

## NEW SPECIES AND A NEW GENUS OF PARASITIC COPEPODS.

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The material for the present paper has been derived from a variety of sources, which have been duly acknowledged under the separate species.

It includes not only true parasites, but also commensals or semiparasites, whose relation to the animals with which they are associated is not even yet fully understood. Five of the species are North American, one was obtained in Japan, one in the Hawaiian Islands, and one in Jamaica. The types of the new species as well as all the specimens herein mentioned are deposited in the National Museum.

LEPEOPHTHEIRUS LONGIPES Wilson.

Plate 1, figs. 1-5.

*Host and record of specimens.*—Four adult females, five males, and two immature females were obtained from the rock bass, *Paralabrax clathratus*, at Crescent Bay, Catalina Island, California, by Dr. A. B. Ulrey, of the University of Southern California. They have been given Cat. No. 49779, U.S.N.M. The males and development stages are new for this species and are here described for the first time.

*Characters of immature female.*—Carapace relatively enormous, three times as long and four times as wide as the rest of the body; free thorax (fourth) segment wider than the genital segment and two-thirds as long; genital segment almost twice as wide as long, with a pair of one-jointed legs at the posterior corners, which are distinctly visible in dorsal view.

Abdomen one-jointed, the same length as the genital segment and half as wide; anal laminae relatively large; fourth legs, if straightened backward, reaching beyond the center of the abdomen, but not to its posterior margin. The chief points of difference between this development stage and the mature adult are the size of the carapace compared with the rest of the body, the relative length and width of

the genital segment, the presence of legs at its posterior corners, and the one-jointed abdomen.

*Specific characters of male.*—Carapace similar to that of mature female, about the same length and width, nearly twice the length of the rest of the body; free thorax (fourth) segment the same width as the genital segment and one-third as long; genital segment obovate, three-fourths as wide as long, with a pair of fifth legs on its lateral margins, a little behind the center, and a pair of sixth legs at the posterior corners.

Abdomen a little more than half the width of the genital segment, two-jointed, the terminal joint twice the length of the basal; anal laminae large, curved inward at the tips, and armed with long plumose setae.

Appendages in general like those of the female, but the second antennae are stouter, as is usual in the male, and are armed with several accessory knobs and adhesion pads. The first maxillae are rather short, stout, and almost perfectly straight; the outer branch at the tip is twice the length of the inner, and the latter has a wide flange along its inner margin.

Color (preserved material) dark yellowish gray.

Total length, 3.75 mm. Length of carapace, 2.35 mm.; width, 2.25 mm. Genital segment, 0.65 mm. long, 0.50 mm. wide.

*Remarks.*—When the species was originally established in 1905<sup>1</sup> no males had been discovered, and there were no data as to locality and host. Afterwards 20 females were obtained from the jewfish (*Stereolepis gigas*) by Dr. J. C. McClendon at La Jolla, California. These were recorded<sup>2</sup> and bear Cat. No. 38567, U.S.N.M. The present specimens are from the same general locality, but from another host. They furnish additional evidence that the species belongs to the Pacific coast, and they supplement the original description by adding the male sex and a development stage.

**ALEBION FUSCUS, new species.**

Plate 1, figs. 6-11; plate 2, fig. 12.

*Host and record of specimens.*—Five females were obtained from the outer surface of a dusky shark, *Carcharhinus obscurus*, at Woods Hole in 1891 by Vinal Edwards. The specimens are somewhat curled and shriveled, as though they had suffered at some time from the drying up of the alcohol; but the best has been selected as the species type with Cat. No. 43559, U.S.N.M.

The other four become paratypes with Cat. No. 43560, U.S.N.M.

*Specific characters of female.*—Carapace ellipsoidal, one-fifth longer than wide and evenly rounded. Posterior sinuses narrow and

<sup>1</sup>Proc. U. S. Nat. Mus., vol. 28, p. 618.

<sup>2</sup>Idem, vol. 35, p. 440.

pointed at the base, the median lobe considerably wider than the lateral lobes and armed at each posterior corner with three large spines.

The transverse groove in the lateral area is situated far forward, leaving the posterior portion of the area nearly twice as long as the anterior. Eyes distinctly visible, rather far forward, small, and fused on the midline. Free thorax segment as wide as the genital segment, but only a fourth as long, covered with a pair of dorsal plates, which overlap considerably the base of the genital segment. The two plates are fused across the midline for the entire length of the free segment, and then separated by a narrow sinus. Each is semielliptical in shape, one-half longer than wide, with a strongly convex lateral margin and a bluntly rounded posterior lobe, which covers the basal third of the genital segment, and is entirely without spines or armature of any sort.

Genital segment half the width of the carapace, with strongly convex lateral margins and long, flattened posterior processes. Each lateral margin is armed with a set of stout spines which begin at the center and extend backward nearly to the base of the posterior process. The latter is narrowed posteriorly and is armed along its inner margin with a row of small spines and three larger ones at the tip.

Abdomen two-jointed, the basal joint considerably larger than the terminal and extending backward on either side of the latter in a bluntly-rounded flattened process, similar to those on the genital segment.

Terminal segment with straight sides and carrying a pair of anal laminae, each of which is long and narrow and tipped with four plumose setae.

The tips of the anal laminae do not quite reach the level of the tips of the posterior processes of the genital segment.

The second antennae have a stout basal joint with a slender terminal claw, which is turned backward. The second maxillae have a long and slender terminal claw, with an accessory claw at its base on the outer side. The maxillipeds are short and stout with a blunt claw.

The swimming legs are similar to those of other species, the exopods of the first three pairs being armed with the long curved processes peculiar to this genus, one on the first pair, two on the second pair, and three on the third pair. The fourth legs are reduced to papillate, one-jointed stumps.

Color (preserved material) dusky brown, deepening into black in the thicker parts of the body.

Total length, 10 mm. Carapace, 5.40 mm. long, 4 mm. wide. Free segment, 2.15 mm. wide. Genital segment, 4 mm. long, 2.25 mm. wide. Egg strings 5 mm. long.

(*fuscus*, black in allusion to the color.)

*Remarks.*—This species may be distinguished from the others belonging to the genus by its darker color, by the presence of visible eyes, and by the large dorsal plates on the fourth segment. The posterior processes of the genital segment are also strongly flattened dorso-ventrally, and the inner margins are curled over dorsally. The lateral areas of the fused second and third segments are separated from those of the cephalothorax and project backward as far as the fourth segment.

ELYTROPHORA HEMIPTERA, new species.

Plate 2, figs. 13-19.

*Host and record of specimens.*—A single female without egg strings was found in a jar with *Temnopleurus pneumaticus*, a new Echinoid from Nagasaki, Japan, by the Bureau of Fisheries steamer *Albatross*. The nature of this parasite is such that its association with the Echinoid is in all probability accidental.

The specimen has been given Cat. No. 53556, U.S.N.M.

*Specific characters of female.*—Carapace only moderately convex, a trifle wider than long, evenly rounded except posteriorly, where it is rather squarely truncated. Its upper surface is divided by two longitudinal furrows, curved like parenthesis marks, into three areas. The central area extends from the frontal plates to a transverse groove between the first and second thorax segments. At its anterior end the cephalic area is indicated by a semicircular groove, with the two small eyes just visible near the posterior margin. Each lateral area is divided by a transverse groove into a longer anterior and a shorter posterior portion. The former is a part of the head, the latter of the first thorax segment. The grooves across the lateral areas are considerably in front of the one across the central area.

The second and third thorax segments are fused and lie between the posterior portions of the lateral areas. The second segment has a pair of short curved lateral wings or areas, which lie just inside those belonging to the first segment; the third segment has none.

The fourth or free thorax segment has a pair of dorsal wings, which are fused on the midline at their bases, while the tips are free. Furthermore, the basal half of each wing is thickened and opaque, while the terminal half is thinner and semitransparent. They thus resemble closely the wings of many of the Hemiptera, and this has suggested the specific name.

The genital segment is barrel shaped, slightly widened posteriorly, with a broad dorsal lobe at each posterior corner. These lobes or wings are attached to the segment diagonally, are more fully chitinized than the segment itself, and are darker in color.

The abdomen is two-jointed; the joints about the same length and half as wide as the genital segment. The basal joint has lobes at its posterior corners similar to those on the genital segment but smaller. The anal laminae are broad and oval, as long as the last abdomen segment, and nearly half as wide; each is armed with four non-plumose setae.

The frontal plates are wide and project anteriorly, with a shallow median sinus. The first antennae are of the usual pattern, but the second pair are stronger and have a large terminal claw. The first maxillae are close to the base of the mouth tube; each consists of a single spine, long, slender, and strongly curved. The second maxillae are also long and slender, with a single terminal claw. The maxillipeds are stout and their terminal claw is abruptly curved near its tip.

The furca is narrow and slender, the base a little longer than the branches, which are cylindrical, straight, and not very divergent.

All four pairs of legs are biramous. The endopods of the first pair are very short and two-jointed, the exopods much longer and stouter; the basal joint carries a spine at the center of the anterior margin and another similarly located on the posterior margin. The second and third legs are similar to those of other Caligids. The endopod of the fourth legs is much shorter than the exopod and has but two joints, while the exopod has three. The basal joint is somewhat triangular, with a slight projection at the inner posterior corner.

*Remarks.*—In 1853 Gerstaecker published<sup>3</sup> the description and figures of a new genus and species of parasitic copepods, to which he gave the name *Elytrophora brachyptera*. In his diagnosis of the genus he wrote (p. 58):

Corporis pars thoracica cephalothorace tribusque annulis thoracicis satis distinctis composita, abdomen annulis duobus, appendicibusque duabus terminalibus, setiferis. Dorsum appendicibus foliaceis in mare duabus, quattuor in femina ornatum. . . . Pedum branchialium paria quattuor, quorum tria annulo thoracico primo, altero quartum affixum.

It is difficult to understand how the thoracic segments could be "satis distinctis" if three pairs of swimming legs were attached to the first segment.

In 1863 Krøyer described and figured<sup>4</sup> a new parasitic copepod from the Vienna Museum under the name *Arneus thynni* Kollar, saying that Kollar had given it a museum label as *Dinematura thynni*. Krøyer gave no diagnosis of the genus, but the description and figures leave no doubt that his parasite was the same as the one previously described by Gerstaecker. In addition the name

<sup>3</sup> Troschel's Archiv für Naturgeschichte, vol. 19, pt. 1, p. 53, pl. 3.

<sup>4</sup> Naturhistorisk Tidsskrift, vol. 3, pt. 2, p. 157, pl. 8, fig. 5.

*Arneus* had been preoccupied by Gistler for a genus of Coleoptera in 1848.

In 1865 Heller, in dealing with the Crustacea of the Novara expedition,<sup>5</sup> showed that both Kollar's museum label and Krøyer's published species were synonyms of Gerstaecker's species. He gave a much better and more detailed description, and illustrated it with excellent figures, but did not change the original genus diagnosis.

This was left for T. and A. Scott, who in their excellent work<sup>6</sup> gave the following genus diagnosis:

First three thoracic segments fused with the head; fourth segment with two dorsal plates. Genital segment lobed posteriorly.

This is the only correct diagnosis hitherto published, and it further stated that all four pairs of legs were biramous; both rami of the first pair two-jointed, of the second and third pairs three-jointed; exopod of the fourth pair three jointed; endopod two jointed.

Although there is only a single female, without egg strings and from a practically unknown host, upon which to found the present species, it substantiates T. and A. Scott's diagnosis in every particular, and adds to the validity of the genus by furnishing a second species.

ACHTHEINUS DENTATUS Wilson.

Plate 3, figs. 20-27.

*Host and record of specimens.*—Seven adult females were taken by Dr. A. B. Ulrey from the outside surface of a thresher shark, *Atopius vulpes*, in an aquarium at the marine station of the University of Southern California, Venice, California, July 14, 1919. They have been given Cat. No. 53555, U.S.N.M. Another lot consisting of six adult females, two young females, and a male was obtained by J. R. Beck from the outside surface of *Mustelus lunulatus*, 3 miles off Venice, California, July 28, 1913. The male has been isolated with Cat. No. 53558, U.S.N.M.; the females, old and young, have been given Cat. No. 53554, U.S.N.M.

*Specific characters of adult female.*—In addition to the description given,<sup>7</sup> the following may be added. On the ventral surface of each posterior lobe of the genital segment is a rudimentary fifth leg, consisting of a large papilla tipped with two small spines. A sixth segment is partially separated from the ventral surface of the genital segment at about the beginning of its posterior third. It takes the form of a large lobe on either side, between which and the genital segment opens the vulva. The egg sacks run back dorsal to the abdomen and ventral to the posterior lobes of the genital segment, in a manner similar to that found in the genus *Dinematura*. There

<sup>5</sup> Reise der *Novara*, p. 189.

<sup>6</sup> British Parasite Copepoda 1913, p. 82.

<sup>7</sup> Proc. U. S. Nat. Mus., vol. 39, 1911, p. 630.

is also a pair of very rudimentary legs connected with this sixth segment, which appear as small bifid papillae, one on the outer margin of each lobe at its base. There are no dorsal plates on this segment.

The claw at the tip of the second antennæ is evidently designed to hold securely when it has once been fastened to any part of the host. In two of the specimens from *Mustelus lunulatus* it was barbed as well as toothed, as shown in figure 20.

*Internal characters.*—The esophagus is short and enters the stomach at its anterior end on the ventral surface. The stomach-intestine starts in the head immediately beneath the mouth and widens gradually backward to the genital segment, then narrows until it reaches the level of the vulvae, where it is suddenly contracted into a short rectum. There is no demarcation between the stomach and intestine.

The ovaries are situated just beneath the dorsal surface of the head, above the anterior end of the stomach; each oviduct starts from the anterior end of the ovary and runs backward along the dorsal surface of the stomach to the genital segment, where it turns sidewise away from the midline and forms an S-loop before reaching the vulva.

The cement glands are ventral to the oviduct, their anterior ends curved outward, their posterior ends slightly enlarged; they show distinct segmentation. Their inner surface is attached to the sides of the stomach intestine in two places. The semen receptacles are just inside of the vulvae and are connected across the midline.

*Specific characters of young female.*—Carapace like that of the adult; lateral portions of the dorsal plates belonging to the second segment visible behind the carapace. These and the dorsal plates of the fourth segment, reduced to tiny semicircles, are confined to the lateral margins of the segments and do not reach the midline. Fifth legs at the posterior corners of the genital segments and visible dorsally, each with a tiny plate inside of it on the dorsal surface of the posterior margin of the segment. No traces of a sixth segment. Abdomen and anal laminae like those of the adult, but entirely free and not covered at all by the genital segment. Anal setae relatively long and strongly curved.

Of the appendages the second antennae are large and stronger than in the adult, and the forceps peg of the maxillipeds is much more complicated, being composed of raised laminae, parallel with one another and having toothed edges (fig. 23). Inside the forceps peg, between it and the base of the claw on the anterior margin, is an accessory peg, also covered with raised laminae. The basipods of the third and fourth legs are smaller than in the adult, but otherwise the legs are the same.

Total length, 3.50 mm. Carapace, 1.80 mm. long, 2 mm. wide; genital segment, 1 mm. wide.

*Specific characters of male.*—This is the first male of the species to be recorded and may be compared with the male of *Achtheinus pinguis* described on page 236 of volume 42 of these Proceedings.

Carapace horseshoe-shaped, three-sevenths of the entire length and as wide as long, not including the posterior lobes. Frontal plates well defined, narrowed to a point on the median line, but wide at the lateral margins, where each projects in a rounded lobe over the basal joint of the antenna. Lateral areas narrow, with the transverse groove about in the center. Posterior lobes narrow but long, almost reaching the posterior margin of the third segment. Eyes fused on the median line.

Second and third segments fused, the narrow lobes at the posterior corners of the second segment reaching back nearly to the fourth segment. The latter segment is about half the width of the carapace and is much narrowed anteriorly where it joins the third segment, with a slight notch on the posterior margin on either side of the midline and some distance from it. Genital segment barrel-shaped, the posterior corners prominent, and each armed with a single large spine. Abdomen short, triangular, and one-jointed; anal laminae scarcely projecting beyond the tip of the abdomen, each armed with four long plumose setae and a short basal spine on the outer margin.

Of the appendages the second antennae are slender and strongly curved, and lack the row of teeth found in the female. The mouth tube is very long and narrow; the maxillae at its base are slender and each is tipped with a long spine. Each maxilliped has but a single claw, much longer than in the female, but shutting down similarly against a pad.

Color (preserved material) a uniform cinnamon brown, lighter and yellowish in the thinner portions of the carapace.

Total length, 3 mm. Carapace, including the posterior lobes, 2 mm. long., 1.40 mm. wide; genital segment, 0.55 mm. long, and the same width.

*Remarks.*—This male shows a marked similarity to that of *pinguis* described in the reference given above. It may be distinguished by the fused eyes, the long spines at the posterior corners of the genital segment, the long and narrow mouth tube, and the presence of but a single claw on each maxilliped. This last character shows that the presence of two claws on the maxillipeds, shutting past each other like the blades of a pair of scissors, must be regarded as a specific character of *pinguis* and not as a character common to the genus.

The two hosts here recorded are new for the genus, as well as the species, and it may be added that a single female specimen of the present species was obtained from another new host, the cow shark, *Notorhynchus maculatus* on the California coast in 1911, and has been given Cat. No. 42274, U.S.N.M.



## TREBIUS LATIFURCATUS, new species.

Plate 4, figs. 28-34.

*Host and record of specimens.*—About 25 females were taken by Dr. A. B. Ulrey from the outside surface of four different kinds of fish in the aquarium of the marine station of the University of Southern California at Venice, California, August 4, 1919. The fish which served as hosts were the small sting ray, *Urolophus halleri*, the California sting ray, *Myliobatis californicus*, the marbled ray, *Pteroplatea marmorata*, and the bastard halibut, *Paralichthys californicus*.

One of the females with fully developed egg strings has been selected as the type of the species and has been given Cat. No. 53551, U.S.N.M.

The remaining specimens become paratypes, with Cat. No. 53552, U.S.N.M.

*Specific characters of female.*—Carapace suborbicular, wider than long, evenly rounded anteriorly, but quite squarely truncated posteriorly. Frontal plates broad and well rounded, their combined length about three-sevenths of the width of the carapace. Transverse grooves dividing the lateral areas placed farther back than in any other species. Eyes fused on the midline and very distinct. Third thorax segment nearly one-half wider than the fourth, but not as long. Fourth segment barrel-shaped, wider than long. Genital segment half the width and two-thirds the length of the carapace, flask-shaped, narrowed into a short neck anteriorly as it joins the fourth segment and posteriorly as it joins the abdomen.

The posterior corners are rounded and armed with spines. The egg strings are about the same width as the abdomen and do not quite reach the tip of the latter; eggs small, 25 to 30 in each string.

Abdomen one-half longer than the genital segment and less than one-third as wide, three-jointed, the terminal joint indistinctly separated from the subterminal. The entire surface of all three joints is sparsely covered with tiny spines. Anal laminae long and narrow, armed with short spines on the outer margin and at the end, but with long capillary setae on the inner margin.

First antennae long and narrow and projecting prominently. Terminal claw of the second antennae as thick as the basal joint and abruptly curved near the tip. Maxillary palp S shaped, with the basal portion slightly enlarged and the tip bluntly rounded. Basal joint of the first maxillae fused with the ventral surface of the head and furnished with a rudimentary exopod in the form of two long spines; endopod broad at the base and then abruptly narrowed to a bifurcate tip, the branches of which are slender and of the same length. Furca small, the rami longer than the basal portion, flattened and considerably enlarged at the tip. All the swimming legs

biramose; rami of the first pair two-jointed, the endopod very much reduced; rami of the other pairs three-jointed, the endopod a trifle longer than the exopod. Fifth legs reduced to spines just in front of the base of the egg strings.

Color (preserved material) reddish yellow, deepening into a brown at the centers of the various segments on the dorsal surface.

Total length, 5.25 mm. Carapace, including third thorax segment, 2 mm. long, 2 mm. wide. Genital segment, 1.10 mm. long, 1 mm. wide. Abdomen 1.90 mm. long, 0.30 mm. wide. Egg strings, 1.60 mm. long. (*latifurcatus*, *latus*, wide and *furcatus*, furnished with a furca.)

*Remarks.*—On comparing this species with others that have been described it shows most resemblance to Krøyer's species, *caudatus*, but differs from it in the presence of visible eyes, in the shape and relative proportions of the carapace, fourth and genital segments, in the spiny covering of the abdomen, and in the shape and armature of the anal laminae. The species *exilis* has a one-jointed abdomen, while the species *tenuifurcatus* has a two-jointed abdomen, relatively very much narrower. In addition the furca of the present species is radically different from that of any others yet described.

In the letter accompanying these parasites it was stated, "They have become rather serious pests in our aquaria at the marine station." Breeding in the restricted areas of aquaria, where every nauplius is protected from its natural enemies, and is insured a suitable host upon reaching the proper stage in its development, a copepod parasite that ordinarily would remain rare may easily develop into a serious menace. And once established they prove very difficult to exterminate, and furnish another illustration of the old adage, "An ounce of prevention is worth a pound of cure."

#### BLAKEANUS, new genus.

*Generic characters of female.*—Head and anterior thorax fused and greatly inflated dorsally after the manner of *Doropygus* and *Buprorus*. Antennae, mouth parts, and four pairs of swimming legs packed closely together in a furrow along the ventral midline. A pair of curved horns at the posterior ventral corners of the inflated portion. Fifth segment abruptly narrowed to normal size. Abdomen distinctly segmented. A pair of external egg strings attached close together on the dorsal surface of the genital segment. Basal joint of first antennae enlarged into a broad setose hand. Second antennae nonprehensile. Maxillipeds with a stout terminal claw. Male unknown.

*Type of genus.*—*Blakeanus corniger*, monotypic.

(*Blakeanus*, to J. H. Blake, one of the pioneers in the United States Bureau of Fisheries, who made many excellent drawings of

parasitic copepods, which have been published in previous papers of this series.)

BLAKEANUS CORNIGER, new species.

Plate 5, figs. 39-43.

*Host and record of specimens.*—A single adult female with mutilated egg strings was taken from the Ascidian, "*Cynthia carnea*," in Long Island Sound by the United States Bureau of Fisheries in 1874. It is made the type of the new genus and species with Cat. No. 53569, U.S.N.M.

*Specific characters of female.*—Anterior body wide and very strongly inflated dorsally; posterior body much narrower and tapered. Head and first four thorax segments fused, with only a partial furrow on the dorsal surface between the head and the first segment. Dorsal inflation greatest in the fourth segment, where the height or thickness is about equal to the length and breadth of the entire inflation.

Along the midline of the ventral surface of this cephalothorax is a shallow longitudinal groove, bordered on either side by a low ridge. This ridge is curved around the anterior end of the groove, where it projects obliquely downward and forward. In the groove are arranged in order the antennae, mouth parts, and four pairs of swimming legs, packed closely together. At the posterior ventral corners of the inflated portion are attached a pair of horns, which extend out obliquely sidewise and backward. Each horn is curved into the shape of the letter **S** and tapers from the base to the tip, which is bluntly rounded.

The fifth thorax segment is abruptly depressed to the level of the genital segment on the dorsal surface, but is considerably extended laterally to the bases of the horns. The groove of demarcation between the fourth and fifth segments is not carried far enough laterally to determine whether the horns belong exclusively to the fifth segment or not, but the indications are that they do.

The genital segment is cylindrical, two-fifths wider than long, with a pair of small rounded projections close together on the midline of the dorsal surface near the anterior margin. Through the tips of these projections the oviducts open into the external egg sacks. The latter are club shaped and considerably swollen posteriorly, and they project a quarter of their length beyond the tip of the abdomen. The eggs are comparatively large and are not arranged regularly in rows. There are about 75 or 80 in each sack.

The abdomen is four jointed, the joints distinctly separated and diminishing slightly in width backward; the first, third, and fourth joints are about the same length, the second is somewhat longer. At the tip of the terminal joint are the anal laminae, which are flattened laterally and curved up dorsally; they are entirely destitute of setae.

The first antennae are peculiar in the enlargement of the basal joint into a wide hand with seven divisions or fingers each tipped with a long and stout seta. The remainder of the antenna is attached like a thumb on the outer margin of the hand instead of the inner. It is not as long as the finger setae and is indistinctly three jointed, each joint armed with short spines. The second antennae are slender, cylindrical, and three jointed, the basal joint very short, the other two much longer and about equal. The terminal joint carries a short claw-like spine at its tip and three small setae on its outer margin.

Since there is but the single specimen it has not been considered advisable to dissect out the mouth parts; but a profile view shows distinctly a short and rather blunt mouth tube, with two pairs of jointed maxillae, tipped with spines. The maxillipeds are large and strong, three jointed; the terminal joint armed with a powerful claw as long as the joint itself and but slightly curved.

There are four pairs of biramose swimming legs, crowded closely together. The rami of the first three pairs are three-jointed, but the endopod of the fourth pair has only two joints.

Color (preserved material), a uniform brownish yellow.

Total length, 4 mm. Inflated cephalothorax, 2.20 mm. long, 2.25 mm. wide, 2.35 mm. thick. Length of egg strings, 2.40 mm.; width, 1 mm.

*Remarks.*—It is to be regretted that there is but a single specimen of this remarkable copepod. It presents, however, even in a cursory examination so many points of divergence from other genera as to leave no doubt of its validity.

The inflated thorax suggests relationship to *Notodelphys* and *Doropygus*, but the external egg cases offer an effective barrier against even including it in the same family with those genera. The enlarged basal joint of the first antenna finds a counterpart in the genus *Bomolochus*, but is unknown amongst the semiparasites. The maxillipeds are fully as well developed as in any of the fish parasites and must function as powerful organs of prehension.

So far as known no other copepod possesses anything that corresponds to the curved horns found at the posterior corners of the inflated cephalothorax. They are very different in structure and hence probably in function from the processes found in the Chondracanthidae and some of the Lernaeopodidae. Their only counterpart seems to be the horns developed on the cephalothorax of the Lernaeidae, but they can not be intended for the same purpose, since they are not buried in the tissues of the host. And, finally, the anal laminae are peculiar in being naked, laterally flattened and dorsally curved, as in some of the Lernaeopodidae.

We conclude, therefore, that this parasite belongs to the group of Notodelphyoida, but that it can not be located in any of the existing families of that group.

PSEUDOMOLGUS HAWAIIENSIS, new species.

Plate 4, figs. 35-38; plate 5, figs. 44-48; plate 6, figs. 49-57.

*Host and record of specimens.*—Eight females and three males were obtained by the Bureau of Fisheries steamer *Albatross* at station 3853 during the Hawaiian explorations of 1902. They were ectoparasitic upon a large Tectibranch mollusk belonging to the genus *Pleurobranchus*.

One of the females has been selected as the species type and has been given Cat. No. 53564, U.S.N.M. The other females and the males become paratypes with Cat. No. 53565, U.S.N.M.

*Specific characters of female.*—Body rather slender, the cephalothorax much wider than the genital segment and abdomen, and oval in outline. The first thorax segment is the widest part of the body and is distinctly separated from the head both by a dorsal groove and by marginal notches. The second segment is nearly as wide as the first; the third and fourth segments are considerably narrower, while the fifth segment is abruptly reduced to less than two-fifths the width of the fourth segment.

Genital segment barrel-shaped, the same length and width, with the vulvae near the center of each lateral margin. Abdomen a little more than half the width and about the same length as the genital segment, three-jointed; joints the same width and length. Anal laminae oblong, each tipped with four setae, two long ones in the center and a short one on either corner. The egg strings are a little less than half the length of the body, are narrowed anteriorly and rather bluntly rounded posteriorly; eggs minute, about 400 in each string.

First antennae slender, a little longer than the cephalon and containing seven distinct joints, the second much longer than any of the others, and all except the basal joint moderately armed with setae. Second antennae much shorter and stouter, four-jointed, the last two joints fused and tipped with three claws of unequal length, jointed near their tip. First maxillae with the masticatory part bifid, the two lappets long, lashlike, and incurved. These lappets are also denticulate along their outer margin, the two proximal denticles on the principal lappet being much larger than the others. The palp is an irregular short lamella, armed with two tiny setae.

Second maxillae with the terminal process armed with nine stout spines of about equal length along the outer margin. Maxillipeds

indistinctly three-jointed, somewhat lamellar, and terminating in a minute sharp point.

First four pairs of legs biramose, each ramus three-jointed; basal joint of the exopods denticulate on the outer margin; terminal joint of the first endopod with one, of the second endopod with three, and of the third and fourth endopods with four spines. All the spines on both endopods and exopods are dagger-shaped.

Color (preserved material), a uniform cinnamon brown.

Total length, 4 mm., exclusive of anal setae. Width of first thorax segment, 2 mm.; length of egg strings, 2 mm.

*Specific characters of male.*—Body smaller and narrower than in the female; abdomen relatively longer and wider and four-jointed, the penultimate joint the shortest. Anal laminae each terminated by three unequal setae, the inner one the longest and the outer one the shortest, the relative lengths being, respectively, 14, 9, 3. The genital segment is considerably enlarged, and shows on the ventral surface at the posterior corners the rudiments of a sixth pair of legs.

The fifth legs are much wider than in the female, and each carries a large seta near the distal end of the outer margin, in addition to the three terminal ones, all four about the same length.

The first antennae are narrower than those of the female and more abundantly supplied with setae. The maxillipeds are very strong; the second joint is coarsely toothed along the distal half of the inner margin; the terminal claw is longer than the second joint and strongly curved.

Color (preserved material), a uniform cinnamon brown.

Total length, 2.85 mm., exclusive of anal setae. Greatest width, 1.25 mm.

(*hawaiiensis*, a native of the Hawaiian Islands.)

*Remarks.*—This species agrees so fully with the two described by Sars<sup>8</sup> that it must be referred to the same genus.

The distinguishing specific characters are the large size, the position of the articulation in the terminal claws of the second antennae, the heavier armature of the second maxillae, and the relatively shorter and thicker anal laminae. Neither of Sars' species was positively parasitic, although *leptostylis* might well have been so. The young females and adult male, which he recorded as "picked up from the bottom residue of a large collecting bottle containing various animals," could easily have been ectoparasites on one of those animals and have been washed off into the bottle. The present species is definitely known to be parasitic since all the specimens were taken directly from its host.

<sup>8</sup> Copepoda of Norway, vol. 6. Copepoda Cyclopoida, pt. 13, 1918, pp. 182 and 184.

## PSEUDOMOLGUS, species.

*Host and record of specimens.*—A single badly mutilated specimen of an adult *Pseudomolgus* female with egg strings was obtained from a Tectibranch mollusk at Laguna Beach, California, August 8, 1918, has been given Cat. No. 53566, U.S.N.M. In all probability this represents a new species of the genus, but owing to the condition of the specimen it does not seem advisable to attempt establishing the species.

It is included here to show that the Tectibranchs of the California coast are infested as well as those of the Hawaiian Islands, and search would probably reveal copepods enough to establish this species and perhaps others.

## MODIOLICOLA JAMAICENSIS, new species.

Plate 7, figs. 58-65.

*Host and record of specimens.*—Five females, three of which carried egg strings, were obtained from black ascidians common upon the mangrove roots on the Bogue Islands, Montego Bay, Jamaica. A single specimen has been selected as the type female and has been given Cat. No. 53567, U.S.N.M. The others become paratypes with Cat. No. 53568, U.S.N.M.

*Specific characters of female.*—Body elliptical, strongly narrowed anteriorly and posteriorly, nearly as wide as long. Cephalon not very distinctly separated from the first thorax segment; the latter the widest part of the body. Second, third, and fourth segments diminishing rapidly in width; fifth segment abruptly narrowed to half the width of the fourth. Genital segment considerably wider and longer than the fifth segment; the openings of the oviducts near its posterior margin and widely separated. Abdomen four-jointed, the joints diminishing slightly in size from in front backward. Anal laminae as wide as long, each armed with five plumose setae; numbering the setae from within outward their lengths come in the following order, beginning with the longest, 2, 3, 1, 4, 5.

The first antennae are seven-jointed, the second joint the longest, and all the joints heavily armed with setae; those of the second, fourth, and seventh joints are especially long and numerous. The second antennae are three jointed, the three joints about the same length. The third or terminal joint is tipped with two stout curved claws, with two setae on the outer and two on the inner margin. The basal and second joint each carry a short seta on their inner margin. The masticatory lappet of the maxillae is elongate and densely hairy, and its base is armed with two setae. The maxilliped is without any armature except a minute spine on the inner margin

near the tip. The terminal joint is short, narrowed beyond the center, and bluntly rounded at the tip. There are four pairs of biramose swimming legs, each ramus three-jointed, the endopod of the fourth legs being shorter and narrower. The spines on the legs are flattened dorso-ventrally and are shaped like broad daggers. The egg strings are a little more than half the total length of the body, narrowed anteriorly and bluntly rounded posteriorly. The eggs are large and are not arranged in definite rows, with 75 to 80 in each string.

Color (preserved material), a uniform grayish brown.

Total length, exclusive of anal setae, 1 mm. Width of first thorax segment, 0.55 mm. Length of egg strings, 0.55 mm. Length of anal setae, 0.21 mm.

(*jamaicensis*, a native of Jamaica).

*Remarks.*—The genus *Modiolicola* was established by Aurivillius for a copepod which he had found inside the common European mussel, *Modiolus vulgaris*, and occasionally in the oyster, *Mytilus edulis*. Canu afterwards recorded another species under the name *Modiolicola inermis*.

T. Scott and Sars have both given supplementary descriptions and figures of the original type species. The present specimens agree so well with those descriptions as to leave no doubt that they belong to the same genus. The endopod of the fourth legs is distinctly three-jointed; the terminal joint long and narrow and tipped with two flattened spines. The second antennae are tipped with two curved claws, with two long setae outside of them; and the last joint of the maxilliped in the female is small, unarmed, and very bluntly rounded. These are the type characters of the genus and yet there are enough differences in the present species to distinguish them from those thus far described.

The most noticeable characters are the short and stout anal laminae, with their long setae and the flattened daggerlike spines on the swimming legs. Both of the previous species of the genus were found in mollusks, while the present specimens came from an ascidian. But it is worthy of note that there are numerous mussels on the mangrove roots, interspersed among the ascidians, and it would be quite possible for free-swimming copepods to pass from one to the other. It is to be regretted that the mussels were not also examined for copepods.



## EXPLANATION OF PLATES.

## PLATE 1.

*Lepeophtheirus longipes* and *Alebion fuscus*.—Fig. 1. Dorsal view of immature female of *L. longipes*. Fig. 2. Dorsal view of male. Fig. 3. Second antenna of male. Fig. 4. First maxilla. Fig. 5. Maxillary palp. Fig. 6. Second antenna of *Alebion fuscus* female. Fig. 7. Second maxilla. Fig. 8. Maxilliped. Figs. 9 to 11. First, second, and third swimming legs.

## PLATE 2.

*Alebion fuscus* and *Elytrophora hemiptera*.—Fig. 12. Dorsal view of *Alebion fuscus* female. Fig. 13. Dorsal view of *Elytrophora hemiptera* female. Fig. 14. Second antenna. Fig. 15. First maxilla. Fig. 16. Furca. Figs. 17 to 19. First, second, and fourth swimming legs.

## PLATE 3.

*Achtheinus dentatus*.—Fig. 20. Second antenna of adult female. Fig. 21. Ventral surface of genital, showing partial separation of sixth, segment (*sg*), sixth legs (*sp*), abdomen (*a*), fifth legs (*lm*), cement glands (*cg*), and oviducts (*od*). Fig. 22. Dorsal view of immature female, showing reproductive system. Fig. 23. Maxilliped. Fig. 24. Accessory laminae on maxilliped. Fig. 25. Dorsal view of male. Fig. 26. Mouth tube and maxillae. Fig. 27. Second antenna.

## PLATE 4.

*Trebius latifurcatus* and *Pseudomolgus hawaiiensis*.—Fig. 28. Dorsal view of *Trebius latifurcatus* female. Figs. 29 to 32. First, second, third, and fourth legs. Fig. 33. Second antenna, maxilla, and maxillary palp. Fig. 34. Furca. Figs. 35 to 38. First, second, third, and fourth swimming legs of *Pseudomolgus hawaiiensis* female.

## PLATE 5.

*Blakeanus corniger* and *Pseudomolgus hawaiiensis*.—Fig. 39. Side view of *Blakeanus corniger* female. Fig. 40. First antenna. Fig. 41. Second antenna. Fig. 42. Maxilliped. Fig. 43. Fourth swimming legs. Fig. 44. First antenna of *Pseudomolgus hawaiiensis* male. Fig. 45. First antenna of female. Fig. 46. Second antenna of female. Figs. 47 and 48. Third and fourth swimming legs of male.

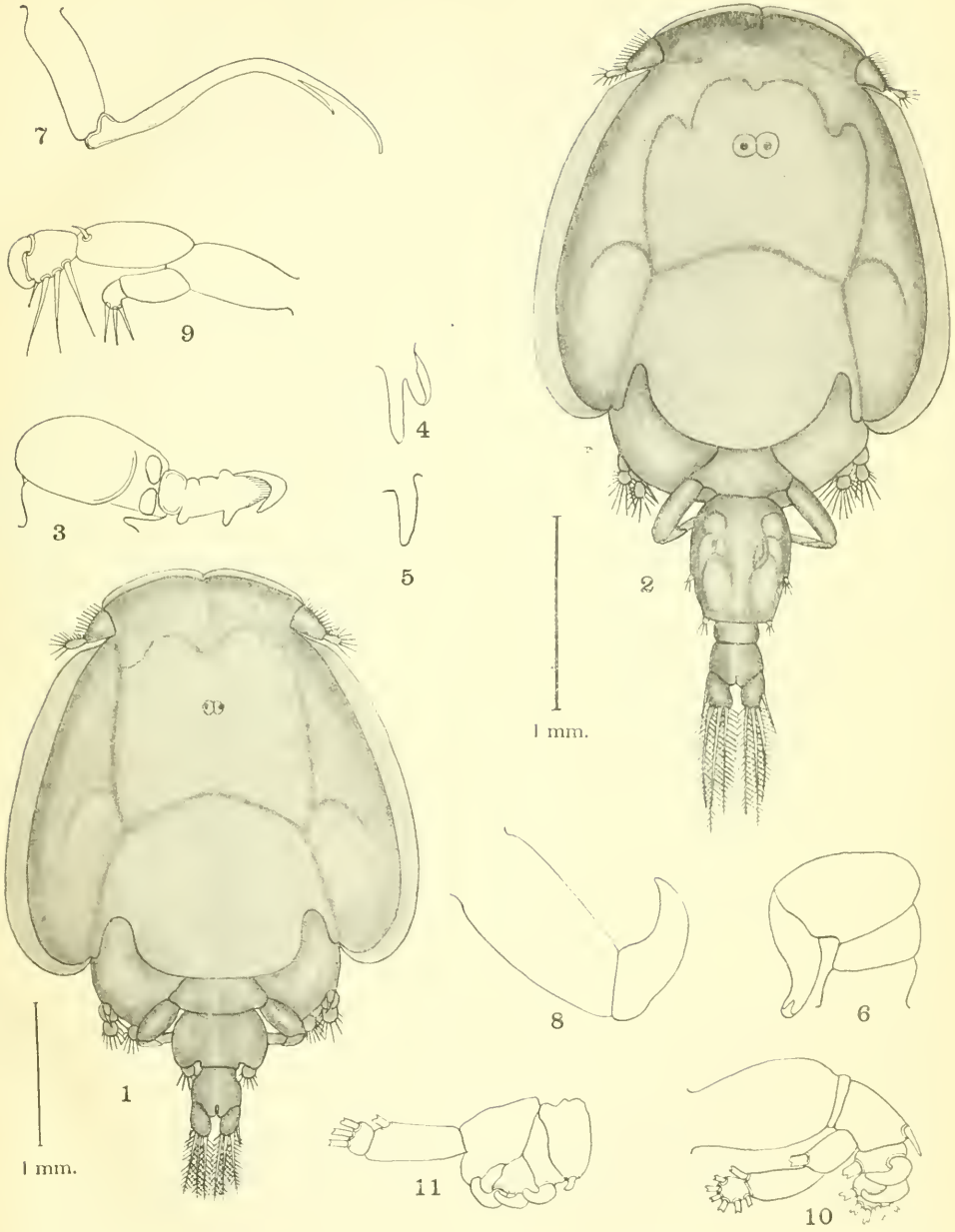
## PLATE 6.

*Pseudomolgus hawaiiensis*.—Fig. 49. Dorsal view of female. Fig. 50. Dorsal view of male. Fig. 51. Second antenna of male. Fig. 52. First maxilla. Fig. 53. second maxilla. Fig. 54. Maxilliped of male. Fig. 55. Ventral surface of genital segment of male. Fig. 56. Fifth leg of male. Fig. 57. Fifth leg of female.

## PLATE 7.

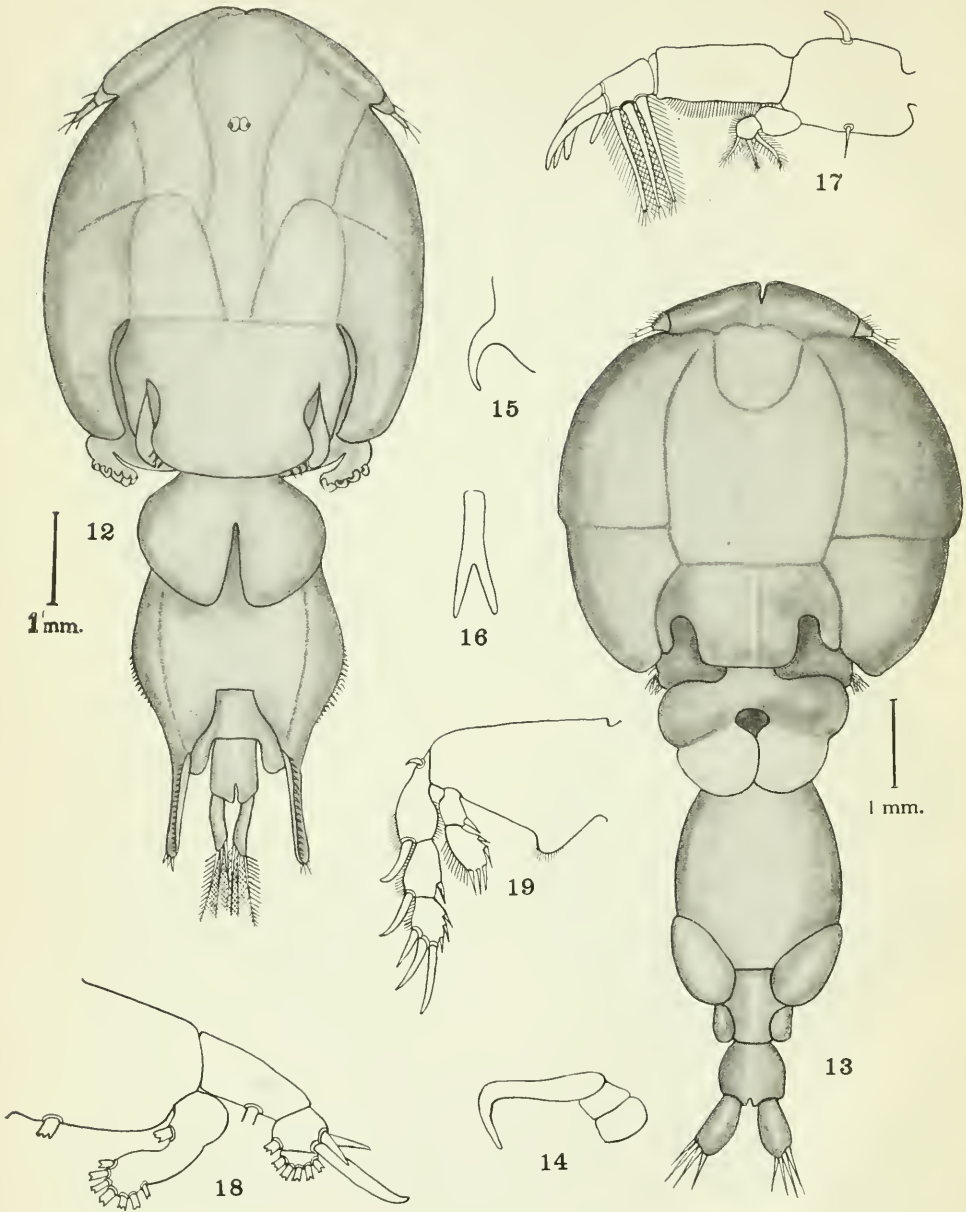
*Modiolicola jamaicensis*.—Fig. 58. Dorsal view of female. Fig. 59. First antenna. Fig. 60. Second antenna. Fig. 61. Second maxilla. Fig. 62. Maxilliped. Figs. 63 to 65. Third, fourth, and fifth swimming legs.





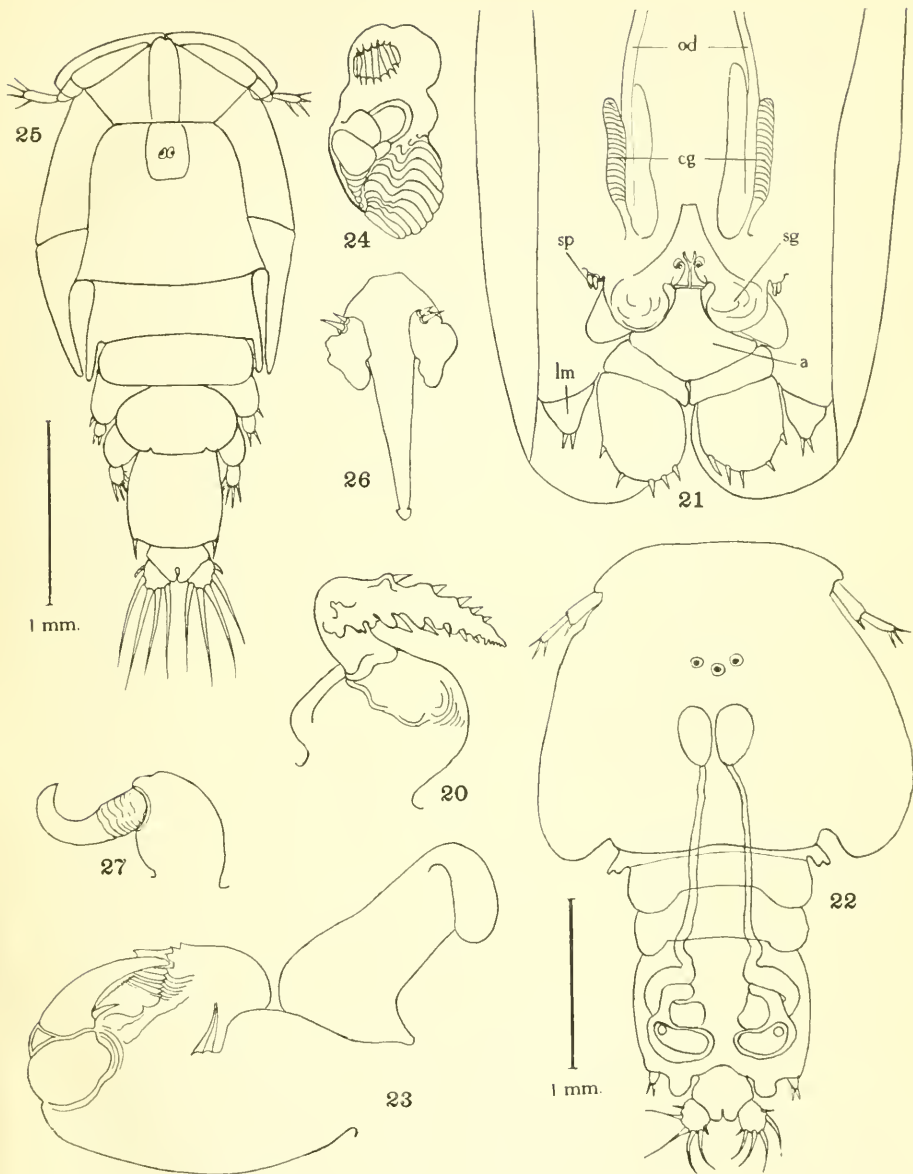
LEPEOPHTHEIRUS LONGIPES AND ALEBION FUSCUS.

FOR EXPLANATION OF PLATE SEE PAGE 17.



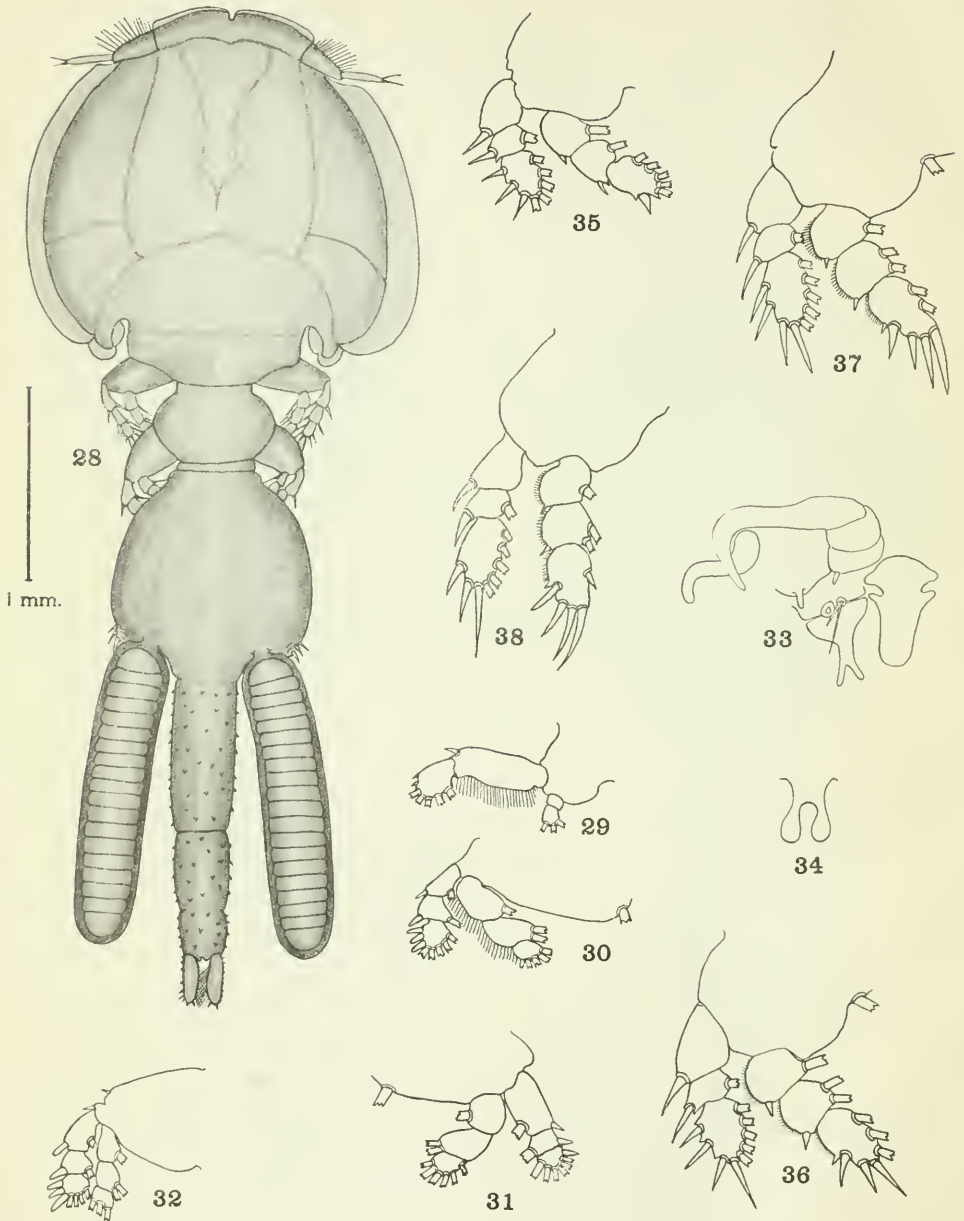
ALEBION FUSCUS AND ELYTROPHORA HEMIPTERA.

FOR EXPLANATION OF PLATE SEE PAGE 17.



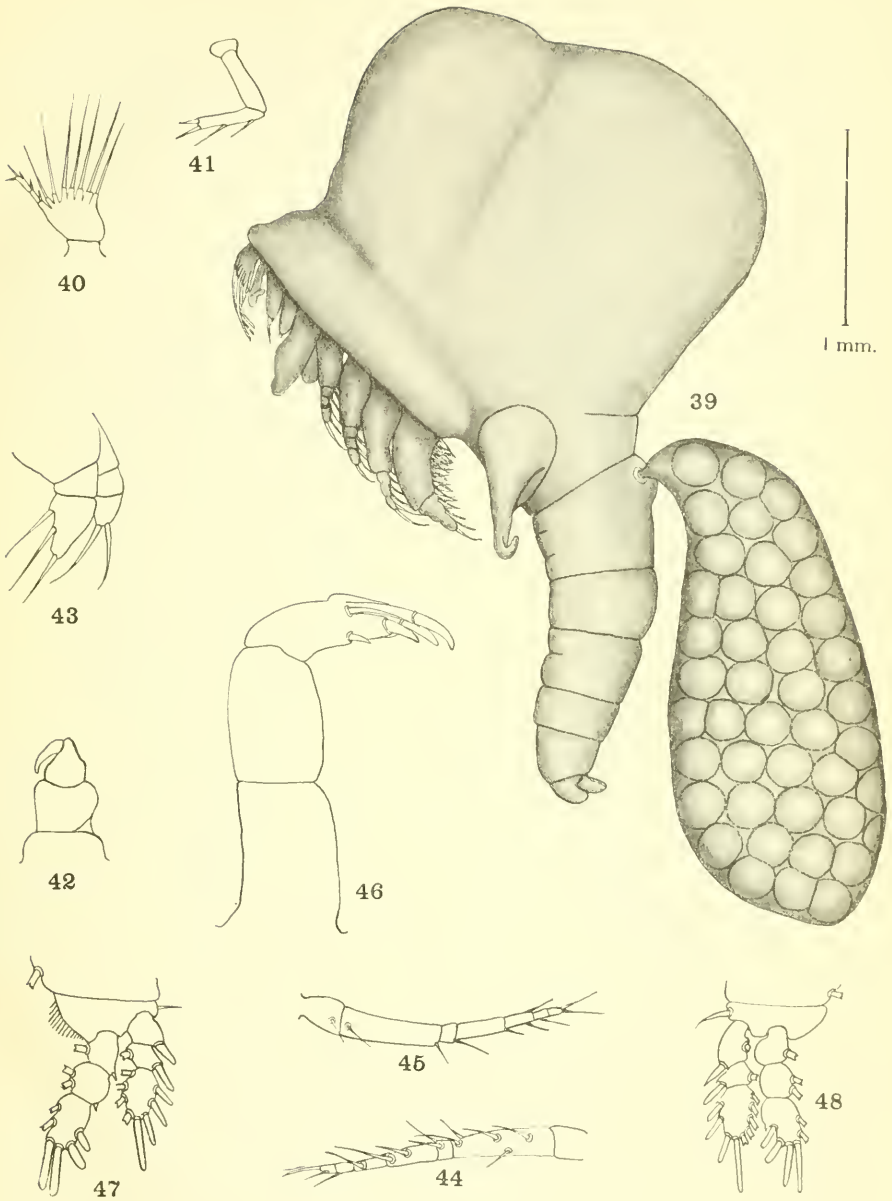
MALE AND FEMALE OF *ACHTHEINUS DENTATUS*.

FOR EXPLANATION OF PLATE SEE PAGE 17.



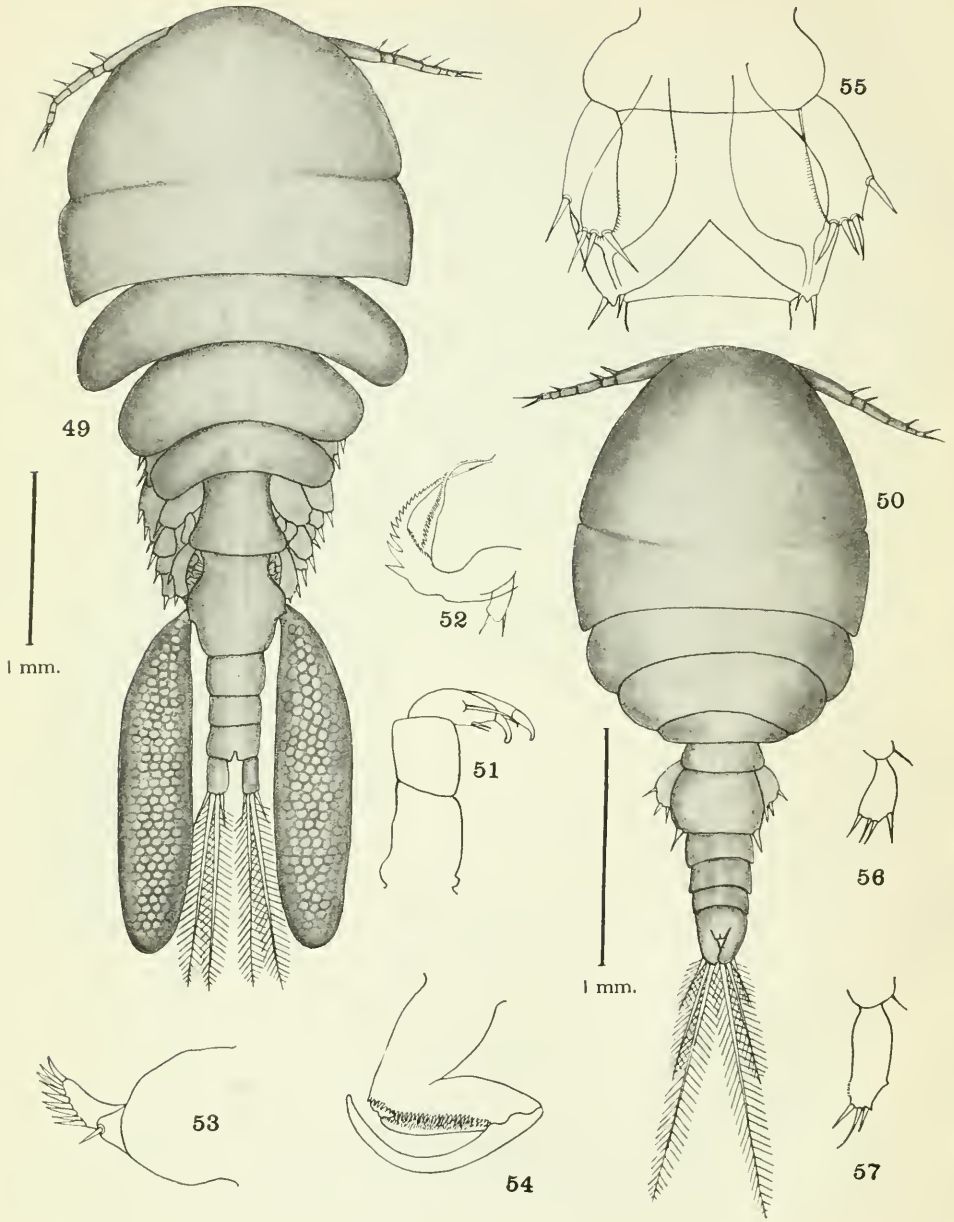
TREBIUS LATIFURCATUS AND PSEUDOMOLGUS HAWAIIENSIS.

FOR EXPLANATION OF PLATE SEE PAGE 17.



BLAKEANUS CORNIGER AND PSEUDOMOLGUS HAWAIIENSIS.

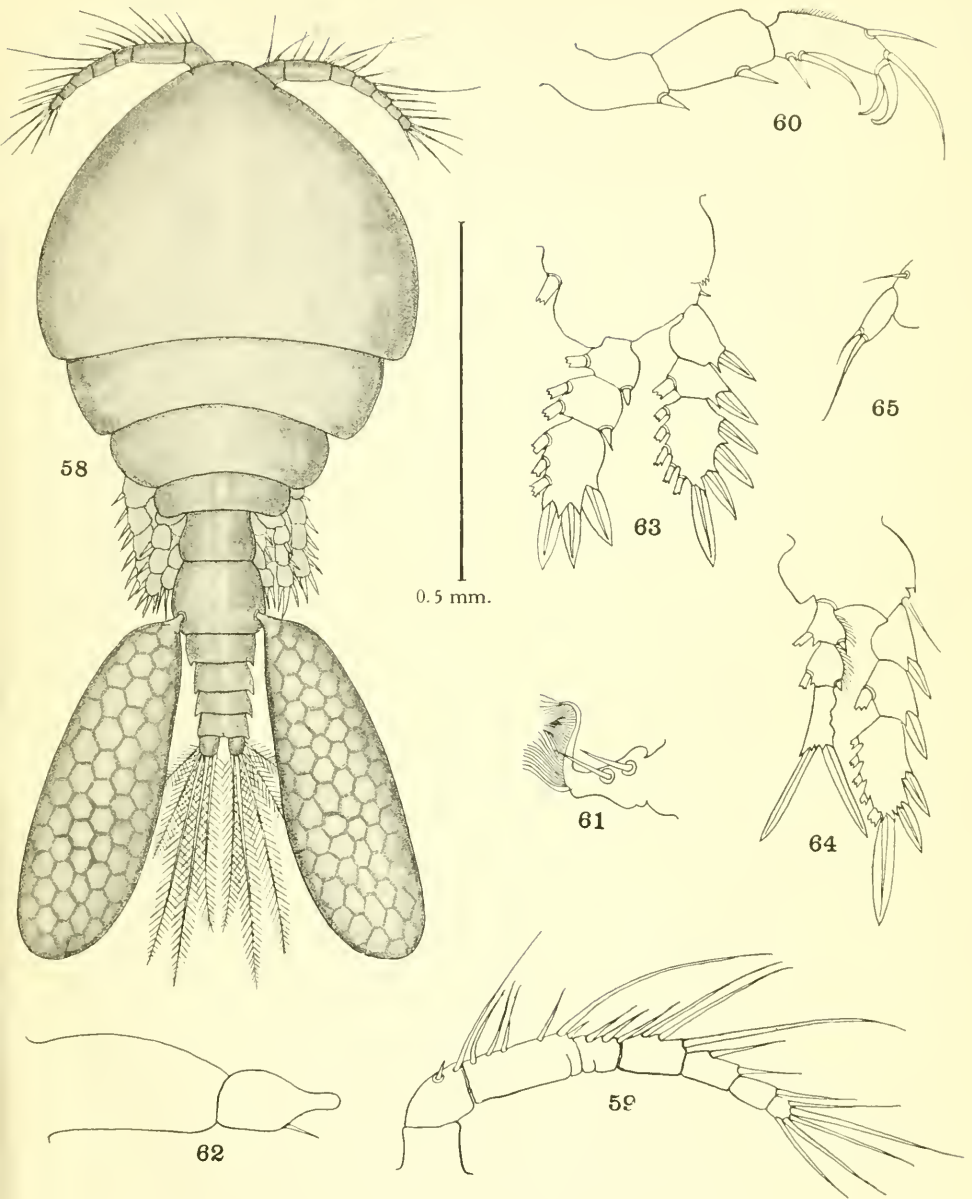
FOR EXPLANATION OF PLATE SEE PAGE 17.



MALE AND FEMALE OF *PSEUDOMOLIGUS HAWAIIENSIS*.

FOR EXPLANATION OF PLATE SEE PAGE 17.





FEMALE OF *MODIOLICOLA JAMAICENSIS*.

FOR EXPLANATION OF PLATE SEE PAGE 17.

