.90, 0.98 (2).

Material studied: In USNM: 2 males, 1 female, Jewel Lake, Contra Costa Co., May 11, 1948, W; 1 male, Prairie Creek, Humboldt Co., Aug. 10, 1948, W; 1 male, Berkeley, Jewel Lake, March 4, 1948, I. LaRivers; 2 males, Oceano Beach, San Luis Obispo Co., Aug. 19, 20, 1948, W; 1 female, Mad River Beach, Humboldt Co., Aug. 14, 1948, W. In CBPH: 4 males, Arcata, Humboldt Co., May 9, 1960, R. P. Maynard; 3 males, 2 females, Willits, Medocino Co., Feb. 20, 1958, R. P. Maynard; 1 male, 3 miles south of Woodside, San Mateo Co., Oct. 15, 1959, G. In UCLA: 1 female, Arcata, Humboldt Co., Sept. 9, 1950, B.

Anatopynia (Psectrotanypus) eumorpha, new species

FIGURES 3*c,d*

Holotype male: USNM 65514, Berkeley, Strawberry Canyon, June 3, 1948, light trap, W.

Palpi blackish-brown; antennal ratio 1.66.

Head and thorax yellowish-white; vittae, postnotum, and sternopleuron pale brown. Halteres white. Prealar bristles brown; dorsomedial bristles long and pale, in 2 erect rows; dorsolateral bristles pale and erect.

Fore tarsus beard length 6 times tarsal diameter (tarsi lost before measurements could be made). Legs stramineous; fore and middle femora darkened apically, tibiae basally; last two tarsal segments somewhat darker; hind leg almost completely pale.

Leg proportions:

	F	*Ti*	*Ta*$_1$	*Ta*$_2$	*Ta*$_3$	*Ta*$_4$	*Ta*$_5$	*Leg Ratio*
Fore	75	95						
Middle	85	93	56	26	20	13	7	0.60
Hind	80	102	77	40	29	17	18	0.75

Wings with large quadrate dark spot centered under m–cu, extending from anal vein to posterior wing margin; distinctly separate second irregular fascia extends completely across wing from R_1 to Cu_2; posterior extension in cell Cu_1 and anterior extension lies along Cu_1. Wing length 3.33 mm.; venarum ratio 0.91.

Abdomen white with pale yellowish-brown longitudinal, middorsal streak broadens posteriorly; segment VI and remainder of abdomen largely pale yellowish-brown.

Allotype: In USNM: Collected with holotype male.

Brown color on thorax somewhat darker than male, abdomen yellowish-brown. The anterior margin of the basal wing spot almost touches the basal extension of the distal wing fascia.

Wing length 3.63 mm.; fore leg ratio 0.69; venarum ratio 0.86.

Paratypes: In USNM: 1 male, 1 female, Berkeley, Strawberry Canyon, June 5, 13, 1948, W; 1 female, Point Reyes, Sonoma Co., March

16, 1948; 1 female, Strawberry Canyon, Alameda Co., May 24, 1948, W.

Males: Wing length 3.11 mm.; venarum ratio 0.90. Abdomen entirely white; beard length 6 times tarsal diameter.

Females: Wing length, range 3.55–3.70; mean 3.63 mm. (3); fore leg ratio, range 0.67–0.74; mean 0.70 (3); venarum ratio, range 0.84–0.91; mean 0.88 (3).

This species is distinguished from related North American species in the key (p. 109).

Anatopynia (*Psectrotanypus*) *venusta* (Coquillett)

Tanypus venustus Coquillett, Proc. U.S. Nat. Mus., vol. 25, p. 91, 1902.

Males: Wing length, range 3.33–4.67; mean 3.84 mm. (16); fore leg ratio, range 0.56–0.65; mean 0.60 (14); antennal ratio, range 1.57–1.93; mean 1.70 (14); venarum ratio, range 0.86–0.97; mean 0.91 (16); hind leg ratio, range 0.63–0.66; mean 0.64 (3).

Females: Wing length, range 3.51–4.63; mean 4.10 mm. (17); fore leg ratio, range 0.57–0.63; mean 0.59 (16); venarum ratio, range 0.92–0.98; mean 0.95 (16); hind leg ratio 0.64, 0.67 (2).

Material studied: In USNM: 2 males, 1 female, Deer Creek, Hot Springs, Tulare Co., Aug. 6, 1947, W; 1 male, Wheeler's Springs, Ventura Co., June 16, 1948, light trap, W; 1 male, Visalia, June 30, 1947, W; 1 male, Kern River Canyon, Kern Co., July 26, 1947, B. Brookman; 1 male, Alum Rock Park, Santa Clara Co., July 8, 1948, W; 1 male, Hume Lake, Aug. 20, 1947, W; 1 male, San Luis Obispo, Aug. 21, 1948, W; 1 male, 1 female, San Luis Obispo, Aug. 19, 1948, W; 1 female, Elderwood, July 18, 1947, bridge, W; 1 female, Buellton, Santa Barbara Co., June 23, 1948, W; 1 female, Santa Cruz, Santa Cruz Co., July 8, 1948, W. In CBPH: 1 male, Parks Air Force Base, Alameda Co., Oct. 13, 1959; 2 males, 2 females, 2 miles from Orcutt, Santa Barbara Co., Aug. 2, 1948, W; 1 female, 2.5 miles north of Manteca, San Joaquin Co., June 19, 1957, G; 1 female, Wrights, Santa Clara Co., Aug. 25, 1955; 1 male, 1 female, 3 miles west of Gilroy, Santa Clara Co., March 25, 1956, G; 1 female, Ft. Barry, Marin Co., March 18, 1954, G. In UCLA: 1 male, 9 females, Westwood Hills, Los Angeles Co., Apr. 6, 1950; 1 male, 1 female, Westwood Hills, Los Angeles Co., May 18, 1955, A. Fukushima; 1 male, Santa Monica Canyon, Los Angeles Co., July 22, 1952; 1 female, Sand Canyon, Orange Co., March 30, 1949; 2 females, Murphy Canyon, San Diego Co., May 8, 1949, B and Heid. In KU: 1 male, Kernville, July 24, 1940, D. E. Hardy. In UCD: 3 males, 1 female, Monticello, 1 mile south, Napa Co., Oct. 8, 1947, R. M. Bohart; 1 male, 2 females, Green Valley, Solano Co., Aug. 29, 1946, R. M. Bohart and H. E. Cott; 1 female, Green Valley, Solano Co., Apr. 3, 1955, R. W. Bushing; 1 female, Green Valley, Solano Co., June 8, 1948, R. M. Bohart.

Key to North American Species of *Anatopynia* Johannsen

(*Anatopynia alaskensis* (Malloch) omitted because insufficiently described)

1. Pulvilli present; wings banded or with coalesced spots (subgenus *Psectrotanypus*) 10
   Pulvilli absent; wings hyaline or with central dark cloud over cross veins or with isolated spots or dusky clouds 2
2. Wings hairy at tip or occasionally well haired; no wing markings except for occasionally infuscate cross veins (subgenus *Anatopynia*) 3
   Wings always well haired; with spots or clouds (subgenus *Macropelopia*) . 6
3. Legs yellowish; with distinct dark preapical femoral band and sub-basal tibial band; tarsi infuscate; cross veins slightly darkened. **A. florens** (Johannsen)
   Legs yellowish or somewhat infuscate, no distinct dark bands 4
4. Thorax and abdomen marked with dark brown or black; fore leg ratio about 0.65; cross veins not darkened 5
   Thorax and abdomen marked with brown; leg ratio about 0.8; cross vein infuscate . . . . . **A. decolorata** (Malloch)
5. Thorax and abdomen marked with black; dististyle of male genitalia long and evenly tapered to tip (Malloch, 1915, pl. 27, fig. 10). **A. marginella** (Malloch)
   Thorax and abdomen marked with dark brown; dististyle of male genitalia shorter and parallel-sided almost to tip (fig. 3*a*). **A. submarginella,** new species
6. Thorax yellow, marked with somewhat polished, blackish-brown vittae; abdomen entirely yellow; wing with faint brown band across middle. **A. algens** (Coquillett)
   Thorax and abdomen fuscous, marked with paler brown 7
7. Small species (body length female, 3.0 mm.); legs pale fuscous with only extreme tips of tibiae darkened . . . . . **A. fastuosa** (Johannsen)
   Larger species (body length female, 3.5–4.0 mm.); legs darker, with both femora and tarsi darkened apically 8
8. Fourth tarsal segment of middle legs two-thirds as long as third; fifth segment only slightly smaller than fourth 9
   Fourth tarsal segment only one-half as long as third; fifth tarsal segment very small. Fore tarsus not distinctly bearded . **A. miripes** (Coquillett)
9. Fore tarsus not bearded; dististyle of male genitalia slightly curved (Malloch, 1915, pl. 28, fig. 2) . . . . . **A. hirtipennis** (Loew) Malloch
   Fore tarsus with long hairs, 6 times tarsal diameter; dististyle straight, almost parallel-sided (fig. 3*b*) . . . . . **A. aclines,** new species
10. Mesonotal ground color dark brown to opaque black 11
    Ground color yellowish-white to brown 12
11. Femora with only subapical brown band; fore tarsus bearded. **A. guttularis** (Coquillett)
    Femora with two brown bands; fore tarsus with only short hairs, 3 times diameter of tarsus . . . . . **A. venusta** (Coquillett)
12. Wing with only dark spot over cross vein . . . . . **A. brunnea** Roback
    Wing with bands or spots or both 13

13. Legs yellow except for slightly darkened tips of femora and tibiae; wing with two cross bands and brown apex containing several hyaline spots. **A. discolor** (Coquillett)
    Legs with subapical femoral band and sub-basal tibial band 14
14. Wing with irregular cross band near middle extending completely across wing. 15
    Wing with central band only behind anal vein; second band near apical one-third extending across wing; tarsal beard 6 times tarsal diameter. **A. eumorpha,** new species
15. Apical one-third of wing brown, marked with several hyaline spots; fore tarsus sparsely bearded . . . . **A. dyari** (Coquillett)
    Apical one-third of wing brown, without hyaline spots; no beard. **A. johnsoni** (Coquillett)

Tanypus carinatus, new species

FIGURES 3*e–i*

Protenthes punctipennis (Meigen) Malloch (in part), Bull. Illinois State Lab. Nat. Hist., vol. 10, p. 383, 1915, dark variety, misidentification.

Holotype male: USNM 65515, 3 miles south of Woodside, San Mateo Co., Apr. 20, 1960, G.

Postocular bristles in single row reaching point medial to dorsal eye extensions. Palpi normal, ratio 8:15:20:33. About 20 clypeal bristles. Antennal ratio 2.31.

Head, thorax, and abdomen blackish-brown, scutellum and pleura somewhat lighter. Pronotum produced anteriorly, considerably wider at apex than at middle; with 17 fine lateral bristles. Mesonotum with tubercle low, inconspicuous and concolorus with remainder of mesothorax; tubercle beset with numerous, rather coarse hairs. Haltere knob apex infuscate yellow, most of knob blackish-brown. Supra-alar bristles 2, 1 long, 1 short; prealar bristles 9; dorsolateral bristles in single row to scutellum; anterolateral bristles 2; scutellar bristles about 20, 10 large ones in posterior transverse row, anteriorly about 10 fine ones in strewn pattern.

Tarsal hairs of fore legs 2 times diameter of tarsus. Femora largely dark with preapical pale annulus; tibia with broad basal and narrow apical black band, remainder of tibia infuscate; tarsal segments 1, 2, and 3 infuscate with black apices, segments 4 and 5 completely dark. Fore tibia with single spur with 2 side spines; spur shorter than diameter of tibial apex; ratio 45:55. Middle tibia with 2 spurs with ratio of 18:20; each with 2 side spines. Hind tibia with spurs 20:25; longer with 3 side spines; comb of 8 short heavy spines.

Leg proportions:

	F	*Ti*	Ta_1	Ta_2	Ta_3	Ta_4	Ta_5	*Leg Ratio*
Fore	57	73	61	30	21	15	10	0.83
Middle	62	70	58	29	20	13	9	0.83
Hind	61	86	75	40	30	18	11	0.87

Wing coloration very near *T. punctipennis* Meigen; anal margin with only two large spots, basal one extending across anal fold. Wing length 3.03 mm.; venarum ratio 1.13.

Allotype: In USNM: Collected with holotype male.

Wing length 3.00 mm.; fore leg ratio 0.78; venarum ratio 1.09. Wing spots larger and more distinct; those along anal margin coalesced with those above, along anal vein; costal cell somewhat darkened along entire length.

Paratypes from California: In USNM: 1 male, Tulare Co., Aug. 5, 1947, W; 4 males, 1 female, Visalia, Aug. 7, 1947, W; 1 male, 1 female, Shafter, Kern Co., June, 1946, B. Brookman. In UCLA: 1 female, Whitmore Tub, Mono Co., Aug. 3, 1952, McDonald. In CBPH: 1 male, 5.3 miles south of Manteca, San Joaquin Co., May 27, 1957, G.

Males: Wing length, range 2.29–2.96; mean 2.60 mm. (7); fore leg ratio, range 0.76–0.81; mean 0.80 (5); antennal ratio, range 2.05–2.43; mean 2.28 (5); venarum ratio, range 1.09–1.20; mean 1.11 (7); hind leg ratio, range 0.81–0.93; mean 0.85 (6).

Females: Wing length 2.32, 2.44 mm. (2); fore leg ratio 0.78, 0.82 (2); venarum ratio 1.08–1.19 (2); hind leg ratio 0.83, 0.84 (2).

Paratypes from Michigan: In INHS: 3 males, 4 females, Grand Junction, Little Bear Lake, Aug. 15, 1914; 1 female, INHS no. 18811.

Head and thorax reddish-brown. Mesothoracic tubercle not too prominent, slightly lighter at apex, not strongly contrasting. Scutellum infuscate yellow. Postnotum dark reddish-brown, sternopleuron concolorus. Haltere knob black, yellow at base of stalk.

Fore legs with beard 5 times tarsal diameter; legs as holotype. Fore leg ratio of males 0.86, 0.93; middle leg 0.90, 0.91; hind tarsi missing. Female: fore leg ratio 0.91; middle and hind tarsi missing.

Abdomen dark brown, pruinose; incisures faintly paler.

Ninth tergite with 16 bristles; carina of diststyle not quite as broad as in California specimens.

Paratype from Louisiana: In JES: 1 male, Natchitoches, U.S. Fish Hatchery, March 21, 1960, reared, JES.

Antennal ratio 2.44. Halteres dark; prealar bristles 10; scutellum with 12 bristles in posterior single row.

Tarsal beard 4 times diameter of fore tarsus; femora dark, each with preapical yellow annulus.

Leg proportions:

	F	*Ti*	*Ta_1*	*Ta_2*	*Ta_3*	*Ta_4*	*Ta_5*	*Leg Ratio*
Fore	46	60	50	29	19	12	8	0.83
Middle	52	58	55	28	19	11	7	0.95
Hind	50	67	64	41	28	18	11	0.95

Carina of diststyle of male genitalia as well developed as California specimens; only 7 bristles on ninth tergite.

Of all the Nearctic species of *Tanypus* this one most closely resembles *T. punctipennis* Meigen (Edwards).[3]

It differs most noticeably by having a smaller and darker tubercle on the mesonotum and by having a more strongly produced mesial carina on the dististyle of the male genitalia. It is distinguished from other Nearctic species in the key (p. 120).

Tanypus imperialis, new species

FIGURES 4*a–c*

Holotype male: USNM 65516, Laguna Lake, Imperial Co., June 9, 11, 1950.

Head with about 12 clypeal bristles; palpi 3-segmented, ratio (length times width) 20 x 16:23 x 12:25 x 10. Antennal ratio 2.04 (in paratype collected with holotype; antennae missing on holotype).

Head and thorax largely yellow; mouthparts, antennal pedicel, vittae, and postnotum shining cinnamon brown. Pronotum strongly produced; mesonotal tubercle yellow. Halteres white. Wing spots small and pale. Wing length 2.32 mm.; venarum ratio 1.03. Prealar bristles 3; dorsolateral bristles in single row; scutellar bristles 6 in posterior transverse row; anterolateral bristles absent. Fore tarsal beard 6 times tarsal diameter; legs yellow, fore femur, extreme tip of tibia, and tips of tarsal segments 1 to 4 with preapicle brown band; tarsal segment 5 largely brown; mid and hind femora with distinct preapical brown band, second indistinct brown band below that, two separated by clear yellow band; remainder of legs as fore leg. Fore tibia with simple spur, no side barbs; spur length:diameter of tibial apex 37:48. Middle tibial spurs slightly curved, with 2 side barbs long and filiform; spur length ratio 30:30. Hind tibial spurs as middle leg, ratio 32:40; no comb.

Leg proportions:

	F	*Ti*	Ta_1	Ta_2	Ta_3	Ta_4	Ta_5	*Leg Ratio*
Fore	45	53	51	23	21	15	10	0.96
Middle	46	52	49	22	17	11	8	0.94
Hind	48	62	66	35	27	18	10	1.06

Abdomen yellowish brown, with middorsal, longitudinal brownish streak near base of each segment. Ninth tergite with 15 bristles; medially directed bristles of basistyle almost uniform in size; dististyle with unique, incurved, lamella-like tip bearing small, subapical spur.

[3] The status of *Tanypus punctipennis* Meigen of American authors was somewhat uncertain due to the brevity of published descriptions. In lieu of type examination, I have examined a series of specimens kindly loaned to me by Dr. Paul Freeman from the collections of the British Museum (Natural History). The specimens were determined by F. W. Edwards, who had examined the Meigen types in Paris. *T. punctipennis* Meigen (Edwards) has proven to be different from the specimens described under this name in American literature. To clarify the status of this species I have given a more complete description of Edwards' material in an appendix to this paper.

Allotype: In USNM: Fish Springs, Salton Sea, Imperial Co., Oct. 18, 19, 1954, Whitney.

Wing pattern and coloration as holotype male. Differs by dorsolateral bristles forming group of 4 bristles just anterior to scutellum and by having 11 prealar and 12 anterolateral bristles. Pronotum produced as in holotype, bearing 5 fine, lateral bristles.

Wing length 2.29 mm.; fore and hind tarsi missing; venarum ratio 1.07.

Paratypes: In UCD: 1 female, 12 miles east of Heber, Imperial Co., May 12, 1956, T. R. Haig. In UCLA: 1 male, collected with holotype; 1 female, Lee's Ranch, Chatsworth, Los Angeles Co., July 25, 1950.

Male: Wing length 2.59 mm.; fore leg missing; antennal ratio 2.04; venarum ratio 1.05; hind leg missing.

Females: Wing length 2.59, 2.70 mm. (2); fore leg ratio 0.69 (1); venarum ratio 1.02, 1.02 (2); hind leg ratio 1.00, 0.80 (2). In female collected 12 miles east of Heber, Imperial Co., dorsolateral bristles in three rows just anterior to scutellum with about 7 bristles in clump; pronotum produced with 5 lateral bristles; prealar bristles 10; anterolateral bristles 10.

In the female from Lee's Ranch, Los Angeles Co., the high leg ratio and the produced pronotum seem to place it in this species; however, the prealar bristles are 9, the anterolateral bristles 4, and the dorsolateral bristles become staggered in 2 rows turning medially just before the scutellum.

This species is quite similar to *T. neopunctipennis* new species but differs in being smaller and by having a strongly produced pronotum and having a distinctly different male genitalia. It is separated from the other Nearctic species in the key (p. 120).

Tanypus parastellatus, new species

FIGURES 4*d,e*

Holotype male: USNM 65517, Laguna Lake, Imperial Co., June 9, 11, 1950.

Head dark; antennal ratio 2.00.

Pronotum parallel-sided; dark brown, infuscate yellow apically. Mesonotum blackish-brown, overlaid with strong greyish-green pruinescence; tubercle very small and dark. Scutellum dark yellowish-brown. Postnotum shining blackish-brown. Halteres yellow. Prealar bristles 10; dorsolateral bristles in single row; anterolateral bristles about 6.

Legs yellowish; black ring above and below knee and at apex of tibiae and at apex of tarsal joints 1 to 3; 4 and 5 largely dark; base of femora somewhat infuscate, with clear yellow fascia between basal infuscation and apical dark band.

Leg proportions:

	F	*Ti*	Ta_1	Ta_2	Ta_3	Ta_4	Ta_5	*Leg Ratio*
Fore	40	53	32	18	13	9	6	0.60
Middle	45	45	33	18	11	8	6	0.73
Hind	40	57	45	23	17	10	7	0.79

Wing spots smaller and more distinct than in *T. stellatus* Coquillett (cf. Malloch, 1915, pl. 27, fig. 5); spot over r-m extending only narrowly onto surrounding membrane. Wing length 2.00 mm.; venarum ratio 1.14.

Abdomen dark brown, apical one-fourth of each segment yellow.

Genitalia with dististyle slightly curved, broadened near middle; proximomesial border of basistyle not strongly projecting as in *T. stellatus* Coquillett.

Allotype: In USNM: Lee's Ranch, Chatsworth, Los Angeles Co., July 25, 1960.

Wing length 2.11 mm.; fore tarsi missing; hind leg ratio 0.74; venarum ratio 1.20. Wing spots darker and larger with spot over r-m approaching size of that found in *T. stellatus.*

Paratype: In UCLA: 1 female collected with the allotype. Wing length 2.22 mm.; fore and hind tarsi missing; venarum ratio 1.14.

The species most closely resembles *T. stellatus* Coquillett, from which it can be distinguished by the dististyle of the male genitalia, which is slightly bent and broadened before the apex, and by the wing spots, which are smaller and do not coalesce. The spot over r–m is distinctly smaller in this species.

Tanypus stellatus Coquillett

Figure 4*f*

Tanypus stellatus Coquillett, Proc. U.S. Nat. Mus., vol. 25, p. 89, 1902 (1903).

I have not examined the type specimen. My interpretation of the species is that of Malloch and is based on material in the Illinois Natural History Survey Collection. A specimen from Cedar Lake, Indiana, July 17, 1914, was used in the following description, which supplements Malloch's earlier one.

Postocular bristles about 12 to 14 on vertex, 6 to 7 on each side of midline in single row. Eyes long, parallel-sided, dorsally extended. Antennal ratio 2.29. Palpi ratio 25:38:50:75. About 20 clypeal bristles.

Pronotum with 21–32 fine lateral bristles. Mesonotum with only faint indication of tubercle characteristic of genus; tubercle dark, concolorus with mesonotum.

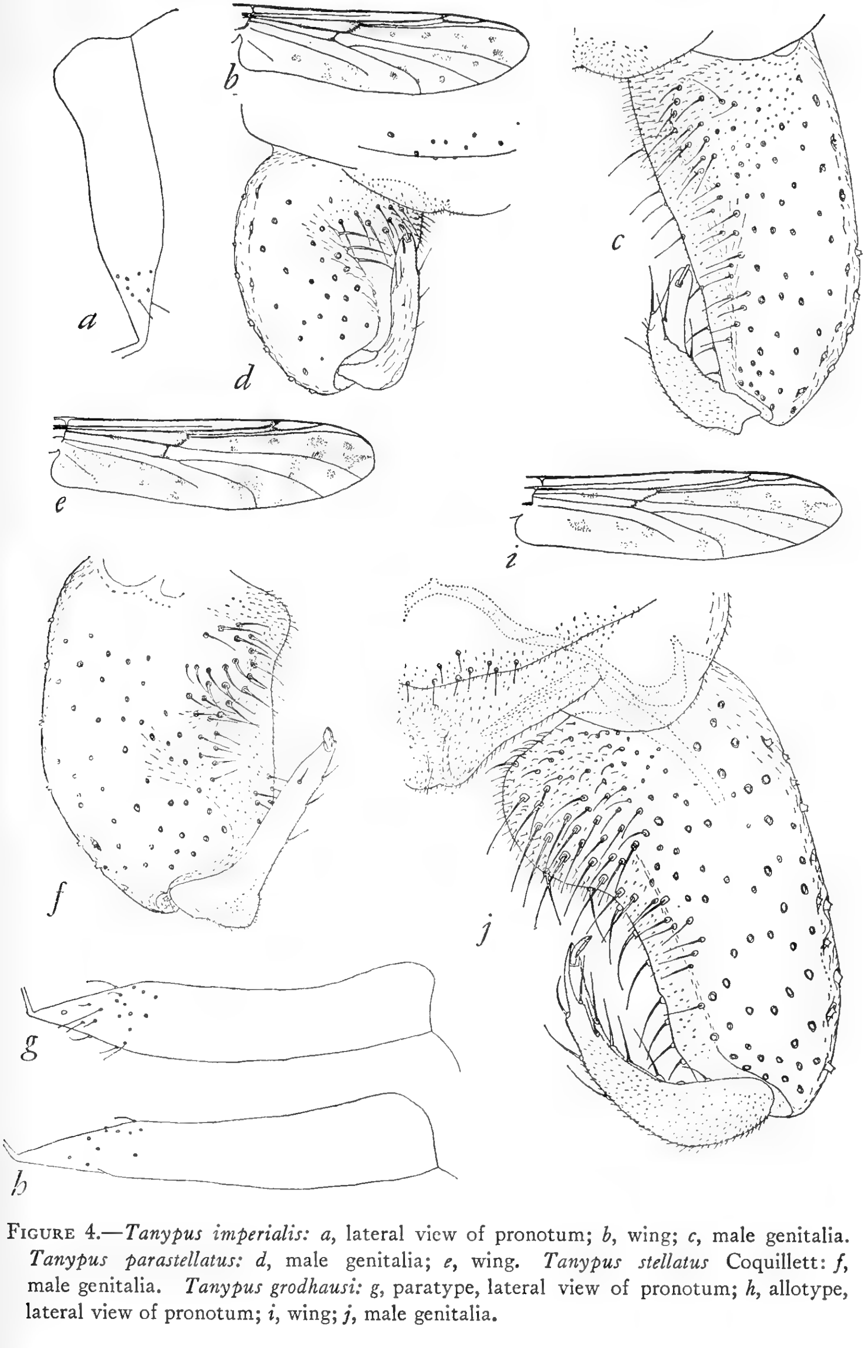

FIGURE 4.—*Tanypus imperialis:* *a*, lateral view of pronotum; *b*, wing; *c*, male genitalia. *Tanypus parastellatus:* *d*, male genitalia; *e*, wing. *Tanypus stellatus* Coquillett: *f*, male genitalia. *Tanypus grodhausi:* *g*, paratype, lateral view of pronotum; *h*, allotype, lateral view of pronotum; *i*, wing; *j*, male genitalia.

One supra-alar bristle; prealar bristles 10; dorsolateral bristles in single row; scutellum with 8 large, posterior bristles in transverse row; anteriorly about 40 fine, strewn bristles; anterolateral bristles 6 to 7.

Leg proportions:

	F	*Ti*	*Ta₁*	*Ta₂*	*Ta₃*	*Ta₄*	*Ta₅*	*Leg Ratio*
Fore	50	63	51	27	20	12	10	0.81
Middle	55	57						
Hind	50	70						

Front tibial spur straight with 2 side barbs; ratio of spur length to tibial diameter at apex 42:50. Fore femur dark with subapical light band.

Middle tibial spurs only slightly sinuate; outer spur slightly shorter than inner with 4 filiform teeth; inner teeth obscured.

Hind tibial spurs with ratio 16:30, both almost straight; each with 3 filiform teeth; teeth on inner longer spur occupy middle one-third of spur; comb of 11 bristles.

Costal extension beyond R_{4+5} 0.144 mm. Spot on r-m large, extending into cells on either side; wing spots large and dark tending to coalesce (cf. Malloch, 1915, pl. 27, fig. 5). Wing length 2.63 mm.; venarum ratio 1.10.

Genitalia with straight dististyle; fairly conspicuous median projection at base of basistyle.

Material examined from California: In USNM: 1 female, Huntington Beach, Apr. 6, 1949. In UCR: 1 male, San Jacinto, Riverside Co., Aug. 1, 1958, S.

Male: Wing length 1.96 mm.; venarum ratio 1.06: fore tarsi missing.

Female: Wing length 2.00 mm.; venarum ratio 1.13.

Material examined from Indiana: 3 males, Cedar Lake, July 17, 1914.

Males: Wing length, range 2.59–2.70; mean 2.64 mm. (3); fore leg ratio 0.78, 0.81 (2); antennal ratio 2.29, 2.64 (2); venarum ratio, range 1.06–1.13; mean 1.09 (3).

Tanypus stellatus is one of the most distinctive members of the genus. It is easily recognized by its dark color; large dark wing spots with the one over r-m extending broadly onto the adjacent membrane; and by the straight, tapered dististyle of the male genitalia.

Tanypus grodhausi, new species

FIGURES 4*g–j*

Holotype male: USNM 65518, Parks Air Force Base, Alameda Co., May 28, 1959, G.

Antennal flagellum with terminal segment darker and clearly separated by articulation; antennal ratio 2.31. Postocular bristles very sparse, in single row of 5 bristles behind eye. About 8 clypeal bristles. Palpi 3-segmented, ratio (length times width) 14 x 9:16 x 6: 15 x 5.

Head behind eyes, small pleural area, lateral margins of pronotum and scutellum yellowish, latter somewhat infuscate; mesonotum greyish-black, heavily overlaid with greyish pollen; postnotum shining black. Tubercle of mesonotum yellow, prominent, and strongly contrasting. Pronotum parallel-sided to apex (or very slightly produced in paratypes); 13 fine lateral bristles; covered completely by microtrichia. Haltere knob white, stalk black. Wing spotted with dark brown on hyaline membrane in distinctive pattern. Wing length 3.51 mm.; venarum ratio 1.01. Supra-alar bristles 2, 1 large, 1 small; prealar bristles 5; dorsolateral bristles in single row becoming multiserial just anterior to scutellum where about 10 to 12 bristles form clump; anterolateral bristles 4; scutellum with 12 large bristles in posterior transverse row.

Fore tarsal beard 7 times diameter of tarsus. Fore tarsal spur smooth, slightly curved spine, one minute side barb; spur length: tibia apex diameter 55:65; middle tibia with two slender spurs, each slightly curved, with two basal slender filiform side teeth; ratio of length of spurs 38:40. Hind tarsal spur same as middle leg; ratio of spurs 50:50; no apparent comb.

Leg proportions:

	F	*Ti*	*Ta*$_1$	*Ta*$_2$	*Ta*$_3$	*Ta*$_4$	*Ta*$_5$	*Leg Ratio*
Fore	60	78	56	28	25	18	13	0.72
Middle	74	80	56	27	23	15	11	0.70
Hind	68	97	73	39	32	20	14	0.75

Each segment of abdomen with apical narrow band of infuscate yellow; basal fascia greyish-black; about 160 bristles on segment II tergite.

Allotype: In USNM: Collected with holotype.

Except for sexual differences, like male. Wing spots somewhat larger and darker and pronotum slightly produced. Wing length 3.66 mm.; fore leg ratio 0.68; hind leg ratio 0.80; venarum ratio 1.05.

Paratypes: In USNM: 1 male, Saratoga Springs, Death Valley, May 30, 1953, W; 1 male, 1 female, Palo Verde, Imperial Co., Apr. 8, 1949, lake margin, W. In UCD: 1 female, Davis, Aug. 1, 1955, D. C. Green; 1 female, Davis, May 14, 1952, S. In UCLA: 54 males, 24 females, Saratoga Springs, Death Valley, March 19, 20, 1955; 33 males, 2 females, Saratoga Springs, Death Valley, May 27, 29, 1955, B et al.; 12 males, Saratoga Springs, Death Valley, Apr. 23, 24, 1955; 1 male, 2 females, Salt Springs, Death Valley, San Bernardino Co., March 24, 1957; 1 female, Lancaster, Los Angeles Co., May 13, 1953; 2 males, 2 females, Huntington Beach, Feb. 21, 1950; 1 male, Resting

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Springs, Inyo Co., May 29, 1955. In CBPH: 12 males, 16 females, Parks Air Force Base, Alameda Co., May 28, 1959; 2 males, Lake Elsinore, Riverside Co., May 13, 1949, E. Meyers. In KU: 3 males, Little Lake, D. E. Hardy, July 25, 1940.

Males: Wing length, range 2.18–3.33; mean 2.68 mm. (23); fore leg ratio, range 0.70–0.90; mean 0.80 (23); hind leg ratio, range 0.74–0.85; mean 0.79 (15); antennal ratio, range 1.83–2.25; mean 2.01 (16); venarum ratio, range 1.02–1.15; mean 1.06 (17).

Females: Wing length, 2.37–3.85; mean 3.11 mm. (21); fore leg ratio, range 0.65–0.73; mean 0.68 (19); hind leg ratio, range 0.73–0.85; mean 0.79 (17); venarum ratio, range 1.04–1.13; mean 1.07 (20).

This species can be distinguished from the other North American members of this genus by the clump of 8 to 12 bristles at the posterior end of the dorsolateral bristle row and by having only 3 spots just posterior to R_{4+5}.

Tanypus neopunctipennis, new species

Figures 5*a–d*

Protenthes punctipennis (Meigen) Malloch (in part), Bull. Illinois State Lab. Nat. Hist., vol. 10, p. 383, 1915, misidentification of *Tanypus punctipennis* Meigen.

Malloch gave what he considered to be a more complete description of *Tanypus punctipennis* Meigen. After examining a series of *T. punctipennis* determined by F. W. Edwards of the British Museum (see appendix), I have concluded that Malloch's identification was erroneous.

Holotype male: In INHS: East St. Louis, Ill., July 18, 1906.

Postocular bristles in single row behind eye, very fine, 16 vertex bristles. Eyes with parallel-sided dorsal extensions. Palpi 3-segmented, ratio 23:25:26. Antennal ratio 2.72.

Pronotum with 14 fine lateral bristles. Mesonotum with prominent tubercle light colored, strongly contrasting with surrounding vittae. Supra-alar bristles 2, 1 large and 1 fine; prealar bristles 7; dorsolateral bristles in single row; scutellar bristles 8 in large posterior single row; 16 anterior fine bristles strewn; anterolateral bristles 3 to 5.

Wings with dark spot over r–m very small, scarcely extending into cells on either side. Costal extension 0.96 mm. beyond R_{4+5}. Wing length 2.77 mm.; venarum ratio 1.00.

Femora somewhat infuscate, each with preapical yellow annulus. Length of fore tibial spur:apical tibia diameter 55:56; ratio of length of spurs of middle tibia 45:44; hind tibia 65:45. Spur of fore tibia with 2 slight barbs; middle, each with 3 longer filiform barbs; hind, each with 2 rather inconspicuous filiform teeth; comb of 8 spines.

Genitalia with curved dististyle; no median carina.

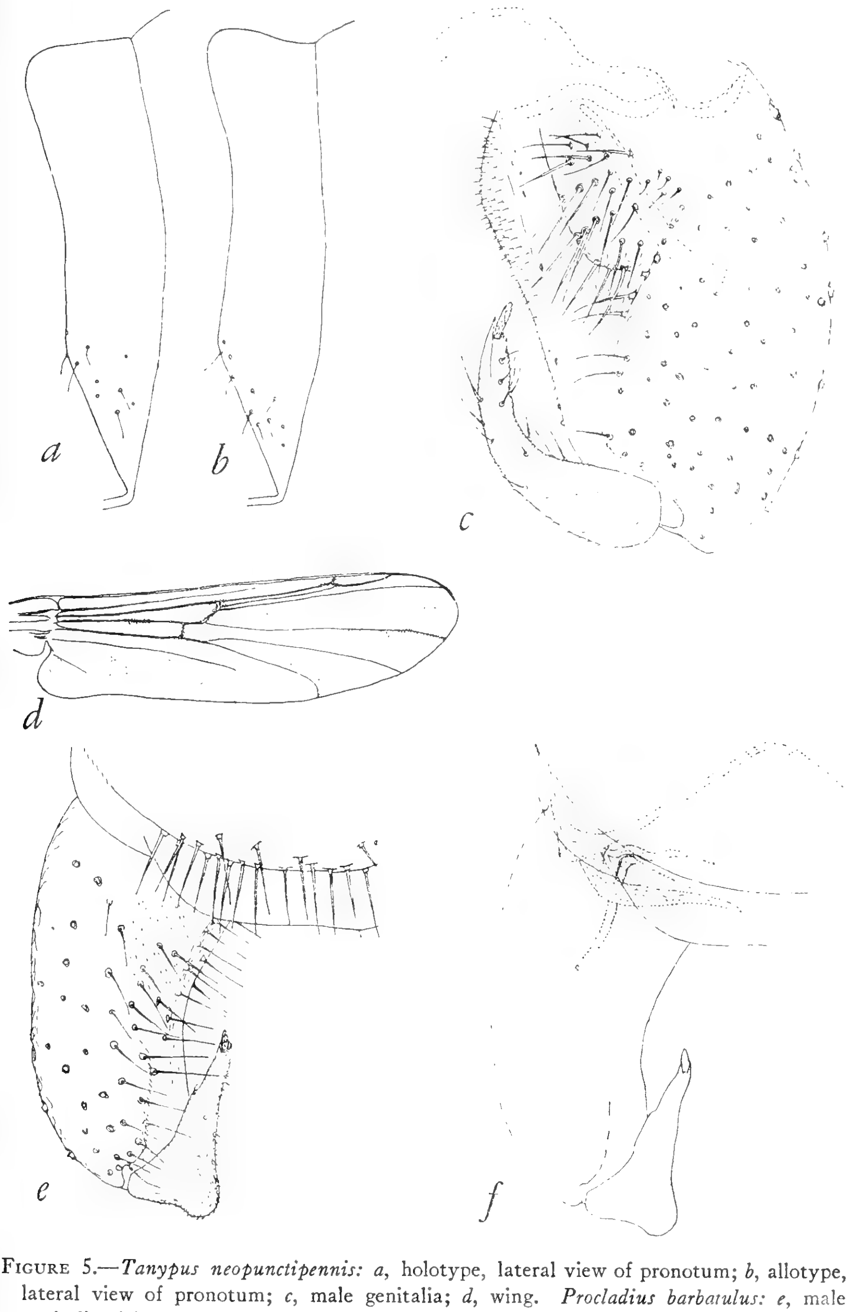

FIGURE 5.—*Tanypus neopunctipennis: a*, holotype, lateral view of pronotum; *b*, allotype, lateral view of pronotum; *c*, male genitalia; *d*, wing. *Procladius barbatulus: e*, male genitalia; *f*, internal "struts" of male genitalia.

Allotype: In INHS: Havana, Ill., Chautauqua Park, Apr. 29, 1914. Coloration similar to holotype; wing spots heavier, membrane more densely haired; stem of M between r–m and m–cu very short, only about one-half as long as in males; pronotum more strongly produced anteriorly; dorsolateral bristles single to just anterior to scutellum where row is doubled for about 4 bristles.

Wing length 3.28 mm.; fore leg ratio 0.80; venarum ratio 1.10; hind leg ratio 0.96.

Paratypes from Illinois: In INHS: 4 males, 3 females, Havana, Apr. 27, 29, 1914; 1 male, Quiver Lake, Havana, Sept. 19, 1895, Hart, Newberry, Hempel; 1 female, Momence, July 17, 1914; 1 male, 2 females, St. Joseph, June 9, 1915; 1 female, Urbana, Sept. 5, 1914; 1 male, Vergennes, Aug. 12, 1914.

Paratypes from Texas: In INHS: 1 female, Lake Lomalta, Sept. 27, 1910.

Paratypes from Louisiana: In USNM, UCLA, JES: 9 males, 2 females, Natchitoches, Chaplain's Lake, Feb. 4, 5, 1957, reared, JES; 1 male, Natchitoches, pool near Northwestern State College Dairy, Oct. 22, 1954, reared, JES; 2 males, Natchitoches, U.S. Fish Hatchery, March 21, 22, 1960, reared, JES.

Paratypes from Alabama: In Dendy, JES: 9 males, Auburn, June 6, 1956, J. S. Dendy; 1 male, Auburn, June 8, 1956, J. S. Dendy; 1 male, Auburn, June 23, 1955, J. S. Dendy.

Males: Wing length, range 2.44–3.07; mean 2.78 mm. (7); fore leg ratio, range 0.84–0.98; mean 0.91 (8); hind leg ratio, range 0.88–1.08; mean 0.97 (7); antennal ratio, range 2.01–2.43; mean 2.22 (7); venarum ratio, range 1.00–1.08; mean 1.04 (3).

Females: Wing length 2.96, 3.33 mm. (2); fore leg ratio 0.74, 0.88 (2); hind leg ratio 0.90 (1); venarum ratio 1.02, 1.08 (2).

This species most closely resembles *T. imperialis*, new species, from which it can be distinguished by the distinctively different genitalia and by having the superior pronotal margin only slightly produced apically. It is distinguished from the other North American species in the key which follows.

Key to North American Species of *Tanypus*

1. Tubercle of mesonotum very small and inconspicuous, concolorus with remainder of mesonotum or only slightly lighter in color; general body color dark; palpi 4-segmented 2

   Tubercle conspicuous, yellow or yellowish-white, strongly contrasting with remainder of brown to dark brown mesonotum; occasionally tubercle infuscate yellow; body with yellowish ground color; palpi 3-segmented . 4

2. Anterior and posterior margins of pronotum nearly parallel; diststyle of male genitalia straight or slightly curved 3
Anterior margin of pronotum strongly produced at apex; diststyle of male genitalia with distinctively produced mesial carina (in cleared genitalia mounts difficult to see) . . . . **T. carinata,** new species
3. Spot over r-m cross vein large extending broadly into cells on either side; wing spots dark and tend to coalesce (cf. Malloch, 1915, pl. 27, fig. 5); diststyle of male genitalia straight; tapering to tip . **T. stellatus** (Coquillett)
Spot over r–m smaller extending into adjacent cells only narrowly; wing spots smaller and more distinct, isolated; diststyle slightly bent, broadened before apex . . . . **T. parastellatus,** new species
4. Dorsolateral bristles in single row to scutellum; with 4 spots in cell behind R_{4+5} 5
Dorsolateral bristles in single row to just anterior to scutellum where row expands to form clump of 8–12 bristles . . . . **T. grodhausi,** new species
5. Pronotum only slightly produced towards apex; diststyle simple, no carina, evenly curved . . . . **T. neopunctipennis,** new species
Pronotum strongly produced at apex; diststyle with unique apical carina bearing subterminal spine . . . . **T. imperialis,** new species

Procladius barbatulus, new species

Figures 5*e,f*

Holotype male: USNM 65519, Hume Lake, Fresno Co., Sept. 24, 1957, G.

Postocular bristles in 2 staggered rows. Eyes with usual parallel-sided dorsal extensions. Clypeal bristles 9; palpi ratio 8:13:18:30. Antennal ratio 1.70.

Head, thorax, and abdomen dark brown, somewhat lighter at shoulders and on pleura. Halteres dark. Pronotum with 18 fine lateral bristles. One supra-alar bristle; prealar bristles 13; dorsomedial bristles 3 on either side of midline on prescutellar area; dorsolateral bristles in single row; anterolateral bristles 6; scutellar bristles about 28, somewhat scattered, posteriorly forming transverse row.

Wings darkened only over r–m and, faintly, over m–cu; membrane well haired with black hairs; anterior veins somewhat darker than posterior. Wing length 2.22 mm.; venarum ratio 1.50.

Legs uniformly dark brown. Fore tarsus with short beard, 4 times tarsal diameter. Fore leg with single tibial spur, slightly shorter than diameter of apex of tibia; middle leg spurs 40:30; hind leg spurs 53:32, comb of 11 spines.

Leg proportions:

	F	*Ti*	Ta_1	Ta_2	Ta_3	Ta_4	Ta_5	*Leg Ratio*
Fore	45	59	44	20	15	10	5	0.74
Middle	51	56	37					0.66
Hind	45	61	43	20	16	9	7	0.70

Abdomen almost uniformly darkened with only faint suggestion of lighter color apically on segments; with about 60 bristles on tergite II.

Female: Unknown.

This species keys to *P. choreus* (Meigen) in Johannsen (1952). There is much confusion as to the identity of *P. choreus* and *P. culiciformis* (Linnaeus). Edwards (1929) lists them as separate species although he points out there may be only a varietal difference between the two. Edwards says the male genitalia of the two species are identical.

Through the kindness of Dr. Paul Freeman of the British Museum (Natural History) I have examined examples of *P. culiciformis* and *P. choreus* determined by Edwards. While there is a slight color and size difference, the genitalia of the two appear to be identical. I must therefore conclude that *P. choreus* is only a variety of *P. culiciformis* and herewith list it as a new synonomy. *P. culiciformis* is redescribed from Edwards' material in the appendix to this paper.

P. barbatulus, new species, may be separated from the rest of the Nearctic species by the distinctive diststyle of the male genitalia. The genitalia resembles those figured by Freeman (1955) for *P. albitalus* Kieffer and *P. polytomus* (Kieffer). These species, however, have distinctively different wing patterns (cf. Freeman, 1955, pl. 1, figs. h and j). *P. sagittalis* (Kieffer) is described by Edwards (1929) as having a diststyle that resembles *P. barbatulus*, new species; however, *P. sagittalis* lacks a fore tarsal beard and can thus be distinguished.

Procladius freemani, new species

FIGURES 6*a–e*

Holotype male: USNM 65520, San Bruno, San Mateo Co., Aug. 23, 1957, R. P. Maynard.

Postocular bristles in 2 staggered rows; reaching medially to dorsal extension of eye. Clypeal bristles 23. Palpi ratio 15:20:39:40. Antennal ratio 2.22.

Head and thorax almost entirely black, heavily dusted with white pollen; heavily infuscate yellow on shoulders, pleura and apex and lateral margin of prothorax. Prothorax with 13-17 lateral bristles. Haltere knob white, stalk infuscate. Supra-alar bristles 2, 1 large, 1 small; prealar bristles about 19; dorsomedial bristle row divides just behind inconspicuous mesonotal tubercle and extends laterally as two rows, 1 on each side, almost to dorsolateral bristle row. Dorsolateral bristles in single row; immediately anterior to scutellum is a transverse row of 5 bristles on each side, lying at right angles to dorsolateral row. Scutellar bristles about 40; anterolateral bristles 6.

Wings with preapical shadow as well as one in posterior margin. Wing length 2.59 mm.

Legs infuscate yellow, apex of tibia and basitarsus black; tarsal segments 2 to 5 largely black; longest hairs of fore leg 3 times diameter of tarsus. Tibial spurs on middle leg subequal, ratio 21:23, slightly shorter than single spur on fore leg; 5 lateral teeth on each spur; hind leg spur ratio 21:25; comb of 12 bristles.

Leg proportions:

	F	*Ti*	Ta_1	Ta_2	Ta_3	Ta_4	Ta_5	*Leg Ratio*
Fore	57	67	50	23	17	11	8	0.75
Middle	62	65	42	19	15	9	8	0.65
Hind	58	73	50	25	18	10	8	0.68

Abdomen with about 60 to 65 bristles on each side of segment II; apical one-half to one-third of each segment yellowish-white; each with basal black fascia.

Genitalia with medially projecting "strut" without denticles; distally projecting "strut" almost straight, of moderate length. Dististyle apex almost straight; angle moderately produced.

I cannot distinguish the female with certainty from that of *P. denticulatus*, new species.

Paratypes: In USNM: 2 males, Shafter, Kern Co., June, 1946, B. Brookman; 1 male, Rockwell Pond, Selma, Aug. 4, 1947, W; 1 male, Stratford, July 8, 1947, W; 1 male, Huntington Beach, Feb. 21, 1950. In UCD: 1 male, Quincy, 4 miles west, Plumas Co., July 16, 1949, W. F. Ehrhardt. In UCLA: 3 males, Whitmore Tub, Mono Co., Aug. 3, 1952, McDonald; 1 male, Berkeley, May 1, 1948, W. In CBPH: 1 male, Lake Merced, San Francis Co., Feb. 10, 1959, G; 7 males, collected with the holotype; 1 male, Bridgeport, Mono Co., May 15, 1959; 2 males, Puddingstone Reservoir, Los Angeles Co., June 22, 1952, G; 6 males, Lake Isabella, Kern Co., June 23, 1959, G.

Males: Wing length, range 2.29–3.11; mean 2.58 (19); fore leg ratio, range 0.66–0.77; mean 0.72 (19); antennal ratio, range 1.57–2.59; mean 2.09 (13); venarum ratio, range 1.40–1.60; mean 1.49 (15); middle leg ratio 0.63 (1); hind leg ratio, range 0.64–0.70; mean 0.66 (7); tarsal beard length, range 2.50–4.40; mean 3.48 times diameter of tarsus (10). The shape of the angle of the dististyle shows some variation which I have interpreted as differences in mounting techniques.

This species can be distinguished from other members of the *culiciformis* group only by the features of the diagnostic male genitalia.

The species is named for Dr. Paul Freeman of the British Museum (Natural History), whose willing answers to vexing points of nomenclature and courteous assistance in obtaining named specimens have encouraged me in my study of the group.

Procladius denticulatus, new species

FIGURES 6*f–h*

Procladius culiciformis, of authors, not Linnaeus.

Holotype male: USNM 65521, Fortuna, Humboldt Co., May 12, 1960, light trap.

Head largely black but some infuscate yellow in front of and behind eyes. Antennal flagellum black. Postocular bristles in 2 staggered rows; reaching almost to midline. Eyes with parallel-sided dorsal extensions. Palpi black, ratio 15:22:36:50. Clypeus somewhat swollen, with about 20 bristles. Antennal ratio 1.74.

Pronotum with wide notch; yellow apically, black laterally; 15 fine lateral bristles. Mesonotum largely shining black; humeri and pleural areas infuscate yellow; greyish pollinose when viewed obliquely; thoracic bristles shining black. Scutellum, postnotum, and sternopleuron black. Halteres yellow, infuscate basally. One supra-alar bristle; prealar bristles 23; dorsomedial bristles staggered in two rows, dividing in front of prescutellar area and extending laterally to reach almost to dorsolateral bristles; dorsolateral bristles in single row, extending medially just in front of scutellum to midline; scutellum with about 48 strewn bristles; anterolateral bristles 6.

Wings with broad triangular black fascia with base extending from point proximal to the termination of R_1 to near the tip of R_{4+5}; apex at termination of Cu_2. Cross veins with dark spot; large dark spot in anal margin. Wing length 3.00 mm.; venarum ratio 1.44.

Legs largely blackish; base of fore femur and, to lesser extent, middle and hind legs infuscate yellow. Fore tibia with single long straight spur, bearing 5 side spines. Middle leg with spurs of almost equal length, each with 5 or 6 spines. Hind leg with outer spur slightly shorter than inner; ratio 48:60; comb of 13 spines.

Leg proportions:

	F	*Ti*	*Ta*$_1$	*Ta*$_2$	*Ta*$_3$	*Ta*$_4$	*Ta*$_5$	*Leg Ratio*
Fore	60	72	59	27	20	13	9	0.82
Middle	65	68	47	23	17	10	8	0.69
Hind	65	84	60	30	20	12	9	0.71

Abdomen black; apical one-third of each segment heavily infuscate yellow; basal dark portion pilose, about 65 bristles on each side of segment II.

I cannot distinguish the female of this species with certainty from that of *P. freemani*, new species.

Paratypes: In USNM: 3 males, Shafter, Kern Co., June 1946, B. Brookman; 1 male, Wheeler's Springs, Ventura Co., June 16, 1948, W; 2 males, Independence, Inyo Co., Aug. 22, 1952, B; 1 male, Hume Lake, July 20, 1947, W; 1 male, Clear Lake, Lake Co., Oct. 11, 1947, W. In UCLA: 2 males, Huntington Beach,

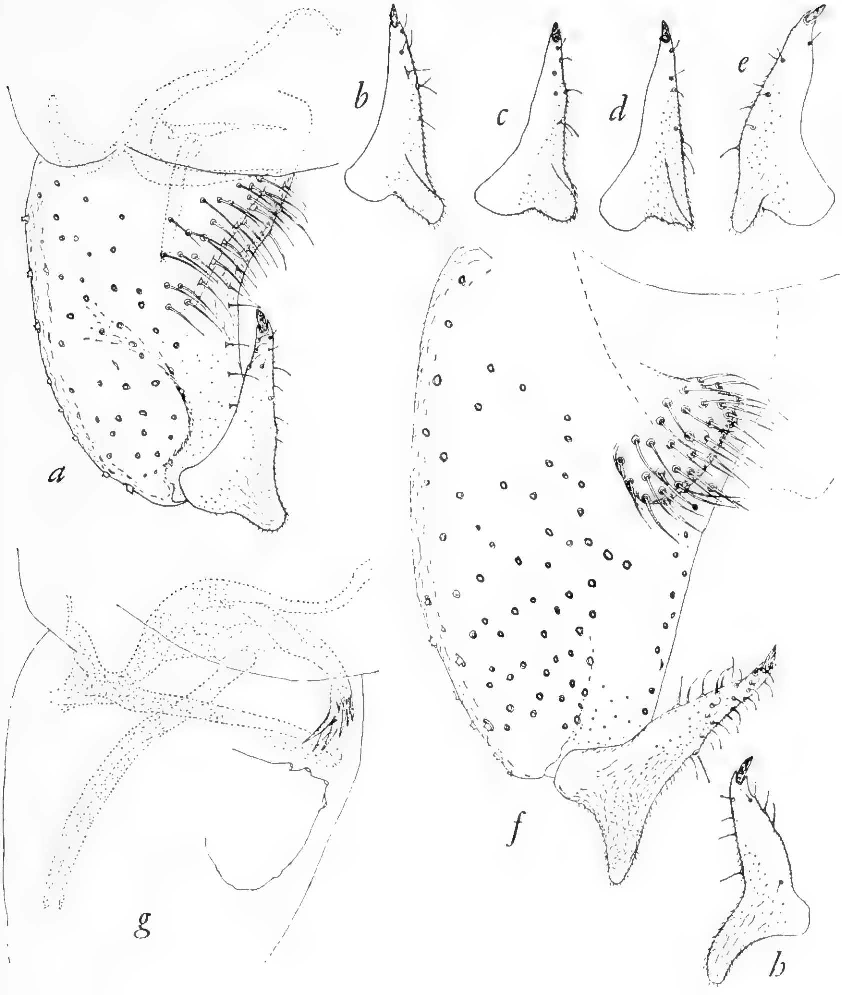

FIGURE 6.—*Procladius freemani: a*, male genitalia; *b–e*, variations in dististyle of male genitalia. *Procladius denticulatus: f*, male genitalia; *g*, internal "struts" of male genitalia; *h*, dististyle of paratype.

Feb. 21, 1950. In Bay: 7 males, Whittier, Feb. 16, 18, 1960. In CBPH: 1 male, 3 miles south of Woodside, San Mateo Co., Apr. 20, 1960, G; 1 male, 3.5 miles north of Sierra City, Sierra Co., July 11, 1957, G. In KU: 1 male, Mono Lake, July 31, 1940, E. E. Kenaga. In UCD: 1 male, Woodland, June 20, 1949, Jack Fowler; 1 male, Davis, Feb. 13, 1958, G. G. Moore; 1 male, Davis, May 20, 1959, F. E. Strong; 5 males, Davis, May 10, 11, 18, 1959.

Males: Wing length, range 2.04–3.00; mean 2.47 mm. (15); fore leg ratio, range 0.67–0.82; mean 0.74 (12); antennal ratio, range

1.74–2.30; mean 2.01 (10); venarum ratio 1.38–1.50; mean 1.45 (9); hind leg ratio, range 0.65–0.71; mean 0.68 (6). Prealar bristles 12, 15. Fore legs with short hairs only; maximum hair length 3 times diameter of tarsus.

The species keys to *P. culiciformis* (Linneaus) in Johannsen (1952). Although I have not examined Johannsen's material, it is most probably referable to *P. denticulatus*, new species, and not *P. culiciformis* (Linneaus). The male genitalia offers a diagnostic characteristic in the presence of the conspicuous denticles terminating the median internal "strut."

The following are the females of *P. freemani*, new species, and *P. denticulatus*, new species. I cannot separate them with any certainty.

In USNM: 4 females, Stratford, July 8, 1947, W; 1 female, Clear Lake, Oct. 4, 1947, W; 2 females, Hume Lake, July 20, 1947, W; 1 female, Topaz Lake, Mono Co., June 5, 1948, W; 1 female, Shafter, Kern Co., June, 1946, B. Brookman; 2 females, Huntington Beach, Feb. 21, 1950. In CBPH: 2 females, 3.8 miles northeast of Manteca, San Joaquin Co., Oct. 8, 1956. In UCD: 5 females, Davis, Nov. 21, 1950, S; 6 females, Davis, May 16, 1952, S; 2 females, Davis, June 3, 1955, A. T. McClay; 2 females, Davis, Apr. 1, 1941, G. E. Bohart; 1 female, Tambark Flat, July 18, 1950, Los Angeles Co., A. T. McClay.

Procladius bellus (Loew)

Tanypus bellus Loew, Berlin Ent. Zeitschr., vol. 10, p. 4, 1866.

Males: Wing length, range 1.37–2.22; mean 1.69 mm. (16); fore leg ratio, range 0.58–0.68; mean 0.62 (13); antennal ratio, range 1.51–1.95; mean 1.74 (11); venarum ratio, range 1.37–1.60; mean 1.43 (10); hind leg ratio 0.57 (1).

A male from Lee's Ranch, Chatsworth, Los Angeles Co., July 25, 1950, is very small and pale. Still another male from Mammoth Lakes, July 29, 1940, D. E. Hardy, has the head, thorax, and abdomen blackish but with no discernible morphological differences from the yellowish to brownish typical forms.

Females: Wing length, range 1.33–1.77; mean 1.56 (6); fore leg ratio, range 0.53–0.61; mean 0.57 (5); venarum ratio 1.32, 1.46 (2); hind leg ratio 0.52, 0.56 (2).

Material studied: In USNM: 7 males, Woodlake, July 28, 1947, W; 3 males, 1 female, Selma, July 10, 1947, W; 1 male, Clear Lake, Lake Co., Oct. 11, 1947, W; 1 male, Stratford, Apr. 8, 1947, W; 2 males, Palo Verde, Imperial Co., Apr. 8, 1949, W, lake margin. In KU: 1 male, Mammoth Lakes, July 29, 1940, D. E. Hardy. In UCLA: 1 male, 2 females, Lee's Ranch, Chatsworth, Los Angeles Co., July 25, 1950. In CBPH: 1 male, Lakeport, Lake Co., July 21, 1955, H. Brydon. In UCR: 1 male, 3 females, San Jacinto, Riverside Co., Sept. 26, 1958, S; 2 males, 2 females, San Jacinto, Riverside Co., July 7, 1958; 1 male, San Jacinto, Riverside Co., Aug. 1, 1958; 1 male, Lancaster, Aug. 18, 1958; 1 female, Lancaster, July 28, 1958, S.

Subfamily Podonominae

Boreochlus persimilis (Johannsen)

FIGURE 7*a*

Trichotanypus persimilis Johannsen, Canadian Ent., vol. 58, p. 99, 1926.
Boreochlus persimilis (Johannsen), Edwards, *in* Edwards and Thienemann, Zool. Anz., vol. 122, p. 153, 1938.

Antennal pedicel dark cinnamon brown; flagellum pale brown; tip slightly enlarged, bent to one side with cluster of short terminal hairs. Eyes reniform. Antennal ratio 0.31.

Thorax dark cinnamon brown, somewhat pollinose. Pronotum details obscured by pointing glue. Haltere stalk pale brown, knob dark brown. One long, pale prealar bristle; dorsomedial bristles long, pale, and appressed; dorsolateral bristles long, pale, suberect, divergent, in single staggered row; scutellar bristles apparently rubbed, at least 4.

Fore leg proportions, 55:60:32:18:15:9:6; fore leg ratio 0.53. Hind tibia with single slender spur beset with prickles on basal half; spur length less than apical diameter of tibia; comb of 6 spines.

Wings densely haired, cuneiform, no anal angle. Squama with 10 hairs; costa greatly elongate (0.088 mm.). Venation as illustrated by Johannsen (1952). Wing length 1.41 mm.; venarum ratio 1.13.

Abdomen pale brown, somewhat darker on dorsal median line (first segment only, others broken off in genitalia mount).

The genitalia differs from the figure given by Edwards only by having the dististyle somewhat excavated on the distal end instead of being slightly enlarged. Such a difference could be attributed to variations in mounting technique, and so I do not consider it significant.

Material examined: 1 male, Fallen Leaf, Lake Tahoe, June 17, 1916, H. G. Dyar.

Podonomus species

Material examined: 4 females, Nevada Co., Northwest of Cisco, May 16, 1948, W.

This is apparently a new species closely related to *Podonomus kiefferi* (Garrett) and *P. arietinus* (Coquillett) but in the absence of the male I prefer not to describe it.

The species appears to differ from the aforementioned species by having the halteres entirely black instead of with a whitish pedicel and by having the abdomen yellowish-brown instead of black.

In addition to the specimens listed above, I have studied an additional female that differs in some particulars and possibly represents a distinct species. In USNM: 1 female, Topaz Lake, Mono Co., July 25, 1948, light trap, R. Coleman.

Subfamily Diamesinae

Pseudodiamesa (Pseudodiamesa) branicki (Nowicki)

Although this species was not represented by males in the collection at hand, the characteristics given by Oliver (1959) for the female are considered diagnostic. In the two specimens that I have seen, the thorax is blackish-brown with only the pronotum and scutellum a lighter brown. The halteres are yellowish-white with the stalk infuscate. Wing length 5.73, 5.92 (2); fore tarsi missing; venarum ratio 0.72, 0.76 (2).

Material examined: 2 females, Blanco's Corral, White Mt., Mono Co., July 7, 1953, elevation 10,000 feet, W. D. McLellan.

Pseudodiamesa (Pseudodiamesa) diastena, new species

FIGURES 7*b,c*

Holotype male: USNM 65522, Mill Valley, Marin Co., Apr. 12, 1953, H. L. Mathis.

Antennal flagellum heavily haired. Postocular bristles in single row below eyes, expanding to form staggered double row behind eyes, then becoming staggered single row toward dorsal part of head; each row terminates even with narrow dorsal eye extension. Eyes bare. About 10 clypeal bristles. Palpi with first and second segments fused, indicated by constriction, ratio 41(13+28):30:35. Antennal ratio 2.75.

Head, thorax, and abdomen black. Prothorax with only 14 lateral bristles; no dorsal bristles; somewhat narrowed dorsally; two halves contiguous. Halteres dark. Prealar bristles 15; dorsolateral bristles partially in double row, forming cluster of 7 bristles just anterior to scutellum; scutellum with about 48 strewn bristles; anterolateral bristles absent.

Fourth tarsal segment on hind leg cylindrical. Fore leg with single long straight tibial spur, ratio of spur length: diameter of tibial apex 70:50. Tibial spurs of middle leg with many encircling fine hairlike denticles, ratio of length of spurs 50:60. Hind tibial spurs as middle leg, ratio 55:75. Comb of 10 bristles at apex with 3 rows of equal-sized bristles just basally, each row decreasing in number.

Leg proportions:

	F	*Ti*	Ta_1	Ta_2	Ta_3	Ta_4	Ta_5	*Leg Ratio*
Fore	60	74						
Middle		67	78					
Hind	75	91	52	27	19	8		0.57

The specimen apparently got wet; the wings were crumpled, with the result that, when a slide preparation was made, the membrane was rubbed as it was flattened under the cover slip; however, there appear to be the alveoli of sparse macrotrichia near the wing tips. Cross vein m–cu narrowly separated from r–m.

This species may be recognized by its genitalia, which is similar to *Pseudodiamesa pertinax* (Garrett) and *P. branicki* (Nowicki), but which has an anal point more slender than either of the two, and in which the basal lobe of the basistyle extends more distally. The dististyle with its spine hidden from a dorsal view appears also to be distinctive; however, this may be the result of a slide-mounting variation.

Allotype: In USNM: Topotypic, Apr. 12, 1953, H. L. Mathis.

Similar to male in coloration and most body features except that second palpus segment longer than first, to which fused; second segment with distinct swelling. Genital plates lamellate with virtually no ventral elongation. Fourth tarsal segments shortened but not distinctly obcordate.

Prodiamesa (*Monodiamesa*) species

There is only one North American record of the subgenus, namely, *Prodiamesa* (*Monodiamesa*) *bathyphilia* Kieffer, an identification based on a larva. Brundin (1951) questions the identity of this North American material. The female at hand will not resolve the question raised by him as only males can be specifically identified with certainty. I believe this specimen to represent a new species but have not so named it because of lack of definitive characteristics in the female. To my knowledge this is the first North American record of the subgenus based on adults.

Material examined: In UCLA: 1 female, Whitmore Tub, Mono Co., Aug. 3, 1952, McDonald.

Diamesa fulva Johannsen?

Diamesa fulva Johannsen, Ent. News, vol. 32, p. 229, 1921.

Head yellowish; antennal pedicel yellow, flagellum black. Eyes without dorsal extension, glabrous. Palpi black; second segment without swelling; subcylindrical.

Prothorax infuscate yellow. Mesonotum and scutellum pale cinnamon brown; vittae not distinct; overlaid with white pollen. Scutellum rounded above; apex not pointed; postnotum blackish-brown; sternopleuron yellowish, somewhat darker on sternum; halteres white.

Fore coxa, trochanter, and extreme base of femur yellow; remainder of leg black. Middle and hind femora and tibiae infuscate yellow; narrow black above and below knee and at apex of tibiae;

basitarsi infuscate yellow basally, apically black as in remainder of tarsus. Fourth tarsal joint obcordate. Fore leg ratio 0.81; middle leg ratio 0.51; hind leg ratio 0.62.

Wings yellowish-brown by transmitted light; C extended; m–cu intersects Cu_1 near base; anal vein reaches far beyond f–Cu. Wing length 2.41 mm.; venarum ratio 0.91.

Abdomen black, with apex of each segment somewhat lighter; venter yellow becoming black at segment VII.

This identification is queried in absence of the male with its diagnostic genitalia.

Material studied: 1 female, 4 miles west of Quincy, Plumas Co., July 16, 1949, W. F. Ehrhardt.

Diamesa nivorunda (Fitch)?

Chironomus nivorundus Fitch, Amer. Journ. Agric. Sci., vol. 5, p. 282, 1847.
Diamesa waltli Johannsen, New York State Mus. Bull., no. 86, p. 174, 1905, not Meigen, Syst. Beschr., vol. 7, p. 13, 1838.

Head, thorax, and abdomen entirely black except halteres, venter of abdomen, and genitalia. Antennal flagellum 7-segmented; first segment slightly less than two times length of segments 2 to 6; length of segment 7 four times 6. Postoculars in single row behind eyes, extending to ventral surface of head. Eyes rounded above, hairy. Palpi ratio 40:55:60:90; second segment dilated distally, then narrowly constricted just before joint.

Prothorax with 13 small lateral bristles; lobes completely divided but with posterior margins in contact. Mesonotum strong greyish pruinosity. Halteres yellowish-white. Body length 3.80 mm. Supra-alar bristles absent; prealar bristles 8, small; dorsomedial bristles absent; dorsolateral bristles in single row; scutellum with 30 to 35 bristles, scattered; dorsolateral bristles continuous onto shoulder with only 1 bristle lateral to main line of bristles.

Fourth tarsal segment cordiform; empodium long, with many lateral branches; claws with 4 basal teeth that are long and attenuate; comb of 17 spines; inner tibial spur long and sinuate, with heavy lateral prickles one half length; outer spur slightly bent with long prickles half length, ratio 44:70.

Leg proportions:

	F	*Ti*	Ta_1	Ta_2	Ta_3	Ta_4	Ta_5	*Leg Ratio*
Fore	70	96	65	30	20	6	9	0.68
Middle	86	90	41	21	15	8	9	0.45
Hind	98	105	65	35	20	7	9	0.62

Wings large, anal lobe strongly right angled; C produced (0.12 mm.); R_1 dilated distally, clavate; R_{2+3} distinctly only on basal one-third;

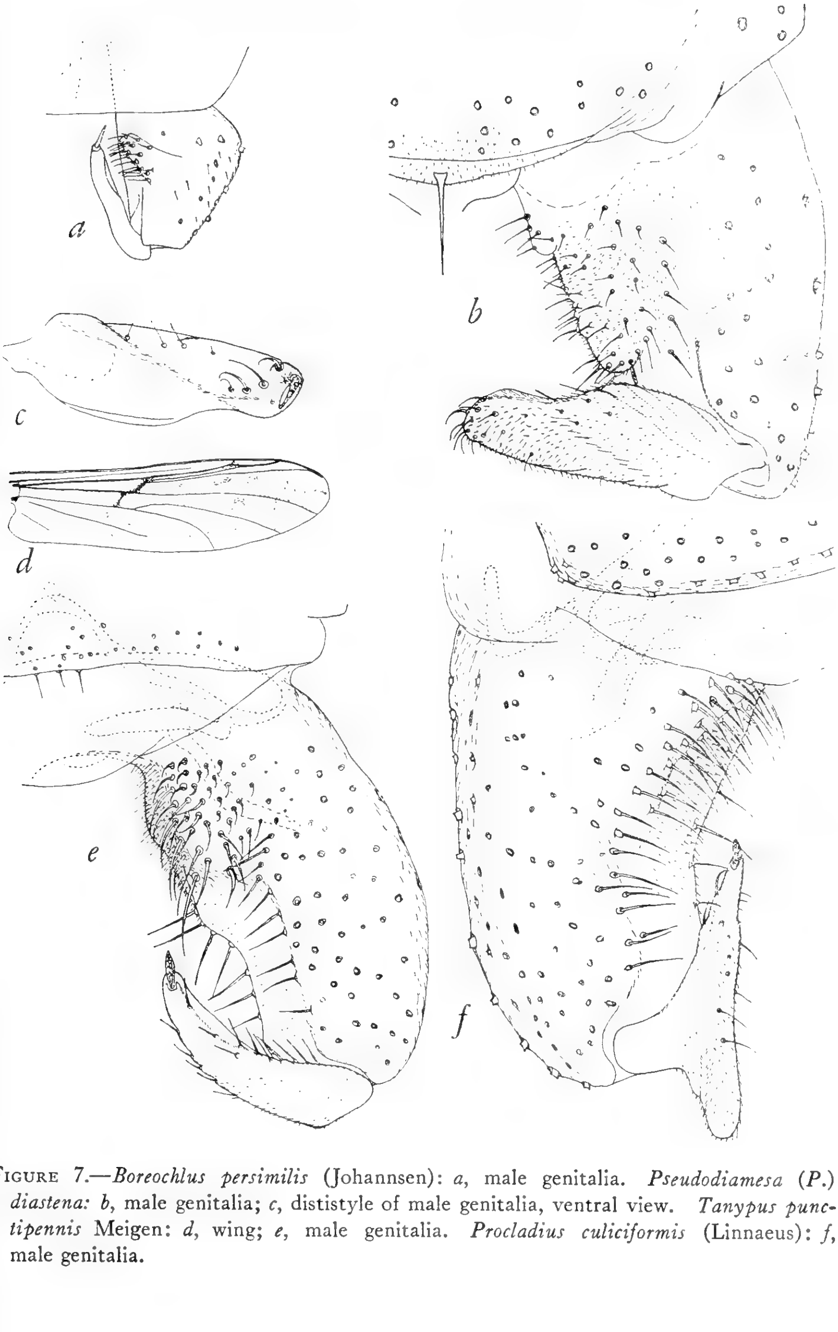

FIGURE 7.—*Boreochlus persimilis* (Johannsen): *a*, male genitalia. *Pseudodiamesa* (*P.*) *diastena*: *b*, male genitalia; *c*, dististyle of male genitalia, ventral view. *Tanypus punctipennis* Meigen: *d*, wing; *e*, male genitalia. *Procladius culiciformis* (Linnaeus): *f*, male genitalia.

R_{4+5} terminates proximal to M; f-Cu proximal to r–m. Anal vein reaches almost to wing tip. Wing length 4.63 mm.; venarum ratio 0.92.

Abdomen black except venter and genitalia dark brown.

Females: Wing length, range 4.37–5.11; mean 4.75 mm. (4); leg ratio, range 0.67–0.72; mean 0.70 (4); venarum ratio, range 0.90–0.97; mean 0.94 (4).

Material examined: In USNM: 2 females, Willow Creek, Fandango Pass, Modoc Co., May 15, 1948, W; 1 female, Alturas, Modoc Co., July 16, 1948, at light, W; 1 female, Nevada Co., northwest of Cisco, May 16, 1948, W. In UCD: 1 female, Ukiah, Feb. 23, 1959, S. M. Fidel, light trap.

These specimens agree well with descriptions of *D. nivorunda* (Fitch) Johannsen; however, in the absence of the male with its diagnostic genitalia this identification is not positive.

Appendix

Tanypus punctipennis Meigen (Edwards)

Figures 7*d,e*

Tanypus punctipennis Meigen, Systematische Beschreibung der Europäischen zweiflügeligen Insekten, vol. 1, p. 61, 1818.

This description is taken from a male in BM(NH): Beesands, South Devonshire, June 8, 1920, F. W. Edwards, 1920–229.

Head greyish-brown; antennal pedicel dark brown. Palpi with 4 segments, 1 and 2 subequal; antennal ratio 2.14.

Thorax dark greyish-brown, vittae outlined by whitish pollen, pleura and scutellum infuscate yellow. Pronotum strongly produced apically. Mesonotum with rather low, somewhat elongate tubercle, dark yellowish-brown; second very small tubercle in center of prescutellar area. Postnotum shining dark brown. Halteres yellowish-white, slightly infuscate below knob. Prealar bristles about 14; dorsomedial bristles extend laterally in one row behind tubercle to join dorsolateral bristles. Dorsolateral bristles in single row forming group of 3 bristles just anterior to scutellum. Scutellum with 16 bristles in posterior transverse row. Anterolateral bristles 3 to 5.

Fore tarsi with beard 6 times tarsal diameter; femora infuscate with clear yellow subapical fascia, space between yellow fascia and joint darker than remainder; thus in certain lights femora appears dusky with dark brown apical band. Tibiae infuscate yellow, with distinct, rather broad sub-basal brown band, apex narrowly darkened as are apices of tarsal segments 1 to 3; 4 and 5 largely dark.

Leg proportions:

	F	*Ti*	*Ta_1*	*Ta_2*	*Ta_3*	*Ta_4*	*Ta_5*	*Leg Ratio*
Fore	70	85	72	34	25	17	10	0.85
Middle	73	82	71	32	22	14	10	0.86
Hind	67	105	95	52	37	22	14	0.90

Wing length 3.40 mm.; venarum ratio 1.08.

Goetghebuer's figure in "Die Fliegen" is in error; the spots in cell R_5 are progressively larger distally with the most basal one so small as to be scarcely distinguishable; there is no distinct spot in the base of cell M, only a faint shadow; cell Cu_1 has a distal dark spot and, near the center, a larger less distinct one; above and beyond the tip of the anal vein is a dark spot and, along its anterior margin, two more, one below f–Cu and the other below m–cu; on the anal margin of the wing are 4 spots, the distal 2 being more or less doubled; r–m cross vein with a large dark blotch, the m–cu cross vein darkened, faintly darkened along M proximal to cross vein. Costal margin clear except for distinct spot at R_1 and faint cloud above large dark r–m spot.

Abdomen dark brown, each segment with narrow apical dusky yellow fascia.

Setae of basal lobe of basistyle heavier than distal ones.

Male: Wing length 3.92 mm.; fore leg ratio 0.80; antennal ratio 2.44; venarum ratio 1.04; anterolateral bristles 4; prealar bristles about 15.

Females: Wing length, 3.51 3.89 mm. (2); fore leg ratio, 0.73, 0.83 (2); venarum ratio 1.01, 1.08 (2); anterolateral bristles 10 (1); prealar bristles about 16 (1).

In one female the pronotum was exceedingly produced, the dorsolateral bristles in a single row becoming about tripled anterior to the scutellum. In the second female the pronotum was moderately produced, the dorsolateral bristles in a single staggered row becoming tripled. In a second male the pronotum was moderately produced, the dorsolateral bristles, as the second female above, forming a group of 10 bristles at the posterior end of the the dorsolateral bristles; the mesonotum was ash grey. Legs infuscate yellow with dark band above and below knee.

Material examined: In BM(NH): 1 male, 2 females, London, Putney, June 10, 1929, F. W. Edwards, B. M. 1929–297; Ormsby, June 22, 1888, G. H. Verall, 93.–36; Radwell, Hertfordshire, June 15, 1917, F. W. Edwards.

Procladius culiciformis (Linnaeus)

FIGURE 7*f*

Tipula culiciformis Linnaeus, Systema naturae, ed. 12, p. 978, 1767.
Tanypus choreus Meigen, Klassifikazion und Beschreibung der Europäischen zweiflügeligen Insekten, vol. 1, p. 23, 1804, new synonomy.

I have examined a series of specimens from the British Museum (Natural History) identified by F. W. Edwards as *P. culiciformis* (Linnaeus) and *P. choreus* (Meigen). Although slight differences in size and color exist between the series I have seen, the chaetoxy, ratios, and genitalia are not significantly different. Essential features are compared below from Edward's material.

	P. culiciformis		P. choreus	
	male (1)	*female (1)*	*males (2)*	*females (2)*
wing length	3.07	2.92	3.15–3.51	3.15–3.29
fore leg ratio	0.69	0.69	0.73–0.74	0.67–0.69
middle leg ratio	0.66	0.62	0.60–0.64	0.58–0.64
hind leg ratio	0.68	0.65	0.64–0.68	0.64–0.65
antennal ratio	2.08		2.00–2.41	
venarum ratio	1.40	1.46	1.37–1.53	1.43–1.55
prealar bristles	19		20	
dorsolateral bristles	mostly 1 row		mostly 1 row	
dorsomedial bristles	2 rows		2 rows	
anterolateral bristles	8		8	

The males identified by Edwards as *P. choreus* had a short, sparse beard about 4 times as long as the diameter of the tarsus while the specimen of *P. culiciformis* had hairs no longer than 3 times the diameter of the tarsus. In the absence of genitalia differences this beard difference could be construed as only varietal.

Material examined: In BM(NH): 2 males, Radwell, Hertfordshire, May, 1918, F. W. Edwards; 1 female, Slapton, South Devonshire, June 9, 1920, F. W. Edwards; 1 female, Ruislip, Middlesex, Sept. 7, 1914, F. W. Edwards [determined as *P. choreus* (Meigen)]; 1 male, 1 female, Radwell, Hertfordshire, June, 1918, F. W. Edwards [determined as *P. culiciformis* (Linneaus)].

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CALIGOID COPEPODS (CRUSTACEA) OF THE HAWAIIAN ISLANDS: PARASITIC ON FISHES OF THE FAMILY ACANTHURIDAE

By Alan G. Lewis[1]

Introduction

The caligoid copepods of Hawaiian fishes have not been studied previously in a systematic manner. The only references that include Hawaiian caligoids are: Nordmann (1864), describing *Norion expansus* and *Peniculus calamus*; Wilson (1924), indicating that *Pandarus satyrus* has been taken from specimens of *Prionace glauca* captured in Hawaii; and Wilson (1932), indicating that *Pandarus smithii* has been collected from sharks taken in Hawaiian waters. In addition, Edmondson (1946) figures a large *Pandarus* species from sharks and a *Lernaeenicus* species from dolphins; Bonnet (1948) lists some Hawaiian caligoids, mainly from pelagic fishes; and Randall (1958) lists by family the copepods taken from stomachs of some parasite-picking fishes of the genus *Labroides* and Randall (1961) lists the parasitic copepods taken from the manini (*Acanthurus triostegus sandvicensis*).

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The author further is grateful to Dr. Paul Illg of the University of Washington for reading the manuscript and offering suggestions for its improvement.

Finally, the author appreciates the comparison made by Dr. S. M. Shiino, of the Prefectural University of Mie, of some specimens of a copepod described in this publication with specimens in his personal collection.

Methods.—The external surface, gill cavities, buccal cavity, and nasal cavities of the acanthurid fishes collected were examined for parasitic copepods. Copepods collected from these regions were killed and preserved in 95 percent ethyl alcohol and later transferred to 70 percent ethyl alcohol. Specimens to be dissected were placed in 85 percent lactic acid to soften and clear them, were stained with methyl blue dissolved in 85 percent lactic acid, and then were dissected in 85 percent lactic acid.

Drawings of the total animal were made with a camera lucida and a Bausch and Lomb arc projector from specimens placed in the acid and covered by a nine-millimeter cover slip. Drawings were made from appendages either in situ on the wholemount or from others dissected off and mounted in Hoyer's mounting medium. Measurements were made with an ocular micrometer.

In the following figures the ♀ and ♂ signs are used separately under each drawing to indicate a difference between the appendage of the female and that of the male, and together (♀♂) to indicate similarity of the appendages. The sex from which the drawing is made is indicated by underscoring the appropriate symbol.

Terminology.—The term "cephalothorax" is used in the descriptions to designate the fused cephalon and two or more thoracic segments, the maxilliped-bearing segment being considered as the first thoracic segment. The term "free thoracic segments" is used to designate those segments of the thorax not fused with the head.

The term "genital segment" designates the fused fifth and sixth thoracic leg-bearing segments.

In the descriptions of all but two of the species the second antenna is described as three-segmented. This is in opposition to many of the earlier, and some of the present-day, workers. The author is accepting the viewpoint at this time that the segment attached to the ventral surface of the cephalothorax along most of its proximal surface is a distinct segment.

The spinelike projection just lateral and posterior to the base of the second antenna is called here the postantennal process; the spinelike projection just lateral to the base of the mouth cone, the postoral process. With this terminology, the two pairs of appendages between the mouth cone and the first thoracic legs become the maxillae and maxillipeds respectively. Applying the term "postantennal process" to the structure immediately behind and lateral to the second antennae is in opposition to Wilson (1905), Heegaard (1947), and others who apply the term "first maxilla" to the process. Excluding the word "cuticular" from the term "postantennal process" is in contrast with Gurney (1927), Lang (1948), and others, but indicates the present author's desire neither to accept nor to reject the belief that the process is not a true appendage. The application of the term "postoral process" to the structure immediately lateral to the base of the mouth cone is in contrast to all other workers who term the process a "maxilla." Both the postantennal and postoral processes are unsegmented, spinelike structures innervated by subesophageal nerves that arise from the same region of the ganglion (Scott, 1901; Wilson, 1905; Lewis, unpublished). Each process possesses at least one setule-bearing nodule. The fact that there is no evidence of segmentation suggests that these structures are not true appendages. Although both are innervated by subesophageal nerves, these nerves arise in close association to each other and in association with a subesophageal nerve that innervates parts of the body musculature and not the musculature associated with any of the oral appendages. The presence of at least one setule-bearing nodule may or may not offer evidence that the processes are appendages, since single setules are found on parts of the body not associated with any appendage.

The mandible here is considered "parted," not segmented. The exact derivation of the adult mandible is not known but the lack of distinct musculature and the indistinct divisions among the parts indicate that a true segmented condition does not exist in the adult appendage.

The term "chitinized," as here used, is synonymous with the term "sclerotized."

In an attempt to provide more characters for the identification of the species in the larger groups, mainly in the genera *Caligus* and *Lepeophtheirus*, the position and composition of the articular surfaces in some of the appendages (the second antenna, maxilla, and maxilliped) have been given. This characteristic appears to be constant although its later use and applicability in the separation of the species should determine its value.

The thoracic leg armature table used by Shiino in his series of publications on caligoid copepods has been adopted with slight modifications by the present author. Such a table gives the number and approximate position of the membranes, spines, and setae found on the first four pairs of thoracic legs. A hypothetical thoracic leg is shown in figure 1, which designates all of the component parts of the armament of the thoracic legs discussed in tabular form in this work.

A table of the hypothetical thoracic leg is given below. When applied to a margin, the term "inner" means that margin closest to the median longitudinal axis of the body of the copepod, the term "outer" indicates that margin furthest from the median longitudinal axis, and the term "middle" indicates that margin between the two rami, applying only to the protopodite. The term "seta" designates a slender, flexible structure that may or may not be plumose. The term "setule" is used to indicate a small seta whether single (s) or forming a fringe (C, c). The term "spine" is used to indicate a stiff, sharply pointed or blunt-tipped projecting process. (For a complete explanation of symbols, see figure 1.)

Leg	Margin	Sternal plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
	outer	f	P	rh, H′	dH	H	2H, Q		d	2p′, 2P
	inner			f, p, s	c, P	c, P	C, P′, 5P, P′	P	c, 2P	2P
	middle			c						

Under "Remarks" the author compares the described species with species that have morphological similarities. Since this work deals with caligoids found on Hawaiian fishes, the comparison primarily involves Indo-Pacific caligoids. Copepods from areas other than this region are used in comparison only if the resemblance to the described form is striking.

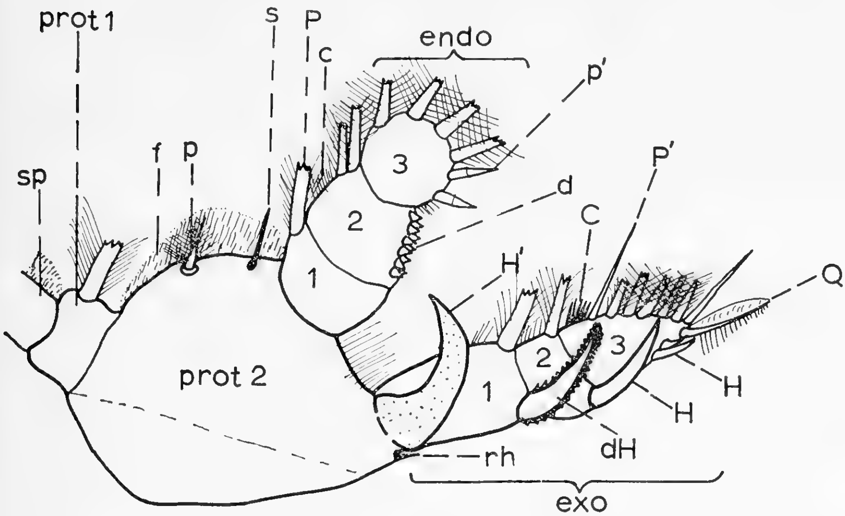

FIGURE 1.—Hypothetical thoracic leg showing various armament components:

C: heavy fringing setules
c: light fringing setules
d: denticulations
dH: denticulated spine
endo: endopodite
exo: exopodite
f: membrane
H: simple spine
H′: hooked spine
P: large plumose seta
P′: large naked seta
p: smaller plumose seta
p′: smaller naked seta
prot: protopodite
Q: seta plumose on one side with membrane on other
rh: spinule
s: solitary hairlike setule
sp: sternal plate
numbers: segment numbers

Family Caligidae

Genus *Caligus* Müller, 1785

DIAGNOSIS.—First three thoracic leg-bearing segments fused with head to form cephalothorax, fourth thoracic leg-bearing segment free, without paired dorsal plates; genital segment without plates or processes; abdomen of one or more segments. Frontal plates with lunules; sternal furca present; first three thoracic leg pairs biramous though endopodite of first pair rudimentary in the adult; fourth thoracic legs uniramous.

REMARKS.—The diagnosis presented above was modified from Wilson (1905). The second maxillae described by Wilson as simple and spinelike are, in the present work, the postoral processes which, in species such as *Caligus constrictus*, may be bifurcate. The first thoracic leg is described here, in opposition to previous workers, as biramous. The presence of an endopodite in the adult and in the developmental stages, whether rudimentary or not, indicates that this appendage, in opposition to the uniramous fourth thoracic legs, is a true biramous appendage.

Caligus kala, new species

FIGURES 2*a–k*, 3*a–f*

MATERIAL.—Adult male (holotype, USNM 105106) collected by author from side of specimen of *Naso hexacanthus* (Bleeker), taken in fish trap between Diamond Head and Koko Head, Oahu, Hawaii, by Samuel Kaolulo.

MEASUREMENTS.—Length from anterior margin to posterior end of caudal rami, excluding setae, 2.85 mm. Greatest length of cephalothorax, including frontal region, 1.89 mm.; greatest width, excluding marginal flange, 1.60 mm. Greatest length of genital segment, excluding setae of fifth legs but including lobate projections, 0.49 mm.; greatest width, 0.62 mm. Greatest length of abdomen 0.29 mm.; greatest width 0.35 mm.

DESCRIPTION.—General background color of alcohol-preserved specimen dark red. Reddish spots present on dorsal surface of cephalothorax and lunules; concentration of spots from posterior edge of frontal plates to eyes, around eyes to narrow median band; median band split into two bands, one on either side of cephalothorax, continuous along margin of cephalothorax to posterior lateral extensions. Other reddish spots scattered irregularly over dorsal surface, concentrated at sutures. Eyes red. Genital segment with reddish tinge; abdomen with reddish tinge, darker along alimentary tract. Caudal rami colorless.

Cephalothorax elliptical, frontal plates large, division between frontal plates and cephalothorax distinct (fig. 2*a*). Lunules large, covering most of frontal plate area; free surface extending posteriorly on ventral surface past junction of frontal region and cephalothorax (fig. 2*c*). Division between frontal region and cephalothorax continuous, irregular in region of lunules, curving anteriorly in middle. Lateral margins of cephalothorax with narrow marginal flange. Posterior sinuses distinct, U-shaped though apex sharp, not broadly curved. Posterior sinuses with small, membranous flange attached to outer lateral surface and projecting dorsally and medially (fig. 2*a*). Posterior margin of median area of cephalothorax slightly convex, projecting slightly past posterior extension of lateral regions; lateral corners of median area sharp, margin not continuous with inner margin of posterior sinuses. Major cephalothoracic grooves distinct, in irregular H-shape. Cross and posterior longitudinal grooves continuous, broadly curved. Cross groove present in middle of cephalothorax, middle of groove extending anteriorly from junction of longitudinal grooves, apex flatly pointed. Anterior longitudinal

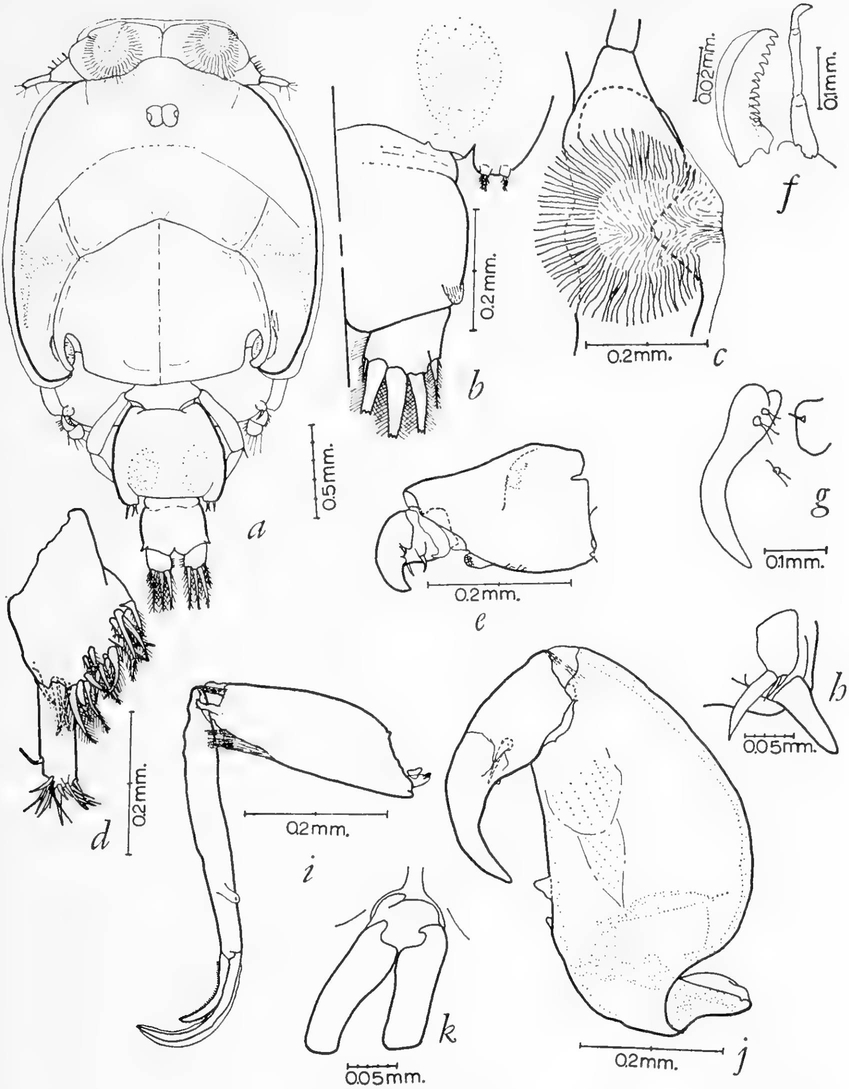

FIGURE 2.—*Caligus kala*, new species (holotype male): *a*, dorsal view; *b*, ventral view showing posterior portion of genital segment, fifth legs, abdomen, and caudal ramus; *c*, lunule; *d*, antennule; *e*, terminal two segments of second antenna; *f*, mandible and enlarged distal, toothed portion; *g*, postantennal process; *h*, postoral process; *i*, maxilla; *j*, maxilliped; *k*, sternal furca.

grooves extending from junction of longitudinal and cross grooves laterally and anteriorly, terminating at junction with indistinct, anteriorly curving cross groove. Apex of indistinct, anteriorly curving cross groove just posterior to eyes. Lateral strengthening regions extending laterally as bar-shaped thickening from junction of major cross and longitudinal grooves and uniting with short longitudinal thickening along lateral margin. Additional grooves present though indistinct. Eyes distinct, in anterior fourth of cephalothorax; inner margins contiguous on median longitudinal axis of body (fig. 2*a*).

Fourth thoracic leg-bearing segment short, wider than long, projecting slightly into median cephalothoracic area; covered dorsally by single, platelike structure protruding laterally at region of fourth thoracic leg attachment, in middle of segment. Posterior margin of segment, at junction with genital segment, distinct.

Genital segment ovoid, wider than long, lateral surfaces projecting slightly past flat posterior margin of middle of segment; posterior margins of lateral extensions almost flat, bearing two minute tubercles, the fifth legs; outer tubercle with minute, plumose seta, inner with two (fig. 2*b*).

Abdomen indistinctly two-segmented, attached to posterior surface of genital segment. Division between first and second segments discontinuous, first segment differentiated by rounded lateral margins. Second segment four times length of first, posterior lateral corners slightly flared (fig. 2*b*).

Antennule two-segmented, excluding frontal plates, attached to frontal region under lateral, free surface of lunule. First segment irregularly diamond-shaped, greatest width about two-thirds greatest length. Distal half of anterior surface and distal surface of first segment with about 22 plumose setae. Second segment elongate, slightly longer than half length of first segment. Second segment with naked seta from distal portion of posterior margin and 13 naked setae from distal surface (fig. 2*d*).

Second antenna three-segmented, attached along entire surface of first segment to ventral surface of cephalothorax just posterior to lunule and slightly medial to base of antennule. First segment long, equal to length of second segment; distal surface forming articular surface for second segment. Second segment well developed, broader proximally than distally; middle of anterior surface with poorly developed adhesion surface; second adhesion surface present as a few serrated ridges on inner anterior surface in same area. Third adhesion surface present on distal end of small, lobate protrusion of distal portion of anterior surface of second segment. Distal surface of second segment irregular, inner portion sloping proximally, outer portion with flat margin; both inner and outer surfaces concave, inner portion receiving ball-shaped proximal end of third segment. Third segment short, proximal end heavily chitinized; with slightly curved, short, strongly developed terminal process projecting at sharp angle to segment. Two setalike accessory processes present on third segment, one on anterior inner surface, second on posterior inner surface. Division between terminal process and segment distinct (fig. 2*e*).

Mandible four-parted; first part broader proximally than distally. Second part short, one-fourth length of first part, tapered sharply to junction with narrower third part. Third part elongate, with irregularly curved margins. Fourth part curved strongly inwards, outer margin with slight, chitinous thickening; outer margin with thin membrane, inner margin with eleven toothlike denticulations (fig. 2*f*).

Postantennal process simple, falciform, acuminate spine attached just lateral to proximal end of first segment of second antenna. Base of process strongly chitinized, ring-shaped; spine continuous with base. Base with two nodules, each with two minute setules. Two additional nodules present, medial to base of process, one from plate medial to anterior end of base, second from ventral surface of cephalothorax medial to posterior end of base (fig. 2*g*).

Postoral process simple, spinelike, extending posteriorly and slightly inward from base just lateral and posterior to proximal end of mouth cone. Distal end of process rounded. Large nodule present just anterior to base of process; length of nodule about half length of process; with three setalike projections, one almost as long as nodule, second and third short, less than half length of first (fig. 2*h*).

Maxilla two-segmented, attached slightly lateral to base of postoral process. First segment slightly shorter than second, wider proximally than distally; inner proximal surface protruding slightly as articular surface. Distal end of segment abruptly narrowed, extending as slim, bifurcate process; distal ends of process forming articular surface for second segment, one part of process on each side, second segment resting in crotch of process. Second segment elongate, slightly wider in middle than at either end. Simple, flexible, lobate process present on second segment, projecting from distal half of inner surface. Distal surface of second segment with two elongate spines, inner approximately one and one-third length of outer. Inner spine with thin membrane along both inner and outer margins; outer spine with frilled membrane along both inner and outer margins (fig. 2*i*).

Maxilliped two-segmented, attached medially and slightly posterior to maxilla. First segment strongly developed, with well-developed, recurved, proximal, articular projection; middle of inner margin with two small, heavily chitinized, tuberculate projections. Distal margin irregular, with several heavily chitinized articular surfaces. Second segment and terminal process falciform; second segment with spine-like accessory process from anterior surface. Terminal process with minute nodule projecting from proximal inner margin; division between terminal process and segment indistinct (fig. 2*j*).

Sternal furca situated between, and slightly posterior to, bases of maxillipeds. Base of furca short, irregular; tines appear to arise separately from base. Tines with flat, chisel-shaped tips and thickened lateral margins (fig. 2*k*).

First thoracic leg biramous though endopodite present only as minute, lobate process at junction of exopodite and protopodite. Protopodite one-segmented, proximal end rounded, with small projection from middle of proximal surface and large projection from outer lateral surface forming articular surfaces. Inner surface of protopodite with numerous minute projections giving rough appearance to region. Exopodite two-segmented; first segment slightly shorter than combined lengths of protopodite and second exopodite segment, with small spine at distal outer corner of segment and short, stiff setules along inner margin. Second segment of exopodite with three terminal spines, outer two of approximately equal length, innermost shorter, strongly curved. Middle spine indistinctly bifid at tip. Three plumose setae on inner lateral margin, all with stiff setules on proximal region (fig. 3*a*).

Second thoracic leg biramous. Protopodite two-segmented; first segment short, narrow proximally, broad distally. Second segment of protopodite broad, width about three-fourths length; length of second segment greater than two and a half times that of first segment. Exopodite three-segmented; first segment longer than combined lengths of second and third, with single, strongly developed spine from outer distal corner. Spine on first segment projecting across surface of second segment; fine membranes present on both inner and outer margins of spine. Second segment short, irregular, with strong spine from outer distal corner; spine projecting across surface of third segment, with fine membranes on both inner and outer margins. Lateral and distal margins of third segment continuous, segment with broadly rounded outline. Third segment with two spines on outer margin; first spine short, simple, second well developed, with membrane along inner margin. Endopodite three-segmented; first segment short, outer margin with slender setules on proximal region, stiff setules on distal region. Second segment longer than first or third, with row of toothlike projections along outer margin of right leg, knoblike projections along outer margin of left (figs. 3*c*,*d*). Third segment short, broadly rounded (figs. 3*b*–*d*).

Third thoracic leg biramous. Protopodite broadly flattened, platelike, with cluster of toothlike projections along outer surface and on inner proximal surface. Exopodite two-segmented; first segment irregular, with two-parted, hooklike process at junction of first segment and protopodite. Second part of hooklike process directed inward at sharp angle to first part. Second segment of exopodite

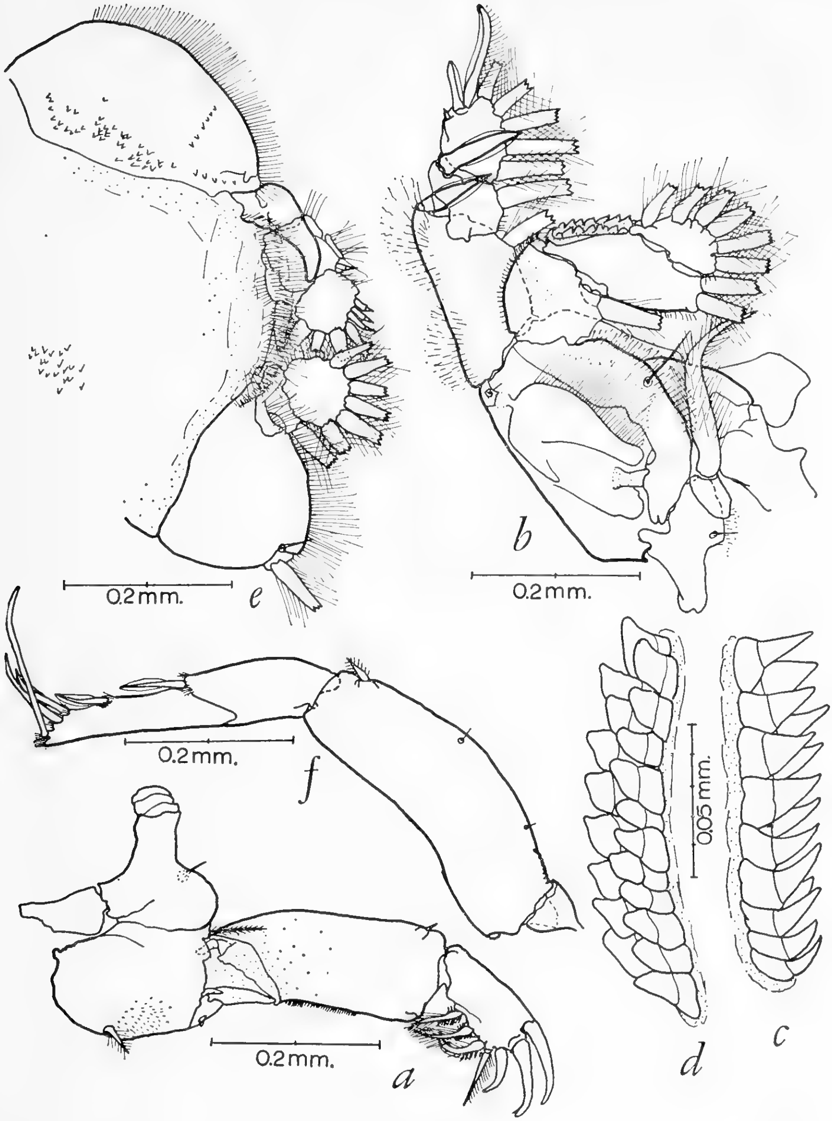

FIGURE 3.—*Caligus kala*, new species (holotype male): *a*, first thoracic leg; *b*, second thoracic leg; *c*, denticulations on outer margin of second segment of endopodite of right second thoracic leg; *d*, same as *c* except for left leg; *e*, third thoracic leg; *f*, fourth thoracic leg.

broadly rounded, lateral and distal margins continuous. Endopodite two-segmented; first segment short, proximal margin indistinct; second segment broadly rounded, lateral and distal margins continuous (fig. 3*e*).

Fourth thoracic leg uniramous, three-segmented. Protopodite one-segmented, equal to combined lengths of two segments of exopodite; middle of proximal surface projecting slightly in irregularly shaped articular surface. Protopodite with two setules projecting from outer margin and one plumose seta from outer distal surface. First segment of exopodite about two-thirds length of second, with single, membrane-margined spine at outer distal corner; base of spine ringed with frilled margin. Second segment with three spines from distal surface, one from outer lateral margin. Spine on outer margin with membrane on both outer and inner margins, base fringed with frilled margin. Inner terminal spine elongate, twice length of next longest spine, slightly curved at tip. Outer spine shortest of three, with fine membrane along outer and inner margins. All three terminal spines with bases rimmed by frilled margin (fig. 3*f*).

Caudal rami slightly wider than long, length approximately one-third length of second abdominal segment; row of setules present along inner margin. Caudal rami with five plumose setae: short seta on outer distal corner, short seta on inner distal corner, and three long setae from middle of distal margin.

The character of the armament of the thoracic legs is given below (for explanation of symbols, see figure 1):

Leg	Margin	Sternal plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	outer inner		s, p p		rh c	3H 3P, P				
II	outer inner	f	 f, P	f, s f, s	f, H c, P	H c, P	h, H, Q, P c, 4P	c, C P	d c, 2P	4P c, 2P
III	outer inner middle	f	f P, s, f c		H′, c, p′ c, P	c, 3p′, P c, 3P		P	c, 3P c, 3p	
IV	outer		2s, p		H	4H				

Remarks.—Except for some minor differences in the armature of the thoracic legs, *Caligus kala*, *C. kuroshio* Shiino, 1959, and *C. bonito* Wilson, 1905, have the same thoracic leg makeup. Shiino (1959a) has indicated that *C. kuroshio* differs from *C. bonito* by a series of minor characteristics such as the position of the accessory lappet on the maxilla and the length relationships of the body parts with other parts. Basically, however, both species are similar. *C. kala* differs from both of the above in the shape and size of the fourth thoracic leg-bearing segment, of the genital segment, and of the abdomen, which is much shorter than that of either *C. kuroshio* or *C. bonito.* In addition, the cephalic appendages of *C. kala* differ slightly from the above two species in characteristics such as the single, instead of bifid, terminal process of the second antenna.

"Kala" is the Hawaiian name for fishes of the genus *Naso*, one of which, *N. hexacanthus*, is the host from which the holotype specimen was taken.

Caligus flexispina, new species

FIGURES 4*a–o*, 5*a–f*

MATERIAL.—Adult female (holotype, USNM 105103), without egg strings, taken by author from caudal fin of specimen of *Acanthurus triostegus sandvicensis* Streets speared by author in Hanauma Bay, Oahu, Hawaii. Adult male (allotype, USNM 105104), taken by author from dorsal fin of specimen of *A. t. sandvicensis* Streets speared by Robert and Donald Morris near Waikiki, Oahu, Hawaii.

MEASUREMENTS.—Holotype: Length from anterior end of body to posterior end of caudal rami, excluding setae, 2.21 mm.; greatest length of cephalothorax, including frontal region, 1.39 mm.; greatest width, excluding marginal flange, 0.90 mm. Greatest length of genital segment 0.62 mm.; greatest width 0.70 mm.

Allotype: Length from anterior end of body to posterior end of caudal rami, excluding setae, 2.30 mm. Greatest length of cephalothorax, including frontal region, 1.56 mm.; greatest width, excluding marginal flange, 1.23 mm. Greatest length of genital segment, excluding projections and setae, 0.39 mm.; greatest width 0.37 mm.

DESCRIPTION.—Female yellowish brown in alcohol, with no distinctive pigmentation marks; eyes reddish tan. Male whitish tan in alcohol, with large yellowish splotches over entire body; eyes red.

Female cephalothorax ovoid, widest posteriorly; frontal region large, lunules large (fig. 4*d*). Anterior margin of frontal region with narrow, membranous flange; division between frontal region and cephalothorax distinct, a trilobed groove, median lobe larger than lateral lobes. Lateral margins of cephalothorax with broad marginal flange. Posterior sinuses distinct, U-shaped, entrances open; sinuses without membranous flange. Middle of cephalothorax extending well behind posterior margins of lateral areas; posterior margin slightly convex, with small concavity in middle of margin, at junction with fourth thoracic leg-bearing segment. Cephalothoracic grooves distinct, major grooves forming irregular H. Cross groove placed slightly anterior of middle of cephalothorax, continuous with posterior longitudinal grooves. Cross groove curving anteriorly from junction with longitudinal grooves, slight indentation present at apex of anterior curving groove. Anterior longitudinal grooves extending laterally and anteriorly, terminating blindly slightly posterior to eyes and close to lateral margins. Lateral thickenings present as narrow bands running from just anterior to junction of cross and longitudinal grooves laterally and posteriorly, terminating in region of lateral margin. Light median groove present, extending from slight indentation at apex of cross groove to middle of posterior margin of median thoracic area. Eyes placed in anterior fourth of cephalothorax, between two short, longitudinal grooves; eye region of female two small, rounded areas, one on either side of two narrow, elongate regions slightly swollen posteriorly and contiguous on median longitudinal axis of body (fig. 4*a*).

Cephalothorax of male slightly different from that of female; widest in posterior medial region, anterior to widest point in female. Posterior margin of protruding median thoracic area convex, without median concavity of female. Cephalothoracic grooves similar to those of female though cross groove without indentation at apex. Longitudinal bars in eye region not as distinct as in female; contiguous elongations of female absent in male, eyes with inner margins touching on median longitudinal axis of body (fig. 4*b*).

Free fourth thoracic leg-bearing segment of female short, narrower at junction with third segment than at junction with genital segment. Fourth thoracic legs attached to widest point of segment, adjacent to junction with genital segment. Divisions distinct between cephalothorax and fourth thoracic leg-bearing segment and between fourth thoracic leg-bearing segment and genital segment.

Fourth thoracic legs of male joined to middle of thoracic segment, not adjacent to junction with genital segment, as in female.

Genital segment of female ovoid, widest posteriorly. Genital segment with broadly rounded lateral margins; posterior margins convex laterally, concave medially, at junction with abdomen. Fifth legs visible as three minute, plumose setae, two arising from slight projection just lateral to opening of oviduct, third from minute projection just lateral and anterior to first two (figs. 4*a*,*c*).

Genital segment of male slightly broader across posterior end than across anterior end. Posterior margin convex. Fifth and sixth legs distinct, fifth as three plumose setae from lateral region of posterior margin, two arising from single, slight protrusion, third just anteriorly, from surface of genital segment. Sixth legs of two plumose setae arising from single, lobate process extending posteriorly slightly past genital segment; inner seta almost twice length of outer (figs. 4*b*,*c*).

Abdomen of female short, length about one-fifth greatest length of genital segment; width slightly greater than greatest length (fig. 4*c*).

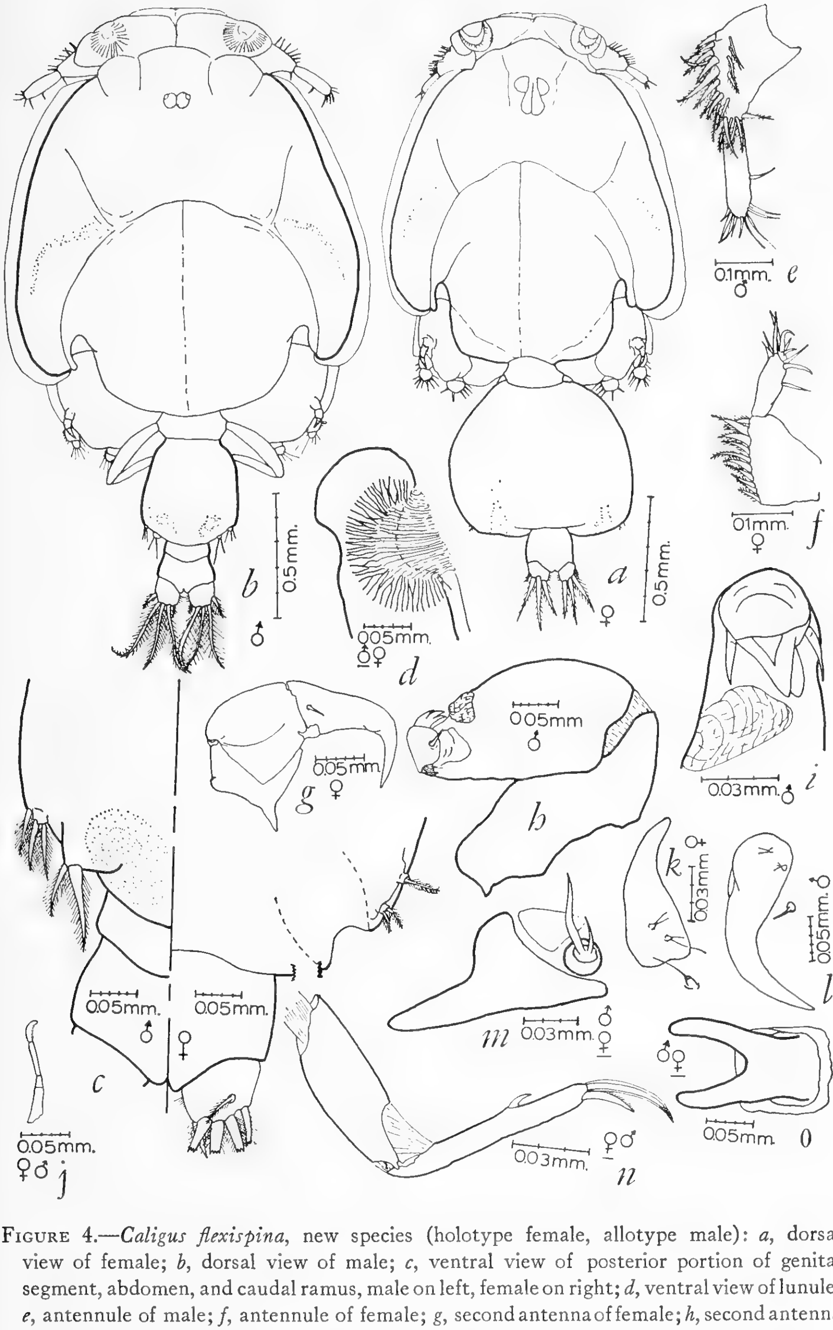

FIGURE 4.—*Caligus flexispina*, new species (holotype female, allotype male): *a*, dorsal view of female; *b*, dorsal view of male; *c*, ventral view of posterior portion of genital segment, abdomen, and caudal ramus, male on left, female on right; *d*, ventral view of lunule; *e*, antennule of male; *f*, antennule of female; *g*, second antenna of female; *h*, second antenna of male; *i*, inner surface of second segment of second antenna with adhesion pad, third segment and terminal process; *j*, mandible; *k*, postantennal process of female; *l*, postantennal process of male; *m*, postoral process; *n*, maxilla; *o*, sternal furca.

Abdomen of male arising from posterior surface of genital segment; of two distinct segments, first segment short, half length of second; second flared slightly at posterior end (fig. 4*c*).

Antennule of female two-segmented, excluding frontal plate, attached to ventral surface of cephalothorax and frontal region just medial to lateral frontal margin of frontal region. Greatest length of first segment one and a half times that of second; greatest width three-fourths greatest length. Anterior margin angular, apex of angle at widest point. First segment with twenty plumose setae on distal two-thirds of anterior margin. Greatest length of second segment more than two and a half times greatest width; proximal portion of segment narrowing abruptly at junction with first segment. Second segment with one naked seta on middle of posterior margin, twelve naked setae on distal surface (fig. 4*f*).

Antennule of male similar to that of female except second segment longer, first segment only slightly longer than second (fig. 4*e*).

Second antenna of female three-segmented, attached slightly posterior and medial to base of antennule. First segment short, forming articular surface for second segment; sharply pointed, posteriorly directed process projecting from posterior proximal surface of segment. Second segment short, strongly developed; greatest width, at proximal end, slightly less than greatest length, tapered slightly towards distal end. Inner and outer distal corners of second segment projecting slightly, heavily chitinized, serving as articular surfaces for third segment. Third segment with uncinate, acuminate terminal process; length of combined segment and process greater than length of preceding two segments. Third segment with small, spinelike accessory process on posterior proximal surface. Division between terminal process and segment not visible (fig. 4*g*).

Second antenna of male three-segmented; first segment as long as second, attached to ventral surface of cephalothorax along entire length. Proximal end of first segment with small, posteriorly directed, pointed projection; anterior end forming concave articular surface for second segment. Second segment strongly developed, with small adhesion pad on inner distal lateral surface; distal surface irregular, with several heavily chitinized regions for articulation with third segment. Third segment with trifid, spinelike terminal process. Third segment short, length including terminal process less than fourth that of second segment, with two setalike accessory processes, one from posterior medial surface of segment, second from anterior medial surface. Division between terminal process and segment distinct (figs. 4*h,i*).

Female and male mandible four-parted. First part long, broad proximally, with uneven taper to slightly narrower distal region.

Second part short, approximately one-third length of first part, tapering sharply to junction with third part. Third part long, slender, length of first and third parts about equal. Third part equal in width throughout entire length. Fourth part short, curved inwards; outer margin slightly thickened, inner margin thin, with 13 toothlike denticulations (fig. 4*j*).

Postantennal process of female simple, spinelike, attached lateral, and slightly posterior, to base of second antenna. Process directed posteriorly, curving medially; two minute nodules present on proximal surface, each bearing two minute setules. Larger nodule present anterior to base of process, bearing single, large setule (fig. 4*k*).

Postantennal process of male as in female, except spinelike process slender, falciform; large nodule adjacent to middle of process, not anterior to base as in female (fig. 4*l*).

Postoral process of female and male simple, located slightly lateral to base of mouth cone. Process directed posteriorly, wider at base, with sharp taper in proximal region, medial and distal portions tapered gradually to blunt, rounded tip. Postoral process with distinct node just anterior to base of process; node with two setule-like structures arising from distal surface, first setule about twice length of second (fig. 4*m*).

Maxilla of female and male two-segmented, attached just lateral and posterior to postoral process. First segment oblong, proximal surface without protruding articular surface, distal surface tapered abruptly to small, narrow, lobate projection with heavily chitinized distal end. Second segment elongate, of approximately equal width throughout; inner proximal surface with small concavity that fits over distal end of first segment as ball-and-socket joint. Second segment with strong spine on inner surface slightly distal to middle of segment. Distal end of second segment with two long spines, inner slightly less than twice length of outer, with fine, membranous margin along inner and outer surfaces; outer spine with frilled membrane along inner surface, very narrow, plain membrane along outer surface (fig. 4*n*).

Maxilliped of female two-segmented, attached slightly medial and posterior to maxilla. First segment slightly more than two times length of second segment plus processes. First segment with projection of inner proximal surface forming articular surface; lateral margins slightly convex, distal margin at angle to lateral margins, slanted sharply inward. Width of second segment less than half greatest width of first segment, tapered slightly from proximal to distal ends. Terminal process of second segment strongly developed, spinelike, curved inwards slightly, less than half length of second segment. Accessory process slender, spinelike projection from inner

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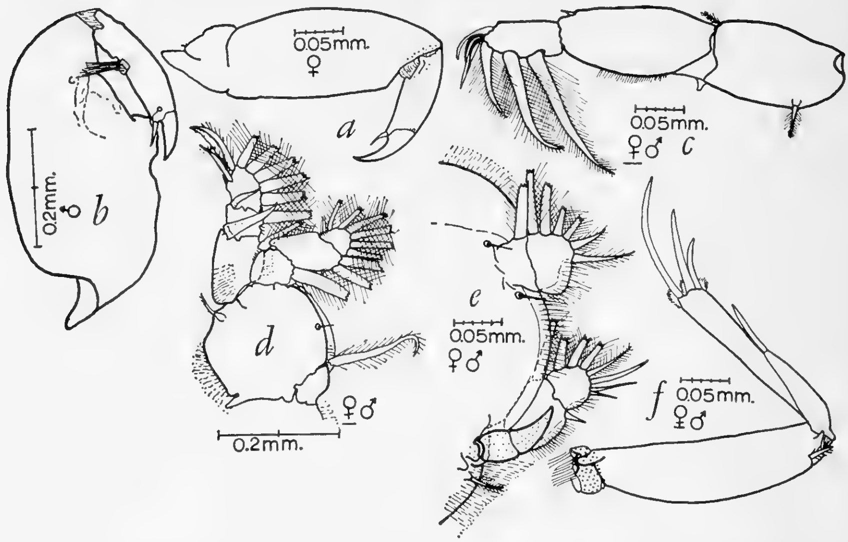

FIGURE 5.—*Caligus flexispina,* new species (holotype female, allotype male): *a,* female maxilliped; *b,* male maxilliped; *c,* first thoracic leg; *d,* second thoracic leg; *e,* third thoracic leg; *f,* fourth thoracic leg.

surface of second segment at junction of segment and terminal process. Division between segment and terminal process distinct. Terminal process and accessory process giving chelate appearance to segment (fig. 5*a*).

Maxilliped of male similar to that of female though more strongly developed. First segment with irregular inner margin; small, flat protrusion present on inner margin that receives distal end of terminal process of second segment when segment flexed (fig. 5*b*).

Sternal furca of female and male situated between, and slightly posterior to, bases of maxillipeds. Tines of furca rounded, curved slightly inwards at distal end. Greatest distance between tines equal to greatest width of base of furca. Bifurcation extending half total length of furca (fig. 4*c*).

First thoracic leg biramous though endopodite reduced to rudiment in adult. Protopodite one-segmented, with plumose seta on inner surface just proximal to middle of segment. Proximal surface without projecting articular surface but with heavily chitinized concavity on outer portion appearing to serve for articulation. First segment of exopodite slightly longer than protopodite, with small, heavily chitinized knobs protruding from distal margin as articular surfaces; with single, small spine on outer surface in distal region of segment and row of setules along inner surface. Second and terminal segment of exopodite short, half length of first segment, slender, tapered in curved manner from broad proximal to narrow distal surface. Second segment with three flexible processes and long, naked seta on distal surface, three plumose setae on inner lateral margin (fig. 5*c*).

Second thoracic leg biramous. Protopodite two-segmented; first segment short, approximately half length of second segment. Second segment broad, with single, naked seta from outer distal corner. Exopodite three-segmented; length of first segment equal to that of second and third combined, with strongly developed spine directed inward, across surface of second segment, from outer distal corner of first segment. Second segment short, with spine similar to that of first segment though smaller; spine arising from outer distal corner and directed inward across surface of third segment. Length of third segment one and a half times that of second; general outline of segment oval. Third segment with two spines, first small, located on outer surface of middle of segment; second spine approximately four times length of first, located just distal to first spine, inner lateral margin plumose. Endopodite three-segmented; first segment short, second segment long, slightly shorter than combined lengths of first and third segments. Third segment short, half length of first segment, distal and lateral margins continuous (fig. 5*d*).

Third thoracic leg biramous. Protopodite one-segmented, flattened; length of protopodite approximately one and a half times width. Exopodite two-segmented, length of first segment almost twice that of second, with two-parted, spinelike process curving inward from junction of exopodite and protopodite. Distance between exopodite and endopodite bases slightly less than half width of protopodite. Endopodite two-segmented; first segment irregular, proximal margin indistinct. Second segment irregularly lobate, distal and lateral margins continuous (fig. 5*e*).

Fourth thoracic leg uniramous, three-segmented. Length of one-segmented protopodite slightly greater than combined lengths of two segments of exopodite. Inner proximal surface of protopodite projecting as lobate articular process. Protopodite with single, plumose seta from outer surface of distal end. First segment of exopodite less than three-fourths length of second segment, with elongate spine from outer distal surface. Second segment of exopodite with three simple spines from distal surface, each with frilled membrane around inner portion of base; frilled membrane attached to segment, not to spine. Inner spine longest, outer two spines successively shorter. Outermost spine with fine membrane along outer surface (fig. 5*f*).

The character of the membranes, spines, and setae on the thoracic legs is given below (for explanation of symbols, see figure 1):

Leg	Margin	Sternal plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	outer		p		rh	3H, P′				
	inner		p		c	3P				
II	outer	f		f, p′	f, H	H	2H, h, Q	c	c	c, 3P
	inner		f, P	f, s	c, P	c, P	c, 5P	P	c, 2P	3P
III	outer	f	f		H′, c, p′	c, 2p′, P′			c	
	inner		P, f, 2s		P	c, 4P		P	5P	
	middle		c, s							
IV	outer		p		H	3H				

Caudal rami of female and male slightly wider than long, greatest length, excluding setae, about one-tenth length of female genital segment. Rami bearing six plumose setae; three long setae present on distal margin, short seta from each distal lateral corner, short seta from median distal ventral surface (fig. 4*c*).

Remarks.—This species is similar to *Caligus oviceps* Shiino, 1952, in the possession of flexible terminal processes on the first thoracic leg and in other thoracic leg characteristics. *C. flexispina* differs from this species in the possession of a fourth process, a naked seta, on the distal end of the first thoracic leg. In addition, *C. flexispina* possesses a distinctly separated fourth thoracic leg-bearing segment in both sexes and a distinct two-segmented abdomen in the male, while the fourth thoracic leg-bearing segment and genital segment in the female of *C. oviceps* are fused and in the male the division of the abdomen is incomplete. *C. oviceps* also possesses a four-segmented fourth thoracic leg while *C. flexispina* has a three-segmented fourth leg.

The name "flexispina" refers to the flexible terminal processes of the first thoracic leg.

Caligus randalli, new species

Figures 6*a,b,d–f,h–l,n–q*,7*a–d*

Material.—Ovigerous female (holotype, USNM 105102) collected by Dr. John Randall from epidermis of specimen of *Acanthurus triostegus sandvicensis* Streets, captured in unknown locality on Oahu, Hawaii.

Measurements.—Length from anterior end to posterior end of caudal rami, excluding setae, 4.14 mm. Greatest length of cephalothorax, including frontal region, 1.84 mm.; greatest width, excluding marginal flange, 1.84 mm. Greatest length of fourth thoracic leg-bearing segment 0.29 mm.; greatest width 0.70 mm. Greatest length of genital segment 1.23 mm.; greatest width 1.03 mm. Greatest length of abdomen, excluding caudal rami, 0.90 mm. Length of egg strings 1.47 mm.; egg strings with about 28 eggs.

Because of the similarity of the holotype specimen to specimens of *Caligus constrictus* Heller, measurements were taken for comparative purposes from an ovigerous female specimen of *C. constrictus* contained in the collections of the U.S. National Museum and identified by C. B. Wilson: Length from anterior end of frontal plate to posterior end of caudal rami, excluding setae, 4.69 mm. Greatest length of cephalothorax 1.23 mm.; greatest width, excluding marginal flange, 1.93 mm. Greatest length of fourth thoracic leg-bearing segment 0.37 mm.; greatest width of fourth thoracic leg-bearing segment 0.53 mm. Greatest length of genital segment 1.84 mm.; greatest width 1.10 mm. Greatest length of abdomen, excuding caudal rami, 0.62 mm. Length of egg strings 2.34 mm. Egg strings with about 45 eggs apiece.

Description.—Holotype specimen light brown in alcohol, no evidence of pigment pattern; eyes light red.

Cephalothorax ovoid, greatest width in middle of body; frontal region narrow, division between region and cephalothorax indistinct. Lunules small, projecting slightly from anterior margin of frontal region (fig. 6*e*). Lateral margins of cephalothorax irregular, with narrow marginal flange. Posterior sinuses distinct, inner corner of lateral regions of cephalothorax overlapping outer corners of thoracic area and closing off openings to sinuses. Posterior sinuses with light, membranous flange attached to outer lateral margin and covering half of sinus. Posterior margin of thoracic area slightly convex, middle of margin projecting slightly. Cephalothoracic grooves distinct; cross groove slightly anterior to middle of cephalothorax, broadly curved, continuous with broadly curved posterior longitudinal grooves. Anterior longitudinal grooves arising from cross groove, extending anteriorly and laterally in broad curve to lateral margins. Two slender, heavily chitinized strengthening regions extending laterally from region of junction of anterior and cross grooves, terminating in region of lateral margin. Two grooves on anterior part of body extending from anterior margin of cephalothorax posteriorly slightly past eyes. Other short, indistinct grooves arising from lateral margin of cephalothorax and extending medially for short distance. Eyes distinct, placed in anterior fourth of cephalothorax, contiguous on median longitudinal axis of body (fig. 6*a*).

Fourth thoracic leg-bearing segment short, middle of segment drawn out laterally at junction of fourth thoracic legs. Posterior three-fourths of segment covered by single, platelike structure distinctly separate from genital segment. Division between fourth thoracic leg-bearing segment and genital segment distinct (fig. 6*b*).

Genital segment longer than wide, median and posterior lateral margins parallel. Posterior lateral surfaces extending past junction of abdomen and genital segment; posterior margin forming sharp angle with lateral margin, middle of posterior margin slightly concave. Genital segment with two pairs of lobate processes projecting from posterior ventral surface (fig. 6*f*).

General outline of abdomen obovoid; length about three-fourths length of genital segment, greatest width more than half length.

Cephalothorax of *C. constrictus* circular, not ovoid as in *C. randalli*. Fourth thoracic leg-bearing segment of *C. constrictus* longer than that of *C. randalli*, anterior portion similar to *C. randalli*, posterior portion forming short, necklike extension; without platelike structure present in *C. randalli* (fig. 6*c*). Posterior lateral surfaces of genital segment forming lobate instead of angular projections (fig. 6*g*). Length of abdomen about one-third length of genital segment in contrast to relatively longer length of abdomen of *C. randalli;* greatest width four-fifths greatest length.

Antennule of *C. randalli* two-segmented, excluding frontal plate, attached to ventral surface of frontal region and cephalothorax just lateral to base of lunule; outer, free margin of lunule overlapping base of first segment of antennule. First segment of antennule broad, greatest width two-thirds greatest length. Anterior surface with approximately twenty plumose setae. Second segment elongate, greatest length 1.3 times that of first segment. Second segment with naked seta from distal portion of posterior margin, eleven naked setae from distal surface (fig. 6*h*).

Second antenna of *C. randalli* three-segmented, attached just posterior and medial to antennule. First segment forming broad, flat articular surface, with small, laterally directed, lappet-like protrusion. Second segment short, slightly longer than wide; proximal end slightly wider than distal. Second segment bearing small, lobate projection from inner distal surface. Third segment, including terminal process, elongate, length greater than two times that of second segment. Terminal process of third segment broadly curved, division between segment and process indistinct; inner terminal surface of process with minute, toothlike projections (fig. 6*i*).

Second antenna of *C. constrictus* similar to that of *C. randalli* though possessing two seta-like processes on terminal process of third segment; processes absent on *C. randalli*.

Mandible of *C. randalli* four-parted. First part slightly broader proximally than distally. Second part short, approximately two-

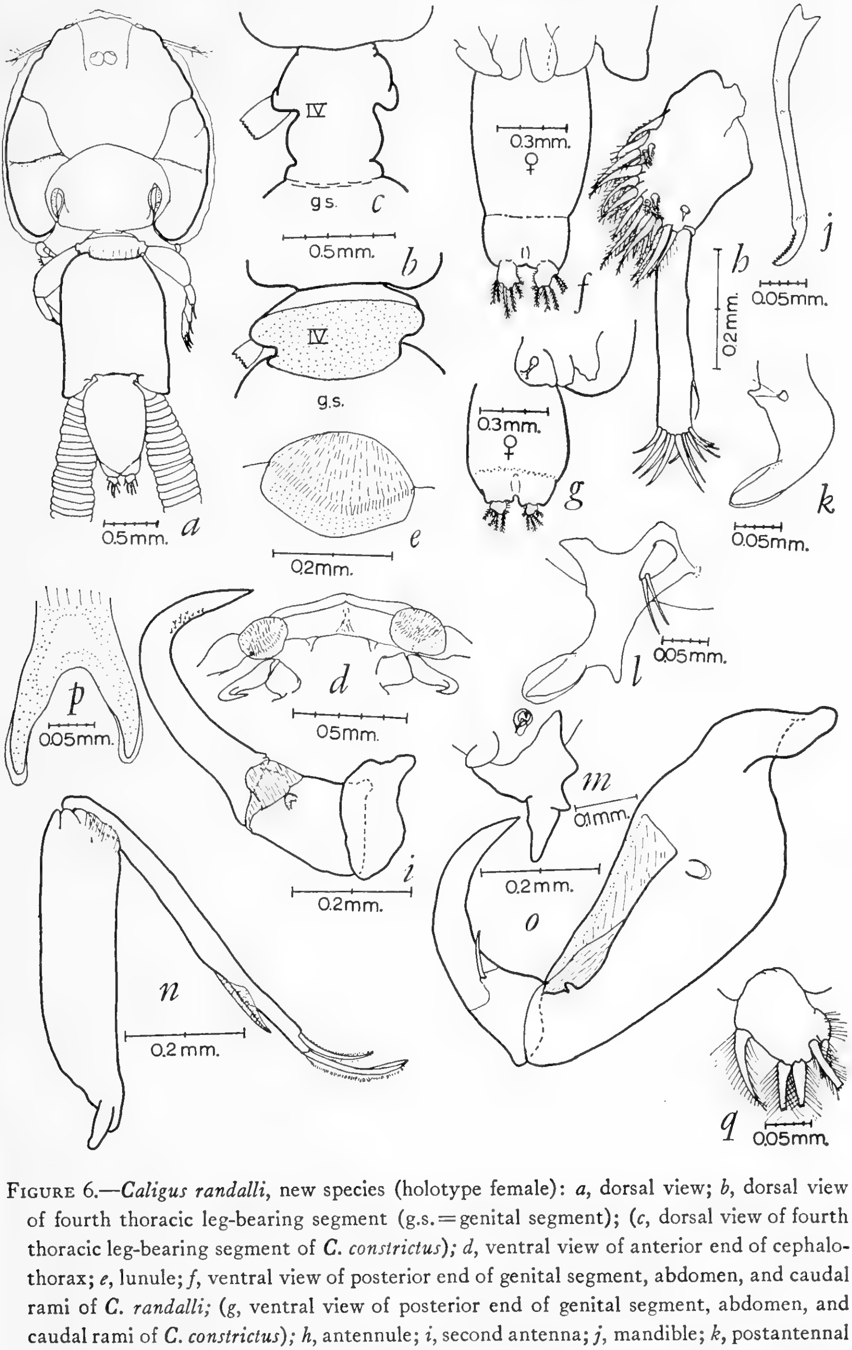

FIGURE 6.—*Caligus randalli*, new species (holotype female): *a*, dorsal view; *b*, dorsal view of fourth thoracic leg-bearing segment (g.s. = genital segment); (*c*, dorsal view of fourth thoracic leg-bearing segment of *C. constrictus*); *d*, ventral view of anterior end of cephalothorax; *e*, lunule; *f*, ventral view of posterior end of genital segment, abdomen, and caudal rami of *C. randalli*; (*g*, ventral view of posterior end of genital segment, abdomen, and caudal rami of *C. constrictus*); *h*, antennule; *i*, second antenna; *j*, mandible; *k*, postantennal process; *l*, postoral process; (*m*, postoral process of *C. constrictus*); *n*, maxilla; *o*, maxilliped; *p*, sternal furca; *q*, caudal ramus.

thirds length of first part, tapering slightly to junction with third part. Third part elongate, slightly swollen at junction of fourth part. Fourth part short, curving inwards, inner margin with 13 denticulations (fig. 6*j*).

Postantennal process of *C. randalli* a simple, curved, spinelike process situated slightly lateral and posterior to second antenna and directed ventrally and posteriorly; with small, naked, chitinous projection and single nodule bearing two long setules present on inner proximal surface (fig. 6*k*).

Postantennal process of *C. constrictus* similar to *C. randalli* though with two setule-bearing nodules and two minute spinules on inner proximal surface.

Postoral process of *C. randalli* basically single, sharply pointed process curving laterally from origin adjacent to base of mouth cone, with membrane continuous around sharply pointed distal end but with single lateral projection on inner margin giving bifurcate appearance to process. Base of process with nodule bearing two setules (fig. 6*l*).

Postoral process of *C. constrictus* with two projections from inner margin instead of one, without membrane around distal end of process.

Maxilla of *C. randalli* two-segmented, attached just lateral and posterior to postoral process. Length of first segment slightly more than four times greatest width; lateral margins parallel through most of length, projection of inner proximal surface forming articular surface. Distal margin of first segment with several lobes forming articular surfaces for second segment. Cluster of three lobes on outer part of surface forming irregular distal concavity for ball-shaped proximal end of second segment. Second segment elongate, length slightly greater than that of first segment. Middle of second segment tapered slightly, bearing folded, membranous margin and row of setules. Inner of two terminal spines 1.3 times length of outer spine, with frilled membrane on outer and inner margins. Outer spine also with frilled membrane on outer and inner margins (fig. 6*n*).

Maxilla of *C. constrictus* similar to that of *C. randalli* though lobate distal margin replaced by slight depression.

Maxilliped of *C. randalli* two-segmented, situated slightly posterior and medial to maxilla. First segment well developed, with large projection of inner proximal surface serving as articular surface. Inner surface of segment with concave depression. First segment with small, lobate projection from posterior surface just proximal to middle of segment. Distal surface of first segment irregular, with several heavily chitinized articular surfaces. Second segment short, with long, strong, falciform terminal process; length of second segment and terminal process about two-thirds length of first segment. Second segment with small accessory spine at terminal end of segment; division between segment and process distinct (fig. 6*o*).

Maxilliped of *C. constrictus* with more distinct projection from posterior surface of first segment; with terminal process of second segment possessing minute denticulations on inner distal surface.

Sternal furca of *C. randalli* located between posterior portion of maxilliped bases. Width across base three-fifths width across tines. Bifurcation extending slightly more than half length of furca. Tines with round tips; with membrane continuous around tip of each tine (fig. 6*p*).

Tines of sternal furca of *C. constrictus* sharply pointed, not rounded as in *C. randalli.*

First thoracic leg biramous though endopodite reduced to rudiment tipped with two minute processes. Protopodite one-segmented, with inner proximal surface covered with minute projections giving segment fuzzy appearance. Two heavily chitinized knobs present as articular surfaces on proximal surface, projecting slightly from segment. First segment of exopodite long, greater than combined length of protopodite and second exopodite segment. First segment of exopodite with articular knob and small spine on outer distal corner, spine surrounded by frilled margin. Second and terminal segment of exopodite with irregular inner and distal margins; distal margin with three spines, outermost longer than inner two, triangular in cross section; inner margin of outermost spine with row of minute obtuse processes. Inner two spines on distal margin wavy, distal portion of inner margins with slight concavity, with fine membrane crossing concavity; inner margins of both spines with row of minute spinules along entire length. Inner distal corner of second segment with single, naked seta (fig. 7*a*).

Second thoracic leg biramous. Protopodite two-segmented, first segment short, approximately one-third length of second. Second segment with single naked seta on outer distal corner. Exopodite three-segmented; first segment slightly more than twice combined lengths of second and third segments, with single spine on outer distal corner, projecting across surface of second segment. Spine on first segment with serrate margins. Second segment of exopodite short, with slightly curved, serrately margined spine on outer distal corner. Third segment longer than second, ovoid, with small, serrately margined spine on outer proximal margin and slightly larger, serrately margined spine just distal to first. Endopodite three-segmented; first segment broad, outer surface lobate, rimmed with row of heavy, toothlike setules. Second segment wider than long, smaller than first segment. Third segment smaller than preceding two, distal and lateral margins continuous (fig. 7*b*).

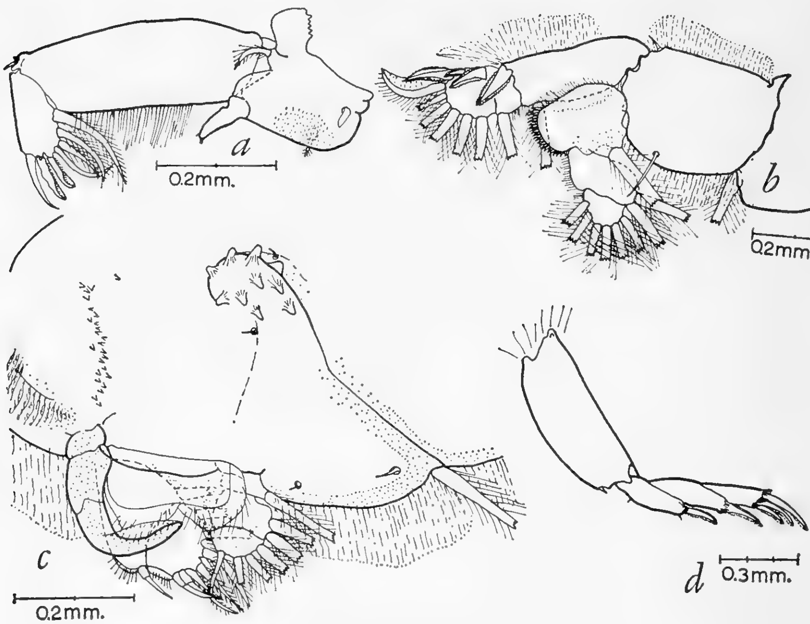

FIGURE 7.—*Caligus randalli*, new species (holotype female): *a*, first thoracic leg; *b*, second thoracic leg; *c*, third thoracic leg; *d*, fourth thoracic leg.

Third thoracic leg biramous. Protopodite broadly flattened, with cluster of ten distinct, knoblike projections from middle of inner ventral surface and longitudinal row of toothlike projections on outer ventral surface. Exopodite two-segmented, with well-developed, two-parted, bluntly pointed process arising from junction of protopodite and first segment of exopodite and curving inwards distally. Process with membranous margin along inner distal surface. First exopodite segment slightly larger than second, wider distally than proximally; second segment rounded. Endopodite three-segmented; first segment short, second and third combined, forming flat, lobate structure; proximal end of second segment narrower than distal (fig. 7*c*).

Endopodite of third thoracic leg of all specimens of *C. constrictus* examined from collections of U.S. National Museum also three-segmented, as in *C. randalli*. This is contrary to Shiino's statement (1959b) that the endopodite is two-segmented.

Fourth thoracic leg uniramous, four-segmented. Protopodite equal to combined lengths of three segments of exopodite. Outer distal corner of protopodite with small spinule. First two segments of exopodite of approximately equal size, both rounded distally, tipped with well-developed, slightly curved spine with membranous, slightly frilled margin along outer and inner margins of spines. Spine on first segment with indistinct frilled membrane around base, frilled membrane around base of second segment spine distinct. Third segment with three spines on distal surface, all with distinct frilled membrane around base. Innermost spine longest, outer two of approximately equal length, inner margins of all three spines lightly setuliferous (fig. 7*d*).

The character of the membranes, spines, and setae on the thoracic legs is given below. Except for minor variations such as the length and spacing of the setae, the thoracic legs of *C. constrictus* and *C. randalli* are identical. Because of this there is no comparison of these appendages in the two species. (For explanation of symbols, see figure 1.)

Leg	Margin	Sternal plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	outer inner		P p		rh c	3H 3P, P′				
II	outer inner	f	 P	f, p′ f, s	f, H c, P	H c, P	2H, Q, P c, 4P	c, C P	c c, 2P	c, 3P 3P
III	outer inner middle	f	f, c P, f, 2s c		H′, c, p′ c, P	c, 2p′, P′ c, 4P		 P	c c, 2P	c, P 3P
IV	outer		rh		2s, H	H	3H			

Width of caudal rami about equal to length, with six plumose setae; two long setae from middle of distal surface and two each from inner and outer distal surfaces. Inner margin setuliferous. Caudal rami arising from distal ventral surface of abdomen (fig. 6*q*—one of inner setae not visible).

Remarks.—The differences between *C. randalli* and its closest relative, *C. constrictus* Heller, are given in the general description of *C. randalli*. *C. constrictus* was not taken from Hawaiian acanthurid fishes, nor has it been taken from other fishes that have been collected from this area. *C. constrictus* has been described from the west coast of Central and North America, and the author has collected specimens (to be published) on fishes of Eniwetok atoll. These two species appear closely related morphologically although there are some distinct differences between them. The major differences are the length of the abdomen and the shape and length of the fourth thoracic leg-bearing segment. The abdomen of *C. randalli* is one and a half times the length of the abdomen of *C. constrictus;* the fourth thoracic leg-bearing segment of *C. constrictus* is 1.3 times that of *C. randalli* and does not possess the platelike structure present on the dorsal surface of the fourth thoracic leg-bearing segment of *C. randalli*. The sum of the differences between the two species—including the differences in the outline of the cephalothorax, the minor differences in the appendages, and the major differences listed above—indicate that, though the two exhibit many common characteristics and appear to be closely related, they should be considered separately.

This species is named in honor of Dr. John Randall, whose work (1961) on the biology of the manini, *Acanthurus triostegus sandvicensis*, the host of the holotype specimen of this copepod, includes a study of the parasites of the fish.

Caligus ligatus, new species

Figures 8*a–q*, 9*a–d*

Material.—Adult male (holotype, USNM 105107) taken by author from external surface of specimen of *Acanthurus dussumieri* Cuvier and Valenciennes captured in fish trap between Diamond Head and Koko Head, Oahu, Hawaii, by Samuel Kaolulo. Immature female (paratype, USNM 105108) taken by author from side of specimen of *Naso hexacanthus* (Bleeker) collected in fish trap between Diamond Head and Koko Head, Oahu, Hawaii, by Samuel Kaolulo.

Measurements.—Holotype: Length from anterior end of body to posterior end of caudal rami, excluding setae, 2.30 mm. Greatest length of cephalothorax, including frontal region, 1.38 mm.; greatest width, excluding marginal flanges, 1.19 mm. Greatest length of genital segment, excluding setae, 0.41 mm.; greatest width 0.39 mm. Greatest length of abdomen, excluding caudal rami, 0.36 mm.

Paratype: Length from anterior end of body to posterior end of caudal rami, excluding setae, 2.05 mm. Greatest length of cephalothorax, including frontal region, 1.23 mm.; greatest width of cephalothorax, excluding marginal flanges, 1.15 mm. Greatest length of genital segment 0.39 mm.; greatest width 0.38 mm. Greatest length of abdomen 0.31 mm.

Description.—Male and female with brownish base color in alcohol, with scattered orange-red spots in semi-diamond shape behind eyes, scattered irregularly over rest of cephalothorax, genital segment and third thoracic legs. Eyes red.

Cephalothorax of male elliptical, frontal region distinct though width less than half that of cephalothorax. Lunules large, extending posteriorly from anterior margin to slightly past junction of frontal region and cephalothorax (fig. 8*e*). Division between frontal region and cephalothorax distinct, trilobed, median lobe larger than slightly irregular lateral lobes. Lateral margins of cephalothorax with narrow, membranous flange. Posterior sinuses distinct, narrow, U-shaped, with small, membranous flange on outer margin. Median cephalo-

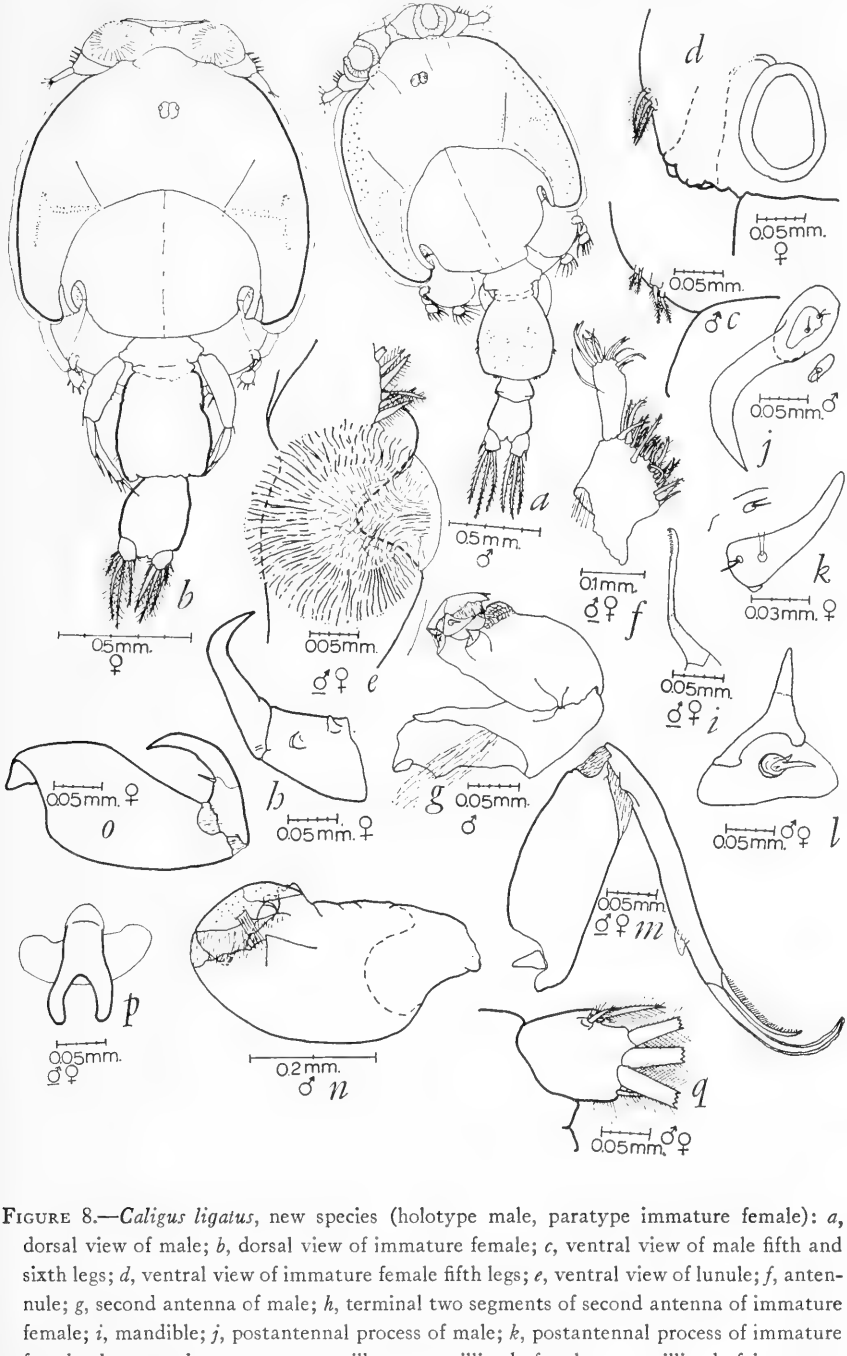

Figure 8.—*Caligus ligatus*, new species (holotype male, paratype immature female): *a*, dorsal view of male; *b*, dorsal view of immature female; *c*, ventral view of male fifth and sixth legs; *d*, ventral view of immature female fifth legs; *e*, ventral view of lunule; *f*, antennule; *g*, second antenna of male; *h*, terminal two segments of second antenna of immature female; *i*, mandible; *j*, postantennal process of male; *k*, postantennal process of immature female; *l*, postoral process; *m*, maxilla; *n*, maxilliped of male; *o*, maxilliped of immature female; *p*, sternal furca; *q*, caudal ramus.

thoracic area extending posteriorly past posterior ends of lateral regions; posterior margin convex, protruding slightly at junction of fourth thoracic leg-bearing segment. Cephalothoracic grooves distinct; major grooves in shape of irregular H with anterior and posterior end flared. Cross groove in middle of cephalothorax continuous with posterior longitudinal grooves, broadly curved anteriorly, apex with additional slight, anteriorly directed curve. Anterior longitudinal grooves extending anteriorly and laterally, terminating blindly posterior to eyes, in region of lateral margin. Light median groove present, extending from apex of cross groove posteriorly to posterior margin of cephalothorax. Eyes small, contiguous on median longitudinal axis of body, located in anterior fourth of cephalothorax between pair of indistinct, longitudinal grooves (fig. 8*a*).

Cephalothorax of immature female ovoid, frontal region similar to that of male, lunules slightly smaller, not extending on ventral surface past division between frontal region and cephalothorax. Posterior sinuses as in male. Median cephalothoracic area extending posteriorly slightly past lateral areas, not protruding at junction of fourth thoracic leg-bearing segment. Cross groove connecting longitudinal cephalothoracic grooves evenly curved, without slight anterior median curve present in male. Character of remaining cephalothoracic grooves as in male. Eyes slightly larger than those of male; grooves bounding eyes in male terminating anterior to eyes in immature female (fig. 8*b*).

Division between cephalothorax and fourth thoracic leg-bearing segment distinct in male and immature female. Fourth thoracic leg-bearing segment wider anteriorly, at region of fourth thoracic leg attachment, than posteriorly. Fourth thoracic leg-bearing segment fused to genital segment, posterior lateral margins lobed, constrictions between lobes appearing as fine, discontinuous lines; lobed condition more distinct in male than in immature female.

Genital segment of male small, ovoid, posterior margin slightly convex. Fifth legs appearing as two minute, plumose setae from posterior ventral lateral surface. Sixth legs present as three minute, plumose setae from slight protrusion on posterior ventral surface (fig. 8*c*).

Genital segment of immature female irregular, longer than wide; posterior margin irregular. Fifth legs visible on posterior lateral margin as group of three small, plumose setae, two projecting from single, slight protrusion of segment, third from second slight protrusion just anterior to first (fig. 8*d*).

Abdomen of male two-segmented, attached to posterior surface of genital segment. First segment short, bell-shaped, second segment one and a half times length of first, wider posteriorly than anteriorly but tapering along posterior margins to narrow, terminal, anal region.

Abdomen of immature female one-segmented, slightly larger than second abdominal segment of male. Anterior surface slightly narrower than posterior, lateral margins broadly convex.

Antennule of male and immature female two-segmented, excluding frontal plate, attached to ventral surface of frontal region under free surface of lunule. First segment one and one-fourth times length of second; wider in middle than at either end. Proximal portion of anterior margin curving concavely outwards to widest point then convexly to narrow distal surface. Distal half of anterior margin with about 22 plumose setae. Second segment club-shaped, with naked seta on distal portion of posterior margin, 15 naked setae from rounded distal surface (fig. 8*f*).

Second antenna of male three-segmented, attached medially and slightly posterior to antennule. First segment long, length equal to that of second segment; broader proximally than distally, attached to cephalothorax along most of inner surface. Distal end of first segment irregularly concave, forming articular surface for second segment. Second segment well developed, proximal two-thirds of inner margin broadly convex, with small, slightly protruding adhesion pad just proximal to inner distal surface and small, acuminate projection on posterior distal surface. Distal surface of second segment irregular, with several articular surfaces not appearing heavily chitinized. Third segment and processes small, less than half length of second segment. Terminal process projecting slightly past region of third segment attachment, forming minute, bifid, sharply pointed structure (fig. 8*g*).

Second antenna of immature female three-segmented, much more weakly developed than that of male. First segment (not shown in figure) short, forming articular surface for second segment, with small, spinelike process projecting posteriorly from posterior margin. Second segment slightly broader proximally than distally, with small, lobate projection from proximal region of posterior surface and small, lappet-like structure from middle of distal region of posterior surface. Third segment and terminal process forming acuminate, spinelike structure; division between segment and process not visible; terminal process curving sharply inwards distally (fig. 8*h*).

Mandible of male and immature female four-parted. First part broader proximally than distally, with even taper to junction of second part. Second part short, about half length of first part, tapering sharply to junction with third part. Third part elongate, slightly swollen distally, at junction with fourth part. Fourth part short, slightly more than half length of third part, curved inward; outer surface thicker than inner surface, inner surface with 12 toothlike denticulations (fig. 8*i*).

Postantennal process of male simple, spinelike process attached lateral to base of second antenna. Base of process a heavily chitinized ring, rest of process slender, falciform, acuminate. Two minute nodules present on basal region, each bearing minute setules. Third nodule present just posterior and medial to base, arising from small plate; third nodule with two minute setules (fig. 8*j*).

Postantennal process of immature female without ringlike base, spine heavier and shorter than that of male (fig. 8*k*).

Postoral process of male and immature female simple, spinelike structure attached lateral to base of mouth cone. Process sharply pointed, with very fine horizontal line dividing process into acuminate distal and broadly tapering proximal parts. Node present just anterior to proximal end of process and bearing three setules (fig. 8*l*).

Maxilla of male and immature female two-segmented, attached adjacent to postoral process. First segment well developed, oblong, greatest width slightly more than one-third greatest length. Lateral margins almost parallel; inner proximal surface projecting as articular surface, distal margin angling sharply inwards from both lateral margins and projecting in outer medial region as narrow articular surface with slightly concave distal end. Second segment slightly longer than first, slender, with little taper throughout length except at proximal and extreme distal ends. Small, membranous projection present on inner margin in distal third of second segment. Two elongate spines on distal end of segment, inner spine one and one-third times length of outer, with plain, light membrane along both inner and outer margins; inner spine with frilled membrane along outer margin, very fine, plain membrane along inner (fig. 8*m*).

Maxilliped of male two-segmented, located medially and slightly posterior to maxilla. First segment strongly developed, inner surface of proximal end projecting slightly as broad articular surface, with heavily chitinized knob on outer proximal corner. Distal end slightly less than half greatest width of segment. Inner lateral margin with protrusion of segment in distal region, protrusion receiving terminal process of third segment when segment flexed. Third segment and process short, less than half length of first segment, terminal process short, acuminate, slightly curved. Seta-like accessory process present on inner margin of segment at junction of segment and terminal process. Inner proximal corner with small, heavily chitinized, knob-like articular process. Division between segment and terminal process distinct (fig. 8*n*).

Maxilliped of immature female two-segmented, first segment similar to that of male except protrusion of inner surface absent. Second segment and terminal process more elongate than in male, more weakly developed. Accessory process from inner distal margin of segment as in male; division between segment and terminal process distinct (fig. 8*o*).

Sternal furca of male and immature female situated between, and slightly posterior to, bases of maxillipeds. Bifurcation extending slightly less than half total length of structure. Tines of furca curving outwards proximally, slightly inwards distally. Distal end of tines bluntly rounded. Base of sternal furca attached to small, butterfly-shaped plate (fig. 8*p*).

First thoracic leg biramous though endopodite reduced to small protuberance on inner surface at junction of protopodite and exopodite. Single segment of protopodite slightly less than three-fourths length of first segment of exopodite, outer proximal margin with slight protrusion serving as articular surface, remaining proximal surface slightly concave, heavily chitinized. Protopodite with short, plumose seta on inner proximal surface and longer plumose seta from outer distal corner. First segment of two-segmented exopodite with spinule and protruding knob on outer distal corner. Greatest length of second segment slightly less than half that of first; distal surface with three spines and naked seta, outermost spine simple, longer than inner two, bifid-tipped spines; inner lateral margin with three plumose setae (fig. 9*a*).

Second thoracic leg biramous. Protopodite two-segmented; first segment short, second segment broad, width slightly greater than length, with small spine on outer distal corner. Exopodite three-segmented; first segment slightly longer than combined lengths of second and third, with spinule projecting from outer distal corner at base of large, well-developed spine curving inward across surface of second segment. Second segment short, about half length of third segment, with large spine projecting from outer distal corner across surface of third segment. Distal margin of third segment convex; third segment with single spine with membrane along both margins, third segment spine, with spinule present at base, on distal lateral surface. Endopodite three-segmented, first segment with single, small spine on distal outer surface; second segment equal to combined lengths of first and third segments, with row of stiff setules along outer lateral margin. Third segment short, lateral and distal margins continuous (fig. 9*b*).

Third thoracic leg biramous. Protopodite broadly flattened, with cluster of small denticulations on outer surface. Exopodite two-segmented; first segment with two-parted, spinelike process from junction of exopodite and protopodite, distal half of spinelike process curving inwards. First segment of exopodite longer than second

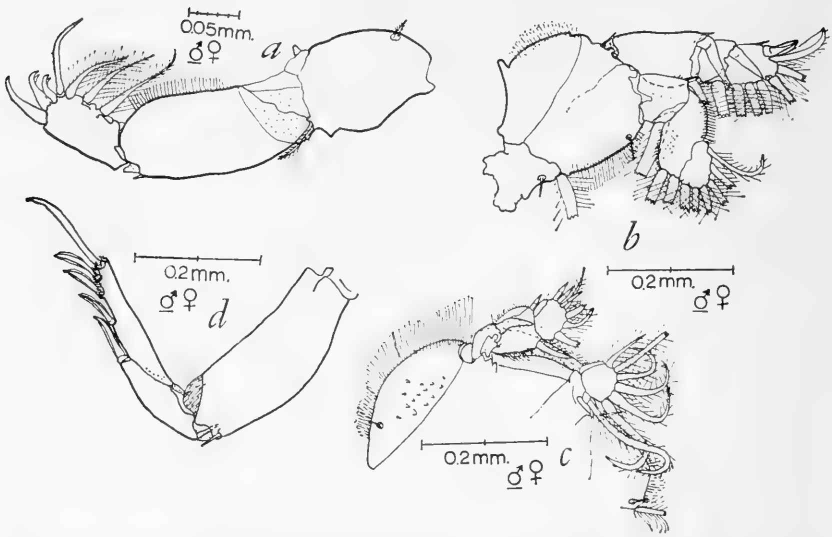

Figure 9.—*Caligus ligatus*, new species (holotype male, paratype immature female): *a*, first thoracic leg; *b*, second thoracic leg; *c*, third thoracic leg; *d*, fourth thoracic leg.

segment; lateral and distal margins of second segment continuous, segment with semicircular appearance. Endopodite two-segmented, proximal margin of first segment indistinct; second segment semicircular, similar to second exopodite segment in shape (fig. 9*c*).

Fourth thoracic leg uniramous, three-segmented. Protopodite one-segmented, almost equal in length to combined lengths of two segments of exopodite. Proximal surface of protopodite with small projection on inner medial portion forming articular surface; distal surface with small spine on outer portion, knoblike articular surface from median portion. First segment of exopodite short, distal end forming shelf-like projection from outer margin of segment and bearing single, well-developed spine. Second segment of exopodite with slender, rodlike process overlying inner margin of first segment. Outer and distal margins of second segment continuous, with four strongly developed spines spaced along margin, proximal spine in close proximity to terminal spine of first segment; terminal spine longest, proximal three spines of approximately equal length. Basal portion of terminal and adjacent two spines surrounded by frilled margin, that of terminal spine arising from spinelike projection of inner margin. All major spines with membrane along inner and outer margins, membranes of terminal spine minute, discontinuous (fig. 9*d*).

The character of the membranes, spines, and setae on the thoracic legs is given below. The thoracic legs of both the male and the immature female are identical except for the fourth thoracic leg which in the immature female, is incompletely developed. (For explanation of symbols, see figure 1.)

Leg	Margin	Sternal plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	outer		p		rh	3H				
	inner		p		c	3P, P′				
II	outer			f, rh	rh, H	H	rh, H, Q, P	c, rh	C, c	c, 4P
	inner		s, P	f, s	c, P	c, P	c, 4P	P	c, 2P	2P
III	outer	f	f, s		H′, c, p′	c, 3p′			c, 2P	
	inner		P, 2s, f		c, P	c, 4P		P	4P	
	middle		c							
IV	outer		rh		H	4H				

Caudal ramus of male and immature female forms about three-fourths length of second abdominal segment of male, length greater than width. Caudal ramus with six-plumose setae, one from median ventral lateral surface, second from lateral margin just posterior and lateral to base of first, three long setae from median posterior margin, and one small seta from inner posterior corner.

Remarks.—*Caligus ligatus* resembles *C. praetextus* Bere, 1936, in general body shape and the second antenna but differs from this species in the shape of the fourth thoracic leg-bearing segment and the genital segment and in the appendages other than the second antenna. The constricted shape of the region of fusion of the fourth thoracic leg-bearing segment and the genital segment is also found in *C. constrictus* Heller although the appendages of this species and those of *C. ligatus* are quite different; *C. constrictus* possesses, for example, a four-segmented fourth thoracic leg but that of *C. ligatus* is only three-segmented. The arrangement of the fourth thoracic leg spines is found in several species of *Caligus* (*C. longicervicis* Gnanamuthu, 1949; *C. sphyraenae* Nunes-Ruivo and Fourmanoir, 1956; *C. quadratus* Shiino, 1954), but the combination of characteristics presented by *C. ligatus* is unique.

The name "ligatus" is used in reference to the constrictions of the posterior portion of the fourth thoracic leg-bearing segment.

Caligus kalumai, new species

Figures 10*a–q*

Material.—Adult, nonovigerous female (holotype, USNM 105109) collected by author from side of specimen of *Acanthurus guttatus* Bloch and Schneider taken by poison near Nanakuli, Oahu, Hawaii, by Dr. William Gosline and others.

Measurements.—Length from anterior end of body to posterior end of caudal rami, excluding setae, 2.94 mm. Greatest length of cephalothorax, including frontal region, 1.75 mm.; greatest width, excluding marginal flange, 1.75 mm. Greatest length of genital segment 0.90 mm.; greatest width 1.11 mm. Greatest length of abdomen 0.25 mm.

Description.—Body with light brown background coloration in alcohol, mottled with yellow and with few scattered red and blue pigment spots over cephalothorax, fourth thoracic leg-bearing segment, genital and abdominal segments. Eyes reddish.

Cephalothorax orbicular; frontal region well developed, with narrow anterior marginal flange. Lunules distinct, extending to division between frontal region and cephalothorax (fig. 10*c*). Groove between frontal region and cephalothorax distinct, continuous, curving anteriorly in smooth, flat curve in middle. Lateral margins of cephalothorax with membranous flange. Posterior sinuses distinct, U-shaped. Median cephalothoracic area extending posteriorly slightly past posterior extensions of lateral regions; posterior margin of area flattened. Lateral corners of protruding median cephalothoracic area rounded, lateral margins continuous with inner margin of posterior sinuses. Major cephalothoracic grooves distinct, forming irregular H; cross groove continuous with posterior longitudinal grooves. Middle of cross groove forming flat anteriorly directed point though apex with slight depression. Posterior longitudinal grooves slightly convex; anterior longitudinal grooves extending anteriorly and laterally from junction with cross and posterior longitudinal grooves, terminating blindly posterior to eyes, medial to lateral margin. Lateral strengthening regions extending laterally from origin just anterior to junction of longitudinal and cross grooves, curving posteriorly and tapering out in region of posterior lateral margins. Two minor grooves present, extending posteriorly from either side of anterior curvature of groove between frontal region and cephalothorax, terminating just anterior to eyes. Light median longitudinal groove present extending posteriorly from slight median depression of major cross groove to posterior margin of thoracic area. Eyes small, contiguous on median longitudinal axis of body in anterior fourth of cephalothorax (fig. 10*a*).

Fourth thoracic leg-bearing segment, genital segment, and abdomen fused. Region of fourth thoracic leg-bearing segment tapered outward sharply from junction of cephalothorax to region of fourth thoracic leg attachment, adjacent to anterior lateral surface of genital segment. Fourth thoracic leg-bearing segment tapered inward slightly from widest point to beginning of genital segment. Division between fourth thoracic leg-bearing segment and genital segment

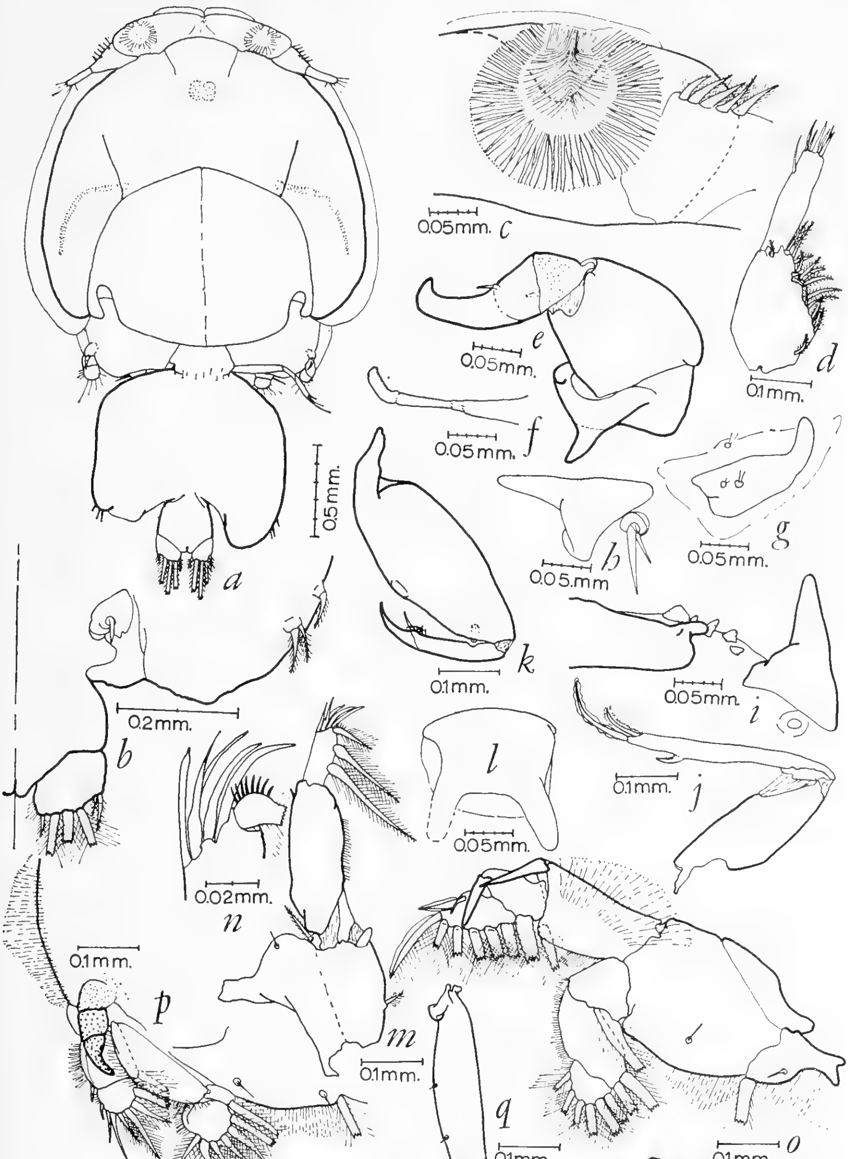

FIGURE 10.—*Caligus kalumai*, new species (holotype female): *a*, dorsal view; *b*, ventral view of fifth legs, abdomen, and caudal ramus; *c*, ventral view of lunule; *d*, antennule; *e*, second antenna; *f*, mandible; *g*, postantennal process; *h*, postoral process; *i*, projections on ventral surface of cephalothorax between postoral process and maxilla, postoral process on right, maxilla on left; *j*, maxilla; *k*, maxilliped; *l*, sternal furca; *m*, first thoracic leg; *n*, distal end of terminal segment of first thoracic leg; *o*, second thoracic leg; *p*, third thoracic leg; *q*, fourth thoracic leg.

visible as very fine groove extending from junction of segments medially, on each side, for about one-fourth width of region; no evidence of division present in middle of segment.

Genital segment swollen, lateral margins almost parallel; posterior lateral regions of segment protruding as irregular lobes; lobes extending to posterior lateral corners of abdomen. Median posterior surface depressed. Fifth legs visible dorsally as three small, plumose setae projecting from posterior lateral margin, single seta from small nodule, two setae from second nodule just posterior to first (fig. 10*b*).

Abdomen one-segmented, width approximately equal to length; widest at posterior lateral corners, margins curving medially both anteriorly and posteriorly, anteriorly in convex curve to region of fusion of abdomen and genital segment, posteriorly in concave curve to slightly projecting anal region (fig. 10*b*).

Antennule two-segmented, excluding frontal plate, attached to frontal region under free surface of lunule, at junction of frontal region and cephalothorax. Greatest length of first segment slightly more than that of second. First segment wider in proximal region than at either end, tapering abruptly to proximal end, gradually to distal; distal end irregular. Anterior surface with about 23 plumose setae. Second segment slender, slightly wider in middle than at either end. Second segment with naked seta on distal region of posterior margin, nine naked setae from distal surface (fig. 10*d*).

Second antenna three-segmented, attached posterior and slightly medial to base of antennule. First segment short, forming articular surface for second segment. Distal surface of first segment concave, posterior surface protruding posteriorly as blunt-tipped, spinelike projection. Second segment wider proximally than distally, lateral margins convex. Greatest width of second segment slightly less than greatest length. Distal margin of segment irregular, inner portion with concave depression; several points of articulation present as heavily chitinized regions. Third segment and terminal process elongate, longer than greatest length of second segment, with two accessory processes, spinelike process on posterior surface of distal end of segment and two-parted, sharp-tipped process on anterior proximal surface of segment. Base of third segment heavily chitinized, protruding slightly proximally as small, rounded articular surface. Terminal process curving sharply in distal region, distal end bluntly pointed (fig. 10*e*).

Mandible four-parted. First part wider proximally than distally, with even taper to junction of second part. Second part short, approximately one-fifth length of first part, tapered slightly to junction of third part. Third part slightly shorter than first part, expanded slightly distally. Fourth part short, half length of first part, width greater than that of distal end of third part. Fourth part curved inward, distal end broadly rounded, inner margin with 11 blunt, toothlike denticulations (fig. 10*f*).

Postantennal process simple, blunt-tipped, spinelike process projecting posteriorly in slight curve from attachment lateral and slightly posterior to base of second antenna. Proximal surface broad, tapering sharply in middle of process to inward curving distal region. Proximal region with two nodules, each with two minute setules; additional nodule present medial to middle of process, projecting slightly from ventral surface of cephalothorax, bearing two minute setules (fig. 10*g*).

Postoral process simple, spinelike, projecting posteriorly from attachment lateral and slightly posterior to base of mouth cone. Outer lateral margin irregularly concave, inner lateral margin straight. Single nodule present anterior to base of process, bearing three setule-like projections (fig. 10*h*).

Maxilla two-segmented, attached just lateral to base of postoral process. Cephalothorax, in region of attachment of maxilla, with several small, heavily chitinized, spinelike processes (fig. 10*i*). First segment with slender projection from inner proximal surface serving as articular surface. Distal lateral margins angling sharply inward to slightly projecting articular surface. Second segment elongate, length slightly greater than greatest length of first segment; proximal surface tapered, inner portion irregular, forming articular surface. Second segment with sharply pointed spine on distal region of inner margin, two flexible spines projecting from distal surface of segment. Inner terminal spine almost twice length of outer, fringed by fine membrane along both margins; outer spine with fine, setuliferous membrane along both margins (fig. 10*j*).

Maxilliped two-segmented, situated posterior and medial to first maxillipeds. First segment obovoid, with strong projection of proximal surface forming articular surface. Middle of inner lateral margin of first segment with small, convex process. Distal surface concave, forming region of attachment and articulation of second segment; distal lateral surface with small, heavily chitinized, knoblike projection. Second segment slender, slightly wider proximally than distally; with small concavity on inner proximal margin, fitting over slight projection of distal lateral surface of first segment when second segment flexed. Second segment with short, inward-curving terminal process and two small, spinelike accessory processes, both on inner surface of distal region of segment. Both accessory processes surrounded by fine, frilled membrane. Division between terminal process and segment distinct (fig. 10*k*).

Sternal furca attached to ventral surface of cephalothorax between, and slightly posterior to, maxilliped bases. Width of base of furca equal to distance between outer distal margins of tines. Right tine broken on holotype specimen; left tine with rounded distal margin. Tines directed laterally from origin at apex of bifurcation. Bifurcation extending two-fifths length of process; apex flat, length slightly less than half width of base (fig. 10*l*).

First thoracic leg biramous though endopodite reduced to simple, minute lobe on inner distal surface of protopodite. Protopodite one-segmented, inner proximal surface extending as small articular process. First segment of two-segmented exopodite slightly longer than protopodite; proximal and distal margins irregular. First segment with single, small spine on outer distal margin. Second segment of exopodite short, less than half length of first segment. Distal margin of second segment with four flexible processes, innermost spinelike, second outermost bifid (fig. 10*n*). Inner lateral margin of second segment with three plumose setae, distalmost seta with stiff setules on proximal portion (figs. 10*m*,*n*).

Second thoracic leg biramous. Protopodite two-segmented; first segment short, proximal region slender, proximal end a two-lobed articular surface. Second segment broad, greatest width twice that of first segment; greatest length slightly more than twice that of first segment. Distal end of second segment irregular. Exopodite three-segmented; greatest length of first segment equal to that of combined second and third segments. First segment with strong, simple spine on outer distal corner, directed at angle across outer distal corner of second segment. Second segment short, with strong, simple spine on outer distal corner, directed at an angle across middle of third segment. Third segment longer than second, width greater than length; lateral margins with irregular convex curve, distal margin forming rounded apex of union of lateral margins. Outer lateral margin of third segment with two spines, small spine from middle of segment curving medially, second spine just distal to first, more strongly developed, with thin membrane along inner and outer margins. Endopodite three-segmented; first and third segments shorter than second. Third segment broadly rounded (fig. 10*o*).

Third thoracic leg biramous. Protopodite one-segmented, broadly flattened. Exopodite two-segmented, with three-parted, spinelike process arising from junction of protopodite and exopodite, and curving inward. First segment of exopodite almost twice length of second, second segment broadly rounded, distal and lateral margins continuous. Endopodite two-segmented; first segment short, with indistinct proximal margin, second segment broadly rounded laterally, flattened distally (fig. 10*p*).

Fourth thoracic leg uniramous, three-segmented. Protopodite one-segmented, slightly longer than combined length of two segments of expodite. Protopodite slender, with two hairlike setules from outer surface, one in proximal region, second in distal region; single, small, plumose seta present on outer distal corner. Greatest length of first exopodite segment slightly less than that of second; with single, elongate spine from distal surface. Second segment of exopodite with three spines on flat distal surface, inner spine longest, outer shortest. All four spines on two segments of exopodite with fine membrane along inner and outer margins; three terminal spines, on second segment, with frilled membrane around base (fig. 10*q*).

The character of the membranes, spines, and setae on the thoracic legs is given below (for explanation of symbols, see figure 1):

Leg	Margin	Sternal plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	outer		s, p		rh	4H				
	inner		p		c	3P				
II	outer	f			f, H	H	2H, Q	c	c	c, 3P
	inner		f, s, P	f, s	c, P	c, P	5P	P	c, 2P	3P
III	outer		f		H′, c, p′	c, 3p′			c, 2P	
	inner	f	P, 2s, f		c, P	c, 3P		P	4P	
	middle		c							
IV	outer		2s, P		H	3H				

Width of caudal ramus greater than length, greatest length approximately two-thirds length of abdomen; inner margin setuliferous. Six plumose setae present on distal margin, one short seta from inner corner, two short setae from outer corner, three long setae from middle of posterior margin (fig. 10*b*).

Remarks.—The fusion of the fourth thoracic leg-bearing segment, genital segment, and abdomen of *C. kalumai* is found in several members of the genus *Caligus*. In general characteristics *C. kalumai* most closely resembles *C. oviceps* Shiino, 1952, and *C. punctatus* Shiino, 1955; it differs from *C. oviceps* by the presence of three segments in the fourth thoracic leg instead of four, the nature of the terminal processes on the first thoracic leg, the presence of two naked spines on the third segment of the exopodite of the second thoracic leg instead of the single plumose spine noted by Shiino for *C. oviceps*, and by other characteristics. *C. punctatus* and *C. kalumai* differ primarily in the characteristics of the first and fourth thoracic legs, *C. punctatus* with short, stiff terminal processes on the first leg, in contrast to the longer, more flexible processes of *C. kalumai;* they differ also in the presence of two marginal, hairlike setules on the protopodite of the fourth thoracic leg of *C. kalumai*, which are absent on *C. punctatus*. In addition, the second segment of the exopodite of *C. punctatus*, as shown by Shiino (1955), appears much longer than the first segment while it is only slightly longer than the first segment in *C. kalumai*. Other characteristics serve to differentiate these two species, but it appears that these two, in addition to *C. oviceps*, are morphologically similar.

The name "kalumai" is derived from two Hawaiian words. The first word, "kalumu," means "to swell." The second, "ma'i," is the term for genitals. The combination of the two terms is used to indicate the condition of the genital segment in the holotype female specimen.

Genus *Lepeophtheirus* Nordmann, 1832

Diagnosis.—Abdomen of one or two segments, usually distinct from genital segment. Lunules absent. Postoral process simple or bifurcate; sternal furca present. First three thoracic legs biramous though endopodite of first rudimentary; fourth leg uniramous, typically with four segments.

Remarks.—Nordmann does not give a synopsis of the characters of the genus in his 1832 publication. The characteristics given above were taken primarily from Wilson (1932) and were modified from descriptions of members of the genus *Lepeophtheirus* given by other authors and from the personal experience of the present author.

Lepeophtheirus dissimulatus Wilson

Figures 11*a–g*, 12*a–r*

L. dissimulatus Wilson, 1905a, p. 631, pl. 22.—Linton, 1907, p. 120.—Brian, 1924, p. 20.—Heegaard, 1943b, p. 20.—Yeatman, 1957, p. 350, figs. 17–31.—Shiino, 1959b, p. 305, figs. 15–16.—Causey, 1960, p. 330.

Distribution.—Bermuda, British West Indies, Dry Tortugas Islands, Galapagos Islands, Revilla Gigedo Islands, Baja California, British Columbia, Mexico, Hawaii.

Hosts.—*Epinephalus morio* (Cuvier and Valenciennes), *E. labriformis* (Jenyns), *E. guaza* (Linnaeus), *Mycteroperca venennosa apua* (Bloch), *Lactophrys trigonus?* (Linnaeus), *Gadus macrocephalus* Tilesius, *Bodianus diplotaenia* (Gill), *Merluccius productus* (Ayres), *Paralichthys californicus* (Ayres), *Hypsopsetta guttulata* (Girard), *Sphyraena argentea* Girard, *Paralabrax nebulifer* (Girard), *Sphaeroides annulatus* (Jenyns), *Galeichthys guatamelensis* (Günther), *Acanthurus olivaceous* Bloch and Schneider, *A. dussumieri* Cuvier and Valenciennes, *A. guttatus* Bloch and Schneider, *A. triostegus sandvicensis* Streets, *Naso hexacanthus* (Bleeker), *Chaetodon quadrimaculatus* Gray, *Zebrasoma flavescens* (Bennett).

MATERIAL.—Eleven adult females from gill cavity of *Acanthurus olivaceous* Bloch and Schneider (USNM 105091), ten adult females and one adult male from external surface and gill cavities of *Acanthurus triostegus sandvicensis* Streets (USNM 105092), one adult male from external surface of *Acanthurus olivaceous* Bloch and Schneider (USNM 105093), and one immature male from external surface of *Zebrasoma flavescens* (Bennett) (USNM 105090). These 24 specimens were selected from a collection of over 300 specimens taken from Oahu, Hawaii, by the author and represent the Hawaiian population of this species in the following description.

MEASUREMENTS.—Thirteen adult females: Average length from anterior margin to posterior end of caudal rami, excluding setae, 2.30 mm.; range 1.93–3.04 mm. Average of greatest length of cephalothorax, including frontal region, 1.47 mm.; range 1.01–1.93 mm. Average of greatest width of cephalothorax, excluding marginal flange, 1.47 mm.; range 1.29–1.84 mm. Average of greatest length of genital segment 0.62 mm.; range 0.49–0.78 mm. Average of greatest width of genital segment 0.70 mm.; range 0.57–0.98 mm. Average of greatest length of abdomen, excluding caudal rami, 0.12 mm.; range 0.08–0.21 mm.

One adult male: Length from anterior end of body to tips of caudal rami, excluding setae, 2.20 mm. Greatest length of cephalothorax, including frontal region, 1.58 mm.; greatest width, excluding marginal flanges, 1.42 mm. Greatest length of genital segment 0.40 mm.; greatest width 0.33 mm. Greatest length of abdomen, excluding caudal rami, 0.12 mm.

DESCRIPTION.—Body of female and male light yellow or yellowish brown in alcohol with scattered blue and few red pigment spots, some stellate, over entire body but concentrated on posterior portion of cephalothorax and genital segment. Eyes red.

Cephalothorax of female and male ovoid, frontal region distinct, separated from cephalothorax by distinct groove. Lateral margin of cephalothorax with distinct membranous flange. Posterior sinuses distinct, of shallow V-shape. Median thoracic region extending posteriorly slightly past posterior extension of lateral regions. Middle of third thoracic leg-bearing segment protruding slightly, forming junction of third and fourth leg-bearing segments. Major cephalothoracic grooves in form of irregular H with lateral distance between ends of H greater than length of anteriorly curving cross groove. Heavily chitinized, barlike strengthening process extending from region of junction of cross groove with two longitudinal grooves laterally and posteriorly, terminating in region of lateral margin. Other indistinct grooves present in region of eyes and frontal plates. Eyes distinct, situated in anterior region of cephalothorax. Two

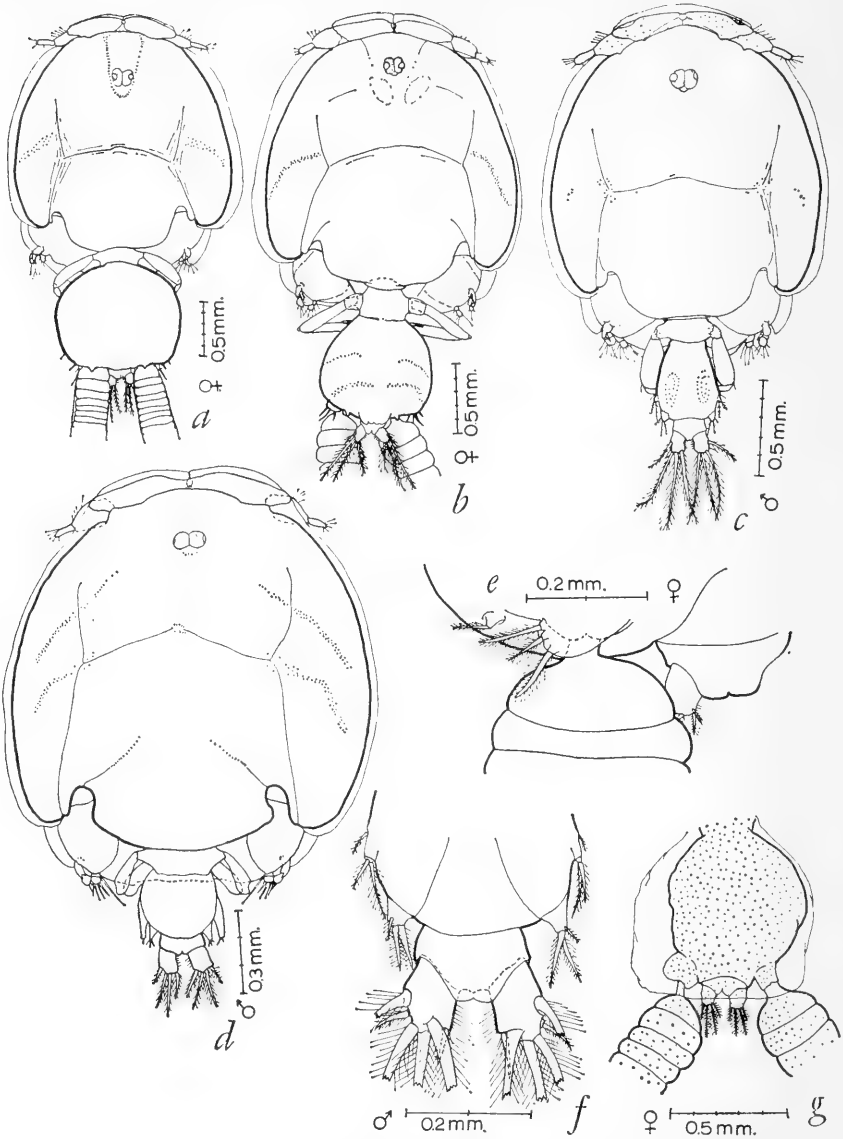

FIGURE 11.—*Lepeophtheirus dissimulatus* Wilson, 1905: *a*, dorsal view of lectotype; *b*, dorsal view of Hawaiian female; *c*, dorsal view of Hawaiian male; *d*, dorsal view of aberrant, immature Hawaiian male; *e*, ventral view of female fifth legs, proximal end of egg string, and abdomen; *f*, ventral view of male fifth and sixth legs, abdomen, and caudal rami; *g*, dorsal view of genital segment of recently ovulated female showing flaccid condition of segment.

major eyes contiguous on median longitudinal axis of body. Median eye remnant present, filling depression formed by converging posterior margins of major eyes (fig. 11*b*).

Fourth thoracic leg-bearing segment of female and male short, lateral regions drawn out in region of fourth leg attachment so that middle of segment wider than either end. Terminal portion of lateral extension cup-shaped, forming socket-like attachment for fourth thoracic legs. Division between fourth thoracic leg-bearing segment and genital segment distinct.

Shape of female genital segment variable, dependent upon number of eggs in segment. Segment flaccid and ovoid, surrounded by loose membrane, in females that recently have extruded egg strings; almost circular in females in which genital segment packed with eggs (figs. 11*b*,*g*). Fifth legs seen ventrally as lobelike projections from posterior ventral surface of genital segment, just lateral to nodelike projection of posterior surface, bearing three plumose setae; additional plumose seta present slightly lateral and anterior to first three (figs. 11*b*,*e*,*g*).

Genital segment of male ovoid, width about three-fourths length. Fifth and sixth legs distinctly visible protruding from segment. Fifth legs small, lappet-like, bearing single, short, plumose seta from base and two plumose setae from distal end, inner seta almost twice length of outer. Sixth legs also lappet-like, more distinct than fifth legs; lappet-like structure with three plumose setae from distal surface (fig. 11*f*).

Abdomen of female short, less than one-third length of genital segment. Both Wilson (1905) and Shiino (1959) indicate that the abdomen arises from the ventral surface of the genital segment. The point of attachment, however, appears to depend on the size of the genital segment. In females with an empty genital segment the abdomen joins to the ventral surface; in those with the genital segment full of eggs the abdomen attaches to the middle (in lateral view) of the posterior surface of the segment.

Abdomen of male similar to that of female though width slightly less than that of female abdomen. Junction of genital segment and abdomen on posterior ventral surface of genital segment.

Length of egg strings variable, containing 10–30 eggs with average of 15. Number of eggs in egg strings of each specimen usually equal, differing by not more than two.

Antennule of female two-segmented, excluding frontal plate, attached to frontal region near posterior lateral margin, lateral edge of frontal region overlapping first segment slightly. First segment about two times length of second, wider in proximal region than in distal, with small, bifurcate protrusion on posterior distal corner. First segment with 20 plumose setae on anterior surface. Width of second segment slightly less in proximal than in middle and distal regions. Second segment with naked seta on middle of posterior surface, 12 naked setae on distal surface (fig. 12*a*).

Antennule of male similar to that of female except bifurcate process present on first segment more distinct, dentate instead of crenate as in female (fig. 12*b*).

Second antenna of female three-segmented, attached to ventral surface just anterior and medial to postantennal process and posterior and lateral to base of antennule. First segment short, forming broad articular surface for second segment. First segment with posteriorly directed, spinelike projection from posterior proximal surface. Second segment strongly developed, greatest width equal to greatest length. Third segment slender, heavily chitinized, with strongly developed, sharply curved, spinelike terminal process. Third segment also with two naked, seta-like accessory processes, one from inner surface of proximal region, second from distal lateral surface. Division between third segment and terminal process visible though incomplete (fig. 12*c*).

Second antenna of male three-segmented. First segment broader proximally than distally, attached to cephalothorax along entire length of proximal surface. Distal end of first segment small, two-pronged, forming articular surface for second segment. First segment with adhesion surface of heavily chitinized, overlapping, platelike structures along major portion of outer lateral surface. Second segment strongly developed; greatest width, in proximal region, slightly more than half greatest length. Outer margin strongly convex proximally, inner margin irregular due to presence of two sets of adhesion surfaces similar to those of first segment. Inner distal surface of second segment with finger-like protrusion; protrusion appearing segmented but segment-like structures probably comparable to heavily chitinized, platelike structures of other adhesion surfaces. Fingerlike protrusion not mentioned by Wilson (1905), Yeatman (1957), or Shiino (1959), but present on material identified by Wilson and Yeatman as *L. dissimulatus*. Protrusion in most specimens curved around second segment and appearing as regular adhesion surface but process not attached to second segment except at proximal end. Third segment with bifurcate terminal process, also with single, naked, seta-like accessory process from distal end (fig. 12*d*).

Mandible of female and male four-parted. First part slightly wider proximally than distally, with even taper to junction of second part. Second part shortest of four, tapered evenly from junction of first to junction of slender third part. Third part rodlike, length almost equal to combined lengths of first two parts. Fourth part slightly longer than second, flattened laterally, slightly thicker along

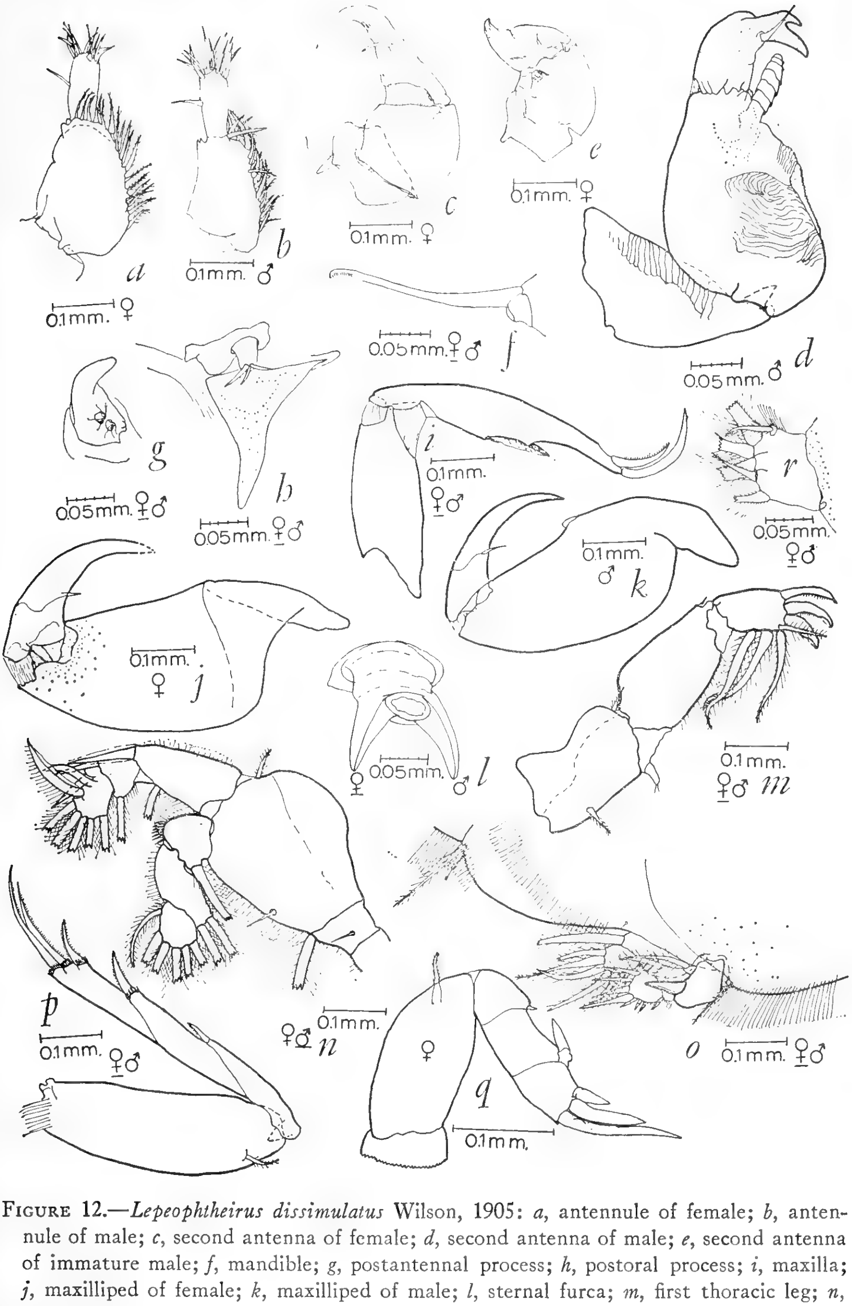

FIGURE 12.—*Lepeophtheirus dissimulatus* Wilson, 1905: *a*, antennule of female; *b*, antennule of male; *c*, second antenna of female; *d*, second antenna of male; *e*, second antenna of immature male; *f*, mandible; *g*, postantennal process; *h*, postoral process; *i*, maxilla; *j*, maxilliped of female; *k*, maxilliped of male; *l*, sternal furca; *m*, first thoracic leg; *n*, second thoracic leg; *o*, third thoracic leg; *p*, fourth thoracic leg; *q*, fourth thoracic leg of immature male; *r*, caudal ramus.

outer margin than along inner, distal half curved inwards, inner margin with 12 toothlike denticulations (fig. 12*f*).

Postantennal process of female and male simple, spinelike, attached lateral and slightly posterior to second antenna. Spinelike process curved inward, distal end rounded; two nodules present on inner proximal region, proximal nodule with three setules, distal nodule with four (fig. 12*g*).

Postoral process of female and male flattened, spinelike, situated just lateral to base of mouth cone and directed posteriorly. Process with broad base, width slightly less than length, tapered irregularly to bluntly pointed distal end. Small, conical node present just anterior to base of process, bearing three setules of approximately equal length (fig. 12*h*).

Maxilla of female and male two-segmented, attached just lateral and posterior to postoral process. First segment short, stocky, inner proximal end protruding as irregular articular surface. Distal lateral margins of first segment tapered irregularly, projecting medially as narrow, lobelike articular surface. Second segment elongate, lateral margins irregularly convex; inner proximal surface irregular, forming articular surface and place of attachment for muscles moving segment. Middle of inner margin indented in two places, minute spine arising from proximal indentation, larger spine, about twice length of first, arising from distal indentation; membrane present, connecting both spines. Smaller proximal spine and membrane not mentioned by Wilson (1905), Yeatman (1957), or Shiino (1959), though both characteristics present on material identified by Wilson and Yeatman as *L. dissimulatus*. (Both membrane and small proximal spine difficult to see unless appendage stained.) Second segment with two long, broadly curved terminal, spinelike processes; innermost about one and a half times length of outer. Inner process with membrane along inner margin and rudiments of narrow membrane along outer; outer process with frilled membrane along outer margin (fig. 12*i*).

Maxilliped of female two-segmented, attached just posterior and medial to maxilla. First segment large, strongly developed, inner proximal surface with lobate protrusion forming articular surface. Outer distal end of first segment irregular, with slightly projecting, lobate process serving as articular surface for second segment. Second segment short, with long, curved, acuminate terminal process and small, spinelike accessory process from inner distal lateral surface; division between second segment and terminal process indistinct (fig. 12*j*).

Maxilliped of male similar to that of female except with small, shelflike structure present on middle of inner margin of first segment (fig. 12*k*).

Sternal furca of female and male attached between, and slightly posterior to, bases of maxillipeds. Bifurcation extending approximately half length of process; tines with bluntly pointed tips (fig. 12*l*).

First thoracic leg biramous though endopodite present only as rudiment at junction of protopodite and exopodite. Protopodite strongly developed, one-segmented, greatest length almost equal to that of first segment of exopodite; proximal surface concave, more heavily chitinized than rest of segment, forming articular surface. Single, plumose seta present on inner proximal surface of protopodite and second, plumose seta on outer distal corner. First segment of two-segmented exopodite wider proximally than distally, proximal and distal margins irregular, proximal with slightly projecting, heavily chitinized medial surface articulating with protopodite. First segment with single spinule on outer distal corner and row of setules along inner margin. Second segment of exopodite palm-shaped, slightly more than half length of first segment, with three spines arising from distal margin and curved inwards. Inner two terminal spines with small, concave depression on distal inner margin across which fine membrane stretches; with row of stiff, very short setules along inner margin of all three spines, extending to tip of first spine, to concavity of second and third (fig. 12*m*).

Second thoracic leg biramous. Protopodite two-segmented; first segment small, less than half length of second. Second segment broad, greatest width about four-fifths greatest length, lateral and distal margins continuous, distal margin irregular. Exopodite three-segmented; length of first segment equal to combined lengths of second and third, with strongly developed, membrane-margined spine projecting distally from outer distal corner. Second segment short, irregular, with slender spine projecting distally from slight protrusion of outer distal corner. Third segment approximately twice length of second, with irregular lateral and distal margins. Two well-developed spines present on outer lateral margin of third segment, first extending distally from shelflike structure on outer proximal surface, second extending outward from attachment just distal and medial to base of first spine. Endopodite three-segmented; second segment longer than first or third. First segment with short row of stiff setules on outer distal margin; third segment rounded distally, lateral and distal margins distinct (fig. 12*n*).

Third thoracic leg biramous. Protopodite one-segmented, strongly flattened, platelike. Exopodite three-segmented; first segment with two-parted, spinelike process arising from junction of protopodite

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and second segment; second, distal, part of process directed inward at right angles to first. Second segment of exopodite flattened distally, lateral margins broadly rounded; third segment almost semicircular, lateral and distal margins continuous. Endopodite two-segmented; first segment broad; proximal margin of segment, as well as that of first exopodite segment, indistinct. Second segment of endopodite broadly rounded, distal and lateral margins distinct (fig. 12*o*).

Fourth thoracic leg uniramous, four-segmented. Protopodite one-segmented, with small, bilobed articular surface projecting slightly from inner proximal margin. Exopodite three-segmented, total length slightly more than that of protopodite. First segment of exopodite with single spine on outer distal corner; inner margin of spine with indistinct, frilled membrane. Second segment with larger spine on outer distal corner; spine with distinct, frilled membrane along inner and outer margins, base of spine encircled by minute, stiff setules. Third segment terminating in broad surface bearing three spines. Outermost spine shortest, about half length of middle spine, with frilled membrane along inner and outer margins. Middle spine slightly shorter than inner spine, with frilled membrane along outer margin only. Inner spine with few, fine setules on inner distal margin. All three terminal spines encircled by minute, stiff setules (fig. 12*p*).

The character of the membranes, spines, and setae of the thoracic legs is given below. The thoracic legs of both sexes are identical. (For explanation of symbols, see figure 1.)

Leg	Margin	Sternal plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	outer		p		rh	3H, P				
	inner		p		c	3P				
II	outer	f	f	f, p	f, H	H	2H, Q, 2p	c, C	c	c, 3P
	inner		f, s, P	f, s	c, P	c, P	c, 3P	P	c, 2P	c, 3P
III	outer	f	f, P		H′	c, p′	3p′, P	c	c	
	inner		f, P, 2s			c, P	c, 3P	P	c, 5P	
IV	outer		p		H	H	3H			

Caudal ramus of female and male similar, width and length about equal. Inner lateral margin setuliferous; six plumose setae present on distal and distal lateral surfaces. Innermost seta small, less than one-fifth length of longest seta; three long setae from median distal margin, small seta present between these three and single seta from outer distal lateral margin (fig. 12*r*).

Aberrant immature male specimen shown in figure 11*d* (second antenna, fig. 12*e*; fourth thoracic leg, fig. 12*q*) differs from adult female and other immature males in elongate fifth and sixth leg processes. Fifth and sixth legs visible in all immature males at this stage of development but in form of small lappets, similar to those of adult male, not extremely long projections as seen in this specimen.

Remarks.—Wilson (1905) erected this species from a series of specimens from the Galapagos Islands and from Bermuda. The material that he deposited in the U.S. National Museum as the type specimens (cotypes) was that from the Galapagos. The lot (USNM 42072, numbered 1505 in Wilson's 1905 publication) contained ten females and one male taken from a specimen of *Epinephalus labriformis* (Jenyns) captured at Charles Island. At the time the present publication was prepared, the original lot contained only six females and one immature male.

Since Wilson did not select a single specimen as the holotype, the present author has taken the liberty of choosing a lectotype from the original lot. The specimen chosen was an ovigerous female 3.13 mm. in length from the anterior end of the body to the posterior end of the caudal rami, excluding the setae. Because the characters of the specimen chosen as the lectotype are in agreement with those given by Wilson (1905), only a dorsal view of the specimen is shown (fig. 11*a*).

Additional measurements of lectotype specimen: Greatest length of cephalothorax, including frontal region, 2.05 mm.; greatest width, excluding marginal flanges, 1.93 mm. Greatest length of genital segment 0.90 mm.; greatest width 1.11 mm.

Lepeophtheirus dissimulatus has been taken on both the Atlantic and Pacific coasts. It appears to be found primarily in tropical and subtropical waters although the U.S. National Museum possesses a collection, identified by C. B. Wilson and by the present author as this species, that was made in British Columbia. The size of the specimens taken in British Columbia is more than twice that of the Hawaiian specimens. The British Columbia female specimens have an average length of 6.26 mm.; the Hawaiian female specimens, an average length of 2.94 mm. The males from the British Columbia collection were only slightly larger than the single male used in the present description (3 mm. in total length to 2.20 mm. for the Hawaiian specimen).

Genus *Anuretes* Heller, 1865

Diagnosis.—Abdomen rudimentary, partially or completely fused to genital segment. Lunules absent. Fourth thoracic legs two-, three-, or four-segmented.

Remarks.—This genus is very similar to *Lepeophtheirus*. The ten species known for the genus, including the new species described in this publication, possess only one characteristic in common: the rudimentary abdomen, and even this is not unique, *A. renalis* Heegaard having a distinct abdomen as does the male of *A. serratus* Shiino, here described for the first time. As Shiino (1954) indicates, all of the species possess characteristics in common with other members of the genus but not in common with all of the members.

Anuretes serratus Shiino

Figures 13*a–n*, 14*a–f*

A. serratus Shiino, 1954e, pp. 260–264, figs. 1–2.

Distribution.—Japan, Hawaii.

Hosts.—*Xesurus scalprum* (Cuvier and Valenciennes), *Naso hexacanthus* (Bleeker).

Material.—Male and ovigerous female (USNM 105097) collected by author from caudal fin of two specimens of *Naso hexacanthus* (Bleeker) taken in fish traps between Diamond Head and Koko Head, Oahu, Hawaii, by Samuel Kaolulo. Two specimens selected from collection of over 100 specimens to exemplify Hawaiian population of species.

Measurements.—Female: Length from anterior end of body to posterior end of caudal rami, excluding setae, 2.48 mm. Greatest length of cephalothorax, including frontal region, 1.85 mm.; greatest width, excluding marginal flanges, 1.56 mm. Greatest length of genital segment and fused abdomen 0.50 mm.; greatest width of genital segment 0.82 mm.

Male: Length from anterior end of body to posterior end of caudal rami, excluding setae, 1.64 mm. Greatest length of cephalothorax, including frontal region, 1.29 mm.; greatest width, excluding marginal flanges, 0.84 mm. Greatest length of genital segment and abdomen 0.45 mm.; greatest width of genital segment 0.48 mm.

Description.—Body of male and female opaque in alcohol, with rows of red pigment spots concentrated in posterior portion of cephalothorax and genital segment. Eyes orange-red.

Cephalothorax of female oblong, slightly longer than wide; frontal region distinct, anterior margin indistinctly crenate. Frontal region set off from cephalothorax by distinct, trilobed groove, median lobe much larger than lateral lobes. Lateral margins of cephalothorax with narrow marginal flange. Posterior sinuses distinct, deep, wider at apex than at opening, with membranous flange around most of margin. Flange not mentioned by Shiino (1954) in original description but present in both female and male specimens. Median cephalothoracic area extending posteriorly slightly past posterior extensions of lateral regions, concealing part of fourth thoracic leg-bearing segment. Longitudinal cephalothoracic grooves distinct, cross groove absent, extending from posterior margin of cephalothorax, just lateral to openings of posterior sinuses, anterior and lateral to just behind eyes. Lateral strengthening regions visible as bar-shaped processes extending from midlateral region of cephalothorax laterally and posteriorly, terminating just medial to lateral margin of cephalothorax. Two distinct grooves extending from anterior margin of cephalothorax posteriorly and medially to region of eyes. Eyes distinct, placed in anterior fourth of cephalothorax, inner margins contiguous on median longitudinal axis of body; median eye remnant visible, contiguous with posterior margins of paired eyes (fig. 13*a*).

Fourth thoracic leg-bearing segment short but distinct, drawn out laterally, at junction of fourth thoracic legs. Division between fourth thoracic leg-bearing segment and genital segment distinct.

Genital segment of female concave at junction of fourth thoracic leg-bearing segment, broadly rounded laterally, posterior lateral surfaces forming two large lobes. Fifth legs appearing dorsally as three plumose setae, ventrally as lappet with three plumose setae, two lateral setae of equal length but shorter than single seta just medial to first two (fig. 13*c*).

Abdomen rudimentary, fused with posterior surface of genital segment, with indistinct, discontinuous line of segmentation visible in stained specimens (fig. 13*c*).

Cephalothorax of male similar to that of female except groove between frontal region and cephalothorax somewhat irregular (fig. 13*b*). Genital segment width not as great, comparatively, as in female, without posterior lateral lobes as in female. Both fifth and sixth legs visible, fifth legs as two plumose setae on posterior lateral margin of genital segment and one plumose seta slightly anterior to first two; sixth legs as small, projecting lobe with two distal, plumose setae (fig. 13*d*). Abdomen broad, short, length less than that of female, division between abdomen and genital segment distinct (fig. 13*d*).

Antennule of female two-segmented, attached to ventral surface of cephalothorax just posterior to lateral frontal region margin; not attached to frontal region. First segment about 1.7 times length of second, widest in middle of segment, anterior margin tapered on both sides of widest point. Anterior surface of first segment with 18 plumose setae. Second segment club-shaped, with one naked seta from middle of posterior margin, 13 from distal surface (fig. 13*e*).

Antennule of male similar to that of female except second segment slightly longer; with two naked setae on posterior margin instead of one as in female, one naked seta arising from middle of posterior margin, second from proximal region of margin (fig. 13*f*).

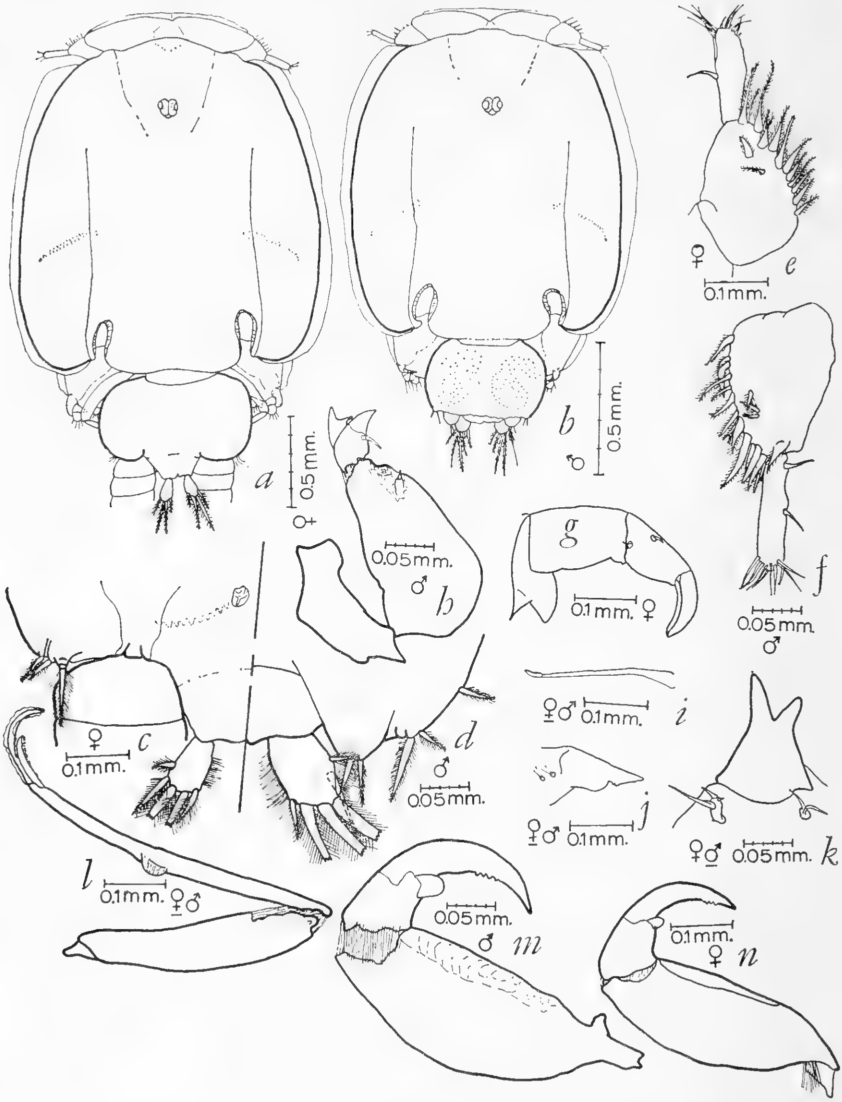

FIGURE 13.—*Anuretes serratus* Shiino, 1954: *a*, dorsal view of female; *b*, dorsal view of male; *c*, ventral view of female fifth legs, posterior end of genital segment, abdomen, and caudal ramus; *d*, ventral view of male fifth and sixth legs, posterior end of genital segment, abdomen, and caudal ramus; *e*, antennule of female; *f*, antennule of male; *g*, second antenna of female; *h*, second antenna of male; *i*, mandible; *j*, postantennal process; *k*, postoral process; *l*, maxilla; *m*, maxilliped of male; *n*, maxilliped of female.

Second antenna of female three-segmented, situated just posterior and lateral to antennule base. First segment small, forming articular surface for second segment, with triangular, posteriorly directed process. Second segment truncate, both proximal and distal surfaces forming broad articular surfaces, distal lateral surfaces heavily chitinized. Third segment with curved terminal process and two spinules, one on proximal, second on medial inner surface. Terminal process distinct from segment, strongly developed; inner surface of process flat, lateral and outer surfaces rounded. Inner, flat surface of terminal process with minute nodules on distal portion, distal end of process tapered to sharp point (fig. 13*g*).

Second antenna of male three-segmented. First segment irregular, attached to cephalothorax along all of proximal and most of inner lateral surface; with broad articular surface on distal end. Second segment strongly developed, proximal region almost three times width of distal; inner distal surface concave, with several small adhesion pads. Third segment short, with compound terminal process and simple spinule serving as accessory process. Compound terminal process consisting of bifurcate process arising from base of simple, curved process. Accessory process arising from inner distal surface of segment (fig. 13*h*).

Mandible of female and male four-parted. First part broad at proximal end, tapered to slender distal end; second part short, tapered to junction of third part. Third part long, length greater than combined lengths of other three parts, tapered slightly to junction of fourth part; fourth part short, curved inwards, slightly thickened along outer margin, distal end rounded, 13 toothlike denticulations present along inner margin (fig. 13*i*).

Postantennal process of female and male attached lateral to base of second antenna. Process spinelike, middle with sharp bend, distal half pointing posteriorly and medially. Distal end of process bluntly pointed; inner margin swollen into distinct lobe, outer margin with small, rounded knob just proximal to sharp bend. Process with two small nodes on inner surface, each with several minute setules (fig. 13*j*).

Postoral process of female and male situated just lateral to base of mouth cone, consisting of bifurcate process and two nodules, one anterior to base of each corner of process, each bearing several setules. Two tines of bifurcation equal in female, sharply pointed; tines unequal in male, outer slightly shorter than inner, both with pointed distal ends. Acuminate condition of inner tine of process in opposition to Shiino's original description (1954) in which inner spine is indicated to be broad, distal end rounded (fig. 13*k*).

Maxilla of female and male two-segmented, attached lateral to postoral process. First segment shorter than second, narrower proximally than distally, with proximal end protruding as articular surface and small, rounded projection present on distal surface and forming articular surface for second segment. Second segment about 1.3 times length of first, inner proximal surface with small but distinct concavity forming ball-and-socket type joint with articular surface of first segment. Second segment with sharp taper in middle, with short membrane stretched along inner surface in region of taper. Distal surface with two elongate, spinelike processes, inner almost two times length of outer, rimmed on both margins with fine membrane; outer spine rimmed on outer margin with frilled membrane (fig. 13*l*).

Maxilliped of female two-segmented, located just posterior and medial to maxilla. First segment strongly developed, ellipsoid, with short projection of proximal surface forming articular surface. Distal margin of first segment irregular, outer portion projecting above inner; distal half of inner lateral surface with distinct depression. Second segment short, with strongly curved, acuminate terminal process and small, flat, lobate accessory structure. Shiino (1954) reports the presence of a spinule on anterior side of second segment, but this spinule was not found on the female specimens examined by the present author. Division between second segment and terminal process indistinct; accessory process arising from distal end of second segment, at base of terminal process. Inner surface of terminal process flat, with minute denticulations on distal portion (fig. 13*n*).

Maxilliped of male similar to that of female except articular projection of proximal end of first segment more distinct, with additional small protrusion of inner proximal margin. Second segment and processes as in female (fig. 13*m*).

First thoracic leg biramous. Endopodite reduced to lobate, rudimentary process with distal end divided into three parts. Endopodite rudiment projecting from junction of protopodite and exopodite. Protopodite one-segmented, irregular in outline, proximal margin more heavily chitinized than rest of segment, with plumose setule present on inner distal lateral surface and plumose seta on outer distal surface. Exopodite two-segmented; first segment slightly longer than second, with spinule and round articular knob on outer distal corner. Spinule not mentioned by Shiino (1954) but present on both male and female specimens. Second segment of exopodite palm-shaped with three spines and plumose seta on distal surface. Outermost spine simple, serrate on inner margin only. Inner two spines broadly flattened, deeply serrate, serrations appearing as overlapping, spinelike extensions of terminal spine (fig. 14*a*).

Second thoracic leg biramous. Protopodite two-segmented; first segment short, second segment approximately two times length of first, width of second segment slightly less than length. Exopodite

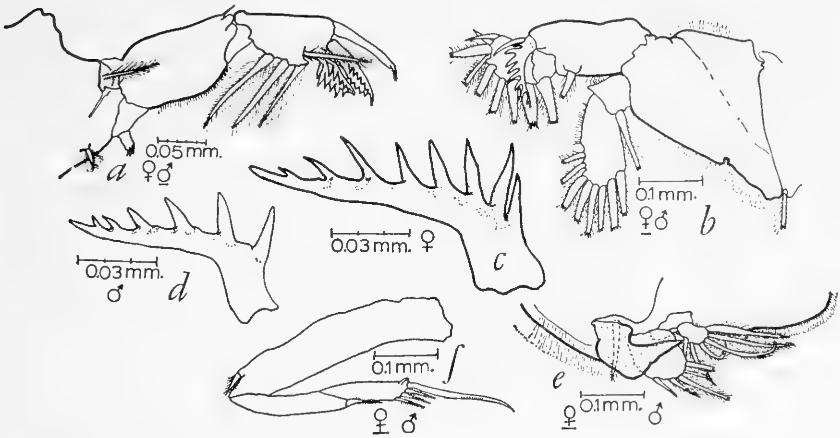

FIGURE 14.—*Anuretes serratus* Shiino, 1954: *a*, first thoracic leg; *b*, second thoracic leg; *c*, ramified spine on first segment of exopodite of female second thoracic leg; *d*, ramified spine on first segment of exopodite of male second thoracic leg; *e*, third thoracic leg; *f*, fourth thoracic leg.

three-segmented, first segment longer than combined lengths of second and third, with multiramous spine on outer distal corner. Axis of spine curving inward, rami directed distally (with regard to axis of exopodite); female with eight rami on spine, excluding tip, male with six (figs. 14*c*,*d*). Second segment of exopodite short, with single, lightly serrated spine on outer distal corner. Third segment of exopodite approximately twice length of second, with two simple spines on outer distal margin; inner and distal margins continuous. Endopodite two-segmented; second segment more than twice length of first, with eight plumose setae, all from distal half of segment (fig. 14*b*).

Third thoracic leg biramous. Protopodite broad, flat plate, semicircular in outline. Protopodite in male with adhesion pad on outer proximal surface. Exopodite one-segmented, with sharply curved, hooklike process arising from junction of exopodite and protopodite. Endopodite two-segmented, first segment short, wide; second segment about two times length of first, half the width; broadly rounded (fig. 14*e*).

Fourth thoracic leg uniramous, three-segmented. Protopodite slender, with single, plumose seta from outer distal margin. Exopodite two-segmented, shorter than protopodite; first segment with one weakly developed terminal spine, second segment with four terminal spines, outer three short, equal in length, rimmed with minute setules; inner spine almost four times length of outer three, with several minute spinules from middle of spine (fig. 14*f*).

The character of the membranes, spines, and seta on the thoracic legs is given below (for explanation of symbols, see figure 1):

Leg	Margin	Sternal plate	Protopodite		Exopodite			Endopodite	
			1	2	1	2	3	1	2
I	outer		p		rh	3H, p			
	inner		p		c	3P			
II	outer	f	f		f, H	H	c, 2H, Q	c	c, 5P
	inner		P	f	c, P	P	c, 4P	P	c, 3P
III	outer	f	P, f, P		H′, p′, 3P			c	3P
	inner		P, f		6P				c, 3P
IV	outer		p		H	4H			

Caudal rami of female and male ovoid in general outline, width slightly more than half the length in both sexes though male slightly wider than female. Caudal rami of female shorter than abdomen, longer than abdomen in male. Five plumose setae present, three from distal surface, one from inner distal corner, one from outer distal corner (figs. 13*c*,*d*).

Remarks.—The significant characteristics of this species are the ramified spines on the third segment of the first thoracic leg and the multiramous spine on the first segment of the exopodite of the second thoracic leg.

The male of *A. serratus*, here described for the first time, differs significantly from the female only in the makeup of the second antenna, the number of branches of the multiramous spine on the first segment of the exopodite of the second thoracic leg, the characteristic male feature of the fifth and sixth legs present on the genital segment, the shorter abdomen, and the slightly larger caudal rami.

As Shiino (1954) has indicated, this species could be placed in the genus *Lepeophtheirus* were it not for the three-segmented fourth thoracic legs: members of this genus have four-segmented fourth thoracic legs. The fusion of the abdomen with the genital segment is found in some members of the genus *Lepeophtheirus;* even in *A. serratus* the abdomen of the male is distinctly separated from the genital segment. The type species of the genus *Anuretes*, *A. heckeli* (Kollar), has no distinct abdomen: it was for the members of the family Caligidae with this characteristic, in addition to the segmentation of the fourth thoracic legs, that Heller (1865) erected the genus. Since Heller's proposal of the genus, only one other species has been placed in it that has no distinct abdomen (*A. brevis* Pearse, 1951), all other species having a rudimentary or well-developed abdomen.

Because of the variety of characteristics that are exhibited by members of this genus, Shiino (1954) has aptly termed it a "waste-basket for such species that can not be located in *Lepeophtheirus*." With the description of more species in the genus, a series of characteristics may be worked out to delimit the genus more distinctly, or else the characteristics of related genera may be expanded to include the species now placed in the genus.

Anuretes menehune, new species

FIGURES 15*a–o*, 16*a–e*

MATERIAL.—Ovigerous female (holotype, USNM 105098) collected by author from dorsal fin of specimen of *Naso hexacanthus* (Bleeker) taken in fish trap between Diamond Head and Koko Head, Oahu, Hawaii, by Samuel Kaolulo. Adult male (allotype, USNM 105099) collected by author from dorsal fin of specimen of *Naso hexacanthus* (Bleeker) taken in fish trap between Diamond Head and Koko Head, Oahu, Hawaii, by Samuel Kaolulo. Three adult females and three adult males (paratypes, USNM 105101) taken by author from dorsal fin of single specimen of *Naso hexacanthus* (Bleeker) collected in fish trap between Diamond Head and Koko Head, Oahu, Hawaii, by Samuel Kaolulo. Adult ovigerous female (paratype, USNM 105100) taken by author from side of specimen of *Naso unicornis* (Forskål) speared by author at Bird Island, Oahu, Hawaii.

These specimens were taken from a collection of over 100 specimens and represent the Hawaiian population of the copepod.

MEASUREMENTS.—Holotype female: Length from anterior end to posterior end of caudal rami, excluding setae, 2.05 mm. Greatest length of cephalothorax, including frontal region, 1.44 mm.; greatest width, excluding marginal flanges, 0.86 mm. Greatest length of fused genital segment and abdomen 0.50 mm.; greatest width of genital segment 0.60 mm.

Allotype male: Length from anterior end to posterior end of caudal rami, excluding setae, 1.39 mm. Greatest length of cephalothorax, including frontal region, 1.07 mm.; greatest width, excluding marginal flanges, 0.74 mm. Greatest length of genital segment, excluding protruding fifth and sixth leg setae, 0.29 mm.; greatest width 0.29 mm.

Paratype female specimens: Average length from anterior end to posterior end of caudal rami, excluding setae, 1.68 mm. Average of greatest length of cephalothorax, including frontal region, 1.23 mm.; average of greatest width, excluding marginal flanges, 0.74 mm. Average of greatest length of genital segment and abdomen 0.43 mm.; average of greatest width of genital segment 0.49 mm.

Paratype male specimens: Average length from anterior end to posterior end of caudal rami, excluding setae, 1.31 mm. Average of greatest length of cephalothorax, including frontal region, 0.98 mm.; average of greatest width, excluding marginal flanges, 0.57 mm. Average of greatest length of genital segment 0.28 mm.; average of greatest width 0.27 mm.

DESCRIPTION.—Body of female and male translucent in alcohol, with small, red pigment spots, some of dendritic shape, in rows on posterior portion of cephalothorax and genital segment, scattered irregularly over rest of body with heaviest concentration in lateral regions of cephalothorax.

Cephalothorax of holotype female specimen elliptical, frontal region present but reduced to undivided, platelike structure with distinct median depression of anterior margin. Anterior groove dividing cephalothorax and frontal region irregular, indistinct. Anterior margin of frontal region with narrow, membranous flange. Lateral margins of cephalothorax with narrow, membranous flange anteriorly, becoming narrower and finally disappearing posteriorly. Posterior sinuses distinct, U-shaped. Median cephalothoracic region extending posteriorly well past posterior extensions of lateral regions, covering part of fourth thoracic leg-bearing segment. Posterior margin of median extension slightly concave, lateral margins rounded, continuous with inner margins of posterior sinuses. Major cephalothoracic grooves present only as pair of longitudinal grooves, cross groove absent. Longitudinal grooves extending from posterior margin of cephalothorax, lateral to posterior sinuses, anteriorly, terminating well back of eyes; curving medially slightly posterior to middle of cephalothorax. Two lateral strengthening regions visible extending laterally and slightly posterior from middle of longitudinal grooves, in region of medial curve, to region of lateral margins of cephalothorax. Eyes small, placed well anterior, between pair of short longitudinal grooves originating at indistinct groove between cephalothorax and frontal region. Median eye remnant absent (fig. 15*a*).

Cephalothorax of allotype male similar to that of female. Frontal region present though indistinct groove separating region from cephalothorax in female absent in male. Lateral margins of cephalothorax with membranous flange continuous to beginning of posterior sinuses. Posterior margin of protruding median cephalothoracic region more concave than in female. Cross groove present though indistinct, connecting medially curved regions of longitudinal grooves (fig. 15*b*).

Fourth thoracic leg-bearing segment of holotype female specimen small, almost completely covered dorsally by median extension of thoracic region. Division between fourth thoracic leg-bearing segment and genital segment indistinct, segments at least partially fused.

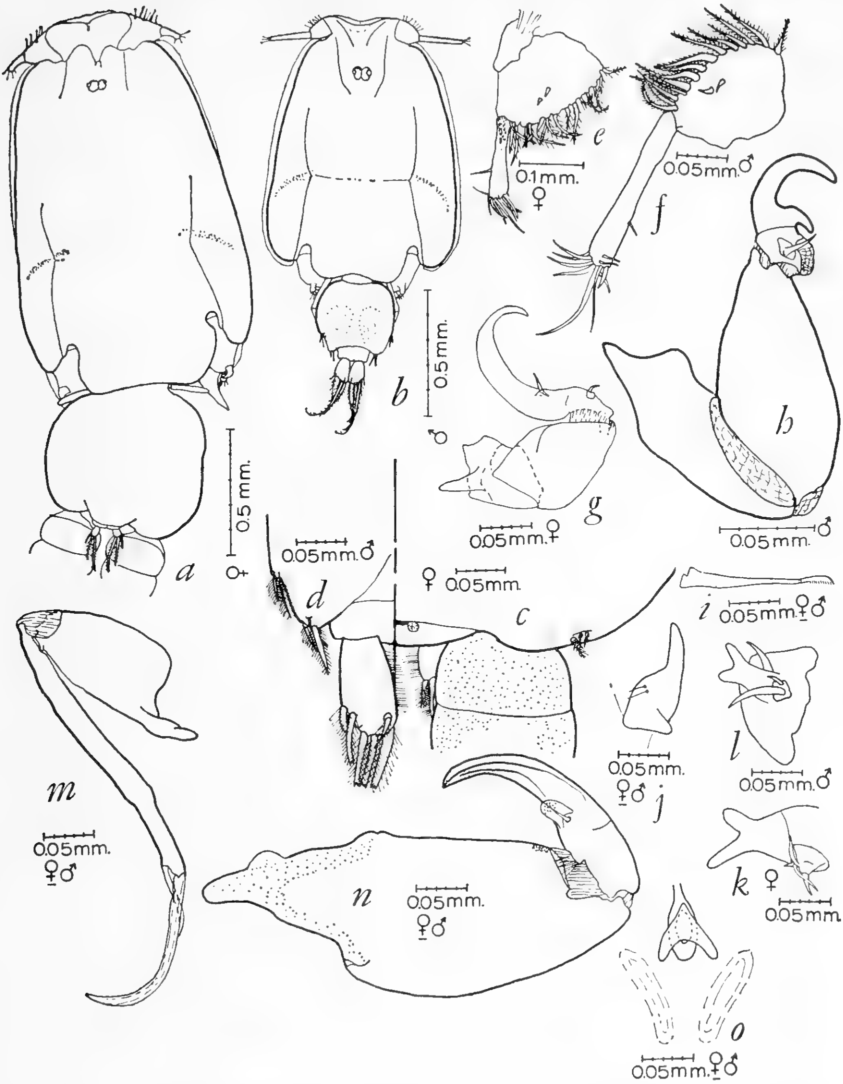

FIGURE 15.—*Anuretes menehune*, new species (holotype female, allotype male): *a*, dorsal view of female; *b*, dorsal view of male; *c*, ventral view of posterior end of female genital segment, fifth legs, abdomen, and caudal ramus; *d*, ventral view of posterior end of male genital segment, fifth and sixth legs, abdomen and caudal ramus; *e*, antennule of female; *f*, antennule of male; *g*, second antenna of female; *h*, second antenna of male; *i*, mandible; *j*, postantennal process; *k*, postoral process of female; *l*, postoral process of male; *m*, maxilla; *n*, maxilliped; *o*, sternal furca and associated processes.

Fourth thoracic leg-bearing segment of allotype male similar to female except division between segment and genital segment distinct.

Genital segment of holotype female specimen slightly wider than long, lateral margins broadly rounded, posterior lateral regions forming large lobe. Fifth legs visible as two minute spinules and single plumose setule from ventral posterior lateral surface of genital segment (fig. 15*c*).

Width of genital segment of allotype male specimen equal to length, lateral margins broadly rounded, posterior lateral regions forming smaller lobes than in female. Fifth and sixth legs distinct; fifth legs as two finely plumose setae from slight indentation of posterior lateral margin; sixth as two finely plumose setae and third, short, naked setule from distal end of lobate ventral posterior lateral surface (fig. 15*d*).

Abdomen of holotype female specimen rudimentary, fused to posterior surface of genital segment; line of division indistinct except in one paratype specimen and discontinuous in this specimen (fig. 15*c*).

Abdomen of allotype male specimen distinct, not fused to genital segment, width approximately twice length (fig. 15*d*).

Spermatophores visible on paratype female specimens as two large, circular structures attached to genital segment by necklike connection. Egg strings short, thick, approximately three-fourths length of cephalothorax, with four to six large eggs in each string.

Antennule of holotype female specimen two-segmented, excluding frontal plate, attached to cephalothorax at posterior edge of frontal region, appearing not to be attached to frontal region. First segment of general triangular shape, proximal end wider than length of segment, anterior margin curving sharply to narrow distal end, bearing 21 plumose setae; distal margin with three plumose setae, anterior dorsal surface with two naked setae. Second segment slender, club-shaped; length equal to length of first segment, with naked seta from middle of posterior margin and 10 naked setae from distal surface (fig. 15*e*).

Antennule of allotype male specimen similar to that of female though second segment much longer, approximately one and a half times that of female (fig. 15*f*).

Second antenna of holotype female specimen three-segmented, attached posterior to antennule base. First segment forming articular surface for second. First segment short, well developed, with long, triangular, distally pointed, posteriorly directed process. Second segment short, well developed, width approximately two-thirds length; with depression on distal surface forming articular surface for third segment. Third segment with recurved, acuminate terminal process; segment and process longer than combined lengths of first two segments, provided with two small, simple, spinelike processes on proximal inner surface. Division between segment and terminal process indistinct (fig. 15*g*).

Second antenna of allotype male three-segmented. First segment long, outer surface of distal two-thirds forming articular surface for second segment, proximal margin forming blunt, posteriorly directed process. Second segment well developed, with broad base, tapered to narrow distal margin. Distal margin of second segment irregular, with heavily chitinized regions forming articular surfaces for third segment. Third segment short, with adhesion surface on inner margin, and seta-like accessory process on posterior surface adjacent to adhesion pad. Terminal process of third segment bifurcate; inner part of bifurcation curving inward and proximally as projection of basal region of process, outer part of bifurcation much longer than inner, extending distally before recurving in same manner as first part. Division between segment and terminal process distinct (fig. 15*h*).

Mandible of female and male four-parted. First part broader proximally than distally, lateral margins irregular. Length of second part approximately equal to that of first, with even taper to junction of elongate third part. Third part as long as combined lengths of first two parts, tapered slightly to junction of fourth part. Fourth part curving medially at distal end, with 11 toothlike denticulations along inner margin (fig. 15*i*).

Postantennal process of female and male simple, slightly curved spine arising lateral and posterior to attachment of second antenna. Spine with two minute nodules on inner proximal surface, each with long setule (fig. 15*j*).

Postoral process of holotype female specimen a plate with projecting bifurcate process and node, at anterior end of plate. Node with three setules of approximately equal length. Inner tine of bifurcate process longer than outer, both tines with rounded distal ends (fig. 15*k*).

Postoral process of allotype male specimen similar to holotype though setule-bearing node with two setules, third setule from base of bifurcate process (fig. 15*l*).

Maxilla of female and male two-segmented, situated lateral and slightly posterior to postoral process. First segment short, well developed, inner proximal surface protruding as lobate articular process. First segment tapered from broad base to narrow distal end, middle of distal end projecting as articular surface for second segment. Second segment elongate, one and a half times length of first segment. Inner proximal margin with small concavity forming ball-and-socket joint with articular surface of first segment. Second segment tapered abruptly in middle, as in *A. serratus*, but without membrane found in this species, with two long, spinelike processes on distal surface, inner process more than twice length of outer, with fine membrane along inner and outer margins. Outer terminal process without membranes (fig. 15*m*).

Maxilliped of female and male two-segmented, attached medial and slightly posterior to maxilla. First segment well developed, with proximal extension of inner surface forming articular surface. First segment tapered from wide proximal to somewhat narrower distal region. Distal surface irregular, with heavily chitinized indentations for articulation with second segment. Second segment short, with strongly developed, curved, clawlike terminal process. Second segment with flat, lobate process and simple, spinelike process as accessory structures. Lobate accessory structure with minute, toothlike denticulations on distal surface. Spinelike accessory structure attached just proximal to middle of base of lobate accessory structure. Inner surface of curved terminal process flat, with very slight denticulations. Division between segment and terminal process indistinct (fig. 15*n*).

Sternal furca of female and male located between, and slightly posterior to, bases of maxillipeds. Base of furca heavily chitinized oval structure; center of base depressed, not heavily chitinized. Bifurcate process single, arrowhead-shaped unit, distinct from oval base, attached to base at proximal end. Furcal tines widely spread, with even concave depression between blunt tips; lateral margins curving medially to attachment with base. Two medially curving ridges present posterior to sternal furca (fig. 15*o*).

The arrowhead-shaped furcal process is absent in one of the paratype specimens (USNM 105100); the only structure present is the heavily chitinized oval base. In addition, both postoral processes either have been lost or have developed irregularly, since only a simple, blunt, spinelike process is present. This variation may lead to taxonomic difficulties in later work as there is no evidence of the loss of these two processes in the specimen.

First thoracic leg biramous though endopodite reduced to rudimentary, lobate process at junction of exopodite and protopodite. Protopodite one-segmented, with slight projection of outer proximal portion forming articular surface; single, lightly plumose setule present on inner proximal lateral margin. First segment of two-segmented exopodite slightly longer than protopodite, proximal and distal margins irregular, outer distal corner with projecting heavily chitinized knob and simple spinule. Second segment of exopodite palm-shaped, proximal and inner margins continuous, irregular, distal margin with three spines and plumose seta. Outermost spine lightly denticulate distally, inner two spines shorter, with small concave depression on inner distal surface. Both inner spines flattened, lateral margins ramified into small secondary spines (fig. 16*a*).

Second thoracic leg biramous. Protopodite two-segmented; first segment small, less than half length and width of second segment. Second segment with large, club-shaped articular process protruding from outer proximal corner. Exopodite three-segmented; first segment longer than combined lengths of second and third segments, with strong spine from outer distal corner directed across surfaces of second and third segments. Second segment short, with smaller spine from outer distal corner; third segment slightly longer than second, broadly rounded, with two small spines on outer lateral margin. Endopodite three-segmented; first and second segments about equal in length, third short, broadly rounded (fig. 16*b*).

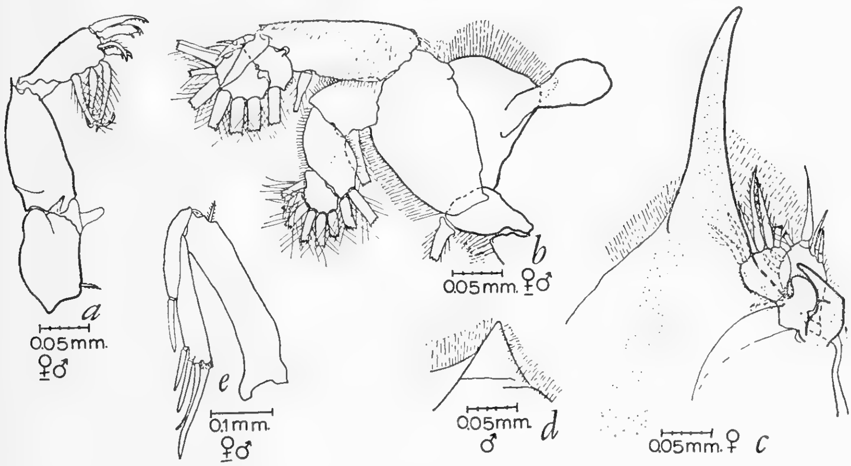

FIGURE 16.—*Anuretes menehune*, new species (holotype female, allotype male): *a*, first thoracic leg; *b*, second thoracic leg; *c*, third thoracic leg of female; *d*, protopodite process of third thoracic leg of male; *e*, fourth thoracic leg.

Third thoracic leg biramous. Protopodite one-segmented, flattened, inner surface extending posteriorly, under genital segment, as large, heavily chitinized, slightly curved, blunt-tipped process in female; male protopodite process extending slightly from segment, not as heavily chitinized as female process (figs. 16*c,d*). Exopodite one-segmented, with curved, one-parted process arising from junction of exopodite and protopodite. Single segment of exopodite longer than wide, broadly rounded. Endopodite two-segmented; first segment broad, with broad distal lobe; second segment broadly rounded, attached to inner corner of first segment (fig. 16*c*).

Fourth thoracic leg uniramous, three-segmented. Protopodite one-segmented, longer than combined lengths of two exopodite

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segments; with single, plumose setule on outer distal margin. Distal end of first segment of exopodite tipped with strong spine reaching to distal region of second segment. Second segment with four spines, inner three borne on distal surface, outer on distal lateral margin. Innermost spine longest, base surrounded by ring of stiff setules fused at base into solid structure. Outer three terminal spines successively shorter, outermost shortest (fig. 16*e*).

The character of the membranes, spines, and setae present on the thoracic legs is given below (for explanation of symbols, see figure 1):

Leg	Margin	Sternal plate	Protopodite 1	Protopodite 2	Exopodite 1	Exopodite 2	Exopodite 3	Endopodite 1	Endopodite 2	Endopodite 3
I	outer	p			rh	3H, P				
	inner					3P				
II	outer	f		f	f, H	H	2h, Q, 2P	c	c	c, 4P
	inner		f, P	f	c, P	c, P	c, 3P	P	c, 2P	2P
III	outer		p, f		3p′, P′			c	3p	
	inner	f	f		4p				c, 3p	
	middle		c							
IV	outer		p		H	4H				

Length of female and male caudal ramus twice width, inner margin setuliferous. Three long, plumose setae on posterior margin, two shorter, plumose setae from outer posterior lateral margin, naked seta from inner posterior ventral surface (figsure 15*c*,*d*).

Remarks.—This species is distinct from other known species of the genus in the inner extension of the protopodite of the third thoracic leg. It is similar to *A. serratus* Shiino, 1954, in the possession of the lobate accessory structure on the maxillipeds and in the secondary, spinelike ramifications of the terminal spines of the first thoracic leg, although those of *A. serratus* are much more distinct than in this species.

Anuretes menehune was found with *A. serratus* on specimens of *Naso hexacanthus* (Bleeker), *A. menehune* usually on the dorsal and anal fins and *A. serratus* on the caudal fin. Although the two species do occur on the same host, the areas they occupy were not observed to overlap.

The name "menehune" is derived from the fabled Menehune tribes that supposedly inhabited the Hawaiian Islands. These people were a legendary race of small people, whose purported construction efforts can still be seen in parts of the Hawaiian Islands. The name is used in regard to the relatively small size of the specimens of this species.

Genus *Dentigryps* Wilson

Diagnosis.—Fourth thoracic leg-bearing segment and genital segment fused in female, covered by single, dorsal plate. Lunules absent, sternal furca present; fifth legs of female elongate, conical, spinelike processes protruding from genital segment.

Remarks.—The genus was established by Wilson (1913) on the characteristics presented by the female of *D. Curtus* Wilson, 1913, the type-species of the genus. With the description of the new species below, the second species known for the genus, the diagnosis has been modified slightly.

Dentigryps bifurcatus, new species

Figures 17*a–c,e–k,m–q*, 18*a–c,e,f*

Material.—Nonovigerous adult female (holotype, USNM 105094) taken by author from side of specimen of *Acanthurus olivaceous* Bloch and Schneider given to author by Mr. Spencer Tinker from collections of Honolulu Aquarium. Mature male (allotype, USNM 105095) collected by author from caudal fin of specimen of *Naso hexacanthus* (Bleeker) captured in fish trap between Diamond Head and Koko Head, Oahu, Hawaii, by Samuel Kaolulo. Mature female (paratype, USNM 105096) collected by Dr. John Randall from epidermis of specimen of *Acanthurus triostegus sandvicensis* Streets captured in unknown locality on Oahu, Hawaii.

Measurements.—Holotype female: Length from anterior end to posterior end of caudal rami, excluding setae, 3.50 mm. Greatest length of cephalothorax, including frontal region, 2.44 mm.; greatest width, excluding marginal flanges, 2.30 mm. Greatest length of fused fourth thoracic leg-bearing segment and genital segment 0.70 mm.; greatest width of genital segment 1.19 mm.; length of left genital segment spine 0.78 mm. Tip of right spine broken.

Allotype male: Length from anterior end to posterior end of caudal rami, excluding setae, 1.97 mm. Greatest length of cephalothorax, including frontal region, 1.48 mm.; greatest width, excluding marginal flanges, 1.48 mm. Greatest length of fourth thoracic leg-bearing segment and genital segment, excluding sixth leg projections, 0.50 mm. (measurement taken on ventral surface); greatest width of genital segment 0.39 mm. Length of projecting fifth legs, excluding setae, 0.18 mm.

Paratype female: Length from anterior end to posterior end of caudal rami, excluding setae, 2.85 mm. Greatest length of cephalothorax, including frontal region, 2.07 mm.; greatest width, excluding marginal flanges, 1.93 mm. Greatest length of fused fourth thoracic leg-bearing segment and genital segment 0.59 mm.; greatest width of genital segment 1.07 mm.; length of genital segment spines 0.66 mm.

Description.—Body of female with large, yellowish blotches in irregular pattern in alcohol; eye spots yellowish orange. Body of male yellowish in alcohol, with red spots scattered over surface; eyes as in female.

Cephalothorax of holotype female specimen ovoid, frontal region small, with thin, membranous flange along anterior margin; frontal region separated from cephalothorax by distinct, trilobed groove, median lobe much larger than lateral lobes. Lateral margins of cephalothorax with narrow, membranous flange. Posterior sinuses distinct, U-shaped, with two small, membranous flaps attached along lateral and anterior margins, one extending ventrally, other dorsally. Inner margin of posterior sinuses continuous with posterior lateral and posterior margins of median cephalothoracic region. Median cephalothoracic region extending slightly posterior to posterior lateral extensions of lateral cephalothoracic regions; middle of posterior margin slightly concave. Dorsal grooves of cephalothorax distinct, H-shaped; anterior portion of grooves terminating blindly posterior to eyes, cross groove, in middle of cephalothorax, curving anteriorly, not as distinct as longitudinal grooves. Lateral strengthening regions extending from just anterior to junction of cross and longitudinal grooves laterally and posteriorly, terminating just inside lateral margins of cephalothorax. Eyes small, situated in anterior third of cephalothorax, inner margins touching on median longitudinal axis of body (fig. 17*a*).

Fourth thoracic leg-bearing segment and genital segment fused in female, covered by single, dorsal plate. Fourth thoracic leg-bearing segment more distinct than in *D. curtus*, genital segment not beginning under posterior portion of cephalothorax as in *D. curtus* but slightly behind it. Genital segment expanded, lateral areas broadly rounded, middle of posterior margin concave, not convex as in *D. curtus*, posterior lateral margins without single, small, pointed protrusion present in *D. curtus* (figs. 17*c,d*). Fifth legs visible as long, acuminate, unjointed, spinelike projections from ventral posterior lateral surface of genital segment. Spinelike projection with three small, plumose setules, one on proximal lateral surface, one on ventral medial surface, one on ventral distal surface (figs. 17*c,d*).

Abdomen of female one-segmented, attached to posterior surface of genital segment, not ventral surface as in *D. curtus*. Width of abdomen approximately same as length. Abdomen without posterior lateral extensions found in *D. curtus* (figs. 17*c,d*).

Cephalothorax of allotype male similar to that of female except frontal region with flatter anterior margin. Region of third thoracic

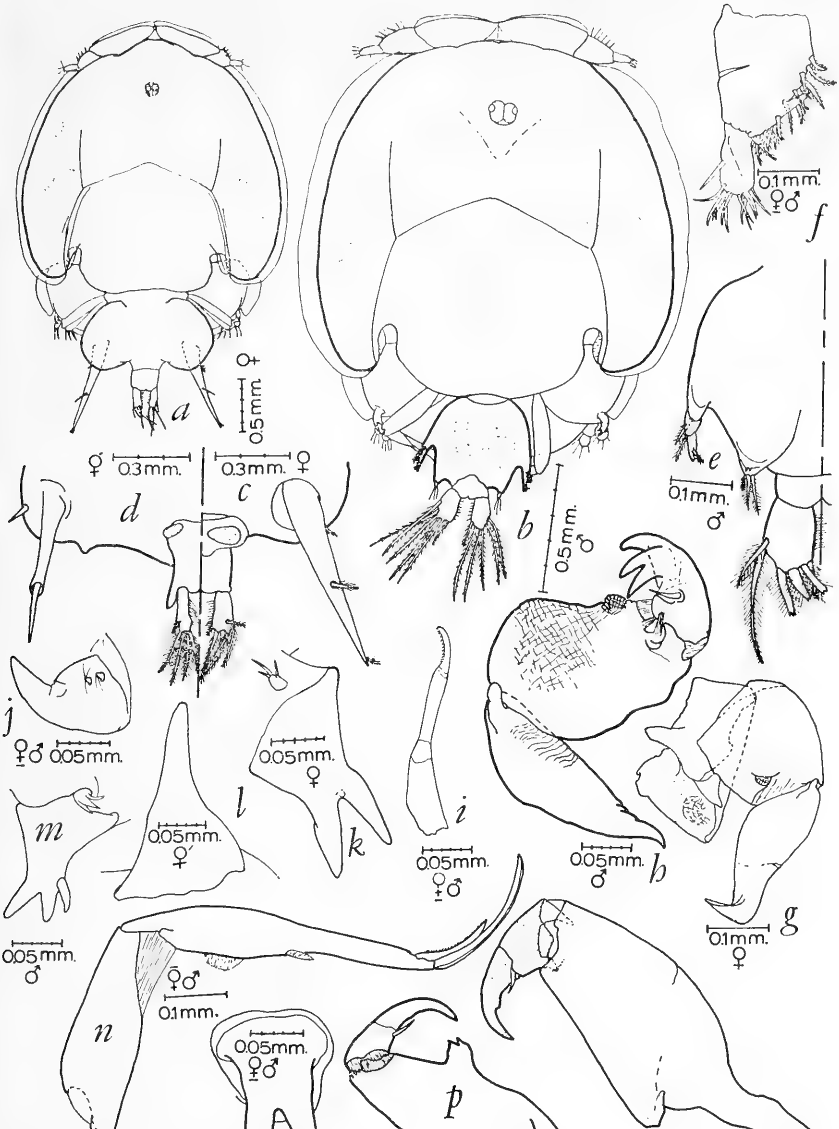

FIGURE 17.—*Dentigryps bifurcatus*, new species (holotype female, allotype male): *a*, dorsal view of female; *b*, dorsal view of male; *c*, ventral view of posterior end of genital segment, fifth leg, abdomen, and caudal ramus of female; (*d*, ventral view of posterior end of genital segment, fifth leg, abdomen, and caudal ramus of female specimen of *D. curtus*); *e*, ventral view of posterior end of genital segment, fifth and sixth legs, abdomen, and caudal ramus of male; *f*, antennule; *g*, female second antenna; *h*, male second antenna; *i*, mandible; *j*, postantennal process; *k*, postoral process of female; (*l*, postoral process of female specimen of *D. curtus*); *m*, postoral process of male; *n*, maxilla; *o*, maxilliped of female; *p*, maxilliped of male; *q*, sternal furca.

leg-bearing segment of thorax, contained in cephalothorax, extended over fourth thoracic leg-bearing segment. Fourth thoracic leg-bearing segment partially visible dorsally, separated from genital segment by distinct line of division; fourth thoracic leg-bearing segment and genital segment not covered by single, dorsal plate as in female. Fifth legs visible as conical projections of lateral margins of genital segment, projections appearing as series of three overlapping, lappet-like processes, each bearing single, terminal, plumose seta. Sixth legs visible as conical projections of posterior lateral margins of genital segment, lappet-like processes visible on fifth legs also present on sixth though not as distinct; sixth legs with three terminal, plumose setules (figs. 17*b*,*e*).

Antennule of male and female two-segmented, excluding frontal plate, attached to ventral surface of both cephalothorax and frontal region just medial to lateral margins of frontal region. First segment broad proximally, tapered on anterior margin to narrow distal end; greatest length one and one-fourth times greatest width. Anterior margin of first segment with fifteeen plumose setae. Second segment slightly more than half length of first, with naked seta on middle of posterior margin and 13 naked setae from rounded distal end (fig. 17*f*).

Second antenna of holotype female three-segmented, attached posterior and medial to antennule base. First segment short, broad, forming articular surface for second segment; with triangular, posteriorly directed process. Second segment well developed, greatest width equal to greatest length, with small adhesion pad on inner distal surface. Second segment with several small, heavily chitinized depressions on distal margin serving as articular surfaces for third segment. Third segment with terminal, clawlike process; division between segment and process indistinct. Terminal process curved sharply inwards distally. Length of third segment and terminal process greater than that of second segment; third segment without accessory processes (fig. 17*g*).

Second antenna of allotype male three-segmented; first segment long, narrow proximally, expanded medially, tapered distally; distal end with projecting, lobate articular process, without posteriorly projecting process of female. First segment with adhesion surface on outer distal half of segment. Second segment strongly developed, swollen proximally, narrow distally. Inner surface of second segment forming adhesion surface proximally; with small, swollen adhesion surface projecting from inner distal surface; both adhesion surfaces on inner surface connected by irregular ridges. Third segment short, with compound terminal process consisting of simple, curved, spinelike structure with bifurcate process fused to anterior lateral surface of terminal process. Third segment with single, spinelike accessory process at indistinct junction of terminal process and segment (fig. 17*h*).

Mandible of female and male four-parted. First part with broad base, tapered regularly to slightly narrower distal end; second part short, distinctly tapered to junction of third part. Third part elongate, length slightly less than combined lengths of first two parts; fourth part slightly more than half length of third, curving inward, bearing 11 toothlike denticulations on inner margin (fig. 17*i*).

Postantennal process of female and male simple, spinelike process attached just lateral, and slightly posterior to, base of second antenna. Spinelike process curved posteriorly, terminating in blunt tip, bearing two minute nodules on inner proximal surface, proximal nodule with two long setules, distal with three (fig. 17*j*).

Postoral process of paratype female specimen bifurcate, attached just lateral to base of mouth cone (process broken in holotype). Postoral process of *D. curtus* simple, spinelike process, not bifurcate as in *D. bifurcatus* (fig. 17*l*). Distance across base of bifurcate process greater than distance between tips, length of tines approximately one-third length of process; single, slight protrusion present just proximal to apex of bifurcation. Single, lobate process present just anterior to base of spine, with three setules from distal surface (fig. 17*k*).

Postoral process of male similar to that of female except with large, finger-like protrusion on inner margin of bifurcate process (fig. 17*m*).

Maxilla of female and male two-segmented, attached slightly lateral and posterior to postoral process. Proximal segment strongly developed, broader at base than at distal end, with articular process forming extension of inner proximal surface. Distal end of first segment flat. Second segment elongate, greatest length about one and one-fourth times that of first segment; inner proximal surface irregular, proximal end articulating with flat distal end of first segment. Proximal half of second segment slightly swollen, both margins convex, with fine, membranous flap on inner margin. Spine with attached membrane present on middle of inner margin of segment. Second segment terminated by two curved, spinelike processes, inner almost twice length of outer, with fine membrane along inner margin. Outer spinelike process on distal end of second segment with frilled membrane along outer margin (fig. 17*n*).

Maxilliped of female two-segmented, attached slightly posterior and medial to maxilla. First segment well developed, with long articular process extending from outer proximal portion of segment. Distal margin with several heavily chitinized surfaces serving as articular surfaces for second segment. Second segment short, forming, with well-developed terminal process, clawlike structure. Distal end of terminal process strongly curved; division between terminal process and second segment distinct, segment with small, spinelike accessory process on inner margin at junction of segment and terminal process. Terminal process of second segment with several small, rounded swellings on inner median surface (fig. 17*o*).

Maxilliped of male similar to that of female except with large protrusion of middle of inner margin to receive distal end of terminal process of second segment when segment flexed. Articular process on proximal end of first segment shorter than that of female (fig. 17*p*).

Sternal furca of female and male situated between, and slightly posterior to, bases of maxillipeds. Greatest width of base of process slightly more than distance across tips of tines; tines directed slightly outward from apex of bifurcation, terminating in blunt tips. Bifurcation extending almost half length of furcal process (fig. 17*q*).

First thoracic leg biramous though endopodite present only as small, finger-like projection at junction of protopodite and exopodite. Protopodite one-segmented, with small projection of outer proximal end forming articular surface. Distal margin of protopodite irregular, with single, plumose setule on outer corner. Exopodite two-segmented, first segment saddle-shaped, with single spinule and large, rounded articular process on outer distal margin. First segment of exopodite of *D. curtus* much longer, with spinule on outer distal margin and setules on inner margin as in *D. bifurcatus*. Second segment of exopodite short, less than half length of first, with three spines and one small, plumose seta on distal surface. Innermost and medial terminal spines with row of fine setules on inner margin and slight concave depression of inner distal surface across which fine membrane stretches (fig. 18*a*).

Second thoracic leg biramous. Protopodite two-segmented; first segment short, slightly more than half length of second segment, with bilobed proximal end. Exopodite three-segmented; first segment longer than combined lengths of second and third, with small lobate process on proximal surface; process also present on *D. curtus* but not reported by either Wilson (1913) or Yeatman (1957). First segment with strongly developed terminal spine on outer corner, spine with row of minute setules along inner margin. Second segment with single spine, spine slightly shorter than that of first segment. Third segment with two spines, proximal extending at slight angle to margin of segment (not visible in figure). Endopodite three-segmented, second segment irregular, greatest length approximately equal to that of first and third segments combined (fig. 18*b*).

Third thoracic leg biramous. Protopodite one-segmented, forming broad, flat, platelike structure. Exopodite three-segmented, with

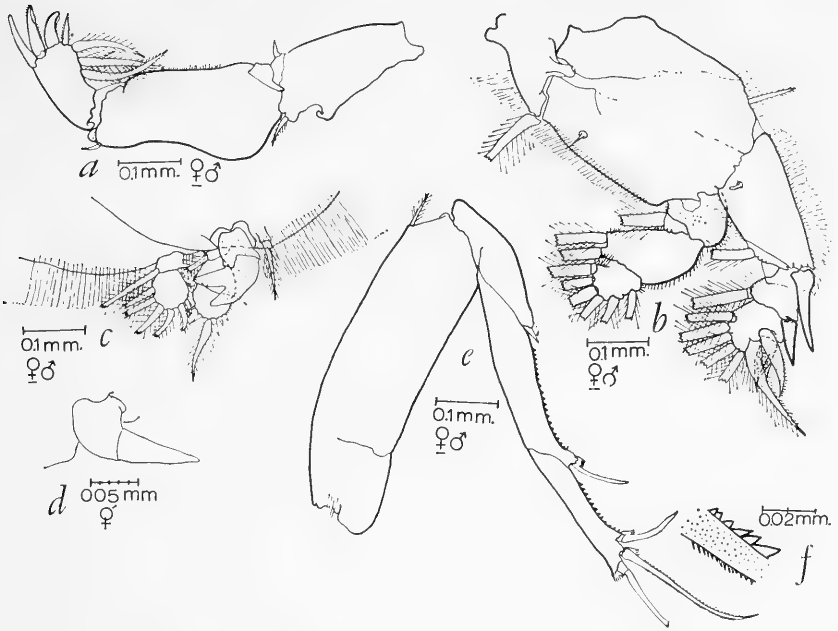

FIGURE 18.—*Dentigryps bifurcatus*, new species (holotype female, allotype male): *a*, first thoracic leg; *b*, second thoracic leg; *c*, third thoracic leg; (*d*, third thoracic leg exopodite process of *D. curtus*); *e*, fourth thoracic leg; *f*, portion of denticulated median terminal spine of fourth thoracic leg.

large, inwardly curved, bifurcate process at junction of protopodite and exopodite. Process of exopodite of third thoracic leg of *D. curtus* simple, not bifurcate (fig. 18*d*). First segment of exopodite small, flattened, second and third segments combined, forming obovate structure. Endopodite two-segmented; first segment broad, short; second segment arising from distal lateral surface of first, length slightly greater than width, segment broadly rounded (fig. 18*c*).

Fourth thoracic leg uniramous, four-segmented. Protopodite one-segmented, length slightly less than combined lengths of all three exopodite segments. Protopodite with single plumose setule from outer distal corner. Exopodite three-segmented; first segment short, with single, short, simple spine from distal end, spine encircled by frilled membrane. Second segment with row of toothlike denticulations along outer margin, with simple spine from slightly swollen distal end, spine encircled by frilled membrane. Third segment with toothlike denticulations along outer margin as in second, distal end with three spines, outermost short, simple, without denticulations; middle spine longer, margins heavily denticulated (fig. 18*f*); inner spine long, lightly denticulated. Three terminal spines encircled by frilled membrane (fig. 18*e*).

The character of the membranes, spines, and setae on the thoracic legs is given below (for explanation of symbols, see figure 1):

Leg	Margin	Sternal plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	outer		p		rh	3H, P				
	inner				c	3P				
II	outer	f		f, p	f, H	H	2H, Q, 2P	c	c	c, 3P
	inner		f, P	f, s	c, P	c, P	c, 3P	c, P	c, 2P	c, 3P
III	outer	f	f, P		H′, c	c, p′	c, 3p′, P	c	c, 3P	
	inner		P, f		P	c, P	c, 3P	P	c, 3P	
IV	outer		p		h	H	H, 2dH			

Caudal rami of female and male attached to posterior surface of abdomen. Width slightly more than half length, greater in male than in female. Inner margin setuliferous; distal end with six plumose setae, three from distal margin, one from inner distal corner, one from outer distal corner, one from ventral surface. Setae from distal margin long, from lateral and ventral surfaces short.

REMARKS.—This is the second known species of the genus. The first, *D. curtus*, is known only from the tropical and subtropical western North Atlantic. The two species possess general similarities but differ in characteristics such as thoracic leg armature and the shape of the various processes and accessory structures. A list of the major differences between *D. curtus* and *D. bifurcatus* is given below:

D. curtus (female; male unknown)	*D. bifurcatus* (female)
1. Posterior end of cephalothorax covering fourth thoracic leg-bearing segment and part of genital segment.	1. Part of fourth thoracic leg-bearing segment visible behind cephalothorax.
2. Posterior end of genital segment almost flat, with two small protrusions of posterior lateral margin.	2. Posterior end of genital segment bilobed, without protrusions.
3. Genital segment spines (fifth legs) jointed, two-parted.	3. Genital segment spines (fifth legs) not jointed.
4. Abdomen attached to ventral surface of genital segment, with small lappet-like protrusion of outer distal corner.	4. Abdomen attached to posterior surface of genital segment, without small lappet-like protrusion of outer distal corner.
5. Postoral process a simple spinelike process.	5. Postoral process bifurcate.
6. Third thoracic leg exopodite process simple.	6. Third thoracic leg exopodite process bifurcate.

The name "bifurcatus" applies to the bifurcate condition of the postoral process and of the third thoracic leg exopodite process.

Family Pandaridae

Genus *Nesippus* Heller, 1865

Diagnosis.—Cephalothorax consisting of cephalon, maxilliped, and first thoracic leg-bearing segments; second, third, and fourth thoracic leg-bearing segments free. Cephalothorax typically longer than wide, with posteriorly projecting lateral regions. Male with or without conspicilla placed slightly anterior and lateral to paired eyes. Second thoracic leg-bearing segment with lateral and posterior lateral projecting lobes. Abdomen small, one-segmented. Distal region of maxillipeds swollen, terminal process knoblike, forceps-like or flattened and clawlike. All thoracic legs biramous; rami of legs 1–3 two-segmented, fourth leg rami one-segmented.

Remarks.—The diagnosis is mainly from Wilson (1907) with modification based on the characteristics of the species described subsequent to his publication. The adult female and male of this genus are found primarily on elasmobranch hosts, but the adult male also is taken in the plankton.

The function of the "conspicilla," Dana's term for the two transparent projections on the dorsal surface in the region of the eyes of some males, is not known. Dana (1853) indicates that they are distinct from the cephalothorax and are of a "brittle, though rather hard" nature.

Nesippus costatus? Wilson

Figures 19*a–e*, 20*a–s*, 21*a–p*

N. costatus Wilson, 1924, pp. 213–214, pl. 20.

Type host.—"A nine-foot shark."

Type locality.—Galapagos Islands.

Material.—Immature male taken by author from cyst on dorsal fin of specimen of *Acanthurus triostegus sandvicensis* Streets captured by U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries, at Midway Island (USNM 105176). Immature male taken by author from cyst on anal fin of specimen of *Acanthurus nigroris* Cuvier and Valenciennes captured in fish trap in Kaneohe Bay, Oahu, Hawaii, by Lester Zukeran (USNM 105177). Immature male from cyst on anal fin of specimen of *Acanthurus xanthopterus* Cuvier and Valenciennes captured in fish trap in Kaneohe Bay, Oahu, Hawaii, by Lester Zukeran (USNM 105178). Male specimen collected by Dr. John Randall from epidermis of specimen of *Acanthurus triostegus sandvicensis* Streets from an unknown locality, probably on Oahu, Hawaii (USNM 105179). Immature male and its exuvium taken by Carolyn Lewis from cyst on pectoral fin of specimen of *Diodon holocanthus* Linnaeus donated by Honolulu Aquarium (USNM 105180). Immature male taken by author from cyst on pectoral fin of specimen of *Diodon holocanthus* Linnaeus donated by Honolulu Aquarium (USNM 105181). One cyst containing immature male taken by author from pectoral fin of specimen of *Ctenochaetus strigosus* (Bennett) donated by Honolulu Aquarium (USNM 105182). Immature male taken by author from cyst on dorsal fin of specimen of *Acanthurus triostegus sandvicensis* Streets speared by N. Ferris in Kaneohe Bay, Oahu, Hawaii (USNM 105183). Immature male taken by author from cyst on dorsal fin of specimen of *Scarus* species speared by author in Hanauma Bay, Oahu, Hawaii (USNM 105184).

Additional specimens, not used in the following description, were taken from cysts on fins of specimens of the following families of fishes: Labridae, Pomacentridae, Zanclidae.

Measurements.—Early encysted stage (two specimens): Length from anterior end of body to posterior end of caudal rami, excluding setae, 1.90 and 2.58 mm. Greatest length of cephalothorax, including frontal region, 0.82 and 1.23 mm.; greatest width 1.03 and 1.31 mm. Greatest length of free thoracic leg-bearing segments, genital segment, abdomen, and caudal rami, excluding setae, 1.11 and 1.60 mm. Greatest length of genital segment 0.18 and 0.34 mm.; greatest width of genital segment 0.36 and 0.42 mm. Greatest length of abdomen 0.13 and 0.17 mm. Greatest length of caudal rami, excluding setae, 0.25 mm.

Late encysted and recently excysted stage (five encysted specimens, one recently excysted specimen): Average length from anterior end of body to posterior end of caudal rami, excluding setae, 3.40 mm.; range 2.94–4.05 mm. Average of greatest length of cephalothorax, including frontal region, 2.02 mm.; range 1.84–2.12 mm.; average of greatest width 2.02 mm.; range 1.66–2.21 mm. Average of greatest length of free thoracic leg-bearing segments, genital segment, abdomen, and caudal rami, excluding setae, 1.93 mm.; range 1.47–2.30 mm. Average of greatest length of genital segment 0.49 mm.; range 0.42–0.59 mm.; average of greatest width 0.73 mm.; range 0.64–0.82 mm. Average of greatest length of abdomen and caudal rami, excluding setae, 0.24 mm.; range 0.15–0.29 mm. Average of greatest length of abdomen 0.21 mm.; range 0.17–0.27 mm. Average of greatest length of caudal rami, excluding setae, 0.18 mm.; range 0.15–0.21 mm.

Description.—Color of all stages light brown to brownish yellow in life, with no distinct color pattern. Conspicilla transparent, distinct on dorsal surface. Eyes reddish brown. Single excysted specimen with light reddish area around posterior medial margin of conspicilla in alcohol.

Cyst of general ovoid shape, appearing to be formed of epidermis of host; found only on fins of host, usually parallel to fin rays. Small opening present on end of cyst, caudal rami setae visible protruding through opening. Color of cyst similar to that of host (fig. 19*a*).

Since the complete life history of this copepod has not been worked out, the stages passed within the cyst have been divided arbitrarily into two groups: the early encysted stage; and the late encysted and recently excysted stage. Cephalothorax of early encysted forms orbicular, frontal region distinct in older specimen, indistinct in younger. Frontal region in older specimen with deep median groove; younger specimen without groove, middle of anterior margin convex. Anterior surface of frontal region with indistinct transverse ridges in older specimen, not visible in younger. Division between frontal region and cephalothorax incomplete in both specimens. Older specimen with distinctly raised, anteriorly bilobed surface at region of junction of frontal region and cephalothorax. Lateral margins of cephalothorax without marginal flange; posterior sinuses of younger specimen slight, apically pointed indentations, shallow but distinct V-shaped sinuses present in older specimens. Posterior margin of cephalothorax, medial to posterior sinuses, trilobed; lateral areas extending further posteriorly than trilobed median portion. Longitudinal grooves of cephalothorax present in younger specimens as indistinct grooves extending from apex of posterior sinuses anteriorly, terminating blindly in posterior fourth of cephalothorax. Grooves of older specimen extending from apex of posterior sinuses anteriorly to just behind eyes, then turning laterally, terminating blindly medial to lateral margins. Older specimen with indistinct medial, longitudinal groove extending from region behind eyes to posterior surface of genital segment. Eyes in both younger and older early encysted forms distinct, consisting of pair of large, circular eyes with inner margins separated, one on either side of median longitudinal axis of body, and small, median, third eye between, and immediately posterior to, paired eyes. Conspicilla indistinct in both specimens, appearing as slightly roughened region anterior and lateral to eyes (figs. 19*b*,*c*).

Second, third, and fourth thoracic leg-bearing segments of early encysted forms free, successively decreasing in size. Second thoracic leg-bearing segment of younger specimen three times as wide as long; width of segment in older specimens slightly more than twice length. Lateral margins of second thoracic leg-bearing segment of younger specimen broadly rounded, of older specimen concave in anterior region, flaring in convex curve posteriorly. Posterior margin of second

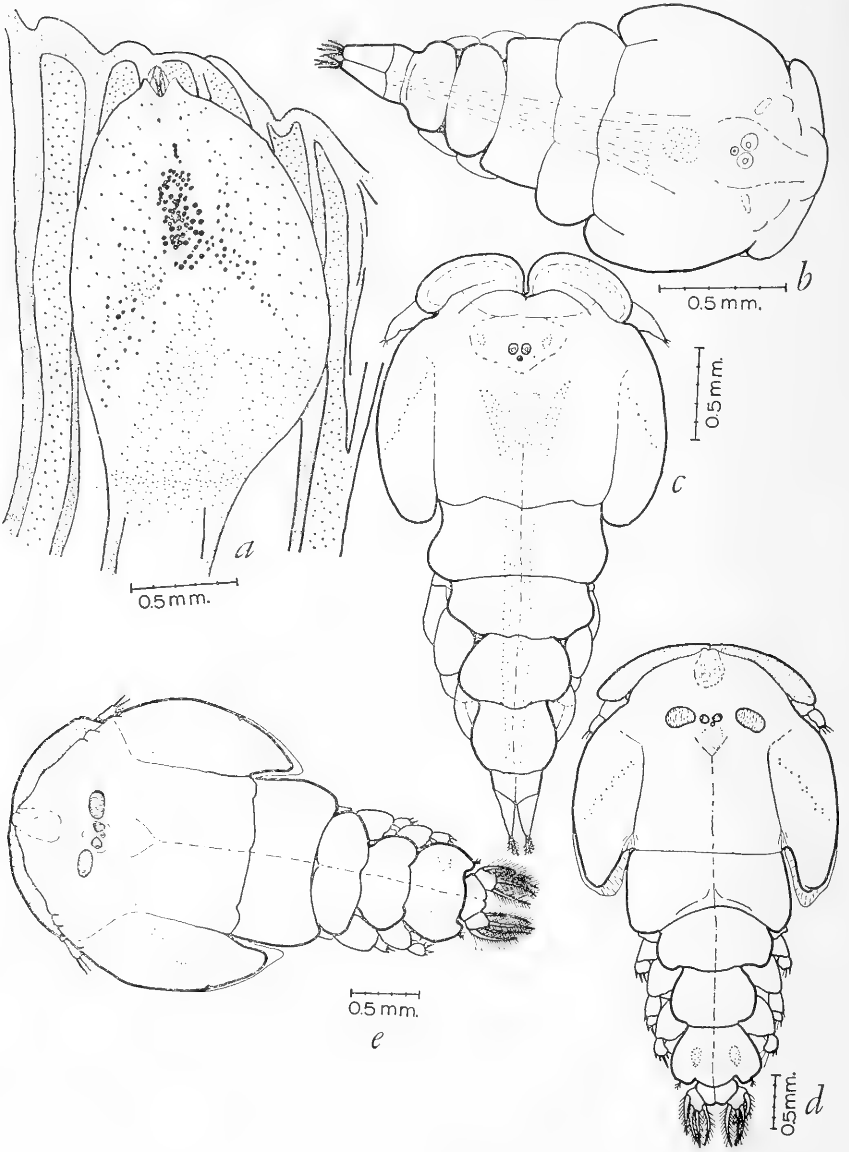

FIGURE 19.—*Nesippus costatus?* Wilson, 1924: *a*, cyst on fin of teleost host; *b*, dorsal view of younger early encysted specimen; *c*, dorsal view of older early encysted specimen; *d*, dorsal view of late encysted specimen; *e*, dorsal view of recently excysted specimen.

thoracic leg-bearing segment irregular in younger specimen, regularly concave in older. Third thoracic leg-bearing segment almost rectangular in younger specimen though tapering slightly posteriorly; greatest width almost three times greatest length; posterior margin concave.

Lateral margins of third thoracic leg-bearing segment concave in anterior portion of older specimen, convex in posterior portion, curving sharply inward to junction of fourth thoracic leg-bearing segment. Greatest width of third thoracic leg-bearing segment in older specimen slightly more than twice length. Lateral margins of fourth thoracic leg-bearing segment of younger specimen broadly rounded, greatest width slightly less than twice greatest length. Fourth thoracic leg-bearing segment in older specimen ovoid, greatest length about three-fourths greatest width.

Width of genital segment in early encysted specimens slightly less than width of fourth thoracic leg-bearing segment. Lateral margins broadly rounded in anterior three-fourths of segment in younger specimen, curving sharply inward posteriorly to slight projection of medial two-thirds of segment; greatest length about two-thirds greatest width. Lateral margins of segment in older specimen flatly convex, greatest length slightly more than two-thirds greatest width. Abdomen short, one-segmented; slightly longer in older than in younger specimen. Greatest length of abdomen approximately half length of genital segment (figs. 20*a*,*b*).

Cephalothorax of late encysted and recently excysted forms ovoid. Frontal region distinct, narrow, anterior margin flatly rounded; frontal region with distinct transverse ridges across entire surface though not as distinct on posterior as on anterior surface. Division between frontal region and cephalothorax distinct, complete; small projecting lobe in middle of margin separating frontal plates in excysted specimen present but not reaching anterior margin in late encysted specimens, though plates separated by distinct groove extending from anterior projecting lobe to anterior margin. Lateral margins of cephalothorax with very thin flange on anterior portion, broader on posterior portion, extending around posterior extensions of lateral regions into posterior sinuses. Posterior sinuses distinct, slender, V-shaped. Posterior sinuses extending anteriorly to junction of cephalothorax and second thoracic leg-bearing segment; posterior extensions of lateral cephalothoracic regions projecting to middle of second thoracic leg-bearing segment. Median posterior margin slightly irregular, extending between apices of posterior sinuses. Longitudinal grooves on dorsal surface of cephalothorax distinct posteriorly, extending from apex of posterior sinuses anteriorly, becoming indistinct lateral and posterior to eyes though discontinuous extensions visible curving anteriorly and laterally, extending to proximity of lateral margin. Indistinct, discontinuous median longitudinal groove present, extending posteriorly to anus from V-shaped, indistinct groove posterior to eyes. Eyes distinct, consisting of pair of oval eyes, one on either side of median longitudinal axis of body, with inner margins

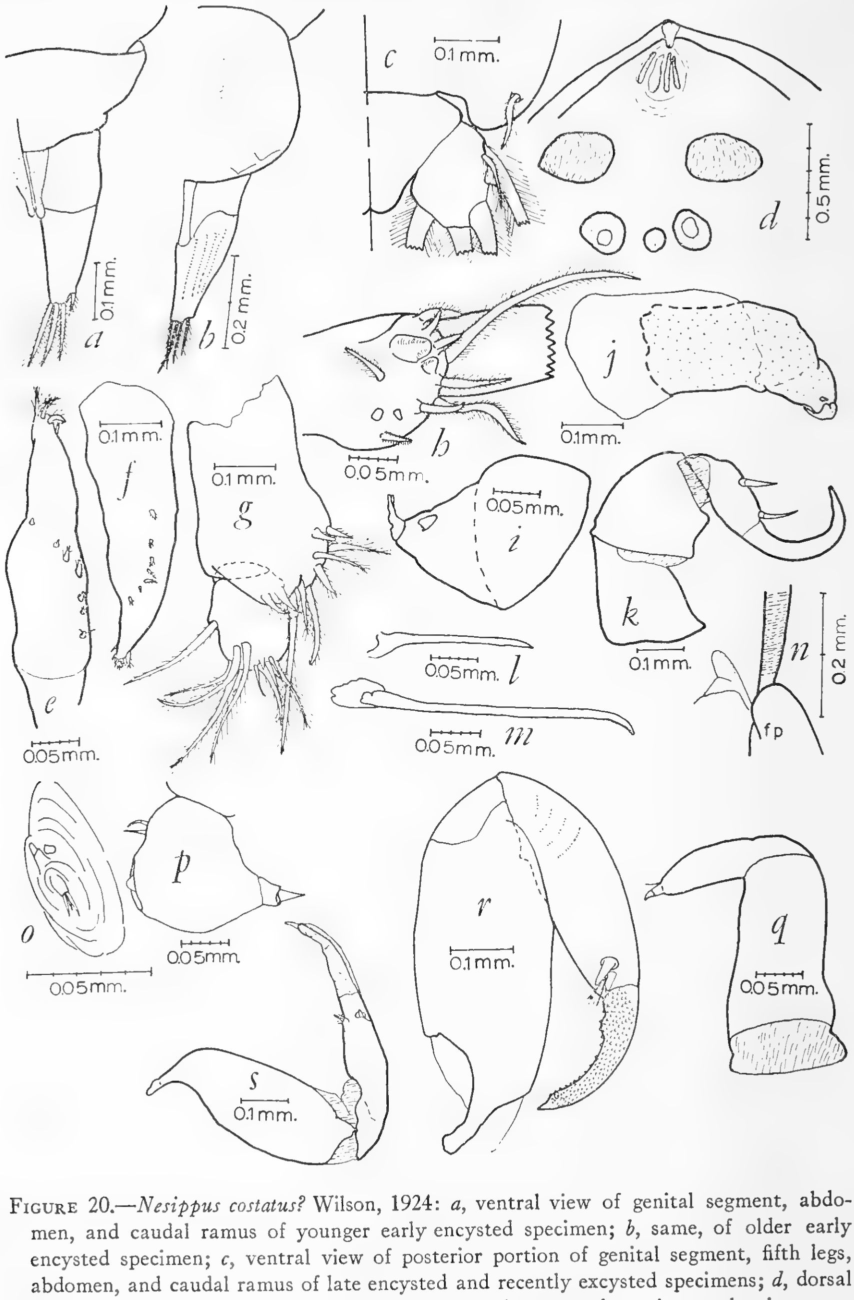

FIGURE 20.—*Nesippus costatus?* Wilson, 1924: *a*, ventral view of genital segment, abdomen, and caudal ramus of younger early encysted specimen; *b*, same, of older early encysted specimen; *c*, ventral view of posterior portion of genital segment, fifth legs, abdomen, and caudal ramus of late encysted and recently excysted specimens; *d*, dorsal view of anterior end of late encysted and recently excysted specimens showing eyes, conspicilla, and frontal organ; *e*, antennule of younger early encysted specimen; *f*, antennule of older early encysted specimen; *g*, antennule of late encysted specimen; *h*, distal end of first segment of antennule of recently excysted specimen; *i*, second antenna of

separated; third, median eye present between paired eyes (fig. 20*d*). Conspicilla large, distinct, oblong; projecting from dorsal surface of cephalothorax just anterior and lateral to paired eyes. Surface of conspicilla ridged, similar in appearance to adhesion pads of many pandarids (fig. 19*d*).

Second thoracic leg-bearing segment of late encysted and recently excysted specimens larger than third or fourth thoracic leg-bearing segment; lateral margins almost parallel, anterior half forming inner margin of posterior sinuses, posterior lateral margins curving smoothly inward, posterior lateral surfaces projecting slightly past anterior end of third thoracic leg-bearing segment. Posterior margin of second thoracic leg-bearing segment concave; greatest length of segment slightly more than half greatest width. Third thoracic leg-bearing segment with broadly rounded lateral margins, greatest length slightly more than half greatest width in encysted forms, slightly less in excysted form. Posterior lateral margins of third thoracic leg-bearing segment forming small, posteriorly projecting lobes in encysted form, middle of posterior margin slightly convex; posterior margin of recently excysted form evenly curved except for slight concavity in middle. Fourth thoracic leg-bearing segment narrower than third, greatest length approximately two-thirds greatest width; lateral margins evenly curved. Posterior lateral corners of fourth thoracic leg-bearing segment of excysted form forming small, posteriorly projecting lobes, encysted form without lobes.

Genital segment of late encysted and recently excysted forms of general ovoid shape, slightly wider than fourth thoracic leg-bearing segment, greatest length approximately two-thirds greatest width; internal spermatophores indistinctly visible in encysted, distinctly visible in excysted specimens. Lateral margins broadly curved; posterior lateral surfaces of genital segment forming small, posteriorly projecting lobes with fifth legs projecting from apex as single plumose seta arising from ventral surface. Middle of posterior margin convex, projecting slightly over anterior surface of abdomen. Abdomen short, one-segmented, greatest length slightly less than greatest width; widest point in anterior median region of segment, tapered to narrower anterior and posterior ends of segment. Posterior margin of abdomen indented at anus (fig. 20*c*).

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younger early encysted specimen; *j*, second antenna of older early encysted specimen; *k*, second antenna of late encysted and recently excysted specimens; *l*, mandible of early encysted specimens; *m*, mandible of late encysted and recently excysted specimens; *n*, adhesion pad on late encysted and recently excysted specimens (fr=frontal region); *o*, postoral process of early encysted specimens; *p*, postoral process of late encysted and recently excysted specimens; *q*, maxilla of early encysted specimens; *r*, maxilla of late encysted specimen; *s*, maxilla of recently excysted specimen.

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Antennule of early encysted forms one-segmented, attached to anterior ventral surface in frontal region. Single segment irregular in shape, flaccid, tapered to round tip bearing six small, plumose setae. Middle of antennule with irregular row of six setae, each with several setules. Two segments of late encysted antennule visible inside early encysted antennule (figs. 20*e,f*).

Antennule of late encysted and recently excysted forms two-segmented. First segment two and a half times length of second in late encysted specimens, approximately two times length of second segment in recently excysted specimen. Lateral margins almost parallel in proximal region, with knoblike convexity of anterior surface in distal region. First segment with eight short, plumose setae, one long plumose seta, two large and two small lobate protrusions, all from knoblike convexity (fig. 20*h*).

Second segment of excysted specimen slightly longer than that of encysted, both with two plumose setae on distal portion of posterior margin, three plumose setae from posterior distal surface, and six naked setae from anterior distal surface. Setae and lobes on excysted specimen developed to slightly greater extent than on encysted specimens (figs. 20*g,h*).

Second antenna of early encysted specimens two-segmented, attached just posterior to base of antennule. Second antenna consisting of large, conical first segment and small, irregular second segment. First segment of older specimen more slender than that of younger, with indication of segmentation visible inside appendage but not externally; both older and younger specimens with small, tubercular projection from posterior distal surface. Distal segment of older specimen recurved more than that of younger; younger specimen with minute, lobate projection from inner distal surface of segment; older specimen without lobate projection but with minute, irregular extension of distal surface (figs. 20*i,j*).

Second antenna of older encysted and recently excysted specimens three-segmented, attached slightly posterior and medial to antennule base. First segment short, broad, width and length about equal, lateral margins irregular, with well-developed articular surface on outer proximal edge articulating with concave depression of segment-like extension of ventral surface of cephalothorax. Inner distal surface of first segment projecting beyond remaining distal surface as broad articular surface, fitting in heavily chitinized depression on outer proximal surface of second segment. Second segment strongly developed, slightly longer than wide, longer than first segment; lateral margins somewhat irregular, inner margin convex. Inner distal surface of second segment projecting as rodlike structure, articulating with knoblike process on third segment. Third segment and terminal process falciform, more so in excysted than in encysted specimens. Length of third segment and terminal process slightly shorter than combined lengths of first two segments. Third segment with two spinelike accessory processes on inner surface, one on proximal, second on distal portions of segment. Division between terminal process and segment distinct (fig. 20*k*).

Mandible of early encysted, late encysted and recently excysted specimens four-parted. Mandible of late encysted and recently excysted specimens slightly longer than that of early encysted. First part of mandible of all specimens broader proximally than distally, with even taper to junction of second part. Second part short, slightly more than half length of first part in early encysted specimens, less than half in late encysted and recently excysted specimens; with little taper to junction of third part. Third part elongate, almost twice length of first part, tapered slightly in younger specimens, not in older. Fourth part short, slightly longer than second part, curved inward slightly at distal end, with distinct, toothlike denticulations along inner margin of older specimens, denticulations not visible in younger specimens (figs. 20*l*,*m*).

Postoral process of early encysted specimens mound-shaped swelling adjacent to base of mouth cone, with two small, lobate protrusions on anterior surface and single, small, apical projection bearing three setules on posterior distal surface (fig. 20*o*).

Postoral process of late encysted and recently excysted specimens bulbous protrusion adjacent to base of mouth cone. Distal surface of process larger than proximal, with single spine projecting from posterior distal surface, two setules from anterior proximal surface and single knob from anterior distal surface, arising from slight depression in surface. Wilson (1924) notes three setules instead of two from the anterior proximal surface and does not mention the spine found on the presently described specimens (fig. 20*p*).

Maxilla of early encysted forms two-segmented, both segments flaccid. First segment with almost parallel lateral margins, no articular surfaces visible. Second segment tapered to blunt tip in younger specimen, rounded but sharper tip in older specimen; length of segment about half that of first segment in younger specimen, two-thirds that of first segment in older specimen. Distal end of second segment in both specimens tipped by small, pointed protrusion; younger specimen with additional, setule-like structure on outer distal corner, structure not present in older specimen (fig. 20*q*).

Maxilla of late encysted specimens two-segmented. First segment strongly developed, with long projection of middle of proximal surface as articular surface. Lateral margins of first segment flatly convex; middle of distal surface projecting as articular surface, middle of distal projection heavily chitinized, articulating with small concavity on inner proximal surface of second segment. Second segment with terminal process slightly shorter than first segment, including proximal extension of first segment. Second segment tapered slightly to blunt distal end, tipped by long, slightly curved, dactyliform process with small-pointed protrusion from tip of process. Terminal process of late encysted form sheathed with membranous structure covered with minute, toothlike denticulations; recently excysted specimen also with sheathed process but denticulations replaced by minute tubercles. Distal end of segment, just proximal to base of terminal process, with two accessory processes on anterior margin: first a short, sharply tipped process; second membranous, irregularly shaped process surrounded by tuft of setules (figs. 20*r*,*s*).

Maxilliped of early encysted form two-segmented, attached posterior to base of maxilla. First segment in younger specimen narrower in proximal than in distal regions, distal region overlapping proximal region giving two-parted appearance to segment. Second segment of younger specimen short, less than one-fourth length of first segment; segment and terminal process continuous, terminal process flaccid, forming slender projection of segment. First segment of older early encysted specimen similar to that of younger but distal portion larger, greatly swollen, with adhesion pad on inner distal surface. Second segment of older specimen similar to that of younger though terminal process short but distinct clawlike process fitting into adhesion pad of first segment. Second segment of older specimen with accessory, spinelike process from inner surface just proximal to base of terminal process. Division between terminal process and segment in older specimen distinct (figs. 21*a*,*b*).

Maxilliped of late encysted and recently excysted specimens similar in general appearance to that of older early encysted specimen. Adhesion pad on inner distal surface of first segment with additional, knoblike process extending from distal margin. Second segment more strongly developed, heavily chitinized at articulation with first segment, with two accessory processes instead of one found in older early encysted specimen; terminal process not clawlike but rounded protuberance similar to that of adhesion pad of first segment and abutting with this process when second segment flexed (figs. 21*c*,*d*).

First thoracic leg of early encysted specimens biramous, both rami dactyliform, without external evidence of segmentation. Both protopodite and rami flaccid. Exopodite extending beyond distal margin of endopodite, with three spines in younger specimen, one from outer distal lateral surface, two from distal margin; four spines on older specimen, three as in younger specimen, from distal margin, fourth from inner distal lateral surface. Endopodite with three minute, lobate projections from distal surface. Early encysted specimens with indistinct evidence of two-segmented exopodite and endopodite visible inside dactyliform rami (figs. 21*e*,*f*).

First thoracic leg of late encysted and recently excysted specimens biramous. Protopodite irregular in outline, with two plumose setae, one on either side of rami. Exopodite two-segmented; first segment longer than second, lateral margins irregularly convex, with single spine from outer distal lateral corner. Second segment with narrow proximal surface, wide distal surface; lateral and distal margins continuous. Endopodite two-segmented, both segments of approximately equal length. First segment slightly shorter than second, with convex lateral margins in encysted specimens, of rectangular shape in excysted specimen. Second segment with continuous distal and outer lateral margins (fig. 21*g*).

Second thoracic leg of early encysted specimens biramous, rami one-segmented. Both protopodite and rami flaccid; protopodite with minute projections on inner surface of younger specimen, plumose setule on older. Exopodite slightly longer than endopodite, tipped with four minute, lobate projections, one from each distal lateral surface, two from distal surface. Endopodite with single plumose setule from middle of inner margin, four minute, sharp projections from distal margin. Two-segmented exopodite and endopodite of late encysted specimens visible inside rami (figs. 21*h*,*i*).

Second thoracic leg of late encysted and recently excysted specimens biramous. Protopodite broad, length approximately three-fourths width, with single naked setule on distal margin next to outer lateral margin of exopodite and plumose seta on inner proximal margin. Exopodite two-segmented; first segment longer than second, narrower proximally than distally, outer surface with patch of short, hairlike projections giving fuzzy appearance to region. First segment with single spine on outer distal lateral margin. Second segment of exopodite orbicular, margins continuous, with three small, membrane-margined spines on outer lateral margin. Endopodite two-segmented; first segment slightly more than half length of second, second segment of general ovoid shape, lateral and distal margins distinct (fig. 21*j*).

Third thoracic legs of early encysted forms biramous, rami one-segmented. Protopodite and rami flaccid; protopodite of older specimen with single, plumose setule from inner proximal margin, with small, knoblike projection outside exopodite of younger specimen. Both rami of about equal length, exopodite of younger specimen with three plumose setules from distal margin, one from inner lateral margin and four minute, spinelike processes from distal outer margin. Exopodite of older specimen with three plumose setules from distal margin; one plumose setule and one minute plumose setule from outer

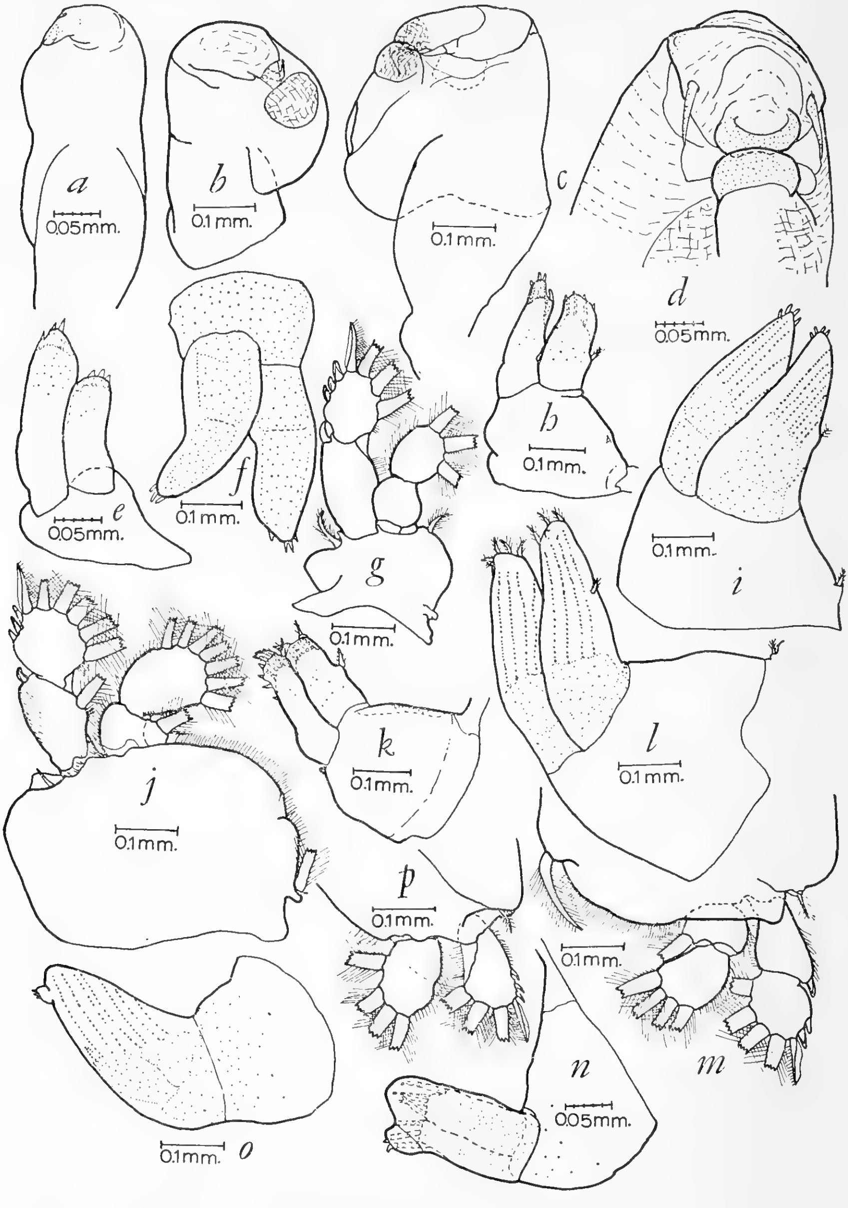

FIGURE 21.—*Nesippus costatus?* Wilson, 1924: *a*, maxilliped of younger early encysted specimen; *b*, maxilliped of older early encysted specimen; *c*, maxilliped of late encysted and recently excysted specimens; *d*, inner distal surface of *c*; *e*, first thoracic leg of younger early encysted specimen; *f*, first thoracic leg of older early encysted specimen; *g*, first thoracic leg of late encysted and recently excysted specimens; *h*, second thoracic leg of younger early encysted specimen; *i*, second thoracic leg of older early encysted specimen;

distal margin. Endopodite of both specimens with three plumose setules from distal margin, one plumose setule from middle of inner margin. Segments of both rami of late encysted forms visible inside rami of early encysted form (figs. 21*k*,*l*).

Third thoracic leg of late encysted and recently excysted specimens biramous. Protopodite broad, greatest length about three-fourths greatest width, with single plumose seta on inner proximal margin, single plumose setule just outside base of exopodite. Expodite two-segmented; first segment longer than second, narrower proximally than distally, with single spine from outer distal corner. Second segment of exopodite broadly rounded, almost orbicular, lateral and distal margins continuous; with two membrane-margined spines on outer margin. Endopodite two-segmented; first segment shorter than second, flared rapidly from narrow proximal to broad distal surface. Second segment narrower proximally than distally, lateral and distal margins distinct (fig. 21*m*).

Fourth thoracic leg of early encysted forms uniramous, two-segmented. Protopodite one-segmented, slightly wider than long; ramus and protopodite flaccid. Ramus with rounded protrusion from distal portion of outer surface, larger in younger than in older specimen; two minute, pointed projections present on protrusion in younger specimen, three in older. Both exopodite and endopodite of late-encysted specimens visible inside single ramus of early encysted specimens (figs. 21*n*,*o*).

Fourth thoracic leg of late encysted and recently excysted forms biramous, rami one-segmented. Protopodite longer than wide, outer surface with distinct groove giving bilobed appearance, with single plumose setule lateral to outer margin of exopodite. Exopodite narrower at proximal than at distal end, with three spines on distal portion of outer margin, each with light membranous margin. Endopodite oblong, with small but distinct indentation of inner margin, indistinct, discontinuous groove visible extending part way across segment from indentation (fig. 21*p*).

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j, second thoracic leg of late encysted and recently excysted specimens; *k*, third thoracic leg of younger early encysted specimen; *l*, third thoracic leg of older early encysted specimen; *m*, third thoracic leg of late encysted and recently excysted specimens; *n*, fourth thoracic leg of younger early encysted specimen; *o*, fourth thoracic leg of older early encysted specimen; *p*, fourth thoracic leg of late encysted and recently excysted specimens.

The character of the membranes, spines, and setae of the thoracic legs of the late encysted and recently excysted specimens is given below (for explanation of symbols, see figure 1):

Leg	Margin	Protopodite	Exopodite		Endopodite	
			1	2	1	2
I	outer inner	p p	H c	3H, Q c, 3P		c 3P
II	outer inner	s P, c	H c, P	3H, Q c, 5P	c P	c, 3P c, 4P
III	outer inner	p P, c	c, H c	2H, Q 4P	c P	c, 2P 2P
IV	outer inner	p P, c	c, 3H, Q c, 3P		c 4P	

The above table includes the armature of the thoracic legs of the late encysted and recently excysted forms only.

Caudal rami of early encysted forms long, conical, length about twice width; attached to posterior end of abdomen. Caudal rami tipped by four plumose setae. Anal region with two long, heavily chitinized, rodlike projections extending posteriorly from genital segment as far as caudal rami. These structures are incorporated into the abdomen of later encysted specimens and do not extend past the posterior end of the abdomen (figs. 20*a*,*b*).

Caudal rami of late encysted and recently excysted forms shorter than those of early encysted specimens, of laminate nature; attached to lateral surface of abdomen. Caudal rami with three long, plumose setae from distal and distal lateral surfaces, one from outer proximal region and one small, plumose seta from outer proximal region (not recorded by Wilson, 1924, for *N. costatus*). Inner margin of caudal rami setuliferous (fig. 20*c*).

Remarks.—The peculiar habit of encysting on the fins of teleost fishes exhibited by the male has not been reported previously in the literature for members of the family Pandaridae. The cyst appears to serve as a protective structure for the developing copepod and to replace the normal attachment cord or second antennal attachment of the chalimus stages of other copepods. The encystment of the copepod does not appear to harm the host to any extent and, when the male excysts, the cyst is absorbed by the host. Empty cysts in various stages of absorption were seen on the fins of teleost fishes, some being visible only as a slight irregularity.

The moult of the form described as the older early encystment stage was frequently found in empty cysts. One of the specimens included in the collection deposited in the U.S. National Museum was moulting when preserved. The moult of this specimen was that of the older early encystment stage, the specimen was in the late encystment stage; no additional moults were observed in the cyst. The moult suggests that at least two stages are passed within the cyst. Whether or not the copepod encysts more than once during its development has not been determined. A specimen in the late encystment stage was removed from its cyst and kept alive for seven days, during which time no change occurred in the animal.

Live copepods, when removed from their cysts, were extremely flexible. This condition is presumably useful during excystment, when the animal backs out of the opening at the end of the ovoid cyst. The opening was present in all of the cysts examined and the tips of the caudal rami of the copepod were observed protruding from the opening. Since copepods purportedly have anal respiration (Wilson, 1905), it appears that this opening serves for respiration and excretion.

All of the type specimens of *Nesippus costatus* Wilson, 1924, and the only specimens known for this copepod, have been lost. For this reason, definite identification of the copepod described here is impossible. The similarity of the late encysted and recently excysted forms to the description of the male of *N. costatus* given by Wilson (1924) indicates that the specimens described here are probably specimens of this species. The differences between the described specimens and the male of *N. costatus* are given in the preceding description.

Family Anthosomatidae

Genus *Norion* Nordmann, 1864

Diagnosis.—Body ovoid, strongly flattened dorsoventrally. Body, except cephalon, maxilliped-bearing segment, and first thoracic leg-bearing segment, covered with shield consisting of single dorsal plate over posterior surface, paired dorsal plates over anterior surface, and single pair of ventral plates, modified second thoracic legs, covering posterior ventral surface. Single posterior dorsal plate and ventral plate pair-forming brood pouch. Abdomen small, ovoid. Eggs in uniseriate strings curled inside brood pouch. Antennule seven-segmented; first pair of thoracic legs reduced, second pair forming ventral plates, third pair lamelliform, fourth pair dactyliform protopodite with rami reduced to minute lobes. Caudal rami obovate.

Remarks.—Nordmann erected this genus for the species *N. expansus* on the basis of a single specimen from the gills of an unknown fish captured in the Hawaiian Islands. The genus was placed by Nordmann in the family Chondracanthidae although Bassett-Smith (1899) and Wilson (1922, 1932), recognizing its affinities with members of the Caligoida, placed it in the family Dichelesthiidae. The overall appearance of the body and the specific appearance of the oral appendages and the cephalothorax indicate its relationship to species of *Anthosoma, Lernanthropus,* and *Sagum.* *Norion* differs from these genera by its extreme dorsoventrally flattened condition, the paired ventral plates that are neither bifid nor produced, and the reduced first thoracic legs. Because of the similarities of the four genera, *Norion* is placed in the family Anthosomatidae with these genera, the latter originally being a subfamily of the family Dichelesthiidae.

Norion expansus **Nordmann**

Figures 22*a–c*, 23*a–k*

N. expansus Nordmann, 1864, pp. 489–491, pl. 6.—Bassett-Smith, 1899, p.469.—Wilson, 1922a, pp. 26–27.

Present hosts (original host unknown).—*Naso lituratus* (Bloch and Schneider), *Naso hexacanthus* (Bleeker).

Distribution.—Hawaii.

Material.—Adult female collected by author from gill lamellae of specimen of *Naso lituratus* (Bloch and Schneider) speared by author off Lehua Rock, Niihau, Hawaii. Two adult females collected by author from gill lamellae of two specimens of *Naso hexacanthus* (Bleeker) taken in fish traps between Diamond Head and Koko Head, Oahu, Hawaii, by Samuel Kaolulo. Two adult females collected by Dr. Hilda Ching from gill cavity of unknown species of *Naso* speared by Edgar Hookano off Kahuluu, Oahu, Hawaii. (USNM 105113–105116.)

Measurements.—Average of greatest length 7.91 mm.; range 6.52–9.02 mm. Average length from anterior margin of head to posterior margin of body 6.72 mm.; range 5.70–7.91 mm. Average of greatest width 6.07 mm.; range 5.15–7.36 mm. Average length of fused cephalon, maxilliped-bearing segment, and first thoracic leg-bearing segment 1.29 mm.; range 1.10–1.56 mm. Average of greatest length from anterior end of second thoracic leg-bearing segment to posterior end of caudal rami 2.76 mm.; range 2.21–3.95 mm. Average of greatest length of single posterior dorsal plate 5.06 mm.; range 4.32–5.98 mm. Average of greatest length of paired dorsal plates 3.86 mm.; range 3.22–4.51 mm. Average of greatest length of paired ventral plates 5.43 mm.; range 4.51–6.90 mm.

Description.—Body yellowish brown in life, with fine, lighter colored vessels around margins of plates. Vessels filled with red fluid in living specimens that may form part of circulatory system; fluid flowing intermittently in response to movement of animal.

Body ovoid, anterior half, except cephalon, maxilliped-bearing segment, and first thoracic leg-bearing segment, covered dorsally by pair of plates projecting anteriorly on either side of head and forming U-shaped depression from apex of which uncovered cephalothoracic portion of body projects. Anterior margins of projecting plates broadly rounded, posterior medial margins irregularly convex; anterior dorsal plates attached to dorsal and lateral surfaces of second thoracic leg-bearing segment. Posterior dorsal portion of body covered by single, broad plate projecting posteriorly past caudal rami for distance equal to length of entire body, excluding plates. Lateral margins of single dorsal plate tapered to evenly rounded posterior end. Lateral margins broadly rounded anteriorly; anterior margins slightly concave, curving anteriorly to evenly rounded anterior median apex. Posterior lateral surfaces of paired dorsal plates overlapping anterior lateral surfaces of single plate. Single posterior dorsal plate attached along entire dorsal surface of third thoracic segment. Second thoracic legs greatly expanded, forming platelike structures covering entire ventral surface posterior to cephalothorax, extending posteriorly almost as far as posterior dorsal plate and anteriorly, along ventral surface of paired dorsal plates, to middle of cephalothorax. Second thoracic legs and posterior dorsal plate form brood pouch. Dorsal and ventral plates attached along adjacent margins by membranes. Surface of all plates covered with minute bumps (figs. 22*a–c*).

Cephalon, maxilliped- and first thoracic leg-bearing segments fused, forming cephalothorax, separated from rest of body by distinct groove though first thoracic leg-bearing segment overlapping second slightly on both dorsal and ventral surfaces (figs. 22*b*, 23*a*). Cephalothorax oblong, wider than long. Anterior and lateral margins of head irregular. Ventral surface of cephalon with padlike structures on lateral and anterior surfaces leaving central depression from which appendages and mouth cone arise (fig. 23*a*). First thoracic leg-bearing segment slender, anterior margin concave on ventral surface; first thoracic legs reduced, forming padlike structure, with concave depression on anterior surface to receive maxillipeds (fig. 23*a*). Second thoracic leg-bearing segment slender, much wider than long, distinct from first thoracic leg-bearing segment and third thoracic leg-bearing segment; anterior surface pocket-shaped for rotation of cephalothorax. Posterior ventral surface of second thoracic leg-bearing segment heavily chitinized in lateral regions, forming base for modified, platelike second thoracic legs attached to segment by narrow, pedunculate extension of proximal region of legs. Third thoracic leg-bearing segment large, expanded medially, larger than all other segments; lateral margins faint but distinct, tapered into single poste-

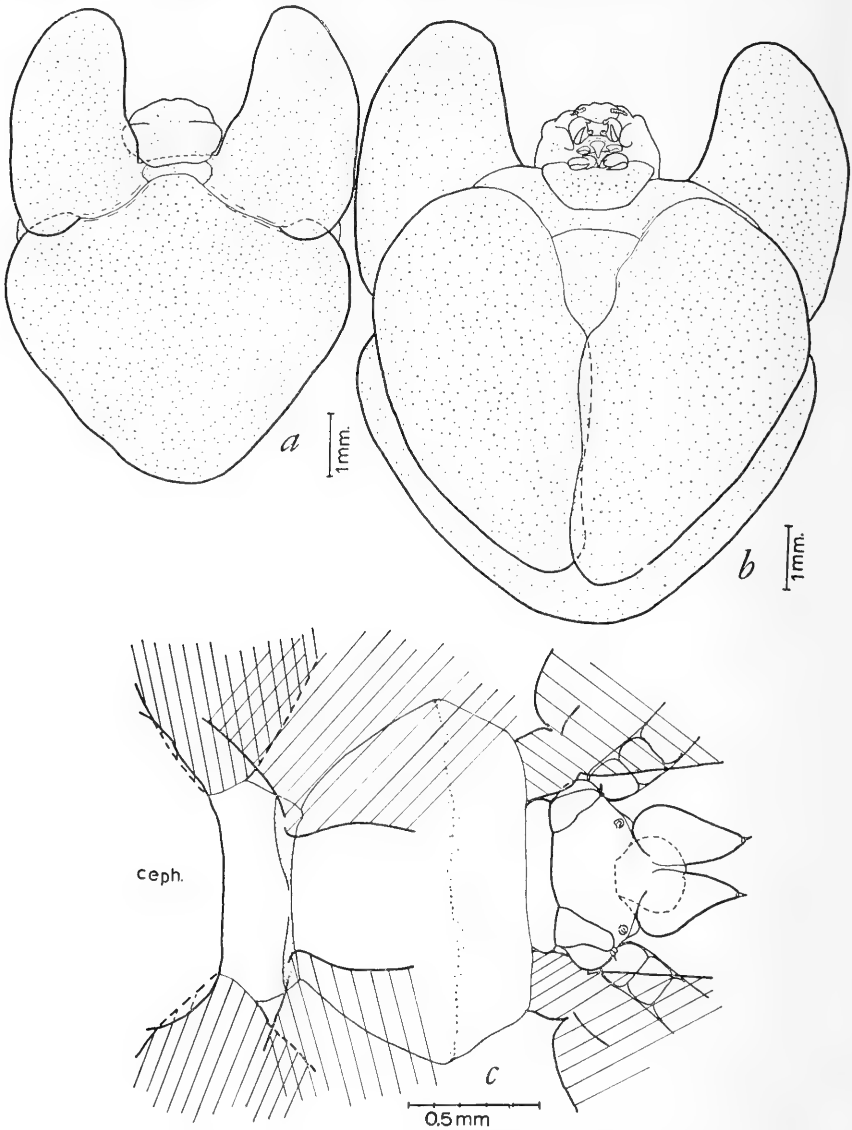

FIGURE 22.—*Norion expansus* Nordmann, 1864 (female): *a*, dorsal view; *b*, ventral view of second specimen; *c*, ventral view of posterior end of cephalothorax (ceph.), second, third, and fourth thoracic leg-bearing segments, genital segment, abdomen (dashed line), and caudal rami (parallel lines indicate position of plates and expanded third thoracic legs).

rior dorsal plate fused to dorsal surface of segment. Fourth thoracic leg-bearing segment slender, width greatly exceeding length, distinctly separated from third thoracic leg-bearing segment and genital segment. Genital segment expanded from anterior junction of fourth thoracic leg-bearing segment to widest point in anterior medial region of segment; lateral margins sharply curved, tapered posteriorly. Posterior and posterior lateral areas with double margin; posterior margin convex dorsally, abdomen joined to median portion; ventral margin tapered to region of fusion of genital segment, abdomen, and caudal rami. "Brown body" (Heider, 1879, for *Lernanthropus*) present at opening to spermatophore duct located on ventral posterior lateral surface of genital segment; circular, varying from brownish red to bright red in alcohol. Abdomen one-segmented, of a general ovoid shape; greatest length twice that of fourth thoracic leg-bearing segment, posterior end broadly rounded (fig. 22*c*).

Egg strings long, uniseriate, coiled inside brood pouch, each string consisting of more than 300 eggs. Eggs "fanned" by vertical movements of single posterior dorsal plate in living, ovigerous specimens (fig. 23*k*).

Antennule seven-segmented, attached to swelling on anterior ventral surface of cephalon. Segments of irregular shape and size, appendage tapered irregularly from large proximal to small distal regions. Second segment with three naked setae on anterior margin; third with one; fourth with minute naked seta on posterior margin; fifth segment with two naked setae on anterior distal margin and one on posterior margin; sixth segment with one long and one short naked seta on anterior distal margin; seventh segment with one long, three short naked setae from distal margin, two minute naked setae from posterior margin (fig. 23*b*).

Second antenna two-segmented, attached posterior to antennule-bearing swelling, on anterior ventral surface of head. First segment strongly developed, curving medially, distal end at right angle to proximal and directly over inner proximal corner. No distinct articular surfaces visible on proximal end of first segment, segment firmly attached to cephalon along entire proximal surface indicating little movement. Second segment short, with strongly developed terminal process. Terminal process of second segment curving strongly inwards, triangular in cross section, inner surface flat (fig. 23*c*).

Mandible appears four-parted. First part with broad proximal end, irregularly tapered to narrower junction of second part. Second part short, less than one-third length of first part, tapered evenly but abruptly to junction of third part, indicated by slight indentation on outer surface. Third part approximately twice length of second, slender, with little taper. Fourth part slightly longer than first, bent slightly but abruptly in proximal region, distal portion straight,

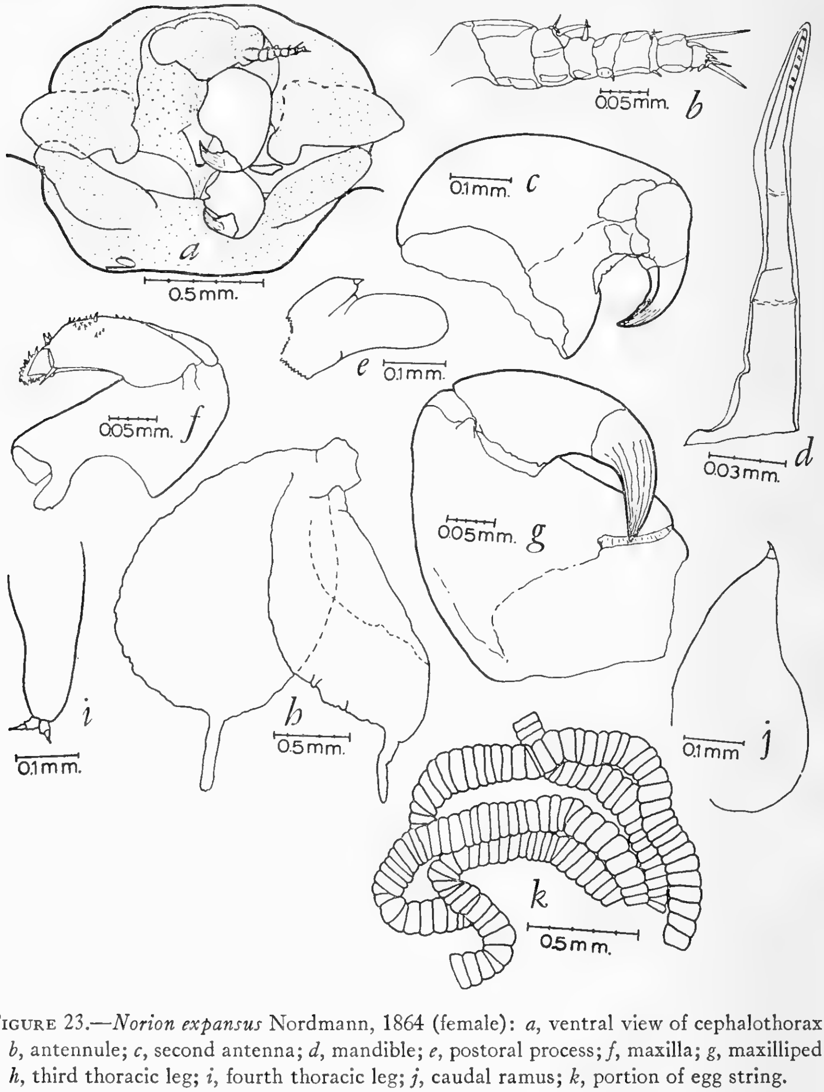

FIGURE 23.—*Norion expansus* Nordmann, 1864 (female): *a*, ventral view of cephalothorax; *b*, antennule; *c*, second antenna; *d*, mandible; *e*, postoral process; *f*, maxilla; *g*, maxilliped; *h*, third thoracic leg; *i*, fourth thoracic leg; *j*, caudal ramus; *k*, portion of egg string.

with six small, conical tubercles projecting from flat inner surface. Entire mandible surrounded by fine, membranous covering (fig. 23*d*).

Postoral process biramous, attached lateral to base of mouth cone, segmentation not visible. Outer ramus lamellate, inner dactyliform; inner ramus with short spine projecting from rounded distal end. Outer ramus about twice length of inner, without processes (fig. 23*e*).

Maxilla two-segmented, situated lateral and posterior to postoral process. First segment well developed, slightly longer than second, inner proximal surface projecting as well-developed, lobate, articular surface. Proximal end of first segment irregular, outer lateral margin convex, inner straight; inner distal margin irregular, with slight articular surface protruding from segment, articulating with slight concave depression of second segment. Second segment curved inward, middle of outer surface with several small clusters of spinules, distal surface with several spinules and bearing terminal process denticulate along inner and outer margins (fig. 23*f*).

Maxilliped two-segmented, attached just posterior and medial to maxilla. First segment strongly developed, proximal end broad, distal narrow, taper primarily on inner surface, outer margin convex. Inner margin irregular, with shelflike formation at proximal end. Distal inner surface of first segment irregular, with two nodelike protrusions, one on posterior surface, second on anterior; protrusions projecting slightly above margin and forming articular surfaces for second segment. Second segment short, heavily chitinized, curved inward; terminal process well developed, spinelike, curved inward. Length of second segment and terminal process approximately two-thirds length of first segment, division between terminal process and segment distinct (fig. 23*g*).

The first and second thoracic legs have been described in the discussion of the body and will not be included in the following descriptions of the thoracic legs.

Third thoracic leg biramous, projecting from posterior lateral margin of third thoracic segment; lamellate, segmentation not visible. Endopodite slightly longer than exopodite, exopodite folded along midline, attached to endopodite along proximal margins. Both endopodite and exopodite with elongate, distally rounded extensions from rounded distal margin; length of extensions almost one-fourth length of appendage (fig. 23*h*).

Fourth thoracic leg biramous, attached to lateral posterior surface of fourth segment. Protopodite large, dactyliform, slightly wider at proximal than at rounded distal end. Exopodite and endopodite minute, one-segmented processes from distal end of protopodite, each tipped by small, spinelike process (fig. 23*i*).

Caudal rami obovate, laminate, greatest length slightly less than two times greatest width; proximal margin indistinct, rami fused to abdomen and posterior surface of genital segment. Outer margin with distinct bulge in proximal portion, pointed distal end tipped by minute, two-parted, spinelike process (fig. 23*j*).

Remarks.—The above description represents the first time this species has been described from specimens since Nordmann's original description (1864). Nordmann indicated that *N. expansus* was similar to members of the cyclopoid genus *Tucca* although both

Bassett-Smith (1899) and Wilson (1922), without seeing the holotype and only specimen, placed the genus *Norion* with the Caligoida.

Nordmann (1864) indicates that he found no evidence of body segmentation other than the presence of appendages in the cephalothorax. This was probably due to the covering of the posterior portion of the body by the single dorsal and paired ventral plates. With sufficient material at hand, this author has been able to examine members of the species in greater detail than did the original author.

The segmentation present in the specimens collected, the distinct segmentation of the antennule, the presence of four pairs of thoracic legs, and the presence of uniseriate egg strings indicate that this genus, represented solely by *N. expansus*, belongs in the Caligoida, not the Cyclopoida. The fusion of the first thoracic leg-bearing segment, the maxilliped-bearing segment, and the cephalon, in addition to the presence of dorsal plates, indicates that the species is a member of the family Anthosomatidae. The similarities of the single dorsal plate covering the posterior surface of the animal and the paired ventral plates found in *N. expansus* to those of some members of the genus *Sagum*, *S. angulatum* (Krøyer), and those of some members of the genus *Lernanthropus*, *L. pagelli* Krøyer and *L. chrysophrys* Shishido, indicate a distinct relationship between these genera. In addition, the maxilla of *N. expansus*, especially the distal end and terminal process of the second segment, is similar to that of members of the genus *Lernanthropus*, and the laminate third thoracic leg of *N. expansus* is similar to the fourth leg of species of the genus *Sagum*.

This parasite is comparatively rare in the Hawaiian Islands; the author collected three from 189 specimens of *Naso*, the only genus upon which the parasite was found. The additional two specimens were collected by Dr. Hilda Ching from a single, large specimen of an unknown species of *Naso*.

Family Lernaeoceridae

Genus *Peniculus* Nordmann, 1832

Diagnosis.—Female: Body elongate; head without horns but lateral lobes may be present; separated from posterior body by neck consisting of thoracic leg-bearing segments 1–3 or segments 2 and 3, one being fused with cephalon in the latter. Fourth thoracic leg-bearing segment swollen, either separated from fused genital segment and abdomen by constriction or fused with these segments. Antennule reduced or absent; second antenna forming organ of attachment, terminal process clawlike, distinct in immature specimens, indistinct in mature. Mouth cone retractible; cephalic appendages consist of second antennae, mandibles, maxillae, and maxillipeds. Thoracic legs platelike, composed solely of protopodite; fifth legs absent. Caudal rami armed with setae.

Remarks.—The diagnosis was taken from Olsson (1869) and Wilson (1932) although recent description of new species of this genus indicates the need for some revision. In addition to distinct morphological characteristics, the proportional relationships of the various body parts have been used as specific characteristics. The validity of this method, especially in a degenerated form such as that of the species in this genus, is dependent upon the degree of difference between the species and the number of specimens available; the amount of variation present, at least in the species described below, is sufficient to warrant careful consideration of the body parts being compared.

Peniculus calamus? Nordmann, 1864

Figures 24*a–q*

P. calamus Nordmann, 1864, pp. 515–517, no figures.—Wilson, 1917, p. 45 [in key].—Shiino, 1956b, pp. 597, 599, 603.

Present hosts (original host unknown).—*Acanthurus dussumieri* Cuvier and Valenciennes, *Acanthurus mata* (Cuvier), *Acanthurus olivaceous* Bloch and Schneider, *Acanthurus triostegus sandvicensis* Streets, *Ctenochaetus strigosus* (Bennett), *Naso hexacanthus* (Bleeker), *Naso unicornis* (Forskål).

Type locality.—Hawaii.

Material.—Two mature females taken by author from caudal fin of specimen of *Acanthurus dussumieri* Cuvier and Valenciennes taken by poison off Waikiki, Oahu, Hawaii, by Dr. William Gosline and others. Four mature females taken by author from caudal fin of specimen of *A. dussumieri* captured in fish trap between Diamond Head and Koko Head, Oahu, Hawaii, by Samuel Kaolulo. Six mature females taken by author from anal and pectoral fins of specimen of *Acanthurus mata* (Cuvier) captured in fish trap between Diamond Head and Koko Head, Oahu, Hawaii, by Samuel Kaolulo. (USNM 105110–105112.)

Measurements.—Average length from anterior end of head to posterior end of abdomen, excluding projecting second antennae and egg strings, 2.85 mm.; range 2.30–3.31 mm. Average of greatest length of head, excluding projecting second antennae, 0.32 mm.; range 0.29–0.36 mm.; average of greatest width 0.22 mm.; range 0.21–0.25 mm. Average of greatest length of neck (first, second, and third thoracic leg-bearing segments) 0.20 mm.; range 0.15–0.22 mm. Average of greatest length of combined fourth thoracic leg-bearing segment, genital segment, and abdomen 2.39 mm.; range 1.84–2.85 mm. Average length of egg strings (eight specimens) 2.94 mm.; range 2.12–3.86 mm.

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Description.—Color of body brown in alcohol, egg strings yellow; body with dark brown splotches and dorsal black spot, the eye, on cephalon. The three pairs of spots on the underpart of the head as described by Nordmann (1864) were not found.

Cephalon ellipsoid dorsally, of general ellipsoid shape laterally, with ventral surface projecting in region of mouth cone. Dark eye spot present on dorsal surface, in middle of anterior portion of cephalon. Division between cephalon and first thoracic leg-bearing segment distinct, curving anteriorly on dorsal surface. First, second, and third thoracic leg-bearing segments forming neck. First thoracic leg-bearing segment short, tapered posteriorly, greatest width about twice greatest length. First segment overlapping second leg-bearing segment slightly, second segment slightly longer than first, tapered to junction of third thoracic leg-bearing segment. Third segment of varying length though generally equal to length of second leg-bearing segment. Posterior portion of third segment flared slightly at junction of fourth thoracic leg-bearing segment. Fourth leg-bearing segment expanded, fused to genital segment; fourth leg-bearing segment, genital segment, and abdomen forming elongate posterior portion of body. Indication of posterior end of fourth leg-bearing segment present as slight constriction in most specimens though absent in some. Anterior margins of fourth leg-bearing segment rounded, curved medially to junction of third segment (figs. 24*c,d*). Lateral margins of fused fourth thoracic leg-bearing segment, genital segment, and abdomen elongate, almost parallel; dorsal and ventral surface with several seta-like projections from epidermis but not projecting above cuticle in most specimens (fig. 24*d*). Abdomen small, projecting from posterior dorsal surface of genital segment; caudal projections overlapping caudal rami. The abdomen shows significant variation in the specimens examined; both long and short caudal projections were observed in the small series; bulbous and rounded terminations of the caudal projections were also seen (figs. 24*e,f*). Both of these variations were found in about equal proportions though the two do not appear to be related, forms with long abdomens being found with and without the bulbous terminations as also were forms with short abdomens (figs. 24*a–f*).

Egg strings long, with 36–42 eggs in each string. Distal end of string either rounded or projecting beyond last egg in string in tapered projection sharply rounded at tip (figs. 24*a,b*).

Antennule absent in all specimens.

Segmentation of second antenna indistinct, probably two-segmented. Appendage projecting anteriorly from anterior ventral surface of head, forming organ of attachment. Both second anten-

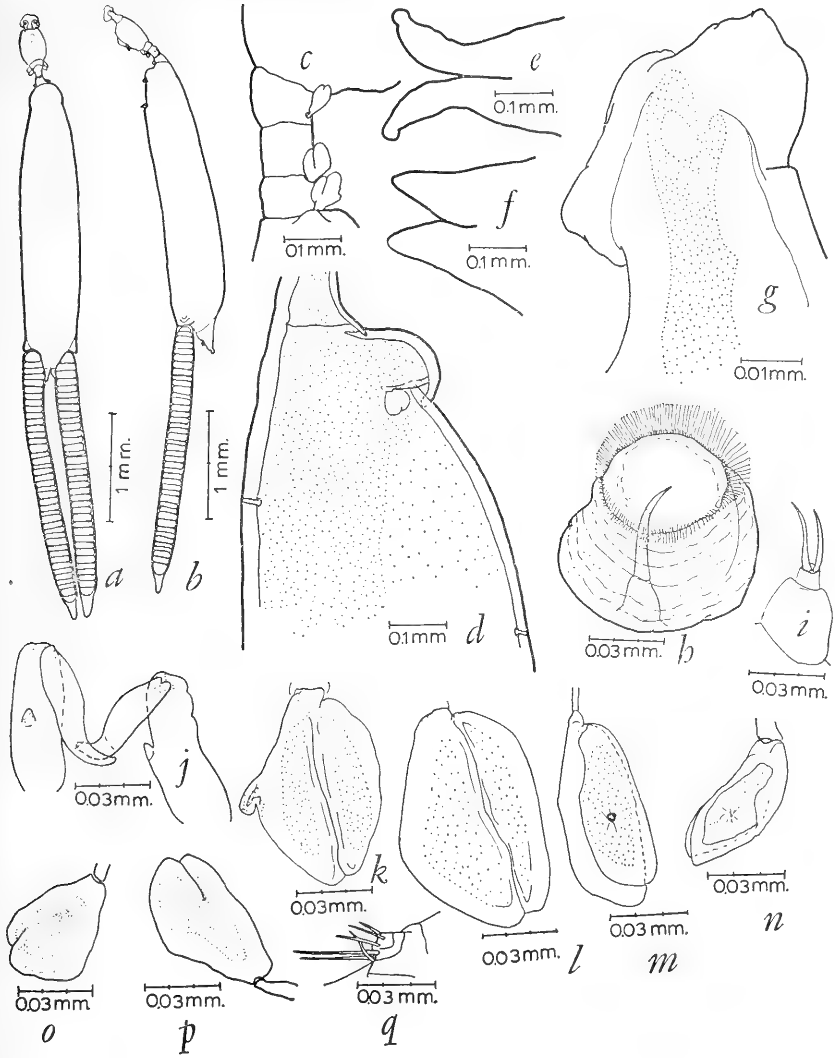

FIGURE 24.—*Peniculus calamus?* Nordmann, 1864 (female): *a*, dorsal view; *b*, lateral view; *c*, lateral view of neck; *d*, lateral view of swollen fourth thoracic leg-bearing segment and anterior part of trunk; *e*, dorsal view of abdomen; *f*, dorsal view of abdomen of second specimen; *g*, second antenna; *h*, mouth cone and mandible; *i*, maxilla; *j* maxilliped; *k*, first thoracic leg; *l*, second thoracic leg; *m*, third thoracic leg; *n*, fourth thoracic leg; *o*, *p*, fourth thoracic legs from different specimens; *q*, caudal ramus. (Stippling=red areas.)

nae buried in single, disc-shaped structure attached to fin rays of host. Disc-shaped structure formed from unknown material but presumably either from cement gland of copepod (frontal organ?) or outgrowth of fin rays of host though disc easily separable intact from fin ray. Distal end of second antenna degenerate in adult, appearing to have been clawlike in younger stages (fig. 24*g*).

Mouth cone conical, protruding from median ventral surface of cephalon, distal surface slightly constricted, with membranous margin flaring outward from distal margin of cone (fig. 24*h*).

Mandible visible as elongate, acuminate process curving inward distally. Divisions not visible (fig. 24*h*).

Maxilla two-segmented, attached lateral to mouth cone. First segment slightly more than four times length of second, gibbous, with distal surface concave. Second segment truncate, with two seta-like projections from distal surface (fig. 24*i*).

The modification of this species is such that the naming of the oral appendages other than the mandibles is difficult. The above appendage is similar to the node on the anterior end of the postoral process in many caligids. Because of the lack of a complete developmental study and the lack of comparative studies with related groups, the appendage is termed a maxilla with reservation.

Maxilliped two-segmented, attached posterior to mouth cone. First segment approximately one and a half times length of second, greatest width slightly less than half greatest length; small protrusion on middle of inner surface. Second segment curving inward distally, terminating in blunt, rounded tip (fig. 24*j*).

In specimens preserved in alcohol, all of the thoracic legs possess a reddish area in the middle of the protopodite; this area is indicated on the figure of the appendage by stippling.

First thoracic leg ovoid, platelike, attached to anterior lateral surface of segment. Greatest width about two-thirds greatest length, distinct protrusion on middle of anterior margin and distinct groove extending from slight indentation on distal margin to proximal region of appendage (fig. 24*k*).

Second thoracic leg one-segmented, of general ovoid shape, attached to posterior lateral surface of segment; slightly larger than first thoracic leg. Median groove present as in first thoracic leg, extending from slight indentation on posterior distal margin proximally to proximal region of leg. Groove incompletely divides appendage into two unequal parts, anterior larger than posterior (fig. 24*l*).

Third thoracic leg ovoid, attached to posterior lateral surface of segment; without median groove but with indentation of distal surface. Third leg appears to consist of two lobate processes, smaller of two fused to lateral surface of larger. Proximal surface projecting slightly as tuberculate process, process attached to rod-shaped sternal plate (fig. 24*m*).

Fourth thoracic leg ovoid, much smaller than preceding thoracic legs. Shape of appendage variable (figs. 24*n–p*); median groove present, extending into leg about one-fourth greatest length of appendage.

Caudal rami minute, projecting slightly from ventral surface of caudal projections of abdomen. Separated from abdomen by incomplete groove; two additional, incomplete transverse grooves in distal half of appendage. Caudal rami with six naked setae, three from apex, three from posterior lateral margin (fig. 24*q*).

Remarks.—Nordmann's description of *P. calamus* (1864) was made from a series of specimens. Since the original description, specimens of this species, including the type specimens, have not been examined. Although the length of the presently described specimens is considerably less than the 5 mm. noted by Nordmann for the type specimens, the specimens are placed tentatively in the species because of the general characteristics that they possess in common with those originally described by Nordmann for *P. calamus*.

Specimens of *P. calamus?* collected by the author are similar to *P. minuticaudae* Shiino in the general shape of the body, the makeup of the thoracic leg-bearing segments, the cephalic appendages, and the thoracic legs. The author is indebted to Dr. S. M. Shiino for comparing specimens of the Hawaiian species with his specimens of *P. minuticaudae*. According to Shiino (in correspondence), the Hawaiian specimens possess "a longer abdominal process which extends straight backward and is more deeply and more distinctly bilobed forming somewhat divergent lobes." In *P. minuticaudae* "the process is shorter, more shallowly bilobed and never extends straight backward, but remains to form a mere triangular stump in lateral view." These characteristics, in addition to others indicated by Shiino (in correspondence), suggest that, although the two species possess similar morphological characteristics, they are distinct.

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NOTES ON ARADIDAE IN THE U.S. NATIONAL MUSEUM III. SUBFAMILY MEZIRINAE [1] (HEMIPTERA)

By NICHOLAS A. KORMILEV

For the privilege of studying the unidentified flat bugs, family Aradidae, in the collections of the U.S. National Museum, I wish to express my deep appreciation to Dr. J. F. Gates Clarke, Curator of Insects, U.S. National Museum, and to Dr. Carl J. Drake, Research Associate, Smithsonian Institution.

The deposition of types of new species is stated beneath the descriptions.

In the descriptions, 20 units=1 mm. for all species but *Placogenis brachyptera* (Kormilev), in which 30 units=1 mm. The first figure in the ratios represents the length; the second, the width of the measured part. In the measurements of the pronotum, the figures within brackets represent the width of the forelobe; the last figure, the width of the hind lobe across the widest part. The length of the head was measured from the middle of the posterior border to the tip of the juga and the width across the eyes, as a more constant unit, and not across the postocular tubercles or spines, which are variable within the species. The lengths of the pronotum, scutellum, and abdomen were taken on the median line; the length of the abdomen was taken from the tip

[1] See N. A. Kormilev, 1958, Notes on Aradidae in the U.S. National Museum I, Proc. U.S. Nat. Mus., vol. 109, no. 3413, pp. 209–222, and N. A. Kormilev, 1960, Notes on Aradidae in the U.S. National Museum II, Journ. New York Ent. Soc., vol. 68, pp. 36–47.

of the scutellum to the tip of the male hypopygium or to segment IX in the female. The width of the scutellum was taken at the base; of the abdomen, at the widest part. The proportions of the antennal segments were taken from the first to the fourth segments.

Subfamily Mezirinae Oshanin, 1908

The collections comprise many specimens of mezirines from the Neotropical Region. It is significant to note that the numerous new species of the genus *Mezira* Amyot and Serville, mostly from the tropical areas of South America, vividly indicate the incompleteness of our present knowledge of the Aradidae from this vast geographical region.

Genus *Placogenis* Usinger and Matsuda

Placogenis Usinger and Matsuda, 1959, Classification of Aradidae, British Museum (Natural History), London, p. 342, fig. 100.

Diphyllonotus Kormilev, 1959, Proc. Ent. Soc. Washington, vol. 61, p. 61, figs. 1, 2.

Placogenis brachyptera (Kormilev)

Diphyllonotus brachypterus Kormilev, 1956, Anal. Soc. Cient. Argentina, vol. 162, p. 151.

Remarks.—This species was described originally from a single brachypterous female from Santa Catarina, Brazil. The abbreviated membrane of the forewing reaches to only the front margin of tergum VI. In the Drake Collection I found a female specimen with fully developed forewings that extended backward to the middle of tergum VII.

Measurements.—Macropterous female: Head almost as long as wide (27:27.5); proportions of antennal segments 14:10:17:13; pronotum much shorter than wide (28:(45):53); scutellum shorter than wide at base (19:29); abdomen as long as wide (92:92).

Length 5.3 mm. Width of pronotum 1.76 mm. Width of abdomen 3.07 mm. Other characters as in brachypterous form.

New record.—Female, macropterous, Rio de Janeiro, Brazil, Drake Collection (USNM).

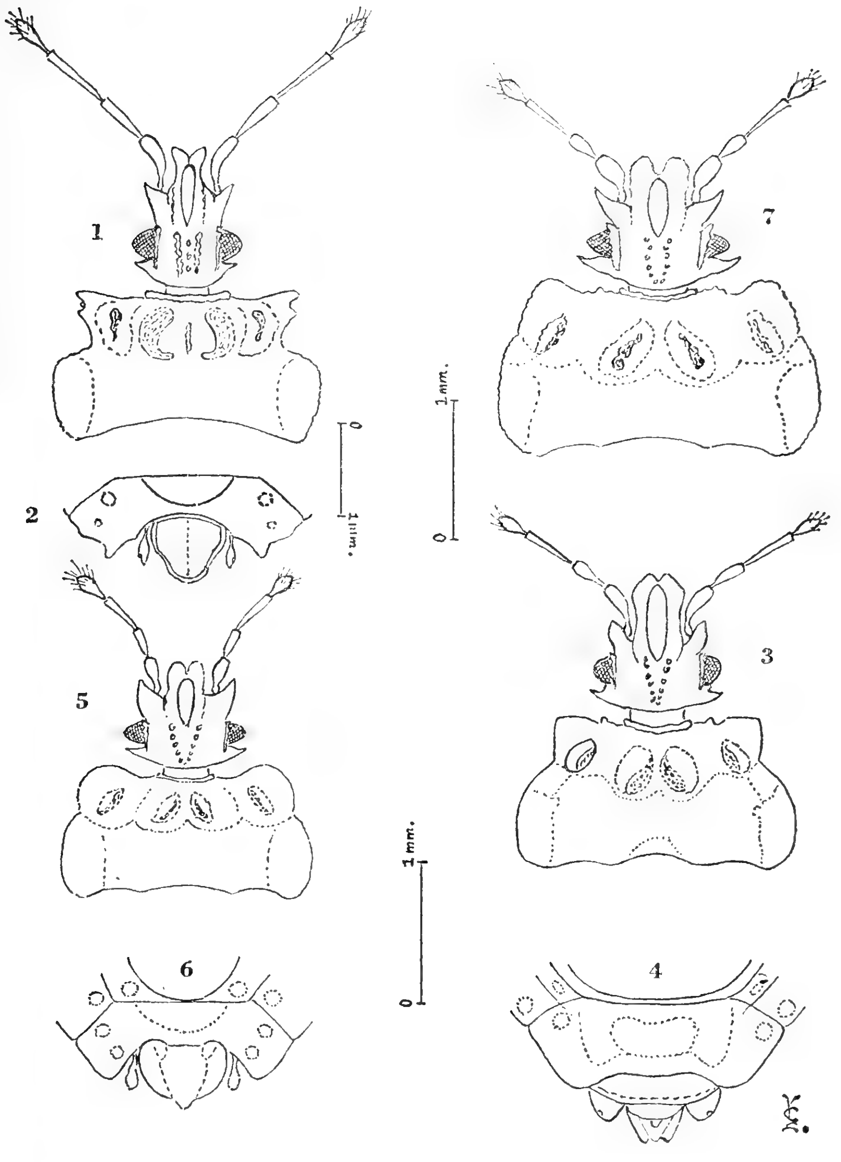
Genus *Cinyphus* Stål

Cinyphus Stål, 1865, Hemiptera Africana, vol. 3, p. 31.

Cinyphus saileri, new species

Figures 1, 2

Male.—Elongate ovate, tapering forward; body covered with curled rusty hairs.



FIGURES 1–7.—1, *Cinyphus saileri*, new species, ♂ head and pronotum; 2, *C. saileri*, tip of ♂ abdomen; 3, *Mezira luteonotata*, new species, ♀ head and pronotum; 4, *M. luteonotata*, tip of ♀ abdomen; 5, *M. costalimai*, new species, ♂ head and pronotum; 6, *M. costalimai*, tip of ♂ abdomen; 7, *M. carioca*, new species, ♀ head and pronotum.

Head longer than width across eyes (31:25); anterior process (clypeus and juga together) long, slightly widening anteriorly, and cleft, reaching three-fourths first antennal segment. Antenniferous tubercles long, spiniform, divergent, raised anteriorly, reaching one-third first antennal segment. Eyes semiglobose, exserted, placed behind middle of head. Postocular tubercles dentiform, short, not reaching outer border of eyes. Infraocular carinae low, with bigger tooth anteriorly. Vertex with setigerous granulation. Antennae long, slender, twice as long as width of head across eyes (52:25); proportions of segments 15:11:15:11. Rostrum not reaching to hind border of long, deep, wide, and transversely rugose rostral groove.

Pronotum almost half as long as width across humeri (30:58); collum slender, distinct. Anterolateral angles expanded winglike laterally, with anterior border straight and not reaching foremargin of collum. Lateral borders of hind lobe denticulate and convergent anteriorly; lateral notch big, rectangular. Foredisc of pronotum with four (2+2) longitudinal ridges, two inner ones thicker, two outer ones thinner; medium line deeply depressed. Hind disc with dispersed setigerous granulation. Hind border deeply and widely excavated at middle.

Scutellum slightly shorter than basal width (27:32); basal border convex; lateral borders convex anteriorly, sinuate posteriorly; tip of scutellum notched. Median ridge tapering to tip; disc transversely rugose. Two (1+1) tubercles placed at basal angles.

Hemelytra reaching hind border of tergum VI. Basolateral borders of corium denticulate, slightly diverging backward, reflexed. Apical border of corium convex exteriorly, apical angle rounded. Membrane sepia, with triangular white spot near apical angle of corium.

Abdomen ovate, almost as long as wide (79:77); postero-exterior angles of connexiva protruding angularly; postero-exterior angles of connexivum VII dentiform, divergent. Exterior borders of connexiva straight; those of connexivum VII convex. Hypopygium with thin median furrow and with rounded rim on upper side posteriorly. Spiracles II to VII ventral, far removed from lateral border, those of VIII lateral and visible from above.

Color.—Sepia; apical half of antennal segment IV, postero-exterior angles of connexiva, and rostrum light brown.

Measurements.—Length 8.35 mm. Width of pronotum 2.60 mm. Width of abdomen 3.56 mm.

Holotype.—Male, Vera Cruz, Mexico, May 13, 1946, on orchid plants, named for Dr. Reece I. Sailer (USNM type 65795).

REMARKS.—This species is allied to *Cinyphus squalidus* Champion; it can be separated from the latter by the following characteristics: antenniferous tubercles acute and divergent; second and fourth antennal segments equal in length; lateral margins of abdomen evenly rounded (subangular posteriorly in *C. squalidus*).

Genus *Santaremia* Kormilev

Santaremia Kormilev, 1960, Journ. New York Ent. Soc., vol. 68, p. 44.

Santaremia robusta Kormilev

Santaremia robusta Kormilev, 1960, Journ. New York Ent. Soc., vol. 68, p. 45, figs. 6–7.

FEMALE.—Slightly larger than male but of same color and general aspect. Lobes of VIII (paratergites) short, triangular, reaching to middle of IX, latter truncate posteriorly. Spiracles II to VI ventral, placed far from lateral border, VII also ventral but situated a little nearer to outer margin; VIII lateral and visible from above.

MEASUREMENTS.—Head shorter than wide across eyes (24:27); proportions of antennal segments 16:10: ? (last two segments missing); pronotum half as long as wide across humeri (30:(42):60); scutellum shorter than width at base (25:32); abdomen longer than wide (75:71).

Length 7.85 mm. Width of pronotum 3.00 mm. Width of abdomen 3.55 mm.

ALLOTYPE.—Female, Para, Brazil, in Drake collection (USNM).

Genus *Mezira* Amyot and Serville

Brachyrhynchus Laporte, *in* Guérin, Mag. Zool., 1833, vol. 2, p. 54 (preoccupied).
Mezira Amyot and Serville, 1843, Histoire naturelle des insectes, Hémiptères, p. 305.
Dusius Bergroth, 1894, Ent. Tidscr., vol. 15, p. 104.

Mezira is the largest genus in the subfamily Mezirinae, and is worldwide in distribution with the exception of colder areas. In 1959 Usinger and Matsuda removed from *Mezira* many species previously assigned therein and created for them the new genera *Daulocoris*, *Strigocoris*, and *Oroessa*. They also resurrected the genus *Arictus* Stål, previously synonymized with *Mezira*, and left 106 species in the genus *Mezira*. In its present sense, after revision, the genus *Mezira* is still too heterogeneous, for the entire complex of the so-called "membranacea group" probably should form a separate genus; it is dubious that the American and African species of the genus *Mezira* could remain in the same genus. At the present time about half of all species classified in *Mezira* belong to the Neotropical Region.

Mezira rugiventris (Champion)

Brachyrhynchus rugiventris Champion, 1898, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 47 (Rhynchota, Hemiptera-Heteroptera, vol. 2), p. 101.

Mezira rugiventris Usinger, 1936, Ann. Ent. Soc. America, vol. 29, p. 510.

New records.—Three males and two females, Satipo, Peru, P. Paprocky collector, August 1940, Drake Collection (USNM).

Known heretofore from Mexico and Guatemala.

Mezira luteonotata, new species

Figures 3, 4

Female.—Elongate, covered with setigerous granulation; hairs short, thin, curled. Lateral borders of abdomen widely rounded.

Head slightly shorter than width across eyes (27:29). Anterior process very robust, long, wide, parallel-sided, rounded anteriorly, slightly cut out in middle at tip, slightly surpassing apex of first antennal segment. Antenniferous tubercles dentiform, narrow, rather blunt at tip, reaching to basal third of first antennal segment. Eyes exserted. Postocular tubercles small, dentiform, acute, reaching to outer border of eyes. Infraocular carinae low, granulate. Vertex with V-formed, setigerous granulation. Antennae slender, short, less than twice as long as head; proportions of antennal segments 11:9:11:? (segment IV missing). Rostrum short, not reaching hind border of rostral groove.

Pronotum less than half as long as width across humeri (28:60); collum slender, finely granulate, slightly cut out in middle. Anterior angles terminating in small tubercles. Anterolateral angles rectangularly expanded, with slightly convex sides, blunt at tip, not produced beyond collum or lateral notch. Lateral borders of forelobe parallel to each other; foredisc convex, sloping laterally, provided with four (2+2) granulate ridges; outer ridges lower than inner, indistinct. Lateral borders of hind lobe parallel to each other, rounded, convergent anteriorly. Hind border almost straight, only rounded posterior angles slightly protruded backward. Hind disc with dense setigerous granulation.

Scutellum shorter than wide at base (27:32); all exterior borders rimmed, with small yellow tubercles at basal angles; median ridge thin and low; disc densely granulate.

Hemelytra not reaching to foreborder of tergum VII. Apical angle of corium acute, apical margin convex, and slightly excavated interiorly.

Abdomen elongate ovate, longer than wide (97:70), maximal width across segment IV; lateral borders widely rounded; postero-exterior angles of connexiva not protruding; those of connexivum

VII rounded. Lobes of VIII (paratergites) long, subtriangular, reaching to two-fifths IX; IX long, tapering backward, tip tricuspidate. Spiracles II to VI ventral, far removed from outer border; VII sublateral, but not visible from above; VIII dorsolateral, not visible from ventral aspect.

Color.—Ferrugineous; tergum VII, VIII, and IX dark ferrugineous; antenniferous tubercles, spot in middle of hind border of head, and posterior angles of pronotum ochraceous; neck, ovate spot in middle of foreborder of scutellum, two (1+1) small tubercles at basal angles and also tip of latter, posterior borders of all connexiva from II to VII, and posterior borders of paratergites, bright yellow. Rostrum and postero-exterior angles of connexiva also yellow.

Measurements.—Length 6.0 mm. Width of pronotum 2.0 mm. Width of abdomen 2.30 mm.

Holotype.—Female, Chapada, Brazil, November, Drake Collection (USNM type 65796).

Remarks.—*M. luteonotata* is allied to *M. rugiventris* (Champion) but it differs from the latter by the following characteristics: smaller size; lateral borders of body not as parallel to each other; anterolateral angles of pronotum not produced either forward or sideways; small yellow tubercles at basal angles of scutellum; tricolor connexivum black, testaceous, and yellow.

Mezira championi, new species

Male.—Elongate ovate, with fine setigerous granulation; setae very short, erect.

Head with median length and width across eyes subequal (23:24); anterior process long, constricted in middle, rounded and slightly notched anteriorly, almost reaching to tip of first antennal segment. Antenniferous tubercles moderately long, acute, divergent. Eyes exserted. Postocular tubercles small, dentiform, reaching to outer border of eyes; infraocular carinae moderately high, crenulate. Vertex with dense setigerous granulation. Antenna slender, less than twice as long as head (36.5:23); proportions of antennal segments 10:7.5:11.5:7.5. Rostrum short, not reaching hind base of rostral groove.

Pronotum half as long as width across humeri (23:47); collum slender, granulate; anterolateral angles rounded, slightly expanded, crenulate, reaching anteriorly to foreborder of collum; forelobe much narrower than hind lobe (38:47). Lateral notch sharply marked; interlobal area deeply depressed. Lateral borders of hind lobe rounded, convergent anteriorly. Forelobe with four (2+2) granulate ridges; hind lobe with dense, dispersed granulation.

Scutellum shorter than wide at base (21:25), rimmed on all sides; disc granulate, with fine, low, granulate, T-shaped, median ridge.

Hemelytra reaching to foreborder of tergum VII (♂); apical border of corium convex, strongly rounded, apical angle blunt.

Abdomen ovate, longer than wide (70:56), maximal width across segment V. Connexivum II granulate; connexiva III to VII almost without granulation, rather scabrous; postero-exterior angles barely protruding; those of connexivum VII extending backward as rounded lobes, extending posteriorly as far as third of hypopygium; lobes of VIII (paratergites) clavate, reaching basal two-thirds of hypopygium; latter cordate, with median ridge elevated backward and terminating before reaching hind border. Spiracles II to VI ventral, placed far from outer margin; those of VII sublateral, not visible from above; VIII lateral and visible.

Color.—Piceous; connexiva III to VII, and lobes of VIII testaceous; membrane blackish, whitish at base.

Measurements.—Length 4.74 mm. Width of pronotum 1.56 mm. Width of abdomen 1.86 mm.

Holotype.—Male, Huatusco, Veracruz, Mexico, Jan. 2, 1952 (USNM type 65797).

Remarks.—This species is dedicated to the memory of the late G. C. Champion, who has contributed so much to knowledge of Central American Aradidae.

The species is allied closely to *M. angustata* (Champion), but it differs from the latter by the following characteristics: anterior process of head relatively longer, almost reaching tip of first antennal segment; antenniferous tubercles narrower, not so divergent; pronotum less constricted at sides; abdomen (♂) with sides widely rounded, not parallel-sided; median ridge of hypopygiun raised backward, not reaching tip of hypopygium.

Mezira mexicana, new species

Female.—Elongate ovate, densely covered with setigerous granulations; granules fine, each with very short erect setal hair.

Head shorter than width across eyes (27:30); anterior process long, robust, slightly widening forward, rounded, notched in middle, anteriorly reaching to apical third of first antennal segment. Antenniferous tubercles spiniform, divergent, reaching middle of first antennal segment. Eyes semiglobose, exserted. Postocular tubercles small, acute, reaching outer border of eyes; infraocular carinae moderately high, crenulate; vertex with four rows of setigerous tubercles. Antennae slender, less than twice as long as head (46:27), proportions of antennal segments 12:9:15:10. Rostrum reaching base of rostral sulcus.

Pronotum shorter than width across humeri (36:65); forelobe much narrower than hind lobe (54:65). Collum slender, granulate; anterolateral angles rounded, moderately expanded, slightly raised, not produced beyond anterior margin of collum. Lateral borders of hind lobe parallel to each other, granulate, convergent anteriorly, feebly cut out before middle. Foredisc with four (2+2) low, granulate ridges; hind disc densely granulate.

Scutellum shorter than wide at base (27.5:35); disc granulate, with low, cross-shaped, median ridge.

Hemelytra not reaching hind border of tergum VI (♀); apical border of corium rounded, apical angle blunt.

Abdomen longer than wide (109:81), with slowly rounded sides; postero-exterior angles of connexiva protruding very little; those of connexivum VII almost rectangular, with blunt tip, not produced beyond foreborder of tergum VIII; lobes of VIII relatively large, rounded, reaching to middle of IX; latter subtruncate. Spiracles ventral, II to VII situated far from lateral border, those of VIII sublateral and not visible from dorsal aspect. Connexivum rugose.

Color.—Piceous; base of first antennal segment and round callous spots on connexival segments yellow-brown to chestnut-brown.

Measurements.—Length 6.7 mm. Width of pronotum 2.16 mm. Width of abdomen 2.70 mm.

Holotype: Female, Loma Bonita, Veracruz, Mexico, July 10, 1948 (USNM type 65798).

Remarks.—*M. mexicana* is allied to *M. reuteri* (Bergroth), but it differs from the latter by the following characteristics: lateral notch and four ridges of pronotum sharply marked; long lobes of VIII.

Mezira costalimai, new species

Figures 5, 6

Male.—Elongate ovate, evenly widening backward to abdominal segment IV, then narrowing posteriorly, covered with setigerous granulation, setae very short and erect.

Head shorter than wide across eyes (♂, 23:27; ♀, 27:30). Anterior process moderately long, either parallel-sided (♂) or widening anteriorly (♀), apically rounded and slightly cut out in middle; reaching almost to tip of first antennal segment. Antenniferous tubercles acute, strongly divergent, reaching to middle of first antennal segment. Eyes strongly exserted. Infraocular carinae low, crenulate. Postocular tubercles acute, slightly passing outer border of eyes. Antennae short, one and a half times as long as head in male (34:23), slightly longer in female (43:27); proportions of antennal segments 9:7:11:7 (male), 11:8:15:9 (female). Rostrum attaining hind border of head.

Pronotum trapezoidal, shorter than wide across humeri (♂, 26:53; ♀, 29:61); forelobe much narrower than hind lobe (♂, 46:53, ♀, 51:61). Collum slender, granulate. Anterolateral angles regularly rounded, crenulate, slightly expanded, but not protruding either forward or sideways. Lateral borders of forelobe slightly diverging backward. Interlobal notch feebly marked; depression distinct but not very deep. Foredisc with four (2+2) granulate ridges equally developed. Lateral borders of hind lobe diverging backward, feebly rounded. Hind disc with dense setigerous granulation.

Scutellum shorter than basal width (♂, 23:26; ♀, 25:30), rounded at apex; all margins rimmed, median ridge flattened.

Hemelytra reaching to foreborder of tergum VII; apical angle of corium rounded, apical border feebly rounded.

Abdomen ovate, longer than wide (♂, 75:65), maximal width across segment IV. Connexiva with postero-exterior angles barely protruding, those of connexivum VII rounded, reaching to middle of hypopygium. Hypopygium subcordate, with rather broad, tapering apically, median ridge, latter becoming slightly elevated posteriorly. Lobes of VIII clavate, reaching to distal third of hypopygium. Female abdomen more rounded laterally; lobes of VIII rounded, reaching to middle of IX, IX deeply excavated apically. All spiracles ventral, placed far from lateral border.

Color.—Head, pronotum, scutellum, and median ridge of hypopygium ferrugineous to dark ferrugineous, mottled with yellow-brown; connexivum and rest of hypopygium yellow-brown. Exterior borders of connexiva bicolored, piceous, and yellow; membrane brown, becoming yellow-brown at base.

Measurements.—Length: male, 5.00 mm.; female, 5.86 mm. Width of pronotum: male, 1.76; female, 2.03 mm. Width of abdomen: male, 2.16 mm.; female, 2.50 mm.

Holotype.—Male, Guaratuba, D. F. Brazil, collected by Aristoteles Silva, June 30, 1940, deposited in Instituto "Oswaldo Cruz," Rio de Janeiro, Brazil.

Allotype.—Female, Horqueta, Paraguay, collected by Alberto Schulze, 1938, in Drake Collection (USNM).

Paratype.—Female, taken with allotype, in collection of author.

Remarks.—It is a pleasure to dedicate this species to Prof. Dr. Angelo da Costa Lima, who kindly lent me the male for classification.

M. costalimai is allied to *M. eurycephala* Kormilev, but it differs from the latter by the following characteristics: much smaller; head narrower; postocular tubercles only slightly passing outer margin of eyes; connexivum bicolored.

Mezira carioca, new species

FIGURE 7

FEMALE.—Elongate ovate, lateral borders parallel, gently narrowing anteriorly and posteriorly; body covered with rough setigerous granulation, with short, erect setae.

Head shorter than width across eyes (28:32); anterior process with sides subparallel, rounded anteriorly, and excavated at tip, reaching to, or almost to, tip of first antennal segment. Antenniferous tubercles pointed, slightly divergent, reaching to basal third of first antennal segment. Eyes exserted. Postocular tubercles strong, pointed, projecting laterally far beyond outer margin of each eye. Infraocular carinae moderately high, crenulate; vertex with V-shaped rows of granulae. Antennae very short, slender, less than one and a half times length of head (39:28); proportions of antennal segments 12:7.5:12:7.5. Rostrum reaches to base of rostral sulcus.

Pronotum less than half as long as width across humeri (32:(58):67). Collum slender; anterolateral angles roundly expanded, slightly raised laterally, crenulate; lateral borders slightly cut out in middle, slightly convex at humeri; hind border also slightly excavated at middle. Foredisc with four (2+2) oblique, granulate ridges; hind disc with scattered, rough, setigerous granulations.

Scutellum shorter than basal width (25:35), typical of Neotropical *Mezira* species.

Hemelytra short, reaching hind border of tergum VI (♀); basolateral borders slightly reflexed; apical border of the corium and apex of apical angle very feebly rounded.

Abdomen longer than wide (95:74), elongate ovate, almost parallel-sided along middle, tapering in gentle curve posteriorly. Connexivum covered with setigerous granulation; connexiva with postero-exterior angles not protruding; lobes of VIII relatively large; rounded, reaching to middle of IX, latter cut out at tip. All spiracles ventral, placed far from outer margin.

COLOR.—Uniformly ferrugineous.

MEASUREMENTS.—Length 6.33. Width of pronotum 2.23 mm. Width of abdomen 2.47 mm.

HOLOTYPE.—Female, Rio de Janeiro, Brazil, Drake Collection (USNM type 65799).

REMARKS.—*M. carioca* is allied to *M. saltensis* Kormilev, but it differs from the latter by the following characteristics: much smaller size; lateral borders of pronotum less excavated; anterior process of head relatively shorter; lobes of VIII relatively larger, reaching to middle of IX (only to basal fourth of IX in *M. saltensis*); anterolateral angles of pronotum more rounded and produced farther forward.

Mezira guianensis, new species

FEMALE.—Resembles *M. carioca* in general aspect, but larger, with finer setigerous granulation, of same general ferrugineous color; antennae slender, relatively longer, 1.7 times as long as head (1.4 times in *M. carioca*); anterior process of head relatively wider anteriorly; anterolateral angles of pronotum more rounded, equally expanded forward and sideways; apical border of corium more rounded; posterior half of abdomen more evenly rounded.

The main difference between these two species lies in the last abdominal segments. In *M. carioca* these segments are short, lobes of VIII (paratergites) larger, produced posteriorly, parallel to each other, regularly rounded apically, reaching to middle of short, deeply excavated apically segment IX. In *M. guianensis* segment VIII a little longer, lobes of VIII smaller, convergent, reaching only to basal third of IX. The latter segment has convergent lateral margins and is barely excavated at apex.

MEASUREMENTS.—Head shorter than width through eyes (33:38), or across dentiform postocular tubercles (33:42); proportions of antennal segments 15:11:19:11; pronotum (40:(65):81); scutellum (40:48); abdomen maximal width across segment IV (120:96).

Length 7.8 mm. Width of pronotum 2.70 mm. Width of abdomen 3.20 mm.

HOLOTYPE.—Female, Tumatumari, Potaro River, British Guiana, June 29, 1927, Drake Collection (USNM type 65800).

Mezira barberi, new species

MALE.—Allied to *M. regularis* (Champion), but somewhat smaller, anterior process of head relatively shorter, and not dilated anteriorly; antenniferous tubercles also shorter, only slightly longer than longitudinal diameter of eye (7:5), whereas in *M. regularis* they are distinctly longer (9:5.5). Third antennal segment only one and a half times longer than second (twice as long in *M. regularis*).

Head shorter than width across eyes (22.5:24), anterior process robust, constricted in middle, rounded apically, tip slightly incised, almost reaching to apex of first antennal segment. Antenniferous tubercles acute, slightly divergent, reaching almost to middle of first antennal segment. Eyes exserted. Postocular tubercles spiniform, slightly exceeding outer border of eyes; infraocular carinae moderately high, crenulate. Vertex with V-form group of setigerous granulae. Antennae moderately slender, less than twice as long as head (38:22.5); proportions of antennal segments 10.5:8:12:7.5. Rostrum reaching almost to base of rostral groove.

Pronotum less than half as long as wide across humeri (25:57); collum tiny, slightly incised at middle; anterolateral angles explanate, rounded, crenulate, not extending beyond front border of collum. Lateral notch sharply marked; interlobal depression deep; foredisc with four (2+2) high, granulate ridges; hind lobe wider than forelobe (57:43); lateral margins parallel to each other, roundly convergent anteriorly; hind margins with three excavations in middle and mesad of rounded hind angles; hind disc roughly granulate.

Scutellum shorter than wide at base (23:30); lateral borders slightly sinuate near tip; disc granulate; median ridge cross-shaped.

Hemelytra reaching over foreborder of tergum VII (♂) or to hind border of tergum VI (♀).

Abdomen longer than wide (83:65); lateral borders parallel-sided, roundly convergent posteriorly; connexiva with postero-exterior angles not protruding. Hypopygium cordiform, median ridge slightly raised backward. Spiracles II to VII ventral, placed far from lateral margin, those of VIII lateral and visible from above. Lobes of VIII in female relatively short, not reaching middle of IX, latter tricuspidate.

Color.—Ferrugineous, partially piceous; hind borders of connexival segments yellow; membrane brown.

Measurements.—Female, head shorter than wide across eyes (23:27); proportions of antennal segments 10:7.5:12.5:9; pronotum shorter than wide across humeri (30:60); scutellum shorter than basal width (25:30); abdomen longer than wide (90:68).

Total length: male, 7.85 mm.; female, 8.65 mm. Width of pronotum: male, 2.85 mm.; female, 3.0 mm. Width of abdomen: male, 3.25; female, 3.4 mm.

Holotype.—Male, Hoboken, New Jersey, intercepted on orchid plants from Venezuela, April 5, 1939 (USNM type 65801).

Allotype (female) and 2 paratypes, same labels as holotype.

Remarks.—This species is dedicated to the late Harry G. Barber, eminent American hemipterist.

Mezira paralata, new species

Female.—Broadly ovate, abdomen subparallel-sided, almost subrectangular in outline, partially covered with conspicuous, yellow, curled hairs.

M. paralata is closely allied to *M. lata* (Champion) but differs from it by the following characteristics: anterior process of head constricted at base, dilated, and distinctly notched at tip, barely reaching to middle of first antennal segment; abdomen subrectangular (not ovate as in *M. lata*); lobes of VIII very short, rounded, reaching only to basal fourth of IX, latter rounded posteriorly; antenniferous tubercles blunt, subparallel to each other; rostrum short, not reaching to hind border of rostral groove.

Color.—Striking, bright testaceous; head and ridges of pronotum ferrugineous; membrane pale brown; body partially clothed with golden yellow curly hairs; ventral surface of body coated with thin layer of white incrustation. Spiracles II to VII ventral, those of VIII sublateral and not visible from dorsal view.

Measurements.—Head almost as long as wide (25:26); proportions of antennal segments 17:11:18:10; pronotum (31:(47):60); scutellum (24:31); abdomen across segment V (90:75).

Length 8.63 mm. Width of pronotum 3.0 mm. Width of abdomen 3.75 mm.

Holotype.—Female, Suretka, Limón Prov., Costa Rica, in Drake Collection (USNM type 65802).

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A GENERIC REVISION OF THE LEAFHOPPER SUBFAMILY NEOCOELIDIINAE (HOMOPTERA: CICADELLIDAE)

By James P. Kramer[1]

The leafhopper subfamily Neocoelidiinae was erected by Oman (1943) in order to accommodate the two North American genera, *Neocoelidia* and *Paracoelidea,* which had been placed in the Jassinae (Deltocephalinae of modern workers) for many years. Evans (1947) added the Neotropical genera *Biza, Chinaia, Coelidiana,* and *Salvina* in his generic checklist of the subfamily. DeLong (1953) partially revised the group, adding new genera and subgenera as well as many new species. He included only one of the genera added by Evans and attempted to place the Neotropical Neocoelidiinae described by Fowler and Osborn with reference to the literature alone. More recently new genera and species have been added by Kramer (1959, 1961, and 1962) and by Kramer and Linnavuori (1959). Although our knowledge of Neotropical fauna is still quite meager, it seems appropriate to synthesize the information we do have at present in order that future workers may have a foundation upon which to build.

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Subfamily Neocoelidiinae

Description.—Small to large leafhoppers (3–13 mm.). Clypellus either approximately parallel-sided or widened distally. Lateral frontal sutures extended near or to ocelli, which are on or near anterior margin of crown or less often on face. Ocellocular areas developed as distinct ledges above antennal pits. Antennae long to very long, frequently exceeding entire length of body including forewings at rest. Face and crown either separated by carina or with carina lacking; carina, when present, usually limited to distance between ocelli. Head in dorsal view angled or rounded apically, often strongly produced beyond eyes. Pronotum short, much wider than long, with lateral margins carinated. Scutellum large and well developed. Venation of forewings usually obscure except apically and with either two or three preapical cells. Male genital structures variously modified but styles usually simple. Ground color various shades of white, yellow, or orange. There are often contrasting markings of various hues on the head, thorax, and forewings.

Diagnosis.—The most useful set of characters for recognition of the Neocoelidiinae consists of the distinct ledge above each antennal base, the exceptionally long antennae (particularly as found in many of the Neotropical genera), and the venation of the forewings, which is usually highly obscure except apically.

Discussion.—As far as it is known, the subfamily is restricted to the Americas, with good representation in both the temperate and tropical areas. The available host and food plant records seem to indicate that most of the species occur on trees or shrubs. According to DeLong (1953), various Nearctic species have been taken on the following genera of plants: *Pinus*, *Acacia*, *Rhus*, *Arctostaphylos*, and *Sphaeralcea*. Except for one species of *Chinaia* known to breed on avocado, the plant relationships of the Neotropical species are unknown.

The key to genera which follows is based almost entirely upon characters of the male genitalia. Although most of these structures are concealed within the genital capsule and require dissection and clearing in order to be observed, they provide the most concrete evidence for an arrangement of genera within the subfamily. Emphasis on the male genitalia for the delimiting of genera is not without precedent. Oman (1949) used this feature extensively in arranging the North American Deltocephalinae, as did Young (1952) in revising the New World Typhlocybinae. Both men provided generic definitions within the respective subfamilies that were more definite and better delimited than any prior to their work. It is hoped that this study will serve a similar purpose.

Key to Genera of Neocoelidiinae

1. Aedeagus consisting of two shafts, one above other, dorsal shaft bearing gonoduct (figs. 2, 8, 17) . . . . **Neocoelidia** Gillette and Baker
   Aedeagus consisting of single shaft, which may be simple or elaborated with processes (figs. 42, 99). 2
2. Face and crown separated by carina, which is as long as distance between ocelli 5
   Face and crown not separated by carina (i.e., carina absent). 3
3. Ocelli located on face below anterior margin of crown; clypellus distinctly expanded distally; connective cruciform . . **Chinaia** Bruner and Metcalf
   Ocelli located on anterior margin of crown; clypellus not distinctly expanded distally; connective Y-shaped or nearly so 4
4. Aedeagus without apical modifications but with long recurved lateral, paired processes; male plates fused for entire length. **Deltocoelidia** Kramer
   Aedeagus with apical modifications but without lateral processes; male plates not fused for entire length . . . . **Xenocoelidia** Kramer
5. Exceedingly large and robust forms, males over 12 mm. in length; head including eyes less than two-thirds pronotal width. **Megacoelidia** Kramer and Linnavuori
   Small to moderate-sized species, males less than 10 mm. in length; head including eyes always more than two-thirds pronotal width 6
6. Ventral margin of male pygofer with distinct apical or preapical hook or pygofer terminating with pointed process (figs. 75, 81) 8
   Ventral margin of male pygofer without hooks and pygofer not terminating with pointed process 7
7. Aedeagus strongly asymmetrical; pygofer with dorsal process; styles of moderate length, not wrinkled, well sclerotized (figs. 49, 45, 47). **Tozzita**, new genus
   Aedeagus symmetrical; pygofer without dorsal process; styles long, wrinkled, and weakly sclerotized (figs. 58, 55, 60) . . . . . **Xiqilliba**, new genus
8. Male pygofer inflated, laterally with distinct dorsoventral suture, hook on ventral margin large and heavy (fig. 50) . . . . . . **Coelana** DeLong
   Male pygofer not inflated, laterally without distinct dorsoventral suture, hook on ventral margin small, slender, or absent 9
9. Aedeagus asymmetrical and deeply cleft dorsoventrally; pygofer with crossed internal processes at apex . . . . . . **Tichocoelidia** Kramer
   Aedeagus symmetrical but at times twisted, never deeply cleft; crossed processes of pygofer, if present, external 10
10. Apex of pygofer in lateral view appearing cleft due to long mesally curved dorsal hook and weakly sclerotized ventral extension; stylar apex in dorsal view curving laterally and caudally (figs. 62, 65) . **Salvina** Melichar
    Apex of pygofer in lateral view and stylar apex in dorsal view not as above . 11
11. Anal tube of male with forked ventral hook; ventral cover of genital capsule sharply narrowed on distal half appearing as two extended "fingers" (figs. 67, 70) . . . . **Cocoelidia** DeLong
    Anal tube of male with single simple or pair of ventral hooks or none; ventral cover of genital capsule not as above 12
12. With small but distinct dark-brown or black spot at apex of crown. . . . 15
    Without spot at apex of crown 13

13. Cercopidlike species (fig. 114); forewing venation distinct; aedeagus simple or with long lateral processes . . . . **Biza** Walker
    Not cercopidlike species; forewing venation obscure; aedeagus simple or with apical processes 14
14. Aedeagus slender, with paired apical processes; male plates with long macrosetae (figs. 80, 78) . . . . **Nelidina** DeLong
    Aedeagus not particularly slender, without apical processes; male plates without macrosetae (figs. 95, 98) . . . . **Coelidiana** Oman
15. All veins of forewings brown and distinct; male plates with macrosetae (figs. 88, 89) . . . . **Coelella** DeLong
    Most veins of forewings yellowish and highly obscure; male plates without macrosetae (figs. 81, 85) . . . . **Neocoelidiana** DeLong

Neocoelidia Gillette and Baker

Figures 1–35

Neocoelidia Gillette and Baker 1895, p. 103. Type of genus *Neocoelidia tumidifrons* Gillette and Baker by original designation.

Paracoelidea Baker 1898, p. 292. Type of genus *Paracoelidea tuberculata* Baker by original designation. New synonymy.

Stenocoelidia DeLong 1953, p. 104. Type of genus *Stenocoelidia virgata* DeLong by original designation. New synonymy.

Stenocoelidia subgenus *Eurycoelidia* DeLong 1953, p. 112. Type of subgenus *Neocoelidia pulchella* Ball by original designation. New synonymy.

Description.—Carina separating face and crown distinct, weakly developed, or absent. Shape of crown in dorsal view highly variable, extremes with anterior margin broadly rounded to sharply angular, nearly always longer at middle than next to eye. Ocelli occur on anterior margin of crown. Head including eyes usually narrower than pronotum, which is more or less indented on posterior margin. Antennae from about half to three-fourths total length of body including forewings. Venation of forewings highly obscure, except apically, in most species.

Ground color ivory white to yellow. Often with spot at apex of crown and pair of dark spots on scutellum. Many with dorsal stripe from apex of crown to distal portion of forewings. Species rarely immaculate.

Male genitalia as discussed below.

Discussion.—The reduction of *Paracoelidea, Stenocoelidia,* and *Eurycoelidia* to synonymy under *Neocoelidia* is based upon the consistently uniform pattern of the male genitalia and the lack of sharply defined limits in gross characters between the groups as previously defined.

Attention is called to the following drawings for the purposes of the discussion: *N. tumidifrons* (figs. 1–6), *N. tuberculata* (figs. 7–13), *N. virgata* (figs. 14–16), and *N. pulchella* (figs. 17–24). The male genitalia of these various type-species show that in all cases the venter of the capsule is covered by a single plate presumably formed by a complete fusion of the normally paired plates. Other mutually shared characters are the comparatively simple pygofers distinguished by a single ventral hook or tooth and the pair of slender simple processes at the base of the anal tube. In all of them the aedeagus consists of two shafts which are arranged one above the other with the dorsal shaft bearing the gonoduct. The connective is uniformly Y-shaped and the styles are basically alike.

DeLong's separation of *Stenocoelidia* and *Eurycoelidia* from *Neocoelidia* on the basis of elongate and slender forms versus short and robust forms holds for some of the species, but others cannot be separated on this basis because of their intermediate condition. *Paracoelidea,* although striking because of the tuberculate clypellus, is considered here as a group within *Neocoelidia* because of the similarities in male genitalia.

The genus *Neocoelidia* is primarily North and Central American but a few species range into northern South America. Knull (1942) has reviewed the North American species, providing a key based largely on color and size. DeLong (1953) described many new species primarily from Mexico and Central America; and although he provided no key, his illustrations of the pygofers and aedeagi are highly adequate for species recognition.

Three species of *Neocoelidia,* the types of which have not been studied since their original description, are discussed here.

Neocoelidia fuscodorsata (Fowler), new combination

Figures 25–28

Tettigonia fuscodorsata Fowler 1900, p. 269, tab. 18, fig. 6.
Stenocoelidia fuscodorsata (Fowler), DeLong 1953, p. 121.
Stenocoelidia clara DeLong 1953, p. 104, new synonymy.

Fowler described *T. fuscodorsata* from a long series of specimens collected at several localities in Mexico and Guatemala. DeLong assumed that Fowler's series included more than one species, which is probably true, but he studied no type material. Through the cooperation of Dr. W. E. China and the British Museum (Natural History), three of Fowler's syntypes, one male and two females, were made available for study. The male with data "Teapa, Tabasco, Mexico" is hereby designated as the lectotype. A comparison of this lectotype and the type of *S. clara* DeLong show that these are conspecific. The colored illustration of *T. fuscodorsata* which appeared with Fowler's description is not diagnostic for the species. The general coloration is as figured, with the following modification: distinct black spot at apex of crown and near each basal angle of scutellum; apical spot fused with dorsal stripe whereas spots on scutellum free. The male genitalia are shown in figures 25–28.

Neocoelidia verecunda (Fowler), new combination

Tettigonia verecunda Fowler 1900, p. 269, tab. 18, fig. 7.
Stenocoelidia verecunda (Fowler), DeLong 1953, p. 122.

Unfortunately this Guatemalan species is known from females only, and its generic placement is open to question. I have studied Fowler's two syntypes in the British Museum and two additional specimens in the collection of the U.S. National Museum. In none of the specimens are the longitudinal red markings on the crown, pronotum, and forewings quite as distinct as illustrated with Fowler's original description.

Neocoelidia crenulata Osborn

FIGURES 29–35

Neocoelidia crenulata Osborn 1923, p. 79.

This species was described from a single male from Minca, Colombia. The type was made available through the courtesy of Dr. G. E. Wallace and the Carnegie Museum. In general it is marked like *N. fuscodorsata* except that there are no spots on the scutellum and the longitudinal dorsal stripe is crenulate on its margins. The genitalia of the type are illustrated in figures 29–35.

Chinaia Bruner and Metcalf

FIGURES 37, 113

Chinaia Bruner and Metcalf 1934, p. 120. Type of genus *Chinaia bella* Bruner and Metcalf by original designation.

DESCRIPTION.—Without carina separating face and crown. Clypellus expanded distally. Shape of crown in dorsal view broadly rounded, wider than long. Ocelli on face distinctly below anterior margin of crown. Head including eyes narrower than pronotum, which is not indented on posterior margin. Antenna very long, exceeding total length of body including forewings. Venation of forewings obscure except at apex.

Ground color yellowish to pale orange, with orange to bright red-orange markings on pronotum and extensively on forewings. Dark-brown markings often found on clavus and apical portion of forewings as well.

Male genitalia: Valve obscure. Plates deep and scoop-shaped. Pygofer either with dorsal processes or an elongation of terminus. Anal tube simple. Connective cruciform and not fused with aedeagus. Aedeagus moderately straight or recurved with or without lateral flaps.

DISCUSSION.—This is a Neotropical genus; most of the described species occur in Central America, but a few are South American.

Chinaia was recently revised by Kramer (1959). A habitus drawing of a typical *Chinaia* can be seen in figure 113.

Deltocoelidia Kramer

Deltocoelidia Kramer 1961, p. 238. Type of genus *Deltocoelidia maldonadoi* Kramer by original designation.

Description.—Without carina separating face and crown. Shape of crown in dorsal view bluntly angular. Ocelli located on anterior margin of crown. Head including eyes about as wide as pronotum, which is broadly indented on posterior margin. Antennae about as long as total length of body including forewings. Venation of forewings obscure except apically.

Ground color stramineous with contrasting markings on crown, pronotum, and forewings in form of stripes and spots.

Male genitalia: Male plates solidly fused and appear as single plate on venter of genital capsule. Both pygofer and anal tube simple. Connective Y-shaped and poorly sclerotized. Aedeagus slender, recurved, and with paired lateral processes.

Discussion.—The single leafhopper at present referable to this genus is the type-species, *Deltocoelidia maldonadoi* Kramer, known only from Venezuela. Illustrations of the male genitalia appeared with the original description.

Xenocoelidia Kramer

Figures 38–44

Xenocoelidia Kramer 1959, p. 30. Type of genus *Xenocoelidia youngi* Kramer by original designation.

Description.—Without carina separating face and crown. Shape of crown in dorsal view rounded or subangular. Ocelli located on anterior margin of crown. Head including eyes either as wide as pronotum or slightly narrower. Posterior margin of pronotum broadly and very shallowly indented. Antennae as long as total length of body including forewings. Venation of forewings obscure except at tip.

Ground color ivory to yellowish with or without contrasting markings on crown, pronotum, and forewings.

Male genitalia: Valve lacking. Male plates fused at least basally, at times for most of length. Pygofer with or without ventral tooth but always with terminus slightly thickened and bearing setae. Anal tube simple. Connective Y-shaped and closely associated with aedeagus but joint between them flexible. Style long with mesal curvature. Aedeagus slender and broadly U-shaped in lateral view with apical elaborations.

Discussion.—This genus was originally described to receive the species *X. youngi* Kramer and *X. colombiana* Kramer. Osborn (1923, p. 77) described *Neocoelidia inflata,* which has been found to be congeneric with the two originally included species. Through the cooperation of Dr. G. E. Wallace of the Carnegie Museum, the types of Osborn's species were made available for study. The generic transfer is made at this time: *Xenocoelidia inflata* (Osborn), new combination.

Key to Species of *Xenocoelidia*

1. Coloration almost uniform ivory white except for tiny fuscous spot at tip of each clavus and yellow hyaline apical portion of each forewing; apex of aedeagus in lateral view with sharp tooth and broad acute bladelike dorsal expansion (Colombia) . . . . **X. youngi** Kramer
   Coloration involving distinct markings on head and pronotum; apex of aedeagus in lateral view appearing as two sharp points 2
2. Head with two pairs of orange spots, one marginal between ocelli and one discal on crown. Pronotum with two orange-margined black spots near anterior margin. Each lateral margin of scutellum with black spot. Orange triangular spot at scutellar apex. Forewings unmarked except for very slight enbrowning along commissural margin. Aedeagal apex in posterior view with one pair of long antlerlike processes (Brazil) (genitalia illustrated in figs. 39–44) . . . . **X. inflata** (Osborn)
   Head with pale-yellow band below and a bright-orange band above anterior margin. Pronotum with lateral margins and an irregular U-shaped anterior central marking bright orange. Scutellum unmarked. Forewings marked as follows: claval suture with a pale yellow band becoming obscure distally; clavus with dusky orange stripe running along scutellum and commissural margin; a brown spot flanks stripe laterally before apex of each clavus. Aedeagal apex in posterior view with two pairs of comparatively short processes (Colombia) . . . . **X. colombiana** Kramer

Megacoelidia Kramer and Linnavuori

Megacoelidia Kramer and Linnavuori 1959, p. 55. Type of genus *Megacoelidia splendida* Kramer and Linnavuori by original designation.

Description.—With distinct carina separating face and crown. Shape of crown in dorsal view subquadrate, wider than long, scarcely angular apically, distinctly concave, and with lateral and posterior margins carinate. Ocelli on anterior margin of crown. Head including eyes comparatively small, less than two-thirds as wide as pronotum. Posterior margin of pronotum broadly but slightly indented. Antennae longer than entire length of body including forewings. Venation of forewings obscure except apically.

Ground color rich deep orange with or without black markings on legs, pronotum, and forewings.

Male genitalia: Valve lacking. Male plates fused basally. Pygofer variously modified distally with elongations or processes. Anal tube and styles simple. Connective Y-shaped and clearly articulated with aedeagus. Aedeagus stout with apical portion recurved.

Discussion.—*Megacoelidia* contains only two known South American species, both of which appeared with the original generic description. The genus contains the largest members of the subfamily.

Key to Species of *Megacoelidia*

Dorsal markings consisting of single narrow black border on posterior margin of pronotum and on apex of each forewing. Male plates in ventral view pointed apically and aedeagus with long paired lateral processes (Brazil).
M. splendida Kramer and Linnavuori

Dorsal markings limited to single narrow black border on apex of each forewing. Male plates in ventral view rounded apically and aedeagus with short paired lateral processes (Bolivia) . . . . **M. aurantia** Kramer and Linnavuori

***Tozzita*, new genus**

Figures 45–49

Type of genus *Tozzita ips*, new species.

Description.—With slender but distinct carina separating face and crown. Crown in dorsal view much longer than wide, bluntly angular apically, and strongly produced beyond eyes. Ocelli near anterior margin of crown but posterior to carina. Head including eyes distinctly narrower than pronotum. Posterior margin of pronotum broadly indented. Antennae as long as body including forewings at rest. Venation of forewings highly obscure except apically.

Ground color stramineous to light brown without definite markings except for black spot at apex of crown. Forewings stramineous hyaline.

Male genitalia.—Valve lacking. Male plates fused for nearly entire length. Pygofer modified only dorsally with processes or extensions. Anal tube with heavily sclerotized portions. Connective more or less V-shaped and articulated with strongly asymmetrical aedeagus.

***Tozzita ips*, new species**

Figures 45–49

Length.—Male 6.75 mm.

Coloration.—Stramineous with indefinite brownish areas on head and thorax. Only distinct marking is black apical spot on crown. Forewings stramineous hyaline.

Male genitalia.—Capsule in ventral view with slight apical notch on ventral cover which is exceeded by the pygofer (fig. 48). Capsule in lateral view with few tiny spines on ventral margin of pygofer, dorsum with blunt, sclerotized process; anal tube with two heavily sclerotized plates, posterior one notched dorsally (fig. 45). Aedeagus in ventral aspect slender and strongly asymmetrical (fig. 49), with apex forked and gonopore opening on narrow mesal extension (fig. 46).

681–546—63——2

Aedeagus slender in lateral view with dorsal hump on basal half and with apical mesal extension slender and recurved (fig. 47).

Holotype.—Male, Riberalta, Bolivia, W. M. Mann, January, 1921–22, Mulford Biological Expedition. USNM type 65826. Female unknown.

Xiqilliba, new genus

Figure 55–60

Type of genus *Xiqilliba bellator*, new species.

Description.—With distinct carina separating face and crown. Crown in dorsal view wider than long and bluntly angular apically. Ocelli near anterior margin of crown but slightly posterior to carina. Head including eyes narrower than pronotum. Posterior margin of pronotum mesally indented. Antennae as long as body including forewings. Venation of forewings comparatively distinct.

Ground color yellow marked with brown or black on head, pronotum, and forewings.

Male genitalia.—Valve lacking. Male plates fused basally for about half length. Pygofer simple. Anal tube with long paired processes extending anteriorly into genital chamber. Styles very long, wrinkled, slender, and poorly sclerotized. Connective modified Y-shaped. Aedeagus slender and simple.

Xiqilliba bellator, new species

Figures 55–60

Length.—Male 6.5 mm.

Coloration.—Grossly appearing as yellow leafhopper with brown stripe extending from anterior margin of crown across pronotum and scutellum on to forewings, where abruptly widens near midpoint of each clavus extending laterally to costal margin of each forewing, thus covering entire distal portion of forewings.

Ground color yellow. Black spot at apex of crown below carina. Crown mesally brown but color vaguely delimited. Pronotum mesally brown with color widest posteriorly. Scutellum with four very dark stripes: two wide lateral and two narrow double-toothed central stripes. Forewings brown except for large yellow patches in anterior costal area.

Male genitalia.—As defined generically with additional characters as follows: long paired processes of anal tube moderately slender but irregular in lateral view (fig. 55), sharply pointed and partially crossed anteriorly and double-pronged basally where joining anal tube in ventral view (fig. 56). Partially crossed anterior portions of processes form base on which aedeagus rests. Aedeagus uniformly slender, upturned distally, with apex projecting slightly caudally (fig. 58).

Holotype.—Male, and one paratype male, Itaituba, Brazil, no other data. USNM type 65827. Female unknown.

Coelana DeLong, new status

Figures 50–54, 108–109

Coelidiana subgenus *Coelana* DeLong 1953, p. 128. Type of subgenus *Neocoelidia modesta* Baker by original designation.

Description.—With carina separating face and crown. Crown in dorsal view broadly angular at apex and slightly wider than long. Ocelli on anterior margin of crown. Head including eyes distinctly narrower than pronotum. Posterior margin of pronotum broadly and sharply indented. Antennae about half as long as body including forewings. Venation of forewings obscure except apically.

Ground color stramineous with small black spot at coronal apex. Forewings stramineous hyaline.

Male genitalia: Valve lacking. Male plates fused basally. Pygofer greatly inflated, clearly exceeding length of plates, and ventral margin with large and heavy hook. Anal tube with ventral process. Connective approximately Y-shaped and articulated with simple aedeagus.

Discussion.—*Coelana* includes two species, *C. modesta* (Baker) (figs. 50–54) and *C. drakei* new species, from South America. Both are known from Bolivia, but *C. modesta* is recorded also from northern Argentina and southern Brazil.

Key to Species of *Coelana*

males only

Length 7 mm. or more; pygofer in lateral view broadly rounded apically and with inner process entire distally (fig. 50); aedeagus transverse (fig. 54).
C. modesta (Baker)

Length 6.5 mm. or less; pygofer in lateral view narrowed apically and with inner process dentate distally (fig. 108); aedeagus short-coupled (fig. 109).
C. drakei, new species

Coelana drakei, new species

Figures 108–109

Length.—Male 6.3 mm.

Coloration.—Uniformly stramineous with only distinct marking consisting of black spot at coronal apex.

Male genitalia.—Capsule in lateral view with pygofer narrowed apically and inner processes double-toothed ventrally at apex, only one process visible in drawing (fig. 108). Aedeagus in lateral view with shaft sharply upturned (fig. 109).

Holotype.—Male, Bolivia, no other data. USNM type 66368 Female unknown.

Discussion.—This species is very close to *C. modesta* but is separated easily from it by the characters in the above key. The species is named for Dr. Carl John Drake, from whose collection the specimen was obtained.

Tichocoelidia Kramer

Tichocoelidia Kramer 1962, p. 104. Type of genus *Tichocoelidia clarkei* Kramer by original designation.

Description.—With carina separating face and crown, lateral and posterior coronal margins carinate. Concave crown in dorsal view angled apically, approximately pentagonal in shape and well produced beyond eyes with ocelli on anterior margin. Head including eyes distinctly narrower than pronotum. Antennae about three-fourths as long as body including forewings. Posterior margin of pronotum mesally indented. Venation of forewings comparatively distinct.

Ground color stramineous to light brown with few additional markings, most of which are inconspicuous. Forewings stramineous hyaline.

Male genitalia: Valve lacking. Male plates short and fused except apically. Pygofers with ventral processes and paired internal processes at apex. Anal tube with pair of ventral hooks. Connective modified Y-shaped and firmly fastened to slender, cleft, asymmetrical aedeagus by flexible joint.

Discussion.—*Tichocoelidia clarkei* Kramer, a Colombian species, is the lone representative of the genus. The genital structures were fully illustrated with the original description cited above.

Salvina Melichar

Figures 61–65

Salvina Melichar 1926, p. 344. Type of genus *Tettigonia dorsisignata* Fowler by subsequent designation of China 1938, p. 184.

Description.—With carina separating face and crown. Crown in dorsal view wider than long, sharply rounded apically, and produced beyond eyes. Ocelli near anterior margin of crown but posterior to carina. Head including eyes slightly narrower than pronotum. Antennae nearly as long as body including forewings. Posterior margin of pronotum broadly and sharply indented. Venation of forewings obscure except apically.

Ground color yellow to orange with contrasting markings, especially on forewings, of black and brighter hues.

Male genitalia: Valve lacking. Male plates separated only apically. Pygofer in lateral view with ventral tooth and appearing cleft at apex due to long mesally curved dorsal hook and weakly sclerotized ventral extension. Anal tube simple but long. Stylar apex in dorsal view curving laterally and caudally. Connective heavy and Y-shaped. Aedeagus simple, compressed and upturned at apex.

Discussion.—The type species was illustrated in color when originally described by Fowler (1900, p. 282, tab. 19, fig. 6). This illustration is very good for showing the general markings of the leafhopper; however, in the specimen at hand the ground color is a brighter yellow-orange and the stripe on the commissural claval area is of a red-wine shade. This species is known from three syntypes, all of which are in the British Museum. Through the kindness of Dr. W. E. China, one male specimen was made available for this study. This male with data "Panama, Volcan de Chiriqui 4000 to 6000 feet, Champion" is hereby designated as the lectotype. The male genitalia of *Salvina dorsisignata* (Fowler), the only included species, are illustrated in figures 61–65.

Cocoelidia DeLong, new status

Figures 66–74

Neocoelidiana subgenus *Cocoelidia* DeLong 1953, p. 126. Type of subgenus *Neocoelidiana antlera* DeLong by original designation.

Description.—With carina separating face and crown. Crown in dorsal view wider than long, bluntly angular apically, and produced beyond eyes. Ocelli on anterior margin of crown. Head including eyes narrower than pronotum. Antennae only about half as long as body including forewings. Posterior margin of pronotum broadly indented. Venation of forewings obscure except at apex.

Ground color sordid yellow to light brown with weakly contrasting yellowish markings on head and dorsum of thorax. Apex of crown with black spot. Forewings brown hyaline.

Male genitalia: Valve lacking. Ventral cover of genital capsule sharply narrowed on distal half appearing as two extended "fingers." Pygofer in lateral view with ventral tooth and dorsal distally hooked process. Anal tube with short, forked ventral process. Connective Y-shaped with stalk bifurcate to receive aedeagus. Style simple. Aedeagus slender, recurved distally with pair of preapical processes.

Discussion.—The Mexican leafhopper, *Cocoelidia antlera* (DeLong), is the only included species. The male genitalia are illustrated in figures 66–74.

Nelidina DeLong, new status

FIGURES 75–80, 110–112

Coelidiana subgenus *Nelidina* DeLong 1953, p. 129. Type of subgenus *Coelidiana defila* DeLong by original designation.

DESCRIPTION.—With carina separating face and crown. Crown in dorsal view wider than long, sharply rounded apically, and produced beyond eyes. Ocelli on anterior margin of crown. Head including eyes narrower than pronotum. Length of antennae at least half as long as body. Posterior margin of pronotum approximately straight across or slightly indented. Venation of forewings most distinct apically.

Ground color various shades of yellow without strongly contrasting markings.

Male genitalia: Valve lacking. Male plates fused basally and with long apical macrosetae. Pygofer in lateral view with a dorsal process or terminal hook. Anal tube simple. Connective very broadly Y-shaped with stalk bifurcate to receive aedeagus. Stylar apex weakly hooked in lateral view. Aedeagus slender with paired apical processes.

DISCUSSION.—*Nelidina* includes two species, *N. defila* (DeLong) (figs. 75–80) and *N. taeniola*, new species, from South America. The type of the genus, *N. defila*, is known only from Peru, and *N. taeniola* is recorded only from Colombia.

Key to Species of *Nelidina*

MALES ONLY

Length 7 mm.; aedeagal processes uniformly slender and not twisted (figs. 79, 80). **N. defila** (DeLong)

Length 4.5 mm.; aedeagal processes ribbon-like and twisted (figs. 111, 112). **N. taeniola,** new species

Nelidina taeniola, new species

FIGURES 110–112

LENGTH.—Male 4.5 mm.

COLORATION.—Uniformly yellowish or yellowish-green without distinct markings. Exceedingly faint dark longitudinal striping on forewings.

Male genitalia: Posterior margin of pygofer beset with numerous fine setae and with small sharp hook or tooth ventrally (fig. 110). Rest of capsule like *N. defila*. Aedeagus transverse with long, twisted, ribbon-like, paired apical processes (figs. 111, 112).

HOLOTYPE.—Male, Chicó, Colombia, elevation 2,900 meters, January 2, 1959, R. F. Ruppel. USNM type no. 34882. Paratype, male with same data.

Neocoelidiana DeLong

FIGURES 81–86

Neocoelidiana DeLong 1953, p. 122. Type of genus *Neocoelidia obscura* Baker by original designation.

DESCRIPTION.—With carina separating face and crown. Crown in dorsal view wider than long, very broadly or bluntly angled apically, and produced beyond eyes. Head including eyes narrower than pronotum. Ocelli on anterior margin of crown. Antennae from half to three-fourths as long as body including forewings. Posterior margin of pronotum broadly and often sharply indented. Venation of forewings highly obscure except apically.

Ground color stramineous to yellow, often with three inconspicious longitudinal stripes of slightly darker shade on crown and pronotum. Apex of crown with black spot. Forewings yellowish hyaline, at times with few additional brown markings or tinges, with veins concolorous.

Male genitalia: Valve lacking. Male plates fused basally for more than half length, without short macrosetae apically. Pygofer in lateral view with dorsal process and either ventral process or ventral hook. Anal tube with single ventral hook. Connective broadly Y-shaped. Apex of style strongly hooked in lateral view. Aedeagus in lateral view approximately S-shaped, often somewhat twisted, and with some sort of apical modifications.

DISCUSSION.—The genus as here defined contains seven species from western United States and Mexico, all of which were treated by DeLong (1953). The male genital structures of the type-species, *Neocoelidiana obscura* (Baker), are shown in figures 81–86.

Coelella DeLong, new status

FIGURES 87–93

Neocoelidiana subgenus *Coelella* DeLong 1953, p. 125. Type of subgenus *Neocoelidia distincta* Oman by original designation.

DESCRIPTION.—With carina separating face and crown. Crown in dorsal view wider than long, bluntly angled apically, and produced beyond eyes. Head including eyes narrower than pronotum. Ocelli on anterior margin of crown. Antennae from half to three-fourths as long as body including forewings. Posterior margin of pronotum broadly and sharply indented. Venation of forewing highly distinct.

Ground color stramineous to yellow, usually with three more or less well-defined longitudinal stripes of slightly darker hue on crown and pronotum. Apex of crown with black spot. Forewings hyaline with veins uniformly brown.

Male genitalia. Valve lacking. Male plates fused for basal two-thirds, with short macrosetae apically. Pygofer with both dorsal process and ventral hook. Anal tube simple. Connective broadly Y-shaped. Apex of style hooked in lateral view. Aedeagus in lateral view with shaft turned either dorsally or ventrally in apical portion. Aedeagal apex simple or elaborated with short paired processes.

Discussion.—The genus contains only two species. The type-species, *Coelella distincta* (Oman), occurs in the southwestern United States, while the second species, *C. venosa* (DeLong) 1953, p. 126, is Mexican. The male genital structures of the type-species are illustrated in figures 87–93.

Biza Walker

Figures 36, 114

Biza Walker 1858, p. 253. Type of genus *Biza crocea* Walker by original designation.

Description.—With carina separating face and crown. Crown in dorsal view subquadrate, wider than long, produced beyond eyes, rounded apically, and carinated laterally and posteriorly. Ocelli on anterior margin of crown. Antennae at least half as long as body including forewings. Head including eyes narrower than pronotum. Posterior margin of pronotum broadly but rather shallowly indented. Forewings broad with venation distinct.

Ground color yellow to orange with extensive brown or fuscous markings on the forewings.

Male genitalia: Valve lacking. Male plates fused only basally. Pygofer in lateral view with only ventral hook or tooth, no dorsal processes, apex acute or rounded. Anal tube and styles simple. Connective Y-shaped and clearly articulated with aedeagus. Aedeagus simple, upturned apically, with or without lateral processes.

Discussion.—As can be seen by reference to the habitus drawing (fig. 114), the general cercopid-like appearance is striking. The included species are known from Central and South America. The genus *Biza* was recently revised by Kramer (1962).

Coelidiana Oman

Figures 94–107

Coelidiana Oman 1938, p. 397. Type of genus *Neocoelidia rubrolineata* Baker by original designation.

Acocoelidia DeLong 1953, p. 130. Type of genus *Acocoelidia unipuncta* DeLong by original designation. New synonomy.

Description.—With carina separating face and crown. Crown in dorsal view variable with length and width subequal or length exceeding width, angled apically, and produced beyond eyes. Ocelli on anterior margin of crown. Head including eyes narrower than pronotum. Antennae from half to nearly equal length of body including forewings. Posterior margin of pronotum broadly and usually sharply indented. Venation of forewings highly obscure except apically.

Ground color stramineous to yellow. Head, pronotum, and scutellum immaculate or with distinct or inconspicuous yellow-to-red markings in form of longitudinal and/or lateral stripes. Apex of crown without black spot. Forewings varying from concolorous to moderately heavily marked with dark brown or black.

Male genitalia: Valve lacking. Male plates fused basally and often for nearly entire length. Pygofer in lateral view quite variable, no true dorsal process, but either terminating with spine of variable length and development or simple; ventral margin with hook or hooks, long apical spine or simple. Anal tube with paired ventral hooks or none. Connective Y-shaped. Style in lateral view strongly hooked apically. Aedeagus simple, slender, or moderately stout, and upturned at apex.

Discussion.—The male genitalia of *Coelidiana rubrolineata* (Baker) and *Coelidiana unipuncta* (DeLong) are illustrated in figure 99 and figures 100–107. Members of *Coelidiana*, as here defined, range from southern Mexico to Brazil. DeLong (1953) treated seven members of this group. *C. undata* (Linnavuori) was transferred to this genus by Kramer (1959).

Two species of *Coelidiana*, the types of which have not been studied since their original description, are discussed below.

Coelidiana coronata (Ball), new combination

Neocoelidia coronata Ball 1916, p. 208.

This rather long-crowned species described by Ball was based upon a unique female from Guatemala. Its generic placement will not be certain until males are available for study. The red markings of the dorsum are quite similar to some other *Coelidiana*.

Coelidiana croceata (Osborn), new combination

Figures 94–98

Neocoelidia croceata Osborn 1923, p. 78.

This Brazilian species is very close to the type-species, *C. rubrolineata*, also from Brazil. The only characters that will successfully allow differentiation are found in the aedeagus. In *C. croceata* the aedeagus is crenulated ventrally and narrowed apically (fig. 95), whereas in *C. rubrolineata* the aedeagus is smooth ventrally and broad apically (fig. 99). The drawings of *C. croceata* male genitalia (figs. 94–98) are based upon the allotype, which is in the Carnegie Museum, Pittsburgh, Pennsylvania.

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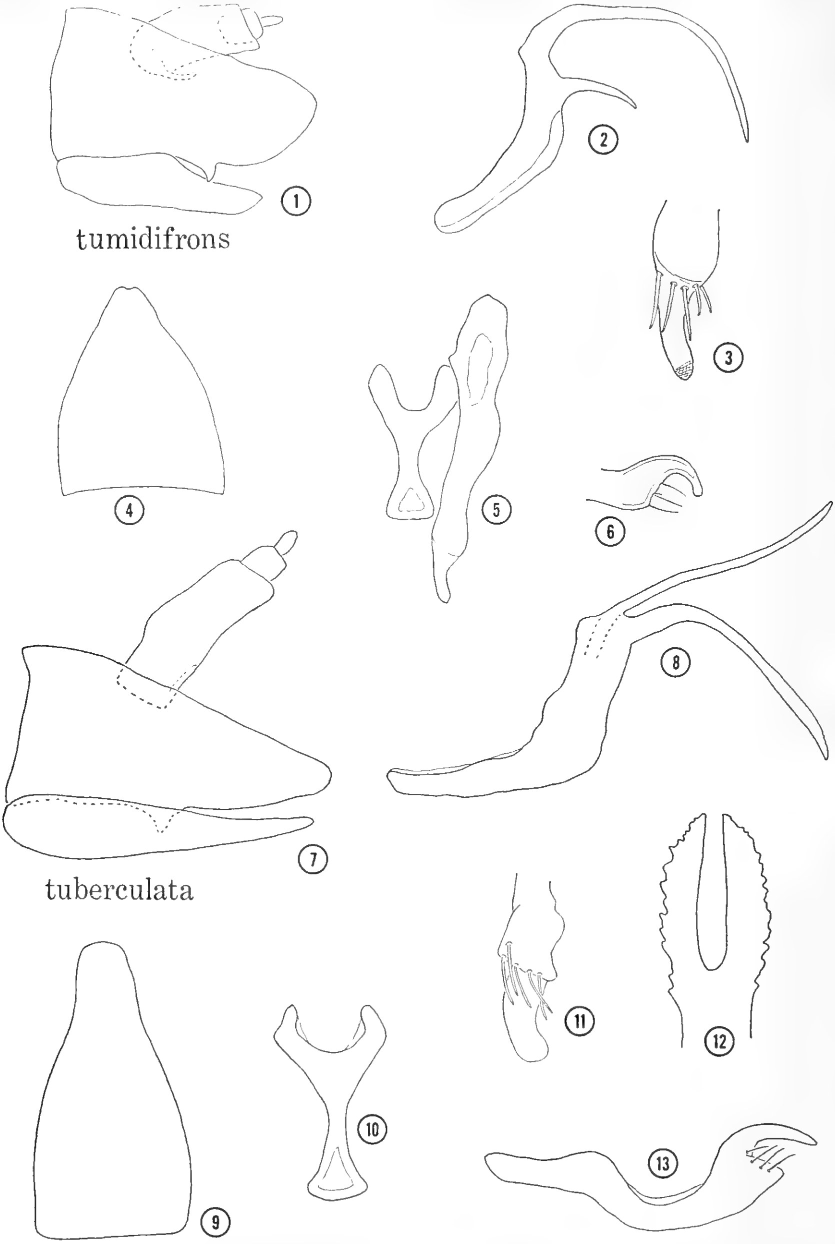
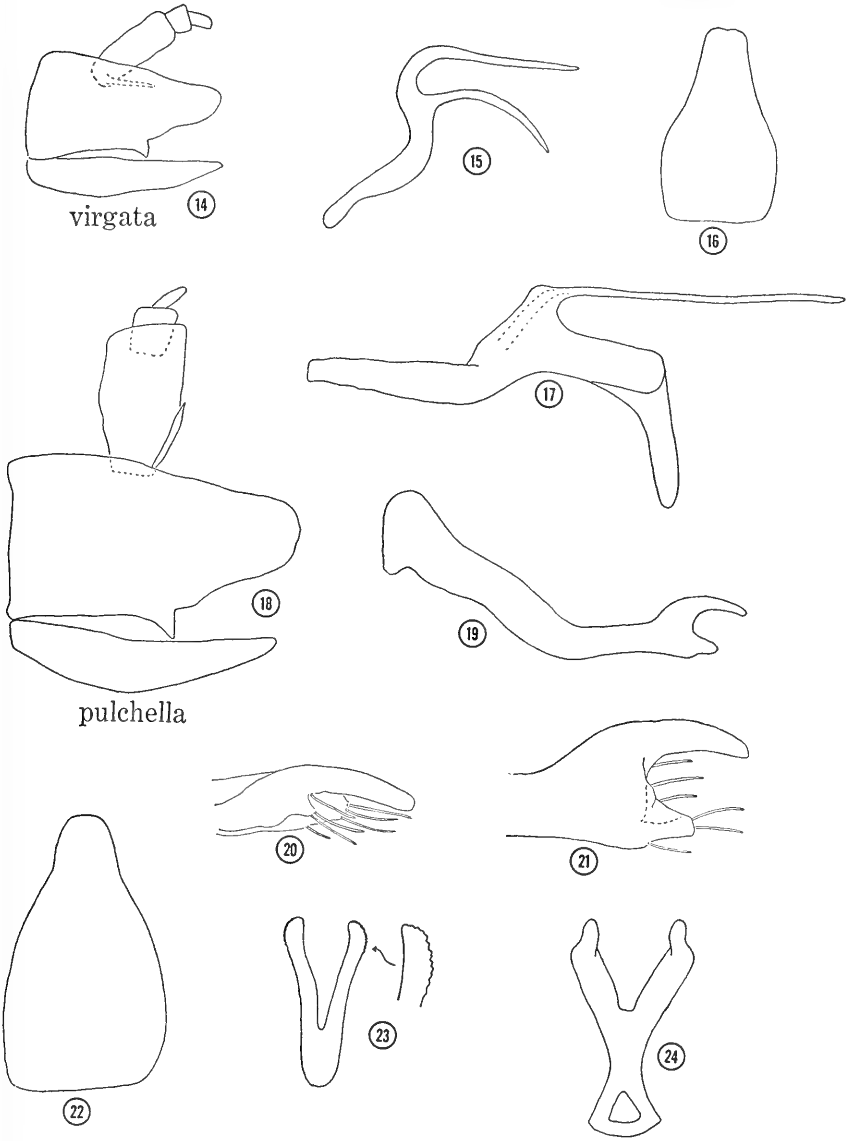
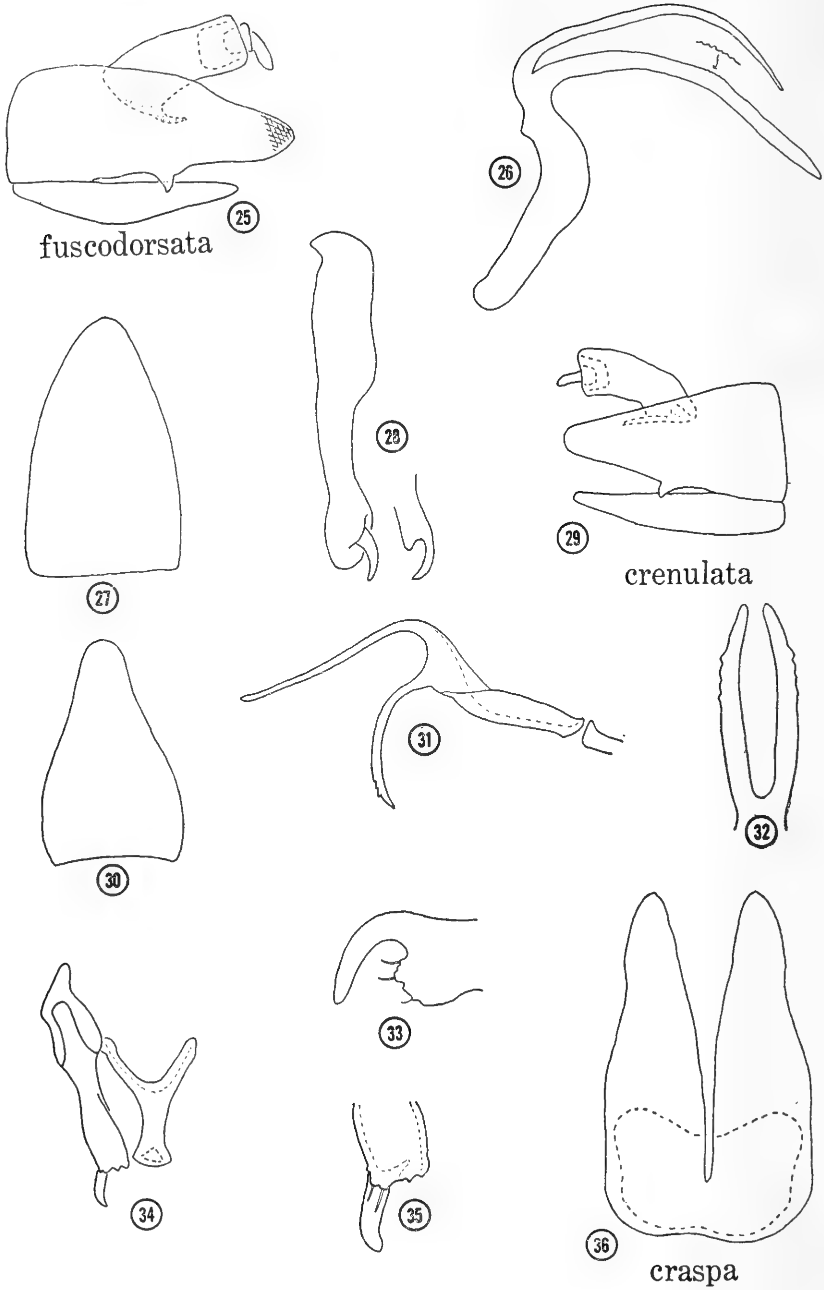


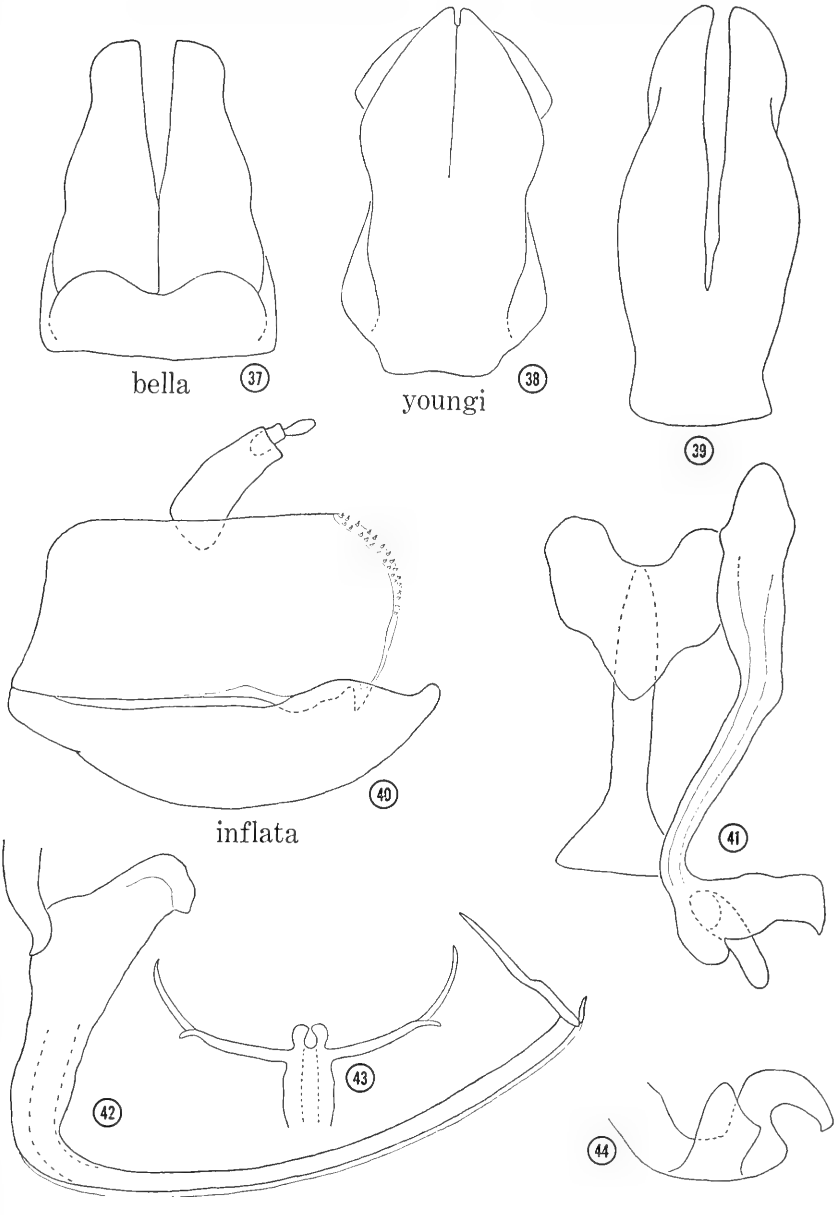
Figures 1–13. *Neocoelidia tumidifrons* Gillette and Baker: 1, lateral view of genital capsule; 2, lateral view of aedeagus; 3, ventral aspect of stylar apex; 4, ventral cover of genital capsule; 5, ventral view of connective and style; 6, lateral aspect of stylar apex. *Neocoelidia tuberculata* (Baker): 7, lateral view of genital capsule; 8, lateral view of aedeagus; 9, ventral cover of genital capsule; 10, ventral view of connective; 11, ventral aspect of stylar apex; 12, dorsal view of apical portion of lower aedeagal shaft; 13, lateral view of style.



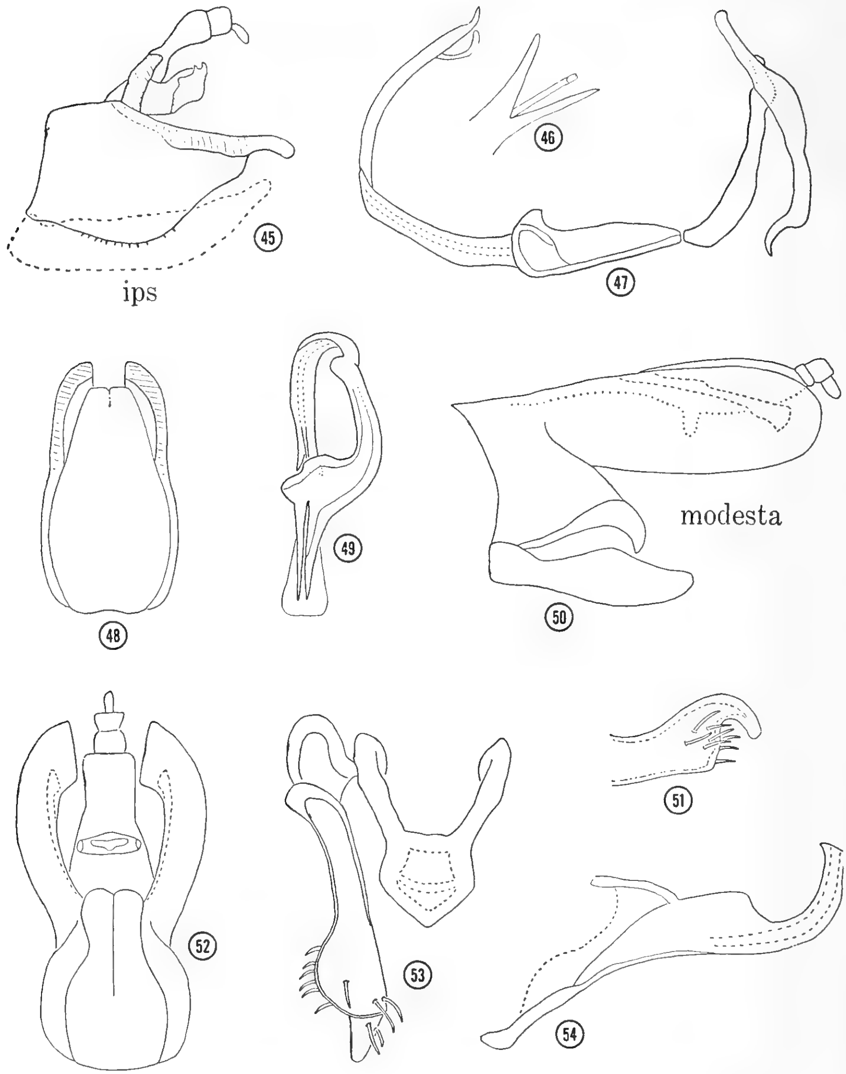
FIGURES 14–24.—*Neocoelidia virgata* (DeLong): 14, lateral view of genital capsule; 15, lateral view of aedeagus; 16, ventral cover of genital capsule. *Neocoelidia pulchella* Ball: 17, lateral view of aedeagus; 18, lateral view of genital capsule; 19, lateral view of style; 20, dorsal aspect of stylar apex; 21, lateral aspect of stylar apex; 22, ventral cover of genital capsule; 23, dorsal view of apical portion of lower aedeagal shaft; 24, dorsal view of connective.



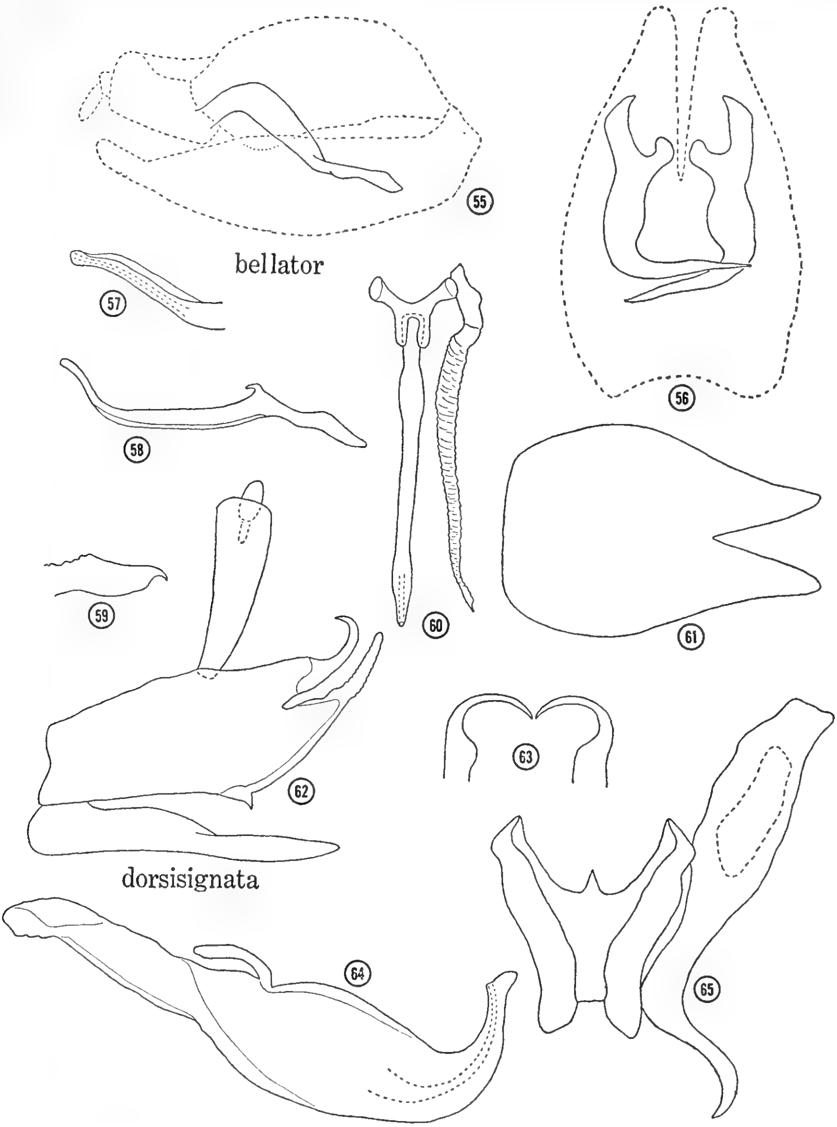
FIGURES 25–36.—*Neocoelidia fuscodorsata* (Fowler): 25, lateral view of genital capsule; 26, lateral view of aedeagus; 27, ventral cover of genital capsule; 28, dorsal view of style and lateral view of stylar apex. *Neocoelidia crenulata* Osborn: 29, lateral view of genital capsule; 30, ventral cover of genital capsule; 31, lateral view of aedeagus; 32, dorsal view of apical portion of lower aedeagal shaft; 33, lateral aspect of stylar apex; 34, ventral view of connective and style; 35, dorsal view of stylar apex. *Biza craspa* Kramer; 36, ventral cover of genital capsule.



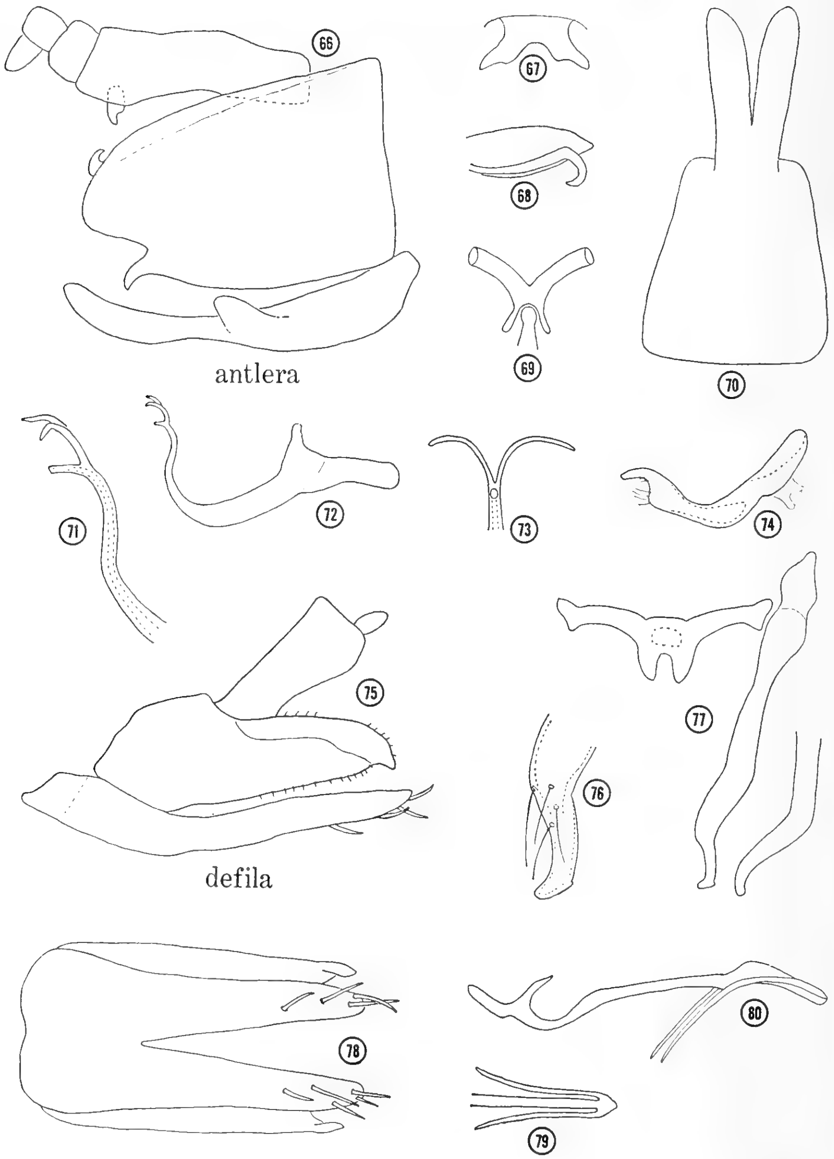
FIGURES 37–44.—*Chinaia bella* Bruner and Metcalf: 37, ventral cover of genital capsule. *Xenocoelidia youngi* Kramer: 38, ventral cover of genital capsule. *Xenocoelidia inflata* (Osborn): 39, ventral cover of genital capsule; 40, lateral view of genital capsule; 41, ventral view of connective and style; 42, lateral view of aedeagus; 43, posterior view of aedeagal apex; 44, lateral view of stylar apex.



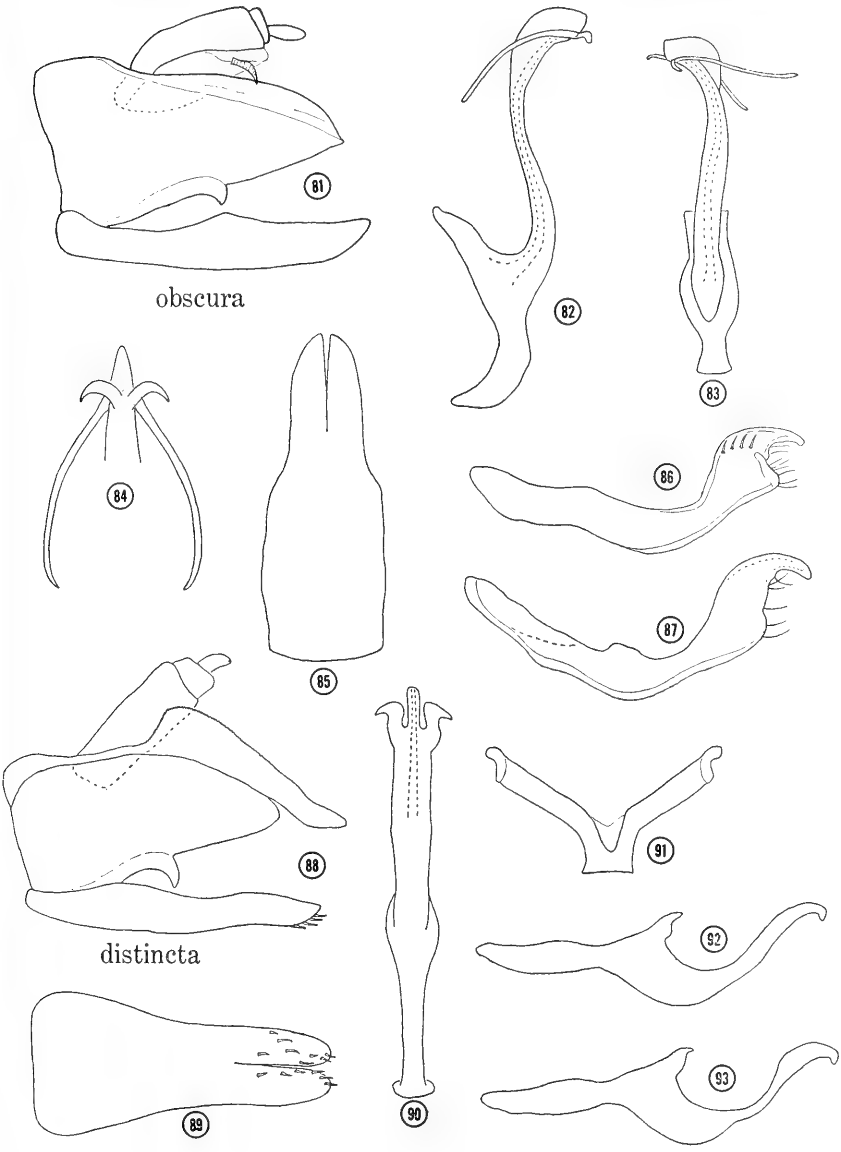
FIGURES 45–54.—*Tozzita ips*, new species: 45, lateral view of genital capsule; 46, dorsal view of aedeagal apex; 47, lateral view of connective, style, and aedeagus; 48, ventral cover of genital capsule with pygofers showing; 49, ventral view of aedeagus. *Coelana modesta* (Baker): 50, lateral view of genital capsule; 51, lateral view of stylar apex; 52, ventral cover of genital capsule with pygofers and anal tube showing; 53, ventral view of connective and style; 54, lateral view of aedeagus.



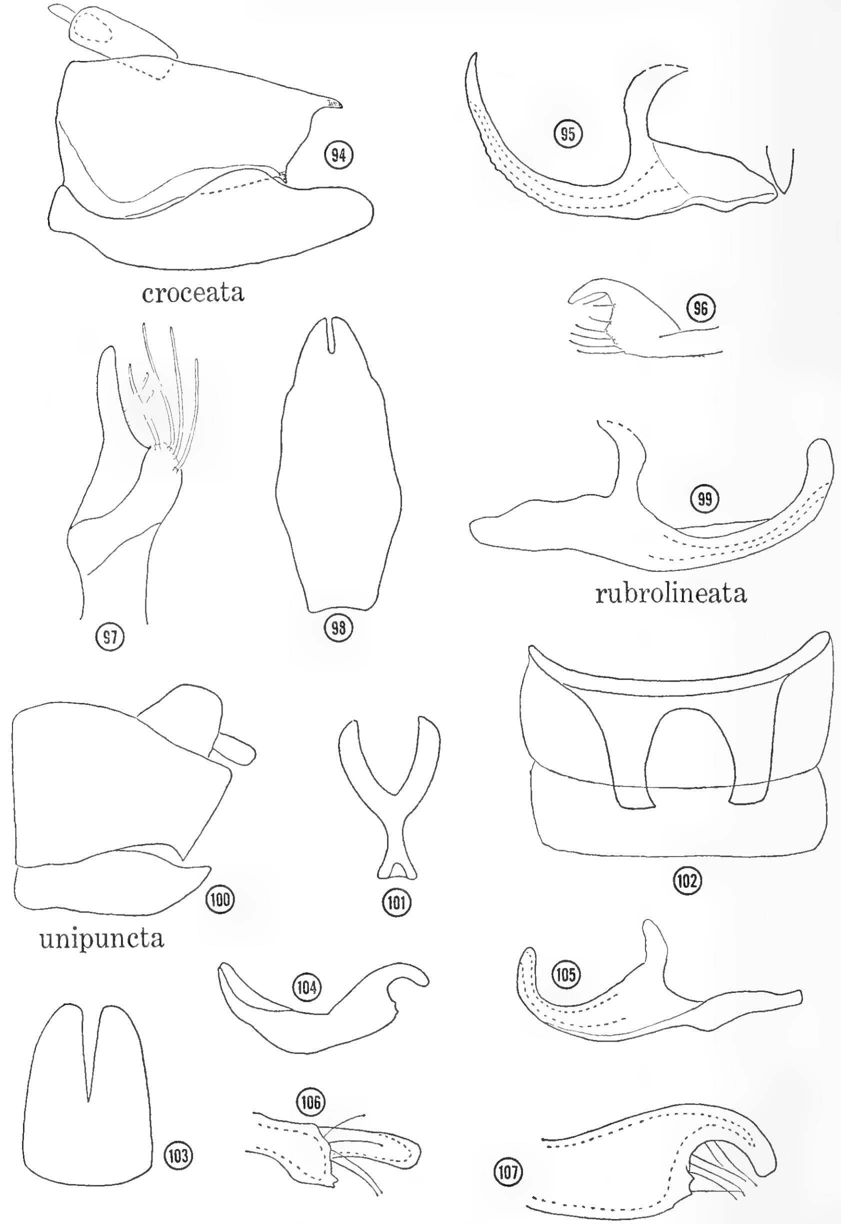
FIGURES 55–65.—*Xiqilliba bellator*, new species: 55, lateral view of genital capsule; 56, ventral cover of genital capsule showing processes of anal tube; 57, lateral view of aedeagal apex; 58, lateral view of aedeagus; 59, lateral view of stylar apex; 60, dorsal view of connective, style, and aedeagus. *Salvina dorsisignata* (Fowler): 61, ventral cover of genital capsule; 62, lateral view of genital capsule; 63, dorsal view of hooks at apex of pygofer; 64, lateral view of aedeagus; 65, dorsal view of connective and style.



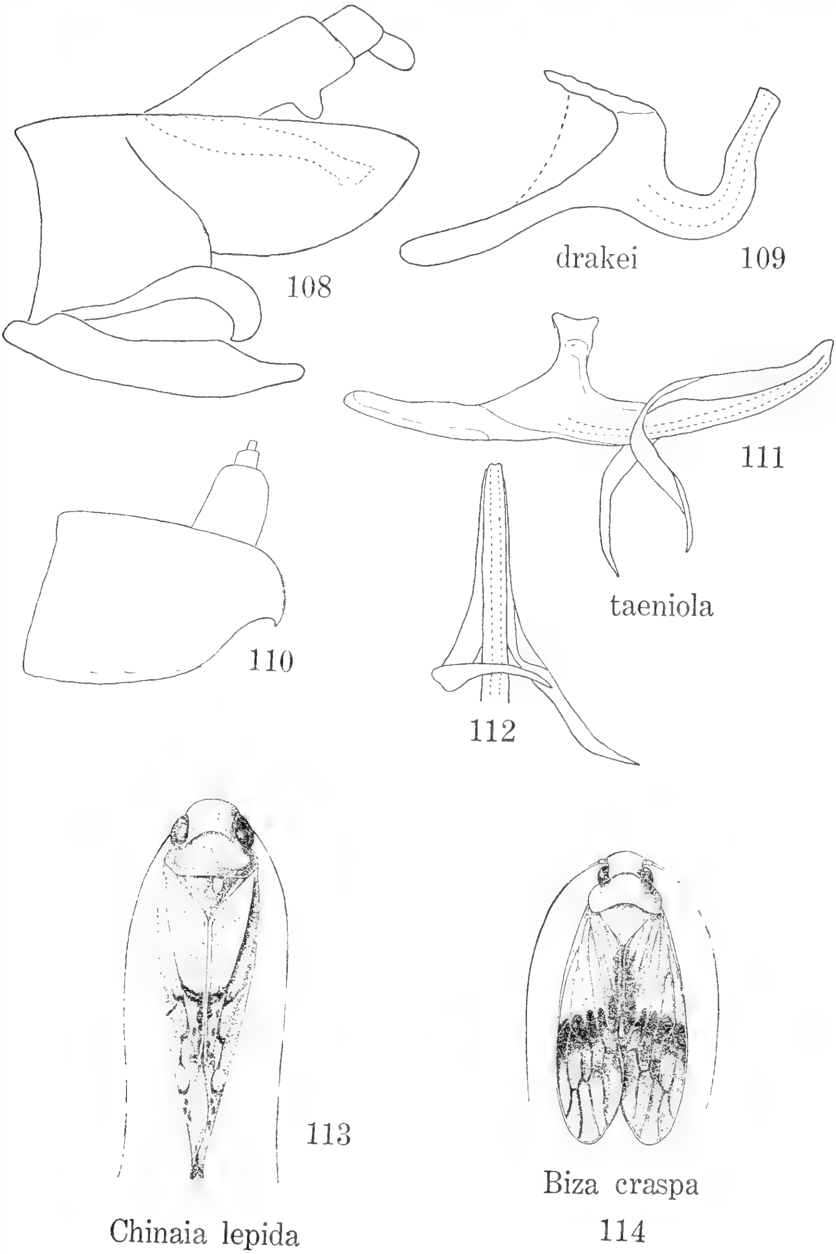
FIGURES 66–80.—*Cocoelidia antlera* (DeLong): 66, lateral view of genital capsule; 67, posterior view of processes on anal tube; 68, dorsal view of apex of pygofer; 69, ventral view of connective with basal portion of aedeagus; 70, ventral cover of genita capsule; 71, lateral view of aedeagal apex; 72, lateral view of aedeagus; 73, posterior view of aedeagal apex; 74, lateral view of style. *Nelidina defila* (DeLong): 75, lateral view of genital capsule; 76, ventral view of stylar apex; 77, ventral view of connective and style, also with lateral view of stylar apex; 78, ventral cover of genital capsule with pygofer showing; 79, ventral view of aedeagal apex; 80, lateral view of aedeagus.



FIGURES 81–93.—*Neocoelidiana obscura* (Baker): 81, lateral view of genital capsule; 82, lateral view of aedeagus; 83, posterior view of aedeagus; 84, posterior view of aedeagal apex; 85, ventral cover of genital capsule; 86, lateral view of style. *Coelella distincta* (Oman): 87, lateral view of style; 88, lateral view of genital capsule; 89, ventral cover of genital capsule; 90, ventral view of aedeagus; 91, posterioventral view of connective; 92, lateral view of aedeagus; 93, lateral view of aedeagus, a variant.



FIGURES 94–107.—*Coelidiana croceata* (Osborn): 94, lateral view of genital capsule; 95, lateral view of aedeagus; 96, lateral view of stylar apex; 97, ventral view of stylar apex; 98, ventral cover of genital capsule. *Coelidiana rubrolineata* (Baker): 99, lateral view of aedeagus. *Coelidiana unipuncta* (DeLong): 100, lateral view of genital capsule; 101, ventral view of connective; 102, ventral view of abdominal base showing apodemes; 103, ventral cover of genital capsule; 104, lateral view of style; 105, lateral view of aedeagus; 106, ventral view of stylar apex; 107, lateral view of stylar apex.



FIGURES 108–114.—*Coelana drakei*, new species: 108, lateral view of genital capsule; 109, lateral view of aedeagus. *Nelidina taeniola*, new species: 110, lateral view of pygofer and anal tube; 111, lateral view of aedeagus; 112, ventral view of aedeagal apex. *Chinaia lepida* Kramer: 113, habitus in dorsal view. *Biza craspa* Kramer: 114, habitus in dorsal view.

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A REVIEW OF THE NORTH AMERICAN MOTHS OF THE FAMILY WALSHIIDAE (LEPIDOPTERA: GELECHIOIDEA)

By Ronald W. Hodges[1]

Introduction

Since most species of Walshiidae are small, inconspicuous moths, many collectors understandably have overlooked them. As a result, a relatively small number of specimens has been taken and our knowledge of the group is limited. Until extensive and intensive collecting has been accomplished, the results of any revisionary study will be limited, subject to reinvestigation. The purpose of this paper is to make known the described genera and species, to attempt to define the genera, and to describe the new species that are at hand. Four North American genera recently have been revised: *Walshia* Clemens (Hodges, 1961), *Ithome* Chambers (Hodges, 1962a), *Periploca* Braun (Hodges, 1962b), and *Perimede* Chambers (Hodges, in press). They will not be discussed further in this paper except for a few notes under "Taxonomic Treatment."

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At present not much is known about the immature stages of most species of Walshiidae; however, some general statements can be made. The known larvae of *Ithome* feed on the florets of species of Leguminosae and Polygonaceae. The larvae of *Walshia miscecolorella* (Chambers) and *W. amorphella* Clemens are stem and root borers; *W. miscecolorella* has been reared from several species of Leguminosae and is potentially a pest of sweet clover in parts of Texas. The larvae of *W. amorphella* are gall formers on the stems of *Amorpha fruticosa* L. and occasionally on *Hydrangea* spp. The known larvae of species of *Aeaea* Chambers are leaf miners in *Ostrya virginiana* (Mill.) K. Koch., *Quercus* spp., and *Rhynchosia tomentosa* (L.) H. & A. Species of *Periploca* (Braun) are known from *Ceanothus* spp. (gall formers on the stems), *Gleditsia* spp., and *Robinia* spp. (borers in the thorns), *Juniperus* spp. (found in the fruits), *Gymnosporangium* spp. (in galls and as a twig girdler). Two species, *Periploca laeta* Hodges and *P. nigra* Hodges, sometimes are pests of ornamental junipers. *Perimede erransella* Chambers has been reared from *Taxodium* spp. and leaves of *Ulmus* spp., but whether this species is a miner during all or part of the larval stage or whether it is an external feeder is not known. *Obithome punctiferella* (Busck) has been found in cages which contained cotton bolls, but whether the larva feeds on the bolls or is a scavenger is unknown. The larvae of *Stilbosis tesquella* Clemens are external feeders on *Amphicarpa* spp. and *Lespedeza* spp. The larvae of *Chrysopeleia purpuriella* Chambers have been reared from the leaves of *Robinia pseudo-acacia* L., but the exact habits are not known. *Sorhagenia rhamniella* (Zeller) and *S. nimbosa* (Braun) are leaf folders on *Rhamnus* spp. in the larval stage.

Because the species of *Aeaea* Chambers have similar maculation and habitus, it was necessary to make genitalic preparations of each specimen. In some of the female abdomens, single larval head capsules were found. During the process of cleaning the specimens, the head capsules were often removed; but they are present on two slides (RWH slides 1167 and 2121), *Aeaea* "d" and *Synploca gumia,* new genus and species, respectively. These head capsules indicate that the species possibly are ovoviviparous, a condition known to occur in the Coleophoridae (Toll, 1952), Tineidae (Diakonoff, 1952), and Oecophoridae (teste Clarke).

I wish to thank the following individuals for providing me with the specimens which form the basis of this study (parentheses enclose abbreviations used in citing the location of specimens): Mr. J. A. G. Rehn, Academy of Natural Sciences, Philadelphia (ANSP); Dr. C. D. MacNeill, California Academy of Sciences (CAS); Dr. J. G. Franclemont, Cornell University (CU); Mr. L. M. Martin, Los Angeles County Museum (LACM); Drs. P. J. Darlington and

H. E. Evans, Museum of Comparative Zoology (MCZ); Dr. J. A. Powell, University of California at Berkeley (UCB); Dr. A. F. Braun, Cincinnati, Ohio (AFB); Mr. M. O. Glenn, Henry, Illinois (MOG); Mr. C. P. Kimball, Barnstable, Massachusetts (CPK); and Dr. A. B. Klots, New York, New York (ABK). Specimens in the United States National Museum are designated by USNM. Particular thanks are given to Drs. Braun, Darlington, Evans, and Mr. Rehn for allowing me to examine type specimens under their care. In addition, Mr. J. D. Bradley furnished me with specimens of *Sorhagenia rhamniella* and *Cholotis semnostola* Meyrick and compared North American material with specimens in the British Museum (Natural History).

The photographs of the adult moths were made by J. Scott, Staff Photographer, Smithsonian Institution.

The specimens of *Stilbosis tesquella* from Highlands, North Carolina, were collected during the summer of 1958 when the author was assisting Dr. J. G. Franclemont under the auspices of a grant from the Penrose Fund of the American Philosophical Society.

Taxonomic Treatment

The name Walshiidae was proposed for a relatively homogeneous group of genera (Hodges, 1962a). At some future date, when more is known about the gelechioids, the group probably will be treated as a subfamily or tribe within the complex, but for the present it must be recognized as being as distinct as several other families.

The characters of the family are as given in Hodges (Revision of Cosmopterigidae, in press) with the following modifications: the forewing with 11 (no. 2 absent) or 12 veins; the hind wing with 6 (3 and 4 absent) or 8 veins; uncus usually present, absent in *Obithome,* new genus, and *Periploca.* In several of the genera there is a tendency toward asymmetry in the male genitalia, usually expressed by a twisting of the valvae with a concomitant reduction of one valva and an enlargement of the other.

The three families, Walshiidae, Cosmopterigidae, and Momphidae, have been placed in either Cosmopterigidae, Lavernidae, or Momphidae on the basis of wing venation; however, as I have indicated (Hodges, ibid.), venation does not offer a satisfactory means of separating these families. For example, by using venation, several genera of cosmopterigids would go into the Oecophoridae; the walshiids, cosmopterigids, and momphids would form a unit; and the Scaeosophidae would be treated as a separate family. Unfortunately, the female genitalia also do not seem to offer diagnostic characters on the family (and often not on the generic) level; however, the male genitalia do present what appear to be reliable means for separating these families, and it is this system of characters which presently forms the basis of our system of classification. The females will have to be associated with males before positive family identification can be made.

Key to Walshiidae, Cosmopterigidae, and Momphidae Based on Male Genitalia

1. Gnathos present 2
   Gnathos absent 3
2. Brachia of gnathos symmetrical . . . . MOMPHIDAE
   Brachia of gnathos asymmetrical . . . . COSMOPTERIGIDAE
3. Aedeagus ankylosed, heavily sclerotized manica articulating with saccus or juxta . . . . WALSHIIDAE
   Aedeagus not ankylosed, manica absent . . . . MOMPHIDAE

The female genitalia of *Ithome* Chambers and *Obithome* are heavily sclerotized, particularly the apophyses. The apophyses are very similar to those of *Adela* Latreille (Pierce and Metcalf, 1935), *Ectroproceros* Diakonoff (Diakonoff, 1955), and *Antispila* Hübner (Kuroko, 1961); however, rather than indicating phyletic relationship, the sclerotization probably represents a modification for a specialized type of oviposition.

Meyrick (1915) transferred *Stagmatophora ceanothiella* Cosens to the Australian genus *Cholotis* Meyrick. In 1921 he synonymized *Cholotis* with the Palearctic genus *Ascalenia* Wocke, thereby making the combination *Ascalenia ceanothiella*. As I have shown (Hodges, 1962b), *A. ceanothiella* belongs to the genus *Periploca*. Genitalic examination of the type-species *Cholotis semnostola* indicates that this genus is distinct from *Ascalenia* and that it has affinities with *Perimede*. Meyrick placed many Central and South American species in *Cholotis* (later *Ascalenia*) and *Prochola* Meyrick. Clarke (in press) subsequently has examined the genitalia of several of Meyrick's type specimens and has transferred many species to other genera. Until the genitalia of the known species in these genera have been examined, the generic combinations must be regarded with caution.

Walshia particornella (Busck) is somewhat intermediate in position between *Walshia* and *Periploca;* however, because of an uncus present in the male genitalia and the general facies of the genitalia, *particornella* is associated with *Walshia*. The ostium bursae of *W. particornella* is in the middle of the seventh sternum, a characteristic that is in contrast to the other known species of Walshia, the ostium bursae of which is on the anterior margin of the seventh sternum; the ostium bursae of *Periploca* is on the anterior margin or medial. The habitus of *W. particornella* is similar to that of *Periploca* species, and the wings are smooth-scaled; the forewings of all known species of *Walshia* have a series of raised scales. At the time of writing I do not feel that

W. particornella is sufficiently distinct to allow me to propose a new genus for it, I am not really satisfied to place it in either *Periploca* or *Walshia*, and I do not think that *Walshia* and *Periploca* should be synonymized; therefore, my alternative is the arbitrary one of retaining *particornella* in *Walshia*.

A season of collecting on the southern part of the Colorado Plateau (Coconino Plateau) showed the following distributional information: no specimens of *Perimede* or *Ithome* were taken, less than 20 specimens of *Periploca* were collected, and one species of *Walshia*, *W. miscecolorella*, commonly was collected. With the exception of *Stilbosis tesquella* and *Aeaea stipator*, new species, which were taken in areas that are tongues of the Sonoran Desert extending onto the southern edge of the Cococino Plateau, none of the species treated in this paper were collected during the same period. The conclusion can be drawn, therefore, that the family is restricted to a warmer climate than is present in the Flagstaff area. Further collecting must be done before any generalized statement on the distribution of the family can be made.

Key to the North American Genera of Walshiidae

1. Raised scales present on forewing 2
   No raised scales on forewing 7
2. Hind wing with 6 and 7 stalked or connate 4
   Hind wing with 6 and 7 separate 3
3. Uncus stout, heavily sclerotized (fig. 17) . . . . **Nepotula**, new genus
   Uncus slight, lightly sclerotized . . . . . **Walshia** Clemens (in part)
4. Valvae reduced, patches of modified scales on eighth sternum (figs. 25 and 25b) . . . . . **Chrysopeleia** Chambers
   Valvae not reduced, no modified scales on eighth sternum 5
5. Saccular margin of male genitalia heavily sclerotized. . **Stilbosis** Clemens
   Saccular margin of male genitalia not heavily sclerotized 6
6. Uncus reduced, appearing as a small lobe, juxta(?) present, aedeagus reduced (fig. 20) . . . . . **Sorhagenia** Spuler
   Uncus normal, long; juxta absent; aedeagus moderate to large (fig. 30). **Aeaea** Chambers
7. Glandular structures associated with male genitalia . . **Perimede** Chambers
   No glandular structures associated with male genitalia 8
8. Uncus present 10
   Uncus absent 9
9. Valvae reduced, eighth segment of abdomen with lateral valva-like extensions (fig. 18) . . . . . **Obithome**, new genus
   Valvae not reduced, no valva-like processes on eighth abdominal segment. **Periploca** Braun
10. Hind wing with 6 and 7 stalked 11
    Hind wing with 6 and 7 separate . . . . . **Walshia** Clemens (in part)
11. Uncus heavily sclerotized, somewhat off center (fig. 19). **Neoploca**, new genus
    Uncus moderately sclerotized, arising from center of margin of tegumen . 12

12. Aedeagus slender, length more than six times width; valvae, often with basal processes . . . . **Ithome** Chambers
Aedeagus stout, length not more than four times width; valvae without basal processes (fig. 24) . . . . **Synploca,** new genus

Neoploca, new genus

Figures 7, 11, 59

Type-species: *Neoploca corusca* Hodges, new species.

Head: smooth-scaled; labial palpus recurved, reaching beyond vertex, third segment shorter than second, apex acute; maxillary palpus folded over base of tongue; eye emarginate on anterodorsal angle; ocellus visible; antenna simple, ciliate, two-thirds length of forewing, pecten absent. Forewing: lanceolate; 12 veins present; 1b furcate basally; 2 developed toward margin of wing; 3, 4, and 5 separate, 3 from angle of cell; 6, 7, and 8 stalked, 7 out of 6 at nearly five-sixths; cell open. Hind wing: lanceolate; cell open; 8 veins present; 1b simple; 2, 3, 4, and 5 almost equidistant; 6 and 7 stalked, diverging at three-fourths, each ending at seven-eighths. Metathoracic tibia with long scales on dorsal surface. Male genitalia: vinculum narrow; tegumen relatively broad; valvae symmetrical, no free parts, setae abundant toward apex and on costal margin; uncus heavily sclerotized, somewhat asymmetrical; aedeagus loosely helical, no cornuti present. Female genitalia: ostium bursae slightly beyond middle of seventh sternum, trapezoidal sclerotized area preceding ostium bursae; ductus bursae and corpus bursae lightly sclerotized, ductus bursae coiled before inception of bursa copulatrix; two spine-shaped signa present.

Neoploca is closest to *Periploca*, but differs from it in having a well-developed uncus and a relatively broad tegumen.

Neoploca corusca, new species

Figures 19, 37, 59

Head: pale, shining gold; thorax and forewing shining bronze-black; cilia shining fuscous; hind wing somewhat shining fuscous, cilia fuscous. Metathoracic leg shining gold or lead colored, apex of femur and tibia shining white; base and apex of first tarsal segment shining white, apex of second segment shining white on external surface, remaining segments unicolorous, ventral surface of first four tarsal segments shining white. Abdomen: apices of segments white with purple reflections, some shining ochreous-brown on segments. Male genitalia: as in figure 19 (RWH slide 2122). Female genitalia: as in figure 37 (RWH slide 532). Alar expanse: 9–12 mm.

Holotype: ♂, Madera Canyon, 4880 feet, Santa Rita Mts., Ariz., July 14, 1959, R. W. Hodges (RWH slide 2123), Cornell Univ. type 3889.

Paratypes: same locality as type, 1 ♀, Aug. 23, 1959 (RWH slide 532), USNM; Peña Blanca Canyon, 4000 feet, Santa Cruz Co., Ariz., 3 ♂, 2 ♀, Aug. 8–11, 1959, R. W. Hodges (RWH slides 531, 2122; RWH wing slide 11), CU, USNM.

Superficially, *N. corusca* is somewhat similar to *Periploca ceanothiella* and *P. gleditschiaeella*, but it differs in having the scales of the forewings unicolorous and in having a well-developed uncus.

Synploca, new genus

Figures 8, 14, 60

Type-species: *Synploca gumia*, new species.

Head: smooth-scaled; labial palpus recurved, almost reaching vertex, second and third segments subequal in length, apex of third segment acute; tongue scaled basally; maxillary palpus folded over base of tongue; antenna three-fifths length of forewing, pecten absent; ocellus visible; anterodorsal margin of eye emarginate. Forewing: lanceolate; 12 veins present; cell closed or nearly closed; 1b furcate basally; 2 from six-sevenths of cell; 3 and 4 distant basally; 4 and 5 approximate basally; 6, 7, and 8 stalked; 9 from end of cell. Hind wing: 8 veins present; 1 simple; 2, 3, and 4 equidistant basally; 6 and 7 stalked, 6 out of 7 slightly beyond two-thirds length of wing. Metathoracic tibia with long scales dorsally. Male genitalia: valva relatively broad, apex rounded, costal and saccular areas not free; aedeagus stout, tapering rapidly to apex; uncus short, bifid. Female genitalia: ostium bursae near base of seventh sternum; sclerotized pregenital plate attaining edge of seventh sternum; ductus bursae and bursa copulatrix lightly sclerotized; two semicircular signa present, each signum with interiorly projecting extension from broadest point.

Synploca gumia, new species

Figures 24, 38, 60

Labial palpus bronze-black, pale basally; white dot at apex of second segment ventrally and 11 or 12 white dots forming row on ventral and anterior surface of third segment; apex white. Base of tongue and face shining pale silver-gold with purple reflections; antenna bronze-black, apical nine or ten segments ochreous; vertex of head, thorax, and forewing bronze-black; cilia of forewing and hind wing pale ochreous; abdomen shining pale ocher. Legs pale bronze-black on outer surface, apices of tarsal segments white. Male genitalia: as in figure 24 (RWH slide 564). Female genitalia: as in figure 38 (RWH slide 571). Alar expanse: 6–9 mm.

Holotype: ♂, Madera Canyon, 4400 feet, Santa Rita Mts., Ariz., Oct. 10, 1959, R. W. Hodges (RWH slide 564), Cornell Univ. type 3888.

Paratypes: same locality as type, 2 ♂, Oct. 26, 1959 (RWH slide 2120), CU, USNM; same locality as type except for elevation, 4880 feet, 21 ♂, 22 ♀, June 30–Nov. 1, 1959 (RWH slides 570, 571, 2121), CU, USNM, BMNH, CNC; same locality as type except for elevation, 5600 feet, 1 ♂, 2 ♀, Sept. 22–Oct. 15, 1959, CU, USNM.

Nepotula, new genus

Figures 2, 16, 61

Type-species: *Nepotula secura* Hodges, new species.

Head: smooth-scaled; labial palpus almost attaining vertex, third segment shorter than second, apex acute; tongue moderate; maxillary palpus folded over base of tongue; antenna two-thirds length of forewing, simple, ciliate, pecten absent (one specimen examined, possibly deciduous). Forewing: broadly lanceolate, apex acute; 12 veins present; 1b furcate basally; 2 extremely faint basally; 4, 5, and 6 equidistant basally; 7 and 8 stalked. Hind wing: lanceolate, apex acute; 8 veins present; 6 and 7 separate. Male genitalia: valva sublinear, costal area a broad fold; vinculum narrow; tegumen relatively broad; uncus present, short, heavily sclerotized; a lightly sclerotized area on under surface of tuba analis. Female genitalia: not known.

Nepotula is closest to *Walshia* but differs from the latter in having a heavily sclerotized uncus and a relatively broad tegumen.

Nepotula secura, new species

Figures 17, 61

Labial palpus, tongue, maxillary palpus, head, and thorax covered with scales which are buff basally and apically, brown-black medially; apices of second and third segments of labial palpus buff-white; undersurface of scape of antenna buff, upper surface and shaft brown-black. Forewing: brown-black along costal margin, becoming pale apically; fascia of brown-black scales at one-fourth from costa to fold, continued beyond fold as series of raised scales; basal one-half of wing uneven tawny-buff becoming paler apically and gradually merging with pale brown-black of apex; three patches of brown-black raised scales at one-half, two costad of fold, and one from fold to dorsal margin; series of patches of brown-black raised scales along costal and dorsal margins of wing starting between two-thirds and three-fourths; brown-black spot in middle of wing above end of fold; cilia pale fuscous-buff basally, fuscous apically. Hind wing: fuscous. Metathoracic leg: femur buff on dorsal third, brown-black on basal two-thirds; tibia and tarsus brown-black; white at middle and apex of tibia and apices of first two tarsal segments; apices of last three tarsal segments dark buff. Male genitalia: as in figure 17 (RWH slide 2003); apex of valva with curved dorsal extension; connection of aedeagus with tegumen short. Female genitalia: not known. Alar expanse: 16 mm.

Holotype: ♂, Pensacola, Fla., Oct. 28, 1961, Shirley Hills (RWH slide 2003, RWH wing slide 44), USNM type 66354.

Aeaea Chambers

Figures 6, 12, 62

Aeaea Chambers, 1874, Canadian Ent., vol. 6, p. 73; 1878, Bull. U.S. Geol. Geogr. Surv. Terr., vol. 4, p. 128; 1880, Journ. Cincinnati Soc. Nat. Hist., vol. 2, pp. 186, 199, 204.—Riley, *in* Smith, 1891, List of the Lepidoptera of boreal America, p. 108 (as synonym of *Chrysopeleia*).—Dyar, 1902 [1903], U.S. Nat. Mus. Bull. 52, p. 540 (as synonym of *Chrysopeleia*).—Forbes, 1923, Cornell Univ. Agric. Exp. Sta. Mem., no. 68, p. 329 (as synonym of *Chrysopeleia*).—Fletcher, 1929, Mem. Dep. Agric. India, Ent. Ser., vol. 11, p. 6 (as synonym of *Chrysopeleia*).

Amaurogramma Braun, 1919, Ent. News, vol. 30, p. 261 (type-species: *Amaurogramma extensa* Braun, 1919, original designation).—Fletcher, 1929, Mem. Dep. Agric. India, Ent. Ser., vol. 11, p. 11.—McDunnough, 1939, Mem. Southern California Acad. Sci., vol. 2, pt. 1, p. 63. New synonymy.

Type-species: *Aeaea ostryaeella* Chambers, 1874, monobasic.

Head: smooth-scaled; labial palpus recurved, smooth-scaled, third segment shorter than second; tongue moderate, scaled for short distance basally; maxillary palpus folded over base of tongue; ocelli present; eye emarginate dorsoanteriorly; antenna three-fifths length of forewing, simple, pecten present, length of scape slightly more than twice width. Forewing: lanceolate, apex rounded or acute; patches of raised scales present; cell open or closed; 11 or 12 veins present; 1b furcate basally, dorsal branch weak, 1c absent; 2 usually absent, sometimes present at margin; 3, 4, and 5 separate, except in *A. extensa;* 7 and 8 out of 6; 11 from beyond middle of cell. Hind wing: linear, apex acute; 5 to 8 veins present; 1 simple or absent; 3, 4, and 5 absent in *rhynchosiae;* 6 out of 7 at three-fourths to four-fifths; 7 to costa, apex in *rhynchosiae.* Metathoracic tibia with long scales dorsally. Male genitalia: symmetrical to asymmetrical; valva usually with separate costal and saccular areas; aedeagus smooth or with linear grooves; tegumen narrow; uncus simple or bifurcate. Female genitalia: usually two signa present; bursa copulatrix and ductus bursae often with minute spines; seventh sternum often modified around ostium bursae, sometimes with patches of broad scales.

The various types of male genitalia at first seem to be unrelated; however, by starting with *Aeaea ostryaeella* as a model, it is possible to derive the others by reduction or by twisting of parts. Venational differences are very slight or nonexistent, and they are not correlated with the genitalic types. Also, the habitus of each is very similar to that of the others. *Aeaea extensa*, the type-species of *Amaurogramma*, has asymmetrical and twisted male genitalia. When I knew only *A. ostryaeella* and *A. extensa*, the two were sufficiently distinct to be considered as separate genera, but the evidence presented by the other species indicates that they are congeneric.

I have not been able to associate the sexes in several instances, with the result that names are applied to the males and letters to the unassociated females. There are 12 males and 13 females, but no female of the eastern species *A. venifica* is known; thus, two of the females from the Southwest represent undescribed species. Until the sexes are correlated, it seems reasonable to withhold naming species on the basis of the female sex. The species for which the sexes have been correlated are *A. victor*, new species, *A. ostryaeella, A. rhynchosiae*, new species, *A. dulcedo*, new species, *A. extensa, A. quadricustatella*, and A. *stipator*, new species. Of these, the first three were associated on the basis of specimens reared from the same food plant at the same time; the others were associated on the basis of locality. It is possible that some of the latter are not correct.

Venation does not seem to offer a criterion for separating all the species. *A. extensa* has 3 and 4 of the forewing stalked, a condition which does not occur elsewhere. In one instance a male and a female have the same venation; however, the maculation of the two sexes is quite distinct. It is possible that some of the species are sexually dimorphic.

An attempt to write a key based on maculation was made, but it was not satisfactory because variation of the maculation within a species, as defined by genitalic characters, is greater than the supposed differences used in the key.

Key to North American Species of *Aeaea*

MALES

1. Uncus simple 2
   Uncus bifurcate 10
2. Valva simple . . . . **A. dulcedo,** new species
   Valva bifurcate at apex or divided into lobes 3

3. Apex of valva bifurcate . . . . **A. venifica,** new species
   Valva divided into lobes 4
4. Costa separate from valva, directed dorsally; remainder of valva entire. **A. juvantis,** new species
   Costa, if separate from valva, directed posteriorly; sacculus separate, at least apically 5
5. Valvae symmetrical. 6
   Valvae asymmetrical . . . . **A. extensa** (Braun)
6. Costa separate from valva (at least apex) 7
   Costa united with valva . . . . **A. venatrix,** new species
7. Uncus tapering to apex 8
   Uncus expanded at apex . . . . **A. stipator,** new species
8. Saccus with acute apex 9
   Saccus with rounded apex . . . . **A. risor,** new species
9. Lobe extending from posterior part of costa; apex of valva acute (fig. 26). **A. ostryaeella** Chambers
   No lobe extending from costa; apex of valva rounded (fig. 57). **A. quadricustatella** Chambers
10. Each ramus of uncus bifid . . . . **A. sagana,** new species
    Rami of uncus simple 11
11. Valvae symmetrical . . . . **A. victor,** new species
    Valvae asymmetrical . . . . **A. rhynchosiae,** new species

FEMALES

1. Ostium bursae preceded by narrow semicircular sclerotized band (fig. 54) . . . . species "f"
   Ostium bursae not preceded by such a band 2
2. Ostium bursae near anterior margin of seventh sternum, seventh sternum heavily sclerotized from ostium bursae to anterior margin (figs. 52 and 55) 3
   Ostium bursae medial on seventh sternum, seventh sternum not heavily sclerotized from ostium bursae to anterior margin 4
3. Sclerotized band preceding ostium bursae with strong longitudinal line, placed to left of center (fig. 52) . . . . species "b"
   Sclerotized band lacking longitudinal line (fig. 55) . . . . . . species "e"
4. Ostium bursae preceded and succeeded by broad sclerotized plates (fig. 51) 5
   Ostium bursae not surrounded by broad plates 7
5. Series of lateral striae from level of ostium bursae to anterior margin of seventh sternum (fig. 47) . . . . **A. rhynchosiae,** new species
   Without series of lateral striae 6
6. Lightly sclerotized flap extending beyond posterior margin of seventh sternum (fig. 51) . . . . species "a"
   Lacking such a flap (fig. 49). . . . . **A. extensa** (Braun)
7. Ostium bursae at apex of conical projection on seventh sternum. species "d"
   No medial projection on seventh sternum 8
8. Posterior margin of seventh sternum emarginate medially (figs. 48 and 50) 9
   Posterior margin of seventh sternum not emarginate 10

9. Submedial sclerotized flap running from anterior to posterior margin of seventh sternum, narrower posteriorly (fig. 50) . . **A. victor,** new species
Without such a longitudinal structure; heavily sclerotized striate area from anterior margin of seventh sternum to middle (fig. 48). **A. dulcedo,** new species
10. Narrow, sclerotized, Y-shaped band extending anteriorly from seventh sternum (fig. 56) . . . . species "c"
Lacking such a band 11
11. Two submedial conical extensions of seventh sternum, extending from anterior margin almost to posterior margin (fig. 45). **A. ostryaeella** Chambers
Lacking such extensions (fig. 46) 12
12. Seventh sternum with broad scales laterally; heavily sclerotized submedial area running posteriorly from anterior margin of seventh sternum to two-thirds, then angling and going to lateral margins (fig. 46). **A. stipator,** new species
Seventh sternum without broad scales laterally; narrow, submedial sclerotized band running from ostium bursae to anterior margin of seventh sternum (fig. 58) . . . . **A. quadricustatella** Chambers

Aeaea juvantis, new species

FIGURE 32

Head, thorax, legs, and forewings covered with dark gray scales, usually with apices pale gray, purplish reflections at some angles of light incidence. Forewing: patch of raised scales dorsad of fold at one-fourth, one on dorsal margin and one costad of fold slightly beyond middle, one costad of fold immediately before end of fold, and four or five small patches along margins before apex; costal and apical cilia with pale-gray tipped scales, dorsal cilia unicolorous. Hind wing: unicolorous, pale gray with cinereous cast. Metathoracic tibia buff at middle and apex, apices of tarsal segments buff. Male genitalia: as in figure 32 (RWH slide 1170); costa free from valva and directed dorsally, sacculus joined with valva. Female genitalia: female not associated with male. Alar expanse: 6–6.5 mm.

Holotype: ♂, Madera Canyon, 4880 feet, Santa Rita Mts., Ariz., July 1, 1959, R. W. Hodges (RWH slide 1992), Cornell Univ. type 3883.

Paratypes: same locality as type, 5 ♂, July 1–9, 1959 (RWH slides 1170, 1993, 2019, 2021; RWH wing slide 19), CU, USNM.

Aeaea juvantis may be separated from *A. stellans*, *A. sagana*, *A. rhynchosiae*, and *A. extensa* by the symmetrical male genitalia; and from *A. dulcedo*, *A. venifica*, *A. venatrix*, *A. ostryaeella*, *A. stipator*, *A. risor*, and *A. victor* by the free costa which is directed dorsally and is slightly swollen apically.

Aeaea dulcedo, new species

FIGURES 29, 48

Maculation: as in *A. juvantis.* Male genitalia: as in figure 29 (RWH slide 1042); valvae symmetrical, costal and saccular regions not separate; uncus simple. Female genitalia: as in figure 48 (RWH slide 1043); posterior margin of seventh sternum emarginate medially, ostium bursae at base of emargination. Alar expanse: 5 mm.

Holotype: ♂, Westwood Hills, Los Angeles Co., Calif., April 1941, R. M. Bohart (RWH slide 1042; RWH wing slide 26), collection of Annette F. Braun.

Paratype: same data as type, 1 ♀ (RWH slide 1043), collection of Annette F. Braun.

The male genitalia of *A. dulcedo* may be distinguished from those of the other known species of *Aeaea* by the presence of symmetrical and simple valvae.

Aeaea venifica, new species

FIGURE 31

Maculation: as in *A. juvantis.* Male genitalia: as in figure 31 (RWH slide 10038); symmetrical, saccular area free from valva apically. Female genitalia: female not associated with male. Alar expanse: 6–7 mm.

Holotype: ♂, Putnam Co., Ill., June 26, 1957, M. O. Glenn (RWH slide 10028), USNM type 66325.

Paratypes: ILLINOIS: ♂, same locality as type, June 23, 1957 (RWH slide 10029), MOG; MARYLAND: Hyattsville, 1 ♂, 1907, Aug. Busck (RWH slide 10006; RWH wing slide 23), USNM; MASSACHUSETTS: Barnstable, 2 ♂, July 12, 26, 1958, C. P. Kimball (RWH slides 2043, 2044), CPK; NEW YORK: Ithaca, 1 ♂, June 16, 1930, A. B. Klots (RWH slide 10038), ABK; ONTARIO: Toronto, 1 ♂, June 1, 1930, H. S. Parish (RWH slide 46), CU.

The male of *A. venifica* may be separated from that of *A. dulcedo* by the free apical portion of the sacculus.

It is curious that no females of this species are known; however, as more material is collected, this sex should be taken.

Aeaea venatrix, new species

FIGURE 28

Maculation: as in *A. juvantis.* Male genitalia: as in figure 28 (RWH slide 1961), valva deeply emarginate with saccular area free apically, costal area not free, vinculum produced anteriorly and emarginate medially, uncus simple. Female genitalia: female not associated with male. Alar expanse: 5–7 mm.

Holotype: ♂, Madera Canyon, 4880 feet, Santa Rita Mts., Ariz., July 17, 1959, R. W. Hodges (RWH slide 2022), Cornell Univ. type 3884.

Paratypes: same locality as type, 7 ♂, July 2–30, 1959 (RWH slides 1169, 1961, 1962, 1966, 1971, 1976, 1994; RWH wing slide 18), CU, USNM.

The males of *A. venatrix* may be separated from those of *A. ostryaeella* by the attached costal area of the valva.

Aeaea ostryaeella Chambers

FIGURES 26, 45

Aeaea ostryaeella Chambers, 1874, Canadian Ent., vol. 6, p. 74; 1878, Bull. U.S. Geol. Geogr. Surv. Terr., vol. 4, pp. 121, 128; 1880, Journ. Cincinnati Soc. Nat. Hist., vol. 2, p. 199.—Hagen, 1884, Papilio, vol. 4, p. 154.—Fletcher, 1929, Mem. Dep. Agric. India, Ent. Ser., vol. 11, p. 6.

Chrysopeleia ostryaeella, Riley, *in* Smith, 1891, List of the Lepidoptera of boreal America, p. 108.—Dyar, 1902 [1903], U.S. Nat. Mus. Bull. 52, p. 540.—Kearfott, *in* Smith, 1903, Check list of the Lepidoptera of boreal America, p. 118.—Barnes and McDunnough, 1917, Check list of the Lepidoptera of boreal America, p. 152.—Heinrich, 1920, Proc. U.S. Nat. Mus., vol. 57, p. 71.—Forbes, 1923, Cornell Univ. Agric. Exp. Sta. Mem., no. 68, p. 329.—McDunnough, 1939, Mem. Southern California Acad. Sci., vol. 2, pt. 1, p. 63.

Chambers' illustration of the venation of this species is quite misleading; however, when one considers the size of the moth and the degree of magnification available to him, it is easy to understand how an incorrect interpretation could have been made. A more accurate interpretation is given in figure 12.

Male genitalia: as in figure 26 (RWH slide 10027), valvae symmetrical, costa free, anterior margin of vinculum emarginate medially, uncus emarginate. Female genitalia: as in figure 45 (RWH slide 1162); seventh sternum with two heavily sclerotized areas starting anteromedially, running posteromedially, free from sternum apically; ostium bursae at center of seventh sternum. Alar expanse: 5–7 mm.

Food plant: *Ostrya virginiana* (Mill.) K. Koch. According to Chambers (1874), the larva mines the leaf between two veins, leaving a row of frass on each side of the mine.

Holotype: ♂, in Museum of Comparative Zoology.

Type locality: Kentucky.

Specimens examined: CONNECTICUT: Lyme, 2 ♂, reared from *Ostrya virginiana*, emerged June 9, 15, 1916, A. Busck (Carl Heinrich genitalia slide, June 27, 1917), USNM; ILLINOIS: Putnam County, 2 ♂, June 28, 1957, July 17, 1959, M. O. Glenn (RWH slides 2039 and 10027), MOG; KENTUCKY: no further locality given, 1 ♂, Chambers, MCZ; MASSACHUSETTS: Barnstable, 2 ♂, July 25, 1958, C. P. Kimball (RWH slides 2041, 2042), CPK; OHIO: Cincinnati, 4 ♂, 5 ♀, Braun, rearing 164, emerged May 23–June 5, 1912, Annette F. Braun (RWH slides 1161, 1162; RWH wing slides 25, 36, 37; A.B. slides Oct. 10, 1930), USNM.

Aeaea quadricustatella Chambers

FIGURES 57, 58

Aeaca quadricustatella Chambers, 1880, Journ. Cincinnati Soc. Nat. Hist., vol. 2, p. 186.

Aeaea quadricristatella, Hagen, 1884, Papilio, vol. 4, p. 154.

Chrysopeleia quadricristatella, Riley, *in* Smith, 1891, List of the Lepidoptera of boreal America, p. 108.—Dyar, 1902 [1903], U.S. Nat. Mus. Bull. 52, p. 540.—Kearfott, *in* Smith, 1903, Check list of the Lepidoptera of boreal America, p. 118.—Barnes and McDunnough, 1917, Check list of the Lepidoptera of boreal America, p. 152.

Amaurogramma quadricristatella, Braun, 1919, Ent. News, vol. 30, p. 262.—McDunnough, 1939, Mem. Southern California Acad. Sci., vol. 2, pt. 1, p. 63.

Maculation: as in *A. juvantis*. Male genitalia: as in figure 57 (RWH slide 872); valvae symmetrical, apex of valva a curved narrow lobe; costa free apically, lobate; apex of uncus acute. Female genitalia: as in figure 58 (RWH slide 659); ostium bursae encircled by sclerotized band, broader posteriorly; narrow sclerotized band on each side of ostium bursae running from anterior margin of seventh sternum to three-fifths.

Holotype: Museum of Comparative Zoology.

Type locality: Texas [Waco].

Specimens examined: FLORIDA: Siesta Key, Sarasota Co., 1 ♂, 1 ♀, June 1, 2, 1957, C. P. Kimball (RWH slides 649, 10041), CPK, USNM; TEXAS: Waco, 1 ♂, Belfrage (RWH slide 872), MCZ.

Aeaea stipator, new species

FIGURES 30, 46

Maculation: as in *A. juvantis*. Male genitalia: as in figure 30 (RWH slide 1972); costal and possibly saccular areas free apically, apex of costa directed medioventrally; apical margin of uncus rounded. Female genitalia: as in figure 46 (RWH slide 2032); lateral patch of broadened scales on each side of ostium bursae, patches extending from anterior margin to three-fourths; ostium bursae at three-fourths. Alar expanse: 7–7.5 mm.

Holotype: ♂, Vail Lake Road, 6500 feet, 9½ miles SE Flagstaff, Coconino Co., Ariz., July 11, 1961, Ronald W. Hodges (RWH slide 2028), USNM type 66326.

Paratypes: ARIZONA: same locality as type, 1 ♂, 2 ♀, July 11, 18, 1961 (RWH slides 2027, 2029, 2030; RWH wing slide 27), CU, USNM;

West Fork, 6500 feet, 16 miles SW Flagstaff, Coconino Co., 1♀, July 15, 1961, Ronald W. Hodges (RWH slide 2032), USNM; 4 miles ESE Pine, Gila Co., 5400 feet, 1 ♀, Sept. 1, 1961, Ronald W. Hodges (RWH slide 2031, RWH wing slide 35), USNM; Madera Canyon, 4880 feet, Santa Rita Mts., 1 ♂, July 9, 1959, R. W. Hodges (RWH slide 1972), CU.

The male of *A. stipator* may be separated from that of *A. ostryaeella* by the rounded apex of the uncus and by the lateral projections of the saccus having rounded apices. The female of *A. stipator* may be separated from that of *A. dulcedo* by having the posterior margin of the seventh sternum rounded, not emarginate; and from species "c" by having the ostium bursae at three-fourths, not one-third.

A female was associated with the male on the basis of six specimens taken in north-central Arizona during the season of 1961. These represent the only species of *Aeaea* taken during the summer, and it is hypothesized that both sexes are the same species.

Apparently, this species is restricted to the lower montaine elevations of Arizona because collecting at elevations of 7200 to 8500 feet failed to turn up any specimens. It is anticipated that future collecting will yield more information concerning the altitudinal and areal distribution of this and the other species of *Aeaea*.

Aeaea risor, new species

Figure 33

Maculation: largely same as in *A. juvantis;* perpendicular, white fascia formed of white-tipped scales at one-third, and oblique white fascia at two-thirds; bright patch of white-tipped scales dorsad of fold beyond base. Male genitalia: as in figure 33 (RWH slide 1166); saccular and costal areas free distally; aedeagus very broad, apex relatively blunt; uncus apparently absent; setae on base of costal area short. Female genitalia: none associated with this species. Alar expanse: 6.5 mm.

Holotype: ♂, Madera Canyon, 4880 feet, Santa Rita Mts., Ariz., Sept. 24, 1959, R. W. Hodges (RWH slide 1166, RWH wing slide 28), Cornell Univ. type 3885.

The male of *A. risor* may be separated from the other species of *Aeaea* by the absence of the uncus, the broad aedeagus, and the distinctly bipartite vinculum.

Aeaea victor, new species

Figures 27, 27a, 27b, 50

Maculation: as in *A. juvantis.* Male genitalia: as in figures 27, 27a, 27b (J. F. G. Clarke slide 10226); saccular and costal areas free apically, uncus broadly bifid apically. Female genitalia: as in figure

50 (JFGC slide 10227); sclerotized area of seventh sternum divided medially, more heavily sclerotized medial border; ostium bursae between one-half and two-thirds. Alar expanse: 6.5–7 mm.

Food plant: *Quercus stellata* Wang. According to notes made by Heinrich and De Gryse, the larvae make a mine, starting near some rib in the leaf, usually the midrib. The mines are covered with frass on the outside.

Holotype: ♂, Cherrydale, Va., Sept. 22, 1922; "Comp. 13935," Hopkins, U.S. 13942g; from oak, A. Busck, C. P. Heinrich (JFGC slide 10226), USNM type 66327.

The male of *A. victor* may be separated from that of *A. risor* by the bifid apex of the uncus; from that of *A. sagana* by the symmetrical valvae. The female differs from that of *A. ostryaeella* by having the seventh sternum divided medially and by having the inner margins concave; in *A. ostryaeella* the inner margins of the processes are convex.

Aeaea sagana, new species

Figure 34

Maculation: as in *A. juvantis*. Male genitalia: as in figure 34 (RWH slide 1991); valvae asymmetrical, apex of valva in loose coil; aedeagus curved; uncus bifid, apex of each ramus bifid. Female genitalia: none associated with this species. Alar expanse: 5.5–10 mm.

Holotype: ♂, Madera Canyon, 4880 feet, Santa Rita Mts., Ariz., Sept. 24, 1959, R. W. Hodges (RWH slide 1171), Cornell Univ. type 3887.

Paratypes: same locality as type, 6 ♂, July 22–Oct. 18, 1959 (RWH slides 536, 585, 700, 1977, 1991, 2011; RWH wing slide 21), CU, USNM; same locality as type except for elevation, 5600 feet, 5 ♂, Sept. 21–Oct. 8, 1959 (RWH slides 700, 1967, 1981, 1982, 1987), CU, USNM.

The male of *A. sagana* may be separated from that of *A. rhynchosiae* by the apex of each ramus of the uncus being bifid.

Aeaea rhynchosiae, new species

Figures 35, 35a, 35b, 47

Maculation: as in *A. juvantis*. Male genitalia: as in figures 35, 35a, and 35b (RWH slide 1038); valvae asymmetrical; costal and saccular areas free for much of length, narrow; aedeagus grooved, curved; uncus bifurcate apically. Female genitalia: as in figure 47 (RWH slide 1040); ductus bursae broad for most of length, becoming narrow before bursa copulatrix; ostium bursae at two-thirds on seventh sternum; two sclerotized plates apparently dividing ostium bursae. Alar expanse: 6–6.5 mm.

685-617—63——2

Food plant: *Rhynchosia tomentosa* (L.) H. and A. Dr. Braun (in litt.) gives the following notes on the mine and early stages: "Mine starts at midrib and extends outward toward margin; lateral vein usually forming boundary of lower side; upper side margin more irregular. Frass ejected at beginning of mine at midrib, collecting in a mass. Parenchyma all consumed. Larva apparently makes several mines as a large larva may be found in a very small mine. Parenchyma consumed over the whole mine. Many deserted mines, perhaps earlier mines large as well as small, often several on one leaf. Larva pale yellow, abdominal and thoracic legs present. Cocoon yellowish or whitish, tapering to a fine point at one end, blunt at the other end, convex and fuzzy."

Holotype: ♂, Chickasaw Forest, near Henderson, Chester Co., Tenn., Braun 1649, emerged July 30, 1938, A. F. Braun (RWH slide 1039), collection of Annette F. Braun.

Paratypes: same locality as holotype, 6 ♂, 9 ♀, emerged July 28–Aug. 2, 1938 (RWH slides 1038, 1040, 1041; RWH wing slide 24), AFB, USNM.

The male of *A. rhynchosiae* may be separated from that of *A. extensa* by the bifid apex of the uncus. The female may be separated from that of species "a" by the submedial striae on the seventh sternum.

***Aeaea extensa* (Braun), new combination**

Figures 36, 49

Amaurogramma extensa Braun, 1919, Ent. News, vol. 30, p. 262.—Fletcher, 1929, Mem. Dep. Agric. India, Ent. Ser., vol. 11, p. 6.—McDunnough, 1939, Mem. Southern California Acad. Sci., vol. 2, pt. 1, p. 63.

Maculation: as in *A. juvantis*. Male genitalia: as in figure 36 (RWH slide 1036); valvae asymmetrical; vinculum like two plates, saccal area of each plate projecting anteriorly and apex of each with short setae; uncus simple. Female genitalia: as in figure 49 (RWH slide 1037); ostium bursae on projecting plate, two sclerotized plates lying above and posteriorly of ostium bursae; heavily sclerotized line running anterolaterally from plates behind ostium bursae to costal margin of seventh sternum.

Holotype: in collection of Annette F. Braun.

Type locality: Loma Linda, California.

Specimens examined: CALIFORNIA: Antioch, Contra Costa Co., 1 ♂, 2 ♀, May 14, 1958; J. Powell (RWH slides 1150, 1151, 1152; RWH wing slide 22), UCB, USNM; Loma Linda, 1 ♂, 1 ♀, June 3, July 22 (RWH slides 1036, 1037), AFB; San Diego, 1 ♀, July 26, 1923 (RWH slide 10007), LACM.

Unnamed Species of *Aeaea*

The remaining females are those which have not been associated with males. As I have stated previously, at least two of them represent new species, but until reared material with associated adults is available, the best course is to illustrate the genitalia and to give alphabetic denotations to the specimens. Each has approximately the same habitus as *A. juvantis* except for "d," which is similar to *A. risor*. The specimens will be retained temporarily in the USNM.

Aeaea species a

Figure 51

Female genitalia: as in figure 51 (RWH slide 1164); ostium bursae at middle of seventh sternum; heavily sclerotized plate anterior to ostium bursae, slightly emarginate posteriorly; two heavily sclerotized plates posterior to ostium bursae; third plate posterior to ostium bursae with convex apex. Alar expanse: 9 mm.

Specimen examined: Madera Canyon, 4880 feet, Santa Rita Mts., Ariz., 1 ♀, July 24, 1959, R. W. Hodges (RWH slide 1164, RWH wing slide 34).

Aeaea species b

Figure 52

Female genitalia: as in figure 52 (RWH slide 1172); ostium bursae at one-third on seventh sternum; heavily sclerotized plate anterior to and laterad of ostium bursae, well-defined line dividing medial and lateral sections of this plate. Alar expanse: 7–7.5 mm.

Specimens examined: Madera Canyon, 4880 feet, Santa Rita Mts., Ariz., 3 ♀, Sept. 19–29, 1959, R. W. Hodges (RWH slides 1990, 2017, 2018; RWH wing slide 31); same locality except for elevation, 5600 feet, 1 ♀, Sept. 23, 1959 (RWH slide 1172).

Aeaea species c

Figures 56 and 62

Female genitalia: as in figure 56 (RWH slide 1965); ostium bursae at one-third; seventh sternum with broad scales arranged in semicircular patches beside ostium bursae; one signum visible. Alar expanse: 7–7.5 mm.

Specimens examined: Madera Canyon, 4880 feet, Santa Rita Mts., Ariz., 4 ♀, July 10–27, 1959, R. W. Hodges (RWH slides 1965, 1974, 2023; RWH wing slide 33).

Aeaea species d

FIGURE 53

Female genitalia: as in figure 53 (RWH slide 1167); ostium bursae approximately at two-thirds, heavily sclerotized collar immediately preceding ostium bursae around ductus bursae, ductus bursae heavily sclerotized until just before bursa copulatrix. Alar expanse: 6.5 mm.

Specimen examined: Madera Canyon, 4880 feet, Santa Rita Mts., Ariz., 1 ♀, Aug. 3, 1959, R. W. Hodges (RWH slide 1167, RWH wing slide 30).

Aeaea species e

FIGURE 55

Female genitalia: as in figure 55 (RWH slide 1963); ostium bursae at one-third; a heavily sclerotized plate extending from anterior margin of seventh sternum to ostium bursae; basal half of ductus bursae moderately heavily sclerotized. Alar expanse: 7–8.5 mm.

Specimens examined: Madera Canyon, 4880 feet, Santa Rita Mts., Ariz., 5 ♀, Aug. 23–Oct. 24, 1959, R. W. Hodges (RWH slides 1165, 1963, 1988, 1995, 2010; RWH wing slide 32); same locality except for elevation, 5600 feet, 4 ♀, Sept. 24–Oct. 15, 1959 (RWH slides 701, 1975, 1980, 1985).

Aeaea species f

FIGURE 54

Female genitalia: as in figure 54 (RWH slide 1968); ostium bursae at two-thirds; semicircular sclerotized area surrounding ostium bursae laterally and anteriorly, broader medially, narrow posteriorly; narrow, sinuous, submedial, sclerotized patch extending from anterior to posterior margin of seventh sternum. Alar expanse: 6.5–7.5 mm.

Specimens examined: Madera Canyon, 4880 feet, Santa Rita, Mts., Ariz., 23 ♀, July 2–Aug. 22, 1959, R. W. Hodges (RWH slides 1173, 1174, 1964, 1968, 1970, 1973, 1978, 1979, 1983, 1989, 1996–2000, 2007–2009, 2012–2016; RWH wing slide 29); same locality except for elevation, 5600 feet (RWH slide 2006).

Stilbosis Clemens

FIGURES 3, 13, 63

Stilbosis Clemens, 1860, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, p. 170; *in* Stainton, 1872, The Tineina of North America, p. 129.—Chambers, 1874, Canadian Ent., vol. 6, p. 72; 1878, Bull. U.S. Geol. Geogr. Surv. Terr., vol. 4, p. 162.—Walsingham, 1882, Trans. Amer. Ent. Soc., Philadelphia, p. 197.—Riley, *in* Smith, 1891, List of the Lepidoptera of boreal America, p. 107.—Dyar, 1902 [1903], U.S. Nat. Mus. Bull. 52, p. 539.—Busck, 1903, Proc. Ent. Soc. Washington, vol. 5, p. 202.—Kearfoot, *in* Smith, 1903, Check list of the Lepidoptera of boreal America, p. 117.—Walsingham, 1909, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 42 (Lepidoptera-Heterocera, vol. 4), p. 7.—Barnes and McDunnough, 1917, Check list of the Lepidoptera of boreal America, p. 152.—Forbes, 1923, Cornell Univ. Agric. Exp. Sta. Mem., no. 68, p. 325.—Fletcher, 1929, Mem. Dep. Agric. India, Ent. Ser., vol. 11, p. 211.—Forbes, 1931, Journ. Dep. Agric. Porto Rico, vol. 4, p. 361.—McDunnough, 1939, Mem. Southern California Acad. Sci., vol. 2, pt. 1, p. 64.

Type-species: *Stilbosis tesquella* Clemens, 1860, monobasic.

Head: smooth-scaled; labial palpus recurved, third segment shorter than second; tongue scaled basally; maxillary palpus folded over base of tongue; eye notched at anterodorsal angle. All surfaces other than hind wings and cilia of forewings covered with metallic scales. Forewing with patches of raised scales; lanceolate; 12 veins present; 2 very weak basally; 6 very short out of 7 and 8; 11 from five-sevenths of cell. Hind wing: narrow lanceolate, 8 veins present. Male genitalia: symmetrical; saccular margin of valva free apically, heavily sclerotized, series of long, heavy setae at base of costa; uncus linear; aedeagus massive, apex acute. Female genitalia: ostium bursae large, surrounded by narrow sclerotized ring; ductus bursae and bursa copulatrix granulose; one or two signa present.

This genus probably has its center of distribution in Central or South America with only two species occurring north of Mexico. *S. tesquella* has been taken from New York to northern Arizona. *S. nubila* is known from the type locality in southern Arizona. Examination of the genitalia of the species of *Stilbosis*, which Walsingham (1909) recorded as *S. tesquella*, indicates that the specimens are neither *S. tesquella* nor *S. nubila*, new species.

Key to North American Species of *Stilbosis*

BASED ON VENATION

Vein 2 of forewing present only at margin . . . . **S. nubila,** new species
Vein 2 of forewing visible from cell . . . . **S. tesquella** Clemens

BASED ON MALE GENITALIA

Ventral margin of sacculus relatively straight (fig. 22) . . . **S. tesquella** Clemens
Ventral margin of sacculus sinuate (fig. 23) . . . . **S. nubila,** new species

BASED ON FEMALE GENITALIA

Ostium bursae round, with lateral sclerotized projections (fig. 41). **S. tesquella** Clemens
Ostium bursae somewhat triangular, without such lateral sclerotized extensions (fig. 40) . . . . **S. nubila,** new species

***Stilbosis tesquella* Clemens**

FIGURES 22, 22a, 41, 63

Stilbosis tesquella Clemens, 1860, Proc. Acad. Nat. Sci., Philadelphia, vol. 12, p. 170; *in* Stainton, 1872, The Tineina of North America, p. 129.—Walsingham, 1882, Trans. Amer. Ent. Soc., Philadelphia, p. 197.—Riley *in* Smith, 1891, List of the Lepidoptera of boreal America, p. 107.—Dyar, 1902 [1903], U.S. Nat. Mus. Bull. 52, p. 539.—Busck, 1903, Proc. Ent. Soc. Washington, vol. 5, p. 202.—Kearfott, *in* Smith, 1903, Check list of the Lepidoptera of boreal America, p. 117.—Walsingham, 1909, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 42 (Lepidoptera-Heterocera, vol. 4), p. 7.—Barnes and McDunnough, 1917, Check list of the Lepidoptera of boreal America, p. 152.—Forbes, 1923, Cornell Univ. Agric. Exp. Sta. Mem., no. 68, p. 325.—Fletcher, 1929, Mem. Dep. Agric. India, Ent. Ser., vol. 11, p. 211.—McDunnough, 1939, Mem. Southern California Acad. Sci., vol. 2, pt. 1, p. 64.

Stilbosis tesquatella, Chambers, 1878, Bull. U.S. Geol. Geogr. Surv. Terr., vol. 4, p. 162, misspelling.—Riley, *in* Smith, 1891, List of the Lepidoptera of boreal America, p. 107 (as synonym of *S. tesquella*).—Walsingham, 1909, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 42 (Lepidoptera-Heterocera, vol. 4), p. 8 (as synonym of *S. tesquella*).

Laverna(?) *quinquicristatella* Chambers, 1881, Journ. Cincinnati Soc. Nat. Hist., vol. 3, p. 293.

Laverna ? quinquecristatella, Walsingham, 1882, Trans. Amer. Ent. Soc., Philadelphia, p. 197 (correction of spelling; as synonym of *S. tesquella*).

Stilbosis quinque-cristatella, Riley, *in* Smith, 1891, List of the Lepidoptera of boreal America, p. 107 (as synonym of *S. tesquella*).

Stilbosis quinquecristatella, Dyar, 1902 [1903], U.S. Nat. Mus. Bull. 52, p. 539 (as synonym of *S. tesquella*).—Walsingham, 1909, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 42 (Lepidoptera-Heterocera, vol. 4), p. 8 (as synonym of *S. tesquella*).—Barnes and McDunnough, 1917, Check list of the Lepidoptera of boreal America, p. 152 (as synonym of *S. tesquella*).—Forbes, 1923, Cornell Univ. Agric. Exp. Sta. Mem., no. 68, p. 325 (as synonym of *S. tesquella*).—McDunnough, 1939, Mem. Southern California Acad. Sci., vol. 2, pt. 1, p. 64 (as synonym of *S. tesquella*).

The male and female genitalia of this common and relatively well-known species are figured for the first time: Figures 22 and 22a (AB slide 14.XI.1930) and figure 41 (RWH slide 577).

Lectotype: *S. tesquella,* present designation, ♀, bearing following labels: "1. 88; 2. Type, *Stilbosis tesquella* B. Clemens, 7482; 3. *Stilbosis tesquella* Clemens, Type!, AB 1902." Academy of Natural Sciences, Philadelphia. *quinquicristatella,* lost.

Type localities: *S. tesquella,* Pennsylvania(?); *S. quinquicristatella,* Amherst, Massachusetts.

Food plant: *Amphicarpa bracteata* (L.) Fern. and *Lespedeza* spp. in the East.

Specimens examined: ARIZONA: Fort Valley, 7350 feet, 7½ miles NW Flagstaff, Coconino Co., 1 ♂, July 19, 1961, Ronald W. Hodges, USNM; Hart Prairie, 8500 feet, 10 miles NNW Flagstaff, Coconino Co., 2 ♂, July 1, 21, 1961, Ronald W. Hodges, USNM; West Fork, 6500 feet, 16 miles SW Flagstaff, Coconino Co., 63 ♂, 9 ♀, July 4–19, 1961, Ronald W. Hodges (RWH slides 1655, 1656; RWH wing slide 42), CU, USNM; KANSAS: Onaga, 3 ♀ (RWH slide 10008), MCZ. MARYLAND: Plummers Island, 4 ♂, May–July, A. Busck, R. C. Sherman, USNM; District of Columbia: 3 ♀, ex hog peanut, emerged June 31, July 6, USNM; MINNESOTA: no further locality, 1 ♂, mining and webbing *Lespedeza* in August, emerged May 10, 1884, CU; NEW JERSEY: Caldwell, 5 ♀, July 8, 1900, W. D. Kearfott, USNM; Essex Co. Park, 9 ♀, June 28–July 28, W. D. Kearfott, CU, USNM; NEW YORK: Irving, 1 ♀, August 26, 1917, Wm. Wild, CU; Ithaca, 8 ♂, 1 ♀, June 6–July 26, Forbes, A. B. Klots, J. G. Franclemont, CU, ABK, JGF; Sea Cliff, 1 ♂, June, USNM; NORTH CAROLINA: Balsam, 8 ♀, July 16–22, 1911, A. F. Braun, CAS, USNM; Highlands Biological Station, Highlands, 3865 feet, 25 ♂, 3 ♀, July 11–August 8, 1958, R. W. Hodges, CU, USNM; OHIO: Cincinnati, 1 ♂, June 14, 1952, A. F. Braun, USNM; PENNSYLVANIA: New Brighton, 1 ♂, July 9, 1907, USNM; Oak Station, 1 ♀, Aug. 1, 1910, F. Marloff, USNM; Pittsburgh, 1 ♂, 3 ♀, July 19, 20, Henry Engel, USNM; TENNESSEE: Monteagle, 1 ♀, June 8, 1930, Richards, CU; UTAH: 2 ♀, CAS; VIRGINIA: Great Falls, 1 ♂, June 13, 1919, A. Busck, USNM.

***Stilbosis nubila*, new species**

FIGURES 23, 40

Maculation: head, thorax, and forewings shining lead colored with brassy reflections at some angles of light incidence. Outer surface of labial palpus dark fuscous, inner surface buff; apical eight segments of antenna white. Forewing: with four patches of raised scales, one at one-fourth costad of fold, one slightly beyond it dorsad of fold, one starting halfway between costa and fold running to dorsal margin, and one at three-fourths costad of fold; few pale yellow scales beyond second patch of raised scales; raised scales at one-half yellow, and an oblique yellow streak running from outer patch of raised scales to costa; cilia pale fuscous. Hind wing: fuscous. Metathoracic leg: outer surface of tibia dark brown with white sub-basally, medially, and apically; apices of first, second, and third and sometimes all of fourth and fifth tarsal segments shining buff. Abdomen: greasy buff-brown dorsally, buff ventrally. Male genitalia: as in figure 23 (RWH slide 606), valva with ventral surface of sacculus sinuous, apex of valva with brush of setae. Female genitalia: as in figure 40 (RWH slide 607), ostium bursae subtriangular, two sclerotized loops anteroproximal of ostium bursae on seventh sternum, two foliate signa present. Alar expanse: 9–12 mm.

Holotype: ♂, Madera Canyon, 4880 feet, Santa Rita Mts., Ariz., Sept. 19, 1959, R. W. Hodges (RWH slide 527), Cornell Univ. type 3886.

Paratypes: Same locality as type, 5 ♂, 13 ♀, Aug. 1–Oct. 1, 1959 (RWH slides 528, 606, 607; RWH wing slide 15), CU, USNM; same locality except for elevation, 4400 feet, Pima County, 1 ♂, Oct. 10, 1959, USNM; same data as type except for elevation, 5600 feet, 1 ♂, 3 ♀, Aug. 1–Sept. 13, 1959, CU, USNM.

The major characters separating *S. nubila* from *S. tesquella* are those given in the keys.

Sorhagenia Spuler

FIGURES 4, 10, 64

Sorhagenia Spuler, 1910, Die Schmetterlinge Europas, vol. 2, p. 384.—Fletcher, 1929, Mem. Dep. Agric. India, Ent. Ser., vol. 11, p. 205 (as synonym of *Chrysoclista*).—Pierce and Metcalf, 1935, The genitalia of the tineid families of the Lepidoptera of the British Islands, p. 28.

Cystiocetes Braun, 1915, Canadian Ent., vol. 47, p. 194 (type-species: *Cystioecetes nimbosus* Braun, 1915, original designation).—Barnes and McDunnough, 1917, Check list of the Lepidoptera of boreal America, p. 152.—Fletcher, 1929, Mem. Dep. Agric. India, Ent. Ser., vol. 11, p. 63.—McDunnough, 1939, Mem. Southern California Acad. Sci., vol. 2, pt. 1, p. 63. New synonymy.

Type-species: *Elachista rhamniella* Zeller, 1839, monobasic.

Head: smooth-scaled; tongue moderate, scaled basally; labial palpus recurved, second segment longer than third, apex of third segment acute; maxillary palpus folded over base of tongue; antenna half length of forewing, scape three times longer than wide, slightly enlarged distally, pecten present; ocelli present. Forewing: lanceolate, patches of raised scales present; 11 or 12 veins present; 2 weak or absent, from two-thirds of cell; 3, 4, and 5 separate; 6 separate or stalked with 7 and 8; 7 and 8 stalked, 7 to costa. Hind wing: sublinear; 8 veins present; 1 weak; 2, 3, and 4 remote; base of 5 weakly present; 6 and 7 stalked. Metathoracic tibia with long scales dorsally. Male genitalia: symmetrical; valva with separate costal and saccular areas; aedeagus small in relation to entire genitalia, distal portion somewhat reduced; uncus reduced; juxta(?) present. Female genitalia: ostium bursae at posterior margin of seventh sternum; ductus bursae heavily sclerotized for length within seventh sternum, moderately heavily sclerotized for remainder of length, latter portion with series of shallow constrictions; bursa copulatrix with two signa; heavily sclerotized, medial plate extending entire length of seventh sternum; apophyses anteriores not connected by sclerotized band.

The larva of the European species, *S. rhamniella*, feeds on *Rhamnus* spp., and *S. nimbosa* has been reared on *Rhamnus*.

Sorhagenia seems to be related most closely to parts of *Aeaea* in relation to the male genitalia; also, the reduction of vein 2 in the forewing is very similar in the the two genera.

Key to North American Species of *Sorhagenia*

BASED ON MALE GENITALIA

"Juxta" somewhat thimble-shaped with depressed apex, series of more heavily sclerotized transverse bands (fig. 20) . . . . **S. nimbosa** (Braun)

"Juxta" with hole in center, lacking sclerotized bands (fig. 21).
S. daedala, new species

BASED ON FEMALE GENITALIA

Pregenital plate narrow, constricted, appearing as attenuated triangle (fig. 44).
S. daedala, new species

Pregenital plate broad, rectangular (fig. 43) . . . . **S. nimbosa** (Braun)

Sorhagenia nimbosa (Braun), new combination

FIGURES 20, 43, 64

Cystioecetes nimbosus Braun, 1915, Canadian Ent., vol. 47, p. 195.—Barnes and McDunnough, 1917, Check list of the Lepidoptera of boreal America, p. 152.—Fletcher, 1929, Mem. Dep. Agric. India, Ent. Ser., vol. 11, p. 63.—McDunnough, 1939, Mem. Southern California Acad. Sci., vol. 2, pt. 1, p. 63.

Head, thorax, and forewings dark fuscous; scales tipped with pale fuscous; hind wing fuscous. Male genitalia: as in figure 20 (RWH slide 588), juxta(?) with concentric series of more heavily sclerotized bands, apex of uncus inset from basal portion. Female genitalia: as in figure 43 (RWH slide 587), pregenital plate subrectangular, heavily sclerotized ridge running from each anterolateral corner toward ostium bursae. Alar expanse: 9–12 mm.

Food plant: *Rhamnus* spp. (including *R. purshiana* D.C.). Braun (1915) gives the following on the larval habits: "The larva feeds within a large inflated gall-like chamber formed from the two halves of the leaf, which are closely appressed above, just below the margins of the leaf, and near each end. The leaf bulges between the lateral veins forming a series of pouches projecting from the large elongate chamber. The larva is pale grayish brown, with head and prothoracic shield shining pale brown. A small silken cocoon is spun, often just outside the larval habitation, where the sides of the leaf diverge, or between leaves on the bottom of the breeding jar."

Holotype: in collection of Annette F. Braun.

Type locality: Mills College, Alameda Co., Calif.

Specimens examined: CALIFORNIA: Colfax, 1 ♂, July 28, 1932, Fourness, USNM; Gold Run, 1 ♀, ex *Rhamnus californicus*, collected June 19, 1932, emerged July 19, 1932, Keifer, USNM; Mills College, 2 ♂, 2 ♀, Braun 284, emerged June 22, 24, G. R. Pilate (AB slide; RWH slides 588, 589), AFB, USNM; Oroville, 6 ♂, 2 ♀, bred from *R. californicus* July 5–26, H. H. Keifer (RWH slides 586, 587), CAS; Wiemar, Placer Co., 1 ♀, July 7, 1932, Fourness, USNM; WASHINGTON: Kent, 3 ♂, 3 ♀, reared from *Rhamnus purshiana* (Burke), USNM; Lynden, 3 ♂, 5 ♀, reared from *Rhamnus purshiana*, July 16–Aug. 28, 1934, J. B. Lauckhart (JFGC slide 3390; AB slides Oct. 14, 27, 1930; RWH wing slide 38), USNM.

Sorhagenia daedala, new species

FIGURES 21, 44

Maculation: as for *S. nimbosa.* Male genitalia: as in figure 21 (RWH slide 590); juxta(?) subcircular, orifice in center; uncus very small, tapering gradually to broadly rounded apex. Female genitalia: as in figure 44 (RWH slide 591); pregenital plate very narrow, anterior arms divergent, reaching anterior margin of seventh sternum; apophyses anteriores and posteriores very slender, long. Alar expanse: 9.5–10 mm.

Holotype: ♂, Mt. Shasta City, Siskiyou Co., Calif., July 4, 1958, J. Powell (RWH slide 590, RWH wing slide 39), USNM type 66355.

Paratype: same data as type, 1 ♀ (RWH slide 591), UCB.

I have not been able to find any consistent differences in the habitus or venation which would enable me to separate *S. daedala* from *S. nimbosa;* therefore, the characters pointed out in the keys based on the genitalia should be used.

Chrysopeleia Chambers

FIGURES 5, 9, 65

Chrysopeleia Chambers, 1874, Canadian Ent., vol. 6, p. 72; 1878, Bull. U.S. Geol. Geogr. Surv. Terr., vol. 4, p. 128 (as synonym of *Aeaea*); 1879, Canadian Ent., vol. 11, p. 9 (as synonym of *Aeaea*); 1880, Psyche, vol. 3, p. 64 (as synonym of *Aeaea*).—Riley, *in* Smith, 1891, List of the Lepidoptera of boreal America, p. 108.—Dyar, 1902 [1903], U.S. Nat. Mus. Bull. 52, p. 540.—Kearfott, *in* Smith, 1903, Check list of the Lepidoptera of boreal America, p. 118.—Barnes and McDunnough, 1917, Check list of the Lepidoptera of boreal America, p. 152.—Forbes, 1923, Cornell Univ. Agric. Exp. Sta. Mem., no. 68, p. 329.—Fletcher, 1929, Mem. Dep. Agric. India, Ent. Ser., vol. 11, p. 49.—McDunnough, 1939, Mem. Southern California Acad. Sci., vol. 2, pt. 1, p. 63.

Chysopeleia, Chambers, 1874, Canadian Ent., vol. 6, p. 72 (lapsus calami).

Type-species: *Chrysopeleia purpuriella* Chambers, 1874, monobasic.

Head: smooth-scaled, labial palpus recurved, third segment shorter than second, apex acute; tongue scaled basally; maxillary palpus folded over base of tongue. Forewing: patches of raised scales; lanceolate, apex acute; 12 veins present; 1b furcate basally; 2 present at margin of wing; 3, 4, and 5 separate; 7 and 8 out of 6; 11 from three-fifths of cell. Hind wing: linear, 7 veins present, 1 absent, 6 out of 7 at three-fifths. Metathoracic tibia with long scales dorsally. Male genitalia: strongly modified, somewhat asymmetrical; valva reduced, apex turned, saccus developed as a triangle; vinculum narrow; uncus a rounded lobe; aedeagus massive, larger than other parts of genitalia, apex very acute; eighth sternum modified, lateral sclerotized section on each side with long scales (possibly assuming function of reduced valvae). Female genitalia: ostium bursae large, slightly distad of middle of eighth sternum; ductus bursae heavily sclerotized for proximal three-fifths; corpus bursae with two signa.

Chrysopeleia purpuriella has the habitus of species of *Aeaea;* however, the male and female genitalia are very distinct from the latter, and for this reason I am treating them as separate genera. Only one species of *Chrysopeleia* is known, and it may be an offshoot from *Aeaea.*

Chrysopeleia purpuriella Chambers

Figures 25, 25a, 25b, 42, 65

Chrysopeleia purpuriella Chambers, 1874, Canadian Ent., vol. 6, p. 73.—Riley, *in* Smith, 1891, List of the Lepidoptera of boreal America, p. 108.—Dyar, 1902 [1903], U.S. Nat. Mus. Bull. 52, p. 540.—Kearfott, *in* Smith, 1903, Check list of the Lepidoptera of boreal America, p. 118.—Barnes and McDunnough, 1917, Check list of the Lepidoptera of boreal America, p. 152.—Forbes, 1923, Cornell Univ. Agric. Exp. Sta. Mem., no. 68, p. 329.—Fletcher, 1929, Mem. Dep. Agric. India, Ent. Ser., vol. 11, p. 49.—McDunnough, 1939, Mem. Southern California Acad. Sci., vol. 2, pt. 1, p. 63.

Aeaea purpuriella, Chambers, 1878, Bull. U.S. Geol. Geogr. Surv. Terr., vol. 4, p. 128; 1879, Canadian Ent., vol. 11, p. 9; 1880, Psyche, vol. 3, p. 64.—Hagen, 1884, Papilio, vol. 4, p. 154.

Chysopeleia [sic] *purpuriella,* Chambers, 1874, Canadian Ent., vol. 6, p. 73 (lapsus calami).

Maculation: as in figure 65; labial palpus dark fuscous-black with deep purple reflections, dorsal surface of second and third segments and apex of third segment shining pale gray; head, thorax, forewings, legs, and abdomen dark fuscous-black with deep purple reflections, most scales unicolorous; undersurface of scape of antenna shining pale gray, forewing sometimes with pale, oblique fascia starting at four-fifths, angled at fold. Hind wing: pale fuscous. Matathoracic tibia with white fascia on outer surface at middle and outer tibial spurs; apices of tarsal segments white. Male genitalia: as in figure 25 (JFGC slide 10225). Female genitalia: as in figure 42 (RWH slide 1160). Alar expanse: 6–8 mm.

Food plant: Chambers (1880) has reared one adult from *Robinia pseudo-acacia* L.; however, he did not separate the larva from those of *Lithocolletis robiniella* Clemens when the leaves were gathered. Chapman has reared the adults of *C. purpuriella* from cocoons which were attached to the smaller branches of apple; but, even though the cocoons were very abundant, no feeding larvae were found.

Holotype: Museum of Comparative Zoology.

Type locality: Kentucky.

Specimens examined: ILLINOIS: Putnam Co., 1 ♂, May 17, 1959, M. O. Glenn (RWH slide 2038), MOG. KENTUCKY: no further locality, 2 ♂, Chambers (RWH slide 871), MCZ, USNM. NEW YORK: Geneva, 2 ♂, 1 ♀, emerged March 29, 1961 (RWH slides 1657–1659), USNM; Ithaca, 1 ♀, June 25, 1931, A. B. Klots (RWH slide 10039), ABK; Six Mile Creek, Ithaca, 2 ♂, 3 ♀, July 23, 25, 1960, R. W. Hodges (RWH slides 1157–1160, RWH wing slide 41), CU, USNM; PENNSYLVANIA: Oak Station, Allegheny Co., 1 ♂, July 11, 1907, Fred Marloff (JFGC slide 10225), USNM.

There is an additional specimen, probably *C. purpuriella*, in the USNM from Dallas, Texas; however, because the abdomen is missing, I hesitate to indicate such a large extension in range without being able to verify the identification by examination of the genitalia.

Obithome, new genus

FIGURES 1, 15, 66

Type-species: *Mompha punctiferella* Busck, 1906.

Head: smooth-scaled; labial palpus recurved, second segment longer than third, apex of third segment relatively blunt; tongue moderate, scaled basally; maxillary palpus directed ventrally and somewhat folded over base of tongue; antenna two-thirds to three-fourths length of forewing, pecten present; ocellus visible. Forewing: lanceolate; 12 veins present; cell closed; 2 from three-fourths of cell; 3 from angle of cell; 7 and 8 long-stalked; 11 from three-fifths of cell. Hind wing: sublanceolate; 8 veins present; 2, 3, 4, and 5 approximately equidistant; 6 from 7 slightly beyond two-thirds length of hind wing. Male genitalia: valvae asymmetrical, right valva longer than left; manica connecting aedeagus to vinculum parallel with aedeagus; vinculum narrow; tegumen narrow, broadened immediately before apex; uncus absent; eighth abdominal segment apparently involved with genitalia, lateral rodlike extension on each side. Female genitalia: apparently modified for piercing; apophyses anteriores and posteriores stout, heavily sclerotized; ostium bursae before middle of seventh abdominal sternum; signum present.

Obithome appears to be derived from *Ithome*. The female genitalia of the two genera are very similar, and probably both represent a modification for piercing or for placing eggs within flower buds. Female genitalic differences between the two are as follows: the apophyses anteriores are joined in *Obithome*, separate in *Ithome;* there is one signum in *Obithome*, none or two in *Ithome*. The male genitalia depart markedly from those of *Ithome*, and, in fact, it is difficult to be sure of the homologies. The eighth abdominal segment has become involved in the genital structure with two lateral lobes, which may functionally replace the valvae. Dorsally, this segment is narrow, and ventrally it is a broad lobe. These four areas form a continuous ring. The valvae are reduced and asymmetrical, the right one being longer than the left. There is a broad lobe or band, extending from valva to valva, to which I cannot apply a name. It may be a part of the valvae. That part which seems to be the tegumen is expanded before the apex and has a series of stout setae in the expanded area. The male genitalia lack both uncus and subscaphium and have accessory valva-like processes arising from the eighth abdominal segment. *Ithome* has an uncus and subscaphium and does not have the valva-like structure.

Obithome punctiferella (Busck), new combination

Figures 18, 39, 66

Mompha punctiferella Busck, 1906, Proc. U.S. Nat. Mus., vol. 30, p. 731.—Barnes and McDunnough, 1917, Check list of the Lepidoptera of boreal America, p. 153.—McDunnough, 1939, Mem. Southern California Acad. Sci., vol. 2, pt. 1, p. 65.

Head: labial palpus with inner surface buff becoming brown apically, outer surface of second segment ochreous basally, brown distally, outer surface of third segment buff basally and distally, brown medially; tongue pale gray-buff basally; face pale ochreous medially, brownish laterally; scales of occiput ochreous-brown with buff apices. Thorax and base of forewing ochreous; most of forewing buff, becoming pale brown at apex, black dots scattered on forewing, cilia fuscous. Hind wing dark fuscous. Methathoracic leg: outer surface of tibia gray-brown on basal half, ochreous on distal half, ochreous streak from base of medial spurs; tarsal segments brown, apices buff-white. Abdomen ochreous-buff. Male genitalia: as in figure 18 (RWH slide 2118). Female genitalia: as in figure 39 (RWH slide 2119). Alar expanse: 8–10.5 mm.

Lectotype: present designation, ♂, bearing following labels: "1. Victoria, 24–4, Tex. 2. H. S. Barber collector. 3. Type No. 9773, USNM. 4. *Mompha punctiferella* Busck, Type! 5. Male genitalia on slide, 1962, R.W.H. 2040." In USNM.

Specimens examined: TEXAS: Corpus Christi, 1 ♂, May 8, 1943, W. M. Gordon (RWH slide 126), CU; Richmond, Brazos River, 6 ♂, 3 ♀, June 22, 1917 (RWH slides 2118, 2119; RWH wing slide 43), CU, USNM; Victoria, 1 ♂, 1 ♀, same data as lectotype, USNM; Victoria, 2 ♂, June 24, 1917 (RWH slide 119), USNM.

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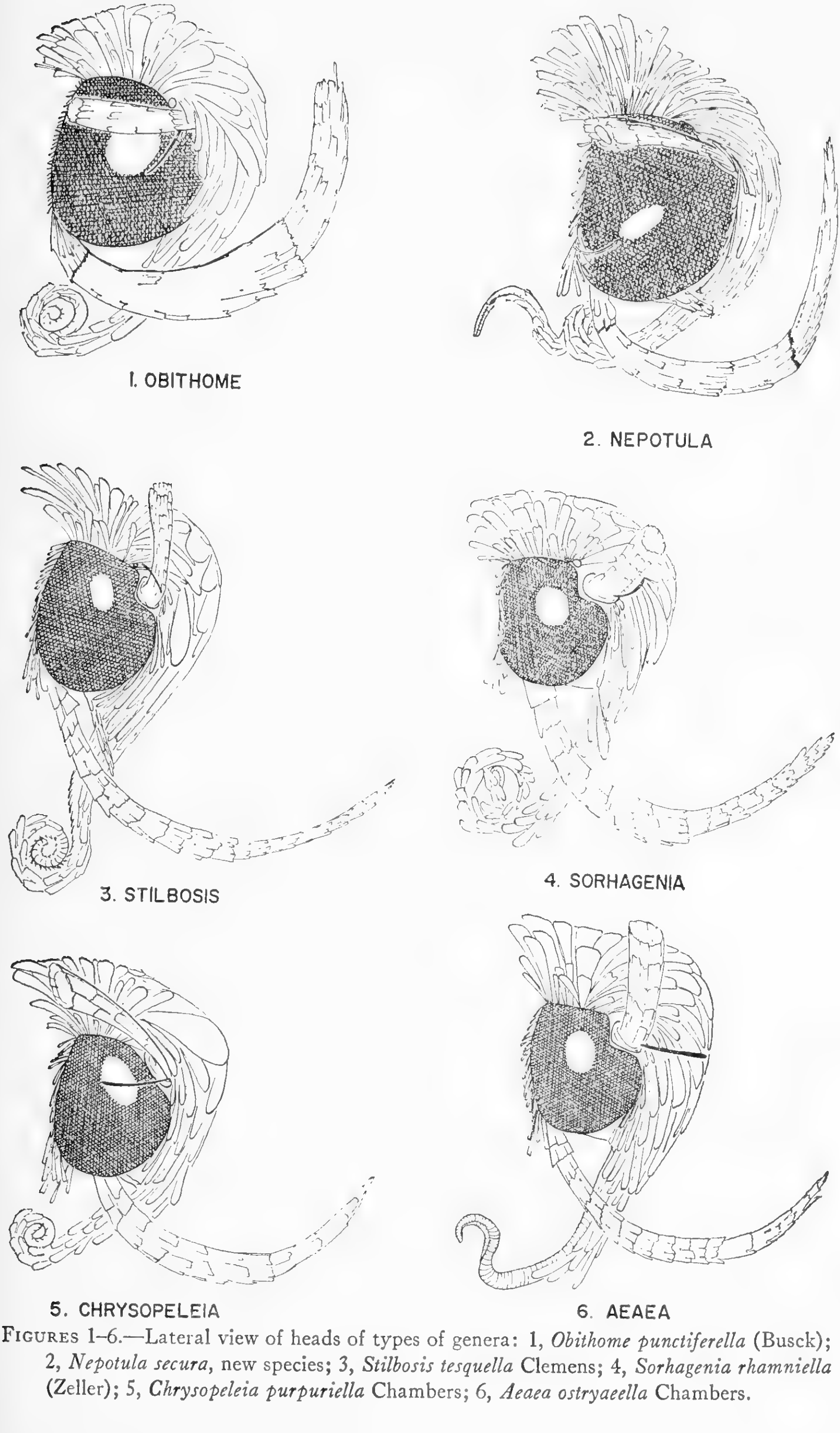
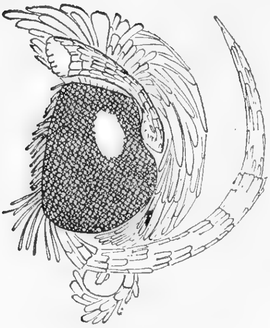
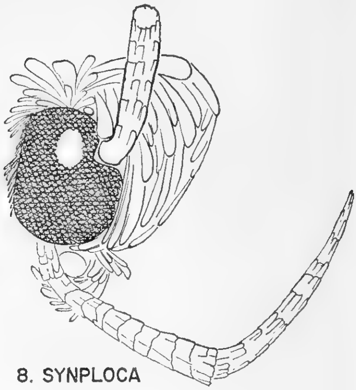


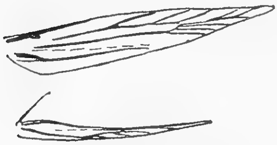
FIGURES 1–6.—Lateral view of heads of types of genera: 1, *Obithome punctiferella* (Busck); 2, *Nepotula secura*, new species; 3, *Stilbosis tesquella* Clemens; 4, *Sorhagenia rhamniella* (Zeller); 5, *Chrysopeleia purpuriella* Chambers; 6, *Aeaea ostryaeella* Chambers.



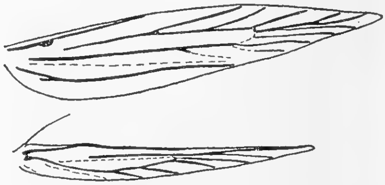
7. NEOPLOCA



8. SYNPLOCA

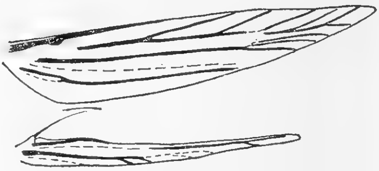


9. CHRYSOPELEIA

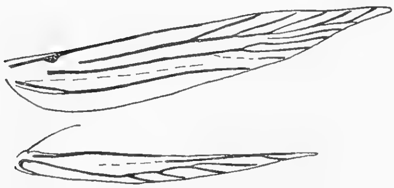


10. SORHAGENIA

11. NEOPLOCA

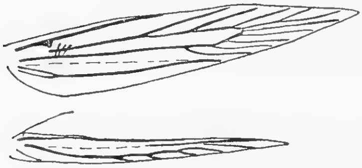


12. AEAEA

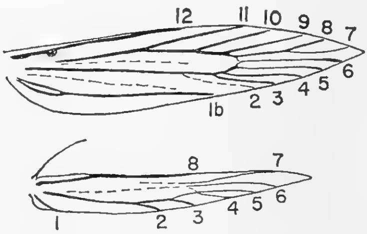


13. STILBOSIS

14. SYNPLOCA



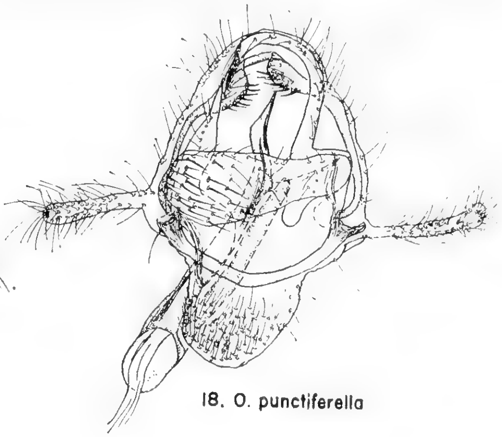
15. OBITHOME



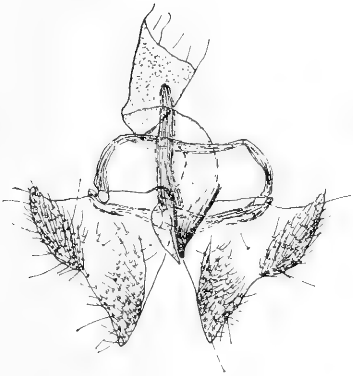
16. NEPOTULA

FIGURES 7–16.—Lateral view of heads of types of genera: 7, *Neoploca corusca*, new species; 8, *Synploca gumia*, new species. Venation of types of genera: 9, *Chrysopeleia purpuriella* Chambers; 10, *Sorhagenia rhamniella* (Zeller); 11, *Neoploca corusca*, new species; 12, *Aeaea ostryaeella* Chambers; 13, *Stilbosis tesquella* Clemens; 14, *Synploca gumia*, new species; 15, *Obithome punctiferella* (Busck); 16, *Nepotula secura*, new species.

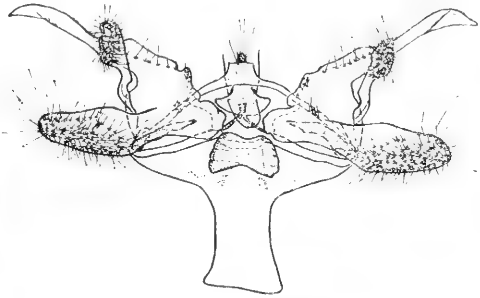
17. N. secura



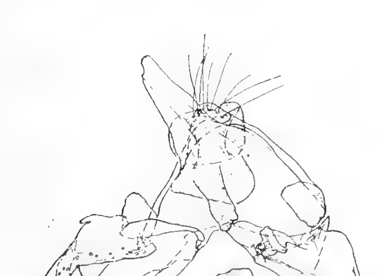
18. O. punctiferella



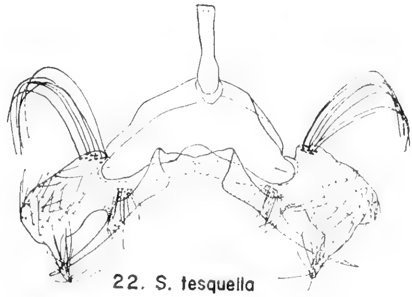
19. N. corusca



20. S. nimbosa



21. S. daedala

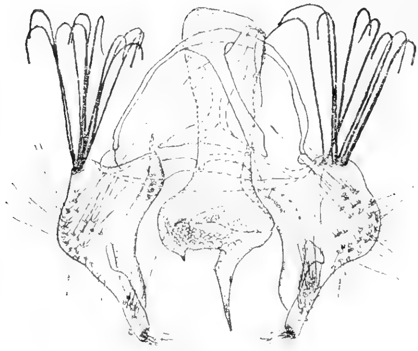


22. S. tesquella

22a.

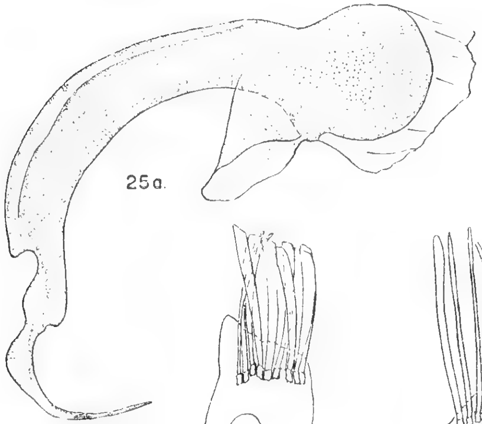
FIGURES 17–22a.—Ventral view of male genitalia: 17, *Nepotula secura*, new species; 18, *Obithome punctiferella* (Busck); 19, *Neoploca corusca*, new species; 20, *Sorhagenia nimbosa* (Braun); 21, *S. daedala*, new species; 22, *Stilbosis tesquella* Clemens; 22a, *S. tesquella*, aedeagus.

685–617—63——3

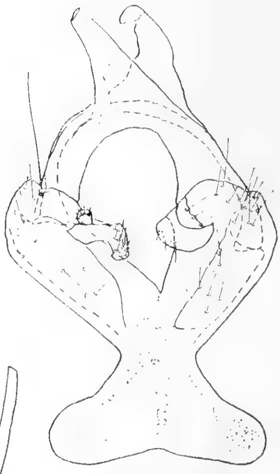


23. S. nubila

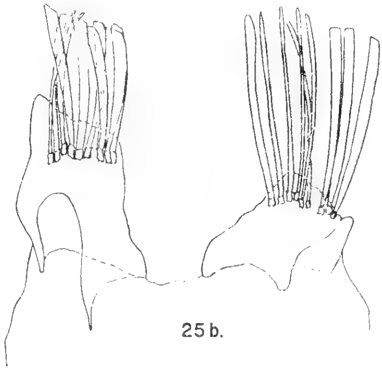
24. S. gumia



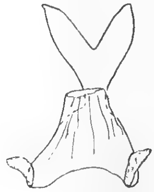
25a.



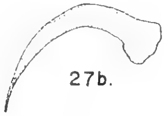
25. C. purpuriella



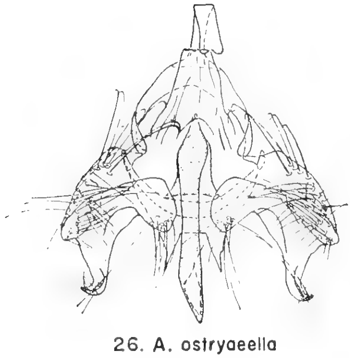
25 b.



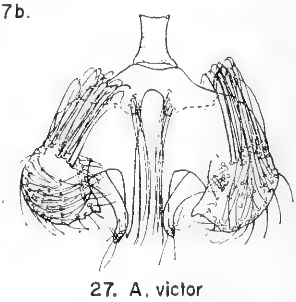
27a.



27b.

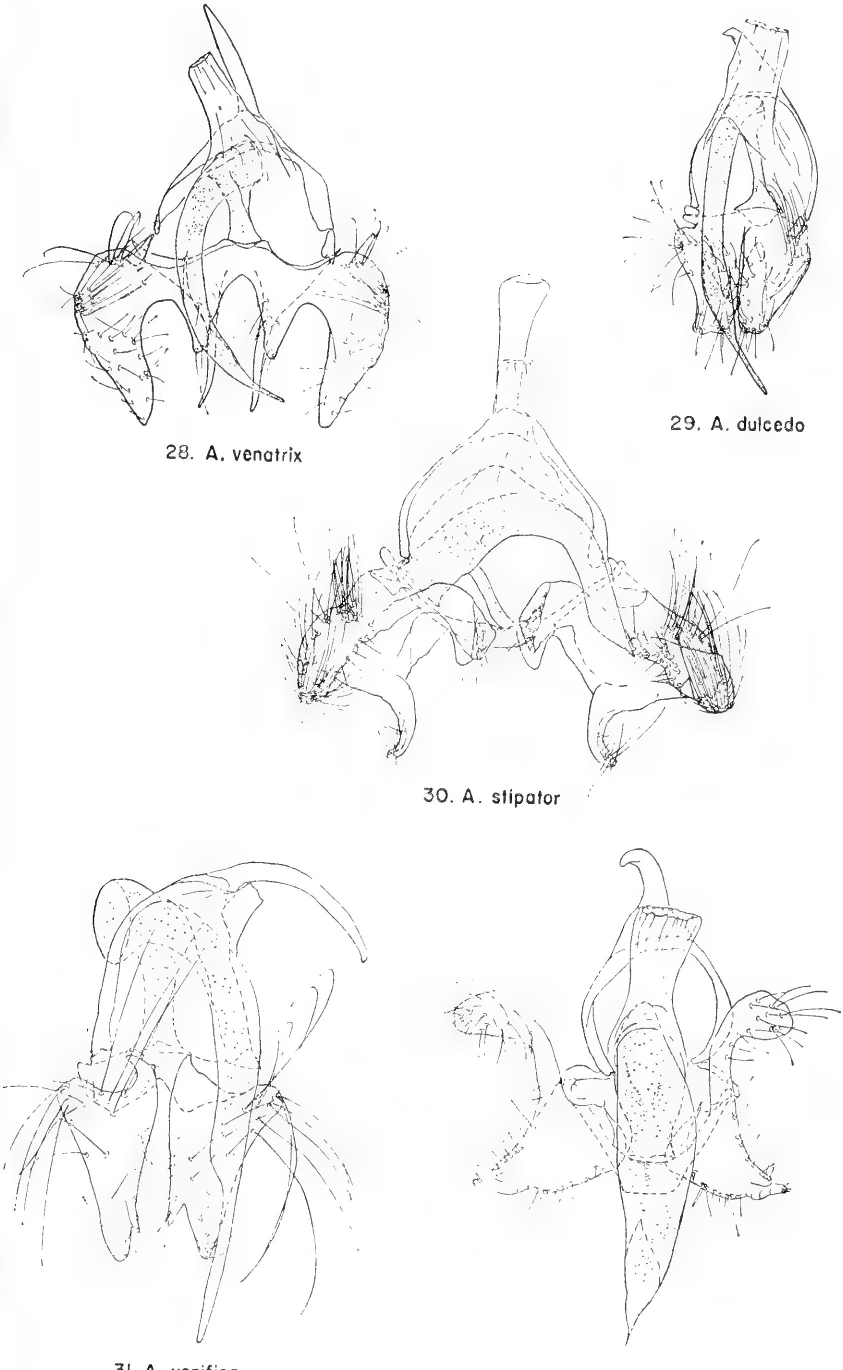


26. A. ostryaeella



27. A. victor

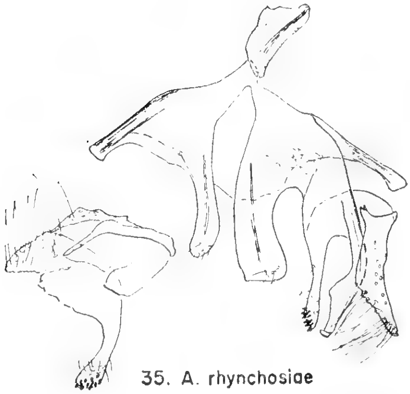
FIGURES 23–27b.—Ventral view of male genitalia: 23, *Stilbosis nubila*, new species; 24, *Synploca gumia*, new species; 25, *Chrysopeleia purpuriella* Chambers; 25a, *C. purpuriella*, aedeagus; 25b, *C. purpuriella*, apex of eighth sternum; 26, *Aeaea ostryaeella* Chambers; 27, *A. victor*, new species; 27a, *A. victor*, tegumen and uncus; 27b, *A. victor*, aedeagus.



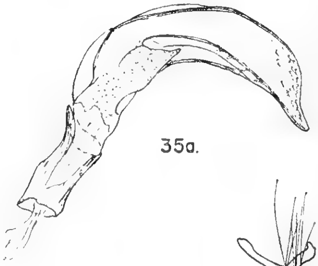
FIGURES 28–32.—Ventral view of male genitalia: 28, *Aeaea venatrix*, new species; 29, *A. dulcedo*, new species; 30, *A. stipator*, new species; 31, *A. venifica*, new species; 32, *A. juvantis*, new species.

33. A. risor

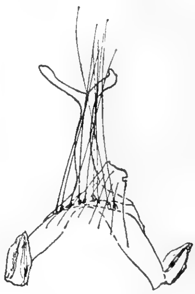
34. A. sagana



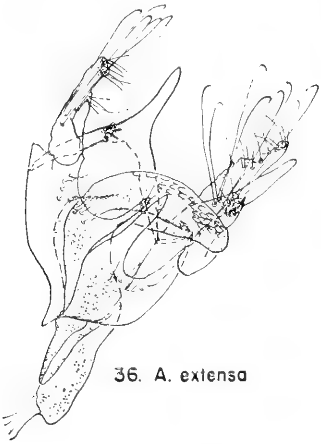
35. A. rhynchosiae



35a.

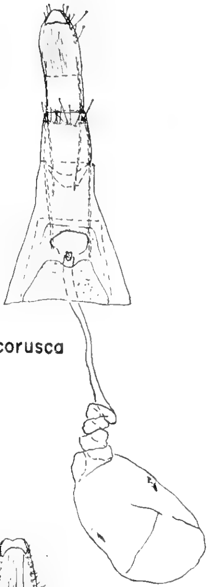


35b.

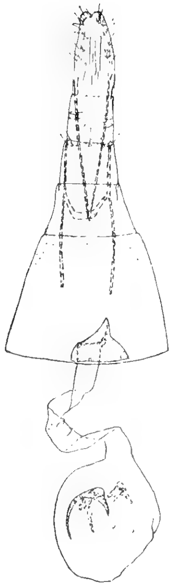


36. A. extensa

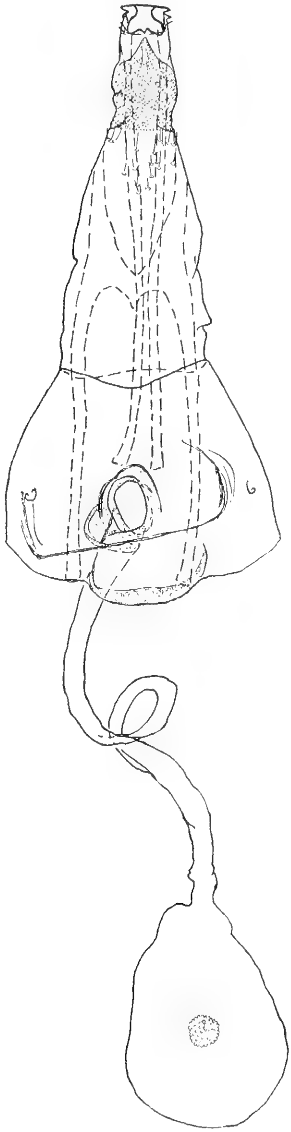
FIGURES 33–36.—Ventral view of male genitalia: 33, *Aeaea risor*, new species; 34, *A. sagana*, new species; 35, *A. rhynchosiae*, new species; 35a, *A. rhynchosiae*, aedeagus; 35b, *A. rhynchosiae*, tegumen and uncus; 36, *A. extensa* (Braun).



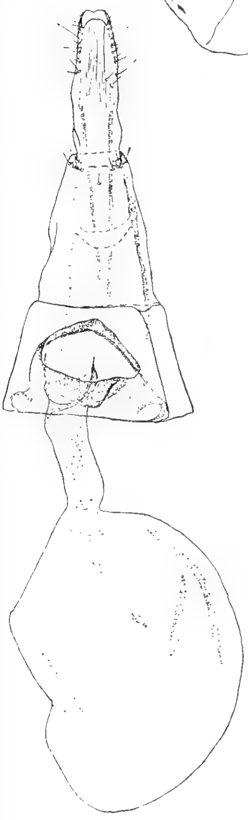
37. N. corusca



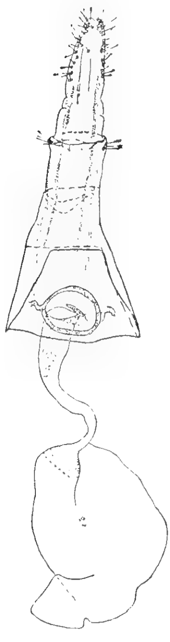
38. S. gumia



39. O. punctiferella

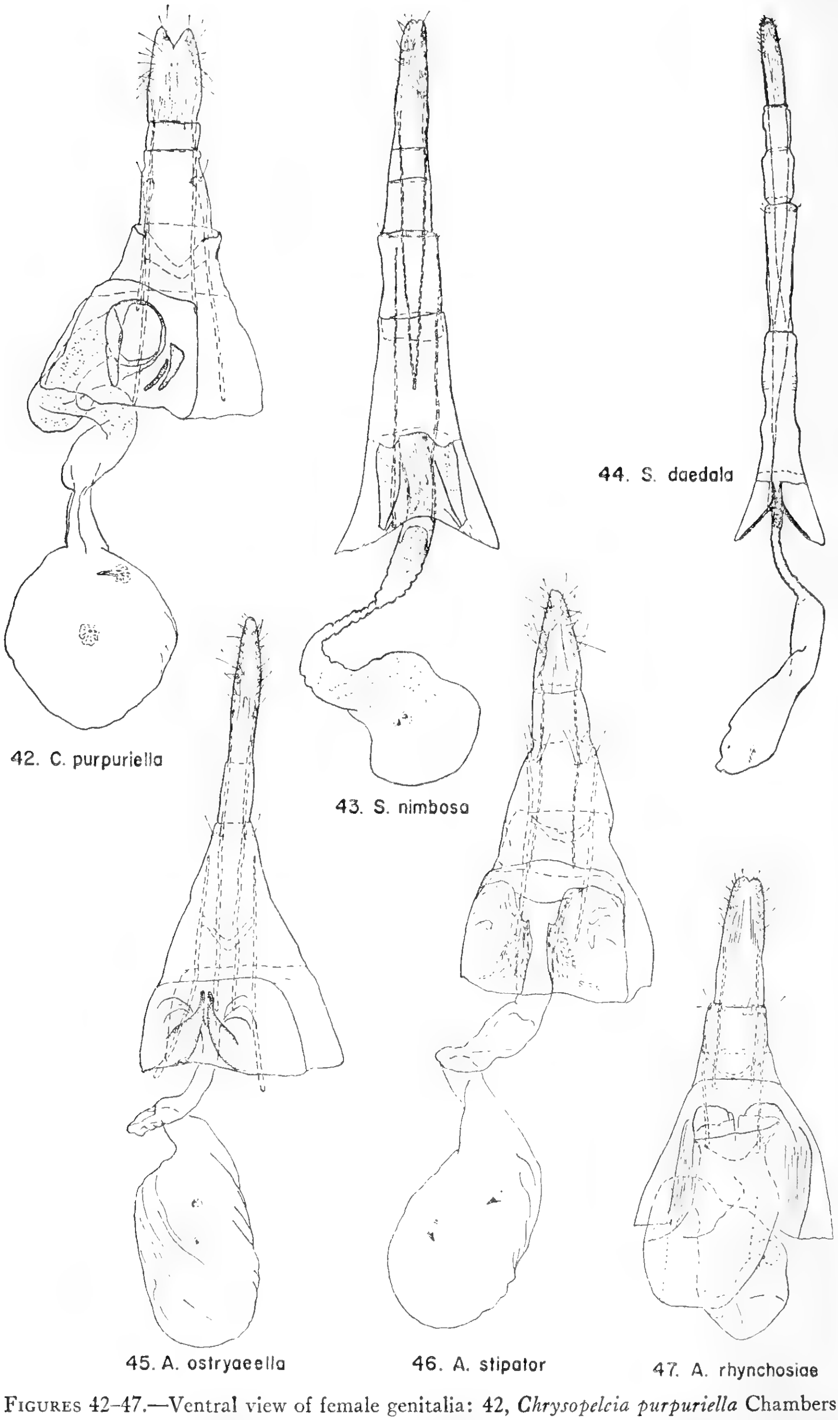


40. S. nubila

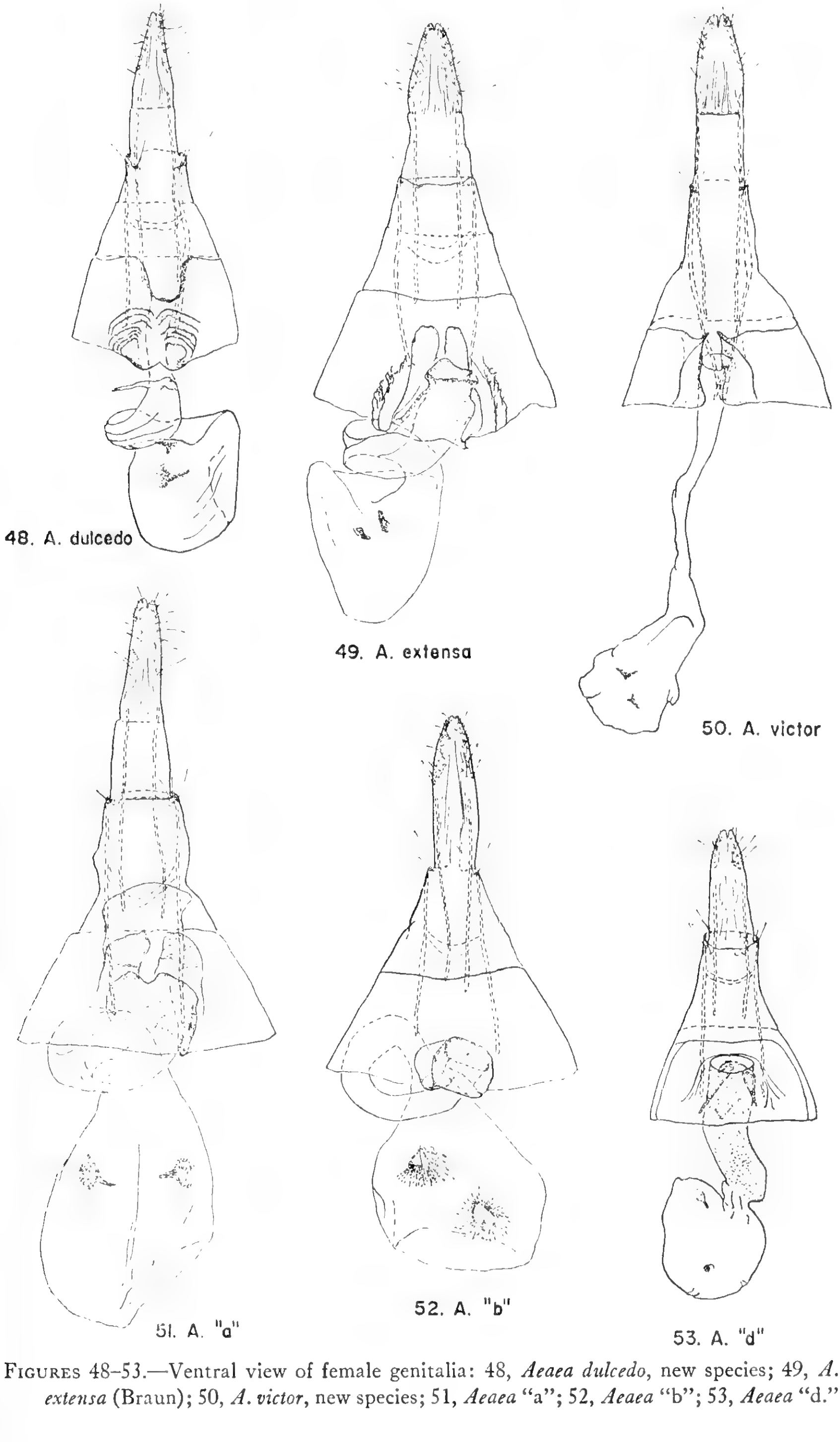


41. S. tesquella

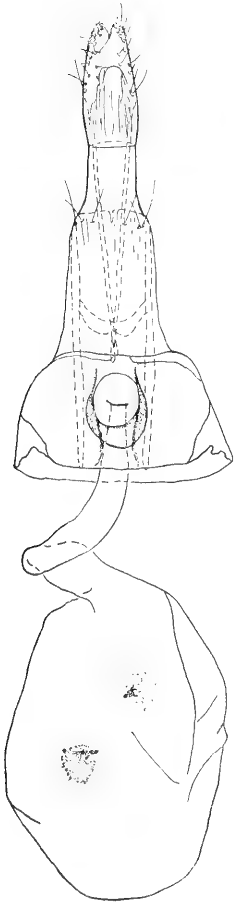
FIGURES 37–41.—Ventral view of female genitalia: 37, *Neoploca corusca*, new species; 38, *Synploca gumia*, new species; 39, *Obithome punctiferella* (Busck); 40, *Stilbosis nubila*, new species; 41, *S. tesquella* Clemens.



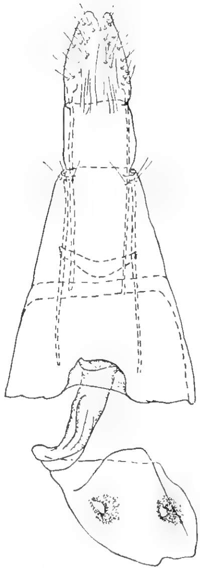
FIGURES 42–47.—Ventral view of female genitalia: 42, *Chrysopelcia purpuriella* Chambers; 43, *Sorhagenia nimbosa* (Braun); 44, *S. daedala*, new species; 45, *Aeaea ostryaeella* Chambers; 46, *A. stipator*, new species; 47, *A. rhynchosiae*, new species.



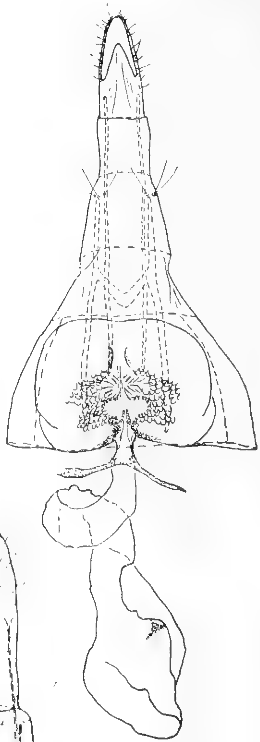
FIGURES 48–53.—Ventral view of female genitalia: 48, *Aeaea dulcedo*, new species; 49, *A. extensa* (Braun); 50, *A. victor*, new species; 51, *Aeaea* "a"; 52, *Aeaea* "b"; 53, *Aeaea* "d."



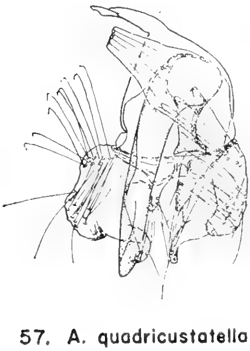
54. A. "f"



55. A. "e"



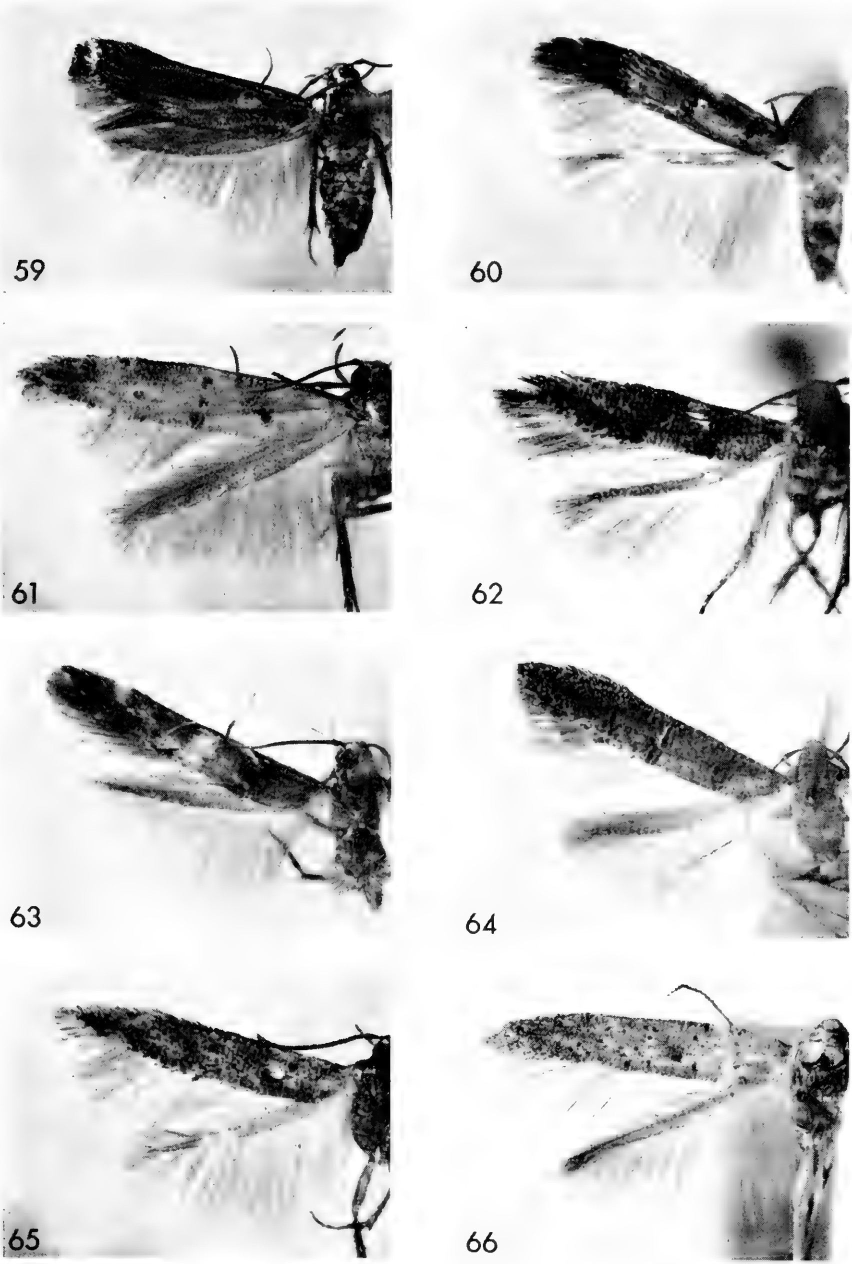
56. A. "c"



57. A. quadricustatella

58. A. quadricustatella

FIGURES 54–58.—Ventral view of female genitalia (except 57): 54, *Aeaea* "f"; 55, *Aeaea* "e"; 56, *Aeaea* "c"; 57, *A. quadricustatella* Chambers, male; 58, *A. quadricustatella* Chambers.



FIGURES 59–66.—Left wings of species of Walshiidae: 59, *Neoploca corusca*, new species, Peña Blanca Canyon, Santa Cruz County, Arizona; 60, *Synploca gumia*, new species, Madera Canyon, Santa Rita Mountains, Arizona; 61, *Nepotula secura*, new species, Pensacola, Florida; 62, *Aeaea* "c," Madera Canyon, Santa Rita Mountains, Arizona; 63, *Stilbosis tesquella* Clemens, West Fork, 16 miles SW Flagstaff, Arizona; 64, *Sorhagenia nimbosa* (Braun), Oroville, California; 65, *Chrysopeleia purpuriella* Chambers, Ithaca, New York; 66, *Obithome punctiferella* (Busck), Victoria, Texas.

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AMERICAN SPECIES OF THE LACEBUG GENUS ACALYPTA (HEMIPTERA: TINGIDAE)

By Carl J. Drake[1] and John D. Lattin[2]

Introduction

The American species of the genus *Acalypta* have been in need of revisional study for years because of synonyms and confusion of its members in the literature and collections. The genus, with the exception of a Mexican indigene, is Holarctic in distribution and as the world species now stand, 10 full species are recognized from North America and 27 from the Palearctic region. The subspecies and varieties are not included in these tabulations. Species inhabiting the coastal region of northern Africa fall into the Mediterranean subregion of Holarctica.

Stål (1873) described the first American form as *Acalypta thomsonii* (pl. 8) from South Carolina. A total of nine species are known from the United States (including Alaska) and four of these are shared with Canada. The two Alaskan species, *A. nyctalis* and *A. lillianis*, are widely distributed in the United States and Canada. Only one species, *A. mniophila* (pl. 5), inhabits Mexico (central part) and it is known solely from the type specimen. The latter is the only American

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representative of the genus not known to occur in the Nearctic region. None of the species is common to both the Old and New Worlds. Fossil forms are unknown.

Acalypta comprises a well-defined, homogenous group of species with similar facies, especially the brachypterous forms (pls. 3–11, 13, 14). The macropterous form (pl. 12) is apparently rather uncommon and only known for three of the American species. The differences in habitus between the dimorphic forms of a species are depicted in the illustrations of *A. barberi* (pls. 11, 12). The macropterous forms likewise are similar in general aspect to one another.

The present paper is based largely upon the collections of the authors, which include all the American species and most of the European forms. The material in the U.S. National Museum, where all the American species are represented, and in the private collection of Mr. Joe Schuh, Kalamath Falls, Oreg., have also been studied. We are indebted to Patricia J. Hogue, Arlington, Va., and Liza Biganzoli, Washington, D.C., for the fine illustrations. The latter also prepared the map (pl. 2) showing the distribution of *Acalypta* spp. in the northwestern United States and bordering provinces of Canada. This work is a byproduct of a tingid project being conducted with the aid of a National Science Foundation grant.

Genus *Acalypta* Westwood

Acalypta Westwood 1840 (synopsis) p. 121.—Stål 1873, pp. 118, 122; 1874, p. 51.—Horváth 1906, pp. 13, 24.—Oshanin 1908, p. 406; 1912, p. 42.—Banks 1910, p. 55.—Van Duzee 1916, p. 25; 1917, p. 211.—Osborn and Drake 1916a, p. 220.—Parshley 1923, pp. 696, 698.—Blatchley 1926, p. 480.—Drake 1928b, pp. 1–9.—China 1943, p. 245.—Hurd 1946, p. 462.—Bailey 1951, p. 32.—Kiritshenko 1951, pp. 240, 244.—Drake and Ruhoff 1959, p. 138; 1960, p. 31.

Orthosteira Fieber 1844, p. 46.

Monanthia (*Orthosteira*): Flor 1860, pp. 330, 331.

Orthostira [sic]: Fieber 1861, p. 130.—Lethierry and Severin 1896, p. 6.

Fenestrella Osborn and Drake 1916a, p. 222.—Parshley 1917a, p. 14.

Drakella Bergroth 1922, p. 152.—Parshley 1923, pp. 696, 698.—Blatchley 1926, p. 481.

Type species: *Tingis carinata* Panzer.

Brachypterous form.—Small, ovate, obovate, or oblong (pls. 3, 7, 8), pronotum subdepressed, elytra more or less convex, general color brownish testaceous to blackish fuscous. Size small, ranging from 1.65–2.70 mm. long.

Head.—Short, only slightly produced in front of eyes, usually armed with one pair of stout, porrect, frontal spines, other spines wanting; eyes large, granulate; bucculae foliaceous, areolate, open or closed in front, extending backwards beneath anterior part of prosternum; sternal laminae of rostral sulcus uniseriate, present on all three sternal divisions, open at base. Labium long, 4-segmented, extending to middle of or slightly beyond metasternum. Antennae long, slender; segment I short, stout, slightly longer and stouter than II; III longest, slenderest; IV moderately long, fusiform to subclavate.

PRONOTUM.—Subdepressed, punctate, unicarinate (pls. 3–6) or tricarinate (pls. 7–15); collar tectiformily raised at middle, produced forward over base of vertex; calli small, impunctate; median carina percurrent on hood and pronotum, ridgelike and without cells on hood, foliaceous and uniseriate on pronotum; lateral carinae customarily slightly lower than median carina, frequently raised anteriorly, composed of one row of areolae, either parallel or slightly divergent posteriorly; paranotum explanate, long, subrectangular, slightly reflexed, two or three areolae deep in front, only one or two wide opposite humeral angle; posterior process triangular, areolate. Legs moderately long, femora slightly swollen, tarsi 2-segmented.

ELYTRA.—Abruptly widened at base to that of pronotal width across paranota, slightly longer than and thus covering abdomen, with inner margins connivent, apices rounded and separated from each other; claval area not clearly defined, concealed beneath backward projection of pronotum; major divisions of costal, subcostal, discoidal, and sutural areas sharply defined by boundary veins from one another (pl. 1A); sutural area much reduced, narrow. Metathoracic wings obsolete. Hypocostal lamina (pl. 1F) of elytron either composed of one complete row of areolae or slightly wider and biseriate in basal third to half.

ABDOMEN.—Segmentation, spiracles, male and female genital segments as figured and labeled in plate 1.

MACROPTEROUS FORM.—Oblong. Pronotum swollen, convex across humeral angles, coarsely punctate. Anterior pair of coxal cavities more distant longitudinally from middle pair than in brachyptery. Elytra (pls. 1, 12) long, much longer as well as wider than abdomen, the sutural areas large, overlapping each other in repose so that their apices lie jointly rounded at rest; claval area (pl. 1) small, sharply defined, always concealed beneath backward projection of pronotum in resting position; costal, subcostal, discoidal, and sutural areas separated from one another by prominent boundary veins; metathoracic wings large, functional. Venation of elytron (pl. 1D) and hind wing (pl. 1E) as labeled in the illustrations. Other structures similar to those in brachypterous form.

Certain structural characters, which usually remain fairly constant in most tingid genera, vary considerably between the pterygopolymorphic forms within a species. These dimorphic differences include such features as: size and convexity of pronotum, spacing longitudinally of coxal cavities, form and length of elytra, absence or presence of metathoracic wings, and general habitus (pls. 11, 12). These dimorphic differences and the structural characters used in classification are semidiagrammatically drawn with their respective names attached in the illustrations (pl. 1).

The American species of *Acalypta* are primarily muscicolous, but the host preference for the different kinds of mosses is unknown. Host label affixed to pins reads simply "moss," "mosses," or "sphagnum." Under unfavorable biotic conditions for mosses, nymphs and adults will seek less acceptable plants nearby for feeding purposes. For example, *A. barberi* was found feeding in numbers (nymphs and adults) on hops at Coburg, Oreg., August 26, 1935, by N. P. Larson. Very little is known about the biology of the American species.

Key to Brachypterous Forms of American *Acalypta*

1. Pronotum unicarinate (pls. 1–6) 2
   Pronotum tricarinate (pls. 7–14) 4
2. Hypocostal lamina uniseriate (pl. 5) . . . . **A. mniophila**
   Hypocostal lamina biseriate in basal third to half, thence posteriorly uniseriate 3
3. Paranotum mostly triseriate; discoidal area obtusely rounded at apex; boundary vein separating discoidal and sutural areas elevated and strongly sinuate (pl. 3) . . . . **A. duryi**
   Paranotum usually biseriate, sometimes with one or two intercalated areolae in front; discoidal area acutely rounded at apex; boundary vein separating discoidal and subcostal areas less elevated, nearly straight in basal two-thirds, then apically gently curved inward (pl. 4) . . . . . . **A. saundersi**
4. Form distinctly oblong; antennal processes spiniform, divergent, not excavated within (pl. 7) . . . . **A. cooleyi**
   Form ovate or obovate; antennal processes short, stout, blunt, excavated within (pls. 8–15) 5
5. Discoidal area about three-fifths as long as an elytron, much narrower than subcostal area; areolae of paranotum and costal area very large (pl. 8). **A. thomsonii**
   Discoidal longer, at least two-thirds as long as an elytron; areolae smaller (pls. 9–15) 6
6. Pronotal carinae low, little raised, each composed of one row of very small areolae; costal area also very narrow, composed of one row of very small areolae (pl. 9) . . . . **A. nyctalis**
   Pronotal carinae more foliaceous, each composed of one row of quadrate areolae; costal area wider, composed of one row of quadrate areolae 7
7. Lateral carinae of pronotum divergent posteriorly (pls. 11, 13) 8
   Lateral carinae of pronotum parallel (pls. 14, 15) 9
8. Paranotum with front and outer margins jointly rounded, not angulate at anterolateral corner; discoidal area deeply concavely impressed longitudinally, about three-fourths as long as elytron (pl. 13) . . . . . . **A. lillianis**
   Pronotum with outer margin nearly straight, not rounded but distinctly angulate at anterolateral corner, discoidal area about two-thirds as long as elytron (pl. 11) . . . . **A. barberi**

9. Form elongate-ovate; antenna rather short, 0.79 mm. long, segment III twice the length of IV (pl. 14) . . . . **A. vandykei**
   Form obovate; antenna 0.94 mm. long, segment III more than two and a half times as long as IV (40:15) (pl. 15) . . . . **A. vanduzeei**

Acalypta duryi Drake

Plate 3

Fenestrella ovata Osborn and Drake 1916a, p. 223, fig. 3; 1917, p. 155, pl. 8, fig. d.—Van Duzee 1917, p. 212.
Drakella [*ovata*]: Bergroth 1922, p. 152.
Drakella ovata: Blatchley 1926, p. 482, fig. 112.
Acalypta ovata: Drake 1928b, p. 3, fig. 1,a.
Acalypta duryi Drake 1930, p. 268.—Hurd 1946, p. 463.—Drake and Ruhoff 1959, p. 138.

Brachypterous form.—Ovate, brown or grayish brown to blackish fuscous; antennae dark brown or fuscous with fourth segment black and subclavate; body beneath blackish fuscous; legs with femora fuscous, the tibiae and tarsi usually brown. Antennal measurements: segment I, 0.10 mm.; II, 0.09 mm.; III, 0.56 mm.; IV, 0.20 mm. Pronotum unicarinate, median carina slowly tapering posteriorly, with one row of three to five areolae behind hood, without areolae behind pronotal disc; paranotum slightly variable in areolation, angulate at anterolateral corner, usually three areolae deep in front and two opposite humeral angle. Costal area with one complete row of areolae, with a variable number of areolae in partial second row at base and apex, uniseriate in middle portion. Division of elytron as shown in illustration (pl. 3). Length 2.00–2.50 mm., width (elytra) 1.25–1.60 mm. Macropterous form unknown.

Holotype.—Brachypterous ♀, Cincinnati, Ohio, in Ohio State University, Columbus, Ohio.

Distribution.—Ohio (Cincinnati), Tennessee (Great Smoky Mts., Sevier Co.), and North Carolina (Great Smoky Mts., Newfound Gap, elevation 5,000–5,200 ft.). Feeds and breeds on mosses. A brachypterous ♀ from the Great Smoky Mts., Tenn., is illustrated.

Acalypta saundersi Downes

Plate 4

Drakella saundersi Downes 1927b, p. 60.
Acalypta saundersi: Drake 1928b, p. 4, fig. 1,b; 1930, p. 268.—Hurd 1946, p. 463.—Drake and Ruhoff 1959, p. 138.

Brachypterous form.—Small, ovate or obovate, sometimes more elongate-ovate, reddish brown to dark fuscous; body beneath flavous to dark fuscous. Legs brownish with femora broadly banded at middle with dark fuscous. Antenna with first, second, and third segments dark fuscous, fourth segment testaceous to brown. Length 1.85–2.38 mm., width 1.00–1.30 mm.

Head armed with two stout frontal spines. Antennal measurements: segment I, 0.20 mm.; II, 0.09 mm.; III, 0.44 mm.; IV, 0.21 mm. Pronotum reticulately punctate, unicarinate; median carina raised anteriorly, uniseriate; hood obtusely projected forward between eyes; paranotum subrectangular, mostly biseriate, triseriate in front, anterolateral corner subangulate. Elytron with costal area uniseriate, frequently with one to three intercalated areolae at base and occasionally with several extra areolae a little before the apex; discoidal and sutural areas wide, each five or six areolae deep in widest part. Hypocostal lamina biseriate in basal third, thence posteriorly uniseriate.

Holotype.—Brachypterous ♀, Goldstream, British Columbia, Canadian National Collection, Ottawa, Canada.

Distribution (pl. 2).—Canada: British Columbia. United States: Washington, Oregon. Feeds and breeds on mosses. A brachypterous female from Corvallis, Oreg., is illustrated.

Acalypta sauteri **Drake**

Plate 6

Acalypta sauteri Drake 1942, p. 14.—Takeya 1951, p. 6.

Brachypterous form.—Ovate to obovate, fuscous-brown with paranota and costal areas yellowish brown; body beneath dark fuscous. Antennal measurements: segment I, 0.12 mm.; II, 0.12 mm.; III, 0.45 mm.; IV, 0.22 mm. Pronotum unicarinate; median carina low, scarcely raised anteriorly, minutely uniseriate; paranotum wide, triseriate in front, anterolateral corner angulate. Costal area composed of one complete row of areolae, often with one or two intercalated cells at base. Hypocostal lamina biseriate basally, thence posteriorly uniseriate. Length 1.65–2.21 mm., width (elytra) 1.20–1.28 mm. Macropterous form unknown.

Holotype.—Brachypterous male, Honshu, Japan (printed locality label "Oayama" or "Ooyama" is an error and probably should read "Ohyama"), in Drake collection (USNM).

Distribution.—Japan: Honshu. A brachypterous ♀ from Mt. Ohyama, Hanagawa Prefecture, Apr. 15, 1939, taken on moss, is illustrated. This species has been intercepted at New York City Port-of-Entry, on moss used in the packing of dormant nursery stock imported from Japan. It is very similar in general appearance to *A. duryi* and *A. saundersi*, but can easily be distinguished from them by the illustrations.

Acalypta mniophila Drake and Ruhoff

PLATE 5

Acalypta mniophila Drake and Ruhoff 1959, p. 136, fig. 1.

BRACHYPTEROUS FORM.—Obovate, widest behind middle of elytra, fuscous-brown with pronotum and costal areas brown; body beneath blackish fuscous. Pronotum reticulate with areolae about same size as those in paranota, unicarinate; median carina low, composed of one row of very small areolae; hood low, obtusely projecting forward between eyes; paranota rather narrow, biseriate, with anterolateral corner rounded. Hypocostal lamina uniseriate. Elytra very convex; costal area narrow, mostly uniseriate, with a few extra areolae in apical third. Antennal measurements: segment I, 0.11 mm.; II, 0.08 mm.; III, 0.40 mm.; IV, 0.22 mm. Length 2.00 mm., width (elytra) 1.25 mm. Macropterous form and male unknown.

HOLOTYPE.—Brachypterous ♀, Central Mexico, on moss, Aug. 16, 1947, in U.S. National Museum (type no. 64870), illustrated.

DISTRIBUTION.—Known solely from the type specimen from Mexico. It can be distinguished from the species of *Acalypta* of the New World possessing unicarinate pronotum (*saundersi* and *duryi*) by the much narrower paranotum and costal area as depicted in the figures. The pair of frontal spines on the head is obsolete. The same structures distinguish it from *A. sauteri* from Japan.

Acalypta cooleyi Drake

PLATE 7

Acalypta cooleyi Drake 1917, p. 213; 1928b, p. 9.—Van Duzee 1917, p. 814.—Hurd 1946, p. 463.—Drake and Ruhoff 1959, p. 138.

BRACHYPTEROUS FORM.—Oblong, fuscous-brown to dark fuscous, body beneath stramineous to blackish fuscous; rostral laminae of sternal sulcus brownish. Legs slender, dark brown with femora tending to be fuscous. Antenna brownish fuscous. Length 2.20–2.55 mm., width (elytra) 1.12–1.30 mm.

Head short, armed with two porrect, frontal spines. Antennal tubercles spiniform, divergent. Antenna long, slender, fourth segment fusiform, segmental measurements: I, 0.18 mm.; II, 0.08 mm.; III, 1.11 mm.; IV, 0.20 mm. Pronotum coarsely punctate, depressed, tricarinate, each carina strongly foliaceous, composed of one row of quadrate areolae, the lateral pair almost as highly elevated as median, slightly divergent posteriorly; paranotum wide, triseriate in form, biseriate opposite humeral angle, outer margin nearly straight; anterolateral corner distinctly angulate, often with a tooth or spine-like lateral projection. Legs slender, femora only a little swollen.

Elytron oblong; discoidal area long, with all boundary veins distinctly raised, longitudinally depressed so as to appear sulcate, mostly three areolae deep; costal area wide, varying from one to two complete rows of areolae. Hypocostal lamina uniseriate. Metathoracic wings obsolete. A brachypterous male from Pinehurst, Oreg., is here designated as the allotype.

Macropterous form.—Known only from the type specimen. Differs from the short-winged form in having pronotum more convex, all carinae slightly less raised; paranotum narrow, biseriate. Elytra with subcostal areas large and overlapping each other in resting posture; costal area biseriate at base and apex, uniseriate at middle. Metathoracic wings large, longer than the abdomen. Length 2.90 mm., width 1.20 mm.

Holotype.—Macropterous ♀, Bozeman, Montana, June 13, 1913, in Drake collection (USNM).

Distribution (pl. 2).—Montana (Bozeman), Oregon (Pinehurst), and California (Sequoia National Forest). The brachypterous form (both sexes) was taken in numbers breeding on mosses at Pinehurst, Oreg., by Joe Schuh.

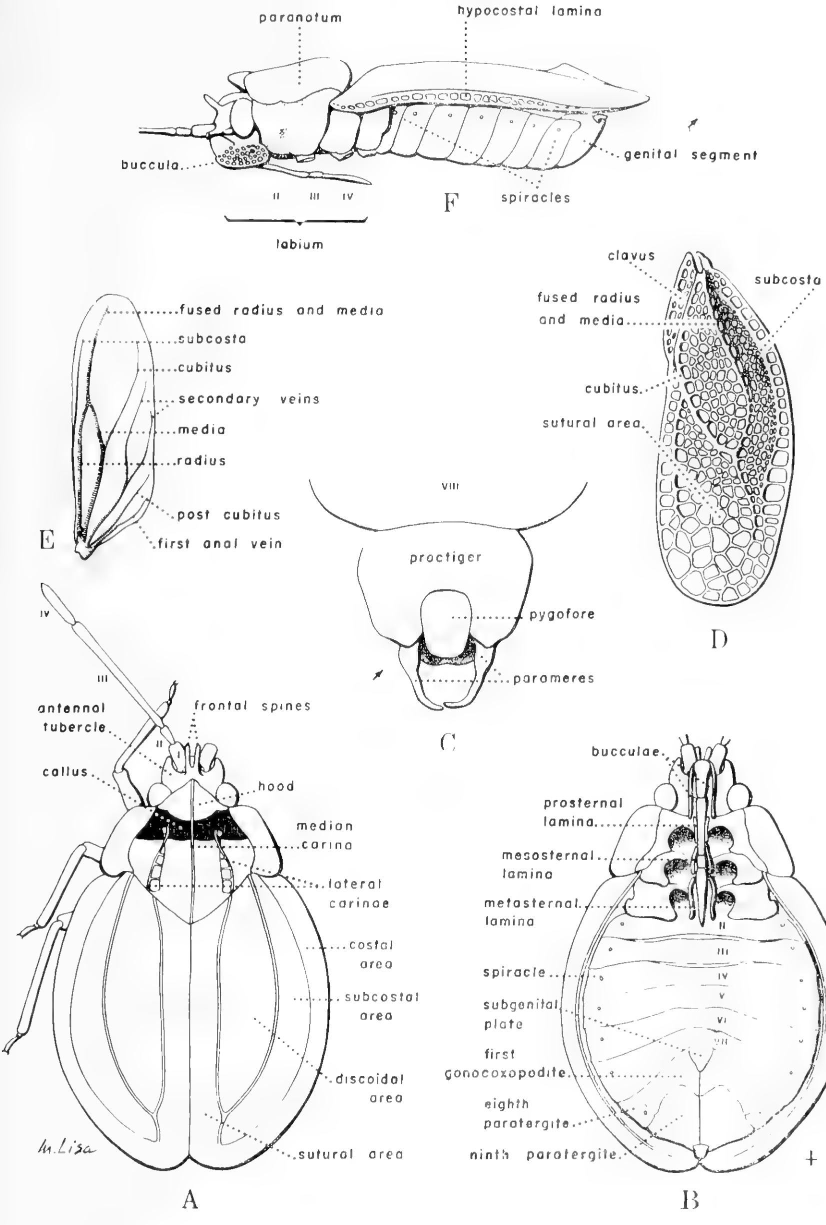
Acalypta thomsonii Stål

Plate 8

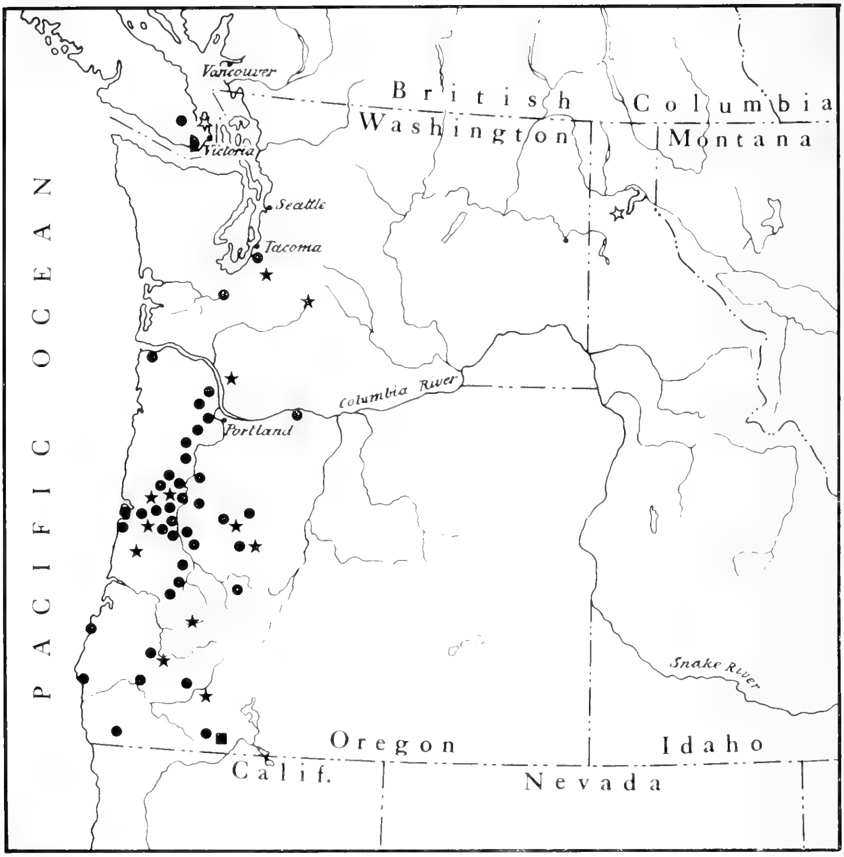
Acalypta thomsonii Stål 1873, p. 122.—Banks 1910, p. 55.—Osborn and Drake 1916a, p. 220.—Heidemann 1917, p. 220, pl. 17, fig. 3 (fig. only).—Van Duzee 1916, p. 25; 1917, p. 211.—Parshley 1923, p. 699.—Blatchley 1926, p. 480, fig. 110.—Drake 1926, p. 377, pl. 34, fig. d; 1928b, p. 4, fig. 2.—Hurd 1946, p. 463.—Bailey 1951, p. 35.—Drake and Ruhoff 1959, p. 138.
Orthostira thomsoni: Lethierry and Severin 1896, p. 7.
Acalypta madelinae Torre-Bueno 1926, p. 117.

Brachypterous form.—Obovate or ovate, testaceous to brownish testaceous with appendages brown to fuscous; fourth antennal segment black; body beneath flavous to dark brown or fuscous.

Head brown, with frontal spines and antennal process testaceous; bucculae closed in front. Antennal measurements: segment I, 0.18 mm.; II, 0.10 mm.; III, 0.53 mm.; IV, 0.22 mm. Pronotum depressed, tricarinate; lateral carinae low, much less raised than median carina, divergent posteriorly, usually with one row of tiny areolae; median carina distinctly raised anteriorly, with a short row of three or four fairly large areolae in front, then posteriorly with areolae becoming obsolete; paranotum wide, almost rectangular in outline, biseriate or triseriate in front and biseriate at base, with anterolateral corner angulate; hood obtusely produced in front. Hypocostal lamina uniseriate.

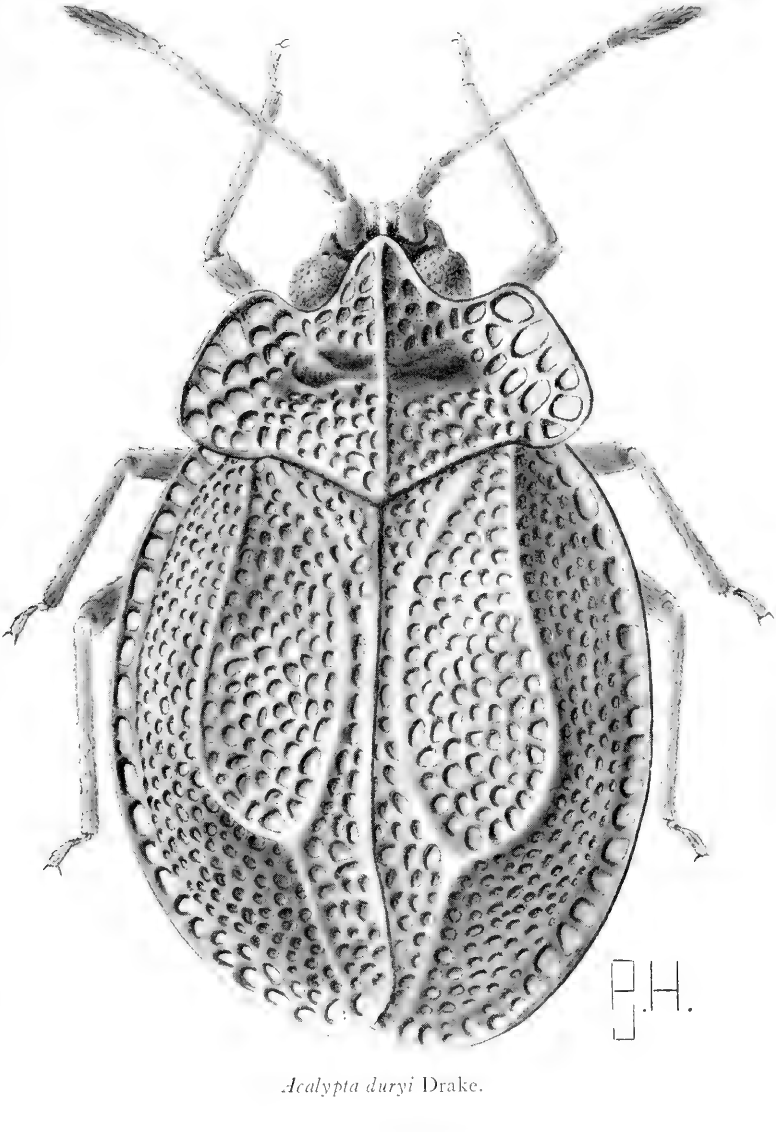


Acalypta, structures used in classification.

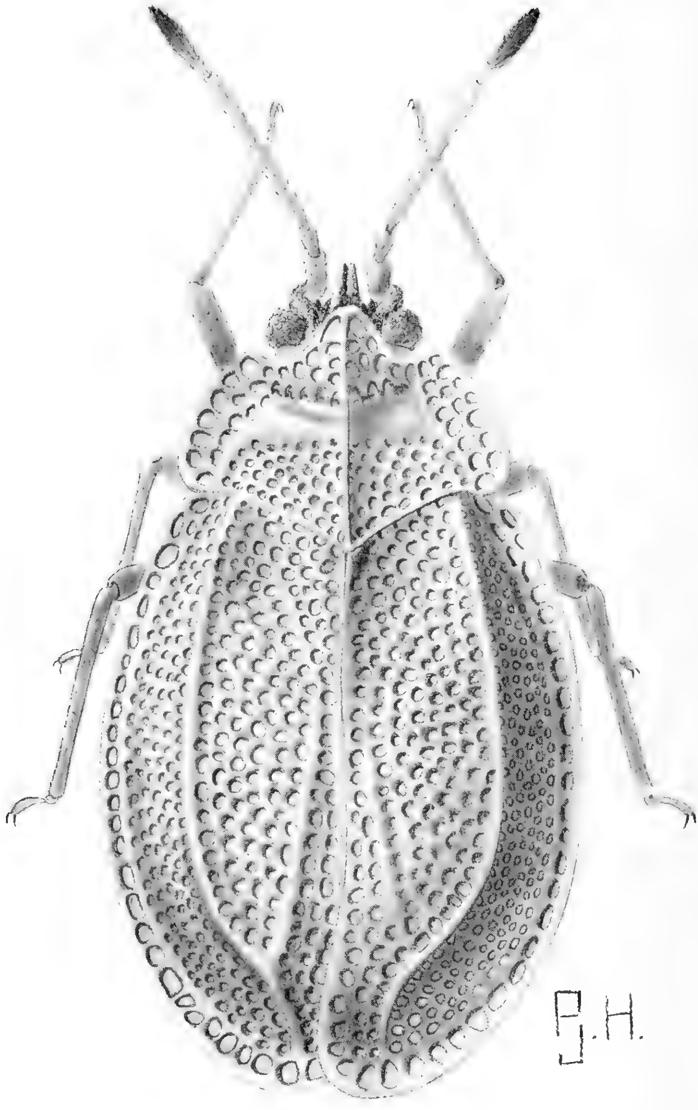


Distribution of *Acalypta* in Northwestern United States and Canada:

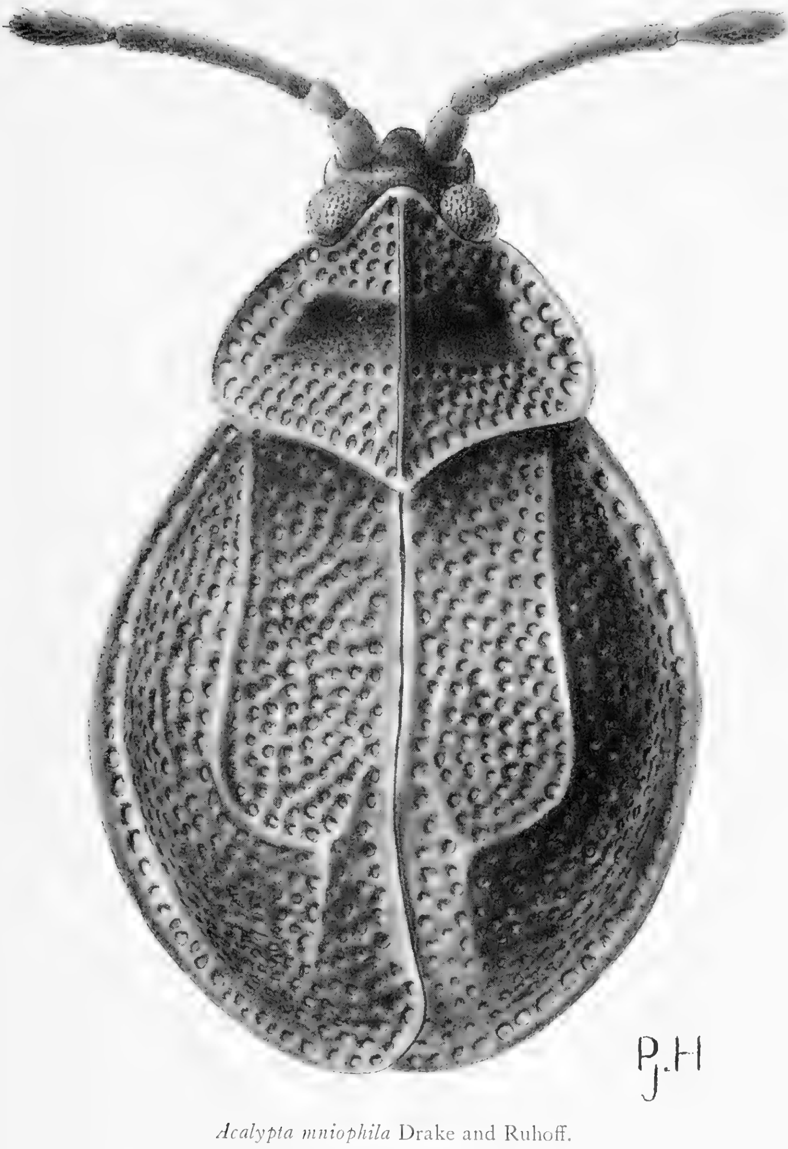
● *A. barberi* Drake
☆ *A. lillianis* Torre-Bueno
★ *A. saundersi* Downes
■ *A. cooleyi* Drake



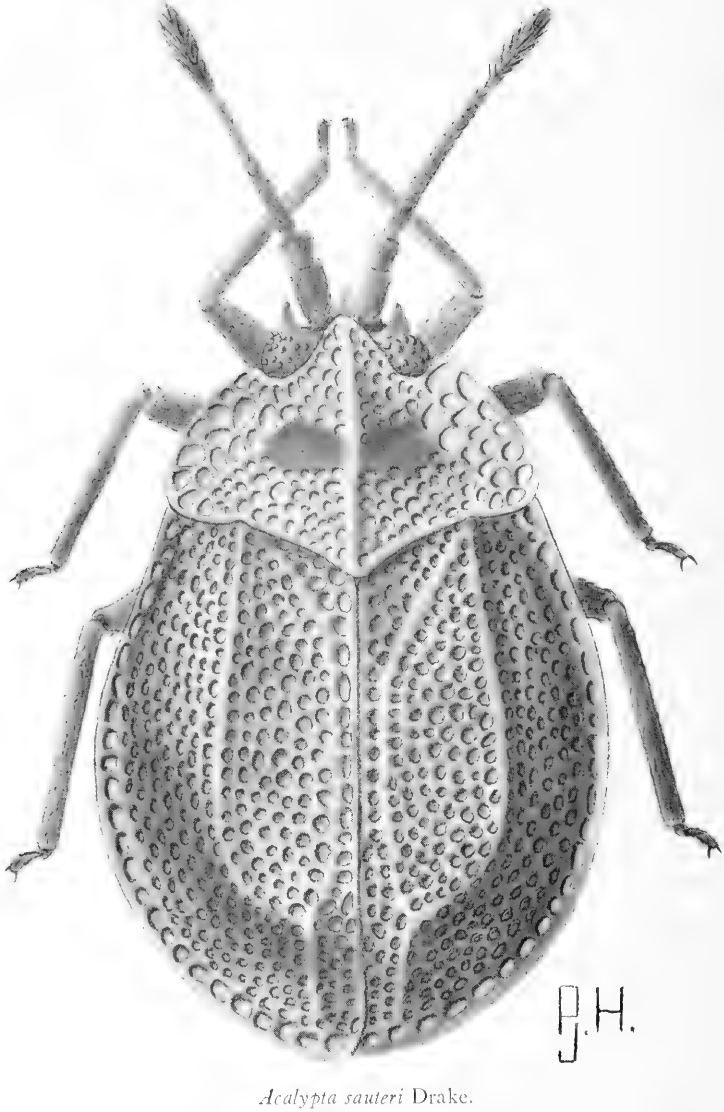
Acalypta duryi Drake.



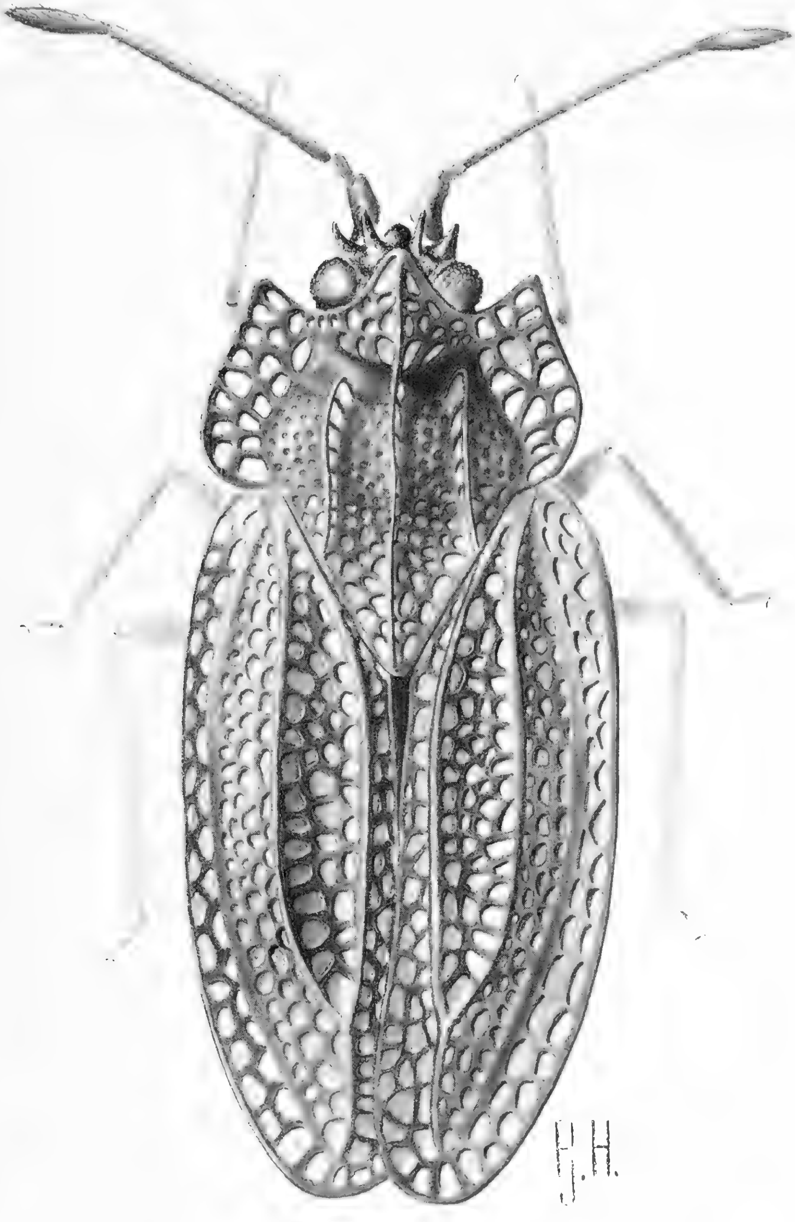
Acalypta saundersi Downes.



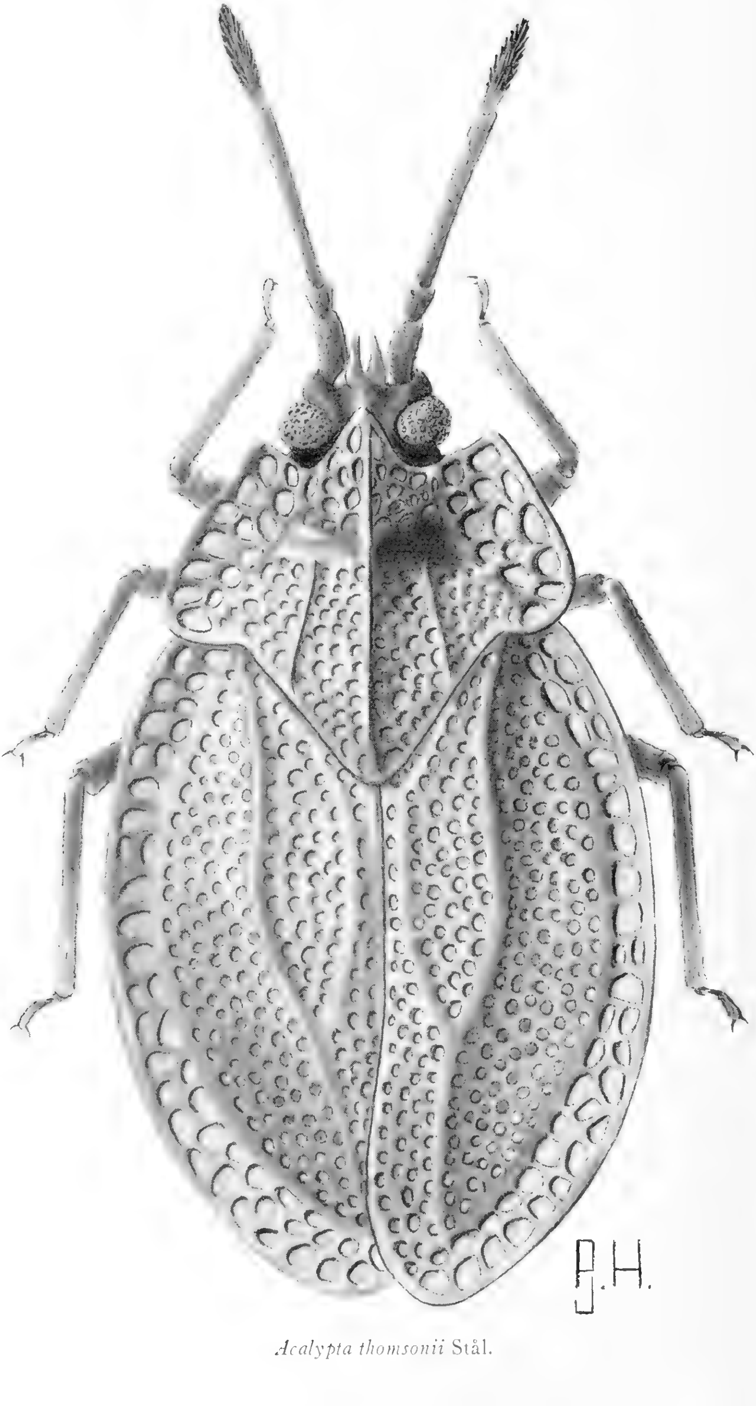
Acalypta mniophila Drake and Ruhoff.



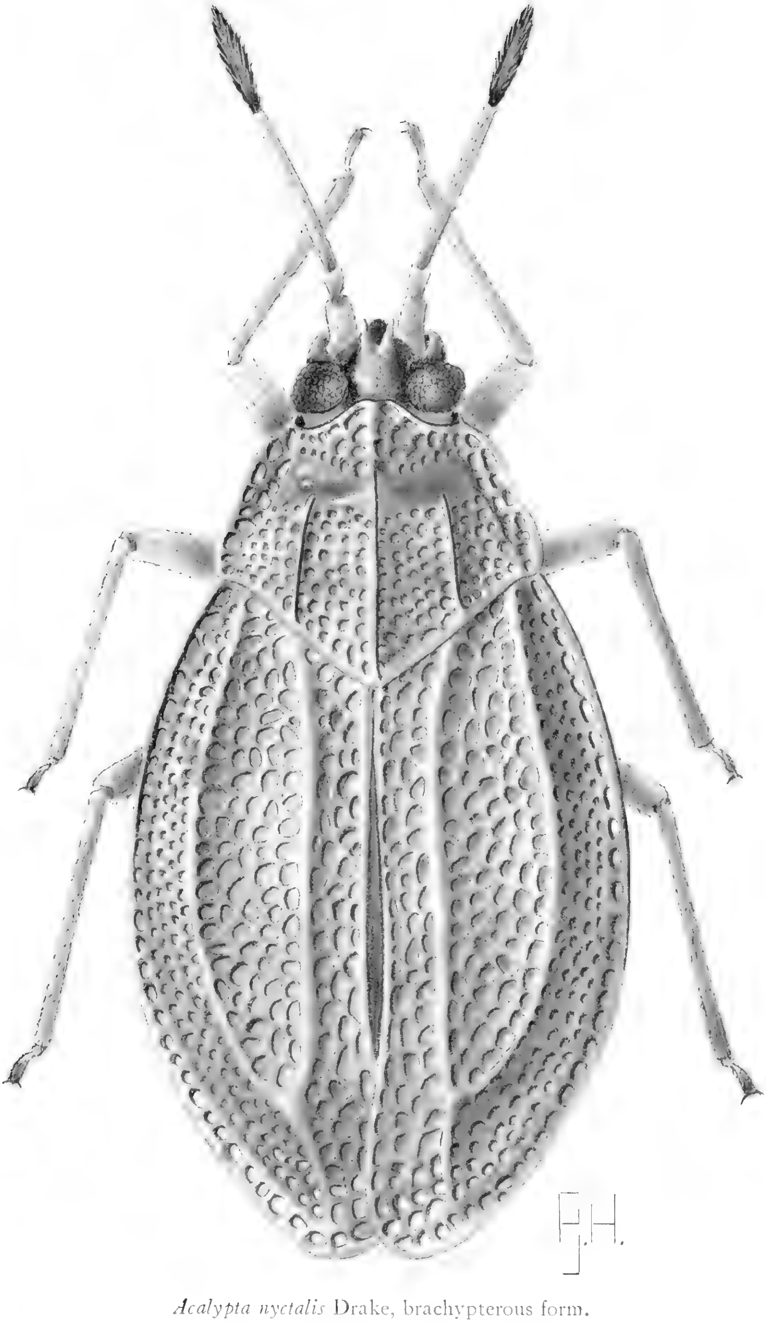
Acalypta sauteri Drake.



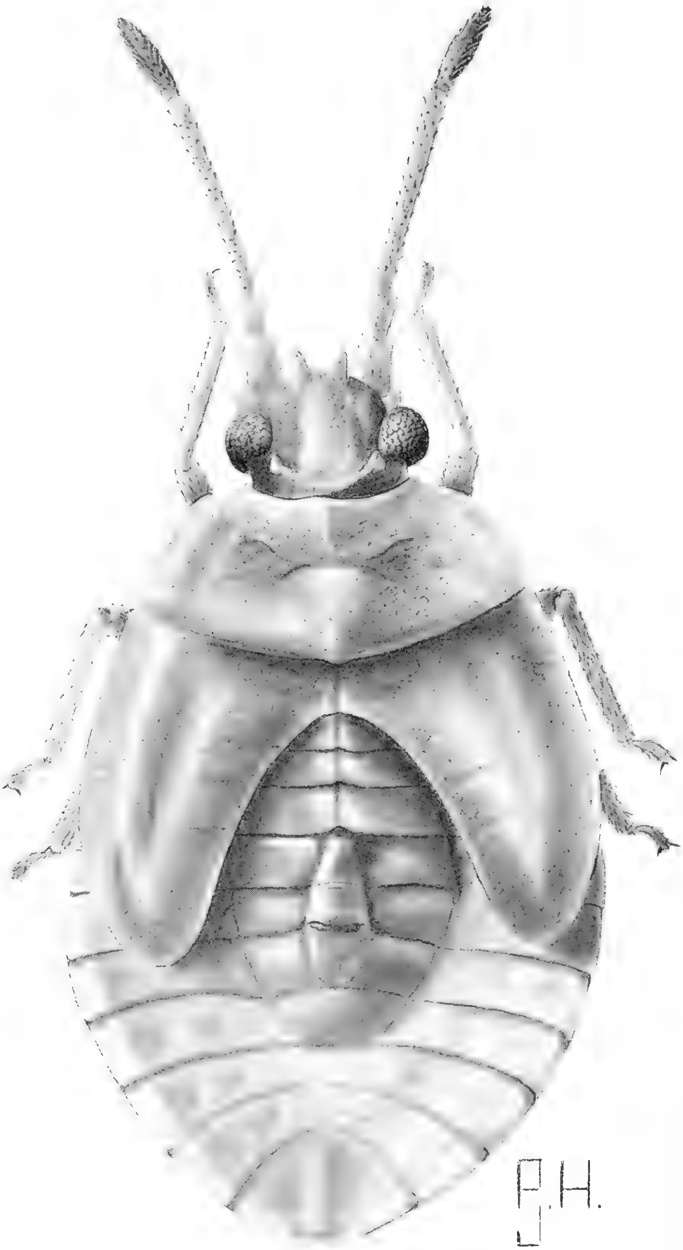
Acalypta cooleyi Drake.



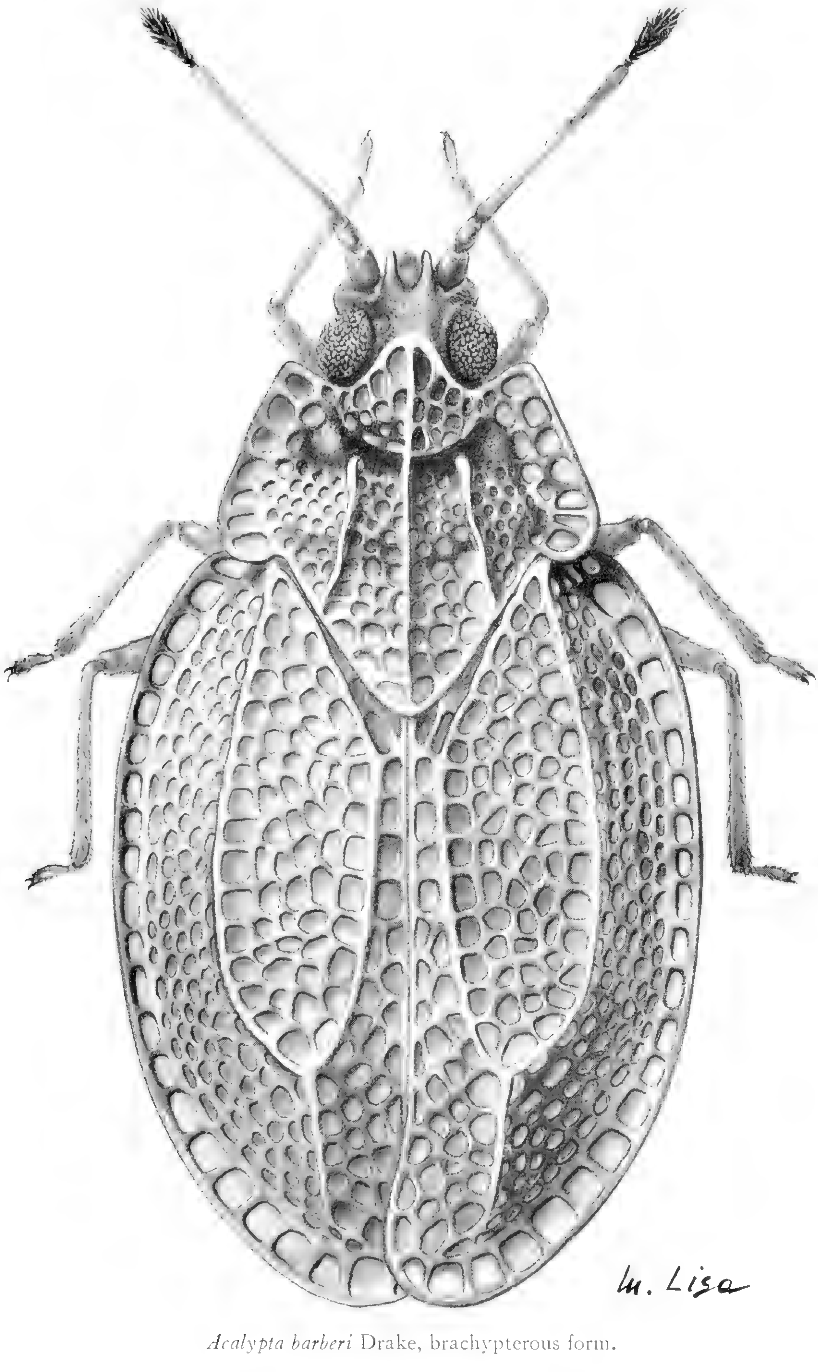
Acalypta thomsonii Stål.



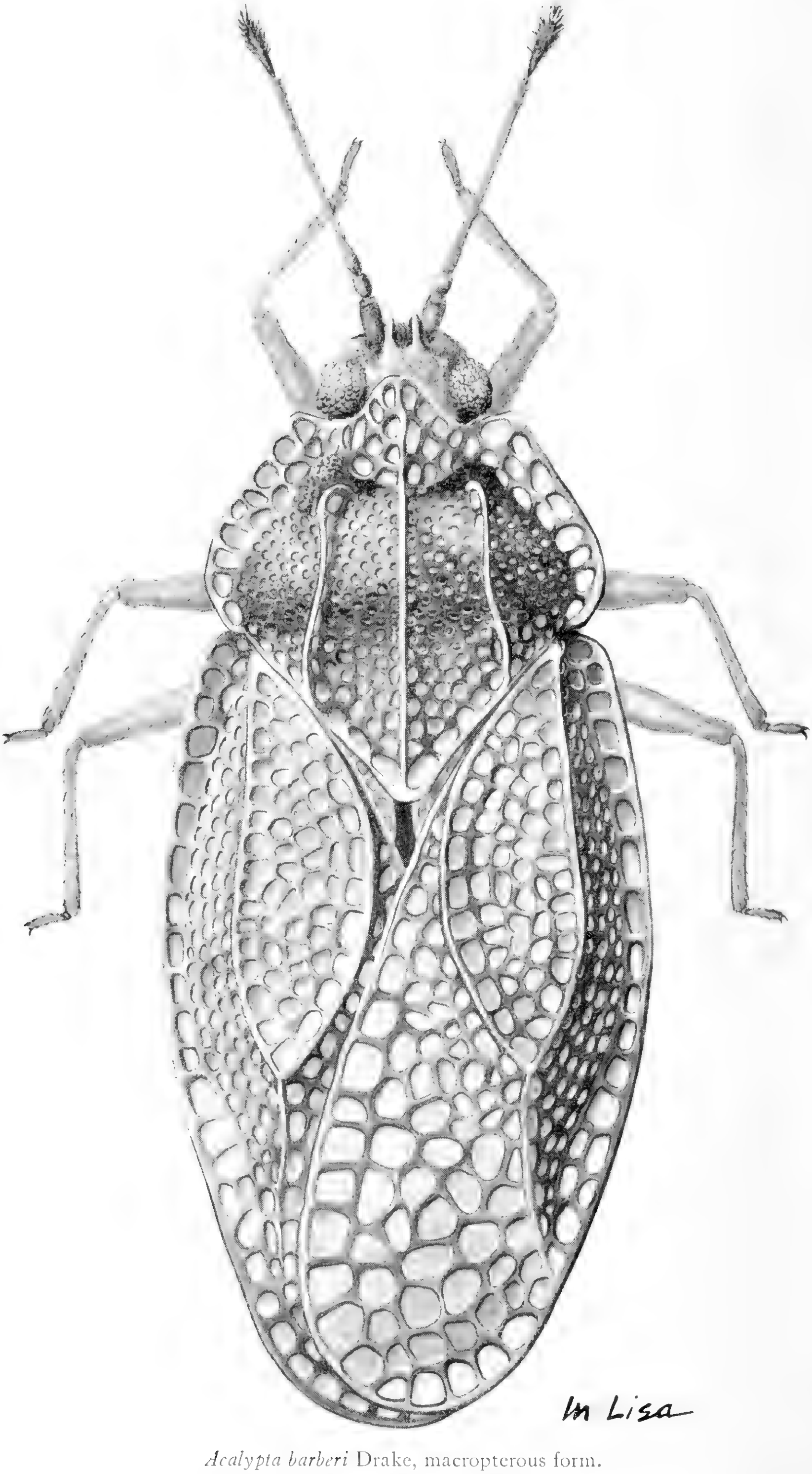
Acalypta nyctalis Drake, brachypterous form.



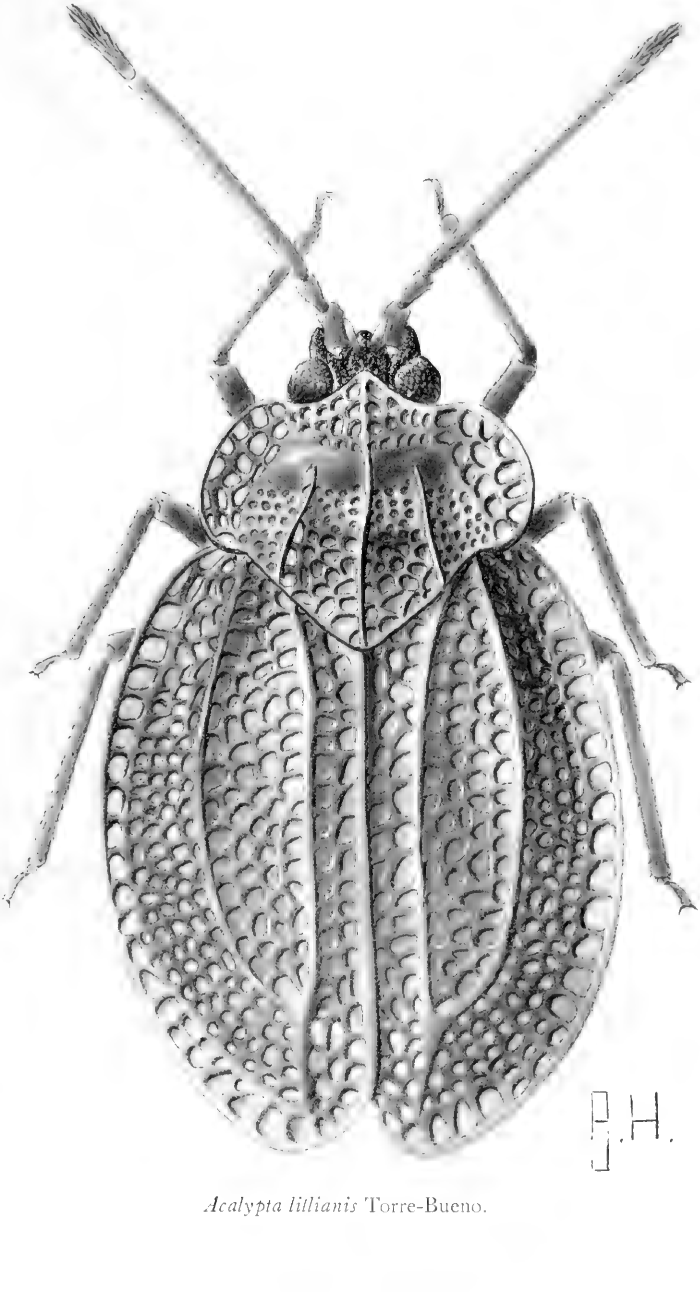
Acalypta nyctalis Drake, fifth instar.



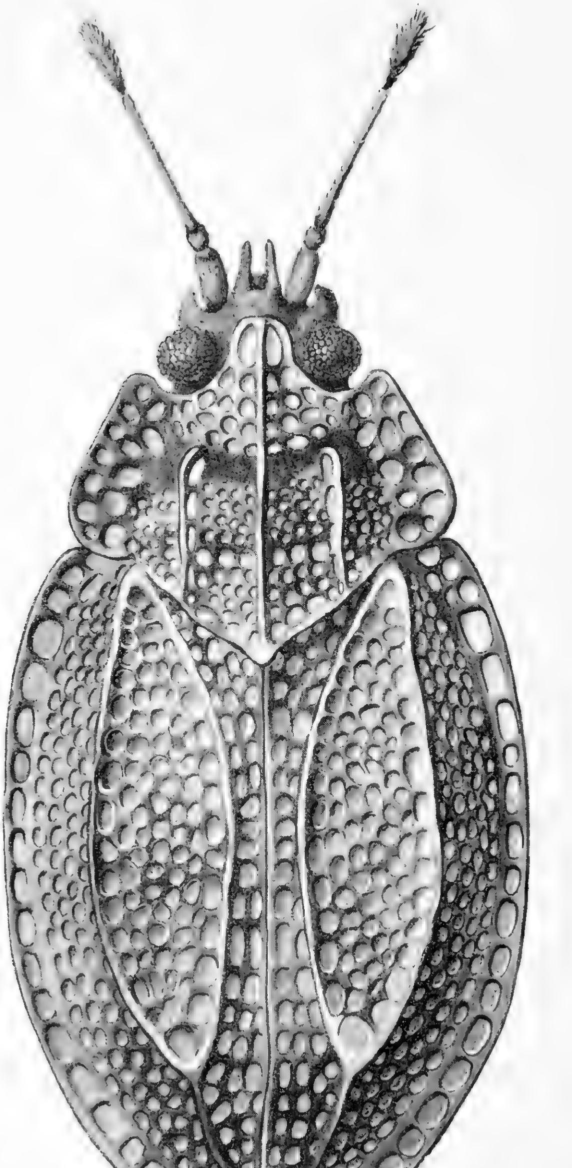
Acalypta barberi Drake, brachypterous form.



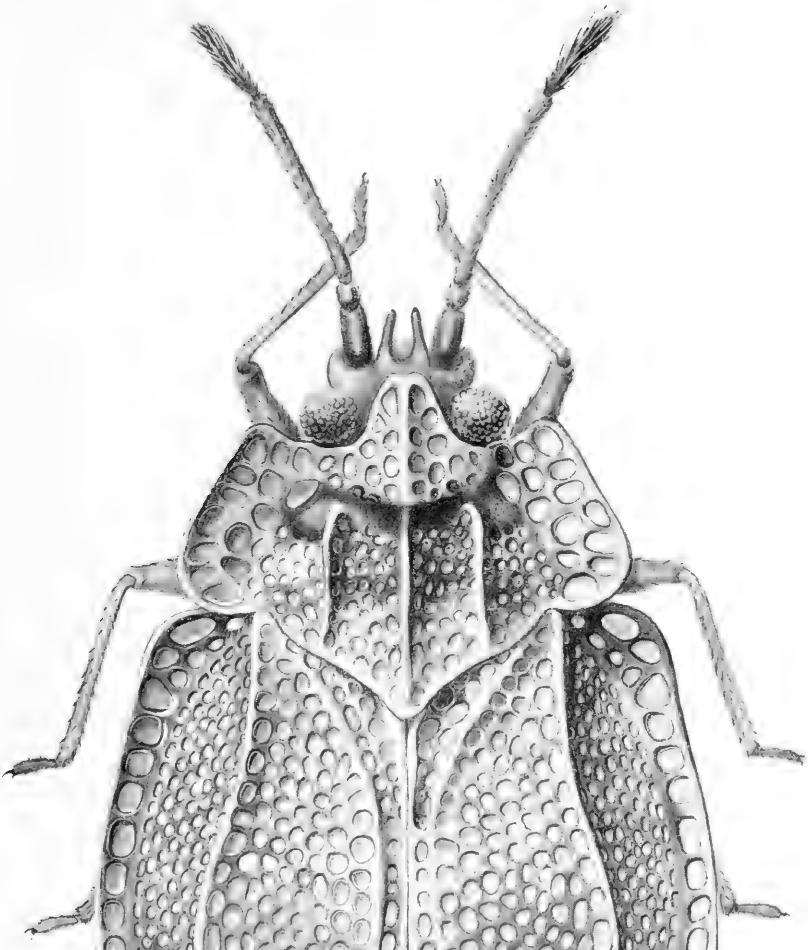
Acalypta barberi Drake, macropterous form.



Acalypta lillianis Torre-Bueno.



Acalypta vandyke. Drake.



Acalypta vanduzeei Drake.

Elytra with fairly large areolae; costal area wide, varying in almost all degrees from one to two complete rows of large areolae, usually with one and a partial second row of areolae; discoidal area narrow, shorter than in other members of the genus, narrower than subcostal area, acutely angulate at base and apex, three or four areolae deep in widest part. Length 2.30–2.70 mm., width (elytra) 1.25–1.55 mm. Macropterous form unknown.

Holotype.—Brachypterous ♂, "Carolina meridionalis" (S.C.), in Naturhistoriska Riksmuseum, Stockholm, Sweden.

Distribution.—Massachusetts, Rhode Island, New Jersey, Maryland, District of Columbia, Virginia, Georgia, North Carolina, South Carolina, and Florida. Known only from the eastern coastal states. Adults and nymphs were collected on mosses, the only known host. It has also been collected during the winter months on mosses. A brachypterous ♀ from Rhode Island is illustrated.

Acalypta nyctalis Drake

Plates 9, 10

Acalypta nyctalis Drake 1928b, pp. 3, 5.—Hurd 1946, p. 463.—Bailey 1951, p. 35.—Lindberg 1958, p. 13.—Drake and Ruhoff 1959, p. 139.

Brachypterous form.—Elongate-ovate, brownish testaceous, antenna testaceous with fourth segment black, legs testaceous. Antennal measurements: segment I, 0.15 mm.; II, 0.10 mm.; III, 0.25 mm.; IV, 0.25 mm. Head with frontal spines rather slender; bucculae open in front. Pronotum reticulate, tricarinate; carinae low, outer pair less elevated than median and slightly divergent posteriorly, each carina slightly raised and becoming uniseriate anteriorly; paranotum rather narrow, mostly biseriate, with a few extra areolae in front; hood small, feebly roundly produced anteriorly. Elytron with very long discoidal area, as wide or slightly wider than subcostal area; costal area usually entirely uniseriate, with small areolae. Hypocostal lamina uniseriate. Length 2.60–2.72 mm., width (elytra) 1.22 mm. Macropterous form and male unknown.

Holotype.—Brachypterous ♀, Franconia, New Hampshire, in U.S. National Museum (type no. 51715).

Distribution.—United States: New Hampshire, Alaska (Point Richardson and Fairbanks); Canada: Newfoundland and Alberta. This is our most northerly distributed member of the genus. A brachypterous ♀ from Point Richardson and the last nymphal instar from Fairbanks, Alaska, are illustrated.

Acalypta barberi Drake

Plates 11, 12

Acalypta barberi Drake 1934, p. 196.—Hurd 1946, p. 463.—Drake and Ruhoff 1959, p. 138.

Acalypta mera Drake 1941, p. 142.—Hurd 1946, p. 465.

Brachypterous form.—Ovate, obovate or elongate-ovate, brownish to dark fuscous, often with a slight reddish tinge, body beneath stramineous to dark fuscous, head often black. Legs brownish, femora usually darker. Antenna brownish with fourth segment blackish. Length 1.90–2.24 mm., width 0.90–1.20 mm.

Head with a pair of porrect frontal spines; bucculae areolate, open in front; antennal measurements: segment I, 0.15 mm.; II, 0.11 mm.; III, 0.46 mm.; IV, 0.20 mm. Pronotum coarsely punctate, tricarinate, each carina composed of one row of moderately large areolae; lateral carinae slightly less raised than median carina, divergent posteriorly; hood small, projected over base of vertex, obtusely rounded at apex; paranotum wide, biseriate, or wider and triseriate in front, anterolateral corner angulate. Hypocostal lamina uniseriate. Elytron with divisions and areolae as shown in illustration.

Macropterous form.—Pronotum distinctly convex, coarsely punctate, carinae slightly less elevated than in brachyptery; paranota biseriate or wider with several interpolated areolae in front and before apex. Elytra much longer than abdomen, sutural areas overlapping each other at rest; clavus distinct, concealed beneath triangular process of pronotum in resting posture; discoidal area about four-sevenths as long as elytron; costal area mostly uniseriate, often with a few intercalated areolae at base and before apex. Length 2.16–2.44 mm., width (elytra) 1.12 mm.

Holotype.—Brachypterous ♀, Merrifield, New York, July 21, 1927, C. R. Crosby, U.S. National Museum.

Distribution.—United States: New York, Oregon. Canada: British Columbia, New Brunswick. See map (pl. 2) for distribution in western United States and Canada. Several thousand specimens were collected by means of Berlese funnels in Oregon by the junior author and associate. Mr. Joe Schuh also has taken many specimens in Oregon. Feeds and breeds on mosses. Numerous adults and nymphs were collected on hops at Coburg, Oreg., Aug. 26, 1935, N. P. Larson. The hops were serving as temporary host plants after the mosses had dried up.

Acalypta lillianis Torre-Bueno

PLATE 13

Acalypta lillianis Torre-Bueno 1916, p. 39.—Osborn and Drake 1916a, p. 221, figs. 1, 2.—Van Duzee 1916, p. 25; 1917, p. 212.—Parshley 1917a, p. 14; 1917b, p. 53; 1923, p. 698.—Barber 1922, p. 17.—McAtee 1923, p. 145.—Blatchley 1926, p. 481, fig. 111.—Drake 1928a, p. 100; 1928b, p. 6.—Froeschner 1944, p. 669.—Hurd 1946, p. 463.—Bailey 1951, p. 32.—Lindberg 1958, p. 14.—Byers 1959, p. 191.—Drake and Ruhoff 1959, p. 139.

Acalypta ovata Osborn and Drake 1916b, p. 9, fig. 1.—Van Duzee 1917, p. 212.—Drake 1932, p. 100.

Acalypta grisea Heidemann 1917, p. 218, pl. 17, fig. 2.—McAtee 1917, p. 78.—Van Duzee 1917, p. 813.

Acalypta modesta Parshley 1921, p. 16.—Downes 1925, p. 14; 1927a, p. 10.—Drake 1928b, pp. 3, 7.

BRACHYPTEROUS FORM.—Ovate, obovate, or elongate-ovate, dark brown to dark fuscous brown. Antenna brown with first two and fourth segments blackish fuscous, III testaceous, sometimes also fuscous, body beneath stramineous to dark fuscous. Length 2.00–2.35 mm., width (elytra) 1.20–1.40 mm.

Head short, armed with two, porrect, frontal spines; bucculae closed or open in front; labium extending to end of sternal sulcus, open at base. Pronotum tricarinate, each carina raised anteriorly and composed of a row of fairly large areolae, the lateral carinae slightly divergent posteriorly; paranotum moderately wide, entirely biseriate or with some extra areolae anteriorly, front and lateral margins jointly rounded, thus rounded at anterolateral corner. Elytron with discoidal area long, slightly more than three-fourths as long as elytron, boundary veins raised, longitudinally sulcate; costal area uniseriate, sometimes with a few intercalated areolae at base and a little in front of apex; subcostal area as wide or slightly wider than discoidal area, each three to four areolae deep in widest part. Hypocostal lamina uniseriate. Hind wings absent.

MACROPTEROUS FORM.—Oblong. Pronotum distinctly convex, tricarinate; carinae less elevated than in brachypterous form, each uniseriate, the lateral pair divergent posteriorly. Elytra much longer than abdomen, sutural areas overlapping each other in repose; clavus well developed, concealed under the backward projection of pronotum in repose; discoidal area about five-sevenths as long as elytron. Metathoracic wings long, functional. Other characters similar to those in brachypterous form. Length 3.00–3.12 mm., width 1.25 mm.

Lectotype.—♀, White Plains, New York, in Snow Museum, University of Kansas.

Distribution.—United States: Maine, New Hampshire, Massachusetts, Vermont, Connecticut, New York, Pennsylvania, Ohio, Indiana, Illinois, Iowa, Michigan, Minnesota, North Dakota, Wisconsin, Nebraska, Virginia, New Jersey, North Carolina, Rhode Island, Idaho, Tennessee, Maryland, District of Columbia, Alaska. Canada: Quebec, Ontario, Newfoundland, British Columbia.

The furcate discoidal area and rounded outer margins of the pronotum separate *A. lillianis* from closely allied species. Host records are from mosses.

Acalypta vandykei Drake

Plate 14

Acalypta vandykei Drake 1928b, pp. 3, 8.—Hurd 1946, p. 463.—Drake and Ruhoff 1959, p. 139.

Brachypterous form.—Elongate-ovate, dark reddish brown with head and body beneath dark fuscous. Antenna with fourth segment subclavate, measurements: segment I, 0.13 mm.; II, 0.08 mm.; III, 0.38 mm.; IV, 0.20 mm. Pronotum with lateral carinae parallel, slightly less raised than median carina, with nearly quadrate areolae; paranotum fairly wide, triseriate in front, biseriate opposite humeral angle. Hypocostal lamina uniseriate. Size and arrangement of areolae and divisions of elytron as shown in illustration. Length 1.88 mm., width (elytra) 1.10 mm. Macropterous form unknown.

Holotype.—Brachypterous ♂, San Francisco County, California, in California Academy of Sciences.

Distribution.—California.

This species can be separated from *A. barberi* by the characters employed in the key. *A. lillianis* differs from the above species by having a longer and more sulcate discoidal area and jointly rounded front and lateral margins of the paranotum. Collected on moss. The allotype is figured.

Acalypta vanduzeei Drake

Plate 15

Acalypta vanduzeei Drake 1928b, pp. 3, 8.—Hurd 1946, p. 463.—Drake and Ruhoff 1959, p. 139.

Brachypterous female.—Ovate, brown with head blackish, body beneath yellowish brown. Pronotum rather short, tricarinate; carinae raised anteriorly, each composed of one row of nearly quadrate areolae; lateral carinae parallel, slightly less raised than median; hood obtuse at apex; paranotum biseriate opposite humeral angle, triseriate in front, angulate at anterolateral corner. Hypocostal lamina uniseriate. Antenna with segment IV fusiform, measurements: segment I, 0.13 mm.; II, 0.08 mm.; III, 0.38 mm.; IV, 0.20 mm. Elytron with divisions and areolae as in illustration. Length 2.25 mm., width (elytra) 1.30 mm.

HOLOTYPE.—Brachypterous ♂, Green Point Ranch, Humboldt County, California; in California Academy of Sciences, Golden Gate Park, San Francisco, Calif.

DISTRIBUTION.—Known only from the two type specimens. The form and longer third antennal segment separate this species from *A. vandykei*. Inhabits moss. The allotype is illustrated.

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THE CALIGID COPEPOD GENUS DENTIGRYPS (CRUSTACEA: CALIGOIDA)

By Alan G. Lewis [1]

Introduction

The genus *Dentigryps* was erected by C. B. Wilson (1913) for *D. curtus*, which Wilson described on the basis of six female specimens taken from the mouth and gill cavities of *Mycteroperca venenosa apua* (Bloch) in Bermuda. Only one additional species has since been described in the genus, *D. bifurcatus* Lewis (1964), although several closely allied species have been described in other genera without any comment on their affinities with *Dentigryps*.

Wilson (1913) indicates that *Dentigryps* may be a connecting link between several genera which include representatives of the families Caligidae and Euryphoridae. This implication is discussed following the description of the four species included in this survey.

This work is based largely on material, including the types of the new species, deposited in the collections of the United States National Museum. The specimens were collected from fishes taken in Florida, the Hawaiian Islands, and at Eniwetok Atoll in the Marshall Islands. The author was assisted by a Sigma Xi RESA grant-in-aid for the summer of 1961. He is grateful for this and for the aid given to him

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by the U.S. Atomic Energy Commission and the Eniwetok Marine Biological Laboratory during the time that the Eniwetok Atoll collections were being made. The loan of some specimens of *Dentigryps curtus* by the division of marine invertebrates, U.S. National Museum, is also deeply appreciated. Additionally, the assistance given to the author by Eugene Shinn, David Au, John Shoup, Samuel Kaolulo, and Lester Zukeran in the collection of the fish hosts greatly facilitated the study.

The drawings included in the figures were made in one of two ways: The entire animal was drawn, with the aid of a Bausch and Lomb Tri- simplex microprojector provided by the University of New Hampshire Central University Research Fund, from specimens stained in Methyl Blue, placed in 85 percent lactic acid and covered with a 9-mm. cover slip; the appendages and processes were drawn, with the aid of a camera lucida, either in situ on the wholemount or removed and mounted in Hoyer's mounting medium. Measurements of the copepods and their component parts were made with an ocular micrometer.

In the figures the ♂ and ♀ signs are used separately under each drawing to indicate a difference between the appendage of the female and that of the male, and together (♂♀) to indicate similarity; the sex from which the drawing was made is indicated by a line under the appropriate symbol.

The terminology used is basically the same as that in Lewis (1964). To facilitate the use of the thoracic leg tables, a hypothetical thoracic leg is shown in figure 1, and the component parts of the armament of the legs are shown in tabular form in table 1.

TABLE 1.—*Armature of hypothetical thoracic leg shown in figure 1.*

Leg	Margin	Sternal plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
	outer	m		m, rh	2s	d, dH	H, h, Q, P	C	c	c, 2p' P
	inner		P, s	m, p, s	P, H	c, fH	fh, mH, Q, 2P	P	c, 2P	c, 3P

Subclass Copepoda: Order Caligoida

Genus *Dentigryps* Wilson

Dentigryps Wilson, 1913, pp. 221-222; Lewis, 1964, p. 203.

Diagnosis.—Adult (emended from Wilson, 1913): Total length of body, excluding setae, ranging from slightly more than 2 mm. to over 7 mm., males smaller than females.

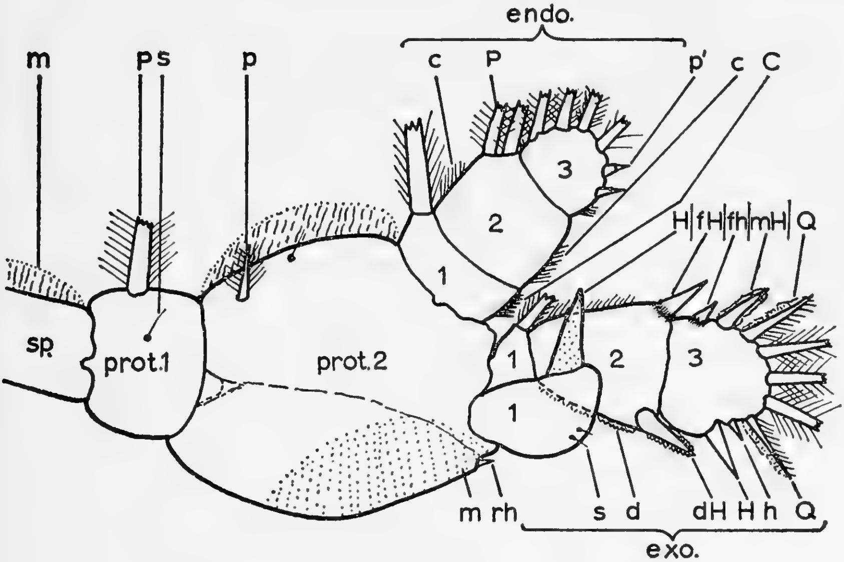

FIGURE 1.—Hypothetical thoracic leg showing the various armament components:

C: heavy fringing setules
c: light fringing setules
d: denticulations
dH: large denticulated spine
endo: endopodite
exo: exopodite
fH: large spine with frill around base
fh: small spine with frill around base
H: large spine
h: small spine
m: membrane
mH: large membrane-margined spine
P: large plumose seta
p: small plumose seta
p′: small naked seta
prot.: protopodite
Q: large seta plumose on one side, membrane-margined on other
rh: spinule
s: solitary hairlike process
sp: sternal plate
Numbers: segment numbers

Cephalothorax strongly compressed dorsoventrally, consisting of cephalosome and four thoracic somites, the first bearing a single pair of maxillipeds, the next three pedigerous. Frontal plates present, flattened, with membrane along anterior margin but without lunules. Lateral cephalothoracic margins with membrane. Lateral posterior surfaces with distinct sinus, median portion of posterior surface forming junction with free fourth pedigerous segment.

Free fourth pedigerous segment either partially or completely covered dorsally by extension of median portion of posterior cephalothoracic surface or bearing some indication of dorsal plates. Dorsal plates, if present, very small, not well developed, not overlapping genital segment. Division between fourth pedigerous and genital segments visible, at least laterally, although often indistinct and incomplete.

Genital segment probably consisting of two segments, at least in the male, as indicated by male fifth and sixth legs. Segment well developed, with or without lobate projections of posterior lateral surfaces. Fifth leg of female and male a distinct, dactyliform or acuminate projection without serrations, sixth leg of male usually a small, knoblike projection although sometimes, as in *D. curtus*, similar to but smaller than male fifth leg.

Abdomen 1-segmented. Caudal rami flattened, not filiform, possessing six setalike projections that are all usually plumose.

Antennules 2-segmented, first segment larger than second, with plumose setae on anterior ventral and distal ventral surface of first segment and naked setae on distal end of second except for one naked seta on distal posterior surface. Antennae 3-segmented, prehensile, female with simple, clawlike terminal process, male with complex terminal process often consisting of several parts. Mandibles rodlike, 4-parted, fourth part short, curving inwards, with inner margin denticulated. Postantennal process present, spikelike, with three nodules, each bearing several hairlike processes. Postoral process present, either bifurcate or simple, frequently with either knob or weakly sclerotized acuminate process on inner surface. Maxillae 2-segmented, second segment tipped by two saber-shaped processes.

Maxillipeds 2-segmented, prehensile, with well sclerotized, clawlike terminal process. Maxillipeds of male frequently with small but

TABLE 2.—*Basic thoracic leg armature for members of the genus* Dentigryps.

Leg	Margin	Sternal plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	outer		p		rh	3H, P				
	inner		p		c	3P				
II	outer	m		m, p	m, H	H	2H, Q, 2P	c	c	c, P(2-3)[1]
	inner		s, P	m, s	c, P	c, P	c, 3P	P	c, 2P	c, P(3-4)[1]
III	outer	m	m, P[2]		s(2-3)	c, p'[3] c, p', (c), 3p', P[4]	c, 3p', P[3]	c	c, P(2-3)[1]	
	inner		P, s, m, s		P, H	c, P[3] c, 4P[4]	(c), 3P	P	c, P(3-4)[1]	
IV	outer		p		h	H	3H			

[1] The sum of the plumose setae on the segment is six.
[2] May be p.
[3] Members with a 3-segmented exopodite.
[4] Members with a 2-segmented exopodite.
(c): c may be absent.

distinct knoblike protrusion from inner surface of first segment that appears to receive distal end of clawlike terminal process of second segment when segment flexed. Sternal furca present, situated between and slightly posterior to maxilliped bases.

First thoracic leg biramous although endopodite reduced to minute, knoblike rudiment in adult. Protopodite 1-segmented, exopodite 2-segmented, second segment tipped by three spines and one seta (see table 2 for remaining basic armature), inner two spines frequently with small, weakly sclerotized, acuminate projection from inner surface. Second thoracic leg distinctly biramous, protopodite 2-segmented, exopodite and endopodite both 3-segmented. Third thoracic leg biramous, protopodite broad, laminate, 1-segmented, exopodite either 2- or 3-segmented, endopodite 2-segmented. Fourth thoracic leg uniramous, protopodite 1-segmented, exopodite (presumably) 3-segmented, denticulations present either on outer surface of second and third exopodite segments, on one or more terminal spines of third exopodite segment or on both segments and spines.

Dentigryps ulua, new species [2]

Figures 2; 3; 4; 12*a,e,i*; 13*a*

(Ulua is the Hawaiian name for many of the carangid fishes.)

Material.—One adult, nonovigerous female designated as the holotype (USNM 107864) taken by the author from the external surface of specimen of *Caranx melampygus*? Cuvier and Valenciennes, captured in trap between Diamond Head and Koko Head, Oahu, Hawaii, by Samuel Kaolulo. One adult male designated as the allotype (USNM 107865) taken from holotype host. Two ovigerous, two nonovigerous adult females, and 1 adult male designated as paratypes (USNM 107866) taken from holotype host. Four ovigerous females, six nonovigerous adult females, and ten adult males designated as paratypes (retained by author) taken from external surface of several specimens of *Caranx melampygus*? captured in traps between Diamond Head and Koko Head, Oahu, Hawaii, by Samuel Kaolulo.

Measurements.—Holotype: Greatest length, excluding caudal setae and fifth legs, 6.90 mm. Greatest length of cephalothorax, including frontal region, 4.50 mm.; greatest width, excluding marginal flanges, 3.60 mm. Greatest length of genital segment, excluding fifth legs, 1.65 mm.; greatest width 1.80 mm. Greatest length of abdomen 0.68 mm. Greatest length of fifth legs 1.37 mm. Greatest length of fifth-leg terminal process 0.07 mm.

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[2] For a comparison of this species with *Lepeophtheirus spinifer* Kirtisinghe, see Discussion (p. 368).

Allotype: Greatest length, excluding caudal setae and fifth legs, 4.88 mm. Greatest length of cephalothorax, including frontal region, 3.30 mm.; greatest width, excluding marginal flanges, 2.78 mm. Greatest length of genital segment, excluding fifth and sixth legs, 0.83 mm.; greatest width 0.98 mm. Greatest length of abdomen 0.30 mm. Greatest length of fifth leg 1.08 mm. Greatest length of fifth-leg terminal process 0.07 mm. Greatest length of sixth leg 0.29 mm. Greatest length of sixth-leg terminal processes 0.18 mm.

For measurements of all specimens, see tables 7 and 8.

Description.—Adult: Body large, female approximately 6–7 mm. in length, excluding setae, male approximately 4.7–5.3 mm. in length, excluding setae. Anterior lateral cephalothoracic margins forming sharply-angled, posteriorly-directed protrusion. Free fourth pedigerous segment slightly covered by posteriorly-projecting median cephalothoracic region, dorsal cuticle appearing as indistinct, platelike structure that does not overlap genital segment. Division between fourth pedigerous and genital segments distinct. Genital segment of female large, lateral posterior surfaces extending posteriorly as distinct, lobate projections. Female and male fifth legs long, heavily sclerotized, extending posteriorly well past posterior end of caudal rami but not past caudal setae, terminating in blunt, scoop-shaped tip bearing plumose setule. Sixth legs of male knob-shaped, with two terminal plumose setules.

First antennular segment with small, heavily sclerotized, shelflike extension of posterior distal surface. Male antenna with terminal

Table 3.—*Armature of thoracic legs I-IV in* Dentigryps ulua, *new species.*

Leg	Margin	Sternal plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	outer		sss[1], p		rh	3 mH, P				
	inner		p		c	3P				
II	outer	m		m, p	m, fmH	mH	2mH, Q, 2P	c	c	c, 3P
	inner		s, P	m, s	c, P	c, P	c, 3P	P	c, 2P	c, 3P
III	outer	m	m, p		3s	c, p'	c, 3p', P	c	c, 2P	
	inner		P, s, m, s		P, H	c, P	3P	P	c, 4P	
IV	outer		p		s, fh	d, fmH	d, 2fmH, fdH			

[1] sss: A nodule bearing three hairlike processes.

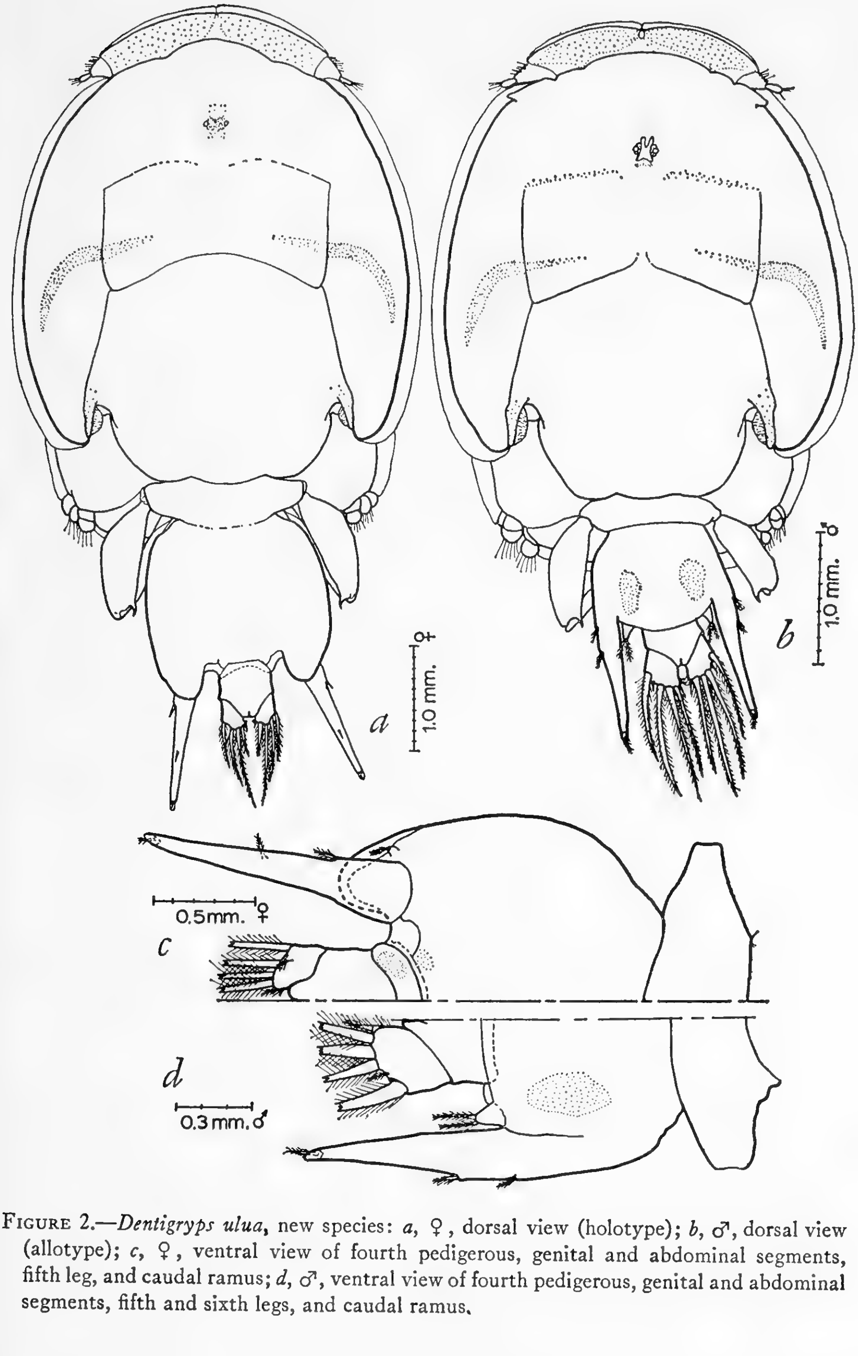

FIGURE 2.—*Dentigryps ulua*, new species: *a*, ♀, dorsal view (holotype); *b*, ♂, dorsal view (allotype); *c*, ♀, ventral view of fourth pedigerous, genital and abdominal segments, fifth leg, and caudal ramus; *d*, ♂, ventral view of fourth pedigerous, genital and abdominal segments, fifth and sixth legs, and caudal ramus.

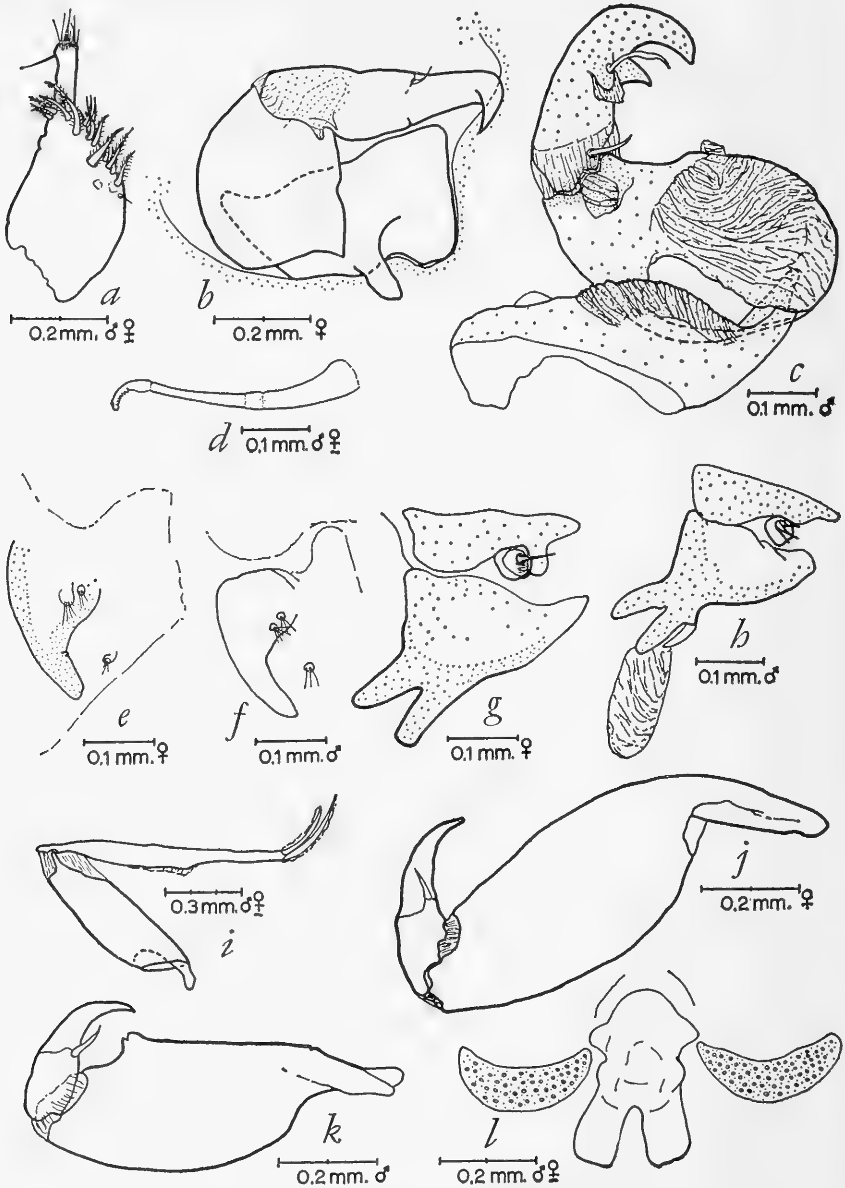

FIGURE 3.—*Dentigryps ulua*, new species: *a*, Antennule; *b*, ♀ antenna; *c*, ♂, antenna; *d*, mandible; *e*, ♀, postantennal process; *f*, ♂, postantennal process; *g*, ♀, postoral process; *h*, ♂, postoral process and adhesion pad posterior to process; *i*, maxilla; *j*, ♀, maxilliped, *k*, ♂, maxilliped; *l*, sternal furca.

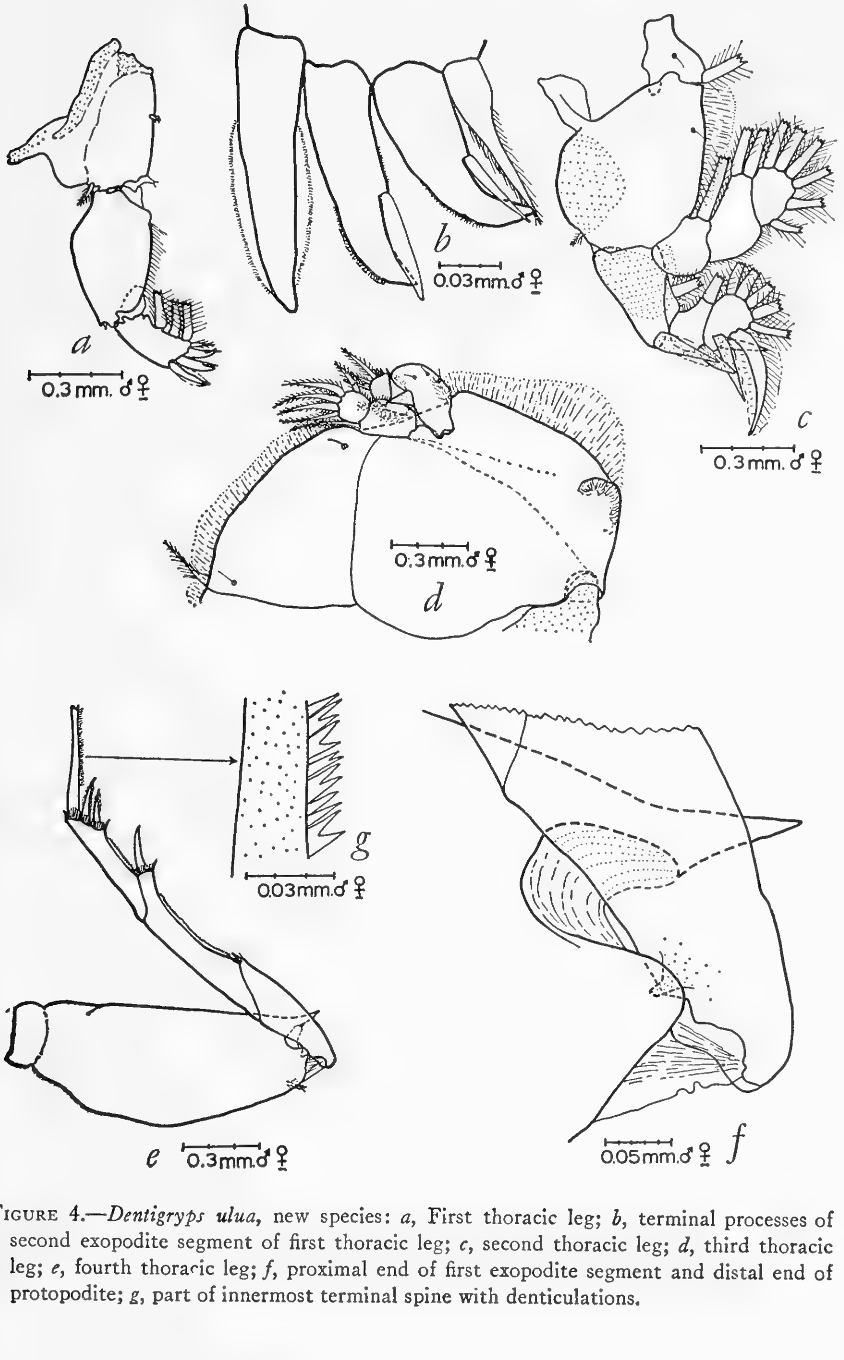

FIGURE 4.—*Dentigryps ulua*, new species: *a*, First thoracic leg; *b*, terminal processes of second exopodite segment of first thoracic leg; *c*, second thoracic leg; *d*, third thoracic leg; *e*, fourth thoracic leg; *f*, proximal end of first exopodite segment and distal end of protopodite; *g*, part of innermost terminal spine with denticulations.

process consisting of bifurcate claw bearing lappet-shaped, membrane-covered process at level of proximalmost furcal ramus. Male with pair of rugose adhesion pads just posterior to mouth cone. Postoral process of female consists of bifurcate protrusion and process-bearing node, of male similar except protrusion constricted at apex of bifurcation and giving rise to short, dactyliform process on inner surface. Sternal furca with chisel-shaped tines. Exopodite of third thoracic leg 3-segmented. Protopodite of fourth thoracic leg with spikelike protrusion of cuticle on inner distal corner.

Dentigryps bifurcatus Lewis, 1964

FIGURES 5; 12*b,f,j*; 13*b*

Dentigryps bifurcatus Lewis, 1964, p. 203, figs. 17, 18.

LOCALITY.—Hawaii.

HOSTS.—*Acanthurus olivaceous* Bloch and Schneider, *Acanthurus triostegus sandvicensis* Streets, *Naso hexacanthus* (Bleeker).

MATERIAL.—Two nonovigerous adult females and two adult males taken by the author from the external surface of a specimen of *Myripristis* sp. captured by spear in Hanauma Bay, Oahu, Hawaii, by Bruce Walsh. Two adult males taken by the author from the external surface of specimen of *Fistularia petimba* Lacépède taken by trap between Diamond Head and Koko Head, Oahu, Hawaii, by Samuel Kaolulo. One nonovigerous adult female taken by the author from

TABLE 4.—*Armature of thoracic legs I–IV of* Dentigryps bifurcatus *Lewis, 1963.*

Leg	Margin	Sternal plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	outer		s?[1], p		h	H, 2mH, P				
	inner		p		c	3P				
II	outer	m		m, p	m, fmdH	mH	dH, mH, Q, 2P	c	c	c, 2P
	inner		s, P	m, s	c, P	c, P	c, 3P	P	c, 2P	c, 4P
III	outer	m	m, P		3s	c, p′	c, 3p′, P	c	c, 3P	
	inner		P, s, m, s		P, H	c, P	c, 3P	P	c, 3P	
IV	outer		p		fh	d, fmH	dm, fmH, fmdH, fmH			

[1] Number of hairlike processes not established with certainty.

a specimen of *Acanthurus olivaceous* Bloch and Schneider captured by trap between Diamond Head and Koko Head, Oahu, Hawaii, by Samuel Kaolulo. All specimens retained by the author.

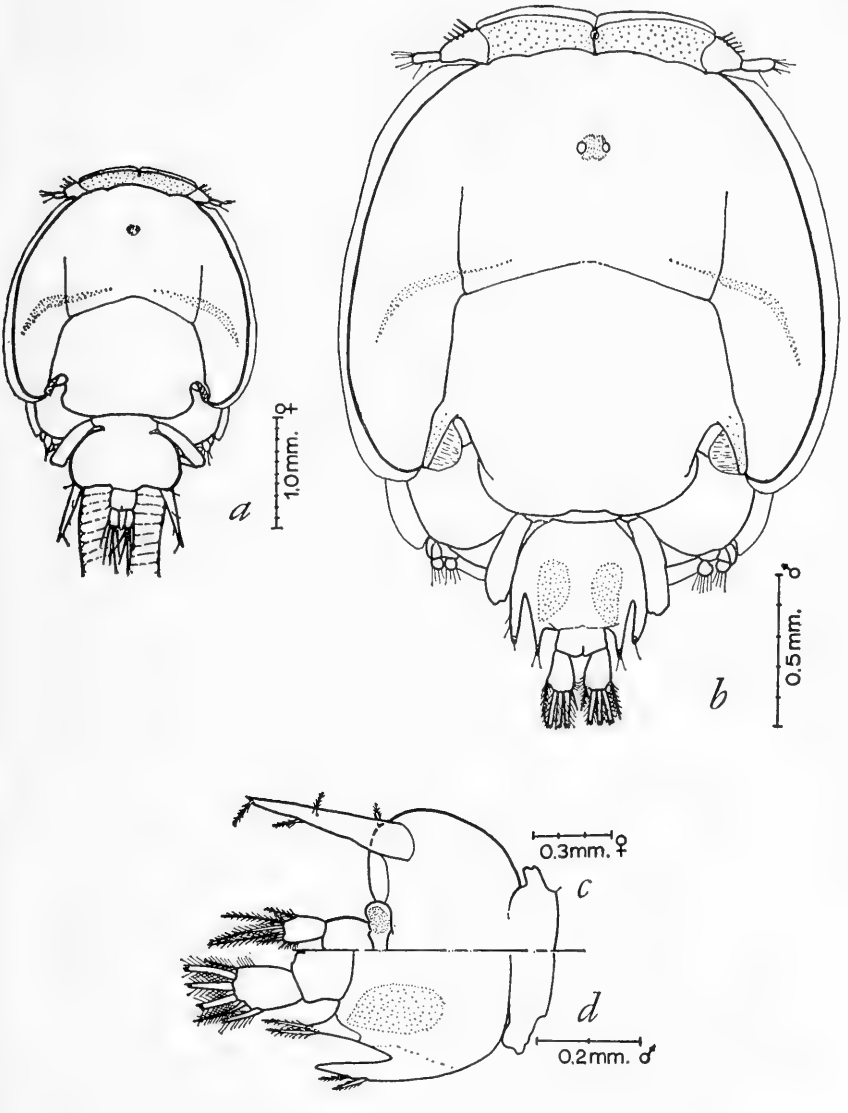

FIGURE 5.—*Dentigryps bifurcatus* Lewis, 1964: *a*, ♀, dorsal view; *b*, ♂, dorsal view; *c*, ♀, ventral view of fourth pedigerous, genital and abdominal segments, fifth leg, and caudal ramus; *d*, ♂, ventral view of fourth pedigerous, genital and abdominal segments, fifth and sixth legs, and caudal ramus.

For measurements of specimens, see tables 7 and 8 under Discussion of the Species.

Description.—Adult: Female approximately 3.0–3.5 mm. in length, male approximately 2.0–2.3 mm., excluding setae. Anterior lateral cephalothoracic margin not forming sharply-angled, posteriorly-directed protrusion. Fourth pedigerous segment of female not covered dorsally by projecting median cephalothoracic region, that of male partially covered. Dorsal cuticle of fourth pedigerous segment indistinctly platelike. Division between fourth pedigerous and genital segments indistinct and incomplete in female, distinct and complete in male. Width of female genital segment slightly less than twice the length. Female fifth legs well developed, heavily sclerotized, extending posteriorly well past caudal rami but not ramal setae, distal end pointed, bearing plumose setule. Male fifth and sixth legs short but distinct, acuminate, projecting posteriorly past posterior end of genital segment. Fifth leg with one plumose setule distally, sixth with two.

Antennule with small, knob-shaped projection of distal posterior lateral surface. Male antenna with terminal process consisting of single, clawlike structure bearing large, bifurcate process from median posterior surface. Male with indistinct indications of pair of adhesion pads posterior to mouth cone base. Third thoracic leg with 3-segmented exopodite.

Dentigryps curtus Wilson

Figures 6; 7; 8; 12*c*,*g*,*k*; 13*c*

Dentigryps curtus Wilson, 1913, p. 222, pl. 32, figs. 127–135; Wilson, 1935, p. 331; Yeatman, 1957, p. 346, figs. 1–16; Lewis, 1964, p. 210, figs. 17*d*,*l*.

Localities.—Bermuda, Dry Tortugas, Fla.

Hosts.—*Mycteroperca venenosa apua* (Bloch), *Mycteroperca tigris* (Cuvier and Valenciennes), *Mycteroperca venenosa* (Linnaeus).

Material.—One ovigerous and three nonovigerous adult females loaned to the author by the U.S. National Museum (USNM 69789), taken by O. L. Williams from the skin of a specimen of *Mycteroperca venenosa* (Linnaeus) captured at Dry Tortugas, Florida. Three ovigerous and three nonovigerous adult females loaned to the author by the U.S. National Museum (USNM 64040), taken by C. B. Wilson from the head of a specimen of *Mycteropreca venenosa apua* (Bloch) captured at Dry Tortugas, Florida. (All U.S. National Museum specimens identified by C. B. Wilson.) Two ovigerous and eleven nonovigerous adult females in addition to one adult male (without caudal rami) collected by Eugene Shinn from the external surface of an unidentified grouper speared off Tennessee Reef, Florida (specimens retained by author). One adult male collected by the author from the left opercle of an unidentified grouper captured by hook and line off Ft. Lauderdale, Florida (USNM 107871).

For measurements of specimens see tables 7 and 8.

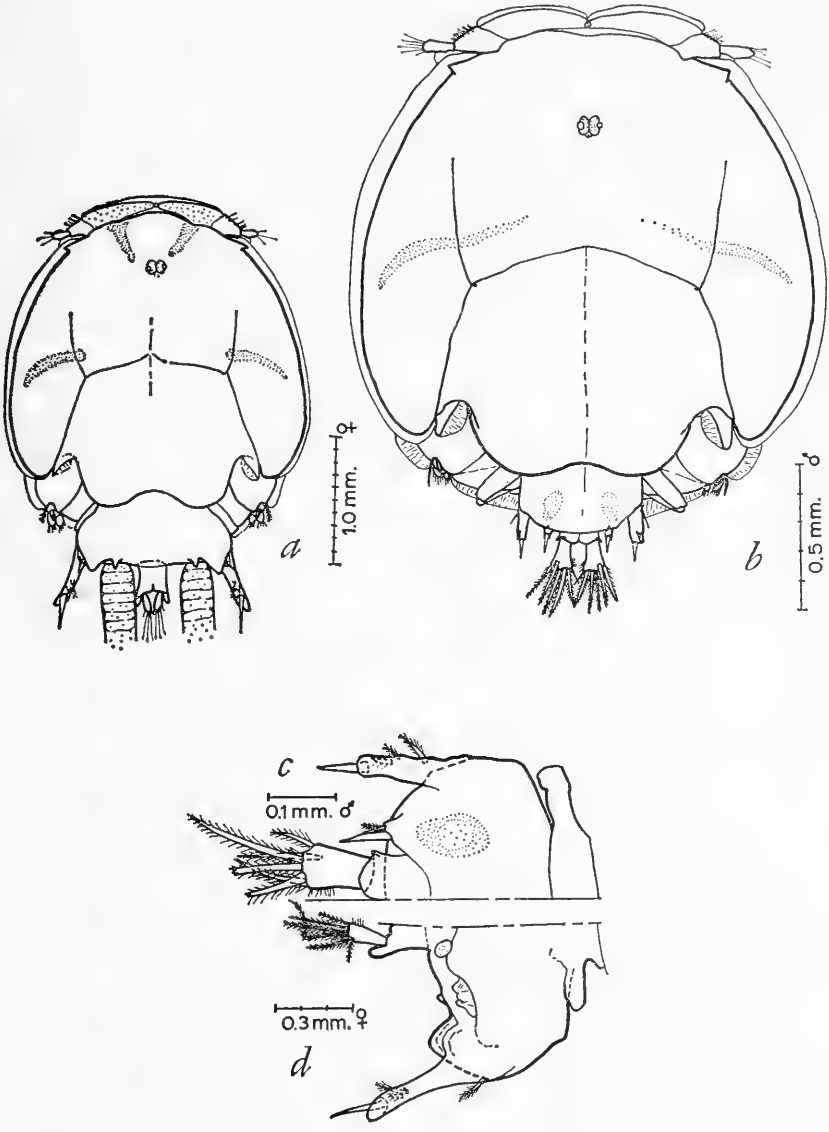

Figure 6.—*Dentigryps curtus* Wilson, 1913: *a*, ♀, dorsal view; *b*, ♂, dorsal view; *c*, ♂, ventral view of fourth pedigerous, genital and abdominal segments, fifth and sixth legs, and caudal ramus; *d*, ♀, ventral view of fourth pedigerous, genital and abdominal segments, fifth leg, and caudal ramus.

Description.—Adult: Female approximately 3–4 mm. in length, male approximately 2 mm. (measurement from one specimen), excluding setae. Anterior lateral cephalothoracic margin forming sharply-angled, posteriorly-directed protrusion. Free fourth pedig-

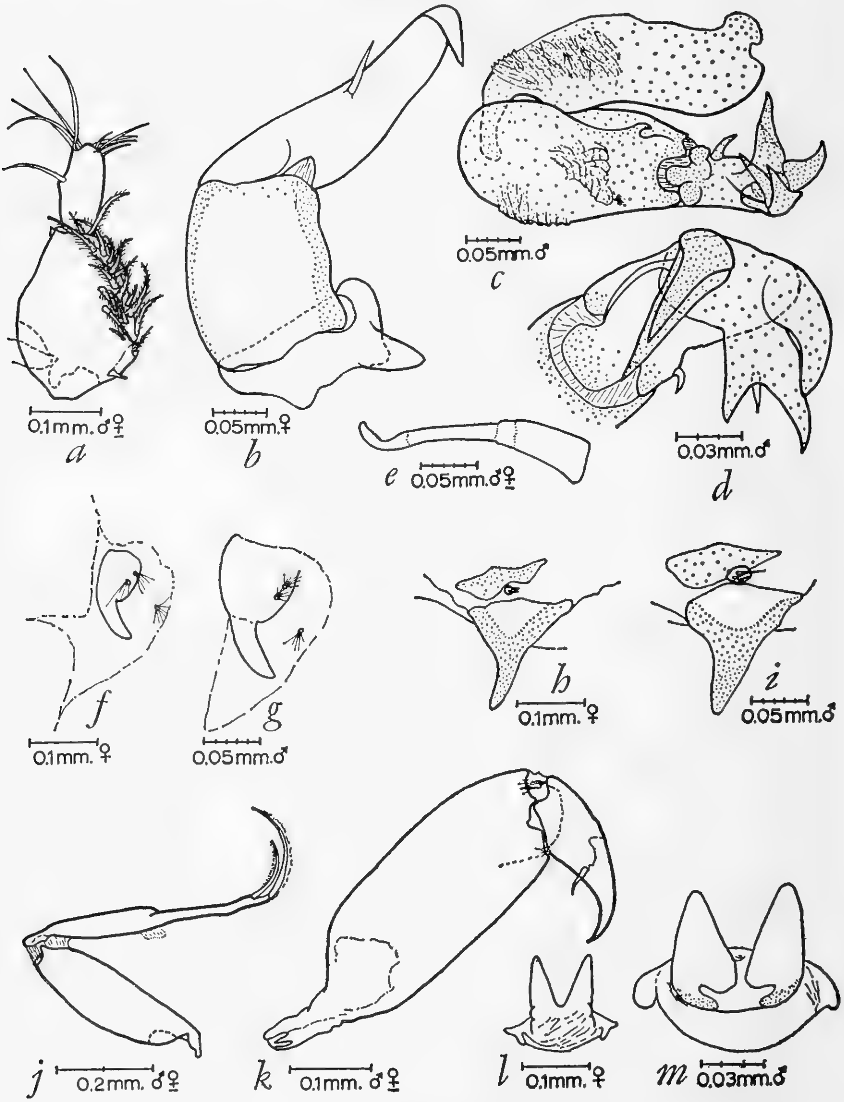

Figure 7.—*Dentigryps curtus* Wilson, 1913: *a*, Antennule; *b*, ♀, antenna; *c*, ♂, antenna; *d*, ♂, third segment and terminal process of antenna; *e*, mandible; *f*, ♀, postantennal process; *g*, ♂, postantennal process; *h*, ♀, postoral process; *i*, ♂, postoral process; *j*, maxilla; *k*, maxilliped; *l*, ♀, sternal furca; *m*, ♂, sternal furca.

erous segment of female covered completely or almost completely by median cephalothoracic region, male completely covered by region which also covers anterior end of genital segment. Division between fourth pedigerous and genital segments indistinct in female, distinct in male. Genital segment of female more than twice as wide as long, with pair of small but distinct projections on each lateral posterior dorsal surface. Male genital segment without posterior processes. Female and male fifth legs appearing 2-parted, consisting of well-

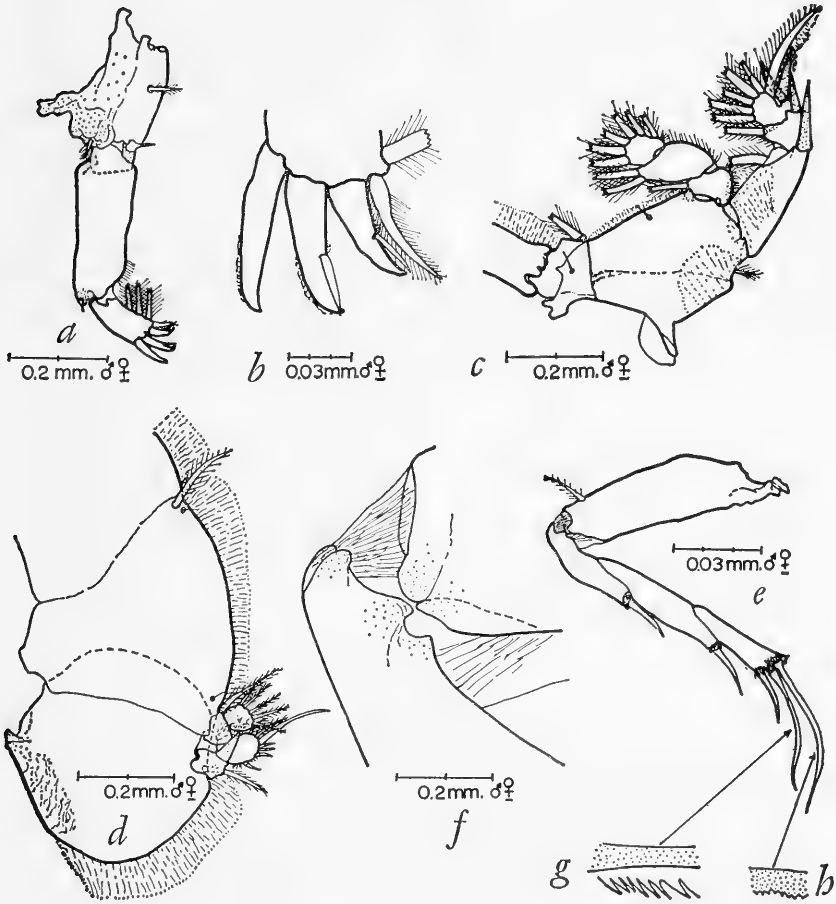

FIGURE 8.—*Dentigryps curtus* Wilson, 1913: *a*, First thoracic leg; *b*, distal end and terminal processes of second exopodite segment of first thoracic leg; *c*, second thoracic leg; *d*, third thoracic leg; *e*, fourth thoracic leg; *f*, proximal end of first exopodite segment and distal end of protopodite of fourth thoracic leg; *g*, denticulations on outer margin of middle terminal spine of fourth thoracic leg; *h*, denticulations on outer margin of inner terminal spine of fourth thoracic leg.

developed, heavily sclerotized proximal portion with scoop-shaped distal end bearing naked but strongly developed spike-shaped terminal seta. Proximal part of leg extending posteriorly to posterior end of abdomen. Male sixth leg short but bearing single, naked, spike-shaped terminal seta. Female with small, lobate extension of posterior lateral abdominal surface, male also with extension but reduced in size.

Distal end of first antennular segment with minute, bifurcate projection of posterior surface. Male antenna with terminal process consisting of double-spined posterior part in which one spine lies above (distal to) other, giving bifurcate appearance in lateral view, additional bifurcate part on anterior lateral portion of process and bearing single accessory process from apex of bifurcation in addition to single, clawlike projection curving anteriorly from base of bifurcation. Third thoracic leg with 2-segmented exopodite, although position and nature of armature elements on outer lateral margin of segment 2 reminiscent of *Dentigryps* species with 3-segmented exopodite (see Discussion of Species).

TABLE 5.—*Armature of thoracic legs I–IV in* Dentigryps curtus *Wilson, 1913.*

Leg	Margin	Sternal plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	outer		p		rh	3mH, P				
	inner		p		c	3P				
II	outer	m		m, p	m, mH	mH	2mH, Q, 2P	c	c	c, 3P
	inner		s, P	m, s	c, P	c, P	c, 3P	P	c, 2P	c?, 3P
III	outer	m	m, P		2s	c, p′, c, 3p′, P		c	c, 3P	
	inner		P, s, m, s		P, mH	c, 4P		P	c, 3P	
IV	outer		p		fmH	fmH	3fmdH[1]			

[1] fmdH: A membrano-encircled spine with a denticulated membranous margin.

Dentigryps litus, new species

FIGURES 9; 10; 11; 12*d,h,l*; 13*d*

(The name "litus," Latin for the coast, the shore, refers to the habitat in which the hosts of this copepod live.)

MATERIAL.—One ovigerous female designated as the holotype (USNM 107867) taken by the author from the external surface of a specimen of *Plectropomus leopardus* (Lacépède) speared by David Au, John Shoup, and Charles King at Eniwetok Atoll. One adult male designated as the allotype (USNM 107868) taken by the author from the external surface of a specimen of *Epinephelus fuscoguttatus* (Forskål) captured by hook and line at Eniwetok Atoll. Two ovigerous and one nonovigerous adult females in addition to one adult male designated as paratypes (USNM 107869) taken by the author from the external surface of the allotype host. Two ovigerous adult females and one nonovigerous adult female designated as paratypes (USNM 107870) taken by the author from the external surface of a specimen of *Aulostomus chinensis* (Linnaeus) captured by hook and line at Eniwetok Atoll. Three ovigerous females and one adult male designated as paratypes (retained by the author) taken from the external surface of a specimen of *Balistoides viridescens* (Bloch) captured by hook and line at Eniwetok Atoll.

Measurements.—Holotype: Greatest length, excluding caudal setae and fifth legs, 3.56 mm. Greatest length of cephalothorax, including frontal region, 2.80 mm.; greatest width excluding marginal flanges, 2.64 mm. Greatest length of genital segment, excluding fifth legs, 0.58 mm.; greatest width 1.10 mm. Greatest length of abdomen 0.35 mm. Greatest length of fifth leg 0.68 mm. Greatest length of fifth-leg terminal process 0.22 mm.

Allotype: Greatest length, excluding caudal setae and fifth legs, 2.78 mm. Greatest length of cephalothorax, including frontal region, 2.33 mm.; greatest width excluding marginal flanges, 2.18 mm. Greatest length of genital segment, excluding fifth and sixth legs, 0.30 mm.; greatest width 0.53 mm. Greatest length of abdomen 0.11 mm. Greatest length of fifth leg 0.32 mm. Greatest length of fifth-leg terminal process 0.14 mm. Greatest length of sixth leg 0.18 mm. Greatest length of sixth-leg terminal process 0.11 mm.

For measurements of all specimens, see tables 7 and 8.

Description.—Adult: Female approximately 3.4–4.0 mm. in length, male approximately 2.4–2.8 mm., excluding setae. Anterior lateral cephalothoracic margin forming sharply-angled, posteriorly-directed protrusion. Free fourth pedigerous segment of female and male almost, if not completely, covered dorsally by median cephalothoracic region. Division between fourth pedigerous and genital segments indistinct in female, distinct in male. Genital segment of female almost twice as wide as long, without posterior dorsal projections but with two small, irregular ventral projections, in region of oviducal opening. Male genital segment irregularly bell-shaped. Female and male fifth legs appearing 2-parted, consisting of well-developed, heavily sclerotized proximal portion with scoop-shaped distal end bearing plumose, strongly developed, spike-shaped terminal seta. Proximal part of female fifth leg extending posteriorly past caudal rami but not ramal setae, proximal part of male fifth leg extending slightly past posterior end of abdomen but not past caudal rami. Male sixth leg bearing two plumose terminal setae. Abdomen without small, lobate extensions of posterior lateral surfaces present in *D. curtus*.

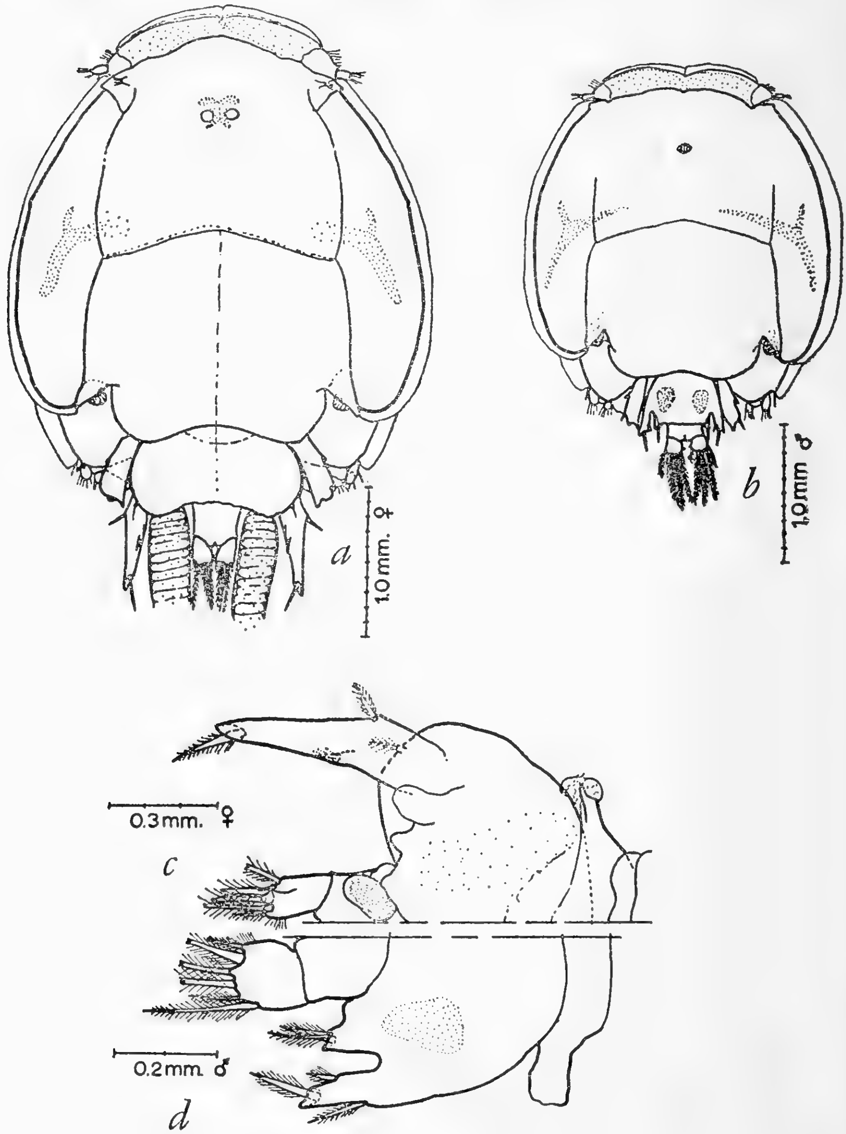

FIGURE 9.—*Dentigryps litus*, new species: *a*, ♀, dorsal view (holotype); *b*, ♂, dorsal view (allotype); *c*, ♀, ventral view of fourth pedigerous, genital and abdominal segments, fifth leg, and caudal ramus; *d*, ♂, ventral view of fourth pedigerous, genital and abdominal segments, fifth and sixth legs, and caudal ramus.

Anterior lateral surface of first antennular segment with single, spike-shaped projection proximally, junction of distal and posterior lateral surfaces forming sharp, slightly projecting point. Male antenna with terminal process consisting of double-spined inner part

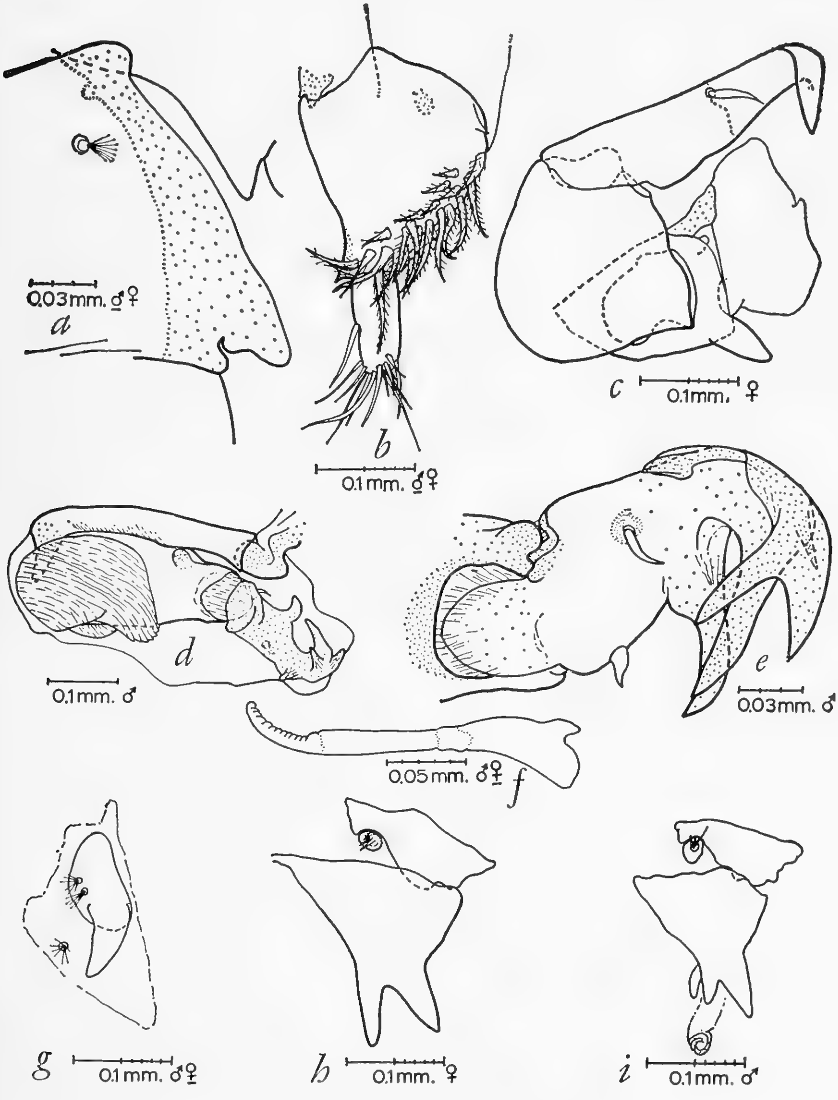

FIGURE 10.—*Dentigryps litus*, new species: *a*, Dorsal view of anterior lateral surface of cephalothorax showing projection of cephalothorax and process-bearing nodule; *b*, antennule; *c*, ♀, antenna; *d*, ♂, antenna; *e*, ♂, third segment and terminal process of antenna; *f*, mandible; *g*, postantennal process; *h*, ♀, postoral process; *i*, ♂, postoral process.

in which one spine lies above (distal to) other, giving bifurcate appearance in lateral view. Additional armature of male antenna terminal process a bifurcate part in distal region, overlying first, double-spined, part and at right angles to it. Second part bearing single, knoblike projection on anterior surface and one on posterior surface, just proximal to distal part of terminal process. Male with distinct indications of pair of adhesion pads posterior to mouth cone. Third thoracic leg with 2-segmented exopodite but armature of second segment not reminiscent of *Dentigryps* with 3-segmented exopodite as is that of *D. curtus.*

TABLE 6.—*Armature of thoracic legs I–IV in* Dentigryps litus *new species.*

Leg	Margin	Sternal plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	outer		ss, p		rh	H, 2mH, P				
	inner		p		c	3P				
II	outer	m		m, p	m, mH	mH	2mH, Q, 2P	C, c	c	c, 2P
	inner		s, P	m, s	c, P	c, P	c, 3P	P	c, 2P	c, 4P
III	outer	m	m, P		3s	c, 4p′, P		c	c, 3P	
	inner		P, s, f, s		P, H	c, 4P		P	c, 3P	
IV	outer		p [1]		frh	fmH	fmH, 2fmdH			

[1] The hook-shaped process on the medial outer surface is considered as an extension of the segment, not part of the associated armature. Hairlike processes are scattered over the surface of the protopodite but are not recorded in this table.

Discussion of the Species

The shape of the cephalothorax is similar in all four species although that of the larger species, *D. ulua,* is slightly more elongate. The anterior region of the lateral cephalothoracic margin is sharply indented in the male of *D. ulua* and in the female and male of *D. curtus* and *D. litus,* and it forms a posteriorly-directed, spikelike projection not present in the female of *D. ulua* or in the female and male of *D. bifurcatus.*

The free fourth pedigerous segment is partially covered by the cephalothorax in the male of *D. bifurcatus* and is almost if not completely covered in both the female and male of *D. curtus* and *D. litus.* The segment is not covered in *D. ulua* and in the female of *D. bifurcatus.* The dorsal cuticle of the fourth pedigerous segment of the female and male *D. ulua* and *D. bifurcatus* appears as an indistinct platelike structure. The junction between the fourth pedigerous segment and genital segment is indistinct and incomplete in the female of *D. bifurcatus, D. curtus,* and *D. litus.*

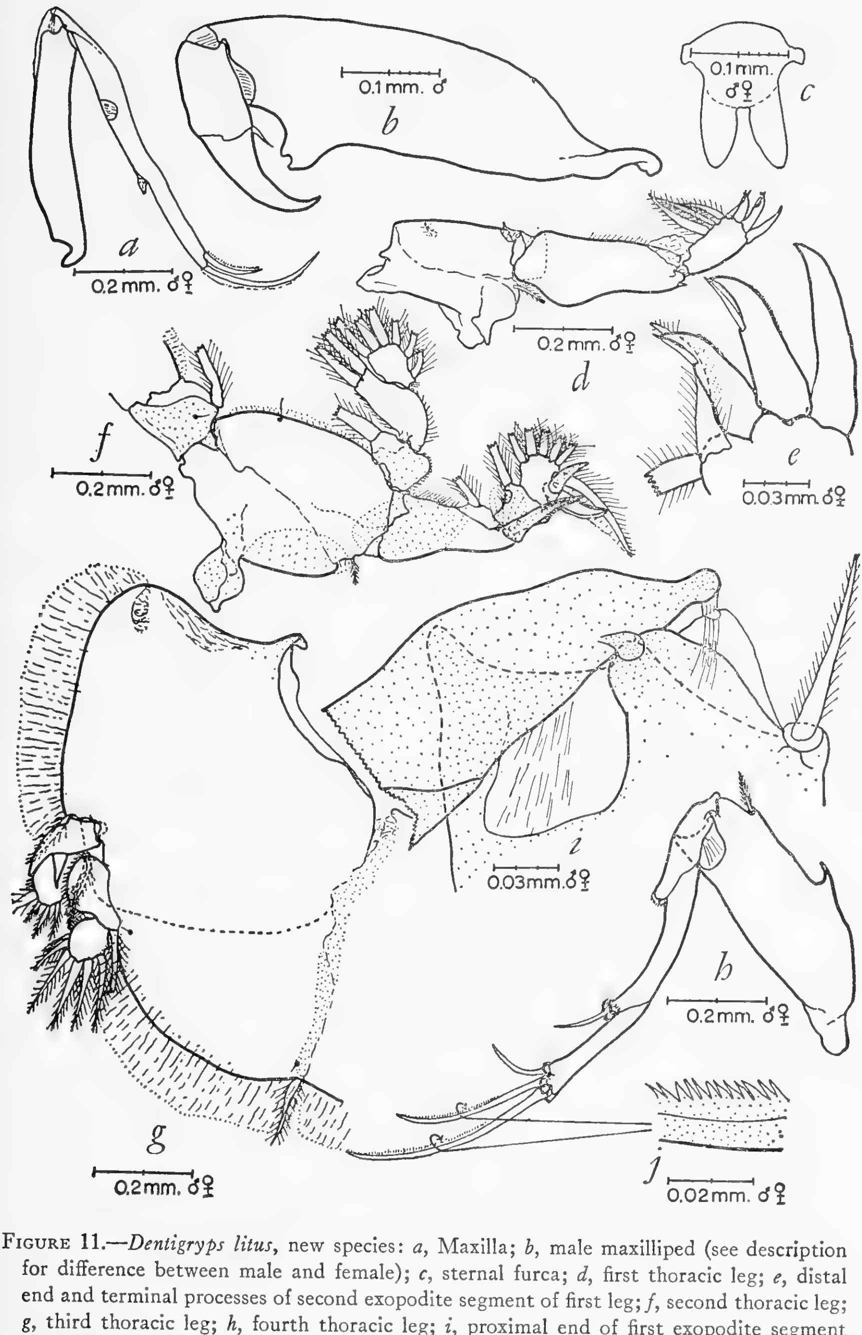

FIGURE 11.—*Dentigryps litus*, new species: *a*, Maxilla; *b*, male maxilliped (see description for difference between male and female); *c*, sternal furca; *d*, first thoracic leg; *e*, distal end and terminal processes of second exopodite segment of first leg; *f*, second thoracic leg; *g*, third thoracic leg; *h*, fourth thoracic leg; *i*, proximal end of first exopodite segment and distal end of protopodite of fourth leg; *j*, part of denticulated inner two terminal spines of fourth leg.

The female genital segment of *D. ulua* has distinct posterior lateral lobes. That of *D. curtus* has two sets of distinct knobs on the posterior surface, the posterior lateral of which may be compared to the posterior lateral lobes of *D. ulua*.

The fifth and sixth legs of the male members of the genus determine at least part of the shape of the segment, due to the association of the legs with the segment. Because of this, no distinct similarities or differences can be shown without discussing the fifth and sixth legs.

The female fifth leg (figs. 12*a–d*) is long and possesses a short terminal process in both *D. ulua* and *D. bifurcatus* and is long and possesses a long and well-developed terminal process in both *D. curtus* and *D. litus*. The only major difference between the female fifth leg of *D. curtus* and that of *D. litus* is that the terminal process of *D. curtus* is naked while that of *D. litus* is plumose.

The male fifth leg (figs. 12*e–h*) of *D. bifurcatus* is spikelike while that of *D. curtus* and *D. litus* is similar, in general makeup, being rather stocky, with a scoop-shaped distal end which gives rise to a naked terminal process in *D. curtus* and a plumose process in *D. litus*, as in the female. The fifth leg of *D. ulua* is much longer than that of *D. curtus* and *D. litus* but, like them, has a scoop-shaped distal end which gives rise to a short process that, in *D. ulua*, is plumose.

The male sixth leg (figs. 12*i–l*) of all four species is short and, in *D. ulua* and *D. bifurcatus*, is of a more generalized nature than the fifth leg. The sixth leg of *D. ulua* is knob-shaped while that of *D. bifurcatus* is spikelike, although with a broad base. The sixth leg of both *D. curtus* and *D. litus* is short and generally knob-shaped but has a scoop-shaped distal end similar to that of the fifth leg. The distal end of the sixth leg of *D. curtus* bears two naked, setalike processes and one plumose seta while that of *D. litus* bears two plumose, setalike processes.

The abdomen of all four species is 1-segmented. The female of *D. curtus* possesses an abdomen with a distinct lobate projection on each posterior lateral surface, while the female of the other three species has either a flat posterior surface, except for the anal indentation, or a biconcave posterior surface which forms the attachment and articulation surface for the caudal rami.

The caudal rami of all four species are fairly similar and do not present differences that appear sufficient to warrant any specific comment.

The antennule appears to present relatively few comparable characteristics, with the exception of one, that of the projection of the posterior distal surface of the first segment present in *D. bifurcatus*, *D. curtus*, and *D. litus*. This projection is heavily sclerotized and, in *D. bifurcatus*, is small and knob-shaped while in both *D. curtus* and

TABLE 7.—*Means and ranges of measurements (in mm.) of female specimens of the four known species of* Dentigryps [1]

Measurement	*D. ulua* (15 specimens)	*D. bifurcatus* (3 specimens)	*D. curtus* (23 specimens)	*D. litus* (10 specimens)
Total length [2]	6. 00–7. 13 (6. 59)	3. 08–3. 45 (3. 28)	3. 15–3. 60 (3. 36)	3. 45–3. 90 (3. 70)
Cephalothorax length [3]	4. 05–5. 25 (4. 43)	2. 33–2. 44 (2. 40)	2. 33–2. 63 (2. 45)	2. 70–3. 00 (2. 90)
width [4]	3. 23–3. 83 (3. 58)	2. 10–2. 33 (2. 25)	2. 25–2. 55 (2. 36)	2. 55–2. 93 (2. 68)
Genital segment length [5]	1. 05–1. 73 (1. 49)	0. 38–0. 60 (0. 53)	0. 53–0. 75 (0. 61)	0. 45–0. 68 (0. 55)
width	1. 28–1. 95 (1. 68)	0. 75–1. 20 (1. 00)	1. 20–1. 35 (1. 29)	1. 13–1. 20 (1. 17)
Abdomen length	0. 53–0. 68 (0. 62)	0. 23 [6]	0. 23–0. 38 (0. 29)	0. 15–0. 23 (0. 20)

[1] The dash-connected measurements indicate the range, and that in parentheses, the mean.
[2] Excluding setae.
[3] Including frontal region.
[4] Excluding marginal flanges.
[5] Excluding fifth legs.
[6] No variation.

TABLE 8.—*Means and ranges of measurements (in mm.) of male specimens of the four known species of* Dentigryps [1]

Measurement	*D. ulua* (12 specimens)	*D. bifurcatus* (4 specimens)	*D. curtus* (1 specimen)	*D. litus* (3 specimens)
Total length [2]	4. 73–5. 25 (4. 95)	2. 10–2. 25 (2. 18)	2. 03 [6]	2. 40–2. 78 (2. 65)
Cephalothorax length [3]	3. 30–4. 20 (3. 48)	1. 65–1. 73 (1. 67)	1. 65	2. 10–2. 33 (2. 20)
width [4]	2. 63–3. 00 (2. 78)	1. 43–1. 65 (1. 54)	1. 58	1. 95–2. 18 (2. 05)
Genital segment length [5]	0. 75–0. 83 (0. 79)	0. 30–0. 38 (0. 34)	0. 23	0. 30–0. 38 (0. 33)
width	0. 83–1. 05 (0. 91)	0. 38–0. 45 (0. 42)	0. 90	0. 53 [7]
Abdomen length	0. 30–0. 45 (0. 36)	0. 08–0. 15 (0. 11)	0. 23	0. 11–0. 15 (0. 14)

[1] The dash-connected measurements indicate the range, and that in parentheses, the mean.
[2] Excluding setae.
[3] Including frontal region.
[4] Excluding marginal flanges.
[5] Excluding fifth and sixth legs.
[6] Only one specimen.
[7] No variation

D. litus it forms a shelflike projection, the base of which extends proximally along the posterior lateral surface of the first segment. In *D. curtus*, this projection is bifurcate distally.

The basic design of the female antenna is similar in all four species. The size of the first and second segments varies to some degree and the complexity of the first segment differs. These are, however, not thought to be of a value sufficient to show interspecific similarities and differences.

The antenna of the male does however show some rather distinct interspecific differences, especially in the makeup of the third segment and the terminal process. The terminal processes of *D. curtus* and *D. litus* are so bizarre that a comparison is almost impossible. The The male antenna of *D. ulua* is quite similar to that of *Lepeophtheirus crassus* (Wilson et Bere) Shiino, 1960, in the position and extent of the adhesion surfaces and the shape and makeup of the third segment and terminal process, although that of *D. ulua* is somewhat more complex. The similarity of the male antenna of *D. bifurcatus* to the other species is questionable, although it is more like that of *D. ulua* in regard to the adhesion surfaces, third segment, and terminal process than either *D. curtus* or *D. litus*.

The postantennal process is fairly similar in all four species and the differences do not appear sufficient to warrant any specific comments.

TABLE 9.—*Female fifth leg measurements (in mm.) and relative lengths*

Species	Specimens	TL [1] L-5 [2]	TL L-5 / TL body	TL TP-5 [3]	TL TP-5 / TL L-5
D. ulua	15	1. 35	0. 21	0. 07	0. 05
D. bifurcatus	3	0. 78	0. 23	0. 07	0. 09
D. curtus	21	0. 69	0. 21	0. 22	0. 33
D. litus	7	0. 84	0. 22	0. 24	0. 28

[1] TL: total length.
[2] L-5: fifth leg.
[3] TP-5: terminal process of fifth leg.

TABLE 10.—*Male fifth and sixth leg measurements (in mm.) and relative lengths*

Species	Specimens	TL [1] L-5 [2]	TL L-5 / TL body	TL TP-5 [3]	TL TP-5 / TL L-5	TL L-6	TL L-6 / TL body	TL TP-6	TL TP-6 / TL L-6
D. ulua	12	1. 14	0. 23	0. 07	0. 06	0. 23	0. 05	0. 13	0. 54
D. bifurcatus	4	0. 25	0. 11	0. 05	0. 19	0. 11	0. 05	0. 06	0. 54
D. curtus	1	0. 18	0. 09	0. 04	0. 22	0. 07	0. 03	0. 04	0. 57
D. litus	3	0. 31	0. 12	0. 12	0. 39	0. 19	0. 07	0. 10	0. 50

[1] TL: total length.
[2] L-5: fifth leg (L-6: sixth leg).
[3] TP-5: terminal process of fifth leg (TP-6: terminal process of sixth leg).

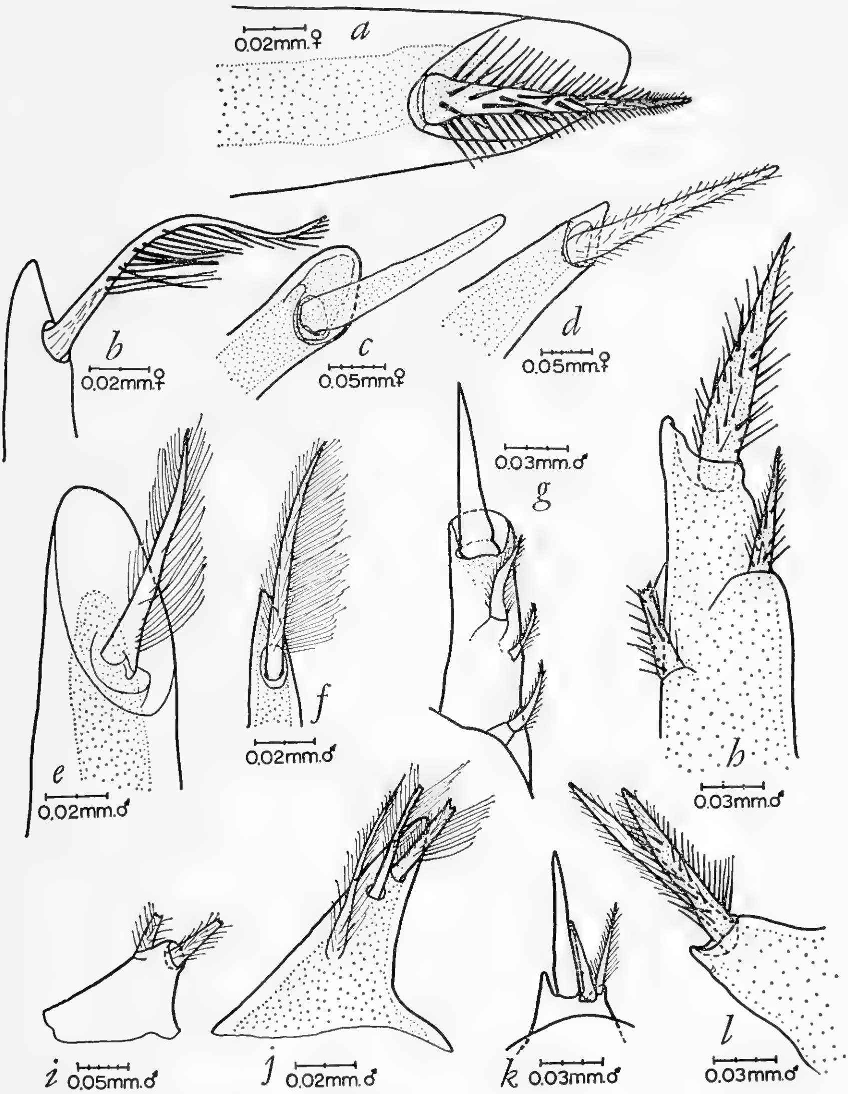

FIGURE 12.—Legs of species of *Dentigryps*: *a–f*, Distal end and terminal process of fifth leg: *a*, ♀, *D. ulua* (dorsal view); *b*, ♀, *D. bifurcatus* (dorsal view); *c*, ♀, *D. curtus* (dorsal view); *d*, ♀, *D. litus* (dorsal view); *e*, ♂, *D. ulua* (dorsal view); *f*, ♂, *D. bifurcatus* (dorsal view); *g*, fifth leg, ♂, *D. curtus* (dorsal view); *h*, fifth leg, ♂, *D. litus* (dorsal view); *i*, sixth leg, ♂, *D. ulua* (dorsal view); *j*, sixth leg, ♂, *D. bifurcatus* (dorsal view); *k*, sixth leg, ♂, *D. curtus* (dorsal view); *l*, sixth leg, ♂, *D. litus* (dorsal view).

One of the structures that has been used in applying the name appendage to the postantennal process is the nodule, arising from the platelike area of sclerotization, which Heegaard (1947) calls "the basal joint" of the first maxilla. In both the male and female of *D. litus* there is a nodule bearing hairlike processes (as do all three of the nodules of the postantennal process) on the dorsal anterior lateral surface of the cephalothorax, just posterior to the division between the frontal region and the cephalothorax (fig. 10*a*) and well separated from any appendage or process. Its presence in this position on *D. litus*, however, implies only that a nodule of this type does not necessarily have to be found in association with a process or an appendage.

The female postoral process of *D. curtus* is simple and not bifurcate while that of *D. ulua, D. bifurcatus*, and *D. litus* is bifurcate. The male postoral process of *D. curtus* is not bifurcate while, as in the female, that of *D. ulua, D. bifurcatus*, and *D. litus* is bifurcate. In the male of the last three species, however, a poorly sclerotized acuminate or dactyliform process arises from the inner margin of the inner tine at the level of the apex of the bifurcation.

A pair of small but distinct adhesion pads on the ventral cephalothoracic surface of the male of *D. ulua* extends posteriorly and medially from the region of the distal end of the postoral process to the region just posterior to the mouth cone. Distinct indications of this adhesion surface appear on the male of *D. litus* and indistinct indications of it on the male of *D. bifurcatus*. *D. curtus* is the only species in which the male does not exhibit any indication of these adhesion surfaces.

The basic structures comprising the maxilla—the two segments, two saber-shaped terminal processes, and the membrane on the second segment—are similar in all four species. The interspecific differences in this appendage are caused by the presence or absence of an accessory structure—a spine or spine-shaped process found in the region of the sharp indentation in the middle of the second segment, and by the minor differences in segment shape. *D. ulua* and *D. curtus* possess the membrane common to all four species but do not possess the spine, while *D. bifurcatus* and *D. litus* possess both the membrane and the spine.

The maxilliped, like the maxilla, is basically similar in all four species, the only major difference being the presence or absence of a distally indented swelling on the inner surface of the male appendage. The male of *D. ulua, D. bifurcatus*, and *D. litus* all possess this swelling while the male of *D. curtus* does not.

The sternal furca of *D. ulua* has chisel-shaped tines while the sternal furca of all of the other species has pointed or rounded tines. In addition, *D. ulua* has a platelike process on either side of the sternal furca while the others either do not have this process or else it is not distinct from the surrounding ventral cephalothoracic cuticle.

The adult first thoracic leg is basically similar in all four species, consisting of a 1-segmented protopodite, a 2-segmented exopodite, and a rudimentary endopodite that gives the leg an indistinctly biramous condition. The differences that occur do so in what could be called secondary armature elements, elements such as the membranes that are present on spines, the individual or small groups of hairlike processes that occur on the segments, the plumose conditions of some of the spines, and small dactyliform or acuminate projections found on some of the spines. These are in contrast to the primary elements such as the spines and setae. The single secondary armature element that appears to be of enough importance to be included in this comparison is a small, acuminate, poorly sclerotized process that projects from the inner surface of each of the inner two terminal spines of the second exopodite segment of *D. ulua, D. curtus*, and *D. litus*. Although *D. bifurcatus* does not possess this process there is, in the same region as the acuminate process on the other species, a distinct membrane, that appears folded and that projects very slightly past the distal end of the terminal spine (the projecting portion is believed to be the folded part of the membrane). As with the first thoracic leg, the comparable difference in the second thoracic leg of all four species occurs in the secondary armature elements. In the second leg however these differences are of such a nature that no distinct trend or grouping can be indicated.

The third thoracic leg (fig. 13, table 11) has a protopodite-exopodite-endopodite segment number of 1–3–2 in *D. ulua* and *D. bifurcatus* and of 1–2–2 in *D. curtus* and *D. litus*. The difference in the number of exopodite segments is important in that it suggests a distinct break between *D. curtus* - *D. litus* and *D. ulua* - *D. bifurcatus*. This break may not be as distinct as it seems, however, as part of the armament of the exopodite of *D. curtus* is unique and suggests a trarsition between the two groups. The outer margin of the distal two exopodite segments in both groups has four small and naked setae that appear to be divided into two parts. In the 1–3–2 group, the second exopodite segment bears one of these setae on its outer distal lateral surface, the remaining three are located on the third segment and are separated from the second segment seta by the division between the segments and by a plumose space. In *D. curtus*, a member of the 1–2–2 group, all four setae are on the second or distalmost segment but there is a distinct space between the proximalmost of the four and the succeeding three setae. This space is plumose. The separation of the proximalmost from the three succeeding setae and the presence of a plumose space is, in *D. curtus*, strongly suggestive of the members of the 1–3–2 group except that there is no indication of segmentation between the proximalmost seta and the other three.

Along the inner lateral surface of the two distal exopodite segments of the 1–3–2 group are four plumose setae, one on the inner-distal lateral surface of the second segment and three on the lateral surface of the third. In addition, the proximal lateral margin of the third segment is plumose. Although both of the species in the 1–2–2 group, *D. curtus* and *D. litus*, have four plumose setae along the second or distal exopodite segment, there is no indication of a plumose surface between the first or proximalmost seta and the second. The spinelike process projecting inward from the inner surface of the first exopodite segment is distinctly separated from the segment by a line of division in all of the species except *D. bifurcatus*. Other than these two characteristics, the differences between the species are the shape of the segments and the variation in the position of the armature components.

Whether the difference in the exopodite makeup of the third leg indicates a fusion of segments (from a 1–3–2 to 1–2–2 condition), a division of segments (from a 1–2–2 to a 1–3–2 condition), or simply a peculiar series in the pertinent armature elements could not be ascertained. The indication is, however, that the distinct difference in the number of segments may possibly be explained by the position and arrangement of the armature.

The fourth thoracic leg protopodite has a distinct, spikelike projection of the inner distal surface in *D. ulua* and a distinct, bluntly tipped projection in *D. litus*. The general armature of the leg and

TABLE 11.—*Armature of third thoracic legs of four species of* Dentigryps.

Species	Margin	Sternal plate	Protopodite	Exopodite 1	Exopodite 2	Exopodite 3	Endopodite 1	Endopodite 2
D. ulua	outer	m	m, p	3s	c, p′	c, 3p′, P	c	c, 2P
	inner		P, s, m, s	P, H	c, P	3P	P	c, 4P
D. bifurcatus	outer	m	m, P	3s	c, p′	c, 3p′, P	c	c, 3P
	inner		P, s, m s	P, H	c, P	c, 3P	P	c, 3P
D. curtus	outer	m	m, P	2s	c, p′, c, 3p′, P		c	c, 3P
	inner		P, s, m, s	P, mH	c, 4P		P	c, 3P
D. litus	outer	m	m, P	3s	c, 4p′, P		c	c, 3P
	inner		P, s, m, s	P, H	c, 4P		P	c, 3P

the dimension and makeup of its components do not permit any clearcut comparisons to be made, but in general the armature of *D. curtus* most closely approximates that of *D. litus*, while those of *D. ulua* and D. *bifurcatus* show some similarities (table 12).

From the comparison of the body and the various appendages it is apparent that there is some interspecific similarity but that a similarity between two species based on one set of characteristics may be offset by differences in other sets of characteristics. The survey does indicate, however, that there is a good deal of similarity

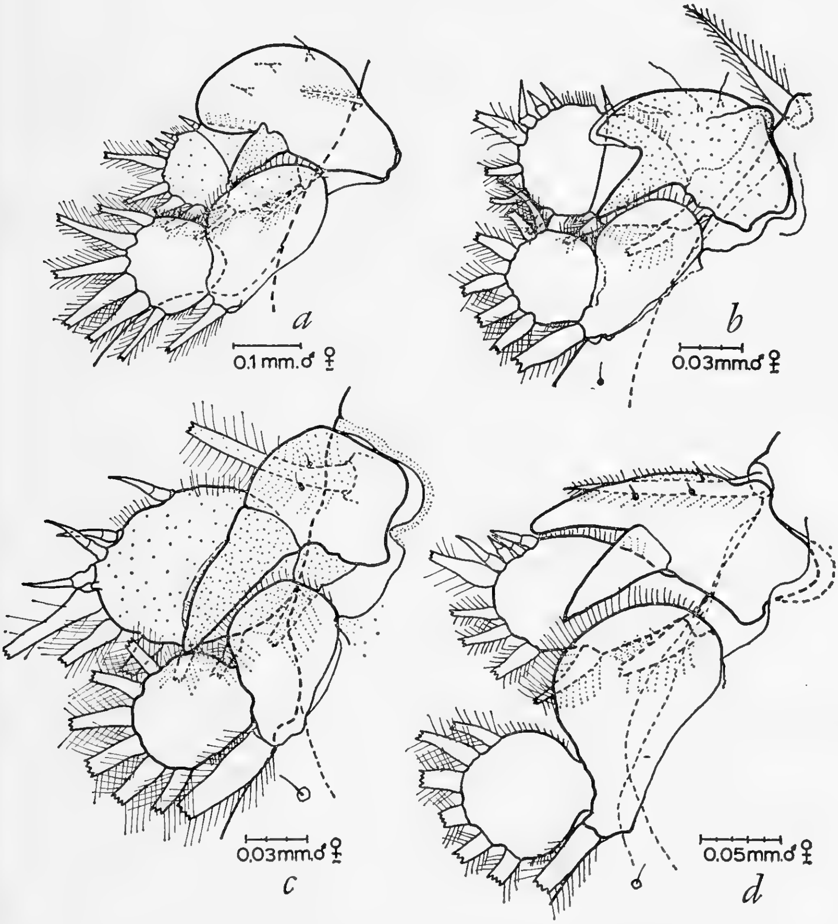

FIGURE 13.—Exopodite and endopodite portion of third thoracic leg of species of *Dentigryps*: *a*, *D. ulua* (ventral view); *b*, *D. bifurcatus* (ventral view); *c*, *D. curtus* (ventral view); *d*, *D. litus* (ventral view).

between *D. curtus* and *D. litus*, particularly with regard to the body shape, the female and male fifth legs, and the third legs. Evidence of similarity between *D. ulua* and *D. bifurcatus* also exists in the armature of the first four thoracic legs.

While the geographic distribution of the four species is not fully known, the reported localities (see table 13) suggest some rather interesting problems, especially with regard to the morphological similarity between *D. curtus* and *D. litus*. *D. curtus* has been reported from the tropical and subtropical Atlantic, *D. litus* has been described from specimens captured at Eniwetok Atoll in the Pacific and has not been found on Hawaiian fishes. It would be of interest to determine whether either of the two species, or a similar species, occurs on fishes in the Indian Ocean or on fishes from the west coast of Africa.

TABLE 12.—*Armature of fourth thoracic legs of four species of* Dentigryps.

Species	Margin	Protopodite	Exopodite		
			1	2	3
D. ulua	outer	p	s, fh	d, fmH	d, 2fmH, fdH
D. bifurcatus	outer	p	fh	d, fmH	d, fmH, fdmH, fmH
D. curtus	outer	p	fmH	fmH	3fmdH
D. litus	outer	p	frh	fmH	fmH, 2fmdH

TABLE 13.—*Reported localities for described species of* Dentigryps.

Species	Reported localities
D. ulua	Hawaiian Islands.
D. *bifurcatus*	Hawaiian Islands.
D. curtus	Bermuda, Dry Tortugas, Florida.
D. litus	Eniwetok Atoll (Marshall Islands).

Key to the Species of *Dentigryps*

The following key has been constructed to include both sexes of the four species discussed in this paper. The characters based on the fifth leg of the female and male of *D. curtus* and *D. litus* are sometimes unusable because the terminal process of that leg may be broken or lost completely.

1. Fifth leg not appearing 2-parted, terminal process short; median cephalothoracic region not completely covering fourth pedigerous segment, if covering it at all 2
   Fifth leg appearing 2-parted, terminal process forming the second part; median cephalothoracic region covering the fourth pedigerous segment . . 3
2. Sternal furca with chisel-shaped tines; fourth thoracic leg with spikelike projection of inner distal surface . . . . **D. ulua**
   Sternal furca with bluntly pointed tines; fourth thoracic leg without spikelike projection of inner distal surface . . . . **D. bifurcatus**
3. Terminal process of fifth leg naked; postoral process simple, not bifurcate. **D. curtus**
   Terminal process of fifth leg plumose; postoral process bifurcate . . . **D. litus**

Discussion of the Genus

In the original description of the genus *Dentigryps*, based on the female of *D. curtus*, Wilson (1913) indicated that owing to the similarity of their appendages the genus was allied to *Lepeophtheirus*, but differed from it in the nature of the free fourth pedigerous segment and genital segment. He also compared the genus with *Homoiotes* on the basis of the fourth pedigerous and genital segments which, he noted, were fused and covered "with a plate similar to the carapace." Wilson further compared the genus to the euryphorid genus *Gloiopotes* on the basis of the fifth legs, to the pandarids on the basis of the "dropping of the abdomen to the ventral surface and its transference forward," and finally to the euryphorid genus *Alebion* because of posterior lobes found on either side of the caudal rami of the female of *D. curtus*. With the availability of new material that includes several new species and the previously undescribed male of *D. curtus*, it is possible to reevaluate the genus and its relationships with members of the families Caligidae and Euryphoridae.

Members of the genus *Dentigryps* do indeed possess characteristics in common with members of the families Caligidae and Euryphoridae. But although the general composition of the cephalothorax, except for the euryphorid genus *Dysgamus*, is similar in both families, the presence of large and distinct fifth-leg projections, especially in the female, allies *Dentigryps* to the family Euryphoridae, although even in this family there are members without the projection (e.g., the female of *Alebion glaber*). In euryphorids that do possess it, however, the fifth-leg projection is often more complex than that of members of the genus *Dentigryps*, a condition that *Gloiopotes ornatus* exemplifies well, the fifth-leg process in this species being heavily serrated. The presence of some indication of platelike formations of the dorsal cuticle of the fourth pedigerous segment of *D. ulua* is likewise a characteristic encountered in the euryphorids, although at least in the female, the usual euryphorid condition is that the plates are well developed and overlap part of the genital segment. The genital segment of female euryphorids is generally large and often lobed posteriorly, a characteristic also noted in *D. ulua*. In general then, the members of the family Euryphoridae and members of the genus *Dentigryps* are alike in several characteristics, of which the most noteworthy is the fifth-leg projection.

The presence of platelike formations of the dorsal cuticle of the fourth pedigerous segment of *D. ulua* is contrary to the diagnosis of the family Caligidae (Wilson, 1905). In this regard, however, the degree of development of these platelike formations in *D. ulua* and their reduced condition in *D. bifurcatus, D. curtus, and D. litus* suggest that on this character alone there is no justification for separating the genus from the family Caligidae, in which it was originally included by Wilson (1913). The problem of the fifth-leg projection and its effect on the family status of the genus cannot be answered by the author at the present time; many euryphorids possess the fifth-leg projection and it is also present in a much reduced state in some of the caligids. In general, however, the appendage complement of *Dentigryps*, and its makeup, especially that of the first four thoracic legs, is characteristic of the family Caligidae. This condition, in addition to the character of the cephalothorax, fourth pedigerous segment, genital segment, and abdomen, appears to warrant the continued inclusion of the genus in the family Caligidae.

Within the Caligidae, *Dentigryps* most closely approximates *Lepeophtheirus*. The major difference between these two genera is the strongly projecting fifth leg of *Dentigryps*. Some members of the genus *Lepeophtheirus*, however, possess small but distinct spikelike fifth legs (e.g., *L. goniistii* Yamaguti, 1936; *L. hastatus* Shiino, 1960). The question now arises as to the degree of relationship that species such as the three mentioned above have with members of the genus *Dentigryps*. The spinelike fifth-leg projections and evidences of platelike formations of the dorsal cuticle of the fourth pedigerous segment which have also been reported for one of these three species do not agree with the diagnosis of the genus *Lepeophtheirus* given in Wilson's review of 1905 but do agree with the modified diagnosis of Lewis (1964). It then appears that the major diagnostic difference between the two genera is the length of the fifth-leg projection, which is long and distinct in members of the genus *Dentigryps* and short and indistinct in those members of the genus *Lepeophtheirus* that possess the characteristic. *Lepeophtheirus spinifer* Kirtisinghe (1937), however, possesses a long and well-developed fifth leg in the female. It may well be that this species also belongs in the genus *Dentigryps* and is closely allied to *D. ulua*. It differs from the latter primarily in the 2-segmented abdomen of the female, the female postoral process, the lack of a spinelike projection on the protopodite of the fourth thoracic leg, and the absence of fifth-leg projections in the male. *L. spinifer* appears to have about the same relation with *D. ulua* as *D. litus* has with *D. curtus*, although neither Kirtisinghe (1937) nor Rangnekar (1959) give a substantial description of the species and do not compare it with *Dentigryps*.

Two other species of the genus *Lepeophtheirus* may also belong in the genus *Dentigryps*. The first, *L. lichiae* Barnard, 1948 (Ann. Mag. Nat. Hist., vol. 12), appears similar to *D. ulua* and *L. spinifer* and, like these, has been taken from carangid fishes. The second, *L. molae* Heegaard, 1962 (Rec. Aust. Mus., vol. 25), has been taken from the sunfish *Mola mola* in Australia.

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A NEW BRAZILIAN MOTH OF THE GENUS GONIOTERMA WITH NOTES ON RELATED SPECIES (LEPIDOPTERA: STENOMIDAE)

By W. Donald Duckworth

This description is published to provide a name for a new species of Microlepidoptera for which Dr. Lauro P. Travassos F. of São Paulo, Brazil, has ecological data to be published.

During the course of the present study I found that the new species is related very closely to several that have been associated improperly with the genus *Stenoma* Zeller. These species have been studied, features critical to their recognition have been discussed and figured, and the species have been placed in their proper position in the genus *Gonioterma* Walsingham.

When fresh, the species examined are rather distinct in coloration, but because they fade rapidly, specific recognition on the basis of color alone is difficult. For this reason the genitalia are described and specific differences are noted from this character. A complete revision of the genus *Gonioterma* is planned, but the present study at least will permit recognition of the included species.

Because, in some instances, characters used to distinguish the females involve differences in size, the illustrations of the female genitalia were all drawn to the same magnification. Mr. Andre Pizzini made the illustrations for this paper.

Gonioterma exquisita, new species

FIGURES 1*a,b*; 2*a,e*

Alar expanse 21–23 mm.

Antenna whitish sprinkled with brown basally, whitish annulated with brown beyond. Head white medially with transverse band of gray between bases of antennae; second segment of palpus white, shaded with brown on outer side, white on inner side. Legs whitish ocherous; forelegs heavily shaded with fuscous, mid- and hindlegs lightly shaded with brown. Tegula and dorsoanterior portion of thorax white, shaded with gray, posterior portion of thorax gray. Abdomen ocherous. Forewing white; base of costa narrowly fuscous; three triangular fuscous costal spots, one at basal third, one near middle, one at apical fourth; from outer corner of apical spot a row of fuscous dots extends from apex along termen to tornus; black spot at base of cell from which a wide band of olivaceous brown extends to inner angle; from apex of middle costal spot an irregular patch of gray extends transversely around basal spot to inner margin; crescent-shaped olivaceous brown spot at end of cell; irregular patch of gray, shaded with olivaceous brown, extends from tornus to apex of apical costal spot; cilia fuscous basally, white beyond. Hindwing light gray with whitish costal margin in males, heavily shaded with fuscous in females; cilia white with gray subbasal line.

Male genitalia: See figures 1*a,b* (slide WDD 2502, paratype). Uncus reduced, curved ventrad; gnathos complete, basal process well developed, rather long, recurved; division of gnathal arms at base of process; tegumen moderately constricted; harpe broad, saccular lobe rather narrow, bluntly pointed; anellar lobes broad, bluntly rounded at apex; aedeagus short, broad, vesica armed with two elongate, convoluted clusters of small, heavy cornuti.

Female genitalia: See figure 2*a* (slide WDD 2503, paratype). Genital plate membranous; ostium small, ostium bursae enlarged; ductus bursae short, less than half length of corpus bursae, which has two dentate signa; anterior margin of eighth abdominal tergum with rectangular indentation.

Type: Brazil, Lassance, Minas Geraes, Nov. 9–12, 1919, USNM 66418.

Described from male holotype, one male paratype, three female paratypes. All paratypes with following data: Brazil, São Paulo, S.P., Ypiranga (April 4, 1960, W. Bokemann). One female paratype is in the Departamento de Zoologia, Secretaria da Agricultura, São Paulo, Brazil.

This species and the others included in this study—*chlorina, aesiocopia, algosa, fastigata, argicerauna, bryophanes*—form a very closely related group within the genus *Gonioterma*. The males of *G. exquisita* are readily separable from the males of the previously mentioned species by the absence, along vein 1a in the hindwing, of a hair pencil that is present in the other species. Also, the forewing of *G. exquisita* has a straight costa and white ground color, whereas the other species mentioned above possess a strongly arched costa in the forewing and lack a white ground color.

The genitalia, although indicating an unusually close relationship between *G. exquisita* and the other species included in this study, provide a number of distinguishing characters. The complete gnathos and the broad harpe, with narrow, bluntly pointed saccular lobe, serve to distinguish the males of *G. exquisita*. The short ductus bursae in the female genitalia serves to separate the females.

Gonioterma chlorina (Kearfott), new combination

Figures 1*c*,*d*; 2*b*

Stenoma chlorina Kearfott, 1911, Ent. News, vol. 22, p. 126.

Type locality: São Paulo, Brazil.

Male genitalia: See figures 1*c*,*d* (slide WDD 2052, São Paulo, Brazil, type). Uncus reduced, curved sharply ventrad; gnathos incomplete, basal process well developed, long, recurved, pointed; division of gnathal arms well below process; tegumen narrowly constricted; harpe narrow, saccular lobe broad, blunt; anellar lobes broad, bluntly rounded at apex; aedeagus narrow, vesica armed with one elongate convoluted cluster of small, heavy cornuti.

Female genitalia: See figure 2*b* (slide WDD 2501, São Paulo, Brazil). Genital plate membranous; ostium large, ostium bursae enlarged; ductus bursae longer than in *G. exquisita*, more than half length of corpus bursae; corpus bursae with two dentate signa; anterior margin of eighth abdominal tergum as in *G. exquisita*.

This species and the following one, *G. aesiocopia*, are very similar in coloration and general appearance. However, the long, recurved, pointed basal process and the division of the gnathal arms well below the process in the male genitalia serve to separate the males of *G. chlorina* from those of *G. aesiocopia*. The females are more difficult to separate, but figures 2*b* and *c* indicate the size differences that will distinguish the species in a majority of instances.

Gonioterma aesiocopia (Walsingham), new combination

FIGURES 1*g*, 2*c*

Stenoma aesiocopia Walsingham, 1913, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 42 (Lepidoptera-Heterocera, vol. 4), p. 179.
Stenoma aphrogramma Meyrick, 1929, Trans. Ent. Soc. London, vol. 76, p. 515.

Type localities: Veracruz, Mexico (*G. aesiocopia*); Taboga Isl., Panama, 200–1,000 ft. (*G. aphrogramma*).

Male genitalia: See figure 1*g* (slide WDD 2051, Rio Tempas, Honduras). Uncus reduced, curved ventrad; gnathos incomplete, basal process poorly developed, short, blunt; division of gnathal arms near apex of process; tegumen moderately constricted; harpe rather broad, saccular lobe broad, rounded at apex; anellar lobes broad, pointed at apex; aedeagus narrow, vesica armed with two elongate, convoluted clusters of small, heavy cornuti.

Female genitalia: See figure 2*c* (slide WDD 2554, Porto Bella, Panama). Genital plate membranous; ostium large, ostium bursae enlarged; ductus bursae long, wider than in *G. exquisita* or *G. chlorina;* corpus bursae with two dentate signa; anterior margin of eighth abdominal tergum as in *G. exquisita.*

The short, blunt basal process and the division of the gnathal arms near the apex of the basal process in the male genitalia distinguish the males of *G. aesiocopia.* The differences in the females have been discussed in the remarks under *G. chlorina.*

Gonioterma argicerauna (Meyrick), new combination

FIGURES 1*e, f*

Stenoma argicerauna Meyrick, 1925, Exotic Microlepidoptera, vol. 3, p. 221.

Type locality: Cantinero, Colombia, 1300 ft.

Male genitalia: See figures 1*e,f* (slide WDD 2555, Colombia). Uncus reduced, curved sharply ventrad; gnathos incomplete, basal process poorly developed, short, blunt; division of gnathal arms well below process; constriction of tegumen parallel-sided; harpe broad, saccular lobe long, tapering to very sharp, slightly recurved point; anellar lobes broad, sharply pointed at apex; aedeagus short, broad, vesica armed with one elongate, convoluted cluster of small, heavy cornuti.

Female genitalia: Unknown.

The parallel-sided constriction of the tegumen and the long narrow saccular lobe that tapers to a sharply pointed apex serve to distinguish the males from the other species.

Gonioterma algosa (Meyrick), new combination

FIGURES 1*h*,*i*; 2*d*

Stenoma algosa Meyrick, 1916, Exotic Microlepidoptera, vol. 1, p. 537.

Type locality: Rio Maroni, French Guiana.

Male genitalia: See figures 1*h*,*i* (slide WDD 2549, Rio Maroni, French Guiana). Uncus reduced, curved sharply ventrad; gnathos incomplete, basal process poorly developed, short, blunt; division of gnathal arms at base of process; tegumen moderately constricted; harpe narrow, saccular lobe broad, rounded; anellar lobes narrow, vesica armed with one elongate, convoluted cluster of small, heavy cornuti.

Female genitalia: Unknown.

This species is readily identifiable by the narrow anellar lobes that taper to sharply pointed apices. Also, the lateral portions of the second and third abdominal terga have patches of large pores around which the cuticle is very heavily sclerotized (fig. 2*d*). The other species included in this study possess these patches of large pores (fig. 2*e*), but the heavy sclerotization occurs only in *G. algosa*.

Gonioterma fastigata (Meyrick), new combination

FIGURE 3*a*

Stenoma fastigata Meyrick, 1915, Exotic Microlepidoptera, vol. 1, p. 430.

Type locality: Bartica, British Guiana.

Male genitalia: Unknown.

Female genitalia: See figure 3*a* (slide WDD 2551, Bartica, British Guiana). Genital plate membranous; ostium small, ostium bursae enlarged; ductus bursae moderately long; corpus bursae with two dentate signa; anterior margin of eighth abdominal tergum with two lateral hooklike lobes curving toward midline.

The two lateral hooklike lobes from the anterior margin of the eighth abdominal tergum serve to distinguish the females of *G. fastigata*.

Gonioterma bryophanes (Meyrick), new combination

FIGURES 1*j*, 3*b*

Stenoma bryophanes Meyrick, 1915, Exotic Microlepidoptera, vol. 1, p. 477.

Type locality: Rio Maroni, French Guiana.

Male genitalia: See figure 1*j* (slide WDD 2838). Uncus long, curved slightly ventrad; gnathos incomplete, basal process well developed, long, truncate at apex; division of gnathal arms near base of process; tegumen moderately constricted; harpe broad, saccular lobe only slightly developed; anellar lobes broad, bluntly pointed at apex; aedeagus short, vesica armed with two elongate, convoluted clusters of small, heavy cornuti.

Female genitalia: See figure 3*b* (slide WDD 2839). Genital plate membranous; ostium large, ostium bursae enlarged; ductus bursae moderately long; corpus bursae with two dentate signa; anterior margin of eighth abdominal tergum with heart-shaped indentation and two pointed, medially directed lobes.

The long uncus and basal process in the male genitalia and the heart-shaped indentation of the anterior margin of the eighth abdominal tergum in the female genitalia serve to distinguish *G. bryophanse* from the other species discussed.

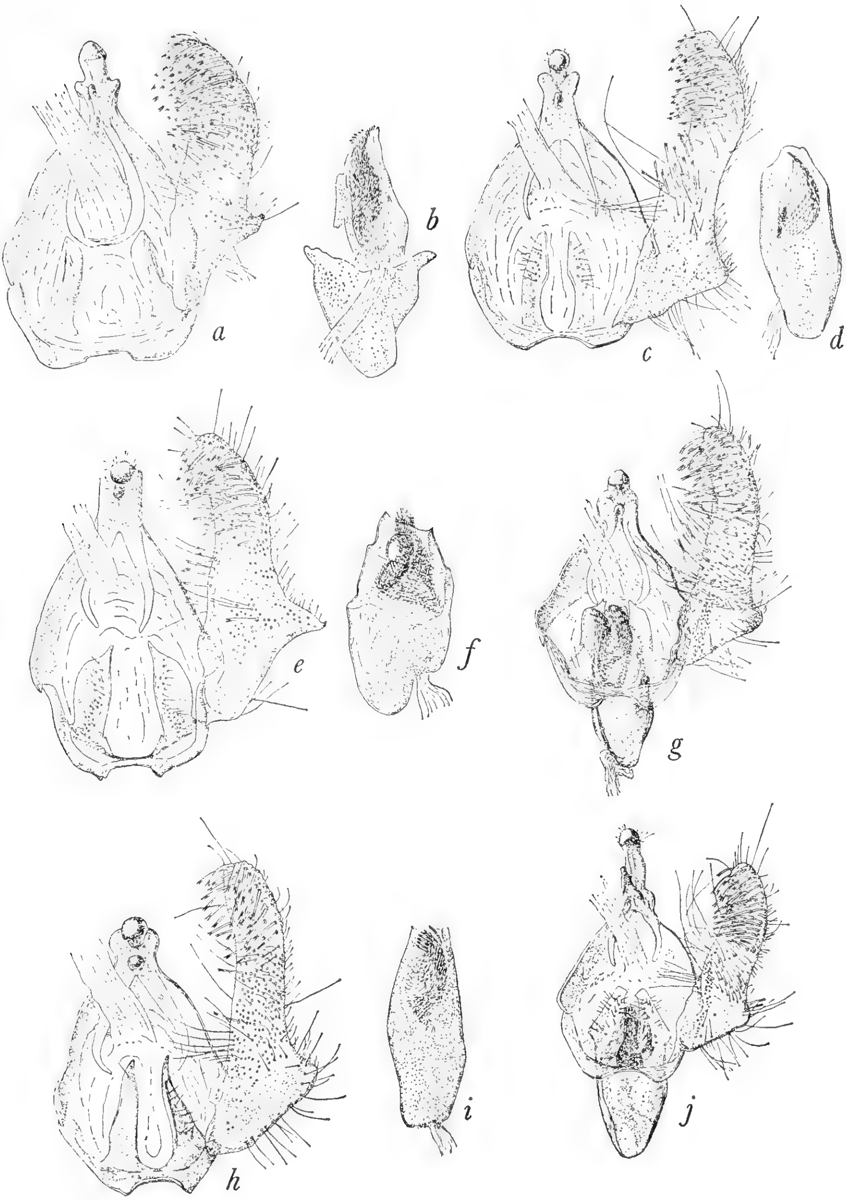

FIGURE 1.—Ventral view of male genitalia: *a*, *G. exquisita*, new species, aedeagus removed; *b*, aedeagus; *c*, *G. chlorina* (Kearfott), aedeagus removed; *d*, aedeagus; *e*, *G. argicerauna* (Meyrick), aedeagus removed; *f*, aedeagus; *g*, *G. aesiocopia* (Walsingham), aedeagus in situ; *h*, *G. algosa* (Meyrick), aedeagus removed; *i*, aedeagus; *j*, *G. bryophanes* (Meyrick), aedeagus in situ.

FIGURE 2.—*a*, *G. exquisita*, new species, ventral view of female genitalia; *b*, *G. chlorina* (Kearfott), ventral view of female genitalia; *c*, *G. aesiocopia* (Walsingham), ventral view of female genitalia; *d*, *G. algosa* (Meyrick), lateral view of abdominal segments 1–3; *e*, *G. exquisita*, new species, lateral view of abdominal segments 1–3.

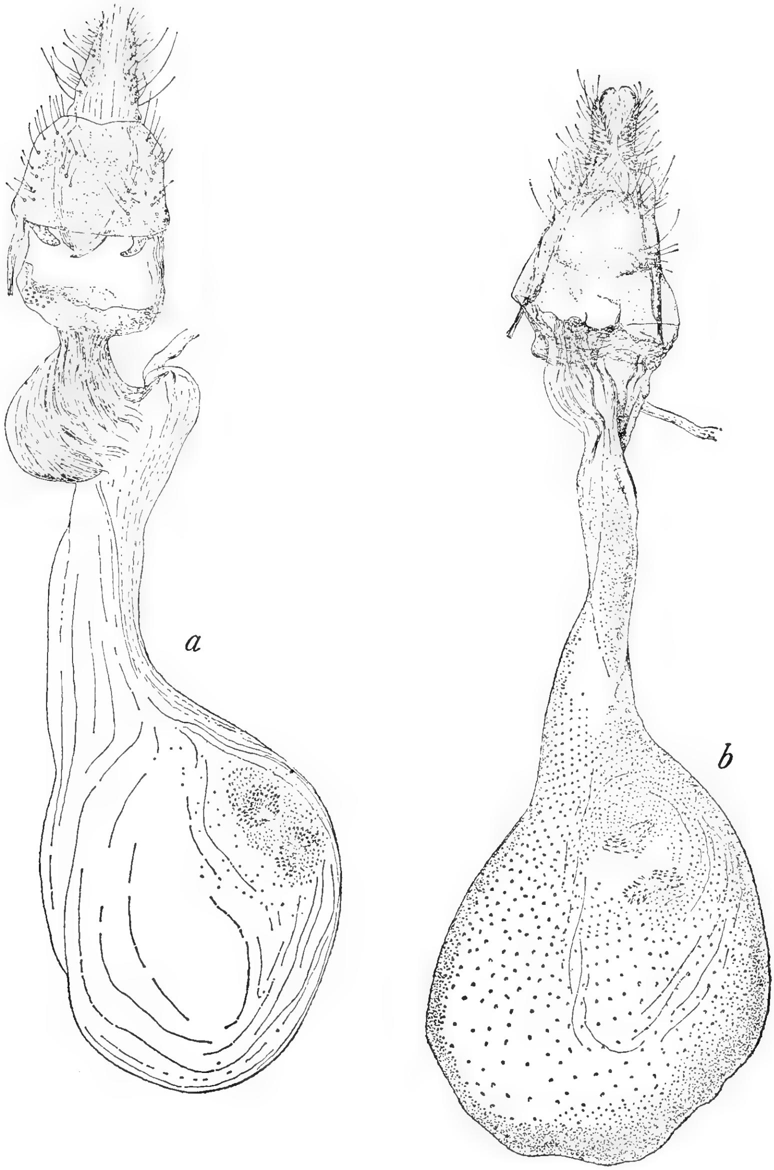

FIGURE 3.—Ventral view of female genitalia: *a, G. fastigata* (Meyrick); *b. G. bryophanes* (Meyrick).

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SEVEN NEW AMPHIPODS FROM THE WEST COAST OF NORTH AMERICA WITH NOTES ON SOME UNUSUAL SPECIES

By Clarence R. Shoemaker[1]

While studying the unidentified amphipods from the west coast of North America in the collections of the Smithsonian Institution, I have noted undescribed species from time to time. Seven of these species are here described and illustrated; also redescriptions and supplementary figures are given of seven other species.

Family Lysianassidae

Kyska, new genus

Antennae 1 and 2 rather short, stout. Eyes large, pyriform. Mandible, incisor smooth with small tooth at inner end; molar conical, without triturating surface; palp 3-jointed. Maxilla 1, inner plate small, with 2 terminal setae; outer plate with 9 terminal spine-teeth,

[1] Died December 28, 1958. This paper, nearly completed, was prepared for publication by Thomas E. Bowman, U.S. National Museum. J. Laurens Barnard of the Beaudette Foundation read the manuscript critically and added several recent references.

2 lateral teeth; palp 2-jointed. Maxilla 2, inner plate shorter than outer. Maxilliped, inner plate with 3 terminal teeth; outer plate without marginal teeth; palp 4-jointed. Gnathopod 1 chelate. Gnathopod 2 slender, normal. Pereopods 3–5 increasing consecutively in length; basipod well expanded. Pleon segment 3 with lower hind corner sharply upturned. Branchiae plaited on both sides. Telson cleft beyond middle.

Type-species.—*Kyska dalli*, new species.

This new genus is very much like *Anonyx*, and the type-species bears a close superficial resemblance to *Anonyx nugax*. The characters that differentiate *Kyska* from *Anonyx* are the comparative shortness of the antennae, the lack of calceoli in the male, and the possession of chelate gnathopod 1 in both sexes; otherwise, the characters of *Kyska* are the same as those given by Stebbing (1906) for *Anonyx*.

Kyska dalli, new species

Figure 1

Male.—Eye black, pyriform. Antenna 1 about as long as head and pereon segment 1 combined, about ⅔ as long as antenna 2; first joint large, second and third joints very short; flagellum about as long as peduncle, composed of 17 joints; accessory flagellum ½ as long as primary and composed of 9–10 joints. Antenna 2, fourth joint slightly longer than fifth, flagellum longer than peduncle and composed of about 28–30 joints. Epistome not projecting beyond upper lip. Other mouthparts as shown in figures.

Coxal plate 1 expanded below, projecting slightly forward. Gnathopod 1, second joint about as long as remaining joints combined; fifth joint short, cup-shaped; sixth joint greatly developed, lower distal end produced forward, forming chela with short, curved, opposing seventh joint (figs. 1*a,h*). Gnathopod 2 normal.

Pereopods 1 and 2 similar, subequal in length. Pereopods 3–5 rather long, slender, increasing in length consecutively; second joints considerably expanded; fourth joint well expanded in pereopod 3, less expanded in pereopods 4 and 5. Seventh joint in all pereopods long, slightly curved.

Pleon segment 1, lower hind corner not produced; segment 2 rather sharply produced; segment 3 sharply upturned. Urosome segment 1 with slight dorsal depression. Uropod 1 reaching back farther than uropod 2, about as far as uropod 3. Uropod 3, outer ramus longer than inner and with small second joint. All uropods bearing only few short spinules. Telson cleft nearly to base, reaching back slightly beyond peduncle of uropod 3.

Gills plaited on both sides. Gill of pereopods 1 and 2 with appendage, that of pereopods 3 and 4 with pointed finger-like appendage.

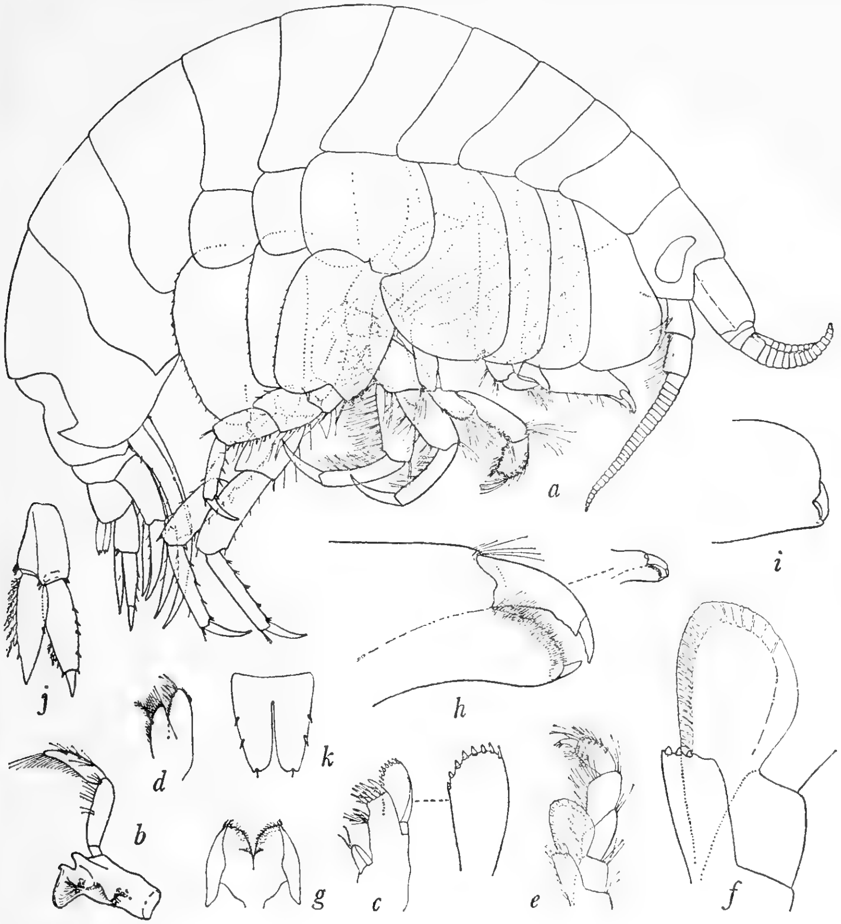

FIGURE 1.—*Kiska dalli*, new genus and species, male: *a*, entire animal; *b*, right mandible; *c*, maxilla 1; *d*, maxilla 2; *e*, maxilliped; *f*, inner and outer plates of right maxilliped; *g*, lower lip; *h*, end of gnathopod 1; *i*, end of gnathopod 2; *j*, uropod 3; *k*, telson.

Gill of pereopod 5 without finger-like appendage, but with short, stumplike appendage. Largest specimens in collection measure 22.5 mm. from front of head to end of uropods.

FEMALE.—Similar to male, but antennae shorter and fewer joints in flagella. Gnathopod 1 chelate, like that of male. Female as large as male.

TYPES.—Holotype male, USNM 95585, and 103 paratypes, USNM 13249, Kyska Island, Alaska, 6–8 fathoms in 1873, by Dr. William H. Dall.

The name "Kyska" was given to one of the principal islands of the Rat Island group, Western Aleutian Islands, in 1873, by Dr. Dall, who collected a number of specimens of this amphipod in the harbor at that time.

In addition to the specimens taken by Dr. Dall, a single specimen of this species was taken by W. G. Hall in 1872 at Nagai Island, another of the larger islands of the Rat Island group.

Family Stenothoidae

Metopa stelleri, new species

Figure 2

Male.—Head not quite as long as first 2 body segments combined; lateral lobe broadly rounded. Eye medium size, round, very light straw-colored in alcohol. Antenna 1 nearly as long as antenna 2, which is nearly as long as body. Antenna 1, first joint longer than second, which is about 5 times as long as third; flagellum longer than peduncle and composed of about 25 joints. Antenna 2, third joint about ⅓ as long as fourth, which is about as long as fifth; flagellum little more than ½ length of fifth peduncular joint, composed of about 11 joints, first of which almost as long as remaning joints combined. Mandible normal, spine row of 15–16 spines; palp with very small third joint. Maxilla 1 normal, palp 1-jointed. Maxilla 2 normal; inner lobe much shorter than outer. Maxilliped with characters of genus. Gnathopod 1 slender, second joint slightly expanded, without lobes, nearly as long as fifth and sixth joints combined; fifth joint about as long and as wide as sixth; sixth joint slightly expanded distally, palm oblique, straight, bearing very fine short spinules throughout, no defining spines, but row of long slender spines on rounding margin, where palm merges into hind margin of joint (fig. 2*d*); seventh joint fitting palm, armed on inner margin with very fine teeth and short spinules. Gnathopod 2 large, strong; second joint not as long as sixth, with rounding lobe on lower front margin; fifth joint less than ½ as long as sixth, with lobe between fourth and sixth joints; sixth joint large, strong, front and hind margins convex, palm very oblique, convex, armed with irregular low teeth and defined by tooth bearing slender spine on its inner margin; seventh joint stout, slightly shorter than palm and bearing minute setules on inner margin.

Pereopod 1 long, slender. Pereopod 2 not as long as pereopod 1, but stouter. Pereopod 3 longer than pereopods 4 or 5, which are subequal in length; second joint slender, without lower lobe. Pereopods 4 and 5 strong; second joint broadly expanded; fourth joint large, broadly expanded with hind margin produced slightly beyond end of fifth joint. Seventh joints of pereopods 1–5 rather short, stout, with inner margins bearing very low forward-pointing teeth (fig. 2*f*). Uropod 1 reaching back slightly farther than uropod 2, 2 slightly farther than 3. Uropods 1 and 2 scantily armed with short spines. Uropod 3, peduncle longer than ramus, armed on upper margin with 8 or 9 short spines. Telson broadly oval, reaching slightly beyond end of third urosome segment, bearing 5 short spines on either lateral margin. Pereon segments 6 and 7 and pleon segments 1 and 2 each produced dorsally into backward-pointing tooth. Coxal plates 2–4 much deeper than their body segments. Coxal plate 4 only of moderate size for genus *Metopa*. Length to 9 mm.

FEMALE.—Very much like male. Antennae shorter than in male. Fifth and sixth joints of gnathopod 1 shorter. Sixth joint of gnathopod 2 not so large; palm less oblique, with fine teeth and shorter defining tooth. Female as large as male.

TYPES.—Holotype male, USNM 96489, and 11 paratypes, USNM 107860, taken at Albatross station 4803, Cape Rollin, Simushir Island, Kuriles (46°42′ N, 151°45′ E) in 229 fathoms, June 24, 1906. Single

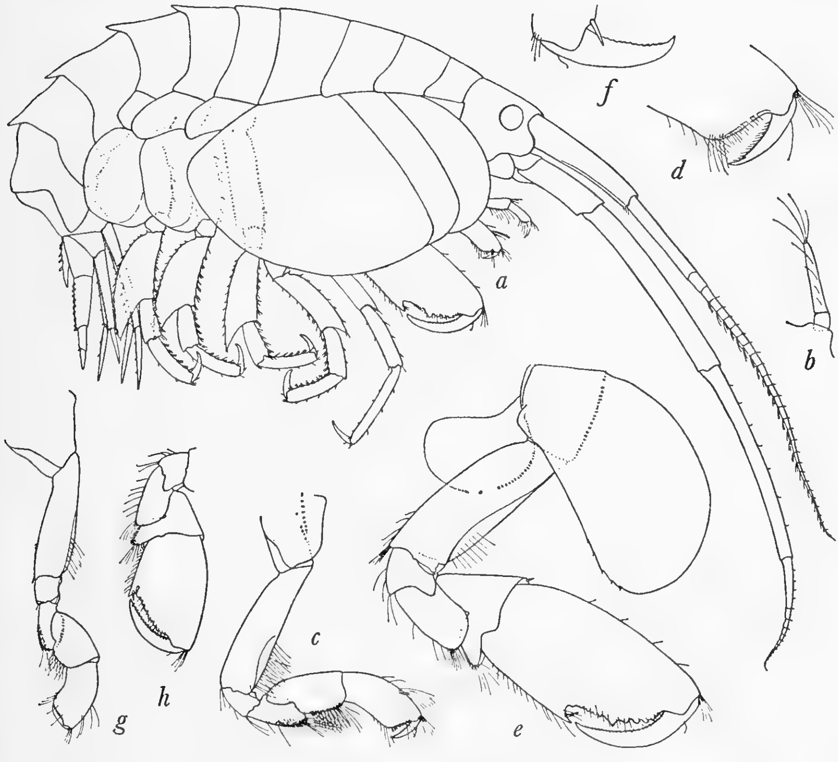

FIGURE 2.—*Metopa stelleri*, new species, male: *a*, entire animal; *b*, mandibular palp; *c*, gnathopod 1; *d*, end of gnathopod 1; *e*, gnathopod 2; *f*, end of pereopod 2; female: *g*, gnathopod 1; *h*, gnathopod 2.

specimen taken on same date at nearby Albatross station 4804 (46°42′ N, 151°47′ E) also in 229 fathoms.

Metopa stelleri differs from *M. cristata* Gurjanova (1955), its closest relative, by the lack of dorsal teeth on the segments anterior to pereon 6.

Metopa cristata Gurjanova

FIGURE 3

Metopa cristata Gurjanova, 1955, pp. 176–178, figs. 7–8.

MALE.—Head not as long as first 2 body segments combined. Eye medium sized, nearly round, light straw-colored in alcohol. Antenna 1 slightly shorter than antenna 2; first joint longer than second, which is about 3 times as long as third; flagellum shorter than peduncle and composed of about 13 joints. Antenna 2, third joint nearly ½ length of fourth, which is nearly as long as fifth; flagellum about ⅔ length of fifth peduncular joint, composed of 8–9 joints. Mandible normal, second joint of palp long, third joint very small. Maxilla 1, inner lobe very short, with 1 apical seta; outer lobe with 6 spine teeth; palp 1-jointed, bearing row of apical spines and row of subapical setae. Maxilliped normal; outer lobe not present.

Gnathopod 1 rather slender; second joint not expanded, as long as fourth and fifth joints combined; fifth joint about as long and slightly wider than sixth; sixth joint expanding slightly distally, palm nearly transverse, armed throughout with very fine teeth, a few short spinules, and defined by several spines; seventh joint nearly as long as palm, armed on inner margin with very fine teeth and several short spines. Gnathopod 2 large, strong, second joint very slightly expanded distally, not as long as sixth; fourth joint extending forward beside lobe of fifth joint, and bearing row of spines on lower margin; fifth joint short, produced below into narrow lobe between fourth and sixth joints; sixth joint large, upper and lower margins slightly convex; palm oblique, nearly straight, armed with low, uneven teeth, and defined by sharp tooth; seventh joint stout and fitting palm.

Pereopods 1 and 2 slender, much alike, but 1 slightly longer. Pereopod 3, second joint scarcely expanded, but with hind margin produced below into rounding lobe. Pereopods 3–5 nearly equal in length; fourth joint produced downward behind to about middle of fifth joint, which is not much shorter than sixth; seventh joint short, rather strong; second joint of pereopods 4 and 5 broadly expanded.

Uropod 1 projecting back slightly farther than 2, 2 slightly farther than 3. All uropods with rather few short spinules. Uropod 3, peduncle slightly longer than ramus and bearing row of very short spinules on upper margin; first joint of ramus with 3 marginal spinules. Telson broadly oval, with 4 minute spinules on either lateral margin.

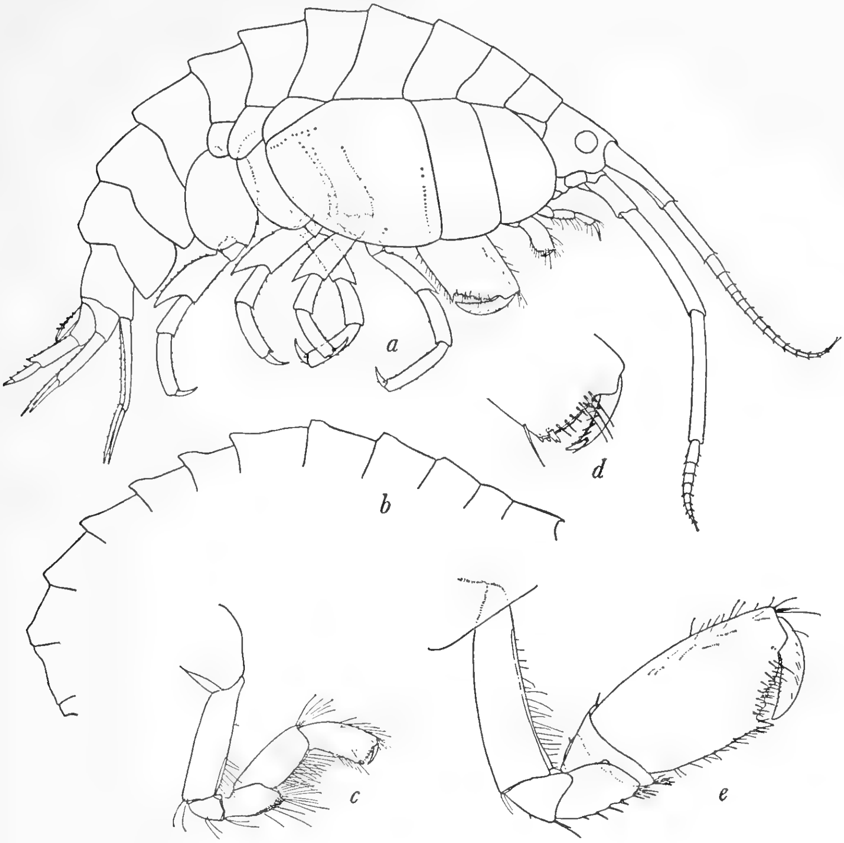

FIGURE 3.—*Metopa cristata* Gurjanova, male: *a*, entire animal; *b*, dorsal part of body of another male; *c*, gnathopod 1; *d*, end of gnathopod 1; *e*, gnathopod 2.

Several pereon segments and all pleon segments produced dorsally into low carinae. These carinae are variable; in some specimens they appear more or less truncate, while in others some are produced slightly backwards. The male measures about 7 mm., and the females in the collection are about 10 mm.

FEMALE.—Very much like the male.

Gurjanova's material, consisting of a male and 2 females, was collected on the east coast of Iturup Island, Kurile Islands, on a sandy bottom at a depth of 207 meters. The present collection (USNM 96488), consisting of 6 males and 22 females, was taken at Albatross station 5037, east of northern Honshu Island, Japan (42°02′40″ N, 142°33′20″ E), at 349 fathoms.

Mesometopa sinuata, new species

FIGURE 4

MALE.—Head not as long as first 2 body segments combined; rostrum short, triangular from above; lateral lobes triangular; eye small, oval; epistome very prominent, deeply cleft (fig. 4*b*). Antenna 1 about ⅓ length of body, peduncle rather stout, first joint longer than second and third combined, flagellum shorter than peduncle and composed of 10 or 11 joints, each of which bears sensory filaments on lower distal corner. Antenna 2 much longer than antenna 1, third joint ½ length of fourth, which is as long as fifth; flagellum slightly shorter than fifth peduncular joint and composed of 1 long and 4 shorter joints.

Mandible, cutting-edge, and accessory plate toothed, 7–8 spines in spine row, palp small, consisting of basal joint bearing lateral spine, and smaller conical second joint bearing apical spine (fig. 4*d*). Maxilla 1, inner plate without setae, outer plate with 5 large, 1 small spine, palp 1-jointed, bearing 7 terminal spines. Maxilliped, inner plate not reaching to base of first joint of palp; outer plate consisting of only short triangular extension of inner margin of third peduncular joint; palp long, slender, fourth joint with very fine teeth on inner margin.

Gnathopod 1 rather short, slender; second joint very slightly expanded; fourth joint reaching to about middle of fifth; fifth joint as long as, but wider than, sixth; sixth joint with front and hind margins slightly convex, palm very oblique, convex, armed throughout with fine sharp teeth, few slender spinules, and defined by group of spines; seventh joint fitting palm, bearing on inner margin row of fine spinules, and small forward-pointing tooth near apex (fig. 4*g*). Gnathopod 2 with outside front margin of second joint expanded into thin transparent lobe on outer and inner front margin; fourth joint with triangular lobe on inside surface projecting above upper margin of fifth joint, lower margin of joint produced forward on outside of lobe of fifth joint; fifth joint normal; sixth joint large, longer than wide, palm very oblique with deep oblong sinus between defining tooth and distal portion of palm, which is provided with several blunt teeth and few setules (fig. 4*h*); seventh joint stout, curved, shorter than palm and bearing closely set setae on inner margin and a few setae on outer margin.

Pereopods 1 and 2 about equal in length, but 2 stouter; fourth joint with front margin produced slightly downward. Pereopod 1 almost entirely devoid of spines. Pereopods 3–5 consecutively shorter. Pereopod 4, second joint linear; fourth joint expanded with lower hind corner reaching to about middle of fifth joint; fifth joint shorter than sixth; seventh joint over ½ length of sixth. Pereopod 5, second

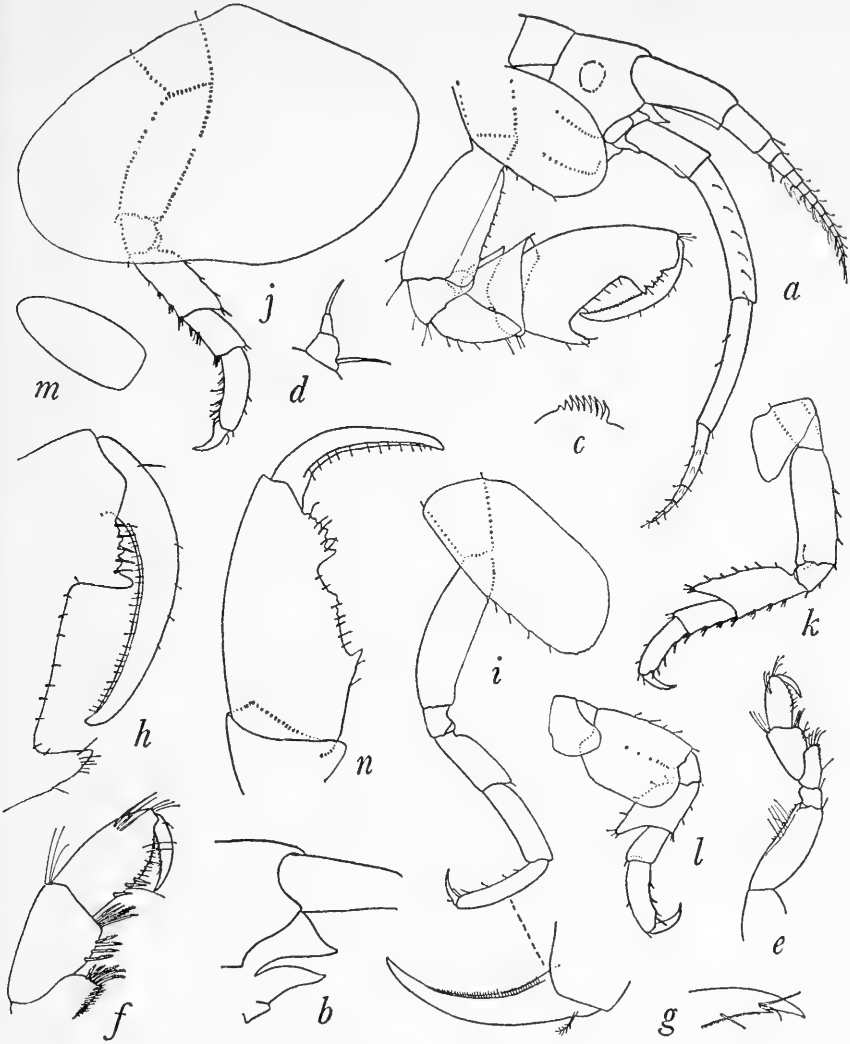

FIGURE 4.—*Mesometopa sinuata*, new species, male: *a*, anterior end of animal; *b*, epistome; *c*, spine row of mandible; *d*, palp of mandible; *e*, gnathopod 1; *f*, end of gnathopod 1; *g*, end of seventh joint of gnathopod 1; *h*, palm and seventh joint of gnathopod 2; *i*, pereopod 1; *j*, pereopod 2; *k*, pereopod 4; *l*, pereopod 5; female: *m*, telson; *n*, end of gnathopod 2.

joint expanded; fourth joint more expanded than that of pereopod 4, with hind margin reaching down beyond middle of fifth; fifth joint much shorter than sixth; seventh joint over ½ length of sixth. Seventh joint of all pereopods with very fine closely set teeth on inner margin (fig. 4*i*). Coxal plates 2–4 much deeper than their body segments, increasing consecutively in depth. Coxal plate 2 reaching forward to front margin of head, evenly rounding below, having several spinules on hind margin. Coxal plate 3 with sides parallel, unevenly rounding below, having several spinules on hind margin. Coxal plate 4 large, with sinuous lower margin (fig. 4*j*).

Pleon segments 2 and 3 with lower hind corner forming less than right angle. Uropod 1 extending back slightly farther than 2, 2 slightly farther than 3. Peduncles of uropods 1 and 2 edged with fine spines, but rami have few, if any, spines. Peduncle of uropod 3 with 3–4 spines on upper margin and 1 spine at distal end of first joint of ramus. Telson reaching to about middle of peduncle of uropod 3 and bearing no spines. Length of male about 4 mm.

Female.—Much like male, even in size. In gnathopod 2 defining tooth of palm not so large; sinus of palm less deep with slight protuberance near middle.

Holotype.—A male, USNM 94503, collected by E. F. Ricketts from boat bottom, Monterey Bay, California, June 9, 1930.

Remarks.—In the U.S. National Museum there are 6 specimens from Monterey Bay and 2 specimens from Moss Beach, San Mateo Co., California; 1 specimen from Squaw Island, near Coos Bay, Oregon, and 1 specimen from South Bay, coast of Coos Bay. The male and female figured are from Moss Beach and were collected by W. H. Marshall, June 1, 1939.

This species differs from *Metopa esmarki* Boeck (1872) from San Francisco, California—transferred to *Mesometopa* by Gurjanova (1951)—by the short fifth joint of gnathopod 1.

Metopelloides dubia, new species

Figure 5

Male.—Head shorter than first 2 body segments combined; lateral lobes rather prominent, evenly rounded; eye not visible. Antenna 1 reaching end of fourth joint of antenna 2; flagellum shorter than peduncle and composed of about 16 joints. Antenna 2 more than ½ length of body; third joint ½ length of fourth, which is longer than fifth; flagellum about as long as fifth peduncular joint and composed of about 16 joints, first of which is long, appearing to be made up of 3–4 fused joints.

Right mandible with rather broad toothed cutting-edge; accessory plate consisting of 4 knoblike spines, upper one of which broadest, lowest one narrowest (fig. 5*d*); spine row with about 18 rather blunt curved spines; molar absent; palp 1-jointed, bearing 4 terminal and 3 lateral spines (fig. 5*c*). Maxilla 1, inner plate lost in dissecting; outer plate with 6 large teeth, 1 small tooth; palp 1-jointed, oblique distal end armed with 13 terminal teeth and row of submarginal setae. Maxilla 2, inner plate shorter, narrower than outer, both very oblique distally, edged with usual spines. Maxilliped, inner plate very small; outer plate very small extension of inner margin of third joint, inner margin

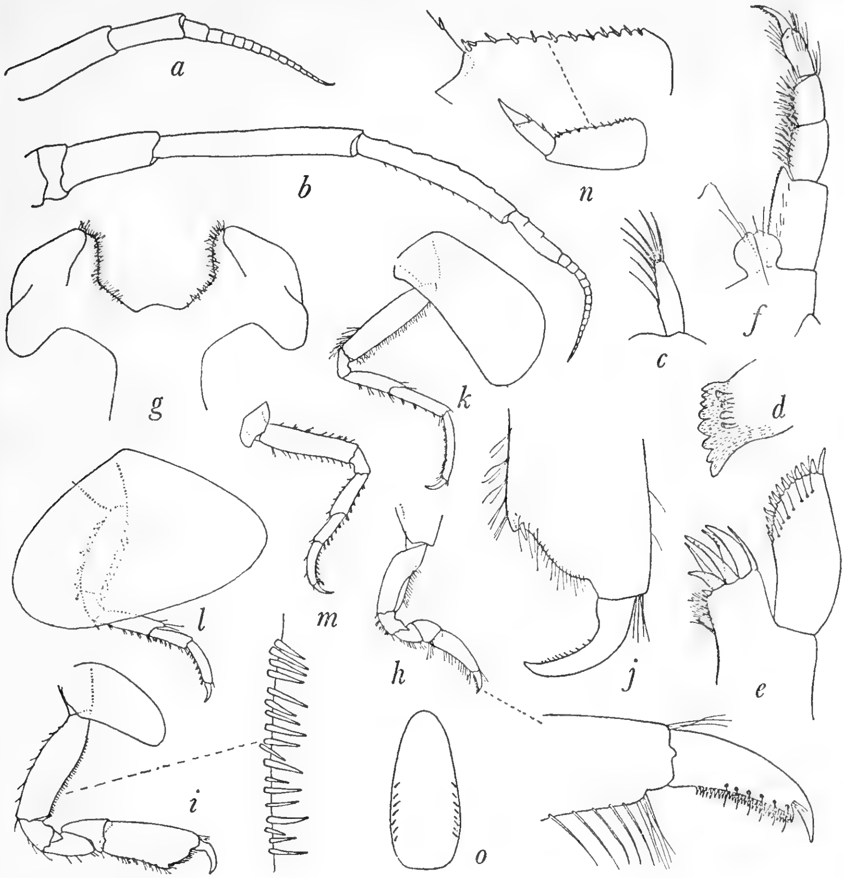

FIGURE 5.—*Metopelloides dubia*, new species, male: *a*, antenna 1; *b*, antenna 2; *c*, mandibular palp; *d*, cutting-edge and accessory plate of right mandible; *e*, maxilla 1; *f*, maxilliped; *g*, lower lip; *h*, gnathopod 1; *i*, gnathopod 2; *j*, end of gnathopod 2; *k*, pereopod 1; *l*, pereopod 2; *m*, pereopod 3; *n*, uropod 3; *o*, telson.

of joint bearing row of very fine spinules (fig. 5*f*); palp rather short, first joint slightly longer than subequal second and third; fourth joint slender, curved, bearing nail and row of fine spinules on inner margin. Lower lip with widely separated lobes; mandibular processes very short, blunt.

Coxal plates 2–4 much deeper than their body segments. Coxal plate 2 extending forward to front of head. Gnathopod 1, second joint about as long as fifth and sixth joints combined; third, fourth, and fifth joints equal in length, third with small downward-pointing lobe; sixth joint narrowing distally, without palm; seventh joint nearly ½ length of sixth, inner margin armed with fine closely set teeth and about 6 setae, and with rather deep angular sinus near apex (fig. 5*h*). Gnathopod 2, second joint not as long as fifth and sixth combined; third, fourth, and fifth joints about equal in length, third bearing small downward-projecting angular lobe; sixth joint twice length of fifth, about twice as long as wide, expanding slightly distally; palm oblique, convex, finely crenulate throughout, defined by rather blunt tooth and 2 spines (fig. 5*j*); seventh joint stout, curved, fitting palm.

Pereopods 1 and 2 slender, pereopod 1 slightly longer (fig. 5*k*). Pereopods 3–5 alike, 4 slightly the longest; second joint linear. Uropod 1 reaching posteriorly farther than 2, 2 farther than 3. Peduncles of all uropods with many fine, closely set spines. Uropod 1, outer ramus with 5 marginal spines; inner ramus with 3 marginal spines. Uropod 2, outer ramus with 4 marginal spines; inner ramus with 3. Uropod 3, peduncle armed with row of short spines on upper outer margin; first joint of ramus with 1 median, 1 distal spine. No terminal spines on any rami. Telson long, narrow, reaching back about ⅔ length of peduncle of uropod 3, and bearing row of 7–8 spinules on either lateral margin. Length, from front of head to end of uropods, about 13 mm.

Holotype.—Male, USNM 95660, taken by U.S. Bureau of Fisheries at St. Paul Island, Pribilof Islands, Jan. 13, 1918, from stomach of duck, *Somateria voniger*.

Remarks.—Because the specimen is from the stomach of a duck, neither gills nor marsupial plates are present, but it is inferred from the great development of the second antenna that the specimen is a male. There is a close resemblance in some of the characters to *Metopelloides shoemakeri* Gurjanova (1938). Her specimen, apparently a female, measured only 4 mm., but the present specimen, presumably a male, measures 13 mm. Whether the difference between these two species is due to the immaturity of Gurjanova's specimen or to the difference in sex is impossible to determine. Further and more abundant material probably will decide the question, but for the present it seems best to regard them as distinct species.

Proboloides pacifica (Holmes)

Figure 6

Metopa pacifica Holmes, 1908, p. 524, figs. 30–31.
Metopella pacifica.—Gurjanova, 1951, p. 478, fig. 315.

Male.—Head nearly as long as first 2 body segments combined; lateral lobes bluntly triangular with apex rounding. Eye not present in alcoholic type. Antenna 1 almost as long as antenna 2, peduncle reaching slightly beyond fourth joint of antenna 2; first joint shorter than second; third joint about ¼ as long as second; flagellum shorter than peduncle and composed of about 14 joints, each of which carries slender sensory filament. Antenna 2 nearly as long as body; third joint not quite ½ length of fourth, which is longer than fifth; flagellum about ½ length of fifth peduncular joint and composed of about 6 joints. Last 1 or 2 flagellar joints missing in both first and second antennae. Mandible with 3-jointed palp; second joint long, third very short; cutting-edge toothed; spine-row of 6 spines; molar not observed. Maxilla 1, inner lobe with 1 terminal seta; outer lobe with 5–6 spine-teeth; palp 2-jointed, bearing 7 spines on inner distal margin of second joint. Maxilla 2 not observed. Maxilliped very slender with rudimentary outer plate.

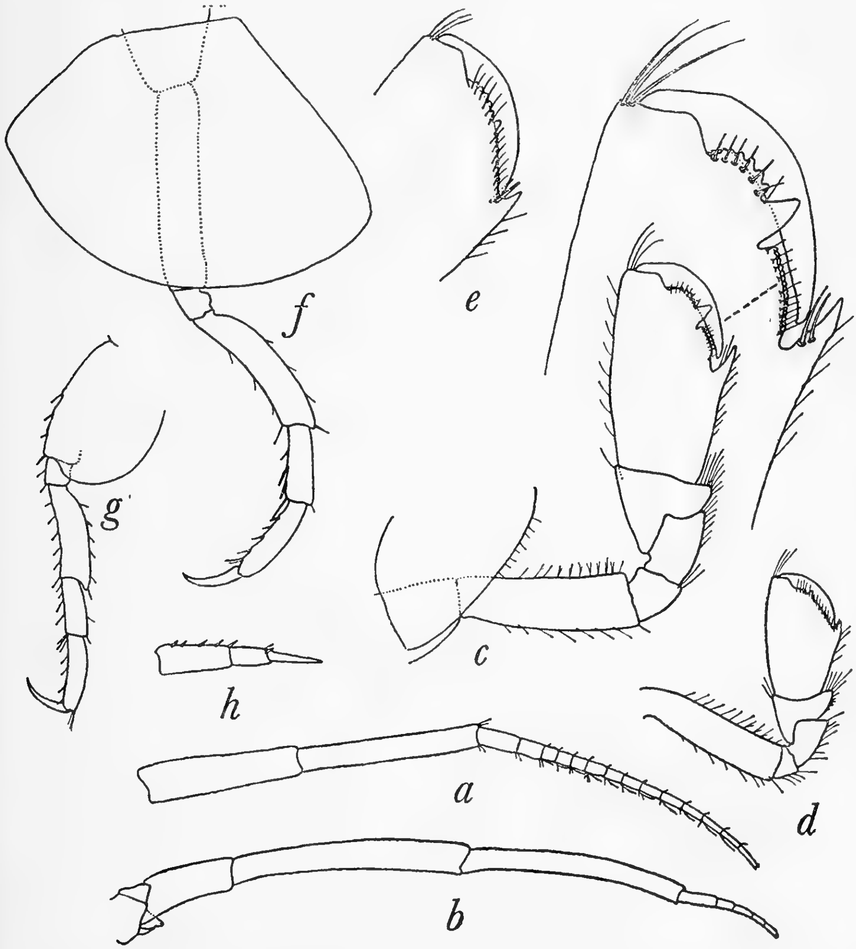

FIGURE 6.—*Proboloides pacifica* (Holmes), male: *a*, antenna 1; *b*, antenna 2; *c*, gnathopod 2; female: *d*, gnathopod 2; *e*, end of gnathopod 2; *f*, pereopod 2; *g*, pereopod 5; *h*, uropod 3.

Gnathopod 1 with fifth joint longer than sixth, which is distinctly subchelate. Sixth joint with palm oblique, convex, defined by spines, and about as long as hind margin of joint. Seventh joint fitting palm and armed on inner margin with minute spinules. Gnathopod 2 large (fig. 6*c*); palm very oblique, defined by stout sharp tooth, with large tooth in middle, on either side of which are small teeth; seventh joint strong, fitting palm. Pereopods 1 and 2 slender, 1 slightly slenderer than 2; fourth joint not produced downward in front; seventh joint rather long, slender, slightly curved. Pereopods 4 and 5 with second joint expanded; fourth joint very slightly expanded, only slightly produced downward; seventh joint about ⅔ length of sixth. Pleon segment 3 about as shown by Sars (1895, pl. 94, fig. 2) for *Metopa invalida.* Uropod 1 reaches back slightly farther than uropod 2, 2 slightly farther back than 3. Uropod 3, peduncle slightly shorter than ramus, first joint of which is shorter than second (fig. 6*h*). Telson narrowly oval with narrow rounding apex, and bearing 3 short spines on either lateral margin. Length 6 mm.

Female.—Gnathopod 2 not as large as in male; palm oblique, convex, defined by tooth and 2 spines (fig. 5*e*), and armed throughout with small rounding teeth, one of which near middle is slightly larger than rest; seventh joint fitting palm.

Remarks.—The above description is based on the 2 syntypes, a male and a female, USNM 38550, from Albatross station 4516, Monterey Bay, California, May 24, 1904, 718–756 fathoms, among hydroids on the back of a spider crab, *Hyas* species.

Holmes' species is here placed in the genus *Proboloides* Della Valle, as it differs from *Metopa* by having a 2-jointed palp to maxilla 1 and not a 1-jointed palp as in *Metopa.* It was assigned to *Metopella* Sars by Gurjanova (1951), perhaps on the basis of Holmes' statement (1908): "Last three peraeopods with the merus not widely expanded"—but, as shown herein, the merus is widely expanded on pereopods 4 and 5.

Family Tironidae

Syrrhoe longifrons, new species

Figure 7

This species differs from *S. crenulata* Goës (1866) as follows: Head elongate, about as long as first 5 body segments combined, produced slightly forward, evenly rounding. Rostrum pointing downward and backward toward body, not straight downward as in *S. crenulata.* Eyes reddish brown in alcohol, elongate, about ½ as long as head, united above and occupying almost entire front of head. Lateral angle of head truncate, not angular. Lower front corner of first 3

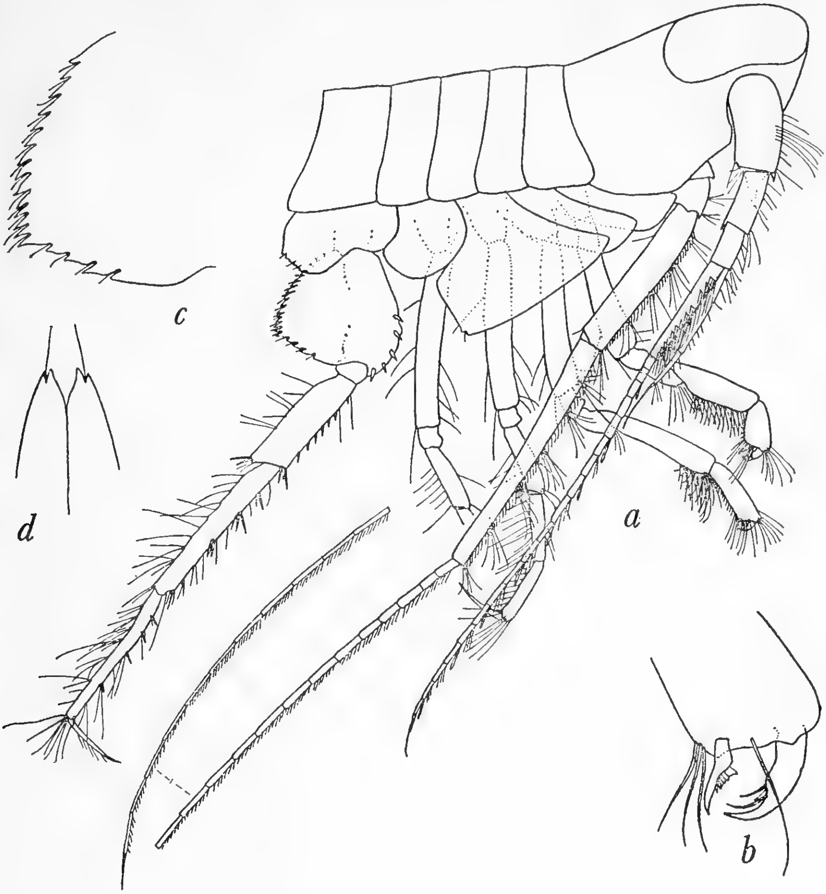

FIGURE 7.—*Syrrhoe longifrons*, new species, male: *a*, anterior end of animal; *b*, distal end of gnathopod 1; *c*, posterior margin of second joint of pereopod 3; *d*, distal end of telson.

coxal plates somewhat more produced. Second joint of pereopods 3–5 more angularly produced behind. The rest of the characters agree rather closely with those of *S. crenulata*. Length of male from front of head to end of uropods about 10 mm.

TYPES.—Male holotype, USNM 94235, and 2 paratypes, USNM 107862, taken at Mittelnacht, Vancouver Island, British Columbia, by G. H. Wailes. Specimens from other localities on Vancouver Island are also present in the collections of the U.S. National Museum.

REMARKS.—Although *Syrrhoe longifrons* resembles *S. crenulata*, the differences given above are found in all the specimens in the U.S. National Museum (all from Vancouver Island) and appear to be constant. The widespread *S. crenulata* is a more northern species and occurs in Alaskan waters.

Family Calliopiidae

***Haliragés bungei* Gurjanova**

FIGURE 8

Haliragés bungei Gurjanova, 1951, pp. 611–612, fig. 414.

FEMALE.—Head as long as first 2 body segments combined; rostrum very short, broad; lateral lobe obliquely truncate; lower corner broadly rounding; eye long, consisting of narrow black central area bordered by colorless ocelli. Antennae subequal, but 1 perhaps slightly shorter. Antenna 1 about as long as head and first 5 body segments combined; peduncle short, joints decreasing consecutively in length; accessory flagellum rudimentary (fig. 8*b*); primary flagellum consisting of about 44 joints, every other one of which bears 2 sensory filaments on lower distal end. Antenna 2 with fifth joint longer than fourth; flagellum consisting of about 38 joints.

Mandible with cutting-edge narrow, toothed; accessory plate narrow with bifid apex; spine-row of 9 spines; molar strong with well-developed triturating surface and armed on upper edge with long slender teeth; palp strong with second joint longest. Upper lip symmetrically rounding. Maxilla 1, inner plate long, armed apically with 5 plumose setae; outer plate armed with 11 serrate spine-teeth; palp 2-jointed, rather broad, bluntly rounding apex armed with 14 serrate spine-teeth and on outside with 6 subapical setae. Maxilla 2, inner plate slightly longer, armed apically with spines, and on inner margin with spines, 4 of which are longer than rest; outer plate armed with apical spines. Lower lip without inner lobes; mandibular processes rather short, apically rounding. Maxilliped, second joint with several spines on outer margin; inner lobe rather long, reaching slightly beyond middle of outer lobe, armed distally with curved plumose spines or setae and 3 short spine-teeth, 2 innermost being separated from third by slight sinus; outer plate reaching middle of second joint of palp, bearing distally a closely set row of slender curved plumose spines, and bearing on inner margin transparent lamella, from base of which arises row of slightly curved serrate spine-teeth; palp rather short, stout, third joint bearing group of spines near middle of outer margin and spines and small rounding lobe distally; fourth joint rather slender, slightly curved, bearing distally sharp nail and few setules.

Gnathopods 1 and 2 alike in form and size, though 1 may possibly be slightly longer; second joint scarcely expanded distally; fifth joint not expanded, about ⅔ as long as sixth; sixth joint long, narrow, of equal width throughout, bearing groups of spines on hind margin; palm convex, very oblique, edged with narrow smooth transparent lamella and merging into hind margin without defining angle, but

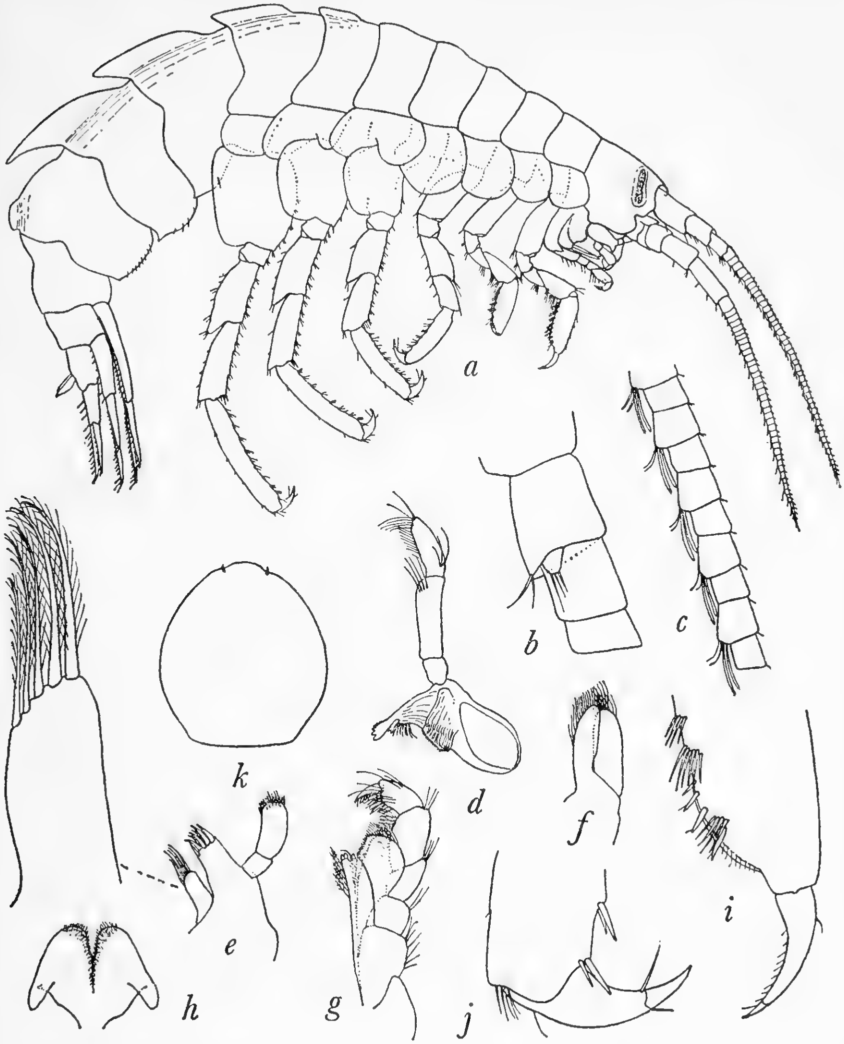

FIGURE 8.—*Halirages bungei* Gurjanova, female: *a*, entire animal; *b*, antenna 1, showing accessory flagellum; *c*, part of flagellum of antenna 1; *d*, mandible; *e*, maxilla 1; *f*, maxilla 2; *g*, maxilliped; *h*, lower lip; *i*, end of gnathopod 1; *j*, end of pereopod 4; *k*, telson.

defined on outside by row of 4 spines, distal one of which longest; seventh joint fitting palm and bearing row of spinules on inner margin.

Pereopods 1 and 2 alike in form and size, fourth joint very slightly expanded distally; sixth joint nearly as long as fourth and fifth combined; seventh joint short, stout, bearing rather long spinule on inner margin. Pereopods 3–5 alike in form, but increasing consecutively in length; second joint expanded but with almost no lower posterior lobe. Coxal plates 1–4 shallow, increasing consecutively in size, fourth excavate behind.

Pereon segment 6 with small backward-pointing dorsal carina. Pereon segment 7 with larger dorsal carina. Pleon segments 1 and 2 each with strong backward-pointing dorsal carina; segment 3 with small dorsal carina which is scarcely backward pointing. Pleon segments 1 and 2 with lower posterior corner sharply produced, lower margin bearing few spinules; segment 3 with lower posterior corner blunt-angled or without angle and lower margin bearing row of spinules.

Uropods 1 and 2 reaching back about same distance. Uropod 1, peduncle longer than rami, outer ramus shorter; both peduncle and rami margined with many fine short spines. Uropod 2, peduncle slightly longer than outer ramus, but shorter than inner; both peduncle and rami margined with fine short spines. Uropod 3 not reaching back quite as far as 2; peduncle slightly shorter than rami and bearing 4 spines on upper margin which are longer than those on rami. Telson reaching to about middle of peduncle of uropod 3, broadly oval, slightly longer than wide, bearing 2 minute apical spinules. Female measures about 13 mm. from front of head to end of uropods.

Remarks.—Gurjanova's specimens, 22 in number, were taken on the east coast of Kamchatka, among algae and on fine sand, up to a depth of 60 m. The U.S. National Museum collections contain 12 specimens from Bering Island, Commander Islands, 9 of them collected by Leonard Stejneger in 1882–83, and 3 specimens collected by N. Grebnitzky on August 6, 1888.

Family Pleustidae

Sympleustes cornigera, new species

Figure 9

Male.—Head with short rostrum, appearing triangular from above; lateral lobe triangularly produced, with narrow rounding apex; lower corner narrowly, sharply produced; eye large, broadly reniform, rather colorless in alcohol. Antenna 1 much longer than antenna 2; first joint longer than second, which is about twice as long as third; flagellum consisting of about 90 joints, first of which is longest.

Mandible with rather broad cutting-edge, but without accessory plate; spine-row of about 14 spines (fig. 7*c*); molar conical with rather small triturating surface; palp about as shown for *Sympleustes latipes* by Sars (1895, pl. 127, fig. m) (=*Stenopleustes*, according to Barnard and Given, 1960). Maxilla 1, inner plate broad, without plumose setae, but fringed with fine setules; outer plate armed with 9 spine-teeth; palp armed with distal row of 7 spines and submarginal row

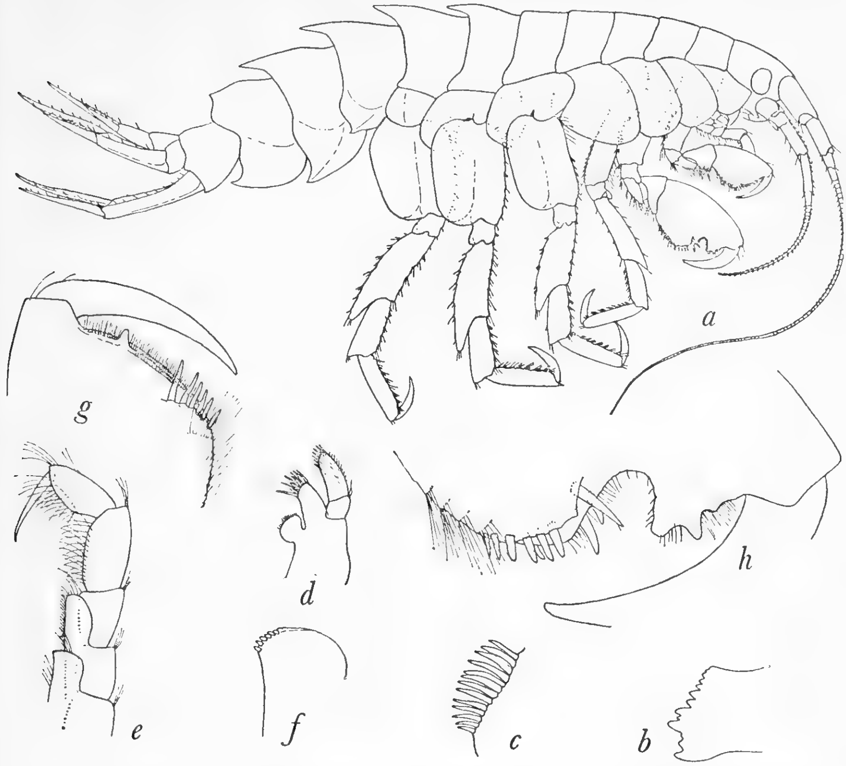

FIGURE 9.—*Sympleustes cornigera*, new species, male: *a*, entire animal; *b*, cutting-edge of right mandible; *c*, spine-row of right mandible; *d*, maxilla 1; *e*, maxilliped; *f*, end of inner plate of maxilliped; *g*, end of gnathopod 1; *h*, end of gnathopod 2.

of 9 setae. Maxilla 2, inner lobe broadly oval; outer lobe narrower, slightly longer, curved slightly inward. Maxilliped rather large; inner plate short, not reaching base of palp, armed on inner distal margin with row of about 6 short spine-teeth (fig. 9*f*); outer plate short and narrow, barely reaching base of second joint of palp, without spine-teeth but bearing slender spinules on inner margin and apex; second joint of palp longest; third joint with apex angular; fourth joint slender, but as long as third.

Gnathopod 1 rather stout; second joint nearly as long as fifth and sixth combined; fifth about ½ length of sixth; sixth joint about ⅔ as wide as long and widest through middle; palm oblique, convex, smooth, bearing small tooth near hinge, without defining angle, but defined by row of 6 long spines on outside, and on inside by 4 rows of spines, below which are several groups of more slender spines (fig. 9*g*); seventh joint rather slender, fitting palm. Gnathopod 2 strongly developed, second and third joints combined as long as sixth; third joint with lower front corner produced downward; fifth joint very short, produced below into narrow lobe; sixth joint large, strong, palm oblique, without defining angle, deeply incised in middle, bearing prominent bicuspid tooth near hinge. Outside of proximal end of palm with row of 6–7 stout spines, one nearest middle of palm largest and separated from rest; opposite these on inner surface of palm are 2 rows of spines, upper row with 2 spines and lower with 3. Rear margin of sixth joint with 8–9 rows of slender spines. Seventh joint strong and, when closed, rests between edge of palm and outside row of spines.

Pereopods 1 and 2 alike, 2 slightly longer. Pereopods 3–5 much alike, 4 slightly the longest; second joint expanded, hind margin smooth; fourth joint rather long, narrow, hind margin produced to about middle of fifth joint.

Coxal plates 1–4 about twice as deep as their respective body segments; first produced forward with lower front corner quadrate. Coxal plates 5 and 6 with small rounding front lobes, deep hind lobes. Sixth and seventh pereon segments and first and second pleon segments produced dorsally into sharp backward-pointing teeth; third pleon segment carinate, produced dorsally to slight angle, but not toothed. Hind margins of pleon segments sinuous, sharply produced below, first least produced.

Uropods 1 and 2 extending back about same distance, which is farther than uropod 3. Telson boat-shaped, broadly oval, slightly longer than wide, hind margin evenly rounding, reaching to about middle of peduncle of uropod 3 and bearing spinule on either lateral margin. Length of male from front of head to end of uropods about 24 mm.

Female.—Appears to be like male, even in gnathopods. Length about that of male.

Types.—Male holotype, USNM 93874, and 27 paratypes, USNM 107863, taken by steamer *Albatross* at station 4781 (52°14′30″ N, 174°13′ E), June 7, 1906, in 482 fathoms.

Remarks.—*Sympleustes quadridens* Bulycheva (1955) also has 4 dorsal teeth but its gnathopods are slender, poorly subchelate, and have elongate fifth joints. It is the only other species with dorsal teeth assigned to the genus "*Sympleustes*" by Barnard and Given (1960).

Parapleustes pugettensis (Dana)

Figure 10

Iphimedia pugettensis Dana, 1853, pp. 932–933, pl. 63, fig. 6.

Parapleustes pugettensis (Dana).—Barnard and Given, 1960, pp. 43–45, fig. 4 (synonomy).

Female.—Head, about as long as first 2 body segments combined; rostrum short, broadly triangular; lateral lobe rather narrowly rounding; eye more or less reniform, broader in some specimens than in others, black or reddish brown in alcohol. Antenna 1 longer than antenna 2; peduncle about as long as head, joints decreasing consecutively in length and thickness; second joint with shallow transparent lobe on inner distal end; flagellum long, slender, composed of 40–46 joints. Antenna 2, second joint with well-developed gland cone; fourth joint slightly shorter than fifth, flagellum composed of 28–30 joints. Mandibles with toothed cutting-edge. Left mandible with broad accessory plate and spine-row of 8 short broad spine-teeth. Right mandible with accessory plate narrower than in left, spine-row of 8–9 spine-teeth. Molar on both mandibles conical with small triturating surface. Mandibular palp short, stout, third joint slightly longer than second. Maxilla 1, inner plate short, bearing 1 distal plumose seta; outer plate with 9 pectinate spine-teeth; second joint of palp armed distally with 7 spine-teeth, below which, on inner margin, are several spines, inner surface with oblique row of 3 long curved subdistal spines, outer surface with row of 5 long curved spines near inner margin. Maxilla 2, inner plate slightly shorter but wider than outer plate; both armed distally with usual spines, inner plate with stout plumose seta on inner margin. Maxilliped, inner lobe reaching to base of outer lobe, armed on truncate distal edge with 4 curved spines and 4 very small spine-teeth; outer lobe not reaching middle of second joint of palp, inner margin without spine-teeth but with submarginal row of spines arranged in pairs; palp rather short, thick, fourth joint as long as third.

Coxal plates 1–4 slightly deeper than their body segments, lower margins evenly rounding, first 3 bearing at hind corners small tooth preceded by notch containing a setule. Coxal plate 1 slightly expanded distally, produced slightly forward. Gnathopods 1 and 2 much alike but 2 larger; second joint slightly expanded distally but not produced; fourth joint in gnathopod 2, but not in gnathopod 1, ending distally in small point; sixth joint with front and hind margins about equally convex; palm very oblique, without defining angle but defined by 2 groups of spines, edged with narrow transparent lamella, row of many short spinules, 3 groups of longer spines, and bearing near distal hinge low tooth more conspicuous in gnathopod 2 than in gnathopod 1. Third joint of gnathopods 1 and 2 with transparent downward-pointing lobe on front margin. Pereopods 1 and 2 much alike, subequal in length; fourth joint produced downward in front; fifth joint shorter than fourth or sixth; sixth slightly longer than fourth; seventh joint stout, curved, about ½ length of

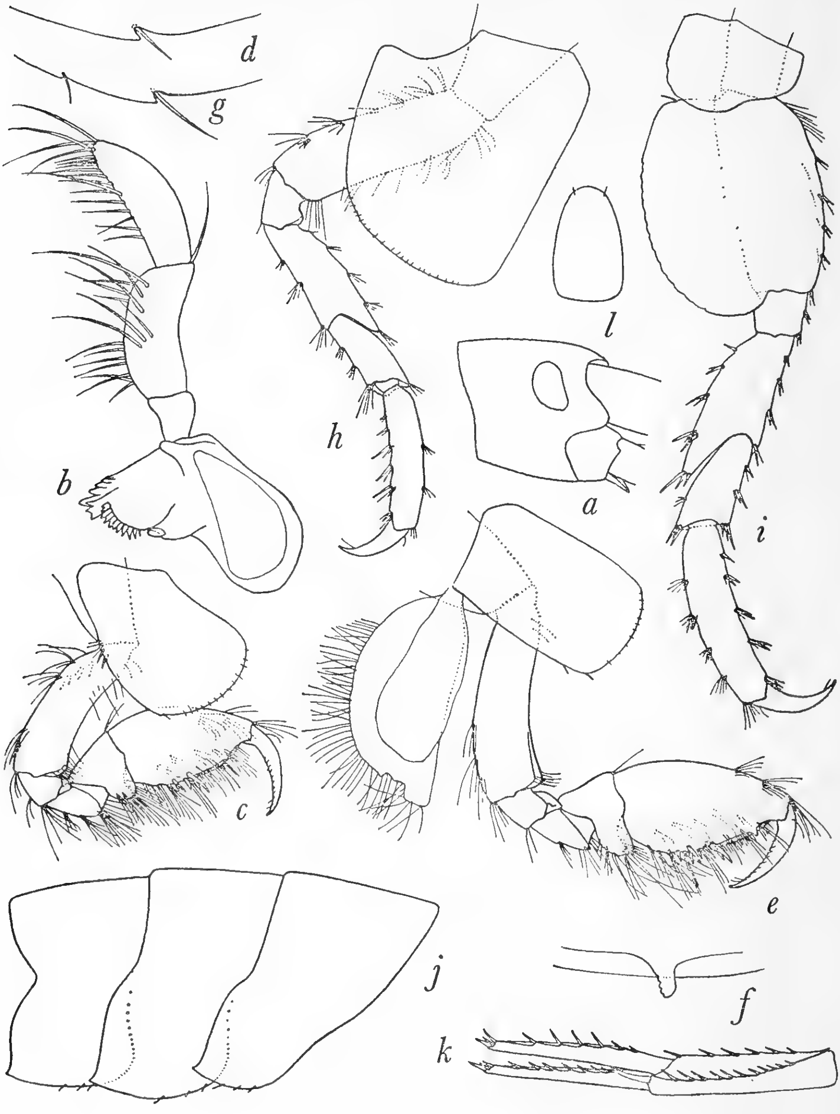

FIGURE 10.—*Parapleustes pugettensis* (Dana), female: *a*, head; *b*, right mandible; *c*, gnathopod 1; *d*, lower margin of coxal plate 1; *e*, gnathopod 2; *f*, tooth on palm, gnathopod 2; *g*, lower margin of coxal plate 2; *h*, pereopod 2; *i*, pereopod 5; *j*, pleon segments 1–3; *k*, uropod 1; *l*, telson.

sixth. Pereopod 3 about equal in length to 2, but slightly shorter than pereopods 4 or 5, which are about equal in length; second joint of pereopods 3–5 much expanded with hind margin smooth or very slightly crenulate; fourth joint produced behind to about middle of fifth; sixth joint longer than fourth; seventh joint nearly ½ length of sixth.

Pleon segments 1–3 very slightly produced at lower hind corner. Uropods 1 and 2 extending back about same distance, slightly farther than uropod 3. Uropod 1, peduncle slightly longer than rami, spinose on outer and inner margins and bearing rather long stout spine at outer distal corner; rami with rows of spines on upper edges. Uropod 2 shorter than 1, with similar armature but with fewer spines. Uropod 3, peduncle about ½ length of inner ramus; outer ramus about ⅔ length of inner, both rami and peduncle armed on upper edges with few spines. Telson keeled below, narrowly oval, bearing 2 minute setae distally, extending back slightly beyond peduncle of uropod 3. None of body segments dentate. Reaches length of about 9 mm.

REMARKS.—*Parapleustes pugettensis* appears to be subject to considerable variation. It has a wide distribution in the North Pacific. Specimens in the U.S. National Museum come from La Jolla northward along the coast of California to Dillon Beach; Cape Arago, Oregon; Vancouver Island; Queen Charlotte Islands; the Alaskan Peninsula and the west coast of Alaska (62°54′ N, 166°38′ W). Barnard and Given (1960) provide information on depth and type of bottom preferred by this species in southern California waters.

Small specimens of 4 or 5 mm. are much less spinose or setose than larger specimens, such as the 9 mm. female from Dillon Beach here figured. *Paramphithoe bairdi,* described by Boeck in 1872 from the coast of California, is in all probability a synonym of Dana's *Iphimedia pugettensis.* Boeck does not give the size of his species, but the description and figures contain nothing that can distinguish it from Dana's species. Gurjanova's species (1938), *Neopleustes derzhavini,* measuring 4 mm., from the Sea of Japan, appears to agree fairly well, so far as her figures show, with Dana's species. A small tooth and seta are shown on her figure (pl. 31, fig. 3) of the first coxal plate, but not on the second; the hind margin of the third pleon segment (pl. 31, fig. 4) is as here shown for *Parapleustes pugettensis* (fig. 10*j*). The teeth on the first 3 coxal plates of many specimens from the west coast of America are so small and inconspicuous that they can be easily overlooked.

Barnard's fine figures (1952) are of a male, while those given here are of a female, showing some of the appendages not illustrated by him. The gnathopods of the 9-mm. female are very much more hirsute than those of the 5-mm. male figured by him.

Family Stilipedidae

Stilipes distincta Holmes

Figure 11

Stilipes distincta Holmes, 1908, p. 536, figs. 41–44.—Gurjanova, 1952, p. 194, fig. 17.

Stilipes distincta was described by Holmes from San Nicolas Island off southern California, and he created the family Stilipedidae to receive it. Gurjanova (1952) recorded and figured this species from the western Bering Sea. The genus *Cacao*, erected by K. H. Barnard (1932, p. 153) for *C. lacteus* from the South Atlantic, has the same characters as *Stilipes* and is here considered a synonym of Holmes' genus. *Cacao sanguineus* Hurley (1954, p. 803), from the southeast coast of New Zealand, now becomes *Stilipes sanguineus* (Hurley). Barnard placed *Cacao* in the family Tironidae with some reservation, but it does not agree with that family in several of its characters.

The genus *Stilipes* is very widely distributed, but up to the present time it is represented by only 3 species, *S. distincta, S. lactea,* and *S. sanguinea.*

A sexually mature male and an ovigerous female were taken by the Albatross at station 4751 at the southern end of Alaska (55°56′50″ N, 132°04′20″ W) in 288 fathoms, Aug. 30, 1905. The description and figures given herein are of this male.

Male.—Head and pereon broad, smooth, evenly arched. Head prominent, tumid, as long as first 3 pereon segments combined, bearing peculiar downward-projecting rostrum (fig. 11*b*). Oval bulging area on lower front margin of head represents eye, but no visual elements can be discerned, animal having been in alcohol so long. Antenna 1 about ½ length of body and about ⅔ length of antenna 2; peduncle short, first joint longer than second and third combined; flagellum composed of many joints, first of which is scarcely any longer than rest; second and third peduncular joints and first 7–10 flagellar joints with brushes of forward-curving setae or spines on lower surfaces. Antenna 2 with prominent gland-cone; third joint short; fourth joint shorter than fifth; fifth joint narrower than fourth; both fourth and fifth joints bearing groups of short setae on upper margin and longer setae on lower margin; flagellum composed of many short joints.

Mandible short, stout, without molar or spine-row; cutting-edge chitinous, very broad, without teeth; right mandible without accessory plate, but left with broad plate edged distally with low teeth; palp with second joint twice as long as third. Maxilla 1, inner plate conical, bearing group of terminal setae; outer plate broad, armed with row of 16–17 stout, compoundly curved spine teeth, and brush of setae on inner rounding corner (figs. 11*d,e*); palp with very broadly expanded

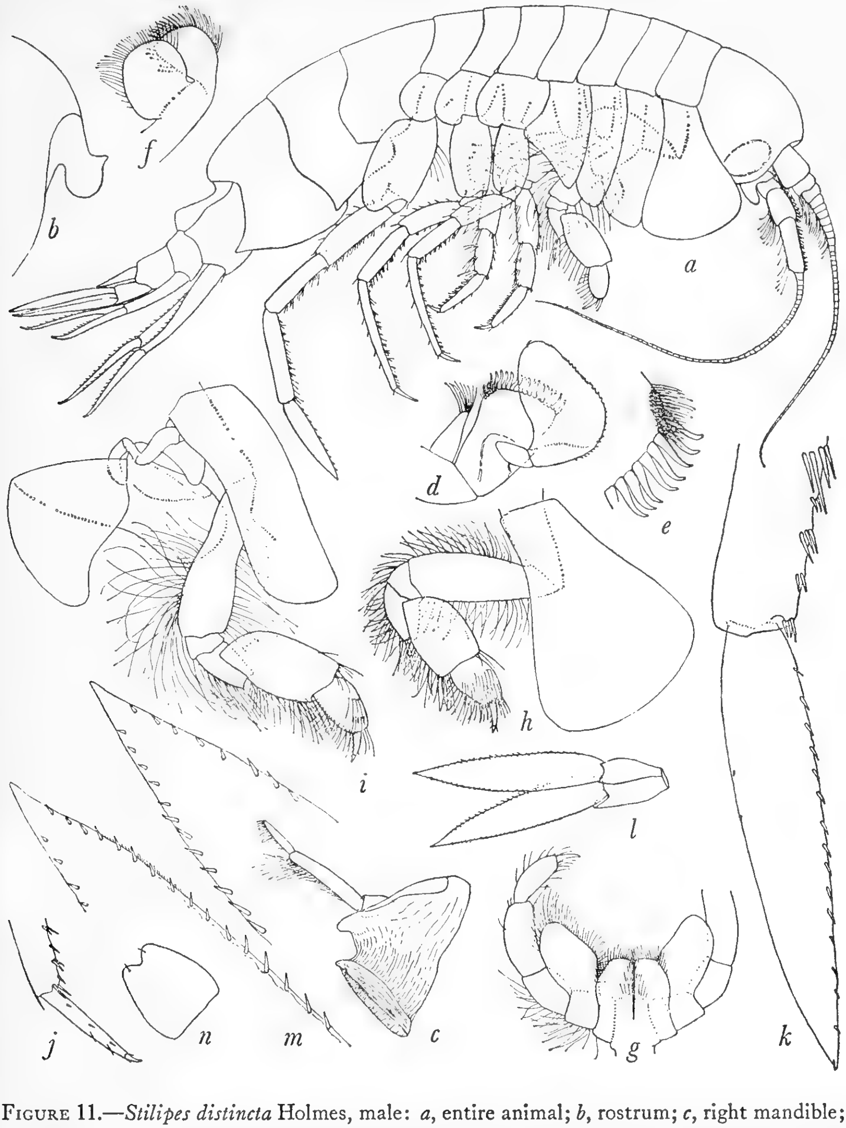

FIGURE 11.—*Stilipes distincta* Holmes, male: *a*, entire animal; *b*, rostrum; *c*, right mandible; *d*, maxilla 1; *e*, teeth of outer plate of maxilla 1; *f*, maxilla 2; *g*, maxilliped; *h*, gnathopod 1; *i*, gnathopod 2; *j*, end of pereopod 4; *k*, end of pereopod 5; *l*, uropod 3; *m*, end of rami of uropod 3; *n*, telson.

second joint bearing low serrations on distal margin. Maxilla 2, inner and outer plates short, broad, inner broader (fig. 11*f*). Maxillipeds rather short, stout; inner lobes short, broad, bearing slender spines but no teeth; outer lobes reaching to middle of second joint of palp and bearing setae but no teeth; palp with second joint longest. Lower lip with outer lobes slightly curved, converging distally; no inner lobes; lateral processes long, narrow.

Gnathopods 1 and 2 simple, much alike; 1 shorter. Gnathopod 1, second joint about as long as fourth to sixth combined; fifth joint slightly longer than wide, nearly twice as long as narrower sixth joint; sixth joint slightly longer than wide, without palm; seventh joint short, weak; second to sixth joints bearing many long slender spines. Gnathopod 2 like 1 except joints are all proportionately longer.

Pereopods 1 and 2 alike, shorter than pereopod 3; fourth joint very slightly expanded; seventh joint small, nearly straight. Pereopods 3–5 increasing consecutively in length; 3 and 4 much alike, second joint not much expanded, twice as long as wide, with lower hind margin slightly lobed; fourth joint slightly expanded; sixth joint nearly twice as long as fifth; seventh joint rather short, nearly straight. Pereopod 5 stouter, longer than 4; second joint nearly twice as long as wide, with rather deep lower hind lobe; fourth joint slightly expanded, scarcely produced behind; fifth joint slightly shorter than fourth; sixth joint slightly longer than fourth; seventh joint greatly developed, as long and wide as sixth and entirely different from that of any other pereopods, being paddle-like, very thin, converging to very sharp apex, and bearing row of short spinules on front margin (fig. 11*k*).

Coxal plates 1–4 deeper than their body segments and decreasing consecutively in depth. Coxal plate 1 greatly expanded distally with front margin reaching front margin of head. Coxal plates 2 and 3 about as wide as their body segments and with sides parallel. Coxal plate 4 nearly as wide as second and third combined, with lower margin curving obliquely upward and upper hind margin excavated to fit front margin of coxal plate 5. Coxal plates 5–7 not quite as deep as their body segments (fig. 11*a*).

Branchiae present on gnathopod 2 and pereopods 1–5, all more or less irregularly folded, crumpled, or lobed.

Pleon segment 1, lower hind corner not produced. Pleon segment 2 sharply produced; segment 3 more sharply produced than 2. Urosome segment 1 with dorsal hump and slight lateral ridges.

All uropods reaching back about same distance. Uropod 1, peduncle slightly longer than inner ramus, which is slightly longer than outer ramus. Uropod 2, peduncle slightly shorter than outer ramus, which is shorter than inner ramus. Peduncle and rami of uropods 1 and 2 edged with many short spines. Uropod 3, peduncle about ⅓ as long as subequal rami, which are lanceolate, thin, flat, edged with short spines (figs. 11*l*,*m*). Telson reaching slightly beyond peduncle of uropod 3, slightly longer than wide, with sides converging to slightly excavated end (fig. 11*n*). Length of male from front of head to end of uropods about 15 mm.

Female.—Ovigerous female like male, except that upper surface of fourth and fifth peduncular joints of antenna 2 do not bear groups of short setae, but there are short setae which do not form groups. Female large, measuring 21 mm.

Remarks.—*Stilipes distincta* superficially very much resembles a hyperiid amphipod, such as *Hyperia*. The 3 species, *S. lactea* (Barnard), *S. sanguinea* (Hurley), and *S. distincta* Holmes, resemble one another superficially but differ slightly in some details. *S. lactea* differs from both *S. sanguinea* and *S. distincta* in having the fifth joint of gnathopod 1 longer than that of gnathopod 2. The fifth joint of both gnathopods in *S. distincta* is somewhat longer than in either of the other 2 species. The outline of the first coxal plate is different in the 3 species. Barnard says that the postero-inferior angle of the second pleon segment is quadrate, not acute. In *S. distincta* this angle is sharply produced. Barnard says merely that the rostrum of *S. lactea* is minute, and Hurley does not mention the rostrum in *S. sanguinea*. The rostrum in *S. distincta* seems to be quite unusual in shape (fig. 8*b*) and may be of diagnostic importance. The spine-teeth of the outer plate of maxilla 1 are figured as being evenly curved in *S. lactea* and *S. sanguinea*, but in *S. distincta* these teeth are somewhat compoundly curved. The eye in *S. lactea* and *S. distincta* appears to be more or less oval, but in *S. sanguinea* it is figured as circular. The telson is somewhat differently shaped in the 3 species. In the specimens of *S. distincta* in the U.S. National Museum the original color has entirely disappeared, the specimens having been in alcohol since 1905. *S. lactea* is said to be brown and white, and in *S. sanguinea* the eye is pink and the other regions of the body orange or deep blood-red. The discovery of additional specimens of this genus will help to clear up their relationships.

Family Paramphithoidae

Uschakoviella echinophora Gurjanova

Figure 12

Uschakoviella echinophora Gurjanova, 1955, p. 200, figs. 14–15.

Female.—Head, upper part rounding, with small blunt forward-pointing rostrum, below which is slight upward-pointing conical protuberance; lateral lobes very shallow; lower front corner slightly produced; row of spines running from top of head down through eye, and few spines below eye. Eye of medium size, bulging, colorless, which may be because of long preservation in alcohol (since 1890). Antenna 1 about ⅓ length of body; first joint slightly longer than second, which is about twice as long as third; flagellum slender, composed of about 35 joints; first peduncular joint bearing several long forward-curving spines and several low ridges; second joint bearing 2 or 3 forward-pointing spines, one of which projects considerably beyond third joint. Antenna 2 slightly longer than 1, fourth and fifth joints about equal in length; flagellum composed of about 40 joints; peduncle without spines such as present on antenna 1.

Upper lip broad, symmetrical, not incised. Mouth parts projecting considerably downward, suggesting parasitic mode of life. Mandible with forward part prolonged; cutting-edge rather narrow with blunt teeth; accessory plate not close to cutting-edge; spine-row consisting of close cluster of 4–5 short stout spines; molar strong, prominent, situated at about middle of mandible, triturating surface narrow; palp situated opposite molar, third joint shorter than second. Maxilla 1, inner plate with 2 apical setae clothed in minute setules, giving them velvety appearance; outer plate with 11 simple spine-teeth; palp slender, with 3 apical velvety spines. Maxilla 2, inner plate shorter, broader than outer, both armed distally with velvety spines. Maxilliped, inner plate broad, reaching to middle of outer plate, armed distally and on inner margin with velvety spines; outer plate very broad, reaching nearly to end of second joint of palp, armed distally and on outer margin with short spines, and on inner margin with short spines which appear to be imbedded in flesh; palp rather short, slender, second joint longest, fourth joint short, stout, bearing minute spinules. Lower lip without inner lobes; mandibular processes broad, strong.

Gnathopods much alike, subequal in size, rather short, slender; second joint nearly as long as third to sixth joints combined; fifth joint longer than sixth; sixth joint slightly expanded distally, with lower distal corner slightly produced, thus forming slight chela with stout seventh joint.

Pereopods 1 and 2 alike in size and form, fifth and sixth joints slightly expanding distally; seventh joint stout, strongly curved, very sharp. Pereopods 3–5 increasing slightly in length consecutively; second joint not much expanded, but that of fifth pereopod broadest; fourth and fifth joints expanded distally with lower hind corner considerably and sharply produced; sixth joint slightly expanded distally; seventh joint stout, very sharp.

Pleon segments rounding below, not produced backward. Uropod 1 reaching back slightly farther than 2 and uropod 3 slightly farther than 1; outer rami of all uropods slightly shorter than inner. Uropod 3, rami somewhat expanded, with narrow pointed apices and many very small marginal spinules. Telson reaching considerably beyond peduncle of uropod 3, about as wide as long, slightly expanding distally, bearing shallow triangular excavation which separates 2 rounding lobes bearing few minute spinules. All gills simple, without plaits or

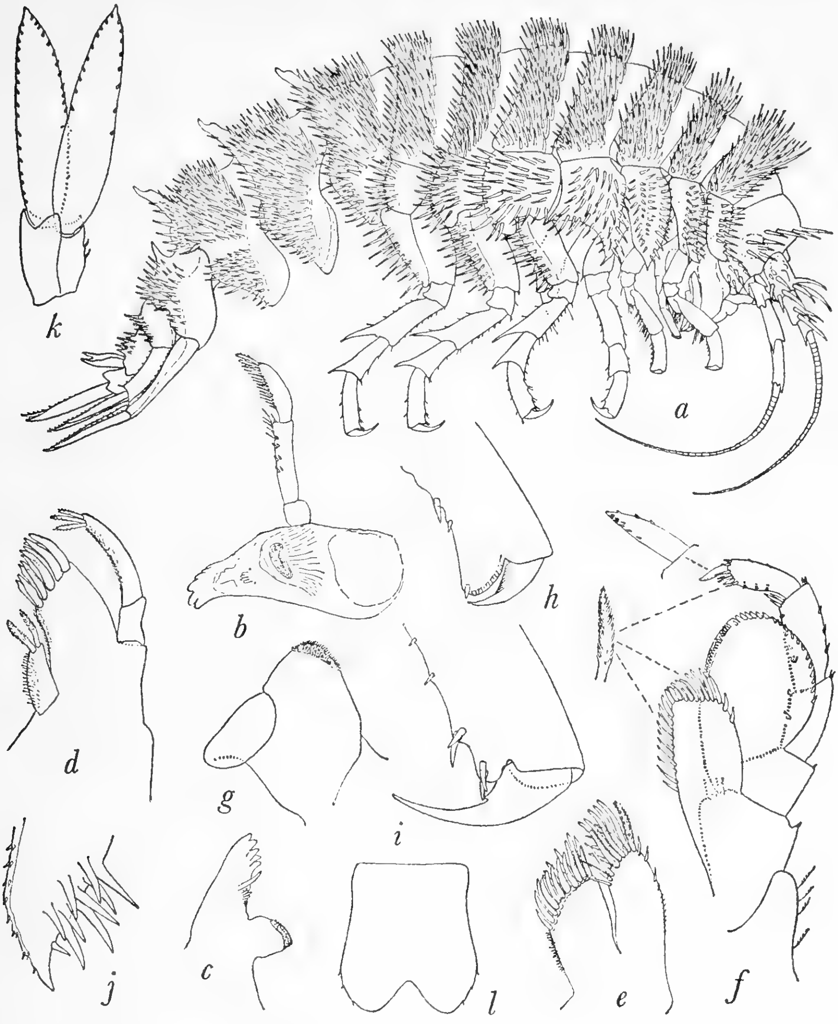

FIGURE 12.—*Uschakoviella echinophora* Gurjanova, female: *a*, entire animal; *b*, right mandible, inside view; *c*, mandible, showing side view of molar; *d*, maxilla 1; *e*, maxilla 2; *f*, maxilliped; *g*, left half of lower lip; *h*, end of gnathopod 2; *i*, end of pereopod 1; *j*, lower end of coxal plate 3; *k*, uropod 3; *l*, telson.

appendages. All body segments and coxal plates densely clothed with long, slender spines. Second joints of pereopods 3–5 bear long spines on posterior margins.

Pleon segments 1–3 each bearing prominent backward-inclined dorsal spine or tooth in addition to regular spines. Urosome segment 1 bearing sharp dorsal tooth directed slightly forward. Largest female in collection measures 30 mm. from front of head to end of uropods.

MALE.—All males in collection small, only about ¼ length of largest females. Males, however, fully developed sexually. Whether males are normally much smaller than females cannot be determined from the present material. All of the males and the smaller females are much less spinose than the large females.

The specimens that Gurjanova studied were taken east of Sturup Island, the northernmost of the Kuril Islands. The specimens taken by the steamer *Albatross* were from the Bering Sea and the vicinity of Otter Island, the westernmost of the Aleutian Islands.

The specimens taken by the *Albatross* were from the following stations: 3231 (53°33′30″ N, 167°15′40″ W), June 18, 1890, in 54 fms., 2 specimens; station 3599 (52°05′00′ N, 177°40′00′ E), June 9, 1894, 1 specimen; station 4782 (52°55′ N, 173°27′ E), June 9, 1906, in 65 fms., 3 specimens; station 4784 (52°55′40″ N, 173°26′00″ E), June 11, 1906, in 135 fms., 2 specimens. One vial without locality, 21 small specimens.

REMARKS.—*Echiniphimedia hodgsoni* (Walker, 1907) also has the body clothed with spines, but the resemblance is only superficial.

Family Gammaridae

Anisogammarus schmitti, new species

FIGURE 13

MALE.—Head about as long as first 2 body segments combined; side lobe with front margin more or less straight, upper and lower corners rounding, shallow notch near upper corner. Eye not very large, reniform, rather narrow and brownish-black in alcohol. Antennae 1 and 2 about equal in length. Antenna 1, peduncular joints decreasing in length consecutively; flagellum perhaps slightly longer than peduncle, composed of about 20 joints; accessory flagellum of 5 joints. Antenna 2, fourth and fifth joints about equal in length; flagellum nearly as long as fourth and fifth joints combined, composed of about 14 joints.

Right mandible, cutting edge toothed and rather narrow; accessory plate sharply toothed; spine-row of 4 or 5 simple spines and several plumose setae. Molar strong, with plumose seta at rear margin. Maxilla 1, inner plate broad, with closely set row of marginal plumose setae; outer plate with 11 pectinate spine-teeth; palp broad, with 7 apical teeth and diagonal row of 5 distal submarginal setae on outside. Maxilla 2, lobes rather broad, bearing usual distal curved spines; inner plate slightly the shorter, bearing diagonal row of 9 plumose spines, first 2 of which longer than rest. Maxilliped rather long,

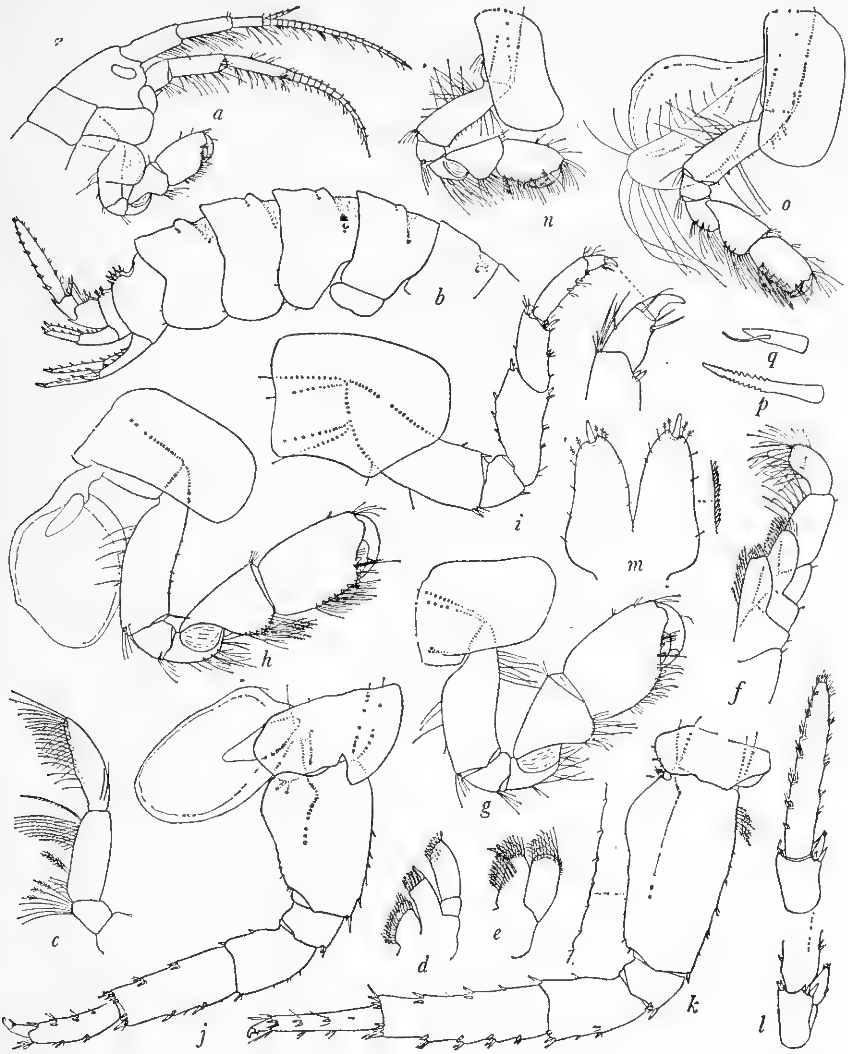

FIGURE 13.—*Anisogammarus schmitti*, new species, male: *a*, front end of animal; *b*, rear end of animal; *c*, mandibular palp; *d*, maxilla 1; *e*, maxilla 2; *f*, right maxilliped; *g*, gnathopod 1; *h*, gnathopod 2; *i*, pereopod 2; *j*, pereopod 3; *k*, pereopod 5; *l*, uropod 3; *m*, telson; female: *n*, gnathopod 1; *o*, gnathopod 2; *p*, spine on outside of palm of gnathopod 2; *q*, spine on inside of palm of gnathopod 2.

slender; inner plate reaching to about middle of outer plate, distal end with curved plumose setae, inner margin with plumose setae, 3 teeth probably present but, because of dense armature of spines, difficult to determine number; outer plate reaching nearly to middle of second palp joint, armed distally with curved plumose spines and on inner margin with stout pectinate spine-teeth; second joint of palp longest, bearing many long curved spines on inner margin; third joint of palp expanding distally, provided with many long curved spines, some of which are pectinate (fig. 13); fourth joint of palp nearly as long as third, bearing long slender nail.

Gnathopods differing little in length, but gnathopod 2 slightly the longer. Gnathopod 1 slightly stouter than 2; second joint slightly longer than sixth joint; fifth joint slightly shorter than sixth and almost as wide; sixth joint ⅔ as wide as long, palm quite oblique, curving gradually into hind margin of joint, armed on outer margin with row of 7–8 blunt, peglike teeth which extend slight way down hind margin of joint and on inside of palm with at least twice as many blunt teeth; seventh joint strong, much curved, bearing nail which occupies about ⅓ of joint. Gnathopod 2, second joint longer than sixth; fifth joint nearly as long and as wide as sixth; sixth about ⅔ as wide as long, palm not as oblique as in gnathopod 1, passing into hind margin of joint by short curve, armed on outside margin with 7 blunt teeth which extend slight way down hind margin of joint; seventh joint not as strongly arched as that of gnathopod 1, nail occupying about ⅓ of its length.

Pereopod 1 slightly stouter and considerably longer than pereopod 2. Pereopod 2 rather stout (fig. 10*i*); seventh joint short, strong, with upward-curving nail. Pereopod 3 much like pereopod 4 but shorter, its coxal plate larger (fig. 13*j*). Pereopod 5 longest (fig. 13*k*).

Seventh pereon segment and pleon segments as shown in figure 13*b*, obtusely angular posterodorsally, each having slight hump anteriorly with lower hind corner broadly rounding. First urosome segment has dorsally on either side a slightly raised ridge armed with spines. Second and third urosome segments have dorsally on either side a very slight ridge armed with spines. Pleopods rather long; rami about twice as long as their peduncles and equal in length. Uropods 1 and 2 extending back about same distance; uropod 3 extending back much farther. Their armature of spines shown by figure 13*b*. Uropod 3, outer 1-jointed ramus about 3½ times longer than peduncle; inner ramus only about ⅙ as long as outer ramus (fig. 13*l*).

Telson reaching to end of peduncle of uropod 3, about as long as broad, cleft about ⅔ its length, lobes dehiscent, each armed apically with spine and several plumose setae (fig. 13*m*). Gnathopod 2 and pereopods 1–5 carrying branchiae, which are broadly oval and have small sausage-shaped appendage. Length of male about 16 mm.

Female.—Very much like male but smaller. Gnathopods smaller, weaker. Gnathopod 1, palm very oblique, without defining angle but with 4 straight sharp spines on outside, where it curves into hind margin of joint, and 4 on inside of palm; seventh joint not as strongly arched, nail long, slender, bearing forward-pointing tooth at its base (fig. 13*n*). Gnathopod 2 (fig. 13*o*) longer than 1; fifth joint as long and as broad as sixth; sixth joint about ⅓ longer than wide, palm transverse, convex, armed throughout with very fine closely set teeth, without defining angle, but armed where it curves into hind margin of joint with 5 slender crenulate spines (fig. 13*p*) on outside, and 6 stout straight spines (fig. 13*q*) on inside; seventh joint fitting palm, nail long, slender, bearing forward-pointing tooth at its base.

Gnathopod 2 and pereopods 1–3 carry marsupial plates which are fringed throughout with long closely set simple setae, only few of which are shown in figure 13*o* in order not to obscure spines on joints of limb. Length of female about 12.5 mm.

Types.—Male holotype, USNM 101742, and 15 paratypes, taken by Dr. Waldo L. Schmitt, station 79, on shore of Squaw Harbor, Baralof Bay, Unga Island, Shumagin group, Alaska, Oct. 20, 1940.

Specimens also taken by Dr. Schmitt offshore, on and under rocks, Sand Point, Popof Island, Alaska, Oct. 25, 1940; and Canoe Bay, Alaska Peninsula, south end near opening of Pavlof Bay, Sept. 17, 1940.

***Anisogammarus confervicolus* (Stimpson)**

Figures 14, 15

Mara confervicola Stimpson, 1856, p. 90.
Gammarus confervicolus.—Stimpson, 1857, pp. 520–521.—Bate, 1862, p. 218, pl. 38, fig. 9.—Holmes, 1904, p. 239.
Melita confervicola.—Stebbing, 1906, p. 428.
Anisogammarus (*Eogammarus*) *confervicolus.*—J. L. Barnard, 1954, pp. 9–12, pls. 9–10.—Bousfield, 1958, p. 86, fig. 10.

Male.—Head, lateral lobe obliquely truncate with front margin slightly concave; eye reniform, black, of medium size. Antennae about ⅓ length of body. Antenna 1 slightly longer than antenna 2; first joint slightly longer than second and bearing 1–2 rather stout spines on lower margin; third joint about ½ length of second; flagellum much longer than peduncle and composed of 26–30 joints; accessory flagellum composed of 5–6 joints and minute terminal joint. Antenna 2, second joint with well-developed gland cone; fourth and fifth joints equal in length; flagellum about equal in length to fifth peduncular joint and composed of 11–15 joints, first 7–8 of which bear calceoli on upper distal corners.

Mandible, molar prominent with triturating surface bearing plumose seta; cutting-edge toothed, accessory plate present; spine-row of about 6–7 spines and several plumose setae; palp well developed with third joint slightly shorter than second. Maxilla 1, inner plate large with many plumose setae on lateral margin and few on distal end; outer plate bearing 11 spine-teeth; palp large, second joint armed on oblique distal margin with 6 spine-teeth and several submarginal

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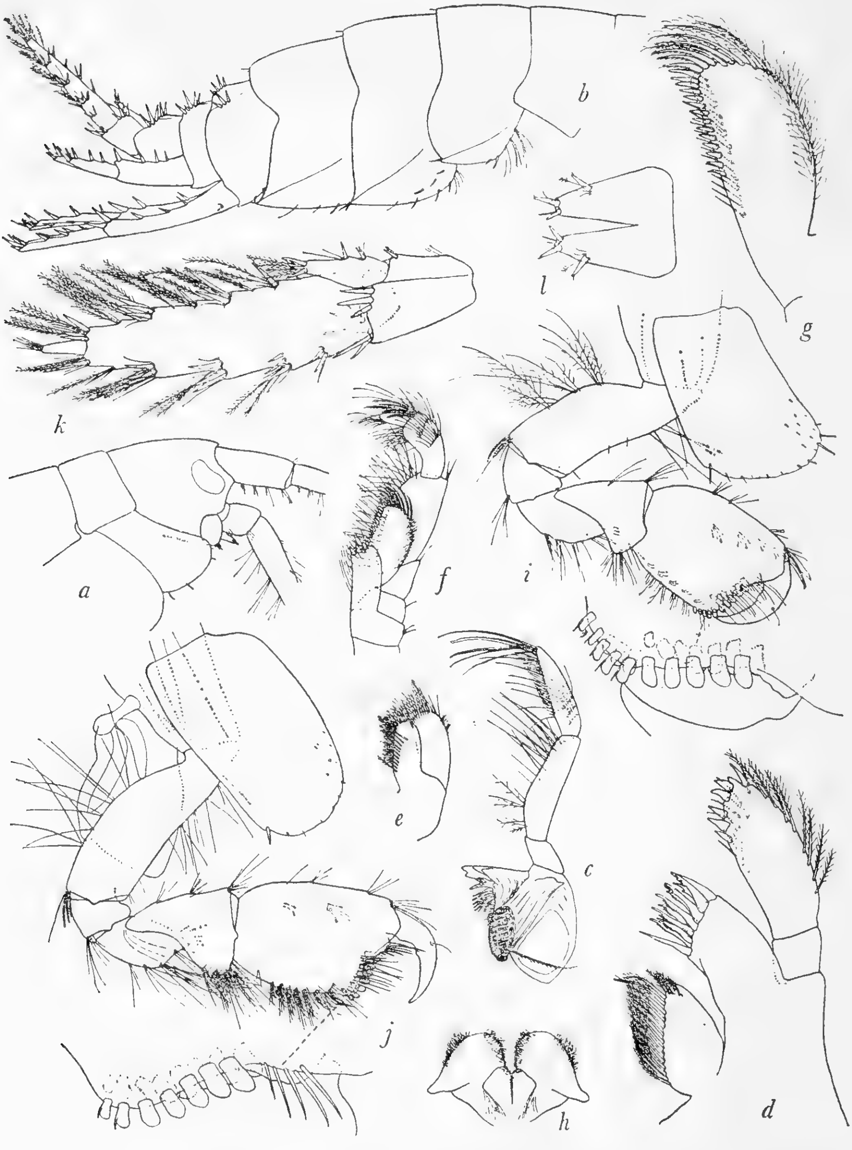

FIGURE 14.—*Anisogammarus confervicolus* (Stimpson), male: *a*, front part of animal; *b*, hind part of animal; *c*, right mandible; *d*, maxilla 1; *e*, maxilla 2; *f*, maxilliped; *g*, outer lobe of maxilliped; *h*, lower lip; *i*, gnathopod 1; *j*, gnathopod 2; *k*, uropod 3; *l*, telson.

setae, and with row of plumose setae on outer lateral margin. Maxilla 2, outer and inner lobes armed distally with many spines; inner lobe armed with spines on inner margin also, and having oblique row of about 11 plumose setae on inner surface. Maxilliped, inner lobe

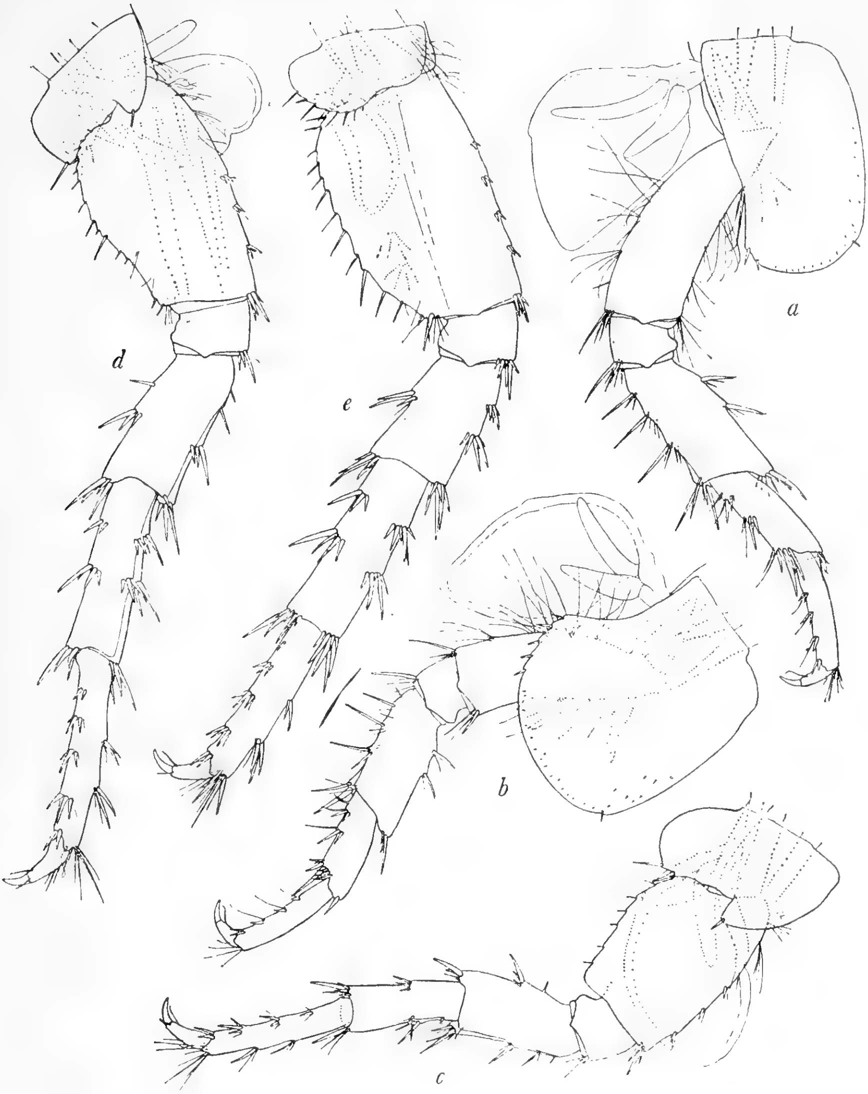

FIGURE 15.—*Anisogammarus confervicolus* (Stimpson), male: *a*, pereopod 1; *b*, pereopod 2; *c*, pereopod 3; *d*, pereopod 4; *e*, pereopod 5.

reaching to about middle of outer lobe, armed distally with 3 spine-teeth and several plumose setae, and on inner margin with usual plumose setae; outer lobe reaching slightly beyond middle of second joint of palp, armed distally with curved plumose spines and on inner margin with spine-teeth and submarginal spinules; palp rather stout but not very long, second joint about as long as third and fourth combined, fourth bearing sharp nail and several distal setae. Lower lip with small inner lobes; outer lobes broad, rounding; mandibular processes short.

Gnathopods 1 and 2 of nearly equal length, 2 slightly longer; second joint longer than sixth; fifth joint slightly over ½ length of sixth; sixth joint longer than wide, upper and lower margins slightly convex, lower margin bearing several groups of spines, palm slightly oblique, armed on inner and outer margins with row of blunt spine-teeth, without defining angle but passing into hind margin of joint by evenly rounding curve, which also bears row of blunt teeth on inner and outer margins; seventh joint stout, curved, bearing slight protuberance on inner margin near hinge, with only apex closing against palm.

Pereopods 1 and 2 alike, 1 slightly the longer; fourth joint very slightly expanded, with front margin produced slightly downward; seventh joint strong, curved, about ½ length of sixth joint, bearing nail, and prominent seta on inner margin. Pereopods 3–5 with second joint expanded. Pereopod 3 shorter than 4 or 5, which are subequal in length. Pereopod 3 with lower hind corner of second joint quadrate, but bluntly rounding. Pereopod 4, second joint with hind margin convex above and concave below, with scarcely any lower hind corner. Pereopod 5 with hind margin of second joint evenly convex and without any lower corner. Seventh joint of pereopods 3–5 like those of 1 and 2, but larger, stronger.

Coxal plates 1–4 not much deeper than their body segments. Coxal plate 1 slightly expanded below and slightly produced forward; lower margin rather flatly convex, provided with few spinules. Coxal plates 2 and 3 deeper than long, with lower margin convex, bearing few spinules. Coxal plate 4 slightly deeper than long, lower margin convex, hind margin below excavation bearing row of short spines. Coxal plate 5 with shallow front lobe bearing small spine, hind lobe also bearing 1–2 spines. Coxal plate 6 much like 5 but not as deep. Coxal plate 7, hind lobe bearing row of spines.

Pleon segment 1, lower lateral margin convex, lower hind corner represented by small produced angle, bearing setule, front margin with several groups of setae and several small spinules. Pleon segment 2 with lower lateral margin nearly straight, lower corner sharply produced, bearing spinule; lower margin with several groups of setae and several spinules. Pleon segment 3 much like 2 but lower hind corner possibly slightly more sharply produced. Urosome segment 1 bearing dorsally 4 groups of spines, 2 outer having 3 spines each, 2 inner 4 spines each. Urosome segment 2 bearing dorsally 2 groups of 3 spines each, between which are 2 central spines. These urosome spines not accompanied by setae. Uropod 1, peduncle longer than rami and armed on upper outer margin with 5 spines, 2 of which are apical; upper inner margin with 3 spines, 1 of which is apical; outer ramus slightly longer than inner ramus, each armed with spines (fig. 5*b*). Uropod 2, peduncle longer than rami, upper outer margin with 3–4 spines, one of which apical, inner margin with 2 spines, one of which is apical; outer ramus slightly the shorter, each armed with spines (fig. 5*b*). Uropod 3 extending back farther than 1; peduncle about ⅓ as long as outer ramus, which bears groups of spines containing few plumose setae on outer and inner margin, second joint small, narrow; inner ramus about ¼ as long as outer, and bearing few spines on inner margin and group of spines and plumose setae apically. Telson reaching slightly beyond end of peduncle of uropod 3, cleft about ⅔ its length, armed with spine and plumose seta on either lateral margin, 2 spines and few spinules on apex of each lobe. Gills of gnathopod 2 and pereopods 1–3 each with 2 finger-like appendages. Gill of pereopod 4 with 3 finger-like appendages, gill of pereopod 5 with 1 appendage.

Stimpson gave .4 to .5 of an inch (about 13 mm.) as the length of this species, but there are specimens in the U.S. National Museum measuring up to 21 mm. that were taken from a brackish pond in Snohomish County, Washington, a pond which receives an inflow from Puget Sound at exceptionally high tides. Apparently Stimpson's description was taken from rather small specimens.

Female.—Much like male but smaller. Antennae somewhat shorter, flagellum of antenna 2 bears calceoli which are smaller than those of male. Gnathopod 1 stronger but shorter than gnathopod 2 and like that of male. Sixth joint of gnathopod 2 comparatively narrow, with palm slightly oblique or nearly transverse. Uropods shorter than those of male.

Remarks.—*Anisogammarus confervicolus* appears to inhabit bays, estuaries, brackish tidepools, and mouths of streams where the water is brackish. In the U.S. National Museum there are specimens from Santa Catalina Island, San Diego, and various localities northward along the coasts of California, Oregon, and Washington. The species appears to be common in Puget Sound and has been taken at Vancouver Island. There are 3 collections from Alaska: 1 from Saginaw Bay, Kuiu Island, Frederick Sound, Alexander Archipelago; 1 from a stream entering Orzenoi Bay, southwest Alaska (stream probably brackish, at least at high tide); and 1 from Sitka. Barnard (1954) gives several localities in Oregon and 1 in Alaska (Alinchak Bay), and Bousfield (1958) records the species from a number of Canadian Pacific localities.

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SHRIMPS OF THE GENUS BETAEUS ON THE PACIFIC COAST OF NORTH AMERICA WITH DESCRIPTIONS OF THREE NEW SPECIES

By Josephine F. L. Hart

Introduction

Shrimps of the genus *Betaeus* are members of the section Caridea and the family Alpheidae (or Crangonidae in much of the North American literature). Members of this genus are characterized by the lack of a rostrum in the adult and by the inversion of the "hands," with the result that the dactyls are on the lower side. The terms "visored shrimps" and "hooded shrimps" are sometimes used because the carapace projects forward to overhang the eyes. Up to the present time four species have been recognized as occurring in the area from Mexico to Alaska: *Betaeus harrimani* Rathbun, *B. longidactylus* Lockington, *B. ensenadensis* Glassell, and *B. harfordi* (Kingsley). However, these species have not been well defined.

The sole published record of *Betaeus harrimani* is the original description by M. J. Rathbun (1904) based on a single female taken in southern Alaska. The examination of a series of both males and females from a number of more southerly locations has made it possible to elaborate on this description. Such an elaboration is especially

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important because of the overlap of the range of the closely allied form *B. longidactylus* Lockington (1877) in California. These two species, as well as *B. ensenadensis* Glassell (1938) of southern California and Mexico, are figured and redescribed here in some detail.

In the 1870's W. N. Lockington and J. S. Kingsley each described two species of hooded shrimps from California. They engaged in considerable controversy in their papers as to whether or not *Betaeus* was a valid genus, and occasionally they referred species of *Betaeus* to the genus *Alpheus;* as a result, in the literature both *Alpheus* and *Betaeus* are used in referring to these shrimps. Lockington (1877b, 1878) described two species briefly, without figures, and, unfortunately, named one *Betaeus equimanus,* a name that had been used previously by Dana (1852, p. 560; 1855, pl. 35) for a shrimp from New Zealand. Early in 1878 Kingsley published a description of apparently the same shrimp and called it *Alpheus harfordi* but indicated that if "*aequimanus*" should prove to be different, the shrimp would have to be called "*aequalis.*" Later in the same year Lockington called it *B. equalis* and enlarged his description by incorporating Kingsley's description of *B. harfordi.* He was convinced that they were identical but because of his use of a preoccupied name, he lost the honor of naming the species. *Betaeus harfordi* (Kingsley) is therefore the valid name.

Holmes (1900) gave a description with more details than those given by the early writers, but unfortunately he added new habitats that perhaps have helped to mask the presence of four distinct forms: two commensal and two free-living.

In 1934 several hooded shrimps were taken in tide pools on the west coast of Vancouver Island by E. G. Hart. These agreed with published descriptions of *B. harfordi* except for a few minor differences. Since shrimps of the family Alpheidae often show considerable variation in relative proportions according to age and sex, no suspicion of significant differences arose until individuals from California were compared with the northern specimens. As a result of a detailed comparative study, it now seems that those found commensal within the mantle cavity of abalones are referable to *B. harfordi* and that the remainder represent three undescribed species. The similar, but quite distinct, form that lives in association with sea urchins I propose to call *B. macginitieae* in recognition of Nettie MacGinitie, who, with her husband Professor G. E. MacGinitie, has contributed so much to our knowledge of the genus. For the two free-living forms I have chosen the names *B. gracilis* and *B. setosus.*

In view of the fact that the published descriptions and figures of the known species are inadequate, an attempt is made herewith to supplement them with more detailed descriptions and illustrations.

The figures are drawn to three magnifications: scales A, B (two times A), C (ten times A). The whole animal, the chelipeds, and chelae are scale A; the dactyli, scale C; and the remainder, scale B. New keys and comparative tables incorporating the new species are presented. In this aspect the work of L. B. Holthuis (1952) on two species found in Chile has been very useful.

In classification, emphasis in the past has been placed on the proportions of the segments of the antennular peduncle, and on the size, shape, and dentition of the large chelae. These features, however, have been found to differ with age, sex, and extent of regeneration. In this paper, therefore, an attempt is made to use as diagnosis those characters that do not vary appreciably during the life of the individual.

Sexual dimorphism also is noted in this account. Differences due to sex are most obvious in large males of *B. longidactylus*, in which the chelipeds are much larger in relative proportion to the rest of the body than in smaller males or in females. All the other species dealt with here also show sexual dimorphism but only to a minor extent such as stouter appendages and narrower pleura on the abdomens of the males.

Acknowledgments

My thanks are due to Dr. Waldo L. Schmitt and Dr. Fenner A. Chace, Jr., of the United States National Museum for the loan of comparative material, for making comparisons with the type of *B. harrimani*, and for much other help. In addition, Dr. Chace read the manuscript and gave invaluable advice. The late Dr. Belle A. Stevens was most helpful in the early stages of the study. I wish also to thank both Dr. Paul L. Illg of the Department of Zoology, University of Washington, and Mrs. G. E. MacGinitie, retired from Kerckhoff Marine Laboratory, for much help and encouragement, as well as for specimens. Thanks also are due to Mr. Keith W. Cox, California Department of Fish and Game, who has given me specimens and much useful data on *Betaeus harfordi* obtained in connection with his work on *Haliotis*.

For the use of material I am indebted to the following: Mr. T. H. Butler and the Fisheries Research Board of Canada; Dr. Joel W. Hedgpeth (Pacific Marine Station); Dr. Rolf Bolin and Dr. Donald P. Abbott (Hopkins Marine Station); Dr. Olga Hartman (University of Southern California, Allan Hancock Foundation) for the loan of the late S. A. Glassell's collection; Dr. James E. Lynch (University of Washington) for collections by Dr. John S. Laurie; and Dr. R. U. Gooding of the University of Washington at the time.

I am also indebted to Mr. C. B. Howland, Victoria, British Columbia, whose patience and ingenuity resulted in successful photographs of the living shrimps. I am grateful also to the Provincial Museum of British Columbia for the use of certain facilities and to the National Science Foundation for a grant providing equipment and aid in the completion of the study. Finally, I want to thank my husband, Dr. G. Clifford Carl, for his help in so many ways.

In addition to the above material I have examined nearly 200 specimens (mainly *B. longidactylus*) from the collection of the Allan Hancock Foundation. I hope to report on this material in a future paper.

Family Alpheidae

Rostrum, if present, unarmed. Eyes usually covered by carapace. Mandibles with incisor process and palp of two segments. First pair of legs often with one chela, or both chelae, powerfully developed. Second pair of legs minutely chelate, long, slender, equal, with segmented carpus. Telson usually broad, rounded.

Genus *Betaeus* Dana

Rostrum not present; front not spined, either emarginate between eyes or evenly rounded. Chelae usually similar, inverted so that dactyls are on lower side. Telson broad. Sixth abdominal somite with movable plate articulated at posterolateral angle. Epipods on at least first two pairs of legs.

Key to Species of *Betaeus* from West Coast of North America

1. Dactyli of walking legs slender and simple 2
   Dactyli of walking legs stout and bifid 4
2. Chelae of first legs with fingers longer than palm.
   B. longidactylus Lockington
   Chelae of first legs with fingers not longer than palm 3
3. Blade of antennal scale broad distally. Fixed finger of first cheliped decreasing in width evenly to sharp curved tip . . **B. harrimani** Rathbun
   Blade of antennal scale narrow distally. Fixed finger of first cheliped truncate before sharp curved tip . . . . **B. ensenadensis** Glassell
4. Front curved, not emarginate . . . . **B. macginitieae,** new species
   Front emarginate 5
5. Emargination shallow. Telson with posterolateral spines small or missing.
   B. harfordi (Kingsley)
   Emargination deep. Telson with posterolateral spines well developed . . 6
6. Peduncle of antennule less than one-half carapace length. Merus of cheliped with lower inner ridge with long bristles, upper ridge ending in sharp tooth; chela with fingers subequal to palm; chela is three times as long as wide.
   B. gracilis, new species
   Peduncle of antennule subequal to carapace length. Merus of cheliped with lower inner ridge usually tuberculate, upper ridge with tuft of hairs; chela with fingers longer than palm; chela is twice as long as wide.
   B. setosus, new species

Betaeus harrimani Rathbun

Figures 1–26, 29–31, 37–39; Plate 1

Betaeus harrimani Rathbun, 1904, pp. 108–110, fig. 49 (type locality, Sitka, Alaska; holotype female, USNM 25692).—Banner, 1953, p. 5.

Female.—Carapace laterally compressed but without carina. Smooth, with minute setae sparsely scattered except where concentrated ventral to hepatic region, where they form a pubesence (seen best in cast skins of large individuals). Longer setae under front and along posterior margin. Front (fig. 17) slightly curved and depressed anteriorly. Anterior margin (fig. 18) with two shallow sinuses. No distinct anterolateral angle. Width of carapace increases to midlateral point and then decreases slightly with faint undulations on margin. Lateral margin joins posterior in smooth curve. Posterior margin angles in sharply to deep cardiac notch.

Abdomen (fig. 1) smoothly rounded with posteroventral margin of pleura of first to third segments rounded, those of fourth and fifth segments angled. First and fifth pleura margined with setae ventrally. Minute setae on smooth surface.

Telson (fig. 26) longer than sixth abdominal segment, much longer than wide, outer margins curved. Two pairs of movable spines on dorsal surface, two spines at each posterolateral angle; outer ones small. Posterior margin deeply curved, plumose setae long.

Eye round with short, sharp-pointed tooth on each stout eyestalk medially.

Antennule with stylocerite broad at base; outer margin slightly convex, inner concave, tip reaching almost to end of second segment of peduncle. First segment of peduncle with sharp compressed tooth ventrally (fig. 2). Second joint usually longer than third. Outer flagellum with sensory part fused except for about three segments that are free from slender terminal flagellum.

Antenna with peduncle slightly longer than that of antennule. Distal margin of basis produced into sharp-pointed flat tooth ventrally. Scale (fig. 19) broad: wide spine exceeding blade, separated from it by short slit distally, outer margin straight. Tip reaching past middle of last segment of antennular peduncle. Flagellum longer than carapace, ovoid in cross section.

Mandibles, maxillules, maxillae, first and second maxillipeds (figs. 3–7) similar to those of *Betaeus truncatus* Dana, as described by Holthuis (1952), but appearing more setose, as illustrated.

Third maxilliped (fig. 8) reaching to end of antennal peduncle. Ischiomeropodite flattened, twisted. Exopodite longer than ischiomeropodite but narrow, fragile-looking, with soft plumose hairs distally and striations on cuticle that can be observed in cast skins.

TABLE 1.—*Distinguishing characters*

Characters	*B. harrimani*	*B. longidactylus*	*B. ensenadensis*
abdomen			
ventral pleural margins	1st and 5th setose	same	1st only setose
telson	wide distally	same	narrow distally
antennule			
2nd segment of peduncle	longer than 3rd	subequal to 3rd	much longer than 3rd
stylocerite	nearly to end of 2nd segment	same	to middle of 2nd segment
antenna			
scale	wide distally, distinct slit	same	narrow distally, minute slit
flagellum	slender, oval in cross section	stout, oval	stout, flattened, oval
1st leg			
merus	stout, flared distally	slender, not flared	stout, slightly flared
chela			
length	more than carapace	less than carapace (except large males)	less than carapace
fingers	shorter than palm	longer than palm	shorter than palm
large tooth	on fixed finger	same	on dactylus
2nd leg			
fingers	shorter than palm	subequal or longer than palm	subequal to palm
3rd and 4th legs	slender	relatively stout	slender
ischium	no movable spine	same	movable spine
merus	slightly dilated	same	dilated, flattened
propodus			
ventral spines	slender	stout	very slender
terminal spines	⅓ dactylus	½ dactylus	⅙ dactylus
dactylus	long, thin, curved	shorter, stouter, straighter	very long, thin, curved
length	40% propodus	30% propodus	60% propodus
uropod			
peduncle	2 large teeth with bristles on curved margin between	same	2 small teeth with serrate setae on straight margin
exopodite	tooth above spine	same	tooth and spine widely separated

TABLE 2.—*Distinguishing characters*

Characters	*B. harfordi*	*B. macginitieae*	*B. gracilis*	*B. setosus*
setae	few	very few	few, small, scattered	numerous
carapace	⅓ or less of total length	more than ⅓ total length	⅓ total length	⅓ or more of total length
front	emarginate, shallow groove between eyes	not emarginate, slightly convex	emarginate, deep groove between eyes	same
abdomen				
5th pleura	blunt angles posteriorly	roundly acute posteriorly	sharp angle posteriorly	same
telson				
posterolateral spines	very small or missing	small	large	same
antennule				
peduncle	equal to ½ carapace length	same	less than ½ carapace length	subequal to carapace length
2nd segment	1½ times third segment	nearly two times third	1⅓ times third	more than 1½ times third
antenna				
blade	narrow distally, as wide as spine	same	not narrow distally, more than twice width of spine	narrow distally, about twice width of spine
3rd maxilliped	to distal ⅓ of 2nd segment of antennular peduncle	same	to end of 3rd segment of antennular peduncle	same
1st leg				
merus	very few setae	same	very few setae	many setae
chela	female: equal to, or less than, carapace length male: equal to, or more than, carapace length	female: less than carapace length male: greater than carapace length	subequal to carapace length	greater than carapace length
gape	female: little or none male: usually a foramen	small, relatively narrow	small or none	female: often none male: large
fingers	equal to, or slightly longer than, palm	shorter than palm	shorter than palm	longer than palm
setae	on cutting edges only	same	only on cutting surfaces and fingers	on cutting edges and margins of chela
uropod				
teeth on peduncle	subequal, no setae, or minute between	very small, no setae	outer slightly larger, few setae between	outer much larger, long stiff setae between
habitat	within mantle cavity of abalone	beneath sea urchins	free-living	same

Penultimate segment short, less than ½ length of distal segment, which has rows of stout bristles medially.

First leg large, usually nearly twice length of carapace, with chela as long as, or longer than, carapace. Ischium short. Merus shorter than chela, somewhat triangular in cross section, distal margin rounded; ventral with two tuberculate ridges separated by shallow sinus. Outer ridge protruding distally to form broad flat process. Outer surface of merus with broad, oblique sinus, devoid of tubercles, into which second leg may fit. On inner surface a longitudinal sinus and distally a deep transverse groove. Large membranous area ventrally into which flat, platelike toothed process of carpus fits. Scattered tubercles over most of surface. Carpus short, rounded dorsally, with transverse and longitudinal sinuses. Chelae (figs. 11, 13, 14, 30, 31) finely tuberculate, spinulate, with fine pubescence, especially dorsally. Not compressed but somewhat flattened on inner side of palm. Great variation in proportion, length, width, dentition of palm and fingers. Fingers occasionally subequal to palm but usually about ½ as long. Gaping, large-toothed type much more common than nongaping, finely denticulated form described by Rathbun (1904). (There can be no doubt that both types are found in *B. harrimani*, as a number of specimens have one chela of each type. One such, kept in the laboratory, had the chelipeds injured and the regenerated chelae both had nongaping fingers). Tips of fingers curved, with chitinous parts interlocking.

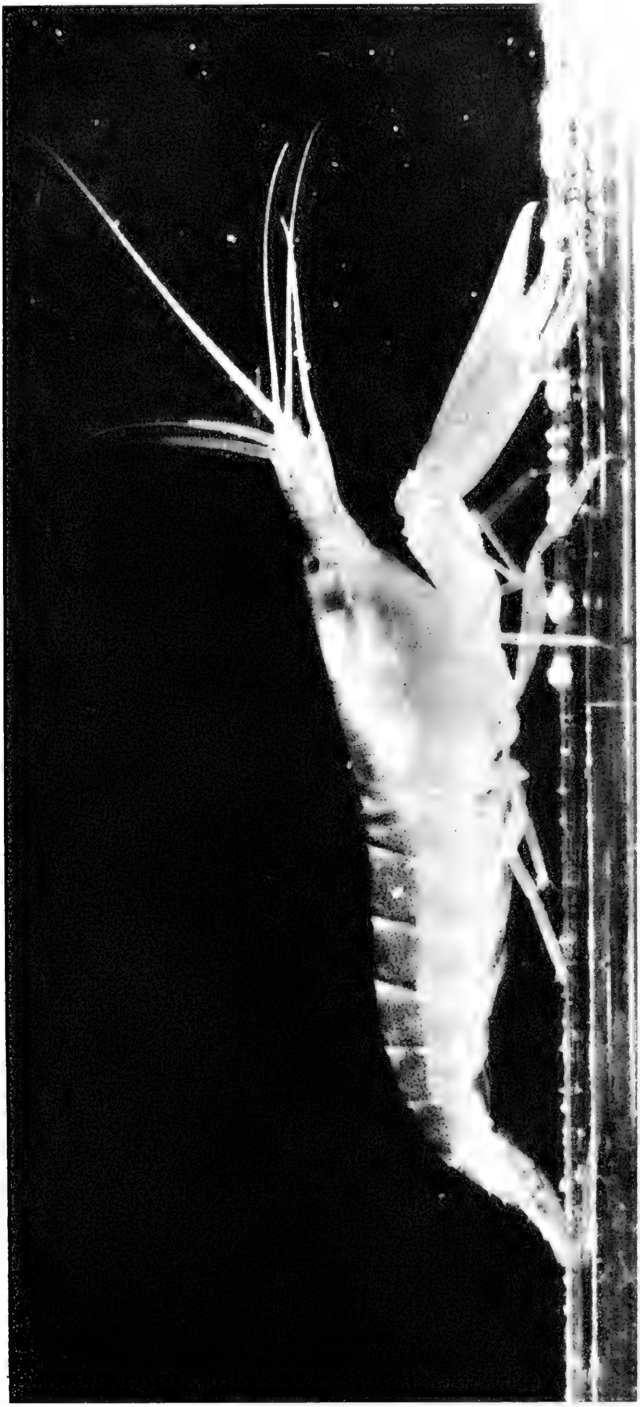
Second leg (fig. 37) very slender, with elongated ischium, nearly as long as 5-jointed carpus, longer than merus. First joint of carpus equal in length to next three together, or to chela; second slightly longer than subequal third and fourth; fifth, twice fourth. Chelate, with palm longer than fingers, tips setose.

Third and fourth legs (figs. 9, 38) slender, somewhat flattened. Ischium subequal to carpus, about ½ length of merus. Merus slightly inflated, with movable spine. Carpus with two ventral terminal spines. Propodus with ventral marginal spines and setae: terminal pair stout, and group of bristles dorsally. Dactylus (fig. 39) curved, thin, sharp-pointed, with curved setae dorsally; more than ⅓ length of propodus, which is nearly as long as merus.

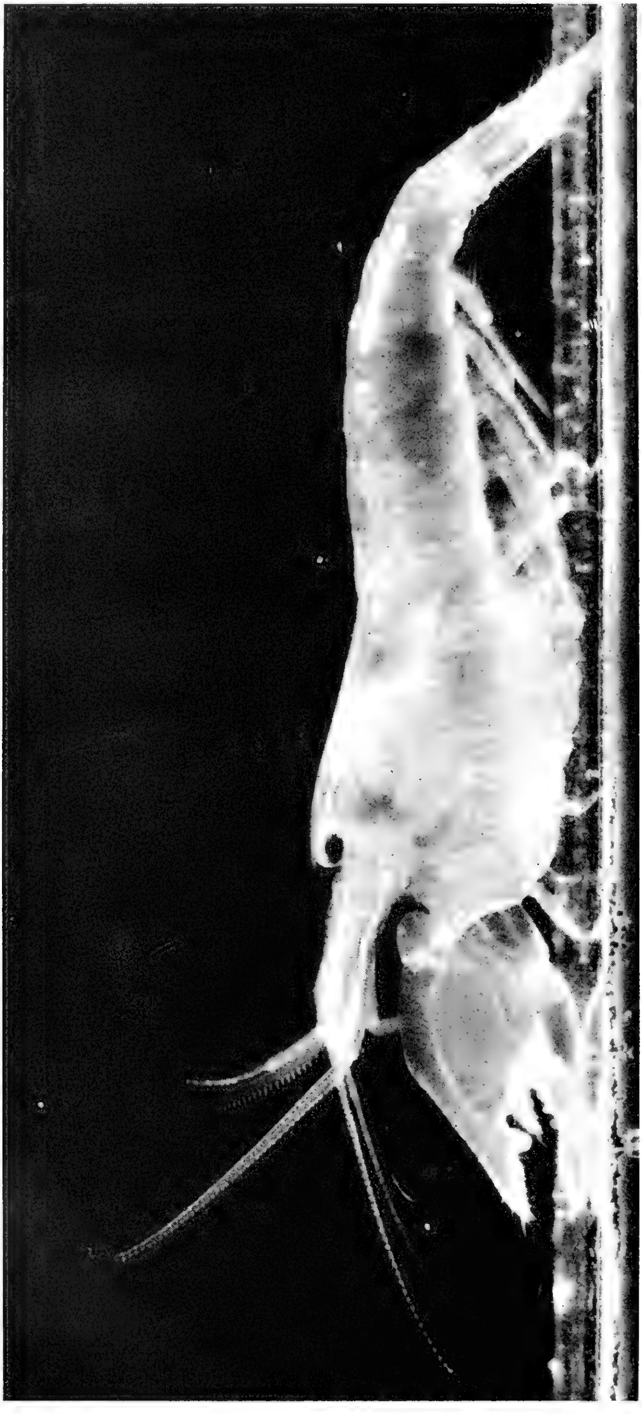
Fifth leg (fig. 10) similar in size and spinulation to third and fourth, but with transverse bands of setae forming brush on distal half of propodus.

First pleopod with small, sparsely setose endopodite. Second to fifth with endopodite and exopodite subequal. Appendix interna straplike.

Uropod (fig. 26) with distal margin of peduncle scalelike, produced into two subequal teeth, curved margin between armed with long



Betaeus harrimani Rathbun, male, photograph of living animal.



Betaeus setosus, new species, female, photograph of living animal.

bristles. Median to these another tooth. Distal angle of outer margin of proximal part of exopodite a sharp tooth, covering base of stout spine; distal margins rounded, with bristles as well as plumose setae. Bristles dorsally on margin of exopodite, scattered over dorsal surface of endopodite. Exopodite and endopodite nearly equal in size, longer than telson but about same width.

Male.—Similar to female except that carapace and abdomen slightly more slender, pubescence on carapace thicker, setae on margin of first pleura sparser. Antennular peduncle with middle segment usually distinctly longer than that of females of comparable size. Chelae usually longer than carapace, with same range of variation as females but often somewhat wider, stouter, as are walking legs. Second pleopod (fig. 16) with appendix masculina only slightly longer than appendix interna, bearing brush of terminal setae.

Color.—The living animal (pl. 1) is transparent, except for chromatophores which occur in a distinct pattern. The color consists of small red chromatophores usually surrounded by dark blue spots. The pigmented areas of the carapace are two broad bands on the dorsal part separated by a thin middorsal line that is unpigmented except between the eyes. Two colored patches occur on the carapace at the base of the antennae. In the female the green eggs in the ovary may show through the integument. The abdomen also is pigmented dorsally and, except for the first segment, the segments are clear anteriorly and middorsally but deeply colored in a band posteriorly at the joints. The lateral part of the sixth abdominal segment often is pigmented as is the telson, which, however, has a light streak. There is a fine band of color near the anterior margin of the tergum of the first segment.

The eyestalks, antennules, and antennae are heavily pigmented. The flagella are reddish. The mouth parts are clear except for the third maxillipeds, which have scattered spots. The chelipeds are well colored, mainly red, but the tips of the claws are clear. The second pair of walking legs is clear, but the rest have scattered red dendritic chromatophores. The uropods are mainly red but the setae are creamy white.

The color ends in a straight line midlaterally and the ventral parts are quite transparent. The coloration varies with the state of the chromatophores. By day, when the red chromatophores are expanded, the animal is reddish or purplish; by night it is distinctly blue. One specimen, after preservation, turned a uniform pale green. The color recorded by Rathbun (1904) is "light green."

Size.—Carapace length of smallest ovigerous female 5.5 mm.; largest female 12.5 mm.; males 2.5–13 mm. Length of chela of largest female 10.5 mm.; largest male 14 mm.

RANGE.—Newport Harbor, Calif., to Sitka, Alaska.

HABITAT.—Intertidal, possibly partly commensal in the burrows of the mud shrimp *Upogebia pugettensis* (Dana) or the ghost shrimp *Callianassa californiensis* Dana. Individuals have been collected from pools formed in the depressions left by boulders on a gravelly beach; the openings of the burrows of the mud shrimps occur in the sides of these pools. Others have been found by chance when excavations were being made for mud or ghost shrimps, and one was found out of water between two slabs of sandstone. In only one locality have the shrimps been found in any numbers: in the oyster dike area of Oakland Bay, Puget Sound, where they were under logs, shells, and debris near the low tide mark, and in the trickle of water leaking from dikes (Dr. J. S. Laurie).

MATERIAL.—The following specimens were examined:

CALIFORNIA.—Newport Harbor, N. MacGinitie, 1 male.—Monterey Bay, Elkhorn Slough, Aug. 2, 1927, G. E. MacGinitie, 1 ovigerous female (Hopkins Marine Station).—Monterey Bay, in muddy sand with *Upogebia*, July 3, 1951, C. Hand, 1 male (USNM 92660).

WASHINGTON.—Willapa Bay, muddy sand, in burrow of *Callianassa californiensis* Dana, May 4, 1958, F. Clogston and R. U. Gooding, 1 male.—Puget Sound: Oakland Bay, near Shelton, in oyster dikes under wood debris, June 28, 1942, A. H. Banner, 1 ovigerous female; Oakland Bay, shore, Sept. 26, 1951, J. S. Laurie, 1 female, 1 male; Oakland Bay, from under board, Aug. 4, 1952, J. S. Laurie, 1 male; Oakland Bay, Aug. 19, 1952, J. S. Laurie, 2 males; Oakland Bay, State Reserve Dikes, Sept. 16, 1952, J. S. Laurie, 43 females (1 ovigerous), 26 males, 1 juvenile; Oakland Bay, Ersudt's Ground, Nov. 2, 1952, J. S. Laurie, 9 females, 7 males; Seabeck, Sept. 18, 1928, 1 female; Warm Beach, June 8, 1931, 1 male.—San Juan Archipelago: San Juan Island, Kanaka Bay, with *Callianassa californiensis* Dana, July 31, 1956, R. U. Gooding, 1 ovigerous female; San Juan Island, Garrison Bay, with *Upogebia pugettensis* (Dana), Aug. 22, 1957, R. U. Gooding, 1 male; Brown Island, with *Upogebia pugettensis* (Dana), July 13, 1961, J. F. L. Carl, 1 male.

BRITISH COLUMBIA.—Victoria: Cadboro Point, under boulder, April 7, 1950, J. F. L. Carl, 1 female; Cadboro Point, in pool formed while digging for mud shrimps, July 27, 1958, G. C. and J. F. L. Carl, 1 ovigerous female, 1 male.—East coast of Vancouver Island: Departure Bay, north of Nanaimo, from stomach of flounder, *Pleuronichthys coenosus* Girard, July 9, 1934, E. Kuitenen, 1 ovigerous female (damaged); Departure Bay, under boulders, July 29, 1938, J. F. L. Carl, 3 females (2 ovigerous); Departure Bay, Aug. 8, 1938, J. F. L. Carl, 1 female; Departure Bay, Aug. 10, 1938, J. F. L. Carl, 3 females, 2 males; Departure Bay, Aug. 24, 1938, J. F. L. Carl, 5 females, 2 males; Departure Bay, March 23, 1939, J. F. L. Carl, 1 female, 1 male; Hammond Bay, north of Nanaimo, muddy gravel, with *Upogebia pugettensis* (Dana), June 22, 1962, J. F. L. Carl, 11 females (3 ovigerous), 8 males; Hornby Island, between slabs of sandstone, July 7, 1959, A. D. Carl, 1 male.—West coast of Vancouver Island, Clayoquot Sound, near Kakawis, Meares Island, June 14, 1946, E. F. Ricketts, 1 male (USNM 84397); Kyuquot, mudflat pool, July 10, 1958, G. C. Carl, 1 ovigerous female.

NOTES.—This is a very agile shrimp, inclined to "play possum" and then to move very quickly. Even in clear water, to see the animal is difficult because of its protective coloration and transparency. The shrimp is so striking in appearance, however—with its large chelipeds and lobster-like form—that specimens found incidentally when other animals are being collected are not likely to be discarded. Yet there are very few preserved specimens even from areas where the fauna is well known. Is it, therefore, really rare or only rarely found? Dr. J. S. Laurie, collecting in Oakland Bay, Puget Sound, seems to be the sole person to have obtained the shrimps in any number, and this was done only over a period of more than one year. Subsequent searching by other workers in the same area has not been productive.

Rathburn (1904) described *Betaeus harrimani* from a single female found at Sitka, Alaska. With the exception of Banner's comment (1953) on the far northern habitat, I am unaware of any other reference to the species in the literature. The present specimens agree with Rathbun's description except in a few minor details. The palm of the second leg seems to be appreciably longer than the fingers, not subequal as she stated, and the posterolateral angles of the fourth and fifth abdominal pleural segments are square, rather than rounded. The proportionate length and width of the palm, the presence of large teeth on the fingers, and the gape differ radically from the finely denticulated, nongaping type she described. There is little doubt that all specimens in the present collections are *B. harrimani* because, although in many specimens both chelae are very different, others have one chela denticulate and nongaping and the other chela toothed and gaping.

Ovigerous females have been found in the field June–September and in the laboratory December–July. The eggs are a bright green when first extruded but become brownish and more transparent before hatching.

Betaeus longidactylus **Lockington**

FIGURES 20–22, 27, 32–34, 40–42

Betaeus longidactylus Lockington, 1877a, p. 35 (type locality, San Diego, California; holotype not extant); 1878, p. 480.—Rathbun, 1904, p. 108.—Baker, 1912, p. 106.—Hilton, 1916, p. 67.—Schmitt, 1921, p. 80, pl. 12; 1924, p. 387.—Johnson and Snook, 1927, p. 310, fig. 262.—MacGinitie, 1930, p. 68; 1935, p. 658, 660, 686, 705–706; 1937, p. 1035.—MacGinitie and MacGinitie, 1949, p. 279.—Ricketts and Calvin, 1952, p. 42, fig. 18.
Alpheus longidactylus Kingsley, 1878a, p. 198.—Holmes 1900, p. 190.

FEMALE.—Carapace laterally compressed but without carina. Smooth, with very fine scattered setae somewhat concentrated over branchial region. Longer setae on posterior margin. Front (fig. 20) straight, depressed anteriorly, slightly swollen over eyes. No distinct junction with lateral margin (fig. 21). Width of carapace increases rapidly so that most of carapace subequal in width, but lateral margin somewhat undulate. Posterolateral margin curved, posterior margin angled below deep cardiac notch.

Abdomen smoothly rounded, with posteroventral margins of first to third segments rounded, those of fourth and fifth angled. First and fifth pleura ventrally margined with plumose setae. Minute setae on smooth surface.

Telson (fig. 27) longer than sixth abdominal segment, nearly twice as long as wide, outer margin slightly undulate. Two pairs of movable spines on dorsal surface, two spines on each posterolateral angle; outer spines very small. Posterior margin deeply curved; plumose setae relatively short.

Eye round. Sharp cone-shaped tooth on median part of short, stout eyestalk.

Antennule with stout peduncle of three subequal segments. Broad-based scimitar-shaped stylocerite reaching almost to end of second segment. Outer flagella with stout fused portion before division into short sensory part and much longer, slender flagellum. Peduncle with large tooth ventrally.

Antenna with stout peduncle slightly longer than antennular peduncle. Distal margin of basis produced into sharp tooth. Scale (fig. 22) broad; wide spine exceeding blade, and separated by distinct slit distally, outer margin straight. Scale reaches nearly to end of antennular peduncle. Flagellum longer than carapace, flattened ovoid in cross section.

Third maxilliped reaching to last segment of antennular peduncle. Ischiomeropodite flat, relatively narrow, curved over mouth parts, slightly shorter than exopodite, about twice as long as ultimate, four times penultimate segment. Medial surfaces all armed with bristles, which are particularly dense on distal segment.

First legs (fig. 32) usually similar in size and shape, with chela much shorter than carapace. Ischium short. Merus slender, increasing in size distally, somewhat triangular in outline with scattered tubercles. Shallow groove on outer side where second leg fits. Carpus short, smooth, cup-shaped, with slight dorsal and larger ventral flattened projection. Chela narrow elongate, covered with fine spines. Fingers longer than palm, narrow gape, with one large flat tooth medially on fixed finger, another proximally, which meshes with similar one on dactylus. Curved corneous tips cross and intermesh. Chela subrectangular, but deepest at base of dactylus. There may not be any large teeth nor any gape when fingers are closed, particularly in small individuals (fig. 33).

Second leg (fig. 40) slender, with ischium subequal to merus. First joint of carpus slightly longer than next three together, subequal to fifth plus palm. Second joint longer than subequal third and fourth. Fingers subequal to, or longer than, palm.

Third leg (fig. 41) relatively stout, slightly flattened, reaching to fingers of cheliped. Ischium about ⅓ length of merus, which is slightly dilated, has movable spine. Carpus stout, nearly twice length of ischium, with two ventral terminal spines. Propodus elongate, subequal to merus, with double row of spines on ventral margin (terminal pair much stouter than others). Dactylus (fig. 42) stout, with curved corneus tip and bristles on slight elevation dorsally.

Fourth leg very like third but somewhat smaller.

Fifth leg more slender. Ischium about ½ length of merus. Undilated merus with movable spine, longer than propodus, twice as long as carpus. Propodus with transverse rows of bristles distally on outer face as well as double row of spines on ventral margin.

First pleopod with slender endopodite about ½ length of exopodite. Second pleopod with endopodite slightly shorter, narrower than exopodite. Appendix interna straplike.

Uropod (fig. 27) with distal margin of peduncle scalelike, produced into two teeth, outer of which stouter, longer, separated by curved margin armed with long bristles. Another tooth median to these. Proximal part of exopodite with large posterolateral tooth, dorsal to large spine, which is nearly as long as distal section. Dorsal surface of endopodite with bristles, all posterior margins fringed with long plumose setae. Exopodite slightly longer than endopodite, both longer than telson.

Male.—Similar to female except carapace and abdomen slightly more slender and setae on first pleuron sparse, not plumose. Small individuals have chelipeds very like those of females but proportionately somewhat larger. Large males develop very large chelipeds, with wide gape, big teeth, and fingers touching only at the tips (fig. 34). When the carapace length is more than 9 mm., the hand may be longer than the carapace and, in some instances, even 1½ this length. Appendix masculina of second pleopod straplike; terminating in a brush of bristles and somewhat longer than appendix interna.

Color.—Published records give the color of the living animal as olive-green, olive-brown, uniform red-brown, or blue-green, with a light middorsal stripe, reddish legs with clear white tips, and dark tail fan with yellow setae.

Size.—Carapace length of smallest ovigerous female 7.8 mm.; largest female 14.5 mm.; males 4–16 mm. Length of chela of largest female 11.3 mm. and of largest male 23.5 mm.

Range.—Tepoca Bay, Gulf of California, Mexico (about 30° N, 113° W) to Elkhorn Slough, Monterey Bay, Calif.

Habitat.—Tide pools, under rocks, in eelgrass, in crevices among materials on boat bottoms, and paired in burrows of echiuroid worm *Urechis caupo* Fisher and MacGinitie or mud shrimp *Upogebia pugettensis* (Dana).

Material.—The following specimens were examined:

Mexico.—San Felipo, May 11, 1937, S. A. Glassell, 1 female.

California.—San Diego, dredged, March 9, 1949, T. E. Bowman, 2 males (USNM 98059).—La Jolla, from kelp holdfasts on beach, Aug. 28, 1918, W. L. Schmitt, 2 females (USNM 53910).—La Jolla, Sept. 21, 1918, W. L. Schmitt, 1 female, 2 males (USNM 53914).—La Jolla, tide pools, Sept. 22, 1918, W. L. Schmitt, 1 ovigerous female, 9 males (USNM 53925).—La Jolla, Bird Rock, Nov. 3, 1942, 1 female, 1 male (Pacific Marine Station, 846, 847).—La Jolla, kelp beds, March 16, 1954, C. Limbaugh, 1 male (USNM 96415).—Laguna Beach, W. A. Hilton, 1 ovigerous female, 2 males (USNM 48982).—Laguna Beach, W. A. Hilton, 1 ovigerous female, 2 males (USNM 50582).—Laguna Beach, W. A. Hilton, 2 ovigerous females (USNM 50586).—Laguna Beach, W. A. Hilton, 1 male (USNM 50590).)—Laguna Beach, under stones, W. A. Hilton, 1 ovigerous female, 2 males, pale olive-green (USNM 52756).—Newport Bay, Jan. 20, 1929, Dec. 16, 1930, G. E. MacGinitie, 1 female, 1 male, 12 juveniles (Hopkins Marine Station).—Santa Catalina Island, west shore of Catalina Harbor, Dec. 12, 1912, *Anton Dohrn*, 3 females (USNM 49981).—Santa Catalina Island, Nov. 28, 1913, *Anton Dohrn*, 5 females, 10 males (USNM 49980).—Catalina Island, Isthmus Harbor, Nov. 27, 1913, *Anton Dohrn*, 9 females, 8 males (USNM 49982).—Catalina Island, west shore of Catalina Harbor, Nov. 28, 1913, *Anton Dohrn*, 20 juveniles (USNM 50012).—Long Beach, H. N. Lowe, 2 males (USNM 53018).—San Pedro, C. F. Baker, 1 male (USNM 29309).—San Pedro, Rocky Point, Feb. 2, 1912, *Anton Dohrn*, 2 males (USNM 49978).—San Pedro, Portuguese Bend, June 26, 1914, *Anton Dohrn*, 1 male (USNM 49979).—San Pedro, Government Breakwater and Point Fermin, littoral, April 2, 1913, *Anton Dohrn*, 3 females, 6 males (USNM 49983).—San Pedro, first rocks north of Port Los Angeles, Dec. 5, 1911, *Anton Dohrn*, 3 females, 2 males (USNM 49993).—San Pedro, May 4, 1919, E. P. Chace, 1 female (USNM 54048).—San Pedro, June 25, 1895, S. J. Holmes(?), Univ. of California, 20 females (14 ovigerous, 5 parasitized), 6 males (USNM 87439).—Santa Monica, near long wharf, Venice Marine Biological Station, 1 male (USNM 46118).—Santa Monica, April 1923, E. P. Chace, 1 male (USNM 57174).—Morro Bay, Feb. 2, 1939, S. A. Glassell, 1 male.—Santa Monica, 8 miles north, open beach in *Upogebia* burrow, Feb. 2, 1931, G. E. MacGinitie, 1 female (Hopkins Marine Station).—Monterey Bay, Elkhorn Slough, April 3, 1930, G. E. MacGinitie, 1 female (Hopkins Marine Station).

Notes.—*Betaeus longidactylus* is a stouter species than *B. harrimani* and may be separated easily on the basis of the chelipeds. The ranges overlap in the region from Newport Bay to Monterey, but few specimens of either species are present in collections from this area. Ricketts and Calvin (1952) state that *B. longidactylus* is very plentiful in southern California, where it occurs on the outer coast, but in the northern part of its range the species is restricted to quiet waters. Berried females have been taken in January, June, August, and September.

Betaeus ensenadensis Glassell

FIGURES 23–25, 28, 35, 36, 43–45

Betaeus, new species, MacGinitie, 1934, pp. 173–174; 1937, pp. 1035–1036.
Betaeus ensenadensis Glassell 1938, pp. 416–419, pl. 28 (type locality, Estero de la Punta Banda, Ensenada, Baja California, Mexico; holotype male, San Diego Soc. Nat. Hist. No. 1121).—MacGinitie and MacGinitie, 1949, p. 279.

FEMALE.—Carapace laterally compressed but without carina; smooth, naked. Front (fig. 23) slightly curved, depressed anteriorly. Anterior margin without sinuses or with shallow ones. Anterolateral angle obtuse (fig. 24). Width of carapace increases rapidly to base of third maxilliped, followed by slight undulation over base of first legs. Posterolateral region rounded. Blunt angle beneath cardiac notch.

Abdomen smoothly rounded with posteroventral margins of pleura of first four segments rounded, fifth bluntly angled. Ventral margin of first pleuron sparsely setose.

Telson (fig. 28) subequal to sixth segment, nearly twice as long as wide, with outer margins slightly undulate. Two pairs of movable spines on dorsal surface, two spines at each posterolateral angle, outer ones very small. Posterior margin slightly curved, armed with plumose setae.

Eye somewhat oval, with small flat tooth on eyestalk.

Antennule with stout scimitar-shaped stylocerite, reaching to about distal third of second segment of peduncle. Subterminally first segment of peduncle produced into thin tooth ventrally. Second segment of peduncle longer than first, which is longer than third. Flattened fused part of outer flagella shorter than peduncle; distally divided into few free segments and slender flagellum subequal to fused portion. Inner flagellum considerably longer.

Antennal peduncle subequal to antennular peduncle, with ventral distal part of basis produced into sharp tooth. Scale (fig. 25) with spine much longer than narrow blade, slit between minute; outer margin almost straight. Scale reaching to middle of third segment of antennular peduncle. Flagellum short, wide, much flattened, reaching slightly past posterior margin of carapace.

Third maxilliped reaching to middle of second joint of antennular peduncle. Ischiomeropodite sparsely setose, slender, flattened, somewhat curved, subequal to two distal segments together in length. Exopodite longer than ischiomeropodite, relatively stout. Penultimate segment shortest, sparsely setose. Distal segment banded medially with many short bristles.

First legs (fig. 35) similar. Ischium short with ridge flatly tuberculated ventrally. Stout merus with deep groove into which second leg fits. Two evenly toothed ridges ventrally, transverse sulcus distally.

Carpus short, rounded dorsally, smooth, except for two tubercles or teeth on inner margin. Platelike ridge ventrally with somewhat rough edge. Chela covered with fine denticles, particularly on outer surfaces. Inner side of chela flat, outer rounded. Dactylus slightly shorter than palm, with three teeth: one small, near junction with palm and meshing with similar tooth on fixed finger; large conical tooth near middle; terminal tooth meshing with truncate terminal part of fixed finger. Fixed finger stout with wide cutting surface bordered on each side with denticulated, elevated edge; both fingers end in sharp tips that cross when closed. Distinct gape.

Second leg (fig. 43) slender. Merus and ischium subequal, slightly shorter than 5-jointed carpus, which has first joint longer than fifth and about equal to second, third, and fourth together, which are subequal to each other. Fingers subequal to palm.

Third (fig. 44) and fourth legs flattened with dilated merus. Ischium nearly ½ merus in length. Distinct movable spines on merus and ischium. Sparsely setose; single spine and setae on distal ventral part of carpus, usually three equidistant spines and terminal pair on ventral part of propodus. Few bristles dorsally. Needle-sharp curved dactylus (fig. 45), more than ½ length of propodus.

Fifth leg without movable spine on ischium, but one on undilated merus. Rather sparse brush of bristles on distal part of propodus. Dactylus similar to that of third or fourth leg.

First pleopod with round-tipped endopodite less than ½ length of exopodite. Second to fifth pleopods with exopodite slightly longer than endopodite, both slender. Appendix interna stout and straplike.

Uropod (fig. 28) broad and considerably longer than telson. Peduncle with straight margin; two small teeth separated by serrated spines graduated in length with longest medial. Proximal margin of exopodite with serrated spines of varying lengths forming thatch between small lateral tooth and large distal spine.

Male.—With straight front. Cheliped (fig. 36) proportionately heavier, wider than that of female (median tooth on dactylus may be missing). Appendix masculina on second pleopod only slightly longer than appendix interna, blunt tip armed with bristles of varied lengths.

Color.—"The carapace, abdomen and chelipeds are covered with light tinted chromatophores in reds and blues, the fingers and telson are tinted a light purple" (Glassell, 1938). "Minute red and blue spots" (MacGinitie and MacGinitie, 1949).

Size.—Carapace length of smallest ovigerous female 5 mm.; largest female 7 mm.; males 4.5–6.8 mm. Length of chela of largest female 6 mm.; of largest male 5.6 mm.

RANGE.—El Estero de la Punta Banda, Ensenada, Baja California, Mexico, to False Bay, San Diego, Calif.

HABITAT.—MacGinitie (1937), MacGinitie and MacGinitie (1949), and Glassell (1938) record the shrimps living in pairs in the burrows of the ghost shrimp *Callianassa californiensis* Dana at Ensenada and in the burrows of the mud shrimp *Upogebia pugettensis* (Dana) at San Diego.

MATERIAL.—The following specimens were examined:

MEXICO.—El Estero de la Punta Banda, Ensenada, Baja California, Dec. 19, 1930, G. E. MacGinitie, 1 ovigerous female, 1 male.—El Estero de la Punta Banda, Ensenada, Baja California, Jan. 21, 1932, G. E. MacGinitie, 7 females (1 ovigerous), 3 males.

CALIFORNIA.—Mission Bay, in burrow, December 1949, T. E. Bowman, 1 specimen (USNM 102442).—False Bay, San Diego, with *Upogebia*, Nov. 18, 1937, G. E. MacGinitie, 3 females (1 ovigerous).

NOTES.—A small, slight shrimp of the same type as *Betaeus harrimani* and *B. longidactylus*, but easily distinguished from these by the shape of the antennal scale, the truncate tip of the fixed finger, the large teeth on the dactylus of the chela, the presence of a movable spine on the ischium of the third and fourth walking legs, and the characteristics of the uropod. Ovigerous females have been taken in November, December, and January.

Betaeus harfordi (Kingsley)

FIGURES 46, 47, 54, 58–61, 73, 74

Betaeus equimanus Lockington, 1877b, p. 43 (type locality, Catalina Island, California; types not extant).

Alpheus harfordi Kingsley, 1878a, pp. 198–199 (type localities, Santa Barbara and Catalina Island, California; types not located); 1878b, pp. 58–59; 1882, p. 124, pl. 2, fig. 4.

Alpheus aequalis Kingsley, 1878a, p. 199.

Betaeus aequalis Lockington, 1878, pp. 479–480.

Alpheus (*Betaeus*) *aequalis* Holmes, 1900, p. 189, pl. 3, fig. 47 (part).

Betaeus harfordi Rathbun, 1904, p. 108.—Schmitt, 1921, p. 79, fig. 55.—MacGinitie and MacGinitie, 1949, p. 279 (part).—Ricketts and Calvin, 1952, pp. 323–324 (part).

FEMALE.—Carapace laterally compressed but without carina; smooth, naked. Front (fig. 46) shallowly emarginate, produced to cover eyes. Anterior margin of carapace (fig. 47) shallowly curved, meeting lateral margin at blunt angle just ventral to base of antenna. Width of carapace increasing to base of third maxillipeds, gradually decreasing to curved posterolateral margin. Posterior margin protrudes slightly before decreasing ventral to cardiac notch.

Abdomen smooth, evenly rounded. Naked except for plumose setae on ventral margin of pleura of first segment. Pleura with posterolateral margins evenly rounded except fifth, which is somewhat acute.

Telson (fig. 58) wide, flat, shorter than uropods. One and one-half to twice length of sixth segment. Lateral margins curved. Distally about ¾ as wide as proximally. Two pairs of small movable spines on distal half of dorsal surface, but posterolateral spines vestigial or missing. Posterior margin curved, bearing long plumose setae.

Eye large, round, on short stalk with small median tooth.

Antennule with stylocerite narrow, sharp-pointed, reaching to distal quarter of second segment of peduncle. Ventrally a slender scimitar-shaped tooth on distal part of first segment of peduncle. Peduncle slender, about ½ carapace length. Second segment about twice length of subequal first and third segments. Flagella slender, short: outer flagella fused for most of length with only terminal tip of sensory part free and remaining flagellum short, slender.

Antenna slender. Peduncle with wide tooth ventrally on margin of first segment; slightly longer than antennular peduncle. Scale (fig. 54) narrow, with stout spine longer than narrow blade, separated from it with slit for about ⅓ of length. Flagellum longer than carapace, ovoid in cross section.

Third maxilliped reaching to end of second segment of antennular peduncle. Relatively narrow, with flattened ischiomeropodite subequal to distal segment, sparsely bristled. Penultimate segment sparsely setose, slightly shorter than distal, which is armed medially with bands of stout bristles and scattered longer setae. Exopodite slightly longer than ischiomeropodite.

First legs subequal, large. Chela slightly shorter than carapace. Ischium short. Merus naked except for few setae on inner margin: triangular in cross section, with dorsal carina smooth, sharp, ending in curved tooth distally, outer ventral ridge smooth, inner one with some flattened tubercles. Carpus short, smooth, naked, cup-shaped with small ventral plate. Chela (fig. 60) smooth, flattened laterally: few fine scattered setae on dorsal ridge, stiff setae near tips of fingers and on cutting surfaces. Palm and fingers subequal but fixed finger much wider than dactylus. Somewhat flattened teeth of cutting surface may mesh without any gape or may have hiatuses on both fingers resulting in a round foramen. Chelae usually alike in dentition. Dorsal ridge of fixed finger and palm compressed, so that margin knife-edged.

Second leg (fig. 61) slender. Ischium longer than merus; both flattened laterally. Carpus with first joint longest, fifth next, others shorter, subequal. Chela longer than first joint, fingers subequal to palm. Cutting surface of fingers spinulate.

Third leg (fig. 73) stout, flattened laterally, with scattered fine setae. Ischium and merus comprise ½ length of appendage. Large movable spine on merus. Carpus, with minute terminal spines, subequal in length to propodus. Propodus armed ventrally with small setae and vestigial spines. Terminal pair larger. Dactylus (fig. 74) short, stout, bifid, but claws masked by two median bands of short stiff bristles.

Fourth leg similar to third, but all segments except ischium slightly smaller.

Fifth leg distinctly shorter than fourth. Subequal merus and propodus each longer than carpus. Brush of 4–5 bands of short stiff setae on distal part of propodus. Dactylus similar to that of third and fourth legs. No movable spine on merus.

First pleopod with round-tipped endopodite, nearly ½ length and width of slender exopodite. Second pleopod with subequal slender endopodite and exopodite. Appendix interna straplike, nearly ⅓ length of endopodite.

Uropod (fig. 58) with posterior margin of peduncle produced into two sharp subequal teeth, separated by concave margin with few small setae. Distal angle of proximal part of exopodite a sharp tooth, covering base of short stout spine. Uropods longer than telson.

Male.—Similar to female except that chelae (fig. 59) are proportionately larger, subequal in length to carapace. Appendix masculina with bristles on margin of distal half and on blunt tip; twice as long as appendix interna, nearly as long as endopodite.

Color.—Dark purple (Lockington, 1878; Holmes, 1900), blue-black (specimen label, E. P. Chace), deep blue (specimen label, W. A. Hilton) and deep blue, occasionally reddish-brown on sides (Mrs. G. E. MacGinitie).

Size.—Carapace length of smallest ovigerous female 6 mm.; largest female 10.7 mm; males 3.3–8 mm. Length of chela of largest female 8.5 mm.; of largest male 8 mm.

Range.—Magdalena Bay, Mexico, to Fort Bragg, Calif. (personal communication, Mr. Keith W. Cox); intertidal to depth of 12 fathoms. This is apparently a very elusive shrimp that leaves its host with little provocation, with the result that, unless precautions are taken to prevent its escape, it may be consistently missed when abalones are collected. Until Mr. Cox was consulted, no specimens had been recorded in any collections taken north of Santa Monica, even with Mr. D. Montgomery checking approximately 350 specimens of *Haliotis* from the vicinity of San Luis Obispo. On the other hand, Dr. Howard Teas, on April 4, 1953, collected at El Estero de Punta Banda, Ensenada, Baja California, Mexico, and reported to the MacGinities that about four out of every five *Haliotis fulgens* had a *Betaeus* in the mantle cavity.

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Habitat.—Found living in mantle cavity of abalone and occasionally free, latter probably temporary state, owing to disturbance of normal host. The specimens examined have occurred most commonly with the pink abalone, *Haliotis corrugata* Gray, but also with the red abalone, *H. rufescens* Swainson, the black abalone, *H. cracherodii* Leach, and the green abalone, *H. fulgens* Phillipi. Mr. Keith Cox reports them also from *H. kamtschatkana* Jonas, *H. wallalensis* Stearns, *H. sorenseni* Bartsch, and *H. assimilis* Dall.

Material.—The following specimens were examined:

Mexico.—Magdalena Bay, Belchers Point, on shore, Jan. 30, 1938, S. A. Glassell, 1 specimen, dried.

California.—La Jolla Cove, July 14, 1942, 1 female (Pacific Marine Station 845).—La Jolla, kelp beds, March 16, 1954, C. Limbaugh, 1 ovigerous female, 1 male (USNM 96414).—La Jolla, with *Haliotis rufescens* Swainson, March 28, 1952, E. Dodge, 1 ovigerous female.—San Clemente Island, living beneath mantle of *Haliotis*, January 1936, Nell Murbarger, 2 ovigerous females, 1 male (USNM 77743).—San Clemente Island, from abalone, May 8, 1888, *Albatross*, 2 females (USNM 63453).—Laguna Beach, from abalone, Sept. 19, 1918, W. A. Hilton, 1 female, deep blue (USNM 53598).—Laguna Beach, shale reef ¼ mile offshore, midway to Corona del Mar, 12 fathoms, from mantle cavity of *Haliotis corrugata* Gray, April 25, 1958, Robert Given, from N. MacGinitie, 1 ovigerous female.—Laguna Beach, off Salt Creek, 8 fathoms, from *Haliotis corrugata* Gray, May 21, 1958, Dale Seemen, from N. MacGinitie, 20 females (7 ovigerous), 5 males; May 26, 1958, 7 females (5 ovigerous).—Laguna Beach, 8 fathoms, from *Haliotis corrugata* (2 specimens from *Haliotis rufescens*), April 28, 1958, Dale Seeman, from N. MacGinitie, 4 females (1 ovigerous), 10 males.—Catalina Island, commensal in shell of green abalone, Venice Marine Biological Station, 1 ovigerous female (USNM 46119).—Catalina Island, Little Harbor, Dec. 27, 1912, *Anton Dohrn*, 2 males (USNM 49977).—San Pedro, Rocky Point, from mantle of black abalone, Feb. 2, 1912, *Anton Dohrn*, 1 ovigerous female (USNM 49975).—San Pedro, in gill chamber of *Haliotis cracherodii* Leach, June 1930, E. P. Chace, 1 ovigerous female, blue-black when alive (USNM 64087).—Santa Barbara Island, from *Haliotis rufescens*, 8 fathoms, Sept. 11, 1962, Keith W. Cox, 22 ovigerous females, 7 males.—Santa Monica Bay, Malibu Point, under mantle of *Haliotis* washed up on beach, Dec. 19, 1937, A. Camp, from R. Crocker, 1 female (Hopkins Marine Station).—Southern California, Nov. 27, 1913, *Anton Dohrn*, 1 female (USNM 49976).

Notes.—Mr. Keith W. Cox informs me that there seems to be a definite correlation in size between the shrimps and their hosts: large shrimps in large abalones, small in small. The usual number is one shrimp per host. Exceptions do occur and on several occasions up to four have been found in the cavity between mantle and shell.

MacGinitie and MacGinitie (1949, p. 279) state:

We have found this shrimp with its purplish-red color form living in the mantle cavity of the green abalone *Haliotis fulgens*. For over a year one has been living under the protectorate of an abalone in one of our aquariums. It usually stays with its head near the region of the mouth of the abalone, and although it is by no means inactive, its host does not give any evidence of being disturbed by its movements. On rare occasions we have seen it make short excursions onto the shell, but it soon returns to its shelter. More frequently it may be seen on the upper surface of the frilly mantle edge of its host. At the least disturbance it hastens beneath the mantle and the abalone closes down over it in what resembles a protective manner.

In a letter, Mrs. G. E. MacGinitie states:

When the abalone diver brought in so many live *B. harfordi* we dumped about 20 of them in an aquarium with two *H. corrugata.* The next morning practically all of them had found a niche somewhere in the two abalones. But they did not all stay with the abalones very long. One per abalone is apparently normal, and soon the others were elsewhere. Six or more took refuge in the niches of the egg case of the horned shark. Another snuggled next to the third abalone in the aquarium—a specimen about an inch long, and the shrimp was at least as long as the "host."

Ovigerous females have been taken in March, April, May, September, and December. Mrs. MacGinitie reports that the eggs, when freshly laid, are nearly opaque and a pale yellowish green, becoming more transparent with development.

Betaeus macginitieae, new species

FIGURES 48, 49, 55, 62–64, 75, 76

Alpheus aequalis Holmes, 1900, p. 189 (part, specimens found on sea urchins).
Betaeus harfordi MacGinitie and MacGinitie, 1949, p. 279 (part, purple ones with sea urchins).

FEMALE.—Carapace laterally compressed but without carina; smooth, naked. Front (fig. 48) produced to form hood, which is curved slightly anteriorly but without emargination. Lateral margin (fig. 49) faintly curved, closely adhered around base of antenna without distinct anterolateral angle. Width of carapace increasing rapidly to base of maxilliped, then decreasing slightly to form curved lateral margin. Posterolateral junction rounded; posterior margin nearly straight ventral to junction of cardiac notch.

Abdomen smoothly rounded. Posterior margins of all pleura rounded but that of fifth somewhat acute. No surface setae and only pleura of first segment margined ventrally with plumose setae.

Telson (fig. 62) flattened, longer than sixth segment. About twice as wide proximally as distally. Two pairs of movable spines dorsally. Posterior margin curved, with pair of small spines (outer smaller) externally, and long plumose setae.

Eye oval, on short eyestalk with small tooth.

Antennule with stylocerite narrow, reaching to last quarter of second segment of peduncle. Peduncle with middle segment nearly twice as long as either first or third; almost bare of setae. Peduncle about ½ length of carapace. Ventrally near distal margin of first segment a stout laterally compressed tooth. Inner flagellum stout, elongate. Fused part of outer flagella stout but free tips short.

Antennal peduncle slightly longer than antennular, with ventral marginal tooth under base of scale. Flagellum flattened, somewhat longer than carapace. Scale (fig. 55) narrow: blade shorter than spine but slightly wider, separated by slit for ½ length. Reaches to nearly middle of third antennular peduncle segment.

Third maxilliped reaches to about middle of second segment of antennular peduncle. Ischiomeropodite broad, flattened, curved over mouth parts; slightly longer than other segments together. Penultimate segment shortest, armed with tufts of stiff bristles, distal segment with bands of stiff bristles on inner margin.

First legs subequal, large. Ischium short, stout. Merus stout, about twice as long as wide, triangular in cross section. Dorsal ridge smooth but ventral ridges with poorly developed setae and teeth. Carpus short, cup-shaped, naked. Chela elongate, more than twice length of merus, 2½ times as long as wide, with palm slightly longer than fingers. Blunt tooth on proximal part of fixed finger, followed by hiatus before denticulate cutting surface, which meshes with similar area on dactylus, which also has similar proximal tooth. Cutting surfaces sparsely setose. Chela somewhat flattened laterally, dorsal and ventral margins rounded, not knifelike.

Second leg (fig. 64) long, slender. Ischium slightly longer than merus, which is shorter than carpus. Carpus with first segment longest, about 1½ of fifth, which is longer than subequal second, third, and fourth segments. Fingers and palm subequal with curved bristles distally and spinulose cutting surface.

Third leg (fig. 75) with stout ischium and slightly dilated merus. Merus slightly longer than propodus, which is 1½ times length of carpus. Movable spine on proximal part of merus. Dactylus (fig. 76) short, ⅙ length of propodus, with bifid tip somewhat hidden by setae. Spines on ventral margin of carpus and propodus short but stout; one pair on carpus, many on propodus with distal pair longest.

Fourth leg similar but slightly smaller.

Fifth leg with shorter ischium. Spines on ventral margin of propodus very small, bristles of brush short. No movable spine on merus.

First pleopod with endopodite curved and ⅓ length of exopodite. Second pleopod with slender subequal exopodite and endopodite. Appendix interna stout, straplike.

Uropod (fig. 62) with posterior margin of peduncle produced into two small teeth close together, without setae. Posterolateral tooth well developed on proximal part of exopodite; spine beneath this somewhat short, stout. Uropods longer than telson.

MALE.—Very similar to female, but chelipeds (fig. 63) slightly longer in proportion. In one specimen, left side of peduncle of uropods cut into two small teeth, but right side with only one tooth. Appendix masculina bristled on distal half and on tip; twice as long as appendix interna and reaching midway between tip of appendix interna and tip of endopodite.

Color.—"Dark purple . . . resembled the color of the sea urchins in whose spines they were entangled when captured" (Holmes, 1900). "In life I have noticed no difference in the color of *B. harfordi* and the last one we are sending you from the sea urchin. For the most part, they are mostly blue, but sometimes along the side the color is a reddish brown. The claws and tail are almost always entirely blue regardless of the color along the sides of the abdomen. I could find no correlation between color and sex" (Mrs. G. E. MacGinitie, letter, 1958).

Size.—Carapace length of smallest ovigerous female 6.8 mm.; largest female 10.5 mm.; males 5.5–10 mm. Length of chela of largest female 10.3 mm.; of largest male 10.5 mm.

Range.—Santa Catalina Island to Monterey, Calif.

Habitat.—Occurs in pairs in association with sea urchins, *Strongylocentrotus franciscana* (Agassiz) and *S. purpuratus* (Stimpson).

Material.—The following specimens were examined:

California.—Santa Catalina Island, Isthmus Harbor, Nov. 27, 1913, *Anton Dohrn*, 1 ovigerous female (USNM 107546).—Laguna Beach, under *Strongylocentrotus purpuratus* (Stimpson) in hole in rock, Nov. 18, 1937, N. MacGinitie, 1 ovigerous female, 1 male.—Corona del Mar and Laguna Beach, shale reef midway between, ¼ mile offshore, 5 fathoms, from beneath *Strongylocentrotus franciscana* (Agassiz), Apr. 17, 1958, Robert Given, from N. MacGinitie, 1 ovigerous female.—Corona del Mar, Arch Rock, tide pool (may have been with purple sea urchin before being disturbed), Oct. 1932, N. MacGinitie, 1 female.—Corona del Mar, off Ladder Rock, 4 fathoms, May 22, 1958, Robert Given, from N. MacGinitie, 1 female holotype (USNM 108228).—Monterey Bay, China Point, June 1908, 2 females (1 ovigerous), 1 male (Hopkins Marine Station).

Notes.—Some specimens have the proximal part of the fingers of the chelipeds denticulate rather than with a distinct tooth. Ovigerous females have been taken in April, June, October, and November. Mrs. MacGinitie reports that the eggs, when freshly laid, are nearly opaque and a pale yellowish-green, becoming more transparent with development.

Betaeus gracilis, new species

Figures 50, 51, 56, 65–67, 77, 78

Betaeus harfordi Hilton, 1916, p. 67.

Female.—Carapace laterally compressed but without carina. Smooth, with scattered fine short setae. Setae on posterior margin of carapace ventral to cardiac notch. Front (fig. 50) depressed, deeply indented medially, covering eyes with two hoods. Anterior margin (fig. 51) evenly curved, rounded at junction with lateral margin. Carapace increases in width to base of first legs, decreasing slightly to rounded posterior. Ventral part of posterior margin concave, then angled sharply to cardiac notch.

Abdomen smoothly rounded, bearing few scattered fine setae. Posteroventral margins of pleura of first three segments rounded, those of fourth and fifth bluntly square. Ventral margin of first pleura with plumose setae.

Telson (fig. 65) wide, flattened, longer than sixth abdominal segment. Two pairs of movable spines dorsally; posterolateral spines well developed, outer pair smaller. Posterior margin curved, bordered with bristles and plumose setae.

Eye round, with sharp tubercle on stalk.

Antennule short, stout. Stylocerite reaches nearly to end of second segment of peduncle; margins curved. Peduncle less than ½ carapace length. Slender inner flagellum scarcely as long as carapace, outer shorter, with fused portion about as long as peduncle, with four free sensory joints and slender terminal flagellum.

Antenna with peduncle longer than that of antennule. Margin of first segment produced into sharp tooth ventrally. Scale (fig. 56) broad, with stout spine, which is longer than blade and separated from it for distal third. Flattened flagellum almost as long as carapace.

Third maxilliped reaches to end of antennular peduncle. Ischiomeropodite subequal in length to last segments together (penultimate slightly shorter). Medially armed with long bristles, distal segment with bands of bristles as well. Exopodite stout, longer than ischiomeropodite.

First legs (fig. 66) subequal. Ischium short. Merus, short, wide, triangular in cross section. Smooth dorsal ridge ending distally in sharp curved tooth, with few bristles on margin. Outer ventral ridge smooth, inner with ten long bristles. Carpus cup-shaped but somewhat elongate; no setae. Chela elongate with few setae on cutting edges and tips of fingers, which are crossed over each other. Dorsal margin of hand evenly rounded, not knifelike. Palm longer than fingers, considerably less than ½ as wide as long. Little gape between fingers.

Second leg (fig. 67) slender. Ischium slightly longer than merus, together longer than carpus, which has first joint longer than fifth, and about as long as second, third, and fourth together. Chela slender, with fingers shorter than palm and with spinulate cutting surfaces.

Third leg (fig. 77) stouter than second. Merus only slightly dilated, bearing movable spine on proximal lower margin; sparsely setose. Merus and propodus subequal in length. Spines on carpus and propodus small, with fine seta beside each spine. Narrow bifid dactylus (fig. 78) with inconspicuous setae at base of claws.

Fourth leg similar but smaller than third.

Fifth leg well developed, but ischium and merus slightly shorter than those of third leg, no movable spine present. No spines on carpus, few on propodus, but usual brush on distal part of propodus. Dactylus longer, more slender than others but similarly bifid.

First pleopod with endopodite short and round at tip. Second pleopod with endopodite subequal to exopodite, appendix interna straplike.

Uropod (fig. 65) longer than telson. Posterior margin of peduncle produced into two teeth, with setae on curved margin between. Outer tooth longer. Lateral margin of exopodite ends in small tooth covering base of large spine, nearly as long as terminal portion.

Male.—Similar to female except tip of stylocerite reaches to end of second segment of antennular peduncle. Left chela with decided gape, large triangular tooth on fixed finger, intermeshing smaller teeth on both fingers. Right chela with gape composed of round hiatuses. Second pleopod with appendix masculina bristled on distal half, terminally on blunt tip.

Color.—Pale olive-green (Hilton, 1916). Specimen label: "green eyes."

Size.—Carapace length of smallest ovigerous female 6 mm.; largest female 8 mm.; male 6 mm. Length of chela of largest female 8 mm.; of male 6 mm.

Range.—Laguna Beach to Monterey Bay, Calif.

Habitat.—Kelp holdfasts (Hilton 1916).

Material.—The following specimens were examined:

California.—Laguna Beach, W. A. Hilton, 1 ovigerous female holotype (USNM 48933), 1 ovigerous female (USNM 108230).—Pacific Grove, January 1928, G. E. MacGinitie, 1 specimen.—Monterey Bay, China Point, shore, June 1908, 1 ovigerous female, 1 male (Hopkins Marine Station).

Notes.—This species may be confused with *Betaeus setosus*, but it has much shorter antennules and antennae, is more slender and less setose. The chelae of the female from China Point are toothed like those of the male: intermeshing, with the hiatuses coinciding to form a foramen. Ovigerous females have been taken in June. The eggs are translucent green (Hilton, 1916).

***Betaeus setosus*, new species**

Figures 52, 53, 57, 68–72, 79, 80; Plate 2

Alpheus aequalis Holmes, 1900, p. 189 (part, free-living form).

Betaeus harfordi MacGinitie and MacGinitie, 1949, p. 279 (part).—Ricketts and Calvin, 1952, pp. 323–324.

FEMALE.—Carapace laterally compressed but no carina. Smooth but with scattered short setae. Tuft of longer setae under front, between eyes; cardiac notch and lower posterior margin fringed with setae. Front (fig. 52) deeply indented medially, slightly depressed but produced laterally to form "blister" over each eye. Anterior margin (fig. 53) smoothly curved. Anterolateral junction rounded. Lateral margin evenly rounded with widest part at base of first legs. Posterior margin somewhat truncate with distinct cardiac notch.

Abdomen rounded, with posteroventral margins of pleura rounded in segments one to three but angled in four and five. Ventral margin of first segment with plumose setae. Smooth with scattered setae.

Telson (fig. 68) longer than sixth segment and about 1½ times as long as widest part. Dorsal surface with scattered setae and two pairs of movable spines. Posterolateral angle with two spines: inner much larger than outer. Posterior margin rounded with bristles and plumose setae.

Eye large, round, and with sharp tooth on stout eyestalk.

Antennule with well-developed stylocerite; slender, sharp-pointed, reaching nearly to end of second segment of peduncle. First segment of peduncle produced ventrally into thin sharp tooth. Middle joint of peduncle nearly twice as long as first or third joints, whole peduncle more than ½ as long as carapace. Inner flagellum slender, about as long as carapace. Outer flagella fused for ½ its length, with long sensory setae, and terminating in short free part and long slender flagellum.

Antenna with first segment of peduncle produced ventrally into sharp tooth. Scale (fig. 57) slender; spine large, longer than blade, separated from slender blade for nearly ½ its length. Peduncle only slightly longer than that of antennule. Flagellum twice as long as carapace: flattened oval in cross section.

Third maxilliped with ischiomeropodite broad, flattened proximally, twisted. Inner margin heavily bristled, outer sparsely. Penultimate segment ½ length of distal segment, with bristles mainly on inner side. Distal segment nearly as long as ischiomeropodite, armed medially with rows of stiff bristles; reaches to end of antennular peduncle. Exopodite longer than ischiomeropodite.

First legs subequal in size. Ischium short, with sharp ridge ventrally. Merus short, stout, triangular in outline: dorsal ridge sharp, covered with soft setae; outer ridge undulate with knobs on proximal part, inner ridge tuberculate for most of its length. Broad oblique groove in which second leg rests. Distal margins of merus concave on inner side of median ridge. Joint membrane large, making pocket into which swollen part of palm and projection of carpus fit, when "wrist" is bent. Carpus cup-shaped, with small plate ventrally, covered with long soft setae dorsally. Chela (figs. 70, 71) large, as long as carapace and nearly as wide, much compressed laterally with upper margin of base of fixed finger thin, sharp. Fixed finger twice as wide at base as dactylus, which is longer than palm. Cutting surfaces, tips of fingers, dorsal part of fixed finger setose. Left chela with large tooth medially on fixed finger, wide gape, smaller teeth intermeshing proximally and terminally before crossed corneous tips. Right chela with slight gape but most of small flat teeth intermeshing. Hands covered with fine short setae.

Second leg (fig. 72) setose with ischium and merus subequal, shorter than carpus, which has first and last joints subequal and twice as long as each of subequal median joints. Fingers almost as long as palm and finely spinulate on cutting surfaces.

Third leg (fig. 79) with stout ischium. Merus inflated with large movable spine on proximal part. Merus and propodus subequal in length. Carpus shorter than either, with pair of stout spines and setae on distal ventral margin. Propodus with stout spines and setae on ventral margin and two large spines terminally. Dactylus (fig. 80) short, broad, bifid, armed with few bristles. Whole appendage setose dorsally.

Fourth leg similar to third but somewhat smaller.

Fifth leg subequal in length to third but without movable spine on merus, no spines on carpus. Spines on propodus small, hidden by transverse bands of setae forming brush on distal third of propodus.

First pleopod with endopodite about ½ exopodite in length and width. Second pleopod with exopodite and endopodite slender, subequal. Appendix interna large, straplike.

Uropod (fig. 68) with posterior margin of peduncle produced into two large teeth; outer distinctly larger than inner. Long bristles on curved margin between teeth. Exopodite with long bristles dorsolaterally and small tooth above stout spine on posterolateral angle of proximal part. Endopodite and exopodite with scattered bristles dorsally. Uropods longer than telson.

Male.—Similar to female except that chelipeds (fig. 69) are larger in proportion, chela longer than carapace, antennular peduncle proportionately longer, abdomen somewhat narrower. First pleopod with very small endopodite. Second pleopod with appendix masculina large and bristled throughout its length. Appendix interna small.

Color.—"Nearly white" (Holmes, 1900) and red or brown with kelp, and green with sea lettuce and eelgrass (MacGinitie and MacGinitie, 1949). These were identified as *Betaeus harfordi* but probably they were *B. setosus*. Living specimens taken in British Columbia were a uniform white or yellow in the light but became pink or orange in the dark. The change in color is due to the presence of tiny red chromatophores thickly dotted over the dorsal half of the animal (except over the eyes) and on the chelae. These expand in the dark. In some specimens there is a pale blue tinge to the chelae and the flagella. The cast skin is a very pale blue dorsally, with yellow setae on the antennal blade and on the tail fan. The chitinous tips of the dactyli of the legs are yellow.

SIZE.—Carapace length of smallest ovigerous female 4.8 mm.; largest female 8.5 mm.; males 3–7 mm. Length of chela of largest female 9 mm.; of largest male 9 mm.

RANGE.—Morro Bay, Calif., to Hecate Strait, Queen Charlotte Islands, British Columbia.

HABITAT.—The "*B. harfordi*" found under a rock at low tide (Holmes, 1900), under rocks and among seaweed (MacGinitie and MacGinitie, 1949), and on pilings (Ricketts and Calvin, 1952), were probably *Betaeus setosus*. The one specimen taken in Washington was found intertidally under a rock on the exposed west side of San Juan Island. In British Columbia, one specimen was dredged at 10 fathoms, some were found in tide pools, and others with *Pachycheles rudis* Stimpson in cavities under the holdfasts of kelp (usually *Pterygophora californica* Ruprecht) or eelgrass roots (*Phyllospadix* species). They often occur in pairs.

MATERIAL.—The following specimens were examined:

CALIFORNIA.—Morro Bay, under rocks, Feb. 1, 1939, S. A. Glassell, 2 ovigerous females.—Monterey Bay, China Point, shore, June 1908, 2 males (Hopkins Marine Station).—Monterey Bay, HMS Line Survey, No. 86, June 2, 1931, G. E. MacGinitie, 2 males (Hopkins Marine Station).—Monterey Bay, J. C. Brown, 1 ovigerous female, 1 male (USNM 23932).—Tomales Point, Dec. 26, 1939, E. F. Ricketts, 2 males.—Tomales Point, reef, *Laminaria*, June 9, 1948, 1 female, 1 male (Pacific Marine Station).—Tomales Point, ocean side, Nov. 28, 1947, 1 female, 1 male (Pacific Marine Station).—Campbell's Cove, inside entrance to Bodego Lagoon, Feb. 11, 1949, Lee O. Miles, 1 ovigerous female (Pacific Marine Station).—Dillon Beach, rocks, north, June 30, 1946, 1 ovigerous female (Pacific Marine Station).

WASHINGTON.—San Juan Island, west side, under rocks, intertidal, July 10, 1960, P. L. Illg, 1 male.

BRITISH COLUMBIA.—Vancouver Island, west coast: Clayoquot Sound, Frank Island, Cox Bay, Tofino, July 10, 1960, J. F. L. Carl, 3 ovigerous females, 1 male; Clayoquot Sound, July 29, 1961, J. F. L. Carl, 1 female holotype (USNM 108229), 5 females (3 ovigerous), 3 males; Clayoquot Sound, Round Island, June 30, 1945, E. F. Ricketts, 2 ovigerous females (USNM 80630); Clayoquot Sound, May 30, 1946, E. F. Ricketts, 1 ovigerous female, 1 male (USNM 84395); Clayoquot Sound, Deadman's Island, June 27, 1945, E. F. Ricketts, 1 ovigerous female, 1 male (USNM 80635); Esperanza Inlet, High Island, near Catala Island and Tatchu Point, June 28, 1934, E. G. Hart, 2 females (1 ovigerous), 1 male; Esperanza Inlet, Nootka Island, tide pool, July 25, 1934, E. G. Hart, 2 ovigerous females, 1 male.—Hecate Strait, Queen Charlotte Islands, 4 miles northeast Rose Point, 10 fathoms, June 24, 1956, T. H. Butler, 1 female.

NOTES.—There are a number of variations to be seen in this species. The inner ridge of the merus of the chelipeds may be almost smooth, or there may be a few tubercles, or there may be a row of uniform beadlike knobs. The dentition of the chelae varies considerably from flat intermeshed teeth, with no gape, to others with a foramen and/or a large square tooth on the fixed finger, but with the tips of the fingers always crossed (figs. 70, 71). Most have similar subequal chelae. To judge from specimens kept in the laboratory, regenerated chelae may be without teeth and a number of moults may be required to regain normal size.

Ovigerous females have been taken February–June in California and May–August in British Columbia. The ovaries and freshly laid eggs are a pale olive-green, becoming lighter and more transparent with development.

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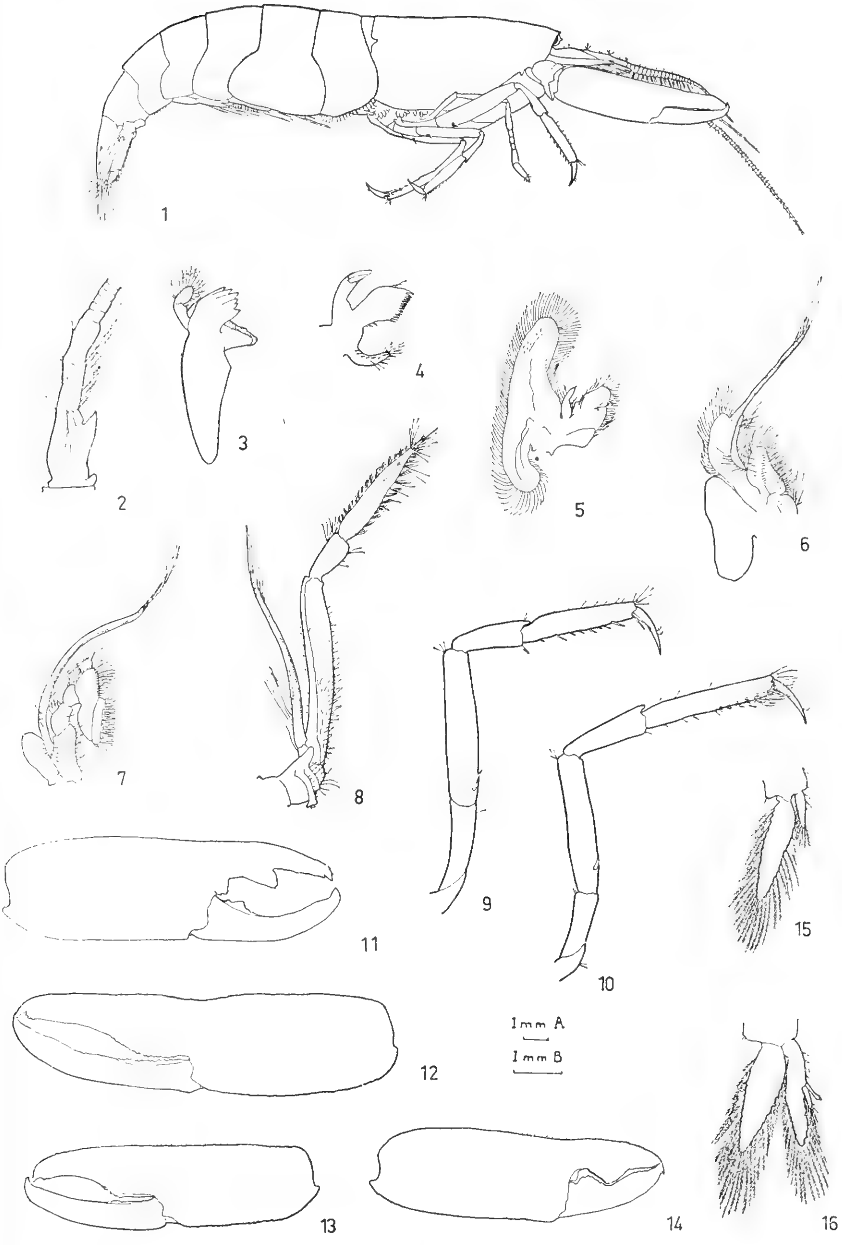
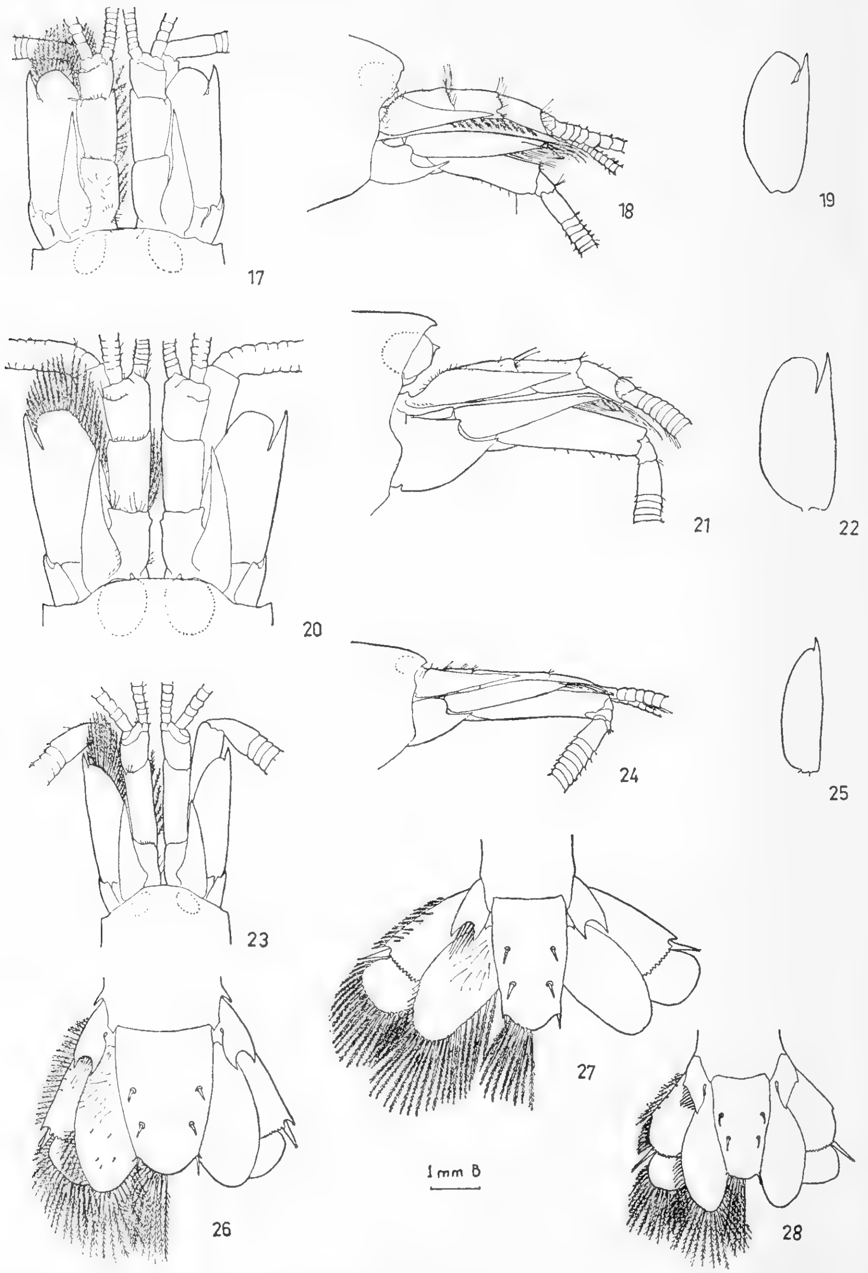
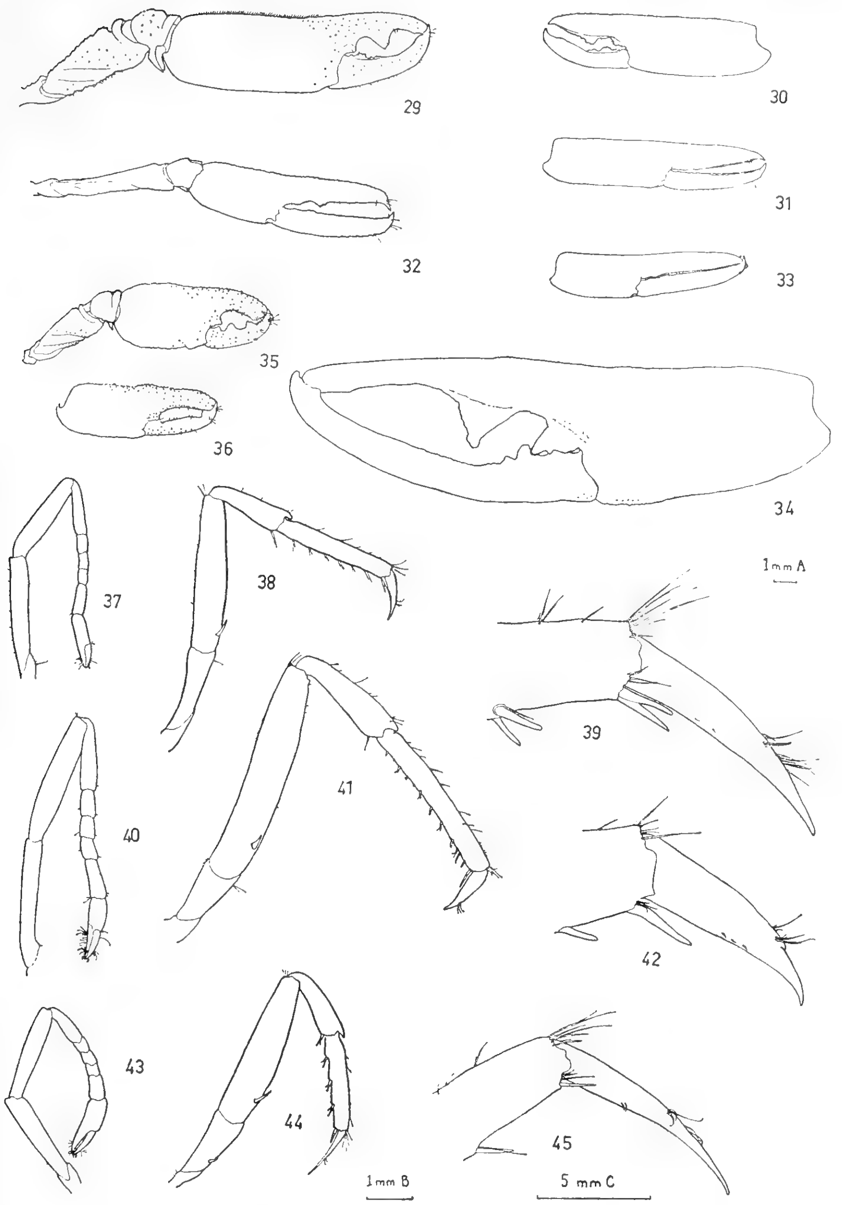


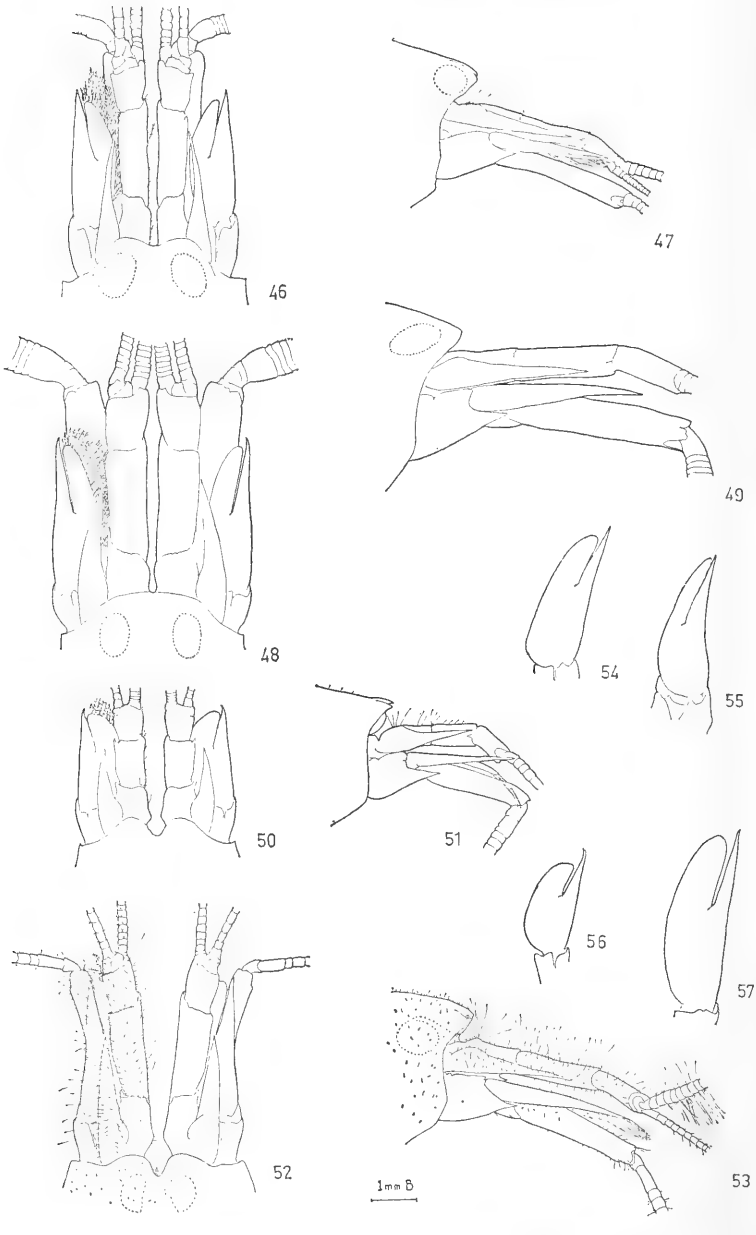
FIGURES 1–16.—*Betaeus harrimani* Rathbun: 1, lateral view; 2, antennular peduncle, lateral view; 3, mandible; 4, maxillule; 5, maxilla; 6, first maxilliped; 7, second maxilliped; 8, third maxilliped; 9, fourth leg; 10, fifth leg; 11, right chela, female; 12, left chela, male; 13, left chela, female; 14, right chela, female; 15, first pleopod, male; 16, second pleopod, male.



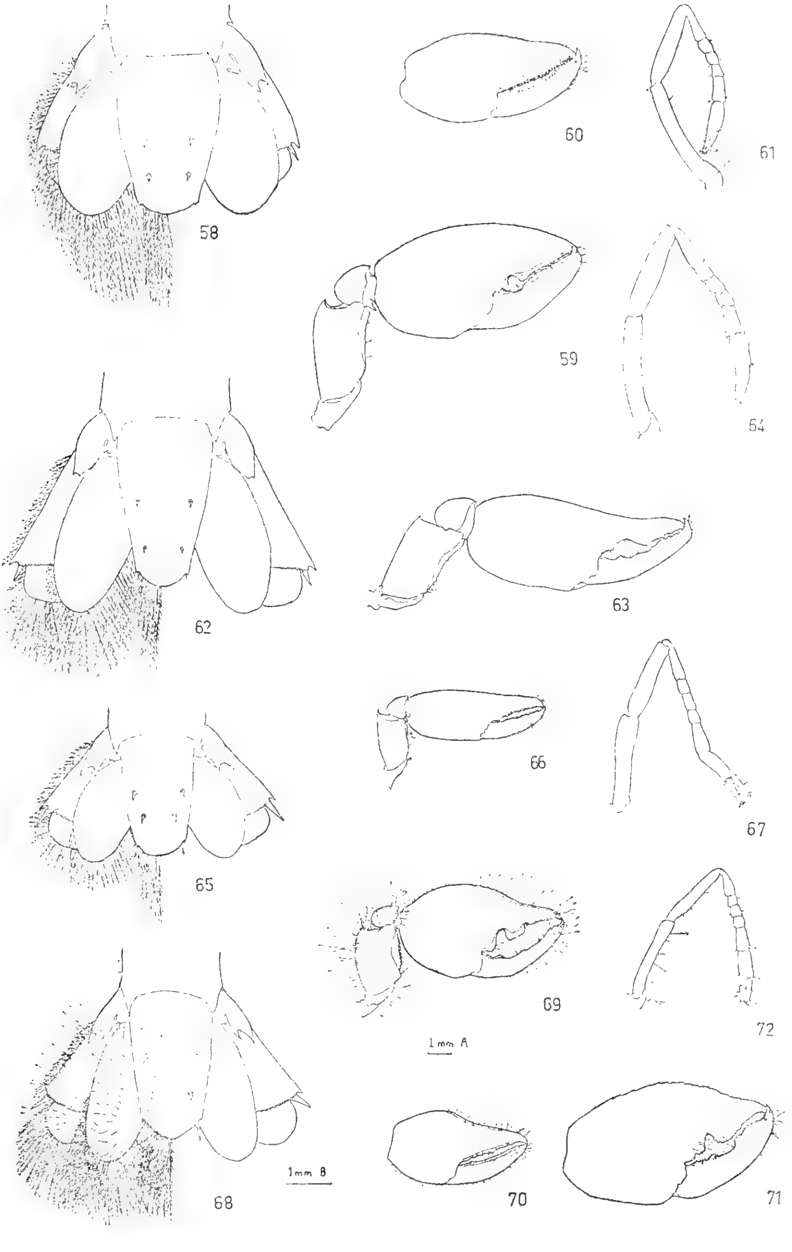
FIGURES 17–28.—*Betaeus harrimani* Rathbun: 17, frontal region, dorsal view, female; 18, same, lateral view; 19, antennal scale; 26, tail fan. *Betaeus longidactylus* Lockington: 20, frontal region, dorsal view, female; 21, same, lateral view; 22, antennal scale; 27, tail fan. *Betaeus ensenadensis* Glassell: 23, frontal region, dorsal view, male; 24, same, lateral view; 25, antennal scale; 28, tail fan.



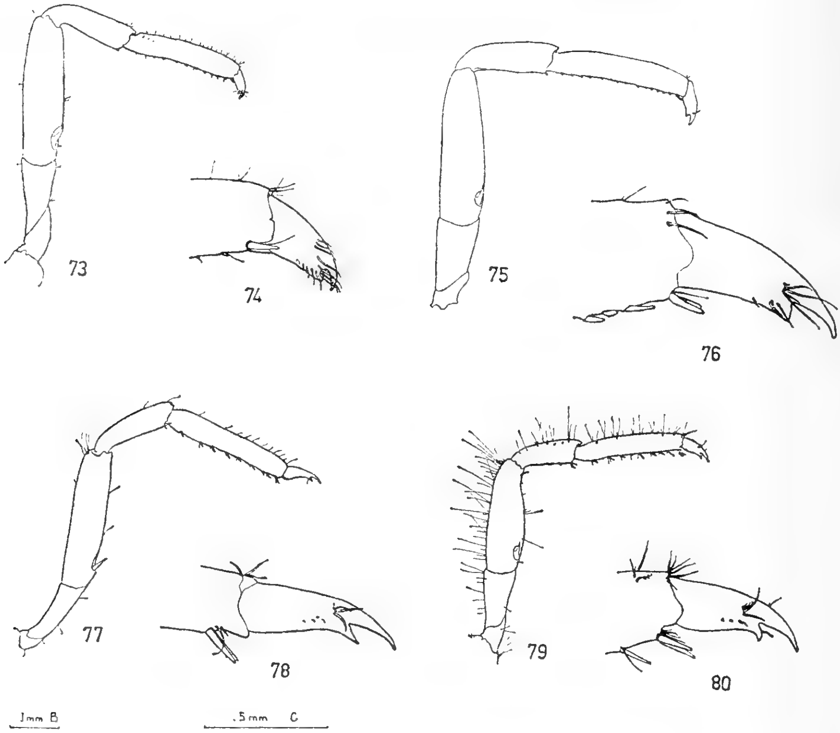
FIGURES 29–45.—*Betaeus harrimani* Rathbun: 29, right cheliped, male; 30, left chela, female; 31, right chela, same; 37, second leg; 38, third leg; 39, dactylus of third leg. *Betaeus longidactylus* Lockington: 32, right cheliped, female; 33, right chela, female; 34, left chela, male; 40, second leg; 41, third leg; 42, dactylus of third leg. *Betaeus ensenadensis* Glassell: 35, right cheliped; 36, right chela, male; 43, second leg; 44, third leg; 45, dactylus of third leg.



FIGURES 46–57.—*Betaeus harfordi* (Kingsley): 46, frontal region, dorsal view, female; 47, same, lateral view; 54, antennal scale. *Betaeus macginitieae*, new species: 48, frontal region, dorsal view, female; 49, same, lateral view; 55, antennal scale. *Betaeus gracilis*, new species: 50, frontal region, dorsal view, female; 51, same, lateral view; 56, antennal scale. *Betaeus setosus*, new species: 52, frontal region, dorsal view, female; 53, same, lateral view; 57, antennal scale.



FIGURES 58–72.—*Betaeus harfordi* (Kingsley): 58, tail fan; 59, right cheliped, male; 60, right chela, female; 61, second leg. *Betaeus macginitieae*, new species: 62, tail fan; 63, right cheliped, male; 64, second leg. *Betaeus gracilis* new species: 65, tail fan; 66, right cheliped, female; 67, second leg. *Betaeus setosus*, new species: 68, tail fan; 69, right cheliped, male; 70, right chela; 71, right chela; 72, second leg.



FIGURES 73–80.—*Betaeus harfordi* (Kingsley): 73, third leg; 74, dactylus of third leg. *Betaeus macginitieae*, new species: 75, third leg; 76, dactylus of third leg. *Betaeus gracilis*, new species: 77, third leg; 78, dactylus of third leg. *Betaeus setosus*, new species: 79, third leg; 80, dactylus of third leg.

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NOTES ON SOME NEARCTIC PSYCHOMYIIDAE WITH SPECIAL REFERENCE TO THEIR LARVAE (TRICHOPTERA)

By Oliver S. Flint, Jr.

Introduction

The caddis-fly family Psychomyiidae is represented in America north of Mexico by 10 genera containing 61 species. The larvae of this family construct fixed retreats that vary from simple silken covers to long tubes and complex trap nets. Until 1944, when Ross published a key to the genera for the larvae and pupae, it was virtually impossible to identify the immature stages of our species, even to genus in most cases. The subsequent modifications of that key (Ross, 1959, and here) permit generic determination of most larvae, but specific determination in our larger genera cannot yet be made with any degree of certainty.

Since the publication of Ross' key (1959), several papers have appeared and a few critical associations have been established that make expansion and modification of his key necessary. Edwards (1961) described the larvae of *Xiphocentron mexico*, and the collection of a metamorphotype (sensu Milne, 1938) of Ross' Genus B (1944, p. 74) establishes its synonymy with *Nyctiophylax vestitus*. A critical examination of more material also has necessitated the synonymy of Genus A (Ross 1944, p. 73) with *Nyctiophylax*. The collection

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of some larvae from Texas, almost certainly *Cernotina*, requires an addition to the key, and examination of other specimens necessitates additional modifications. The discovery of a new species of *Nyctiophylax* and the recognition of a synonym in *Cyrnellus* are also reported here.

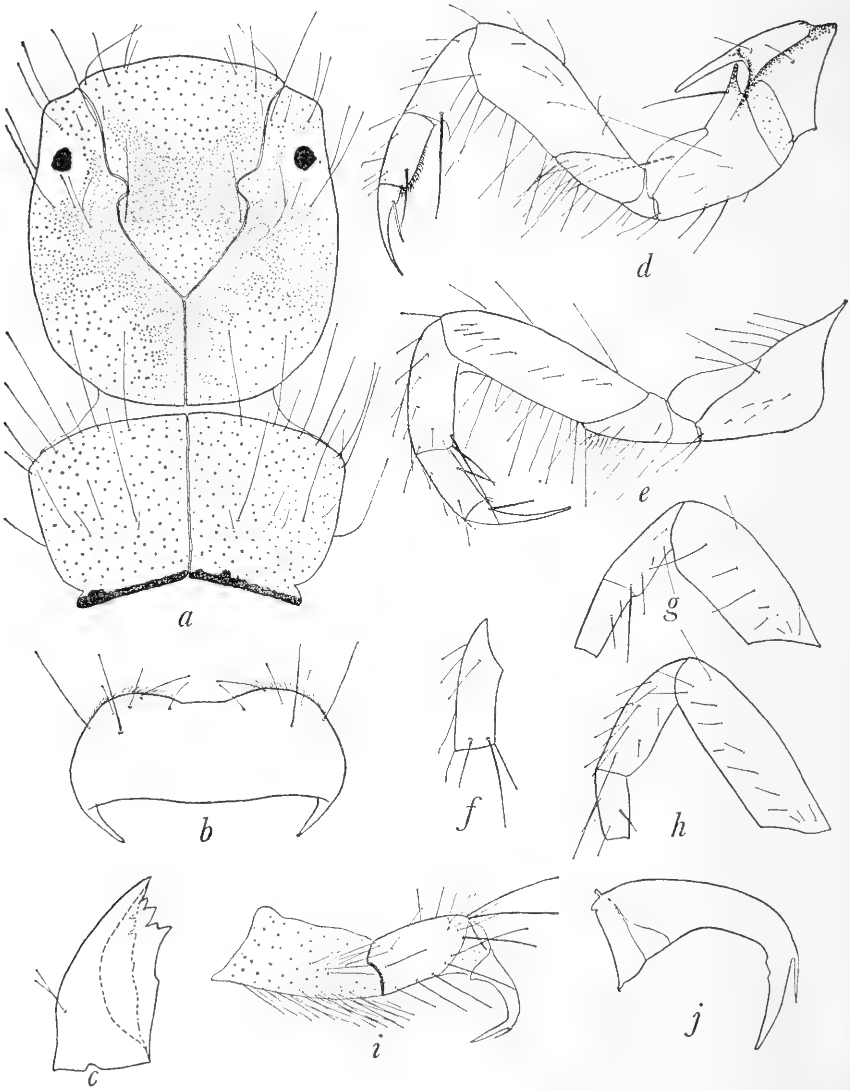

FIGURE 1.—*Cyrnellus fraternus: a*, head and pronotum, dorsal aspect; *b*, labrum, dorsal; *c*, left mandible, dorsal; *d,e*, foreleg and midleg, posterior; *f*, tibia of hind leg, posterior; *g,h*, femur, tibia, and tarsus of foreleg and midleg, anterior; *i*, anal proleg, lateral; *j*, anal claw, lateral.

I wish to express my appreciation to Dr. H. H. Ross, of the Illinois Natural History Survey, and Dr. S. S. Roback, of the Philadelphia Academy of Natural Sciences, for their loan of specimens. Dr. P. J. Darlington, Jr., of the Museum of Comparative Zoology at Harvard University, made it possible for me to study the Banks types of *Cyrnellus*. The material used in this study is from four sources: Illinois Natural History Survey (INHS), Academy of Natural Sciences of Philadelphia (ANSP), United States National Museum (USNM), and the author's collection (OSF).

Key to the Genera of Psychomyiidae Based on the Larvae

1. Foretrochantin broad, hatchet-shaped, set off by a basal suture (Psychomyiinae) . . . 7
   Foretrochantin pointed, fused to pleuron (Polycentropodinae) . . . 2
2. Both mandibles with a linear brush mesally, and equilateral in outline; tarsi broad and densely pilose . . . **Phylocentropus**
   Right mandible never with a brush, and distinctly longer than broad; tarsi not pilose . . . 3
3. Muscle scars of head and pronotum as pale or paler than surroundings . . . 4
   Muscle scars darker than surroundings . . . 6
4. Anal claw with well-developed ventral teeth . . . 5
   Anal claw without ventral teeth . . . **Cyrnellus**
5. Anal claw with ventral teeth much shorter than apical hook and with an external tooth; foretibiae and midtibiae with 3 short dark setae on posterior face . . . **Nyctiophylax**
   Anal claw with ventral teeth nearly as long as apical hook, no external tooth; foretibiae and midtibiae with 1 short dark seta on posterior face. (*Cernotina*?) Genus C
6. Basal segment of anal proleg without setae . . . **Neureclipsis**
   Basal segment of anal proleg with setae . . . **Polycentropus**
7. A broad flat process anteriorly from mesopleuron; tibiae and tarsi fused. **Xiphocentron**
   No process on mesopleuron; tibiae and tarsi distinct . . . 8
8. Anal claw with several long teeth ventrally . . . **Psychomyia**
   Anal claw lacking ventral teeth . . . 9
9. Left mandible with linear brush; mandibles distinctly longer than broad. **Tinodes**
   Left mandible with 2 discrete brushes; mandibles equilateral in outline . . **Lype**

Cyrnellus fraternus (Banks), new combination

Figure 1

Cyrnus fraterna Banks, 1905, p. 17.
Nyctiophylax fraternus.—Ross, 1938b, p. 12 (designates lectotype).
Nyctiophylax marginalis Banks, 1930, p. 231.—Ross, 1938b, p. 12 (designates lectotype). New synonymy.
Cyrnellus marginalis.—Ross, 1944, p. 71 (male and female).—Sublette, 1957, p. 378 (mentions larvae).—Ross, 1959, p. 1033 (keys larvae).

I recently had the opportunity to study the lectotypic female of *raternus* and found that its forelegs had a preapical spur and its maxillary palpi a long second segment. These characteristics indicate that the species belongs to the genus *Cyrnellus*, not *Cernotina* as indicated by Ross (1944, p. 293). The specific synonymy is based on the fact that only one species is known in this genus in the Nearctic region. In addition, several large collections containing both sexes have been made in recent years at Plummers Island, Maryland, the type locality of *fraternus*.

The female metamorphotype which permitted the establishment of the association of larva and adult was borrowed from Dr. H. H. Ross. The larva was included in Ross' key in 1959; however, no description or figures have been published.

LARVA.—Length, 9 mm. Head yellowish, marked with brown which varies greatly in intensity, muscle scars pale (fig. 1,*a*). Labrum slightly more than twice as wide as long (fig. 1,*b*). Mandibles with dorsal edge overhanging ventral; left mandible lacking mesal brush (fig. 1,*c*); right mandible like figure 2,*c*. Maxillolabium like figure 2,*b*, except labial lobe barely reaches base of galea. Pronotum sclerotized, generally pale (fig. 1,*a*), sometimes darker, then with pale muscle scars. Legs without any setae greatly shortened, only apical setae of tibiae conspicuously darkened (fig. 1,*h*). Basal segment of anal proleg bearing setae ventrally and laterally (fig. 1,*i*). Anal claw curved at nearly a right angle, without ventral teeth, but with accessory tooth externally at angle (fig. 1,*j*).

MATERIAL.—Iowa: Keokuk, walls of valve chamber New Lock 19, Aug. 27, 1958, C. R. Fremling, 4 larvae, 1♀ pupa (INHS). Oklahoma: Texhoma, Dec. 8, 1950, J. E. Silvey, 1 larva (INHS). Tennessee: Cumberland R., near Hermitage Hills, Oct. 11, 1962, S. S. Roback, 11 larvae (ANSP); Cumberland R., above Old Hickory Dam, Oct. 3, 1959, S. S. Roback, 16 larvae (ANSP); Tennessee R., New Johnsonville, Oct. 14, 1958, S. S. Roback, 14 larvae (ANSP); Tennessee R., below Pickwick Dam, Oct. 20, 1959, R. M. Sinclair, 10 larvae (INHS); South Holston R., above Kingsport, Nov. 29, 1945, J. S. Dendy, 3 larvae (INHS). Virginia: James R., Richmond, July 26, 1951, J. D. Lattin, 6 larvae (ANSP).

REMARKS.—The larvae of this species are markedly similar to the larvae of *Nyctiophylax* in having an enlarged dorsal edge of the mandibles and pale muscle scars; however, the setation of the legs and structure of the anal prolegs and claws indicate an affinity to *Polycentropus*. This combination of characters is distinctive.

I have never collected the immature stages of this species, but Dr. Roback states (in litt.) "I have found *Cyrnellus* both in rivers and lake situations on wood and on rock. In the Cumberland River, for example, I found it on rocks up in the lake along the banks and also below Old Hickory Dam in about 15 feet of water, also on rocks. It apparently can take the range of flow from practically standing water to quite rapidly flowing water. On these rocks it lives under an amorphous silk mat usually silt covered."

Genus *Nyctiophylax* Brauer

The genus is found throughout the world with the exception of Australia–New Zealand and Europe, although it is well represented in the Baltic Amber. In North America there are at least 5 closely related species. Larvae of this genus were first described by Noyes (1914) as *Cyrnus pallidus* (?), and later by Ross (1944) as Genus A and Genus B. Ulmer (1957) described the larvae and pupae of the Sumatran *N. flavus*. Generic characters of the larvae are given below:

Head about as wide as long; muscle scars pale. Labrum over twice as wide as long (fig. 2,*d*). Mandibles with dorsal edge overhanging ventral edge, left mandible with mesal brush (fig. 2,*c*). Pronotum sclerotized, with pale muscle scars; mesonotum and metanotum membranous. Forefemora with stout dark setae ventrally and anteriorly; foretibiae with 3 stout dark setae posteriorly and 4 anteriorly; midtibiae with 3 stout dark setae both posteriorly and anteriorly (fig. 2,*e–i*). Ninth segment ventrally with a T-shaped area of small spicules. Basal segment of anal prolegs with spicules basoventrally; and long hairs apically and apicomesally (fig. 2,*k*). Anal claw with strong teeth ventrally, and an accessory tooth externally (fig. 2,*j*).

The pale muscle scars of the head and pronotum and enlarged dorsal margin of the mandibles relate the genera *Nyctiophylax*, *Cyrnellus*, and the one described here as Genus C. The short, broad, and black setae on the legs also indicate a close relationship between *Nyctiophylax* and Genus C, as do the ventral teeth on the anal claw. The larvae of *Nyctiophylax* differ from those of Genus C in having 3 dark setae posteriorly on the midtibiae and hind tibiae, setae ventrally on the basal segment of the anal proleg, and a dorsal brush on the apical segment; also in having the ventral teeth shorter and farther from the base on the anal claw as well as an external tooth on the claw.

Key to Larvae of Genus *Nyctiophylax*

1. Dark color on genae completely enclosing frontoclypeus posteriorly . species A
   Dark color of the genae not meeting broadly posterior to frontoclypeus . . 2
2. Dark color extending anteriorly along frontal sutures to anterior margin of the head . . . . **N. nephophilus**
   Dark color of head not reaching anterior margin . . . . **N. vestitus**

Nyctiophylax vestitus (Hagen)

FIGURE 2

Polycentropus vestitus Hagen, 1861, p. 293.
Nyctiophylax vestitus.—Ross, 1938b, p. 13 (designates lectotype); 1944, p. 70 (male and female).
GENUS B Ross, 1944, p. 74; 1959, p. 1032.

Although the adults of this species are commonly collected at lights throughout much of eastern North America, the larvae have remained unknown until recently. Ross (1944) gave the first description of the larvae under the name Psychomyiidae Genus B. In the summer of 1961 I collected a male metamorphotype of the species, finally establishing the correlation of stages.

LARVA.—Length 8 mm. Head yellowish, with brown area neither reaching anterior margin nor extending posteriad of frontoclypeus (fig. 2,*a*).

MATERIAL.—Illinois: Kankakee R., Momence, May 26, 1936, H. H. Ross, 1 larva (INHS). Virginia: Broad Run, Thoroughfare Gap, Fauquier County, July 22, 1961, O. S. Flint, 1 larva, 1 ♂ pupa (USNM); May 27, 1961, 27 larvae, 4 pupae (OSF); June 14, 1961, 1 larva, 1 pupa (USNM); Thornton R., above Sperryville, Mar. 4, 1961, O. S. Flint, 9 larvae (USNM); Apr. 15, 1961, 7 larvae (USNM). North Carolina: Deep Creek, 2,000 ft., near Bryson City, May 19, 1959, O. S. Flint, 1 larva (OSF); June 7, 1961, 1 larva (USNM).

REMARKS.—There is considerable variation in the shape of the clasper of the male. It may well be that further study will show that our present concept of the species includes several closely related species. For this reason, I give figure 2*l*, showing the clasper from the metamorphotype. In all likelihood the name *vestitus*, based on a female, is correctly associated with this male as the type locality is Washington, D.C., and this is the only clasper shape I have seen from the area.

The larva of this species is most like that of *nephophilus*, differing from it in the coloration of the head. In *vestitus* the dark area does not reach the anterior margin of the head.

The larvae are found on rocks in streams generally about a meter or two wide, near one or the other end of the pools, generally shunning the fastest water of the rapids and cascades. They construct, in some angle on a rock, a silken shelter of considerable rigidity beneath which they hide. The shelter is open at both ends, but as far as can be seen no trap net is constructed. At pupation time the shelter is strengthened and closed except for a cylindrical aperture at one end. The end of the cylinder inside the shelter is partially closed by a silken sieve.

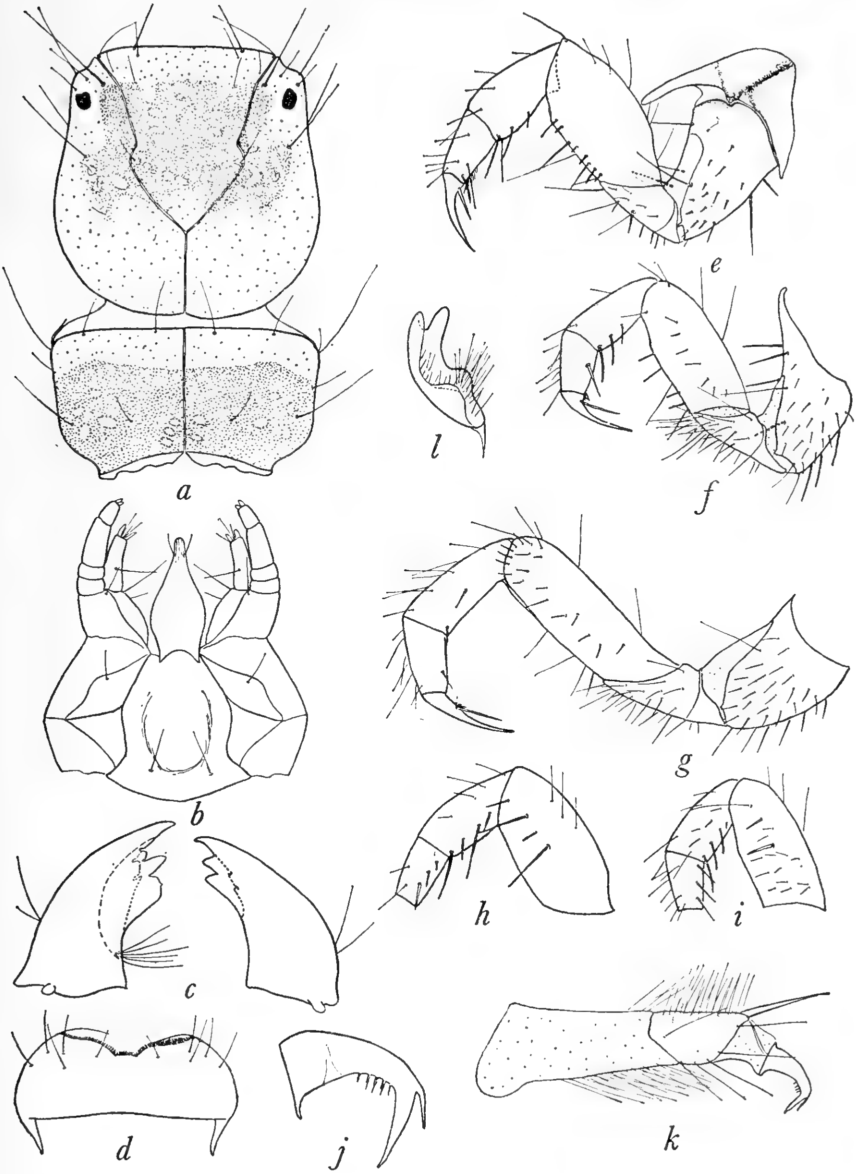

FIGURE 2.—*Nyctiophylax vestitus: a*, head and pronotum, dorsal aspect; *b*, maxillolabium, ventral; *c*, mandibles, dorsal; *d*, labrum, dorsal; *e–g*, foreleg, midleg, and hind leg, posterior; *h,i*, femur, tibia, and tarsus of foreleg and midleg, anterior; *j*, anal claw, lateral; *k*, anal proleg, lateral; *l*, clasper of male, caudal.

Nyctiophylax nephophilus Flint, new species

Figure 3, *a–c*

In the material collected in the Southern Appalachians in 1961 were found a male and female that belong to an undescribed species. The clasper of the male is quite different from that of any known Nearctic species, but may be contrasted with *vestitus* most readily. From this species it differs in having the inner margin of the clasper slightly convex, and the lateral process shorter and directed laterad.

Adult.—Length of forewing, male 6 mm., female 8 mm. Color of specimens in alcohol pale brown, wing membrane white around thyridium, at r–m, and tip of Cu. Male genitalia (fig. 3,*b*,*c*): Tenth tergum semimembranous, elongate in lateral view. Cercus quadrate, bearing a decurved process from mesal face. Clasper with apicomesal point long, lateral point short, directed laterad, inner margin convex. Female genitalia: Lobes of eight sternum short and wide. Tip of abdomen with 3 pairs of short processes.

Holotype male, allotype female: South Carolina, Oconee County, Walhalla Federal Fish Hatchery, June 6, 1961, R. A. and O. S. Flint (USNM type 66796).

I attribute the following larvae to this species purely on circumstantial evidence—the adults were collected beside the stream in which this larval form occurs.

Larva.—Length 9 mm. Brown spot on head extending to anterior margin along frontal sutures, but not extending much posterior to frontoclypeus (fig. 3,*a*).

Material.—South Carolina: E. Fork of Chattooga R., Walhalla Federal Fish Hatchery, May 18, 1959, O. S. Flint, 6 larvae (OSF); June 6, 1961, 14 larvae, 2 pupae (USNM); Sept. 11, 1958, 3 larvae (OSF). North Carolina: Green's Cr., near Highlands, June 6, 1961, O. S. Flint, 3 larvae, 1 prepupa, (USNM); Sept. 11, 1958, 1 larva (OSF); stream, biological station, Highlands, July 1, 1958, O. S. Flint, 2 larvae, 1 pupa (OSF); Deep Cr., 2,000 ft., near Bryson City, June 7, 1961, O. S. Flint, 1 larva (USNM); Crabtree Meadows, Blue Ridge Parkway, Sept. 2, 1959, O. S. Flint, 4 larvae (OSF).

Remarks.—The larvae of this form are very similar to those of *vestitus*, but the dark area on the head reaches the anterior margin along the frontal sutures.

The habits of the immature stages of this species seem to be the same as recorded for *vestitus*, with the possible exception of their inhabiting slightly smaller streams.

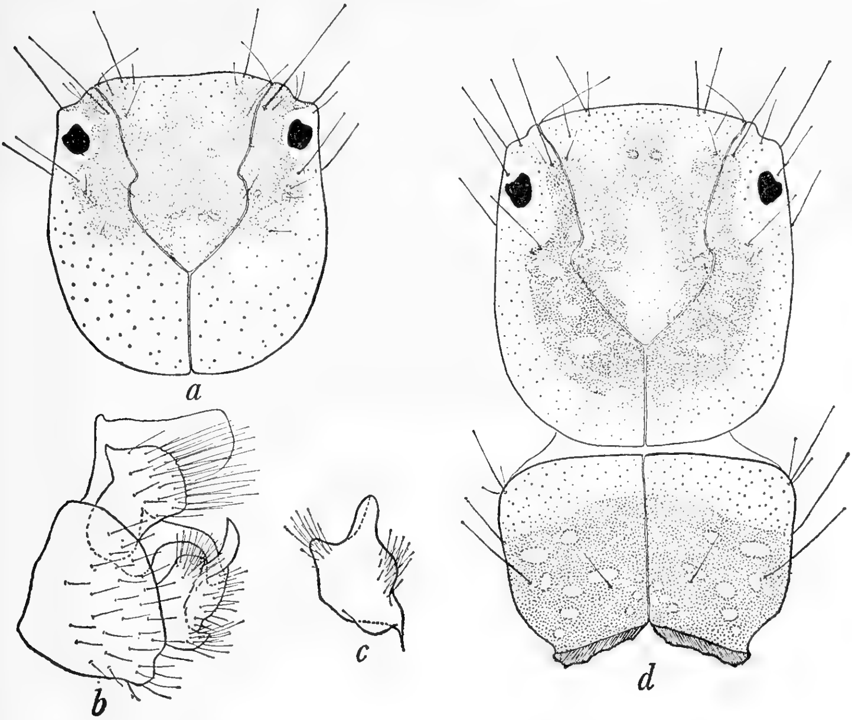

FIGURE 3.—*a–c*, *Nyctiophylax nephophilus*: *a*, head, dorsal aspect; *b*, male genitalia, lateral; *c*, male clasper, caudal. *N.* species A: *d*, head and pronotum, dorsal.

Nyctiophylax species A

FIGURE 3,*d*

Cyrnus pallidus (?), Noyes, 1914, p. 263 (misidentification).
GENUS A Ross, 1944, p. 73; 1959, p. 1032.

This larva may be that of *N. uncus* Ross, which has the same general distribution, or of some presently unrecognized member of the genus.

LARVA.—Length 9 mm. Brown area on genae broadly joined posterior to frontoclypeus, and with conspicuous pale muscle scars and a large pale spot centrally on frontoclypeus (fig. 3,*d*).

MATERIAL.—Ontario: La Vase R., 1 mile NW. of La Vase L., near North Bay, Sept. 24, 1957, S. S. Roback, 12 larvae (ANSP). Wisconsin: Namekagon R., Spooner, June 5–6, 1936, Frison and Ross, 1 larva (INHS). Michigan: Platte R., Honor, Sept. 16, 1936, Ross and Burks, 3 larvae (INHS); Big Sable R., N. of Scotville, Sept. 16, 1936, Ross and Burks, 2 larvae (INHS); power dam on Au Sable R., Grayling, June 17, 1935, T. H. Frison, 1 larva (INHS). Illinois: Rock Cr., Erie, June 5, 1940, Mohr and Burks, 1 larva (INHS). Delaware: West Cr., near Newark, June 7, 1951, T. Dolan IV, 2 larvae (ANSP). Virginia: Thornton R., above Sperryville, Apr. 15, 1961, O. S. Flint, 1 larva (USNM).

Remarks.—The larvae of this form have a more elongate head capsule than either of the other species, and the brown spot on the head completely encloses the frontoclypeus posteriorly. The T-shaped patch of spicules on the ninth sternum is present, but much less conspicuous than in the other species.

To judge by the remarks on the biology of *Cyrnus pallidus* by Noyes (1914), the larvae must have similar habits to the other species of the genus.

Genus C, new form

Figure 4

These larvae are almost unquestionably *Cernotina*, and quite possibly *C. astera* Ross the type locality of which is the same spring from which some of these larvae were collected.

Larva.—Length 8 mm. Sclerites pale yellowish; head with a dark area centrally on the frontoclypeus which bears pale muscle scars (fig. 4,*a*). Head capsule conspicuously longer than broad. Labrum about twice as wide as long (fig. 4,*b*). Mandibles and maxillolabium as in *Nyctiophylax*. Pronotum sclerotized, mesonotum and metanotum membranous. Foretibiae and midtibiae with 1 short, dark seta in posterior series and 4 in anterior series; midtibia with an additional apicoventral black seta (fig. 4,*c-g*). Basal segment of anal proleg with a small number of setae apicomesally (fig. 4,*h*). Anal claw with 4 very long teeth ventrally (fig. 4,*i*).

Material.—Texas: San Felipe Spring, Del Rio, Sept. 21, 1960, Flint and Collette, 8 larvae (OSF); stream, near Bandera, Oct. 9, 1960, Flint and Collette, 9 larvae (OSF).

Remarks.—The larvae are most closely related to those of *Nyctiophylax*, from which they differ in the much longer head capsule, the setation of the legs (especially the fewer dark setae on the posterior row of the tibiae), and in the unique structure of the anal claw.

They seem to construct the same type of larval shelter as *Nyctiophylax*, and frequent similar areas in the same type of streams.

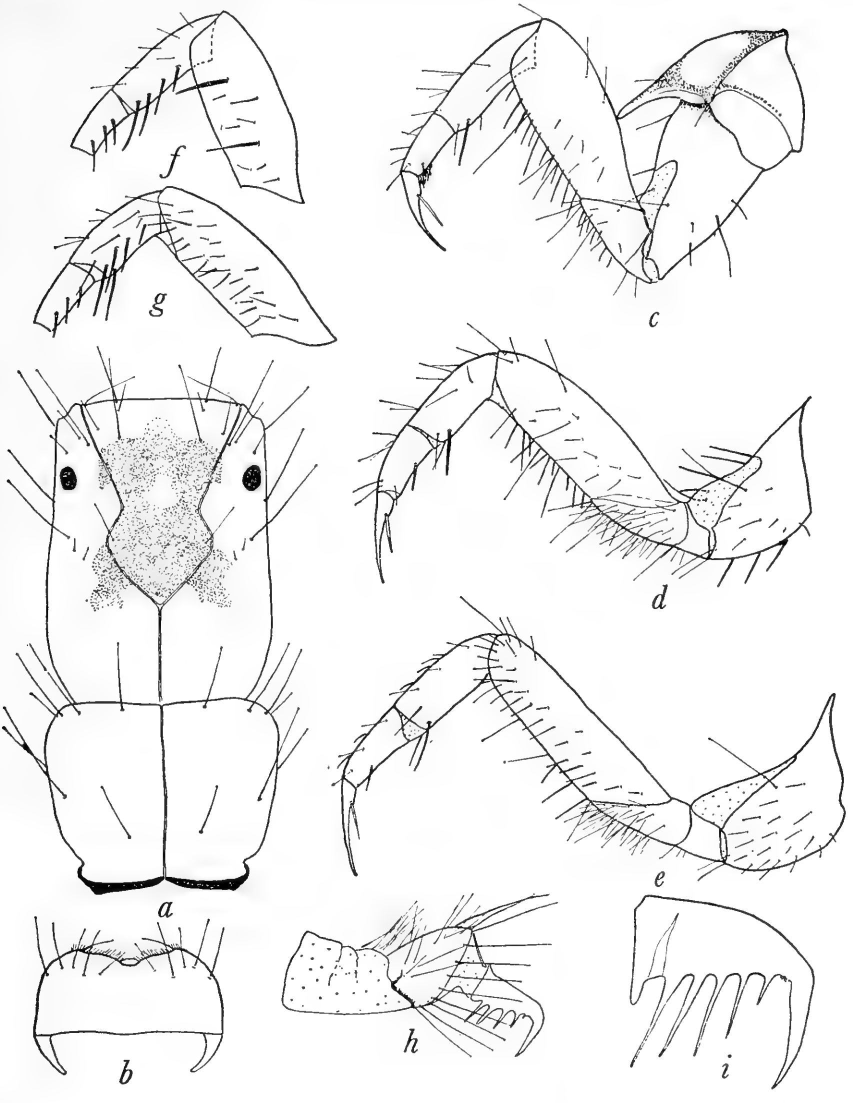

FIGURE 4.—Genus C: *a*, head and pronotum, dorsal aspect; *b*, labrum, dorsal; *c–e*, foreleg, midleg, and hind leg, posterior; *f,g*, femur, tibia, and tarsus of foreleg and midleg, anterior; *h*, anal proleg, lateral; *i*, anal claw, lateral.

Polycentropus cinereus Hagen

Figure 5,*g*

Polycentropus cinereus Hagen, 1861, p. 293.—Ross, 1944, p. 67 (male and female, larva).

Ross (1944) provided good figures of the head and anal prolegs of the larva of this species, but unfortunately did not illustrate the mandibles. During the preparation of this paper I examined the larval mandibles in a male metamorphotype and discovered they had the dorsal margin overhanging the ventral (fig. 5,*g*). The presence of this characteristic in a species of *Polycentropus* renders the key proposed by Ross (1944) incorrect. For this reason the color of the muscle scars on the head is used in place of the shape of the mandibles. This characteristic is not only constant in all specimens of the genus examined by me, but also in the exotic species for which descriptions are available.

Genus *Psychomyia* Pictet

The larvae of this genus have been relatively well known for a long time, those of the European species being first described around the turn of the century. Ross described the immature stages of the Nearctic *P. flavida* in 1944, and the larva of the other eastern species is described here. The larvae of this genus are easily separated from all the other known Psychomyiinae by the presence of well-developed ventral teeth on the anal claw.

Key to Larvae of *Psychomyia*

1. Anterior margin of frontoclypeus with a conspicuous pair of submesal processes . . . . **P. nomada**
   Anterior margin of frontoclypeus with submesal processes almost obsolete . . . . **P. flavida**

Psychomyia nomada (Ross)

Figure 5, *c–e*

Psychomyiella nomada Ross, 1938a, p. 138.
Psychomyia nomada.—Ross, 1944, p. 75 (male).

This species, which has been reported only from the Great Smoky Mountain region of North Carolina, is now recorded from Virginia. During the summer of 1961 I was able to collect a number of metamorphotypes of this species, thereby correlating the three stages.

Larva.—Length 6–7 mm. Sclerites pale yellowish brown, nearly immaculate; membranous areas greenish. Frontoclypeus with anterior margin bearing a pair of conspicuous projections submesally (fig. 5,*c*). Mandibles with several broad mesal teeth (fig. 5,*d*).

Material.—Virginia: Broad Run, Thoroughfare Gap, Fauquier County, May 22, 1961, P. J. Spangler, 9♂ 1♀ (USNM); May 27,

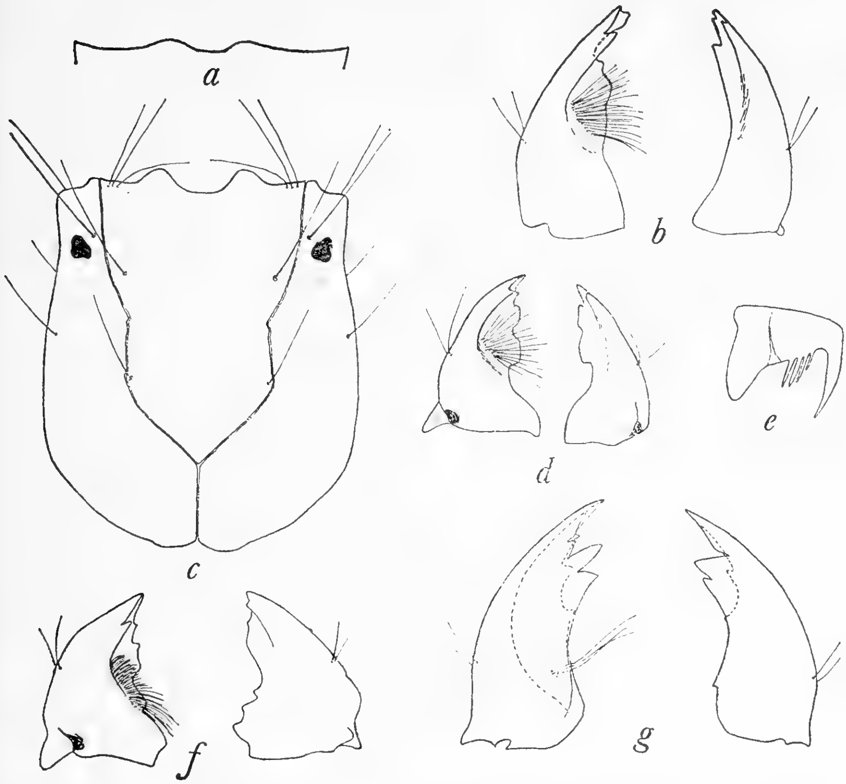

FIGURE 5.—*a,b*, *Psychomyia flavida*: *a*, anterior margin of frontoclypeus; *b*, mandibles, dorsal. *c–e*, *P. nomada*: *c*, head, dorsal; *d*, mandibles, dorsal; *e*, anal claw, lateral. *Tinodes*: *f*, mandibles, dorsal. *Polycentropus cinereus*: *g*, mandibles, dorsal.

1961, O. S. Flint, 2 larvae, 4 prepupae, 2♂ 4♀ pupae (OSF); Thornton R., above Sperryville, Apr. 15, 1961, O. S. Flint, 3 larvae (USNM); Jefferson National Forest, 5 miles east of Buchanan, June 19–20, 1961, A. B. Gurney, many ♂♀ (USNM).

REMARKS.—The larvae of this species are much like those of *P. flavida*, but differ in the conspicuous projections from the frontoclypeus, and the differently shaped mandibles.

The habits of this species are apparently similar to those of *Nyctiophylax*, with which they are found. The larval shelter is considerably smaller, however, as one would expect from their comparative sizes.

Psychomyia flavida Hagen

FIGURE 5, *a,b*

Psychomyia flavida Hagen, 1861, p. 294.—Ross, 1938b, p. 14 (designates lectotype); 1944, p. 75 (male, female, larva).

This species is widespread over eastern North America and as far west as Colorado and Saskatchewan. Ross (1944) provided the only description of the larvae of this species.

The larvae studied differ from the preceding species in having the processes from the anterior margin of the frontoclypeus barely developed (fig. 5,*a*), and in having longer mandibles that lack the broad mesal teeth (fig. 5,*b*). Those figured are from a recently molted individual so that the tips are not worn; by the end of the instar they will be considerably shorter.

MATERIAL.—New York: Willseyville Cr., near Willseyville, Aug. 20, 1956, O. S. Flint, 2 larvae (OSF); Sept. 16, 1956, O. S. Flint, 1 larva (OSF). North Carolina: Green's Cr., near Highlands, May 18, 1959, O. S. Flint, 5 larvae (OSF). South Carolina: E. Fork Chattooga R., Walhalla Federal Fish Hatchery, Oconee Co., June 6, 1961, O. S. Flint, many larvae, pupae (USNM).

Genus *Tinodes* Stephens

FIGURE 5,*f*

No larva of a Nearctic species of *Tinodes* has definitely been correlated with the adult. There are, however, two larvae in the collection of the USNM, probably from Utah, that seem safely referable to this genus. They agree very closely with the larvae of *Lype* (Flint, 1959) but differ by their greater size (12 mm.) and the conformation of the mandibles. The left mandible of *Tinodes* bears a single linear hair brush rather than two as in *Lype*, both mandibles are distinctly longer than broad, whereas in *Lype* they are equilateral in outline, and the dentation on the inner margin is quite different in the two genera. These larvae of *Tinodes* do not possess small teeth on the ventral margin of the anal claw, as do the European species.

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THE JAMBELÍ CULTURE OF SOUTH COASTAL ECUADOR

By Emilio Estrada, Betty J. Meggers, and Clifford Evans

This brief report is the result of fieldwork from 1958 to 1961 in the mangrove swamps and *salitres* of the southern Ecuadorian coast. The survey of the Jambelí islands was undertaken during the summer of 1958 by Estrada, Meggers, and Evans. In 1960, Estrada tested stratigraphically a site, identified as G-84, within the present town of Posorja. Early in 1961, he made a preliminary survey of the *salitres* of Lagarto and El Morro. During the summer of that year, the three authors revisited this area and the sites on the southeastern coast of Puná Island. The strata cut at G-86 was also part of the final season's work. All the pottery was classified at the Museo Víctor Emilio Estrada, and notes taken there are the basis for the type descriptions. Except for type samples of sherds, all pottery and other artifacts were deposited in the Museo Estrada.

Most of the area occupied by the Jambelí Phase sites is not under private ownership, but we wish to express our appreciation to the many local residents for their guidance and assistance with excavation. Particular thanks are due Jorge Swett, who secured permission for us to investigate G-86, one of three sites that has sufficient depth for stratigraphic excavation. In Guayaquil, Walter Molina assisted in processing the sherds for analysis. In Washington, we are indebted to George Robert Lewis for the line drawings of specimens, and to Judith Hill for typing the manuscript.

For support of certain of the field expenses during the 1958 season, the junior authors received Grant 2370 from the Penrose Fund of the American Philosophical Society. The 1961 investigations were part of Project J of the program organized by the Institute of Andean Research on "Interrelationships of New World Cultures," financed by a grant from the National Science Foundation. To all three organizations, we wish to express our deep appreciation.

Completion of this report was delayed by the unexpected death of the senior author in November 1961. Although he did not see the final version of the manuscript, we have retained the authorship we had agreed upon together, not only because we believe that Estrada would accept its content, but because without his persistence the Jambelí culture, represented by some of the most unproductive and uninviting sites to be found on the Ecuadorian coast, would have remained only superficially known.

Geographical Distribution and Site Characteristics

Sites of the Jambelí culture occur on the coastal portions of the Provinces of El Oro and Guayas, extending from the Peruvian border up the coast and around the Gulf of Guayaquil to the vicinity of Playas (fig. 1). All the sites included in this survey are located on the peninsula between Playas and the Canal del Morro, on Puná Island or on the islands off the coast of El Oro. Sherds of Jambelí pottery types are reported from Tendales in El Oro Province, but this part of the mainland and the portion of Guayas Province extending along the eastern side of the Gulf of Guayaquil have not been surveyed.

Today, this region does not present the uniform appearance that it must have had during the existence of the Jambelí culture. The Playas–Posorja area has suffered noticeable desiccation within the memory of the residents, so that only small remnants are left of the mangrove swamps that once occupied about 50 percent of the area. Their former extent is indicated by the dotted lines representing the boundaries of the large *salitres* that have taken their place (fig. 2). This part of the coast now receives little rain, forcing the abandonment of once prosperous cattle ranches and reducing to ghost towns formerly populous communities. The same environmental situation exists on Puná Island except for the southeastern part, which is low and broken into small islands of mangrove giving it an appearance comparable to that of the islands of El Oro to the south (fig. 3).

The distribution and character of the Jambelí Phase sites indicates that the southern portion of the area conserves the appearance that

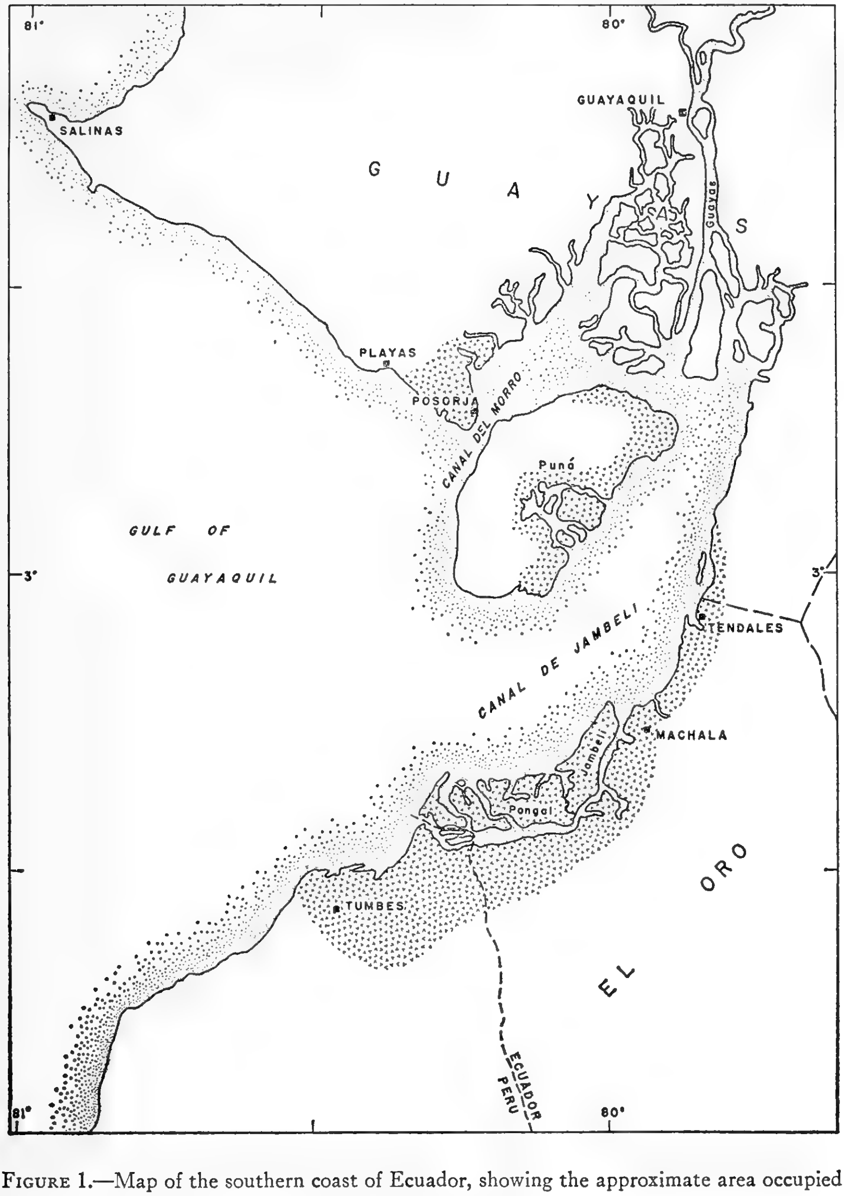


FIGURE 1.—Map of the southern coast of Ecuador, showing the approximate area occupied by sites of the Jambelí Phase.

the northern portion must also have presented around the beginning of the Christian Era. The mangrove islands extend at the present time from the Peruvian border northeastward to the vicinity of Machala along the coast of El Oro Province (fig. 4). The western side, exposed to the ocean, is subject to erosion from pounding waves,

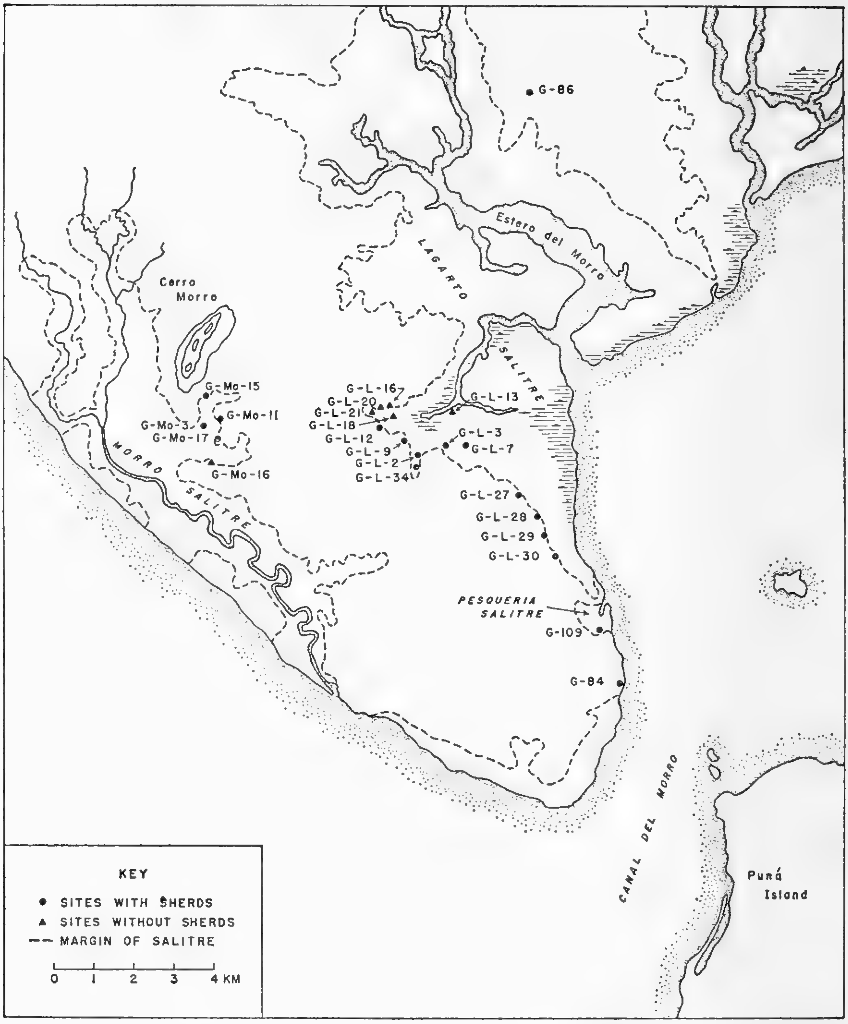


FIGURE 2.—Map of the southern Guayas coast, showing the locations of the Lagarto and Morro *salitres* and sites identified with the Jambelí Phase.

particularly evident at Site O-6: Las Huacas. Mangrove swamp also occupies a fringe of varying width along the mainland coast. In occasional areas among the islands, and on the mainland beyond the mangrove zone, the land rises 1–5 m. and the vegetation becomes xerophytic as it is to the north.

All Jambelí Phase sites are shell middens, the most common shell species being the small mangrove oyster *Ostrea columbiensis*. The accumulation is usually less than 50 cm. in thickness, although one site (G-86) had 1.60 m. of shell refuse mixed with sherds. Fragments

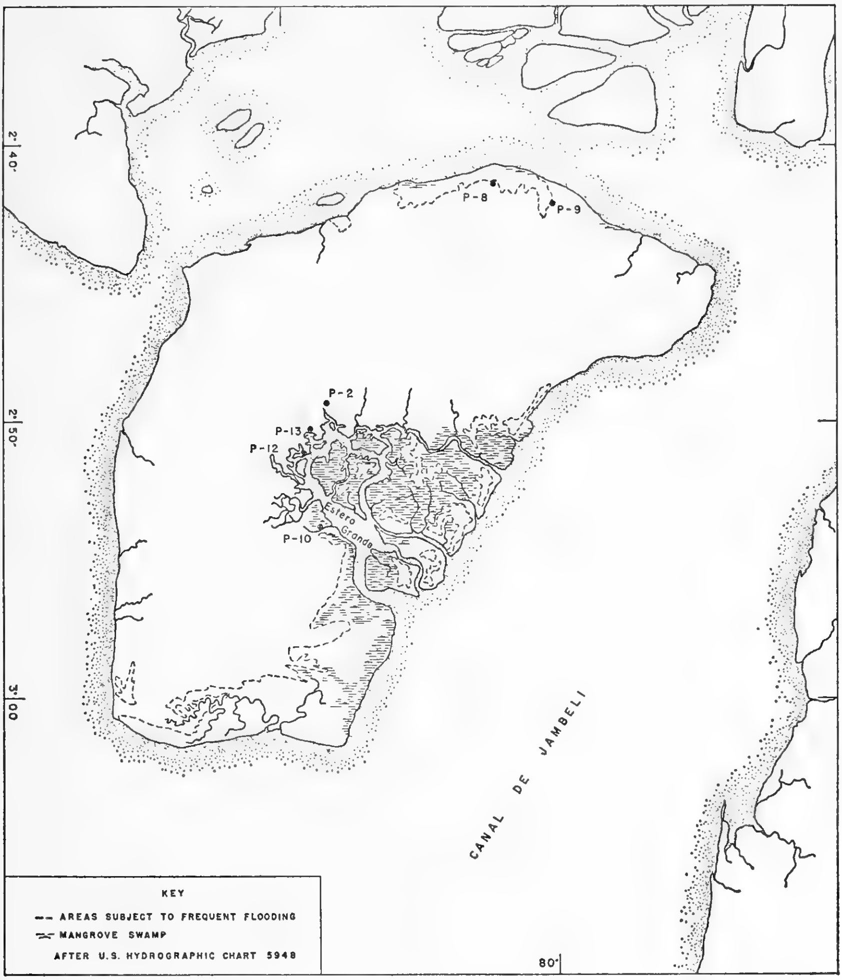


FIGURE 3.—Map of Puná Island, showing the area occupied by mangrove swamp and location of Jambelí Phase sites.

of fire-burnt rock and stone chips also occur. Site area varies from a maximum of 150 × 40 m. (Site O-5) to about 10 m. in diameter, excluding badly eroded remnants of habitation sites. The majority of the sites are from 10–30 m. in diameter, with the refuse 20–40 cm. in depth, consisting principally of densely compacted shells (pl. 1, *b*).

In terms of their present-day environmental situation, the Jambelí culture sites fall into two groups: those on the margins of *salitres*, and those in active mangrove swamps. All the sites on the Guayas coast belong to the former group. They are located either at the edge of the *salitre* (pls. 1, *a*, and 2), or on an island 10 m. or more

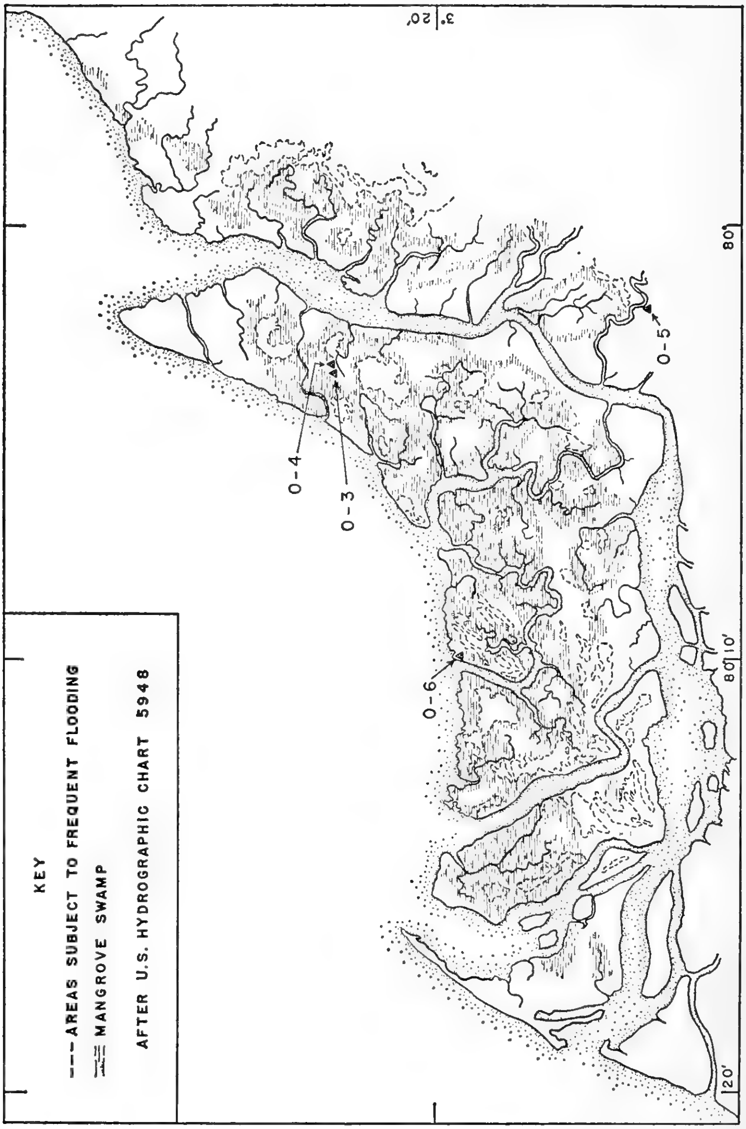


Figure 4.—Map of the coast of El Oro Province, showing distribution of mangrove swamp and location of Jambelí Phase sites.

from the former shoreline (pl. 3, *a*). Most of the *salitre* sites are exposed to wind action and are badly eroded. Many are reduced to small remnants and were identified with the Jambelí culture by the characteristic occurrence of shells of the mangrove oyster (*Ostrea columbiensis*), no sherds having been found. Since the seriated sequence shows these Guayas Province sites to be of equivalent age to those in the Province of El Oro, it is evident that a change has taken place in the elevation of the coast here with a silting up of the bays and inlets that has not affected the area to the south. Whether or not the progressive desiccation of the bays and destruction of the mangrove swamps are related to the abandonment of the area by the Jambelí culture, or whether this alteration occurred at a later date, is uncertain.

Some of the Jambelí sites on Puná Island and all those on the islands of El Oro Province are on small areas of high land scattered through what is predominantly mangrove swamp (pl. 4). At P-2: Campo Alegre on Puná Island, the situation is like that on the Guayas mainland: a shell midden bordering a flat now dry except in the rainy season (pl. 5). Except that their exposed condition resulting from the lack of covering vegetation makes them subject to damage from erosion, these *salitre* sites are not significantly different from those in living mangrove swamps.

Only three sites had sufficient depth of deposit and were sufficiently undisturbed to permit stratigraphic excavation. Two are on the Guayas mainland and the third on the coast of El Oro. The center of the modern town of Posorja (G-84) is a site of the Valdivia culture reoccupied by the Jambelí culture. A 2 × 1 m. excavation, made by Estrada, showed that the upper 40 cm. of the refuse deposit contained Jambelí material, with sherds more abundant than in any other Jambelí site. The midden contained characteristic shell refuse of mangrove oyster (*Ostrea columbiensis*), small clams (especially *Anomalocardia subimbricata*), and miscellaneous other shell species.

The site of G-86: La Manguita is located northeast of the town of El Morro on a branch of the Salitre San Miguel, which connects with Lagarto Salitre. The site occupies a hill about 100 m. from the *salitre*. Another shell midden occupies a rise 200 m. to the south. G-86 has a diameter of 14 m. The refuse is densely compacted with large quantities of mangrove oyster with some admixture of small clams and other species of shellfish. A 2.0 × 1.5 m. test was begun on the east side of the midden near the top and excavated in 20-cm. levels (pl. 3, *b*). The shell was pulverized and mixed with dirt, some showing traces of burning. All refuse was sifted, but the only artifacts encountered were a fragment of a stone bark beater (pl. 6, *b*) in Level 60–80 cm. and a perforated shell in Level 80–100 cm.

Several large fire-burnt stones came from Level 120–140 cm. Sterile black clay at a depth of 160 cm. established the bottom of the midden accumulation.

The site of O-5: Embarcadero is about 5 km. inland from the mouth of the Estero Embarcadero (fig. 4), where the left bank rises to 2 m. above high tide level. Shell refuse was visible for a distance of about 150 m. along this bank (pl. 4, *a*). The midden area slopes off to the surrounding land, which measures roughly 1 m. above high tide, a contour that is easily seen from the water. Along the eroded bank, vertical columns of shell about 10 cm. in diameter and about a meter long could be seen in several places, possibly representing former post holes. The site is densely overgrown but the midden deposit could be traced for 30–40 m. inward from the bank. Miscellaneous testing showed that sherds were fairly abundant throughout. A 1 × 1 m. stratigraphic excavation, designated as Cut 1 and controlled in 20-cm. levels, was placed 50 cm. in from the edge of the bank. The refuse consisted of hard, lumpy clay with an abundant admixture of shell, sherds, some fishbones, and small broken rocks. Sherds were present to a depth of 80 cm., where a dense layer of shells 20–25 cm. thick was encountered. Below this was sticky clay, the natural soil of the bank. The only unusual artifacts were a pottery figurine arm from Level 20–40., cm. and anther figurine fragment from Level 40–60 cm.

None of the sites investigated in the Playas–Posorja region produced any human skeletal remains. White-on-red pottery was collected by Estrada from Site P-4, which consisted of a small circle of erect stones with two extended burials in the center (Estrada, 1957 a, p. 28 and fig. 10). Site O-7: Tendales, reported by local residents and not visited by any of the authors, produced human skeletal remains in association with ceramics of Jambelí types. This site, discovered during excavation of irrigation trenches, is reported to be several hundred square meters in area.

For ease in reference throughout the report, sites belonging to the Jambelí culture are listed below. Group "A" includes those from which sherd collections have been classified and which appear in Appendix Table 1. Group "B" includes sites in the *salitres* where no sherds were recovered, but in which the character of the site, its location, and the composition of the shell refuse are typical of the Jambelí Phase.

A. Jambelí Sites With Pottery:
- El Oro Province:
  - O-3: Estero Chivería No. 1
  - O-4: Estero Chivería No. 2
  - O-5: Embarcadero
  - O-6: Las Huacas
  - O-7: Tendales

Puná Island, Guayas Province:
- P-2: Campo Alegre No. 1
- P-8
- P-9
- P-12: Los Chalacos
- P-13: Jerónimo

Guayas Province:
- G-84: Posorja
- G-86: La Manguita
- G-109

Lagarto Salitre, Guayas Province:
- G-L-2
- G-L-3
- G-L-7
- G-L-9
- G-L-12
- G-L-27
- G-L-28
- G-L-29
- G-L-30: Cangrejito
- G-L-34

El Morro Salitre, Guayas Province:
- G-Mo-3
- G-Mo-11
- G-Mo-15
- G-Mo-17

B. Jambelí Sites Without Pottery:

Lagarto Salitre, Guayas Province:
- G-L-13
- G-L-16
- G-L-18
- G-L-20
- G-L-21

El Morro Salitre, Guayas Province:
- G-Mo-16

Artifacts

As is typical of cultures of the Regional Developmental Period on the Ecuadorian coast (cf. Estrada, 1962, p. 52), the Jambelí culture is characterized by a variety of small ornaments, figurines, and objects of uncertain utility. The most frequently used material is shell, except for figurines, the majority of which are of pottery. Stone was rarely employed, possibly in part because of the absence of suitable raw materials in the mangrove swamp area. Bone and wood were probably also utilized, but conditions of preservation have prohibited their survival.

Shell Artifacts

Shell artifacts are of two kinds: small complete shells carved or perforated for suspension, and objects fashioned from *Spondylus* shell. The latter are the more abundant and variable. All are well made, with good symmetry. Surfaces vary from highly polished to slightly blemished.

Perforated complete shells.—All three examples of this type come from the surface of O-6: Las Huacas. Two are cone shells perforated on one side near the pointed end by sawing a horizontal notch

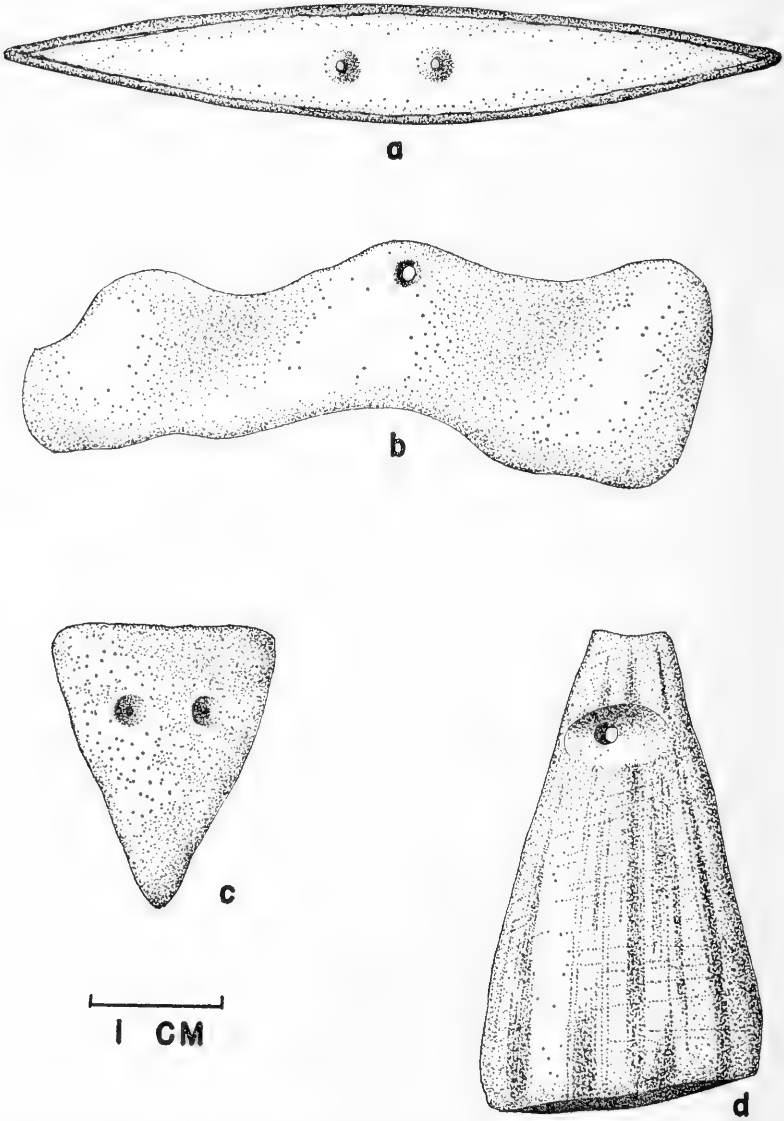


Figure 5.—Shell ornaments: *a–c*, pendants of worked shell from O-6, surface; *d*, small complete shell perforated for suspension from O-6, surface.

until the center of the notch cuts through to the interior (fig. 5, *d*). Length is 3.3 cm.; diameter at lower edge is 2.0 and 2.2 cm. The other shell is a small *Oliva peruviana* Lamarck perforated near one end by the same technique. Length is 2.2 cm.

Carved conch shell.—A small conch shell (fig. 6, *a*), 9 cm. long,

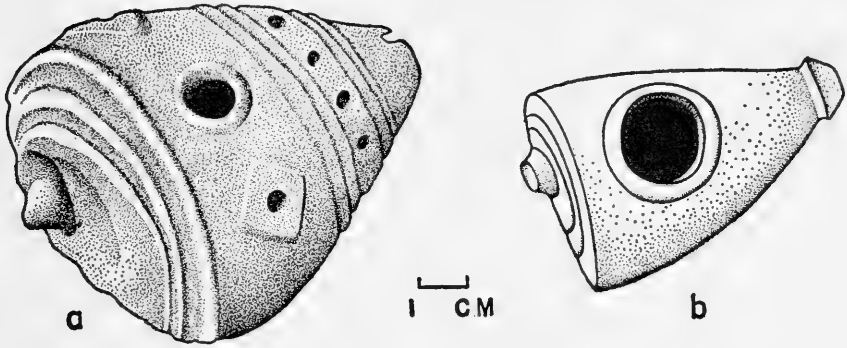


Figure 6.—Small carved and perforated conch shells: *a*, Jambelí Phase example from O-6, surface; *b*, Guangala Phase example from La Libertad (after Bushnell, 1951, fig. 24, 1).

has been decorated with perforations and diamonds by cutting out portions of the surface to a depth of 2–3 mm. It comes from the surface of Site O-6. In size and construction it is very similar to an object described by Bushnell (1951, p. 62) as a shell box from the Guangala culture (fig. 6, *b*).

Beads.—Sixteen, flat, circular beads (fig. 7, *a–d*) carved from *Spondylus* shell come from the surface collection at O-6: Las Huacas. They are typically two-tone in color, partly red or orange and the remainder white. Three are pure white. Surfaces are usually polished but sometimes remain slightly pitted. The central perforation is slightly conical, the maximum diameter being less than 1 mm. greater than the minimum diameter. Diameter ranges from 1.4–2.3 cm.; thickness from 0.5–1.0 cm., with a single example of a thickness of 1.0–1.5 mm. Diameter of perforations range from 4–5 mm. Thickness is not correlated with diameter, so that some of the thickest beads have some of the smaller diameters.

Bead blank.—One *Spondylus* disk (fig. 7, *e*) 2.5 cm. in diameter and 1.5 cm. thick, from Site O-6, probably represents a blank for the manufacture of a bead.

Atlatl hook.—A small object from the surface collection at Site O-6 of red *Spondylus* shell, carved in the form of a bird head, probably represents an atlatl hook (fig. 8, *b*). It is 5 mm. thick at the flat base and tapers slightly toward the top. The edges are rounded. There is a perforation 5 mm. in diameter through the center. The surfaces are not perfectly even and blemishes in the shell remain.

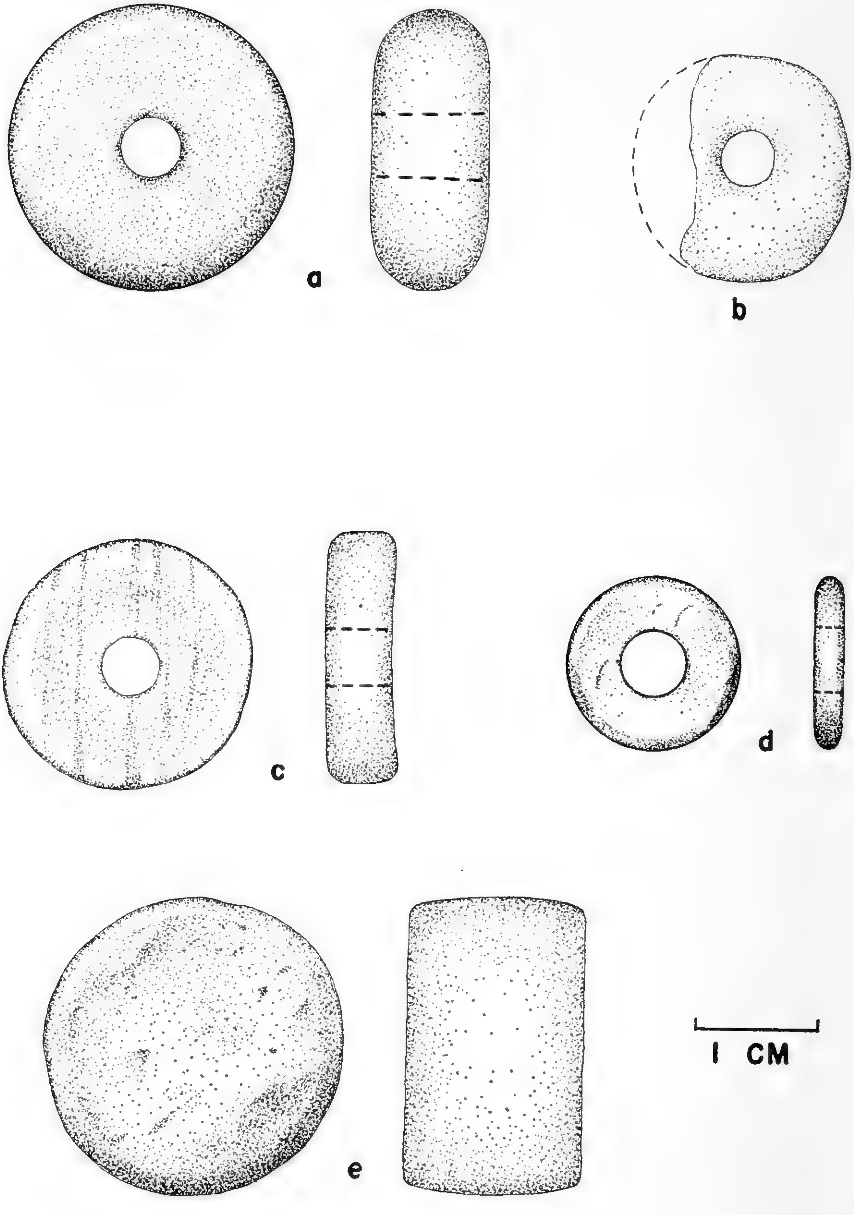


FIGURE 7.—Shell beads and blank from O-6, surface: *a–d*, finished beads of *Spondylus* shell; *e*, unperforated blank.

ANTHROPOMORPHIC AMULETS.—Two small highly stylized anthropomorphic objects from O-6: Las Huacas may be pendants or amulets (fig. 9). They are of similar size but differ in form. One (fig.

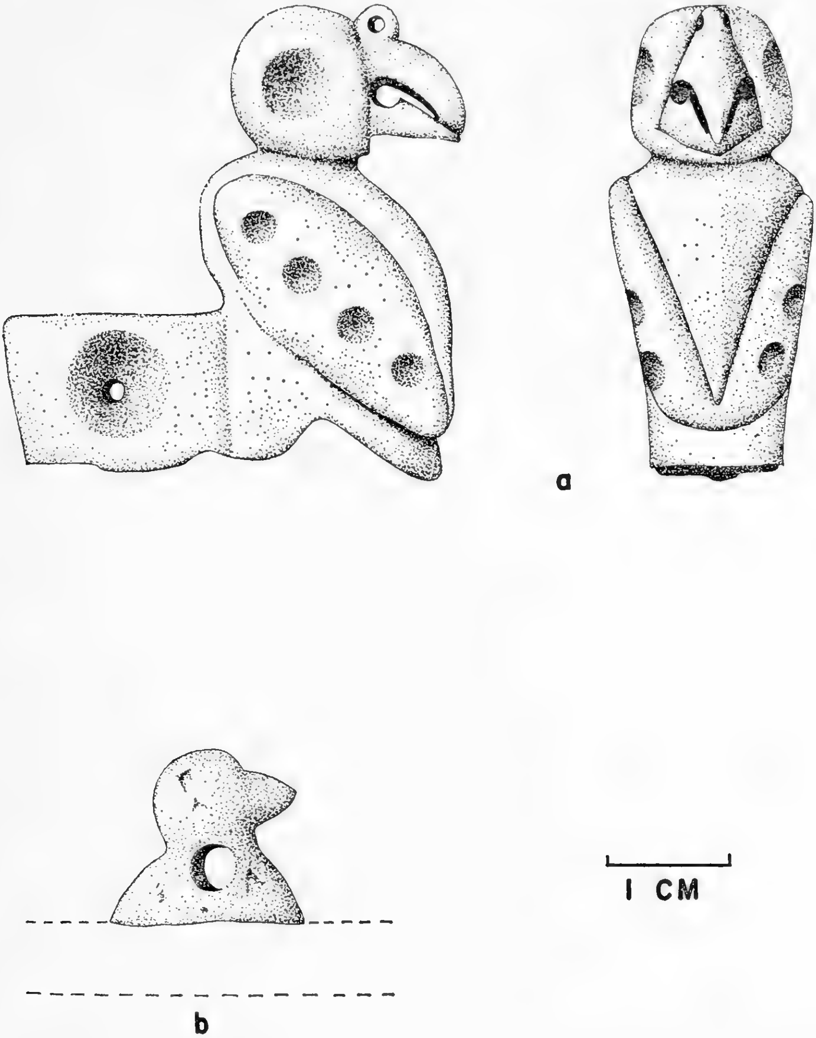


FIGURE 8.—Carved shell objects from O-6, surface, in the form of birds: *a*, carving of unknown use; *b*, possible atlatl hook.

9, *b*) is of orange-red *Spondylus* shell, less pitted on the back than on the front side. Width tapers from 2.2 cm. at the head to 1.3 cm. at the feet. Thickness is 2–3 mm. Two slight depressions represent eyes; the head is set off from the body by nicks at the sides, and a nick at the base separates the legs. Two horizontal incisions on the lower front suggest crossed arms. A perforation runs through the center of the head. Total height is 3.5 cm.

The other object, of a white shell, is generally similar in execution but thicker and lacks the perforation for suspension (fig. 9, *a*). The

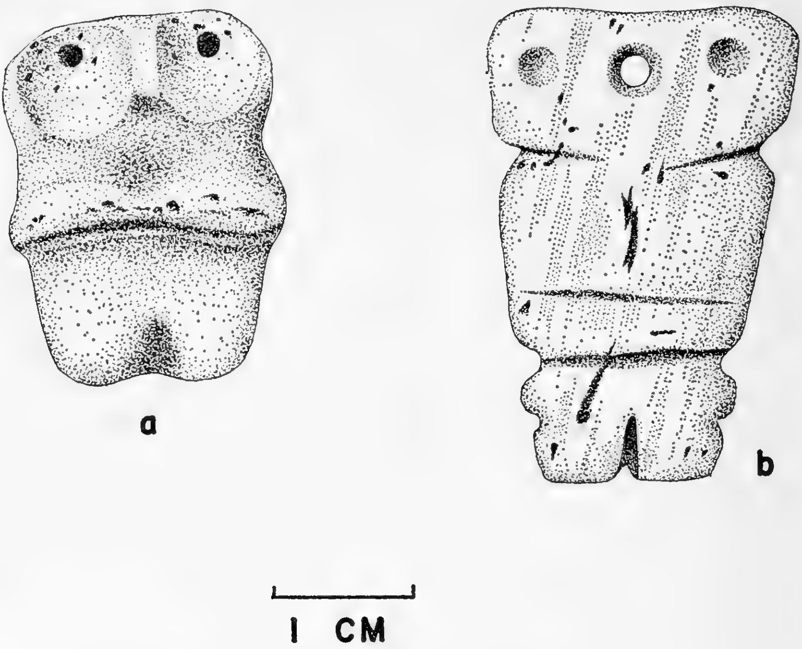


Figure 9.—Anthropomorphic shell amulets or pendants from O-6.

surfaces are smooth and unblemished except for the top of the head, which has tiny pits. Height is 2.7 cm., width 2.0 cm., and thickness 1.8 cm. A groove rather than a notch separates the legs, and a ridge substitutes for incisions to suggest folded arms. Rounded pits form the eyes and the nose is a ridge down the center of the face.

Plain pendants.—Three small objects of worked shell from O-6: Las Huacas have one or two perforations suggesting they may have been used as pendants (fig. 5, *a–c*). Two have well smoothed surfaces; the third is somewhat rough and may be unfinished. The latter is triangular, 2.2 cm. from base to apex. Two holes are partially drilled (fig. 5, *c*). Another is 5.7 cm. long and 0.8 cm. wide at the center, tapering to a point at both ends. Thickness is 3 mm. The edges are slightly beveled. Two perforations are biconically drilled at the center (fig. 5, *a*). The third example is irregular in form, measuring 5.1 cm. long with undulating edges. There is a perforation at one edge near the center (fig. 5, *b*).

Bird ornament.—A beautifully carved bird (fig. 8, *a*) of creamy white, slightly striped *Spondylus* shell comes from O-6: Las Huacas. The surface is even and polished. The bird, probably a parrot, has the head turned toward the tail. A large conical depression, 2 mm. deep and occupying the center of the head, forms the eye. A row of four smaller depressions 1 mm. deep runs down the center of each wing. A rectangular projection at the front of the base is biconically drilled, apparently for attachment. The size and shape suggest that it may have formed part of an atlatl. Total height of the bird is 4.0 cm.; width 1.1 cm.; length from tail to front of projection, 4.0 cm.

Stone Artifacts

Only a few stone objects come from sites of the Jambelí culture. They fall into two categories: utensils and ornaments.

UTENSILS

Metates.—Two metate fragments, one of sandstone and the other of coarse-grained conglomerate, come from the surface of O-5: Embarcadero. Both have a slightly concave upper surface, worn smooth and even. The larger fragment is thickest (3.5 cm.) at the center and tapers toward the edge; the other has its maximum thickness at the edge. The original sizes cannot be reconstructed.

Manos (fig. 10).—One complete mano came from O-5: Embarcadero surface and a fragment from O-5, Cut 1, Level 60–80 cm. The complete example, of gray-green gabbro, is 13.0 cm. long and 7.5 cm. in maximum width. Both ends are worn convex, and wear is also visible on all but one side. The fragment is part of a rough, rounded cobble of gneiss, 7.0 cm. wide and 5.5 cm. thick, showing wear on one side only.

Hammerstones (figs. 11 and 12, *b*).—Three cobbles of fine grained quartzite, all from the surface of O-6: Las Huacas, are battered on one or more edges from hammering. Form is generally ovoid, length from 7.5–9.2 cm. One has red paint covering one half of the surface (fig. 12, *b*).

Knife or saw (pl. 6, *d*).—A small fragment of fine grained sandstone from G-86, Cut 1, Level 120–140 cm. has a beveled edge that could have been used for sawing or cutting.

Bark beaters (pl. 6, *b–c*).—Two flat stone slabs, grooved on one surface, have been identified as bark cloth beaters. The nearly complete example (pl. 6, *c*) comes from G-L-30: Cangrejito. It is 6.5 cm. long, 4.5 cm. wide and 1.1 cm. thick. The form is rectanguloid with rounded corners. The upper surface is flat and bears two lengthwise grooves 2.5 mm. deep dividing the area approximately into thirds. One groove is 3.5 mm. wide, the other 4.5 mm. wide. The reverse surface is slightly irregular. The edges are flat. The fragment, from G-86, Cut 1, Level 60–80 cm., has four grooves 2.0–2.5 mm. wide and 5–7 mm. apart on the flat upper face. Thickness is 7.5 mm.

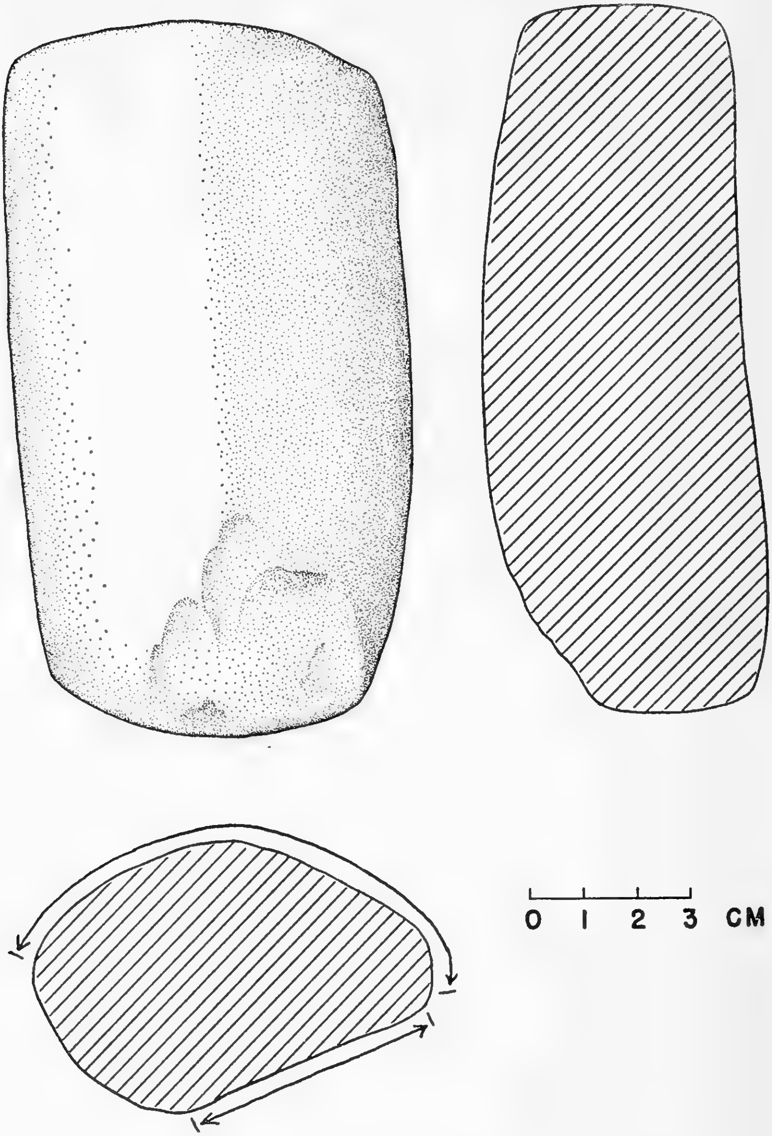
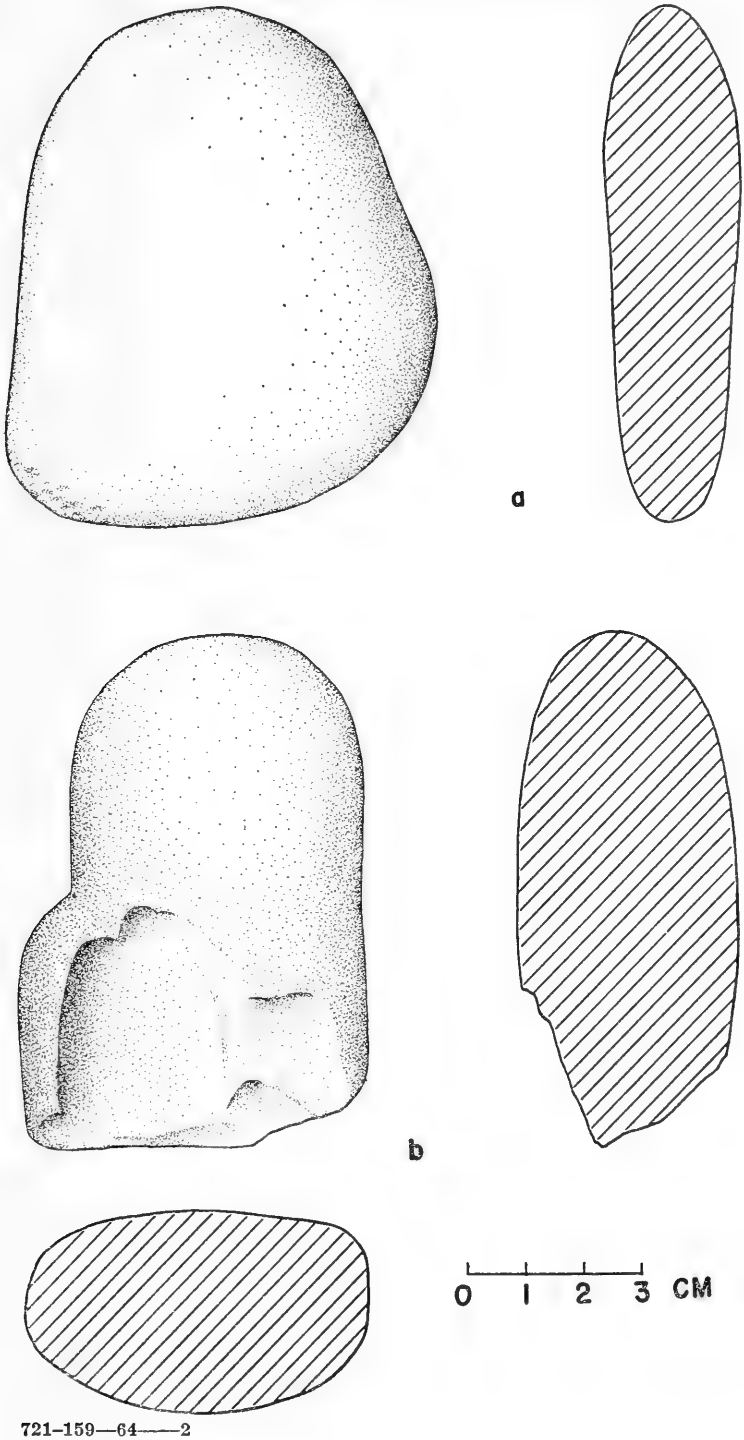


FIGURE 10.—Stone mano from O-5, surface.

FIGURE 11.—Hammerstones from O-6, surface.



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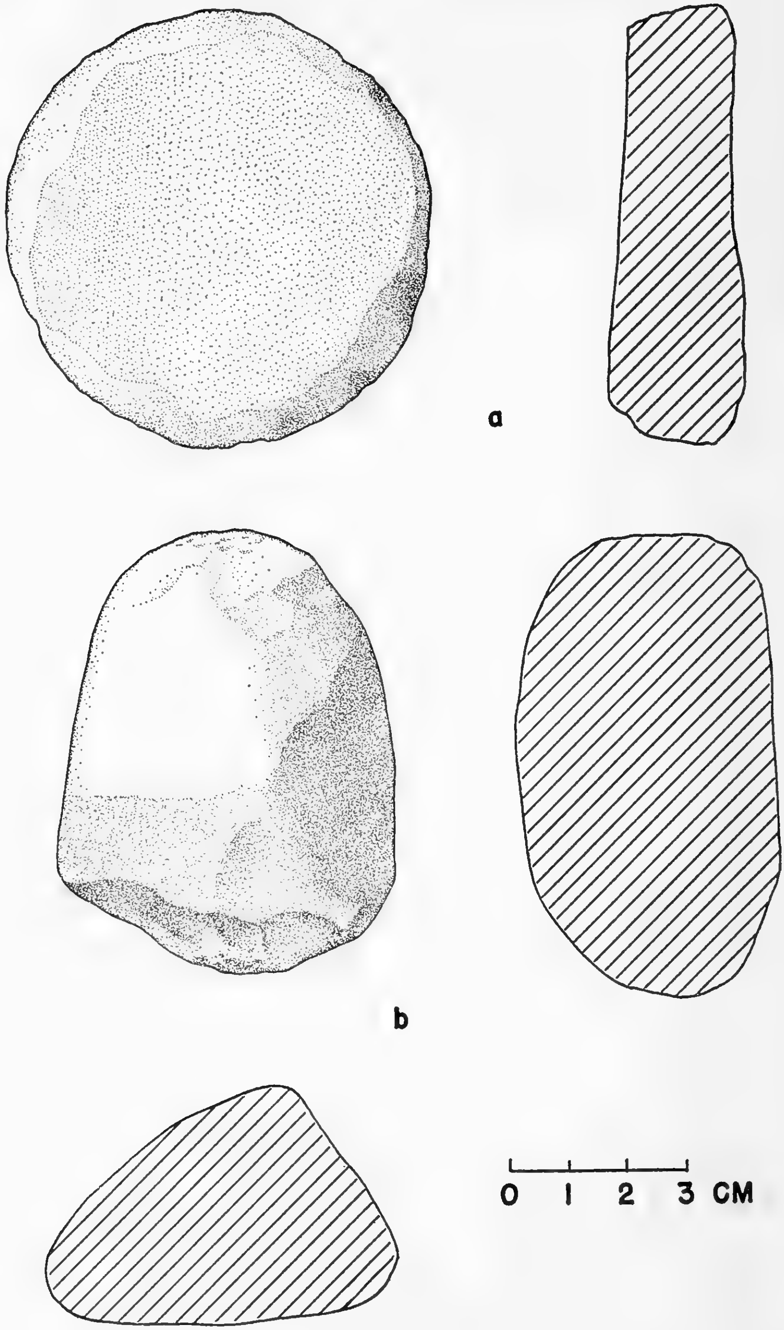


FIGURE 12.—Stone objects of the Jambelí Phase: *a*, crudely shaped disk from O-5, Cut 1, Level 80–100; *b*, hammerstone partly coated with red pigment from O-6, surface.

Worked stone.—A fragment of serpentine, 6.5×5.5 cm. and 2.0 cm. thick, shows grooves and circular marks produced by cord sawing. A small ovoid projection left from the sawing remains at the center. The object is from G-86, Cut 1, Level 0–20 cm.

Discoidal shaped stone (fig. 12, *a*).—A piece of fine conglomerate has been shaped into a disk 7 cm. in diameter and 1.8–2.5 cm. thick. The edges are rounded, and one surface is even while the other is slightly irregular. The object is from O-5, Cut 1, Level 80–100 cm.

ORNAMENTS

Beads (fig. 13).—Basalt, shale, serpentine and chlorite schist were used for the manufacture of beads. One example of asymmetrical

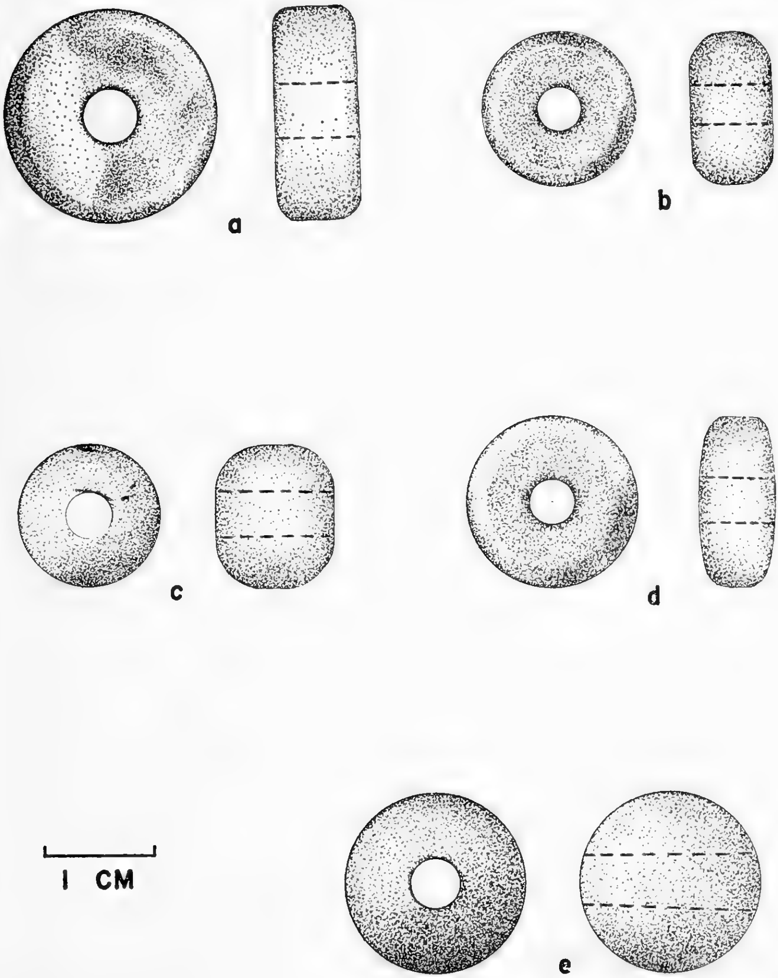


Figure 13.—Stone beads showing variation in diameter and thickness; all from O-6, surface.

form, with one side flat and the other irregularly faceted, came from G-Mo-3. Diameter is 1.5 cm. The remainder are from O-6: Las Huacas. One is perfectly round; the rest are flat disks like the beads made of shell, with flat faces and rounded or slightly flattened edges, and biconically perforated through the center. Diameter ranges from 1.4–2.0 cm., thickness from 2–11 mm.

Spindle whorl (?).—One beadlike object of soft, dark blue-gray stone with a well polished surface has the turreted form frequently associated with spindle whorls. It is 1.4 cm. in diameter, 8 mm. thick, and has a perforation 5 mm. in diameter through the center. It is from O-6: Las Huacas.

Pottery Artifacts

Figurines.—A highly stylized hollow anthropomorphic figurine is characteristic of the Jambelí culture. The head is rectanguloid, long from side to side, and narrow from chin to top. The top is flat, or slightly to deeply depressed in the center above the nose creating two marked lobes. There is a perforation at the center top. In profile, the top of the head is rounded or tapered. The body is semicylindrical, typically expanded to a maximum diameter below the arms and tapering toward the neck and feet. The legs are typically not separated; the feet are formed by eversion of the lower end of the body outward at the front and back (figs. 14, *a*, and 16, *a*). Incised lines indicate a minimal number of toes, usually three per foot. Arms are small, solid projections at the shoulder (fig. 15, *a*, *c*), attached when the surface was sufficiently dry to form a poor bond. The arms are frequently missing, leaving a clean break. Fingers may be represented by short incised lines on the front side. Occasionally, hands are more realistically formed by a reduction in the diameter of the arm.

Facial features vary within narrow limits. Eyes are typically a perforation surrounded by four incised lines in a diamond arrangement (figs. 14 and 15, *b*). One has a larger ring instead of a diamond (fig. 15, *a*). Another has two short gashes (fig. 15, *c*). The nose is a prominent, rounded nubbin, projecting 1.0–1.5 cm. above the surface of the face. Ear treatment is highly variable, and ears may be indicated either by incision (fig. 14, *c*) or by an expansion at the side of the head (fig. 14, *a*). One or more horizontal incisions define the forehead, and vertical incisions above suggest hair. The mouth is a narrow, horizontal, straight, or slightly curved gash 1.0–2.3 cm. long.

The front of the body is well smoothed or striated polished and may bear either painted or incised decoration or both. Two parallel incisions usually occur on the neck, and this "necklace" may be elaborated with rows of perforations (fig. 14, *a*, and 15, *c*). Two bodies have more

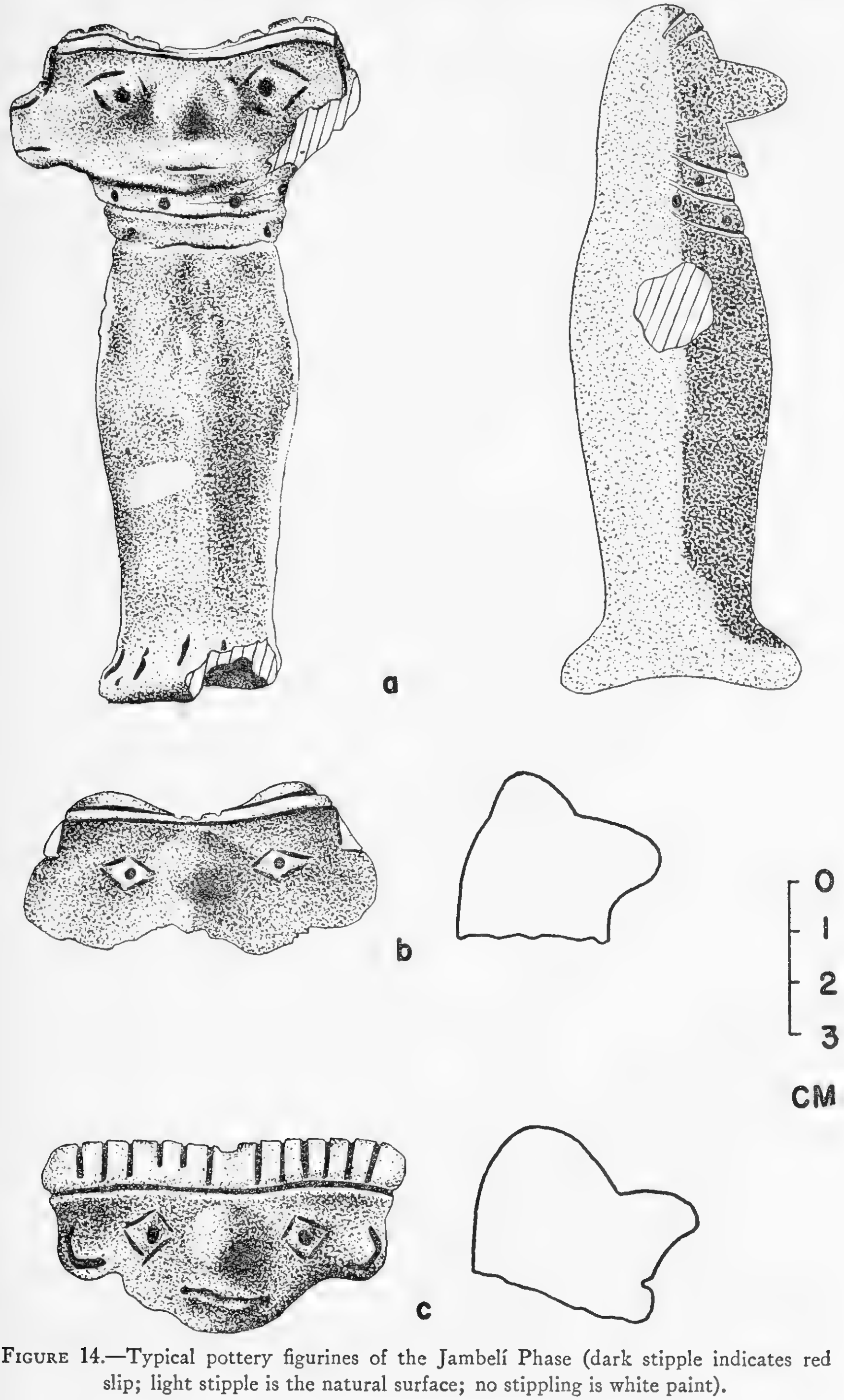


FIGURE 14.—Typical pottery figurines of the Jambelí Phase (dark stipple indicates red slip; light stipple is the natural surface; no stippling is white paint).

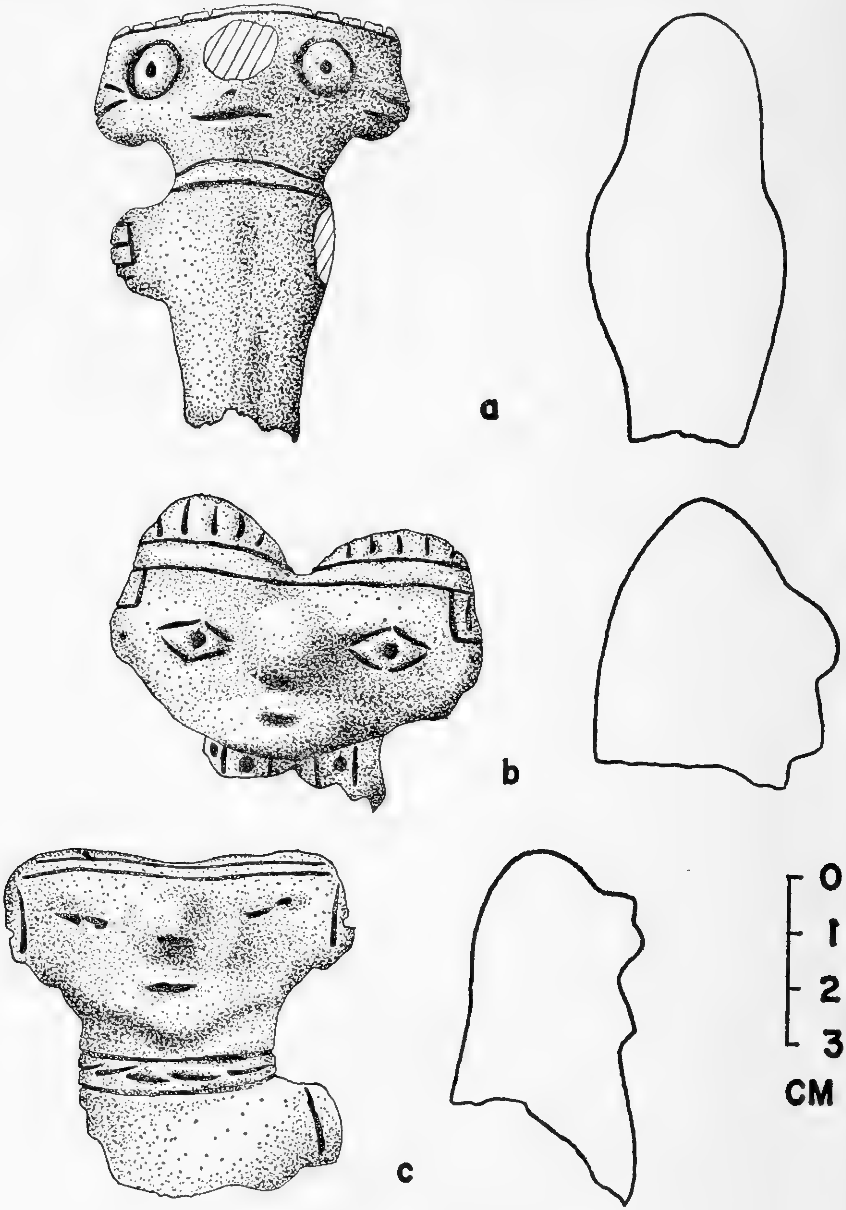


FIGURE 15.—Typical pottery figurines of the Jambelí Phase.

extensive incised and punctate decoration (fig. 16, *b*), while three others show traces of white-on-red painting. One arm has negative painting (fig. 30, *a*). Zones of the face are also typically white or red. The back is unpolished and undecorated.

Only two of the figurines are complete. One of these is 15.5 cm. tall, the other 6.2 cm. Judging from the proportions of the fragmentary examples, these probably represent the size range. Complete heads range from 3.0–8.5 cm. in width, with the majority from 6.2–8.5 cm. Arms project 1.0–2.3 cm. outward from the body wall.

Imported figurines.—One atypical figurine body fragment comes from Site O-3 (fig. 17, *a*). It is solid, with flat surfaces, and is 1.3–1.6 cm. thick. One arm curves from the shoulder to join the body at the hip. The front has incised and red painted decoration. Two other fragments from the same site appear to represent the same style. In

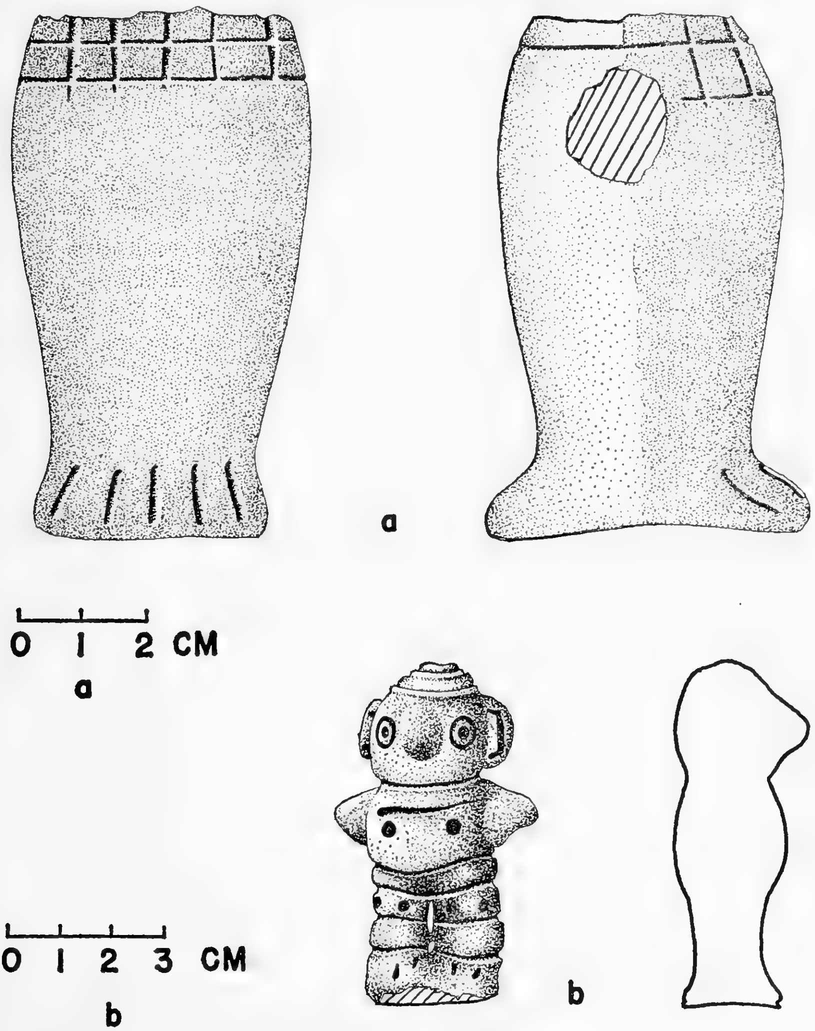


Figure 16.—Typical pottery figurines of the Jambelí Phase (dark stipple indicates red slip)

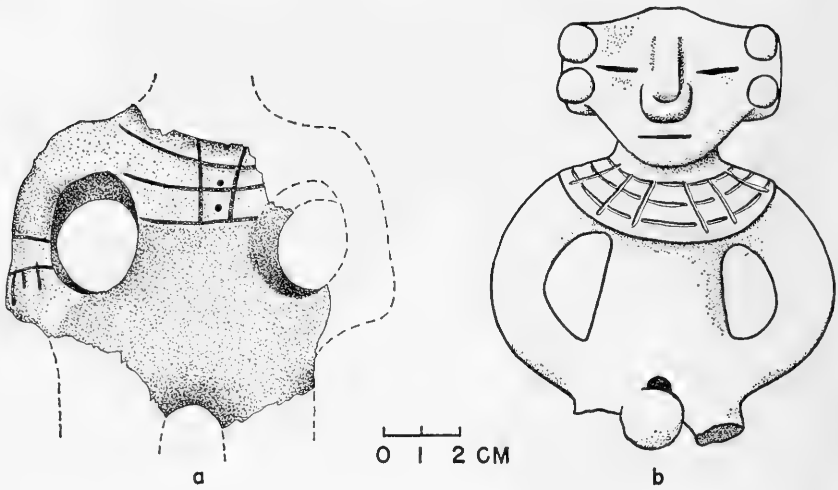


FIGURE 17.—Figurines suggesting contact between the Jambelí and Guangala Phases: *a*, solid pottery figurine body from O-3, surface (stippling indicates red paint); *b*, pottery figurine from the Guangala Phase showing similar form and collar treatment (after Bushnell, 1951, fig. 19, *j*).

general style, these figurines resemble a common Guangala type (fig. 17, *b*), although differences in detail suggest a copy rather than derivation by trade.

A small pottery figurine head from the surface of Site O-6 exhibits unusual treatment of the facial features and headdress (fig. 18). The eyes are low rounded applique with two short horizontal gashes not joined at the center. The nose, broken off, has two round holes at the base representing nostrils. The mouth is formed by two shallow grooves meeting at the center. The headdress gives the impression of a helmet, with flaps projecting down over the ears. An ornament has been broken off at the top. This is the only figurine head shown with earplugs. The style of headdress is similar to that of La Plata Sentado figurines of the Bahía culture (Estrada 1962, fig. 128, *a–b*).

BEADS.—Two pottery beads, one from G-84, Cut 1, Level 20–30 cm. and the other from the surface of O-6, are of the same form and size as the more common disk-shaped beads of shell. Both have flat, parallel surfaces, one with a slightly tapered and the other with a rounded edge. Diameters are 1.9 and 1.3 cm.; thickness 6 mm.; diameter of perforation, 4.5 mm. Surfaces are even but not polished. Form is symmetrical.

WORKED SHERDS.—Three sherds (two Jambelí Plain and one Ayalan Plain) from O-3: Chivería have grooves worn on the exterior surface from rubbing with a shaft.

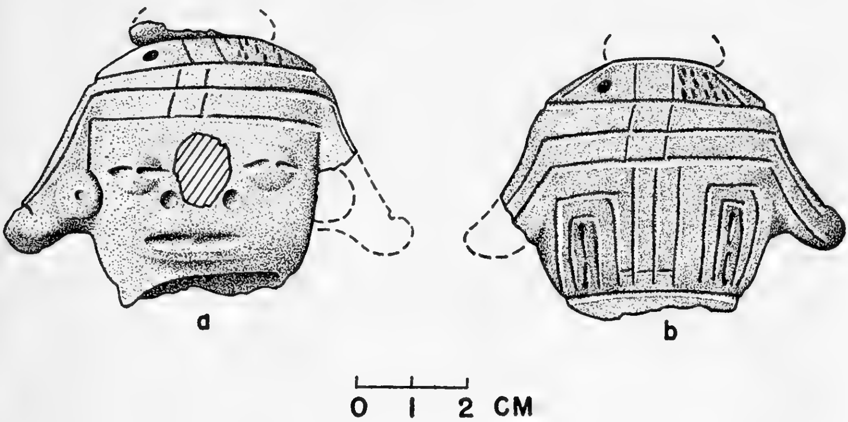


FIGURE 18.—Atypical figurine head from O-6, surface, with features suggestive of Bahía Phase influence.

Three plain sherds from O-3: Chivería have been shaped into crude disks with a diameter of 5–7 cm. and are biconically perforated through the center.

Pottery Types

The description of the pottery of the Jambelí culture is based on the analysis of 15,414 sherds from surface collections and stratigraphic excavations (see Appendix, Table 1). Some of the sites produced sherds with such badly eroded surfaces that it was possible only to identify the ware as of the Jambelí type. Material of this kind, however, was not used in compiling the pottery type descriptions. Very few complete vessels have been recovered, and the majority of the vessel shapes have been reconstructed from rim profiles and diagnostic body and base sherds. The drawings of reconstructed vessel shapes are generalizations that do not show the alternative base forms mentioned in the vessel shape descriptions. Terminology for vessel shape description follows the definitions used for the Valdivia culture (Evans, Meggers, and Estrada, 1959, pp. 26–68). Pottery type descriptions are arranged in alphabetical order, with the Spanish equivalent in parentheses for ease in cross-reference with previous publications in Spanish.

VESSEL FORM

1. ROUNDED, SHALLOW TO DEEP BOWL (fig. 19, *1*):
   Rim: Outsloping to nearly vertical and direct. Rim diameter varies from 8–28 cm.
   Lip: Rounded or slightly tapered.
   Base: Rounded or slightly flattened.


0 1 2 3 CM
RIM SCALE
1
2
3
4

FIGURE 19.—Rim profiles and reconstructed vessel shapes 1–7 of the Jambelí Phase.

2. Carinated Bowl (fig. 19, *2*):
   Rim: Outsloping walls turn upward 2.0–3.5 cm. below the lip producing a slightly angular profile. Body wall thickness is frequently slightly greater above than below the angle. Rim diameter varies from 14–34 cm.
   Lip: Rounded.
   Base: Flattened or slightly rounded, or annular.
3. Shallow Bowl With Flat Rim (fig. 19, *3*):
   Rim: Wall thickness expanded to produce a flat horizontal or slightly insloping top 0.6–2.0 cm. wide. Exterior rim diameter varies from 16–30 cm.
   Lip: Rounded or tapered.
   Base: Probably flattened or annular.
4. Shallow Bowl With Beveled or Upturned Rim (fig. 19, *4*):
   Rim: The appearance of an angular rim is produced either by beveling of the rim or by a carination 1.0–2.5 cm. below the lip. There is considerable variation in the form of the rim profile, all resulting in the same general shape effect. Rim diameter varies from 18–42 cm.
   Lip: Rounded or tapered.
   Base: Tall annular pedestal bases probably belong to this form, diameter 14–18 cm.
5. Bowl With Everted Rim (fig. 19, *5*):
   Rim: Everted with a flattened outsloping top. Body wall is thickened at the angle of eversion. Exterior rim diameter varies from 22–36 cm.
   Lip: Rounded or tapered.
   Base: Rounded; possibly occasionally annular or pedestal.
6. Shallow Bowl With Interior Rim Thickening (fig. 19, *6*):
   Rim: The interior wall thickness increases by 3–5 mm. from 3.0–5.5 cm. below the lip, producing a well defined raised band. Rim diameter varies from 16–24 cm.
   Lip: Rounded.
   Base: Probably rounded or slightly flattened.
7. Deep Bowl With Expanded Rim (fig. 19, *7*):
   Rim: Expanding 1–3 cm. below the lip to a thickness 0.5–1.0 cm. greater than the body wall. Since these bowls are typically large, this helps to strengthen the rim. Rim diameter 30–36 cm.
   Lip: Rounded or slightly flattened.
   Base: Probably rounded or slightly flattened.
8. Shallow Bowl With Exterior Flange Rim (fig. 20, *8*):
   Rim: Thickened on exterior wall 1–2 cm. below lip to produce a more or less prominent downsloping flange. Rim interior sometimes has a raised band as in Vessel Shape 6; a flat horizontal or insloping top is more typical. Exterior rim diameter varies from 18–34 cm.
   Lip: Rounded.
   Base: Several large sherds show attachment for hollow polypod legs and it is possible that this is the characteristic base form.
9. Jar With Constricted Neck and Everted Rim (fig. 20, *9*):
   Rim: Strongly everted, most frequently with a strongly angular interior profile slightly rounded on the exterior by thickening of the wall. There is a continuous variation from a short eversion to an outsweeping neck, correlated to some extent with vessel size. Shoulder may be rounded or slightly angular. Rim diameter varies from 10–24 cm.

Lip: Rounded or slightly flattened.
Base: Probably rounded or slightly flattened.

10. ROUNDED JAR WITH CONSTRICTED MOUTH (fig. 20, *10*):
Rim: Incurving and direct or slightly expanded. Mouth diameter 8–20 cm.
Lip: Rounded.
Base: Probably rounded or slightly flattened.

11. JAR WITH EXTERIORLY THICKENED RIM (fig. 20, *11*):
Rim: Incurving from rounded or slightly angular shoulder and thickened on the exterior to 1–4 times the thickness of the body wall. Thickened area is 1.3–4.5 cm. wide, the smaller rims belonging to smaller sized jars. Rim interior is typically concave, exterior convex. Mouth diameter ranges from 20–46 cm.
Lip: Rounded.
Base: Probably rounded or slightly flattened.

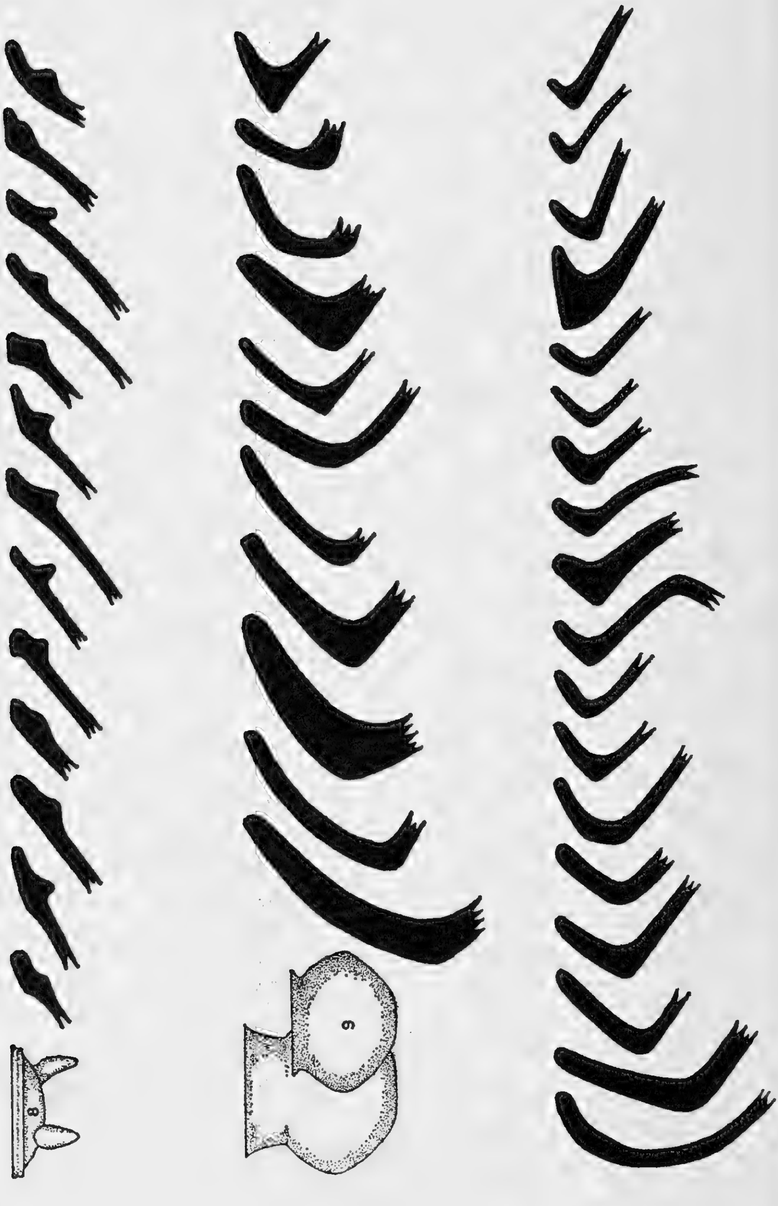
12. LARGE COMPOTERA WITH APRON FLANGE (fig. 21, *12*):
Rim: Slightly everted and thickened, with a broad flange added 1–3 cm. from the lip on the exterior. More rarely, the flange is not inset, but drops from the edge of the rim. The flange is 3.5–5.0 cm. wide and may be insloping, vertical or outsloping. Rim diameter ranges from 24–44 cm.
Lip: Rounded or tapered.
Base: A tall annular pedestal with diameter 20–30 cm.

13. LARGE COMPOTERA (fig. 21, *13*):
Rim: Slightly expanded or slightly everted with flattened top. Occasionally with a low ridge on the exterior 4–5 cm. below lip. Exterior rim diameter, 28–50 cm.
Lip: Rounded.
Base: Tall annular pedestal with diameter 20–30 cm.

BASE FORM

Sherds of several base forms, in addition to the common slightly flattened type, are represented in the pottery samples (fig. 22). Unfortunately, all of the complete vessels recovered have rounded or slightly flattened bases, so that reconstruction of the vessel forms to which the annular, pedestal, and polypod bases belong must be inferred from other kinds of evidence. One vessel shape and rim is clearly associated with a polypod base and this is shown on the diagram of rim and reconstructed vessel shapes (fig. 20, *8*); the other associations are too uncertain to appear on the diagram.

1. ROUNDED OR SLIGHTLY FLATTENED: All the complete bowls are slightly flattened on the bottom so that the vessel will rest without tipping. The base is not sharply defined, but blends into the curved body wall. This form of base is probably the most common, and is probably associated with most, if not all, of the rim forms.
2. ANNULAR (fig. 22, *a*): A low annular ring, with a base diameter of 8–20 cm., and a height of 1.5–4.5 cm., is represented in the following pottery types: Jambelí Plain, Ayalan Plain, Jambelí White-on-Red, Jambelí Polished Red, Jambelí Red Banded, and Jambelí Negative.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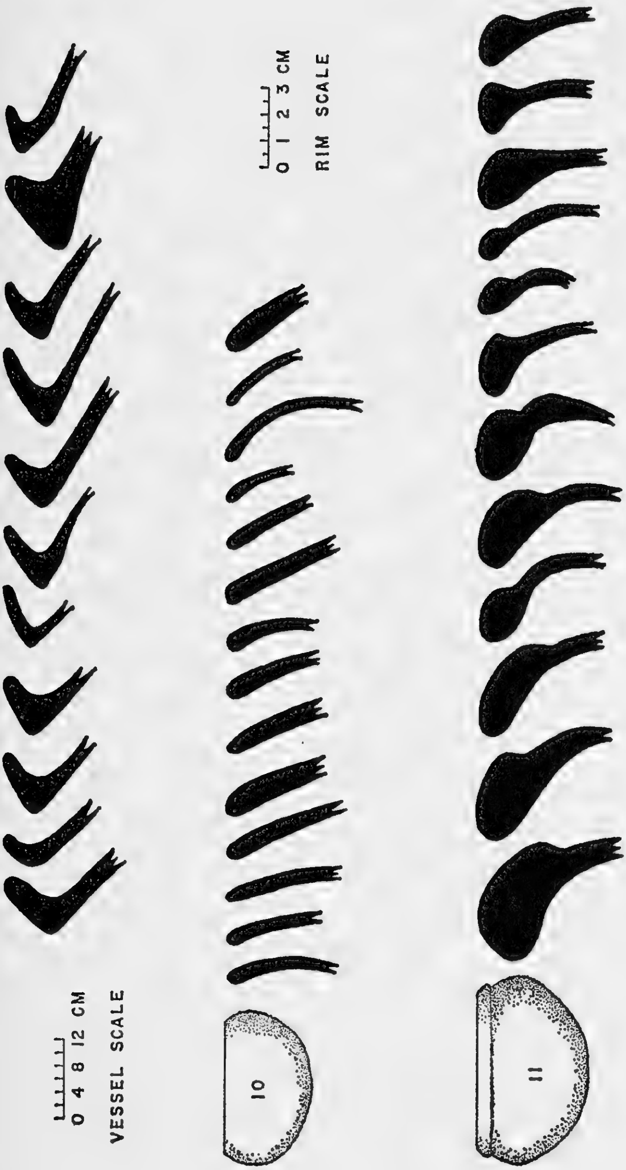

FIGURE 20.—Rim profiles and reconstructed vessel shapes 8–11 of the Jambelí Phase.

FIGURE 21.—Rim profiles and reconstructed vessel shapes 12–13 of the Jambelí Phase.

FIGURE 22.—Forms of bases associated with Jambelí Phase vessel shapes: *a*, annular; *b*, annular pedestal; *c*, hollow polypod; *d*, solid polypod.

3. ANNULAR PEDESTAL (fig. 22, *b*): A tall annular pedestal, measuring 6.0–8.5 cm. in existing height and 14–30 cm. in base diameter, is associated with the following pottery types: Jambelí Red Wash, Jambelí White Wash, Jambelí Incised. None of the Ecuadorian sherds had any of the body wall attached but complete vessels with this form of base are represented in the collection from Garbanzal, Peru (Mejía Xesspe, 1960, lam. 1, *a–c*).
4. HOLLOW POLYPOD (fig. 22, *c*): Hollow legs, circular in cross section, with maximum diameter near attachment to the body wall, tapering to a rounded tip, are associated with the following pottery types: Jambelí Plain, Ayalan Plain, Jambelí White-on-Red, Jambelí Red Banded. Maximum diameter is 2–5 cm. Only one is complete enough to reconstruct the length, which is about 9 cm. The area of attachment is visible on several rim sherds of Form 8, but these are too small to indicate whether the legs were used in sets of three or more.
5. SOLID POLYPOD (fig. 22, *d*): A single example of a solid leg, similar in form to the hollow ones but less bulbous, is classified as Jambelí Plain. Maximum diameter is 3 cm.; length 7.5 cm.

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Pottery Type Descriptions

Ayalan Plain (Ayalan Ordinario)

SIZE OF SAMPLE: 4924 sherds.

PASTE:

Temper: Fine sand containing mica, which glitters in pinpoint specks on the surface. Sand grains less than 1 mm.; abundant and well distributed. Eroded surfaces not abrasive to touch.

Texture: Fine grained, compact, slightly laminated appearance; occasional air pockets.

Color: Cross section varies from completely bright orange to completely dark gray, the majority of the sherds being orange.

Method of manufacture: Coiling.

SURFACE:

Color: Range similar to Jambelí Plain; typically orange to tan. Rarely, surfaces are gray.

Treatment: Smoothed, usually leaving fine brushlike marks parallel to the rim. Bowl interiors generally even but not slick or smooth. Some surfaces slightly striated. The swiping treatment so characteristic of Jambelí Plain is rare.

Hardness: 3.5–4.0

FORM (total rims from seriated samples, 405):

Rim: Exteriorly thickened, everted, interiorly thickened, expanded, or direct, with rounded, flattened or tapered lip.

Body wall thickness: Range 0.4–1.2 cm.; majority 4–6 mm.

Base: 1) Flattened; 2) annular, diameter 6–16 cm.; or, 3) hollow polypod, maximum diameter 5 cm.

Reconstructed common vessel shapes:

Form 9—46 percent
Form 4—13.8 percent
Form 1—13.6 percent
Form 5—5.2 percent.

Minor vessel shapes (frequency less than 5 percent): Forms 8, 10, 3, 2, 11, 7, 12, and 13.

Appendages:

Rim lug (fig. 23, *e*): Lobe extending outward at 30° angle from rim; maximum width 4.2 cm. A single specimen comes from the surface of Site O-6.

Spout: Slightly concave wall, exterior diameter 4 cm. Also from surface of Site O-6 (fig. 23, *a*).

TEMPORAL DIFFERENCES WITHIN THE TYPE: None discernible.

CHRONOLOGICAL POSITION OF THE TYPE: Ayalan Plain is the principal plain pottery type in the early part of the seriated sequence (see fig. 38).

Jambelí Incised (Jambelí Inciso)

SIZE OF SAMPLE: 80 sherds.

PASTE: Like Ayalan Plain; see that type description for details.

SURFACE: Even, but not smooth or slick. Portions of either surface may have red wash or red slip.

FORM (total rims from seriated samples, 9):

Rim: Direct, everted or expanded, with rounded lip.

Body wall thickness: 0.4–1.5 cm.

Base: Tall annular pedestals represent a high proportion of sherds with incised decoration. Base diameter 10–18 cm. Probably associated with Vessel Shape 4.

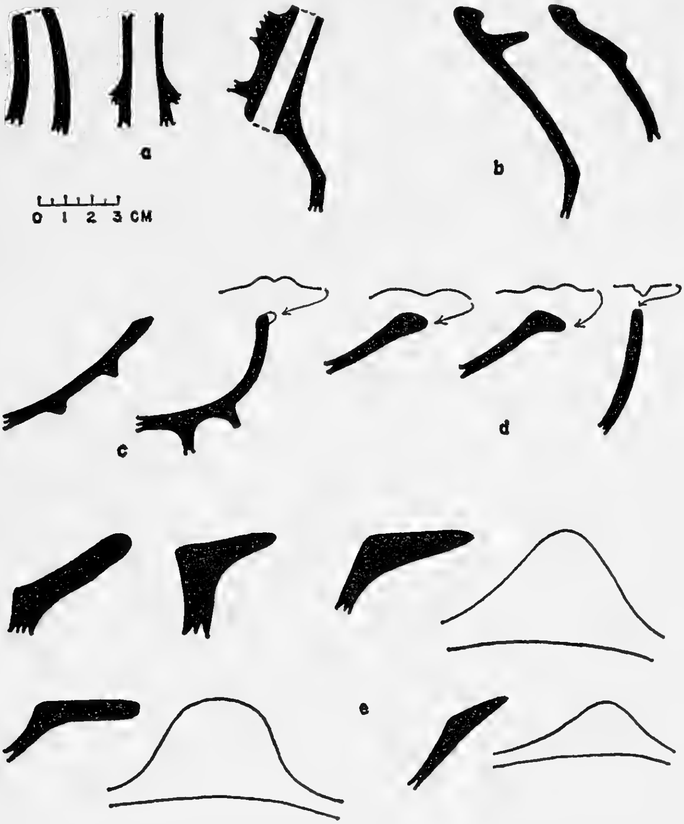

FIGURE 23.—Rim embellishments: *a*, spouts; *b*, neck flanges; *c*, body flanges; *d*, undulating rims; *e*, rim lugs.

Reconstructed common vessel shapes: Forms 12, 4, and 9.

DECORATION (pl. 7; figs. 24–29):

Technique: Incisions alone or combined with nubbins, openwork, or impressed rings. Incised lines straight and sharply defined (fig. 24). Width 0.5–1.5 mm.; depth 0.5–2.0 mm.; generally with little variation on single sherd. Incised lines combined with rings and openwork are more deeply cut than those associated with nubbins. Nubbins are small (diameter 4–6 mm.) circular pellets of slight elevation, and not worked into the adjacent surface (pl. 7). Openwork consists of small circular perforations or small openings triangular or approximately keyhole in shape, typically not exceeding 1.5 cm. in maximum dimension (figs. 25–26). Impressed rings always have a punctate in the center (figs. 27–28).

Motif: Rectilinear patterns composed of straight parallel, intersecting, or stepped lines. Only one of the three forms of embellishments associated with incision—openwork, impressed rings, or applique pellets—is used on any single vessel. Designs are simple. Incision and pellets occur most frequently on Form 9, incision and openwork on annular bases of Form 4, and incision and impressed rings on flanges of Form 12.

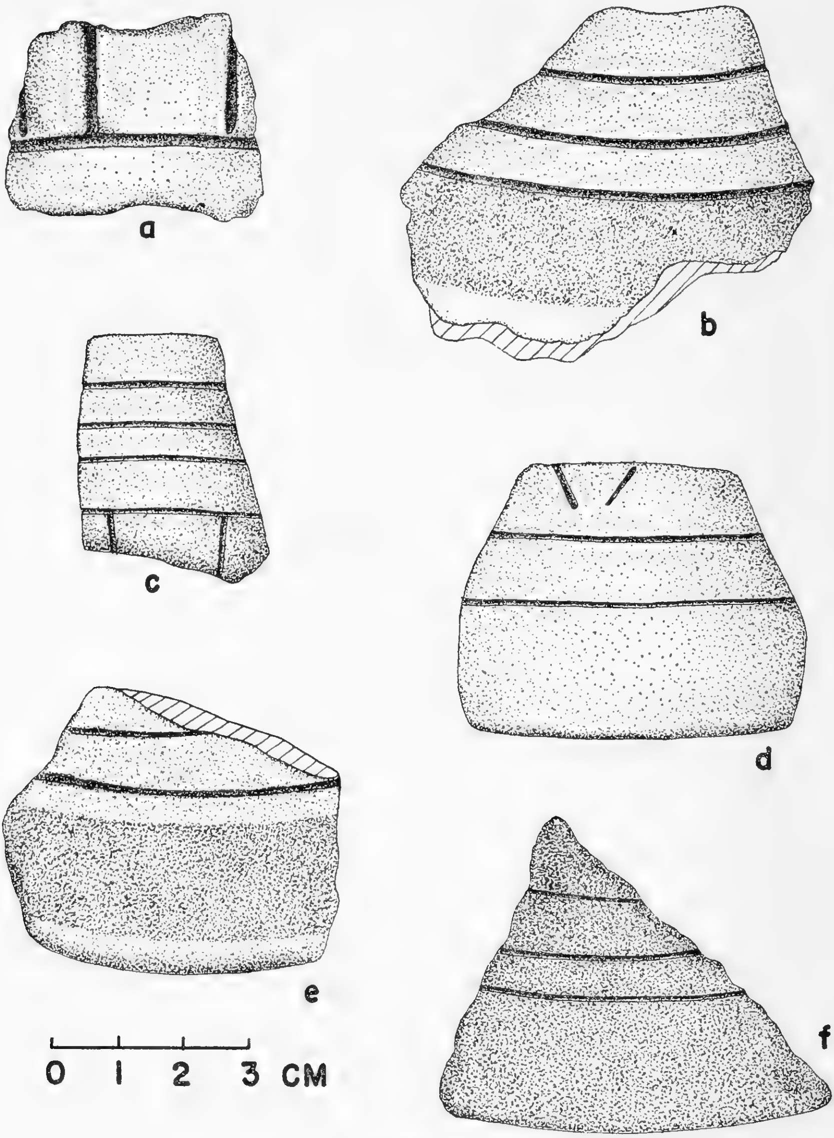

FIGURE 24.—Sherds of Jambelí Incised (dark stippling indicates red slip; light stippling, natural surface; no stippling, white paint).

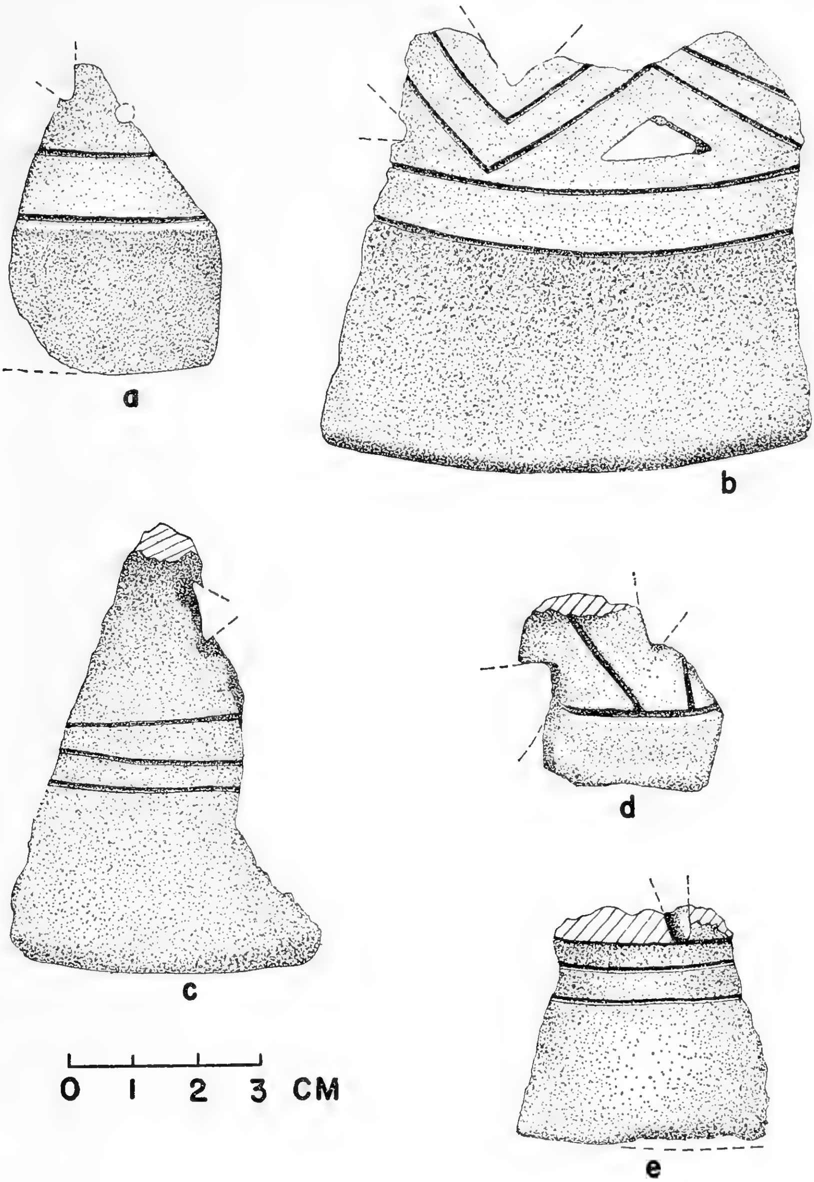

FIGURE 25.—Sherds of Jambelí Incised with openwork (dark stippling indicates red slip; light stippling, natural surface).

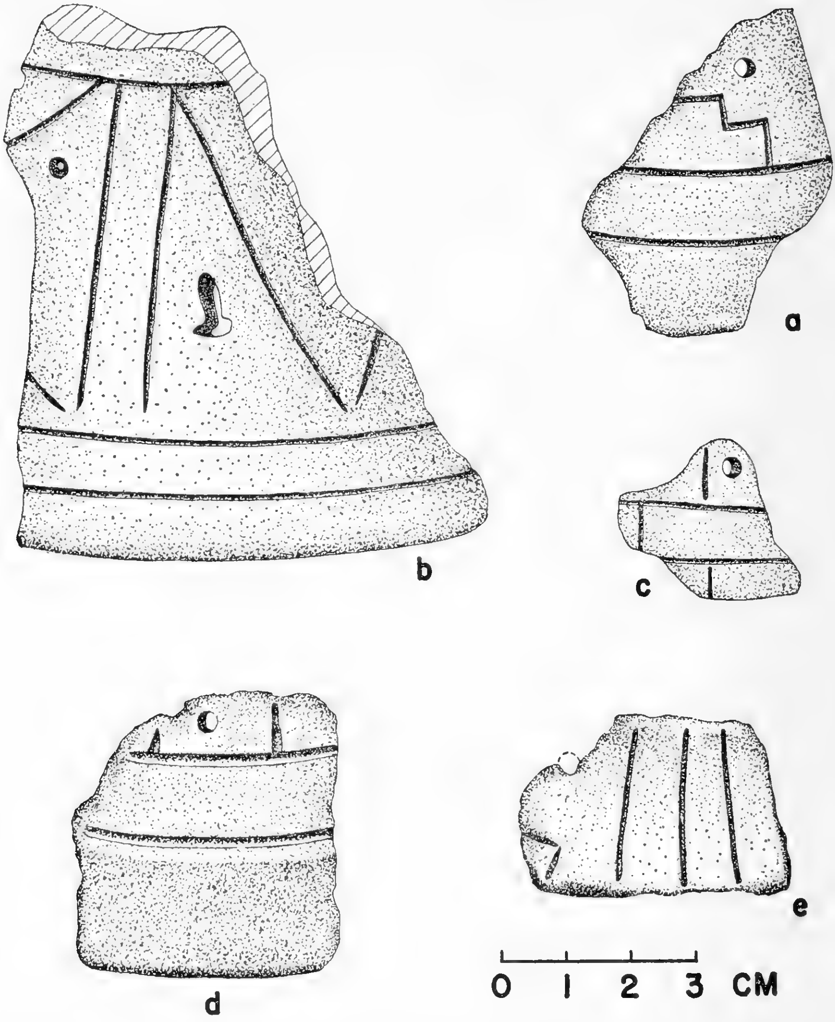

Figure 26.—Sherds of Jambelí Incised with openwork (dark stippling indicates red slip; light stippling, natural surface).

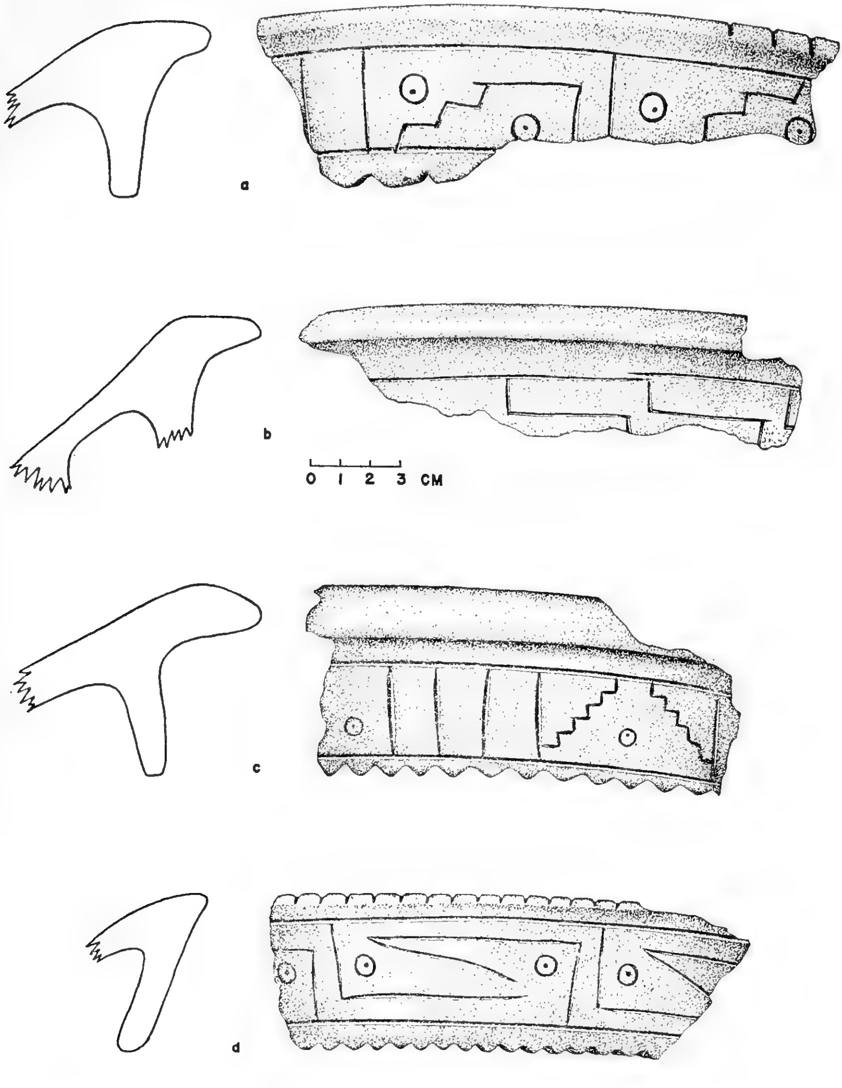

FIGURE 27.—Sherds of Jambelí Incised with impressed rings on the flange of Vessel Form 12.

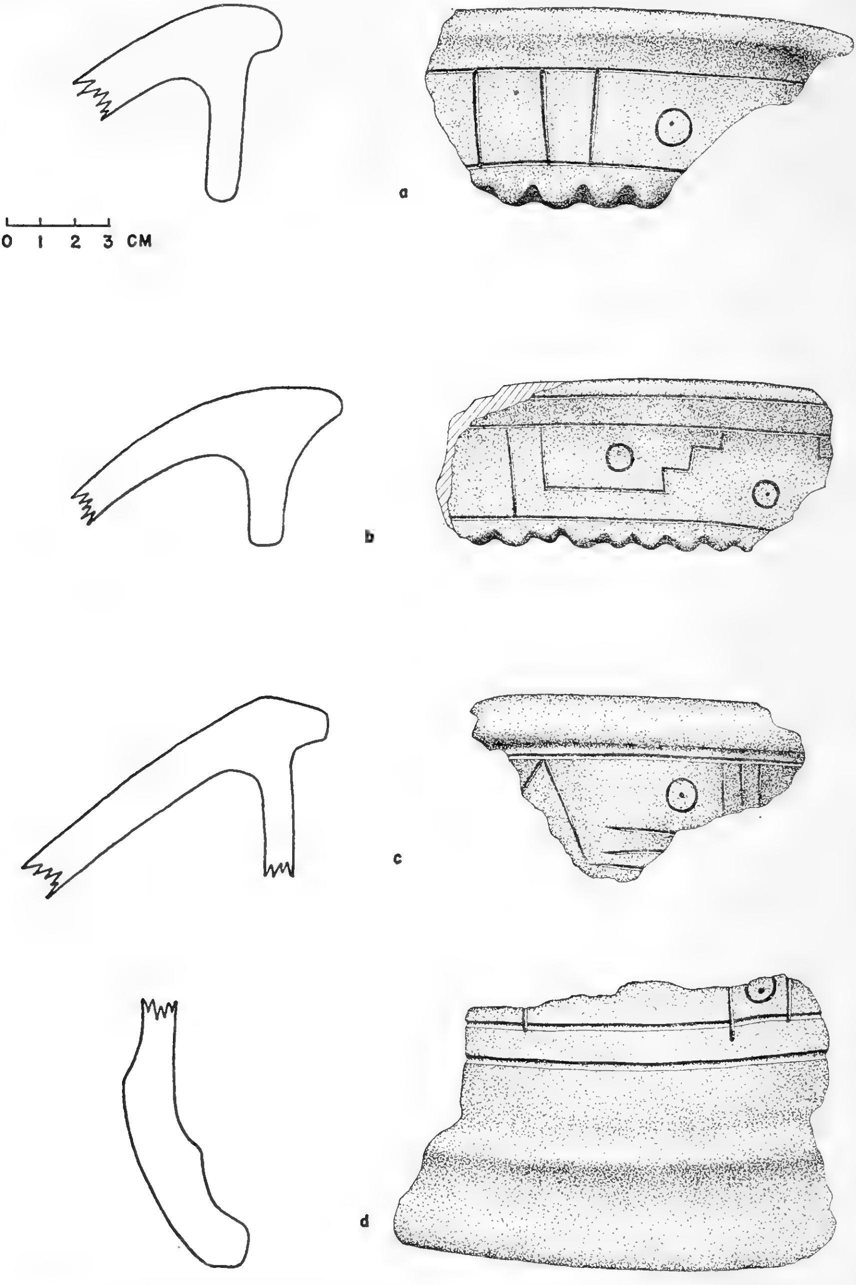

FIGURE 28.—Sherds of Jambelí Incised with impressed rings on the flange and pedestal base of Vessel Form 12.

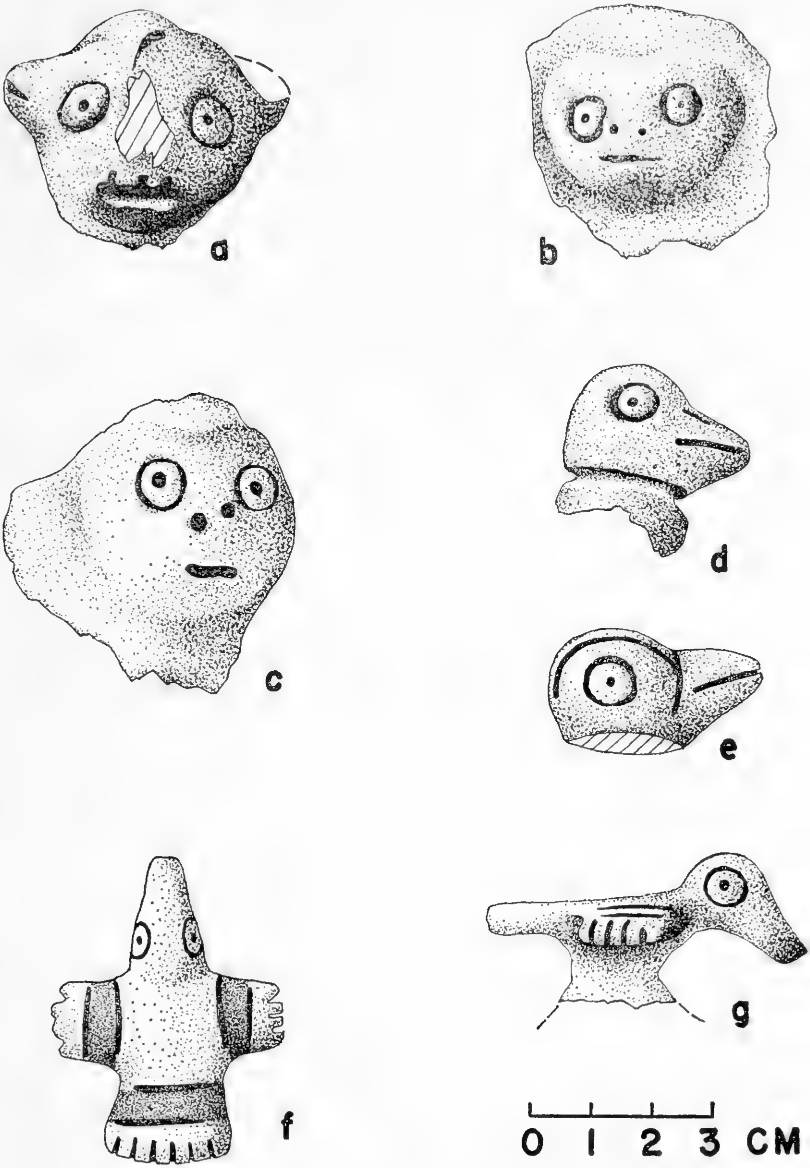

FIGURE 29.—Adornos from vessels of Jambelí Incised (dark stippling indicates red paint; light stippling, natural surface).

Associated techniques: Seven small pottery adornos were collected from the surface of Site O–6. Several complete vessels from Garbanzal, Peru, show this kind of adorno on the upper part of tall pedestal bases with incised decoration (fig. 42: 55–56; Mejía Xesspe, 1960, lam. 1, *a*, *c*,), and the adornos from Site O–6 must have occupied the same position. The surface is generally even, but unpolished, and only one adorno shows traces of slip or paint. Three are identifiable as bird heads (fig. 29, *d–g*); the remaining four are generalized but probably represent an animal (fig. 29, *a–c*). All have the same type of eye: a ring with a punctate in the center. The animal heads have slightly to highly projecting noses, with two punctates at the base to represent nostrils. The mouth is an irregular horizontal gash. These heads are attached at the back to the vessel wall. Two are solid and the other two are hollow. Of the three birds, two are heads and the other a complete bird with outstretched wings. The latter has zoned red paint between the pairs of incisions on the wing and tail.

Temporal Differences Within the Type: None discernible.

Chronological Position of the Type: Present in small frequency throughout the seriated sequence (see fig. 38).

Jambelí Negative (Jambelí Negativo)

Size of Sample: 45 sherds.

Paste: Majority like Ayalan Plain; a few like Jambelí Plain. See those type descriptions for details.

Surface: Painting applied to plain or red slipped surface. Plain surfaces even but not polished. Red slip varies from thin unpolished coating to polished red slip comparable to Jambelí Polished Red. Rare sherds are white slipped on the rim, then painted.

Form (total rims from seriated samples, 17):

Rim: Direct with rounded or tapered lip. Rarely expanded with flat top.
Body wall thickness: 3–7 mm.
Base: Typically flattened; rarely annular 14–16 cm. diameter.
Reconstructed common vessel shapes:

Form 1—82.5 percent
Form 3—11.8 percent
Form 10—5.9 percent.

Decoration (figs. 30 and 31):

Technique: Black paint applied by the resist or negative technique to a plain, red slipped or white slipped portion of the surface. Frequently combined with white paint on a red slipped surface, either as an integrated design in which the negative painting is alternated with or superimposed on the white painted design, or on the opposite surface (i.e., the interior is negative painted and the exterior white-on-red). Where well preserved, the black is dark and covers the red slip completely. Edges of painted areas are sharply defined. Black lines are more unequal in width than unpainted lines left by the application of resist material. Negative paint is fugitive and frequently difficult to detect even when the surface is wet, suggesting that this technique of decoration may have been more common than the eroded condition of the sherds now indicates.

Motif: Lines and dots, independently or in combination. Dots are unpainted areas to which resist material was originally applied. They occur in a single row in the center of a band 8 mm. wide, or several adjacent rows cover a larger area. Dots are 3–7 mm. in diameter, with little variation on a single design. Smaller dots are more circular than larger ones, which may be slightly ovoid. Rarely, dots are black and surrounded by a black ring. Separation is from 1–3 mm. Unpainted stripes range from 2–8 mm. in width; black stripes from 1–9 mm. Lines are straight or curved, and parallel lines are commonly employed.

TEMPORAL DIFFERENCES WITHIN THE TYPE: None discernible.

CHRONOLOGICAL POSITION OF THE TYPE: Present in minor frequency throughout the seriated sequence (see fig. 38).

Jambelí Plain (Jambelí Ordinario)

SIZE OF SAMPLE: 6488 sherds.

PASTE:

Temper: Abundant coarse white quartz sand with abundant pinpoint flecks of mica. Quartz grains 1–2 mm. frequent, some up to 5 mm., and well distributed in paste.

Texture: Sandy, giving abrasive feeling to eroded surfaces; compact; not friable. Tendency to show lamination parallel to surface.

Color: Typically, completely oxidized so that the cross section has the same color as the surface. Thick rim may have medium to dark gray core.

Method of manufacture: Coiling; sometimes fractured along coil junctions.

SURFACE:

Color: Rather uniformly orange to orange-tan or orange-brown; occasional medium gray fire clouds.

Treatment: Smoothing varies with vessel shape. Bowl interiors relatively even, showing fine brush marks adjacent to the rim, but never slick to touch; bowl exteriors typically swiped, leaving characteristic elongated marks from dragged temper grains parallel to rim. Jar necks have brushlike marks on interior and exterior; bodies poorly smoothed leaving uneven and irregular pitted surfaces.

Hardness: 4–4.5

FORM (total rims from seriated samples, 561):

Rim: Exteriorly thickened, everted, interiorly thickened, expanded or direct, with rounded, flattened, or tapered lip.

Body wall thickness: Range 0.4–1.2 cm.; majority 5–7 mm.

Base: 1) flattened; 2) annular, diameter 10–28 cm.; 3) hollow polypod; maximum diameter 4–5 cm.; 4) solid polypod, diameter 3 cm., length 7.5 cm.

Reconstructed common vessel shapes:

Form 9—46 percent
Form 4—19.7 percent
Form 11—14.8 percent.

Minor vessel shapes (frequency less than 5 percent): Forms 1, 5, 10, 3, 2, 12, and 13.

Appendages:

Rim lug: Trianguloid lobe projection extending horizontally outward 3 cm. at rim. Examples are from the surface of Sites O-3 and O-6 (fig. 23, *e*).

TEMPORAL DIFFERENCES WITHIN THE TYPE: None discernible.

CHRONOLOGICAL POSITION OF THE TYPE: Increases from a frequency of 3.6 percent at the earliest site to become the dominant plain type in the latter part of the seriated sequence (see fig. 38).

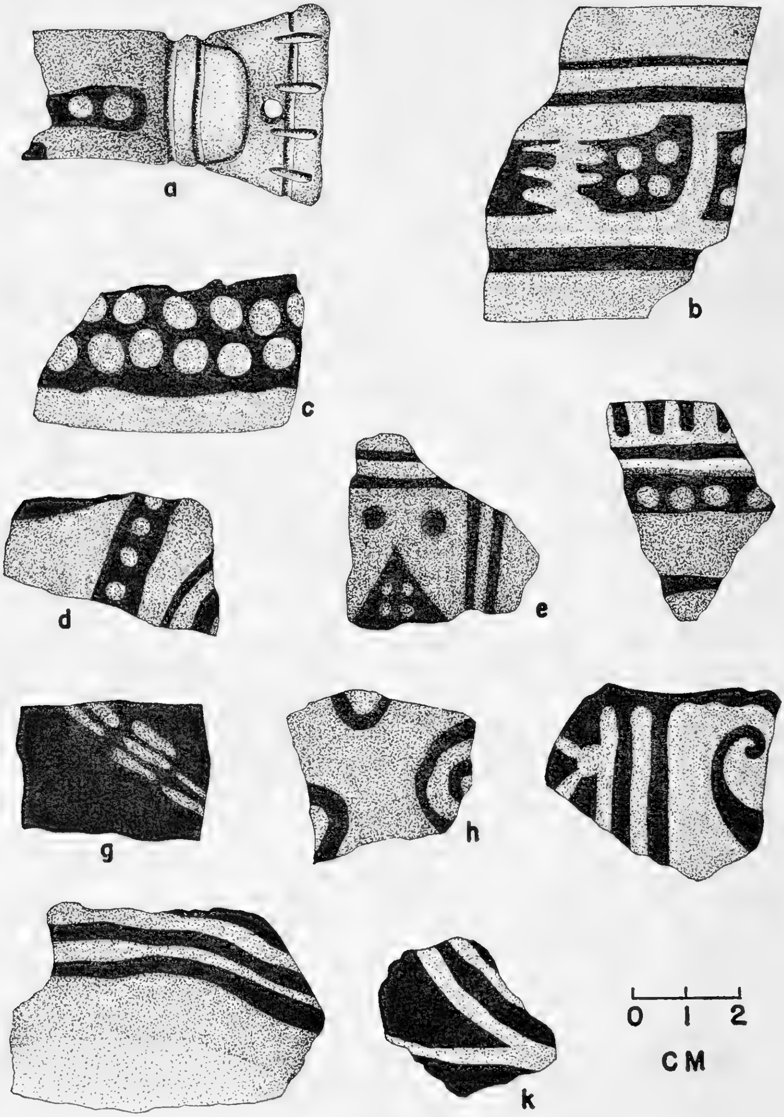

FIGURE 30.—Sherds of Jambelí Negative (black indicates black paint; dark stippling, red slip; light stippling, natural surface).

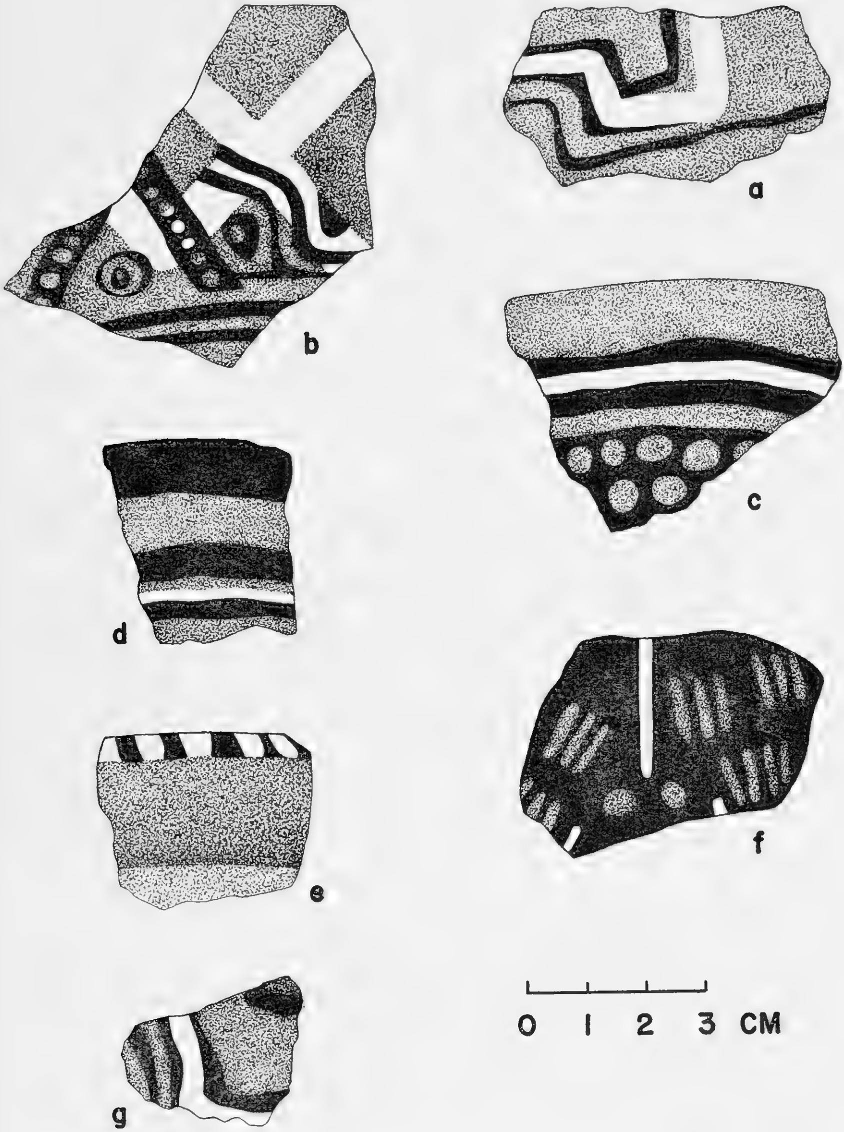

FIGURE 31.—Sherds of Jambelí Negative in combination with white paint (black indicates black paint; dark stippling, red slip; no stippling, white paint).

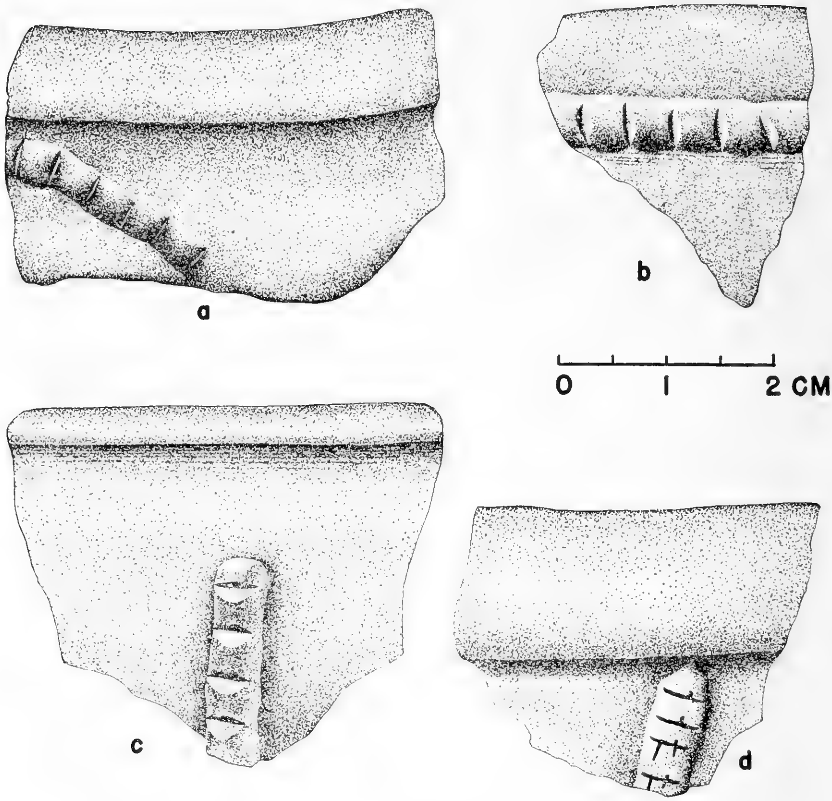

FIGURE 32.—Sherds of Jambelí Punctate, nicked rib variety.

Jambelí Punctate (Jambelí Punteado)

SIZE OF SAMPLE: 52 sherds.

PASTE and SURFACE: Like Jambelí Plain or Ayalan Plain; see those type descriptions for details.

FORM (total rims from seriated samples, 18):

Rim: Direct or everted with rounded or tapered lip.

Body wall thickness: 4–10 mm.

Base: Probably rounded or slightly flattened.

Reconstructed common vessel shapes:

Form 9—61 percent
Form 1—16.6 percent
Form 2—16.6 percent
Form 5—5.5 percent.

DECORATION:

Technique: Punctates represent a great variety of size and form, ranging from "pinpoint" marks to irregularly shaped gashes (figs. 32–33). Most typical are short incisions less than 8 mm. long and less than 0.5 mm. wide. Pinpoint punctates are next in frequency. Circular or ovoid marks, or other

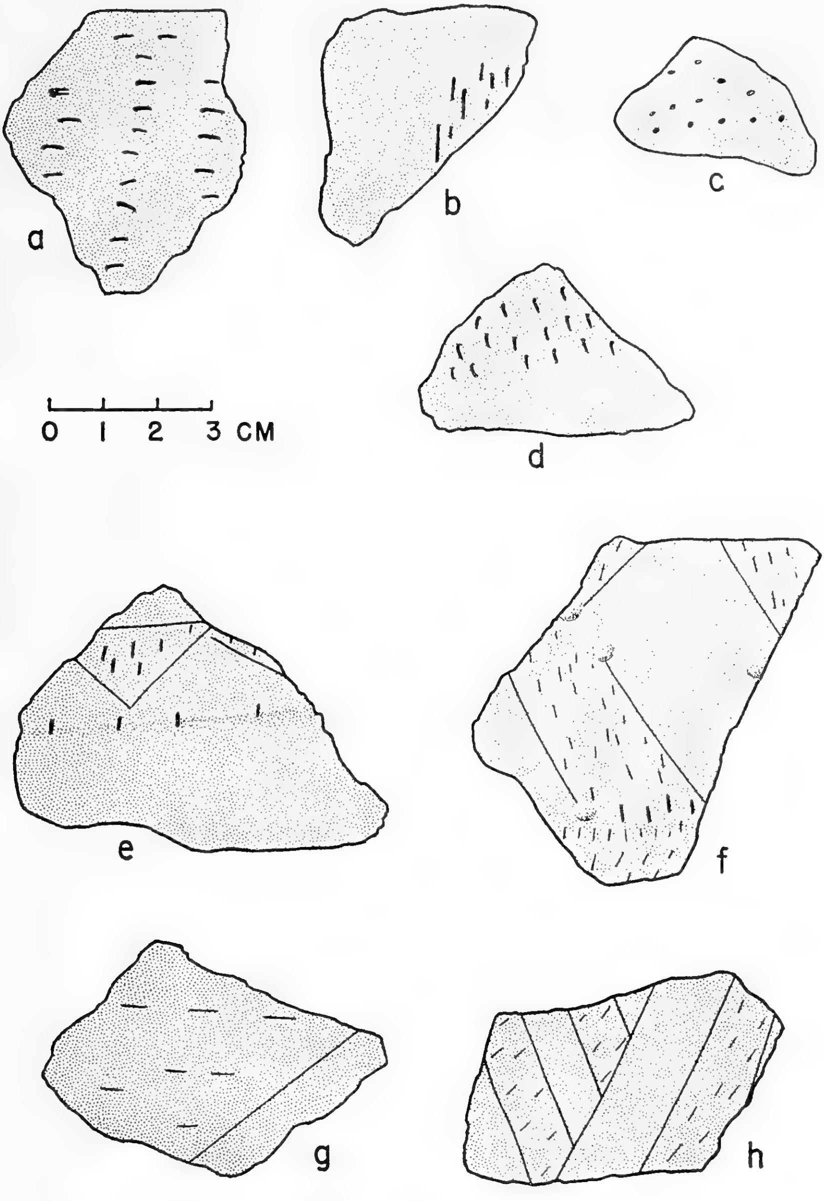

FIGURE 33.—Sherds of Jambelí Punctate, unzoned and zoned varieties.

forms, are very rare. Punctates on a single sherd do not differ markedly in size. Application is somewhat haphazard and punctates are not typically evenly spaced or arranged in rows, except when applied to ribs or rims. Incised lines are fine and generally straight. Some sherds also have zoned red slip. Decoration is always on the exterior.

Motif: Punctate decoration can be divided into four classes: 1) Nicked rim—a row of nicks along the edge of the lip, or more rarely around the neck of vessels of Form 9; 2) Nicked rib—a row of nicks along an applique rib on the upper vessel wall (fig. 32); 3) Punctate areas—overall application of punctation to the entire surface, or large areas thereof (the latter differs from zoned punctate in the absence of a bordering incision); 4) Zoned punctate—bands or triangular areas outlined by incised lines and filled with punctations, which may be randomly distributed or in rows.

Temporal Differences Within the Type: None discernible. All four motifs occur throughout the seriated sequence.

Chronological Position of the Type: Present in small frequency throughout the seriated sequence (see fig. 38).

Jambelí Polished Red (Jambelí Rojo Pulido)

Size of Sample: 1320 sherds.

Paste: Like Ayalan Plain; see that type description for details.

Surface:

Color: Unslipped surfaces light orange to tan, very uniform in hue. Slipped surfaces rich red.

Treatment: Unslipped surfaces even, occasionally smooth; majority show fine smoothing marks and minor defects; more eroded than slipped surfaces. Slipped surfaces (exterior of jars and deep bowls; both surfaces of shallow bowls), well smoothed, even, polished. Slip appears thinner than on Jambelí White-on-Red, but this may result from greater erosion.

Hardness: 3.5–4.0

Form (total rims from seriated samples, 330):

Rim: Direct, interiorly thickened, everted, with rounded or tapered lip.

Body wall thickness: 0.3–1.4 cm.; majority 5–8 mm.

Base: Typically slightly flattened; occasionally annular; diameter 8–20 cm.

Reconstructed common vessel shapes:

Form 1—48.2 percent
Form 9—24.2 percent
Form 6—7.0 percent
Form 8—6.4 percent.

Minor vessel shapes (frequency less than 5 percent): Forms 5, 4, 10, 3, and 13.

Temporal Differences Within the Type. None discernible.

Chronological Position of the Type. Present with relatively uniform frequency throughout the seriated sequence (see fig. 38).

Jambelí Red Banded (Jambelí Rojo en Bandas)

Size of Sample: 183 sherds.

Paste: Like Ayalan Plain; see that type description for details.

Surface:

Color: Light orange to light tan.

Treatment: Smoothed, producing an even but not polished finish; fine horizontal smoothing marks visible on interior, rim, or exterior, usually not present on bowl interiors.

Hardness: 3.5–4.0

Form (total rims from seriated samples, 83):

Rim: Direct, everted, interiorly thickened, or expanded with rounded or tapered lip.

Body wall thickness: 5–8 mm.

Base: Probably typically slightly flattened; 6 hollow polypod feet, maximum diameter 4 cm.; one annular base 9 cm. diameter.

Reconstructed common vessel shapes:

Form 1—20.4 percent
Form 9—21.6 percent
Form 3—19.3 percent
Form 8—16.9 percent
Form 4—12.0 percent
Form 5—6.0 percent.

Minor vessel shapes (frequency less than 5 percent): Form 6.

DECORATION: Red slip or wash applied in bands or zones in four major ways (frequently occurring in combination): 1) along the rim interior for a width of 1.5–2.5 cm.; 2) along the rim top; 3) covering the exterior and extending 1.5 cm. over onto the interior; 4) concentric bands on the interior. A single example shows circular areas 1 cm. in diameter on the exterior.

TEMPORAL DIFERENCES WITHIN THE TYPE: None discernible.

CHRONOLOGICAL POSITION OF THE TYPE: Present throughout the seriated sequence in a frequency of under 5 percent (see fig. 38).

Jambelí Red Wash (Jambelí Rojo Bañado)

SIZE OF SAMPLE: 641 sherds.

PASTE: Like Ayalan Plain; see that type description for details.

SURFACE:

Color: Typically light orange on plain surfaces. Wash the same shade of red as Jambelí Polished Red.

Treatment: Plain surface smoothed, leaving slight to marked irregularities and horizontal smoothing marks; some bowls swiped on exterior; more poorly finished than plain surfaces on vessels with polished red slip. Surface to which red wash was applied is more even and smooth but leaving faint smoothing tracks sometimes visible, as well as mica flecks.

Hardness: 3.5–4.0

FORM (total rims from seriated samples, 182):

Rim: Direct, everted, or exteriorly thickened with rounded lip.

Body wall thickness: 0.3–1.5 cm.; majority 5–9 mm.

Base: Typically slightly flattened; rarely annular pedestal; about 10 cm. diameter.

Reconstructed common vessel shapes:

Form 9—66.5 percent
Form 2—13.2 percent.

Minor vessel shapes (frequency less than 5 percent): Forms 1, 6, 5, 8, 10, 3, and 11.

TEMPORAL DIFFERENCES WITHIN THE TYPE: None discernible.

CHRONOLOGICAL POSITION OF THE TYPE: Present with little change in frequency throughout the seriated sequence. Diminished percentage in the earliest sites may reflect loss by erosion rather than smaller original frequency (see fig. 38).

Jambelí Shell Scraped (Jambelí Raspado con Concha)

SIZE OF SAMPLE: 446 sherds.

PASTE: Typical of Jambelí Plain and Ayalan Plain, with a slightly higher frequency of incompletely oxidized examples.

SURFACE:

Color: Typically light orange to tan. Large gray areas are common on the exterior, less frequent on the interior.

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Treatment: One surface scraped with the edge of a ribbed clamshell producing broad parallel grooves more or less 1.5 mm. wide and 1.5 mm. apart, varying with the size of the shell used as the tool. The majority show scraping in one direction only, but intersecting or overlapping patterns occur. About 95 percent of the sherds are scraped on the interior only, suggesting that this is a technique of surface finish rather than one of intentional decoration since the vessels are constricted mouthed jars. Exterior scraping is restricted to the necks of jars of Form 9, and the marks run vertically, probably for decorative effect (pl. 8).

Hardness: 3.5–4.5

Form (total rims from seriated samples, 36):

Rim: Everted and slightly to markedly thickened at the angle of eversion, or direct with rounded or flattened lip.

Body wall thickness: 0.3–1.1 cm.; majority 4–6 mm.

Base: Probably slightly flattened.

Reconstructed common vessel shapes: Form 9—94.3 percent.

Minor vessel shapes (frequency less than 5 percent): Forms 1 and 10.

Temporal Differences Within the Type: None discernible.

Chronological Position of the Type: Present throughout the seriated sequence with no apparently significant change in frequency (see fig. 38).

Jambelí White-on-Red (Jambelí Blanco Sobre Rojo Pulido)

Size of Sample: 599 sherds.

Paste:

Temper: Sand abundantly mixed with minute grains of mica; sand typically fine but with occasional coarser inclusions up to 1.5 mm. Abundant and well mixed.

Texture: Fine grained, sandy; tendency to laminated appearance accentuated by slit air pockets parallel to surface.

Color: Range from completely oxidized light orange, to orange along the surface with medium to dark gray core, to gray through entire cross section.

Surface:

Color: Decorated areas covered with a thin red slip, typically a dark rich red of relatively uniform hue. Undecorated surfaces light orange or tan. Gray fire clouds may occur on interior or exterior.

Treatment: Slipped surfaces smooth, even, and where uneroded show a gloss. Unslipped surfaces even, sometimes showing smoothing marks, but not polished. Sparkling pinpoint mica grains are visible on slipped and unslipped surfaces.

Hardness: 3.5–4.0

Form (total rims from seriated samples, 227):

Rim: Direct, interiorly thickened, everted, with rounded or tapered lip.

Body wall thickness: 0.3–1.1 cm.; majority 3–5 mm.

Base: 1) Slightly flattened; 2) Annular, diameter 16–18 cm.; 3) Hollow polypod, maximum diameter 4–5 cm.

Reconstructed common vessel shapes:

Form 1—62 percent

Form 3—15 percent

Form 6–7.9 percent.

Minor vessel shapes (frequency less than 5 percent): Forms 5, 4, 9, 8, 10, 12, and 13.

Additional rare vessel shapes: 1) Jar with spout and bridge handle: Spout length 4 cm., exterior diameter 1.3 cm., interior diameter 0.8–0.9 cm., maximum body diameter 12 cm. (fig. 23, *a*).

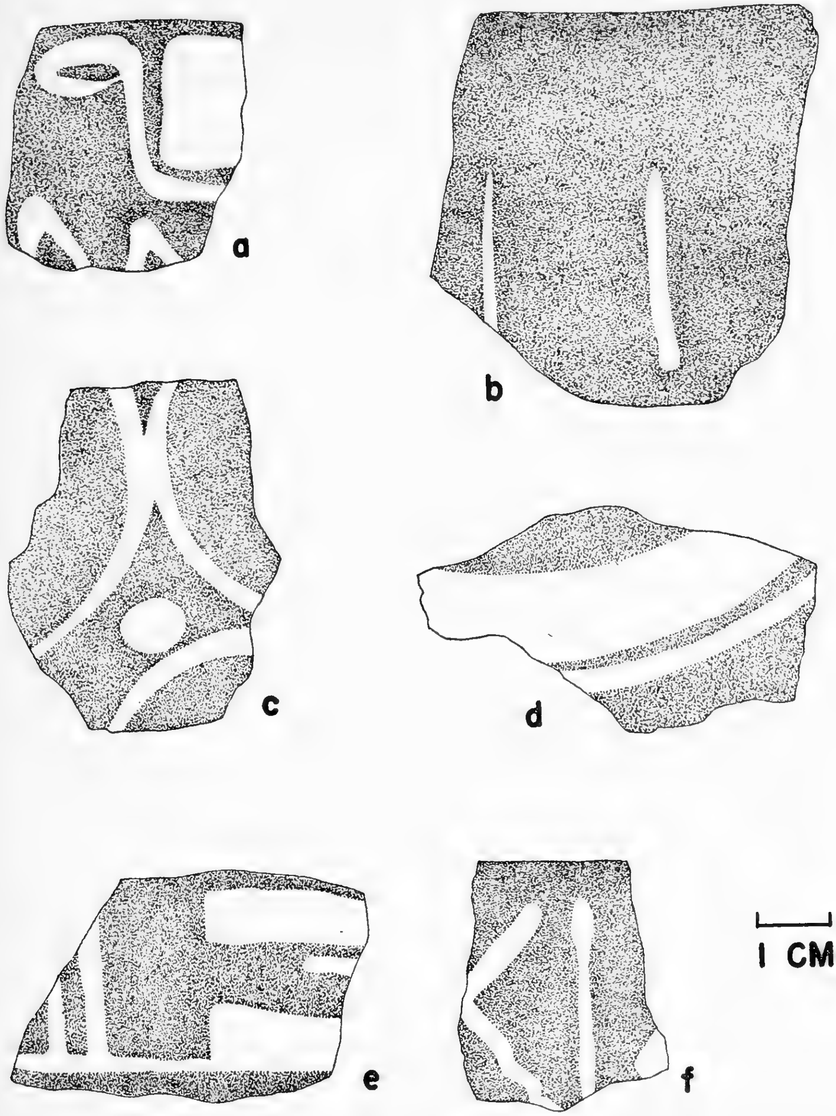


FIGURE 34.—Sherds of Jambelí White-on-Red (dark stippling indicates red slip; no stippling, white paint).

DECORATION:

Technique: 1) White stripes and zones on red slip. Stripes typically 2–7 mm. wide, occasionally 1.3–1.8 cm. wide; some variation in width due to poor control of brush; termination may be tapered to point or thickened by excess paint; paint sometimes thick and easily chipped off. Solid areas are rectanguloid, up to 4 by 6 cm., or circular. Unequal thickness of paint makes color vary from white to pinkish in thin places where underlying red

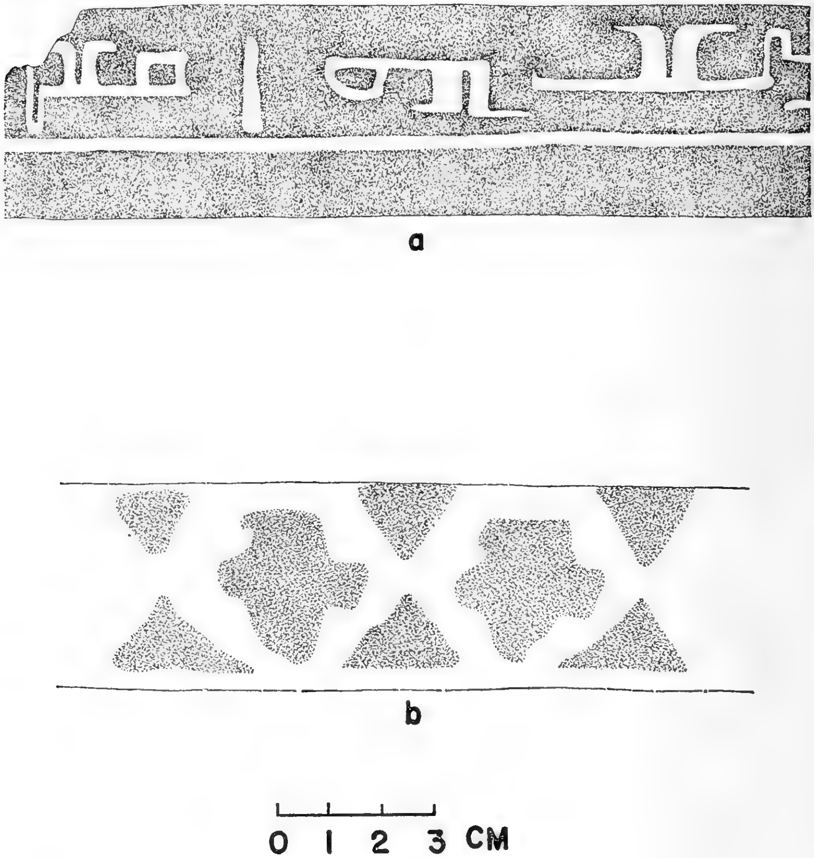


FIGURE 35.—Rolled out designs from complete vessels of Jambelí White-on-Red (dark stippling indicates red slip; no stippling, white paint).

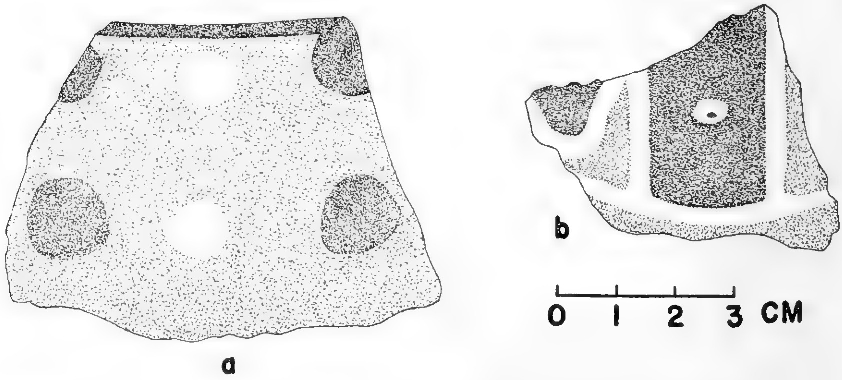


FIGURE 36.—Sherds of Jambelí White-on-Red, white and red variety (dark stippling indicates red slip; light stippling, natural surface; no stippling, white paint).

slip shows through. Solid areas were outlined and then filled in (figs. 34–35; pls. 9–10). 2) Alternating bands of red and white, white applied after red and may overlap slightly onto red areas (fig. 36).

Motif: Rectilinear patterns composed of single or parallel lines forming rectangular or diamond-shaped areas or stepped designs are most typical of white-on-red decoration. Curvilinear designs are rare. Solid areas are typically rectangular, rarely circular, and most frequent on the exterior. White and red designs are usually concentric bands, alternating white and red, with red bands slightly wider than the white ones. A rare variant consists of red and white spots on an unslipped surface (fig. 36, *a*). Painting is applied to interior of shallow bowls, exterior of deep bowls and jars; occasionally to both surfaces.

Temporal Differences Within the Type: None discernible. Both white-on-red and white and red techniques occur throughout the seriated sequence.

Chronological Position of the Type: Characteristic throughout the seriated sequence (see fig. 38).

Jambelí White Painted (Jambelí Blanco Pintado)

Size of Sample: 74 sherds.

Paste: About 50 percent like Ayalan Plain; the remainder like Jambelí Plain; see those type descriptions for details.

Surface:

Color: Red-orange, orange, brownish, or gray as a result of differential firing. A few sherds have a thin red wash; none has a polished red slip.

Treatment: Smoothed, sometimes leaving horizontal smoothing marks; surface remains somewhat uneven and irregular with small defects. Broad scraping tracks on interior. Mica flecks glisten on both surfaces.

Hardness: 3–4

Form (total rims from seriated samples, 25):

Rim: Direct or everted with rounded lip.

Body wall thickness: 0.3–1.0 cm.; majority, 3–7 mm.

Base: Probably slightly flattened.

Reconstructed common vessel shapes:

Form 9—88 percent

Form 2—12 percent.

Additional rare vessel shapes: 1) Miniature vessel with rounded body, slightly constricted mouth spanned by strap handle; height including handle 7.7 cm., maximum body diameter 5.6 cm., mouth diameter 3.5 cm. (pl. 11, *f*). 2) Jar of Form 9 with a horizontal flange around the neck 2 cm. below the rim; mouth diameter 9 cm. (fig. 23, *b*).

Appendages:

Horizontal Rim Lobe (pl. 11, *d*). A bowl of Form 2 has a prominent lobed lug extending horizontally from the rim exterior. Width at point of attachment, 6 cm.; outward projection, 3.5 cm. The upper surface has two white bands perpendicular to the mouth. The specimen is from the surface of Site O-6.

Decoration (fig. 37; pl. 11):

Technique: White painted lines 2–5 mm. wide, with variation in width on a single sherd. Differences in paint thickness produce color range from white to pinkish. Spacing of parallel lines not uniform.

Motif: Parallel straight lines in groups of three or more, usually running vertically down from the rim. Rare examples have parallel horizontal lines or diagonal lines. Painting may occur on the exterior of jars, interior of bowls, or the interior slope of everted rims of Form 1.

Temporal Differences Within the Type: None discernible.

Chronological Position of the Type: Present in minor frequency throughout the seriated sequence (see fig. 38).

Jambelí White Wash (Jambelí Blanco Bañado)

Size of Sample: 71 sherds.

Paste: Like Ayalan Plain; see that type description for details.

Surface:

Color: Plain surfaces light orange or light tan; medium gray fire clouds common.

Treatment: Smoothed, often leaving smoothing marks faintly visible. White wash uneven, unequal in thickness, sometimes smeared, and not thick enough to obliterate defects in the smoothing of underlying surface; rarely smooth, never polished. Bowls better smoothed than jars.

Hardness: 3.5–4.0

Form (total rims from seriated samples, 23):

Rim: Direct or everted with rounded lip.

Body wall thickness: 0.3–1.3 cm.; majority 3–5 mm.

Base: Probably typically flattened; two pedestal bases, diameters 20 and 30 cm.

Reconstructed common vessel shapes:

Form 2—52.3 percent

Form 5—13.1 percent

Form 10—13.1 percent.

Minor vessel shapes (frequency less than 5 percent): Forms 9, 8, 12, and 13.

Temporal Differences Within the Type: None discernible.

Chronological Position of the Type: Present in minor frequency throughout the seriated sequence (see fig. 38).

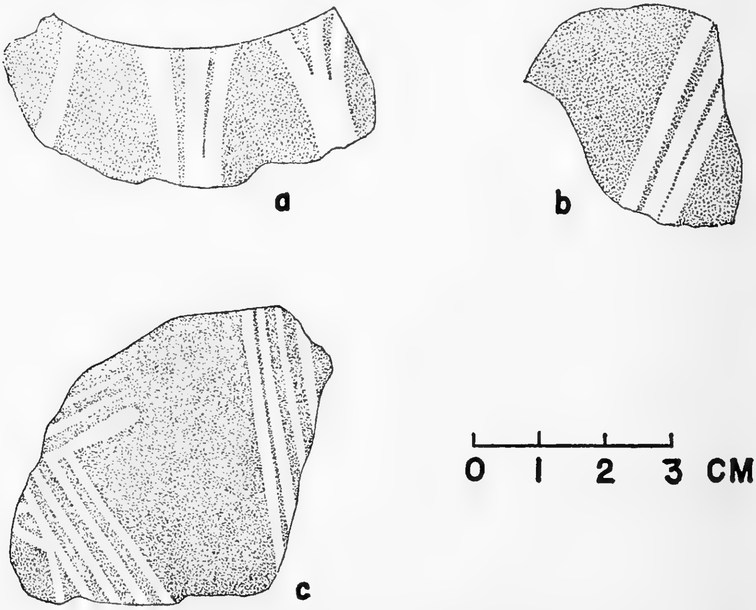


Figure 37.—Sherds of Jambelí White Painted (stippling indicates natural surface; no stippling, white paint).

Posorja Polished Plain (Posorja Pulido)

Size of Sample: 458 sherds.

Paste:

Temper: Fine sand, grains not easily visible.

Texture: Fine grained, compact but often laminated, with long fine air pockets.

Color: Medium gray to tannish gray.

Surface:

Color: Dusty gray tan where polish eroded; polished areas vary from dark gray to tan.

Treatment: Even and, where uneroded, slick to touch. Fine horizontal brush marks faintly visible on interior, more rarely on exterior.

Hardness: 3.5–4.0

Form (total rims from seriated samples, 22):

Rim: Direct, everted, or interiorly thickened with rounded lip.

Body wall thickness: 4–7 mm.

Base: Probably rounded or slightly flattened.

Reconstructed common vessel shapes:

Form 9—22.7 percent
Form 10—18.2 percent
Form 2—18.2 percent
Form 1—9 percent.

Minor vessel shapes (frequency less than 5 percent): Forms 8 and 11.

Temporal Differences Within the Type: None discernible.

Chronological Position of the Type: Present only during the early half of the seriated sequence (see fig. 38).

Trade Sherds

Several sites of the Jambelí Phase produced sherds of plain or decorated types belonging to two other cultures found in the Province of Guayas. The largest number are of Guangala Phase origin; a few represent the early Manteño Phase.

Guangala Phase Types.—Sherds of Guangala Phase origin include plain types and the following decorated types (Appendix Table 2): Barcelona Painted Dark Line (Barcelona Línea Oscura), Guangala Burnished Line (Guangala Bruñido), Guangala Finger Painted (Guangala Pintado con Dedo) and Chorrera Iridescent (Chorrera Iridiscente). Although Guangala pottery was identified at only a few sites, its seriated position (fig. 38) suggests that contact between the Jambelí and Guangala Phases occurred throughout the duration of the Jambelí Phase as it is now known.

Manteño Phase Types.—A few plain sherds from Site G-L-30 were identified by Estrada as representing the fine kaolinite paste of Playas Gray Polished (Playas Gris Pulido). Two decorated sherds from Site O-3 are Playas Engraved (Playas Grabado) (Estrada, 1957 a, p. 72). These types are characteristic of the Manteño culture, which is later than the Regional Developmental Period. Since these sherds are from surface collections, they are most easily explained as intrusions resulting from later Manteño occupation of the area around the Gulf of Guayaquil.

Unclassified Decorated

Most of the decorated sherds left unclassified were too small or too badly eroded to identify. The remainder consisted principally of applique nubbins.

Applique Nubbins.—One rim of Form 9 from Site O-5 has two rounded pellets attached side by side under the everted rim. Traces of red wash are visible on the upper surface of the rim, which has a diameter of 14 cm. Another rim from the same provenience has a nubbin with a punctate in the center in the same position on the rim exterior.

Several sherds from the surface of Site O-3 are ornamented with a horizontal row of low applique nubbins 2–5 mm. high, applied either to the surface or to a low ridge.

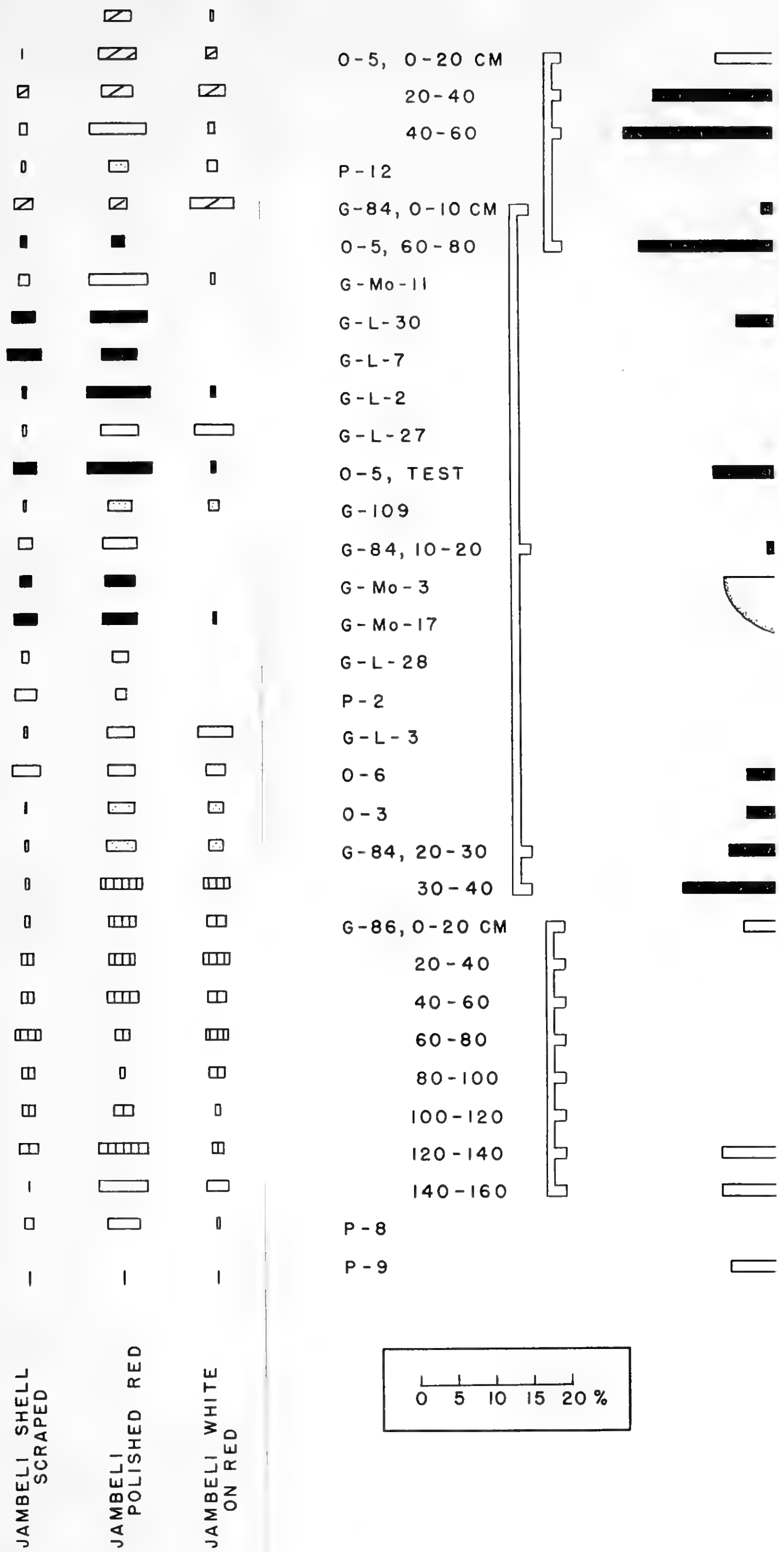
Implications of the Seriated Sequence

The seriated sequence of the Jambelí culture is based on trends in change of frequency in the plain types derived from analysis of the sherds from stratigraphic excavations at sites G-84, G-86 and O-5. Into this framework, surface collections from 10 additional sites were seriated. Finally, the attempt was made to include sites represented by a sample of less than 100 sherds, and 7 of these fit the pattern of change sufficiently well to be incorporated into the graph (fig. 38).

The two principal plain types exhibit a rather smooth pattern of change, in which Jambelí Plain, tempered with coarse micaceous sand, increases in popularity while Ayalan Plain, tempered with fine micaceous sand, shows a corresponding decline in frequency. Some of the samples exhibiting a larger amount of both types than is consistent with the pattern of the curve reflect an unusually high degree of surface erosion. This loss of surface results in the classification of some sherds as plain that might originally have had a slipped or painted surface. Sites P-2 and G-L-3 are examples of this kind of distortion.

The only real time marker, in terms of presence or absence, is Posorja Polished Plain, which is restricted to the early half of the sequence. It perhaps represents a survival of the polished plain ware tradition characteristic of the preceding Formative Period.

None of the decorated types exhibits any consistent pattern of change. Each type maintains a relatively uniform frequency from the earliest to the latest site, with fluctuations that can be attributed either to differential amounts of surface erosion or to errors resulting from the small size of the sherd sample. Attempts were made to



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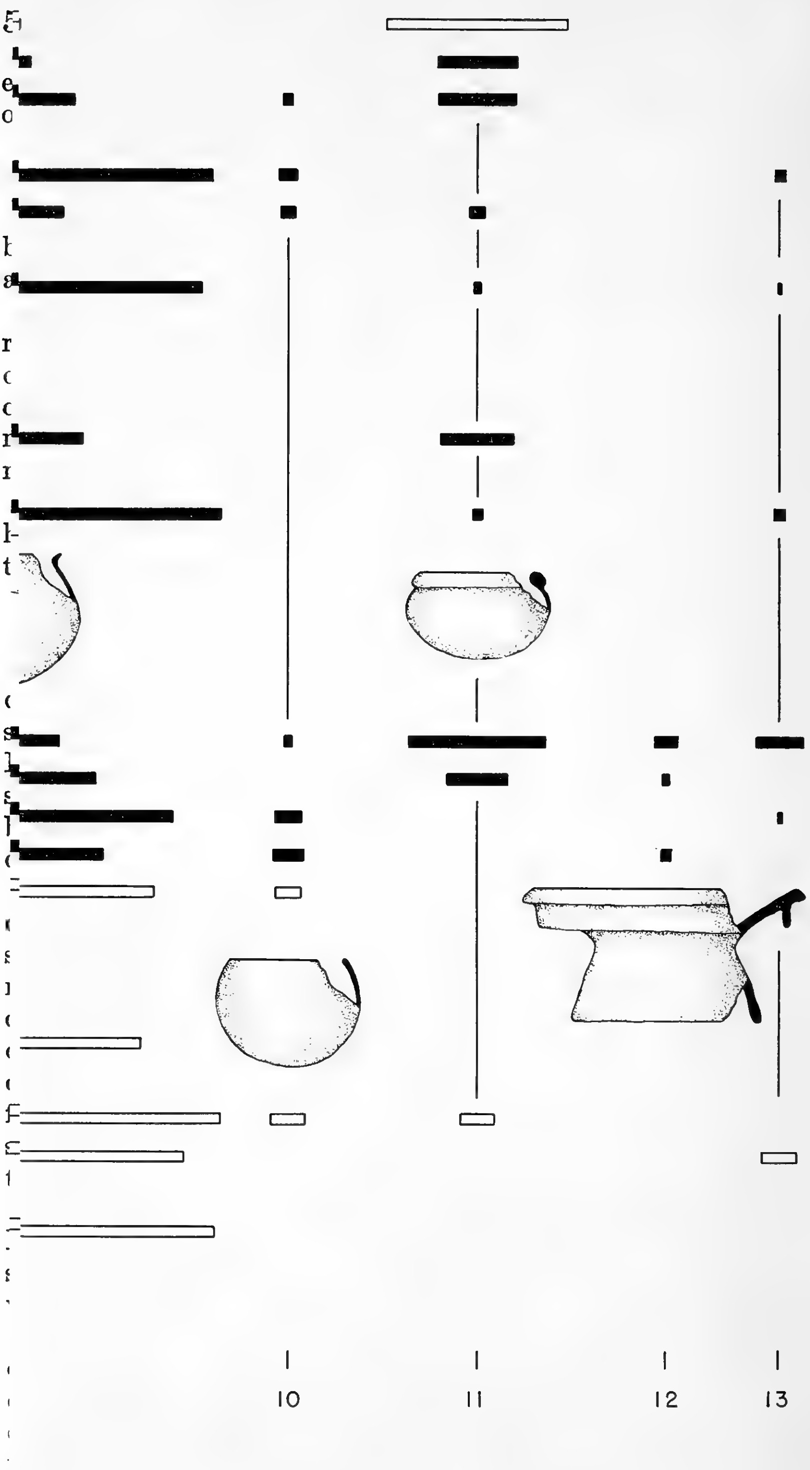

.E 39.—Changes in vessel shape frequency during the seriated sequence of the Jambelí Phase (white bars indicate samples with less than 49 rims).

FIGURE 38. Seriated sequence of the Jambelí Phase.

[illegible] Changes in vessel shape frequency during the seriated sequence of the Jambeli Phase (white bars indicate samples with less than 49 rims).

detect temporal differences in the decorative motifs, but no distinctions could be found that could not be attributed to deficiencies in the size of the sample.

Analysis of the rim forms and reconstructed vessel shapes showed the same picture of cultural uniformity through time (fig. 39). Only two forms have a restricted distribution: Form 5, a bowl with an everted rim, and Form 12, a large compotera. Both are limited to the early half of the sequence. Annular bases are present throughout, and this is probably also true of hollow legs since their absence from the earliest and latest levels can be accounted for by the small size of the sherd sample. The only solid leg comes from an early site. Spouts, although very rare, appear to occur throughout the sequence.

Discussion of the temporal differences in the frequency of various types of artifacts is hampered by the fact that these are relatively rare in comparison to sherds. The majority of those artifacts included in this report are from Site O-6, where the constant erosion of the site by the sea, and the existence of a resident population able to salvage objects as they were revealed, provides a combination of collecting circumstances not met with at any other Jambelí site. In view of the relatively small amount of excavation undertaken, it consequently is difficult to determine whether the absence of figurine fragments from the lower third of the sequence reflects a real absence or the inadequacy of collections from early sites. The two bark beater fragments are from sites that occupy an early and a late position, suggesting that this trait was present throughout the sequence.

Of considerable interest is the question of whether the entire area in which the Jambelí culture remains are found was occupied at the same time, or whether a movement from north to south or south to north can be inferred. The seriated position of the sites does not provide a clear-cut conclusion, but the absence of any El Oro Province sites in the lower third of the seriated sequence may reflect a more recent movement into that part of the area from the north. In the upper third of the sequence, the situation is reversed. The largest sites are in El Oro or southeastern Puná Island, and those in the Playas–Posorja region are typically small with sparse pottery refuse. If this interpretation of a shift in population concentration from north to south is correct, it may be correlated with the gradual desiccation of the northern portion of the area, which caused the extinction of the mangrove swamp on which the subsistence of the Jambelí Phase was largely dependent.

In summary, it can be said that all the evidence derived from an examination of the chronological distribution of ceramic traits, artifacts, and other cultural features of the Jambelí culture presents a picture of uniformity and consistency. There is no indication that contacts that the people of this culture had with neighboring contemporary groups produced any disturbing effect or resulted in the introduction of any novel elements into their way of life. Part of the explanation of this stability may lie in the habitat, which was unattractive to the agricultural populations that occupied the rest of the Ecuadorian coast at the time the Jambelí culture was in existence.

Chronological Position and Affiliations

Neither carbon-14 nor obsidian dates are currently available for any sites of the Jambelí culture, but several kinds of evidence place it in the Regional Developmental Period in the chronology of the Ecuadorian coast. One is the presence of the ceramic horizon markers—white-on-red painting and negative painting—characteristic of this period. Another is the occurrence of trade pottery and artifacts from the Guangala and Bahía cultures in Jambelí refuse, establishing the contemporaneity of the Jambelí sites with these two Regional Developmental cultures.

Although decorative techniques are less elaborate and varied than in other regional complexes, the vessel shapes, figurines, shell and stone ornaments, and other aspects of the material culture are typical of the prevailing pattern throughout the coastal area between 500 B.C. and A.D. 500, as is evident from the following tabulation:

	Culture complexes			
Traits	*Jambelí*	*Guangala*	*Tejar*	*Bahía*
White-on-Red painting	X	X	X	X
Negative painting	X	X	X	X
Red paint in bands	X	X	X	X
Pottery figurines	X	X	?	X
Polypod or tripod vessel supports	X	X		X
Tall annular base of compotera with cutout design areas	X	?	X	
Carinated bowl	X	X	X	X
Compotera	X	X	X	X
Shell container	X	X		
Stone bark beater	X			X
Shell atlatl hook	X	X		
Shell pendant	X	X		
Spindle whorl	X	X	X	X

What sets the Jambelí culture apart is its subsistence emphasis. While sites of the Guangala and Bahía cultures contain some shell, this is the principal component of Jambelí habitation refuse. At a time when the conversion to agriculture, introduced in the late Formative, had been achieved to the north, the Jambelí culture apparently preserved the shellfish gathering pattern characteristic of the early Formative Valdivia and Machalilla cultures. An explanation for this lag can be found in the hostility of the environment around the Gulf of Guayaquil to agricultural exploitation. The presence of a few metate and mano fragments in Jambelí refuse can be interpreted either as an indication of limited use of cultivated plants or as evidence of the exploitation of wild plant foods. In any case, it is clear that the major subsistence emphasis of the Jambelí culture was different from that prevailing on other parts of the Ecuadorian coast during the Regional Developmental Period (fig. 40).

Of the contemporary regional cultures, the Jambelí culture is most closely affiliated with the Guangala complex, which occupied the northern portion of the Guayas coast (fig. 41). Jambelí White-on-Red is practically identical to Guangala White-on-Red in vessel shape, surface finish, and decorative technique and motif (pl. 12). While the type seems too common in Guangala sites to have originated by trade from the Jambelí culture, this possibility cannot be ruled out until more detailed analysis has been made of the Guangala ceramic sequence (cf. Bushnell, 1951, p. 44). Another decorative technique shared by the two complexes is red paint in bands. The Jambelí ceramic complex, however, is much simpler and less varied than that of the Guangala culture.

Throughout the seriated sequence, there is evidence of contact with the Guangala culture in the form of trade sherds.[1] While these represent a number of the most common decorated types—Barcelona Painted Dark Line (Barcelona Línea Oscura), Guangala Burnished Line (Guangala Bruñido), Guangala Finger Painted (Guangala Pintado con Dedo) and Chorrera Iridescent (Chorrera Iridiscente)—it is of interest to note that not a single sherd of Guangala Bicolor, La Libertad Bicolor, or La Libertad Tricolor was recovered. Since these types are more characteristic of the late Guangala culture, their absence may be an indication that the period of contact is to be equated with early Guangala. Confirmation of this possibility will have to await more detailed analysis of the ceramic sequence of the Guangala culture.

Two diagnostic artifacts from Jambelí sites can be related to the Guangala culture. One, a body fragment of a solid pottery figurine (fig. 17, *a*), is unlike the typical Jambelí figurine type but generally resembles a common Guangala type (fig. 17, *b*). The second object, a carved complete shell with a hole at the center providing access to the interior (fig. 6, *a*), is like shells from the Guangala culture identified as containers (fig. 6, *b*). Whether the Jambelí example was acquired by trade or is locally made cannot be determined, but it is

[1] The assumption made by Estrada (1961, Cuadro 1) from preliminary analysis of stratigraphy at G-84 that the Guangala types are survivals into the later Jambelí complex has not proved correct.

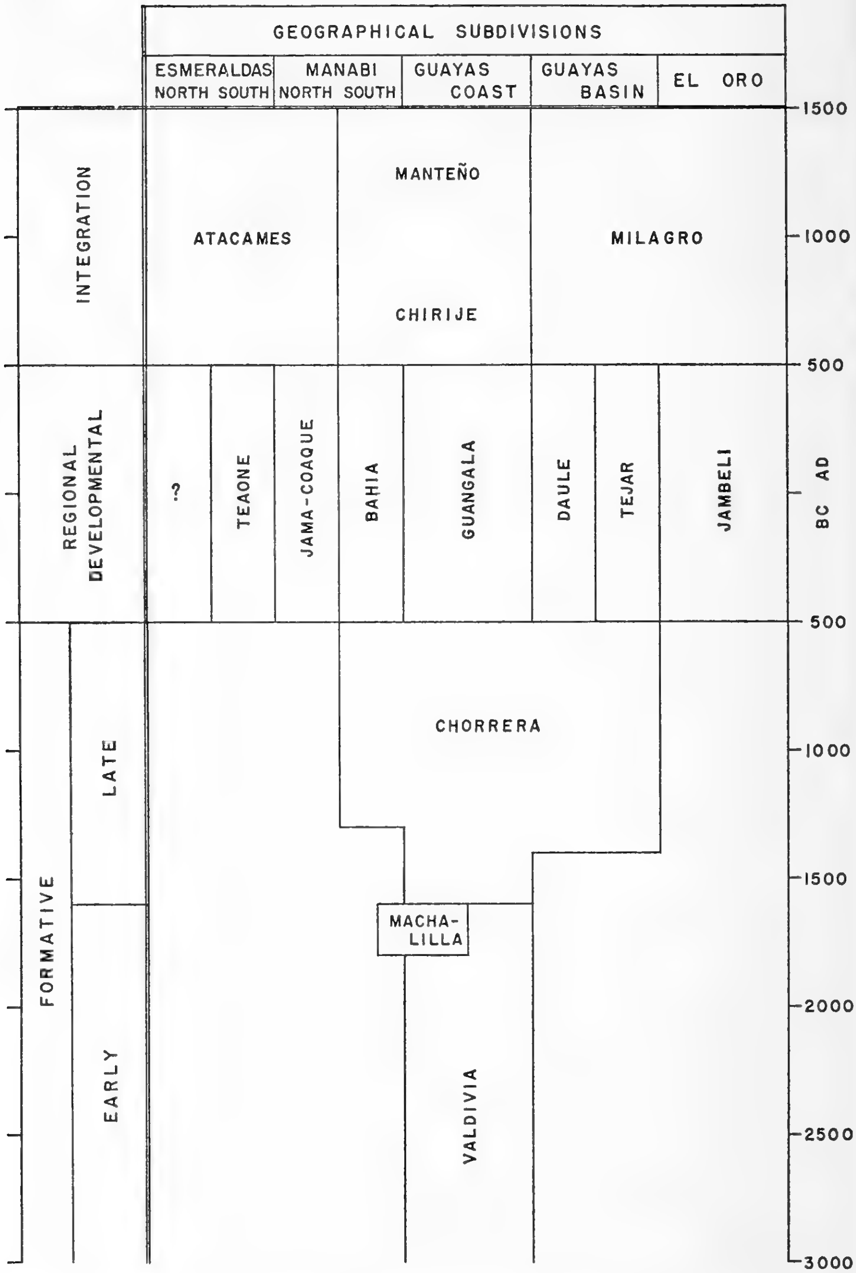

FIGURE 40.—Chronological sequence of archeological complexes on the Ecuadorian coast.

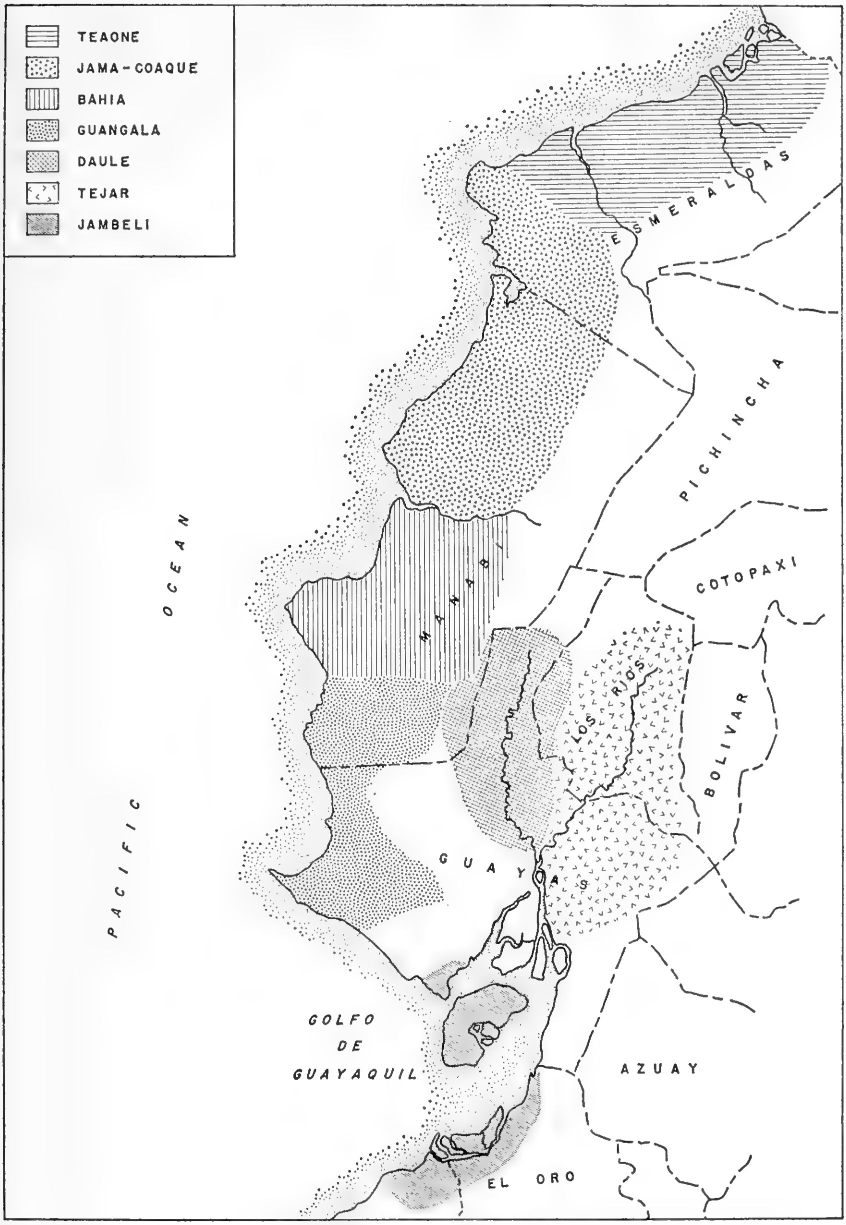

FIGURE 41.—Approximate geographical distribution of archeological complexes on the Ecuadorian coast during the Regional Developmental Period.

a rare enough object to be interpreted as evidence of contact between the two groups regardless of its origin.

Unfortunately, no carbon-14 dates are yet available for sites of the Guangala culture. Absolute dates have been obtained from obsidian at two Guangala sites, and these cover a range from 340 B.C. to A.D. 360 (Evans and Meggers, 1960, fig. 19).

Another link to absolute chronology is the stone bark beater (pl. 6, *b–c*), which is known elsewhere on the Ecuadorian coast only from the Bahía culture (pl. 6, *a*). The site of M-7: Esteros from which the specimen came, has two carbon-14 dates: 2150±240 or 190 B.C. (Sample W-833), and 2200±240 or 240 B.C. (Sample W-834) (Rubin and Alexander, 1960, p. 181). Since the trait is likely to have reached the Jambelí culture from the Bahía area, the dates may be slightly earlier than the appearance of bark beaters farther to the south, although this is not necessarily the case. An atypical pottery figurine head has a headdress with ear flaps (fig. 18) resembling those frequently worn by La Plata Sentado figurines of the Bahía culture (Estrada, 1957, figs. 70 center and 90) providing another possible link with the north.

To the south, the only archeological materials showing strong affinities with the Jambelí culture are those from Garbanzal, 9 km. south of Tumbes on the right bank of the Río Tumbes in Peru (Ishida et al., 1960, p. 423). Two sites are reported, one on the alluvial terrace and another on a higher terrace. Although the investigators have considered both to belong to the same cultural complex, correlations with Ecuadorian archeology suggest that a distinction should be made. The site on the lower level produced 23 complete vessels and additional fragments readily classifiable into pottery types of the Jambelí Phase, including Jambelí Incised, Jambelí White-on-Red, Jambelí White Painted, Jambelí Polished Red, and Jambelí Negative (op. cit., p. 120, fig. 54–56). The sand and mica temper is also typical of Jambelí wares (Mejía Xesspe, 1960, lam. 1, *F*). Vessel shapes duplicate those representing the Jambelí Phase (fig. 42).

The characteristics of the second Garbanzal site, on the upper terrace, appear to be different. Artifacts were recovered from shaft and chamber tombs (Mejía Xesspe, 1960, fig. 2), and included globular jars and 34 pieces of copper ax money (Ishida et al., p. 423 and Appendix 1, fig. 2). In Ecuador, both shaft tombs and ax money are associated with cultures of the later Integration Period.

A distinction between the two Garbanzal sites is important for establishing the absolute dating of the Jambelí culture because a carbon-14 date has been obtained for Tomb 2 at the site on the upper terrace of Garbanzal by the Radiocarbon Laboratory of the Department of Physics and Chemistry, Gakushuin University. The sample

(G-605) gave a date of 1740 ± 70 years or A.D. 220 (Ishida et al., 1960, p. 518). This is earlier than expected if it refers to the Milagro culture, as the copper ax money would imply. However, the characteristics of the site and associated materials do not permit its identification with the Jambelí culture as it is known in Ecuador.

The only evidence in conflict with the chronological placement of the Jambelí culture between 500 B.C. and A.D. 500 is the few sherds of early Manteño types from surface collections at Sites G-L-30 and

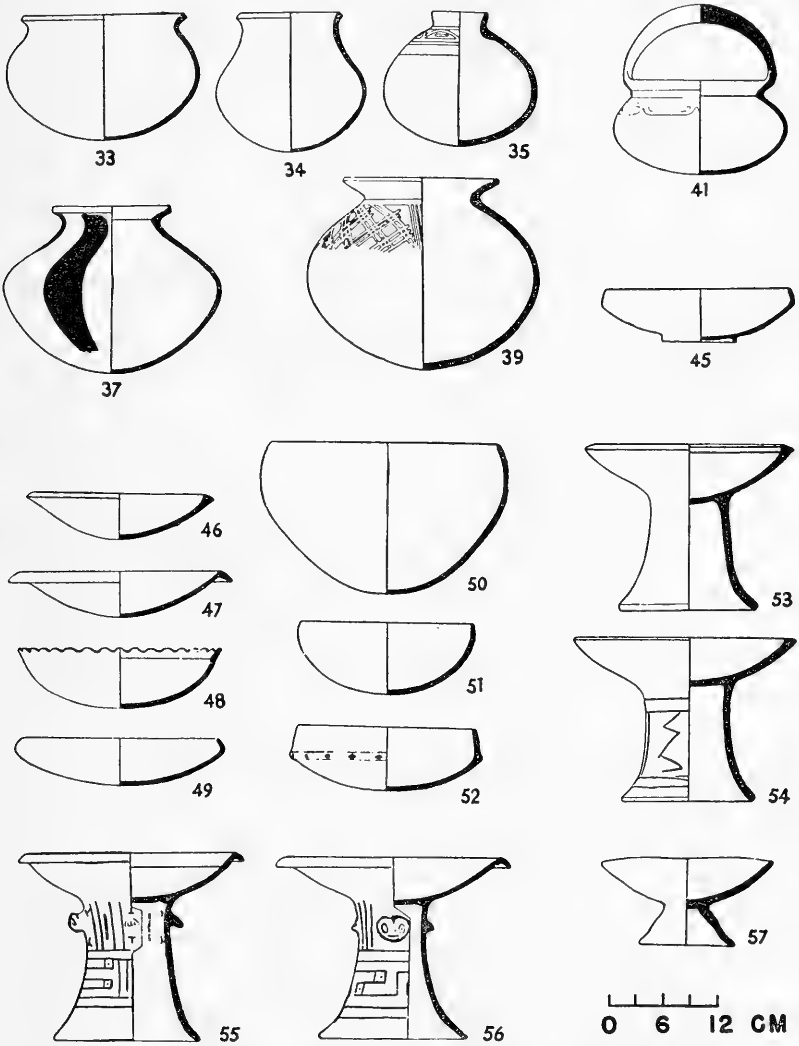

FIGURE 42.—Vessels of Jambelí shapes from the site of Garbanzal, Peru. Identifying numbers have been retained from the original figure (after Ishida et al., 1960, p. 120).

O-3. Bushnell (1951, p. 48) identifies this material with the Guangala culture also, and if he is correct it may be added to other evidence of trade relations with the Guangala Phase. The alternative is to attribute these few surface sherds to later visits by the Manteño, who are known to have occupied the Gulf of Guayaquil during the Integration Period (Estrada, 1957 a).

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TABLE 1.—*Frequency of pottery types*

Pottery types	Sites															
	G-84: Cut 1								G-86: Cut 1							
	0–10 cm.		10–20 cm.		20–30 cm.		30–40 cm.		0–20 cm.		20–40 cm.		40–60 cm.		60–80 cm.	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Jambelí Plain	777	55. 3	292	40. 4	324	25. 6	209	28. 2	76	26. 1	45	20. 7	24	18. 3	34	17. 5
Ayalan Plain	306	21. 7	239	33. 0	467	37. 0	256	34. 5	128	44. 0	111	50. 7	59	44. 9	95	49. 0
Posorja Polished Plain	–	–	11	1. 5	90	7. 2	41	5. 5	3	1. 1	13	6. 0	16	12. 2	16	8. 3
Jambelí Shell Scraped	17	1. 2	5	0. 7	7	0. 5	10	1. 3	3	1. 1	4	1. 8	5	3. 8	7	3. 6
Jambelí Polished Red	75	5. 3	44	6. 1	85	6. 7	60	8. 1	33	11. 3	15	7. 0	9	7. 0	16	8. 3
Jambelí White-on-Red	31	2. 3	23	3. 1	50	3. 9	27	3. 7	21	7. 2	12	5. 5	9	7. 0	10	5. 1
Jambelí Red Wash	111	7. 9	48	6. 6	118	9. 3	81	11. 0	12	4. 1	6	2. 7	5	3. 8	8	4. 1
Jambelí White Painted	–	–	2	0. 2	3	0. 3	2	0. 2	–	–	–	–	–	–	–	–
Jambelí Red Banded	22	1. 6	15	2. 1	27	2. 1	9	1. 2	14	4. 8	11	5. 1	3	2. 3	7	3. 6
Jambelí Negative	2	0. 1	–	–	–	–	1	0. 1	–	–	–	–	–	–	–	–
Jambelí White Wash	13	0. 9	10	1. 4	18	1. 4	2	0. 2	–	–	–	–	–	–	–	–
Jambelí Incised	8	0. 6	6	0. 8	–	–	2	0. 2	1	0. 3	–	–	–	–	–	–
Jambelí Punctate	11	0. 8	4	0. 5	10	0. 8	7	0. 9	–	–	1	0. 5	1	0. 7	–	–
Unclassified	–	–	–	–	–	–	3	0. 4	–	–	–	–	–	–	1	0. 5
Guangala Phase types	34	2. 4	25	3. 4	65	5. 2	32	4. 3	–	–	–	–	–	–	–	–
Manteño Phase types	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Totals	1, 407	100. 0	724	100. 0	1, 264	100. 0	742	100. 0	291	100. 0	218	100. 0	131	100. 0	194	100. 0

See footnote at end of table.

TABLE 1.—*Frequency of pottery types*—Continued

Pottery types	Sites															
	G-86: Cut 1								G-109		G-L-2		G-L-3		G-L-7	
	80–100 cm.		100–120 cm.		120–140 cm.		140–160 cm.		Surface		Surface		Surface		Surface	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Jambelí Plain	62	23. 0	50	18. 4	62	14. 0	22	9. 3	35	42. 6	15	48. 5	81	46. 3	23	49. 0
Ayalan Plain	142	52. 5	163	60. 0	272	61. 5	120	51. 0	26	31. 8	9	29. 2	78	44. 6	14	29. 8
Posorja Polished Plain	17	6. 3	27	10. 0	48	10. 8	32	13. 6	–	–	–	–	–	–	–	–
Jambelí Shell Scraped	19	7. 0	10	3. 7	16	3. 6	12	5. 1	5	6. 1	3	9. 6	10	5. 7	3	6. 4
Jambelí Polished Red	11	4. 1	5	1. 8	25	5. 6	30	12. 7	14	17. 1	3	9. 6	5	2. 8	7	14. 8
Jambelí White-on-Red	17	6. 3	12	4. 4	6	1. 3	7	2. 9	1	1. 2	–	–	–	–	–	–
Jambelí Red Wash	–	–	–	–	5	1. 1	–	–	–	–	–	–	–	–	–	–
Jambelí White Painted	–	–	–	–	2	0. 4	–	–	–	–	–	–	–	–	–	–
Jambelí Red Banded	1	0. 4	3	1. 1	5	1. 1	4	1. 7	–	–	–	–	–	–	–	–
Jambelí Negative	–	–	–	–	1	0. 2	6	2. 5	–	–	–	–	–	–	–	–
Jambelí White Wash	–	–	1	0. 3	–	–	–	–	–	–	–	–	–	–	–	–
Jambelí Incised	–	–	–	–	–	–	3	1. 2	–	–	1	3. 1	–	–	–	–
Jambelí Punctate	–	–	–	–	2	0. 4	–	–	1	1. 2	–	–	1	0. 6	–	–
Unclassified	1	0. 4	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Guangala Phase types	–	–	1	0. 3	–	–	–	–	–	–	–	–	–	–	–	–
Manteño Phase types	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Totals	270	100. 0	272	100. 0	444	100. 0	236	100. 0	82	100. 0	31	100. 0	175	100. 0	47	100. 0

See footnote at end of table.

TABLE 1.—*Frequency of pottery types*—Continued

Pottery types	Sites															
	G-L-9		G-L-12		G-L-27		G-L-28		G-L-29		G-L-30		G-L-34		G-Mo-3	
	Surface		Surface		Surface		Surface		Surface		Surface		Surface		Surface	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Jambelí Plain	2	–	1	–	27	46. 5	30	46. 1	10	–	852	47. 7	32	48. 5	115	47. 6
Ayalan Plain	1	–	–	–	19	32. 8	24	37. 0	8	–	508	28. 7	28	42. 5	91	37. 6
Posorja Polished Plain	–	–	–	–	–	–	–	–	–	–	3	0. 2	–	–	–	–
Jambelí Shell Scraped	–	–	1	–	1	1. 7	4	6. 2	–	–	52	2. 9	1	1. 5	10	4. 1
Jambelí Polished Red	1	–	1	–	10	17. 3	6	9. 2	2	–	280	15. 7	5	7. 5	22	9. 1
Jambelí White-on-Red	–	–	–	–	1	1. 7	1	1. 5	–	–	20	1. 1	–	–	–	–
Jambelí Red Wash	–	–	–	–	–	–	–	–	–	–	29	1. 6	–	–	1	0. 4
Jambelí White Painted	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jambelí Red Banded	–	–	–	–	–	–	–	–	–	–	2	0. 1	–	–	–	–
Jambelí Negative	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jambelí White Wash	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jambelí Incised	–	–	–	–	–	–	–	–	1	–	2	0. 1	–	–	3	1. 2
Jambelí Punctate	–	–	–	–	–	–	–	–	–	–	2	0. 1	–	–	–	–
Unclassified	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Guangala Phase types	–	–	–	–	–	–	–	–	–	–	6	0. 3	–	–	–	–
Manteño Phase types	–	–	–	–	–	–	–	–	–	–	27	1. 5	–	–	–	–
Totals	4		3		58	100. 0	65	100. 0	21		1, 783	100. 0	66	100. 0	242	100. 0

See footnote at end of table.

TABLE 1.—*Frequency of pottery types*—Continued

Pottery types	*Sites*															
	G-Mo-11		*G-Mo-15*		*G-Mo-17*		*O-3*		*O-5*		*O-5: Cut 1*					
	Surface		*Surface*		*Surface*		*Surface*		*Surface*		*0–20 cm.*		*20–40 cm.*		*40–60 cm.*	
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*
Jambelí Plain	31	59. 6	1	–	41	47. 7	716	35. 6	649	68. 5	320	78. 9	507	66. 6	295	54. 0
Ayalan Plain	17	32. 8	–	–	33	38. 4	716	35. 6	119	12. 6	48	11. 8	121	15. 9	103	18. 9
Posorja Polished Plain	–	–	–	–	–	–	4	0. 2	–	–	–	–	–	–	–	–
Jambelí Shell Scraped	1	1. 9	–	–	3	3. 4	151	7. 6	11	1. 2	–	–	4	0. 5	17	3. 1
Jambelí Polished Red	2	3. 8	–	–	7	8. 1	150	7. 5	71	7. 5	30	7. 0	77	10. 1	46	8. 5
Jambelí White-on-Red	–	–	–	–	–	–	99	4. 8	47	4. 9	5	1. 2	28	3. 6	36	6. 8
Jambelí Red Wash	1	1. 9	–	–	–	–	81	4. 0	30	3. 1	–	–	–	–	18	3. 3
Jambelí White Painted	–	–	–	–	–	–	20	1. 0	3	0. 3	–	–	6	0. 8	11	2. 0
Jambelí Red Banded	–	–	–	–	–	–	37	1. 8	1	0. 1	2	0. 5	–	–	1	0. 2
Jambelí Negative	–	–	–	–	–	–	4	0. 2	4	0. 4	–	–	5	0. 6	12	2. 2
Jambelí White Wash	–	–	–	–	–	–	13	0. 6	2	0. 2	1	0. 2	–	–	3	0. 5
Jambelí Incised	–	–	–	–	1	1. 2	6	0. 3	11	1. 2	1	0. 2	10	1. 3	–	–
Jambelí Punctate	–	–	–	–	1	1. 2	3	0. 1	–	–	1	0. 2	–	–	–	–
Unclassified	–	–	–	–	–	–	7	0. 3	–	–	–	–	5	0. 6	3	0. 5
Guangala Phase types	–	–	–	–	–	–	7	0. 3	–	–	–	–	–	–	–	–
Manteño Phase types	–	–	–	–	–	–	2	0. 1	–	–	–	–	–	–	–	–
Totals	52	100. 0	1		86	100. 0	2, 016	100. 0	948	100. 0	408	100. 0	763	100. 0	545	100. 0

See footnote at end of table.

TABLE 1.—*Frequency of pottery types*—Continued

Pottery types	Sites																
	O-5: Cut 1		*O-5*		*O-6*		*P-2: No. 1*		*P-8*		*P-9*		*P-12*		*P-13*		*Totals*
	60–80 cm.		*Test*		*Surface*		*Surface*		*Surface*		*Surface*		*Surface*		*Surface*		
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*
Jambelí Plain	271	49. 4	75	37. 9	117	29. 2	57	48. 7	18	10. 8	9	3. 6	168	53. 1	13	–	6, 488
Ayalan Plain	128	23. 4	56	28. 3	108	27. 0	52	44. 4	59	35. 3	130	52. 0	57	18. 0	13	–	4, 924
Posorja Polished Plain	–	–	–	–	3	0. 7	–	–	43	25. 7	68	27. 2	23	7. 2	–	–	458
Jambelí Shell Scraped	28	5. 0	3	1. 5	6	1. 5	2	1. 7	1	0. 6	6	2. 4	8	2. 5	–	–	446
Jambelí Polished Red	26	4. 7	20	10. 1	31	7. 7	5	4. 2	22	13. 2	21	8. 4	47	15. 0	1	–	1, 320
Jambelí White-on-Red	60	11. 7	21	10. 6	37	9. 2	–	–	10	6. 0	2	0. 8	6	2. 0	–	–	599
Jambelí Red Wash	14	2. 4	9	4. 6	61	15. 2	–	–	–	–	3	1. 2	–	–	–	–	641
Jambelí White Painted	15	2. 5	2	1. 0	6	1. 5	–	–	2	1. 2	–	–	–	–	–	–	74
Jambelí Red Banded	–	–	1	0. 5	2	0. 5	–	–	5	3. 0	6	2. 4	5	1. 6	–	–	183
Jambelí Negative	5	0. 8	2	1. 0	–	–	–	–	–	–	1	0. 4	2	0. 6	–	–	45
Jambelí White Wash	–	–	5	2. 5	–	–	–	–	2	1. 2	1	0. 4	–	–	–	–	71
Jambelí Incised	–	–	3	1. 5	18	4. 5	1	1. 0	–	–	2	0. 8	–	–	–	–	80
Jambelí Punctate	–	–	–	–	6	1. 5	–	–	–	–	1	0. 4	–	–	–	–	52
Unclassified	1	0. 1	1	0. 5	6	1. 5	–	–	5	3. 0	–	–	–	–	–	–	33
Guangala Phase types	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	170
Manteño Phase types	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	29
Totals	548	100. 0	198	100. 0	401	100. 0	117	100. 0	167	100. 0	250	100. 0	316	100. 0	27		[1]15,613

[1] Total for Guangala and Manteño Phases: 199. Total for Jambelí Phase: 15,414.

TABLE 2.—*Type and frequency of sherds of Guangala Phase pottery types*

Guangala Phase pottery types	*Jambelí Phase sites*															
	G-84: Cut 1								*G-86: Cut 1*		*G-L-30*		*O-3*		*Totals*	
	0–10 cm.		*10–20 cm.*		*20–30 cm.*		*30–40 cm.*		*100–120 cm.*		*Surface*		*Surface*			
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*
Barcelona Painted Dark Line	6	0. 4	14	1. 9	22	1. 7	12	1. 6	–	–	6	0. 3	–	–	60	
Guangala Polished Red	14	1. 0	1	0. 1	9	0. 7	–	–	–	–	–	–	–	–	24	
Guangala Burnished Line	3	0. 2	–	–	2	0. 2	3	0. 4	–	–	–	–	–	–	8	
Guangala Finger Painted	–	–	6	0. 8	23	1. 8	5	0. 7	–	–	–	–	–	–	34	
Chorrera Iridescent	1	0. 1	–	–	3	0. 3	3	0. 4	–	–	–	–	7	0. 3	14	
Incised	–	–	–	–	1	0. 1	–	–	–	–	–	–	–	–	1	
Plain	10	0. 7	4	0. 6	5	0. 4	9	1. 2	1	0. 3	–	–	–	–	29	
Totals [1]	34	2. 4	25	3. 4	65	5. 2	32	4. 3	1	0. 3	6	0. 3	7	0. 3	170	

[1] See Guangala Phase column in Appendix Table 1.

TABLE 3.—*Frequency of rim shapes*

Sites and levels arranged in seriated order [1]	Rim shapes															
	1		*2*		*3*		*4*		*5*		*6*		*7*		*8*	
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*
O-5: Cut 1:																
0–20 cm.	11	24. 0	–	–	–	–	13	28. 2	–	–	–	–	1	2. 2	–	–
20–40 cm.	39	41. 1	–	–	–	–	22	23. 2	1	1. 0	2	2. 1	1	1. 0	–	–
40–60 cm.	38	49. 3	–	–	–	–	6	7. 8	–	–	–	–	4	5. 2	–	–
P-12	7	–	1	–	4	–	–	–	–	–	–	–	1	–	–	–
G-84: Cut 1:																
0–10 cm.	21	12. 3	1	0. 6	8	4. 7	4	2. 3	–	–	3	1. 7	–	–	18	10. 5
O-5: Cut 1:																
60–80 cm.	22	45. 1	1	2. 0	–	–	6	12. 3	–	–	1	2. 0	2	4. 0	–	–
G-Mo-11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G-L-30	38	19. 0	7	3. 5	10	5. 0	3	1. 5	–	–	2	1. 0	–	–	17	8. 5
G-L-7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G-L-2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
G-L-27	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O-5: Test	13	25. 5	4	7. 8	–	–	10	19. 7	–	–	–	–	1	1. 9	–	–
G-109	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G-84: Cut 1:																
10–20 cm.	9	11. 8	1	1. 3	2	2. 6	1	1. 3	–	–	3	3. 9	1	1. 3	6	7. 9
G-Mo-3	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G-Mo-17	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G-L-28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P-2: No. 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G-L-3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O-6	31	16. 7	14	7. 6	2	1. 1	20	11. 0	10	5. 5	4	2. 2	4	2. 2	–	–
O-3	79	17. 1	15	3. 2	3	0. 6	89	19. 4	36	7. 8	23	4. 9	17	3. 7	–	–
G-84: Cut 1:																
20–30 cm.	35	21. 6	3	1. 9	8	4. 9	2	1. 2	4	2. 4	3	1. 9	1	0. 6	10	6. 2
30–40 cm.	26	33. 7	1	1. 3	5	6. 5	1	1. 3	–	–	2	2. 6	1	1. 3	8	10. 4

G-86: Cut 1:																
0–20 cm.	5	18. 6	–	–	2	7. 4	3	11. 1	1	3. 5	2	7. 4	–	–	–	–
20–40 cm.	1	–	1	–	5	–	1	–	–	–	–	–	–	–	–	–
40–60 cm.	1	–	1	–	2	–	1	–	–	–	–	–	–	–	1	–
60–80 cm.	2	–	–	–	8	–	–	–	–	–	–	–	–	–	–	–
80–100 cm.	1	4. 5	2	9. 0	7	32. 0	1	4. 5	–	–	–	–	–	–	1	4. 5
100–120 cm.	3	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–
120–140 cm.	5	23. 8	–	–	–	–	–	–	–	–	–	–	–	–	1	4. 7
140–160 cm.	5	23. 8	–	–	4	19. 1	–	–	–	–	–	–	–	–	–	–
P-8	5	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
P-9	7	21. 2	4	12. 1	–	–	–	–	–	–	–	–	–	–	–	–
Totals	407		56		73		183		52		45		34		62	

[1] See fig 39.

TABLE 3.—*Frequency of rim shapes*—Continued

Sites and levels arranged in seriated order [1]	*Rim Shapes*													
	9		*10*		*11*		*12*		*13*		*Unclassified*		*Totals*	
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*
O-5: Cut 1:														
0–20 cm.	4	8. 6	–	–	11	24. 0	–	–	–	–	6	13. 0	46	100. 0
20–40 cm.	11	11. 6	–	–	10	10. 5	–	–	–	–	9	9. 5	95	100. 0
40–60 cm.	18	23. 4	1	1. 3	8	10. 4	–	–	–	–	2	2. 6	77	100. 0
P-12	3	–	–	–	–	–	–	–	–	–	–	–	16	–
G-84: Cut 1:														
0–10 cm.	103	60. 2	4	2. 3	–	–	–	–	2	1. 3	7	4. 1	171	100. 0
O-5: Cut 1:														
60–80 cm.	10	20. 4	1	2. 0	1	2. 0	–	–	–	–	5	10. 2	49	100. 0
G-Mo-11	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G-L-30	114	57. 0	–	–	2	1. 0	–	–	1	0. 5	6	3. 0	200	100. 0
G-L-7	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G-L-2	2	–	–	–	–	–	–	–	–	–	1	–	3	–
G-L-27	3	–	–	–	–	–	–	–	–	–	–	–	4	–
O-5: Test	13	25. 5	–	–	5	9. 8	–	–	–	–	5	9. 8	51	100. 0
G-109	2	–	1	–	–	–	–	–	–	–	3	–	6	–
G-84: Cut 1:														
10–20 cm.	47	62. 0	–	–	1	1. 3	–	–	1	1. 3	4	5. 3	76	100. 0
G-Mo-3	1	–	3	–	–	–	–	–	–	–	–	–	5	–
G-Mo-17	2	–	–	–	–	–	–	–	–	–	–	–	3	–
G-L-28	3	–	–	–	–	–	–	–	–	–	–	–	3	–
P-2: No. 1	3	–	–	–	–	–	–	–	–	–	3	–	6	–
G-L-3	1	–	–	–	–	–	–	–	–	–	–	–	1	–
O-6	36	19. 5	2	1. 1	33	17. 9	5	2. 7	11	6. 0	12	6. 5	184	100. 0
O-3	134	29. 1	–	–	37	8. 1	5	1. 0	–	–	24	5. 1	462	100. 0
G-84: Cut 1:														
20–30 cm.	80	49. 5	6	3. 7	–	–	–	–	1	0. 6	9	5. 5	162	100. 0
30–40 cm.	24	31. 2	3	3. 9	–	–	1	1. 3	–	–	5	6. 5	77	100. 0

R-86: Cut 1:														
0–20 cm.	12	44. 6	1	3. 7	–	–	–	–	1	3. 7	–	–	27	100. 0
20–40 cm.	7	–	–	–	–	–	–	–	–	–	1	–	16	–
40–60 cm.	1	–	–	–	–	–	–	–	–	–	–	–	7	–
60–80 cm.	8	–	1	–	–	–	–	–	–	–	–	–	19	–
80–100 cm.	9	41. 1	–	–	–	–	–	–	–	–	–	–	21	–
100–120 cm.	5	–	–	–	–	–	–	–	–	–	–	–	10	–
120–140 cm.	13	62. 1	1	4. 7	1	4. 7	–	–	–	–	–	–	21	100. 0
140–160 cm.	11	52. 4	–	–	–	–	–	–	1	4. 7	–	–	21	100. 0
P–8	10	–	1	–	–	–	–	–	–	–	2	–	19	–
P–9	20	60. 6	–	–	–	–	–	–	–	–	2	6. 1	33	100. 0
Totals	710		25		109		11		18		106		1, 891	

[1] See fig. 39.

TABLE 4.—*Frequency of base forms, unusual vessel appendages, figurines, and bark beaters at sites of the Jambelí Phase*

Sites in order of seriated sequence (See fig. 39)	*Categories included*						
	Annular base	*Hollow polypod base*	*Solid polypod base*	*Lug*	*Spout*	*Figurine*	*Bark beater*
O-5: Cut 1:							
0-20 cm.	1	–	–	–	–	1	–
20-40 cm.	–	–	–	–	–	–	–
40-60 cm.	1	–	–	–	–	1	–
P-12	3						
G-84: Cut 1:							
0-10 cm.	–	1	–	–	–	–	–
O-5: Cut 1							
60-80 cm.	1	–	–	–	–	–	–
G-Mo-11	–	–	–	–	–	–	–
G-L-30	–	4	–	–	1	–	1
G-L-7	–	–	–	–	–	–	–
G-L-2	–	–	–	–	–	–	–
G-L-27	–	–	–	–	–	–	–
O-5: Test	1	–	–	–	1	–	–
G-109	–	–	–	–	–	–	–
G-84: Cut 1:							
10-20 cm.	–	2	–	–	1	–	–
G-Mo-3	–	–	–	–	–	–	–
G-Mo-17	–	–	–	–	–	–	–
G-L-28	–	–	–	–	–	–	–
P-2: No. 1	–	–	–	–	–	–	–
G-L-3	–	–	–	–	–	–	–
O-6	5	–	–	3	1	7	–
O-3	12	–	–	1	–	4	–
G-84: Cut 1:							
20-30 cm.	2	2	–	–	–	–	–
30-40 cm.	–	–	–	–	–	–	–
G-86: Cut 1:							
0-20 cm.	–	1	–	–	–	–	–
20-40 cm.	–	–	–	–	–	–	–
40-60 cm.	1	–	–	–	–	–	–
60-80 cm.	2	1	–	–	–	–	1
80-100 cm.	–	–	1	–	–	–	–
100-120 cm.	2	–	–	–	1 (?)	–	–
120-140 cm.	3	–	–	–	–	–	–
140-160 cm.	3	–	–	–	–	–	–
P-8	–	–	–	–	–	–	–
P-9	2	–	–	–	–	–	–
Totals	39	11	1	4	5	13	2

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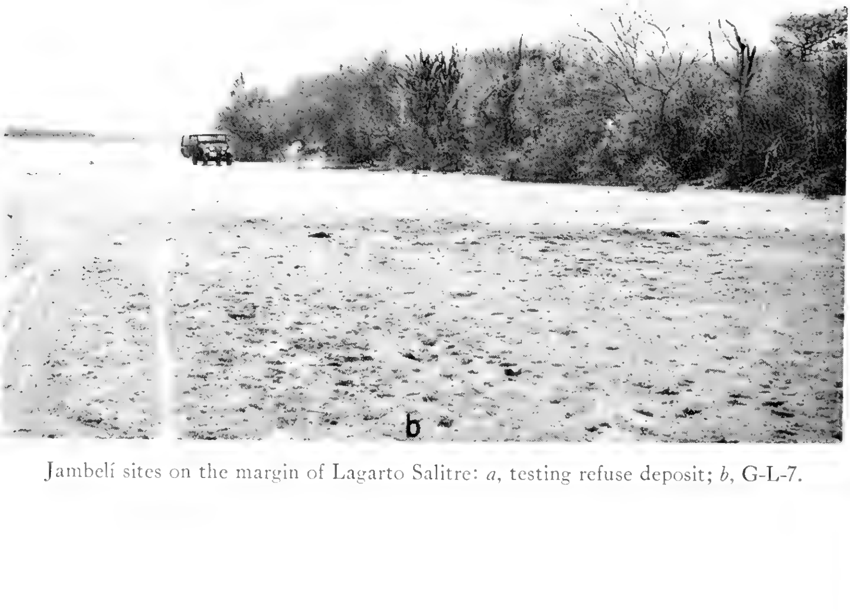
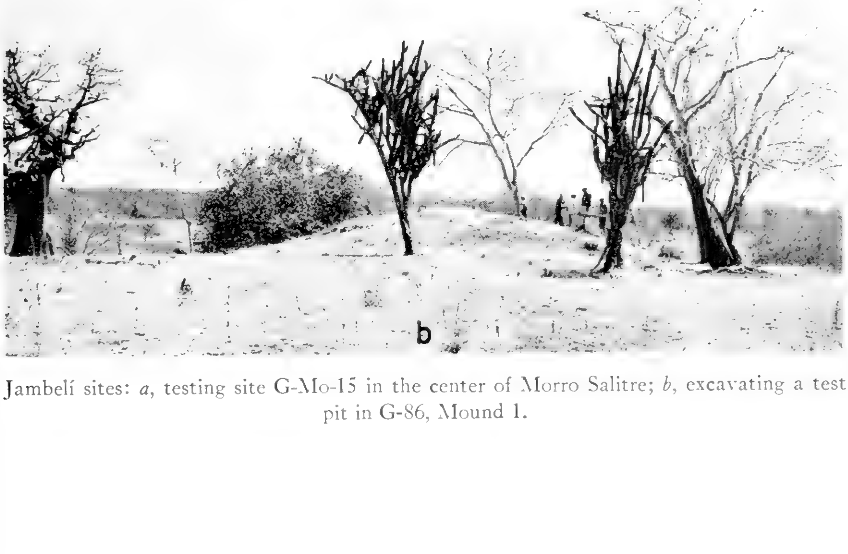
Jambelí sites in Lagarto Salitre: *a*, site on the margin of the *salitre*, showing present environment; *b*, closeup of refuse deposit showing concentration of shells.



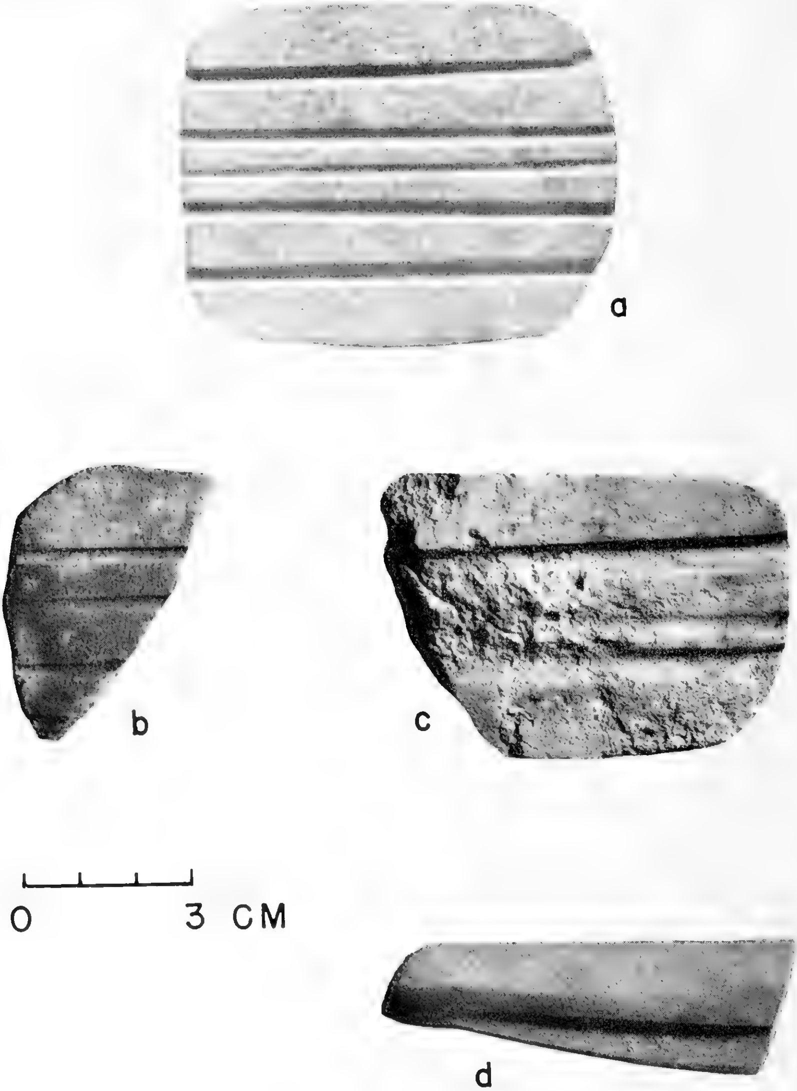
Jambelí sites on the margin of Lagarto Salitre: *a*, testing refuse deposit; *b*, G-L-7.



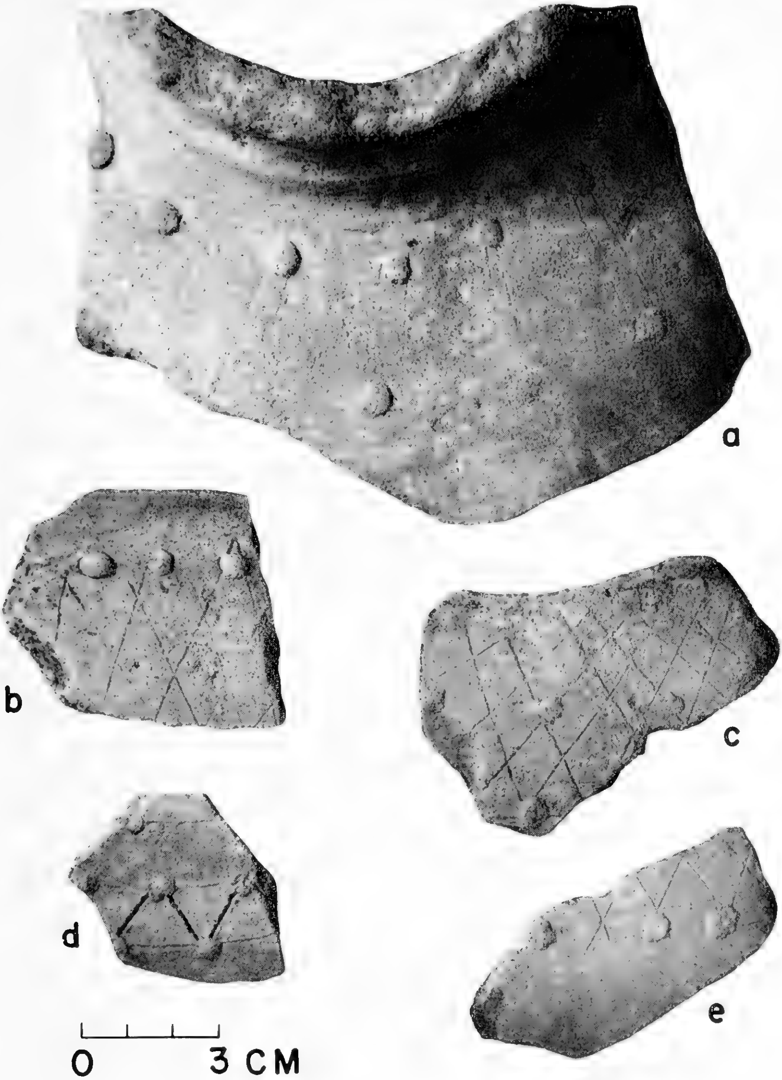
Jambelí sites: *a*, testing site G-Mo-15 in the center of Morro Salitre; *b*, excavating a test pit in G-86, Mound 1.

Jambelí sites in El Oro province: *a*, O-5: Embarcadero as seen from the water; *b*, O-6: Las Huacas, showing eroded bank and modern occupation of the site.

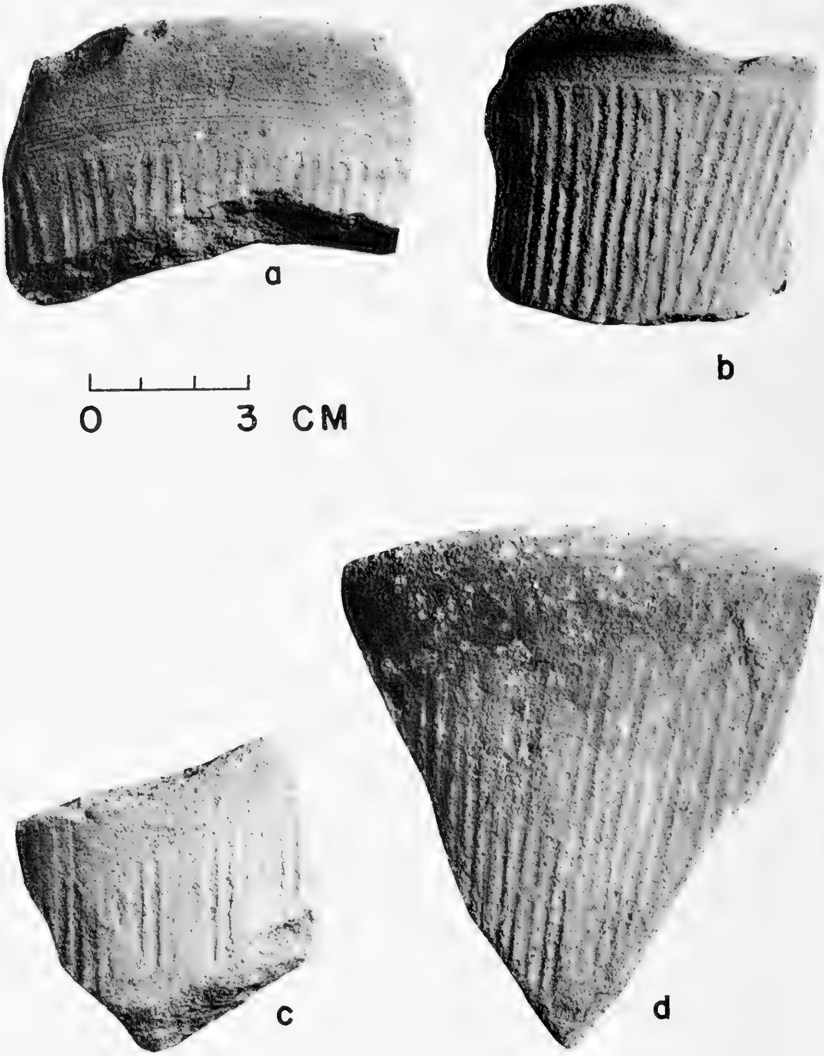
Views of P-2: Campo Alegre, occupying the slopes surrounding the *salitre*.



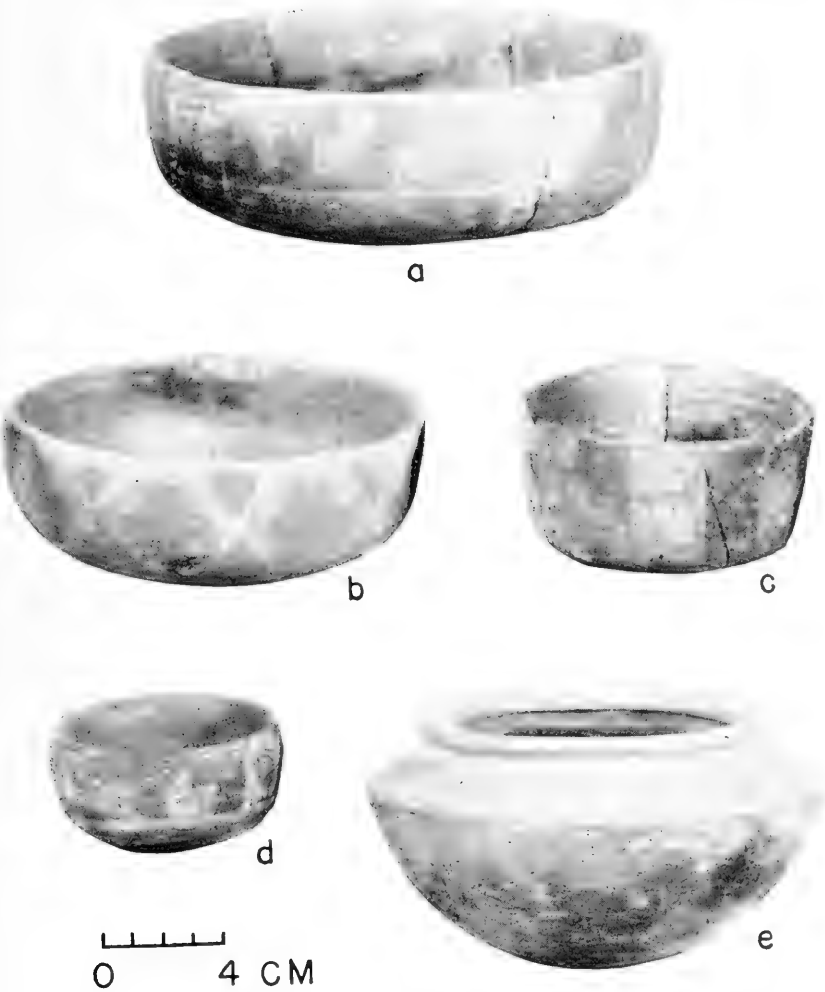
Stone artifacts of the Jambelí Phase: *a*, bark beater from M-7: Esteros, a site of the Bahía Phase; *b*, bark beater fragment from G-86, Cut 1, Level 60–80 cm.; *c*, bark beater from G-L-30, surface; *d*, saw or knife of sandstone from G-L-30.



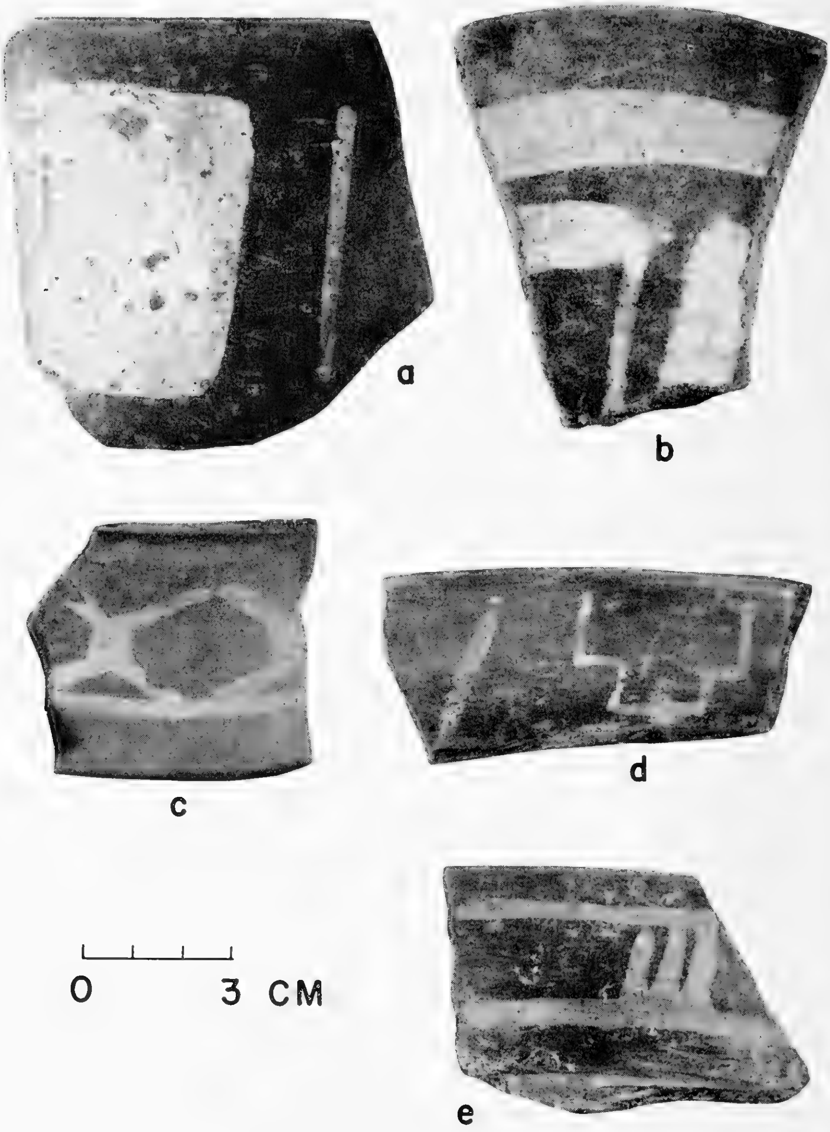
Sherds of Jambelí Incised, variety combining incision with applique nubbins.



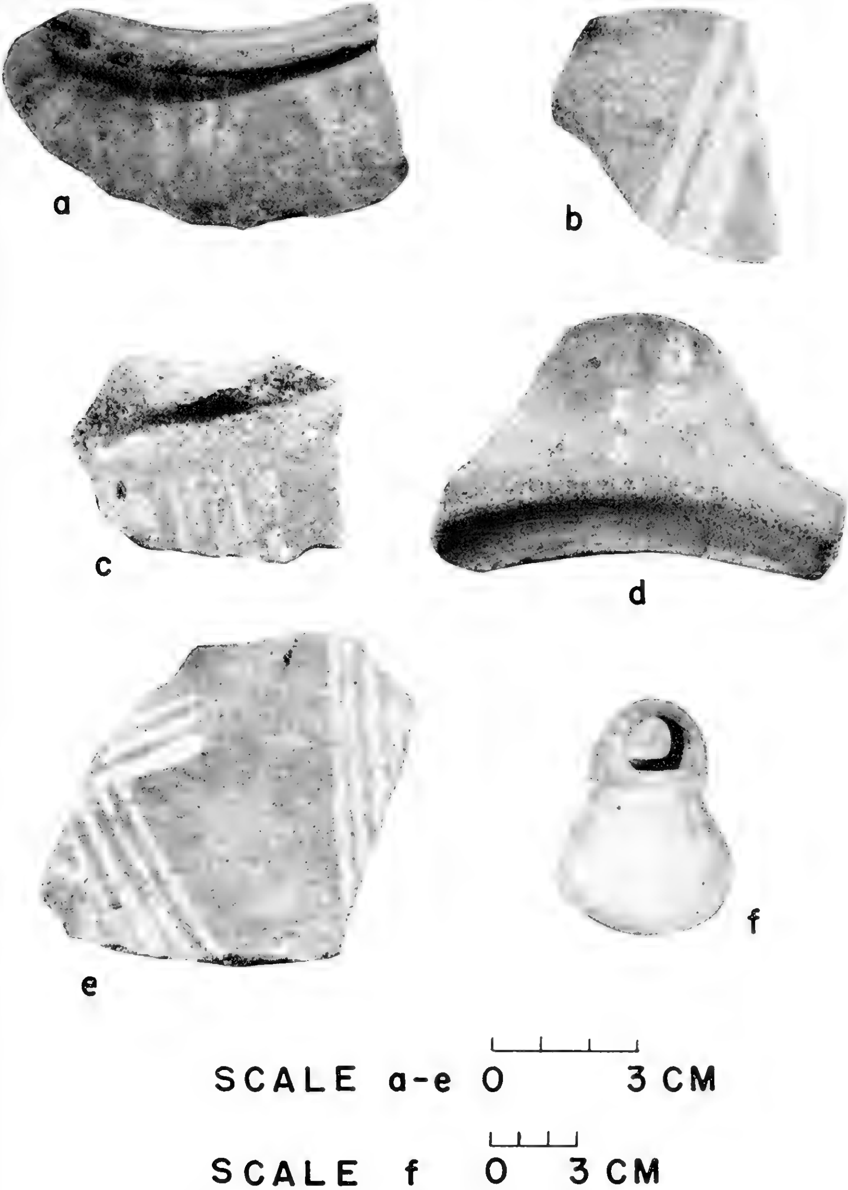
Sherds of Jambelí Shell Scraped.



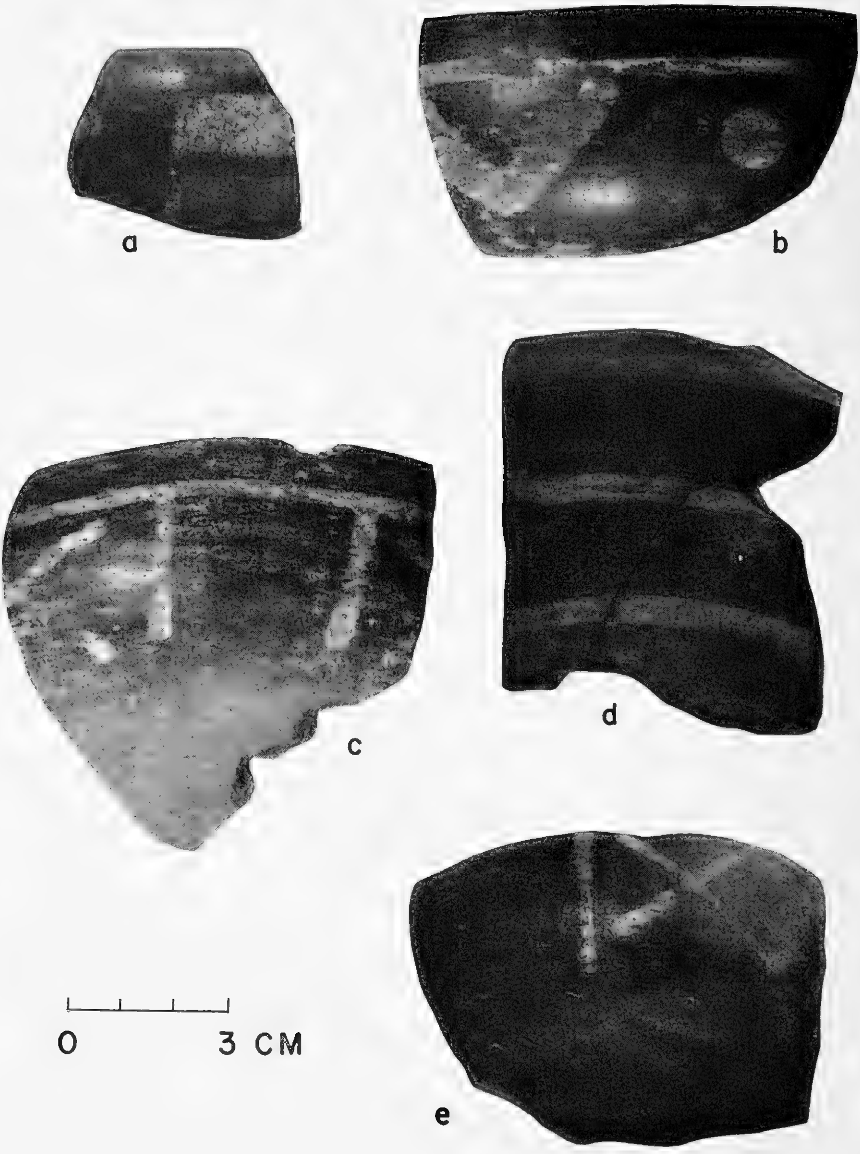
Vessels of Jambelí White-on-Red.



Sherds of Jambelí White-on-Red.



Sherds and miniature vessel of Jambelí White Painted.



Sherds of Guangala White-on-Red, of the Guangala Phase.

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A REVISION OF THE CARCHARHINID SHARK GENERA SCOLIODON, LOXODON, AND RHIZOPRIONODON

By Victor G. Springer

Introduction

The purpose of this paper is to revise the genera *Scoliodon*, *Loxodon*, and *Rhizoprionodon*. The most recent studies allocate all the species included in this report to a single genus, *Scoliodon*, and it is for this reason, together with their superficial resemblance to each other, that the three genera are treated together. While these genera do not seem to form a natural group, judgment of their relationships is deferred until the other genera of the family Carcharhinidae are more completely known.

Among the three genera, *Scoliodon* is quite distinct from the other two and easily distinguishable from all other Carcharhinidae. *Loxodon* and *Rhizoprionodon* perhaps are closely related, and it is possible that the two subgenera under *Rhizoprionodon* should be elevated to generic status. Differences separating the genera, as they are here recognized, are presented in the key, and their characteristics are discussed under the respective generic headings.

The characters previously used in assigning the species herein to a single genus and separating them primarily from *Carcharhinus* have never been adequately evaluated. These characters are the smooth and oblique teeth, the nature of the labial furrows, and, in *Loxodon*, the presence of a spiracle (see diagnosis under *Loxodon*). In addition to these characters, and more important, I find that the group can be conveniently, though not naturally, separated from other carcharhinids in having the origin of the second dorsal fin never in advance of the middle of the anal base and frequently over or behind the anal axil. The group differs from most carcharhinids in having the cusps of most teeth smooth although in the larger specimens of some *Rhizoprionodon* species the cusps become serrulate.

These characters are not unique; a few other carcharhinids, e.g., *Carcharhinus porosus* (Ranzani) and *C. borneensis* (Bleeker), have a posteriorly placed second dorsal origin (but never posterior to a vertical line through the middle of the anal base). These species, however, have noticeably serrated teeth, the upper teeth possessing very large basal serrations on the posterior (lateral) margins, and thus differ from all the species treated in the present study. Because *Carcharhinus porosus* and *C. borneensis* lack a long upper labial furrow, they might be confused superficially with *Scoliodon laticaudus*, *Loxodon macrorhinus*, *Rhizoprionodon oligolinx*, or *R. taylori*. Aside from the nature of the teeth, *Scoliodon* (q.v.) can be distinguished by its unique fin positions; *Loxodon* (q.v.), by its short dorsal fin base, by the second dorsal fin usually originating posterior to a vertical line through the anal axil, and by having a notched orbital rim; *Rhizoprionodon oligolinx* and *R. taylori*, by having the origin of the second dorsal fin over, or posterior to, a vertical line through the posterior third of the anal base.

Several species assigned to the genus *Scoliodon* have been described from fossil teeth. I choose not to treat them here as I believe the affinities of fossils based only on teeth are at present indecipherable and possibly will remain so in most cases. This viewpoint is based on the close similarity of teeth within the living genera included in the present study, as well as a similarity to the teeth of the distantly related Sphyrnidae. The problem is further confused by the heretofore unrecognized dental sexual dimorphism that is found in several carcharhinids, including *Rhizoprionodon* and *Scoliodon*. Relationships presently based only on teeth, therefore, are open to question.

The species of *Scoliodon*, *Loxodon*, and *Rhizoprionodon* are distributed primarily through the shallow tropical marine waters of the world, with some forms straying over moderate depths and into temperate areas. None of the species is known to occur in the Mediterranean or in Oceania.

All the species treated herein, with the possible exceptions of *Rhizoprionodon terraenovae* and *R. taylori*, are used commonly as food, and one, *Scoliodon laticaudus*, is considered a delicacy. The two exceptions noted should be edible also, but they have received little attention as food, possibly because of local prejudices in the areas where they occur.

The following abbreviations have been used in the text:

AMNH—American Museum of Natural History, New York
AMS—Australian Museum, Sydney
ANSP—Academy of Natural Sciences of Philadelphia
BMNH—British Museum (Natural History), London
CAS—California Academy of Sciences, San Francisco
CNHM—Chicago Natural History Museum
DHMB—Department of Harbors and Marine, Brisbane
DIRU—Department of Ichthyology, Rhodes University, Grahamstown, South Africa
GVF—George Vanderbilt Foundation (to be incorporated with SU—see below), Stanford, California
HUI—Hebrew University, Jerusalem, Israel
IFAN—Institute Francais d'Afrique Noire, Dakar, Senegal
IRSN—Institut Royal de Sciences Naturelles de Belgique, Brussels
ISH—Institut für Seefischeri, Hamburg
ISZZ—Institut für Spezielle Zoologie und Zoologisches Museum, Berlin
MCZ—Museum of Comparative Zoology, Harvard University
MNHN—Museum National d'Histoire Naturelle, Paris
MRAC—Musee Royal de l'Afrique Centrale, Tervuren, Belgium
NFIS—Natur-Museum und Forschungs-Institut Senckenberg, Frankfurt
NMV—Naturhistorisches Museum, Vienna
QMB—Queensland Museum, Brisbane
RNH—Rijksmuseum van Natuurlijke Historie, Leiden
SIO—Scripps Institution of Oceanography, La Jolla
SMNS—Staatliches Museum für Naturkunde, Stuttgart
SMW—Stadtisches Museum Wiesbaden
SU—Division of Systematic Biology, Stanford University
UCLA—University of California at Los Angeles
UMML—University of Miami Institute of Marine Science
UMMZ—University of Michigan Museum of Zoology, Ann Arbor
UND—University of Natal, Durban, South Africa
UWS—University of Washington, Seattle
USNM—United States National Museum, Washington
UZMK—Universitetets Zoologiske Museum, Kobenhavn
ZSZM—Zoologisches Staatinstitut und Zoologisches Museum, Hamburg

During the course of this study, I was afforded the opportunity of examining and radiographing specimens from the collections of a large number of American and foreign institutions; I was also furnished radiographs and data on several specimens I did not see.

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The drawings of the sharks were done by my generous colleague J. A. F. Garrick, and the shark teeth, by Dorothea B. Schultz.

Stewart Springer (no relation) read the manuscript and offered valuable criticisms.

During the course of the study I had the good fortune of having numerous discussions with, and suggestions from, J. A. F. Garrick. His perceptive comments and criticisms were of great value in improving the work and the manuscript.

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Methods and Definitions

Measurements.—Measurements on sharks are notoriously difficult to obtain with accuracy, and it is rare that one investigator can reproduce exactly another's measurements or even his own; nevertheless, proportions based on measurements are one of the few types of characters available for the description of sharks. But many errors originate in the twisted and distorted shapes that result from preservation procedures. The snout tip is one of the most important reference points on a shark, yet in numerous preserved specimens the tip has been pushed in, mashed, or crushed beyond reconstruction because the specimen has been forced into too small a bottle.

During the course of this study it became apparent that any given character—counts, fin shapes, fin positions, etc.—could vary widely within a species. Usually there would be at least one character in which each specimen of a particular species differed widely from all the remaining. The nature and extent of this variation was greater than I expected from my experience with teleostean fishes. For this reason, the reader should make allowances for variability when trying to fit his own specimens to my descriptions.

Total length (t.l.): Each specimen was laid on its side in a normal position on a standard fish measuring board (i.e., the caudal fin was not stretched to its fullest extent toward the midline of the body axis but was placed at what appeared to be its normal angle to the body). The total length is the distance from the tip of the snout (along the projected midline of the body axis) to a point on a vertical line through the tip of the upper lobe of the caudal fin.

This measurement contains two errors: (1) Because a shark in contour has a broad head and a narrow tail, the sagittal plane of its body is not parallel to the measuring board when the side of the shark is laid flat on the board. The total length measured along this inclined plane is shorter than the total length measured when the tail of the specimen is raised to make the sagittal plane parallel to the measuring board. The amount of error depends on the relative thicknesses of the head and tail.

(2) Total lengths of various sized specimens cannot be measured comparably because in many of the larger specimens there is a tendency for the axis of the upper caudal lobe to become raised in relation to the horizontal axis of the body. Thus, proportional measurements based on total lengths of large specimens appear greater than those based on the total lengths of smaller specimens, which may not actually be the case. (The angle also varies somewhat in sharks of the same size.)

Snout tip to—

outer nostrils: A straight pencil line was drawn between the anterior margins of each nostril. One point of a pair of dividers was placed on the tip of the snout and the other on the center of the line. The distance between the two points of the dividers was measured.

eye: Pencil lines were extended ventrally from the anterior rim of each orbit and joined on the underside of the head. One point of the dividers was placed on the tip of the snout and the other on the center of the line. The distance between the two points of the dividers was measured.

mouth: One point of the dividers was placed on the tip of the snout and the other on the tip of the lower jaw. The distances between the two points was measured.

gill-opening: (This and the next seven measurements were made with the specimen lying on its side on the measuring board.) A line was drawn across the underside of the head connecting the first gill-opening of each side at the point of its junction with the body. A right-angled triangle was placed vertically on the measuring board with the vertical edge crossing the midpoint of the line. The distance measured was the point where the base of the triangle intersected the scale on the measuring board.

pectoral origin: I found the origin of each pectoral fin by pressing my thumbnail at the junction of the anterior margin of that fin with the body and by locating the point of insertion of the hard internal element comprising that margin. This point on each fin was connected with a line across the ventral surface of the specimen, and the midpoint of this line was crossed by the edge of the triangle as above. The distance measured was the point where the base of the triangle intersected the scale on the measuring board. Frequently, because of deformities or poor preservation, one point of origin was much in advance of the other. By measuring the distance to the midpoint of the connecting line, I obtained the approximate distance to the true origin.

pelvic origin: This was determined and measured in a way similar to that of the pectoral origin.

first dorsal origin: The origin was found in the same manner as that used for the pectorals and pelvics. A line perpendicular to the measuring board (parallel to the anterior end of the board) was extended ventrally over the side of the shark and the vertical edge of the triangle was placed on this line; the distance along the measuring board was recorded.

second dorsal origin: The second dorsal origin is a difficult point to establish and can vary considerably with each investigator. I used the point which I subjectively considered to be the point where the sharp anterior edge of the fin first faded out as it passed into the dorsal body contour. A line was drawn ventrally from this point and the distance to it measured in the same manner as it was done for the first dorsal fin.

anal origin: This was determined and measured in the same manner as for the second dorsal origin except that it was necessary only to mark the origin and to place the vertical edge of the triangle on it.

upper caudal origin: This origin was determined to be at the point where the comparatively thin anterior dorsal edge of the upper caudal lobe faded into the dorsal body contour. The point is usually close to the posterior end of the upper precaudal pit. A line was extended ventrally, and, using the triangle, I measured the distance to this line.

lower caudal origin: This was obtained in a way similar to that used for the upper caudal origin except that it was necessary only to mark the origin.

Distance between the inner corners of the nostrils: Measured as the least distance between the two nostrils.

Mouth width: The distance between the corners of the mouth.

Mouth length: The distance from the tip of the lower jaw to the midpoint of a line connecting the corners of the mouth.

Upper labial furrow length: The distance from the anterior end of the upper furrow to the posterior tip of the fold formed by the furrow.

Lower labial furrow length: The distance from the anterior end of the lower furrow to the posterior tip of the fold formed by the upper furrow.

Gill-opening length: Measured by placing the divider points at the dorsal and ventral points of junction of the gill-opening with the body.

Eye diameter: The length of the horizontal diameter of the rim of the orbit.

First dorsal fin, second dorsal fin, and anal fin—

total length: Measured from the origin to the tip of the posterior margin of the fin. This measurement usually is slightly smaller than the sum of the next two measurements because of the difficulty of determining the exact anterior margin of the axil.

length of base: Measured from the origin to the axil. The latter point is determined by raising the posterior margin of the fin and placing one point of the dividers on the most posterior extension of the base. This point is somewhat posterior to the anteriorly extending furrow of the posterior margin.

length of posterior margin: The distance from the axil to the posterior tip of the fin.

height: A measurement perpendicular to the base of the fin made by placing one point of the dividers at the axil and the other at an imaginary point on the level of the tip of the anterior margin of the fin.

Pectoral and pelvic fins—

inner corner: The angle formed by the junction of the distal and posterior margins of the fin.

length of base: Measured in same manner as the vertical fins above.

length of anterior margin: Measured as the length of a straight line from the origin to the most distal point on the anterior margin of the fin.

length of distal margin: Measured as the length of a straight line from the most distal point on the anterior margin to the tip of the inner corner.

Pectoral width: Measured as the length of a line perpendicular to the anterior margin and extending to the tip of the inner corner.

Clasper length: Measured as the distance between the two points of a pair of dividers with one point in the axil of the pelvic fin and the other on the tip of the clasper.

During the course of this study I noticed the lack of male specimens with developing claspers. All males I examined had either juvenile or completely formed claspers. Plotting clasper lengths (as percent t.l.) against total length (see species accounts) established this impression. An explanation of the phenomenon probably lies in the fact that claspers do not mature gradually with the growth of the individual. Their growth to maturity begins abruptly and is completed in a very brief period of time and generally simultaneously within a given population (year class) of males. Some males with intermediately developed claspers undoubtedly will be collected, but only few in comparison with those having juvenile or completely developed claspers. Thus, puberty in males is of a much shorter duration than periods of complete immaturity or maturity. Heath (1960) noted that the claspers of *Squalus acanthias* and *Mustelus canis* mature rapidly with little increase in body length at time of maturation.

Caudal fin—

length of the upper lobe: Measured as the length of a straight line from the upper caudal origin to the distal tip of the upper lobe.

length of the lower lobe: Measured as the length of a straight line from the lower caudal origin to the distal tip of the lower lobe.

dorsal tip to notch: Measured as a straight line from the tip of the upper lobe to the distal tip of the notch.

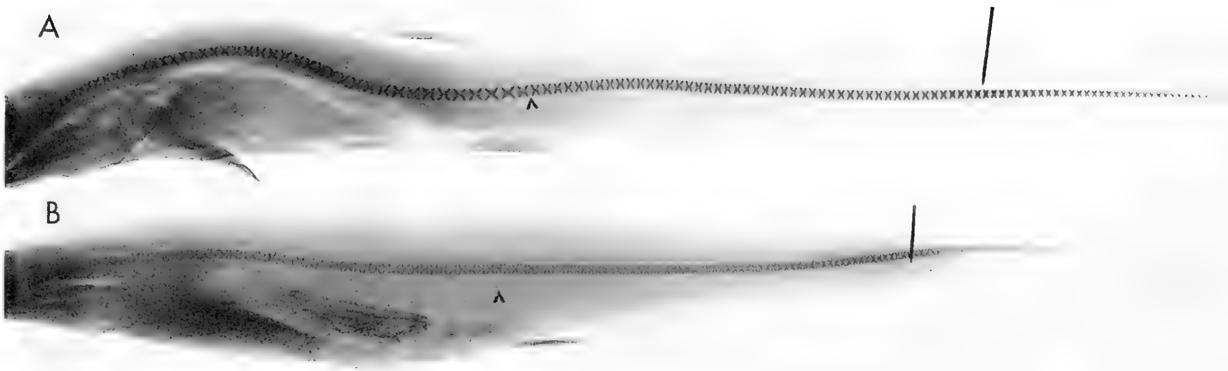
notch depth: Measured from the distal tip of the notch to the proximal end of its incision.

Dorsal-pectoral ratio.—This ratio is found by dividing the total length of the first dorsal fin by the length of the anterior margin of the pectoral fin and multiplying by one hundred (table 3).

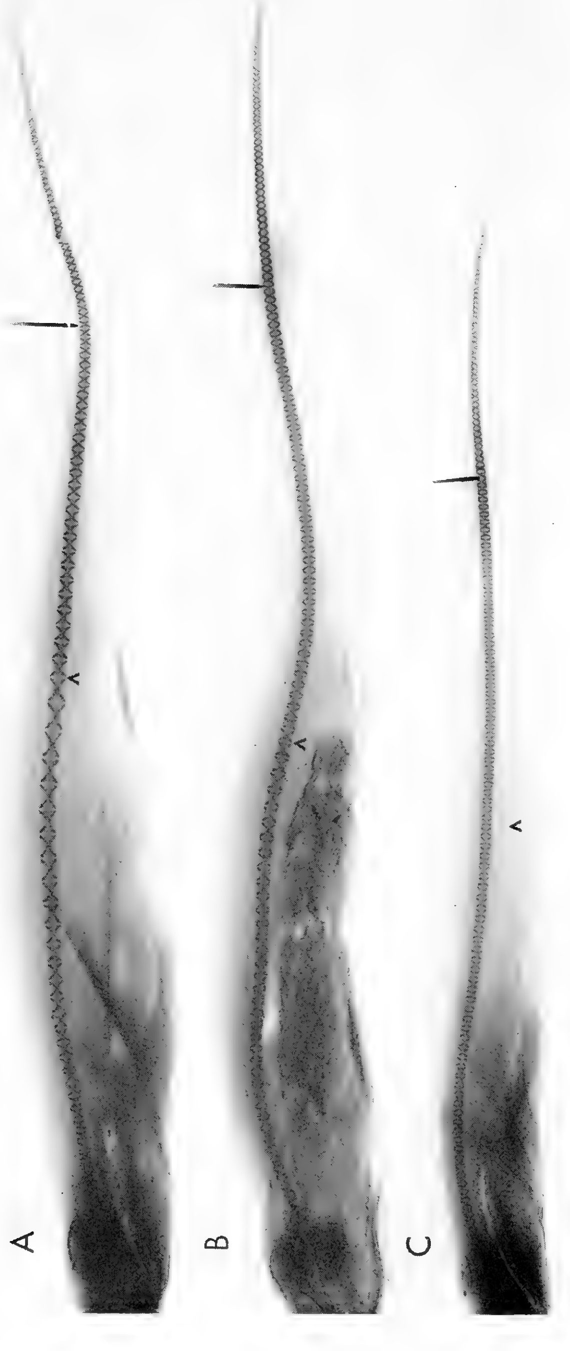
Counts.—Teeth: In this study only the upper jaw is considered to have a symphysial tooth, and there is always one, never more. The teeth on the outer margin of each jaw form a "row" and a single tooth of the row with those teeth aligned inward to it comprise a "series."

It was found that total counts of teeth in a row of either jaw gave more constant results than counts from a single ramus of either jaw.

The most posterior teeth of a ramus frequently are very small



RADIOGRAPHS.—Figure A: *Loxodon macrorhinus*, SU 26819, embryo, Oriental Negros, Philippine Islands (caret indicates presumable point where diplospondyli begins; pin indicates separation of precaudal from caudal vertebrae); Figure B: *Scoliodon laticaudus*, SU 32434, Chusan Island, Tinghai, China (caret indicates presumable region where diplospondyli begins; pin indicates separation of precaudal from caudal vertebrae).



RADIOGRAPHS.—Figure A: *Rhizoprionodon terraenovae*, USNM 125873, Mobile Bay, Alabama (caret indicates presumable point where diplospondyli begins; pin indicates separation of precaudal from caudal vertebrae); Figure B: *Rhizoprionodon lalandei*, USNM 100811, Bandeirantes, Brazil (caret indicates presumable point where diplospondyli begins; pin indicates separation of precaudal from caudal vertebrae); Figure C: *Rhizoprionodon oligolinx*, SU 41986, Calcutta, India (caret indicates presumable region where diplospondyli begins; pin indicates separation of precaudal from caudal vertebrae).

(sometimes a series consists of a single tooth) and extremely difficult to count. Competent colleagues, not engaged in elasmobranch studies, were given specimens on which to count the teeth and more often than not made significant errors. Caution, as well as magnification and good illumination, is recommended strongly for such counts.

Enlarged hyomandibular pores: In the genus *Rhizoprionodon*, there is a discrete group of comparatively large and noticeable pores of the hyomandibular series opening near the upper labial furrow and extending dorsoposteriorly a short distance (see figures of the various species). Frequently these pores are in a straight line, sometimes irregularly biserial. Some difficulty in counting was found when the pores were clogged or when they had not broken through the denticles (in small specimens). Counts should be made under magnification and any large gaps between pores should be searched for obscured members of the series. Sometimes the most anterior pore is well separated from the remaining ones. *Scoliodon* may have a few enlarged pores, but they are frequently difficult to find. (See also description of *Loxodon*.)

Vertebrae: Radiographs of sharks were made using a very fine-grain industrial film. The vertebral count was separated into two parts: (1) precaudal vertebrae, which includes all complete centra anterior to the forward edge of the upper precaudal pit; (2) caudal vertebrae, which includes those centra posterior to the precaudal vertebrae.

Precaudal vertebral counts are sometimes subject to an error of plus or minus two vertebrae. One reason for this is that to establish accurately the position of the first vertebra is not always possible because of masking by other structures behind the head, including the occipital condyles. Another is that sometimes an error in establishing the last precaudal vertebra occurs because of the angle with which the X-rays entered the body in the region of the precaudal pit; a two-dimensional parallax is created on the film. This last problem was circumvented in most instances by sticking a pin, to mark the first caudal vertebra, into the vertebral column immediately posterior to the anterior margin of the precaudal pit. The errors affect the counts very little.

At the tip of the caudal fin the last few vertebrae are frequently and irregularly fused (each fusion was counted as one vertebra), or they are too small to give good resolution on the film. Caudal vertebral counts were made under high illumination and magnification, and they are reasonably accurate for the purposes of this study.

In embryos, precaudal vertebrae are formed early, but caudal vertebrae are not completely formed until shortly before birth; therefore, precaudal, but not caudal, vertebral counts from embryos can be used (in *Loxodon*, for which I had few specimens, caudal counts of embryos were used). In those instances wherein several embryonic siblings or an embryo and its mother were available, none of the embryonic counts are reported in the tables. If only the embryo was available, the body count was included.

In the genus *Loxodon* and the type subgenus of *Rhizoprionodon*, the precaudal centra become gradually and markedly elongate (plates 1 and 2) to a point above the region between the anus and posterior pelvic base, where they become abruptly reduced in length. The point at which reduction occurs is presumably the point where diplospondyly begins. In *Scoliodon* and the subgenus *Protozygaena* (plates 1 and 2), the precaudal centra remain more or less constant in length and the point at which reduction takes place is noticeable only on close scrutiny. Sometimes the diplospondyly is irregular with elongate and reduced centra interspersed over a short distance.

Key to *Scoliodon*, *Loxodon*, and *Rhizoprionodon*

(Characters separating these three genera from other carcharhinid genera are discussed in the introduction; characters delimited in the key are not repeated in the generic or specific diagnoses and descriptions unless necessary.)

1a. Posterior tip of first dorsal fin extending to, or beyond (usually), a vertical line through the midbase of pelvic fin; origin of pectoral fin below, or only slightly in advance of, fifth-gill opening; distal tip of appressed pectoral fin over, or anterior (usually) to, its inner corner; snout tip to first dorsal origin 34.7–40.8 percent of total length; length of gill-openings equal to, or greater (usually) than, horizontal eye diameter; length of anal base 6.9–8.4 percent of total length; number of precaudal vertebrae exceeding number of caudal vertebrae by 43–57 (one specimen out of 98 had only 35 more precaudal vertebrae than caudal vertebrae) (Indo-Pacific).
Scoliodon laticaudus

1b. Posterior tip of first dorsal fin never extending much, if any, beyond a vertical line through the origin of pelvic fin; origin of pectoral fin below fourth to third gill-opening; distal tip of appressed pectoral fin posterior to its inner corner; snout tip to first dorsal origin 27.0–34.0 percent of total length; length of one or more gill-openings less than horizontal eye diameter; length of anal base 3.3–5.4 percent of total length; number of precaudal vertebrae ranging from 18 less than to 26 more than number of caudal vertebrae 2

2a. Posterior rim of orbit with a slight notch at midlevel; origin of dorsal fin posterior to appressed pectoral inner corner by a distance greater than length of the fourth gill opening; eye larger at all sizes (compare table 6 with tables 4, 10, 11, 13–17); mouth small, its width 4.9–5.9 percent of total length; its length 3.1–4.2 percent of total length; base of first dorsal fin 6.2–7.6 percent of total length; lengths of upper and lower labial furrows combined is less than 1.5 percent of total length (Indo-Pacific).
Loxodon macrorhinus

2b. Posterior rim of orbit without a notch; origin of dorsal fin rarely posterior to appressed pectoral inner corner by a distance as great as length of fourth gill-opening, usually over, or in advance of, appressed pectoral inner corner; eye smaller at all sizes; mouth larger, its width 6.2–7.8 percent of

TABLE 1.—*Frequency distribution of total teeth in outer row*

	Upper jaw											Lower jaw													
	23	24	25	26	27	28	29	30	31	32	33	21	22	23	24	25	26	27	28	29	30	31	32	33	34
S. laticaudus	–	–	3	6	35	10	26	6	3	–	1	–	–	–	2	5	17	12	31	5	13	1	2	–	2
L. macrorhinus	–	–	13	2	3	1	–	–	–	–	–	–	–	–	3	1	12	3	2	–	–	–	–	–	–
R. longurio	–	–	–	–	16	2	13	1	–	–	–	–	–	–	–	–	21	2	9	–	–	–	–	–	–
R. acutus	1	–	63	4	7	–	–	–	–	–	–	–	1	2	66	1	4	–	–	–	–	–	–	–	–
R. terraenovae	–	1	18	–	1	–	–	–	–	–	–	–	–	–	18	1	1	–	–	–	–	–	–	–	–
R. porosus	–	1	19	1	1	–	–	–	–	–	–	–	–	–	22	–	–	–	–	–	–	–	–	–	–
R. lalandei	–	–	21	–	–	–	–	–	–	–	–	–	–	2	19	–	–	–	–	–	–	–	–	–	–
R. oligolinx	30	6	19	–	–	–	–	–	–	–	–	1	42	4	8	–	–	–	–	–	–	–	–	–	–
R. taylori	8	1	–	–	–	–	–	–	–	–	–	1	8	–	–	–	–	–	–	–	–	–	–	–	–

	Both jaws																							
	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67
S. laticaudus	–	–	–	–	–	2	–	4	5	11	12	12	8	12	6	9	3	2	1	1	1	–	–	1
L. macrorhinus	–	–	–	–	–	3	1	9	1	1	1	3	–	–	–	–	–	–	–	–	–	–	–	–
R. longurio	–	–	–	–	–	–	–	–	–	16	2	3	2	8	1	–	–	–	–	–	–	–	–	–
R. acutus	–	–	–	2	2	59	2	6	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R. terraenovae	–	–	–	–	1	16	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R. porosus	–	–	–	–	1	19	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R. lalandei	–	–	–	–	2	19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R. oligolinx	1	28	6	9	4	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R. taylori	1	7	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 2.—*Frequency distribution of number of precaudal vertebrae minus number of caudal vertebrae*

	Minus 19–17	16–14	13–11	10–8	7–5	4–2	1–0–1	Plus 2–4	5–7	8–10	11–13	14–16	17–19	20–22	23–25	26–28	29–31	32–34	35–37	38–40	41–43	44–46	47–49	50–52	53–55	56–58
S. laticaudus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	5	18	30	29	11	4
L. macrorhinus	–	–	–	–	–	–	1	2	6	7	1	–	1	–	3	1	–	–	–	–	–	–	–	–	–	–
R. longurio	–	–	1	–	1	9	12	7	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R. acutus	1	7	24	36	28	27	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R. terraenovae	2	8	26	28	7	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R. porosus	–	3	9	25	14	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R. lalandei	–	–	–	–	–	–	–	–	2	13	15	12	2	1	–	–	–	–	–	–	–	–	–	–	–	–
R. oligolinx	–	–	–	–	–	–	–	–	2	–	4	19	20	5	2	–	–	–	–	–	–	–	–	–	–	–
R. taylori	–	–	–	–	–	–	–	–	–	2	4	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 3.—*Frequency distribution of dorsal-pectoral ratios (total length of first dorsal fin divided by length of pectoral anterior margin times 100)*

	80 81	82 83	84 85	86 87	88 89	90 91	92 93	94 95	96 97	98 99	100 101	102 103	104 105	106 107	108 109	110 111	112 113	114 115	116 117	118 119	120 121	122 123	124 125	126 127	128 129	130 131	132 133	134 135	136 137
S. laticaudus	–	–	–	–	–	–	–	–	–	–	–	1	–	2	3	2	2	7	1	3	3	3	1	3	1	1	1	–	2
L. macrorhinus	1	2	3	3	2	4	2	2	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R. longurio	–	–	–	–	–	–	3	1	–	1	5	4	4	2	2	2	2	1	1	4	–	–	–	–	–	–	–	–	–
R. acutus	–	–	–	–	–	5	1	2	8	7	22	16	16	12	9	3	–	1	–	–	–	–	–	–	–	–	–	–	–
R. terraenovae	1	–	–	2	3	3	5	6	9	3	2	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R. porosus	–	–	2	–	6	3	6	7	5	3	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R. lalandei	–	–	–	–	–	–	–	–	–	–	1	–	4	3	5	6	1	–	5	–	6	2	–	–	–	–	–	–	–
R. oligolinx	–	–	–	–	–	–	–	–	–	–	–	1	1	2	8	4	6	7	2	8	4	3	1	–	–	–	–	–	–
R. taylori	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	1	4	1	–	–	–	–	–	–	–

total length: its length 4.1–5.3 percent (usually more than 4.2 percent) of total length; base of first dorsal fin 7.8–10.9 percent of total length (only one specimen out of 70 below 8.3 percent); lengths of upper and lower labial furrows combined is more than 1.5 percent of total length. **3 Rhizoprionodon**

3a. Upper labial furrow short or virtually absent, 0–1.3 percent of total length (rarely more than 1 percent), usually shorter than lower labial furrow; teeth modally fewer (see tables 1–3) 4

3b. Upper labial furrow longer, always present, more than 1.1 percent of total length (usually more than 1.3 percent), rarely shorter than lower labial furrow; teeth modally more (see tables 1–3) 5

4a. Total enlarged hyomandibular pores on both sides of head 7–16 (only 2 of 54 specimens with more than 14); precaudal vertebrae 84–91 (Indo-Pacific north of Australia) . . . . **Rhizoprionodon oligolinx**

4b. Total enlarged hyomandibular pores on both sides of head 15–22; precaudal vertebrae 73–80 (Australia) . . . . **Rhizoprionodon taylori**

5a. Total teeth in outer row of both jaws 53–58; total teeth in outer row of lower jaw 26–28; total teeth in outer row of upper jaw 27–30; snout tip to outer nostrils usually longer at any given size (fig. 1), ranging from 4.5–6.0 percent of total length (Eastern Pacific) . . . **Rhizoprionodon longurio**

5b. Total teeth in outer row of both jaws 47–53 (only 2 specimens out of 74 of *R. acutus* with 53); total teeth in outer row of lower jaw 22–26 (only 1 specimen out of 19 of *R. terraenovae* and 4 of *R. acutus* with 26); total teeth in outer row of upper jaw 23–27 (1 specimen each of *R. porosus* and *R. terraenovae* and 7 of *R. acutus* with 27); snout tip to outer nostrils usually shorter at any given size (fig. 1), 3.2–4.5 percent of total length in *R. porosus* and *R. terraenovae*, 4.4–5.1 percent in *R. lalandei*, 4.0–5.4 percent in *R. acutus* (other than Eastern Pacific) 6

6a. Tip of appressed pectoral fin fails to reach level of middle of first dorsal base; dorsal-pectoral ratio 100–123 (only 1 out of 33 specimens with less than 105); clasper length 5.9 percent or more of total length in males 500 mm. or larger; largest specimen seen: 640 mm.; precaudal vertebrae 79–90 (rarely less than 84), outnumbering caudal vertebrae 5–20 (usually 7 or more); centra in posterior monospondylous region scarcely longer than those in anterior diplospondylous region (pl. 2B) (Western Atlantic). **Rhizoprionodon lalandei**

6b. Tip of appressed pectoral fin reaches to, or beyond, level of middle of first dorsal base (for dorsal-pectoral ratio, see 7a and 7b); clasper length 3.9 percent or less in males less than 620 mm.; attaining a length of over 1000 mm.; precaudal vertebrae 55–79, equal to, or fewer in number than, caudal vertebrae (one specimen of *R. acutus* with one more caudal vertebra than body vertebrae); centra in posterior monospondylous region markedly longer than those in anterior diplospondylous region (pl. 2A) 7

7a. Snout tip 4.0–5.4 percent of total length, usually greater at any given size (fig. 1); dorsal-pectoral ratio usually larger (91–114, most specimens 100 or more, table 3) (Africa to Australia) . . . . . **Rhizoprionodon acutus**

7b. Snout tip 3.2–4.5 percent of total length, usually smaller at any given size (fig. 1); dorsal-pectoral ratio usually smaller (81–104, few specimens over 100, table 3) (Western Atlantic) 8

8a. Precaudal vertebrae 58–66 (1 specimen out of 74 with 66, North Carolina) (Atlantic and Gulf coasts of the United States and Mexico). **Rhizoprionodon terraenovae**

8b. Precaudal vertebrae 66–75 (2 specimens out of 58 with 66, Brazil) (Western Atlantic except United States and Mexico) . . **Rhizoprionodon porosus**

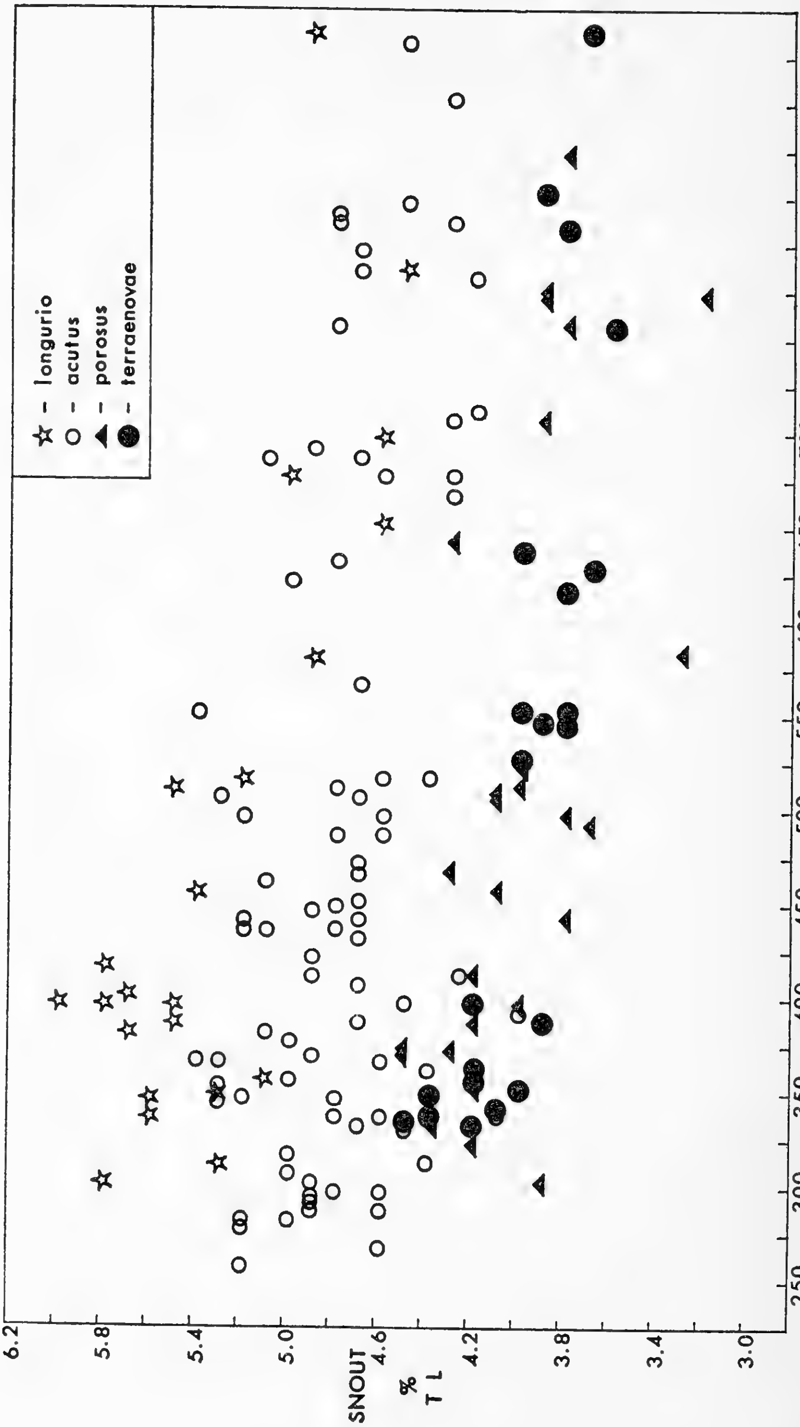


FIGURE 1.—Snout tip to outer nostrils as percent of total length versus total length in the subgenus *Rhizoprionodon*.

Scoliodon Müller and Henle

Scoliodon Müller and Henle, 1837, Sitzb. Akad. Wiss. Berlin, p. 114 (name only).

Scoliodon Müller and Henle, 1837, Arch. Naturg., vol. 3, no. 1, p. 397 (name and diagnosis).

Scoliodon Müller and Henle, 1838, L'Institut, vol. 6, no. 244, p. 64 (name and diagnosis).

Scoliodon Müller and Henle, 1838, Mag. Nat. Hist., new. ser., vol. 2, p. 35 (name and diagnosis).

Scoliodon Müller and Henle, 1841, Systematische Beschreibung der Plagiostomen, 2nd page 27 (a subgenus with three included species; type species *Carcharias* (*Scoliodon*) *laticaudus* Müller and Henle, by subsequent designation, Gill, 1862, Ann. New York Lyc., vol. 8, p. 401).

Physodon Valenciennes *in* Müller and Henle, 1841, Systematische Beschreibung der Plagiostomen, p. 30 (a subgenus; type species *Carcharias* (*Physodon*) *mülleri* Valenciennes by monotypy).

In several copies of Müller and Henle (1841), except that in the British Museum, seen by me, there are two pages numbered 27 and two numbered 28. The first page 27 lists *Scoliodon* as a new genus and the description terminates and is complete at the bottom of the first page 28. The second page 27 lists *Scoliodon* as a subgenus and the description continues from page 28 to page 29. Obviously, the first pair of pages were not meant to be included and their elimination from the text causes no discontinuity. This is not so with the second pair. For nomenclatural purposes I disregard the first pages 27 and 28.

Bigelow and Schroeder (1948, p. 292) included in their synonymy of *Scoliodon* (which embodies all three genera treated in my study) the genus *Cynocephalus* (not *Cynocephalus* Gill, 1862) which they attributed to Bleeker (1879). They designated *Carcharias* (*Scoliodon*) *macrorhynchus* Bleeker (1852, but 1858 in their work) as type species. However, Bleeker (1878) first used the name *Cynocephalus* for a group of shark species that did not include *C.* (*S.*) *macrorhynchus;* therefore, Bigelow and Schroeder were in error in dating the genus from 1879 and *C.* (*S.*) *macrorhynchus* could not be designated as type species for the genus.

Cynocephalus was first used validly in 1768 for a genus of mammals; Bleeker's usage of the name was apparently an extrapolation from Gill (1862), who gave a key to shark genera and designated *Squalus glaucus* Linnaeus as type species of *Cynocephalus*, listing no other species. For these reasons, I do not believe Bleeker was creating a genus, and future workers should refrain from selecting a type from Bleeker and erecting an additional junior homonym.

Diagnosis.—Small sharks (largest specimen seen 581 mm. t.l.) distinct from all other Carcharhinidae in having the tip of the posterior margin of the first dorsal fin extending posteriorly beyond the level of the origin of the pelvic fin to a point over, or beyond (usually), the middle of the pelvic base; distinct from all Carcharhinidae except *Aprionodon isodon*, *Carcharhinus oxyrhynchus*, and *C. temmincki* in having the origin of the pectoral fin below, or only slightly in advance of, the level of the fifth gill-opening. Differing from most Carcharhinidae in having the outer tip of the appressed pectoral fin over, or in advance of, its inner corner and from all Carcharhinidae in having both the tip and inner corner well in advance of the level of the origin of the first dorsal fin. The origin of the second dorsal fin ranges from above the posterior third of the anal base to over the anal axil. It is usually over the posterior fifth of the anal base.

A single common species distributed from the coasts of Japan and southeast Asia to India and the Dutch East Indies, exclusive of New Guinea, and absent also from Australia, the Philippines, and Oceania. At the present time I know of no close relative to this genus among the other carcharhinid genera.

Scoliodon laticaudus Müller and Henle

FIGURES 2, 3; PLATE 1B

"Pala Sorra" Russell, 1803, Descriptions and figures of two hundred fishes . . . Coromandel, vol. 1, p. 9, fig. 14 (a common name).

Carcharias (Scoliodon) laticaudus Müller and Henle, 1841, Systematische Beschreibung der Plagiostomen, p. 28, pl. 8 (India).

Carcharias (Physodon) mülleri Valenciennes *in* Müller and Henle, 1841, ibid., p. 30, pl. 19, fig. 1 (Bengal).

Carcharias (Scoliodon) macrorchynchos Bleeker, 1852, Verh. Bataviaasch Gen., vol. 24, p. 31, pl. 1, fig. 1 (Batavia, spelled *macrorhynchos* in other parts of the paper and in subsequent literature).

Carcharias palasorra Bleeker, 1853, Verh. Bataviaasch Gen., vol. 25, p. 9 (Coromandel, based on "Pala Sorra" Russell, see discussion below).

DIAGNOSIS.—Distinctive characters are those of the genus (p. 568).

DESCRIPTION (see also table 4).—Body vertebrae 97–112 (table 5), centra not markedly elongate in posterior monospondylous region (pl. 1B); caudal vertebrae 50–62, total vertebrae 148–171; teeth smooth-edged, upper teeth 12–1–12 to 16–1–16; lower teeth 12–12 to 17–17 (higher, or lower, counts in upper and lower jaws correlated); enlarged hyomandibular pores 0–5 on each side of head (rarely more than 2; frequently difficult to see).

Denticles imbricate, 3-ridged and 3-toothed in young, 3- to 5-ridged and 3- to 4-toothed in adults.

Color of preserved specimens: Buff brown, purplish brown, or gray brown, darker above, pale below; fins sometimes darker than body; edges of fins at all sizes without dark margins except sometimes the dorsal and distal edges of the upper caudal lobe; in adult males the distal third of clasper abruptly paler than remainder.

The appearance of this species is most striking for its comparatively long and greatly depressed snout (snout in front of nostrils is up to 7.0 percent of t.l. and almost always more than 5.4 percent).

The upper labial furrow is developed poorly and exists only as a short crease directed at a right angle from the lower furrow, which is visible when the mouth is closed.

There is no interdorsal ridge and the lower precaudal pit is essentially obsolete.

Growth changes (see table 4): Snout length to outer nostrils, eye, mouth, first gill-opening, pectoral origin, and pelvic origin tend to decrease in percent of t.l. with increased t.l., as do distance between inner nostrils, mouth width, gill-opening lengths, and eye diameter. Height of first dorsal fin, anterior and distal margins of pectoral fin, width of pectoral fin and distance from tip of caudal fin to notch tend to increase with increased t.l.

In the largest specimens examined the axis of the upper caudal lobe has been raised in relation to the horizontal axis of the body as compared with the condition in small specimens (even including mature individuals; see fig. 2).

Males may mature at about 350 mm. t.l. as determined by what appears to be a fully developed clasper (when the clasper is about 8 percent of t.l.). The following tabulation for *Scoliodon* indicates that claspers gradually increase in proportionate length until the shark reaches about 350 mm. t.l. The clasper lengths then increase abruptly and remain more or less constant in proportionate length until the shark is about 450 mm. t.l. At this point there is a gradual decrease in proportionate clasper length.

Locality	*T.L.*	*Clasper Length* (%)	*Locality*	*T.L.*	*Clasper Length* (%)
India	126	2.9	China	344	2.9
India	165	2.4	Malaya	352	8.5
India	167	2.7	China	360	2.8
India	174	2.9	India	378	9.8
India	176	2.3	India	389	8.8
India	185	2.9	Malaya	392	8.9
China	188	2.2	India	423	9.2
India	207	3.5	Ceylon	426	9.4
India	236	3.0	India	455	9.6
India	238	4.0	India	484	7.7
India	240	3.7	India	506	8.9
India	257	4.2	China	581	8.1

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TABLE 4.—*Proportional dimensions in percent of total length of* Scoliodon laticaudus

	♀ 153 mm. India SU 41984	♂ 165 mm. India SU 41984	♂ 207 mm. India SU 41983	♀ 228 mm. China USNM 86334	♀ 277 mm. China SU 32434	♀ 323 mm. China SU 32434	♂ 352 mm. Malaya SU 38377	♂ 378 mm. India SU 41982	♀ 460 mm. India SU 14444	♀ 462 mm. China SU 13969	♂ 484 mm. India MNHN 1041 [1]	♀ 518 mm. India MNHN 1123 [2]	♀ 542 mm. India USNM 196135
Snout tip to:													
outer nostrils	6.8	7.0	6.3	6.4	6.9	6.2	5.7	5.6	5.6	6.3	5.2	6.1	6.0
eye	10.5	11.2	10.4	9.6	10.8	9.9	9.4	9.0	8.7	9.6	7.8	8.5	8.9
mouth	10.5	11.2	9.6	9.2	10.5	9.6	8.8	8.2	8.3	9.1	7.4	8.7	8.7
1st gill-opening	22.8	23.6	20.8	19.7	21.3	18.9	18.8	17.5	18.0	18.8	16.1	17.0	18.4
pectoral origin	27.4	28.4	25.2	24.6	25.2	24.2	23.6	21.7	22.4	22.5	20.9	22.4	24.6
pelvic origin	47.1	49.6	47.8	47.8	48.8	46.9	45.4	45.8	47.4	44.8	44.4	45.8	47.0
1st dorsal origin	40.5	40.6	39.2	40.8	37.8	37.4	36.4	36.5	35.8	35.7	34.7	35.1	37.8
2nd dorsal origin	66.7	66.0	65.7	66.7	66.1	65.5	66.7	66.3	65.7	64.5	65.4	64.9	68.4
anal fin origin	61.5	60.6	62.3	60.5	60.3	58.8	60.0	59.4	60.5	57.7	59.5	59.4	61.4
upper caudal origin	79.0	78.6	77.7	78.5	77.6	76.8	76.1	76.2	78.9	77.0	79.7	77.4	79.0
lower caudal origin	75.8	76.4	75.8	75.5	74.7	74.4	74.2	73.2	75.6	74.5	76.0	75.0	76.0
Nostrils:													
distance between inner corners	7.2	7.0	6.6	6.6	6.5	6.5	5.7	5.8	5.2	4.8	5.0	5.3	5.4
Mouth:													
width	7.8	7.3	7.5	7.4	6.7	6.5	7.1	5.8	5.6	6.3	5.7	6.2	6.1
length	5.9	6.7	6.3	6.1	5.1	5.3	5.4	5.0	5.0	4.0	4.5	4.9	4.8
Labial furrow lengths:													
upper	0.0	0.4	0.4	0.4	0.4	0.4	1.1	0.1	0.1	0.3	0.2	0.1	0.2
lower	0.8	0.9	1.4	0.6	1.1	0.9	2.8	0.7	0.6	0.4	1.0	1.1	1.1
Gill-opening lengths:													
1st	3.3	3.0	3.0	2.6	2.3	2.2	2.6	2.5	2.2	1.9	1.8	2.2	2.7
2nd	3.3	3.2	3.3	3.0	2.7	2.5	2.8	2.9	2.6	2.2	2.1	2.1	3.2
3rd	3.3	3.6	3.5	3.2	2.9	2.8	2.8	2.9	2.8	2.4	2.2	2.4	3.5
4th	3.3	3.5	3.6	3.0	2.9	2.7	3.1	2.6	2.6	2.4	2.2	2.4	3.2
5th	3.3	2.8	3.7	3.2	2.6	2.6	2.6	2.4	2.4	2.4	1.9	2.5	2.5

Eye:													
horizontal diameter	3.3	2.7	2.4	2.5	1.8	2.0	2.0	2.0	1.6	1.6	1.4	1.4	1.5
1st dorsal fin													
length of base	9.2	8.8	9.2	7.9	9.4	8.0	9.6	9.2	8.7	8.6	7.9	8.6	9.3
posterior margin	–	3.6	4.6	3.7	4.0	4.3	4.3	4.8	5.0	3.6	4.8	4.7	4.6
height	5.9	6.3	7.5	6.1	6.5	7.0	7.7	8.7	8.3	6.9	8.6	8.1	8.9
2nd dorsal fin:													
length of base	3.5	3.3	3.4	3.5	3.2	3.4	2.6	3.2	3.0	2.8	3.4	2.6	2.8
posterior margin	–	4.5	4.1	3.9	4.0	4.5	4.5	4.2	4.3	3.9	4.5	4.5	4.2
height	2.0	1.8	1.7	1.5	1.8	2.2	2.0	1.8	1.9	1.7	1.8	2.0	1.9
Anal fin:													
length of base	7.8	8.4	7.0	7.9	6.9	8.0	7.1	7.4	8.0	8.2	8.4	7.4	7.2
posterior margin	–	3.4	3.6	3.1	3.2	3.1	3.7	3.7	3.0	3.0	3.4	3.1	3.3
height	2.5	2.3	2.0	1.8	2.1	2.5	3.1	2.6	2.7	2.3	2.8	2.5	3.7
Pectoral fin:													
length of base	5.7	5.4	5.9	6.4	6.1	6.5	6.5	6.1	6.3	5.8	5.0	5.3	5.5
length of anterior margin	10.0	9.1	10.1	9.6	10.5	10.8	11.1	11.6	11.1	10.0	11.1	11.6	12.4
length of distal margin	6.5	7.0	7.5	7.0	6.9	8.4	8.2	8.2	8.3	7.8	9.0	11.0	10.2
width	7.2	7.9	8.2	7.4	8.0	9.0	8.5	9.0	8.0	7.8	8.7	9.8	9.8
Pelvic fin:													
length of base	5.2	4.5	5.3	5.3	5.4	5.3	5.4	5.3	5.6	5.0	5.5	4.6	5.8
length of anterior margin	5.9	4.4	5.2	4.6	5.2	5.0	5.5	5.0	5.0	5.2	4.5	4.2	5.5
length of distal margin	3.9	4.1	4.3	3.5	3.6	4.3	4.3	4.0	5.0	4.4	5.3	5.8	5.5
length of claspers	–	2.4	3.5	–	–	–	8.5	9.8	–	–	7.7	–	–
Caudal fin:													
length of upper lobe	22.7	23.0	21.8	22.4	22.4	22.9	23.3	23.5	20.9	23.2	20.1	22.8	22.0
length of lower lobe	9.3	8.5	9.2	8.3	9.3	9.6	9.4	9.5	8.7	9.3	9.4	9.1	10.0
length from tip to notch	4.5	4.6	5.1	4.4	5.1	5.6	5.7	5.6	5.4	4.8	5.9	7.6	7.4
notch depth	5.2	4.8	4.8	5.3	4.7	5.3	4.5	5.3	4.3	4.3	4.2	3.8	4.7

[1] Holotype of *Physodon mülleri.*
[2] Lectotype of *Carcharias (Scoliodon) laticaudus.*

Sexual dimorphism: There is a striking difference in dentition of adult males as compared with females or juvenile males (fig. 3). In adult males the cusps of the teeth are long and slender and the middle and posterior teeth of each side of the lower jaw are erect. The anterior teeth are greatly elongate and flexuous and somewhat round in cross section. Several rows of the anterior lower teeth in the adult male appear to be functional. Sexual dimorphism of dentition in sharks has been reported only for the squalid genus *Deania* (see Bigelow and Schroeder, 1957, and Garrick, 1960). Dental sexual dimorphism also exists in *Rhizoprionodon lalandei*, *R. oligolinx*, and probably *R. taylori*; it also exists to a much lesser degree in *Loxodon*. The phenomenon is probably widespread and unrecognized in sharks. *Physodon* is based on an adult male *S. laticaudus* and the type description of *S. laticaudus* is based on an adult female.

This species is free-living at sizes of at least 126 mm. t.l. (130–150 mm. according to Setna and Sarangdhar, 1949). Maximum size in Indian waters is about 26 inches (approximately 660 mm.). Breeding occurs all year with peak parturition from November through January. Up to 12 embryos occur per uterus, but usually no more than 14 young per female. Mature eggs are small, about one mm. in diameter (Setna and Sarangdhar, 1949).

Thillayampalam (1928) has given a detailed anatomical description of *S. laticaudus* (as *Scoliodon sorrakowa*). Some portions of the work are based on other species (*Rhizoprionodon*), but the study is an important one.

Distribution (see "Material").—This is a common species and its absence from Australia, the Philippines, the Celebes, Moluccas, New Guinea, and Oceania I believe to be real. The distribution seems to indicate that the species is essentially a continentally restricted one, able to traverse only the narrowest passes between coastlines. Setna and Sarangdhar (1949) reported that the species (as *S. sorrakowa*) lived in rocky areas up to three miles offshore in Bombay waters.

Nomenclatural discussion.—As mentioned above, *Physodon mülleri* was based on an adult male of *S. laticaudus*. Its dentition is markedly different from that of the female upon which Müller and Henle's description of *C.* (*S.*) *laticaudus* was based. There are adult males in the syntypic series of *S. laticaudus* but undoubtedly these were not examined for dentition. This is indicated by the fact that, in the first pair of pages 27 and 28 in Müller and Henle's Plagiostomen (see discussion on page 573), the description of *C.* (*S.*) *laticaudus* is of a single stuffed female specimen in the Berlin Museum. In the second pair of pages 27 and 28, additional material (including alcohol-preserved specimens) is listed, but the description is identical with the previous one.

In order to insure the stability of the name *C.* (*S.*) *laticaudus*, I believe that a lectotype should be designated. In the present situation the normal procedure would be to select the single stuffed specimen upon which the original description was based. However, in view of the importance of vertebral characters for shark classification, I have chosen to select one of the alcohol-preserved specimens in the Paris Museum (see "Material").

The type of *C.* (*S.*) *macrorhynchos* Bleeker is missing, but the description and figure are sufficient for placing it in synonymy. Günther (1870) first synonymized Bleeker's species with *S. laticaudus*, and Bleeker, in an unpublished manuscript (*Ennumeratio nova revisa*) in the Leiden museum, accepted this as correct.

There is a history of confusion surrounding the trivial names *sorrakowa* and *palasorra*, both of which have been applied to *S. laticaudus*. Russell (1803), not binomial nomenclature, described "Pala Sorra" and "Sorra Kowah" from Vizgapatam, Coromandel, India. The names used were native common names. Cuvier (1829) added the following in a footnote to the last word under *Le Bleu* (*Sq. glaucus* L.), which is the last species he mentions under *Les Requins:*

> Ajoutez le *Squ. ustus*, Dum. (*Sq. carcharia minor*, Forsk.), Lac., I, VIII, 1; *Requin a nageoires noires*, Quoy et Gaym., Zool. de Freyc., pl. 43, f. 1; le *Sq. glauque*, Lac., I, ix, 1, qui est différent de celui de Bl.; le *Sq. ciliaris*, Schn., pl. 31, dont les cil marquent seulement l'extrême jeunesse, Le *palasorrah* [sic] et le *sorrakowah* [sic], Russ., XIV et un assez grand nombre e'espèce nouvelles que nous décrirons dans notre histoire de poissons.

There is no reason to believe from the information contained above that Cuvier was intending to name Russell's forms. Rather it seems he was merely citing the native names. In support of this is the fact that the generic name (*Sq.*) that appears before the other species is omitted before *palasorrah* and *sorrakowah*. Nevertheless, on the basis of the above quotation most subsequent authors credited Cuvier (1829) with authorship of *Carcharias palasorra* and *C. sorrakowah*. Fowler (1936) first called attention to the fact that the first of these two names could not date from Cuvier (1829) because it was not proposed in binomial form. He did not credit the name, however, nor did he mention *sorrakowah*. Klausewitz (1960) also recognized that *palasorrah* as it appeared in Cuvier (1829) was not a valid name. He assigned authorship of *Carcharias palasorrah* to Bleeker (1853) and placed the name in synonymy with *C. acutus* Rüppell but gave no reasons for his actions. He did not discuss *sorrakowah*.

Müller and Henle (1841), in their monograph of the Plagiostoma, list Russell (1803) in their literature references and mention the "Pana Sorrats" and the "Sorra Kowats" as doubtful synonyms of their genus *Carcharias*. They make no mention of Cuvier's (1829) treatment of the two forms.

The earliest reference which I can find citing Russell's names in binomial form is Bleeker (1853). Bleeker merely gave a compiled list of species and their Russell equivalents. On page 9 he lists the two as follows:

Carcharias palasorra Cuv. (spec. dub.) Pala sorrah No. 14
Carcharias sorrakowa (spec. dub.) Sorra kowah No. 15

On page 80 he lists them as follows:

Carcharius (?) palasorra Cuv. Pola sorrah Russ. No. 14
Carcharius (?) sorrah kowah Blkr. Sorrah kowah Russ. No. 15

Bleeker, then, must be recognized as the author of these two names with the species based on Russell (1803).

Carcharias palasorra can be recognized from Russell's figure as the same as *Scoliodon laticaudus* and a junior synonym of it. The position of the origin of the pectoral fin beneath the fifth gill-opening places it here. *Carcharias sorrakowa* can be either of two species,

TABLE 5.—*Frequency distribution of precaudal vertebrae number in* Scoliodon laticaudus

	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112
India	1	1	–	1	3	5	11	8	7	13	5	1	3	1	–	–
Thailand	–	–	–	1	2	–	–	–	–	–	–	–	–	–	–	–
Penang	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
Moluccas	1	–	2	3	–	–	1	–	–	–	–	–	–	–	–	–
Singapore	–	–	–	2	1	1	1	–	–	–	–	–	–	–	–	–
Batavia	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
China	–	–	–	–	1	–	2	3	1	2	3	3	1	2	1	1
Japan	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–

Rhizoprionodon acutus or *R. oligolinx;* it is doubtful that its exact identity will ever be known. To consider it the same as *R. acutus* is to place it in junior synonymy; to consider it the same as *R. oligolinx* is to give it senior synonymy. This would not be bad were it not for the fact that *C. sorrakowa* almost universally has been considered a senior synonym of the common species *Scoliodon laticaudus*. To recognize the name for a species of *Rhizoprionodon* would be confusing. This is involved further by the fact that the name commonly used for *R. oligolinx* has been *S. palasorra*. Nomenclature can best be served, I think, by recognizing *C. sorrakowa* as a synonym of *R. acutus* and by fixing the name through the designation of a neotype. This I have done in the discussion of *R. acutus* (p. 598).

MATERIAL.—INDIA: ISZZ 7830 (1: ca. 420 mm., dried); Bombay, ANSP 77533 (2: 176–196), MNHM 1123 (1: 518, female, here designated lectotype of *Carcharias* (*Scoliodon*) *laticaudus*), USNM 196135 (1: 542), BMNH 1889.2.1.4151–8 (11: 163–420), NFIS [no number]

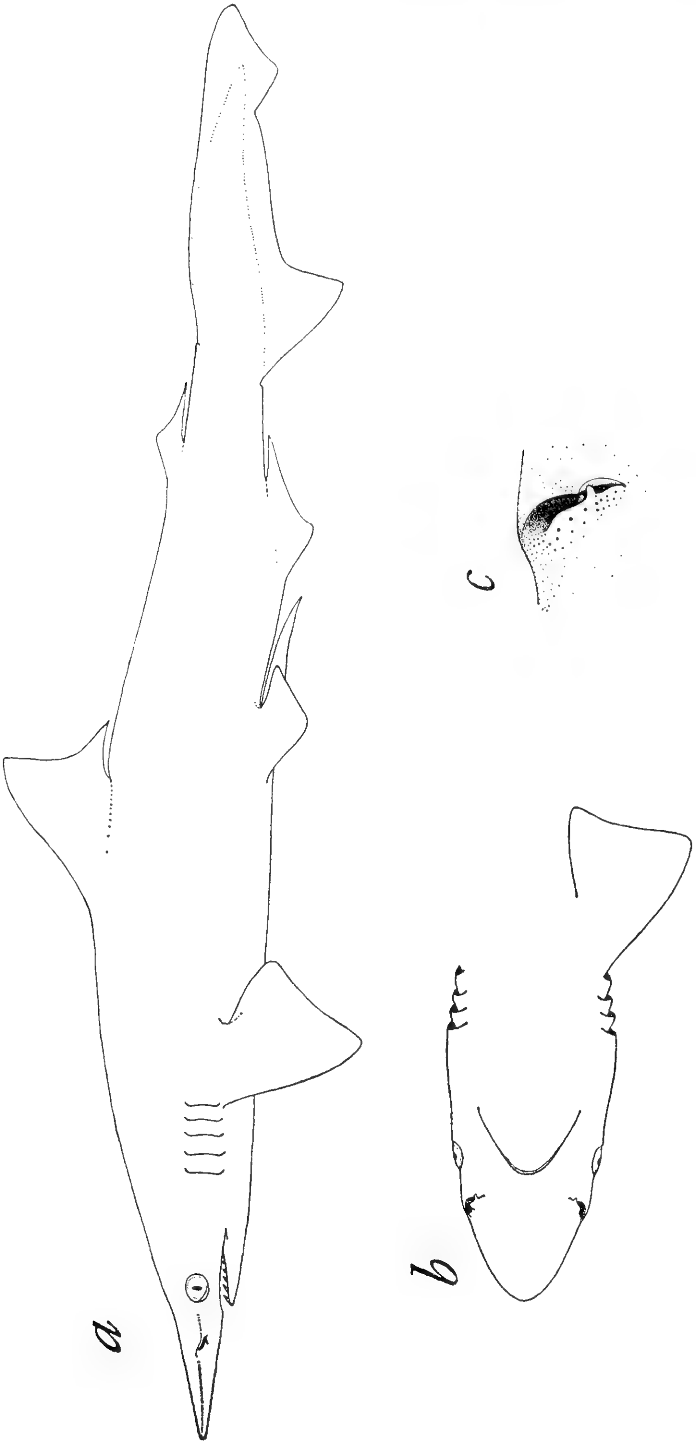

FIGURE 2.—*Scoliodon laticaudus*, SU 38377, 352 mm. t.l., **mature male** from Singapore: ***a*, left side; *b*,** underside of head; ***c*,** enlarged left nostril.

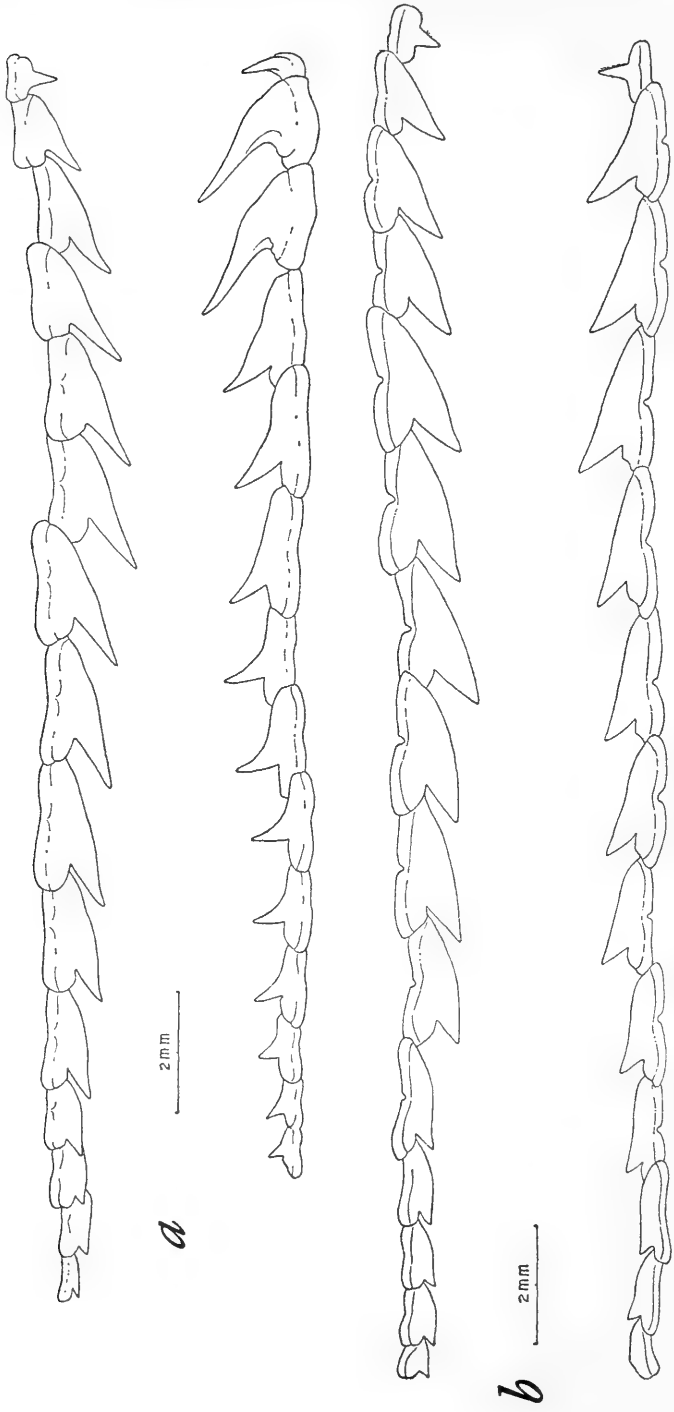

FIGURE 3.—*Scoliodon laticaudus*: *a*, SU 41982, 378 mm. t.l., mature male from India, right upper and lower teeth (symphysis to the right); *b*, SU 14444, 460 mm. t.l., female from India, right upper and lower teeth (symphysis to the right).

(2: 170–365); Alibag, ZSZM H1391 (3: ca. 167–ca. 281), ZSZM H1374 (1: ca. 402), ZSZM H1375 (8: 264–282), ISH 3/61 (6: 176–506); Kanara, BMNH 1889.2.1.4160 (1: 312); Karwar, ZSZM H1392 (1: 208), ZSZM H1376 (3: 126–218), ISH 4/61 (1: 173); Calicut, BMNH 1899.2.1.4159 (1: 455); Malabar Coast, MNHN 1066 (3: 167–257), MNHN 1122 (1: 423); Pondicherry, UZMK 378 (1: 330); Emur Fisheries Station, Madras Presidency, SU 41983 (1: 207); Madras, BMNH 1889.2.1.4161–3 (2: 337–389); Puri Orissa State, SU 41982 (1: 378); Vizagapatam, SU 1444 (1: 460); Calcutta, SU 41984 (3: 153–165); Bengal, BMNH [no number] (2: 174–240), MNHN 1041 (1: 484, holotype of *Physodon mülleri*); Ceylon, NMV [no number] (1: 175), NMV [no number] (1: 426). GULF OF THAILAND: off Menam River, UZMK [no number] (1: 321); ca. 12°11′ N. and ca. 100°41′ E., GVF 2470 (1: 255). THAILAND: Bangkok, ANSP 60404 (1: 283); Bandon Bight, USNM 86905 (2: 100–137, embryos). MALAYA: Penang, UZMK 377 (1: 370); Singapore, SU 38377 (3: ca. 328–293), MCZ 182 (1: 333), CNHM 15652 (1: 459). JAVA: Batavia, USNM 72479 (1: 422); Straits of Molucca, UZMK 404–409 (6: ca. 210–ca. 253), ANSP 517 (1: 186). EAST INDIAN ARCHIPELAGO: BMNH 1867.11.28.190 (1: 467, female; this specimen is cataloged as holotype of *C.* (*S.*) *macrorhynchos*, but since Bleeker listed only a male, 218 mm., this specimen cannot be a type; the holotype is apparently lost). SARAWAK: BMNH 1895.2.28.74–75, in part (1: ca. 143). CHINA: BMNH 1851.12.27.253–4 (3: 162–245); Chinai, Chusan Island, Tinghai, SU 32434 (4: 258–333); Foochow, USNM 86970 (1: ca. 212), USNM 86334 (1: 228); San-tu, Fukien, ANSP 89616 (1: 323); Wenchow, Chekiang, CAS 875 (1: 275); Amoy, BMNH 1863.2.23.13–16 (4: 159–165), BMNH 1860.7.20.32 (1: 344); Hong Kong, UZMK 376 (1: 581), BMNH 1939.3.23.1 (1: 360), ANSP 76687 (1: 349), SU 13770 (1: ca. 522), SU 13969 (1: 462). JAPAN: BMNH 1862.11.1.30 (1: 155) "TRIESTE" [error]: NMV [no number] (1: 405).

Loxodon Müller and Henle

Loxodon Müller and Henle, 1838, Mag. Nat. Hist., new ser., vol. 2, p. 36 (name and diagnosis).

Loxodon Müller and Henle, 1838, Arch. Naturg., vol. 4, no. 1, p. 84 (name and diagnosis).

Loxodon Müller and Henle, 1841, Systematische Beschreibung der Plagiostomen, p. 61 (type *Loxodon macrorhinus* Müller and Henle, 1841, by monotypy).

DIAGNOSIS.—Sharks of moderate size (reaching at least 905 mm. t.l.) distinguished from other carcharinid genera by the following combination of characters: origin of second dorsal fin ranges from over, and just in advance of, anal axil to slightly behind anal axil (usually); cusps of teeth smooth and obliquely directed rearward; labial furrow on upper jaw poorly developed, usually shorter than that on lower jaw, which is not visible when the mouth is closed; pectoral fin origin below fourth to third gill-opening; tip of posterior margin of first dorsal fin not reaching beyond level of pelvic origin; distal tip of appressed pectoral fin not reaching much, if any, beyond level of first dorsal origin; hyomandibular pores usually not forming a discrete enlarged series on either side of the corner of the mouth (pores in the series enlarged posteriorly, but gradually, rather than abruptly, as in *Rhizoprionodon*); pores frequently not distinguishable. Other important distinguishing characters as in key couplet 2a (p. 568). (Note: *Loxodon* was described as having a small spiracle. In embryos a tiny spiracle is present, but it is so small that to distinguish it from adjacent pores of the lateral line system is hardly possible. In adults the spiracle is not noticeable to an untrained observer. It is for this reason that *Loxodon* specimens most often have been referred to "*Scoliodon*" species (not *S. laticaudus*). For practical purposes, the spiracle in *Loxodon* is absent. Some specimens of *Scoliodon* and *Rhizoprionodon* have noticeably enlarged pores in the spiracular region. One of these could possibly be the remnant of a spiracle, but I have been unable to demonstrate this.)

The shallow notch in the posterior rim of the orbit is always present though it may not always be obvious to an untrained observer unless compared with the smooth orbital rims of other species (see fig. 4). Occasionally there are two notches or an area around the notch that appears to be scarred. The flap on the nostril is frequently triangular without a developed nipple-like lobe. The labial furrows are very short and, for practical purposes, absent on the upper jaw; however, in one specimen examined, the upper labial furrow on one side was present and comparable to that of some specimens of *Rhizoprionodon*. The distance from the tip of the upper caudal lobe to the subterminal notch is generally much greater and slenderer than in the other species treated in this paper, but sometimes it approaches the size and form as found in *Rhizoprionodon* (figure 4*a* illustrates one such specimen). Both precaudal pits are present but the lower is not as well developed as the upper. The body and fins have a generally slenderer appearance than in *Rhizoprionodon*.

Growth changes: Snout length to origin of pectoral fin, pelvic fin, first dorsal fin, second dorsal fin, anal fin, upper and lower caudal lobes tend, in general, to increase in percent of t.l. with increased t.l.

Eye diameter, length of upper caudal lobe, and distance from tip of upper caudal lobe to notch tend to decrease in percent of t.l. with increased t.l.

From the few specimens examined it does not appear that there is much, if any, change in the relation of the axis of the upper caudal lobe with the horizontal axis of the body with increased t.l.

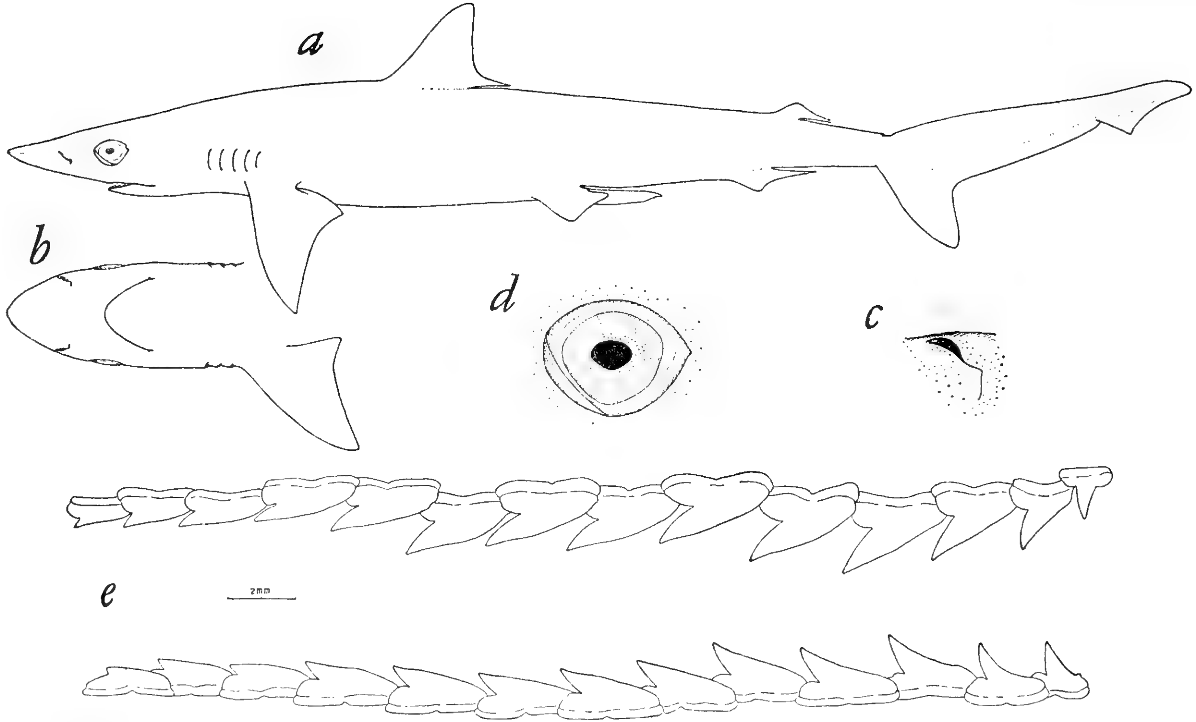

FIGURE 4.—*Loxodon macrorhinus*, USNM 170559, 745 mm. t.l., mature male from the Philippine Islands: *a*, left side (note double notch on posterior rim of orbit); *b*, underside of head; *c*, enlarged left nostril; *d*, USNM 197349, 544 mm. t.l., immature male from the Philippine Islands, enlarged left eye (note single notch on posterior rim of orbit); *e*, UMMZ 177117, 668 mm. t.l., female from the East China Sea, right upper and lower teeth (symphysis to the right; base line refers only to teeth).

TABLE 6.—*Proportional dimensions in percent of total length of* Loxodon macrorhinus

	♂ 356 mm. Embryo Philippines SU 26821	♂ 391 mm. Embryo Philippines SU 26819	♀ 421 mm. Embryo Mauritius MCZ 513	♂ 498 mm. Philippines SU 13670	♂ 513 mm. Amboina BMNH 1858.4.21.511	♂ 521 mm. Queensland QMB I13/1526 [1]	♀ 543 mm. Amboina RNH 7371	♀ 572 mm. Philippines USNM 170560	♂ 573 mm. Amboina BMNH 1867.11.28.-174	♂ 660 mm. Misol BMNH 1870.8.31.70	♀ 668 mm. East China Sea UMMZ 177117	♂ 745 mm. Philippines USNM 170559
Snout tip to:												
outer nostrils	3.8	3.8	4.0	4.6	4.7	5.4	4.7	4.5	4.5	4.9	4.5	4.2
eye	7.1	7.0	7.1	7.6	7.8	8.9	7.8	8.0	7.9	8.4	8.1	7.2
mouth	8.4	8.4	8.6	9.0	8.7	9.8	8.8	9.1	8.7	9.4	9.0	8.3
1st gill-opening	17.1	16.4	16.1	15.9	15.9	18.2	16.0	16.1	16.4	15.9	17.1	17.0
pectoral origin	19.9	19.7	19.0	19.3	19.5	21.2	19.0	19.4	19.6	18.9	20.2	20.0
pelvic origin	40.2	38.9	42.0	41.8	42.8	44.0	42.2	42.7	43.3	42.1	45.2	44.4
1st dorsal origin	29.2	29.4	30.9	30.3	31.3	32.6	28.5	30.6	30.6	30.0	33.5	31.8
2nd dorsal origin	60.2	57.6	60.6	61.3	61.6	61.8	59.8	61.4	62.8	61.6	64.3	65.1
anal fin origin	53.0	53.7	56.3	56.8	57.5	58.7	56.6	58.3	55.3	57.6	60.4	61.0
upper caudal origin	71.0	68.4	71.6	71.7	71.6	73.0	70.3	73.0	73.5	72.3	74.9	75.0
lower caudal origin	69.0	67.0	69.8	70.7	70.4	71.7	69.0	72.6	71.8	71.1	73.5	73.8
Nostrils:												
distance between inner corners	5.2	4.9	5.5	5.2	5.1	5.8	4.6	4.5	4.7	5.3	5.1	5.2
Mouth:												
width	4.9	4.9	5.2	5.6	5.4	5.7	5.6	5.1	5.2	5.4	5.4	5.9
length	4.0	4.1	3.8	3.4	3.9	3.5	3.7	4.0	3.8	3.1	4.2	3.7
Labial furrow lengths:												
upper	0.2	0.4	–	0.3	0.2	–	0.2	0.1	0.3	0.2	0.3	0.2
lower	0.8	0.8	–	1.1	0.8	–	0.8	0.9	1.0	0.6	0.8	0.9
Gill-opening lengths:												
1st	1.7	1.7	1.8	1.6	1.6	1.8	1.4	1.4	1.6	1.5	1.9	1.6
2nd	1.7	1.7	1.8	1.6	1.9	2.1	1.6	1.6	1.7	1.8	1.9	1.6
3rd	1.7	1.7	1.9	1.8	1.9	2.3	1.7	1.6	1.7	1.9	2.1	1.9
4th	1.6	1.6	1.9	1.8	1.8	2.2	1.7	1.6	1.8	2.0	2.0	1.9
5th	1.4	1.5	1.7	1.4	1.7	1.7	1.4	1.2	1.4	1.4	1.4	1.3
Eye:												
horizontal diameter	3.6	3.6	3.3	3.0	3.0	2.9	2.8	2.8	2.6	2.6	2.6	2.8
1st dorsal fin:												
length of base	7.6	6.9	6.6	6.8	6.5	7.1	7.3	6.3	6.8	7.0	7.5	7.2
posterior margin	3.4	3.3	3.3	3.8	3.3	3.8	3.5	3.5	3.6	3.8	3.7	3.9
height	6.2	5.6	6.9	7.9	7.6	7.6	7.5	7.9	7.5	8.1	7.3	7.2

2nd dorsal fin:												
length of base	2.0	2.2	1.8	2.1	2.0	2.0	2.2	2.4	1.9	2.0	2.2	2.1
posterior margin	4.2	4.1	4.8	4.6	4.3	4.8	4.2	4.5	4.4	4.4	4.9	–
height	1.3	1.3	1.4	1.2	1.5	1.5	1.5	1.2	1.6	1.5	1.5	1.1
Anal fin:												
length of base	4.2	3.8	4.2	3.8	3.3	3.8	3.8	4.1	3.6	4.0	3.7	3.9
posterior margin	3.9	3.8	3.3	4.2	3.7	4.1	3.7	4.0	3.7	3.9	4.5	3.8
height	1.7	1.8	1.5	1.5	1.9	1.9	1.8	1.6	2.1	2.0	2.3	1.5
Pectoral fin:												
length of base	4.2	4.4	4.0	4.1	3.9	4.3	4.1	4.2	4.0	4.1	4.8	4.6
length of anterior margin	11.5	11.5	11.9	11.5	11.7	12.5	11.4	11.4	11.3	11.8	12.7	11.7
length of distal margin	9.0	7.9	7.6	8.2	8.4	8.9	8.2	8.6	8.5	9.2	8.8	9.5
width	7.6	7.2	6.9	7.2	6.6	7.9	6.5	7.0	6.8	7.0	7.5	7.8
Pelvic fin:												
length of base	3.7	3.7	3.1	3.8	3.3	3.6	3.6	4.0	3.5	3.6	3.7	4.0
length of anterior margin	4.7	4.4	4.8	4.4	3.9	3.8	3.6	4.0	4.2	3.9	4.6	3.7
length of distal margin	4.0	3.5	3.6	3.4	3.3	3.8	3.9	3.5	3.8	3.9	4.2	3.7
length of claspers	2.6	2.4	–	2.3	2.3	2.7	–	–	2.8	2.4	–	7.2
Caudal fin:												
length of upper lobe	29.5	31.7	29.0	28.5	28.3	27.0	29.7	29.0	27.0	27.4	25.0	26.0
length of lower lobe	9.8	9.8	10.4	8.8	10.2	9.2	10.0	–	9.2	9.3	9.4	9.5
length from tip to notch	8.0	8.2	7.1	7.7	8.0	7.1	6.8	7.2	7.6	6.7	6.0	6.2
notch depth	3.5	2.8	3.1	3.0	3.3	3.6	2.7	3.0	2.6	3.0	3.0	3.0

[1] Holotype of *Scoliodon affinis*.

TABLE 7.—*Frequency distribution of precaudal vertebrae number of* Loxodon macrorhinus

	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106
Holotype (locality unknown)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mauritius	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Red Sea	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gulf of Oman	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sumatra	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Amboina and Misol	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	1
Philippine Islands	–	–	–	–	–	–	2	1	1	1	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Formosa	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
East China Sea	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Australia	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–

This genus is at least superficially closest to *Rhizoprionodon*.

A single species distributed from the southwest coast of Africa to the Red Sea, India, the Philippines, Dutch East Indies, and Australia.

Loxodon macrorhinus Müller and Henle

FIGURE 4; PLATE 1A

Loxodon macrorhinus Müller and Henle, 1841, Systematische Beschreibung der Plagiostomen, p. 61, pl. 25 (embryo, locality unknown).

Carcharias (Scoliodon) dumerili Bleeker, 1856, Act. Soc. Sci. Indo-Neerl., vol. 1, p. 70 (Amboina).

Scoliodon jordani Ogilby, 1908, Proc. Roy. Soc. Queensland, vol. 21, p. 88 (outer Caloundra Bank, Queensland).

Scoliodon affinis Ogilby, 1912, Mem. Queensland Mus., vol. 1, p. 29 (Noosa Head, south Queensland).

Scoliodon ceylonensis Setna and Sarangdhar, 1946, Proc. Nat. Inst. Sci. India, vol. 12, no. 5, p. 252 (Bombay waters; no type material listed).

DIAGNOSIS.—Distinctive characters are those of the genus (q.v.).

DESCRIPTION (see also table 6).—Precaudal vertebrae 77–106 (table 7), centra in posterior monospondylous region elongate (plate 1A); caudal vertebrae 71–86; total vertebrae 148–191; upper teeth 12–1–12 to 13–1–14; lower teeth 12–12 to 14–14 (higher, or lower, counts in upper and lower jaws correlated).

Denticles imbricate, 3- to 5-ridged and 3- to 4-toothed.

Color of preserved specimens: brown to gray brown above, pale below. Pectoral and pelvic fins pale-edged; caudal either pale-edged or with a narrow black margin; first dorsal dusky distally. The distal portions of the claspers of adult males paler than remainder.

A low, short interdorsal ridge is sometimes present close to the first dorsal fin (e.g., one specimen from the Philippines had it, another did not).

The largest immature male seen, from Misol Island, was 660 mm. t.l., and had a clasper length equal to 2.4 percent of the t.l. The smallest mature male, from the Philippines, was 745 mm. t.l. and had a clasper length equal to 7.2 percent of the t.l. The skin of a male approximately 900 mm. t.l. from Kenya, Africa, had a clasper length of 63.5 mm., ca. 7.3 percent of t.l.

The largest embryo seen was 421 mm. t.l. and the smallest non-embryo specimen was 429 mm. t.l.

The cusps of the teeth of adult males may be slightly more erect than those of females, but the difference is not striking. The cusps are smooth, even in large specimens.

DISTRIBUTION (see "Material").—The presence of this species in India is based on Setna and Sarangdhar (1950, as *Scoliodon acutus*).

Its apparent absence from Oceania is in accord with the distributions of the other species discussed in the present study.

The species is quite common in Philippine waters. I saw large numbers of small specimens in the Manila fish market during April 1962. Its relative abundance elsewhere is unknown although Setna and Sarangdhar (1950) report it as uncommon in Indian waters.

Wheeler (1959), who gave an excellent description of *Loxodon*, reported the species common at Zanzibar. His longest specimen was 905 mm. An 850 mm. female contained two embryos. One specimen was caught in a trammel net at a depth of about four fathoms.

Nomenclatural discussion.—The types of the nominal forms, except *Scoliodon ceylonensis* Setna and Sarangdhar and *S. jordani* Ogilby, were examined and apparently are the same species. The holotype of *S. jordani* was reported by Ogilby (1916) as having been destroyed. The short outward-directed upper labial groove and the appressed pectorals extending only to beneath the origin of the first dorsal fin of *S. jordani* indicate that it was probably a *Loxodon*. No type was designated for *S. ceylonensis* but the tooth counts and the nature of the labial folds as given in the original description place it in *Loxodon*. Setna and Sarangdhar (1950), without comment, placed their species in synonymy with *Carcharias acutus* Rüppell; however, the figures and description they give are clearly those of a *Loxodon*, and, as such, confirm my suspicions concerning the original description.

Material.—no locality: ISZZ 4479 (1: ca. 315 mm., embryo, holotype of *Loxodon macrorhinus*). kenya: Shimoni, DIRU 15A (1: ca. 900, head and skin). mauritius island: MCZ 513 (1: 421, embryo). seychelles islands: BMNH 1869.5.14.15 (2: ca. 315–ca. 335, embryos). red sea: NFIS 926 (1: ca. 345, embryo), NMV [no number] (1: 858). egypt: Kosseir, SMNS 1787 (1: ca. 375, embryo). gulf of oman: Muscat, BMNH 1892.1.16.9–10 (1: 734). sumatra: Padang, NMV [no number] (1: 691). misol island: BMNH 1870.8.31.70 (or .79?) (1: 660). amboina island: BMNH 1858.4.21.511 (1: 513), BMNH 1867.11.28.174 (1: 573, male, listed as type of *Carcharias dumerili* Bleeker, but Bleeker described the species from a 553 mm. female), RNH 7371 (1: 543, holotype of *Carcharias dumerili*). australia: Queensland, QMB [number missing] (1: 797, this specimen was with a group of sharks, all from Queensland; tags had corroded); Noosa Head, QMB I13/1526 (1: 521, holotype of *Scoliodon affinis*). philippine islands: Oriental Negros, Dumaguete, SU 26821 (1: 356, embryo), SU 26819 (1: 391, embryo), SU 13670 (1: 498); Limbones Cove, USNM 170560 (1: 572); off Luzon Point (1: 745); Manila area, USNM 197349 (3: 500–544). formosa: Thape, ISZZ 6964 (2: 429–443). japan: East China Sea, UMMZ 177117 (1: 668).

Rhizoprionodon Whitley

Rhizoprion Ogilby, 1915, Mem. Queensland Mus., vol. 3, p. 132 (type *Carcharias* (*Scoliodon*) *crenidens* Klunzinger, 1880, a synonym of *Carcharias acutus* Rüppell, 1835, by original designation), a junior homonym of *Rhizoprion* Jourdan, 1861, a fossil Cetacean.

Rhizoprionodon Whitley, 1929, Australian Zool., vol. 5, p. 354 (a substitute name for *Rhizoprion* Ogilby).

Protozygaena Whitley, 1940, The fishes of Australia, vol. 1, p. 110 (type *Physodon taylori* Ogilby, 1915, by original designation; retained in my study as a subgenus).

Diagnosis.—Sharks of small to moderate size (reaching a t.l. of at least 1000 mm.) distinguished from other carcharhinid genera by the following combination of characters: origin of second dorsal fin ranges from over middle of anal base (rarely) to over anal axil; cusps of teeth smooth to serrulate and obliquely directed rearward; labial furrow on upper jaw usually well developed, except in most specimens of *R. oligolinx* and *R. taylori;* lower labial furrow visible when mouth is closed; pectoral fin origin below fourth to third gill-opening; tip of posterior margin of first dorsal fin not reaching much, if any, beyond level of pelvic origin; distal tip of appressed pectoral fin not extending posteriorly much, if any, past level of anterior two-thirds of first dorsal base; differing from all carcharhinids I have examined in having a discrete series (sometimes irregularly biserial) of enlarged hyomandibular pores on the outer side of each corner of the mouth. Other distinguishing characters as in key couplets 1b and 2b (p. 568).

Subgenera.—I recognize two subgenera, *Rhizoprionodon* and *Protozygaena*, within the genus. The nominal subgenus includes *R. terraenovae*, *R. porosus*, *R. acutus*, and *R. longurio;* the subgenus *Protozygaena* includes *R. lalandei*, *R. taylori*, and *R. oligolinx*.

The nominal subgenus differs from *Protozygaena* in having markedly elongate centra in the posterior monospondylous region (plate 2A), as opposed to scarcely elongate centra in that region (plate 2B, C); in only rarely having more precaudal vertebrae than caudal vertebrae, as opposed to always having more precaudal than caudal vertebrae in *Protozygaena;* in the absence of a marked sexual dimorphism of the dentition of the lower jaw of adults, as opposed to its presence in *Protozygaena;* in having the cusps of at least some teeth noticeably serrulate in large specimens, as opposed to smooth or faintly irregular cusps in *Protozygaena;* in generally having more teeth, a longer upper labial furrow, in attaining a size of 900–1000 mm., and in having males mature only at sizes greater than 600 mm., as opposed to fewer teeth, a shorter upper labial furrow, in attaining a size of less than 700 mm., and in having males mature at less than 600 mm. (as small as 380 mm. in *R. oligolinx*).

TABLE 8.—*Frequency distribution of total number of enlarged hyomandibular pores on both sides of head in* Rhizoprionodon

	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
R. longurio	–	–	–	–	–	–	–	–	–	1	3	2	5	3	2	10	1	1	2	1	1	1	–	–	–	–	–	–	–	–	–	–
R. acutus	–	–	–	–	–	–	–	–	1	7	8	11	8	17	10	17	10	8	10	4	2	1	4	–	–	–	–	–	–	–	–	–
R. terraenovae	–	–	–	–	–	–	–	–	–	1	–	3	4	2	5	3	4	3	5	8	3	6	3	1	–	1	–	1	–	–	–	–
R. porosus	–	–	–	–	–	–	–	–	–	–	–	–	1	2	2	2	2	4	6	1	4	2	1	1	1	–	–	–	–	–	–	1
R. lalandei	–	–	–	–	–	–	–	1	–	–	1	1	1	5	9	3	1	–	3	1	–	–	–	–	–	–	–	–	–	–	–	–
R. oligolinx	2	3	2	11	6	8	12	10	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R. taylori	–	–	–	–	–	–	–	–	1	1	3	–	–	–	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 9.—*Frequency distribution of precaudal vertebrae number of* Rhizoprionodon acutus

	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
Madeira Islands	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–
Africa																									
West Coast	–	–	–	–	–	–	–	–	–	1	2	1	–	–	2	–	2	1	–	–	1	–	–	–	–
East Coast	–	–	–	–	–	–	–	–	–	–	–	–	4	6	5	2	2	–	–	–	–	–	–	–	–
Madagascar	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–
Red Sea	–	–	–	–	–	–	1	–	–	–	1	–	2	1	1	2	2	1	–	–	–	–	–	–	–
Gulf of Oman	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
Persian Gulf	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2	2	–	1	–	–	–	–	–	–	–
India and Ceylon	–	–	1	–	4	1	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Andaman Islands	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
Thailand	–	–	1	1	–	–	2	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Singapore-Bintang	–	–	–	1	–	1	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Padang, Sumatra	–	–	–	–	–	2	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Batjan and Macassar	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1
Aru Islands	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Australia	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	3	5	2	–	1	–	1	–	–	–
Sitankai, Philippines	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–
Sarawak-North Borneo	–	–	–	–	1	1	1	1	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
Mindanao, Philippines	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Panay, Philippines	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Unisan, Philippines	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Luzon, Philippines	2	2	8	8	3	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Formosa	–	–	–	–	1	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Japan	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 10.—*Proportional dimensions in percent of total length of* Rhizoprionodon acutus

	♂ 368 mm. India SU 30502 [1]	♀ 387 mm. Liberia USNM 179719	♂ 442 mm. Red Sea NFIS 761	♂ 445 mm. Red Sea HU E57/666	♂ 455 mm. Queensland QMB 12/292 [2]	♀ 477 mm. Nigeria BMNH 1936.8.20.1	♂ 500 mm. Northern Territory USNM 174076	♀ 553 mm. Red Sea USNM 47603	♂ 568 mm. Persian Gulf USNM 148103	♂ 624 mm. Red Sea HUI E57/664	♂ 678 mm. Liberia USNM 179718	♂ 678 mm. Red Sea HUI E57/663	♀ 690 mm. Persian Gulf USNM 148104	♀ 785 mm. Northern Territory USNM 174077	♂ 800 mm. Queensland USNM 176744	♀ 817 mm. Zanzibar MCZ 401 [3]	♀ 820 mm. Formosa USNM 191192
Snout tip to:																	
outer nostrils	5.4	5.1	4.7	5.2	4.7	4.7	4.6	5.4	4.7	5.0	4.6	4.3	4.7	4.2	4.7	4.8	4.8
eye	8.7	8.8	7.9	8.5	8.2	8.0	8.0	8.3	7.7	8.4	7.8	7.2	7.8	7.1	7.6	8.0	7.6
mouth	9.5	9.8	8.8	9.3	-	8.8	9.0	8.7	8.3	8.8	8.7	8.0	8.8	7.9	8.3	8.2	8.2
1st gill opening	-	18.9	19.0	19.8	18.2	19.5	18.6	18.1	19.2	19.6	18.1	19.3	18.9	17.8	18.9	17.7	18.0
pectoral origin	22.3	22.5	22.4	22.5	21.1	22.4	21.6	21.2	21.5	22.3	21.4	22.1	21.8	20.5	22.1	20.4	20.7
pelvic origin	45.4	45.8	44.1	45.0	42.6	46.2	43.8	45.8	44.6	44.9	44.0	46.2	49.0	44.6	46.2	47.6	45.4
1st dorsal origin	31.0	30.0	28.7	29.7	29.2	30.6	29.0	30.8	29.6	29.2	29.9	29.8	30.8	28.7	30.5	30.2	31.1
2nd dorsal origin	62.7	62.2	60.8	61.4	61.7	64.2	63.0	63.4	63.6	62.5	63.2	64.4	67.0	65.0	66.5	65.6	65.6
anal fin origin	60.4	58.9	58.4	58.0	57.6	60.0	58.4	59.8	59.5	59.4	59.2	61.2	63.9	60.2	62.2	62.2	61.8
upper caudal origin	73.4	73.2	76.6	72.4	73.8	74.8	74.0	76.3	72.8	73.6	73.8	76.7	77.0	76.2	75.2	75.5	75.6
lower caudal origin	72.2	71.8	71.0	70.8	71.8	73.2	72.0	72.0	71.3	72.1	73.0	75.0	75.5	74.2	74.4	74.7	74.4
Nostrils:																	
distance between inner corners	5.4	5.6	4.9	5.0	4.9	5.6	5.1	4.9	5.1	4.9	4.9	4.8	5.1	4.7	5.1	4.7	4.6
Mouth:																	
width	6.5	7.7	7.0	6.5	6.9	7.1	6.9	6.3	7.1	6.2	6.7	6.8	7.3	7.0	6.8	7.3	6.4
length	5.2	4.4	4.5	4.5	4.1	4.9	4.4	4.3	4.1	4.4	4.4	4.4	4.6	4.5	4.5	4.9	4.6
Labial furrow lengths:																	
upper	1.8	1.8	1.4	2.0	1.9	1.8	2.0	1.6	1.8	1.6	1.7	1.8	1.6	1.9	-	1.8	1.7
lower	1.2	1.4	1.4	1.0	1.3	1.4	1.2	1.3	1.4	1.5	1.3	1.2	1.5	1.5	-	1.3	1.7
Gill-opening lengths:																	
1st	-	1.9	1.9	1.9	1.7	1.7	1.7	1.4	1.8	1.8	1.8	2.1	2.1	1.8	1.5	1.9	1.8
2nd	2.0	2.1	2.0	2.2	2.0	2.0	2.2	1.8	2.1	2.1	2.1	2.4	2.5	2.1	1.9	2.1	2.0
3rd	2.3	2.2	2.0	2.4	2.3	2.2	2.4	2.0	2.6	2.3	2.1	2.8	2.6	2.3	2.1	2.5	2.1
4th	2.4	2.0	2.0	2.2	2.4	2.2	2.3	2.0	2.8	2.2	2.1	2.6	2.6	2.2	2.2	2.4	2.0
5th	2.0	1.6	1.6	1.6	1.9	1.8	1.8	1.4	2.3	1.8	1.6	1.9	2.1	1.8	1.6	1.9	1.6

Eye:																	
horizontal diameter	3.0	2.7	2.4	2.4	2.5	2.7	2.3	2.5	2.3	2.3	2.1	2.2	2.3	1.9	2.2	2.1	2.2
1st dorsal fin:																	
length of base	9.8	8.9	9.4	8.9	9.3	8.7	9.4	8.9	9.8	9.2	9.0	9.7	9.8	10.1	9.4	9.6	8.9
posterior margin	4.9	4.6	4.8	4.7	4.5	5.1	4.5	4.5	4.7	4.6	4.9	4.4	4.8	4.2	4.4	5.1	4.9
height	9.2	8.7	9.5	-	8.5	8.8	8.6	8.7	9.2	9.5	-	-	8.6	8.2	-	9.6	8.1
2nd dorsal fin:																	
length of base	3.0	3.0	2.9	2.5	3.2	2.7	2.5	2.5	3.1	2.9	2.8	3.1	2.4	2.5	2.3	2.5	2.3
posterior margin	4.6	4.6	5.3	5.0	4.5	5.1	4.7	4.9	4.7	5.0	4.9	4.5	5.1	4.3	4.5	5.2	5.0
height	2.2	2.0	1.8	-	1.8	2.2	1.9	1.8	2.1	2.0	1.9	1.9	1.9	-	1.6	2.1	1.8
Anal fin:																	
length of base	5.4	4.8	4.4	4.9	5.2	5.1	4.9	4.5	5.3	5.2	4.9	5.3	4.8	4.8	4.5	4.6	4.6
posterior margin	4.4	4.4	4.8	4.4	4.1	4.6	4.3	4.3	4.5	4.6	4.6	4.4	4.1	4.3	4.2	4.7	4.6
height	3.5	3.4	2.8	2.5	2.5	3.2	2.8	2.2	2.8	2.9	2.9	2.4	2.7	2.9	2.8	3.3	2.5
Pectoral fin:																	
length of base	5.4	5.0	4.7	5.1	4.6	5.2	5.3	5.8	5.4	5.3	5.2	5.0	5.7	5.4	5.5	5.2	5.3
length of anterior margin	13.3	12.9	12.7	12.6	11.8	13.7	12.8	13.0	13.6	13.6	13.0	13.1	13.6	13.1	12.9	14.1	13.1
length of distal margin	8.7	8.5	9.3	9.6	8.5	10.6	9.4	9.3	10.0	9.9	10.0	9.9	10.5	9.9	10.2	11.2	9.8
width	7.6	8.2	7.6	7.8	7.6	8.4	7.7	7.6	8.0	8.3	8.0	7.1	7.7	7.8	7.8	8.1	7.7
Pelvic fin:																	
length of base	4.6	4.2	4.5	4.2	4.2	4.0	4.7	-	4.6	5.1	4.7	4.5	4.3	4.2	4.8	4.3	4.3
length of anterior margin	4.9	4.7	4.8	4.3	4.5	4.4	4.8	4.7	4.6	4.3	4.9	4.2	4.0	4.5	4.2	4.5	4.4
length of distal margin	4.1	4.1	4.0	4.4	4.4	4.6	4.2	4.0	4.2	4.5	4.1	4.5	4.4	4.1	4.2	4.9	4.1
length of claspers	2.2	-	2.3	2.2	2.3	-	2.8	-	3.1	8.3	3.4	8.4	-	-	7.2	-	-
Caudal fin:																	
length of upper lobe	26.1	26.4	27.5	27.6	26.3	25.8	25.8	26.0	27.0	26.6	26.3	25.0	23.6	24.1	24.4	25.3	24.9
length of lower lobe	10.3	10.1	11.5	10.7	9.4	10.5	9.5	10.8	10.4	10.1	10.0	9.3	9.4	9.4	9.6	10.5	9.2
length from tip to notch	6.0	5.8	5.7	5.7	6.3	6.2	6.2	6.0	6.6	6.2	5.8	5.9	5.9	5.2	5.8	5.9	5.7
notch depth	2.7	3.4	3.7	3.6	3.1	3.2	2.8	3.3	3.1	2.9	3.5	2.8	2.7	2.8	2.5	2.5	2.7

[1] Neotype of *Scoliodon sorrakowa*.
[2] Holotype of *Scoliodon longmani*.
[3] Holotype of *Scoliodon vagatus*.

The nominal subgenus *Rhizoprionodon* has a circumtropical distribution with the exception of Oceania. The subgenus *Protozygaena* is found in the western south Atlantic and the Indo-Pacific exclusive of Oceania and the coasts of Africa.

Rhizoprionodon (Rhizoprionodon) acutus (Rüppell)

FIGURES 5, 6

"Sorra Kowah" Russell, 1803, Descriptions and figures of two hundred fishes . . . Coromandel, vol. 1,p. 9, fig. 15 (a common name).

Carcharias acutus Rüppell, 1835, Fische des rothen Meeres, p. 65, pl. 18, fig. 4 (market at Djetta; lectotype designation in Klausewitz, 1960, Senck. Biol., vol. 41, nos. 5, 6, p. 292).

Carcharias sorrakowa Bleeker, 1853, Verh. Bataviaasch Gen., vol. 25, p. 9 (Vizagapatam, based on "Sorra Kowah" Russell; see nomenclatural discussion under *Scoliodon laticaudus*).

Carcharias (Scoliodon) walbeehmi Bleeker, 1856, Nat. Tijdschr. Ned. Ind., vol. 10, p. 253 (Bintang).

Carcharias (Scoliodon) crenidens Klunzinger, 1879, Sitzb. Akad. Wiss. Wien, vol. 80, p. 426, pl. 8, fig. 3 (Queensland).

Scoliodon longmani Ogilby, 1912, Mem. Queensland Mus., vol. 1, p. 30 (Moreton Bay).

Scoliodon vagatus Garman, 1913, Mem. Mus. Comp. Zool., vol. 36 (text), p. 116 (Zanzibar).

Carcharias eumeces Pietschmann, 1913, Jahrb. Nassauischen Ver. Naturk., vol. 66, p. 172, p. 1 (Bibundi).

DIAGNOSIS.—Upper labial furrow well developed, 1.4 to 2.0 percent of t.l.; precaudal centra markedly elongate in posterior monospondylous region (as in plate 2A); precaudal vertebrae less in number than caudal vertebrae (equal in 1 out of 124 specimens); anterior margin of pectoral fin usually equal to, or shorter than, total length of first dorsal fin (79 out of 102 specimens); snout in front of nostrils 4.6–5.4 percent of t.l. in specimens less than 575 mm. t.l. (54 specimens; 4.0–4.5 percent in 8 specimens); 4.2–5.1 percent in specimens over 575 mm. t.l.; total teeth in outer row of upper jaw usually 25 (63 specimens out of 75); total teeth in outer row of lower jaw usually 24 (66 specimens out of 74); total enlarged hyomandibular pores usually more than 16 (110 out of 118 specimens); first dorsal origin usually slightly in advance of level of appressed pectoral inner corner (ranging to just behind inner corner); origin of second dorsal fin ranges from above posterior third of anal base to over anal axil; tip of appressed pectoral fin usually reaches to below, or beyond level of, the anterior third of the first dorsal base (infrequently only to the anterior fifth). Males maturing only at sizes over 600 mm.

DESCRIPTION (see also table 10).—Precaudal vertebrae 55–79 (table 9); caudal vertebrae 64–83; total vertebrae 121–162; upper teeth 11–1–11 to 13–1–13 (usually 12–1–12); lower teeth 11–11 to 13–13 (usually 12–12); cusps of some upper teeth in large specimens faintly

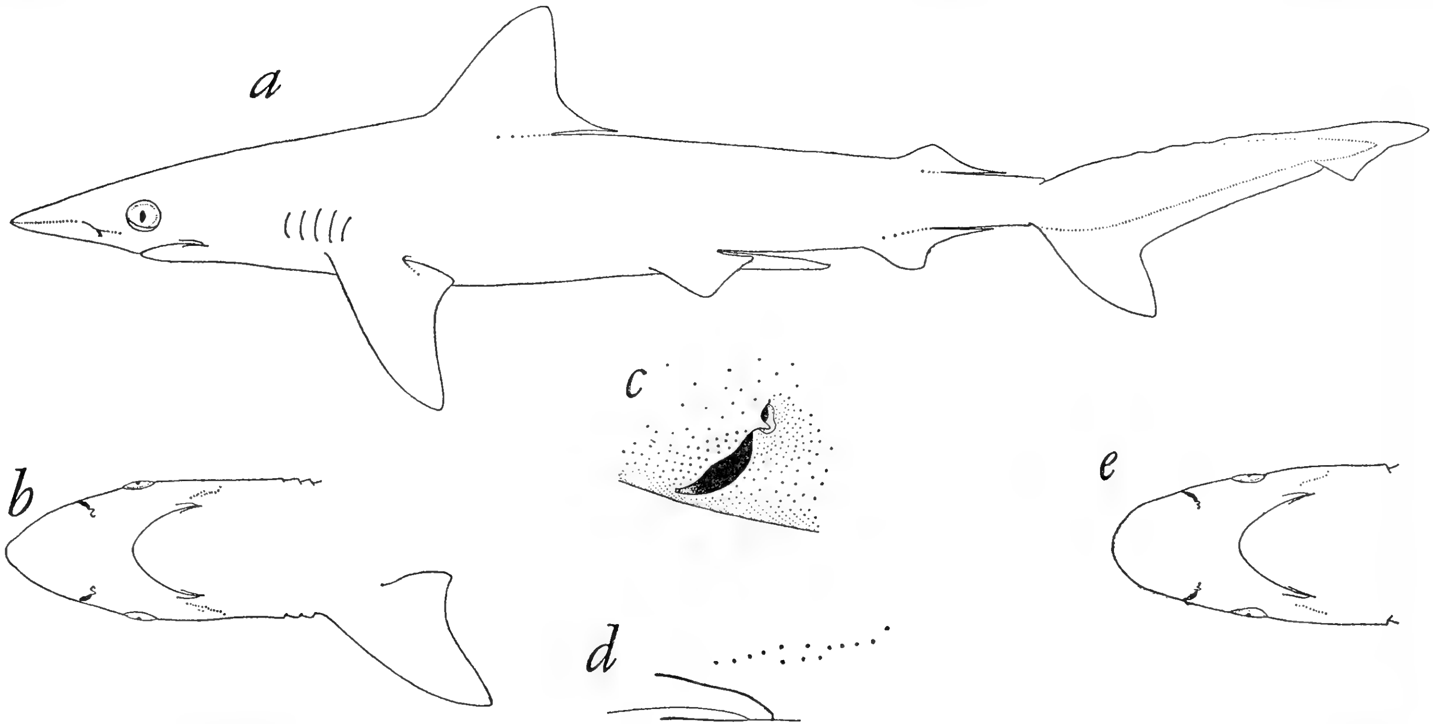

FIGURE 5.—*Rhizoprionodon acutus*, HUI E57/664, 624 mm. t.l., mature male from the Red Sea: *a*, left side; *b*, underside of head; *c*, enlarged right nostril; *d*, enlarged left labial furrows and adjacent enlarged hyomandibular pores; *e*, USNM 197343, 635 mm. t.l., female from the Red Sea, underside of head (*b* and *e* indicate the range of variation in snout shapes).

to moderately serrulate; cusps of lower teeth adumbrating this condition; dentition of mature males and females similar; sometimes cusps of teeth of mature males slightly more erect than those of females.

Denticles imbricate, 3-ridged and 3-toothed in young, 3- to 5-ridged and 3-toothed or with irregular posterior margin in adults.

Color of preserved specimens quite variable. Body gray, purplish gray, gray brown or buff brown above, pale below. Pectorals dark with a pale distal edge; pelvics and anal pale or dusky; upper caudal lobe usually with a dark edging in young; edging present or absent in adults; lower caudal lobe without a dark edging; other fins uniformly dark.

A low and poorly developed interdorsal ridge present or absent. Both precaudal pits present, the upper better developed.

Growth changes: There is a general tendency for distance from snout tip to outer nostrils, eye, mouth, and pectoral origin to decrease in percent of t.l. with increased t.l.; eye diameter, second dorsal base, and caudal notch depth decrease similarly. Distance from snout tip to second dorsal origin, anal origin, upper and lower caudal lobe origins tend to increase in percent of t.l. with increased t.l.

In large specimens there is a tendency for the axis of the upper caudal lobe to become raised in relation to the horizontal axis of the body.

The smallest mature male examined was 624 mm. t.l. from Eritrea. In general, males apparently mature at smaller sizes in the Red Sea than elsewhere, as seen in following tabulation:

Locality	*T.L.*	*Clasper Length (%)*	*Locality*	*T.L.*	*Clasper Length (%)*
Philippines	271	3.0	Red Sea	442	2.3
Philippines	280	2.9	Red Sea	445	2.2
Philippines	283	2.4	India	446	2.6
Formosa (embryo)	285	2.4	Australia	455	3.1
Philippines	288	2.7	Senegal	490	2.6
Philippines	296	2.8	Australia	500	2.8
Philippines	299	2.1	Persian Gulf	510	2.2
Philippines	304	2.3	Madagascar	510	2.3
Nigeria	352	2.2	Philippines	519	2.4
Gulf of Aden	331	2.9	Australia	520	2.2
North Borneo	335	2.3	Red Sea	560	2.2
Philippines	343	2.6	Persian Gulf	568	3.1
Philippines	350	3.1	Japan	576	2.5
Nigeria	353	2.2	Ghana	609	2.8
India	358	2.2	Red Sea	624	8.3
Australia	368	2.0	Australia	672	6.6
India	378	2.3	Red Sea	678	8.4
Philippines	391	1.9	Liberia	678	3.4
Senegal (embryo)	409	2.2	South Africa	692	3.4
Australia	440	2.1	Senegal	696	7.4

Locality	*T.L.*	*Clasper Length* (%)	*Locality*	*T.L.*	*Clasper Length* (%)
Philippines	709	7.6	Senegal	789	8.2
Philippines	722	8.0	Macassar	794	8.4
Australia	760	7.3	Australia	800	7.2
French Equatorial Africa	775	7.1	Gulf of Thailand	816	7.3
			Australia	874	6.9

The largest embryos seen were 409–411 mm. from Senegal; the smallest non-embryos from Senegal were 401–409 mm., and the smallest, from nearby Ghana and Nigeria, 308–320 mm. The smallest non-embryo examined was 242 mm. from the Philippines, where specimens under 300 mm. were not uncommon. The largest specimen examined from the Philippines was 722 mm. whereas the large embryos from Senegal were taken from a female 940 mm. (not seen by me). These figures may indicate that there are geographic populations varying in sizes attained, as well as indicating variation in size at birth in a given locality.

Geographic variation is indicated also in table 9, where groupings of precaudal vertebral numbers seem markedly different from one locality to another. The pattern of this variation is difficult to follow and will necessitate the examination of large numbers of specimens from many localities before it can be resolved.

Specimens from the Red Sea are noticeable for considerable variation in snout shape, ranging from rather acute to bluntly rounded. Also seen were some small west African specimens that had blunt snouts. Specimens with either acute or bluntly rounded snouts had the same relative snout lengths.

Some figures are available on the variation of precaudal vertebral counts in embryonic siblings and their mothers. A female from the Persian Gulf had 70 precaudal vertebrae; her two embryos had 68 and 72 precaudal vertebrae. A female from the Red Sea had 65 precaudal vertebrae and her three embryos had 68, 68, and 70 precaudal vertebrae. Three embryonic siblings from Senegal had 69, 69, and 70 precaudal vertebrae, and three from Durban, South Africa, had 71, 72, and 75 precaudal vertebrae.

Distribution.—This species is widely distributed from the Madeira Islands to Australia and Japan.

Relationships.—Within the subgenus *Rhizoprionodon*, *R. acutus* is most closely related to *R. porosus* and *R. terraenovae*, from which *R. acutus* differs in having a typically longer snout in front of the nostrils (fig. 1) and a higher dorsal-pectoral ratio (table 3).

Nomenclatural discussion.—The reasoning for placing *Scoliodon sorrakowa* Bleeker (1853) into the synonymy of *R. acutus* is given in the nomenclatural discussion of *Scoliodon laticaudus* (p. 580). Inasmuch as Bleeker's name is based on a Russell (1803) species for which no type material is available, I here designate SU 30502, a 368 mm. immature male, as neotype of *Scoliodon sorrakowa* (label data with the specimen is as follows: "*Scoliodon walbeehmi*, Madras Presidency, India. Coll. Madras Fisheries Dept., 1923, Herre 1934 Expeditions. Vizagapatam, Research. Madras, 1933"). The neotype is from the same general locality as the holotype and it conforms to Russell's figure and description except that it is approximately 9 mm. longer than the holotype.

I have examined all the type material of the nominal forms placed into the synonymy of *R. acutus* and find no reason for maintaining any as distinct from that species.

MATERIAL.—MADEIRA: ISZZ 7593 (1: 415 mm.). SENEGAL: MNHN A8005 (1: ca. 435); Goree, IFAN [no number] (2: 409–411, embryos), IFAN [no number] (1: 789), ZSZM 6288 (1: 401); St. Louis, NMV [no number] (1: 490); Dakar, IRSN 8.395 (1: 696); Joal, USNM 196156 (1: 354, embryo). FRENCH GUINEA: Sobane, USNM 196155 (1: 409); Konkoure, Mundung, ISH 296/59 (2: 426–435); Tamara Island, IRSN 6.907 (1: 516). LIBERIA: Kru Station, USNM 179719 (1: 387); Bushrod Island Beach, USNM 179718 (1: 678). GHANA: Elmina, Ashantee, USNM 42247 (1: ca. 310), USNM 42212 (1: ca. 320): Prampram, BMNH 1939.7.12.1 (1: ca. 770): Accra, BMNH 1930.3.24.1 (1: 609). NIGERIA: Lagos, BMNH 1937.4.19.1–2 (2: 308–352), BMNH 1936.8.20.1 (1: 477). CAMEROON: Bibundi, SMW 931 (1: ca. 495, holotype of *Carcharias eumeces*), NMV [no number] (1: ca. 488). FRENCH EQUATORIAL AFRICA: 29 miles south of Cape Lopez, MRAC 80253 (1: ca. 856), MRAC 80253 (1: 775); 11 miles south of Cape Lopez, IRSN 8.391 (1: 823). ANGOLA: 20 miles west northwest of Moanda, IRSN 8.393 (1: 445); 12 miles west of Moanda, MRAC 80252 (1: 466); south of Safaire, MRAC 80172 (1: 356); 8 miles west of Rio Cuanza, IRSN 8.390 (1: ca. 810). UNION OF SOUTH AFRICA: Durban, ANSP 73239 (1: 692), UND 82A–C (3 embryos). PORTUGUESE EAST AFRICA: Delagoa Bay, ANSP 55297 (1: 355). MOZAMBIQUE: Beira, DIRU 12 (1: 489). MADAGASCAR: east coast, ZSZM 7379 (1: ca. 378); Tamatave, NMV [no number] (1: 510). ZANZIBAR: MCZ 401 (1: 817, holotype of *Scoliodon vagatus*), MCZ 24 (1: ca. 610). GULF OF ADEN: Aden Harbor, RNH 12384 (2: 310–331). RED SEA: USNM 47603 (1: 553). ERITREA: HUI E57/660 (1: 730, and three embryos), HUI E57/658 (1: 649), HUI E57/662 (1: 646), HUI E57/661 (1: 669), HUI E57/659 (1: 721), HUI E57/663 (1: 678), HUI E57/666 (1: 445), HUI E57/664 (1: 624); near Massawa, USNM 197343 (1: 635); Hanfilah, Hasein Island [Dahlak Archipelago], NMV [no number] (1: 761). SAUDI ARABIA: Djetta [Jidda], NFIS 2783 (1: ca. 440, lectotype of *Carcharias acutus*, stuffed), NFIS 761 (2: 442–448).

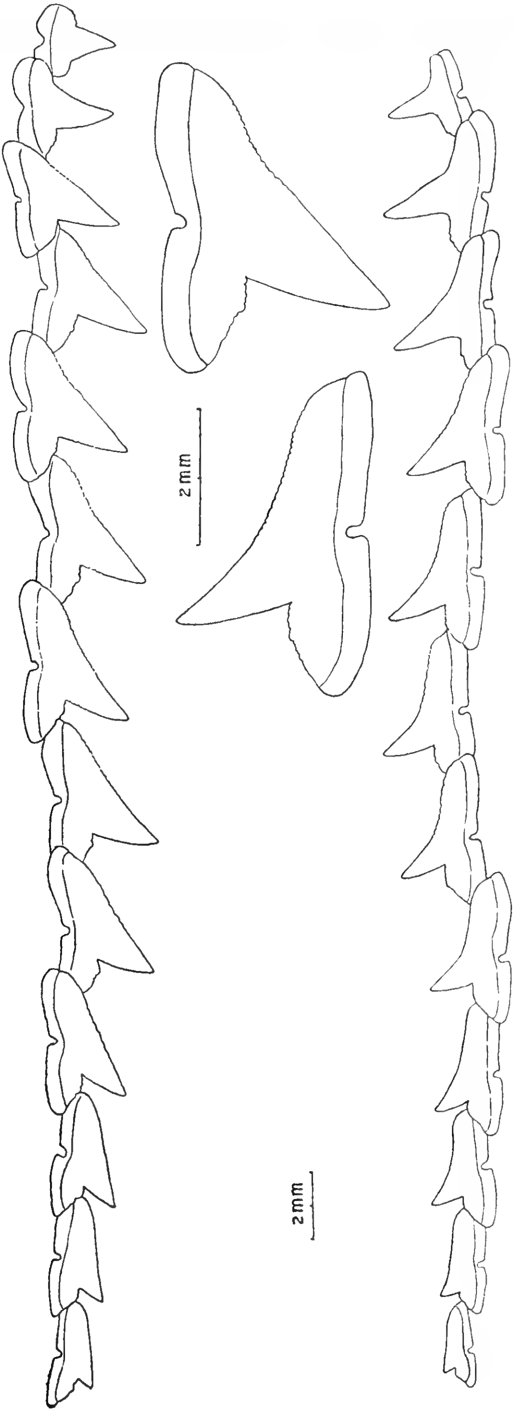

FIGURE 6.—*Rhizoprionodon acutus*, USNM 176744, 800 mm. t.l., mature male from Australia, right upper and lower teeth (symphysis to the right; inserted teeth are enlarged fifth upper and lower teeth from the right).

SUEZ: NMV [no number] (1: 560). GULF OF OMAN: Muscat, BMNH 1892.1.16.9–10 (1: 706). PERSIAN GULF: Ras el Mustaf, UZMK CN4 (1: 510); Jabrin, UZMK CN3 (1: 500); Tarut Bay, Zaal Island, USNM 148103 (1: 658), USNM 148104 (1: 690, and two embryos). INDIA: Malabar, BMNH 1889.2.1.4167–9 (1: 302); Calicut, SU 41986, in part (1: 371); Krusdai Island, Gulf of Manar, SU 41985 (1: 378); Madras, NFIS 4027 (1: 365), RNH 8575 (1: 341); Madras Presidency, SU 30502 (1: 368, neotype of *Scoliodon sorrakowa*); Pondicherry, MNHN 946, in part (1: 448); 50 miles from Ceylon, NMV [no number], in part (1: 338). ANDAMAN ISLANDS: BMNH 1870.6.14.21 (1: 360). THAILAND: NMV [no number] (2: 335–362); Bangkok, UZMK P0521 (1: 404): 13°09–13′ N. and 100°52–55′ E., 3–4 miles offshore, GVF 1557 (1: ca. 840); 12°30–40′ N. and 101°00–25′ E., GVF 1565 (2: 816–882). MALAYA: Singapore, NMV [no number] (1: 317), BMNH [no number] (1: 360). BINTANG ISLAND: BMNH 1867.11.28.191 (1: 440, female, holotype of *Carcharias* (*Scoliodon*) *walbeehmi*; no locality listed with specimen, but Bleeker described the species from a female, 453 mm., from Bintang); Rio, RNH 7368 (1: 421, female listed as holotype of *C.* (*S.*) *walbeehmi*, but I consider the difference in lengths too great to recognize this specimen as holotype). SUMATRA: Padang, NMV [no number] (1: ca. 790, and three embryos). MACASSAR: BMNH 1872.3.12.3 (1: 794). BATJAN [BACHAN] ISLAND: ISZZ 7674 (1: 321). ARU ISLANDS: near Meriri, NFIS 4026 (1: 450). AUSTRALIA: Northern Territory: Little Lagoon, northwest end of Groote Eylandt, Gulf of Carpentaria, USNM 174076 (1: 500); Bay of Yirrkalla, Northwest of Cape Arnhem, USNM 174077 (1: 785); Queensland: SMNS 2449 (1: ca. 575, holotype of *Carcharias crenidens*); Townsville, QMB I6190 (1: 672); Cape Cleveland, QMB I7034 (1: 874); Salamander Rocks, QMB I7136 (1: 440); Lindeman Island, AMS IA6159 (1: 760), AMS IA6681 (1: ca. 205, embryo); Brisbane, USNM 176744 (1: 800); Moreton Bay, QMB I12/292 (1: 455, holotype of *Scoliodon longmani*), AMS I12621 (1: 337); Moreton Island, DHMB 368 (1: 520); Deception Bay, QMB I8241 (1: 368), I8240 (1: 342). PHILIPPINES: MCZ 484 (1: 284): Sitankai, SU 13725 (1: 686); south Tumindao Lagoon, USNM 151235 (1: 716); Mindanao, SU 13152 (1: 722); Panay: Iloilo, SU 14454 (1: ca. 410); Capiz, SU 26862 (1: ca. 280); Unisan, Tayabas, SU 26820 (1: ca. 298); Luzon: Cavite, SU 9639 (2; 271–342); Orion, Bataan Province, ANSP 52798 (1: 481), ANSP 86371 (1: 242); Manila, UZMK 385 (1: 358), UZMK 386 (1: 277), SU 20592 (3: 283–296); Manila Bay: SU 26818 (3: 283–291), CNHM 46987 (1: 335), CNHM 46993 (1: 350), UWS 8568 (1: 299), SU 29621 (4: 258–304); La Monja Island, USNM 151234 (1: 709); Manila, fish market, USNM 151236 (2: 470–519), USNM 151238

(1: ca. 343), USNM 151239 (1: ca. 332). NORTH BORNEO: Sandakan, CNHM 23259 (1: 372), USNM 151237 (1: ca. 301), SU 27725 (2: 335–416), CNHM 21880 (1: ca. 420). SARAWAK: Santubong, BMNH 1894.1.19.88 (1: 420). FORMOSA: Tam Shui [Tanshui] ,Taipei Hsien, USNM 191192 (1: 820); Takao [Kashiung], CNHM 52099 (1: 285, embryo), CNHM 59261 (1: 909). JAPAN: BMNH 1862.11.1.80–132 (1: 576). HELGOLAND [undoubtedly an error]: SMNS 139 (1: 400).

Rhizoprionodon (Rhizoprionodon) terraenovae Richardson

PLATE 2A

Squalus (Carcharias) terraenovae Richardson, 1836, Fauna Boreali Americana, vol. 3, p. 289 (off Newfoundland).

DIAGNOSIS.—Upper labial furrow well developed, 1.6–2.2 percent of t.l.; precaudal centra markedly elongate in posterior monospondylous region (plate 2A); precaudal vertebrae less in number than caudal vertebrae; anterior margin of pectoral fin usually longer than total length of first dorsal fin (32 out of 37 specimens); snout in front of nostrils 3.8–4.5 percent of t.l. in specimens less than 575 mm. t.l., 3.6–4.0 percent of t.l. in specimens over 575 mm. t.l.; total teeth in outer row of upper jaw usually 25 (18 out of 20 specimens); total teeth in outer row of lower jaw usually 24 (18 out of 20 specimens); total enlarged hyomandibular pores on both sides of head usually more than 16 (52 out of 53 specimens); first dorsal origin usually over, or in advance of, level of appressed pectoral inner corner (ranging to slightly behind inner corner); origin of second dorsal fin ranges from above midpoint of anal base to over posterior fifth of anal base; tip of appressed pectoral fin reaches beyond level of anterior third of first dorsal base. Males maturing at sizes over 640 mm.

DESCRIPTION (see also table 11).—Precaudal vertebrae 58–66 (66 in only 1 specimen out of 74; table 12); caudal vertebrae 67–81; total vertebrae 126–144; upper teeth 11–1–12 to 13–1–13 (usually 12–1–12); lower teeth 12–12 to 13–13 (usually 12–12); cusps of some upper teeth in large specimens faintly to moderately serrulate; cusps of lower teeth adumbrating this condition; dentition of mature males and females similar (at least to sizes of about 840 mm.); enlarged hyomandibular pores 8–18 on each side of head.

Denticles imbricate, 3-ridged and 3-toothed in young; 3- to 5-ridged and 3- to 5-toothed or irregularly margined in adults.

Color of preserved specimens variable: Body slate gray, buff or gray brown above, large specimens frequently with a few scattered round pale spots about one-third eye diameter; body pale below. Pectorals dark with pale distal edges; pelvics and anal pale or dusky; caudal dark with a black border, except for anterior and sometimes

Table 11.—*Proportional dimensions in percent of total length of* Rhizoprionodon terraenovae

	♂ 335 mm. Florida USNM 158479	♀ 341 mm. Texas USNM 116448	♀ 354 mm. Texas USNM 116448	♂ 362 mm. Texas USNM 116448	♂ 365 mm. Texas USNM 116448	♀ 390 mm. Texas USNM 116488	♀ 555 mm. Louisiana USNM 127128	♀ 557 mm. Louisiana USNM 127119	♂ 621 mm. Florida USNM 196168	♀ 827 mm. Texas USNM 127105
Snout tip to:										
outer nostrils	4.2	4.4	4.0	4.2	4.2	3.9	4.0	3.8	3.8	3.9
eye	7.7	7.9	7.8	7.7	7.6	7.0	7.3	7.4	6.8	7.0
mouth	8.6	8.8	8.8	8.7	8.4	8.2	7.9	7.8	7.3	7.4
1st gill-opening	19.4	19.6	19.8	18.8	19.2	18.2	18.7	18.3	18.5	18.3
pectoral origin	22.4	22.9	21.8	21.8	22.5	21.3	22.2	21.8	21.1	21.2
pelvic origin	45.7	46.4	45.2	43.4	45.4	44.4	45.6	45.3	43.5	45.8
1st dorsal origin	31.0	32.2	31.1	31.2	31.0	30.8	30.6	31.4	29.6	31.2
2nd dorsal origin	61.5	63.3	62.4	61.6	63.0	62.8	63.2	63.8	63.0	63.7
anal origin	59.5	59.2	59.8	58.3	59.4	59.0	60.4	60.2	59.5	60.0
upper caudal origin	73.0	74.8	74.8	73.8	75.4	74.1	75.2	74.2	75.2	74.5
lower caudal origin	72.5	72.7	73.4	72.1	74.0	72.3	73.7	73.3	73.2	73.3
Nostrils:										
distance between inner corners	5.4	5.7	5.5	5.5	5.5	5.3	5.2	5.0	4.4	4.7
Mouth:										
width	7.8	7.4	6.9	6.9	7.1	7.4	7.1	7.0	6.9	6.9
length	4.5	5.0	4.7	4.7	4.9	4.5	5.2	4.9	4.3	4.5
Labial furrow lengths:										
upper	1.7	2.2	2.0	2.1	1.9	1.8	2.0	1.9	2.1	1.7
lower	1.5	1.7	1.4	1.3	1.6	1.7	1.4	1.5	1.4	1.4
Gill-opening lengths:										
1st	2.1	1.8	1.9	1.9	1.9	1.7	1.8	1.8	1.9	1.8
2nd	2.3	2.1	2.0	2.1	2.1	2.0	2.1	2.2	2.4	2.0
3rd	2.4	2.2	2.3	2.2	2.2	2.2	2.2	2.3	2.5	2.2
4th	2.1	2.0	2.2	1.8	2.1	2.0	2.1	2.3	2.3	2.1
5th	1.5	1.7	1.7	1.3	1.7	1.6	1.6	1.8	1.8	1.7
Eye:										
horizontal diameter	3.3	2.8	2.8	2.9	2.8	2.6	2.4	2.4	2.2	2.2
1st dorsal fin:										
length of base	9.0	9.3	9.2	9.1	9.0	9.0	8.6	9.0	8.9	9.6
posterior margin	3.9	3.8	4.0	3.9	3.6	3.8	3.7	4.2	3.6	3.9
height	7.4	8.1	7.4	8.0	7.7	8.4	8.1	8.1	8.0	9.2
2nd dorsal fin:										
length of base	3.0	2.9	3.2	3.2	3.2	3.0	2.8	2.7	2.9	3.0
posterior margin	4.5	4.7	4.2	4.7	4.2	4.5	4.5	4.8	4.5	5.0
height	2.0	2.2	2.0	2.2	1.9	2.1	2.2	2.3	1.9	2.5
Anal fin:										
length of base	4.2	5.0	4.8	4.7	5.0	4.9	4.9	4.5	5.2	4.8
posterior margin	3.9	4.0	3.8	4.2	3.8	3.8	4.0	4.2	3.7	3.9
height	2.8	3.0	2.7	3.0	2.8	2.6	3.0	3.0	2.7	2.6
Pectoral fin:										
length of base	5.1	5.0	5.1	5.3	5.4	4.8	4.9	5.3	5.4	5.1
length of anterior margin	12.8	12.8	12.4	12.8	13.3	13.2	13.6	14.4	13.9	13.7
length of distal margin	7.5	9.1	7.5	8.1	9.2	9.2	9.7	11.0	10.3	10.2
width	7.5	8.5	8.5	7.5	8.4	7.5	8.2	8.9	8.0	8.1
Pelvic fin:										
length of base	–	4.2	4.5	4.3	4.1	3.9	4.6	4.5	4.2	4.4
length of anterior margin	4.8	5.2	5.4	5.4	4.5	5.0	4.4	5.4	4.7	5.0
length of distal margin	3.6	4.3	3.8	4.2	3.8	4.1	4.4	4.5	4.2	4.1
length of claspers	2.4	–	–	2.5	2.2	–	–	–	2.4	–
Caudal fin:										
length of upper lobe	27.2	26.4	26.2	26.5	25.4	26.4	25.2	25.9	25.8	25.0
length of lower lobe	9.6	10.2	11.1	10.4	9.3	10.5	10.5	10.8	9.8	10.8
length from tip to notch	5.7	5.7	5.5	5.4	5.3	6.6	5.9	6.8	6.5	5.9
notch depth	3.6	3.6	3.6	3.6	3.3	3.6	3.3	3.2	3.0	2.7

posterior edge of lower lobe; first dorsal dark, sometimes with a darker posterior edging; second dorsal uniformly dark or black in adults, usually with an irregular blackening of the apex in young.

A low interdorsal ridge present in all well-preserved specimens examined. Both precaudal pits present, the upper better developed.

Growth changes: There is a general tendency for distance from snout tip to outer nostrils, eye, mouth, and first gill-opening to decrease in percent of t.l. with increased t.l. Distance between inner corners of nostrils, eye diameter, length of upper caudal lobe, and notch depth also decrease in similar manner. Distance from snout tip to second dorsal origin and length of anterior and distal margins of pectoral fin tend to increase in percent of t.l. with increased t.l.

In large specimens there is a tendency for the axis of the upper caudal lobe to become raised in relation to the horizontal axis of the body.

Insufficient information is available to establish the size at which males first mature, but based on the following tabulation, it appears that this size is greater than 640 mm. t.l.:

Locality	*T.L.*	*Clasper Length* (%)	*Locality*	*T.L.*	*Clasper Length* (%)
Texas	227	2.2	Mississippi	492	2.5
Texas	319	2.4	South Carolina	498	2.6
North Carolina	324	2.5	South Carolina	545	2.6
Alabama	329	2.4	Florida	545	2.5
Florida	335	2.4	Florida	621	2.4
Texas	341	2.0	Georgia	631	2.5
Florida	345	2.2	New Jersey	642	2.9
Florida	348	2.5	Louisiana	647	2.9
Texas	362	2.5	Yucatan	810	8.3
Texas	365	2.2	Florida	843	7.1
North Carolina	378	2.0	Florida	ca. 915	ca. 8.0

The smallest non-embryo examined was 227 mm. and the largest embryo was 292 mm. The largest specimen seen was about 915 mm., but it seems probable that specimens reach approximately 1000 mm. Bigelow and Schroeder (1948) reported specimens of 930 mm., but whether these were *R. terraenovae* or *R. porosus* is not clear.

Only one female with embryos was examined for precaudal vertebrae counts. The female had 59 and the embryos 59 and 60. Three other sibling embryos each had 60 precaudal vertebrae.

Distribution and nomenclatural discussion.—Northeastern coasts of North America from the Bay of Fundy south to Yucatan, Mexico. The species was described from a specimen from Newfoundland, but Jordan and Evermann (1896) and Bigelow and Schroeder (1948) believe that this is in error and that the specimen is from the southern United States (reasons not stated). No other specimens are recorded from Newfoundland and this assumption may be correct; however, the type specimen is not known to exist and it is not possible to discern from the description just what species of *Rhizoprionodon* Richardson might have had. Since the name has been used widely for the North American species, it seems best to retain it here.

The species occurs in marine and brackish waters at depths (over depths?) as great as 153 fathoms.

RELATIONSHIPS.—*Rhizoprionodon terraenovae* and *R. porosus* are cognate species. The separation of these two species is based on precaudal vertebral numbers (table 12) that are correlated with geographically non-overlapping distributions of the species. Some minor proportional differences are indicated in tables 11 and 13, but since these are small, they seem scarcely of value in recognizing the species.

The explanation for the existence and distribution of two cognate species such as *R. terraenovae* and *R. porosus* is not clear. The Pleistocene glacial relict theory of Walters and Robins (1961) does not seem to apply here as the two species apparently are common in both the tropical and temperate portions of their distributions. Continued separation is also a problem. The species are essentially shallow-water forms, but some specimens of each species have been taken well out to sea and in waters of great depth (see *R. porosus*). Even if depth and expanses of water hindered mixing of the two species, it would still be necessary to explain why they have not invaded each other's territory from the Central American coast, where *R. terraenovae* is reported from Yucatan and *R. porosus* from Honduras.

Rhizoprionodon terraenovae and *R. porosus* are related closely to *R. acutus*, from which they differ primarily in having a shorter snout length (fig. 1) and a lower dorsal-pectoral ratio (table 3).

MATERIAL.—NEW BRUNSWICK: Bay of Fundy, Grand Manan Island, MCZ 178 (1: 400 mm.). NEW JERSEY: Holly Beach, ANSP 22058 (1: 642). MARYLAND: Baltimore, UZMK 358 (1: ca. 488). VIRGINIA: Chesapeake Bay, Cape Charles, USNM 42491 (1: 530). NORTH CAROLINA: MCZ 1320 (3: 296–362), NMV [no number] (6: 355–370); Fort Macon, ANSP 561 (1: ca. 285), MCZ 35209 (2: 313–341); Beaufort, USNM 51892 (1: 378), USNM 51879 (1: 324), CAS 19777 (1: 344). SOUTH CAROLINA: Charleston, USNM 25181 (4: 437–545), MCZ 712 (1: 312); 33°38′ N. and 77°36′ W., USNM 38511 (1: ca. 785). GEORGIA: 33°52′ N. and 78°13′ W., 5 fathoms, USNM 196179 (1: 631). FLORIDA: USNM 39350 (1: ca. 915, skin); 29°47′ N. and 80°12′ W., 145–153 fathoms, USNM 158479 (1: 335); Indian River, USNM 7306 (4: ca. 333-ca. 375); 24°44′ N. and 80°43′ W., 30 fathoms, USNM 196801 (1: 758); Key West, USNM 125883 (1: 550); Tortugas, USNM 61126 (1: 228, embryo); west coast at 26°10′ N., 26 fathoms, USNM 196168 (1: 621); west coast at 26°44′ N., 29.5

TABLE 12.—*Frequency distribution of precaudal vertebrae number in* Rhizoprionodon terraenovae *and* R. porosus

	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
R. terraenovae																		
Bay of Fundy	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
New Jersey	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Maryland	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Virginia	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
North Carolina	–	–	1	–	5	2	2	3	1	–	–	–	–	–	–	–	–	–
South Carolina	–	–	1	1	1	2	–	1	–	–	–	–	–	–	–	–	–	–
Georgia	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Florida																		
East Coast	–	–	–	2	–	1	1	1	–	–	–	–	–	–	–	–	–	–
Keys	–	–	–	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–
West Coast	1	3	1	1	1	1	1	–	–	–	–	–	–	–	–	–	–	–
Alabama	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mississippi	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
Louisiana	1	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
Texas	2	–	5	9	5	3	1	1	–	–	–	–	–	–	–	–	–	–
Yucatan	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total	4	5	10	16	16	11	5	6	1									
R. porosus																		
Bahamas	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	–
Cuba	–	–	–	–	–	–	–	–	–	–	–	2	1	–	–	–	2	–
Jamaica	–	–	–	–	–	–	–	–	–	1	–	–	1	2	3	–	4	–
Hispaniola	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	2	2	2
Puerto Rico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
Virgin Islands	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
Martinique	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
Grenada	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–
Honduras	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
Panama	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–
Venezuela	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–
Brazil	–	–	–	–	–	–	–	–	2	2	4	4	3	5	1	1	–	–
Uruguay	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–
Total									2	3	5	7	8	8	7	5	11	2

fathoms, USNM 196267 (1: 843); Sanibel Island, San Carlos Bay, SU 36077 (1: 344); Clearwater, ANSP 40041 (1: 381); St. Marks, USNM 92231 (1: 345); Apalachicola Bay, near West Pass, USNM 125767 (1: 348), USNM 125764 (1: 337); Pensacola, USNM 30814 (1: 284, embryo), USNM 30706 (1: 545; 2 embryos: 280 and 292). ALABAMA: Mobile Bay, USNM 125873 (1: 329). MISSISSIPPI: Gulf coast, USNM 147773 (1: 492). LOUISIANA: half mile off Grand Isle, USNM 127127 (1: 647), USNM 127128 (1: 555), USNM 127129 (1: 549); two miles southeast of Grand Isle, USNM 127119 (1: 557). TEXAS: Harbor Island, USNM 127105 (1: 827); Galveston, USNM 116451 (13: ca. 299–ca. 374), USNM 116448 (5: 341–390), USNM 121618 (4: 227–341); Brownsville, USNM 171765 (3: ca. 275–ca. 285, embryos). MEXICO: south of Alacran Reef, one and a half miles off Yucatan, USNM 160830 (1: 810).

Rhizoprionodon (Rhizoprionodon) porosus Poey

FIGURES 7, 8

Squalus porosus Poey, 1861, Memorias sobre la historia natural de Cuba, vol. 2, p. 339, pl. 19, figs. 11, 12 (Cuba).

DIAGNOSIS.—Upper labial furrow well developed, 1.8–2.3 percent of t.l. (1.3 and 1.5 in 2 out of 19 specimens); precaudal centra markedly elongate in posterior monospondylous region (as in Plate 2A); precaudal vertebrae less in number than caudal vertebrae; anterior margin of pectoral fin usually longer than total length of first dorsal fin (32 out of 35 specimens); snout in front of nostrils 3.7–4.5 percent of t.l. in specimens less than 575 mm. t.l.; 3.3–4.3 percent of t.l. in specimens over 575 mm. t.l.; total teeth in outer row of upper jaw usually 25 (19 out of 22 specimens); total teeth in outer row of lower jaw 24; total enlarged hyomandibular pores on both sides of head more than 17; first dorsal origin usually slightly behind, or over, level of appressed pectoral inner corner (ranging to slightly in advance of inner corner); origin of second dorsal fin ranges from above midpoint of anal base to over posterior fourth of anal base; tip of appressed pectoral fin reaches beyond level of anterior third of first dorsal base. Males maturing at a size between 575 and 644 mm.

DESCRIPTION (see also table 13).—Precaudal vertebrae 66–75 (66 in only 2 out of 58 specimens; table 12); caudal vertebrae 69–85; total vertebrae 136–159 (only 1 with less than 140); upper teeth 11–1–12 to 13–1–13 (usually 12–1–12); lower teeth 12–12; cusps of some upper teeth in large specimens faintly to moderately serrulate; cusps of lower teeth adumbrating this condition; dentition of mature males (one seen) and females similar; enlarged hyomandibular pores 9–19 on each side of head.

Denticles imbricate, 3-ridged and 3-toothed in young; 3- to 5-ridged and 3-toothed or irregularly margined in adults.

Color of preserved specimens similar to that in *R. terraenovae* (p. 601). Springer (1950) described the color of a fresh specimen (as *Scoliodon terraenovae*) from deep water off the Bahamas. It was characterized as having "unusually vivid markings of white spots and white edges on the fins."

A low interdorsal ridge present or absent. Both precaudal pits present, the upper best developed.

Growth changes: From the data at hand (table 13) growth changes do not appear to be as marked as in the cognate *R. terraenovae*. Such changes possibly are obscured because of the variability to be expected among insular populations and the great geographical range represented. In contrast, the *R. terraenovae* figures were obtained, with one exception, from Gulf of Mexico specimens. Such dimen-

Table 13.—*Proportional dimensions in percent of total length of* Rhizoprionodon porosus

	♂ 323 mm. Jamaica USNM 9342	♂ 400 mm. Haiti ANSP 91757	♀ 413 mm. Brazil MCZ 432	♀ 460 mm. Uruguay MCZ 525	♂ 490 mm. Cuba CAS IU139	♂ 501 mm. Jamaica USNM 30014	♂ 510 mm. Brazil USNM 43357	♀ 710 mm. Cuba USNM 19795	♀ 775 mm. Cuba USNM 33079	♀ 810 mm. Virgin Islands USNM 179846
Snout tip to:										
outer nostrils	4.2	4.0	4.2	4.1	3.7	3.8	4.1	3.9	3.9	3.8
eye	8.0	7.4	7.6	7.0	7.1	7.2	7.5	6.8	7.3	7.0
mouth	8.9	8.0	8.3	7.6	7.6	7.8	8.4	7.2	7.4	7.4
1st gill-opening	20.8	17.7	17.7	17.4	18.4	17.6	18.6	17.3	17.4	17.7
pectoral origin	24.2	21.5	20.6	20.2	21.2	21.0	21.6	20.2	21.3	20.6
pelvic origin	47.6	44.5	46.0	45.6	44.9	45.7	45.7	45.8	48.0	45.2
1st dorsal origin	32.5	27.0	29.6	29.8	29.2	29.8	31.4	29.4	31.8	30.0
2nd dorsal origin	63.7	60.5	61.8	62.0	61.6	62.1	63.2	63.2	-	63.1
anal origin	61.2	57.6	59.4	59.1	59.2	60.1	60.2	60.5	62.5	60.0
upper caudal origin	75.2	72.7	73.9	73.9	73.5	73.4	74.9	75.2	76.4	74.4
lower caudal origin	73.9	71.5	72.6	72.1	72.2	71.6	73.7	74.0	75.0	73.5
Nostrils:										
distance between inner corners	5.6	5.2	5.1	5.0	5.2	5.4	5.5	4.8	5.2	5.1
Mouth:										
width	7.6	7.0	7.3	6.7	7.2	6.6	7.3	7.0	7.2	7.2
length	5.0	4.3	4.1	4.1	4.5	4.6	4.4	4.2	4.8	4.4
Labial furrow lengths:										
upper	2.0	2.0	2.2	1.8	2.0	2.0	2.0	1.3	2.3	1.9
lower	1.8	1.6	1.4	1.3	1.5	1.3	1.5	1.4	1.6	1.6
Gill-opening lengths:										
1st	2.1	1.7	2.0	1.7	1.6	1.7	1.6	1.6	1.7	2.0
2nd	2.4	1.9	2.1	1.9	1.9	2.0	2.1	1.9	2.0	2.1
3rd	2.5	2.1	2.3	2.1	2.0	2.5	2.2	2.1	2.5	2.2
4th	2.5	2.3	2.2	2.0	2.3	2.3	2.2	2.1	2.7	2.1
5th	2.1	2.0	1.7	1.5	1.8	1.8	1.7	1.8	2.1	1.6
Eye:										
horizontal diameter	3.4	2.7	2.8	2.4	2.8	2.6	2.6	2.2	2.1	2.0
1st dorsal fin:										
length of base	9.3	8.5	8.7	7.8	9.2	8.5	9.0	8.9	8.4	9.2
posterior margin	4.0	3.9	3.9	4.0	3.5	4.3	3.5	3.7	4.1	3.8
height	9.0	8.6	7.8	7.3	8.3	10.1	8.0	9.6	9.6	8.6
2nd dorsal fin:										
length of base	3.0	3.0	3.3	2.6	3.3	2.9	2.8	2.8	-	2.8
posterior margin	4.0	4.5	4.5	4.6	4.5	5.0	5.2	4.4	4.7	5.2
height	1.9	2.2	2.1	2.3	2.3	2.6	2.1	2.4	2.2	2.5
Anal fin:										
length of base	4.5	4.4	4.9	4.1	4.1	4.4	4.5	4.2	4.0	4.7
posterior margin	3.4	4.1	3.9	4.3	3.6	4.2	4.3	3.9	-	4.3
height	2.8	3.2	3.1	3.2	2.9	3.2	2.7	3.0	3.0	2.8
Pectoral fin										
length of base	5.1	4.2	4.9	4.8	4.6	4.5	4.8	4.5	5.0	5.0
length of anterior margin	13.4	13.2	13.3	11.2	13.9	14.1	13.1	13.9	14.7	14.4
length of distal margin	9.8	9.2	8.8	8.7	9.7	11.0	9.2	11.6	11.5	10.6
width	8.3	7.9	8.0	7.9	7.8	8.1	7.8	8.1	8.0	8.1
Pelvic fin:										
length of base	4.0	4.0	4.0	3.5	3.2	4.2	3.6	4.2	4.7	4.1
length of anterior margin	4.2	4.9	4.5	3.9	4.3	5.0	4.4	4.5	4.5	4.6
length of distal margin	4.4	4.0	4.3	3.9	4.0	4.4	4.0	4.0	4.7	4.4
length of claspers	2.6	2.0	-	2.7	2.6	2.6	3.9	-	-	-
Caudal fin:										
length of upper lobe	25.8	28.0	26.8	26.6	26.4	26.8	26.9	25.2	24.2	26.0
length of lower lobe	10.4	11.3	10.1	9.3	11.5	11.6	10.9	11.6	11.0	10.9
length from tip to notch	6.1	6.9	6.5	6.5	5.7	5.7	5.5	5.7	6.0	5.6
notch depth	3.4	3.3	3.4	3.1	2.8	3.1	3.1	2.6	2.7	3.1

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sions as do show growth changes in *R. porosus* indicate a course of development similar to that found in *R. terraenovae.*

Only one mature male, 644 mm., was seen; the largest immature male was 575 mm. The following tabulation presents the available data on proportionate clasper lengths:

Locality	*T.L.*	*Clasper Length (%)*	*Locality*	*T.L.*	*Clasper Length (%)*
Jamaica	323	2.6	Uruguay	460	2.7
Brazil	340	2.4	Uruguay	472	2.2
Brazil	357	2.7	Cuba	490	2.6
Panama	376	2.1	Jamaica	501	2.6
Brazil	397	1.8	Grenada	501	1.9
Brazil	399	1.8	Brazil	510	3.9
Haiti	400	2.0	Brazil	514	2.4
Brazil	433	2.1	Venezuela	575	3.0
Brazil	434	2.0	Brazil	644	8.0

The smallest non-embryo seen was 310 mm. The largest embryo was 390 mm. The largest specimen examined was a stuffed female from Brazil, approximately 1050 mm.

Little data on sibling variation is available. Three embryos, presumably siblings, from Saba Bank had 72, 73, and 74 precaudal vertebrae. Two others from Cuba had 75 and 76 precaudal vertebrae.

Distribution.—Essentially from the continental and insular shorelines of the western Atlantic between 24° N. and 35° S. latitudes. Backus (1957) reported taking a specimen (as *Scoliodon terraenovae*) from the surface about 65 miles north of Barbuda, where the depth was about 3300 fathoms.

Relationships.—See under *Rhizoprionodon terraenovae* (p. 604).

Nomenclatural discussion.—It is not known whether a type exists for *S. porosus*. The illustrations of the teeth and the description are sufficient to establish that Poey had a species of *Rhizoprionodon*. Since only one species of *Rhizoprionodon* occurs in Cuba, I have elected to use Poey's name for it.

Material.—bahamas: Bimini, USNM 196526 (1: 775 mm.); about three-fourths of a mile west of Riding Rock Light in 60 feet of water, UMML 10410 (2: 797–844). cuba: USNM 9832 (2: ca. 248–ca. 251, embryos), USNM 19795 (1: 710), USNM 33079 (1: 775); Havana, CAS IU139 (1: 490), SU 10845 (1: 462), USNM 24793 (1: 758). jamaica: USNM 9342 (2: 323–388), USNM 30014 (1: 501), USNM 30059 (1: 380), SU 11825 (1: 461), SU 11826 (1: 518), SU 11827 (1: ca. 500), MNHN 1070 (1: ca. 430), NMV [no number] (1: ca. 385), CNHM 2797 (1: ca. 409), CNHM 2799 (1: ca. 503). haiti: Port-au-Prince Bay, ANSP 91757 (3: ca. 310–400), USNM 133660 (2: 525–ca. 535). santo domingo [dominican republic]: ANSP 77115 (1: 584),

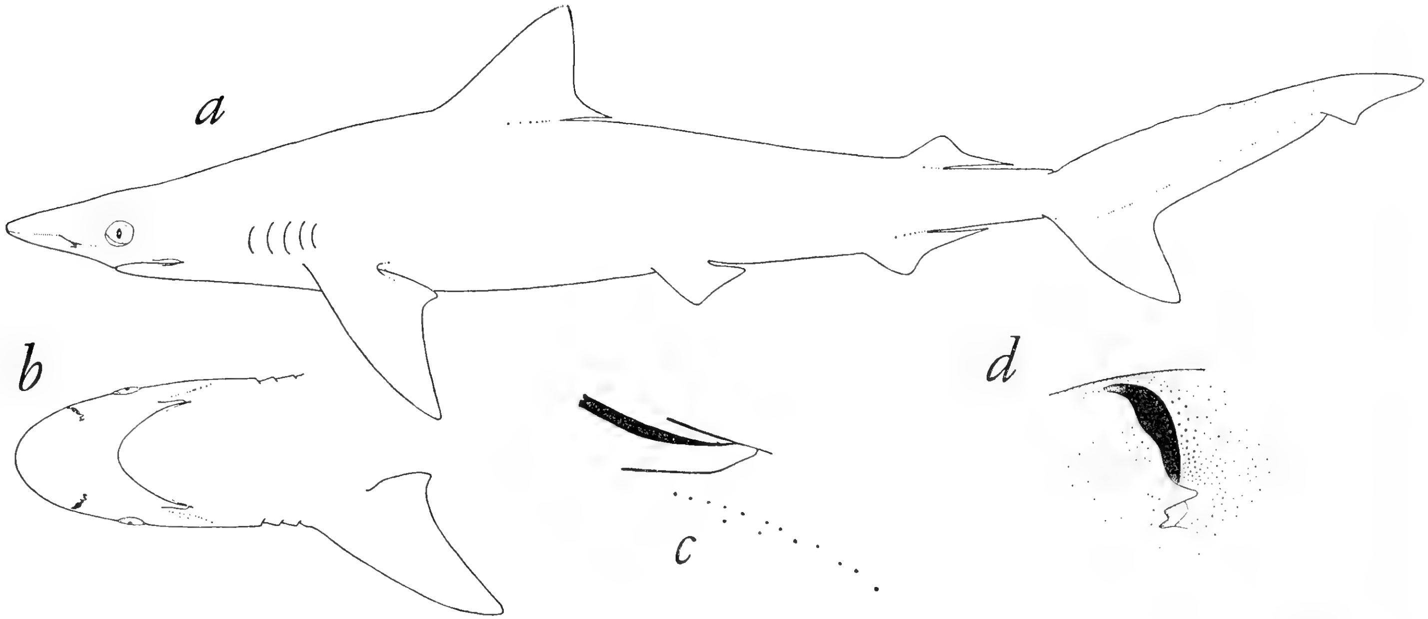

FIGURE 7.—*Rhizoprionodon porosus*, USNM 179846, 851 mm. t.l., female from the Virgin Islands: *a*, left side; *b*, underside of head; *c*, enlarged right labial furrows and adjacent enlarged hyomandibular pores; *d*, enlarged left nostril.

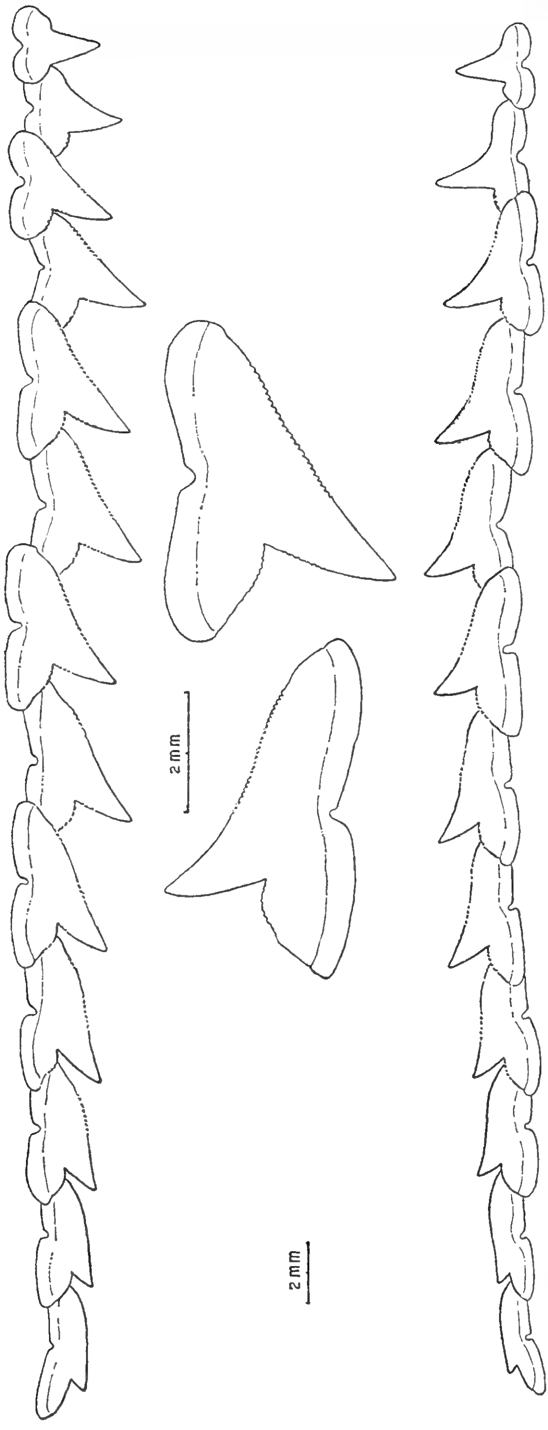

FIGURE 8.—*Rhizoprionodon porosus*, USNM 33079, 775 mm. t.l., female from Cuba, right upper and lower teeth (symphysis to the right; inserted teeth are enlarged fifth upper and lower teeth from the right).

NMV [no number] (1: 410). PUERTO RICO: west of El Mario, USNM 196613 (1: 472). VIRGIN ISLANDS: Booby Rock, St. John, USNM 179846 (1: 851). SABA BANK [ISLAND]: RNH 9270 (3: 380–390, embryos). GRENADA ISLAND: BMNH 1904.6.24.1 (1: 501). MARTINIQUE ISLAND: MNHN 1143 (1: 444). HONDURAS: USNM 44470 (1: 303). PANAMA: off reef at Ft. Sherman, AMNH 11413B (1: 333); Colón, market, USNM 79324 (1: 376). VENEZUELA: Caracas Bay, RNH 23321 (1: 575). BRAZIL: MNHN 3467 (1: ca. 1050, stuffed); Pernambuco, MCZ 714 (2: 340–376); Recife, high sea, SU 52747 (1: 343), SU 52857 (2: 390–434), SU 52858 (1: 397), SU 52859 (1: 366), SU 52860 (1: ca. 482); Bahía, USNM 43357 (1: 510), MNHN 1144 (1: 644), BMNH [no number] (1: 432); Rio de Janeiro, BMNH 1923.7.30.1 (1: 415), BMNH 1903.6.9.130–132 (2: 488–540), MCZ 720 (1: 357), MCZ 432 (2: 413–476), MCZ 160 (1: 514); Marica, SU 52748 (1: ca. 388); Santos, littoral of São Paulo, SU 52861 (1: 433); Maceio, SU 8446 (2: 370–399). URUGUAY: Maldonado, MCZ 525 (1: 460), NMV [no number] (1: 472).

Rhizoprionodon (Rhizoprionodon) longurio (Jordan and Gilbert)

FIGURE 9

Carcharias longurio Jordan and Gilbert, 1882, Proc. U.S. Nat. Mus., vol. 5, p. 106 (Mazatlán).

DIAGNOSIS.—Upper labial furrow well developed, 2.1–2.6 percent of t.l.; precaudal centra markedly elongate in posterior monospondylous region (as in plate 2A); precaudal vertebrae ranging from 12 less to 8 more than caudal vertebrae; anterior margin of pectoral fin usually equal to, or shorter than, total length of first dorsal fin (27 out of 32 specimens); snout in front of nostrils 5.1–6.0 percent of t.l. in specimens less than 575 mm. t.l., 4.5–5.0 percent of t.l. in specimens over 575 mm. t.l.; total teeth in outer row of upper jaw usually 27 or 29 (29 specimens; 28 or 30 in 3 specimens); total teeth in outer row of lower jaw 26 (21 specimens; 27 or 28 in 11 specimens); total enlarged hyomandibular pores on both sides of head usually more than 16 (32 out of 33 specimens); first dorsal origin usually over, or slightly in advance of, level of appressed pectoral inner corner, infrequently slightly behind level of inner corner; origin of second dorsal fin occurs above posterior third of anal base and always in advance of anal axil; tip of appressed pectoral fin reaches to below level of anterior one- to two-thirds of first dorsal base. Males maturing at sizes over 600 mm.

DESCRIPTION (see also table 14).—Precaudal vertebrae 68–86; caudal vertebrae 73–85; total vertebrae 146–167; upper teeth 13–1–13 to 15–1–14; lower teeth 13–13 to 14–14 (higher and lower counts usually correlated); cusps of some upper teeth in large specimens slightly serrulate; cusps of lower teeth adumbrating this condition;

TABLE 14.—*Proportional dimensions in percent of total length of* Rhizoprionodon longurio

	♂351 mm. Mexico SIO H51-306	♀358 mm. Mexico SIO H51-306	♂402 mm. Mexico UCLA W52-246	♂418 mm. Mexico UCLA W52-246	♀517 mm. Mexico USNM 28306 [1]	♀518 mm. Mexico USNM 29551 [1]	♂583 mm. Panama USNM 78101	♂657 mm. Peru USNM 127756	♂688 mm. Peru USNM 127756	♂792 mm. Mexico USNM 28330 [1]
Snout tip to:										
outer nostrils	5.3	5.1	5.8	5.8	5.5	5.2	4.9	4.6	4.9	4.5
eye	8.8	8.7	9.1	9.4	8.8	8.4	8.4	7.8	8.1	7.9
mouth	9.7	9.5	9.8	10.0	9.0	9.0	8.9	8.2	8.1	7.9
1st gill-opening	20.5	19.8	21.4	21.3	20.3	20.2	21.3	20.8	20.4	19.6
pectoral origin	24.5	22.8	24.9	24.4	23.4	23.2	23.4	23.6	23.7	23.5
pelvic origin	47.0	47.0	47.0	46.2	47.6	46.4	48.0	50.4	48.6	48.2
1st dorsal origin	32.8	32.4	32.8	32.3	33.1	32.6	33.1	34.0	32.4	33.0
2nd dorsal origin	64.6	65.4	64.7	64.4	63.8	64.3	66.2	69.2	66.0	69.1
anal fin origin	60.4	61.3	61.2	60.5	60.9	61.4	63.0	66.1	63.2	65.4
upper caudal origin	76.3	75.6	75.9	74.6	74.7	75.1	76.4	-	77.0	76.5
lower caudal origin	74.4	74.4	73.6	73.4	73.3	73.6	75.0	78.0	75.5	75.8
Nostrils:										
distance between inner corners	5.2	5.0	5.2	5.2	4.8	5.0	4.9	4.9	4.8	4.9
Mouth:										
width	7.1	7.0	6.6	7.1	6.8	6.8	7.0	7.5	6.8	6.9
length	4.9	4.5	5.1	5.3	5.2	5.2	5.0	5.3	5.4	5.4
Labial furrow lengths:										
upper	2.3	2.2	2.3	2.5	2.1	2.4	2.4	2.4	2.2	2.6
lower	1.6	1.4	1.4	1.8	1.8	1.7	1.7	1.7	1.7	1.6
Gill-opening lengths:										
1st	2.0	2.1	1.6	1.9	1.9	2.1	1.9	2.1	1.8	1.7
2nd	2.2	2.2	2.0	2.1	2.3	2.2	2.2	2.4	2.2	2.1
3rd	2.3	2.2	2.2	2.2	2.6	2.1	2.4	2.4	2.4	2.4
4th	2.1	2.2	2.3	2.1	2.6	2.3	2.5	2.7	2.5	2.3
5th	1.6	1.7	1.6	1.7	2.1	1.8	1.9	2.0	1.8	1.6
Eye:										
horizontal diameter	2.7	2.9	2.9	2.5	2.3	2.3	2.1	2.3	2.1	2.0
1st dorsal fin:										
length of base	9.1	9.5	9.1	9.6	8.3	8.7	9.4	9.4	9.9	8.8
posterior margin	4.1	3.9	3.7	3.9	4.6	5.0	3.9	3.6	3.8	4.9
height	7.5	7.5	7.8	7.5	8.1	8.4	8.2	8.3	8.6	9.2
2nd dorsal fin:										
length of base	3.0	2.8	2.5	3.0	2.7	2.9	2.4	2.9	3.2	2.5
posterior margin	4.4	4.5	4.4	4.3	4.7	5.0	4.8	4.3	4.6	5.3
height	1.9	2.0	1.6	1.6	1.6	1.7	1.8	2.0	2.3	1.5
Anal fin:										
length of base	4.4	5.1	4.5	4.4	4.1	4.3	4.2	4.6	4.4	3.6
posterior margin	3.8	3.6	3.5	3.4	4.4	4.4	4.1	4.1	4.1	4.7
height	2.7	2.8	2.5	2.7	2.7	2.7	2.7	2.8	2.6	2.7
Pectoral fin:										
length of base	4.5	5.3	4.9	5.0	4.8	5.2	5.1	5.3	5.1	5.3
length of anterior margin	12.0	11.7	12.2	11.7	12.6	12.8	12.8	13.8	13.4	14.4
length of distal margin	8.4	8.4	8.7	8.9	9.5	9.6	10.0	11.9	10.8	11.4
width	8.0	8.1	8.7	7.9	7.7	8.5	7.5	8.8	8.3	8.7
Pelvic fin:										
length of base	4.4	4.5	4.2	4.1	4.1	4.1	4.5	4.8	5.5	4.9
length of anterior margin	5.0	5.0	4.7	4.7	5.0	4.8	4.6	5.0	4.6	5.2
length of distal margin	3.6	3.6	3.6	4.0	3.9	4.2	4.1	4.7	4.2	4.0
length of claspers	2.2	-	2.1	2.4	-	-	3.8	-	7.3	9.7
Caudal fin:										
length of upper lobe	25.2	25.2	24.4	25.6	23.6	25.4	23.5	-	23.6	23.9
length of lower lobe	8.6	9.5	8.9	9.3	9.7	10.2	10.5	10.2	10.5	10.2
length from tip to notch	6.3	6.4	5.7	6.0	5.8	5.1	6.6	6.5	6.2	5.6
notch depth	3.3	3.9	3.8	3.3	3.6	3.9	2.9	2.9	2.8	3.6

[1] Syntypes of *Carcharias longurio.*

dentition of mature males and females similar; sometimes cusps of teeth of mature males slightly more erect than in females; enlarged hyomandibular pores 8–15 on each side of head.

Denticles imbricate, 3-ridged in young and adults, 3-toothed in young, 3-toothed or irregularly margined in adults.

Color of preserved specimens variable: Body slate or purplish gray, or gray brown above, pale below. Pectorals dark with a pale distal edge, pelvics and anal pale or dusky; upper caudal lobe with a dark margin on dorsal and ventral edges in young; edging on ventral margin absent in adults; lower caudal lobe without dark edging; first and second dorsal fins dusky with posterior margin pale in adults, pale or dark-margined in young.

A low interdorsal ridge present in all specimens examined. Both precaudal pits present, the upper better developed.

Growth changes: There is a general tendency for distance from snout tip to outer nostrils, eye, mouth, and pectoral origin to decrease in percent of t.l. with increased t.l. Distance between inner corners of nostrils and eye diameter also decrease in a similar manner. Distances from snout tip to pelvic, second dorsal, and anal origins tend to increase in percent of t.l. with increased t.l., as do first dorsal height, posterior margin of anal fin, anterior and distal margins of pectoral fin, and length of lower caudal lobe.

In large specimens there is a tendency for the axis of the upper caudal lobe to become raised in relation to the horizontal axis of the body.

Too little information is available to establish the size at which males first mature, but based on the following tabulation it appears that this size is greater than 583 mm.:

Locality	*T.L.*	*Clasper Length* (%)	*Locality*	*T.L.*	*Clasper Length* (%)
Mexico	351	2.2	Panama	583	3.8
Mexico	388	2.3	Peru	688	7.4
Mexico	402	2.1	Panama	702	8 5
Mexico	402	2.2	Mexico	792	9.2
Mexico	402	2.0	Mexico	916	7.1
Mexico	418	2.4			

The smallest non-embryo seen was 351 mm. and the largest embryo, 300 mm. Hubbs and McHugh (1950) reported free-living specimens as small as 343 mm. and embryos as large as 327 mm. The largest specimen seen was 916 mm., but five embryos are indicated as having been taken from a 1540 mm. female from Peru (Hildebrand, 1946).

The five sibling embryos mentioned above have precaudal vertebral counts of 79, 81, 82, 83, and 86, a range of 8 vertebrae. The known range of variation for the species covers a span of only 19 vertebrae.

I have noted no geographic variation in any character studied.

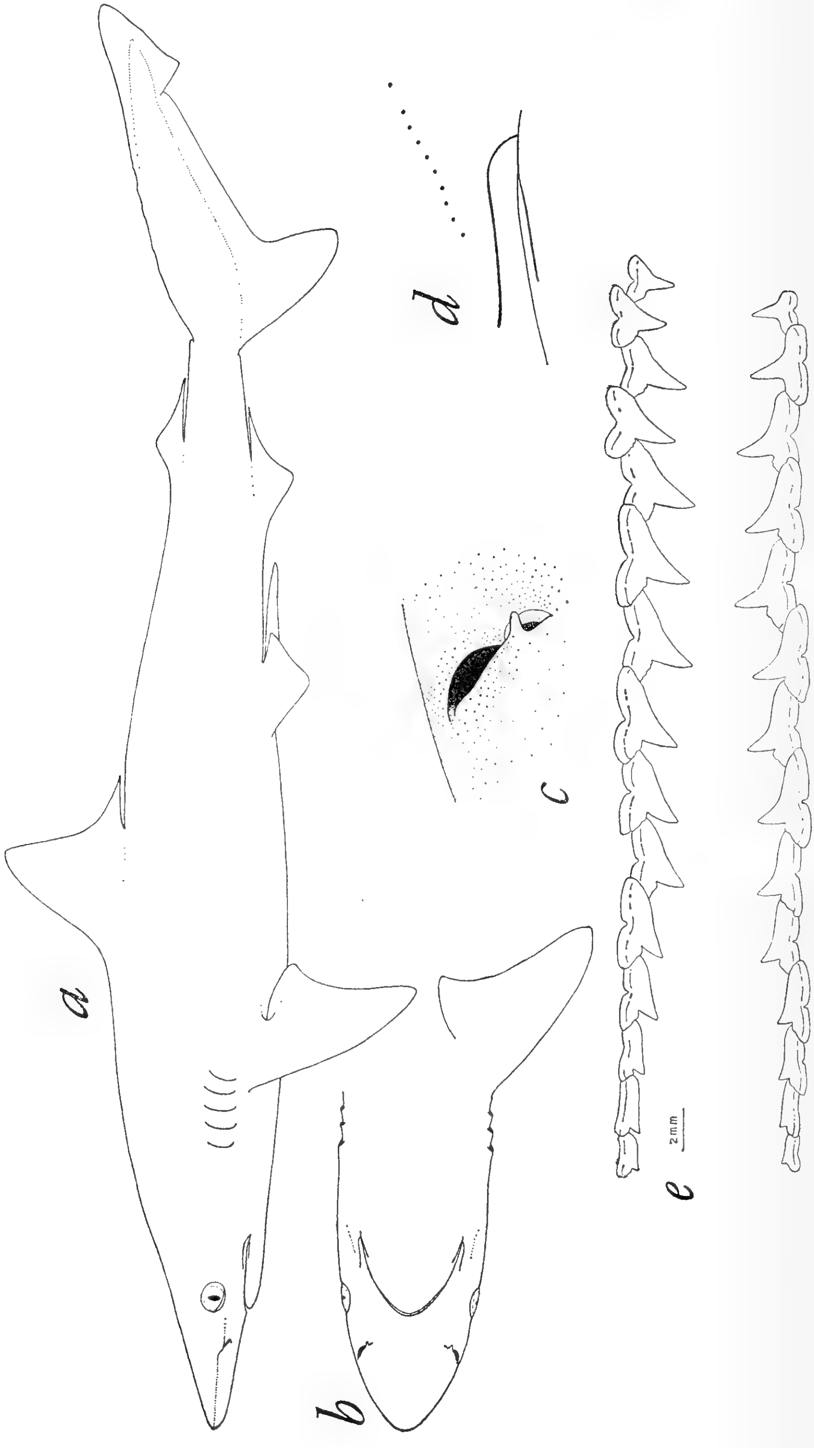

FIGURE 9.—*Rhizoprionodon longurio*, USNM 127756, 688 mm. t.l., mature male from Peru: *a*, left side; *b*, underside of head; *c*, enlarged left nostril; *d*, enlarged left labial furrows and adjacent enlarged hyomandibular pores; *e*, USNM 127756, 657 mm. t.l., female from Peru, right upper and lower teeth (symphysis to the right; base line refers only to teeth).

Distribution.—Eastern Pacific Ocean from Peru to southern California, from waters as deep as 15 fathoms.

Relationships.—Within the subgenus *Rhizoprionodon, R. longurio* forms a separate offshoot from the remaining three species, differing mainly in its high tooth counts, long snout, and upper labial furrow lengths.

Material.—mexico: Baja California: San Juanico Bay, USNM 196122 (1: 388 mm.), USNM 190594 (2: 402–403), UCLA W52–246 (12: 385–466), SIO H51–306 (2: 351–358); Concepción Bay, USNM 46852 (1: 916); beach one-half mile south of San Felipe, USNM 190590 (1: 385); Sonora: Salinas Bay, SU 17329 (2: 398–460); Mazatlán, USNM 28306 (1: 517, syntype of *Carcharias longurio*), USNM 28330 (1: 792, syntype of *Carcharias longurio*), USNM 29551 (1:518, syntype of *Carcharias longurio*), SU 11594 (1: ca. 685). panama: NMV [no number] (1: 525); 1–3 miles southeast of Isla Taboga, 2–4 miles off Río Pacora, UCLA W53–273 (4: 301–349); Panama City, USNM 78101 (1: 583); Panama City, fish market, USNM 79291 (1: 702). peru: Gulf of Guayaquil: 81°13′ W. and 4°13′ S., USNM 127756 (2: 657–688); off Mt. Organos, Cabo Blanco, USNM 127776 (5: 282–300, embryos from 1540 mm. female).

Rhizoprionodon (Protozygaena) lalandei Valenciennes

Figures 10, 11; Plate 2b

Carcharias (Scoliodon) lalandii Valenciennes *in* Müller and Henle, 1841, Systematische Beschreibung der Plagiostomen, p. 30 (Rio de Janeiro, Martinique, Guadeloupe).

Scoliodon intermedius Garman, 1913, Mem. Mus. Comp. Zool., vol. 36 (text), p. 115 (Philippines, East Indies).

Diagnosis.—Upper labial furrow well developed, 1.4–2.1 percent of t.l.; precaudal centra slightly elongate in posterior monospondylous region (plate 2b); precaudal vertebrae greater in number than caudal vertebrae; anterior margin of pectoral fin shorter than total length of first dorsal fin (equal to, in 1 out of 33 specimens); snout in front of nostrils 4.4–5.1 percent of t.l. in specimens less than 575 mm. t.l., 4.4–4.7 percent of t.l. in specimens over 575 mm. t.l.; total teeth in outer row of upper jaw 25; total teeth in outer row of lower jaw 24 (23 in 2 out of 21 specimens); total enlarged hyomandibular pores on both sides of head usually more than 16 (25 out of 26 specimens); first dorsal origin usually over level of appressed pectoral inner corner, ranging to just behind inner corner; origin of second dorsal fin usually over anal axil but may occur as far forward as above posterior fourth of anal base; tip of appressed pectoral fin reaches to below level of anterior third or less of first dorsal base. Males maturing at about 500 mm.

Description (see table 15).—Precaudal vertebrae 79–90 (only 4 specimens out of 45 with less than 85); caudal vertebrae 67–79;

TABLE 15.—*Proportional dimensions in percent of total length of* Rhizoprionodon lalandei

	♂352 mm. Surinam USNM 196134	♀366 mm. Surinam USNM 196134	♂370 mm. Surinam USNM 196133	♂390 mm. Surinam USNM 196134	♂446 mm. Brazil SU 14049	♀501 mm. MCZ 485 [1]	♂503 mm. Venezuela USNM 127099	♂519 mm. Venezuela USNM 127099	♀612 mm. Venezuela USNM 127099
Snout tip to:									
outer nostrils	4.7	4.6	4.9	4.6	4.8	4.6	4.7	4.8	4.7
eye	8.2	8.0	8.4	8.1	8.3	7.4	7.9	8.0	8.0
mouth	8.7	8.7	8.8	8.6	8.3	7.8	8.3	8.5	8.2
1st gill-opening	18.2	18.8	18.9	18.0	18.6	17.9	18.5	19.1	19.1
pectoral origin	21.0	20.8	21.9	21.0	21.8	21.3	21.7	22.2	22.6
pelvic origin	43.8	44.6	45.6	45.2	45.8	45.6	46.2	46.0	48.0
1st dorsal origin	30.7	31.2	31.1	31.0	30.3	29.9	32.4	31.4	32.4
2nd dorsal origin	62.2	63.6	64.0	63.6	63.7	65.0	65.8	65.7	67.3
anal fin origin	59.1	59.8	60.0	59.2	60.1	61.6	61.7	61.7	63.0
upper caudal origin	74.4	74.3	75.4	74.9	75.4	75.2	76.0	76.1	77.3
lower caudal origin	72.4	72.4	73.5	73.3	73.8	74.4	74.4	74.9	76.0
Nostrils:									
distance between inner corners	5.1	4.9	4.9	5.1	5.0	4.8	4.8	4.9	4.9
Mouth:									
width	6.4	6.1	6.4	6.2	6.4	6.4	6.7	7.0	7.2
length	4.5	4.4	4.6	4.1	4.5	4.5	4.9	5.0	5.2
Labial furrow lengths:									
upper	1.5	1.7	1.5	1.6	1.8	1.8	1.7	1.8	1.6
lower	1.2	1.1	1.2	1.6	1.4	1.5	1.3	1.7	1.5
Gill-opening lengths:									
1st	1.6	1.5	1.8	1.5	1.8	1.4	1.4	1.7	1.6
2nd	1.9	1.8	1.9	1.9	2.1	1.6	1.8	2.0	1.9
3rd	2.2	1.9	2.0	2.2	2.3	1.9	1.9	2.2	2.1
4th	2.3	2.1	2.1	2.1	2.2	1.9	2.0	2.2	2.2
5th	2.0	1.4	1.8	1.8	1.7	1.6	1.6	1.7	1.6
Eye:									
horizontal diameter	2.7	2.3	2.7	2.4	2.2	2.1	2.4	2.5	2.1
1st dorsal fin:									
length of base	9.3	9.6	9.1	9.5	9.7	8.4	9.4	10.0	10.8
posterior margin	4.3	4.4	4.5	4.6	4.8	5.2	4.2	4.2	4.4
height	7.1	7.2	6.9	7.2	8.1	8.2	8.3	8.1	8.2
2nd dorsal fin:									
length of base	2.4	2.7	2.4	2.8	2.4	2.3	2.4	2.4	2.5
posterior margin	4.3	4.3	4.1	4.6	5.0	4.7	4.7	4.8	5.0
height	1.7	1.6	1.7	1.7	1.7	1.8	1.6	1.8	1.9
Anal fin:									
length of base	4.5	4.3	4.5	4.9	4.8	4.1	4.3	4.4	4.4
length of posterior margin	3.6	3.9	3.9	3.7	4.5	3.9	3.8	4.1	4.2
height	2.2	2.3	2.4	2.3	2.6	2.8	2.4	2.5	2.6
Pectoral fin:									
length of base	5.2	4.9	5.1	4.9	5.2	5.1	5.0	5.3	5.4
length of anterior margin	11.1	11.6	11.1	11.6	12.9	12.8	11.9	12.2	12.9
length of distal margin	7.9	7.9	7.7	7.4	9.8	9.1	9.4	9.7	9.9
width	7.5	7.3	7.5	7.4	8.9	8.3	8.1	8.1	8.4
Pelvic fin:									
length of base	4.3	4.2	4.0	4.0	4.0	4.1	4.4	4.5	4.5
length of anterior margin	4.4	4.6	4.6	4.5	4.7	4.6	4.6	4.6	4.7
length of distal margin	3.7	3.8	3.6	3.7	4.3	4.3	3.8	4.4	4.6
length of claspers	2.2	–	2.6	2.2	3.3	–	7.1	7.4	–
Caudal fin:									
length of upper lobe	25.3	26.5	25.3	24.9	25.7	25.1	24.7	24.9	23.6
length of lower lobe	9.2	9.6	10.0	9.5	9.6	10.6	9.8	9.6	9.5
length from tip to notch	5.4	6.0	5.4	5.4	6.3	6.8	5.9	6.5	6.0
notch depth	4.0	4.1	4.0	4.1	4.0	3.2	3.8	3.8	3.6

[1] Lectotype of *Scoliodon intermedius.*

total vertebrae 153–168; upper teeth 12–1–12; lower teeth 11–12 to 12–12 (usually 12–12); cusps of teeth smooth to faintly irregular, posterior margins sometimes denticulate; anterior teeth of lower jaw of mature males distinct from those of females and young males (fig. 11); in mature males cusps of anterior teeth of lower jaw are slenderer and rounder in cross section than in females and young males. This situation is somewhat analagous to, but less striking than, that found in *Scoliodon* (p. 578). Enlarged hyomandibular pores 6–14 (rarely less than 8, usually 10 or 11) on each side of head.

Denticles imbricate (adults), 3-ridged and 3-toothed in young, 3- to 5-ridged and 3- to 5-toothed or irregularly margined in adults.

Color of preserved specimens: Body slate gray or brownish gray above, pale below; pectorals dusky with a pale distal margin (one young specimen had a blackish diffuse blotch near the tip of each pectoral); pelvics and anal pale or light dusky; caudal dusky or with a pale area centrally on each side; posterior margin of upper and lower lobes black-edged; first dorsal dusky with or without a pale posterior margin; second dorsal dusky. Distal portion of clasper of adult male sometimes abruptly paler than remainder.

A low interdorsal ridge present in well-preserved specimens. Both precaudal pits present, the upper better developed.

Growth changes: There is a slight tendency for distance from snout tip to outer nostrils, eye, and mouth to decrease in percent of t.l. with increased t.l. Length of upper lobe of caudal fin and caudal notch depth also decrease in similar manner. Distance from snout tip to pelvic, second dorsal, anal, and upper and lower caudal origins increase in percent of t.l. with increased t.l., as do also mouth width and length, first dorsal height, anal height, anterior and distal margins of pectoral fin, and width of pectoral fin.

In large specimens there is a tendency for the axis of the upper caudal lobe to become raised in relation to the horizontal axis of the body.

On the basis of the following tabulation males appear to mature at between 446 and 503 mm.:

Locality	*T.L.*	*Clasper Length (%)*	*Locality*	*T.L.*	*Clasper Length (%)*
Brazil	292	2.1	Brazil	392	2.7
Brazil	303	2.6	Brazil	400	2.8
Brazil	311	2.2	Brazil	446	3.3
Brazil	324	2.6	Venezuela	503	7.1
Brazil	338	2.0	Panama	510	5.9
Brazil	350	2.7	Venezuela	512	7.2
Surinam	353	2.2	Venezuela	519	7.4
Brazil	358	2.4	Panama	538	7.1
Surinam	370	2.6	Brazil	540	5.3
Surinam	390	2.2	Brazil	640	6.3

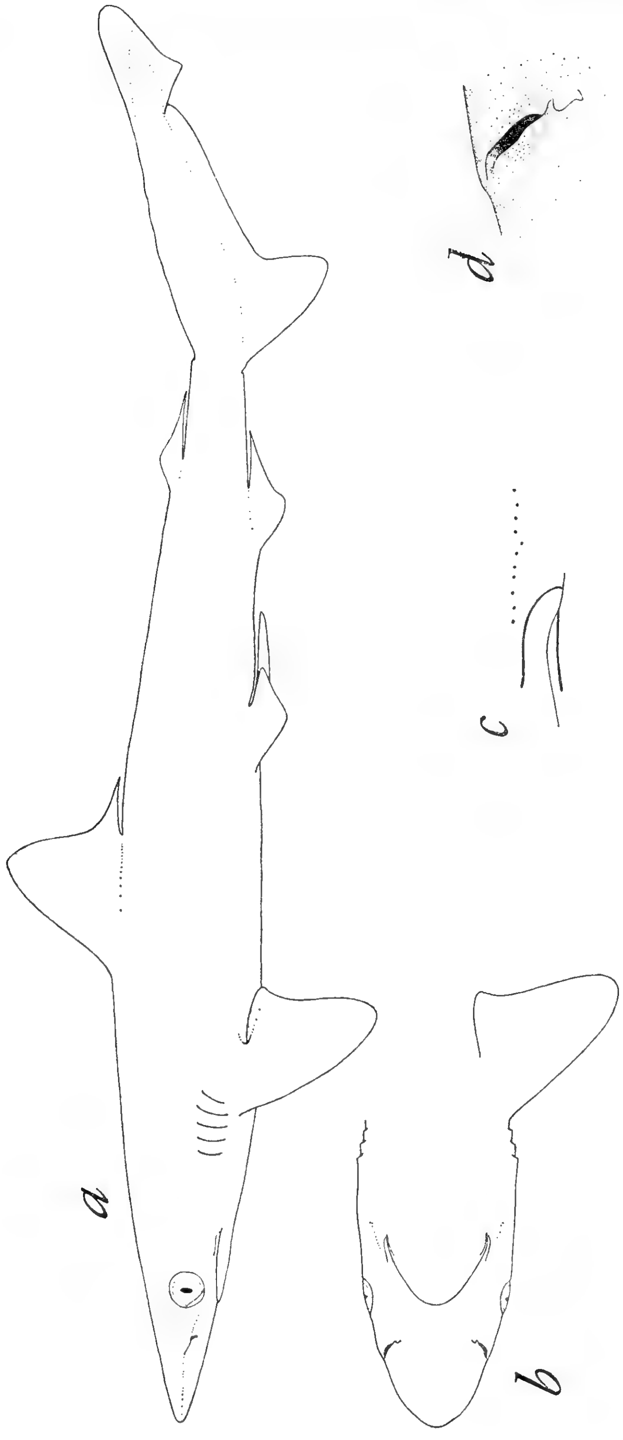

FIGURE 10.—*Rhizoprionodon lalandei*, USNM 127099, 519 mm. t.l., mature male from Venezuela: *a*, left side; *b*, underside of head; *c*, enlarged left labial furrows and adjacent enlarged hyomandibular pores; *d*, enlarged left nostril.

No embryos were seen; the smallest non-embryo examined was 292 mm. and the largest was 640 mm.

Distribution.—Western Atlantic continental coasts from Colón, Panama, to Florianopolis, Brazil.

Relationships.—*Rhizoprionodon lalandei* is most closely related to the cognates *R. oligolinx* and *R. taylori*. It differs from them in always having well-developed upper labial furrows (always longer in percent of t.l. than either of the two cognates) and a typically higher tooth count. In addition, it differs from *R. taylori* in having a greater number of precaudal vertebrae and from *R. oligolinx* in having more enlarged hyomandibular pores.

Nomenclatural discussion.—The type material of *R. lalandei* consists of specimens of two species, *R. porosus* and what is here considered *R. lalandei*. Lectotype designation is made in the material listed below. The lectotype, MNHN 945, has label data indicating only Brazil as the locality from which it was collected and DeLalande as the collector. The Brazilian type locality given by Müller and Henle (1841) is stated specifically to be Rio de Janeiro, but it is not associated with any particular specimen. The Leiden Museum syntype mentioned by Müller and Henle also has only Brazil listed on the label.

The type material of *Scoliodon intermedius* consists of two specimens also belonging to two species. One, 284 mm., is an *R. acutus* from the Philippines. The other, 501 mm., belongs in the subgenus *Protozygaena* and is labeled from the East Indies. The type description is based on a single specimen, obviously the larger of the two, and I designate it here as lectotype (see "Material"). This specimen has longer labial furrows and somewhat longer precaudal centra in the posterior monospondylous region than do *R. taylori* and *R. oligolinx*. Both of these characters, as well as its enlarged hyomandibular pore count of 20 and possibly its precaudal vertebral count (one less than for any specimen of *R. oligolinx*), exclude its being *R. oligolinx*, which is the only member of the subgenus known from the East Indies. Its higher precaudal vertebral count also seems to exclude it from *R. taylori*, which is known only from Australia.

The combination of these critical characters falls in nicely with those of *R. lalandei*. Unless there is another species of the subgenus in the Pacific or the specimen is an aberrant one of either of the two species known from the Pacific, it seems probable that the specimen is *R. lalandei* and that the locality data somehow has been incorrectly recorded.

Material.—panama: Colón, USNM 79288 (1: 510 mm.), USNM 79290 (1: 538), ANSP 49849 (1: ca. 410). gulf of venezuela:

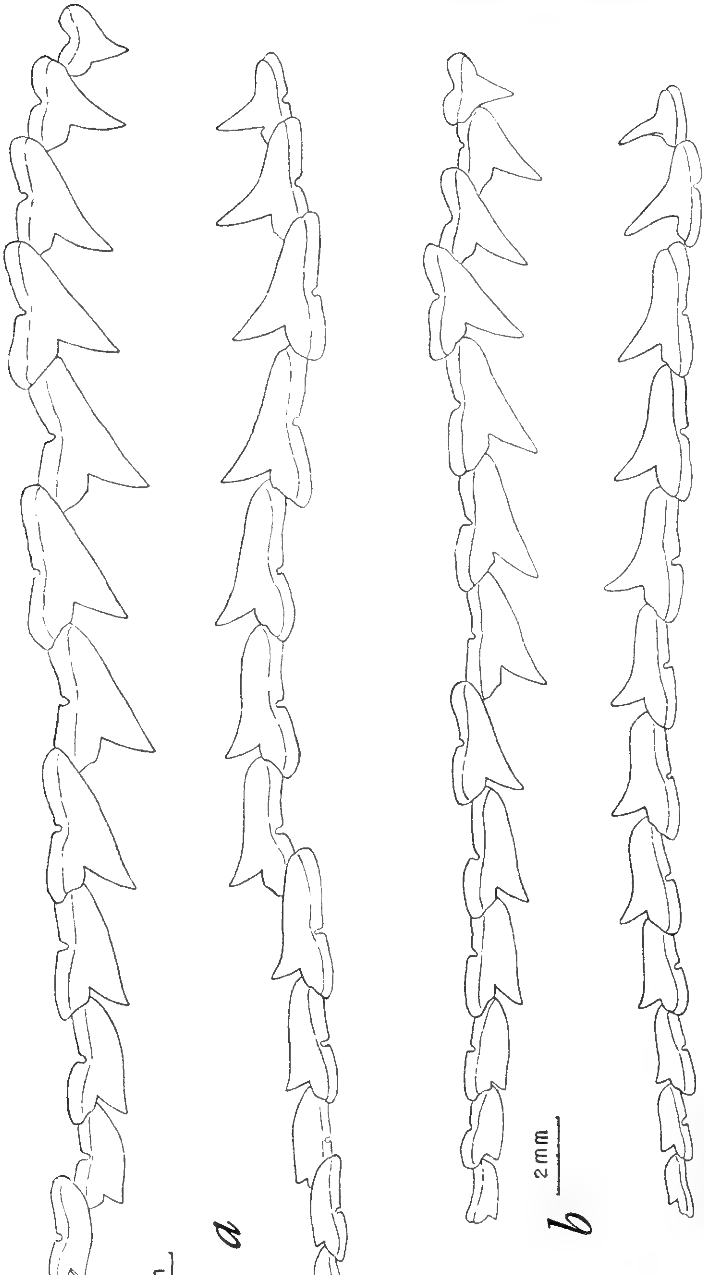

FIGURE 11.—*Rhizoprionodon lalandei*, USNM 127099 from Peru: *a*, 612 mm. t.l., female, right upper and lower teeth (symphysis to the right); *b*, 512 mm. t.l., male, right upper and lower teeth (symphysis to the right).

USNM 127099 (4: 503–612). SURINAM: 6°24′–6°22′ N. and 54°55′–54°59′ W., at 14 fathoms, USNM 196133 (1: 370); 6°21′–6°20. 5′ N., and 54°59′–54°54′ W., at 14 fathoms, USNM 196134 (3: 352–390). BRAZIL: MNHN 945 (1: 303, male, here designated lectotype of *Carcharias* (*Scoliodon*) *lalandei*), RNH 4339 (1: 315); Recife, Pernambuco, USNM 104310, (1: 417); Bahía, UZMK 356 (1: 572); Victoria, SU 52749 (1: 640), SU 52853 (1: ca. 330), SU 52854 (1: ca. 365), SU 52856 (4: 292–311); Rio de Janeiro, MCZ 91 (1: 605), ZSZM 8037 (1: ca. 340), NMV [no number] (1: 501), MNHN 1065 (1: 489), BMNH 1903.6.9.130–132 (1: 591); Bandeirantes, USNM 100811 (3: 324–350); south of Ilha Grande, SU 52759 (1: ca. 605); fish market at Rio de Janeiro, SU 52750 (1: ca. 317), SU 52751 (1: 412), SU 52752 (1: 540), SU 52753 (1: 400), SU 52754 (1: 338), SU 52755 (1: 335), SU 52756 (1: 311), SU 52757 (1: 330); Santos, SU 14049 (2: 392–446), CAS 11812 (1: 313); mouth of Rio Itapoca, (1: 358); Florianopolis, Ribeirao, SU 52862 (1: 506). "EAST INDIES" [probably in error]: MCZ 485 (1: 501, here designated lectotype of *Scoliodon intermedius*).

Rhizoprionodon (Protozygaena) oligolinx, new species

FIGURES 12, 13; PLATE 2C

DIAGNOSIS.—Upper labial furrow poorly developed, 0.0–1.3 percent of t.l. (less than 1.0 percent in 37 out of 45 specimens); precaudal centra not obviously elongate in posterior monospondylous region (plate 2c); precaudal vertebrae greater in number than caudal vertebrae; anterior margin of pectoral fin shorter than total length of first dorsal fin; snout in front of nostrils 3.7–4.7 percent of total length (only 3 specimens over 575 mm. seen and snout length of only 1 of these was measured, 610 mm., 3.9 percent); total teeth in outer row of upper jaw 23–25 (23 in 30 out of 55 specimens); total teeth in outer row of lower jaw 21–24 (22 in 42 out of 55 specimens); total enlarged hyomandibular pores on both sides of head usually less than 16 (55 out of 56 specimens); first dorsal origin over, or just posterior to, level of appressed pectoral inner corner; origin of second dorsal fin usually over a point just in advance of anal axil, but may occur as far forward as above posterior third of anal base; tip of appressed pectoral fin reaches to below level of anterior third or less of first dorsal base. Males maturing at less than 380 mm.

DESCRIPTION (see table 16).—Precaudal vertebrae 84–91 (only 1 specimen each, out of 54, with 84 and 91); caudal vertebrae 64–75; total vertebrae 151–162; cusps of teeth smooth to faintly irregular; posterior margins sometimes denticulate; anterior teeth of lower jaw of mature males distinct from those of females and young males

TABLE 16.—*Proportional dimensions in percent of total length of* Rhizoprionodon oligolinx

	♂272 mm. India USNM 175349	♂276 mm. India SU 41981	♀315 mm. Thailand ANSP 60403	♀395 mm. Malaya MCZ 180	♂400 mm. Java UMMZ 177113	♂413 mm. Thailand ZSZM 7533	♀417 mm. Malaya SU 14197	♂435 mm. Java UMMZ 177113	♀458 mm. Malaya MCZ 111	♂489 mm. Thailand USNM 196799 [1]
Snout tip to:										
outer nostrils	4.5	4.7	4.7	4.5	4.4	4.4	4.6	4.6	4.4	4.1
eye	7.5	8.2	7.7	7.5	7.2	7.2	7.6	7.4	6.8	7.0
mouth	8.1	8.3	8.2	7.7	7.5	7.8	8.0	7.7	7.2	7.3
1st gill-opening	19.9	18.1	18.1	18.0	18.0	18.2	17.3	17.7	16.4	16.8
pectoral origin	23.2	21.8	21.2	20.8	21.8	22.0	21.1	20.9	19.6	20.8
pelvic origin	45.6	44.5	45.7	46.0	45.0	46.2	46.6	46.0	45.0	46.0
1st dorsal origin	33.1	31.9	31.8	31.6	30.2	31.7	31.2	31.7	30.1	30.8
2nd dorsal origin	63.3	62.3	63.8	63.8	63.3	65.4	65.0	64.2	63.2	65.5
anal origin	59.2	58.7	59.4	60.2	60.0	61.2	61.2	61.4	59.0	61.5
upper caudal origin	73.2	74.3	74.0	73.9	74.6	76.0	74.8	75.2	74.5	76.6
lower caudal origin	72.5	71.7	72.5	72.4	73.3	74.4	74.1	73.6	72.7	75.0
Nostrils:										
distance between inner corners	5.5	5.1	5.1	4.3	4.8	4.5	4.6	4.8	4.5	4.5
Mouth:										
width	7.2	7.1	7.7	6.5	7.0	6.5	6.9	6.6	6.6	7.1
length	5.3	5.1	4.6	5.1	4.9	5.0	4.4	4.8	4.9	4.8
Labial furrow lengths:										
upper	0.7	0.6	0.5	0.2	0.5	0.5	0.5	0.9	0.3	0.3
lower	1.4	1.5	1.4	1.5	1.4	1.4	1.3	1.4	1.4	1.3
Gill-opening lengths:										
1st	1.9	1.7	1.7	1.5	1.6	1.6	1.4	1.6	1.7	1.9
2nd	2.2	2.0	1.9	1.7	2.0	1.8	1.7	1.8	1.7	2.4
3rd	2.3	2.2	2.1	1.8	2.2	1.9	1.9	2.2	2.1	2.6
4th	2.4	2.5	2.3	2.0	2.4	2.2	2.1	2.4	2.1	2.7
5th	2.0	2.1	2.0	1.8	1.8	1.9	1.8	2.1	1.6	2.3
Eye:										
horizontal diameter	3.2	3.0	2.8	2.2	2.2	2.4	2.2	2.3	2.1	2.1
1st dorsal fin:										
length of base	9.8	9.5	10.0	9.5	9.7	9.0	9.2	9.6	10.1	10.1
posterior margin	4.2	4.3	5.0	4.7	4.8	4.5	4.9	4.8	5.1	3.9
height	8.3	8.0	7.9	8.6	7.9	7.6	7.3	8.1	8.5	8.0
2nd dorsal fin:										
length of base	2.2	2.9	2.2	2.7	2.8	2.4	2.4	2.9	2.4	2.5
posterior margin	5.1	5.0	5.5	5.3	5.2	5.2	5.0	5.1	5.1	4.7
height	1.7	1.7	1.7	1.8	1.6	1.9	1.7	1.6	1.9	1.6
Anal fin:										
length of base	4.8	5.2	4.8	4.7	4.8	5.1	5.1	4.8	4.8	5.0
length of posterior margin	4.8	4.0	5.0	4.8	4.9	4.5	4.7	4.7	4.9	4.3
height	2.7	2.9	2.7	3.1	2.6	2.7	2.7	2.7	2.9	2.4
Pectoral fin:										
length of base	5.3	5.5	5.3	5.3	5.6	4.9	5.9	5.1	5.1	5.5
length of anterior margin	12.4	11.8	11.7	13.3	12.2	12.2	12.0	12.4	13.1	11.7
length of distal margin	7.9	7.3	7.6	8.4	9.2	8.2	8.4	8.4	9.1	8.0
width	7.6	7.7	8.0	8.0	8.4	7.9	7.5	7.9	8.1	7.4
Pelvic fin:										
length of base	4.0	4.1	4.1	4.0	4.6	4.5	4.3	4.4	3.8	4.3
length of anterior margin	5.2	4.5	5.3	5.0	4.6	4.9	4.7	4.6	5.1	4.3
length of distal margin	4.0	4.3	3.8	4.3	4.6	4.4	4.3	4.2	3.9	3.9
length of claspers	2.0	2.2	–	–	8.6	8.7	–	8.5	–	7.7
Caudal fin:										
length of upper lobe	27.2	26.6	25.1	25.9	25.4	24.6	25.8	25.2	26.4	23.5
length of lower lobe	10.3	10.2	10.5	11.7	–	10.1	10.1	9.8	11.4	9.6
length from tip to notch	6.0	6.3	6.0	5.9	6.0	5.9	6.4	6.4	5.6	6.3
notch depth	4.2	4.0	4.6	3.9	3.9	3.8	3.6	3.5	3.9	3.3

[1] Holotype of *Rhizoprionodon oligolinx.*

(fig. 13); in mature males the cusps of the anterior teeth of the lower jaw (and sometimes upper) are slenderer and rounder in cross section than in females and young males. This situation is somewhat analogous, but less striking than that found in *Scoliodon* (p. 578). Enlarged hyomandibular pores 3–8 (usually 4–7) on each side of head.

Denticles imbricate, 3-ridged and 3-toothed in young, 3- to 5-ridged and 3- to 5-toothed or irregularly margined in adults.

Color of preserved specimens: Body slate gray or brownish gray above, pale below; pectorals dusky with a pale margin; pelvics and anal pale or light dusky; caudal uniformly dusky or with a pale area centrally on each side; margins of upper caudal lobe black to dusky-edged; first dorsal with or without a pale or faintly dusky posterior margin; second dorsal dusky. Distal portion of clasper of adult male sometimes abruptly paler than remainder.

Interdorsal ridge, when present, very faint. Both precaudal pits present, the upper better developed.

Growth changes: There is a slight tendency for distance from snout tip to eye, mouth, first gill-opening, and pectoral origin to decrease in percent of t.l. with increased t.l. Eye diameter and caudal notch depth decrease similarly. There is a slight tendency for snout tip to anal origin and upper and lower caudal lobe origins to increase in percent of t.l with increased t.l.

In large specimens there is a tendency for the axis of the upper caudal lobe to become raised in relation to the horizontal axis of the body.

The following tabulation indicates that males have mature claspers at between 287 and 380 mm.; however, in at least one male, 387 mm., with mature claspers, dentition was still sexually undifferentiated.

Locality	*T.L.*	*Clasper Length* (%)	*Locality*	*T.L.*	*Clasper Length* (%)
Java	219	2.2	Java	400	8.6
India	261	2.8	Thailand	413	8.7
India	272	2.6	Java	414	9.4
India	272	2.0	Madura Straits	435	9.3
India	276	2.2	Java	435	8.5
India	280	2.7	Thailand	448	8.6
Ceylon	287	2.2	Thailand	461	9.0
Japan	380	9.0	Thalland	481	8.2
Thailand	387	7.8	Thailand	489	8.7

The smallest non-embryo examined was 219 mm. from Batavia; the largest embryo was 261 mm. from Bombay. An embryo 231 mm. was examined from Batavia indicating variation in size at birth. The largest specimen seen was 610 mm. from Kanara, India.

No information is available on vertebral variation among siblings.

724–334—64——5

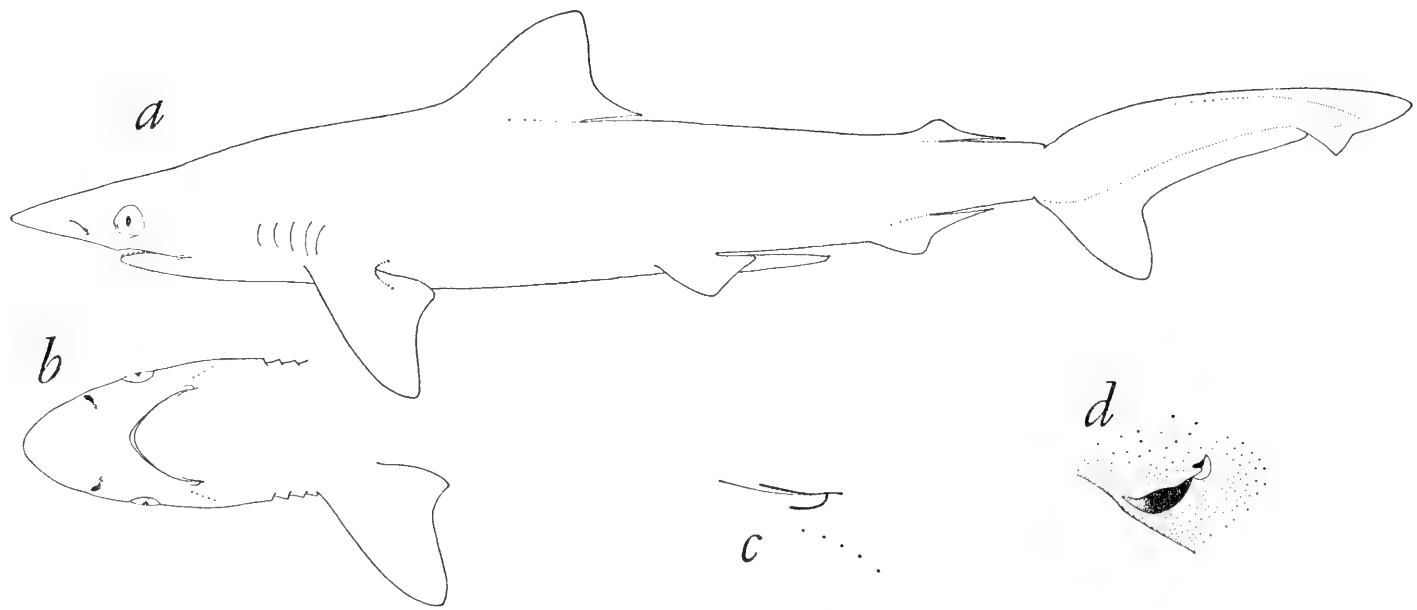

FIGURE 12.—*Rhizoprionodon oligolinx*, UMMZ 117113, 435 mm. t.l., mature male from Java: *a*, left side; *b*, underside of head; *c*, enlarged right labial furrows with adjacent enlarged hyomandibular pores; *d*, enlarged right nostril.

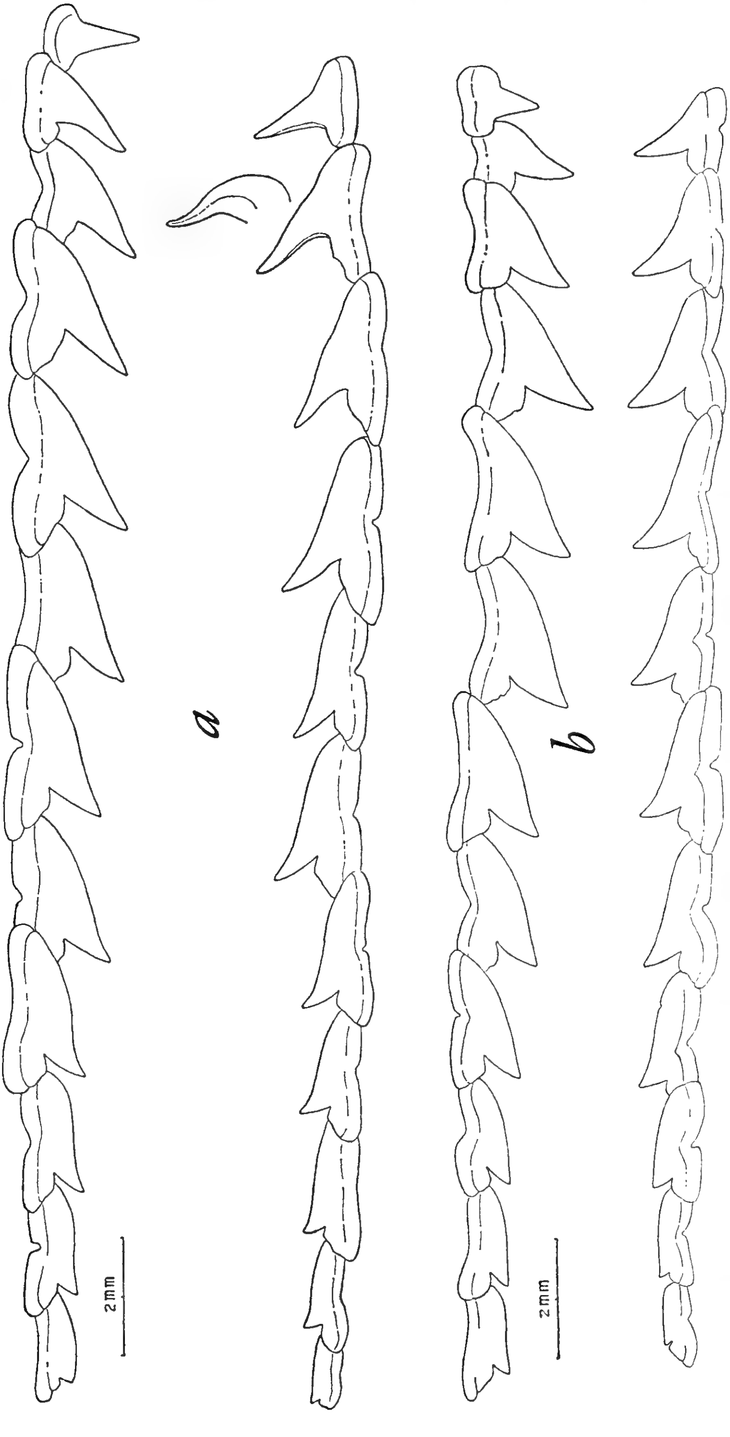

FIGURE 13.—*Rhizoprionodon oligolinx*: *a*, UMMZ 117113, 400 mm. t.l., mature male from Java, right upper and lower teeth (symphysis to the right; inserted tooth is edge-on view of second lower tooth from the right); *b*, SU 14197, 417 mm. t.l., female from Singapore, right upper and lower teeth (symphysis to the right).

Distribution.—From the Persian Gulf, India, Thailand, Malaya, Java, and Madura Straits. One specimen listed from Japan may be an error as no specimens have been identifiably reported from China or the Philippines.

Relationships.—I consider *Rhizoprionodon oligolinx* and *R. taylori* cognate species. *Rhizoprionodon oligolinx* differs from *R. taylori* in having fewer enlarged hyomandibular pores and more precaudal vertebrae. It is also close to *R. lalandei*, from which it is distinguished in having shorter labial furrows, fewer enlarged hyomandibular pores, and typically fewer teeth.

Nomenclatural discussion.—This species frequently has been called *Scoliodon palasorra*, especially in the Indian literature. I have found that name to be referable to *Scoliodon laticaudus*.

The name "oligolinx" comes from the Greek, meaning "short furrow," and refers to the short upper labial furrow found in this species.

Material.—Holotype: USNM 196799, 489 mm. male, Gulf of Thailand, ca. 11°56′–12°03′ N. and ca. 102°14′30″–102°17′45″ E., about 2–3 miles offshore, at a depth of 0–10 meters, January 12, 1961, obtained from the Bangkok fish market [information furnished by fisherman; original register number GVF 2467].

Paratypes: persian gulf: near Hormuz, UZMK CN5 (1: 276 mm.). india: Sind, BMNH 1889.2.1.4150 (1: 594); Bombay, BMNH 1889.2.1.4164–6 (3: 272–608), ANSP 88351 (1: 261, embryo); Alibag, ZSZM H1377 (1: ca. 244), ISH 5/61 (1: 301); Kanara, BMNH 1889.2.1.4175 (1: 610); Coast of Malabar, MNHN A7783 (4: 242–265); Quilon, USNM 175349 (1: 272); Pondicherry, MNHN 946, in part (1: 280); Madras, BMNH 1889.2.1.4161–3 (1: 294); Vizagapatam, BMNH 1868.10.25.21 (1: ca. 260), SU 41981 (1: 276); Calcutta, SU 41986, in part (1: 292). ceylon: CNHM 58887 (1: 287); 50 miles off coast, NMV [no number], in part (1: ca. 305). gulf of thailand: taken with holotype, GVF 2467 (2: 463–502); ca. 13°09–13′ N. and ca. 100°52–55′ E. GVF 1557 (2: 452–461); ca. 13°20–27′ N. and ca. 100°45′15″–57′ E., GVF 1548 (1: 462); from Chol Buri south to Rayong, GVF 1541 (4: 387–481); Bangkok, ANSP 87215 (1: 220), ANSP 60403 (1: 315), NMV [no number] (1: 391), ISZZ 7533 (1: 413). malaya: Singapore, MCZ 180 (1: 395), CNHM 15653 (1: 390), NMV [no number] (1: 226), NMV [no number] (1: ca. 227), SU 14197 (1: 417); Penang, MCZ 111 (1: 458). sumatra: Medan, ANSP 77276 (2: 235–260); Padang, ZSZM 10377 (1: 253). java: RNH 4713 (1: 414), MNHN A7772 (1: 407), IRSN 506 (1: 438); Batavia, CNHM 15654 (1: 231, embryo), MCZ 1387 (1: 219); vicinity of Batavia, UMMZ 177113 (3: 250–435). madura straits: UZMK 382 (1: 435), UZMK 385 (1: 385). japan: BMNH [no number] (1: 380).

Additional material: EAST INDIAN ARCHIPELAGO: BMNH [no number] (1:430); USNM 40029 (1:355; this specimen is listed in the catalog as questionably from Queensland, Australia; I believe it did not come from Australia).

Rhizoprionodon (Protozygaena) taylori (Ogilby)

FIGURE 14

Physodon taylori Ogilby, 1915, Mem. Queensland Mus., vol. 3, p. 117 (Townsville, north Queensland).

DIAGNOSIS.—(Not until this study was in an advanced stage was it realized that *R. taylori* and *R. oligolinx* were separate species; the description that follows is deficient because most of the material examined was not available to me during the writing.) Upper labial furrow poorly developed, 0.7–1.1 percent of t.l.; precaudal centra not obviously elongate in posterior monospondylous region (as in plate 2c); precaudal vertebrae greater in number than caudal vertebrae; anterior margin of pectoral fin shorter than total length of first dorsal fin; snout in front of nostrils 4.0–5.0 percent of t.l. in specimens less than 575 mm. t.l. (5 specimens measured), 4.2 percent of t.l. in specimens over 575 mm. t.l. (2 specimens measured); total teeth in outer row of upper jaw 24–25 (24 in 8 out of 9 specimens); total teeth in outer row of lower jaw 21–23 (22 in 8 out of 9 specimens); total enlarged hyomandibular pores on both sides of head usually more than 16 (6 out of 8 specimens); first dorsal fin origin over level of appressed pectoral inner corner; origin of second dorsal fin ranges from over posterior fourth to over posterior sixth of anal base; tip of appresssed pectoral fin reaches to below level of anterior third or less of first dorsal base. Only two males seen, ca. 310 and 407 mm. t.l., both immature; clasper length in latter 4.8 percent of t.l.

DESCRIPTION (see table 17).—Precaudal vertebrae 73–80; caudal vertebrae 62–70; total vertebrae 135–149; cusps of teeth smooth to faintly irregular; posterior bases sometimes denticulate; enlarged hyomandibular pores 7–11 on each side of head.

Denticles imbricate, 3- to 5-ridged and 3-toothed or irregularly margined (based only on USNM 174075).

Color of preserved specimen (USNM 174075): Body brownish gray above, pale below. Pectorals darker than body color with a pale distal margin; pelvics and anal somewhat lighter than pectorals; caudal paler than body, without black edging on upper lobe; pale posterior edge on lower lobe; first and second dorsal fins about same color as body dorsally.

Interdorsal ridge present or absent. Both precaudal pits present, the upper better developed.

TABLE 17.—*Proportional dimensions in percent of total length of* Rhizoprionodon taylori

	♀ 542 mm. Northern Territory AMS IA1611	♀ 555 mm. Northern Territory USNM 174075	♀ 598 mm. Queensland MCZ 36653
Snout tip to:			
outer nostrils	4.0	4.0	4.2
eye	7.1	7.3	7.1
mouth	7.4	7.3	7.1
1st gill-opening	17.7	16.9	17.6
pectoral origin	21.0	20.0	20.4
pelvic origin	45.0	46.8	44.8
1st dorsal origin	31.0	30.2	29.2
2nd dorsal origin	63.7	66.0	63.7
anal origin	59.9	62.5	59.4
upper caudal origin	76.0	77.6	75.0
lower caudal origin	74.6	76.4	73.7
Nostrils:			
distance between inner corners	4.6	4.7	4.8
Mouth:			
width	6.7	6.2	6.3
length	4.1	4.7	4.3
Labial furrow lengths:			
upper	0.8	0.7	0.8
lower	1.2	1.0	1.2
Gill-opening lengths:			
1st	1.9	1.6	1.7
2nd	2.2	2.0	1.9
3rd	2.4	2.3	2.2
4th	2.5	2.3	2.3
5th	2.1	2.1	1.8
Eye:			
horizontal diameter	1.7	1.9	1.9
1st dorsal fin:			
length of base	10.0	10.9	10.5
posterior margin	5.0	5.8	5.2
height	8.6	8.7	8.3
2nd dorsal fin:			
length of base	3.0	2.8	2.8
posterior margin	4.8	5.2	4.9
height	1.9	1.9	1.8
Anal fin:			
length of base	5.3	5.0	5.2
posterior margin	4.1	4.6	4.3
height	2.4	2.6	2.8
Pectoral fin:			
length of base	4.8	6.1	5.7
length of anterior margin	13.0	13.9	12.9
length of distal margin	9.4	9.1	9.0
width	8.7	8.0	8.5
Pelvic fin:			
length of base	4.6	4.9	4.9
length of anterior margin	4.5	5.0	5.0
length of distal margin	4.9	4.2	4.6
length of claspers	-	-	-
Caudal fin:			
length of upper lobe	24.3	23.8	25.0
length of lower lobe	10.0	10.3	10.2
length from tip to notch	7.0	6.2	6.9
notch depth	3.1	3.7	3.4

FIGURE 14.—*Rhizoprionodon taylori*, USNM 174075, 555 mm. t.l., female from Australia: *a*, left side; *b*, underside of head; *c*, enlarged right nostril; *d*, enlarged right labial furrows and adjacent enlarged hyomandibular pores; *e*, right upper and lower teeth (symphysis to the right; base line refers only to teeth).

All specimens seen were non-embryos and ranged from ca. 310 to ca. 666 mm.

DISTRIBUTION.—Australia from Derby, Western Australia, northward around to south Queensland. The single specimen from Western Australia had 73 precaudal vertebrae while those (9 specimens) from the Northern Territory and Queensland had 77–80. This may indicate some differentiation in the populations.

RELATIONSHIPS.—See under *R. oligolinx* (p. 626).

NOMENCLATURAL DISCUSSION.—Whitley (1940) gave a figure of a specimen that he mistakenly believed to be Ogilby's holotype of *Physodon taylori*. Ogilby (1916) reported his specimen as 657 mm. (Queensland Museum catalog number I12/738) and Whitley illustrated a specimen (I4539, according to Queensland Museum records) approximately 22 inches long, about 4 inches shorter than the holotype. I failed to find the holotype in a search of the Queensland Museum collections, and a note in the museum files indicated that previous efforts to find it had also met with no success.

The nature of the teeth and labial furrows and the position of the anal fin in relation to the second dorsal fin, however, make it certain that Ogilby had a species closely related to *R. oligolinx*. I, therefore, use his name for the only species of such relationship and for which there is no other name available.

MATERIAL.—AUSTRALIA: Western Australia: Derby, AMS IB1551 (1: ca. 390 mm.); Northern Territory: 3.5 miles off Peron Island, QMB I7806 (1: ca. 600); Little Lagoon, Groote Eylandt, Gulf of Carpentaria, USNM 174075 (1: 555); Pellew Islands, Gulf of Carpentaria, AMS IA1611 (1: 542), QMB I3958 (1: 407); Queensland: Cairns, Cooktown Station, MCZ 36653 (1: 598); Townsville, QMB I4539 (1: 522); Salamander Rocks, QMB I6886 (1: 666); Deception Bay, DHMB 45 (1: 323); Burnett River, AMS IB7028 (1: ca. 310).

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(New genera, species, etc., are printed in *italics*. Page numbers of principal entries also in italics.)

*No. 3492, Emilio Estrada, Betty J. Meggers, and Clifford Evans, The Jambelí Culture of South Coastal Ecuador, pp. 483–558, is indexed separately on pp. 649–654.

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