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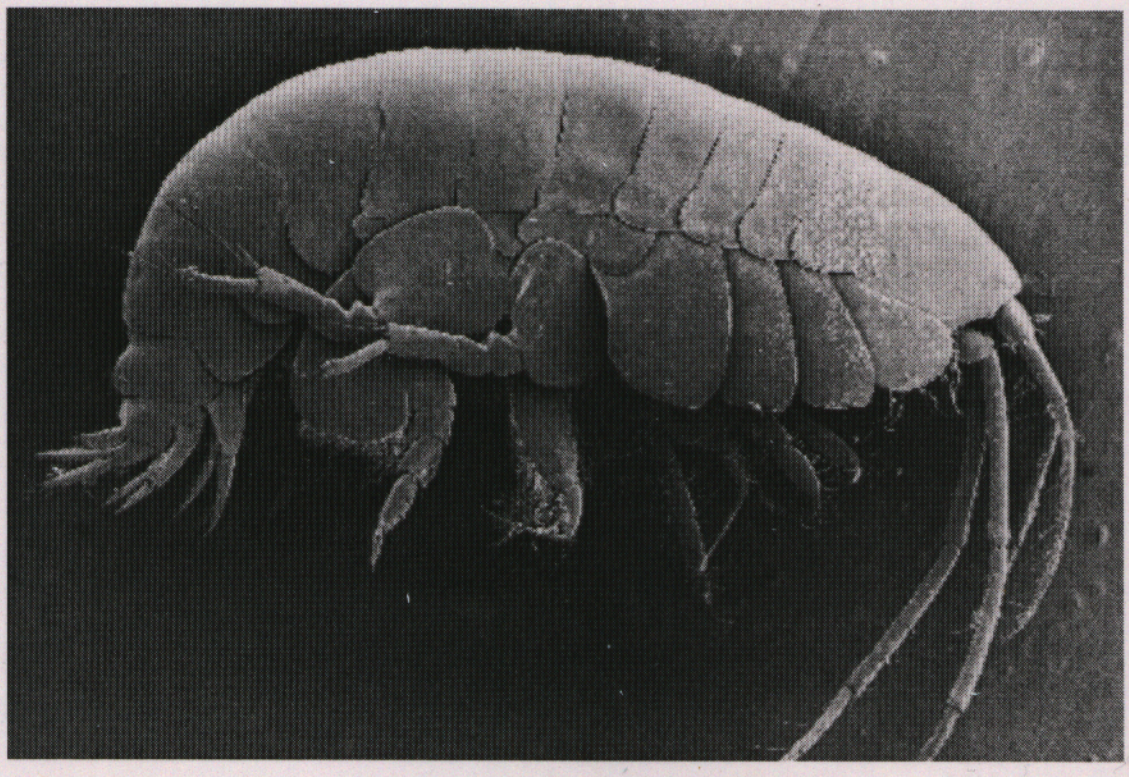
Taxonomic Atlas of the Benthic Fauna of the Santa Maria Basin and Western Santa Barbara Channel

FINAL REPORT
Volume 12 of 14

The Crustacea Part 3 — Amphipoda



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U.S. Department of the Interior
Minerals Management Service
Pacific OCS Region

OCS Study
MMS 95-0034

Taxonomic Atlas of the Benthic Fauna of the Santa Maria Basin and Western Santa Barbara Channel

FINAL REPORT
Volume 12 of 14

The Crustacea Part 3 — Amphipoda

Edited by:

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Submitted by:

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San Diego, California 92121

For:

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Minerals Management Service
Pacific OCS Region
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Camarillo, California 93010

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DISCLAIMER

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TAXONOMIC DISCLAIMER

This report is not deemed nor intended to be a valid publication for the naming of new taxa as stipulated in the International Code of Zoological Nomenclature, Article 8b.

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BACKGROUND: The Taxonomic Atlas of the Santa Maria Basin and western Santa Barbara Channel is an extension of the benthic reconnaissance (Phase I) and monitoring programs (Phase II) that were conducted by the MMS since 1983. The organisms that were collected as part of those programs provide the material on which the Atlas is developed. In order to fully document the fauna collected by those programs, a series of 14 volumes will be prepared that provide keys, descriptions, and illustrations of the benthic fauna of the hard and soft substrate environments. A team of 40 experts on the fauna has been assembled to carry out this work and their contributions are distributed among the 14 volumes.

OBJECTIVES: The objectives of Volume 12 are to provide keys, descriptions, and illustrations to the amphipod crustaceans of the Santa Maria Basin and western Santa Barbara Channel.

DESCRIPTION: The volume on the Amphipoda includes five chapters. The first is an introduction to amphipods that includes sections on amphipod morphology, reproduction and development, collection and preservation, laboratory methods, a glossary, and a key to the families of Amphipoda from southern California. Chapters 2-5 treat most of the families of Amphipoda encountered in the Santa Maria Basin and western Santa Barbara Channel. A total of 22 families, 67 genera, and 115 species of the Gammaridea are treated along with 4 families, 6 genera, and 12 species of Caprellidea. The Lysianassidae are not included. For

each family, keys to species in the study are presented along with illustrated diagnoses for each species.

SIGNIFICANT CONCLUSIONS: This compilation of offshore amphipods represents the first effort to synthesize and develop a faunal guide for this difficult, yet important component of central California benthic communities. The descriptions and keys that are presented will permit users to identify most of the genera and species within the study area and afford some applicability outside of the immediate study area. Out of 115 species of gammarid amphipods, three species, *Photis typhlops* Conlan, *P. linearmanus* Conlan, and *Gammaropsis ocellata* Conlan were identified as new to science and were described and named in a separate paper. Another species, *Microjassa* sp. A, has also been identified as new to science and is being described separately (Conlan, in press).

STUDY RESULTS: The fauna of the Santa Maria Basin and western Santa Barbara Channel is evaluated from samples that were taken from depths of about 50 to 1,000 m. Organisms were collected from soft sediments using box cores and from rocks using manipulator arms of submersibles and remotely operated vehicles. The collections are organized into sets of vouchers from Phase I and II that have been made available to the team of investigators. Additional material from the bulk collections now archived with the Natural History Museum of Los Angeles County is also being examined. The total number of species treated in the entire Taxonomic Atlas (14 volumes) may exceed 1,000 species.

The offshore amphipods of California are reasonably well known from early monographic studies by J. L. Barnard conducted in the 1950's and 1960's . However, the discovery of numerous additional species in the region and changes to the taxonomy of amphipods at the generic and family levels have rendered most of the earlier compilations obsolete. The Taxonomic Atlas, therefore, represents the first effort to assemble information on the offshore amphipods of Central California. Although more or less restricted to those species collected as part of the MMS programs, the preparation of keys and illustrated descriptions of the fauna provides a welcome compilation for local taxonomists to use in their monitoring programs.

For this study, a total of 115 species of gammarid amphipods and another 12 species of caprellids are described and illustrated. All families encountered as part of the MMS studies were treated, except for the Lysianassidae. An introductory chapter deals with basic amphipod morphology and presents an illustrated key to the families. This chapter is followed by four others that treat the different families.

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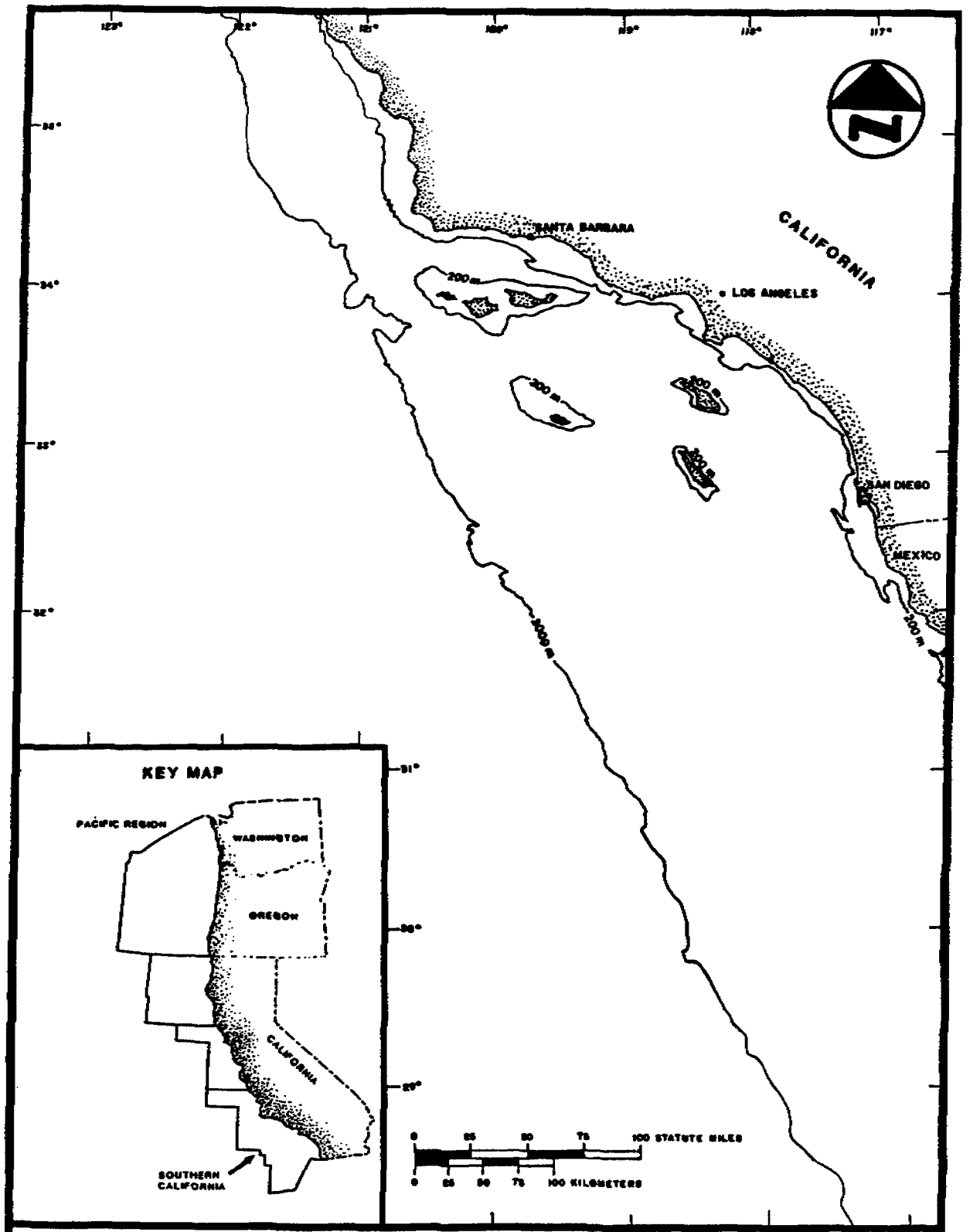

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The volume on the Amphipoda includes five chapters. The first is an introduction to amphipods that includes sections on amphipod morphology, reproduction and development, collection and preservation, laboratory methods, a glossary, and a key to the families of Amphipoda from southern California. Chapters 2-5 treat most of the families of Amphipoda encountered in the Santa Maria Basin and western Santa Barbara Channel. A total of 22 families, 67 genera, and 115 species of the Gammaridea are treated along with 4 families, 6 genera, and 12 species of Caprellidea. The Lysianassidae are not included. For each family, keys to species in the study are presented along with illustrated diagnoses for each species. Three species, *Photis typhlops* Conlan, *P. linearmanus* Conlan, and *Gammaropsis ocellata* Conlan were identified as new to science during the course of this study are were described and named in a separate paper. Another species, Microjassa sp. A, has also been identified as new to science and is being described separately (Conlan, in press).

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LIST OF ACRONYMS

BLM	Bureau of Land Management.
BRA	Refers to a station designation from the MMS Phase I Reconnaissance: Benthic Rocky, transect A/B.
BRC	Refers to a station designation from the MMS Phase I Reconnaissance: Benthic Rocky, transect C/D.
LACMNH	Los Angeles County Museum. A historical designation for Natural History Museum of Los Angeles County, Los Angeles, California, USA.
MMS	Minerals Management Service.
SBMNH	Santa Barbara Museum of Natural History, Santa Barbara, California, USA.
USNM	United States National Museum. A historical designation for the National Museum of Natural History (NMNH), Smithsonian Institution, Washington, D.C., USA.

1. Introduction to the Amphipoda

by

Les Watling[1] and J.D. Thomas[2]

More than 5700 species of gammarideans, in about 1060 genera, were known at the time of Barnard's magnificent compilation (Barnard & Karaman 1991). In addition, about 200 species of caprellideans have been described. New species are being added at a rate of more than 100 a year, making the Amphipoda one of the most diverse of all marine invertebrate groups.

Along the California coast, taxonomic studies of Amphipoda have been stimulated by the work of two individuals, S.J. Holmes and J.L. Barnard. Holmes (1908) wrote the first large, comprehensive paper describing Californian species, including one new family, seven new genera, and 25 new species. Barnard wrote more than three dozen papers on Californian amphipods and described a very large number of new taxa. In addition, Barnard devoted much attention to sorting out definitions of, and relationships among, the amphipod families. At present, there is still no completely satisfactory familial arrangement for either the gammaridean or caprellidean amphipods, or at least, one on which most amphipod systematists can agree.

Morphology

All amphipods are characterized by the lack of a carapace covering any portion of the thorax, the first thoracic segment being fused to the head (with the first thoracic appendage, therefore, being termed a maxilliped), and abdomen divided into two parts of three segments each, the anterior of which bears pleopods, and the posterior part with appendages modified as uropods. From this basic design there have evolved a multitude of modifications, the most extreme making defining the Amphipoda as a whole very difficult. In the following account, the basic gammaridean will be described, and important modifications, especially in the caprellideans, noted. Barnard's generalized gammaridean is given in Fig. 1.1, and scanning electron microscopic views of three basic gammaridean body designs are illustrated in Figs. 1.2-1.4. Details of appendages from a gammaridean are shown in Figs. 1.5 and 1.6 from Bousfield (1973) and from a caprellidean in Fig. 1.7 from Vassilenko (1974).

The head bears two pairs of antennae, mouthparts, and eyes, all of which possess important taxonomic information. While most beginning students of the group may be loathe to remove mouth appendages, it is often necessary in order to properly determine the family or generic placement of the specimen. From anterior to posterior the head appendages are: first antenna (also called antennule), second antenna (or antenna), upper lip (labrum), mandible, lower lip (labium), first maxilla (maxillule), second maxilla (maxilla), and maxilliped (not a true head appendage).

Non-appendage details of the head that need to be observed are the rostrum and eyes. The rostrum is an anterior expansion of the head, generally between and above the peduncles of the first antennae. In many amphipod families the rostrum is minute, but in a few, for example, the Oedicerotidae and Phoxocephalidae, the rostrum may be very large, sometimes bearing the eyes, and occasionally incorporating an expansion of the side of the head as well. The eyes of amphipods are compound, one on each side of the

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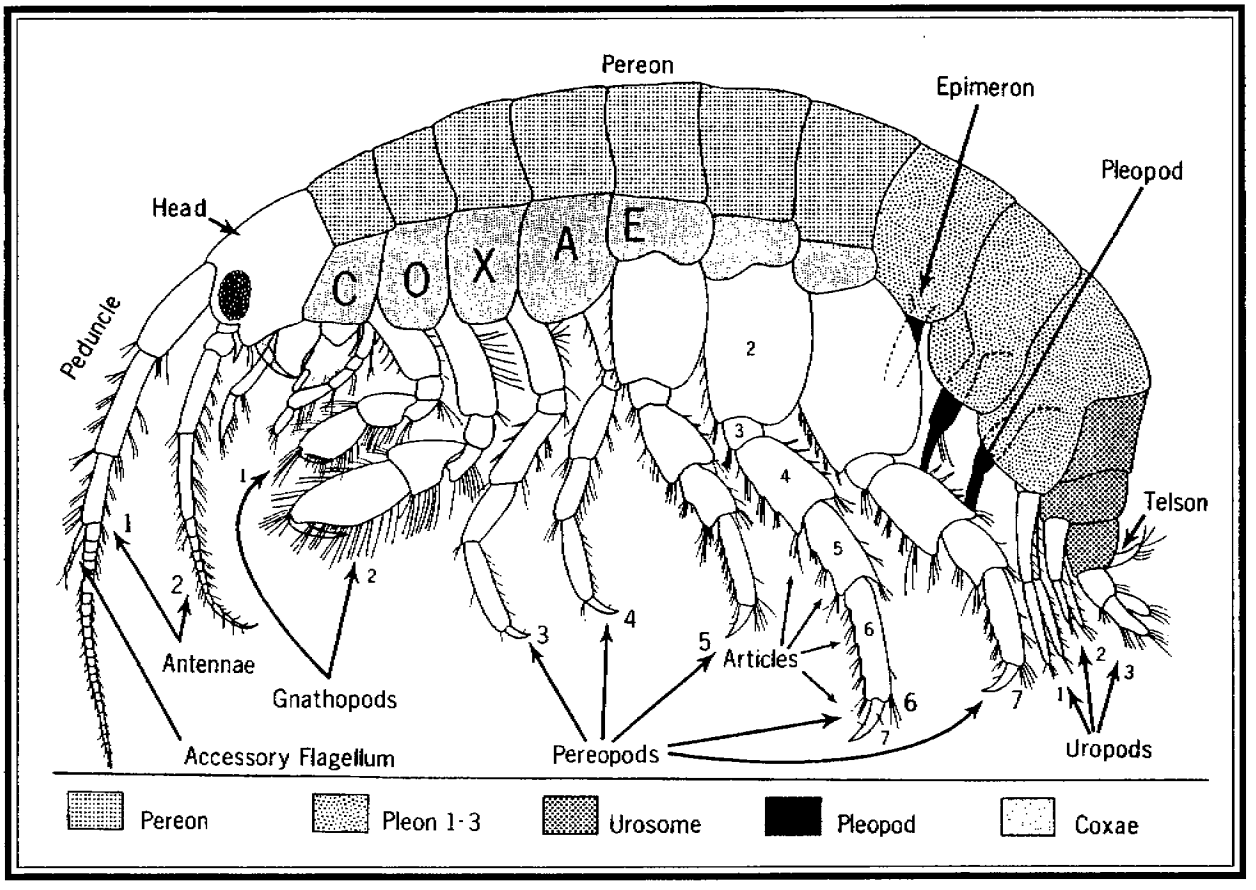

Figure 1.1. Basic diagram of generalized gammaridean amphipod (from Barnard and Karaman, 1991).

head, but may be secondarily reduced or subdivided. Dark pigments may or may not be present. If present the eye looks black, otherwise it may be difficult to discern. In ampeliscids, the eye is reduced and subdivided, with two separate corneal lenses being present on each side of the head (see Fig. 1.3, but note that the eye has no exoskeletal mark in the corophiid (Fig. 1.2) and gammarid (Fig. 1.4). In oedicerotids, the eye is often enlarged and moved to the top of the head, with the two eyes becoming confluent. Almost all shallow water amphipods have eyes, but the eyes are gradually lost at greater depths.

The first antenna consists of a peduncle of three articles (often called segments, but the latter term should be reserved for divisions of the body) and one or two rami, termed the main flagellum and accessory flagellum. The main flagellum is always present, but the accessory flagellum may be of varying lengths or absent. To find the accessory flagellum one needs to look on the inside (or medial surface) of the first antenna; it is often tiny and may need to be observed at high magnification. In males of some families, and occasionally in females, the first antennae bear complex sensory structures. The calynophore is a modification of the peduncle articles and is manifested externally by numerous rows of specialized sensory setae termed aesthetascs. Calceoli are specialized cup-shaped structures which occur all along the antennular flagellar articles, facing anteriorly. The exact function of these structures is unknown.

The second antenna is always uniramous. It consists of five peduncular articles and a variable number of flagellar articles. The basal article of the peduncle bears the opening of the maxillary gland (the excretory organ), known as the gland cone.

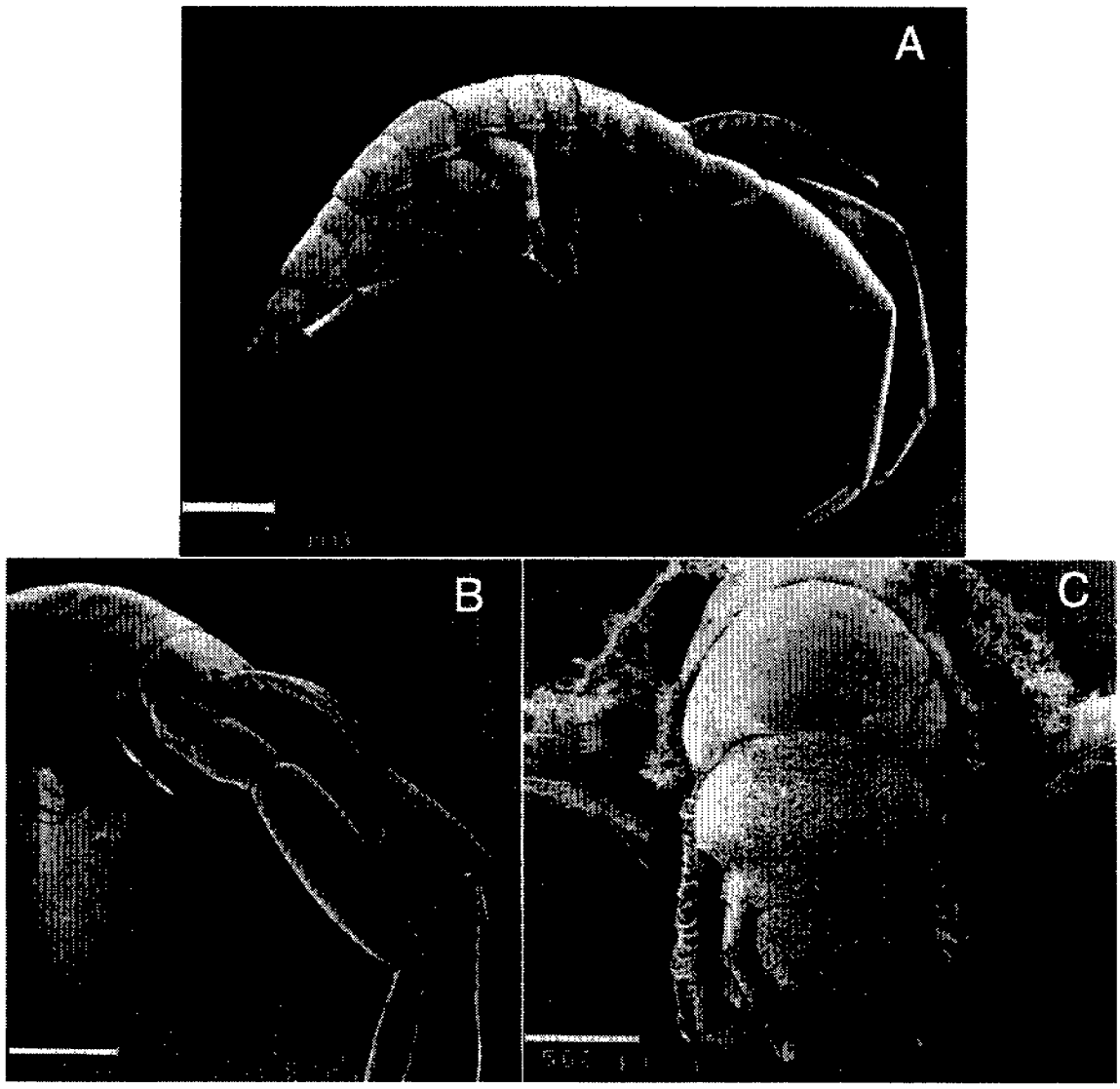

Figure 1.2. SEM views of a corophiid amphipod, *Corophium volutator*. A, side view of body. B, head and antennae. C, dorsal view of peonite 3 and urosome.

The front of the head of an amphipod supports the insertion of the antennules and antennae, and extends ventrally to form the epistome to which the upper lip (labrum) is attached. The epistome in many families is singularly undistinguished, but in certain groups, such as the lysianassoids, it may project strongly between the antennae. The upper lip is positioned so as to keep food particles being handled by the mandibles from passing beyond the mouth area. It may be cleft, asymmetrically bilobed, or bear a distal fringe of setae. There is also some evidence that mucus is secreted into the buccal region by the labrum.

The mandibles are the primary appendages by which food is passed into the mouth. The mandibles are also of significant taxonomic importance, at least at the family level, and often at the generic level. While there is a wide range of mandiblular structures, the basic mandible consists of a distal incisor process, a lacinia mobilis (accessory tooth), and a setal row (sometimes called lifting spines), which leads to the proximal molar process. In the basic mandible, a food particle is cut by the incisor and accessory tooth, lifted to the molar by the setal row, and crushed by the molar before being ingested. Some of the many modifications

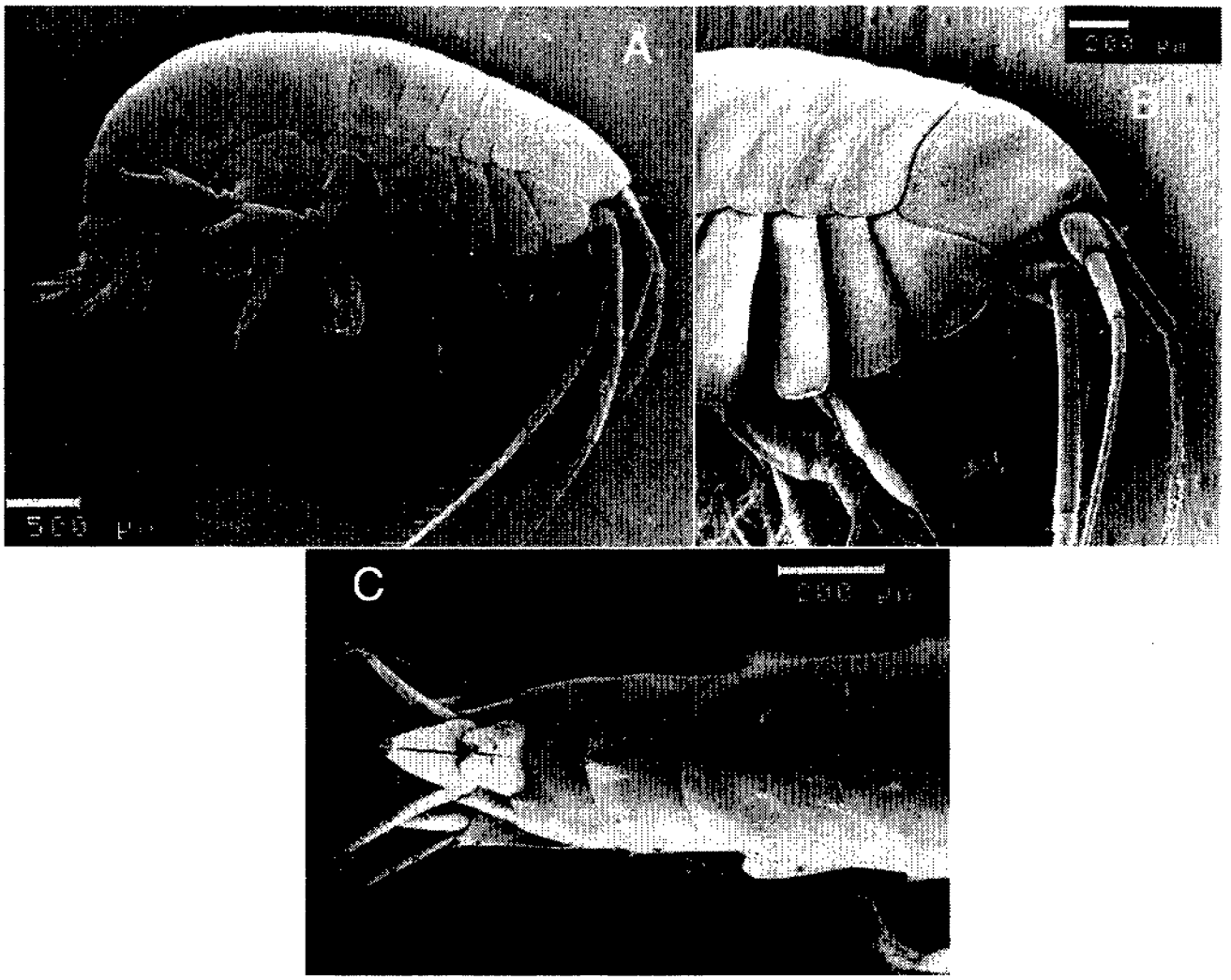

Figure 1.3. SEM views of an ampeliscid amphipod, *Ampelisca agassizi*. A, side view of body. B, head and pereonites 1-4. C, dorsal view of pleonites 1-2 and urosome.

which may be seen involve the loss or reduction of the molar, loss of the setal row, fixation of the accessory tooth into a rigid structure, loss of the accessory tooth on one molar but not on the other, and in a few genera, reduction of the incisor. In some families where the species are commensals of other invertebrates, the mandibles and other mouthparts may be reduced or vestigial.

Posterior to the mandibles is the lower lip (labium). It forms the posterior border to the mouth region. The shape of the lower lip seems to correlate somewhat with the strength and shape of the mandible. If the mandible is elongate, the lower lip is widely split and extends strongly ventrally. On the other hand, if the mandible is short and stocky, the lower lip is compact and may have its lobes coalesced.

The paired first maxillae (maxillules) are small and often difficult to remove. Each consists of a small inner lobe, an outer lobe bearing several heavy setae and a palp of one or two articles.

The second maxillae (maxillae) are smaller than the maxillules and consist of two fleshy lobes. This pair of appendages generally is of little taxonomic importance except in selected groups.

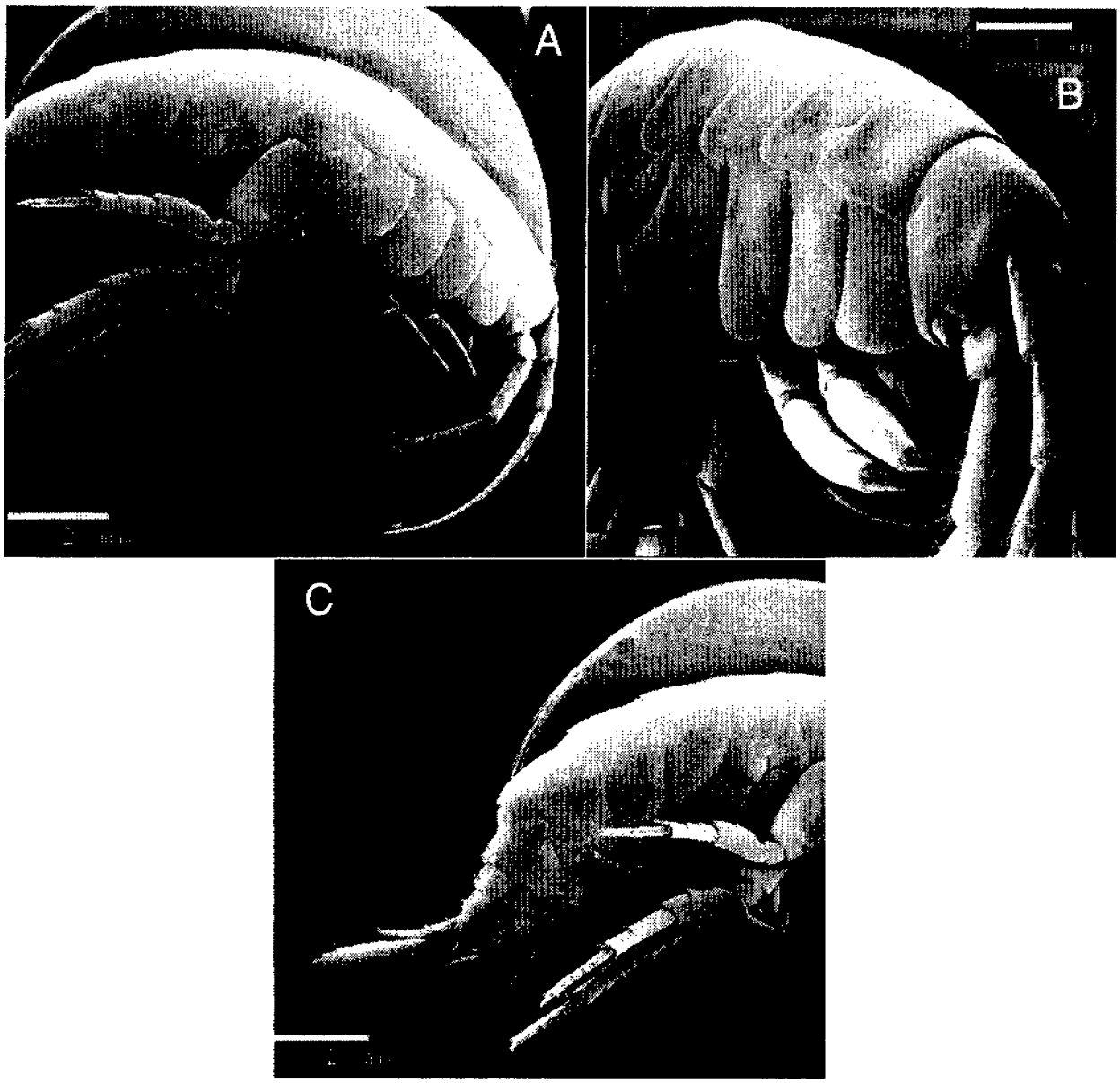

Figure 1.4. SEM views of a gammarid amphipod, *Gammarus oceanicus*. A, side view of body exclusive of urosome. B, head and pereonites 1-5. C, pleosome and urosome.

The last pair of head appendages are the maxillipeds. These are generally quite large, extend ventrally from the head and then curve forwards to the region of the mandible enclosing the mouthpart field. The maxillipeds form the most ventral part of the mouthpart appendage group and must be removed before any of the other mouthparts can be seen. Arising from the large base of the maxilliped are two large endites, the inner and outer plates. The inner plates come together medially and are often partially fused. The outer plates are usually more widely separated and bear several types of setae along the medial margin. The article from which the outer plate is derived also bears a four article palp. This palp exhibits a variety of shapes, from elongate to very short, reduced, or even absent. The details of the outer plate and the palp are important at the family and generic levels.

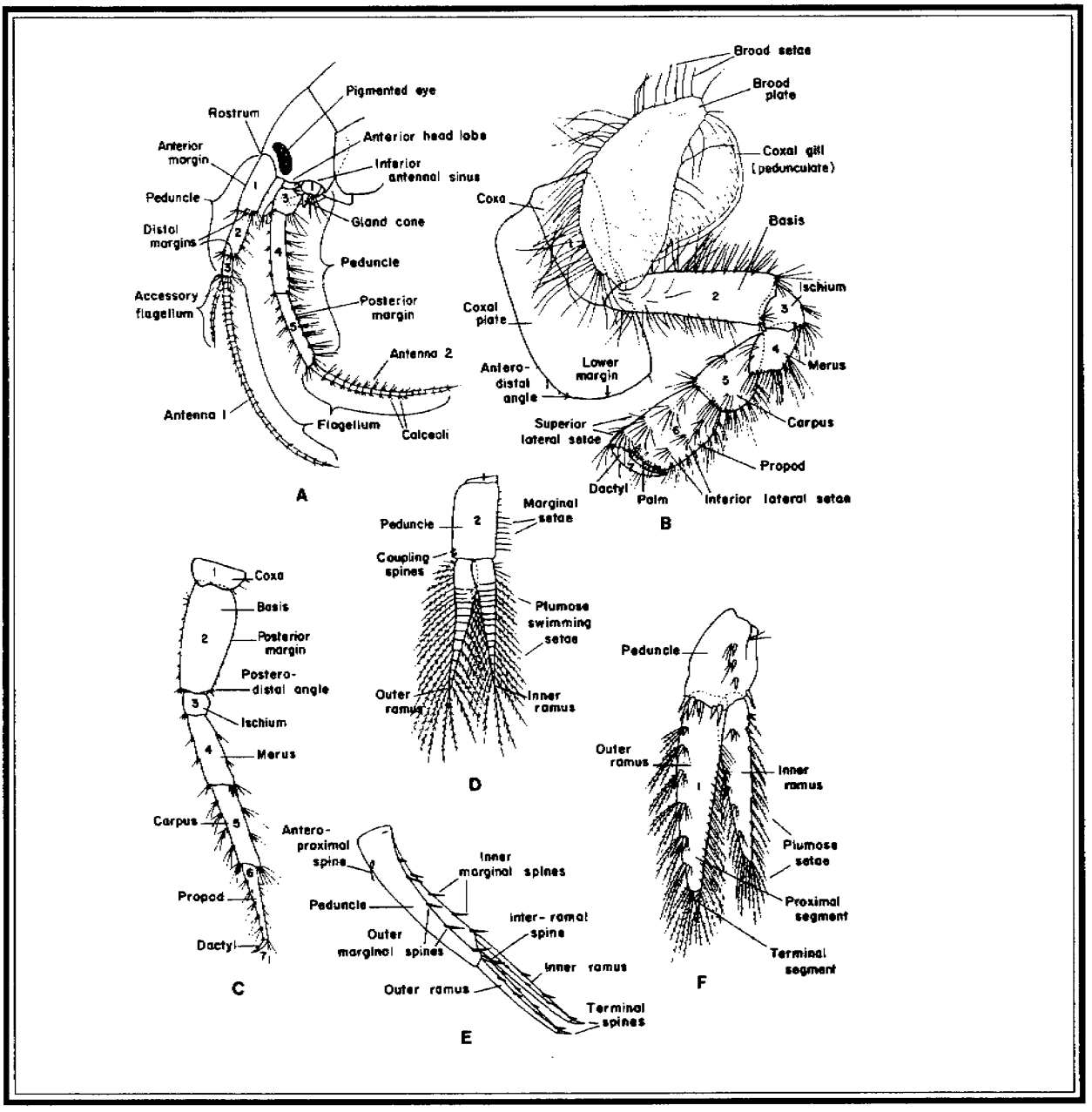

Figure 1.5. Basic gammaridean body parts. A, head; B, gnathopod; C, pereopod; D, pleopod; E, uropod 1; F, uropod 3 (from Bousfield, 1973).

The thorax consists of seven somites (segments). Since the eighth thoracic somite bearing the maxilliped is fused to the head, the modified thorax is called a pereon, the individual somites are pereonites, and the appendages are pereopods. There is often a great deal of functional specialization (tagmosis) among the pereonites of amphipods. In the following paragraphs, the appendages will be dealt with according to their functional group.

The basic thoracic appendage is uniramous and consists of seven articles. From the body outward these articles are called the coxa, basis, ischium, merus, carpus, propodus, and dactylus. The first two articles comprise the protopod. In crustaceans with biramous limbs, the basis bears an endopod and an

exopod. Since amphipod thoracic limbs are uniramous, the basis bears only the five-articulate endopod. In all amphipod groups except the caprellids, the coxa is greatly expanded to form a flat plate essentially contiguous with the ventrolateral margin of the body. These coxal plates can often be very large, dramatically changing the side profile of the animal (e.g., Stegocephalidae, Stenothoidae).

The first two pairs of pereopods are termed gnathopods and function primarily to move food particles to the mouth appendages. In general, the gnathopods consist of seven articles and can be chelate, subchelate or simple, with subchelate condition being the most common. In the subchelate forms, the sixth article (the propodus) often has the distal margin subdivided, with the border along which the dactyl folds being called the palm, or palmar margin. The gnathopods may take on a wide variety of shapes and designs according to the feeding habits of the species. For example, in Gammaridae (senso lato) and allied families, the gnathopods are, for the most part, about equal in size and are used primarily for holding larger detrital or plant particles while the mouth appendages break off smaller fragments. In some Corophiidae, one or both pairs of gnathopods may be armed with very long setae which serve to form a filter basket, with the gnathopods being used to sieve fine particles from large sediment boluses. In the Leucothoidae and Anamixidae, the second pair of gnathopods are greatly enlarged and are used to intercept and redirect water currents bearing fine suspended particles that are generated by their tunicate hosts. In addition to their feeding function, the second pair of gnathopods in the male are used for carrying the female prior to mating. For many amphipods, the exact function of the gnathopods is unknown as detailed studies of the biology of many families remain to be documented.

Pereopods 3 and 4 are more leg-like, usually unspecialized, and are often reduced in size or number of articles (especially in the caprellids). They differ also from the following three pairs of pereopods in having the dactyls directed posteriorly. They seem to function in grooming the gnathopods and, in tube-building, burrowing. In some domicolous species, secretions from glands in the bases produce copious quantities of a sticky substance (probably mucus with unknown additives called "amphipod silk") that is used in tube or burrow construction and cementation.

Pereopods 5, 6, and 7 have the dactyls oriented anteriorly, increase in length posteriorly, and show a large degree of variation according to how the legs are used. The coxae of these legs are usually smaller than those of the preceding legs, and in many cases are bilobed. In families where the basis of the gnathopods and pereopods 3 and 4 is generally linear, it is often expanded posteriorly on pereopods 5-7. The morphological details of these legs is usually distinct at least to the family level. For example, in the Ampeliscidae, the bases are greatly expanded and the particular shape of the posterior expansion of the basis on pereopod 7 is unique to each genus. Pereopods 5-7 differ considerably from each other in the Phoxocephalidae, with pereopod 6 being the longest. All haustoriids have several articles on pereopods 5-7 greatly expanded and armed with many stiff setae. In some oedicerotids, pereopods 5 and 6 look alike and are much shorter than the greatly elongated pereopod 7.

The pereopods also bear gills, and in females, brood plates (= oostegites). In most families there are gills attached to the medial surfaces of coxae 2-7, but occasionally they may be on only coxae 2-6, 3-6, 3-5, or, as in the caprellids, on 3 and 4. Brood plates are generally attached to the medial surfaces of coxae 2-5, but may be on coxae 3 and 4 only. Brood plates originate in immature females as small pouches, then on subsequent molts appear fully formed but without marginal setae and finally, when the eggs are laid the brood plates are fully setose.

The amphipod abdomen consists of six somites which are functionally subdivided into two groups of three somites each: an anterior pleosome whose somites bear pleopods, and a posterior urosome whose somites bear uropods. In caprellids the abdomen is variously reduced, with both the number of abdominal somites and the constituent appendages eventually becoming so small that the exact affinities of the appendages cannot be determined. Amphipodan pleopods are generally biramous, the rami being multi-articulate and heavily setose. The pleopods are used to generate a respiratory current past the gills, and in many families with swimming or burrowing habits, are the principal propulsive structures.

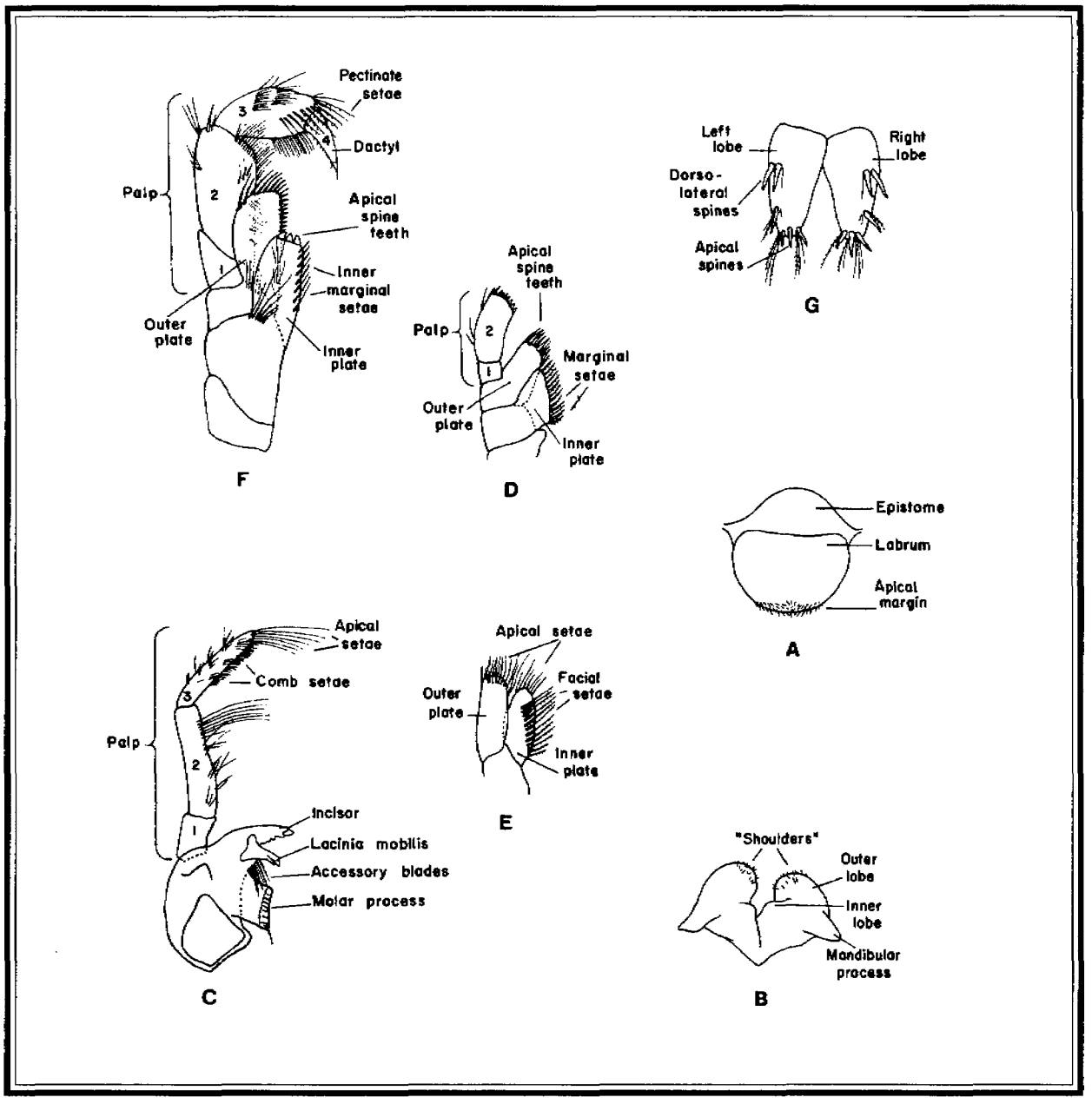

Figure 1.6. Mouthpart structure and terminology. A, upper lip; B, lower lip; C, mandible; D, maxilla 1; E, maxilla 2, F, maxilliped; G, telson (from Bousfield, 1973).

Of the three pairs of uropods, the first two are most likely to be similar in general structure to each other. They usually consist of an elongate peduncle and two rami. Much greater variability is seen in the structure of the third uropods. These appendages may be biramous or uniramous, with the rami either cylindrical or flattened. The latter design is generally seen in those species where swimming is an important, or predominant, mode of locomotion. In the more sedentary species, the third uropods may be significantly reduced, as for example, in most of the tube-dwelling corophiids.

Figure 1.7. Details of body plan and appendages of a caprellidean amphipod (from Vassilenko, 1974).

At the posterior end of the body is the telson. The anus exits on the underside of the telson, but generally not terminally. As with the third uropods, the shape of the telson varies considerably with the lifestyle of the species. Most sedentary, domicolous, or tube-dwelling species have very small, short, and thick telsons. At the other extreme, species that are primarily or exclusively swimmers have elongate telsons, which are often cleft. The subdivision of the telson allows for greater steering and braking control in the water. In those families where the telson is of a design other than short and thick, the shape and ornamentation of the telson is of strong taxonomic importance.

Reproduction and Development

Fertilization in amphipods occurs in the brood pouch, with the sperm being deposited just before the eggs are extruded. In some benthic forms, males guard or grasp females, a process termed amplexus. In many cases, amplexus involves the male grasping the dorsal part of the female body at the posterior margin of pereonite 2 with his second gnathopods. The pair of amphipods may move about for one or two weeks in this condition. Immediately after the female molts, the male grasps the female venter to venter and sperm are added to the brood pouch, followed very soon by the female extruding the eggs. In pelagic forms mating is also venter to venter, but most likely is an event of short duration.

Development is direct. Most amphipod eggs are quite yolky so cleavage is not total beyond the first two divisions. All leg primordia develop on the embryo simultaneously. The young hatch bearing all appendages, with full number of articles. As development proceeds, additional setae are added along the margins of the appendages.

There has been very little study of instars of amphipods, so it is not known whether all amphipod species progress through the same number of molts before maturity or whether development can be significantly abbreviated in some groups.

Collection and Preservation

Amphipods can be collected using many different techniques. Benthic mud or sand-dwelling forms are often obtained in bottom grab or dredge samples. Those with pelagic mating stages can be taken in standard zooplankton nets. Since many amphipods are domicolous, or commensal, it is also worthwhile to break apart sponges, colonial tunicates, etc., or examine the mantle cavities of bivalves and the filter baskets of large solitary tunicates. Species living on rocky shores in and amongst algae are best obtained by removing large clumps of algae and soaking the clumps in 10% formalin. Along sandy beaches amphipods can be obtained by digging holes in the sand just above the low water wave swash. As water drains into the hole, and the sand walls of the hole collapse, amphipods will usually be swept into the hole and can be collected in the few seconds as they swim about.

Amphipods are best preserved initially in 5 - 10% buffered formalin (commercial borax will do as the buffering agent). After 48 hrs to a week of fixation, the specimens should be transferred to a 70% ethanol solution. Isopropanol can also be used, but specimens stored in this solution are often brittle, with the result that legs are often lost. One should note that if there is the possibility that some specimens will be used for genetic work, then formalin should <u>not</u> be used as a fixative. Rather, all specimens should be put directly into ethanol and handled carefully as they will be somewhat brittle.

Laboratory Methods

In the laboratory both compound and dissecting microscopes will be needed for proper examination of material. Specimens usually can be sorted to family, and dissections made under a good quality dissection microscope. The higher magnifications of the compound microscope is used for examining the details of the smaller appendages, especially those from the mouth region. Once the local fauna is known, it is generally not necessary to do full dissections, so the sorting and counting of specimens can proceed at a much faster rate.

Everyone has their preferred mode of dissection of an amphipod. The method to be outlined works well, but should not be considered the only way to approach the problem. Only one of each appendage should be removed from the body initially. To access the mouthpart appendages more easily, the entire head can be removed by inserting one set of forceps tips at the head—pereon junction and pulling the body with another pair of forceps. Usually the head with all appendages, including the maxillipeds, and the foregut will come off intact. By immersing the head, especially if it is very small, in a glycerol-alcohol mixture in a watchglass, the mouthparts can be slowly teased off. All appendages, as they are removed, should be temporarily mounted on glass microscope slides using glycerin. If very small cover slips are used, then a series of single appendages can be mounted on one slide. After examination, drawing, etc., the appendages can then be removed from the slide and stored in alcohol in 1/4 dram vials in the larger vial containing the remainder of the body.

Acknowledgements

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Glossary

Most of the terms defined here follow the usage given in Barnard & Karaman (1991).

Accessory flagellum: the secondary ramus of the first antenna, attached to the medial distal margin of the last peduncle article.

Aesthetasc: a specialized sensory seta found on the antennae; they are usually flattened and do not taper distally.

Article: a subdivision of an appendage; used in preference to the terms segment and joint

Basis: the second article of a thoracic appendage.

Calceolus: a small sense organ on the flagellar articles of the antennae, often globular, button-shaped, or linguiform.

Callynophore: the partially or completely fused proximal articles of the main flagellum of antenna 1 bearing multiple rows of aesthetascs usually grouped together into one or two large groups to form a brush.

Carpochelate: a condition where the carpus is extended distally as an immovable finger and forming a pincer with the propodus and dactyl.

Carpus: The fifth article of a thoracic appendage.

Chelate: a condition where the propodus extends along the dactyl as an immovable finger and against which the dactyl presses.

Cleft: divided almost completely into two parts.

Conical mouthparts: in lateral view the mouthpart group (from upper lip to maxillipeds) is extended strongly and tapering ventrally.

Corneal lens: a biconvex modification of the cuticle directly over the ommatidia.

Coxa: the first article (immediately next to the body) of an appendage.

Coxal plate: the lateral and ventral extension of the coxal margin.

Dactyl: the seventh article of a thoracic appendage.

Emarginate: a slightly concave depression in a margin, often used to describe the distal end of the telson.

Entire: not cleft or emarginate, margin whole throughout.

Epimeron: the ventrolateral extension of the pleuron of peonites 1-3.

Epistome: the anterior part of the head above the upper lip; may be extended ventrally when labrum is small or anteriorly to form a lobe.

Flagellum: the distal part of the antennae, on antenna 1 beginning with the fourth article and on antenna 2 with the sixth article.

Fossorial: applied to pereopods when used for burrowing, the articles of which are excessively spiny and broadened

Gnathopod: the second and third thoracic appendages (first and second pereopods) which are often used in food procurement.

Hand: the sixth article of a gnathopod or other subchelate pereopod.

Ischium: the third article of a thoracic appendage.

Incisor: the distal extension of the body of the mandible, usually toothed, but occasionally blade-like.

Joint: the junction between two articles of an appendage.

Labium: the lower lip, a flap-like appendage, often subdivided, immediately behind the mandibles.

Labrum: the upper lip, a flap-like appendage on the front of the head anterior to the mandibles.

Lacinia mobilis: an articulated accessory plate near the incisor, often toothed, may be missing on either the right or left mandibles, and sometimes is rigid and not moveable.

Lifting setae: the row of setae between the incisor and the molar of the amphipod mandible. Used in preference to raker setae.

Mandible: the anteriormost appendage pair of mouth appendages, located between the upper and lower lips.

Merochelate: having an immoveable finger projecting distally from the merus.

Merus: the fourth article of a thoracic appendage.

Molar: the often large, columnar process extending medially from the body of the mandible; in its heaviest form used for crushing food particles before they enter the mouth; in other forms may be a small pubescent nub, or fleshy setose flap.

Obsolescent: vestigial or nearly absent.

Palm: the posterior distal surface or margin of the propodus against which the dactyl closes in subchelate appendages; defined posteriorly by spine-setae, or notches, etc.

Palp: the distal articles of a limb, usually of different size (width) than the proximal articles; in amphipods applied only to the mandible, maxilla 1, and maxilliped.

Peduncle: the combined basal (proximal) articles of certain appendages from which there may be, or have been, two rami extending; used for the first three articles of antenna 1, five articles of antenna 2, one (possible two) article of pleopods, and one article of uropods.

Pereon, pereonite (also spelled peraeon, pereion): the seven free thoracic segments of the body, each one of which is referred to as a pereonite.

Pereopod (also spelled peraeopods, pereipods): an appendage of a pereonite.

Plate: a flattened lobe extending distally or medially on an article of a maxilla or maxilliped.

Pleon, pleonite: the anterior three abdominal segments, each of which is referred to as a pleonite; in the higher caprellids several, or all, pleonites are lost.

Pleopod: an appendage of the pleon, usually used in swimming or generatng a respiratory current.

Pleurae: ventrolateral extensions of the body segments; in amphipods most visible as epimerae (epimeral plates), but can occasionally be seen on at least the anterior pereonites in a few families.

Propodus: the sixth article of a thoracic appendage.

Pubescent: a thick covering of very fine setae or hair-like extensions of the cuticle.

Quadrate mouthparts: mouth appendges arranged in rectangular or box-like formation; maxillipeds usually form ventral floor of this box by extending horizontally strongly forward.

Raker spine: applied to the setae arranged in a row between the incisor and molar processes of a mandible; also called lifting spines or setae, or more simply, the seta row; the origin of this term is obscure and its use should be discouraged.

Subchelate: a condition where the dactyl of an appendage is folded back against the propodus, closing against part of the propodal margin.

Uropod: an appendage attached to one of the urosomites; phyletically uropods are modified pleopods.

Urosome, urosomite: the terminal tagmosis of the body comprising the last three pleonites, each somite referred to as a urosomite; in some families one or more of the segments may be fused, and in caprellids most are lost.

Key to the Gammaridean Amphipod Families of Southern California

1A. Gnathopod 2 with unusually elongate article 3; mandible elongate, with incisor reaching to front of head ..... Lysianassidae (not included in this volume) (Fig. 1.8)

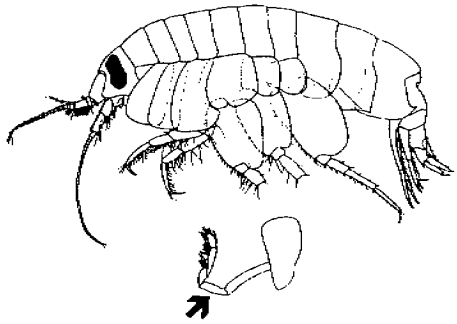


Figure 1.8

1B. Gnathopod 2 article 3 of normal length; mandible not as above 2

2A. Eyes present as two pairs of cuticular lenses (occasionally blind); coxae 1-4 of approximately equal length; pereopod 7 basis posteriorly expanded and articles 3-7 short ..... Ampeliscidae (Fig. 1.9)

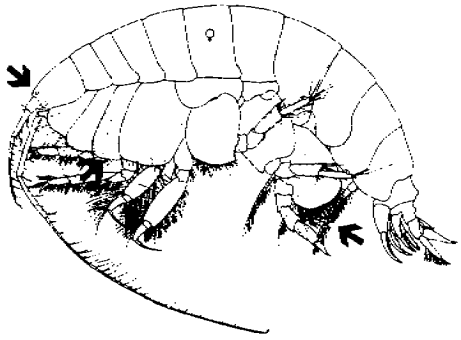
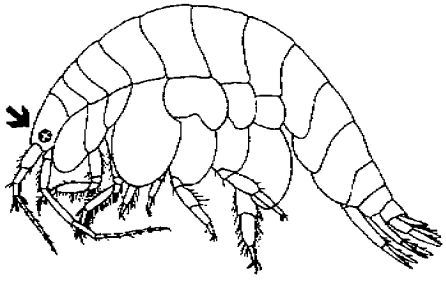


Figure 1.9

2B. These characters not combined 3

3A. Eyes with 4 evenly-spaced ommatidia in a circular arrangement; coxa 3 reduced, smaller than coxae 2-4 ..... Argissidae (Fig. 1.10)

Figure 1.10



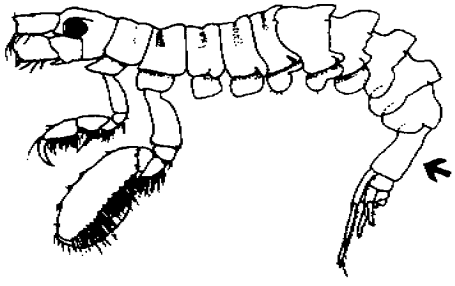
3B. Eyes otherwise or absent; coxa 3 not reduced, subequal to coxae 2-4 4

4A. Uropod 3 biramous (one ramus may be very small) 7

4B. Uropod 3 uniramous, reduced, or absent 5

5A. Urosomite 1 elongate; urosomites 2-3 coalesced ..... Podoceridae (Fig. 1.11)

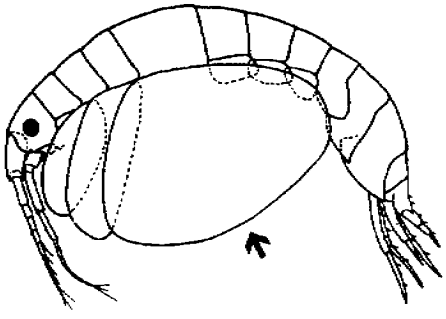
Figure 1.11



5B. Urosomite 1 normal; urosomites 2-3 separate 6

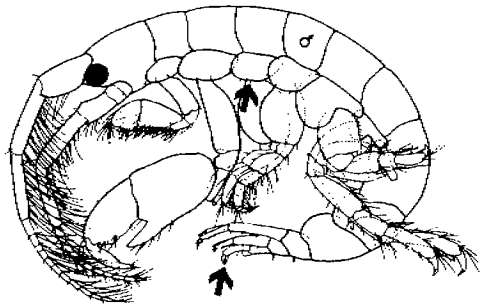
6A. Coxae 2-4 large, overlapping, coxa 4 immense ..... Stenothoidae (Fig. 1.12)

Figure 1.12



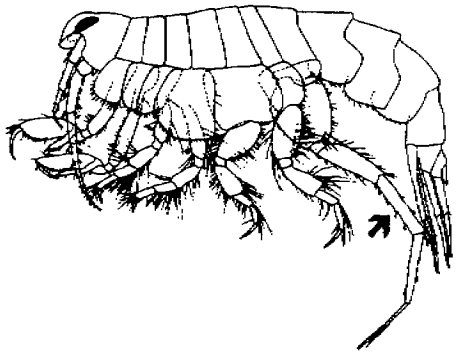
6B. Coxae 2-4 relatively short, of nearly similar size, not overlapping significantly ..... Corophioidea (in part) (Fig. 1.13)

Figure 1.13



7A. Pereopod 7 very much longer and of different shape than pereopods 5-6; eyes, when visible, enlarged, covering much of dorsal surface of head ..... Oedicerotidae (Fig. 1.14)

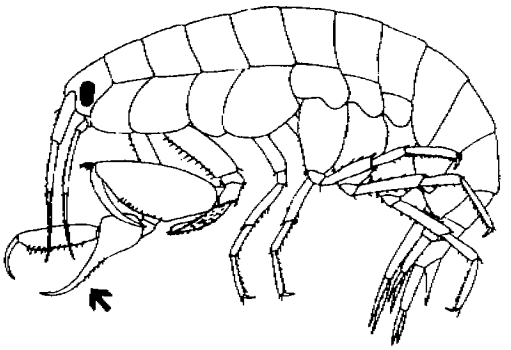
Figure 1.14



7B. Pereopod 7 may be slightly longer but generally is not of different shape than pereopods 5-6; eyes may be large but are situated on sides of head 8

8A. Gnathopod 1 carpochelate ..... Leucothoidae (Fig. 1.15)

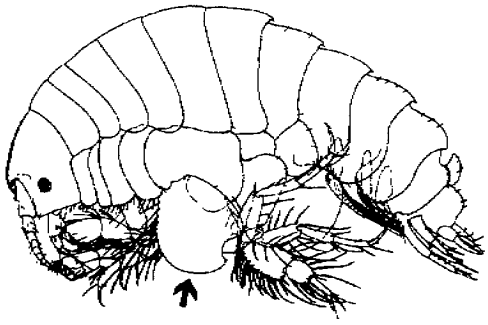
Figure 1.15



8B. Gnathopod 1 simple, or subchelate 9

9A. Pereopod 5, coxa and basis enlarged (3-4 times larger than coxae 1-3); urosomites coalesced .... Dexaminidae (Fig. 1.16)

Figure 1.16



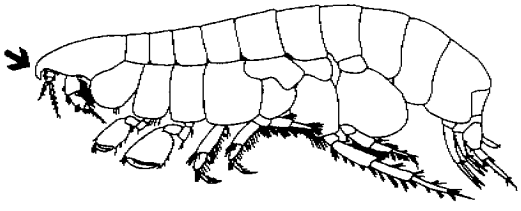
9B. Pereopod 5, coxa and basis of normal proportions, not enlarged; urosomites 2-3 separate 10

10A. Pereopods 5-7 armed with heavy spine-like setae (fossorial) 11

10B. Pereopods 5-7 with few heavy setae 12

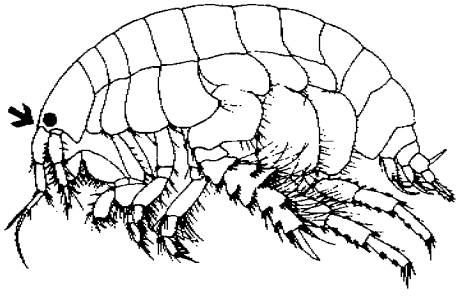
11A. Rostrum visor-like; uropod 1 peduncle with numerous long setae; pereopod 7 much shorter than pereopods 5 or 6 ..... Phoxocephalidae (Fig. 1.17)

Figure 1.17



11B. Rostrum lacking; uropod 1 peduncle with few short spine-setae; pereopod 7 equal to or slightly shorter than pereopods 5 or 6 ..... Urothoidae (Fig. 1.18)

Figure 1.18

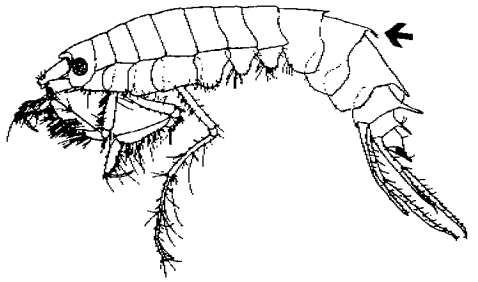


12A. Coxa 4 anterior and posterior margins similar, posterior margin not excavate posteriorly 13

12B. Coxa 4 posterior margin differs from anterior margin in being excavate proximally 17

13A. Pleon segments 1-3 with 2-10 small to large dorsal teeth ..... Melphidippidae (Fig. 1.19)

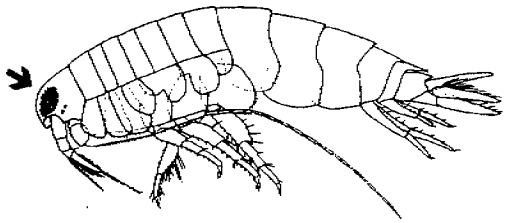
Figure 1.19



13B. Pleon segments dorsally smooth or with few small teeth 14

14A. Head helmet-shaped, forehead protuberant; accessory eyes sometimes present .... Synopiidae (Fig. 1.20)

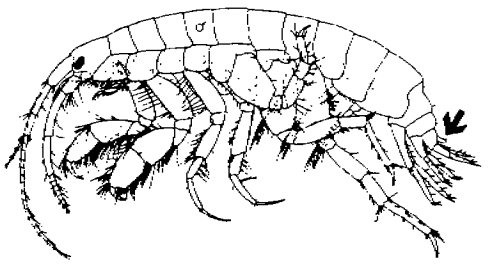
Figure 1.20



14B. Head not helmet-shaped; accessory eyes never present 15

15A. Telson short, thick, rarely cleft ..... Corophiidae (part) (Fig. 1.21)

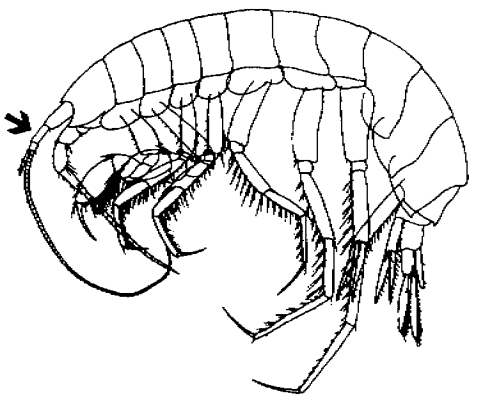
Figure 1.21



15B. Telson, thin, usually cleft 16

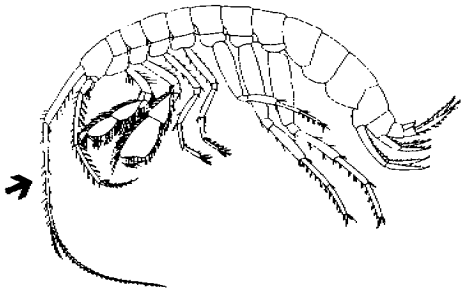
16A. Eyes generally absent, greatly enlarged if present; peduncle of antenna 1 shorter than that of antenna 2 ..... Pardaliscidae (Fig. 1.22)

Figure 1.22



16B. Eyes, if present, of normal size; peduncle of antenna 1 longer than that of antenna 2 ..... Gammaridae (part) (Fig. 1.23)

Figure 1.23

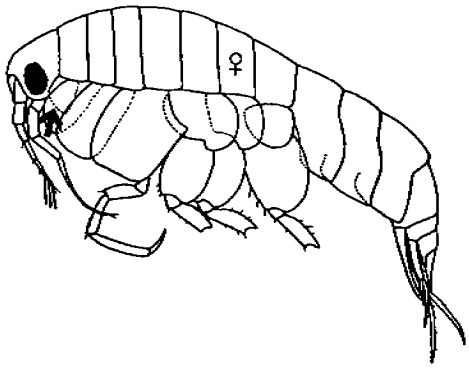


17A. Head with rostrum 18

17B. Head without rostrum 19

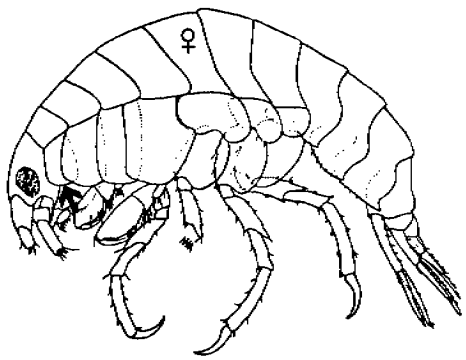
18A. Coxa 1 small, mostly hidden by following coxae ..... Amphilochidae (Fig. 1.24)

Figure 1.24



18B. Coxa 1 of normal size, not hidden by following coxae ..... Pleustidae (Fig. 1.25)

Figure 1.25

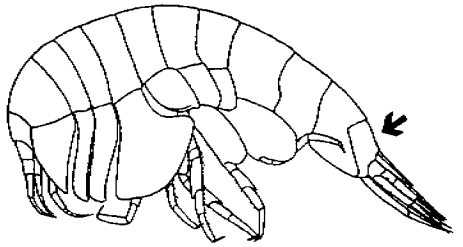


19A. Gnathopods weak, feeble, simple 20

19B. Gnathopods generally large, subchelate 21

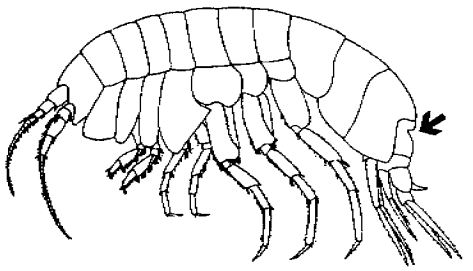
20A. Urosomite 1 without dorsal carina; head partially hidden by coxa 1 ..... Stegocephalidae (Fig. 1.26)

Figure 1.26



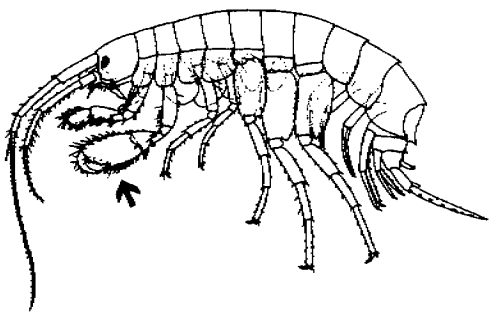
20B. Urosomite 1 with dorsal carina; head not much covered by coxa 1 ..... Stilipedidae (Fig. 1.27)

Figure 1.27



21A. Gnathopod 2 larger than gnathopod 1, especially in dimensions of the propodus .... Gammaridae (Fig. 1.28)

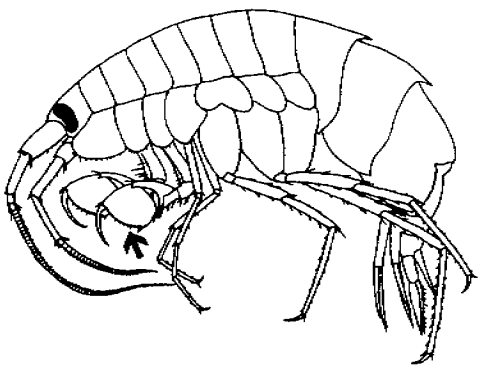
Figure 1.28



21B. Gnathopods equal in size or gnathopod 1 the largest 22

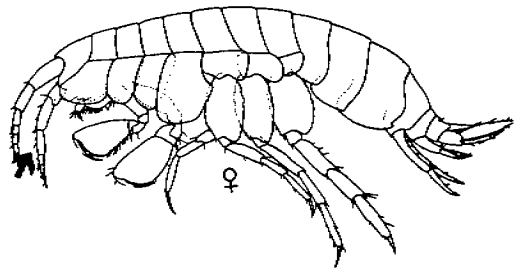
22A. Antenna 1 accessory flagellum of 1 or 2 articles, vestigial or absent; antenna 2 peduncle articles 4 and 5 more setose along posterior margin ..... Eusiridae (Fig. 1.29)

Figure 1.29



22B. Antenna 1 accessory flagellum usually of more than 2 articles; antenna 2 peduncle articles 4 and 5 more setose along anterior margin ..... Liljeborgiidae (Fig. 1.30)

Figure 1.30



Literature Cited

Barnard, J.L. and G. Karaman. 1991. The families and genera of marine gammaridean Amphipoda (except marine gammaroids). Records of the Australian Museum, Supplement 13: 1-866.

Bousfield, E.L. 1973. Shallow-water gammaridean Amphipoda of New England. Cornell Univ. Press.

Holmes, S.J. 1908. The Amphipoda collected by the U.S. Bureau of Fisheries Steamer "Albatross" off the west coast of North America, in 1903 and 1904, with descriptions of a new family and several new genera and species. Proceedings of the United States National Museum 35 (1654): 489-543.

Vassilenko, S.V. 1974. Caprellids of the seas of the USSR and adjacent waters. Opredeleliteli po Faune SSSR 107: 1-287. [In Russian]

2. The Families Argissidae, Dexaminidae, Eusiridae, Gammaridae, Leucothoidae, Melphidippidae, Oedicerotidae, Pardaliscidae, Phoxocephalidae, Podoceridae, Stegocephalidae, Stenothoidae, Stilipedidae, Synopiidae, and Urothoidae

by

J. D. Thomas[1] and L. D. McCann[2]

Introduction

Prior to a detailed observation of a specimen to be identified, several characters should be quickly noted. These characters are: 1.—presence or absence of an accessory flagellum (may require close observation if small). 2.—general shape of telson, whether cleft, entire, or notched. 3.— uropods 1,2,and 3 biramous or uniramous. 4.—general morphology of uropod 3 rami/ramus, whether scalelike, elongate, shortened, multiarticulate, or bearing hooked spines, and the proportion of ramus/rami to peduncular length. 5.—shape and position of the eyes. 6.—dominance of gnathopods 1 and 2, and type of chelation, i.e. chelate, subchelate, carpochelate, simple. 7.—in fresh material, any distinctive markings or color patterns.

Each family section includes the following; a diagnosis of the family, and genera found in the Santa Maria Basin study, full species listings with author and date; any synonymies; pertinent references (especially those with good figures or descriptions); station data listing all confirmed records in the study area; ecology and distribution section listing prior and known distributions of each species (including updates from this work).

Family Argissidae Walker, 1904

Diagnosis (modified from Bousfield, 1973). Eyes with 4 evenly spaced ommatidia in pinwheel or eyes absent. Antennae 1 shorter than 2, accessory flagellum 2-articulate. Upper lip slightly emarginate. Lower lip, inner lobes distinct. Mandible molar strong, palp long and thin. Maxilla 1, outer plate with 8 apical teeth. Pereonal segments short and deep. Coxae 1-3 decreasing in size posteriorly, coxa 4 largest, rounded distally, and coxa 5-7 bilobed, posterior lobe larger than anterior. Gnathopods 1 and 2 simple or weakly subchelate, similar. Pereopods 3 and 4 short and small. Pereopods 5-7 subequal, posterior margin article 2, convex with rounded distal expansion, dactyls short. Pereopod 7, segments 4-6, margins with plumose setae. Coxal gills saclike, on pereonites 2-7. Oostegites large, lamellate, margins setose. Uropods biramous, uropod 3 rami foliaceous, outer ramus biarticulate. Telson deeply cleft.

Remarks. 1 genus, monotypic.

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Argissa Boeck, 1871

Type Species. *Argissa typica* Boeck, 1871, original designation.

Diagnosis. See diagnosis of the family.

Remarks. monotypic.

Argissa hamatipes (Norman, 1869)

Figure 2.1

Syrrhoë hamatipes Norman, 1869: 279.
Argissa typica Sars, 1895: 141-142, plate 48.
Argissa hamatipes: Shoemaker, 1930: 37- 40, figures 15 and 16.— Bousfield, 1973: 121-122, plate XX. —Lincoln, 1979: 334, figure 157.—Hirayama, 1983: 147-149, figures 38-41.—Barnard and Barnard, 1983: 607- 608.

Material Examined. Santa Maria Basin, California, Phase, II, Sta. PJ15, 155 m, October 1986, (3 specimens).

Diagnosis. Female 3-6 mm, male 4.7-6 mm. Urosomite 1-3 with mid-dorsal carina extending beyond the anterior edge of the telson in the male (See diagnosis of the family).

Remarks. The characteristic eye of *Argissa hamatipes* easily distinguishes this species from all other families, however, in examining the literature there are inconsistencies that suggest that *A. hamatipes* is actually a complex of closely related species. Differences include the size and type of mandibular palp article 3; and the length and stoutness of the peduncle of the antennae. There are questionable records from France and Ceylon, which are probably another species (Stephensen, 1931). All of our specimens were damaged.

Type Specimen and Locality. Specimen damaged. St. Magnus Bay, Shetland Islands.

Distribution and Habitat. Cosmopolitan. Pacific from California, South Africa, Okhotsk and Japan seas; North Atlantic from Labrador to North Carolina, Greenland, Iceland, Britain, Norway, Denmark, on muddy, sandy and rocky bottoms, 4-1096 m.

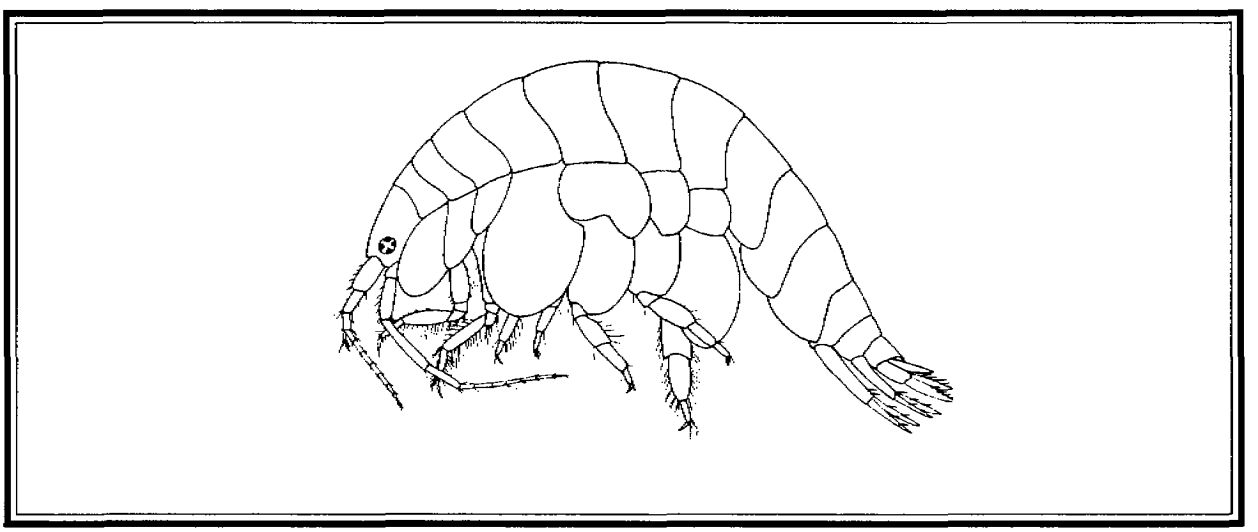


Figure 2.1. *Argissa hamatipes* (Norman, 1869) (from Barnard, 1969).

Family Dexaminidae Leach, 1814

Subfamily Prophliantinae, Barnard and Karaman, 1991

Diagnosis (from Barnard and Karaman, 1991). Eyes, if present, ommatidial. Accessory flagellum 1-2 articulate, usually vestigial. Gnathopods 1-2 subchelate, small. Pereopods 3-4 not glandular. Coxae ordinary to acuminate. Coxa 5 enlarged at least 2.5 times wider than coxae 1-4. Pereopod 7 less than 1.2 times as long as pereopod 6, occasionally of different form than 5-6 but article 2 not of shape and setation found in Ampeliscidae. At least 2 urosomites coalesced together. Uropod 3 biramous. Telson laminar, more or less cleft.

Remarks. 5 genera (including subgenera), 37 species in the subfamily.

Guernea (Prinassus) reduncans (Barnard, 1958)

Figures 2.2, 2.3

Dexamonica reduncans Barnard, 1958: 130-132, plates 26-27.
Guernea (Prinassus) reduncans: Barnard, 1970: 173, figures 1-3.

Material Examined. Santa Maria Basin, California, Phase, II, Sta. R4, 92 m, October 1988, (28 specimens), Sta. PJ16, 130 m, October 1986, (10 specimens).

Description (modified from Barnard, 1958). Both sexes 2.0-2.5 mm. Eyes medium in size, lenses few in number. Antenna 1 with dorsal notch in peduncle article 1. Antenna 2 of female very short, article 5 shorter than 4. Mandible with large molar, accessory plate present. Upper lip with rounded lower edge. Lower lip with outer lobes apically acute but not prolonged. Maxilla 1 inner plate with apical setule and fused spine. Maxilla 2, outer edge of outer plate with only one seta. Coxae 1-2 narrowing apically. Gnathopods 1 and 2 similar. Dactyls of all pereopods each with a distal spine. Uropods 1-2 with large distal spines on rami, uropod 3 with a few spines. Telson cleft nearly to base, not elongated, each lobe triangular. Mid-dorsal carinae extending from pereonite 5 backwards, increasing in size, absent on urosomite 2 and 3 (carina on urosomite 1 produced anteriorly in female, pyramid-shaped in male). Urosomite 2 and 3 fused, bearing one or more dorsal spines.

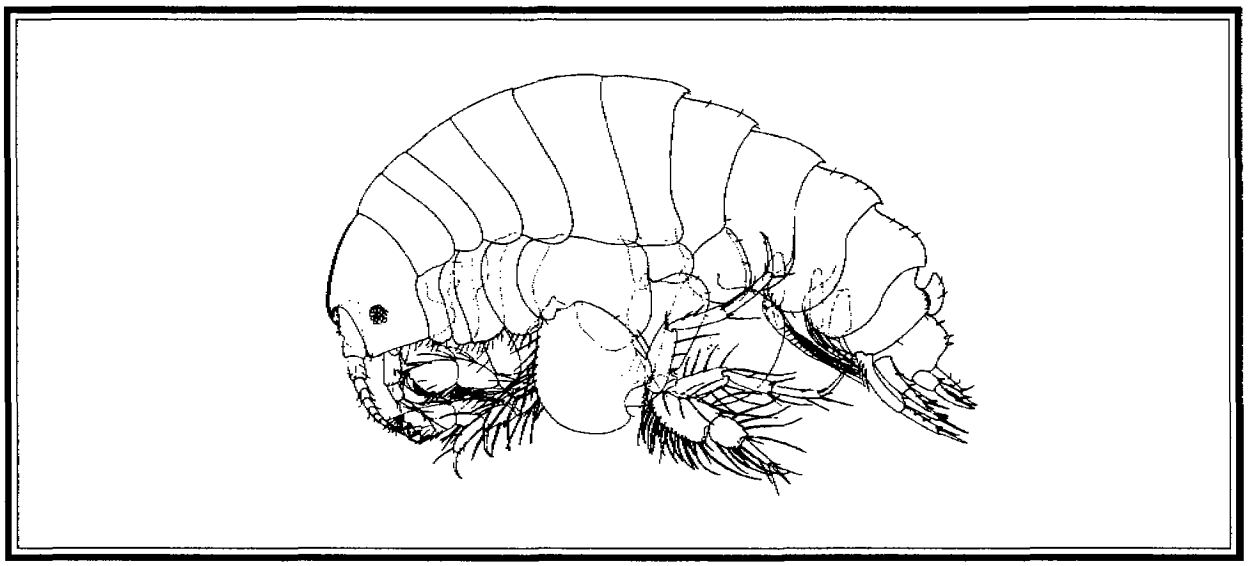


Figure 2.2. *Guernea reduncans* (Barnard, 1958), female.

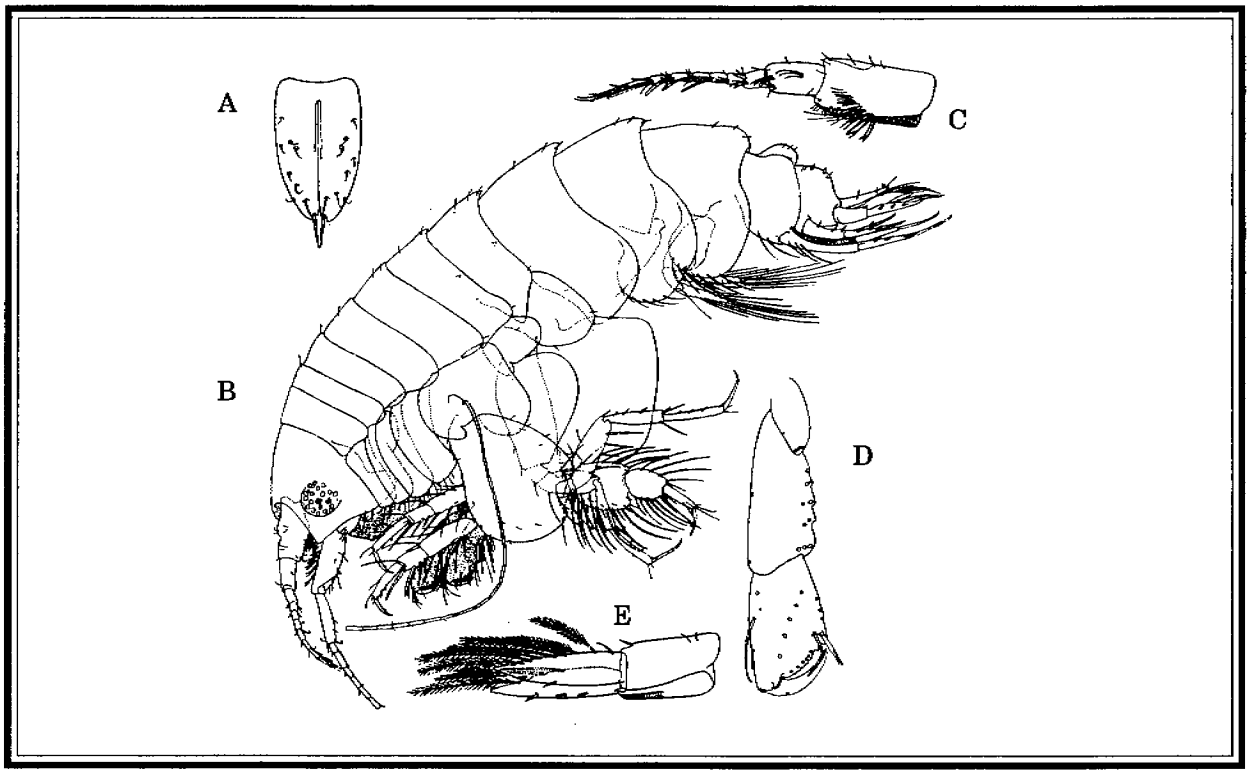


Figure 2.3. *Gurnea (P.) reduncans*, male, 2.4 mm; A, Telson; B, Lateral view, antennae 2 in two pieces; C, Antenna 1. Note dorsal knotch; D, Gnathopod 1; E, Uropod 3 (from Barnard, 1958).

Remarks. The subgenus *Prinassus* is characterized by having an anteriorly produced dorsal process in the female and a high keel in the male on urosomite 1 (Barnard, 1970). The presence of a dorsal notch on antenna 1 was either initially overlooked by Barnard (1958), or it could be an artifact of preservation (Barnard, 1970). This species is closely allied with the circumboreal *G. (P.) nordenskioldi* (Hansen, 1888), but *G. (P.) reduncans* has a spine on the mandible and the lateral cephalic lobes are more acutely angular. Barnard (1970) mentions a few other characters to distinguish the two species, which seem variable.

Type Specimen and Locality. Holotype AHF No. 551, ovigerous female, 2.0 mm. Station 3491-55, Santa Monica Bay, California.

Distribution and Habitat. Pt. Conception south to Ensenada, Baja California, on green mud, rare, to 92 m.

Family Eusiridae Stebbing, 1888

Diagnosis (from Barnard and Karaman, 1991). Accessory flagellum 0 to 2-articulate. Sexual dimorphism not obvious.

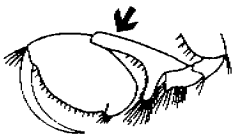
Remarks. 63 genera, 313 species.

Key to the Eusiridae of the Santa Maria Basin

1A. Gnathopod normal, carpus attaching distally to propodus 2

1B. Gnathopod carpus attaching medially to propodus (eusirid-like; Figure 2.4) ..... *Eusirus longipes*

Figure 2.4



2A. Gnathopods subchelate with wide, rounded, oblique palms and long dactyls, carpus with posterior lobe extending distally; telson long, tapering, or pointed, distinctly cleft ..... (*Rhachotropis*) 3

2B. Gnathopods subchelate with long, narrow, transverse palms, and tiny dactyls, carpus without posterior lobe; telson short, rounded, with slight indentation only ..... *Oradarea longimana*

3A. Urosomite 1 bearing 1 large dorsal tooth 4

3B. Urosomite 1 without teeth 6

4A. Epimera segment 2 with small to large dorsolateral carinae or teeth 5

4B. Epimera segment 2 without dorsolateral carinae or teeth ..... *Rhachotropis distincta*

5A. Epimera 1-3 without prominent dorsolateral carinae; epimera 2 with tinyteeth on dorsolateral margin ..... *Rhachotropis faeroensis*

5B. Epimera 1-3 with prominent dorsolateral carinae; epimera 2 without teeth on dorsolateral margin ..... *Rhachotropis clemens*

6A. Eyes huge, touching dorsally; epimeron 2, posteroventral corner acuminate .... *Rhachotropis oculata*

6B. Eyes large, not touching dorsally, or absent; epimeron 2 posteroventral corner rounded or angled ..... *Rhachotropis inflata*

Eusirus Krøyer, 1845

Type Species. *Eusirus cuspidatus* Krøyer, 1845, 1846.

Diagnosis (from Barnard and Karaman, 1991). Body ordinary, compressed, often weakly carinate or toothed. Rostrum small to large, lateral cephalic lobes ordinary, anteroventral margin of head not produced. Eyes reniform or absent. Antennae subequal, or 1 longer than 2 (type), peduncular article 1 as long as head, articles progressively shorter, or article 2 as long as article 1 (type), often longer, article 3 short, not produced, primary flagellum article 1 ordinary, or often more than twice as long as peduncle article 3, accessory flagellum 1-articulate, elongate. Upper lip entire, subrounded, broader than long; epistome unproduced. Molar triturative,

columnar, article 2 of mandibular palp unlobed, article 3 of variable length. Maxilla 2, inner plate broad, often with strong medial setae. Maxilliped, inner plates not long, outer plate longer than inner, palp 4-articulate, article 4 slightly shorter than 3, and not spinose along inferior margin, article 3 unlobed. Coxae ordinary to short, coxa 1 not produced anteriorly but expanded ventrally. Coxa 4, posterior lobe excavate or very poorly so. Gnathopods alike, subchelate, both eusirid-like. Pereopods 3-7 elongate, simple, dactyls simple. Epimeron 3 smooth or serrate (type). Outer rami of uropods 1-2 shortened, with lateral and dorsal spines. Uropod 3 ordinary, not extended beyond uropod 1, peduncle without large process, rami lanceolate. Telson elongate or short, variable, cleft, incised or emarginate, apices without long armaments.

Remarks. 22 species.

Eusirus longipes (Boeck, 1861)

Figures 2.4, 2.5, 2.6

Eusiris longipes Boeck, 1861: 656.
Eusiris helvetiae Bate, 1862: 155.
Eusirus bidens Heller, 1867: 32, figure 19.
Eusirus longipes: Sars, 1895: 420-421, plate 148.—Lincoln 1979: 402, figure 191.—Hirayama, 1985: 29-35, figures 141-147.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 16, 591 m, December 1984, (1 specimen, F), Phase II, Sta. R4, 92 m, October 1988, (1 specimen).

Description. 6.5-13 mm. Eyes very large, reniform. Lateral cephalic lobe, short, truncated. Antenna 1 longer than 2. Calceoli present. Coxa 1 produced anteriorly. Coxae 1-3 with 1-3 small teeth on posterodistal edge. Pleonite 1 and 2 with mid-dorsal tooth; segment 3 posterior margin convex and coarsely serrate. Gnathopods robust, carpus L-shaped, propodus fitting into L, dactyls long and slender, prehensile. Telson covered with minute triangular scales, cleft approximately one-third its length.

Remarks. This material represents a new depth record for the species.

Type Specimen and Locality. North Atlantic.

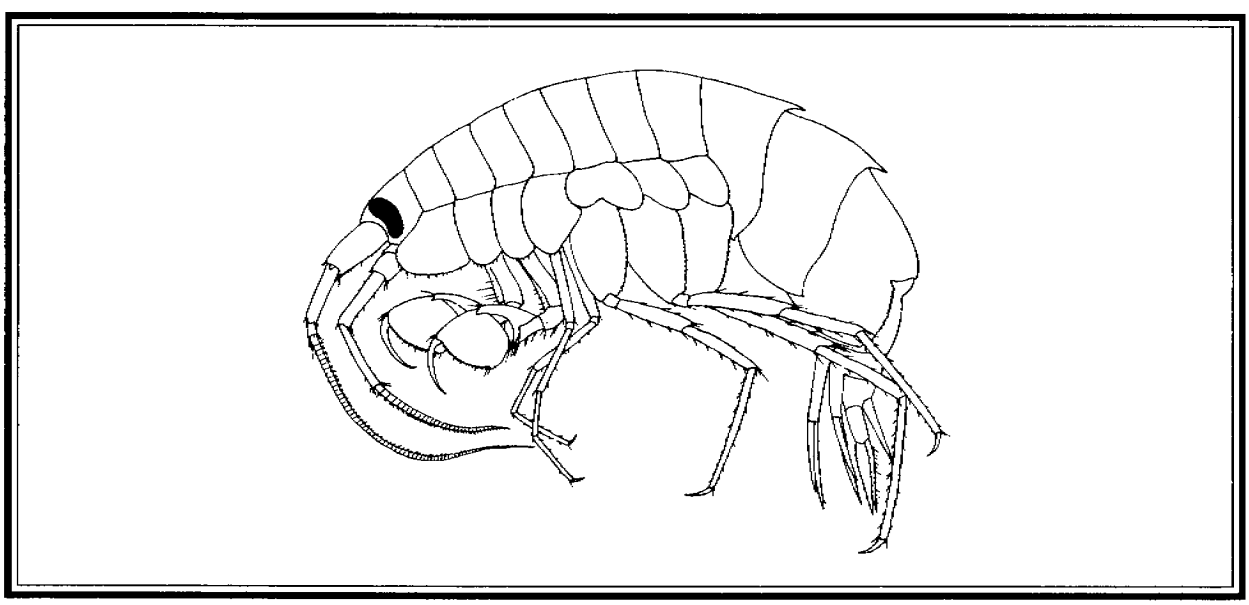


Figure 2.5. *Eusiris longipes*, female (from Lincoln, 1979).

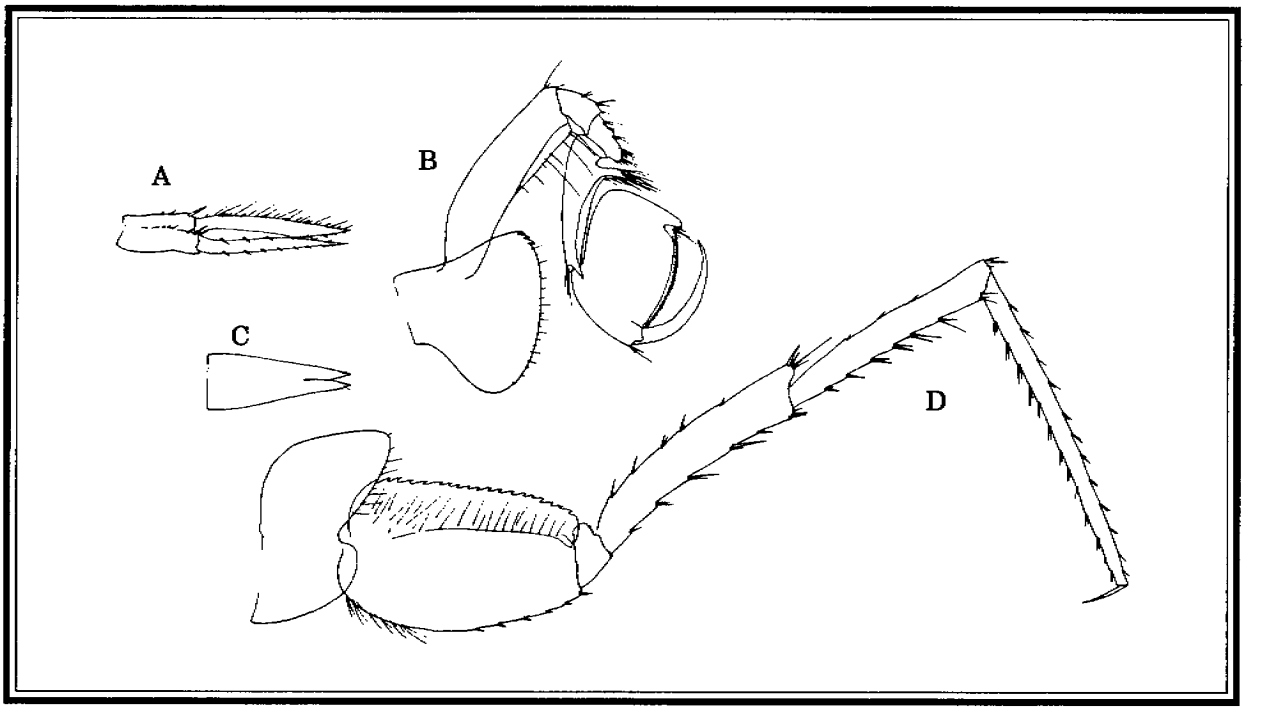


Figure 2.6. *Eusirus longipes*, female; A, Uropod 3; B, Gnathopod 1; C; Telson; D; Pereopod 7 (from Lincoln, 1979).

Distribution and Habitat. Mediterranean and Adriatic Seas; Atlantic: Great Britain, Norway to Arctic ocean; Pacific: southern California, Japan, in *Lithothamnion*, 6-591 m.

Oradarea Walker, 1903

Type Species. *Oradarea walkeri* Shoemaker, 1930.

Diagnosis. Eyes reniform. Body slender, compressed, carinate or toothed. Rostrum large, lateral cephalic lobes ordinary, anteroventral margin of head weakly produced. Antenna 2 longer than 1, peduncular articles of antenna 1 progressively shorter, article 1 shorter than head, article 2 often as long as 1, article 3 not produced; article 1 of primary flagellum ordinary, about as long as article 3 of peduncle, accessory flagellum 1-articulate. Epistome unproduced. Molar triturative, columnar, article 2 of mandibular palp unlobed, article 3 shorter than 2. Lower lip, inner lobes obsolescent. Maxilla 1, inner plate with many medial setae, palp long, article 1 shorter than 2. Maxilla 2, inner plate not broader nor longer than outer, inner plate with facial row of many setae and other medial setae. Maxilliped, inner plate not relatively long, outer plate slightly shorter than inner, palp of 4 articles, 4 shorter than 3, 3 lobed, 4 not spinose along inferior margin. Coxa ordinary, coxa 1 not produced anteriorly nor expanded ventrally, coxa 4 with posterior lobe excavate. Gnathopods diverse, medium, 2 longer than 1, subchelate, not eusirid-like, small, carpus of both shorter than (type) or as long as propodus, without posterior lobe, carpus with numerous small posterior setae. Gnathopod 1 short, gnathopod 2 very slender, or linear, carpus and propodus elongate. Pereopods 3-7 ordinary, simple, dactyls simple. Epimeron 3 smooth. Outer rami of uropods 1-3 shortened, rami with lateral and dorsal spines. Uropod 3 ordinary, scarcely extended beyond uropod 1, peduncle without large process, rami lanceolate, strongly unequal. Telson ordinary, incised, emarginate, almost entire, linguiform, without long apical armaments.

Remarks. 14 species.

Oradarea longimana (Boeck, 1871)

Figure 2.7

Amphithopsis longimana Boeck, 1871: 120.
Oradarea longimana: Shoemaker, 1930: 299-306, figures 35-37.—Thurston, 1974: 35-36.
Leptamphopus longimanus: Stephensen, 1931a: 279-280.

Material Examined. Santa Maria Basin, California, Phase II, Sta. R6, 410 m, October 1987, (36 specimens).

Description (modified from Shoemaker, 1930). Both sexes to 11 mm. Lateral cephalic lobe triangularly produced, margin rounded. Accessory flagellum, short, 1-articulate. Gnathopods 1 and 2, dactyls tiny, one fifth length of propodus, fitting against proximal edge of palm. Pleonites 1 and 2 with a tooth-like projection mid-dorsally. Telson short, rounded, with slight indentation.

Remarks. Several species have been synonomized with *O. longimana* (see Vanhoffen, 1907 and Shoemaker, 1930 for details). *O. novaezealandiae* (Thomson, 1879) is closely related to *O. longimana*, but is readily distinguished from the latter by a mid-dorsal tooth on pereonite 7 (Barnard, 1972a). Both species lack the integumentary scales found in other species of the genus.

Type Specimen and Locality. Greenland.

Distribution and Habitat. Altantic: Greenland and Gulf of St. Lawrence, (in whelk egg masses, Shoemaker, 1930), Pacific: southern California, 54-682 m.

Rhachotropis Smith, 1883

Type Species. *Oniscus aculeatus* Lepechin, 1780.

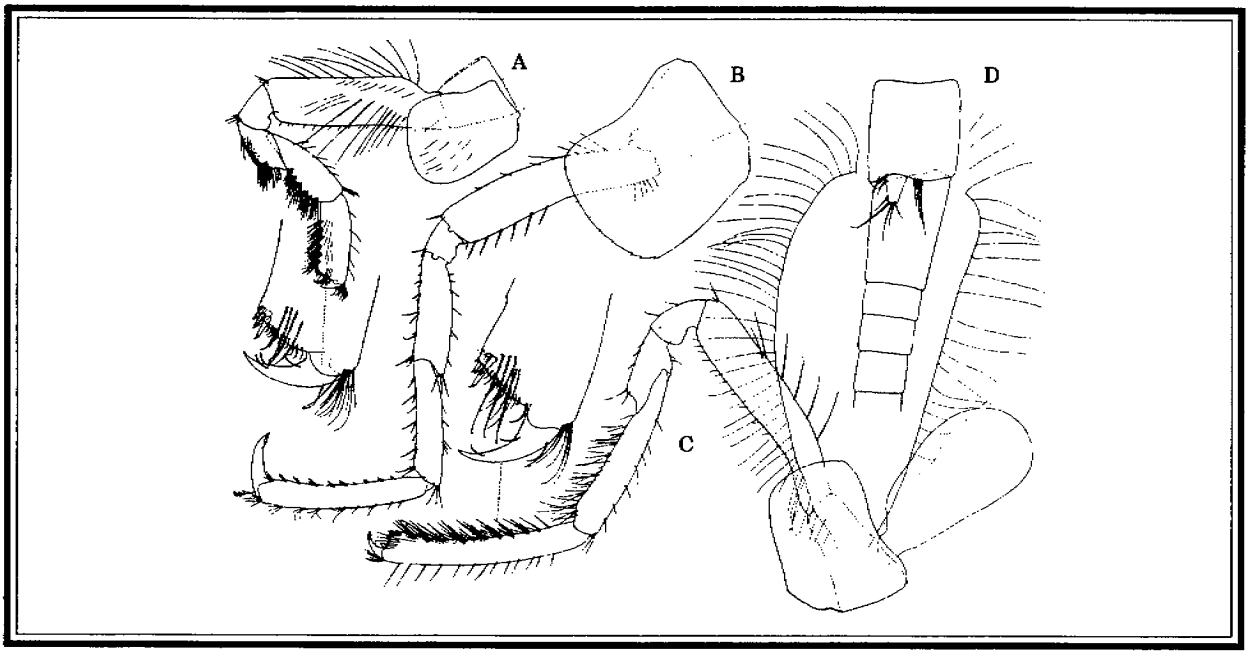


Figure 2.7. *Oradarea longimana*, female; A, Gnathopod 1; B, Pereopod 3; C, Gnathopod 2, with close-up of dactyl; D, Antenna 1, accessory flagellum (from Shoemaker, 1930).

Diagnosis. Body ordinary to slender, compressed, carinate or toothed. Rostrum small-to-large, lateral cephalic lobes ordinary; anteroventral margin of head not produced. Eyes round, reniform, or absent. Antennae subequal, article 1 of antenna 1 as long as or longer than head, article 2 usually as long as article 1, article 3 shorter, not produced; primary flagellum article 1 short in female, often twice as long as article 3 of peduncle in male; accessory flagellum 1-2-articulate, short. Antennae 1 and 2 with tympanic calceoli. Upper lip entire, subrounded, broader than long, epistome unproduced. Molar triturative, columnar, article 3 of mandibular palp unlobed, article 3 as long as or longer than 2. Lower lip, inner lobes short. Maxilla 1, inner plate with 1-4 medial setae, lacking facial setae, with few medial setae, palp long, article 1 short. Maxilla 2, inner plate broad but shorter than outer, outer plate narrow. Maxilliped, inner plate not relatively long, outer plate slightly or greatly longer than inner, palp 4 articulate, article 4 shorter than 3 and not spinose along inferior margin, article 3 unlobed. Coxae very short, coxa 1 strongly produced anteriorly or expanded ventrally, coxa 4 with or without weak posterior lobe, excavate or not. Gnathopods alike, large, subchelate, carpus much shorter than propodus, with strong posterior lobe extending distally, numerous posterior setae, spines on palms of gnathopods thin or inconspicuous. Pereopods 3-7 elongate, simple, dactyls simple. Epimeron 3 serrate, or rarely smooth. Outer rami of uropods 1-2 variable, rami with lateral and dorsal spines. Uropod 3 ordinary, not exceeding beyond uropod 1, peduncle without large process, rami lanceolate. Telson elongate, cleft, incised, emarginate, or entire, triangular or linguiform, without long apical armaments.

Remarks. 43 species.

Rhachotropis clemens Barnard, 1967

Figure 2.8

Rhachotropis clemens Barnard, 1967:16-18, Figure 5; 1971: 10, Figure 6.

Material Examined. Santa Maria Basin, California, Phase II, Sta. R4, 92 m, October 1986, (1 specimen), Sta. R3, 409 m, (1 specimen), Sta. PJ18, 158 m, (1 specimen), Sta. R2, 161 m, (4 specimens).

Description (modified from Barnard, 1967). Female 4.5 mm, male 3.3 mm. Eyes present or absent. Rostrum pointed, extending slightly more than half-way along article 1 antenna 1, slightly recurved. Lateral cephalic lobes asymmetrically acute. Antenna 1 article 1, distal end with three sharp cusps, article 2 with 1 cusp, accessory flagellum vestigial. Coxae well developed, coxa 1 strongly produced anteriorly, blunt apically, coxae 2-4 not acuminate. Gnathopod 1 basis with medial row of stout spines; Gnathopods 1-2, carpal lobes interequal in size; second articles of pereopods 3 and 4 slender, posterior margins sharply serrate. Pereopods 5-7, article 2 oval, armed posteriorly with large but sparsely occuring serrations; pereonite 7 lacking dorsal tooth posterior margin ventrolaterally produced. Pleonites 1 and 2 each with one posterodorsal tooth and one posterolateral tooth on each side, carinae poorly developed, pleonite 3 lacking dorsal sculpture, urosomite 1 bearing one large, nearly oblique dorsal tooth and one sharp cusp dorsal to insertion of uropod 1. Epimeron 2 with sinuous, minutely serrate posterior margin, epimeron 3 strongly serrate ventrally and posteriorly. Telson cleft about one-twelfth of its length, margins smooth with sparse spines.

Remarks. Our specimens agree well with the eyed variety of Barnard (1971), however, the posterior margin of pereopod 3 is closer to the eyeless variety of Barnard (1967). It is possible that two species are represented here, but until adequate material is available for comparative study we will continue to assign material to *Rhachotropis clemens.*

Type Specimen and Locality. Holotype AHF No. 6121, female, 4.5 mm. Station 7234, 27°38'00"N, 115°16'16"W, 791-842 m.

Distribution and Habitat. Pacific from Oregon to Baja California, 92-842 m.

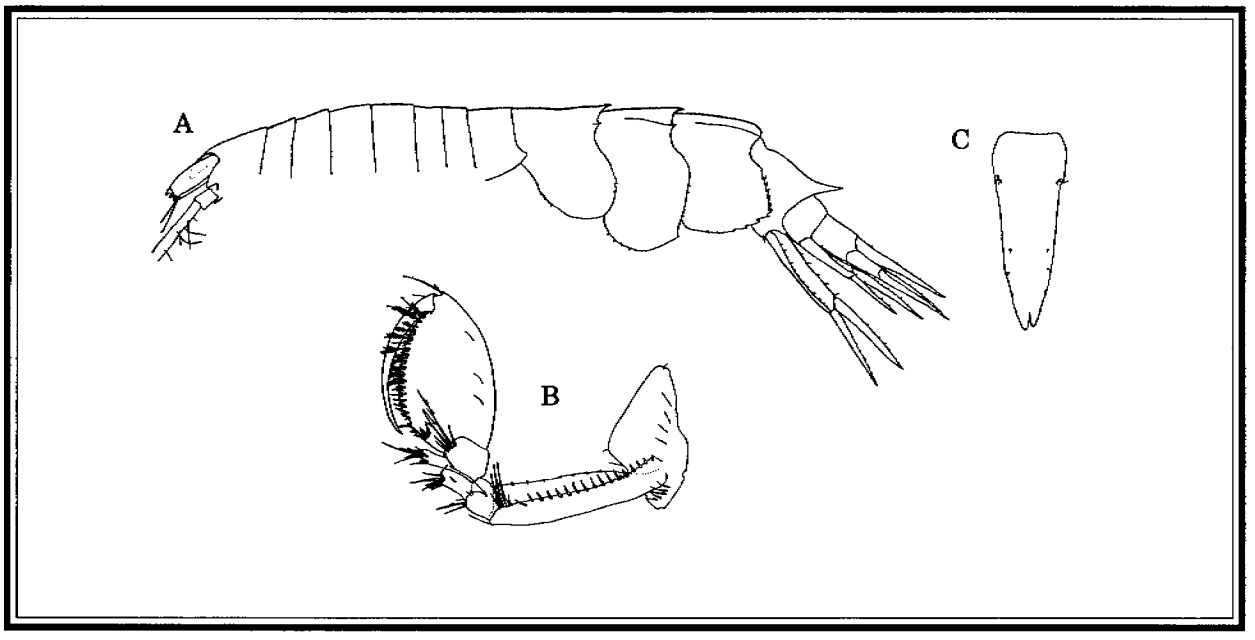


Figure 2.8. *Rhachotropis clemens*, female, 4.5 mm; A, Lateral view of epimeral segements and urosomites; B, Gnathopod 1; C, Telson. (from Barnard, 1967).

Rhachotropis distincta (Holmes, 1908)

Figure 2.9

Gracilipes distincta Holmes, 1908: 529, Figure 35.
Rhachotropis distincta: Shoemaker, 1930: 98-105, Figure 41-44.

Material Examined. Santa Maria Basin, California, Phase, II, Sta. R9, 410 m, May, 1989, (1 badly damaged specimen).

Description (from Shoemaker, 1930). Both sexes 8.5-19 mm. Eyes absent. Rostrum rounded, inclined slightly downward. Pleonites with dorsal carinae produced into a sharp tooth, lateral carinae lacking, pleonites rounded laterally, 2 and 3 with a few short spines. Epimeron 3 edges rounded, smooth, with a few short spines. Uropods with very finely serrated edges. Telson extending as far back as uropod 2, cleft one-twelfth its length, margins finely serrate.

Remarks. This is the only described *Rhachotropis* species from California lacking lateral carinae.

Type Specimen and Locality. Holotype USNM No. 38552, female, 8 mm. Station 4429, Santa Cruz Island, California, 928-1244 m.

Distribution and Habitat. North Atlantic from Bay of Biscay, France, Newfoundland to Marthas Vineyard, Mass.; North Pacific from Kamchatka to southern California, Santa Cruz Island, in mud, generally 378-1244 m, but found to 7000 m.

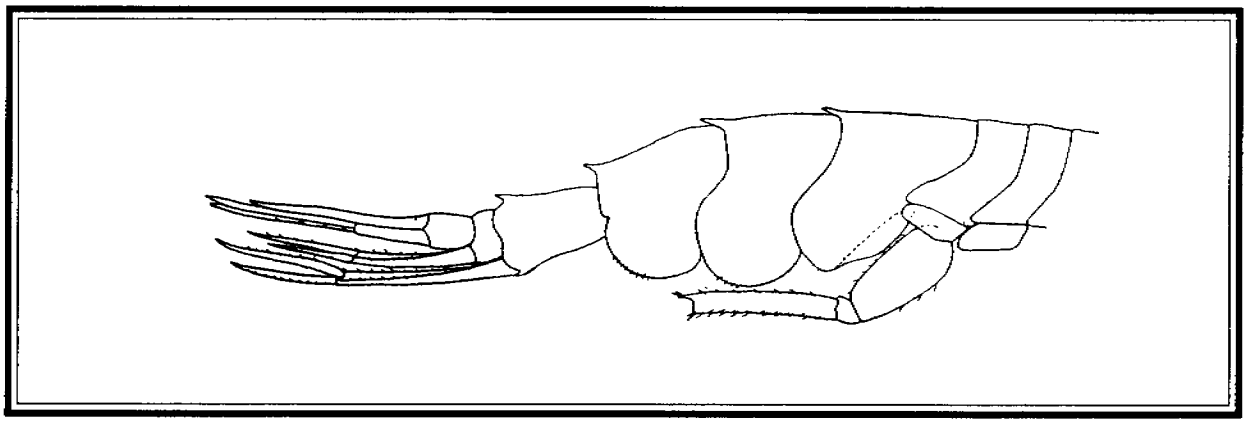


Figure 2.9. *Rhachotropis distincta*, female; Epimera 1-3 and urosomites (from Shoemaker, 1930).

Rhachotropis faeroensis Stephensen, 1944

Rhachotropis faeroensis Stephensen, 1944: 18, figure 10.

Material Examined. Reported from this study, but specimens unavailable.

Description (modified from Stephensen, 1944). Female 8 mm, male 10 mm. Eyes usually absent. Rostrum extending to midpoint of antenna 1, article 1, recurved downward. Lateral lobes of head half as long as rostrum, obtuse. Pereon not carinate, but pereonite 5-7 and pleonite 1 each with a dorsal tooth, second pleonite, posterior edge with 2 pairs of very small dorso-lateral teeth. Urosomite 1 (male) anterior margin with knob followed by a deep dorsal depression. Pleonite 3 with a few small denticulations (< 4) laterally. Telson two-thirds length of rami of uropod 3, cleft approximately one-eight its length, apices acute.

Remarks. Description and figures are limited for this species making it difficult to determine relationships, but it appears to be close to *R. clemens*, if not a deep water variant of the same species.

Type Specimen and Locality. 6 specimens total-no holotype designated, all damaged. Faeroe Islands, 61°15' N, 09°35' W and 61°08' N, 09°28' W, 820-900 m.

Distribution and Habitat. North Atlantic, Faeroe Islands, 820-900 m.

Rhachotropis inflata (Sars, 1883)

Figure 2.10

Tritropis inflata Sars, 1883: 104-105, plate 5, Figure 7a-c.
Rhachotropis tumida Sars, 1895: 430-431, plate 152.
Rhachotropis inflata: Gurjanova, 1951: 713-714, Figure 497.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 73, 98 m, November 1983, (1 specimen), Phase II, Sta. PJ12, 145 m, October 1986, (1 specimen), Sta. R9, 154 m, January 1987, (3 specimens).

Description (modified from Sars, 1895). Female 6 mm, male < 6 mm. Eyes moderately large, reniform, lateral, not meeting dorsally. Body short and stout. Epimeral plates with low carinae extending from midsegment to posterior edge, and dorsolateral carinae, all with posterior teeth. Epimeron 2 rounded, angular. Pleonite 3 with many denticulations on lateral edge. Urosomite 1 dorsally smooth; telson extending one-half the length of uropod 3 rami, cleft almost one-half its length.

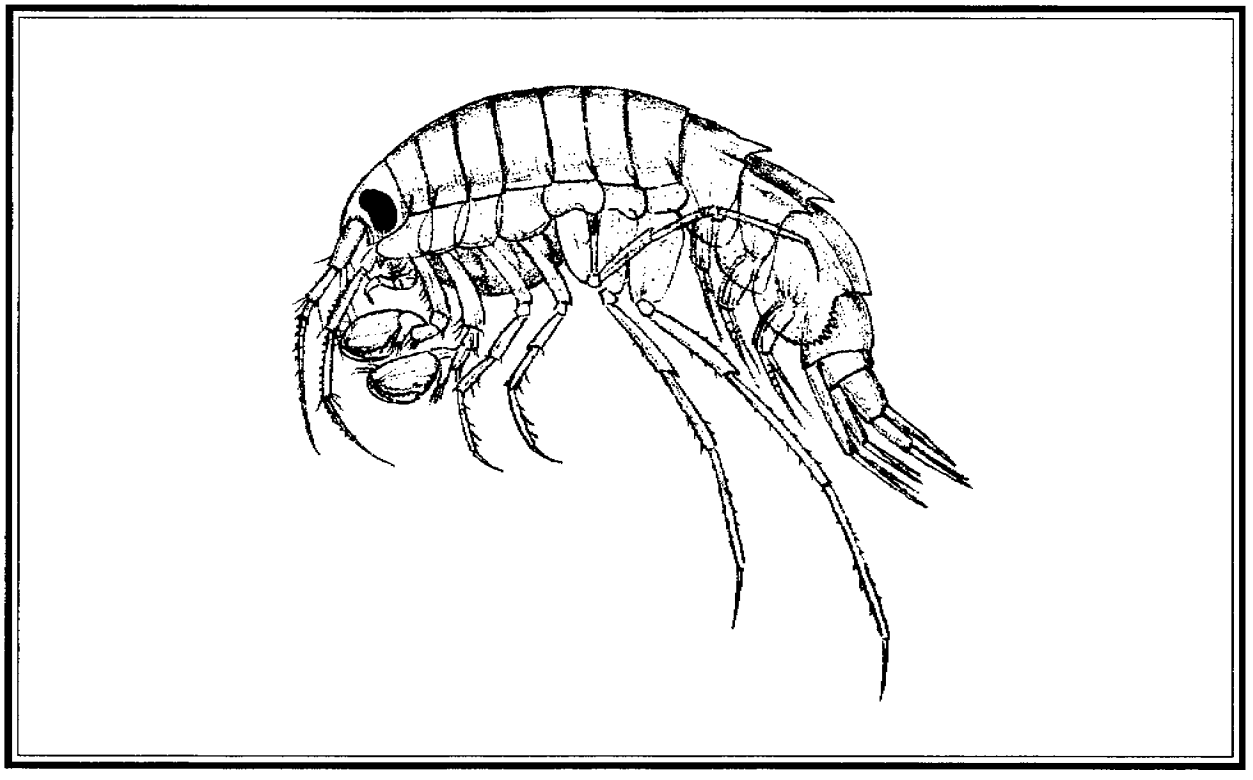


Figure 2.10. *Rhachotropis inflata;* Lateral view (from Sars, 1883).

Remarks. Specimens we examined were missing antennae. This species can be distinguished from other members of the genus having lateral teeth on the epimera by the lack of a dorsal tooth on urosomite 1. It is distinguished in dorsal view from *Rhachotropis oculata* (Hansen, 1888), with which it is very similar, by the shape of the eyes (tear drop vs huge, oval) and the disjunction between them (eyes are closest anteriorly, the disjunction widening posteriorly. In *Rhachotropis oculata* the gap is narrow and of constant width).

Type Specimen and Locality. 6.5 mm, Norway, 37-92 m.

Distribution and Habitat. North Atlantic: Greenland and Norway, Virginia (1 specimen), Kara Sea-North of the former Soviet Union; Pacific: Oregon, on algal covered stones (9 m), southern California, generally 40-154 m.

Rhachotropis oculata (Hansen, 1888)

Figure 2.11

Tritropis oculata Hansen, 1888: 140, plate 5, Figure 7-7e.
Rhachotropis oculata: Barnard, 1966b: 18, Figure 2b-f.—Bousfield, 1973: 78, plate XI.2.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 42, 100 m, September 1984, (1 specimen, F).

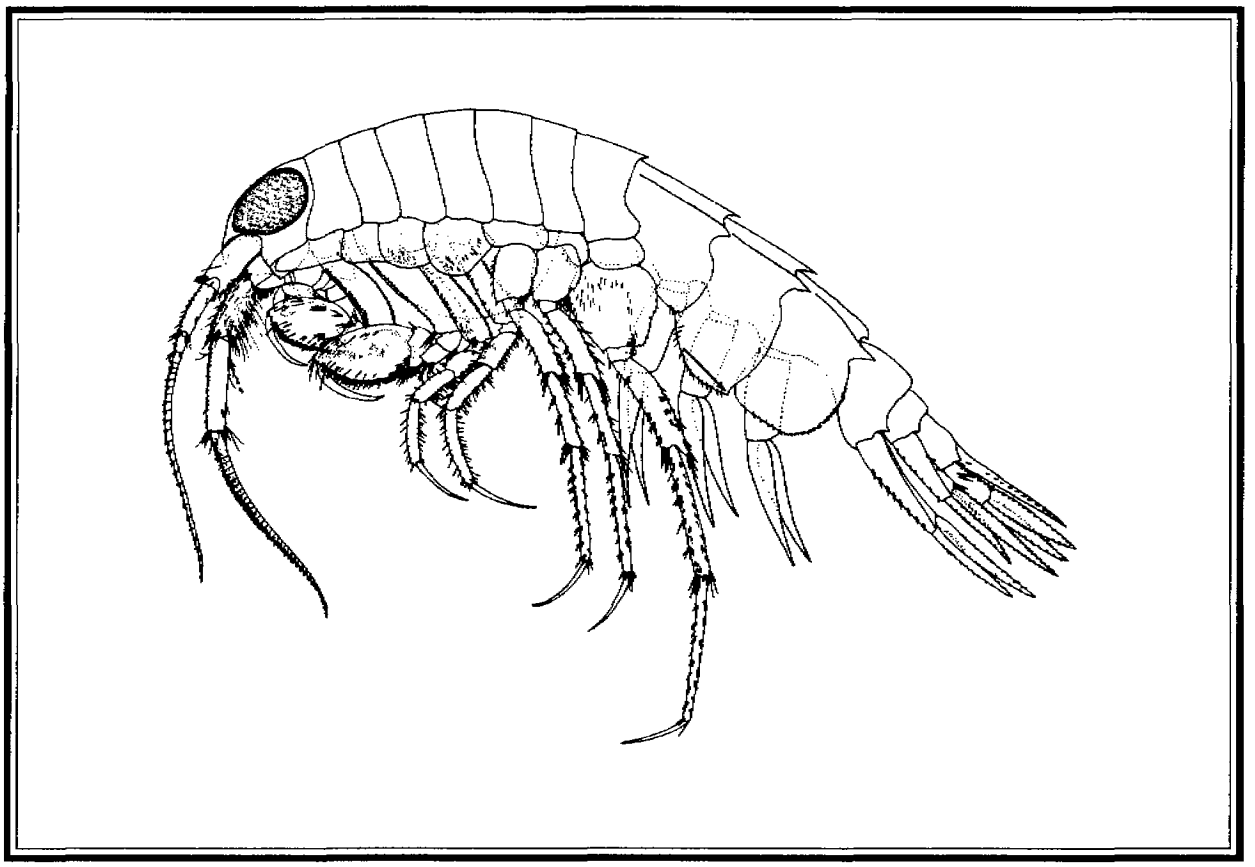


Figure 2.11. *Rhachotropis oculata*, female; lateral view. Note the acuminate posteroventral corner on epimeron 2 (from Bousfield, 1973).

Description (modified from Bousfield, 1973). Both sexes 9.5-12 mm. Eyes very large, covering most of side of head and nearly meeting middorsally. Rostrum downturned. Pleon with single dorsal and dorsolateral carinae and posterior tooth. Epimeron 2 with acute posteroventral corner. Urosomite 1 dorsally smooth. Telson not reaching to tip of uropod 3, cleft about two-fifths its length, outer margins convex, sparsely spined.

Remarks. This species is also without a dorsal tooth on urosomite 1. Another useful character, distinguishing *R. oculata* from *R. inflata*, is the produced corner of pleonite 2 (Barnard, 1966b).

Type Specimen and Locality. Female 9.5 mm, male 11.5 mm. Greenland, 63°35' N, 52°57' W and 67°04' N, 54°28' W, on sand, mud, and clean rock, 18-79 m.

Distribution and Habitat. Pan-arctic, North Atlantic from Greenland and Labrador to Cape Cod; North Pacific from southern California, Bering Sea, Okhotsk Sea, and Japan Sea, 18-274 m.

Family Gammaridae Leach, 1814

Diagnosis (modified from Bousfield, 1973). Rostrum short. Antennae long and robust, accessory flagellum usually prominent. Mouthparts normal, lower lip inner lobes present or variously reduced. Coxae 1 unmodified. Gnathopods 1 and 2 subchelate, strongly in male, usually similar, 2nd usually larger. Abdominal segments usually distinct, urosome typically with dorsal clusters of spines and/or setae. Pereopods 3-5

increasing successively in length, bases not greatly expanded. Uropod 1, peduncle with proximal anterior spine(s). Uropod 3, rami usually foliaceous, extending beyond uropods 1 and 2. Telson usually deeply cleft. Coxal gills pedunculate, present on pereonites 2-7, accessory and sternal gills sometimes present. Oostegites large, with many long simple marginal setae, present on segments 2-5 inclusive.

Remarks. 72 marine genera (Barnard and Karaman, 1991), 378+ species.

Key to the Gammaridae of the Santa Maria Basin

1A. Uropod 3 rami subequal ..... (*Maera*) 2

1B. Uropod 3 inner ramus minute, scale-like ..... *Melita dentata*

2A. Uropod 3 peduncle and rami approximately equal in length; rami short ..... *Maera simile*

2B. Uropod 3 peduncle one-half or less length of rami; rami long ..... *Maera danae*

Maera Leach, 1814

Type Species. *Maera grossimana* (Montagu, 1808).

Diagnosis (modified from Bousfield, 1973). Eyes small, rounded. Body slender, elongate, dorsally smooth. Rostrum short, anterior lobe rounded. Second antennal sinus deep, convex. Antenna 1 slender, longer than 2, peduncle elongate, 3 short, accessory flagellum long. Mandible, palp slender, weakly setose; segment 1 with distal tooth. Maxilla 1, inner plate with 3 apical setae. Maxilla 2, inner plate margin bare. Coxal plates shallow, smooth below, tending to separation. Coxae 5 and 6 with bilobed ventral margin. Coxa 1 produced anterodistally. Gnathopod 2 powerfully subchelate in both sexes, larger in male, segment 5 posterior lobe broad. Pereopods 5-7 slender, basis barely expanded, dactyls with short nail and subapical tooth. Uropods 1 and 2 strong, rami subequal. Uropod 3 very large, elongated, rami broad, subequal, outer 2-articulate. Telson short, lobes slightly diverging, broadly acute.

Remarks. 65 species.

Maera danae (Stimpson, 1854)

Figure 2.12

Leptothoe danae Stimpson, 1854: 46, plate 3, Figure 32.
Maera danae: Shoemaker, 1955: 53-54.—Barnard, 1964b: 108-109.—Bousfield, 973: 67, plate X.1.
Maera loveni Barnard, 1962b: 103, figure 19.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 59, 216 m, September 1984, (numerous, good specimens).

Description (modified from Bousfield, 1973). Both sexes 18.0-22.9 mm. Eyes small, round, black. Antenna 1, accessory flagellum with approximately 6 articles. Uropod 3, rami elongate.

Remarks. *M. danae* and *M. loveni* (Bruzelius, 1859) are closely related. "In *M. loveni* the defining tooth of the palm of the second gnathopod of the male bears a long, slender spine, and the second

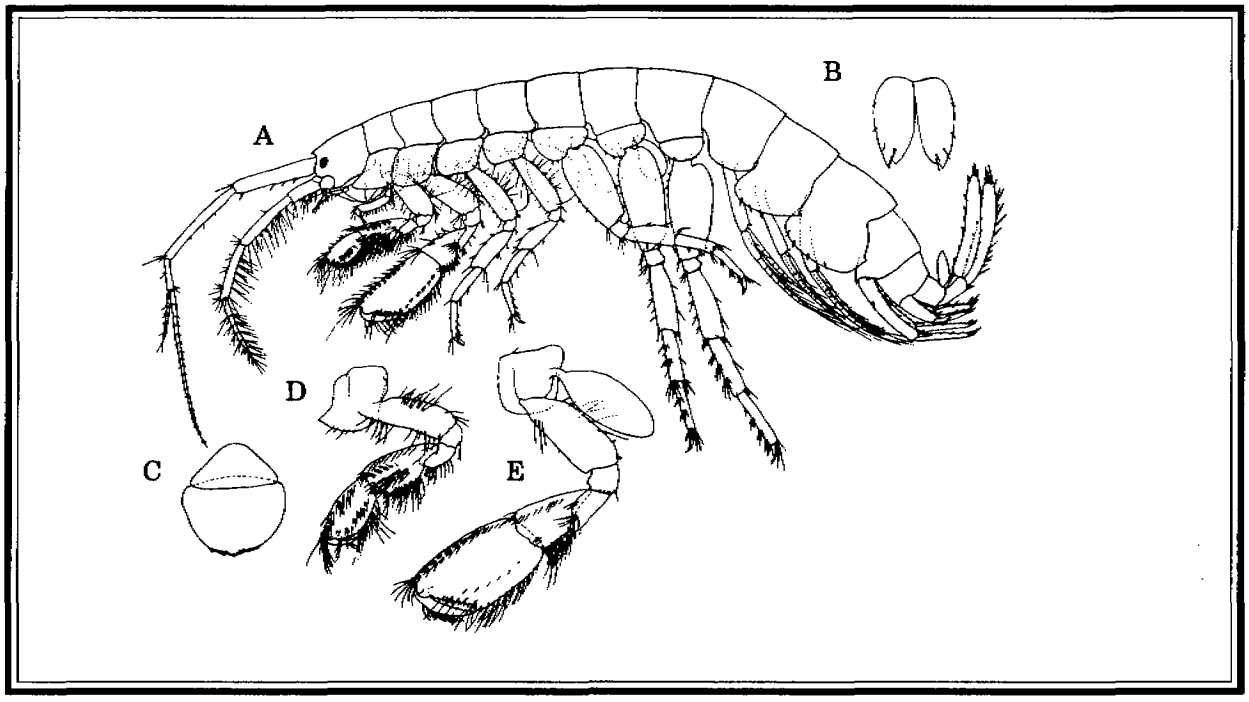


Figure 2.12. *Maera danae*, female; A, Lateral view; B, Telson; C, Upper lip; D, Gnathopod 1; E, Gnathopod 2 (from Bousfield, 1973).

joint of the fifth, sixth, and seventh pereopods is long and narrow" (Shoemaker, 1955). Barnard (1964b) states that *M. danae* has a similar spine, though it is smaller and often hidden by the tooth and that "the shape of adult male gnathopod 2, with its distinctly excavate palm and defining tooth, the stouter pereopods 3-5 and especially the touching coxae distinguishes *M. danae* better". However, these characters are not consistently treated in the literature and may as readily be attributed to differences in size or sex, rather than to any difference in species. Our specimen matches Bousfield's description of *M. danae* fairly well, and gnathopod 2 does have a prominent spine behind the tooth. According to Shoemaker (1955), *M. loveni* is much larger than *M. danae*. The taxonomy of this genus is confused and awaits further resolution.

Type Specimen and Locality. 22.9 mm. Canada, Grand Manan Island.

Distribution and Habitat. Subarctic, North Atlantic from Grand Manan, New Brunswick to Newport Rhode Island; North Pacific from Pt. Barrow Alaska to San Quintin Bay, Baja California, on mud bottoms along rocky shores, shell and sand bottoms, and in areas with coralline algae, 13-216 m, but predominantly deep water.

Maera simile Stout, 1913

Figure 2.13

Maera simile Stout, 1913: 644-645.—Barnard, 1959a: 24-25, plate 4.
Maera inaequipes Barnard, 1954: 16-18, plate 16-17 (not Costa, 1851).

Material Examined. Santa Maria Basin, California, Phase I, Sta. 2, 200 m, (9 specimens).

Description. Female 12 mm, male 14 mm. Eyes large, reniform or absent (deep water). Antenna 1, flagellum with 10-11 articles. Uropod 3, rami short.

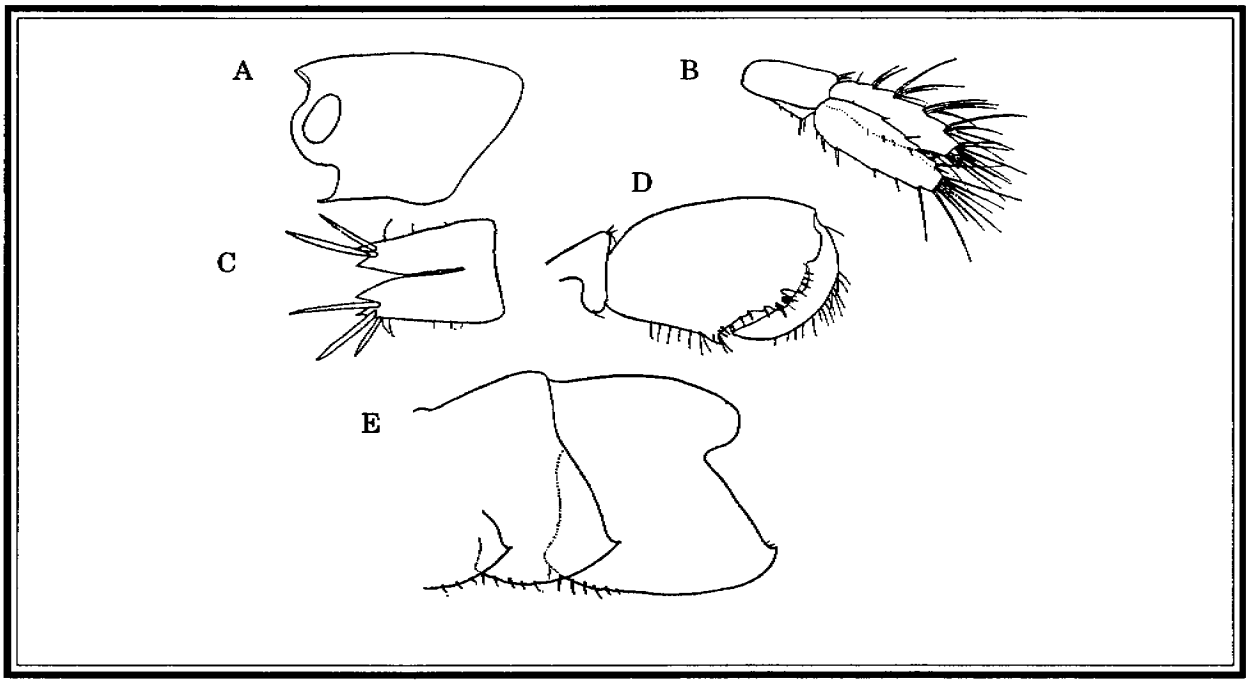


Figure 2.13. *Maera simile*, male, 10 mm; A, Head. B. Uropod 3; C, Telson; D. Gnathopod 2; E, Epimera 1-3, female, 8 mm (from Barnard, 1959).

Remarks. The above species differ from *M. inaequipes* (Costa, 1851) (see Barnard 1954) by the following characters: its smaller size (6-7 mm); gnathopod 2, the palm is transverse in *M. inaequipes*, and oblique in *M. danae, M. loveni,* and *M. simile*. Unlike *M. danae*.and *M. loveni, M. similis* does not have elongate rami on uropod 3.

Type Specimen and Locality. 5-8 mm, Kelp hold fasts from deep water, Laguna Beach, California.

Distribution and Habitat. Puget Sound, Washington to Baja California and Topolobampo, Gulf of California, occasionally on kelp hold fasts, 0-221 m (depths > 50 m usually submarine canyons).

Melita Leach, 1814

Type Species. *Melita palmata* (Montagu, 1804).

Diagnosis (from Bousfield, 1973). Body slender, pleon dorsally mucronate, dentate, or spinose. Rostrum very short, anterior lobe short, broad. Antennae 2, sinus sharply incised. Coxal plates moderately deep, smooth below, coxa 4 largest, 5 anterior lobe deeper. Antenna 1 longer than antenna 2, peduncle elongate, accessory flagellum prominent. Mandible, palp slender, weakly setose, tending to reduction of segments. Maxilla 1, margin of inner plate setose, outer plate with 7 apical spine teeth. Maxilliped, inner and outer plates well developed. Lower lip, inner lobes strong. Gnathopod 1 small, slender, carpus longer than propodus (both sexes). Gnathopod 2 strongly subchelate (larger in male), carpus short, lobe short and deep. Pereopods 3 and 4 slender, dactyls short. Pereopods 5-7, article 2 expanded, similar, 6 and 7 subequal. Uropod 3, outer ramus elongate, 2-articulate, margins spinose, inner ramus short, scale-like. Telson deeply cleft, lobes diverging, apices acute.

Remarks. 61 species.

Melita dentata (Krøyer, 1842)

Figures 2.14, 2.15

Gammarus dentatus Krøyer, 1842:159.
Melita dentata: Sars, 1895: 513-514, plate 181, figure 1.—Holmes, 1905: 504-506, figure.—Bousfield, 1973: 65-66, plate IX.1.—Lincoln, 1979: 304-305, figure 142.

Material Examined. Santa Maria Basin, California, Phase I, Sta. R2, 161 m, May 1989, (4 specimens).

Description. Both sexes 18-30 mm. Eyes small, reniform, black. Coxae 1-4, posterolateral corner with small tooth. Segments of pleon and urosome with 2-6 mid-dorsal teeth, most pronounced on urosomite 1. Epimeron 3 posterolateral corner acuminate, produced backward. Uropod 3 long and slender, outer ramus at least 3 times longer than inner.

Remarks. This species was reported from Louisiana (Pearse, 1912), but Shoemaker examined the specimens and determined they were not *M. dentata*. Gnathopod 2 was very distinctive in the specimens we examined. The dactyl is distally inflated, spatulate, and closes on the medial surface of the palm. It is not clear whether or not all of the *M. dentata* described in the literature possess this character.

Type Specimen and Locality. Greenland.

Distribution and Habitat. Atlantic and Arctic Oceans, including White Sea, Barents Sea, Spitzbergen, Norway, Bohuslän, Kattegat, British Isles, Iceland, Greenland, Labrador, Gulf of St. Lawrence, Newfoundland, Nova Scotia, Bay of Fundy, New England, Hudson Bay; Pacific from Japan, Kamchatka and Pt. Barrow Alaska to Corona Del Mar, California, most abundant on sand, but also found on gravel, shell hash, and under stones, 30-282 m.

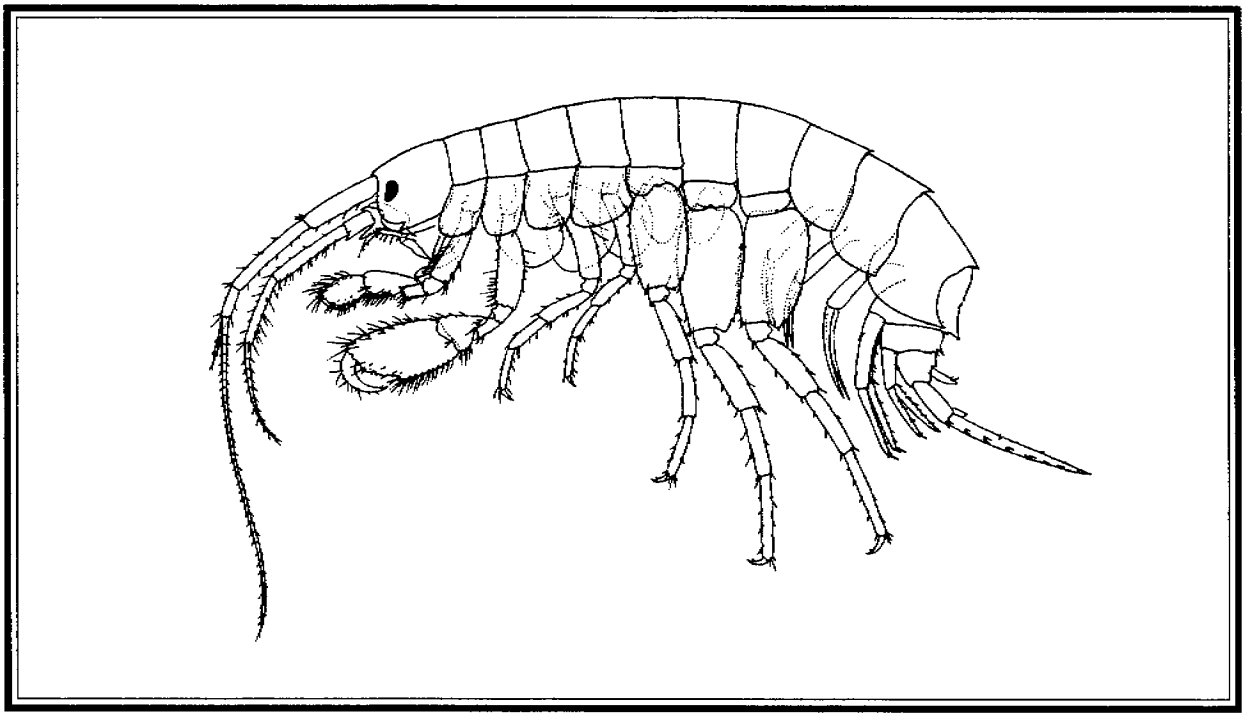


Figure 2.14. *Melita dentata*, male (from Bousfield, 1973).

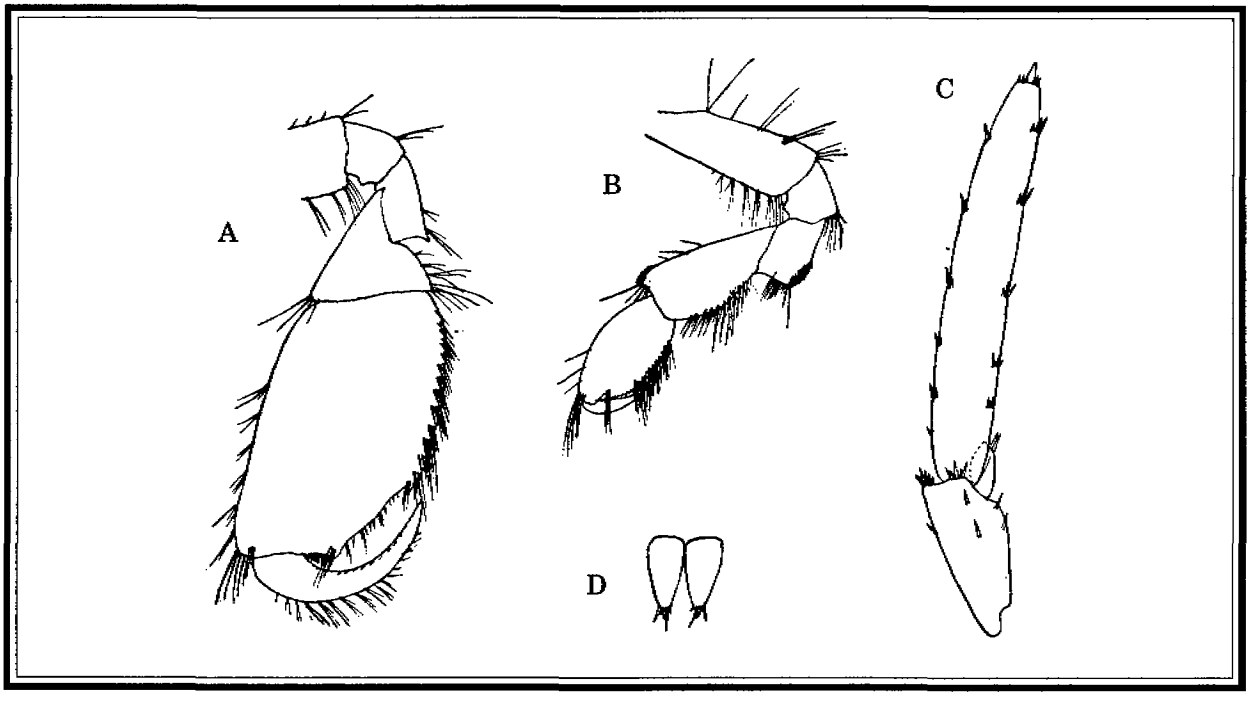


Figure 2.15. *Melita dentata*, male: A, Gnathopod 2; B, Gnathopod 1; C, Uropod 3; Note length of outer ramus; D, Telson (from Holmes, 1905).

Family Leucothoidae Dana, 1852

Diagnosis (modified from Barnard and Karaman, 1991). Antenna 1, accessory flagellum vestigial, 1 to 2-articulate. Mandible lacking molar. Upper lip with epistome. Maxilliped, outer plates very small, probably never larger than inner plates. Coxa 1 ordinary. Gnathopod 1 carpochelate. Gnathopod 2 enlarged, often with a produced carpal lobe. Telson entire.

Remarks. 3 genera (including subgenera), 59 species.

Leucothoe Leach, 1814

Type Species. *Gammarus spinicarpus* (Abildgaard, 1789), original designation.

Diagnosis (from Barnard and Karaman, 1991). Maxilla 1, palp 2-articulate. Maxilla 2 moderately setose. Maxilliped, outer plates reaching less than halfway to apex of palp article 1. Coxa 2 variable, broad or long, acute or rounded below and anteriorly long or very short.

Remarks. 58 species (including *Leucoethella* subgenera).

Leucothoe spinicarpa (Abildgaard, 1789)

Figure 2.16

Gammarus spinicarpus Abildgaard, 1789: 66, plate CXIX, figure 1-4, 17.
Leucothoe spinicarpa: Sars, 1895: 283, plate 100, plate 101, figure 1.—Barnard, 1962c: 132, figure 7 A-C. —Krapp-Schickel, 1975: 94-96, plate 1-2.—Watling and Holman, 1983: 224-231, figure 10.—Ledoyer, 1986: 676-677, figure 260.

Material Examined. Not reported from this study.

Description (modified from Holman and Watling, 1983). Female 3-21 mm, male 2.75-19.0 mm. Eyes oval, red or black. Rostrum poorly developed. Antenna 1 article 3 plus flagellum equal in length to peduncle articles 1 and 2. Adult antenna 2 article 5 much shorter than article 4. Mandibular palp 3-articulate, article 2 longest, more than twice length of article 3. Gnathopod 1, propodus approximately twice as long as basal portion of carpus. Gnathopod 2, in adult, propodus moderately crenulate along distal portion of palm (but see Barnard, 1962c). Pereopods 3 and 4 with nunerous short spines. Epimeron 3 posterodistal corner occasionally with small tooth but without distinct notch or sinus above. Telson triangular, almost three times as long as width of base.

Remarks. There is some doubt whether this represents one cosmopolitan species or a complex of species. Holman and Watling (1983) identified at least 3 variants in Antarctic waters alone, which may represent different species. Records from several sources differ in one or all of the following features: size, eye color, characteristics of the gnathopods and the shape of coxae 3 and 4, distribution, and depth range. It is commonly reported from California waters, therefore we have included it here.

Type Specimen and Locality. Norway.

Distribution and Habitat. Cosmopolitan. Atlantic from Greenland, Norway, British Isles, Shetland Islands, France, and the Azores; Mediterranean from Egypt, Tunesia, and Algeria, Adriatic and Aegean Seas; Antarctic Peninsula, Tierra del Fuego; Pacific from San Diego to Monterey Bay California, on algal bottoms, often found within tunicates or sponges (*Microcosmus,* and *Phallusia*) (Krapp-Schickel, 1975), abundant, subtidally, from 55-1505 m. Found intertidally, 0-6 m, in the Gulf of California and the Galapagos Islands.

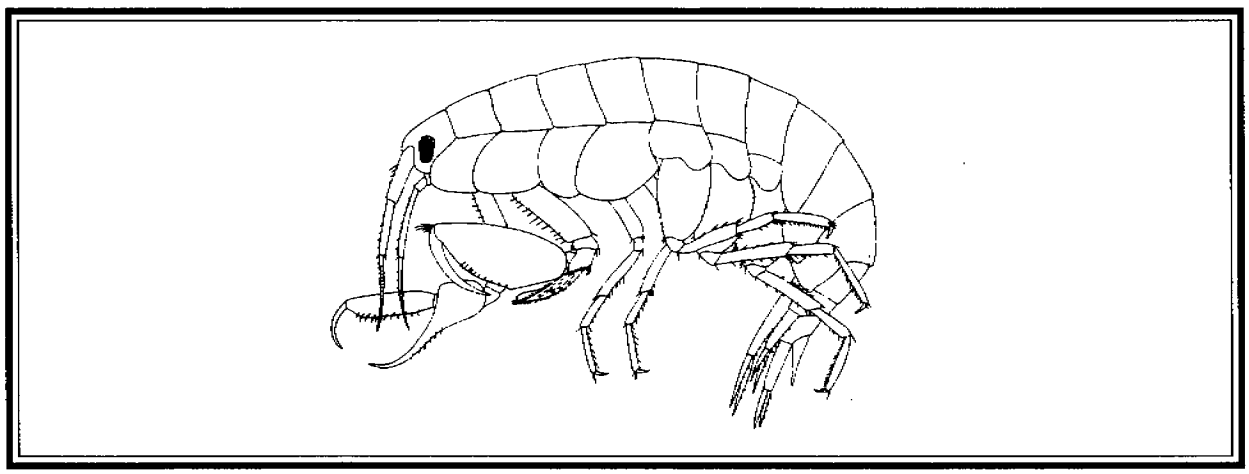


Figure 2.16. *Leucothoe spinicarpa* (from Barnard and Karaman, 1991).

Family Melphidippidae Stebbing, 1899

Diagnosis (from Lincoln, 1979). Body slender, compressed or depressed. Rostrum small. Eyes very large. Lateral lobes broadly produced, often acute apically. Coxal plates moderately large, or short and scarcely contiguous, usually setose. Mouthparts basic, mandible with large molar, palp well developed. Maxilla 1 and 2 inner plate densely setose medially. Maxilliped inner and outer plates spinose, palp elongate. Gnathopods slender, simple or feebly subchelate, sexes generally similar. Pereopods elongate, slender. Pleon segments robust, pereon segments short. Posterior segments often toothed dorsally, some teeth arranged transversely. Uropods large. Uropods 1-2 spinose. Uropod 2 outer ramus, shortened. Uropod 3 spinose or naked, reaching beyond end of uropod 2, rami subequal, lanceolate or foliaceous (rami often lost in preserved material). Telson typically cleft, occasionally emarginate or entire. Sexual dimorphism in antennae only.

Remarks. 7 genera (Barnard and Barnard, 1983), 13+ species. There appear to be inconsistencies among the genera of this family, especially within *Melphisana* and *Melphidippa*. Characters diagnostic of the genera are not always present in the species assigned to them, particularily regarding features of the telson and eyes.

Key to the Melphidippidae of the Santa Maria Basin

1. Telson deeply cleft; pereopods 3 and 4, dactyls elongate and setose 2

1. Telson entire or apically notched; pereopods 3 and 4, dactyls short, only sparsely setose .... *Melphisana bola*

2. Eyes large, bulging; telson short, with shallow cleft forming a wide gap ..... *Melphidippa amorita*[3]

2. Eyes small, not bulging; telson elongate, cleft more than half its length, gap narrow ....*Melphidippa borealis*

Melphidippa Boeck, 1871

Type Species. *Melphidippa goesi* (Goes, 1866).

Diagnosis (from Barnard and Barnard, 1983). Body very slender. Lateral lobes rounded or quadrate, weak sinus present. Eyes poorly defined. Antennae elongate, about equal length. Antenna 1, flagellum much longer than peduncle, slender. Accessory flagellum 2-to-multi-articulate. Antenna 2 elongate, peduncle strongly setose, flagellum slightly longer than article 5 of peduncle. Antenna 1 and 2 sexually dimorphic. Mouthparts basic, mandibular palp article 3 twice as long as 1. Maxilla 1 and 2 inner plates densely setose medially. Gnathopods small, setose, weakly subchelate or simple. Gnathopod 1, carpus broadly lobate, propodus thin, with oblique weak palm, gnathopod 2 with unlobed carpus, propodus thinner and more elongate, palm very short, oblique. Coxal plates short, scarcely contiguous. Pereopods long and slender, setose. Pereopods 3-4 dactyls usually elongate and setose. Pereopods 5-7 dactyls often elongate. Pleon segments

[3] See remarks under this species

distinctly toothed dorsally, some teeth arranged transversely. Uropod 3 rami 1-articulate, lanceolate. Telson triangular, cleft half-way, poorly armed.

Remarks. 10 species (Barnard and Barnard, 1983).

Melphidippa amorita Barnard, 1966

Figures 2.17, 2.18

Melphidippa amorita Barnard, 1966a: 74, figure 26.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 14, 299 m, March 1985, (1 specimen).

Description (from Barnard, 1966a). Female 6.4 mm. Eyes bulging. Gnathopods and pereopods elongate. Gnathopods poorly subchelate, slender, propodus shorter than carpus. Coxa 4-6 not bilobed, but evenly triangular. Pleonites 1-5 each with a long dorsal tooth, marginal serration present on epimera 1-4. Uropods 1-2 elongate and with shortened outer rami. Telson short, a shallow cleft forming bilaterally gaping, acute lobes, each with lateral seta.

Remarks. This species has been incompletely defined and only tentatively assigned to the Melphidippidae because the identification is based on only 1 specimen, missing several crucial parts (the antennae and uropod 3). Our material consisted of 3 damaged specimens, 2 of which clearly exhibited the gaping cleft in the telson and the posterior serrations on epimera 1-4, distinguishing it from *M. borealis* Boeck, 1871.

Type Specimen and Locality. AHF No. 6012, female, 6.4 mm. Station 6836, Tanner Canyon, 32°36'00"N, 119°05'18"W, 496 m.

Distribution and Habitat. Tanner Canyon, southern California, 496 m.

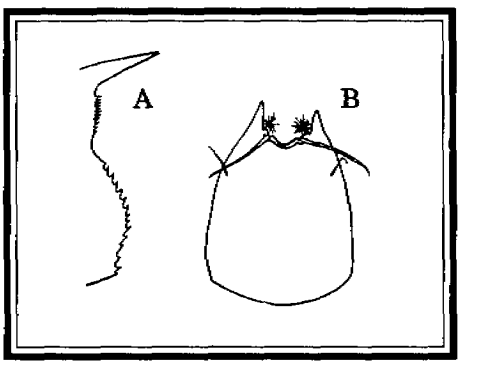


Figure 2.17. *Melphidippa amorita*, female, 6.4 mm; A, Epimeron 3; B, Telson (from Barnard, 1966a).

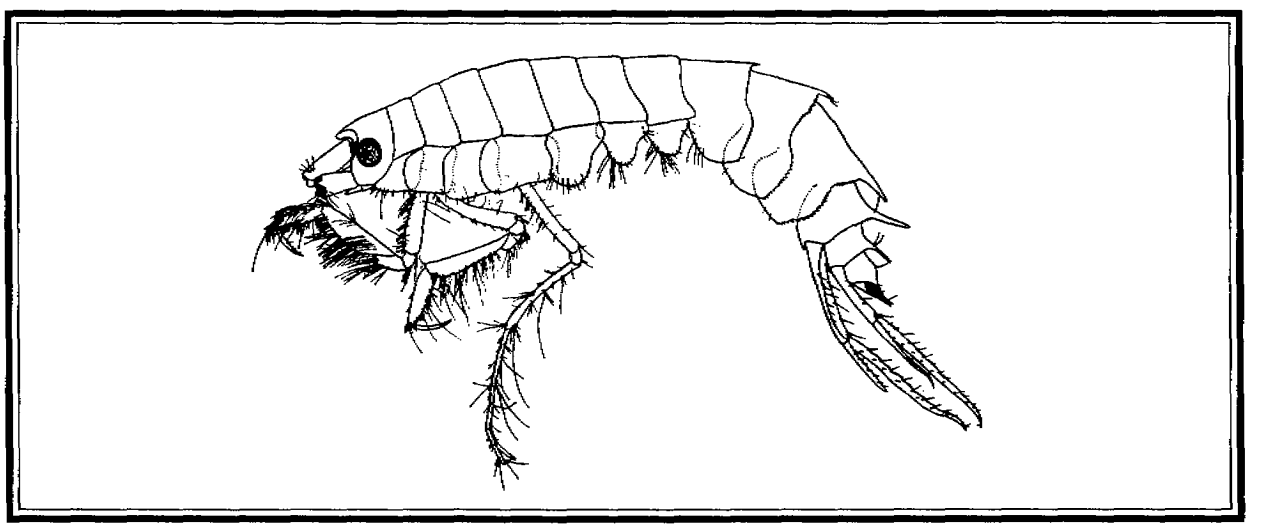


Figure 2.18. *Melphidippa amorita*, female.

Melphidippa borealis Boeck, 1871

Figure 2.19

Melphidippa borealis Boeck, 1871: 139.—Sars, 1895: 486-487, figure 170.—Nagata, 1965: 178-179, figure 20.

Material Examined. Santa Maria Basin, California, Phase II, Sta. PJ15, 155 m, October 1986, (1 specimen), Sta. R2, 161 m, May 1987, (3 juvenile specimens).

Description (modified from Sars, 1895). Both sexes 3.5-7.0 mm. Lateral lobes of head broadly rounded. Eyes small, not bulging. Accessory flagellum long, 5-articulate. Gnathopod 2, propodus long, approximately equal in length to carpus. Coxa 4-6 not bilobed, but broadly rounded. Telson elongate, nearly three times longer than wide, cleft more than one-half its length, lobes unequally bidentate, each with a lateral seta.

Remarks. Identification beyond genus is difficult due to damaged specimens and the lack of diagnostic appendages on much of the material, however, gnathopod 2 and the pattern of teeth on the pleonites appears consistent with *M. borealis,* previously reported from the Pacific.

Type Specimen and Locality. Norway, Christianiafjord, Nordlandia, Hardangerfjord.

Distribution and Habitat. Atlantic: Norway; Pacific: Seto Sea, Japan, southern California?, 32-260 m.

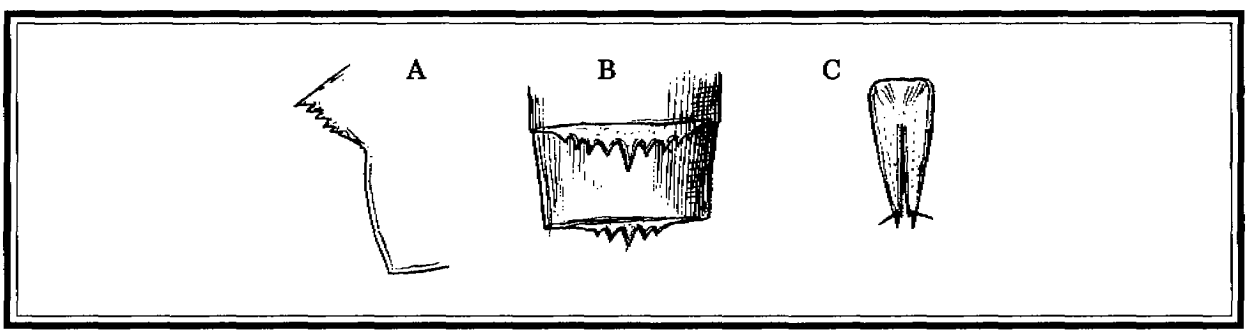


Figure 2.19. *Melphidippa borealis*, female; A, Epimeron 3; B, Epimeron 2 and 3, dorsal view; C, Telson (from Sars, 1895).

Melphisana Barnard, 1962

Type Species. *Melphisana bola* Barnard, 1962b.

Diagnosis (modified from Barnard and Barnard, 1983). Body slender. Rostrum of medium size, lateral lobes subglobose, sinus absent. Eyes present but not filling lobes in female. Antennae elongate, antenna 1 longer than 2, flagellum much longer than peduncle, accessory flagellum 1-articulate, vestigial. Antenna 2 elongate. Mandibular palp articles 1 and 3 subequal in size. Maxillae medially setose. Coxa short, poorly setose, coxa 1 expanded. Gnathopods feeble, scarcely subchelate. Gnathopod 1, carpus broad, scarcely lobate, propodus thin, with oblique long but weak palm, gnathopod 2 with unlobed carpus, propodus similar. Pereopods 3-4, dactyls short, and not setose. Pleon dorsally toothed, some teeth arranged transversely. Uropod 3 rami 1-articulate, lanceolate. Telson entire, apically emarginate, poorly armed.

Remarks. 2 species.

Melphisana bola Barnard, 1962

Figure 2.20

Melphisana bola Barnard, 1962b: 81-82, figure 7.

Material Examined. Santa Maria Basin, California, Phase II, Sta. R4, 92 m, May 1987, (5 specimens), Sta. PJ16, 130 m, October 1986, (1 specimen).

Description (modified from Barnard, 1962b). Both sexes 2.4-3.0 mm. Eyes bulging, colorless, but with numerous ommatidia. Article 2 of first antenna in male longer than article 1, but subequal in female. Maxillae inner plates densely setose medially. Gnathopods 1 and 2 similar in size and structure. Gnathopod 2 subchelate, article 6 expanded. Gnathopod 1, article 6 linear, setose. Pleonites 1-5 bearing a mid-dorsal tooth, pleonites 2 and 3 bearing small teeth to either side of the main tooth. Posterior edges of epimera 2 and 3 serrate. Telson uncleft, broad, with distal concavity, and a spine projecting from each side.

Remarks. In specimens we examined, pleonite 3 has a long posteriorly projecting tooth, pleonite 2 has a somewhat shorter tooth and urosomite 1 and 2 have teeth on the posterodistal margin. Otherwise the ornamentation of the pleonites and urosomites and the apical setae on the telson agree with *M. bola*. The emarginate telson, is similar to *M. japonica* Nagata, 1965. Uropod 3 and antenna 2 were missing in the original description of *M. bola*. Specimens we examined were missing most appendages, making a definitive identification difficult.

Type Specimen and Locality. AHF No. 582, male, 2.4 mm. Station 5628, northwest of Oceanside, California, 33°18'30"N, 117°32'30"W, on fine gray sand, 37 m.

Distribution and Habitat. Southern California coastal shelf, on sand, 12-130 m.

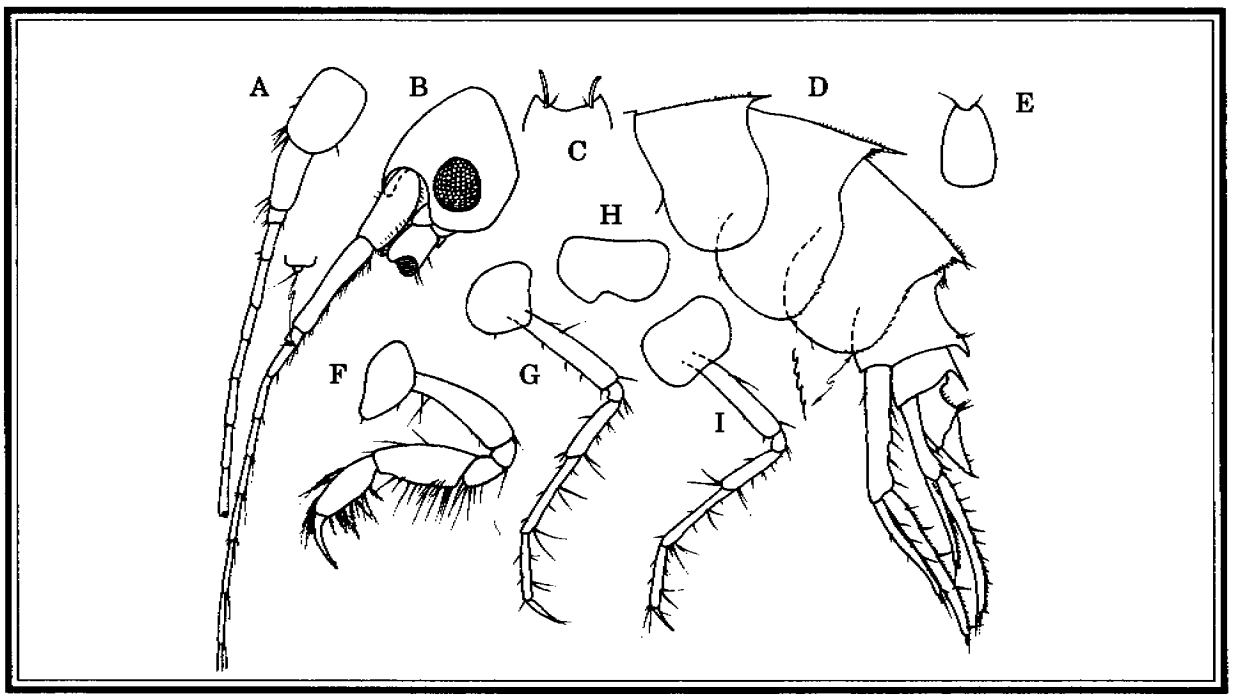


Figure 2.20. *Melphisana bola*, male, 3 mm; A, Antenna 1 (proximal end only); B, Head with close-up of accessory flagellum; C, Telson; D, Pleon; E, Telson; F, Gnathopod 2; G, Pereopod 3; H, Upper lip, female, 3 mm; I, Pereopod 4 (from Barnard, 1962b).

Family Oedicerotidae Liljeborg, 1865

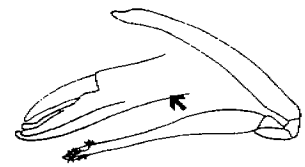
Diagnosis (from Barnard and Karaman, 1991). Head large, eyes, when present, dorsally appressed or fused together. Pereopods 5-6 equally short, pereopod 7 much longer and of different shape than pereopods 5-6. Pereopods weakly fossorial. Uropods 1-2, apices of rami naked or bearing immersed nails, subapical spines lacking. Telson short, entire or emarginate.

Remarks. 32 genera (including subgenera), 193 species.

Key to the Oedicerotidae of the Santa Maria Basin

1A. Gnathopod 2, chelate; carpus long and narrow (Figure 2.21) ..... (*Synchelidium*) 14

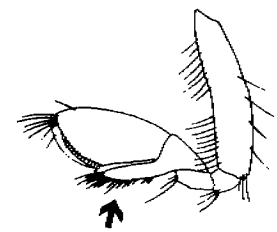
Figure 2.21



1B. Gnathopod 2, subchelate, or carpochelate; carpus of variable size and shape, but not long and narrow 2

2A. Gnathopod 2, carpal lobe produced along propodus (Figure 2.22) ..... (*Monoculodes*) 8

Figure 2.22



3A. Rostrum strong, projecting and acuminate; eyes large, filling rostrum; end of ..uropod 2 reaching at least to end of rami on uropod 3 ..... *Westwoodilla caecula*

3B. Rostrum generally short and blunt; eyes often absent or small, not filling rostrum; end of uropod 2 almost reaching end of rami on uropod 3 ..... (*Bathymedon*) 4

4A. Telson apically indented ..... *Bathymedon pumilis*

4B. Telson apically rounded 5

5A. Rostrum very small and short, not recurved 6

5B. Rostrum extending half-way to three-quarters length of antenna 1, article 1, recurved, acute 7

6A. Eyes absent; gnathopod 1, carpal lobe detached but not projecting ..... *Bathymedon covilhani*

6B. Eyes present, granular and diffuse; gnathopod 1, carpal lobe detached, strongly projecting .... *Bathymedon kassites*

7A. Eyes absent; posterior pereon with microscopic scales ..... *Bathymedon vulpeculus*

7B. Eyes present; posterior pereon without scales ..... *Bathymedon roquedo*

8A. Eyes absent 9

8B. Eyes present 10

9A. Gnathopod 1, carpal lobe produced, reaching palmar margin ..... *Monoculodes necopinus*

9B. Gnathopod 1, carpal lobe barely produced, not reaching posterior margin .... *Monoculodes latissimanus*

10A. Rostrum nearly horizontal; eyes narrow, filling rostrum ..... *Monoculodes glyconica*

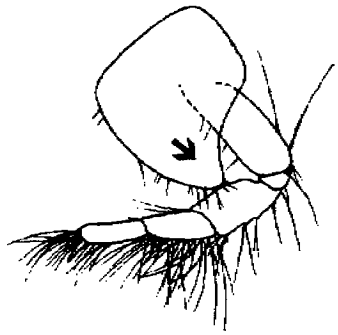
10B. Rostrum recurved; eyes round, not filling rostrum 11

11A. Telson emarginate ..... *Monoculodes emarginatus*

11B. Telson entire 12

12A. Coxa 4, posteroventral corner produced, posterior edge concave (Figure 2.23); epimeron 2, posterior edge concave, posteroventral corner acutely produced ..... *Monoculodes spinipes*

Figure 2.23



12B. Coxa 4, posteroventral corner not produced, posterior edge nearly straight; epimeron 2, posterior edge not concave, posteroventral corner not acutely rounded 13

13A. Rostrum short, blunt, not exeeding first peduncular article 1, antennae 1; gnathopod 1 carpus width four times length ..... *Monoculodes hartmanae*

13B. Rostrum long, pointed, exceeding first peduncular article 1, antennae 1; gnathopod 1 carpus width two times length ..... *Monoculodes norvegicus*

14A. Rostrum blunt, not recurved; antennal sinus shallow; eyes lateral; epimeron 2, posteroventral corner angular; pereopod 7, basis expanded, with very short setae ..... *Synchelidium rectipalmum*

14B. Rostrum acuminate, strongly recurved; antennal sinus deep; eyes dorsal; epimeron 2, posteroventral corner acuminate; pereopod 7, basis narrow, with long setae ..... *Synchelidium shoemakeri*

Aceroides Sars, 1895

Type Species. *Halicreion latipes* Sars, 1883.

Diagnosis (from Barnard and Karaman, 1991). Cutting edge of mandible scarcely projecting and either poorly or well toothed. Molar medium, ridged. Inner lobes of lower lip separate or fused. Gnathopods similar to one another, subchelate, moderately stout, carpus with strong, sharp posterior lobe projecting distalwards, partially guarding propodus. Palm of both gnathopods oblique. Uropod 2 fully reaching end of rami on uropod 3. Uropod 3 well developed.

Remarks. 8 species. This genus falls into a complex of genera still not well defined, including: *Arrhis, Anoediceros, Aceroides* (Barnard and Karaman, 1991).

***Aceroides* sp. A**

Material Examined. Santa Maria Basin, California, Phase I, Sta. 69, 927 m, October 1984, (3 specimens)

Description. Mandibular palp, article 2 straight. Antenna 1, article 2 longer than article 1. Coxae 3 and 4 excavate below. Gnathopod 1, article 4, posterodistal process shorter than that on article 5, carpal lobe blunt and not guarding propodus. Gnathopod 2 larger than gnathopod 1, palm shorter than posterior margin of propodus, carpal lobe extending less than a third of the way along posterior margin of propodus. Telson short, blunt, and slightly emarginate.

Remarks. This form may represent a new species of *Aceroides*.

Distribution and Habitat. Santa Maria Basin, California, 927 m.

Bathymedon Sars, 1895

Type Species. *Halimedon longimanus* Boeck, 1871, original designation.

Diagnosis (from Barnard and Karaman, 1991). Cutting edge of mandible not projecting and untoothed. Molar medium, ridged. Inner lobes of lower lip separate. Gnathopods somewhat diverse, subchelate, slender, usually gnathopod 2 more slender, carpus of gnathopod 1 with blunt moderately developed posterior lobe projecting distalwards at right angles, lobe becoming obsolescent on gnathopod 2, with carpus more elongate. Palm of both gnathopods oblique. Uropod 2 almost reaching end of rami on uropod 3. Uropod 3 well developed.

Remarks. 24 species. "There is little to distinguish *Bathymedon* from *Westwoodilla*. Generally we have placed in *Bathymedon* any species with either weak rostrum, poorly developed eyes, or straight article 2 of the mandibular palp, but some of these species have mixtures of the *Westwoodilla* form of the 3 cited characters" (Barnard and Karaman, 1991).

Bathymedon covilhani Barnard, 1961

Figure 2.24

Bathymedon covilhani Barnard, 1961: 85, figure 53; 1966a: 75.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 69, 927 m, September 1984, (3 specimens).

Description (from Barnard, 1961). Male 6 mm. Eyes absent. Rostrum short, cephalic lobe angular. Epistome conically produced in front. Coxa 1 markedly produced forward, first 3 coxae with stout spines on posterior edges. Gnathopods, carpus, posterior lobe detached distally from the posterior margin. Telson rounded apically.

Remarks. Barnard (1966a) states that *B. gorneri* Gurjanova, 1951 may be identical or closely related to this species. Differences include a more strongly projecting mandibular molar, a more slender first mandibular palp article, a shorter fourth article of the maxillipedal palp, and a more convexly projecting telsonic apex than in *B. covilhani*.

Type Specimen and Locality. Holotype ?male, 6 mm. Station 745, Gulf of Panama, 7°15'N 79°25'W, 915 m.

Distribution and Habitat. Oregon, 200-800 m, southern California to Panama, 549-1720 m.

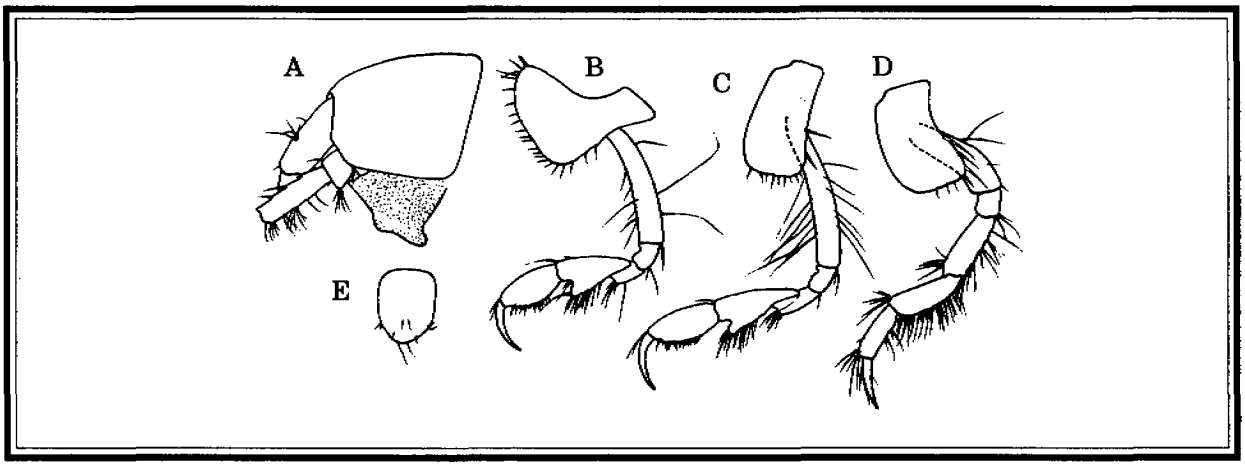


Figure 2.24. *Bathymedon covihani*, male, 6 mm; A, Head with epistome (stippled); B, Gnathopod 1; C, Gnathopod 2; D, Pereopod 3; E, Telson (from Barnard, 1961).

Bathymedon kassites Barnard, 1966

Figure 2.25

Bathymedon kassites Barnard, 1966a: 75-76, figure 28.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 69, 927 m, (1 specimen).

Description (from Barnard, 1966a). Female 3.0-3.2 mm. Eyes faint, formed of granular material in the rostrum and dorsal cephalon, rostrum very small, anterior edge of head below antennal corner nearly vertical. Antenna 1 peduncle, intermediate in length, article 3 much shorter than article 1. Gnathopods,

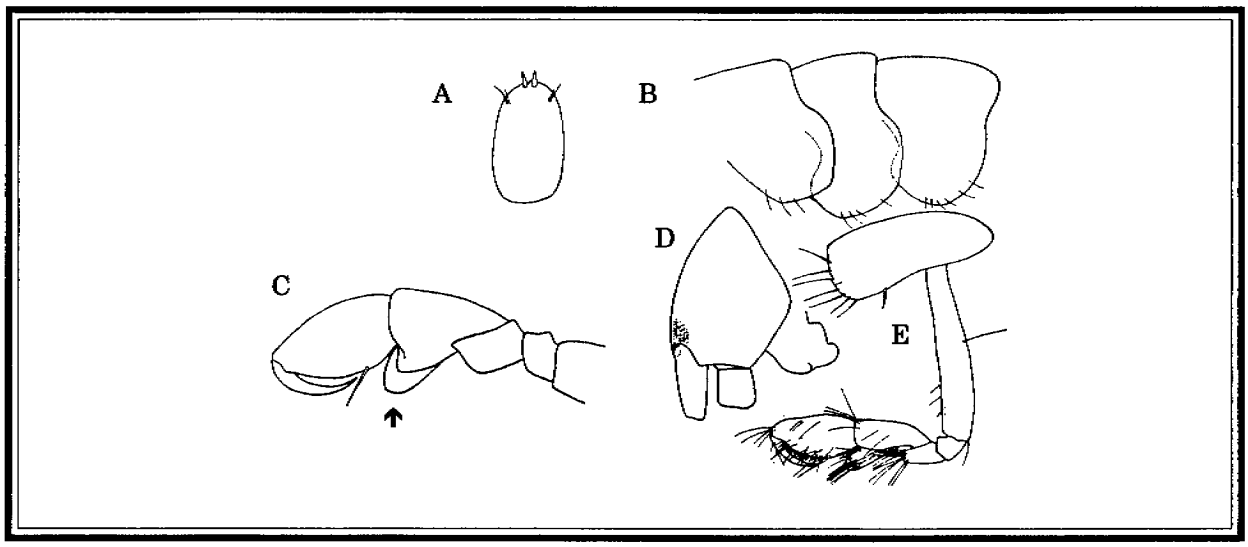


Figure 2.25. *Bathymedon kassites*, female, 3.2 mm; A, Telson B; Epimera 1-3; C, Gnathopod 1 with setae removed (note produced carpal lobe); D, Head and epistome; E, Gnathopod 2 (from Barnard, 1966a).

carpus and propodus subequal in length, posterior lobes on carpus strongly projecting, lobe of gnathopod 2 sharper, palms longer than posterior margins of sixth articles. Coxa 1 produced forward but not greatly. Pereopods 3-4 with slender article 2. Pleonite 4 unarmed. Telson apically rounded, bearing two very stout spines.

Remarks. This is one of only 2 *Bathymedon* species from southern California with eyes.

Type Specimen and Locality. AHF No. 5918, female, 3.2 mm. Station 6494, Monterey Canyon, California, 36°46'58"N, 121°55'56"W, 750 m.

Distribution and Habitat. Monterey, California and the Santa Maria Basin, 750-927 m.

Bathymedon pumilis Barnard, 1962

Figure 2.26

Bathymedon pumilis Barnard, 1962e: 351-352, figure 1.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 9, 398 m, October 1984, (1 specimen), Phase II, Sta. R3, 409 m, January 1987, (1 specimen).

Description (from Barnard, 1962e). Male 2.5-2.8 mm. Eyes absent. Rostrum short. Lateral cephalic lobe vertical in front. Antennae equal in length. Epistome not conical in front. Coxa 1 produced forward, but not greatly. Gnathopod 2, carpal lobe nearly obsolete. Dorsal surface of pleonite 4 smooth. Telson emarginate, bearing 2 medial setae.

Remarks. This species is distinguished by the emarginate telson and asetose coxa 4.

Type Specimen and Locality. Holotype AHF No. 5621, male, 2.75 mm. Station 4753, off Pt. Loma, California, 32°41'50"N, 117°20'25"W, green mud, 97 m.

Distribution and Habitat. Southern California coastal shelf, rare, 66-409 m, and Oregon, 150-225 m, with one record from 800 m.

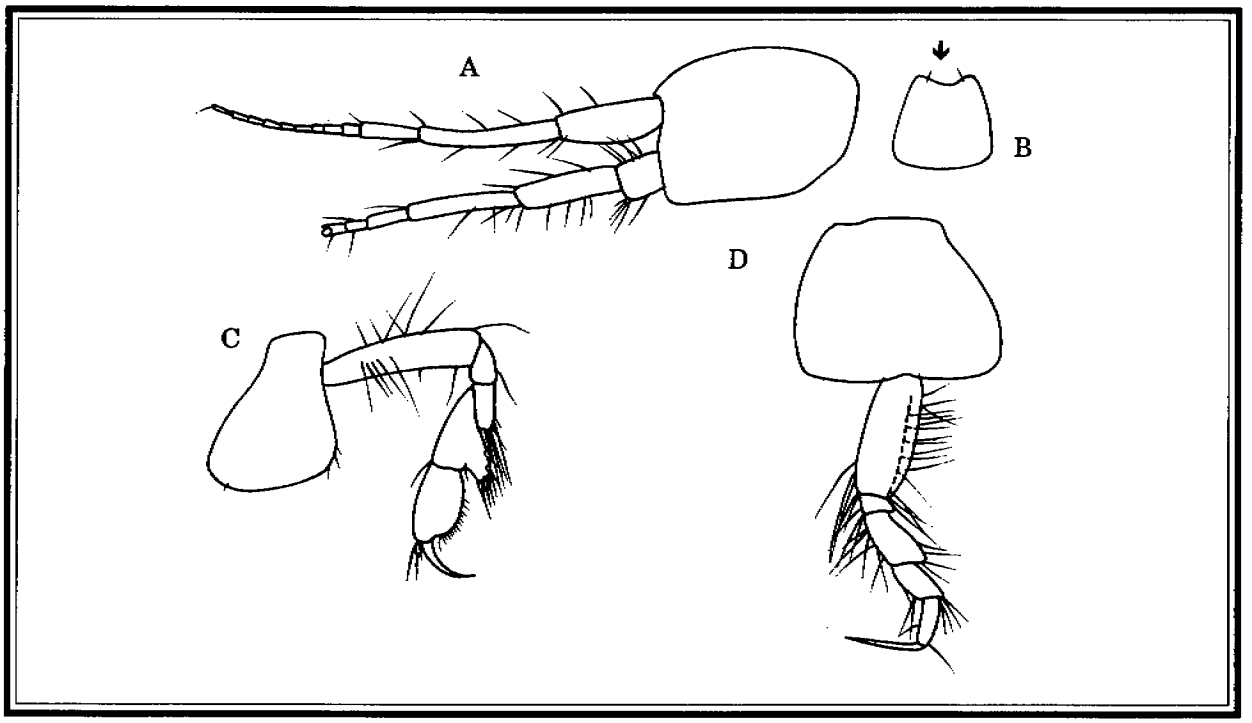


Figure 2.26. *Bathymedon pumilis*, male, 2.5 mm; A, Head; B, Telson (note emargination); C, Gnathopod 1; D, Pereopod 5 (from Barnard, 1962e).

Bathymedon roquedo Barnard, 1962

Figure 2.27

Bathymedon roquedo Barnard, 1962e: 354, figure 2.

Material Examined. Reported from this study, but not supported by collections.

Description (from Barnard, 1962e). Male 5.5 mm. Eye composed of a small amount of yellowish tissue. Rostrum stout, nearly horizontal, with dorsal anterior surface curving downward to form an obtusely acute point. Rostrum extending about three-quarters of the way along antenna 1, article 1 and well beyond the slightly protruding, acute lateral lobe. Antenna 1 exceeding the peduncle of antenna 2. Gnathopods 1 and 2 slender, gnathopod 1, carpal lobe distinct, but indistinct on gnathopod 2. Gnathopod 2, carpus much longer than propodus. Telson apically rounded, nearly truncate.

Remarks. This species bears a superficial resemblance to *B. vulpeculus* Barnard, 1971, but the rostrum is much stouter and it bears distinct, though poorly developed eyes (Barnard, 1971). Though previously recorded from California, our material consisted of one unidentifiable specimen.

Type Specimen and Locality. Holotype AHF No. 557, ?male, 5.5 mm. Station 3727, Smugglers Cove Anchorage, Santa Cruz Island, California, 34°00'55"N, 119°31'45"W, coarse sand, 22 m.

Distribution and Habitat. Southern California, 22-107 m.

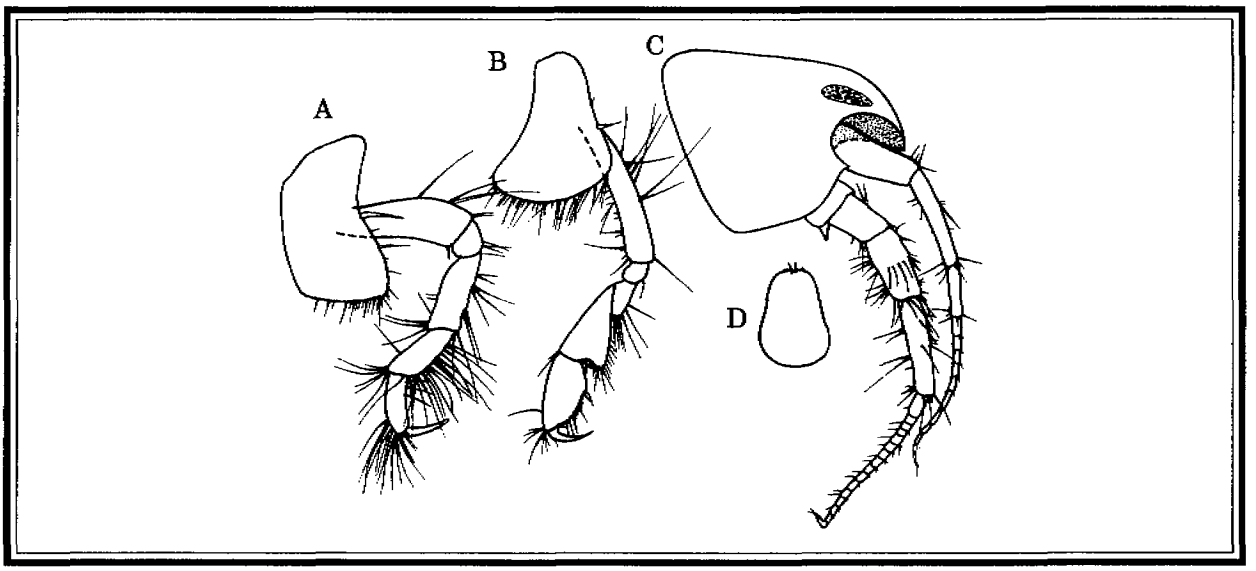


Figure 2.27. *Bathymedon roquedo*, male, 5.5 mm; A, Pereopod 3; B, Gnathopod 1; C, Head, D, Telson (from Barnard, 1962e).

Bathymedon vulpeculus Barnard, 1971

Figure 2.28

Bathymedon vulpeculus Barnard, 1971: 45, figure 28.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 82, 394 m, (1 specimen), Sta. 104, 294 m, (1 specimen), Phase II, Sta. R6, 410 m, January 1987, (1 specimen), Sta. R3, 409 m, May 1987, (2 specimens).

Description (from Barnard, 1971). Male 4.8 mm. Eyes absent. Rostrum of medium length, slender, acute, nearly straight, reaching about halfway along article 1 of antenna 1 and being about twice as projected as lateral cephalic lobe. Anteroventral cephalic margin below antennal sinus nearly vertical, dorsally produced into a short, narrow quadrate extension. Epistome rounded in front. Antenna 1, peduncular article 3 less than half as long as article 1. Coxa 1 strongly produced forward. Palms of gnathopods longer than carpal lobes. Gnathopod 1 and 2, carpus longer than propodus. Pereopods 3-4, dactyl about as long as article 6. Body densely covered with very minute, broadly triangular, ragged scales (especially posteriorly, commencing about pereonites 4-5). Scales so small as to be poorly resolved under oil immersion, but very dense and noticeable because of the fuzzy appearance of the posterior body (see figure 48). Telson short, apically rounded, poorly setose.

Remarks. Our specimens do not have posterior scales and the telson is distinctly truncate. Other diagnostic characters match published descriptions, therefore we hesitate to elevate this to a new species designation. The specimens we examined have conspicuous muscle attachment sites visible throughout the cuticle on the dorsal surface of the head (in preserved specimens). See Barnard, (1971) for similar species from other parts of the world.

Type Specimen and Locality. Holotype USNM No. 127129, male, 4.8 mm. Station 25, 44°39.3'N, 128°57.4'W, 800 m.

Distribution and Habitat. Pacific: from southern California and Oregon, 294-800 m.

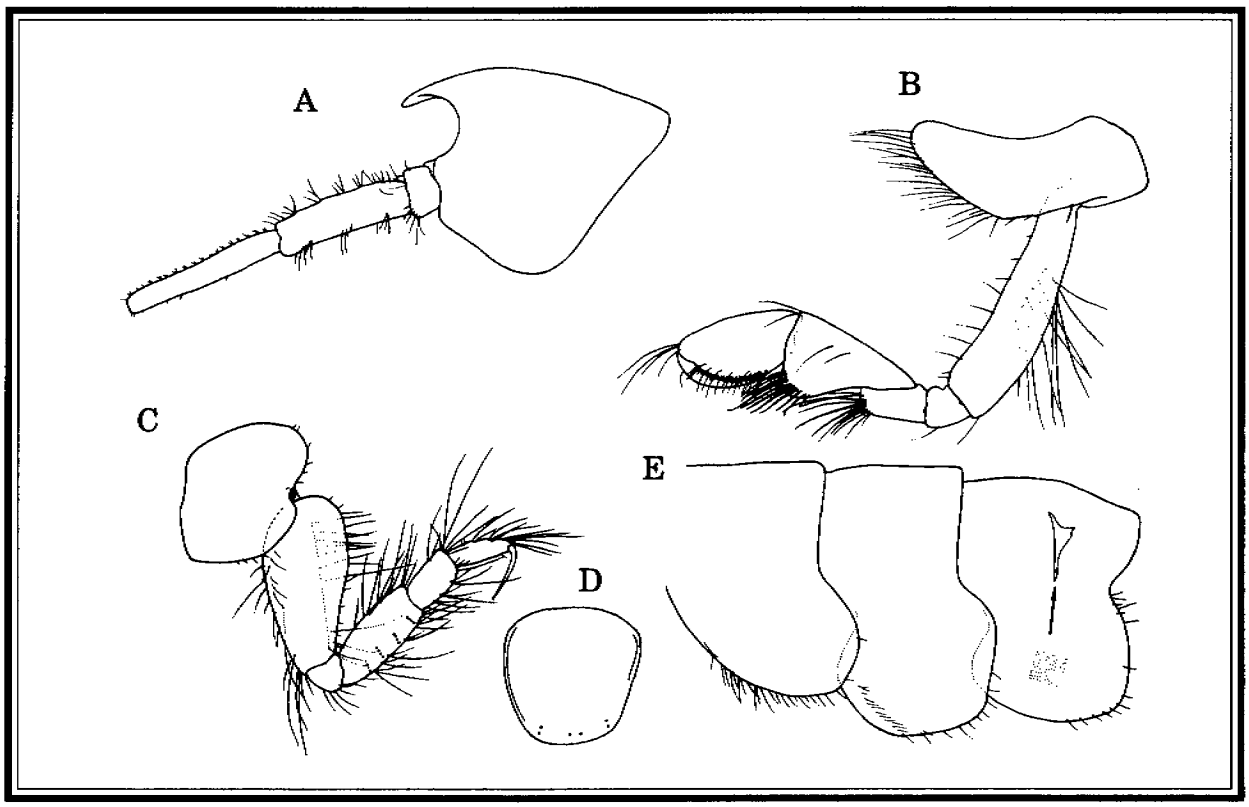


Figure 2.28. *Bathymedon vulpeculus*, male, 4.8 mm; A, Head; B, Gnathopod 1; C, Pereopod 5;D, Telson with the setae/spines removed; E, Epimera 1-3 showing a square of the minute, ragged scales present on the posterior, with a close-up of one scale (from Barnard, 1971).

Monoculodes Stimpson, 1853

Type Species. *Monoculodes demissus* Stimpson, 1853. Type obscure, diagnosis based on *M. carinatus* as depicted by Sars (1895).

Diagnosis (from Barnard and Karaman, 1991). Cutting edge of mandible slightly projecting and toothed. Molar large, ridged. Inner lobes of lower lip separate. Gnathopods diverse, gnathopod 1 stout, gnathopod 2 more slender and longer, carpus with strong, blunt posterior lobe guarding propodus, less so on gnathopod 1, strongly on gnathopod 2. Gnathopods 1 and 2, palm oblique. Uropod 2 almost reaching end of rami on uropod 3. Uropod 3 well developed.

Remarks. 54 species.

***Monoculodes emarginatus* Barnard, 1962**

Figure 2.29

Monoculodes emarginatus Barnard, 1962e: 361-363, figure 4.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 104, 294 m, January 1985, (4 specimens).

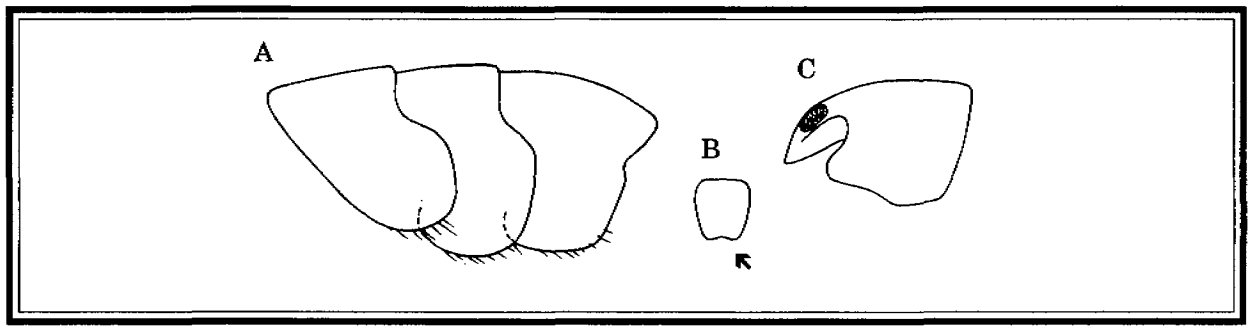


Figure 2.29. *Monoculodes emarginata*, female, 4.5 mm; A, Epimera 1-3; B, Telson (note slight emargination); C, Head (from Barnard, 1962e).

Description (from Barnard, 1962e). Female 4.5 mm. Rostral area transparent, containing a small pigmentless eye (in alcohol) which lies as far back from the apex as its own length. Rostrum moderately stout, slightly deflexed, not tapering rapidly, subacute at apex, extending to the end of but not exceeding antenna 1, article 1. Lateral cephalic lobe crowded dorsally, blunt. Antenna 1 nearly as long as peduncle of antenna 2. Gnathopods relatively stout but gnathopod 2 more slender than 1, the carpal lobes relatively stout, not quite reaching palms of propodus. Pereopods 3 and 4, dactyl as long article 6. Epimera rounded. Telson apically emarginate, unadorned.

Remarks. The bare, emarginate telson of this species is distinctive.

Type Specimen and Locality. Holotype AHF No. 5412, female, 3.5 mm. Station 2637, off Santa Catalina Island, California, 33°21'59"N, 118°20'00"W, sandy mud, 73 m.

Distribution and Habitat. Oregon, California, coastal shelf, to San Quintin Bay, Baja California, 55-294 m.

Monoculodes glyconica Barnard, 1962

Figure 2.30

Monoculodes gylconica Barnard, 1962e: 363, figure 5.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 108, 492 m, January 1984, (3 specimens).

Description (from Barnard, 1962e). Male 6 mm. Eyes filling rostrum, composed of trapezoidal globules of material, bleached to ochre in alcohol. Rostrum long, straight, slender, acute, nearly reaching the end of the first article of antenna 1. Lateral cephalic lobe produced boldly into a slightly upturned process. Antenna 1 reaching well beyond peduncle of antenna 2. Gnathopod 1, carpal lobe barely visible, considered to be absent as in *Monoculodes mertensi* Gurjanova, 1951. Gnathopod 2, carpal lobe distinctly developed but small, reaching less than one-half length of propodus. Pereopods 3 and 4, dactyl as long as article 6. Telson apically rounded.

Remarks. This species most closely resembles *Monoculodes mertensi* (Barnard, 1962e). The telsons on our specimens have one pair of mid-apical setae, and two pairs of short, apico-lateral setae.

Type Specimen and Locality. Holotype AHF No. 5411, male, 6 mm. Station 2843, San Pedro Basin, off Los Angeles, California, 33°26'01"N, 188°00'00"W, gray-green sandy mud, 421 m.

Distribution and Habitat. Coastal slopes and basins of Oregon to southern California, 216-800 m.

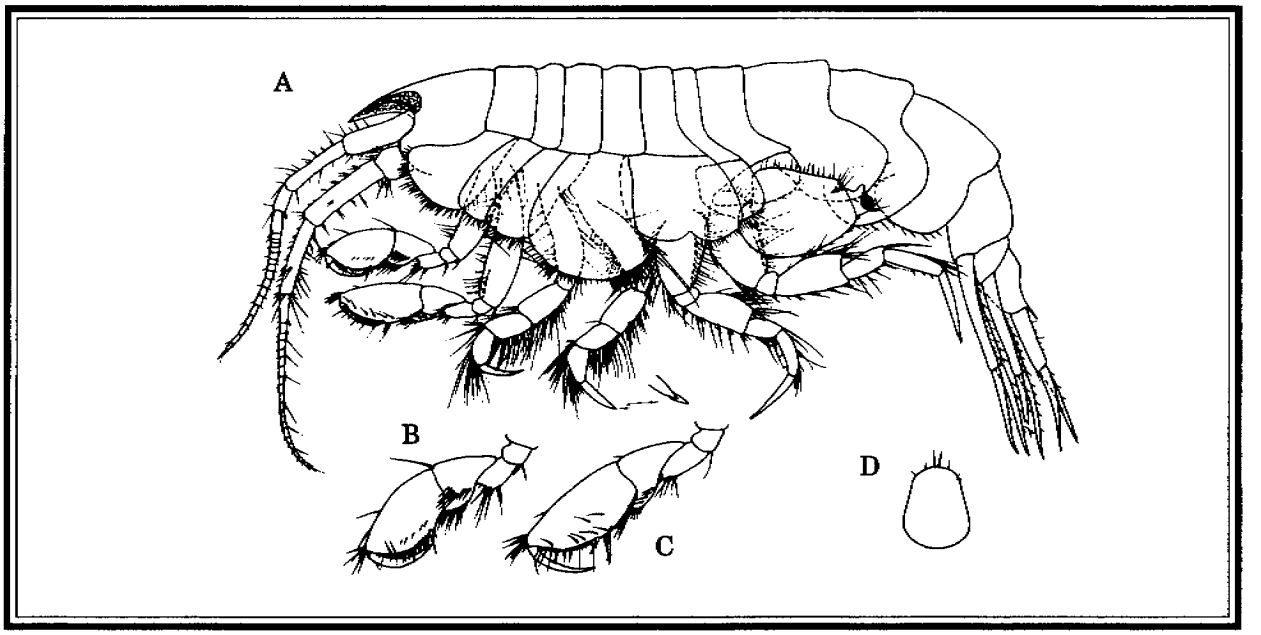


Figure 2.30. *Monoculodes glyconica*, male, 6 mm; A, Lateral view; B, Gnathopod 1; C, Gnathopod 2; D, Telson (from Barnard, 1962e).

Monoculodes hartmanae Barnard, 1962

Figure 2.31

Monoculodes hartmanae Barnard, 1962e: 363, figure 5-7.—Barnard, 1969a: 218, figure 26, a, b.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 42, 100 m, (1 specimen).

Description (from Barnard, 1962e). Female 4-4.6 mm, male 3 mm. Rostrum stout, deflexed, blunt apically in female, more acute in male. Eyes relatively slender and slightly reniform from side view, only partially occupying rostrum, variable in shape due to preservation and nearness to molting of different animals. Lateral cephalic lobe subacute. Antenna 1 shorter than peduncle of antenna 2. Gnathopod 1 with long slender carpal lobe reaching to palm of propodus, the lobe with parallel margins, with a relatively slender propodus. Gnathopod 2 with posterior carpal lobe slender, reaching palm, the propodus three and one-half times as long as broad. Pereopods 3 and 4, dactyl nearly as long as article 6. Epimera rounded. Telson truncate.

Remarks. The telsons of specimens we examined were truncate and scarcely convex, with 2 very short sub-apical setae. It may also be of note that the posterior margin of epimera 3 is not emarginate as in the other California species (Barnard, 1962e) (see Figure 51).

Type Specimen and Locality. Holotype AHF No. 558, female, 4.0 mm. Station 2993, off El Segundo, Santa Monica Bay, California, 33°54'59"N, 118°28'47"W, 38 m.

Distribution and Habitat. Pt. Conception, California to Bahía de San Quintín, Baja California, 1-146 m, common in rocky intertidal and scarce below 37 m.

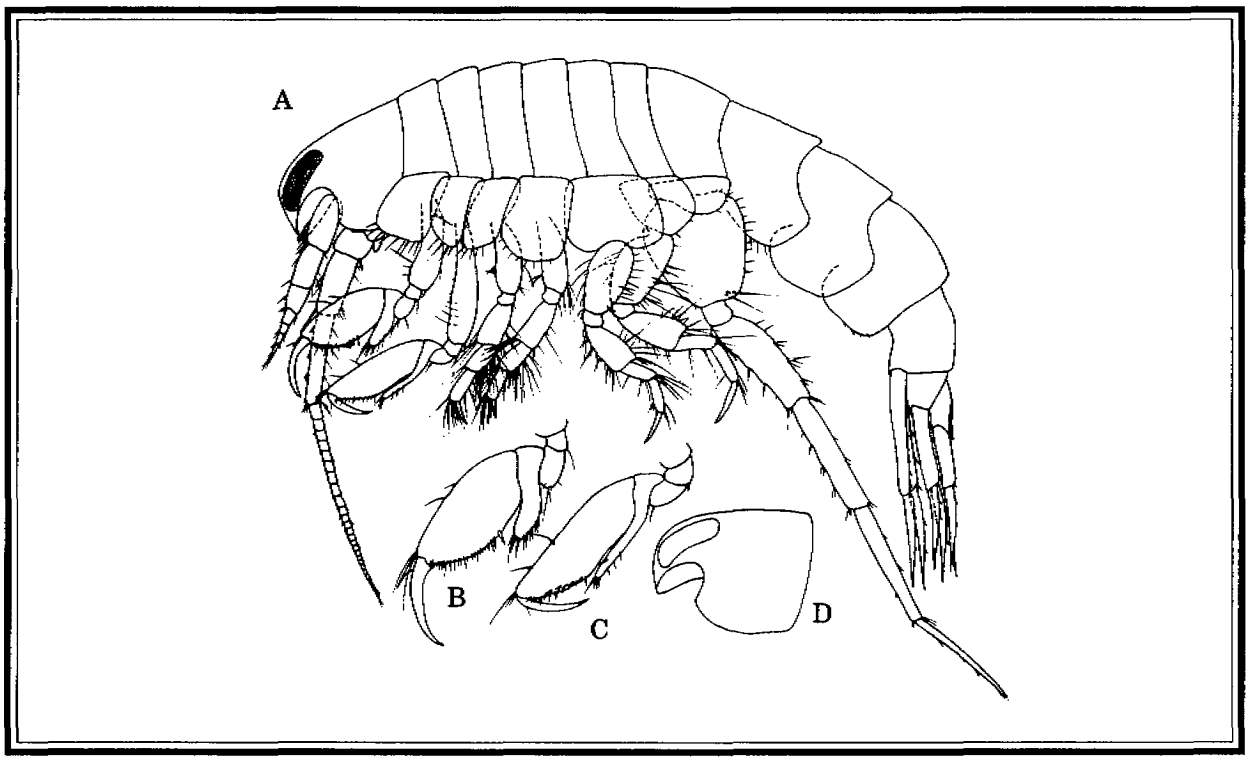


Figure 2.31. *Monoculodes hartmanae*, male, 3 mm; A, Lateral view; B, Gnathopod 1; C, Gnathopod 2; D, Head. (from Barnard, 1962e).

Monoculodes latissimanus Stephensen, 1931

Figure 2.32

Monoculodes latissimanus Stephensen, 1931: 244-245, figure 70.—Barnard, 1966a: 76-77, figure 29.—Barnard, 1967: 113-114, figure 52a-c.—Ledoyer, 1983: 65, figure 4L.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 63, 930 m, November 1984, (3 specimens).

Description (modified from Stephensen, 1931). Female 3-7 mm, male 4.5 mm. Eyes absent. Rostrum only feebly curved and covers the proximal three-quarters of first article of antenna 1. Lateral cephalic lobes square. Gnathopod 1 with coxa extremely widened distally, and the carpal lobe extremely broad, as broad as long, reaching to the middle of the posterior margin of propodus, end oblique. Gnathopod 2 similar. Pereopod 3-7, dactyls nearly as long as article 5 and 6 combined. Epimera rounded. Telson apically concave with 2 short, thick apical spines.

Remarks. This species is similar to *M. abacus* Barnard, 1961 another deep water species (Barnard, 1966a). The figures show epimera 2-3 with very few setae (none on epimeron 2, and 2 on epimeron 2) in *M. latissimanus*, this is in contrast to *M. necopinus* Barnard, 1967 also from California waters, which has very setose epimera (6 setae on epimeron 2, 22 on 3). The telsons on our specimens exhibit a slightly concave apical margin, with 2 distinctive, stout spines.

Type Specimen and Locality. Holotype female, 7 mm. West Greenland, 63°30'N, 54°25'W, 1096 m.

Distribution and Habitat. Greenland, Mediterranean, southern California to Baja California, 344-2393 m.

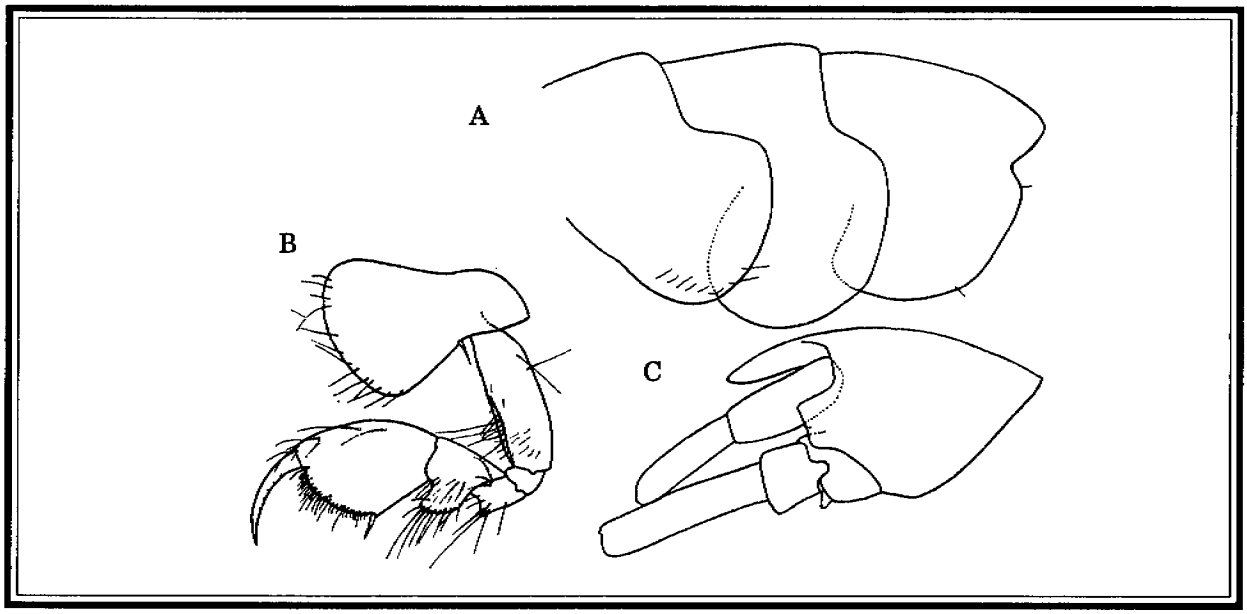


Figure 2.32. *Monoculodes latissimanus*, female, 3 mm; A, Epimera 1-3; B, Gnathopod 1; C, Head (from Barnard, 1966a).

Monoculodes necopinus Barnard, 1967

Figure 2.33

Monoculodes necopinus Barnard, 1967: 114-115, figure 53.

Material Examined. Reported from this study, but not supported by collections.

Description (from Barnard, 1967). Male 6.7 mm. Eyes absent. Rostrum small, slender, straight, acute, reaching halfway along article 1 of antenna 1. Lateral cephalic lobes broad, obliquely truncated, not defined anteroventrally from remainder of head. Antenna 1, articles 1 and 2 equal to each other in length, article 3 about one-third as long as article 2. Epistome broadly rounded anteriorly. Gnathopods, carpus moderately expanded, posterior margins much shorter than palms; carpus posterior lobes extending along full length of posterior margins of propodus, merus scarcely produced posterodistally. Gnathopod 2, carpus with slightly narrower and longer posterior lobe than gnathopod 1. Pereopods, dactyl at least as long as article 6. All epimera rounded posteroventrally. Epimera rounded. Telson truncate, armed with two very stout, short, terminal spines.

Remarks. The only specimen we examined was damaged and not easily identifiable beyond genus. With the exception of an unproduced carpal lobe on gnathopod 1, this specimen exhibited many characters attributable to *M. latissimanus* rather than to *M. necopinus*, however both these species have moderately produced lobes.

Type Specimen and Locality. Holotype AHF No. 6019, male 6.7 mm. Station 7229, 27°54'25"N, 115°40'00"W, 1720-1748 m.

Distribution and Habitat. Pacific: Cedros Trench, Baja California, 1748 m.

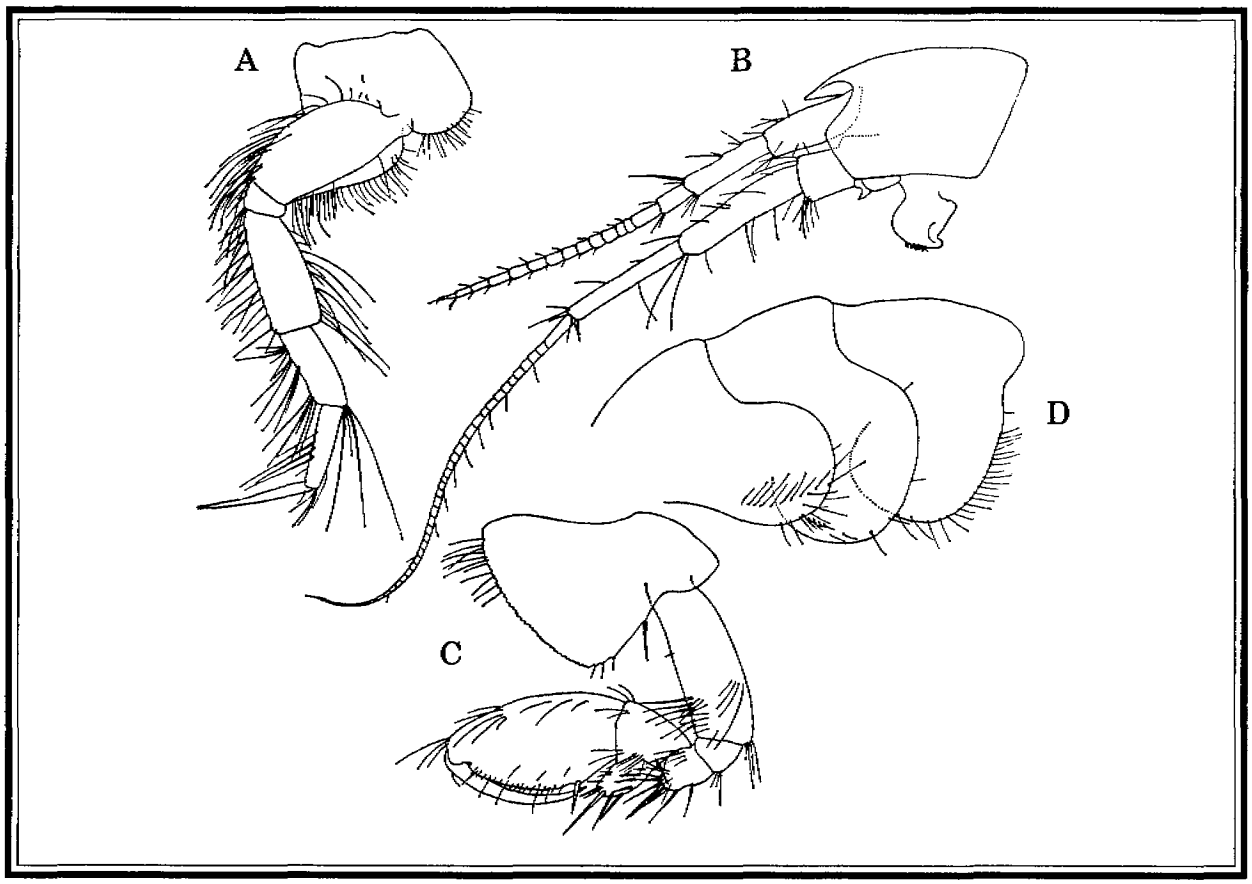


Figure 2.33. *Monoculodes necopinus*, male, 6.7 mm; A, Pereopod 5; B, Head; C, Gnathopod 1; D, Epimera 1-3 (from Barnard, 1967).

Monoculodes norvegicus (Boeck, 1861)

Oedicerus norvegicus Boeck, 1861: 650.
Monoculodes norvegicus Sars, 1895: 301-302, plate 107, figure 1.—Barnard, 1962e: 367.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 42, 100 m, October 1984, (1 specimen), Phase II, Sta. R4, 92 m, January 1987, (1 specimen).

Description (based on Sars, 1895). Female to 6.0 mm. Eyes large, oval, red, close together at base of rostrum. Rostrum stout, acuminate, reaching past article 1 on antenna 1. Lateral cephalic lobes broad. Gnathopod 2 slender, propodus very narrow, nearly four times longer than broad, carpal lobe almost to distal edge of propodus. Pereopods, dactyl elongate, but not quite as long as article 6. All epimera rounded posteroventrally. Telson truncate, slightly emarginate, with 2 tiny, short spines.

Remarks. In California, this species is most common in communities dominated by the ophiuroid *Amphiodia urtica*, and is especially abundant in the *Amphiodia-Onuphis* facies (Barnard, 1962e). The large eyes and telson, with 2 pair of short setae on either side of a slight apical emargination, distinguish this species from other *Monoculodes* in California waters.

Type Specimen and Locality. North Atlantic.

Distribution and Habitat. Pacific: southern California, Arctic Ocean; North Atlantic: Iceland, Gulf of St. Lawrence, North Sea including Skagerrak and Kattegat, 20-376 m.

Monoculodes spinipes Mills, 1962

Figure 2.34

Monoculodes spinipes Mills, 1962: 12-14, figure 3.—Barnard, 1962e: 368-369, figure 10.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 73, 98 m, January 1985, (1 specimen).

Description (from Mills, 1962b). Female 9.0 mm. Rostrum slightly deflexed, slender, acute, extending three-quarters the length of article 1, antenna 1. Eyes placed behind rostral apex a distance slightly less than the length of the eye, about one-third of eye length borne on rostrum. Lateral cephalic lobes blunt, squared off. Antennae very setose (only in types). Gnathopod 1 stout, posterior lobe of carpus with fleur-de-lis shape. Gnathopod 2, propodus moderately slender, the posterior lobe of carpus reaching palm. Second pleonal epimeron concave behind, and projecting at lower corner. Apex of telson slightly convex, with 4 tiny spines.

Remarks. The figures of Mill's show more setose antennae and epimeral plates than in Barnard (1962e). The concave posterior edge and projecting lower corner of epimeron 2, may be a distinguishing character of the species, but because many of the species in this genus have not been adequately described for this character (Barnard, 1962e), its value is unknown.

Type Specimen and Locality. Holotype NMC, female, 9 mm. Station 4, Vancouver Island, British Columbia, intertidal, sand, shell and rock.

Distribution and Habitat. British Columbia to southern California, intertidal to 98 m.

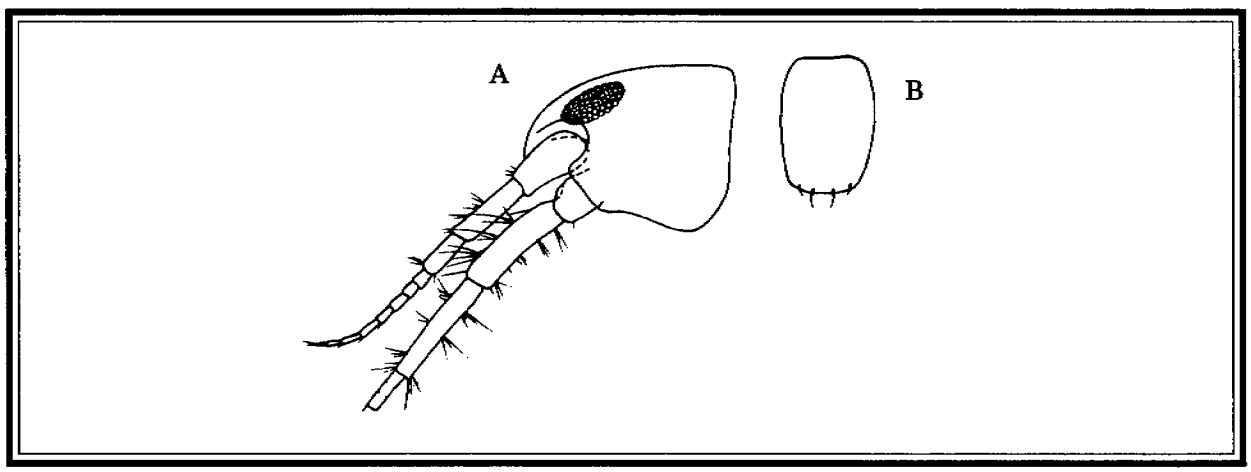


Figure 2.34. *Monoculodes spinipes*, 4.5 mm; A, Head; B, Telson (from Barnard, 1962e).

Synchelidium Sars, 1895

Type Species. *Kroyeria haplocheles* Grube, 1864, selected by Chevreux and Fage, 1925.

Diagnosis (from Barnard and Karaman, 1991). Cutting edge of mandible projecting and well-toothed. Molar small, lacking ridges, conical, with apical spine(s), setulose. Lower lip inner lobes separate but poorly developed and separated by incision, outer lobes with wide gape. Gnathopods diverse, gnathopod 1 stout, gnathopod 2 slender, carpus with sharp strong posterior lobe projecting distalwards and guarding

propodus, lobe becoming less appressed to propodus on gnathopod 1, and fused to propodus on gnathopod 2. Gnathopod 1, palm transverse or oblique, of gnathopod 2 chelate. Uropod 2 fully reaching end of rami on uropod 3. Uropod 3 well developed.

Remarks. 12 species.

Synchelidium rectipalmum Mills, 1962

Figure 2.35

Synchelidium rectipalmum Mills, 1962: 17-19, figures 5, 6B.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 9, 398 m, September 1984, (1 specimen), Sta. 22, 99 m, October 1984, (3 specimens), Sta. 76, 387 m, January 1985, (1 specimen).

Description (from Mills, 1962). Female 4.0 mm, male 3.5 mm. Eyes lateral. Rostrum short, not strongly downturned, blunt. Antennal sinus shallow. Maxilliped, outer plate with nine long spines. Gnathopod 1, palm almost perpendicular to lower margin. Pereopod 7, article 2 narrow, posterior margin with long setae. Epimera rounded.

Remarks. This species is distinguished from all others of the genus by the perpendicular palm of gnathopod 1 (Mills, 1962). *S. rectipalmum* also has a spine-like extension of the carpus that meets the dactyl, a character which is not present in *S. shoemakeri* Mills, 1962.

Type Specimen and Locality. Cotypes, MNC No. 3678, males, 3.5 mm. Station H2, Perry Passage, Queen Charlotte Islands, British Columbia, on sand and shells.

Distribution and Habitat. British Columbia to Costa Rica, rocky intertidal to 398 m on coarse substrate.

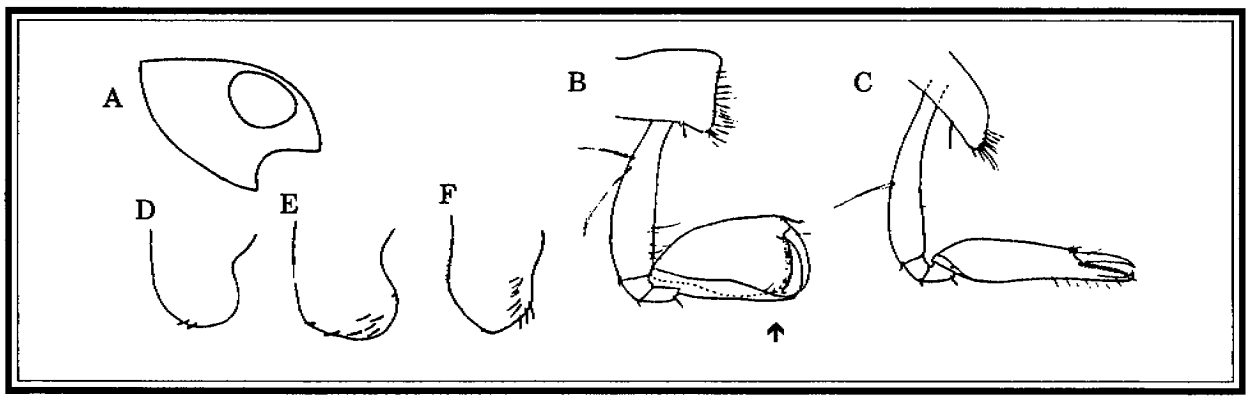


Figure 2.35. *Synchelidium rectipalmum*, male, 3.5 mm; A, Head; B, Gnathopod 1 (note spine-like carpal projection); C, Gnathopod 2; D, Epimeron 1; E, Epimeron 2; F, Epimeron 3 (from Mills, 1962).

Synchelidium shoemakeri Mills, 1962

Figure 2.36

Synchelidium shoemakeri Mills, 1962: 15-16, figure 4, 6A.

Material Examined. Santa Maria Basin, California, Phase II, Sta. R5, 154 m, 1987, (5 specimens).

Description (from Mills, 1962). Both sexes to 3.5 mm. Eyes meeting dorsally, near distal end of rostral process? Rostrum strongly recurved, acuminate. Antennal sinus deep. Maxilliped, outer plate with seven short spines. Gnathopod 1, palm oblique. Epimeron 2 with acute posteroventral corner. Pereopod 7, article 2, broad, posterior margin with very short setae.

Remarks. This species is distinguished from all others by the acute posteroventral corner of epimeron 2 (Mills, 1962). Other easily distinguishable characters in specimens we examined included an oblique palm, and ommatidia scattered dorsally on the head.

Type Specimen and Locality. Holotype NMC No. 3671, male, 3.5 mm. Station V17, Boat Bay, Vancouver Island, sand, stones, rock, eel grass, kelp.

Distribution and Habitat. British Columbia to southern California, rocky intertidal in northern end of its range, subtidal in southern California to about 183 m, but rarely found below 40 m.

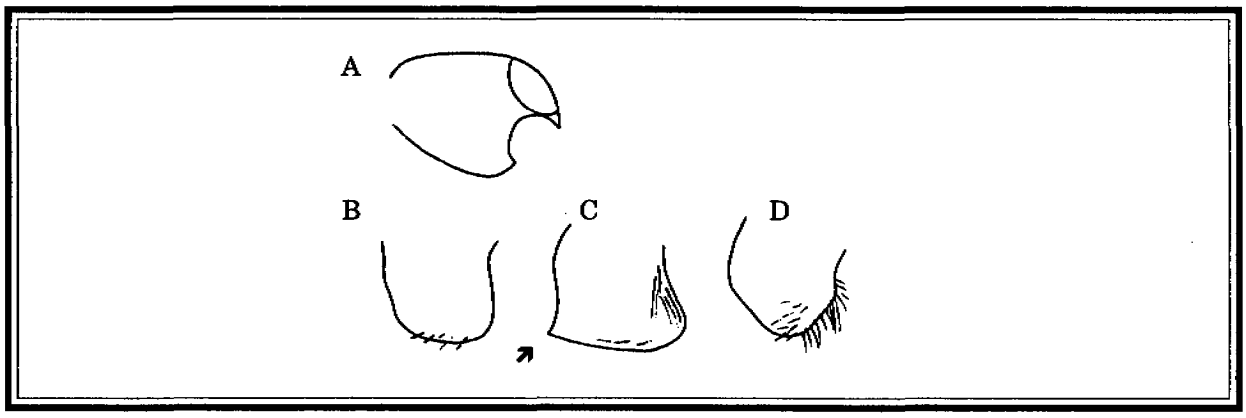


Figure 2.36. *Synchelidium shoemakeri*, male, 3.5 mm; A, Head; B, Epimeron 1; C, Epimeron 2; D, Epimeron 3; (from Mills, 1962).

Westwoodilla Bate, 1857b

Type Species. *Westwoodilla caecula* Bate, 1857b.

Diagnosis (from Barnard and Karaman, 1991). Cutting edge of mandible not projecting, and untoothed. Molar large, ridged. Inner lobes of lower lip separate. Gnathopods similar to one another, feeble, subchelate, carpus with blunt small posterior lobe projecting distalwards at right angles, lobe becoming obsolescent on gnathopod 2. Palm of both gnathopods oblique. Uropod 2 fully reaching end of rami on uropod 3. Uropod 3 well developed.

Remarks. 10 species.

Westwoodilla caecula (Bate, 1857)

Figure 2.37, 2.38

Westwoodea ceaculus Bate, 1857b: 58.
Halimedon müllerii Sars, 1895: 327-329, plate 115.
Halimedon acutifrons Sars, 1895: 329-330, plate 116, figure 1.
Westwoodilla caecula: Enquist, 1949: 335-338, figures 40-56—Mills, 1962: 5-9, figure 1.—Lincoln, 1979: 354, figure 167.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 73, 98 m, (3 specimens).

Description (modified from Mills, 1962). Female 7-8 mm, male 6 mm. Eye toward distal end of frontal process. Rostrum strongly recurved, acuminate. Lateral cephalic lobe produced to a small point. Gnathopods, article 5 long, ending in short setose expansion. Mandibular palp curved and expanded proximally, with spinules. Apex of telson broadly rounded, armed with several small spines.

Remarks. Given the variability in the descriptions of *W. caecula* in the literature and its cosmopolitan distribution, it is probable that it represents a complex of species. In our specimens, the mandibular palp, article 2 was scarcely curved (a curved article 2 being one of the primary characters distinguishing this genus from *Bathymedon*).

Type Specimen and Locality. Britain.

Distribution and Habitat. Pacific: Japan Sea, Laptev and Barents Seas, British Columbia to southern California; North Atlantic from Greenland, Gulf of St. Lawrence, Norway, Britain, and France, 0-500 m.

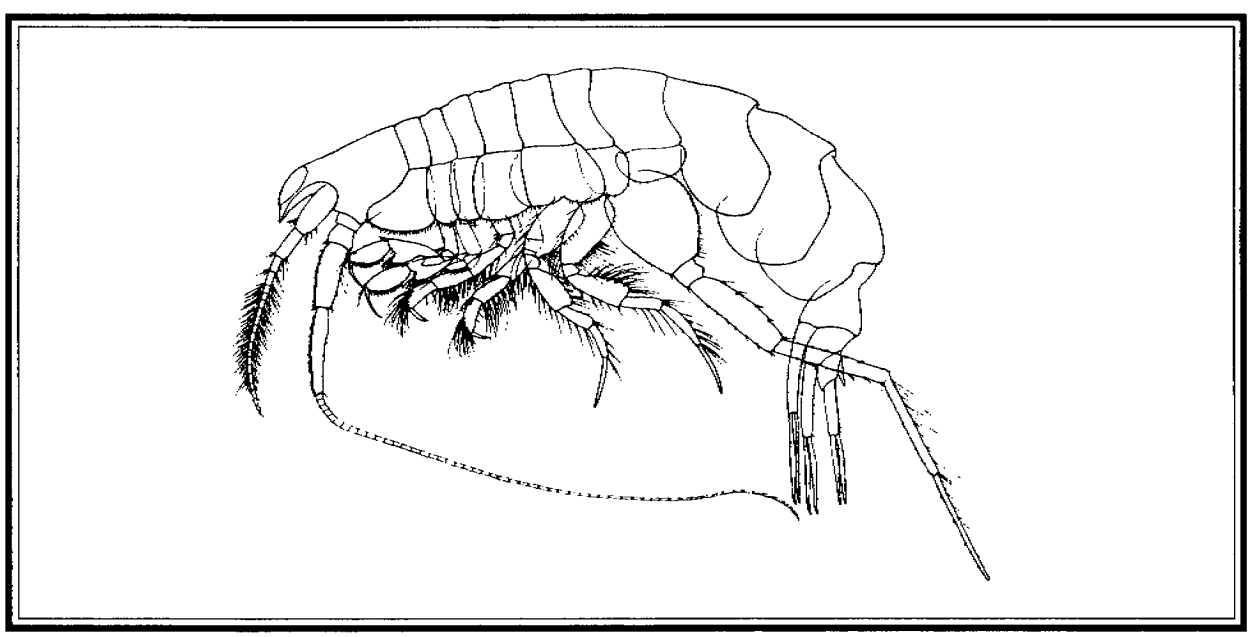


Figure 2.37. *Westwoodilla caecula* Bate, 1857, male (from Lincoln, 1979).

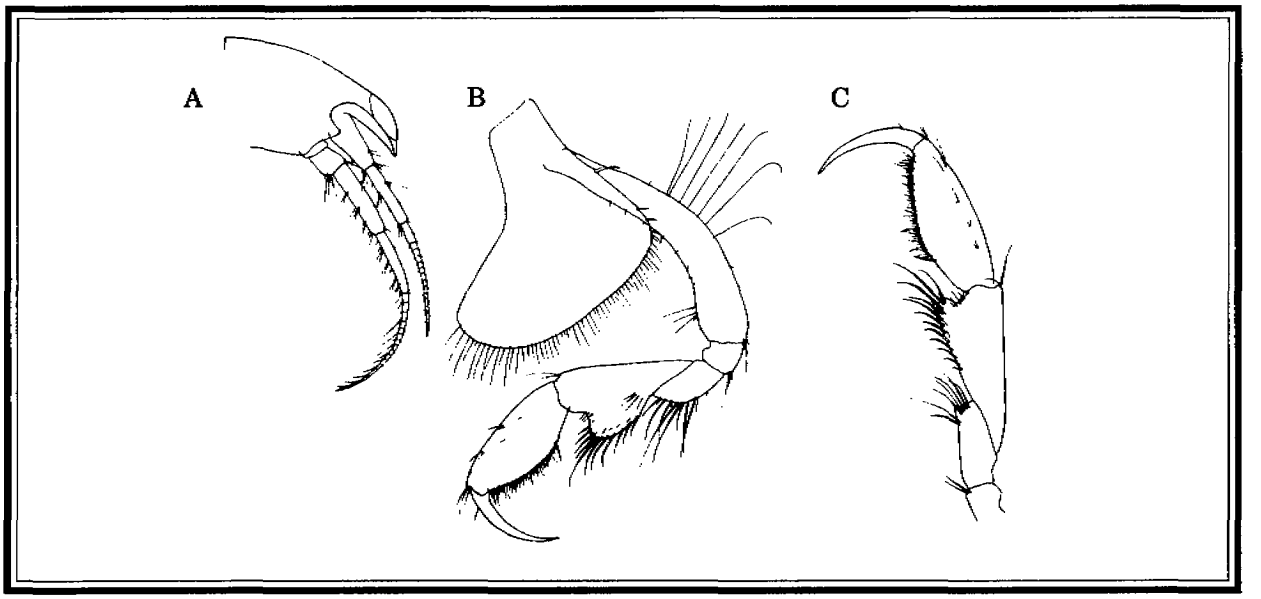


Figure 2.38. *Westwoodilla caecula;* A, Head, female; B, Gnathopod 1; C, Gnathopod 2; B and C, male (from Lincoln, 1979).

Family Pardaliscidae Boeck, 1871

Diagnosis (from Barnard and Karaman, 1991). Body laterally compressed. Coxae short. Accessory flagellum well developed. Molar absent, incisor and body of mandible flat, inner plates of maxillipeds short to barely visible.

Remarks. 18 genera, 63 species.

Key to the Paradaliscidae of the Santa Maria Basin

1A. Lateral cephalic lobe produced forward, acuminate; urosomite 1 with paired, small, mid-dorsal teeth ..... *Nicippe tumida*

1B. Lateral cephalic lobe not produced forward; urosomite 1 without paired mid-dorsal teeth 2

2A. Urosomite 2 with long thin dorsal tooth; gnathopod 1 propodus excavate, with bundle of spines at proximal edge ..... *Rhynohalicella halona*

2B. Urosomite 2 without dorsal tooth or tooth very small; gnathopod 1, propodus not excavate, without bundle of spines at proximal edge 3

3A. Urosome without teeth; gnathopods 1-2, article 6 as long as or much longer than article 5 4

3B. Urosome with teeth; gnathopods 1-2 article 6 much shorter than article 5 ..... *Pardalisca* sp.

4A. Gnathopod dactyl with 1-2 inner teeth; rostrum short ..... *Pardaliscella symmetrica/yaquina* complex[4]

4B. Gnathopod dactyl without inner teeth; rostrum long, narrow ..... *Halicoides synopiae*

Halicoides Walker, 1896

Type Species. *Halicoides anomala* Walker, 1896.

Diagnosis (from Barnard and Karaman, 1991). Rostrum well developed. Eyes absent. Ratio of peduncular articles on antenna 1 = 13:5:4, base of primary flagellum inflated with callynophore in male only, article 1 of flagellum much longer than article 3 of peduncle, peduncle article 2 short. Accessory flagellum present (aberrant in holotype of type species, see Thurston, 1976). Mouthparts forming quadrate bundle below head. Upper lip rounded below. Mandibles symmetrical, incisors smooth, palp fully developed, article 3 about one third as long as 2. Inner lobes of lower lip coalesced, with raphus. Maxilla 1, palp not expanded apically. Maxilla 2 well developed, plates equal. Inner plates of maxilliped small, outer plates medium. Palp more than one and one-half times as long as medial edge of outer plate. Coxae 1-4 subquadrate, alike, even, broader than long. Gnathopods simple, slender, propodus of gnathopod 1 much longer than carpus, equal on gnathopod 2, carpus not lobate, dactyls normally claw-shaped, without inner teeth. Pereopods simple. Urosomal teeth absent. Telson elongate, deeply cleft.

Remarks. 10 species.

***Halicoides synopiae* (Barnard, 1962)**

Figure 2.39

Pardisynopia synopiae Barnard, 1962b: 77-78, figures 3 and 4.

Material Examined. Santa Maria Basin, California, Phase II, Sta. PJ5, 152 m, October 1986, (1 specimen), Sta. R8, 90 m, January 1987, (1 specimen), Sta. R4, 92 m, October 1988, (1 specimen).

Description (modified from Barnard, 1962b). Female 5 mm. Eyes absent. Pereopod 6, article 2 with straight posterior edge, without a lobe at lower corner. Urosomite 1 with posteriorly directed dorsal tooth reaching almost to insertion of telson. Urosomite 2, posterior margin with a single long seta and with long, thin, dorsal tooth. Urosomite 3, epimeron with straight posterior edge and quadrate lower corner. Uropod 3, interramus with nodulose distomedial margin.

Type Specimen and Locality. AHF No. 5724, female, 5.0 mm. Station 4873, off Laguna Beach, 33°30'36"N, 117°47'58"W, bottom of green mud, 174 m.

Distribution and Habitat. Monterey Bay to Baja, California, 52-1748 m.

[4] See remarks under *Pardaliscella symmetrica* and *P. yaquina*. Also note the description of *Princaxelia* sp A in the text, not included in this key.

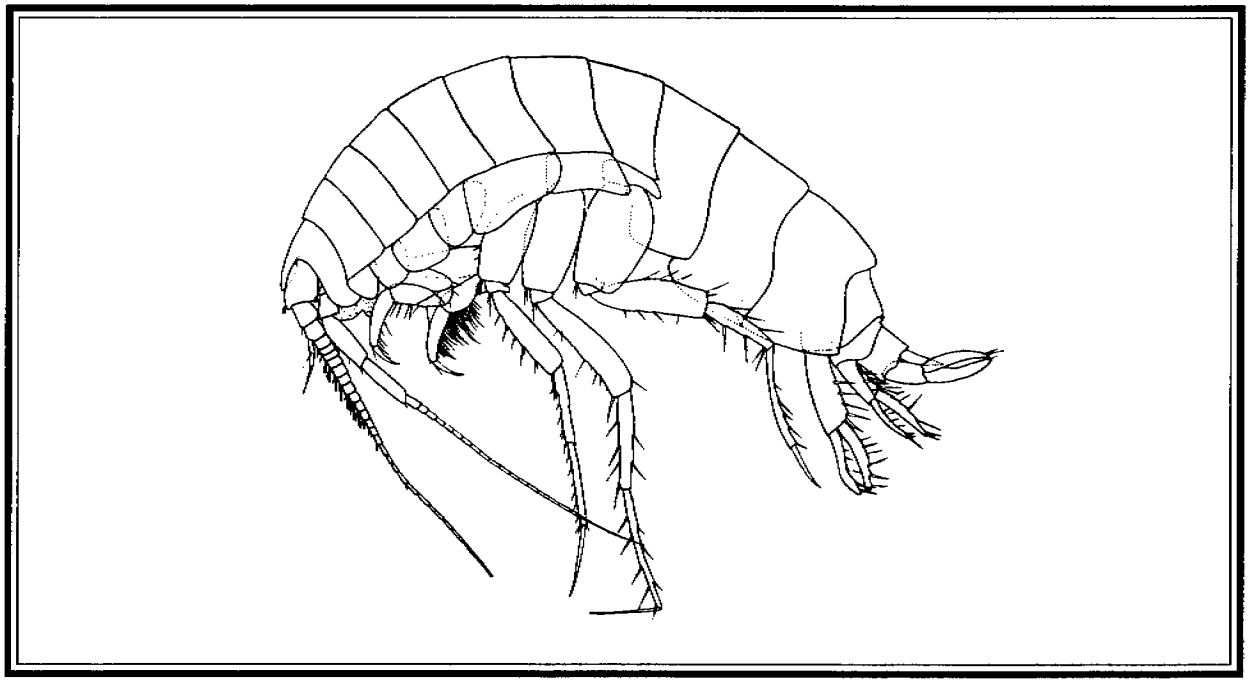


Figure 2.39. *Halicoides synopiae*, female (Barnard, 1962b).

Nicippe Bruzelius, 1859

Type Species. *Nicippe tumida* Bruzelius, 1859.

Diagnosis (from Barnard and Karaman, 1991). Rostrum small. Eyes present, weak pigment only. Ratio of peduncular articles on antenna 1 = 12:9:3, base of primary flagellum narrow, articulate, article 1 of flagellum scarcely longer than article 3 of peduncle, article 2 of peduncle short (elongate in male). Accessory flagellum present. Mouthparts forming quadrate bundle below head. Upper lip almost symmetrically incised. Mandibles asymmetrical, incisor on left weakly toothed, on right strongly toothed, palp fully developed. Inner lobes of lower lip coalesced. Maxilla 1, palp expanded apically. Maxilla 2 well developed, thin, plates equal. Both plates of maxilliped small. Palp almost 3 times as long as medial edge of outer plate. Coxae 1-4 subquadrate, alike, even, broader than long. Gnathopods weakly subchelate, stout, propodus of both gnathopods longer than carpus, carpus with long, broad, lobe, dactyls normally claw-shaped, without inner teeth. Pereopods simple. Urosomal teeth moderate to weak. Telson elongate, deeply cleft.

Remarks. 2 species.

***Nicippe tumida* Bruzelius, 1859**

Figure 2.40

Nicippe tumida Bruzelius, 1859: 99.—Sars, 1895: 410-411, plate 144.—Barnard, 1959b: 39, figures 1 and 2. —Lincoln, 1979: 394, figure 187.

Material Examined. Santa Maria Basin, California, Phase II, Sta. R4, 92 m, January and May 1987, (1 male, 1 female, 1 juvenile).

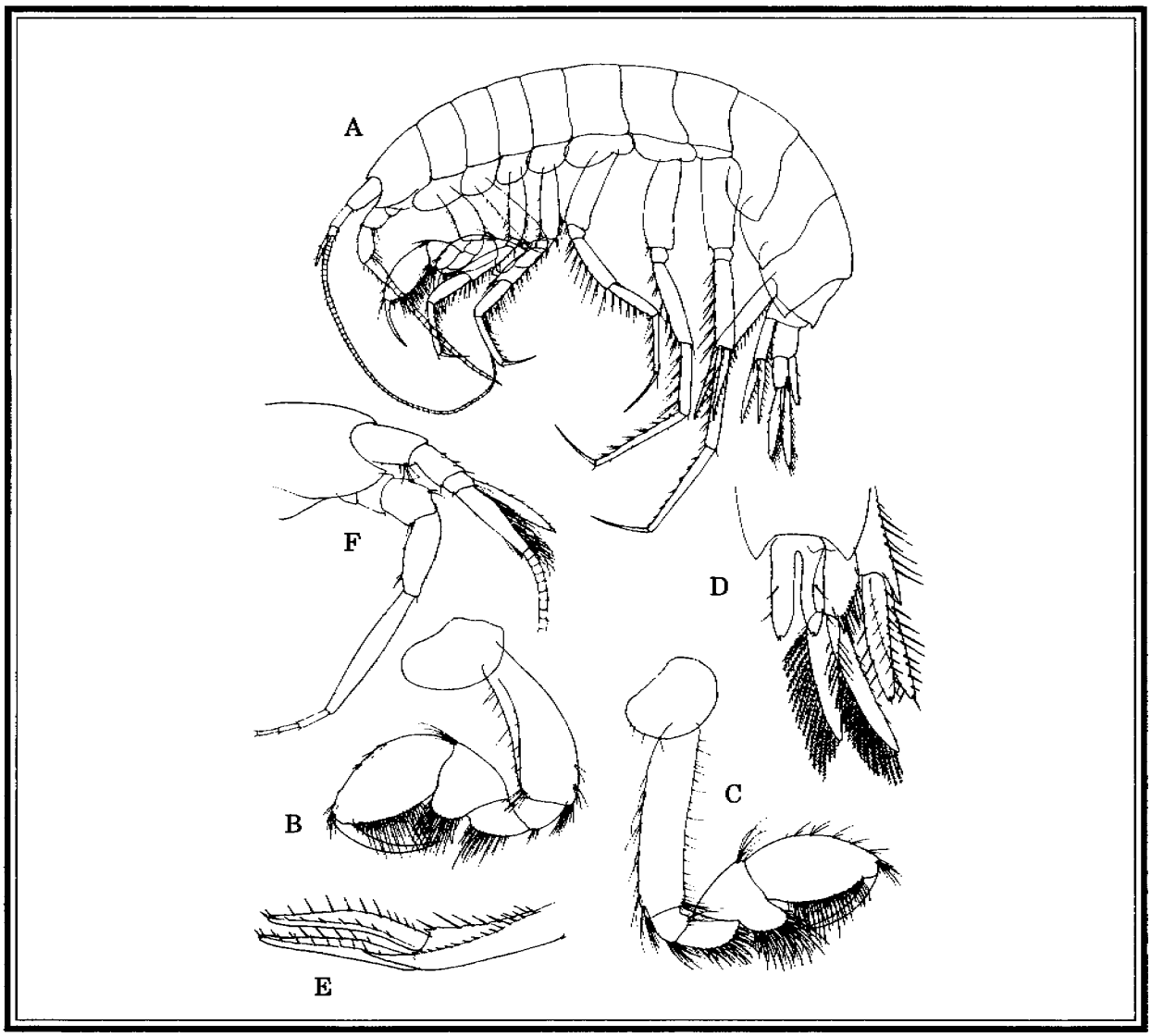


Figure 2.40. *Nicippe tumida*, female; A, Lateral view; B, Gnathopod 1; C, Gnathopod 2; D. Uropods 2-3, telson; E, Uropod 1; F, Head and antenna, male (from Lincoln, 1979).

Description. Both sexes 6.5-14.0 mm. Ommatidia scattered along lateral cephalic lobes. Urosomite 1 with paired mid-dorsal teeth. Telson narrow, nearly 3 times longer than broad, cleft almost to base and dilated at bottom.

Remarks. Barnard (1959b) includes *N. unidentata* K.H. Barnard, 1932 tentatively with the distribution records of *N. tumida* based on Enequist (1949), who suggests that it may represent phenotypic variation in the same species, however, Barnard did not synonymize the two. *N. unidentata* bears only 1 dorsal tooth on urosomite 1 and the telson is scarcely twice as long as broad, distinguishing it from *N. tumida*. There is a questionable record from the Mediterranean (Ledoyer, 1973), of 1 aberrant specimen. Our specimens agree well with published accounts for this species. Obviously identifiable features include, the 'tumid' (swollen) accessory flagellum and elongate primary flagellar article 1, antenna 1, furnished with a dense anterior tuft of setae in the male, and the dorsal bidentate tooth on urosomite 1. The accessory flagellum is not swollen in the female, but it is longer than the relatively short peduncular article.

Type Specimen and Locality. Christianiafjord, Norway.

Distribution and Habitat. Cosmopolitan. Atlantic from Davis Straight, west of Greenland into the Skagerrak and Barents Sea to South Africa; Pacific from Okhotsk and Japan Seas, California, 35-1369m (greatest depth near Iceland).

Pardalisca Krøyer, 1842

Type Species. *Pardalisca cuspidata* Krøyer, 1842.

Diagnosis (from Barnard and Karaman, 1991). Rostrum small. Eyes present or absent. Ratio of peduncular articles on antenna 1 = 11:8:3 down to 11:5:3, base of primary flagellum in female narrow, articulate, in male callynophore present, flagellum article 1 much longer than peduncle article 3 of male, shorter in female, peduncle article 2 short. Accessory flagellum present. Mouthparts forming quadrate bundle below head. Upper lip grossly and asymmetrically incised below. Mandibles asymmetrical, incisor on left weakly toothed, on right strongly toothed, palp fully developed. Inner lobes of lower lip separate. Maxilla 1 palp expanded apically. Maxilla 2 well developed, thin, plates equal. Inner plates of maxilliped small to obsolescent, outer plates large. Palp just as long as medial edge of outer plate. Coxae 1-4 quadrate, similar, even, scarcely broader than long. Gnathopods simple, slender, but carpus stout, not lobate, propodus of both gnathopods much shorter and thinner than carpus. Dactyls either stubby or claw-shaped, with many inner teeth. Pereopods simple. Urosomal teeth strong. Telson elongate, deeply cleft.

Remarks. 9 species.

***Pardalisca* sp.**

Figure 2.41

Pardalisca sp. Barnard, 1967: 124-126, Figure 59-60.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 55, 590 m, September 1984, (2 specimens).

Description. Female 8.8 mm. Eyes absent. Gnathopod 1, carpus barely twice as long as propodus. Urosomal carinae very small.

Remarks. Our specimens most closely resemble *P. tenuipes* Sars, 1895 in the pereopods, telson, and gnathopods, however they differ in lacking eyes, and the urosome, epimera and cephalic lobe are as figured for Barnard's (1967) *Pardalisca* sp., also reported from deep water.

Type Specimen and Locality. Female, 8.8 mm. Station 7229, 27 54'25" N, 115 40'00" W, 1720-1748 m, Cedros Trench, Baja California.

Distribution and Habitat. Santa Maria Basin, California and Cedros Trench, Baja California, 590-1748 m.

***Pardaliscella* Sars, 1895.**

Type Species. *Pardalisca boeckii* Malm, 1871.

Diagnosis (from Barnard and Karaman, 1991). Rostrum small. Eyes absent. Ratio of peduncular articles on antenna 1 = 24:14:17, base of primary flagellum narrow, with weak callynophore, article 1 of flagellum longer than article 3 of peduncle, article 2 peduncle short. Accessory flagellum present. Mouthparts forming quadrate bundle below head. Upper lip even of asymmetrically incised. Mandibles asymmetrical,

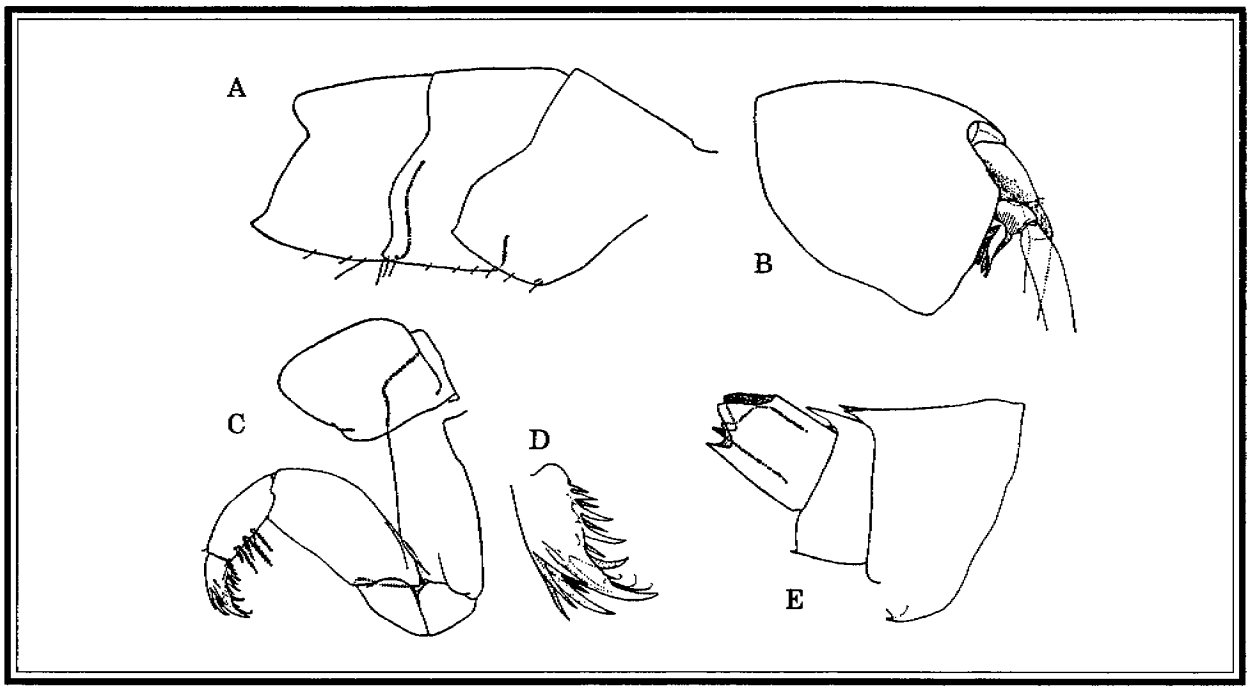


Figure 2.41. *Pardalisca* sp., female, 8.8 mm; A, Epimera 1-3; B, Head; C, Gnathopod 1; D, Close-up of gnathopod 1 dactyl showing serrations; E, Urosomites 1-3 (Barnard, 1967).

incisor on left smooth, weakly toothed, on right strongly toothed, palp fully developed, thin plates equal. Inner plates of maxilliped small, outer plates medium. Palp about 1.5x as long as medial edge of outer plate. Coxae 1-4 subquadrate, even boader than long. Gnathopods simple, moderately stout, propodus of both gnathopods about as long as carpus. Carpus not lobate, dactyls normally claw-shaped, with 1-2 inner teeth. Pereopods simple. Urosomal dorsal teeth absent. Telson scarcely elongate, partly cleft.

Remarks. 6 species.

Pardaliscella symmetrica Barnard, 1959

Figure 2.42

Pardaliscella symmetrica Barnard, 1959b: 41-42, figure 4.

Material Examined. Reported from this study, but not supported by collections.

Description (from Barnard, 1959b). Female 5 mm. Inner plate of maxilla 1 represented by a small bump bearing an apical seta. Antenna 1 slightly longer than antenna 2. Epimeron 3 with sharp posteroventral tooth at corner. Telson cleft less than 50 percent of its length.

Remarks. The description of *P. symmetrica* is incomplete. This species is closely allied with *P. yaquina* Barnard, 1971 and upon detailed examination of the types, may prove to be the same species. We received 1 small juvenile from the study area, which was inadequate for species confirmation.

Type Specimen and Locality. AHF No. 5715, female, 5 mm. Station 4873, off Newport, California, 33°30'36"N, 117°47'58"W, green silt, 174 m.

Distribution and Habitat. Oregon to southern California, 92-1749 m.

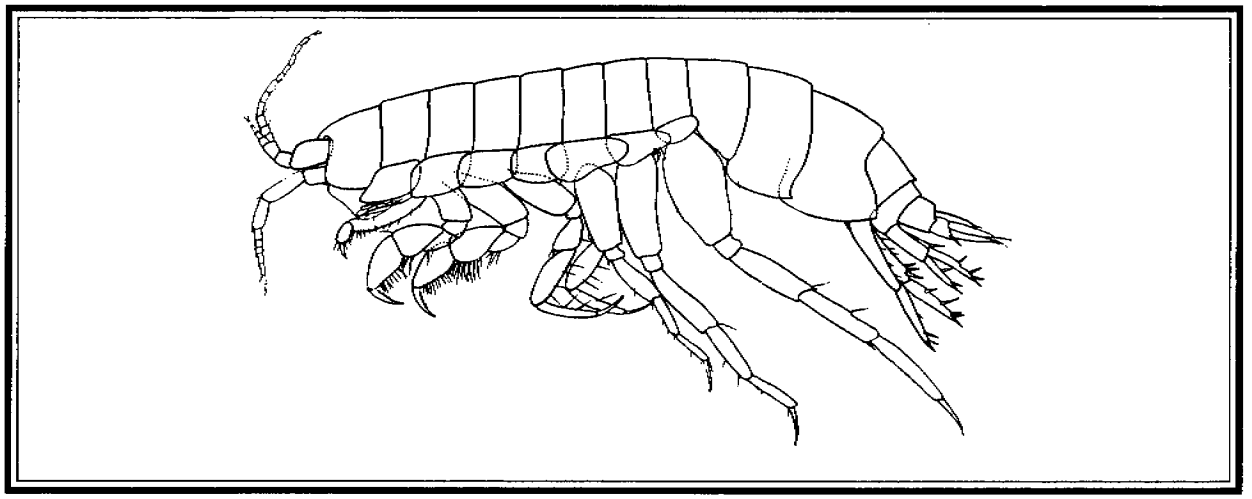


Figure 2.42. *Pardaliscella symmetrica*, male, 3 mm; Lateral view (from Barnard, 1959).

?Pardaliscella yaquina Barnard, 1971

Figure 2.43

?*Pardaliscella yaquina* Barnard, 1971: 60-63, figure 39.

Material Examined. Santa Maria Basin, California, Sta. PJ15, 155 m, (1 specimen), Sta. R3, 409 m, October 1986, (1 specimen), Sta. PJ1, 145 m, May 1987, (1 specimen).

Description (modified from Barnard, 1971). Urosomite 1 and 2 each with very small mid-dorsal tooth. Pleonal epimera 1-3 with sharp posteroventral tooth, largest on epimeron 2. Uropods stubby, stout. Telson cleft about 60 percent of length.

Remarks. Only urosomite 1 was produced into a weak triangular, mid-dorsal process, in our specimens. See remarks on *P. symmetrica.*

Type Specimen and Locality. Holotype female, 3.3 mm. Station 11, 44°38.6'N, 125°50.0'W, 400 m.

Distribution and Habitat. Oregon to southern California, 145-409 m.

Princaxelia Dahl, 1959

Type Species. *Princaxelia stephenseni* Dahl, 1959, original designation.

Diagnosis (from Barnard and Karaman, 1991). Rostrum small. Eyes present. Ratio of peduncular articles on antenna 1=9:5:2, base of primary flagellum with callynophore in male, article 1 of flagellum much longer than article 3 of peduncle, article 2 of peduncle short. Accessory flagellum present. Mouthparts forming quadrate bundle below head. Upper lip weakly and asymmetrically incised. Mandibles slightly asymmetrical, incisor on left almost smooth, on right weakly toothed, palp fully developed. Inner lobes of lower lip coalesced. Maxilla 1, palp expanded apically. Maxilla 2 well developed, plates equal. Inner lobes of lower lip coalesced. Inner plates of maxilliped small, outer plates large; palp more than 3 times as long as medial edge of outer plate. Coxae 1-4 quadrate, alike, even, broader than long. Gnathopods simple, stout,

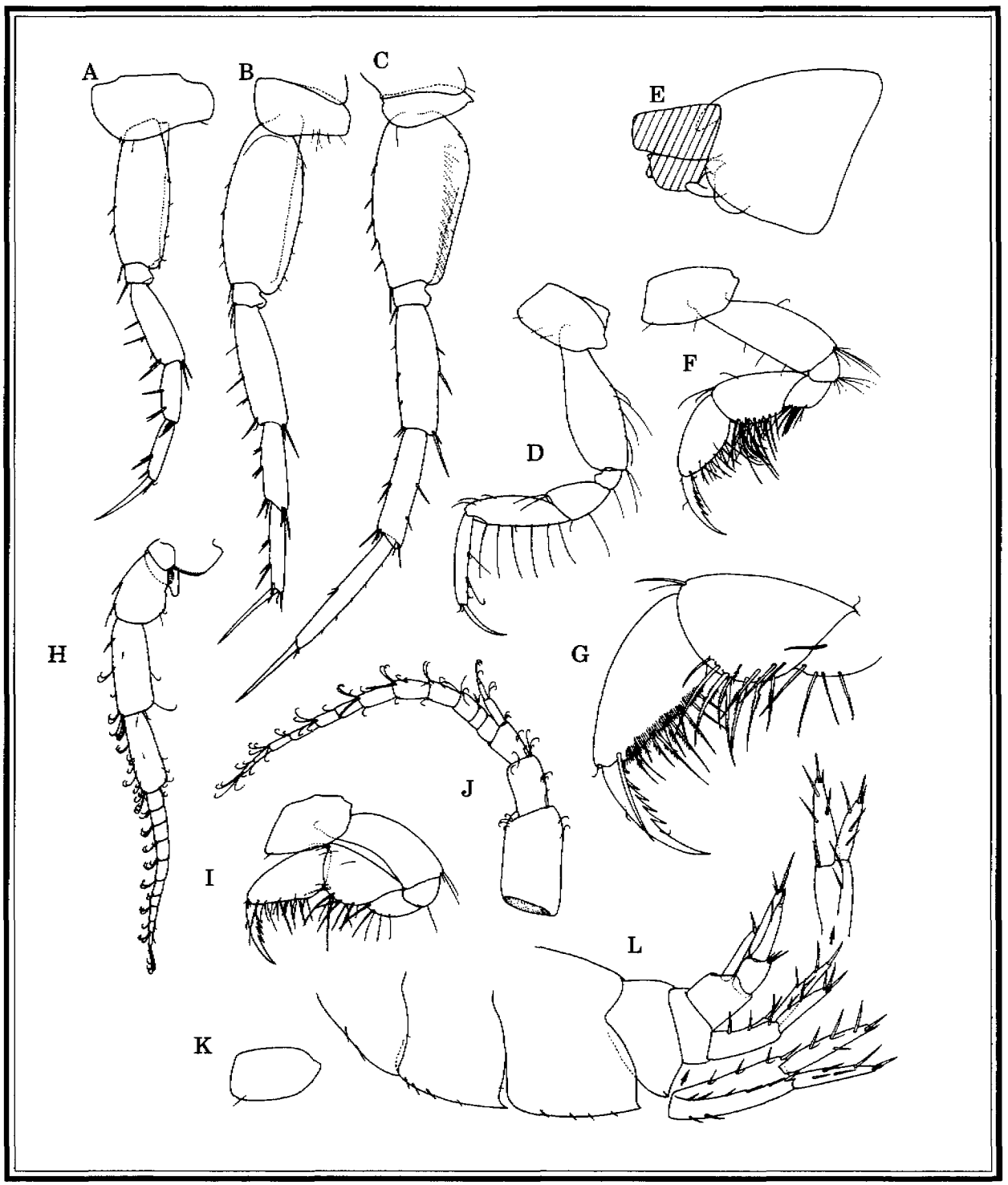


Figure 2.43. *Pardaliscella ?yaquina*, female, 3.3 mm; A, Pereopod 5; B, Pereopod 6; C, Pereopod 7; D, Pereopod 4; E, Head; F, Gnathopod 2; G, Gnathopod 2, close-up of dactyl; H, Antenna 2; I, Gnathopod 1; J, Antenna 1; K, Telson; L, Epimera 2 and 3, urosomites with close-ups of uropods (from Barnard, 1971).

article 6 of both gnathopods much shorter and narrower than article 5, carpus with broad, shallow lobe, dactyls normally claw-shaped, without inner teeth. Pereopods simple. Urosomal teeth strong. Telson elongate, deeply cleft.

Remarks. 3 species.

Princaxelia sp. A

Material Examined. Santa Maria Basin, California, Phase I, Sta. 63, 930 m, (3 specimens).

Description. Dorso-ventrally flattened. Antenna 1, article 1 flat and wide. Coxae very short. Gnathopod 1 and 2 similar, carpus inflated, almost twice as wide as propodus. Uropods elongate. Uropods 1 and 2 lanceolate, sparsely spinose along outer edge of peduncle and outer ramus. Uropod 3 not ornamented, rami lanceolate, foliose. Telson not tapering from base.

Remarks. The material we examined was limited to 3 specimens and was in poor condition, therefore we are hesitant to give this a new species designation or include it in the key. Two of the species in this genus have Pacific distributions, but have not been recorded as far east or north as California. Our specimens do not appear to be any of the currently described species.

Distribution and Habitat. Santa Maria Basin, California, 930 m.

Rhynohalicella Karaman, 1974

Type Species. *Halicella halona* Barnard, 1971.

Diagnosis (from Barnard and Karaman, 1991). Rostrum well developed. Eyes absent. Ratio of peduncular articles on antenna 1 = 30:10:9, base of primary flagellum with callynophore, article 1 of flagellum much longer than article 3 of peduncle, article 2 of peduncle short. Accessory flagellum present. Mouthparts styliform, forming conical bundle below head. Upper lip evenly incised. Mandibles symmetrical, incisors smooth, palp represented by tubercle with 2 setae. Inner lobes of lower lip separate. Maxilla 1, palp not expanded apically. Maxilla 2 represented by single elongate plate. Inner plates of maxilliped absent. Outer plates large. Maxilliped palp only as long as medial edge of outer plate. Coxae 1-4 softly subtriangular or trapezoidal, weakly diverse, broader than long. Gnathopods simple, of medium stoutness, propdus of gnathopod 1 much longer than carpus, carpus with short, broad, shallow lobe. Gnathopod 2 simple, carpus elongate and more broadly lobate, dactyls normally claw-shaped, without inner teeth. Pereopods simple. Urosomal teeth strong. Telson elongate, deeply cleft.

Remarks. monotypic genus.

Rhynohalicella halona (Barnard, 1971)

Figure 2.44

Halicella halona Barnard, 1971: 56-60, figures 35-37.
Rhynohalicella halona: Karaman, 1974: 33.

Material Examined. Santa Maria Basin, California, Phase II, Sta. R3, 409 m, October 1988, (2 specimens).

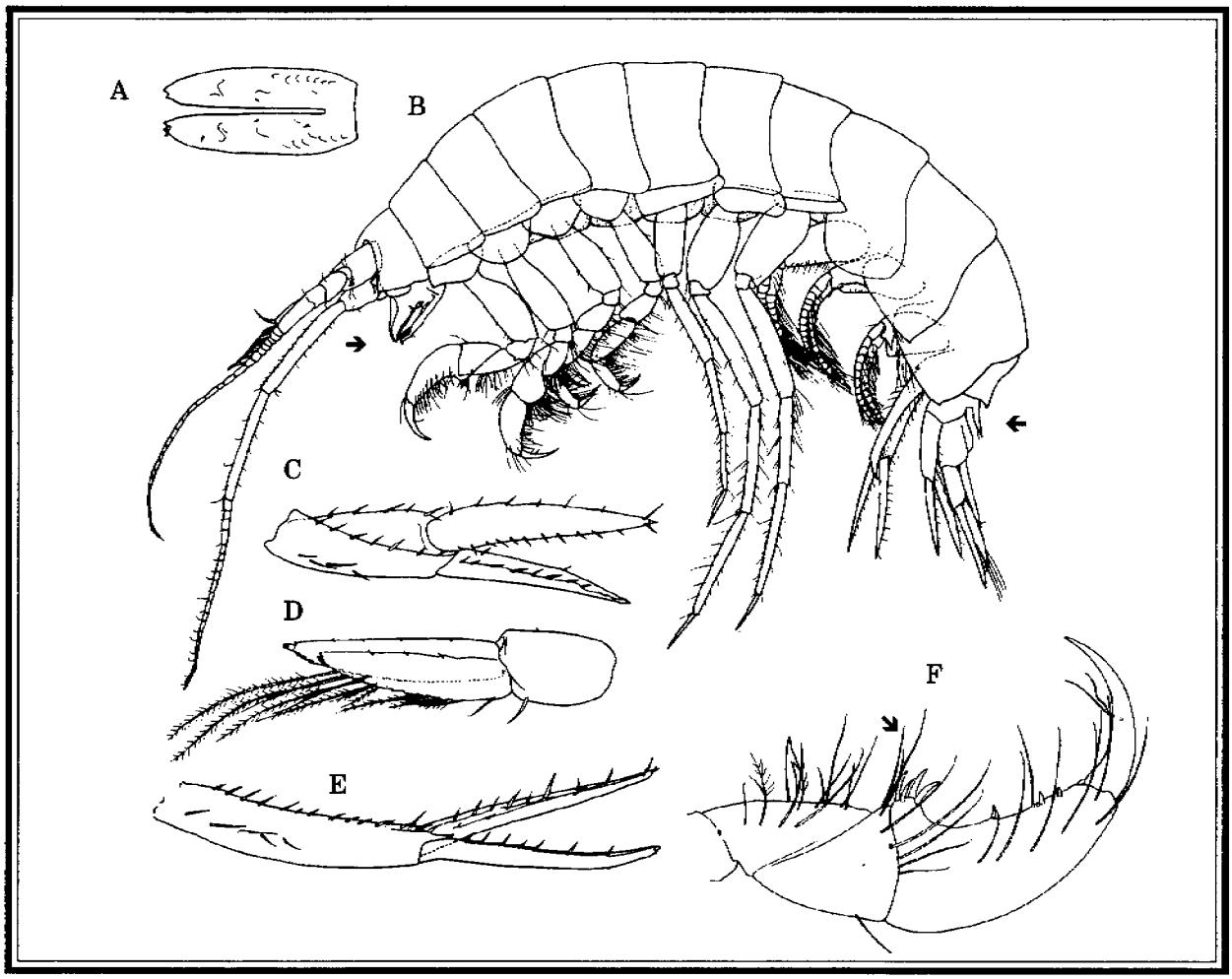


Figure 2.44. *Rhynohalicella halona*, male, 5.6 mm; A, Telson; B, Lateral view (note the quadrate bundle forming the mouthparts and the dorsal spine on urosomite 2); C, Uropod 2; D, Uropod 3; E, Uropod 1; F, Gnathopod 1 (note the proximal spinose protrusion) (from Barnard, 1971).

Description (from Barnard, 1971). Male 5.6 mm. See diagnosis of the genus. Mandibular palp vestigial. Maxilla 1 with small, conical, 1-articulate palp. Posterior margin of gnathopod 1, propodus deeply excavate and defined by proximal spinose protrusion. Epimeron 1 posteroventrally rounded, epimera 2-3 with weak posteroventral tooth. Urosomite 2 with posteriorly directed tooth reaching almost to insertion of telson. Urosomite 3, with weak mid-dorsal tooth. Telson elongate, cleft three-quarters of its length.

Remarks. This study yields the first documented records from California waters.

Type Specimen and Locality. USNM No. 127128, male, 5.6 mm. Station 21, 44°39.1'N, 124°36.3'W, 200 m.

Distribution and Habitat. Oregon and southern California, 200-409 m.

Family Phoxocephalidae Sars, 1895

Diagnosis (from Barnard and Karaman, 1991). Rostrum visor-like or absent. Ventral cephalic cheek weak or absent. Antenna 1, article 3 short. Antenna 2, article 4 with facial spines. When rostrum reduced or absent, facial spines occurring on article 4 of antenna 2 or articles 4-5 of pereopods 5-6. Right incisor broad and 3+ toothed (generally only Tipimeginae more than 3 toothed). Mandibular palp, article 3 with only 0-2 sets of outer setae closely contiguous on opposite faces, never in serial ranks, apex bevelled, all other setae dominantly apical. Molar, if triturative, cup-shaped, otherwise spinose and simple. Inner plate of maxilla 1 never pointed, never with more than 2 fully medial setae, other setae apical or absent. Coxae regular. Pereopod 5 with facial spines on articles 4-5. Pereopod 7 distinct from pereopods 5-6, much shorter than 6, article 2 broadly expanded in free, plate-like lobe. Epimeron 1 well developed. Peduncles of pleopods longer than wide. Rami of uropods 1-2 styliform. Uropod 3 biramous. Telson deeply cleft.

Remarks. 68 genera, 263 species. This family is fraught with taxonomic problems: the distinctions among genera are not clearly defined, and many specific descriptions are incomplete. Two primary characters used in separating genera include the presence or absence of a displaced spine and/or an inter-ramal spike, on uropod 1. The placement of these spines is difficult to visualize, and often hard to interpret, particularily when only one character is present. Another characteristic used to distinguish genera deals with the presence of an ensiform process on antenna 2. We have found this character inconsistent within the *Rhepoxynius* and *Harpiniopsis*. Unfortunately, we have been forced to use some of these characters in this key, for lack of better information. With limited numbers of specimens and time, we have not been able to address these difficulties adequately, but have tried to document variability in the material we examined. Characters we found to be conservative, include the shape and setation patterns of the epimera.

Key to the Phoxocephalidae of the Santa Maria Basin

1A. Rostrum constricted (Figure 2.45) ..... (*Rhepoxynius*) 2

Figure 2.45

1B. Rostrum unconstricted 6

2A. Pereopod 7, posterior margin with 2-4 large teeth or cusps, margin otherwise smooth 3

2B. Pereopod 7, posterior margin without large teeth, margins with many small to medium serrations 4

3A. Pereopod 7 with 3-4 large cusps ..... *Rhepoxynius variatus*

3B. Pereopod 7 with 2 large, irregularly shaped cusps ..... *Rhepoxynius bicuspidatus*

4A. Uropod 3, inner ramus short, less than half the length of outer ramus (female only) .... *Rhepoxynius daboius*

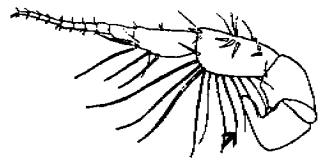
4B. Uropod 3, inner ramus at least half as long as outer ramus (both sexes) 5

5A. Pereopod 7, article 2 with 4-5 medium teeth; epistome rounded, without cusp ..... *Rhepoxynius heterocuspidatus*

5B. Pereopod 7, article 2 with 9 small teeth or serrations; epistome with a long, sharp cusp ..... *Rhepoxynius menziesi*

6A. Antenna 2, article 1 with ensiform process (sometimes small and weak) (Figure 2.46) 12

Figure 2.46



6B. Antenna 2, article 1 without ensiform process 7

7A. Urosomite 1 and 3 with dorsal processes; eyes absent ..... *Leptophoxus falcatus icelus*

7B. Urosomite 1 and 3 without dorsal processes; eyes present 8

8A. Epimeron 3 posterior margin asetose 9

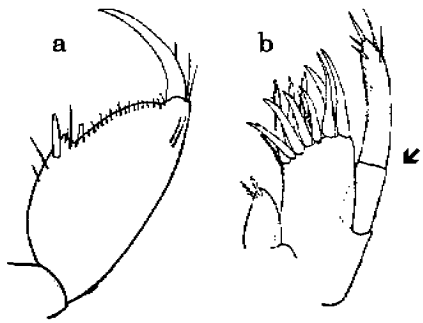
8B. Epimeron 3 posterior margin with setae 10

9A. Maxilla 1, palp 1-articulate; gnathopod 1 palm nearly transverse (Figure 2.47) ..... *Metaphoxus frequens*

Figure 2.47

9B. Maxilla 1, palp 2-articulate (Figure 2.48b); gnathopod 1 palm oblique (Figure 2.48a) ..... *Paraphoxus oculatus*

Figure 2.48



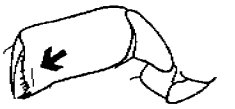
10A. Epimeron 3 posteroventral corner rounded with 2-3 short setae, ventral margin setose; gnathopods 1-2 palms, nearly transverse to transverse 11

10B. Epimeron 3 posteroventral corner bluntly angled with 6-9 long basofacial setae on lateral flange; epimeron 2 ventral margin with 4-6 setae; gnathopods 1-2, palms oblique ..... *Eyakia robusta*

11A. Epimeron 3 posterior margin with 2 short setae; Epimeron 2, ventral margin with 6 setae; gnathopod 1-2 palms weakly transverse ..... *Cephalophoxoides homilis*

11B. Epimeron 3, posterior margin with 3 short setae; Epimeron 2 ventral margin with 1 or fewer setae; gnathopod 1-2 palms strongly transverse (Figure 2.49) ..... *Parametaphoxus fultoni*

Figure 2.49



12A. Pereopod 7, article 2 anteroventral margin with 7-12 long plumose setae ..... (*Pseudharpinia*) 13

12B. Pereopod 7, article 2 anteroventral margin without setae 14

13A. Head with dorsal crest; Pereopod 7, article 2 anteroventral margin with 10-12 long plumose setae ..... *Pseudharpinia excavata*

13B. Head without dorsal crest; Pereopod 7, article 2 anteroventral margin with 7 plumose setae .... *Pseudharpinia* sp. 1

14A. Eyes present 15

14B. Eyes absent ..... (*Harpiniopsis*) 16

15A. Cephalic lobe with acute, downward projecting tooth; epimeron 3 posteroventral corner produced upward into a large tooth ..... *Heterophoxus oculatus*

15B. Cephalic lobe without downward projecting tooth (cheek may project forward slightly); epimeron 3 posteroventral corner rounded, or acuminate, but without tooth ..... (*Foxiphalus*) 22

16A. Lower corner of cephalic lobe acuminate, produced forward 17

16B. Lower corner of cephalic lobe bluntly angular, rounded 20

17A. Epimeron 3, ventral margin with concave sinus; pereopod 7 posterior serrations increasing in size distally, culminating in 2 large teeth ..... *Harpiniopsis profundis*

17B. Epimeron 3, ventral margin without sinus; pereopod 7 posterior serrations small to moderate in size, approximately equal in size over entire margin 18

18A. Cephalic lobe, lower corner reaching article 3 of antenna 2; ensiform process on antenna 2 strong, acute; head sometimes with a dorsal crest ..... *Harpiniopsis fulgens*

18B. Cephalic lobe, lower corner reaching article 1 or 2 of antenna 2; ensiform process on antenna 2 weak, small; head never with a dorsal crest 19

19A. Epimeron 3, posteroventral margin bluntly angular; rostrum short, wide, and blunt ..... *Harpiniopsis naiadis*

19B. Epimeron 3, posteroventral margin acuminate, upturned; rostrum long and narrow ..... *Harpiniopsis galera*

20A. Epimeron 3 with tooth, posteroventral corner acuminate 21

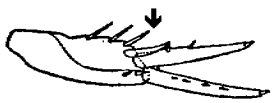
20B. Epimeron 3 without tooth, posteroventral corner rounded ..... *Harpiniopsis epistomata*

21A. Epimeron 3, posterior margin vertical, with long acuminate tooth postero-ventrally extending 1/4 of the way up the pereon, ventral margin with 5 setae ..... *Harpiniopsis* sp. 2

21B. Epimeron 3 posterior margin angled slightly, with very long acuminate tooth posteroventrally extending midway up the pereon, ventral margin asetose ..... *Harpiniopsis emeryi*

22A. Peduncle of uropod 1 with displaced apicomedial spine (Figure 2.50) 23

Figure 2.50



22B. Peduncle of uropod 1 lacking displaced apicomedial spine ..... *Foxiphalus golfensis*

23A. Epistome, cusp prominent, sharp 24

23B. Epistome, cusp weak or lacking 25

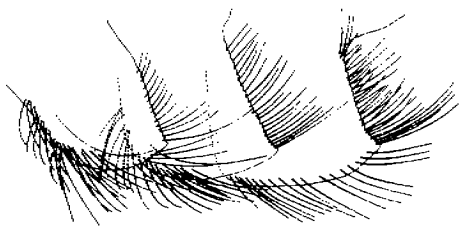
24A. Cusp of epistome large (Figure 2.51); gnathopod 2, article 5 little more than half length of article 6; epimeron 2 with 8 basofacial setae ..... *Foxiphalus similis*

Figure 2.51

24B. Cusp of epistome small to medium; gnathopod 2, article 5 3/4 length of article 6;epimeron 2 with 4 basofacial setae ..... *Foxiphalus cognatus*

25A. Epimera 2-3, posterior and ventral margins densely setose (Figure 2.52); rostrum not extending beyond antenna 1, article 2 ..... *Foxiphalus major*

Figure 2.52



25B. Epimera 2-3, posterior margin moderately setose, ventral margin scarcely setose (Figure 2.53); rostrum extending beyond antenna 1, article 2 ..... *Foxiphalus obtusidens*

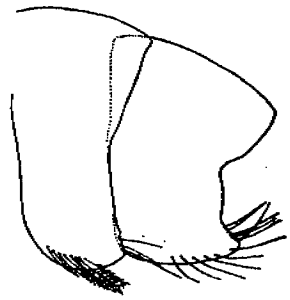


Figure 2.53

Cephalophoxoides Gurjanova, 1977.

Type Species. *Phoxocephalus bassi* Stebbing 1888, original designation.

Diagnosis (from Barnard and Karaman, 1991). Rostrum unconstricted. Eyes present. Antenna 1, article 2 short, ventral setae confined apically. Antenna 2, article 1 not ensiform, article 3 with 2 facial setules, facial spines on article 4 in 2+ rows, all spines thick, article 5 short. Right mandibular incisor with 2-3 teeth, right lacinia mobilis bifid, flabellate, molar triturative. Palpar hump small to medium, apex of palp, article 3 oblique. Inner plate of maxilla 1 without setae, palp 1-articulate. Maxillipeds ordinary, apex of palp article 3 not strongly protuberant, dactyl elongate, apical nail distinct. Gnathopods dissimilar, gnathopod 2 strongly enlarged, carpus of gnathopod 1 of ordinary length, free, with weak eusirid attachment, of gnathopod 2 similar but cryptic, palms oblique or transverse to chelate, propodus of gnathopods 1 ordinary to thin, rectangular, often elongate, of gnathopod 2 broadened, both poorly setose anteriorly. Pereopods 3-4, article 5 with posteroproximal setae, article 6 with thin armaments. Pereopod 5, article 2 broad, but often tapering distally, articles 4-5 of pereopods 5-6 narrow. Pereopod 7 ordinary, article 3 ordinary, dactyl ordinary. Epimeron 3 ordinary or rounded and smooth, bearing 0-8 long setae. Peduncle of uropod 1 without major displaced spine, rami of uropods 1-2 not continuously spinose to apex, without subapical spines or nails, inner ramus of uropod 1 with 1 row of marginal spines. Inner ramus of uropod 2 ordinary. Uropod 3 ordinary, rami longer than peduncle, outer ramus 2-articulate, with 2 apical setae. Telson ordinary to long, with or without supernumerary lateral or dorsal setae.

Remarks. 8 species.

Cephalophoxoides homilis (Barnard, 1960)

Figure 2.54

Phoxocephalis homilis Barnard, 1960: 301, plate 49-50.
Cephalophoxoides homilis: Gurjanova, 1977: 81.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 4, 393 m, September 1984, (11 specimens).

Description (from Barnard, 1960). Female 2.75-4.0 mm, male 3.0 mm. Eyes with well developed lenses. Gnathopods with enlarged terminal articles, propodus of each longer than broad. Pereopod 5, article 2 broadly expanded. Uropod 1 with rami slightly unequal. Pereopod 6 not elongated. Pereopod 7, lobe of article 2 expanding distally. Epimeron 3 nearly straight behind, smooth except for setules. Uropod 2 with slender spines on peduncle and outer ramus.

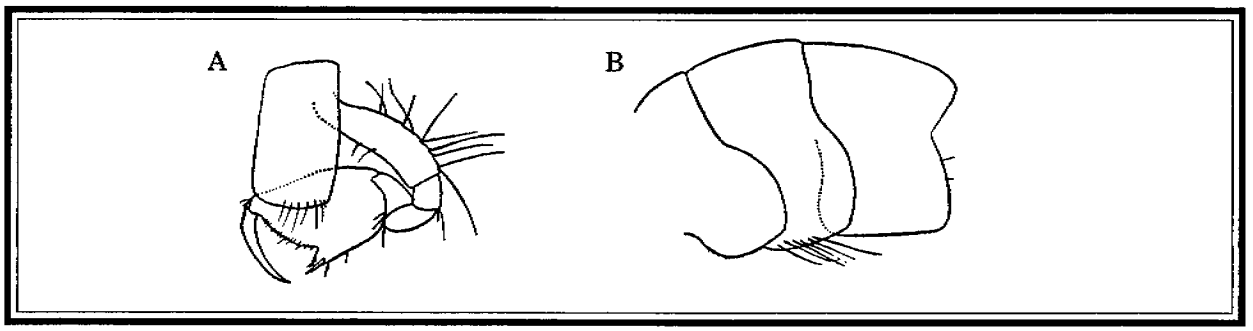


Figure 2.54. *Cephalophoxoides homilis*, male, 3 mm; A, Gnathopod 2; B, Epimera 1-3 (from Barnard, 1960).

Remarks. Our specimens have 2-3 setae on the posterior margin of epimeron 3, none on the ventral margin, 6-7 setae on the ventral margin of epimeron 2, and gnathopod 2 is weakly transverse.

Type Specimen and Locality. Holotype AHF No. 5311, female, 4 mm. Station 2293-53, SW of Newport, California, 33°30'00"N, 117°57'57"W, 461 m.

Distribution and Habitat. Monterey to San Cristobal Bay, Baja California, 62-2059 m, but generally 180-365 m.

Eyakia Barnard, 1979b

Type Species. *Parharpinia calcarata* Gurjanova, 1938, original designation.

Diagnosis (from Barnard and Karaman, 1991). Rostrum unconstricted. Eyes present. Antenna 1, article 2 of medium length, ventral setae widely spread. Antenna 2, article 1 not ensiform, article 3 with 2 facial setules, facial spines on article 4 in 2+ rows, plus special apical spines, all spines thick, article 5 ordinary. Right mandibular incisor with 3 teeth, right lacinia mobilis bifid, flabellate, molar not triturative, pillow shaped, with 3-4+ splayed spines, one of those very large. Palpar hump small, apex of palp article 3 oblique. Inner plate of maxilla 1 with 4 setae, palp 2-articulate. Maxillipeds ordinary, apex of palp article 3 not strongly protuberant, dactyl elongate, apical nail distinct. Gnathopods dissimilar, gnathopod 2 moderately to strongly enlarged, gnathopod 1, carpus of ordinary length, but short on gnathopod 2, without eusirid attachment, palms oblique, propodus of gnathopods 1-2 ordinary or ovatorectangular, and weakly elongate, poorly setose anteriorly. Pereopods 3-4, article 5 with posteroproximal setae, article 5 with thick armaments. Pereopod 5, article 2 broad, but tapering distally, article 4-5 of pereopods 5-6 narrow. Pereopod 7 ordinary, article 3 ordinary, dactyl ordinary. Epimeron 3 ordinary, bearing 3 or more long setae. Uropod 1, peduncle without major displaced spine, rami of uropods 1-2 not continuously spinose to apex, without subapical spines, inner ramus of uropod 1 without 1 row of marginal spines. Inner ramus of uropod 2 ordinary. Uropod 3 ordinary, outer ramus 2-articulate, with 2 apical setae. Telson ordinary.

Remarks. 5 species.

***Eyakia robusta* (Holmes, 1908)**

Figure 2.55

Paraphoxus robustus Holmes, 1908: 518-521, figure 27.—Barnard, 1960: 235-237, plate 25.
Eyakia robustus: Barnard, 1979a: 375-376.—Barnard and Barnard, 1981: 305-309, figure 1m, w, y.

Material Examined. Santa Maria Basin, California, Phase II, Sta. R5, 154 m, October 1986, (1 specimen).

Description (modified from Barnard, 1960). Female 8-15 mm, male 6.5-12 mm. Head broad, rostrum long, blunt, not recurved. Eyes small. Body narrow. Epistome not produced. Maxilliped palp, article 4 with apical spine. Gnathopods 1-2, article 5 shorter than 6, article 6 rather slender, palm oblique. Pereopod 5 slender, article 6 longer than 5. Pereopod 6 slender, article 2 prolonged conically at distal posterior corner. Pereopod 7, article 2 moderately slender, extending down to the middle of article 4, strongly convex on lower edge, with approximately 9 minute teeth. Uropod 1, upper edge of peduncle with slender, long setae, outer ramus with 2, inner ramus with one stout spine. Uropod 2, upper edge of peduncle with crowded, long stiff setae, outer ramus bare, inner with 3 stout spines. Uropod 3, inner ramus about one-half as long as outer ramus, article 2 of outer ramus very slender and about one-sixth as long as article 1, otherwise stout. Third epimeron posterior edge slightly concave, lower corner armed with a large, blunt tooth, the upper edge of which continues as a setose flange onto the lateral surface of the epimeral plate. Telson broad, apices blunt, each armed with 3 long spines.

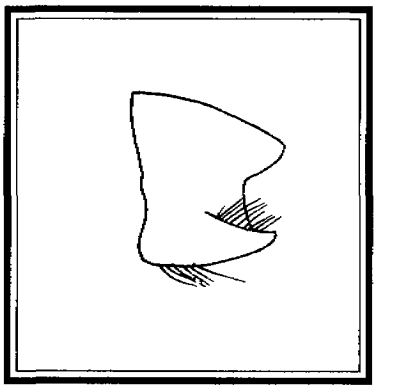


Figure 2.55. *Eyakia robusta*, female, 10 mm; Epimeron 3 (from Barnard, 1960).

Remarks. This species is readily distinguished from others in the genus by the large tooth on the posteroventral corner of epimeron 3. The setose flange on epimeron 3 is also distinctive.

Type Specimen and Locality. Holotype USNM No. 38547, 1 male and 1 female, 8 mm. Station 4304, off Pt. Loma, California, 46 m.

Distribution and Habitat. Inner Aleutian Islands to Bahia de San Quintin, Baja California, 4-221 m, mainly concentrated in 55-100 m and associated with the brittle star *Amphiodia urtica* (Barnard, 1960). Also found swimming at the surface of the neritic zone.

Foxiphalus Barnard, 1979a

Type Species. *Pontharpinia obtusidens* Alderman, 1936, original designation.

Diagnosis (from Barnard and Karaman, 1991). Rostrum unconstricted. Eyes present. Antenna 1, article 3 elongate, ventral setae narrowly to widely spread. Antenna 2, article 1 ensiform, article 3 with 2 facial setules, facial spines on article 4 in 2+ rows, spines thick, article 5 ordinary. Right mandibular incisor with 3 teeth, right lacinia mobilis bifid or simple, thin. Molar not triturative, with 4+ splayed spines. Palpar hump medium, apex of palp article 3 oblique. Inner plate of maxilla 1 with 4 setae, palp 2-articulate. Maxillipeds ordinary, apex of palp article 3 not strongly protuberant, dactyl elongate, apical nail distinct. Gnathopods ordinary, small, similar, carpus of ordinary length to elongate, free, palms oblique, propodus ovatorectangular, poorly setose anteriorly. Pereopods 3-4, article 5 with posteroproximal setae, article 6 with thick armaments. Pereopod 5, article 2 broad, pereopods 5-6, articles 4-5 medium to narrow. Pereopod 7 ordinary, article 3 ordinary, dactyl ordinary. Epimeron 3 ordinary, bearing 3 or more long setae. Peduncle of uropod 1, with major displaced spine apicomedially or not, rami of uropods 1-2 not conspicuously spinose to apex, without subapical spines or nails, inner ramus of uropod 1 with 1 row of marginal spines. Uropod 2, inner ramus ordinary. Uropod 3 ordinary, one of rami not longer than peduncle, outer ramus 2-articulate, with 2 apical setae. Telson with supernumerary lateral or dorsal spines (in adults or open sea forms).

Remarks. 9 species. There are some confusing synonomies within this group that need to be addressed more thoroughly.

Foxiphalus cognatus (Barnard, 1960)

Figures 2.50, 2.56

Paraphoxus cognatus Barnard, 1960: 233-235, plate 24.—Barnard, 1969: 219-222.
Foxiphalus cognatus: Barnard and Barnard, 1982a: 24-26.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 94, 96 m, November 1983, (1 specimen).

Description (from Barnard, 1960). Male 4-4.7 mm. Head rather broad and short, rostrum tapering evenly anteriorly, rostrum reaching middle of antennae 1, article 2. Eyes large, oval. Epistome produced, acute but rather short, variable. Maxillipedal palp article 4 with an apical spine. Gnathopods, carpus much shorter than propodus, the latter rather slender in gnathopod 1, stouter in gnathopod 2, palm oblique. Pereopod 5 moderately slender, articles 4-6, successively more slender and longer. Pereopod 6 slender, article 2 with posterior ventral corner slightly produced and rounded broadly. Pereopod 7, article 2 narrow, extending more than midway along article 4, its lower edge rounded, sweep point near distal end of article 3, posterior edge with about 9 minute teeth, rest of appendage slender, article 6 longer than 5. Uropods 1-2, apices of rami each bear a short, articulated spine. Urosomite 1 with lateral setule at base of uropod 1. Uropod 1 with a few long peduncular spines, the distalmost being the stoutest, rami with small spines. Uropod 2 with short, crowded spines on peduncle, outer ramus with 4 small spines, inner ramus with one. Uropod 3, inner ramus as long as article 1, outer ramus about one-fifth as long as article 1. Third epimeron, posterior edge nearly straight, lower corner sub quadrate, lower posterior edge with 4 stiff setae. Telson broad, apices broadly rounded, notched laterally, each notch with 1 to 3 short spines.

Remarks. Barnard and Barnard (1982a) state that "*F. cognatus* has a smaller epistomal cusp and stouter displaced spine on the molar" than *F. similis* (Barnard, 1960) and a longer 5th article of the gnathopods (Barnard, 1969). The Barnards' (1982a) redescription of the holotype differs from the original in several features, particularily the dimensions and setation of the telson. Our material has a sharp, moderately sized epistomal cusp, pereopod 7, article 2 has 3 minor serrations, epimeron 2 with a single posterior seta, and 3 subfacial setae, epimeron 3 rounded, with 3-4 setae on the ventral margin, and a linear posterior margin, with 5 setae.

Type Specimen and Locality. Holotype AHF No. 5114, male, 4 mm. Station 2047-51, Emerald Cove, Santa Catalina Island, California, dip net.

Distribution and Habitat. Dillon Beach, California, to Bahía de Los Angeles and La Paz in the Gulf of California, in coarse shell sand, surface to 324 m.

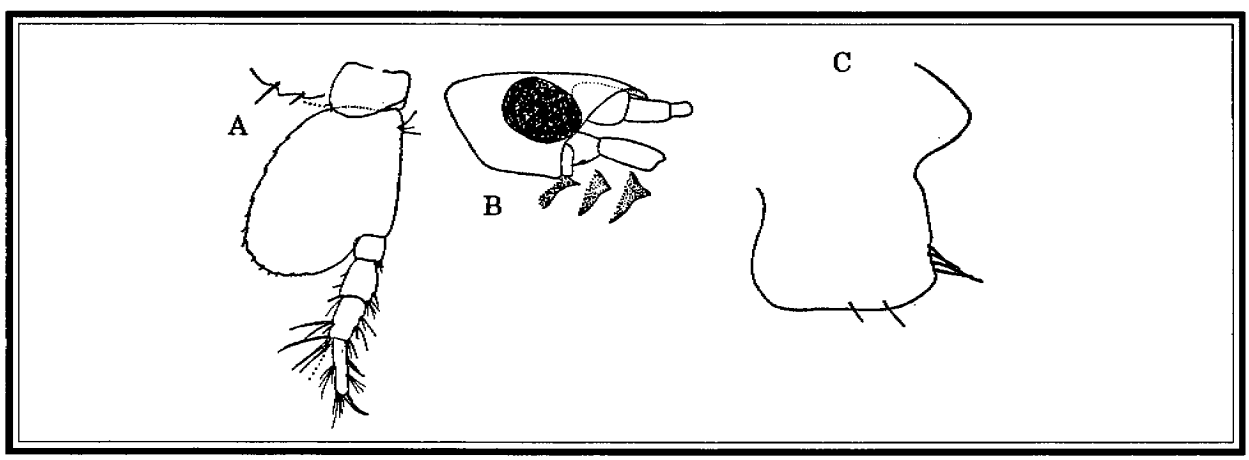


Figure 2.56. *Foxiphalus cognatus*, male, 4 mm; A, Pereopod 7; B, Head with 3 variations of the epistome; C, Epimeron 3 (from Barnard, 1960).

Foxiphalus golfensis (Barnard and Barnard, 1982)

Figure 2.57

Paraphoxus obtusidens Barnard, 1960: 249-259, plate 33-37 (in part-especially plate 33: figure g, plate 37(=AHF 677); not other parts and Alderman, 1936.
Foxiphalus golfensis Barnard and Barnard, 1982a: 28-30, figure 3 part.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 64, 59 m, (3 specimens).

Description (from Barnard and Barnard, 1982a). Female 7.4-9.1 mm, male 4.4-5.2 mm. Eyes medium to large. Rostrum unconstricted, broad, elongate, exceeding middle of antenna 1, article 2. Epistome slightly produced, triangular anteriorly. Pereopod 7, article 2, broadly ovate posteriorly, almost reaching apex of article 4, serrated laterally and ventrally (11 serrations), smaller notches ventrally, each with a short seta, medial apex of article 6 weakly combed, bearing 3 weak digital processes. Urosomite 1 with lateral setule at base of uropod. Uropod 1, peduncle without displaced spine.

Remarks. There are several partial synonomies here which are a bit confusing, see Barnard, 1979, page 133. The species differs from all others in the genus by the "setosity of the ventral margin on article 2 of pereopod 7" (Barnard and Barnard, 1982a). We observed pereopod 7, article 2, posterior margin with 3 teeth and short setae, ventral margin with 7 small serrations, 5 of which bear a long single seta. This character may prove valuable in separating this species from congeners. Although the presence or absence of digital processes and "combing" on pereopod 7, article 6 may be of diagnostic importance (Barnard, 1960), it is a difficult character to see.

Type Specimen and Locality. Holotype AHF No. 379, female, "n", 9.13 mm. Mexico, Gulf of California, off Isla Ildefonso, 91 m, on sand and shell.

Distribution and Habitat. Pt. Conception, California to Baja California, Mexico and Costa Rica, 0-91 m.

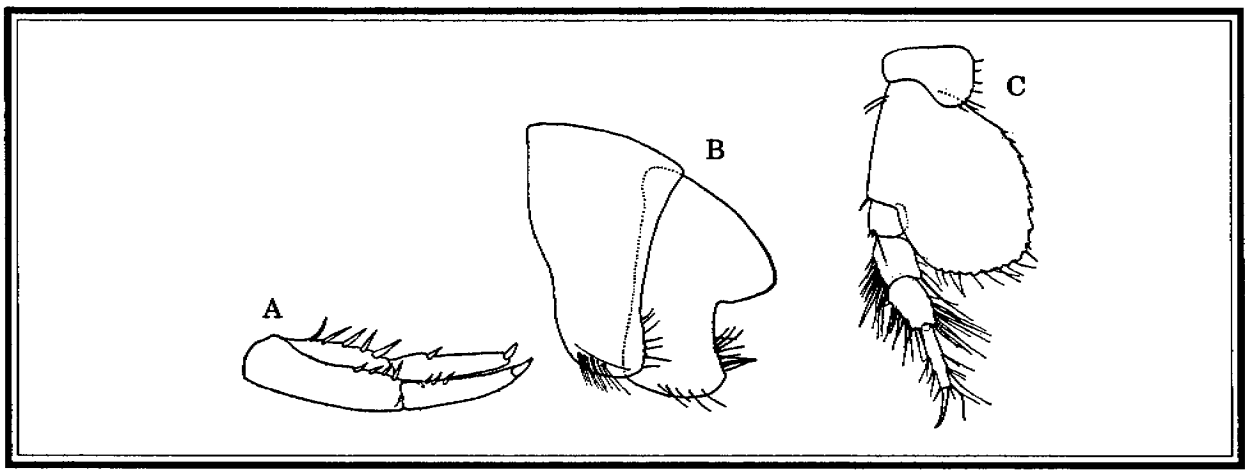


Figure 2.57. *Foxiphalus golfensis*, female, 8.5 mm; A, Uropod 1; B, Epimera 2-3; C, Pereopod 7 (from Barnard, 1960).

Foxiphalus major (Barnard, 1960)

Figure 2.58

Paraphoxus obtusidens major Barnard, 1960: 259-261, plate 32.
Foxiphalus major: Barnard and Barnard, 1982a: 12-14, figure 1 (part).

Material Examined. Reported from this study, but not supported by collections.

Description (from Barnard and Barnard, 1982a). Female 12-17.5 mm, male 6.7-17 mm. Rostrum unconstricted, elongate, broad, tapering to narrow apex, slightly exceeding apex of article 3 on antenna 1. Eyes small. Epistome unproduced. Pereopod 7, article 2 reaching middle of article 4, posterior edge with 4 small serrations, medial face with numerous scattered setae, medial apex of article 6 not combed, bearing 7+ digital processes especially strongly spinose. Epimera 2 and 3 alike in form, epimera 3 margins very setose. Uropod 1 without ventral or lateral setule at base, peduncle with a large, displaced spine. Telson usually glandular.

Remarks. Though very similar to *F. obtusidens* (Alderman, 1936), the latter species is usually much larger. "The following points are useful in distinguishing large adults from *P. obtusidens*: 1) broad fourth and fifth articles of pereopod 7; 2) the more hemispherical lower edge of article 2, pereopod 7; 3) broader pereopod 5, article 4 being much broader than 5; 4) similarity of second and third epimera, and more dense setation; 5) a somewhat stouter fifth article of pereopods 3-4; and 6) more numerous and different forms of spines and setae on uropods 1-2" (Barnard, 1960). We observed only one, sparsely setose, damaged specimen, but it was not identifiable as *F. major*.

Type Specimen and Locality. Holotype AHF No. 3816, female 17.5 mm. Station 888-38, near the mouth of Salinas River, Monterey Bay, California, 36°44'30"N, 121°49'30"W, sand bottom, 18-23 m.

Distribution and Habitat. Oregon to Bahía Blanca, Baja California, on coarse sand, 0-91 m, in cold water or upwelling south of Pt. Conception, California.

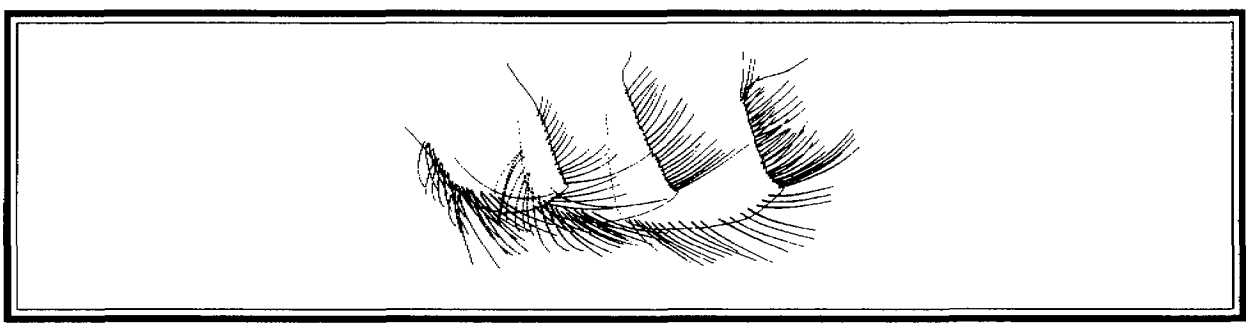


Figure 2.58. *Foxiphalus major*, female; Epimera 1-3 (from Barnard and Barnard, 1982a).

Foxiphalus obtusidens (Alderman, 1936)

Figures 2.53, 2.59

Pontharpinia obtusidens Alderman, 1936: 54-56, figures 1-13, 19.
Paraphoxus obtusidens major: Barnard, 1960: 249-259, plate 33-37 (in part, not *P. major* and not plate 33: fig. F, G, or plate 36: fig. G-K, P, or plate 37.
Foxiphalus obtusidens: Barnard and Barnard, 1982a: 4-12, figure 1 (part).

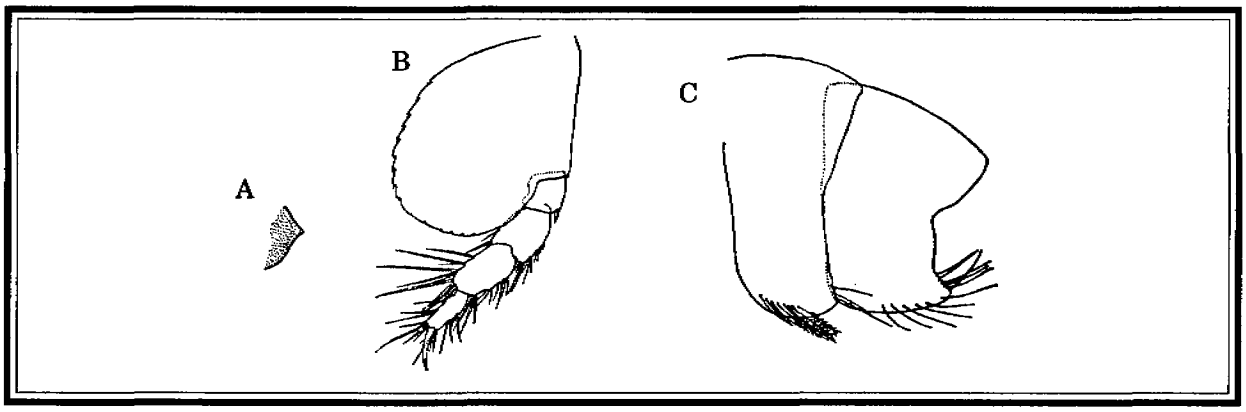


Figure 2.59. *Foxiphalus obtusidens*; A, Epistome; B, Pereopod 7, male, 5 mm; C, Epimeron 3; A and C, female, 6 mm. (from Barnard, 1960, plate 35).

Material Examined. Santa Maria Basin, California, Phase I, Sta. 79, 98 m (1 specimen).

Description. Female 5.6-15.0 mm, male 5.7-7.0 mm. Head broad, elongate, almost reaching apex of antenna 1, article 2. Eyes medium. Pereopod 7, article 2 reaching apex of article 4, posterior margin with 6 small serrations, medial apex of article 6, very weakly combed, bearing 2 weak digital processes. Urosomite 1 with lateral setule at base of uropod 1. Uropod 1, peduncle with enlarged, displaced spine.

Remarks. This species exhibits a great deal of phenotypic variation in the number of spines on pereopod 3 and 4, setosity of epimeron 2, degree of ensiformity on antenna 2 (Barnard and Barnard, 1982a), and in the shape of the epistome. The specimen that we examined agreed fairly well with Barnard (1960), figure 35, in characters such as pereopod 7, and epimeron 3. On uropods 1-3, both rami are bare midway to the distal tip.

Type Specimen and Locality. Holotypes USNM, female 9 mm, male 5 mm. Kelp holdfasts, Moss Beach, California.

Distribution and Habitat. Pacific: Kuril Islands, Okhotsk Sea, Alaska, common from California to Columbia, on sand and in tide pools, 0-210 m. For detailed phenotypic and geographic information see Barnard and Barnard, 1982a.

Foxiphalus similis (Barnard, 1960)

Figures 2.51, 2.60

Paraphoxus similis Barnard, 1960: 230-233, plates 22, 23.
Foxiphalus similis: Barnard and Barnard, 1982a: 19-23.

Material Examined. Santa Maria Basin, California, Phase II, Sta. PJ20, 148 m, October 1986, (3 specimens).

Description. Female 3.5-4.0 mm, male 3.5-4.51 mm. Head broad, short, almost reaching apex of antenna 1, article 2. Eyes medium. Cusp of epistome huge, massive, pointed, bluntly. Pereopod 7, article 2 almost reaching middle of article 5, posterior margin with 9 small serrations, medial apex of article 6 not combed, bearing 5+ digital processes. Urosomite 1 with lateral setae, but without ventral seta. Uropod 1 with enlarged displaced apical spine.

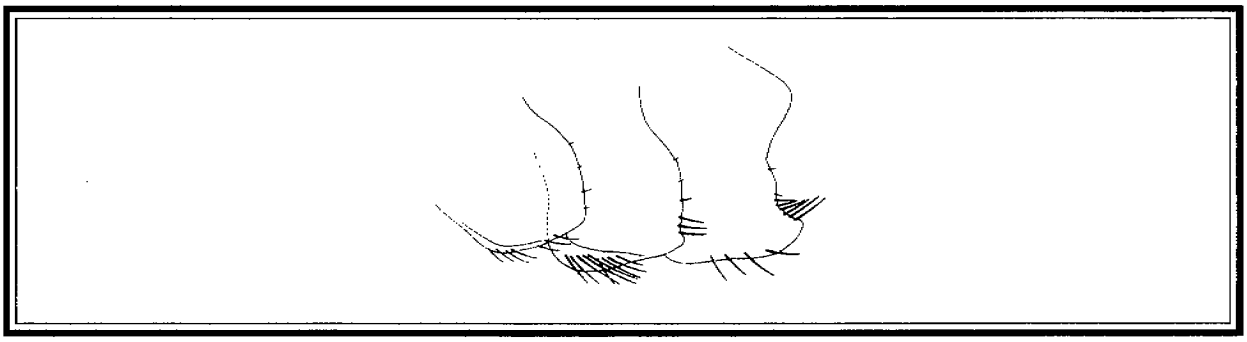


Figure 2.60. *Foxiphalus similis*, male; Epimera 1-3 (from Barnard and Barnard, 1982a).

Remarks. The male variant from Alaska differs from the normal *F. similis* in several characters including a "more upswept posteroventral tooth of epimeron 3, presence of 2 more spines on each lobe of the telson, even shorter article 2 on outer ramus of uropod 3, narrow spread of setae on coxae 1-3, and stronger spine on urosomite 1 at base of uropod" (Barnard and Barnard, 1982a). The specimens we examined exhibited the following characteristics: pereopod 7, article 2, extends almost to the end of article 5, posterior margin with 8 medium serrations, ventral margin smooth with few setules. Epimeron 3, posterior margin, slightly tapering (not straight), with 7 posterior setae and 6 ventral setae. Epimeron 2 with tuft of 7-10 ventral facial setae.

Type Specimen and Locality. AHF No. 5310, female, 3.75 mm. Station 2292-53, off Huntington Beach, California, 33°35'30"N, 118°05'30"W, fine mud, 110 m.

Distribution and Habitat. Aleutian Islands to southern California, 30-324 m, often associated with *Rhepoxinius bicuspidatus* (Barnard, 1960) and the brittle star *Amphioda urtica* (see Barnard, 1960). Also caught in plankton nets.

Harpiniopsis Stephensen, 1925

Type Species. *Harpiniopsis similis* Stephensen, 1925.

Diagnosis (from Barnard and Karaman, 1991). Rostrum unconstricted, head often with antennal tooth. Eyes absent. Antenna 1, article 2 short, ventral setae weakly ventral or almost confined apically. Antenna 2, article 1, not or weakly ensiform, article 3 with several facial setules, facial spines on article 4 in 1 main row, spines thin, article 5 ordinary to short. Right mandibular incisor with 3-4 teeth, right lacinia mobilis bifid or simple, flabellate or thin, molar not triturative, with 2+ splayed spines. Palpar hump small, apex of palp article 3 oblique. Inner plate of maxilla 1 with 2 setae, palp 2-articulate. Maxillipedal inner plates poorly armed, thick, apex of palp article 3 not strongly protuberant, dactyl stubby, apical nail distinct, elongate. Gnathopods ordinary, small, similar, or gnathopod 2 weakly enlarged, article 5 of gnathopods 1-2 short, free to cryptic, palms oblique, propodus ordinary to thin, ovatorectangular to elongate, poorly setose anteriorly. Pereopods 3-4, article 5 with posteroproximal setae, article 6 with thin armaments. Pereopod 5, article 2 narrow, article 4-5 of pereopods 5-6 narrow. Pereopod 7 ordinary (often with spike teeth), article 3 enlarged, dactyl ordinary. Epimeron 3 variable, ordinary or rounded, bearing approximately 3 long setae. Peduncle of uropod 1 without major displaced spine, rami of uropods 1-2 not continuously spinose to apex, without subapical spines or nails, inner ramus of uropod 2 ordinary. Uropod 3 ordinary, one of rami longer than peduncle, outer ramus 2-articulate, with 0-2 apical setae. Telson ordinary or with supernumerary lateral or dorsal setae.

Remarks. 27 species.

Harpiniopsis emeryi Barnard, 1960

Figure 2.61

Harpiniopsis emeryi Barnard, 1960: 334-336, plate 69.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 108, 492 m, January 1984, (1 specimen).

Description (from Barnard, 1960a). Female 4.25 mm. Lower corner of head very slightly produced. Epistome not produced. Pereopod 7 small, article 2 not very broad, lower posterior edge with 2 small teeth. The lower corner is formed by 2 larger teeth. Epimeron 3 with a very long upturned tooth at the lower posterior corner.

Remarks. To date, no male has been described. "This species closely resembles *H. galera* Barnard, 1960 but differs in the very elongated tooth of the third pleonal epimera" (Barnard, 1960). We examined a second specimen with characteristics very close to *H. emeryi*, but with slight variations (pereopod 7 with a single posteriorly directed process and no other serrations, and the tooth on epimeron 3 not as distinct as in *H. emeryi*). Whether this represents intraspecific or interspecific variation is unclear, given the small sample size.

Type Specimen and Locality. AHF No. 549, ovigerous female, 4.25 mm. Station 2632, Newport Beach, 33°31'58"N, 117°55'57"W, sandy gray-green mud, 421 m.

Distribution and Habitat. Oregon and southern California slopes and basins to middle Baja California, 344-2800 m.

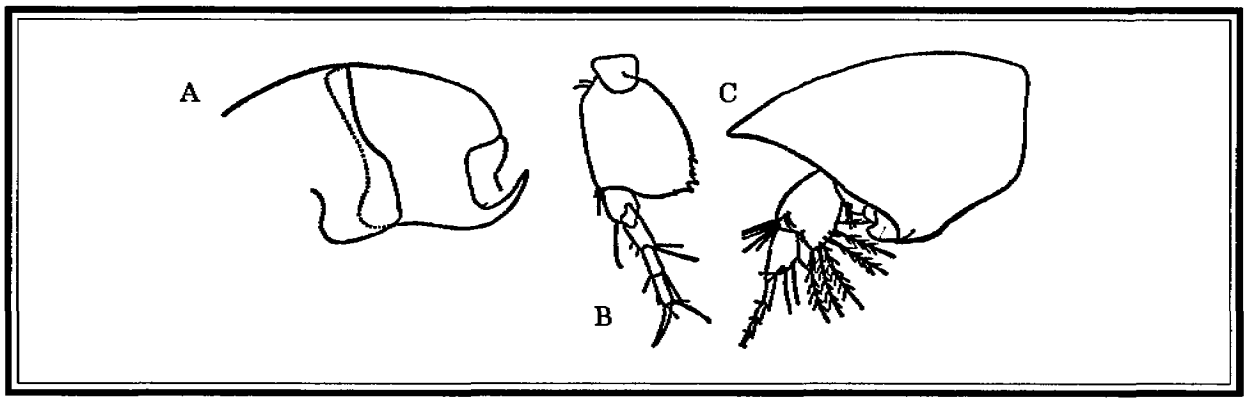


Figure 2.61. *Harpiniopsis emeryi*, female , 4.5 mm; A, Epimera 2 and 3; B, Pereopod 7; C, Head with antenna 2 (from Barnard, 1960).

Harpiniopsis epistomata Barnard, 1960

Figure 2.62

Harpiniopsis epistomatus Barnard, 1960: 326-328, plates 62, 63.—Barnard, 1966a: 85.

Material Examined. Santa Maria Basin, California, Phase, I, Sta. 35, 548 m (numerous specimens).

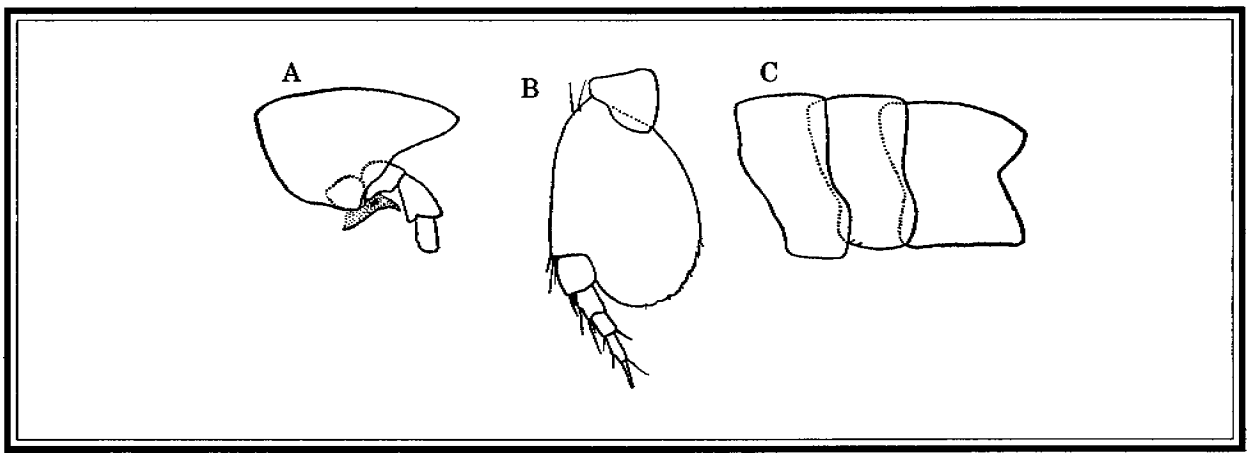


Figure 2.62. *Harpiniopsis epistomata*, female, 3.75 mm; A, Head with epistome (stippled); B. Pereopod 7; C. Epimera 1-3 (from Barnard, 1960).

Description (from Barnard, 1960). Female 3.5 mm, male 3.0-3.25 mm. Head with lower corner unproduced. Epistome produced into a long, acute process. Pereopod 7, article 2 rounded below, produced down to the end of article 4, posterior edge with 1-2 small distal serrations. Rest of appendages normally setose. Epimeron 3 linear, oblique, lower corner rounded.

Remarks. Epimeron 3 is fairly distinctive in this species, and used in conjunction with the produced epistome, provides adequate information for specific identification.

Type Specimen and Locality. AHF No. 5314, female, 3.5 mm. Station 2229-53, Long Pt., Santa Catalina Island, 33°36'00"N, 118°13'57"W, sandy clay, gravel, rocks, 805 m.

Distribution and Habitat. Oregon and southern California slopes and basins to middle Baja California, 371-1626 m.

Harpiniopsis fulgens Barnard, 1960

Figure 2.63

Harpiniopsis fulgens Barnard, 1960: 332-334, plate 67, 68.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 15, 393 m, (2 specimens).

Description (from Barnard, 1960). Female 3.0-10.5 mm. Head rather short, strongly and acutely produced at lower corner, sometimes with a slight dorsal crest. Epistome not produced. Pereopod 7, article 2 produced down to end of article 3, posterior edge with 5-6 shallow teeth on the distal edge only. Rest of appendage normally setose. Epimeron 3, posterior edge almost straight, prolonged into a large, blunt process.

Remarks. This species exhibits some variation in the shape of epimera 3, grading from a blunt process into a definite tooth like that in *H. similis*. They differ in that *H. fulgens* has spines on the rami of uropods 1 and 2 and a much longer article 6 of pereopod 6 (Barnard, 1967). With further study, the two species may prove to be synonymous (Barnard, 1960). The Phase I material agreed well with the literature on *H. fulgens*, although in our specimens, pereopod 7, article 2, extends all the way to the end of article 4, with 4 teeth on the posterior margin.

Type Specimen and Locality. AHF No. 5315, female, 3.75 mm. Station 2306-53, south of Pt. Fermin Light, California, 33°36'07"N, 118°18'00"W, clay and mud, 393 m.

Distribution and Habitat. Oregon to Baja California, slopes and basins, 128-2667 m.

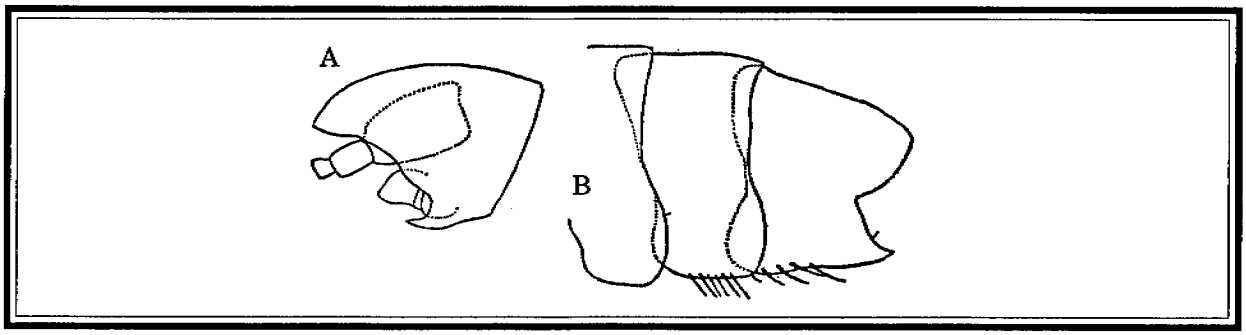


Figure 2.63. *Harpiniopsis fulgens*, female, 32 mm; A, Head; B, Epimera 1-3 (from Barnard, 1960).

Harpiniopsis galera Barnard, 1960

Figure 2.64

Harpiniopsis galerus Barnard, 1960: 336, plate 70-72.
Harpiniopsis galera: Barnard, 1966a: 85.

Material Examined. Santa Maria Basin, California, Sta. R2, 161 m, May 1987, (19 specimens).

Description (from Barnard, 1960). Female 2.0-3 mm, male 3.5 mm. Lower corner of head scarcely produced. Epistome not produced. Pereopod 7, article 2 produced down to the end of article 3, posterior edge quite variable in configuration, with 4-8 shallow teeth. Rest of appendage slender and with normal setation. Epimeron 3 with moderately large, slightly upturned tooth. Urosomite 1 bears a posterolateral spine on each side.

Remarks. This species differs from *H. emeryi* in the shorter tooth of pleonite 3 and the more numerous and better developed posterior teeth of pereopod 7 (Barnard, 1960). The posterior margin of epimeron 3 had 2 setae in our specimens, rather than the 1 figured by Barnard.

Type Specimen and Locality. AHF No. 5316, female, 2.5 mm. Station 2436-53 SE of Long Pt., Santa Catalina Island, California, 33°20'00"N, 118°18'00"W, sandy mud and clay, 80.5 m.

Distribution and Habitat. Southern California, 80-549 m, possibly Oregon, 2800 m.

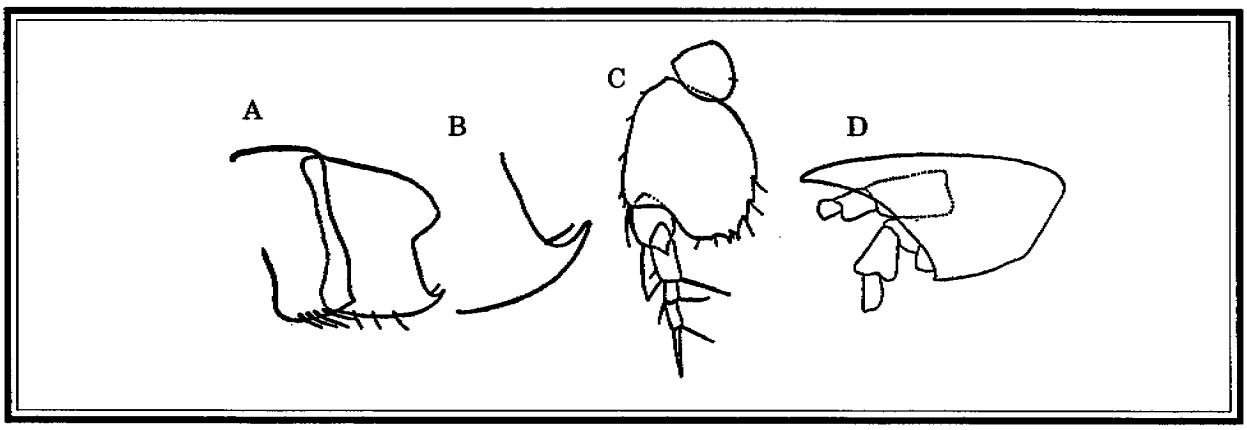


Figure 2.64. *Harpiniopsis galera*, female, 3 mm; A, Epimera 2 and 3; B, Epimera 3 close-up; C, Pereopod 7; D, Head (from Barnard, 1960).

Harpiniopsis naiadis Barnard, 1960

Harpiniopsis naiadis Barnard, 1960: 336-339, plate 73.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 33, 396 m, (1 specimen).

Description (from Barnard, 1960). Female 2.75-3.0 mm. Lower corner of head with a short, pointed cusp. Epistome not produced. Pereopod 7, article 2 produced down to the end of article 3, posterior edge with 4 small teeth. Epimeron 3 with an oblique posterior edge, prolonged to form an acute process at the lower corner.

Remarks. Male unknown. Barnard 1971, strongly suggests that this may be a synonym of *H. fulgens*, the two species being separated by only slight differences in highly variable characters, including the degree of prolongation of epimeron 3, (in *H. naiadis* the prolongation is usually blunt and weak, whereas in *H. fulgens* it is sharp, and moderately long), the size of the cephalic tooth (*H. naiadis* has a weak cephalic tooth while *H. fulgens* has a strong tooth) and the length of spines on uropod 2, peduncle (they are slightly more elongate in *H. fulgens*).

Type Specimen and Locality. AHF No. 5317, female, 2.75 mm. Station 2344, Santa Catalina light, 33°19'54"N, 118°14'20"W, sandy mud, gravel, rocks, 384 m.

Distribution and Habitat. Oregon to middle Baja California, 339-2800 m.

Harpiniopsis profundis Barnard, 1960

Figure 2.65

Harpiniopsis profundis Barnard, 1960: 330, plate 66.—Barnard, 1966a: 86, figure 40.

Material Examined. Reported from this study, but not supported by collections.

Description (from Barnard, 1960). Female 3.6-4.5 mm, male 4.8 mm (variant). Lower corner of head with a medium-sized process. Epistome not produced. Pereopod 7, article 2 produced down to the end of article 4, distal posterior edge oblique and armed with about 8 teeth, which increase in size distally, the last 2 large. Third epimera with lower posterior corner strongly produced.

Remarks. The male is known only from 2 variant juvenile specimens, exhibiting a somewhat broader posterior lobe on pereopod 7, article 2, with a more truncated oblique ventral margin bearing shallower teeth, and uropod 1, rami lacking spines. The specimens reported from deep water are a bit different from their freshwater counterparts (Barnard, 1960). We had only 1 specimen reportedly of this species, probably a juvenile, which could not be positively identified. Our specimen exhibited the following characters: Pereopod 7, article 2, extends only midway along article 4, with truncate posteroventral notch. Pereopod 6 enlarged. Epimeron 3, without hook, posterior margin angular, not produced.

Type Specimen and Locality. AHF No. 548, female, 4.5 mm. Station 2850, west of Catalina Island, 33°14'00"N, 118°18'04"W, green mud, 1135 m.

Distribution and Habitat. Southern California to middle Baja California, 385-2398 m.

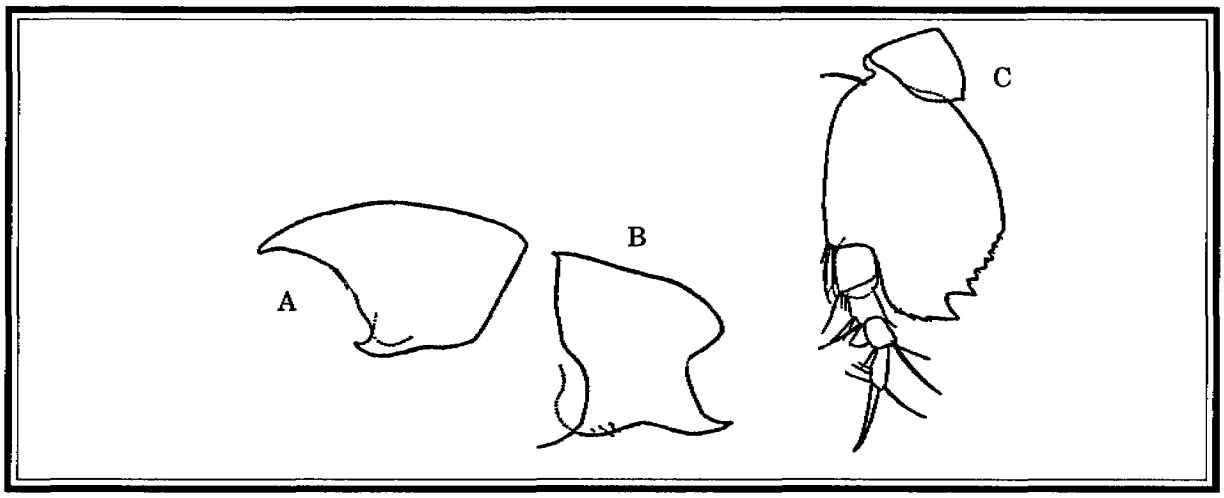


Figure 2.65. *Harpiniopsis profundis*, female, 4.5 mm; A, Head; B, Epimeron 3; C, Pereopod 7 (from Barnard, 1960).

Harpiniopsis sp. 2

Figure 2.66

Material Examined. Santa Maria Basin, California, Phase II, Sta. R3, 409 m, May 1987, (2 specimens).

Description. Lateral cephalic lobe rounded, not produced. Pereopod 7 rounded, article 2 extending less than half-way along article 4, posterior margin with 4 large teeth and several minor serrations. Epimeron 3 with long upturned tooth, posterior margin vertical.

Remarks. Our material was limited to 2 good specimens. Epimeron 3 had a granular appearance.

Distribution and Habitat. Santa Maria Basin, California, 409 m.

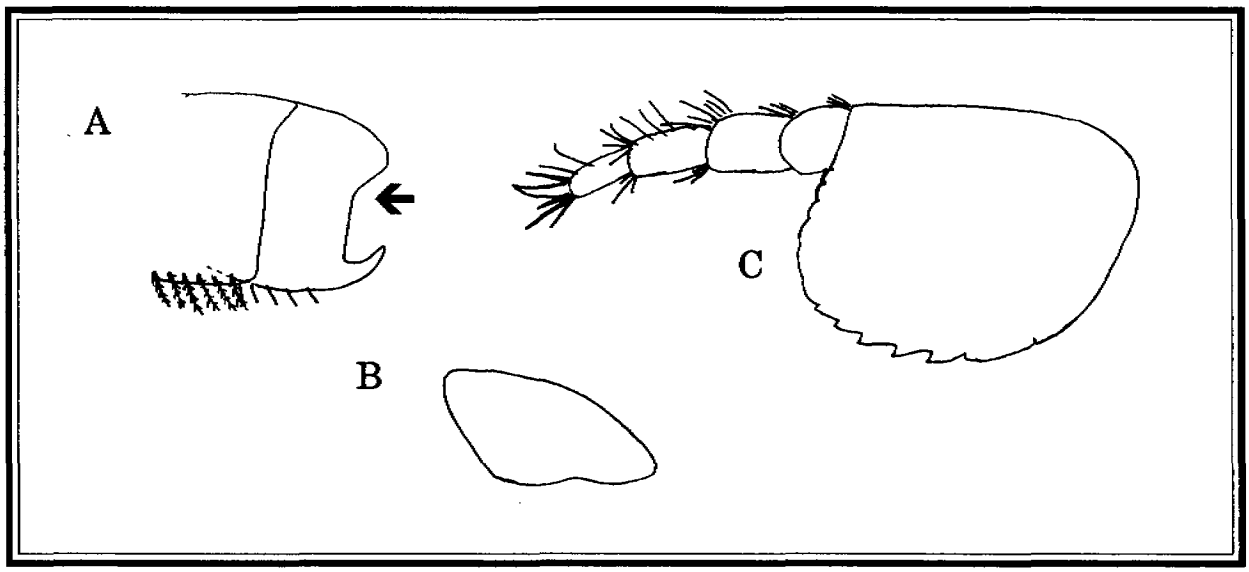


Figure 2.66. *Harpiniopsis* sp. 2, female?; A, Epimera 2 and 3, note vertical posterior margin on the former; B, Head; C, Pereopod 7.

Heterophoxus Shoemaker, 1925

Type Species. *Harpinia oculata* (Holmes, 1908), original designation.

Diagnosis (from Barnard and Karaman, 1991). Rostrum unconstricted. Eyes present. Antenna 1, article 2 short, ventral setae widely spread, but almost confined apically. Antenna 2, article 1 strongly ensiform, article 3 with many facial setules, facial spines on article 4 in 1 main row, spines thin, article 5 very short. Right mandibular incisor with 4+ teeth, right lacinia mobilis bifid, flabellate, molar not triturative, with 3 basally fused spines. Palpar hump medium, apex of palp article 3 oblique. Inner plate of maxilla 1 with 2 setae, palp 2-articulate. Maxillipedal inner plates partly fused, poorly armed, apex of palp article 3 not strongly protuberant, dactyl not elongate, but apical nail distinct. Gnathopods small, similar, article 5 of gnathopods 1-2 very short, without eusirid attachment, almost cryptic, palms oblique, propodus of gnathopods 1-2 ovatorectangular, elongate, poorly setose anteriorly. Pereopods 3-4, article 5 with posteroproximal setae, article 6 with thin armaments. Pereopod 5, article 2 narrow, articles 4-5 of pereopods 5-6 narrow. Pereopod 7 of ordinary size, article 3 enlarged, dactyl ordinary. Epimeron 3 ordinary, bearing 3 or more long setae. Peduncle of uropod 1 without displaced spine, rami of uropods 1-2 continuously spinose to apex, or not, inner ramus of uropod 1 with 1 row of marginal spines. Inner ramus of uropod 2 ordinary. Uropod 3 ordinary, one of rami longer than peduncle, outer ramus 2-articulate, with 2 apical setae. Telson ordinary or with supernumerary lateral spines.

Remarks. 6 species.

Heterophoxus oculatus (Holmes, 1908)

Figure 2.67

Harpinia oculata Holmes, 1908: 521-523, figure 28.
Harpinia affinis Holmes, 1908: 523-524, figure 29.
Heterophoxus pennatus Shoemaker, 1925: 22-26, figure 1-3.
Heterophoxus oculatus: Barnard, 1960: 320-324, plates 59-61.
Heterophoxus oculatus, forma *nitellus* Barnard, 1960: 325, plate 61, figure A-F.

Material Examined. Santa Maria Basin, California, Phase II, Sta. R4, 92 m, May 1987, (32 specimens).

Description. Female 4-9 mm, male 5.5-7.5 mm. Eyes large, renal shaped in male. Third pleonal epimeron with a moderate to long tooth. Pereopod 7, article 2 not reaching to end of article 4. Pereopod 7, article 2, with sharp, pointed teeth. Uropods with numerous plumose setae (male only).

Remarks. One of the distinguishing features of this species is the large ensiform process on the peduncle of antenna 2. Pereopod 7, article 2, of our specimens had a lobate ventral margin with numerous serrations and plumose setae. Article 2 extended nearly to the end of article 4. The eyes in the females consist of a thin linear band of large ommatidia at the rear margin of the head.

Type Specimen and Locality. Holotype USNM No. 38548, female 8 mm. Station 4342, Coronado Island, Mexico, 97-121 m.

Distribution and Habitat. Alaska to Bahía Honda, Panama and Costa Rica, rocky intertidal, on silts with rare exception, 2-1941 m, in shallow water in Baja California, but most common from 95-366 m.

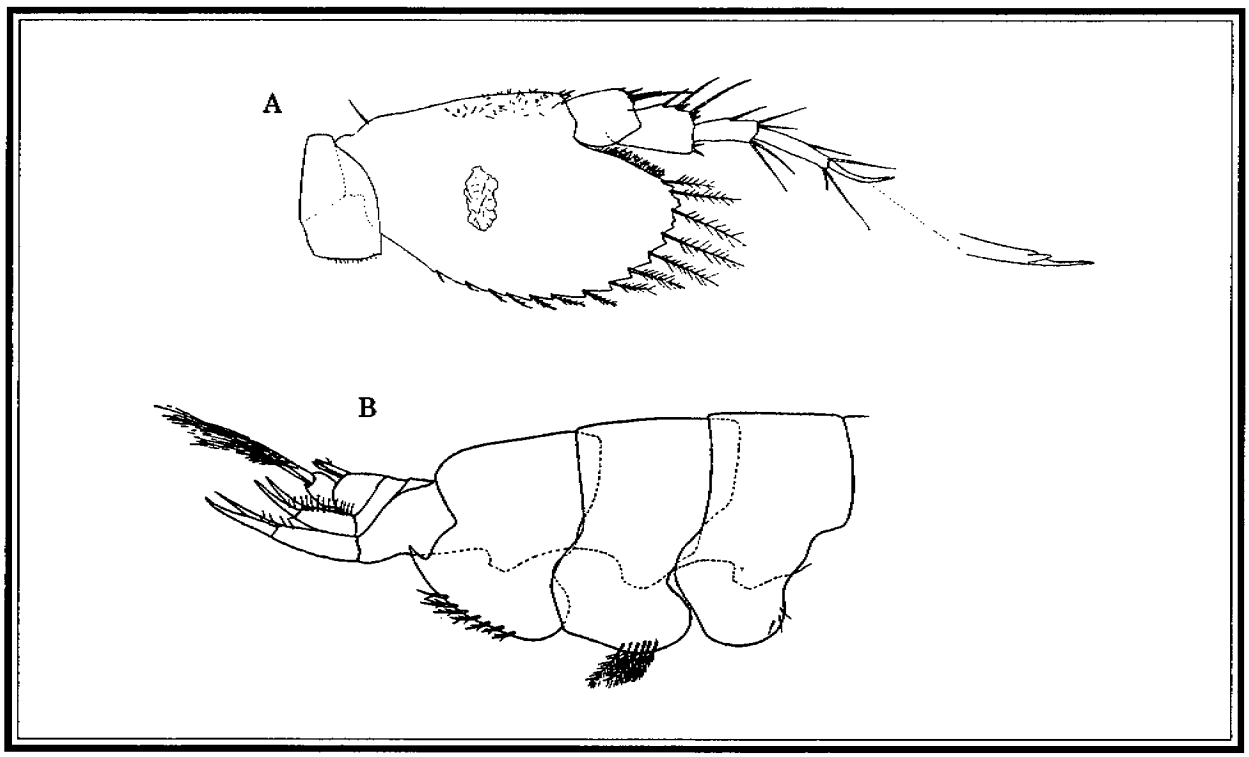


Figure 2.67. *Heterophoxus oculatus*, male, 5 mm; A, Pereopod 7 with close-up of dactyl; B, Epimera 1-3 and uropods (from Shoemaker, 1925).

Leptophoxus Sars, 1895

Type Species. *Phoxus falcatus* Sars, 1883.

Diagnosis (from Barnard and Karaman, 1991). Rostrum unconstricted, but downturned. Eyes absent. Antenna 1, article 2 short, ventral setae confined apically. Antenna 2, article 1 not ensiform, article 3 with 2 facial setules, facial spines on article 4 in 1 ragged row, all spines thin, article 5 ordinary. Right mandibular incisor with 3 teeth, right lacinia mobilis bifid, thin, molar not triturative, with 3 basally fused spines. Palpar hump small, apex of palp article 3 truncate. Inner plate of maxilla 1 without setae, palp 1-articulate. Maxilliped plates feeble, apex of palp article 3 strongly protuberant, dactyl elongate, apical nail distinct. Gnathopods, dissimilar, gnathopod 2 strongly enlarged, gnathopod 1-2, carpus very short, with eusirid attachment, cryptic, palms oblique, propodus of gnathopod 1 ordinary, ovarectangular, of gnathopod 2 broadened, both poorly setose anteriorly. Pereopods 3-4, article 5 without posteroproximal setae, article 6 with thin armaments. Pereopod 5, article 2 broad, pyriform, articles 4-5 of pereopods 5-6 narrow. Pereopod 7 ordinary, article 3 ordinary, dactyl ordinary. Epimeron 3 rounded, bearing 3 or fewer long setae. Urosomite 3 with dorsal hump. Peduncle of uropod 1 with no major displaced spine, rami of uropods 1-2 not continuously spinose to apex, inner ramus of uropod 1 with 1 row of marginal spines. Inner ramus of uropod 2 ordinary. Uropod 3 ordinary, one of rami longer than peduncle, outer ramus 2-articulate, second article elongate, with 2 apical setae. Telson elongate.

Remarks. monotypic genus.

Leptophoxus falcatus icelus Barnard, 1960

Figure 2.68

Phoxus falcatus Sars, 1883: 84.
Leptophoxus falcatus: Sars, 1895: 147-148, plate 50.—Barnard, 1960: 308.
Leptophoxus falcatus icelus Barnard, 1960: 308-311, plate 53, 54.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 50, 591 m, (3 specimens).

Description . Both sexes 2.5-4.0 mm. Rostrum distinctly carinate and recurved into a hook. See diagnosis of genus.

Remarks. This species is fairly distinctive, based on the shape of the rostrum and the presence of a hump on urosomite 3.

Type Specimen and Locality. AHF No. 5313, female, 3.75-4 mm. Station 2413-53, Long Pt., Catalina Island light, 33°30'00"N, 118°10'00"W, muddy clay, 375 m.

Distribution and Habitat. Atlantic Ocean from Greenland, Norway, North Sea, Bohuslän, and the Skagerrak; Pacific from southern California slopes and basins, to Baja California, muddy bottoms, 56-2258 m (rare in California).

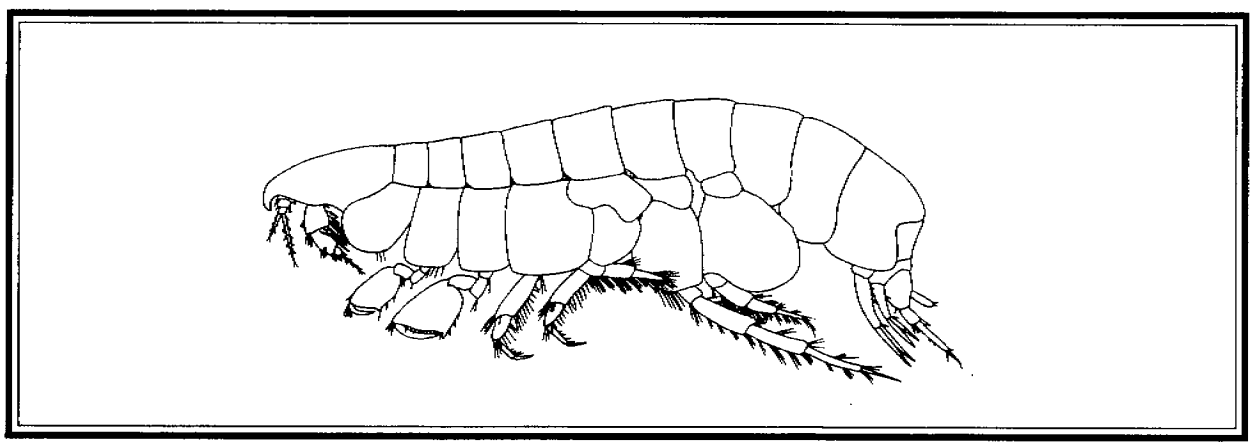


Figure 2.68. *Leptophoxus falcatus*, female; Lateral view. (from Barnard and Karaman, 1991).

Metaphoxus Bonnier, 1896

Type Species. *Phoxus simplex* Bate, 1857a.

Diagnosis (from Barnard and Karaman, 1991). Rostrum unconstricted. Eyes present. Antenna 1, article 2 short, ventral setae confined apically. Antenna 2, article 1 not ensiform, article 3 with 2 facial setules, facial spines on article 4 in 2+ rows, all spines thin, article 5 short. Right mandibular incisor with 3 teeth, right lacinia mobilis bifid, flabellate, molar not triturative, with 1 conical fused spine. Palpar hump small, apex of palp article 3 oblique. Inner plate of maxilla 1 without setae, palp 1-articulate. Maxillipedal plates small, poorly armed, apex of palp article 3 not strongly protuberant, dactyl elongate, apical nail distinct. Gnathopods large, similar, but gnathopod 2 weakly to strongly enlarged, gnathopods 1-2, carpus very short, cryptic, palms oblique, propodus of gnathopods 1-2 ovarectangular, elongate or broadened, poorly setose anteriorly. Pereopods 3-4, article 5 without posteroproximal setae, article 6 with thin armaments. Pereopod 5, article 2 broad, pereopods 5-6, articles 4-5 narrow. Pereopod 7 ordinary, article 3 ordinary, dactyl ordinary.

Epimeron 3 rounded, bearing 3 or fewer long setae. Peduncle of uropod 1 without major displaced spine, rami of uropods 1-2 not continuously spinose to apex, without subapical spines or nails, inner ramus of uropod 1 with 1 row of marginal spines. Inner ramus of uropod 2 ordinary. Uropod 3 ordinary, one of rami longer than peduncle, outer ramus 2-articulate, with 2 medium to vestigial apical setae. Telson ordinary but elongate.

Remarks. 5 species.

Metaphoxus frequens Barnard, 1960

Figures 2.47, 2.69

Metaphoxus frequens Barnard, 1960: 304-306, plate 52.

Material Examined. Santa Maria Basin, California, Sta. 13, 197 m, December 1984, (1 specimen).

Description (from Barnard, 1960). Female 2.5-3.5 mm. Maxilliped with inner plate rather narrow and armed apically with one long seta, the base of which is as wide as the plate. Gnathopods 1-2 with palm oblique, not chelate in appearance. Gnathopod 1, propodus twice as long as broad, anterior and posterior edges parallel. Pereopod 7 with that part of the appendage distal to article 3, short in relation to article 2.

Remarks. Barnard (1960) claims that *M. frequens* can readily be distinguished by the elongate propodus of gnathopod 1, however this seems to be a feature common to species in several genera. Gnathopod 2 is variable (Barnard, 1960). Our specimen has nearly transverse gnathopods (contrary to the generic diagnosis), epimeron 3 is devoid of all setae, and epimeron 2 bears 2 basofacial setae.

Type Specimen and Locality. Holotype AHF No. 5312, female, ovigerous, 3 mm. Station 2294-53, SSE of Newport, California, 33°33'56"N, 117°52'00"W, fine mud and clay, 86 m.

Distribution and Habitat. Pacfic from Oregon to Isla Isabel, Mexico, on sand, 4.3-458 m.

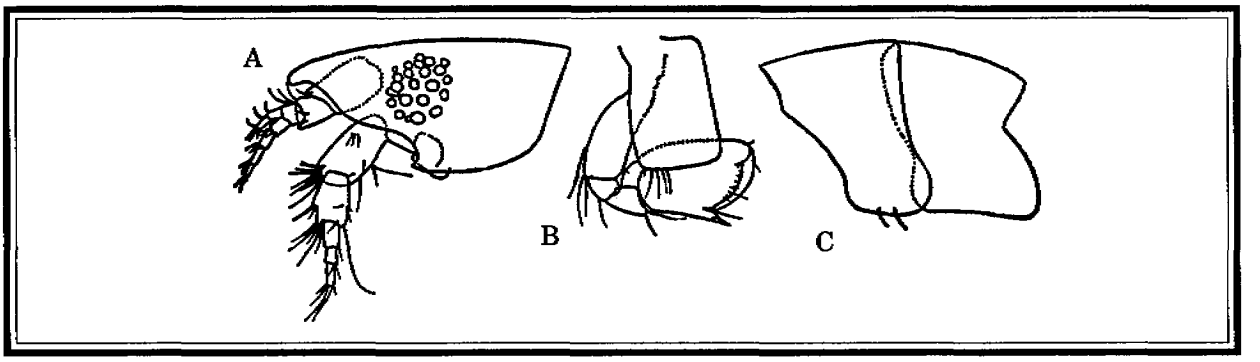


Figure 2.69. *Metaphoxus frequens*, female, 3 mm; A, Head; B, Gnathopod 2; C, Epimera 2-3 (from Barnard, 1960).

Parametaphoxus Gurjanova 1977

Type Species. *Phoxocephalus fultoni* Scott, 1890, original designation.

Diagnosis (from Barnard and Karaman, 1991). Rostrum unconstricted. Eyes present. Antenna 1, articles 2 medium length, ventral setae confined apically. Antenna 2, article 1 not ensiform, article 3 with 2 facial setules, facial spines on article 4 in 1 row, all spines thin, article 5 ordinary. Right mandibular incisor with 3-4 teeth, right lacinia mobilis unknown, molar not triturative, with 1 basally fused spine. Palpar hump small, apex of palp article 3 oblique. Inner plate of maxilla 1 without setae, palp 1-articulate. Maxilliped

plates small, poorly armed, apex of palp article 3 not strongly protuberant, dactyl elongate, apical nail distinct. Gnathopods enlarged, dissimilar, gnathopod 2 weakly larger than 1, gnathopod 1 carpus short, scarcely free, of gnathopod 2 very short and cryptic, palms transverse-chelate to oblique respectively, propodus of gnathopods 1-2 elongate, broadened, poorly setose anteriorly. Pereopods 3-4, article 5 without posteroproximal setae, article 6 with thin armaments. Pereopod 5, article 2 broad, pyriform, articles 4-5 of pereopods 5-6 narrow. Pereopod 7 ordinary, article 3 ordinary, dactyl ordinary. Epimeron 3 rounded, bearing 3 or fewer long setae. Peduncle of uropod 1 without major displaced spine, rami of uropods 1-2 not continuously spinose to apex, without subapical spines or nails, inner ramus of uropod 1 with 1 (or no) row of marginal spines. Inner ramus of uropod 2 ordinary. Uropod 3 ordinary, one of rami longer than peduncle, outer ramus 2-articulate, with 0-2 apical setae (variable by sex, etc). Telson elongate.

Remarks. 2 species.

Parametaphoxus fultoni (Scott, 1890)

Figures 2.49, 2.70

Phoxocephalus fultoni Scott, 1890: 327-328.
Metaphoxus fultoni: Barnard, 1964b: 103, figure 18.—Karaman, 1973: 79-84, figures 18-20.
Parametaphoxus fultoni: Gurjanova, 1977: 81.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 6, 109 m, January 1985, (8 specimens), Sta. 65, 107 m, (1 specimen).

Description (modified from Karaman, 1973). Female 2.3-3 mm. Eyes very large, round in both sexes. Gnathopods semichelate, palms transverse. Epimera 2 with one plumose seta (contrary to generic diagnosis). Uropod 1, both rami lacking spines or setae. Uropod 3, peduncle longer than inner ramus. Female oostegytes elongate, with long, apical setae. Telson cleft three-quarters, gaping slightly.

Remarks. Specimens agree with Barnard (1964b), gnathopods strongly transverse, epimeron 3 with 3 short setae on the posterior margin, ventral margin bare, and epimeron 2, ventral margin with 1 seta.

Type Specimen and Locality. North Atlantic.

Distribution and Habitat. Mediterranean Sea including France, Italy and the Adriatic; Eastern Atlantic from England to Tunisia; Eastern Pacific from Monterey Bay, California, to Bahía de San Cristóbal, Baja California, on muddy sand to fine gravel, 0-170 m.

Paraphoxus Sars, 1895

Type Species. *Phoxus oculatus* Sars, 1879.

Diagnosis (from Barnard and Karaman, 1991). Rostrum unconstricted. Eyes present. Antenna 1, article 2 short, ventral setae almost confined apically. Antenna 2, article 1 not tapering, article 3 with 2 facial setules, facial spines on article 4 in 1 row, plus rudimentary row, some spines thick, some spines thin, article 5 short. Right mandibular incisor with 3 teeth, right lacinia mobilis bifid, flabellate. Molar not triturative, with 3 basally fused spines. Palpar hump small, apex of palp article 3 oblique. Inner plate of maxilla 1 with 2 setae, palp 2-articulate. Maxillipeds ordinary, apex of palp article 3 not strongly protuberant, dactyl elongate, apical nail distinct. Gnathopods ordinary, small, gnathopod 2 weakly enlarged, carpus of gnathopod 1 of ordinary length, free, without eusirid-like attachment, of gnathopod 2 shorter and almost cryptic, palms oblique, propodus of gnathopods 1-2 ordinary, poorly setose anteriorly. Pereopods 3-4, article 5 with posteroproximal setae, article 6 with thin armaments. Pereopod 5, article 2 broad, articles 4-5 of pereopods 5-6 medium to narrow. Pereopod 7 ordinary, dactyl ordinary. Epimeron 3 rounded, bearing 3 or fewer long setae. Urosomite

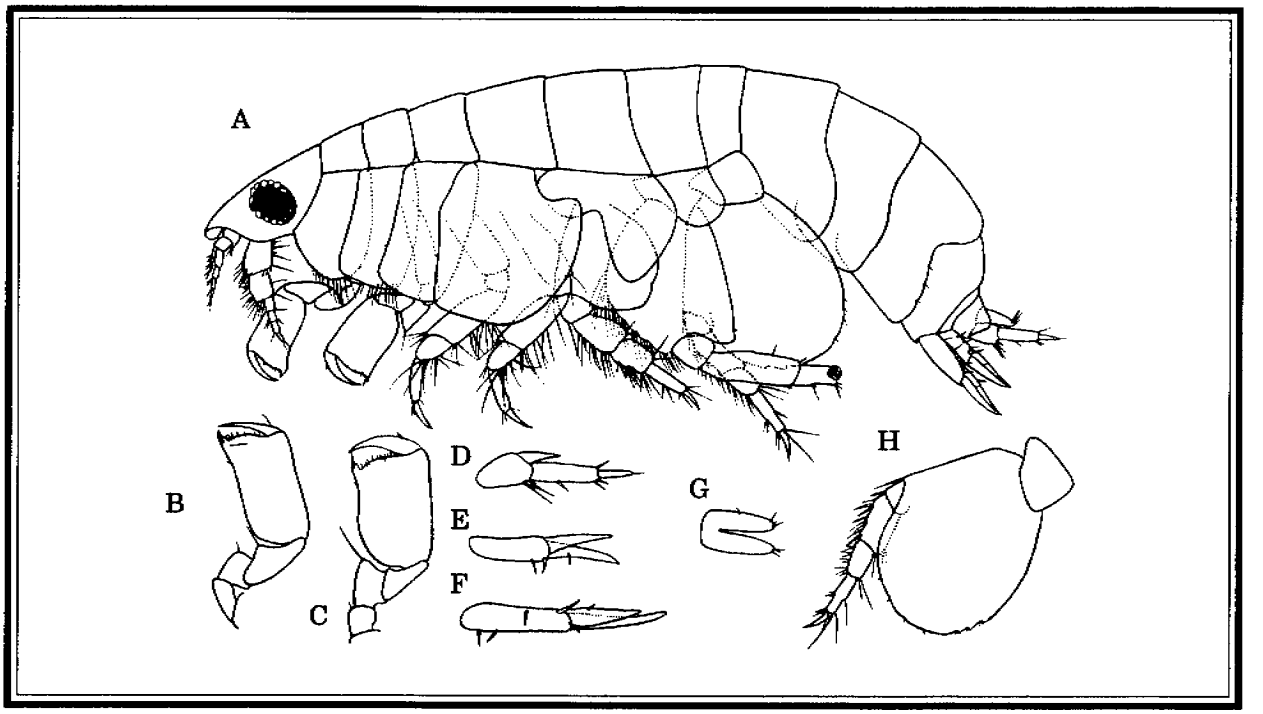


Figure 2.70. *Parametaphoxus fultoni*, female, 3 mm; A, Lateral view; B, Gnathopod 1; C, Gnathopod 2; D, Uropod 3; E, Uropod 2; F, Uropod 1; G, Telson; H, Pereopod 7 (from Barnard, 1964b).

3 without dorsal hook. Peduncle of uropod 1 without major displaced spine, rami of uropods 1-2 not continuously spinose to apex, without subapical spines or nails, inner ramus of uropod 1 with 1 row of marginal spines. Inner ramus of uropod 2 ordinary. Uropod 3 ordinary, rami longer than peduncle, outer ramus, 2-articulate, with 2 apical setae. Telson ordinary, without supernumerary lateral or dorsal spines.

Remarks. 2 species.

Paraphoxus oculatus (Sars, 1879)

Figures 2.48, 2.71

Phoxus oculatus Sars, 1879: 441.
Paraphoxus oculatus: Sars, 1895: 149-150, plate 51.—Chevreux, 1900: 34-36, plate 5, figure 5.—Barnard, 1960: 240-242, figure 27-28.—Karaman, 1973: 91-98, figure XXV-XXVIII.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 25, 390 m, September 1984, (3 specimens), Sta. 82, 394 m, (4 specimens), Phase II, Sta. R2, 161 m, October 1986, (5 specimens).

Description. Female 3-5 mm, male 4 mm. Eyes large, reniform in male. Maxilla 1, palp 2-articulate. Epistome large. Pereopod 6 elongate, twice length of pereopod 7. Pereopod 7, article 2, lobe extending to the end of article 4, posterior margin with numerous serrations. Uropod 3, inner ramus barely half the length of the outer in female.

Remarks. Specimens from California are less than half the size of the Norwegian material (Barnard, 1960). The literature did not consistently illustrate that pereopod 6 is twice the length of pereopod 7. In our

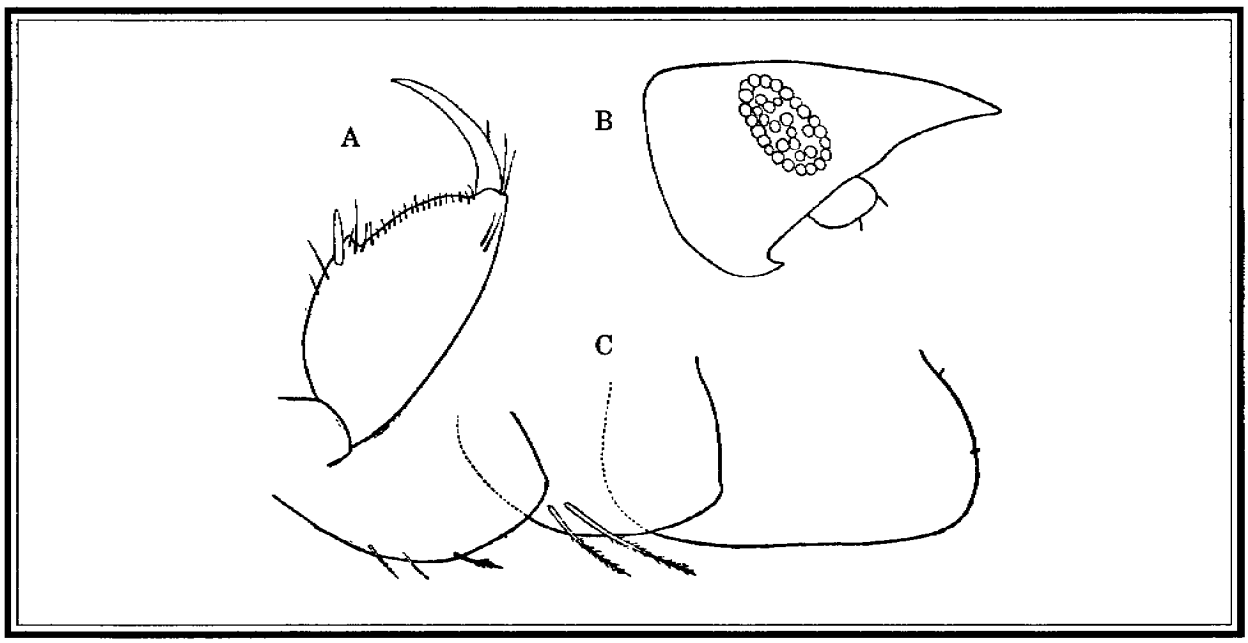


Figure 2.71. *Paraphoxus oculatus*, female, 3 mm; A, Gnathopod 2, propodus and dactyl; B, Head; C, Epimera 1-3 (from Karaman, 1973).

specimens, pereopod 6 was one and one-half to two times the length of pereopod 7, epimeron 3 was devoid of setae, and epimeron 2 had 2 plumose setae on the anterioposterior corner.

Type Specimen and Locality. Norway.

Distribution and Habitat. Arctic Ocean; Atlantic: Greenland, Kara Sea, Norway, Iceland, East Greenland, British Isles; Mediterranean east to Tunisia, South Africa, Pacific from southern California to Galapagos Islands, Japan, commonly on mud or clay, 27-2398 m. In California, not shallower than 161 m.

Pseudharpinia Schellenberg, 1931

Type Species. *Pseudharpinia dentata* Schellenberg, 1931.

Diagnosis (from Barnard and Karaman, 1991). Rostrum unconstricted. Eyes absent. Antenna 1, article 2 short, ventral setae widely spread. Antenna 2, article 1 ensiform, article 3 with several facial setules, facial spines on article 4 in 1 or 2 (weakly) rows, spines mostly thin, article 5 very short. Right mandibular incisor with ?4 teeth, right lacinia mobilis ?bifid, flabellate, molar not triturative, with 4+ splayed spines. Palpar hump small, apex of palp article 3 oblique. Inner plate of maxilla 1 with 2 setae, palp 2-articulate. Maxillipeds ordinary, apex of palp article 3 not strongly protuberant, dactyl stubby, apical nail distinct. Gnathopods ordinary, small, similar, gnathopod 2 weakly enlarged, article 5 of gnathopods 1-2 short, free, palms oblique, propodus of gnathopods 1-2 thin, ovarectangular, poorly setose anteriorly. Pereopods 3-4, article 5 with posteroproximal setae, article 6 with ?thin armaments. Pereopod 5, article 2 narrow, articles 4-5 of pereopods 5-6 narrow. Pereopod 7 ordinary, article 3 enlarged, dactyl ordinary. Epimeron 3 ordinary, bearing 3 or more long setae. Peduncle of uropod 1 without major displaced spine, some rami of uropods 1-2 continuously spinose to apex, with subapical spines or nails, inner ramus of uropod 2 often with 2 rows of marginal spines. Inner ramus of uropod 2 ordinary. Uropod 3 ordinary, one of rami longer than peduncle, outer ramus 2-articulate, with 2 apical setae. Telson ordinary or with supernumerary lateral or dorsal spines.

Remarks. 12 species.

Pseudharpinia excavata (Chevreux, 1887)

Figure 2.72

Harpinia excavata Chevreux, 1887b: 568-570.—Chevreux, 1900: 37-38, plate 6, figure 1.—Barnard, 1962d: 47-50, figures 37, 38.

Harpiniopsis sanpedroensis Barnard, 1960: 328-330, plates 64, 65.

Harpiniopsis excavata: Barnard, 1964a: 18-21, figure 16; 1966a: 85, figure 40 (part).—Barnard, 1967: 133-134.

Pseudharpinia excavata: Barnard and Karaman, 1991: 628-629.

Material Examined. Reported from this study, but not supported by collections.

Description (modified from Barnard, 1962d). Female 4-8 mm, 1 specimen 13 mm. Lateral cephalic lobe produced forward, acuminate. Antenna 2, peduncle with large ensiform process. Epistome rounded, not produced. Pereopod 7, article 2 produced down to the end of article 3 or 4, posterior edge smooth, lower oblique edge with about ten small serrations, anteroventral edge of article 2 expanded and bearing about 10-15 large plumose setae. Epimeron 3 with a tooth at lower posterior corner. Uropods 1 and 2 very spinose.

Remarks. Male unknown. *P. abyssalis* (Pirlot, 1932) may be confused with *P. excavata*, particularily in the juvenile stages (Barnard, 1960). All of the specimens we examined from this study probably represent a new species of *Pseudharpinia*.

Type Specimen and Locality. Female, coast of Finisterre, Spain, 363-510 m.

Distribution and Habitat. Eastern Pacific Ocean: Alaska to southern California; mid Atlantic Ocean off Africa and Europe in deep basins, on green mud, 363-5110 m.

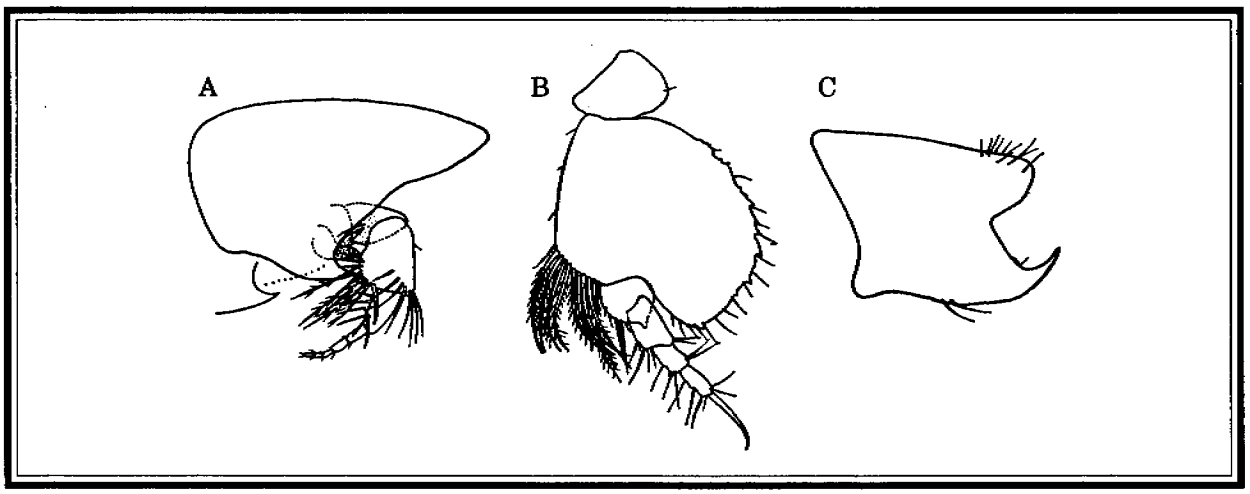


Figure 2.72. *Pseudharpinia excavata*, female, 5 mm; A, Head with close-up of acuminate lateral lobe; B, Pereopod 7, note setae on anteroventral edge; C, Epimeron 3 (from Barnard, 1960).

Pseudharpinia sp. 1

Figure 2.73

Material Examined. Santa Maria Basin, California, Phase I, Sta. 20, 396 m, 1984, (4 specimens), Phase II, Sta. R3, 409 m, January 1987, (20 specimens).

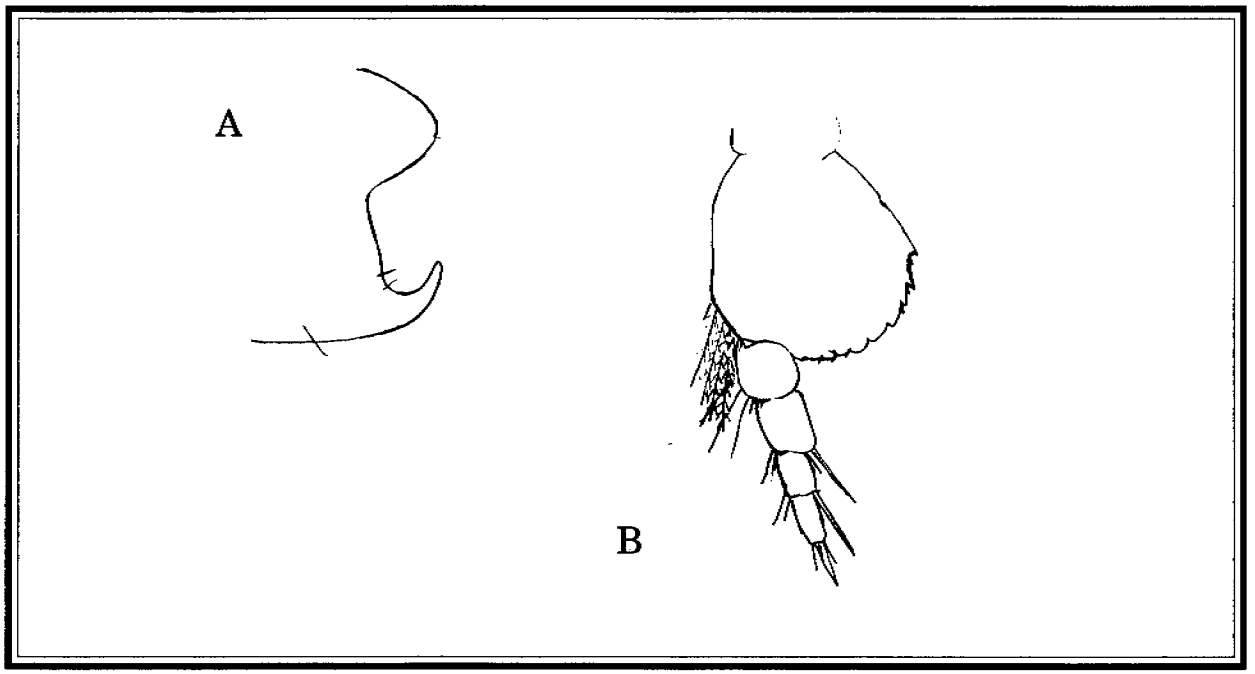


Figure 2.73. *Pseudharpinia* sp. 1; A, Epimera 3; B, Pereopod 7.

Description. Lateral cephalic lobe produced forward, acuminate. Antenna 2, peduncle with large ensiform process reaching to the end of article 2. Epistome rounded. Pereopod 7, article 2, posterior edge with 5-6 teeth, with short, sparse setae not extending past the edge of the teeth, and few serrations on ventral edge, extending midway along article 4. Pereopod 7, anterior edge nearly straight and without setae, with 4-7 long plumose setae at anteroventral margin. Epimeron 3 with 1-4 setae midfacially forward and 2 small setae above the upturned tooth.

Remarks. In the specimens we examined, the serrations on the lower oblique margin of pereopod 7, article 2 are very rounded, and appear to be larger than in *P. excavata*. Epimera 3 does sometimes bear a few setae posterodorsally, however they are very tiny and difficult to see.

Distribution and Habitat. Santa Maria Basin, California, 396-409 m.

Rhepoxynius Barnard, 1979b

Type Species. *Pontharpinia epistoma* Shoemaker, 1938, original designation.

Diagnosis (from Barnard and Karaman, 1991). Rostrum constricted. Eyes present. Antenna 1, article 2 elongate to medium, ventral setae widely to narrowly spread. Antenna 2, article 1 weakly ensiform, article 3 with 2 facial setules, facial spines on article 4 in 2+ rows, all spines thick, article 5 ordinary. Right mandibular incisor with 3 teeth, right lacinia mobilis bifid or simple, thin, molar not triturative, with 4+ splayed spines. Palpar hump small, apex of palp article 3 oblique. Inner plate of maxilla 1 with setae, palp 2-articulate. Maxillipeds ordinary, apex of aplp article 3 not strongly protuberant, dactyl elongate, apical nail distinct, often weak. Gnathopods ordinary, small, similar, carpus of gnathopods 1-2 of ordinary length to elongate, free, without eusirid-like attachment, palms oblique to transverse, propodus of gnathopods 1-2 ordinary to thin and elongate, poorly setose anteriorly. Pereopods 3-4, article 5 with posteroproximal setae,

article 6 with thick armaments. Pereopod 5, article 2 broad, articles 4-5 of pereopods 5-6 broad to medium. Pereopod 7 ordinary, article 3 ordinary, dactyl ordinary. Epimeron 3 ordinary, bearing 3 or more long setae. Peduncle of uropod 1 with major displaced spine apicomedially or not, rami of uropods 1-2 not continuously spinose to apex, without subapical spines or nails, inner ramus of uropod 1 with 1 row of marginal spines. Inner ramus of uropod 2 ordinary. Uropod 3 ordinary, one rami longer than peduncle, outer ramus 2-articulate, with 2 apical setae. Telson ordinary.

Remarks. 15 species.

Rhepoxynius bicuspidatus (Barnard, 1960)

Figures 2.45, 2.74

Paraphoxus bicuspidatus Barnard, 1960: 218-221, plate 15-16.
Rhepoxynius bicuspidatus: Barnard and Barnard, 1982b: 45-47.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 21, 49 m, (6 specimens), Phase II, Sta. PJ16, 130 m, October 1986, (4 specimens).

Description (from Barnard, 1960). Female 3.3-4.5 mm. Rostrum constricted anterior to the eyes, varying from medium length to long, apex broad. Eyes very small. Body broad. Antenna 2 with prominent ensiform process. Epistome minutely produced anteriorly. Maxillipedal palp article 4 unmodified apically. Gnathopods 1 and 2 similar, article 5 longer than 6, the latter rather narrow, palm transverse. Pereopod 7, article 2 not broadly expanded, extending downward nearly to the end of article 4, sweep point near distal end of article 3, lower edge truncated and dipping anteriorly, article 2, posterior edge with two large teeth, one each near the dorsal and ventral edges, the dorsal one varying from as long to much longer than the ventral spur. Epimeron 2 lacking basofacial setae. Uropod 1 and 2 with rami shorter than peduncles. Uropod 1 with peduncle armed with about 4 medium-sized spines becoming slender proximally. Each ramus has a short marginal spine and a terminal claw. Third epimeron, posterior edge slightly convex, lower corner scarcely produced and bearing one seta.

Remarks. The large teeth on pereopod 7, article 2 are distinctive to this species. Workers in California (Cadien, personal communication) have also documented a variant of this form which has 2 spurs on the posterodorsal margin of pereopod 7, and 1 on the posteroventral margin, and is found in depths less than 20 m. The material we examined consisted only of the standard bicuspid form.

Type Specimen and Locality. Holotype USNM No. 97307, female, 3.3 mm. Station 126-33, Santa Maria Bay, Lower California, 24°45'00"N, 112°13'30"W, 9-46 m.

Distribution and Habitat. Monterey Bay, California, to Bahía Santa María, Baja California, 28-475 m, often associated with dense populations of the brittle star *Amphiodia urtica* (Barnard, 1960), mainly at depths from 55-92 m, but as shallow as 2 meters at San Quintín, Baja California.

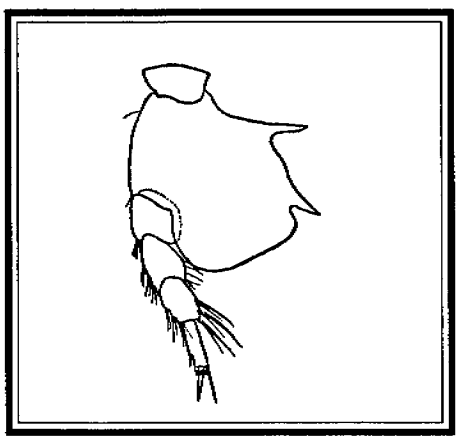


Figure 2.74. *Rhepoxynius bicuspidatus*, female, 4 mm; Pereopod 7, see remarks above (from Barnard, 1960).

Rhepoxynius daboius (Barnard, 1960)

Paraphoxus daboius Barnard, 1960: 210-212, plate 10-11.
Rhepoxynius daboius: Barnard and Barnard, 1982b: 30-32.

Material Examined. Reported from this study, but specimens unavailable.

Description (from Barnard and Barnard, 1982b). Female 3.33-4.0 mm, male 2.0 mm. Head with tenuous but rather broad rostrum. Eyes very small, in some specimens not visible. Epistome produced into a small, acute cusp. Maxillipedal palp article 4 apically simple. Gnathopod 1, article 5 much longer than 6, with transverse palm. Pereopod 7, article 2 nearly as wide as long, extending down nearly to the end of article 4, sweep point at middle of article 4, lower edge truncated, posterior edge with 3-4 small teeth, articles 4 and 5 rather stout. Uropod 2, 1-2 spines rather stout, each ramus of each uropod with one spine, peduncle of uropod 1 with one marginal spine, of uropod 2 with 2 spines. Uropod 3 inner ramus less than one third as long as outer, article 2 of outer less than one third as long as article 1. Third epimeron, posterior edge convex, lower corner slightly produced, bearing one seta. Telson rather slender, apices rounded, lateral notches each with 3 long setae.

Remarks. Barnard (1960) found a few specimens in California waters bearing characteristics of both *R. daboius* and *R. lucubrans* (Barnard, 1960), blurring the distinction between the species and perhaps indicating that hybridization is occurring.

Type Specimen and Locality. AHF No. 536, female, 3.75 mm. Station 2227-53, Santa Catalina Island, 33°24'12"N, 118°20'01"W, fine, dark green mud, 234 m.

Distribution and Habitat. Alaska to southern California coastal slopes, 77-813 m.

Rhepoxynius heterocuspidatus (Barnard, 1960)

Figure 2.75

Paraphoxus heterocuspidatus Barnard, 1960: 224-226, plate 19-20; 196-197.
Rhepoxynius heterocuspidatus: Barnard and Barnard, 1982b: 38-42, figure 4, (part).

Material Examined. Santa Maria Basin, California, Phase I, Sta. 64, 59 m (6 specimens).

Description. Female 3.75-6.85 mm, male 3.0-4.75 mm. Head with broad rostrum but constricted in front of eyes. Eyes small. Body rather broad and dorsally flattened. Epistome not produced, rounded in front. Maxillipedal palp article 4 with small apical spine and subterminal seta. Gnathopods 1-2, article 5 longer than 6, the latter moderately to very broad and expanding distally, palm scarcely oblique. Pereopod 7, article 2 generally rather broad, posterior edge of article 2 with 4-5 teeth of variable size, sweep point as far as the apex of article 4, lower edge broad, scarcely dipping anteriorly and slightly convex, article 5 and 6 finely combed, lacking digital processes. Uropods stout.

Remarks. The near shore specimens differ from their open water counterparts in the spination patterns on uropods and pereopods (Barnard, 1960). Pereopod 7, article 2 in our specimens varied slightly, extending from three-quarters to the entire length of article 4, the posteroventral margin lacked teeth, but medium sized teeth are present at the proximoposterior border of article 2.

Type Specimen and Locality. AHF No. 539, ovigerous female, 4.2 mm. Station 2313-53, off Seal Beach, California, 33°42'06"N, 118°05'22"W, brown sandy mud, gravel, 14 m.

Distribution and Habitat. Pt. Conception, California, to Bahía de Los Angeles, Baja California, on rock, in algae and corallines, sandy mud, and gravel, 0-146 m (only one specimen collected at 146 m).

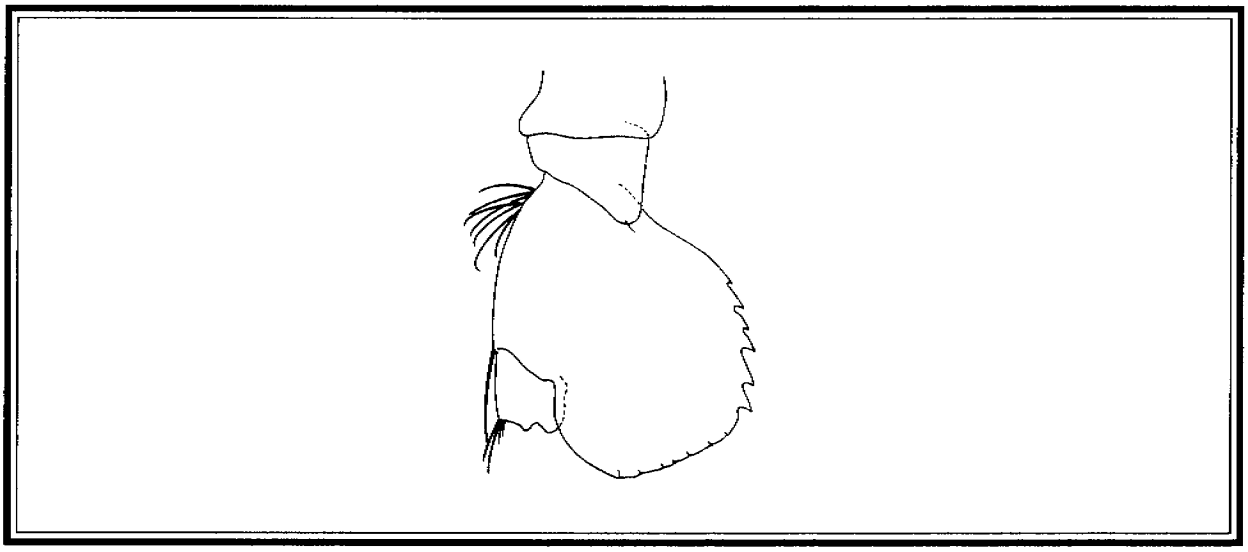


Figure 2.75. *Rhepoxynius heterocuspidatus*, female; Pereopod 7 (from Barnard and Barnard, 1982b).

Rhepoxynius menziesi (Barnard and Barnard 1982)

Figures 2.46, 2.76

Paraphoxus epistomus Barnard, 1960: 205-209, plates 6-8.
Rhepoxynius menziesi Barnard and Barnard, 1982b: 8-10, figure 2 (in part).

Material Examined. Santa Maria Basin, California, Phase II, Sta. R8, 90 m, January 1988, (13 specimens).

Description (modified from Barnard and Barnard, 1982b). Female 3-7 mm, male 4-7 mm. Eyes medium. Rostrum contricted, narrow, and elongate reaching the middle of article 2 on antenna 1. Epistomal cusp long and sharp. Pereopod 7, article 2 reaching the middle of article 4, with 9 serrations, the medial apex of article 6 finely combed and bearing 2 weak digital processes. Uropod 2 with approximately 4 basofacial setae on the peduncle of uropod 2. Telson especially long, with elongate apical spines in females.

Remarks. Barnard and Barnard (1982b) separated this species (the west coast morph) from *R. epistomus* (Shoemaker, 1938) (the east coast morph) on the basis of the elongation of apical telsonic spines (in females) and the presence of four (approximately) basofacial setae on the peduncle of uropod 2 as opposed to 1 in *R. epistomus*. He removed three other morphs, *R. lucubrans, R. hudsoni* Barnard and Barnard, 1982b, and *R.* species D, from *R. epistomus* and it remains to be determined whether they are all valid species. In our specimens, article 2 of pereopod 7 extends to the midpoint of article 5 and there are numerous small teeth or serrations on the posterior margin extending down to the proximal corner. The epistome is sharp and distinctive. Both males and females we examined had no visible ensiform process on antenna 2.

Type Specimen and Locality. Holotype AHF 5322, female, 3.19 mm. southern California, 33°40' 00"N, 118°05'08"W, 22 m.

Distribution and Habitat. Southern California to Baja California, 10-90 m (when all *R. epistomus* material is re-examined this range will undoubtedly be extended, its former range extending from Oregon to Panama, 0-507 m).

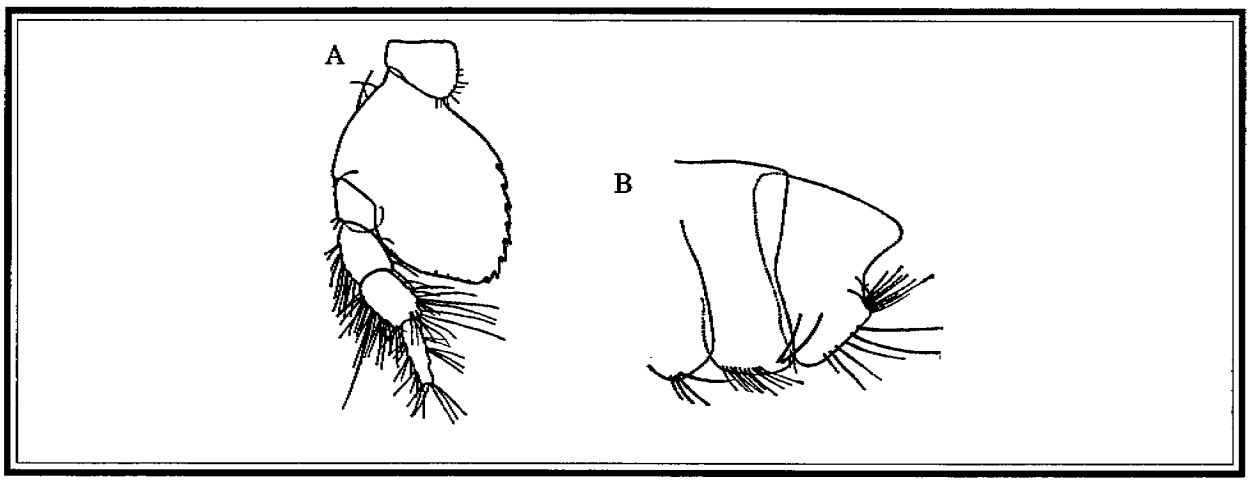


Figure 2.76. *Rhepoxynius menziesi*, female, 5.5 mm; A, Pereopod 7; B; Epimera 1-3 (from Barnard, 1960).

Rhepoxynius variatus (Barnard, 1960)

Figure 2.77

Paraphoxus variatus Barnard, 1960: 198-202, plates 3-4.
Rhepoxynius variatus: Barnard and Barnard, 1982b: 24-28, figure 4 (in part).

Material Examined. Santa Maria Basin, California, Phase I, Sta. 86, 197 m (1 specimen).

Description (modified from Barnard, 1960). Female 3.2 - 4.75 mm, male 3-3.5 mm. Head broad, rostrum slightly to moderately tenuous but bluntly rounded at apex, eyes medium in size. Epistome acutely produced, very long and acute or rather stouter and more blunt. Maxilliped palp article 4 lacks apical spine. Gnathopods 1-2, article 5 longer than 6, the latter narrow, palm transverse. Pereopod 7 variable, expansion of article 2 as broad as long, its lower edge reaches nearly to the end of article 4, is truncated and dips anteriorly, sweep point at end of article 3, with 3-5 teeth on posterior edge, usually large. Epimeron 2 without basofacial setae. Third epimeron, posterior edge straight, lower corner scarcely produced, setae sparse or absent on posterior edge. Uropod 1 peduncle with 1-4 spines, rami each bearing a small apical submerged spine and 0-1 marginal spines. Uropod 2 upper edge of peduncle with 3-5 stout spines, inner ramus with or without a marginal spine. Apices of rami with small, often difficult to see submerged spines. Uropod 3 inner ramus about one-fourth as long as outer or as much as one-third as long, article 2 of outer ramus about one-third as long as article 1 or as little as one-sixth as long. Telson slender, apices acute or slightly rounded, each lateral notch with 2 setae.

Remarks. This species exhibits considerable variation in setosity and spinosity, thus the name (Barnard, 1960). It can be distinguished from other species in the group by "the sharp epistomal cusp, lack of displaced medial spine on peduncle of uropod 1, and no other unusual characters such as spikes on pereopod 7 or urosome" (Barnard and Barnard, 1982b). Other characters of possible note include, the absence of basofacial setae on epimeron 2, and the presence of larger teeth and serrations on pereopod 7, article 2, though these characters may be variable. The specimen we examined agreed with the type description in all major characters, the 4 major cusps and straight ventral margin of pereopod 7, article 2, the transverse palm of the gnathopods, and acute epistome probably being the most diagnostic features.

Type Specimen and Locality. Holotype AHF No. 534, female, 3.2 mm. Station 2310-53, Long Beach, California, 33°40'00"N, 118°10'00"W, sandy mud, 28 m.

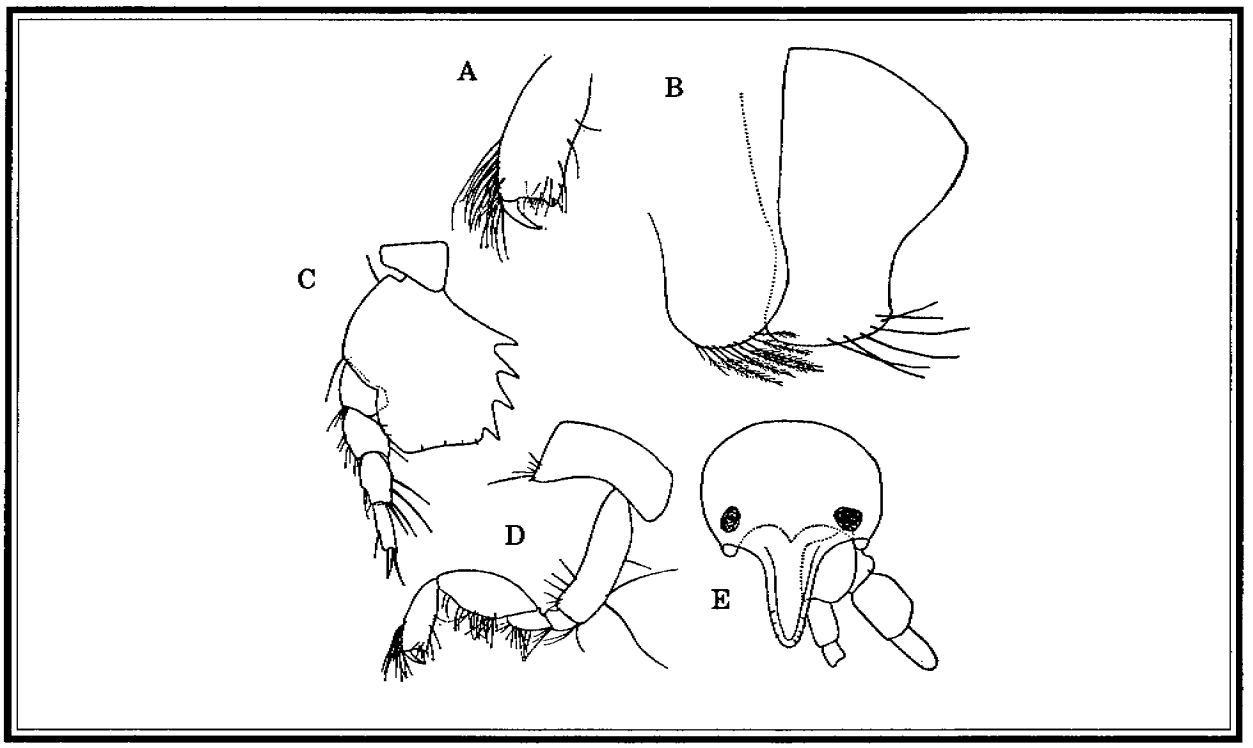


Figure 2.77. *Rhepoxynius variatus*, female, 4 mm; A, Close-up of gnathopod 2 showing transverse palm; B. Epimera 2 and 3; C, Pereopod 7; D, Gnathopod 2; E, Dorsal view of head (from Barnard, 1960).

Distribution and Habitat. Monterey Bay, California to Bahía San Ramon, Baja California, 4-110 m, most abundant in < 37 m of water.

Family Podoceridae Leach, 1814

Diagnosis (modified from Barnard and Karaman, 1991). Corophioid with urosomite 1 elongate, twice or more as long as urosomite 2. Abdomen flexed beneath thorax. Accessory flagellum variable, often absent. Body variable, broadly depressed or subcylindrical, occasionally rugose or weakly toothed and carinate; some posterior pereonites or posterior urosomites occasionally fused together. Coxae small, usually discontiguous, occasionally splayed. Antennae very long. Maxilla 1 usually reduced or absent. Pereopods 3-7, article 2 usually rectolinear, rarely expanded on pereopods 5-7 without spines or processes. Coxal gills simple, 3-5 pairs, oostegites 3-4 pairs. Pereopods glandular or not. Pleopods with slender peduncle. Uropod 1 normal, uropod 2 variable, normal to absent. Uropod 3 always reduced or absent, with or without small ramus. Telson subcircular or ovate, fleshy, often not very thick, occasionally fused to urosome.

Remarks. 11 genera, 75 species.

Key to the Podoceridae of the Santa Maria Basin

1A. Uropod 3 present, reduced ..... *Podocerus cristatus*

1B. Uropod 3 absent 2

2A. Pereopods 3 and 4, article 2 expanded, oval; coxal gills on pereopod 3-5 .. (*Dyopedos*) 3

2B. Pereopods 3 and 4, article 2, linear; coxal gills on pereopods 2-5 ..... *Dulichia rhabdoplastis**

3A. Male and female coxa 1 produced forward into a long tooth; eyes present within large, lateral bulges; pereopods 3 and 4, article 6 shorter than article 5 ..... *Dyopedos arcticus**

3B. Male and female?, coxa 1 without tooth; eyes not bulging laterally; pereopod 3 and 4, article 5 and 6 elongate, subequal in length ..... *Dyopedos* sp. 1

Dulichia Krøyer, 1845

Type Species. *Dulichia spinosissima* Krøyer, 1845 (see figure 2.78)

Diagnosis (from Barnard and Karaman, 1991). Eyes large. Body subcylindrical, dorsally corrugated or provided with elevations of teeth or humps, or carinate. Rostrum short-to-long, thorn-like, or vertically keeled, (in type species all of anterior head thrust into large keel), ocular lobes obsolescent, blunt, antennal sinus weak to deep. Antennae long, 1 longer than 2, both slender. Antenna 1, peduncular article 3 much longer than article 1, articles 2-3 longest, accessory flagellum 2-3-articulate, main flagellar articles few. Antenna 2, peduncular article 3 short, flagellum with few articles. Epistome unproduced anteriorly. Upper lip incised, broad, almost, bilobed, or rounded, entire. Mandible normal, palp strong, slender, article 3 rectolinear, shorter than 2. Lower lip with entire outer lobes, with well-developed inner lobes, mandibular lobes long, pointed. Inner plate of maxilla 1 triangular, short, without setae, outer plate with 9 spines, palp 2-articulate. Plates of maxilla 2 of ordinary width, inner plate short, with mediofacial row of setae. Inner plate of maxilliped with distal spines, outer plate normal, not reaching apex of palp article 2, with spines on medial margin, palp with 4 articles, article 2 long, article 3 unlobed, article 4 very short, with long nail and setae. Coxae very small, short, serially discontiguous, of various sizes and shapes, spiniform, coxa 1 dilated, produced forward, coxa 2 larger than 1, often produced or dilated, coxa 4 not longer than coxa 1, not lobed posteriorly, coxa 5 as long as or somewhat longer than 4, coxae 6-7 not much smaller than anterior coxae. Gnathopods 1-2 diverse, gnathopod 2 much larger than 1, gnathopod 1 in male poorly subchelate, palm short, carpus longer and broader than propodus, poorly but broadly lobed. Propodus slender. Gnathopod 2 enlarged, subchelate, with basis dilated distally, carpus much shorter than propodus, lobed. Propodus dilated, sometimes with false chela, dactyl long. Pereopods 3-4 normal, similar, with slender article 2, article 4 barely dilated, dactyls short. Pereopods 5-7 elongate, similar to each other, progressively scarcely longer, with linear article 2, not prehensile, dactyls of pereopods 5-7 short, curved, with several inner marginal setae. Coxal gills present on segments 2-5. Pleopods normal. Epimeron 3 ventrally sinuous. Urosome depressed, pereonite 1 very short, last 2 pereonites fused together, urosomites 2-3 coalesced, urosomite 1 elongate. Uropods 1-2 biramous, normal, rami slightly unequal, longer than peduncle. Peduncles of uropods 1-2 without ventrodistal process. Uropod 3 absent. Telson entire, longer than broad, ovate, almost naked.

Remarks. 5 species.

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*See remarks and species under these groups.

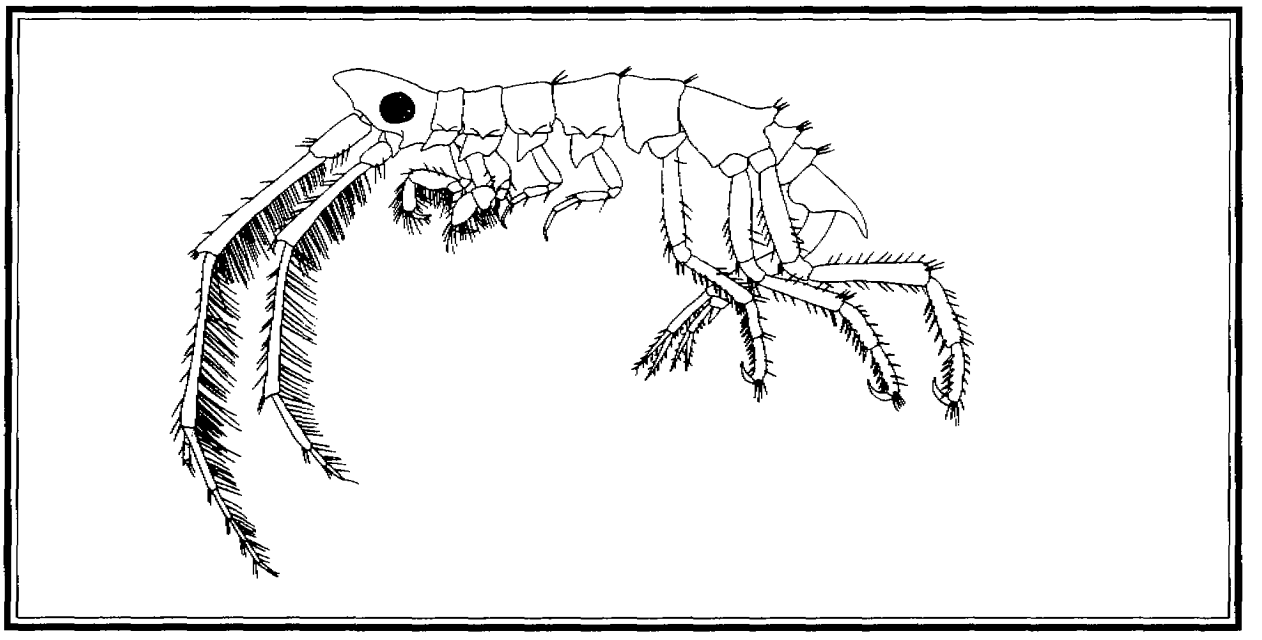

Figure 2.78. *Dulichia spinosissima* Krøyer, 1845 (from Barnard and Karaman,1991).

Dulichia rhabdoplastis McCloskey, 1970

Dulichia rhabdoplastis McCloskey, 1970: 92-98, figures 1-18.—Laubitz, 1977: 946-947, figure 2.

Material Examined. Reported from several stations in the Santa Maria Basin, but unsupported by collections.

Description (McCloskey, 1970). Female 3.3-4.5 mm, male 4-6.6.0 mm. Head shorter than pereonite 1 and 2, spade-shaped from above. Rostrum extending forward, visor-shaped. Antenna 1 longer than body in male. Gnathopod 2, propodus with two large teeth on palm, the largest arising near the proximal joint and extending to level of base of the smaller distal tooth. Coxa small, smooth, without spines. Telson small, ovate.

Remarks. Key features aiding in specific identification within this genus, include the shape and length of gnathopods, rostrum, and uropods. *D. rhabdoplastis* appears to be an obligate commensal with the sea urchin *Strongylocentrotus franciscanus* (Agassiz) (see McCloskey, 1970 and Laubitz, 1977). All five *Dulichia* species are arctic or subarctic in distribution (Pacific and Atlantic), *D. rhabdoplastis* being the only species currently recorded from California. It is reported from the area, but the material we examined from the Santa Maria Basin (2 specimens) was not *Dulichia rhabdoplastis*. All of our specimens were damaged and impossible to identify beyond genus.

Type Specimen and Locality. Holotype USNM No. 125663. Male, 4 mm, commensal on *Strongylocentrotus franciscanus,* San Juan Channel, Washington, 10 m.

Distribution and Habitat. Prince William Sound, Alaska to Monterey Bay, California, 3 to 25 m.

Dyopedos Bate, 1857

Type Species. *Dyopedos porrectus* Bate, 1857b.

Diagnosis (from Barnard and Karaman, 1991). Eyes small-to-large. Body cylindrical. Rostrum short, ocular lobes barely visible, blunt, antennal sinus almost absent. Antennae long, 1 longer than 2, both

slender. Antenna 1, peduncular article 3 immensely longer than 1, article 3 longest, accessory flagellum 1-4 articulate, main flagellar articles few but elongate. Antenna 2, peduncular article 3 short, flagellar articles few but elongate. Epistome unproduced anteriorly. Upper lip broad, fleshy, bilobed. Mandible normal, palp strong, slender, article 3 rectolinear, shorter than 2. Lower lip with entire outer lobes, with well-developed inner lobes, mandibular lobes long, blunt. Inner plate of maxilla 1 short, without setae, outer plate with 9 spines, palp 2-articulate. Plates of maxilla 2 rather broad, inner plate with only mediomarginal setae. Inner plate of maxilliped with distal spines, outer plate normal, not reaching apex of palp article 2, with spines and notches on medial margin, palp with 4 articles, article 2 long, aritcle 3 unlobed, article 4 short, with long setae. Coxae very small, discontiguous, of various sizes and shapes, 1-4 approximately equal in size, occasionally spiniform, coxa 1 produced forward, coxa 4 not longer than coxa 1, not lobed, coxa 5 somewhat longer than 4, coxae 6-7 not smaller than anterior coxae. Gnathopods 1-2 diverse, gnathopod 2 much larger than 1, gnathopod 1 in male poorly subchelate, almost simple, carpus long, almost linear, barely lobed, longer than propodus. Propodus slender, scarcely almond-shaped. Gnathopod 2, enlarged, subchelate or chelate, with basis slender, carpus much shorter than propodus, lobed. Propodus dilated, sometimes with false chela, and process on posterodistal margin, dactyl long. Pereopods 3-4 short, similar, with inflated article 2, article 4 scarcely dilated, dactyls short. Pereopods 5-7 not elongate, similar to each other, sometimes progressively longer, with linear article 2, not prehensile, pereopod 6 usually shorter than and different from pereopods 5 and 7, with broader article 2, dactyl of pereopods 5-7 short, curved, smooth. Coxal gills present on segments 3-5. Pleopods normal. Epimeron 3 often bisinuate ventrally. Urosome depressed, smooth, pereonite 1 very short. Last 2 pereonites fused together. Urosomites 2-3 coalesced, urosomite 1 elongate. Uropods 1-2 biramous, normal, rami unequal. Uropod 1, rami as long as peduncle. Uropod 2, rami longer than peduncle. Peduncle of uropods 1-2 without ventrodistal process. Uropod 3 absent. Telson entire, longer than broad, ovate, almost naked.

Remarks. 9 species.

Dyopedos arcticus (Murdoch, 1885)

Figure 2.79

Dulichia arctica Murdoch, 1885: 521-522.
Dyopedos arcticus: Shoemaker 1955: 69-70, figure 20.—Laubitz, 1977: 962-964, figure 11.

Material Examined. Santa Maria Basin, California, Phase II, Sta. R4, 92 m, May 1987 through May 1988, (81 specimens), Sta. R6, 410 m, May 1987, (5 specimens).

Description (modified from Laubitz, 1977). Female 5.9-10.5 mm, male 16.5- 20.0 mm. Eyes small to large, bulging laterally, red in alcohol. Antenna 1, accessory flagellum 1-articulate. Coxa 1 produced forward into a long tooth in male, smaller and produced ventrally in female. Coxa 2 of male with 2 ventrally produced teeth, 3-7 with one, less pronounced tooth. Gnathopod 1, carpus broad, longer than propodus. Uropod 1, peduncle twice length of uropod 2, peduncle. Uropod 2, outer ramus about three-quarters length of inner ramus.

Remarks. Our specimens agree well with Shoemaker (1955) in the following characters: coxa 1 with spiniform ventral process in male, (with small process in female), coxae 2 with 2 ventral spiniform processes, coxa 3-5 with ventrally directed spines, eyes bulging laterally. The spiniform process on coxa 1 varies from straight to recurved. Several specimens from this study identified as *D. monocanthus* (Metzger, 1875) were actually *D. arcticus* supporting Laubitz's (1977) suggestion that many specimens identified from the west coast as *D. monocanthus* were misidentified and are probably *D. arcticus*.

Type Specimen and Locality. Cotypes USNM No. 7899, 7900. Pt. Barrow, Alaska, on mud, 10 m.

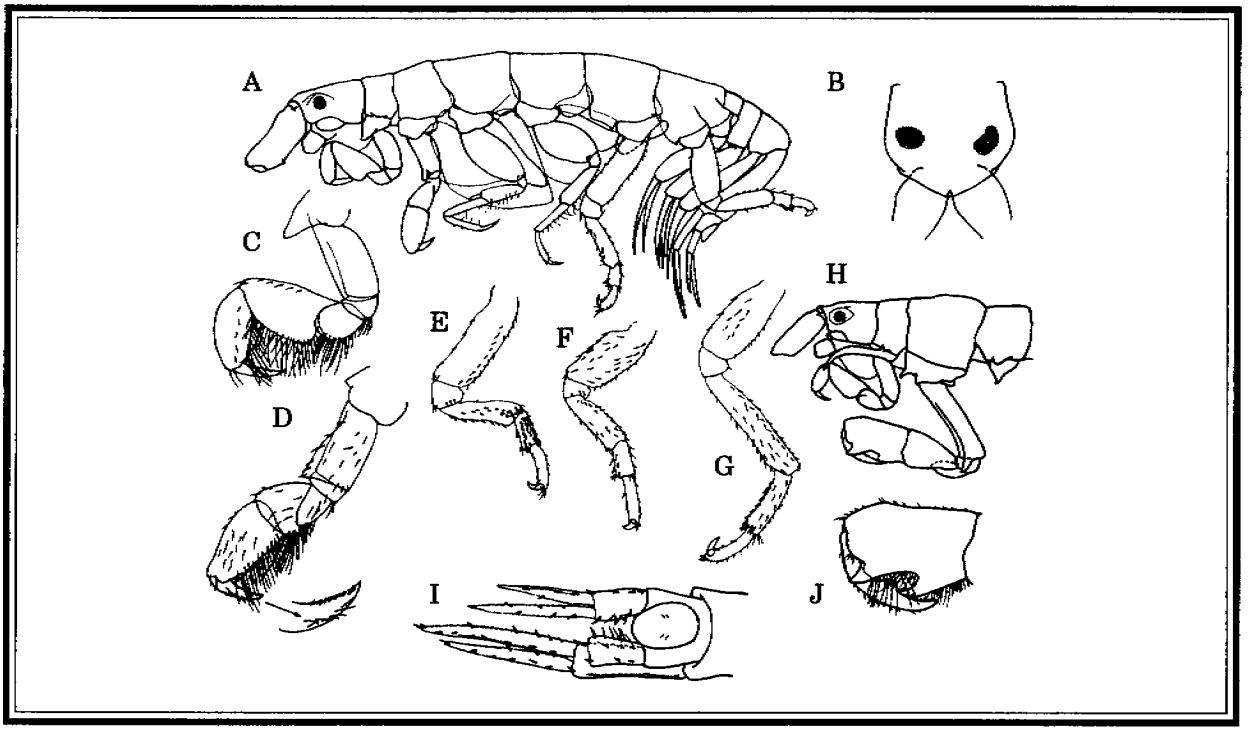

Figure 2.79. *Dyopedos arcticus*, female; A, Lateral view; B, Dorsal view of head; C, Gnathopod 1; D, Gnathopod 2 with close-up of dactyl; E, Pereopod 5; F, Pereopod 6; G. Pereopod 7; H-J, male; H, Lateral view; I, Telson and uropod 1 and 2; J, Gnathopod 2, propodus and dactyl (from Laubitz, 1977).

Distribution and Habitat. Pan Arctic including Bering Sea, Baffin Island, Labrador, Gulf of St. Lawrence, Grand Manan, Bay of Fundy, Cape Cod; Pacific from Pt. Barrow Alaska to southern California, 9-410 m.

Dyopedos monacanthus (Metzger, 1875)

Dulichia monacanthus Metzger, 1875: 296.
Dyopedos monacanthus: Sars, 1895: 638, plate 230.—Laubitz, 1977: 968-969, figure 15.

Material Examined. Reported from this study, but not supported by collections.

Description (modified from Laubitz, 1977). Female 2.9-7.9 mm, male to 7.4 mm. Eyes large. Antenna 1, accessory flagellum 3-articulate. Coxa 1 of male produced forward into a long tooth, coxa 2 with small tooth at anteroventral corner, coxa 3 and 4 bluntly pointed. Coxae of female small and without spines. Gnathopod 1, carpus not broader than propodus and subequal in length. Urpod 1, peduncle more than twice length peduncle of uropod 2. Uropod 2, outer ramus more than three-quarters length of inner ramus.

Remarks. This species is reported from this study and has been recorded from the Pacific previously, however, its primary distribution is Atlantic. All specimens we examined were *M. arcticus* (see remarks under this species).

Type Specimen and Locality. 5 mm. Skagerrak, 210 m.

Distribution and Habitat. Arctic Ocean, ?Chukchi Sea, and North Atlantic including Iceland, Gulf of St. Lawrence, Bay of Fundy, Cape Cod, British Isles, Denmark, Norway, Skagerrak, Kattegat; Pacific: ?northern California, (a Pacific distribution is questionable, see remarks for *M. arcticus*), often found clinging to algae, hydroids, and bryozoans, on sand-gravel, to silt clay, 12-217 m.

Dyopedos sp. 1

Material Examined. Santa Maria Basin, California, Phase II, Sta. R6, 410 m, May 1987, (5 specimens).

Description. Eyes present, but not bulging laterally. Pereopods 3 and 4, article 5 and 6 elongate, subequal. Coxa small, coxae 3 and 4 with ventrally produced spine. Uropods long and spinose. Uropod 2, outer ramus almost three-quarters length of inner ramus, apical spines long.

Remarks. Most of the appendages were missing on our specimens, but visible characters and a survey of the literature, suggest this is a new species.

Distribution and Habitat. Santa Maria Basin, southern California, 410 m.

Podocerus Leach, 1814

Type Species. *Podocerus variegatus* Leach, 1814.

Diagnosis (from Barnard and Karaman, 1991). Body often dorsally corrugated or provided with elevations, teeth, humps, or carinate or smooth, depressed. Rostrum short, ocular lobes short, blunt, antennal sinus deep. Eyes large to weak, often bulging laterally. Antennae of medium to great length, 1 shorter than 2, 1 slender, antenna 2 stout; peduncular article 3 of antenna 1 longer than 1, article 2 longest, accessory flagellum 1 to 2-articulate, main flagellar articles few. Antenna 2 peduncular article 3 scarcely elongate, peduncle moderately stout, flagellum short, poorly articulate. Epistome produced anteriorly. Upper lip incised, bilobed. Mandible normal, palp strong, article 3 clavate, shorter than article 2. Lower lip with entire outer lobes, with well-developed inner lobes, mandibular lobes long, pointed or blunt. Inner plate of maxilla 1 short to vestigial, with or without 1 seta, outer plate with 9 (?11) spines, palp 2-articulate. Outer plates of maxilla 2 rather broad, inner plate with only sparse mediomarginal setae. Inner plate of maxilliped with distal spines, outer plate normal, reaching half-way to apex of palp article 2, with spines on medial margin, palp with 4 articles, article 2 long, article 3 unlobed, article 4 short, with long nail and setae. Coxa very small, short, weakly discontiguous, of various sizes and shapes, not progressively elongate from 1 to 4, often spiniform, coxa 1 dilated, produced forward, coxa 2 shorter or longer than 1, often produced, coxa 4 not longer than coxa 1, not lobed, coxa 5 as long as 4, coxae 6-7 not much smaller than anterior coxae. Gnathopods 1-2 diverse, gnathopod 2 greatly larger than 1, gnathopod 1 in male poorly subchelate, carpus shorter than or as long as propodus, weakly lobed. Gnathopod 2 enlarged, weakly subchelate or essentially simple, very setose, with basis barely dilated, merus enlarged, barely merochelate, extended and fused distally along posterior margin of carpus, carpus much shorter than propodus, mostly fused to merus or cryptic, propodus dilated, dactyl long. Pereopods 3-4 longer than gnathopods, similar, with slender article 2, article 4 dilated, dactyls medium. Pereopods 5-7 similar to each other, progressively slightly longer or pereopod 6 longer, pereopod 5-7 with narrow to broad unlobed or barely lobed article 2, dactyl of pereopods 5-7 medium, curved. Sternal processes of thorax absent. Coxal gills undescribed, present on segments ?2-6. Epimeron 3 not bisinuate. Pleopods normal. Uropods 1-2 biramous, rami grossly unequal. Uropod 1, inner ramus as long as peduncle. Uropod 2, inner ramus much longer than peduncle. Peduncle of uropods 1-2 with or without ventrodistal process, that of uropod 2 smaller. Last 2-3 pereonites often fused. Urosomite 1 elongate. Uropod 3 forming small flap lacking rami, very short, obtuse distally, with few armaments. Telson entire, short, broader than long, ovate or semicircular, spinose.

Remarks. 32 species.

Podocerus cristatus (Thomson, 1879)

Figure 2.80

Cyrtophium cristatum Thomson, 1879: 331, plate 16, figures 9-15.
Podocerus cristatus: Barnard, 1962a: 67-69, figures 31-32.

Material Examined. Reported from this study, but specimens unavailable.

Description (modified from Barnard 1962a). Both sexes 3.5-6.0 mm. Eyes large. Pereonal segments 5-7 and pleonal segments 1-2 with distinct mid-dorsal carinae, (carina on 5 is weak) pereonites 3 and 4 with rudiments of a carina (in large specimens). Second gnathopod, palm in male with 2? processes near distal end. Telson conical, with 2 long setae apically.

Remarks. Three species have been described from southern California, *P cristatus, P brasiliensis* (Dana, 1853), and *P. fulanus* Barnard, 1962a. *P. brasiliensis* is distinctive in having no dorsal carinae, *P. fulanus* is an estuarine species and can be distinguished from the other 2 species by the poorly setose palm of male gnathopod 2 and the single palmar process near the dactyl hinge (Barnard, 1962a). Descriptions of *P. cristatus* in the literature are incomplete.

Type Specimen and Locality . Male, Dunedin Harbour, New Zealand, among *Sertularia* and seaweeds, 7-9 m.

Distribution and Habitat. Probably circumpolar and circum-warm temperate, Pacific from Dunedin, New Zealand, New South Wales, Australia, South and West Africa, southern California, to Magdalena Bay, Baja California, among Sertularidae (hydroid), *Boltenia* (ascidean), and seaweeds (see Barnard, 1962a), on mud, gravel, 7-100 m.

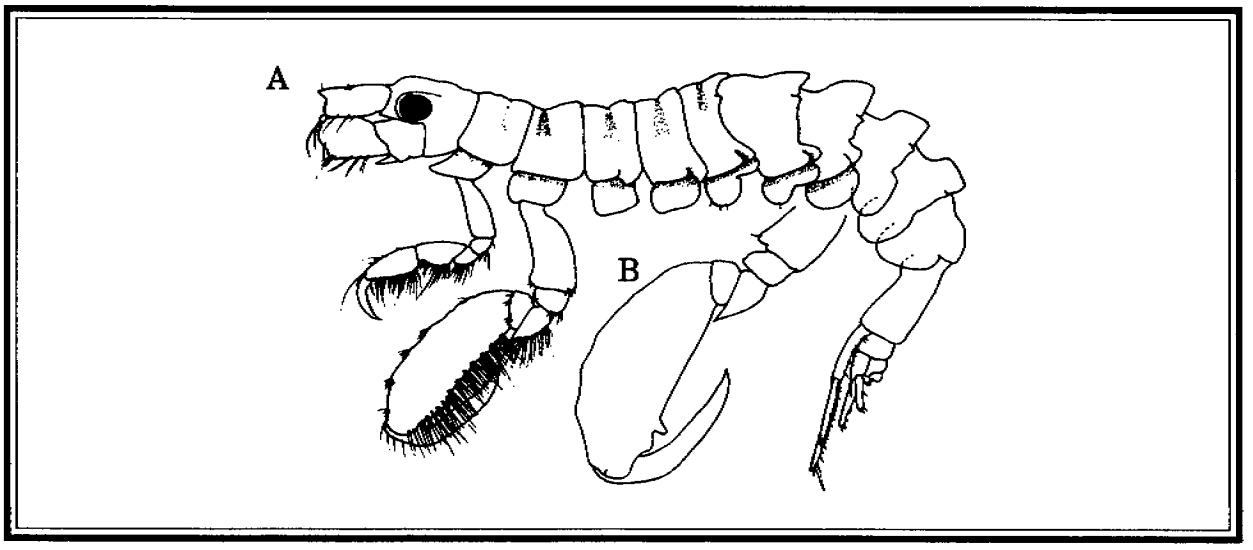

Figure 2.80. *Podocerus cristatus*, male, 6.0 mm; A, Lateral view; B, Gnathopod 2 minus setae (from Barnard, 1962a).

Family Stegocephalidae Dana, 1855

Diagnosis (from Barnard and Karaman, 1991). Body laterally compressed but from lateral view appearing stout and globular. Coxae 1-4 forming lateral shield with deeply convex ventral margin, coxa 4 very large, coxae 2-3 narrowest and thinly rectangular, coxa 1 shortest, broad basally, strongly tapering, acuminate, not covered by following coxae. Antennae 1 with very short peduncle, articles 2-3 scarcely developed, accessory flagellum 1-2-articulate. Mandible without molar and palp. Gnathopods feeble, simple. Pereopod 5, article 2 rectolinear, hidden behind coxa 4.

Remarks. 19 genera, 56 species.

Stegocephalus Krøyer, 1842

Type Species. *Stegocephalus inflatus* Krøyer, 1842.

Diagnosis (from Barnard and Karaman, 1991). Body smooth. Antenna 2 article 4 of peduncle shorter than article 5. Upper lip ordinary, asymmetrically lobed. Mandibular incisor toothed (often weakly). Lower lip ordinary, with several bidigitate distal fingers. Maxilla 1, ordinary, palp 1-articulate. Outer plate of maxilla 2 gaping and geniculate, spines with hooks. Inner plate of maxilliped reaching apex of palp article 1, palp 4-articulate, article 2 unproduced. Dactyls of gnathopods simple. Pereopods 3-4 simple. Pereopod 6, article 2 expanded or intermediate. Pereopod 7 with 7 articles, article 2, lobe pointed below. Uropod 3 biramous, outer ramus 1-articulate, peduncle shorter than rami. Telson longer than broad, cleft.

Remarks. 2 species.

***Stegocephalus hancocki* Hurley, 1956**

Figure 2.81

Stegocephalus hancocki Hurley, 1956: 28-34, plates 9-11.—Gurjanova, 1962: 375.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 15, 393 m, November 1983, (2 specimens).

Description (modified from Hurley, 1956). Female 5.5 mm. Eyes absent. Antenna 1, flagellum slightly longer than peduncle. Antenna 2, peduncle article 4 and 5 subequal. Pereopod 6 and 7 coxae subrectangular, article 2 ovate and expanded posteriorly. Pereopod 7 anterior margin with a few short spines, posterior margin finely serrate. Epimeron 3, posteroventral corner serrate. Uropod 3 inner ramus shorter than outer ramus. Telson cleft one-half to two-thirds its length.

Remarks. This species is similar to *S. inflatus* Krøyer, 1842 which can be distinguished from *S. hancocki* by the coarsely serrated ventral margin of epimera 3, an acuminate posteroventral corner on pereopod 7, article 2, and the produced lateral cephalic lobe extending to the end of article 1, antenna 1 (Hurley, 1956).

Type Specimen and Locality. Holotype slide, AHF No. 4113, female, 5.5 mm. Station 1223-41, San Pedro Channel, SW of Newport, California.

Distribution and Habitat. California coast, green sand and mud, 200-458 m.

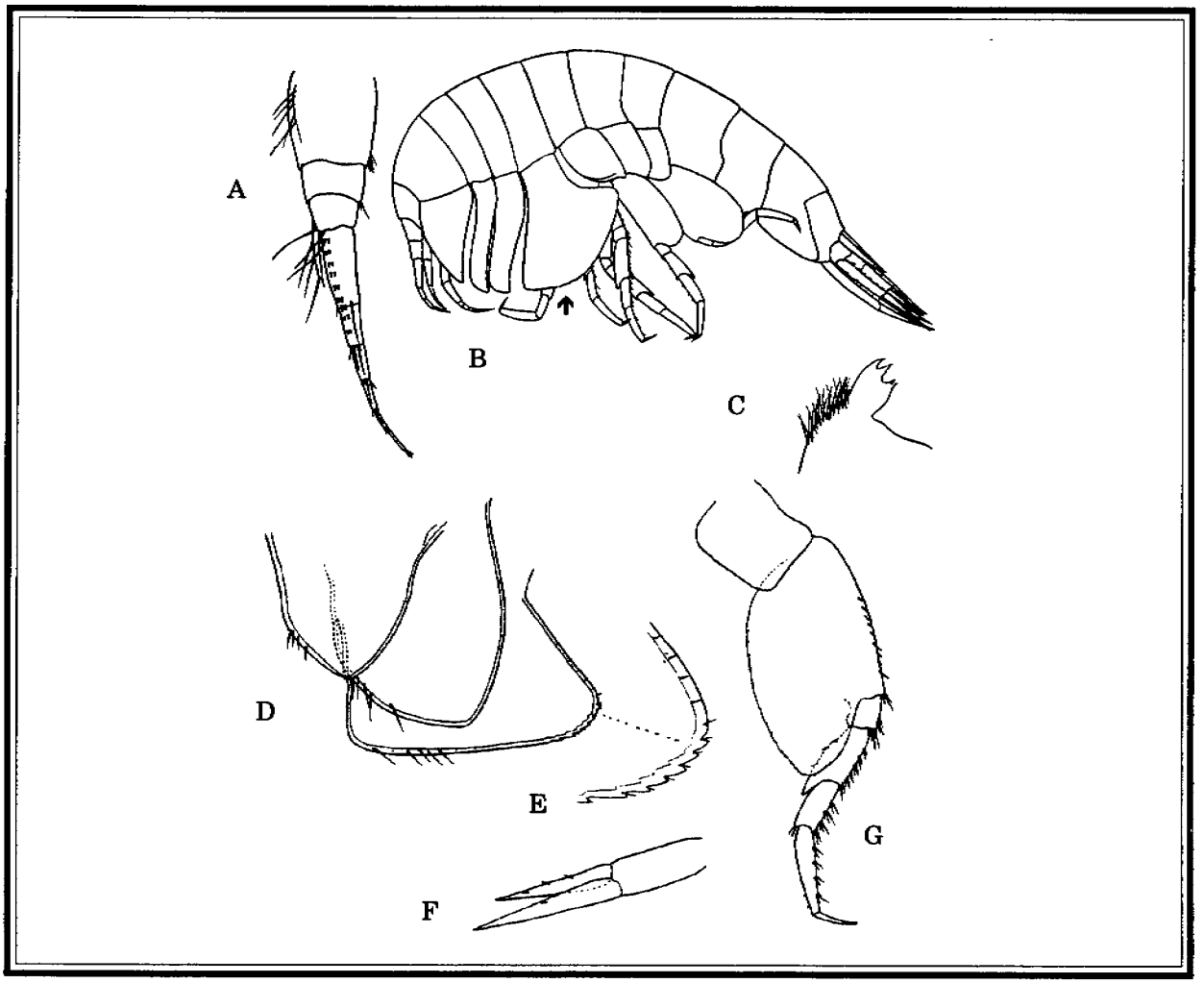

Figure 2.81. *Stegocephalus hancocki*, female, 5.5 mm; A, Antenna 1; B, Lateral view, note the shape of coxa 4; C, Lower lip, distal angle, note digitate fingers; D, Epimera 1-3; E, Close-up of epimeron 3 showing serrated edge; F, Uropod 3; G, Pereopod 7 (from Hurley, 1956).

Family Stenothoidae Boeck, 1871

Diagnosis (from Barnard and Karaman, 1991). Accessory flagellum 0 to 2-articulate. Mandibular molar barely visible. Outer plates of maxillipeds vestigial. Coxa 1 very small and partially covered by following coxae. Coxa 4 enlarged, shield-like, not posterodorsally excavate. Pereopod 3, article 2 rectolinear. Uropod 3 uniramous. Telson entire.

Remarks. 31 genera, 218 species.

Key to the Stenothoidae of the Santa Maria Basin

1A. Antenna 1, article 1 produced anterodistally; pereonite 4 swollen dorsally .... *Hardametopa nasuta*

1B. Antenna 1, article 1 not produced; ; pereonite 4 not swollen dorsally 2

2A. Gnathopod 2 elongate, article 6 and 7 equal in length; pereonite 4 elongate, longer than 5 .... *Stenothoe frecanda*

2B. Gnathopod 2, normal, propodus longer than dactyl; pereonites 4 and 5 subequal in length 3

3A. Telson armed with spines 4

3B. Telson without spines or setae 5

4A. Telson with 3 pair of lateral spines 6

4B. Telson with 2 pair lateral spines 7

5A. Pereopod 6-7, article 2 expanded, lobate; eyes very large, nearly covering side of head .... *Stenula modosa*

5B. Pereopods 6-7, article 2 rectolinear, not expanded; eyes medium, not covering side of head .... *Parametopella* sp. 1

6A. Pereopod 6 and 7 short, article 2 expanded posteriorly, lobate ..... *Metopa dawsoni*

6B. Pereopod 6 long, article 2 rectolinear, pereopod 7 short, article 2 expanded posteriorly, lobate .... *Stenothoides bicoma*

7A. Accessory flagellum present; gnathopod 1, propodus linear, shorter than carpus .... *Metopella aporpis*

7B. Accessory flagellum absent; gnathopod 1, propodus slightly expanded, equal to carpus in length .... *Parametopella ninis*

Hardametopa Barnard and Karaman, 1991

Type Species. *Metopa nasuta* Boeck, 1871, selected by Barnard and Karaman, 1991.

Diagnosis (from Barnard and Karaman, 1991). Antenna 1 bearing nasiform process on article 1. Accessory flagellum absent. Mandibular palp 2-to-3-articulate. Maxilla 1, palp 1-articulate. Inner plate of maxilla 2 ordinary. Inner plates of maxillipeds well separated. Gnathopod 1 small, simple, article 4 barely chelate, article 5 elongate, unlobed, article 6 linear. Gnathopod 2 scarcely enlarged, palm strongly oblique, carpus short, lobed. Pereopods 5-7 with rectolinear article 2. Pereonite 4 elongate and swollen. Pleonite 4 weakly extended posterodorsally. Telson ordinary, flat.

Remarks. 2 species.

Hardametopa nasuta (Boeck, 1871)

Figure 2.82

Metopa nasuta Boeck, 1871: 64; Sars, 1895: 276-277, plate 98.
Metopella nasuta: Lincoln, 1979: 204, figures 80, 93.—Just, 1980: 50, figure 53.

Material Examined. Reported from this study, but specimens unavailable.

Description (from Lincoln, 1979). Both sexes 2-4 mm. Eyes small and rounded. Body very short and broad. Antenna 1 and 2 very short, only about one-quarter body length slender, subequal. Antenna 1 peduncle article robust and equal to length of articles 2 and 3 combined, anterodistal angle strongly produced, flagellum about 8 articulate. Antenna 2, peduncle articles 4 and 5 subequal, flagellum about 7-articulate. Pereon segment 4 much longer than rest and with low rounded dorsal keel. Coxa 1 extremely small, plates 2-3 very elongate, plate 4 extremely large. Epimeral plate 3 quadrate. Gnathopod 1 simple, slender, propodus about equal to length of carpus, palm not delimited, posterior margin with approximately 3 long setae, margin microscopically toothed. Gnathopod 2 only moderately large, propodus subrectangular, tapering proximally, palm weakly oblique, palmar margin much less than half length of posterior margin delimited by small tooth and 1-2 small spines, palmar margin distinctly toothed. Pereopods 5-7 elongate and very slender, sparsely setose, article 2 slender, article 4 scarcely expanded and only slightly produced distally. Urosomite 1 with dorsal keel. Uropods 1-2 slender, rami devoid of spines. Uropod 3 peduncle short with single distal spine. Telson tongue-shaped with 2 pairs of small dorsolateral spines, apex rounded.

Remarks. The dorsal swelling on pereonite 4 and produced peduncle article of antenna 1 distinguish this species.

Type Specimen and Locality. Hardangerfjord, Norway.

Distribution and Habitat. North Atlantic: Greenland, Iceland, Norway, 10-183 m.

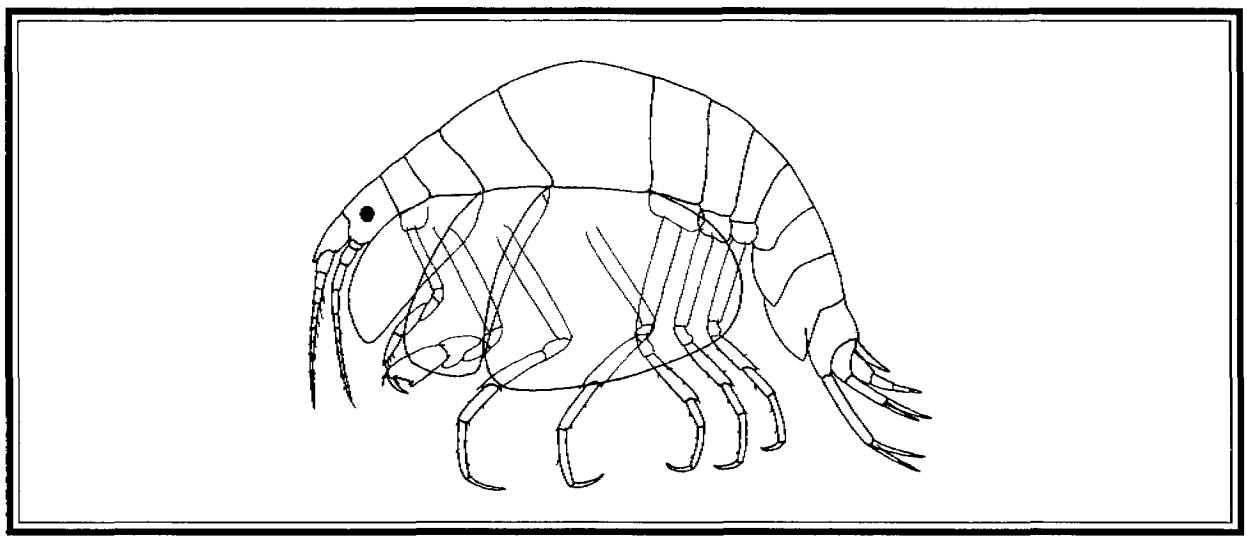

Figure 2.82. *Hardametopa nasuta* (Boeck, 1871), female (from Lincoln, 1979).

Metopa Boeck, 1871

Type Species. *Leucothoe clypeata* Krøyer, 1842, selected by Boeck, 1876.

Diagnosis (from Barnard and Karaman, 1991). Antenna 1 lacking nasiform process on article 1. Accessory flagellum absent or vestigial. Mandibular palp 2 to 3-articulate. Maxilla 1, palp 1-articulate. Inner plate of maxilla 2 ordinary. Inner plates of maxillipeds mostly fused together or well separated (type). Gnathopods 1-2 subchelate, different from each other in size and shape. Gnathopod 1 small, almost simple (variable), article 4 barely chelate, article 5 elongate, barely lobed, article 6 scarcely expanded, almost linear. Gnathopod 2, enlarged, palm oblique, articles 4-5 short, article 5 lobed. Pereopod 5 with rectolinear article 2. Pereopods 6-7 with expanded, lobate article 2. Pereonite 4 short. Pleonite 4 not extended posterodorsally. Telson ordinary, flat.

Remarks. 50 species.

***Metopa dawsoni* Barnard, 1962**

Figure 2.83

Metopa dawsoni Barnard, 1962c: 139-142, figure 10-11.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 6, 109 m, October 1984, (20 specimens), Sta. 1, 98 m, (19 specimens), Phase II, Sta. R1, 91 m, October 1986, (1 specimen).

Description (from Barnard, 1962c). Female 5.0 mm, male 3.0-4.3 mm. Antenna 1 slightly longer than antenna 2. Accessory flagellum forming a minute bump. Gnathopod 1 with propodus about half as long as carpus and both articles with parallel edges parallel, dactyl short, almost one-third as long as propodus, bearing 4-5 setules along inner margin, basis slender, merus not strongly produced behind. Gnathopod 2 with nearly transverse palm defined by a large deflexed tooth which points medially when not flattened on the microscope slide, palm with a large excavation and a multitoothed process near finger hinge, dactyl failing to reach the defining tooth, ischium produced anteriorly, merus unusual in forming a thin transparent process on the medial side of carpus and bearing an anterior spine, carpus bearing minute denticulation along anterior edge. Coxa 4 not sinuous along lower margin. Epimeron 3 slightly attenuated and quadrate at lower corner. Telson with 3 lateral spines on each side. Pereopods 4-5, article 4 stout. Strong sexual dimorphism in gnathopods.

Remarks. This species is one of three from California (*Stenothoides bicoma* Barnard, 1962c, *Stenothoe frecanda* Barnard, 1962c, and *M. dawsoni*) that have 3 paired lateral spines on the telson. Both species are easily separated from *M. dawsoni* by the shape of pereopod 6. *Proboloides tunda* Barnard, 1962c has also been found off of California at 545-611 m, but it differs in having a pointed telson and no eyes.

Type Specimen and Locality. Holotype AHF No. 598, male 3 mm. Station 6098, off Pt. Fermin, southern California, 33°38 45N, 118°14 45W, 44 m.

Distribution and Habitat. Southern California coastal shelf, 55-183 m.

Metopella Sars, 1895, revised

Type Species. *Metopa longimana* Boeck, 1871, selected by Gurjanova, 1938.

Diagnosis (from Barnard and Karaman). Antenna 1 lacking nasiform process on article 1. Accessory flagellum present. Mandible palp 2 -to-3-articulate. Maxilla 1, palp 1-articulate. Inner plate of maxilla 2

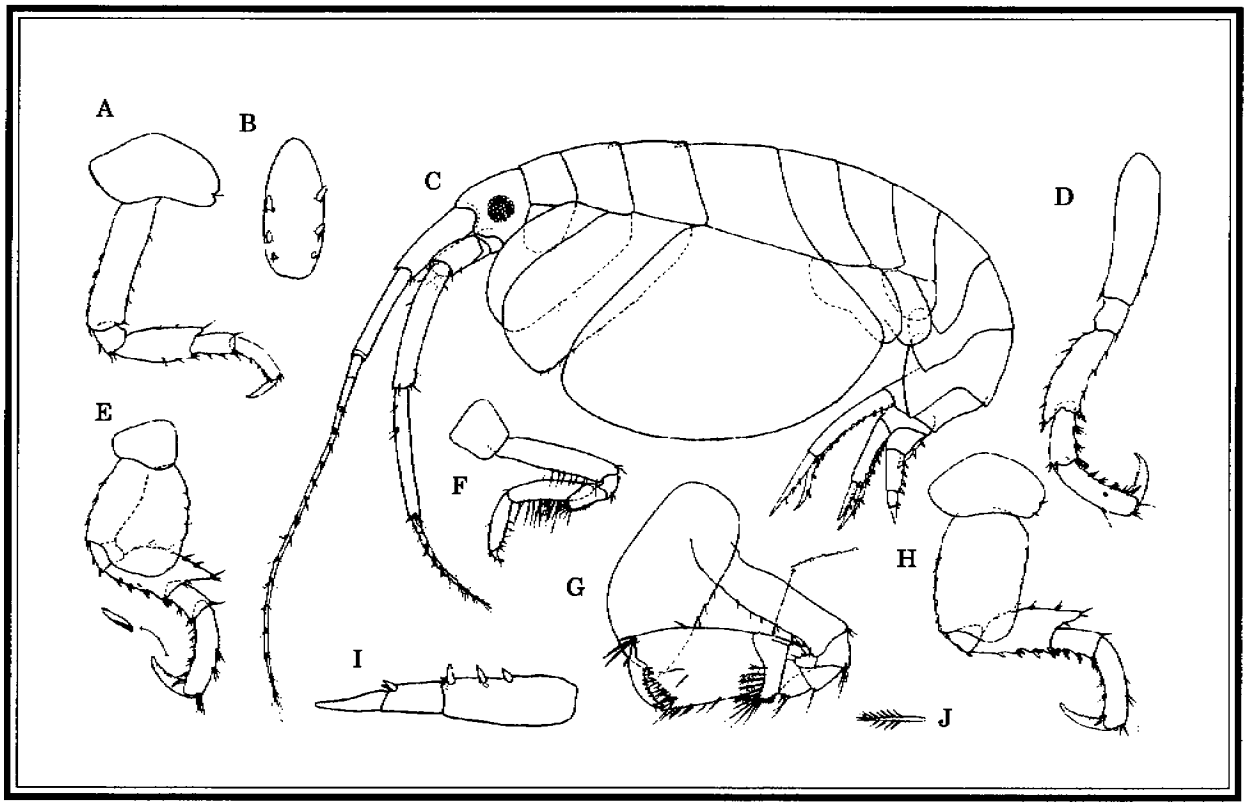

Figure 2.83. *Metopa dawsoni*, female, 3.8 mm; A, Pereopod 5; B, Telson; C, Lateral view; D, Pereopod 4; E. Pereopod 7; F, Gnathopod 1; G, Gnathopod 2 with close-up of anterior margin; H, Pereopod 6; I, Uropod 3; J, Gnathopod 2, close-up of carpal setae (from Barnard, 1962c).

ordinary. Inner plates of maxillipeds well separated. Gnathopods 1-2 different from each other in size and shape, gnathopod 1 small, simple, merus barely chelate, carpus elongate, unlobed, propodus linear. Gnathopod 2 slighty enlarged, palm weakly oblique, article 4-5 short, carpus lobed. Pereopod 5-7 with rectolinear article 2 but article 2 on pereopod 7 broader than on pereopods 5-6 (variable). Pereonite 4 ordinary. Pleonite 4 not extended posterodorsally. Telson ordinary, flat.

Remarks. 7 species.

Metopella aporpis Barnard, 1962

Figure 2.84

Metopella aporpis Barnard, 1962c: 142-144, figures 12 and 13.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 16, 591 m, October 1984, (2 specimens).

Description (from Barnard, 1962c). Female 2.5, male 2.4 mm. Gnathopod 1, propodus shorter than carpus, simple, with parallel edges, posterior edge with 4-5 long setae, dactyl half as long as propodus, with 3-4 setae on posterior edge. Gnathopod 2, palm oblique, formed of a shallow quadrate excavation bounded on both sides by a long, sharp tooth, the posterior-most forming the defining tooth, the anterior tooth

being an extension of a minutely toothed process near the dactyl hinge. Gnathopod 2 with dactyl nearly reaching end of palm, carpus forming a medial translucent lobe projecting anteriorly and appressed to the side of merus, the anterior edge of carpus with rows of minute denticles. Pereopod 3 much longer than pereopod 4 and poorly spinose, pereopod 4 having numerous stout posterior spines on article 5 and 6. Telson with 2 lateral spines on each side near base.

Remarks. The proximolateral spines on the telson are very stout relative to other California species. See Barnard, 1962c for a listing of other closely related species.

Type Specimen and Locality. Holotype AHF No. 5729, male, 2.4 mm. Station 4834, near Pt. Mugu, California, 34°00'20"N, 119°01'45"W, rock bottom, 141 m.

Distribution and Habitat. Monterey Bay California to Cristobal Bay, Baja California, 24-591 m, south of Pt. Conception, California, not shallower than 84 m.

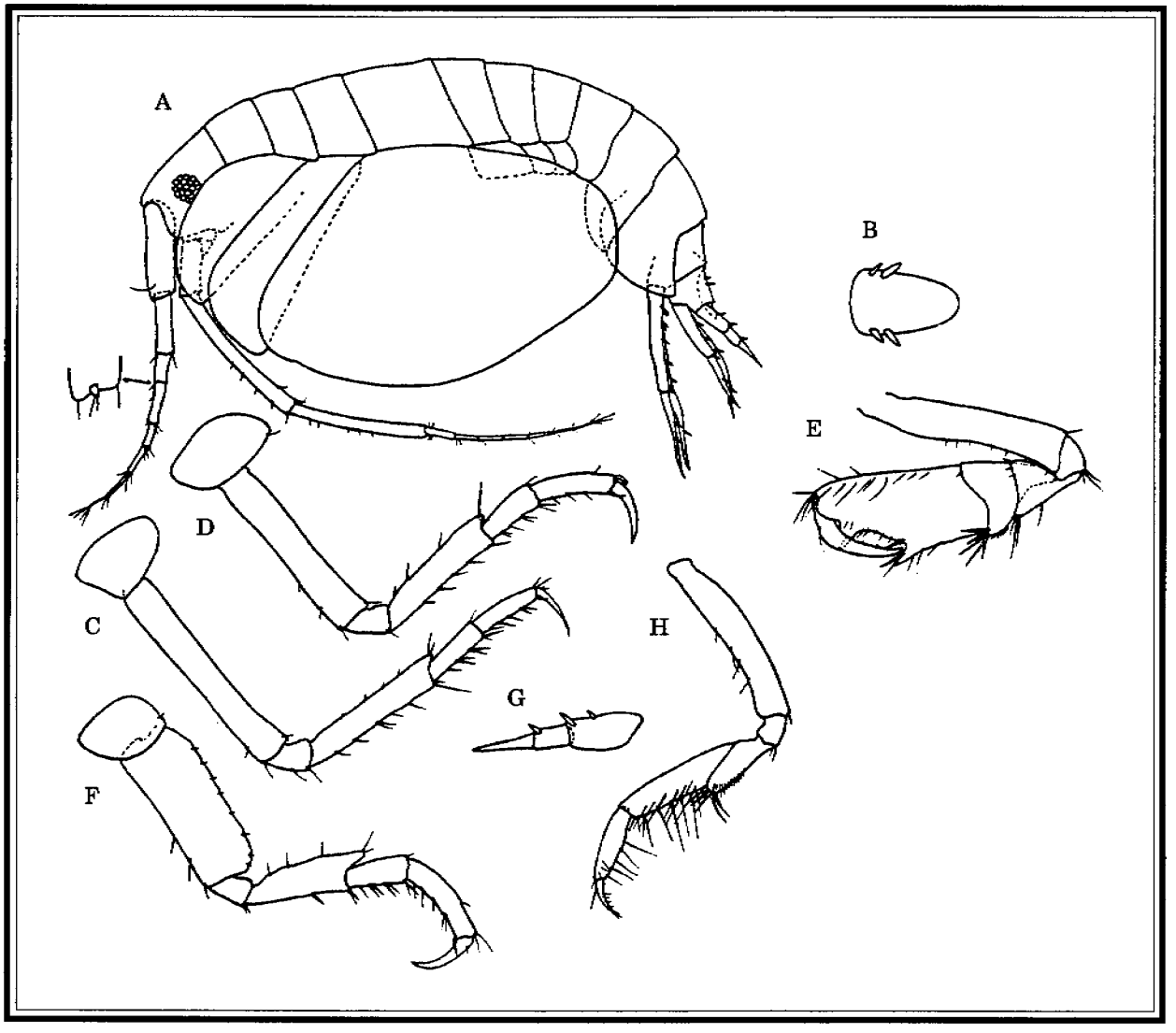

Figure 2.84. *Metopella aporpis*, male, 2.4 mm; A, Lateral view with close-up of accessory flagellum; B, Telson; C, Pereopod 6; D, Pereopod 5; E, Gnathopod 2; F, Pereopod 7; G, Uropod 3; H, Gnathopod 1 (from Barnard, 1962c).

Parametopella Gurjanova, 1938

Type Species. *Stenothoe cypris* Holmes, 1905, original designation.

Diagnosis (from Barnard and Karaman, 1991). Antenna 1 lacking nasiform process on article 1 (variable). Accessory flagellum absent. Mandibular palp absent. Maxilla 1, palp 1-articulate. Inner plate of maxilla 2 ordinary. Inner plates of maxillipeds partially fused together. Gnathopods 1-2 different from each other in size and shape, gnathopod 1 small, simple, carpus short, lobed, propodus expanded. Gnathopod 2 enlarged, palm strongly oblique, carpus short, lobed. Pereopods 5-7 with rectolinear article 2. Pereonite 4 ordinary. Pleonite 4 not extended posterodorsally. Telson ordinary, flat.

Remarks. 5 species.

Parametopella ninis Barnard, 1962

Figure 2.85

Parametopella ninis Barnard, 1962c: 45-47, figures 14-15.

Material Examined. Reported from this study, but not supported by collections.

Description (from Barnard, 1962c). Female 1.9-2.8 mm. Articles of antenna simple, not produced. Gnathopod 1 slender, simple, carpus and propodus equal in length, the posterior margin of propodus with 4 slender setae, the posterior margin of dactyl with 3 slender setae. Gnathopod 2 small, slender, carpus nearly two-thirds as long as propodus, with broad posterior lobe, becoming acute at apex, the palm oblique, straight, defined by 2 spines. Telson with 2 lateral spines on each side.

Remarks. The male is not described for this species. We examined numerous specimens, all of which were small, possibly juveniles. of *Parametopella* sp 1 Thomas and McCann. The latter may represent an undescribed species. *P. ninis* has previously been recorded from California, and is very similar to *P.* sp 1, therefore we have included it in the key.

Type Specimen and Locality. Holotype AHF No. 586, female, 1.9 mm. Station 5711, Santa Monica Bay, California, 33°55'54"N, 118°31'16"W, 57 m.

Distribution and Habitat. Southern California coastal shelf, 57-183 m.

Parametopella sp. 1

Material Examined. Santa Maria Basin, California, Phase II, Sta. R4, 92 m, January 1988, (39 specimens).

Description. Antenna 1 lacking nasiform process on article 1. Gnathopod 1, article 5 and article 6 equal in length. Telson without spines.

Remarks. This species is similar to *P. ninis* in all characters examined (we did not dissect mouthparts), with the exception of the unarmed telson (one of the adult specimens we examined had a pair of minute lateral setules on the telson (visible only under the compound scope).

Distribution and Habitat. Santa Maria Basin, California, 92 m.

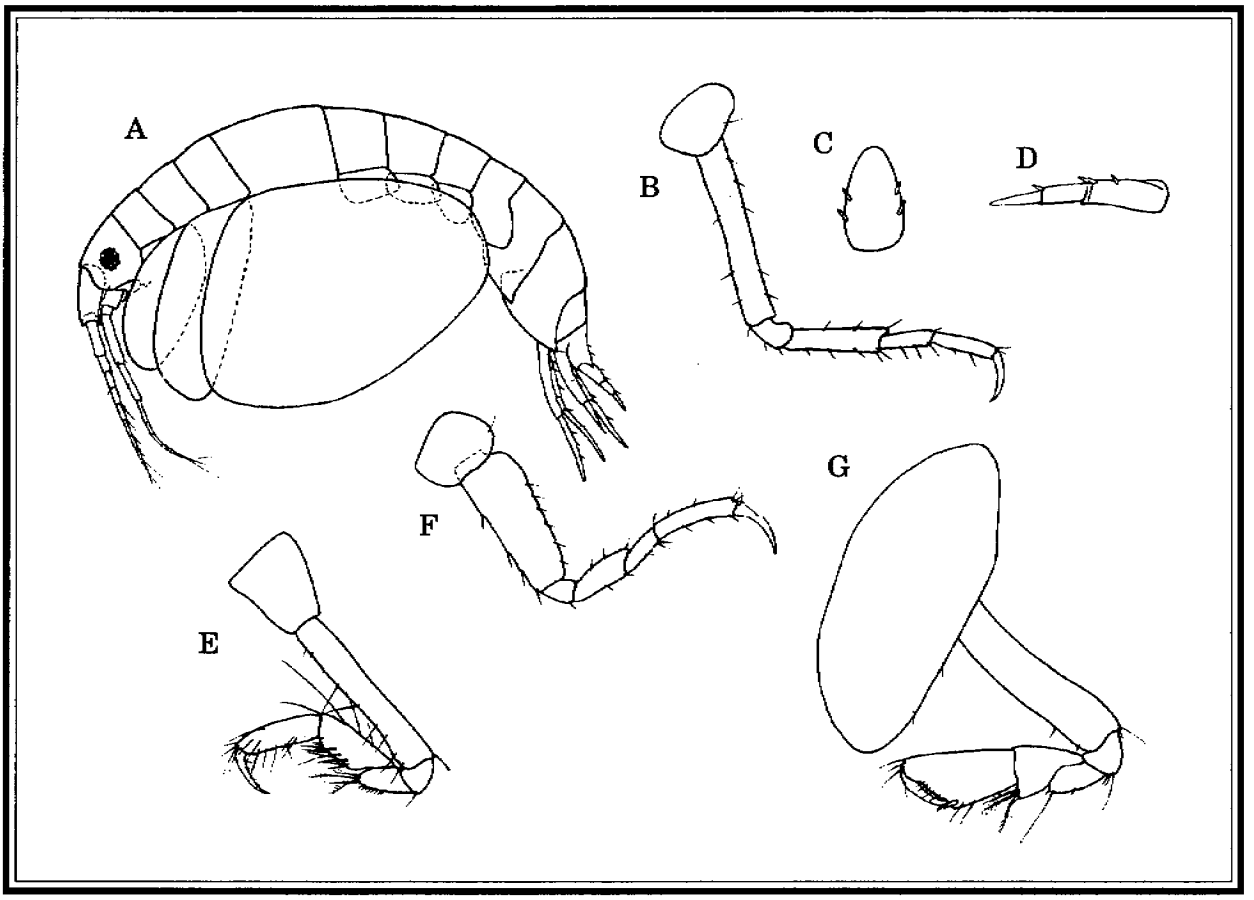

Figure 2.85. *Parametopella ninis*, female; A, Lateral view; B, Pereopod 6; C, Telson; D, Uropod 3; E, Gnathopod 1; F, Pereopod 7; G, Gnathopod 2 (from Barnard, 1962c).

Stenothoe Dana, 1852

Type Species. *Stenothoe valida* Dana, 1853.

Diagnosis. Antenna 1 lacking nasiform process on article 1. Accessory flagellum absent or 1-articulate. Mandibular palp absent. Maxilla 1, palp 2-articulate. Inner plate of maxilla 2 unproduced. Inner plates of maxillipeds well separated. Gnathopods 1-2 subchelate, very different from each other in size and shape, gnathopod 1 small, subchelate, palm oblique and as long as posterior margin of propodus, merus barely chelate, carpus shorter than propodus, lobed, expanded. Gnathopod 2 enlarged, palm strongly oblique, merus elongate, lobed, carpus short, lobed. Pereopod 5, article 2 rectolinear. Pereopods 6-7 with expanded and lobate article 2. Pereonite 4 ordinary. Pleonite 4 not extended posterodorsally. Telson ordinary, flat.

Remarks. 51 species.

Stenothoe frecanda Barnard, 1962

Figure 2.86

Stenothoe frecanda Barnard, 1962c: 151, figure 18.

Material Examined. Reported from this study, but not supported by collections.

Description (from Barnard, 1962c). Male 3.6 mm. Body not carinate. Gnathopod 1, merus strongly projecting distally and behind. Gnathopod 2 elongate, with palm and posterior margin contiguous, bearing near finger hinge a small triangular-shaped process with 2 smaller distal processes (these less well developed in female), the palm lined with short setae, not denticulate, dactyl as long as propodus, stout, lined on inner edge with short setae. Uropod 3, ramus, article 2 straight, not geniculate, the peduncle slightly longer than the ramus. Pereopods 5-7, article 4 of intermediate expansion. Telson with 3 lateral spines on each side.

Remarks. Our material consisted of one specimen from 100 m, which exhibited the following variations from *S. frecanda*: gnathopod 2, palmar angle much more transverse (it is straight in *S. frecanda*), dactyl more recurved. We are hesitant to make a determination without more material. This species is related to *S. valida* Dana, 1853 but differs in having the distal palmar teeth of gnathopod 2 perpendicular rather than oblique to the palm, and differs from *S. marina* Bate 1857b by the stout finger (dactyl) of the gnathopods.

Type Specimen and Locality. Holotype AHF No. 587, male, 3.6 mm. Station 5632, off San Mateo Pt., California, 33°22'50"N, 117°39'00"W, 66 m.

Distribution and Habitat. Monterey Bay to southern California shelf, 64-92 m.

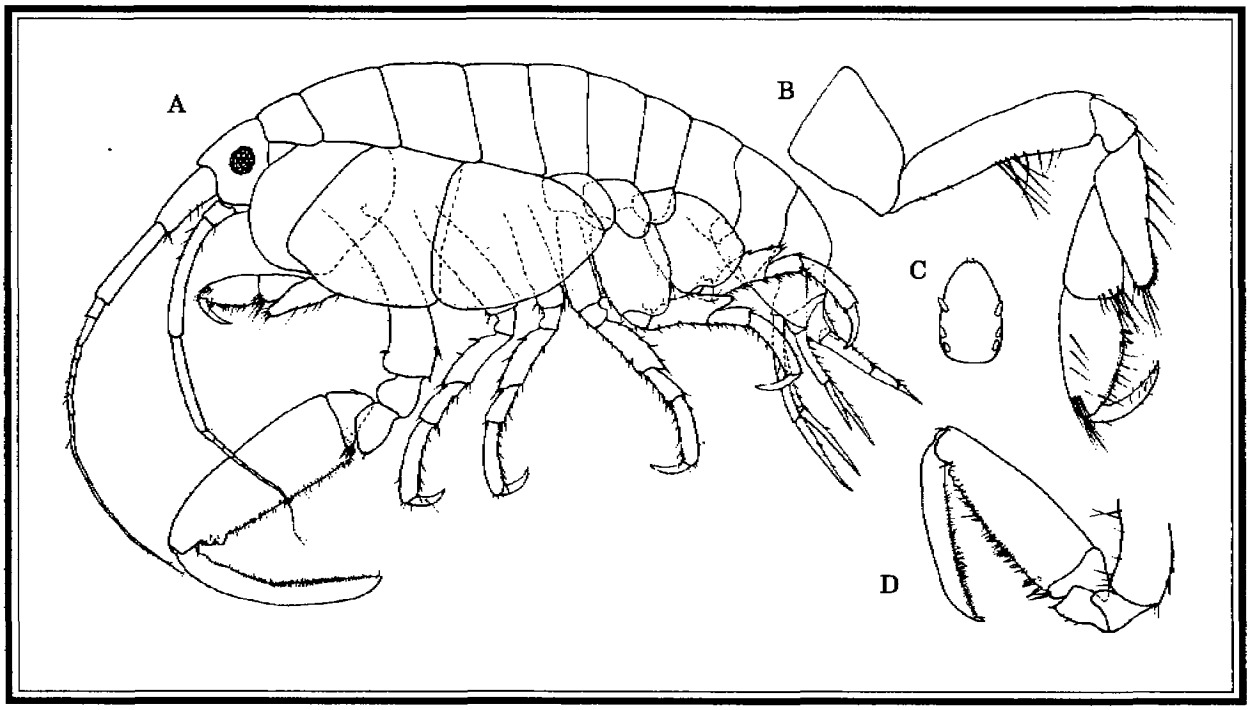

Figure 2.86. *Stenothoe frecanda*, male, 4 mm; A, Lateral view; B, Gnathopod 1; C, Telson; D, Gnathopod 2, female, 4 mm (from Barnard, 1962c).

Stenothoides Chevreux, 1900

Type Species. *Stenothoides perrieri* Chevreux, 1900.

Diagnosis. Antenna 1 lacking nasiform process on article 1. Accessory flagellum absent or 1-articulate. Mandibular palp absent or 1-articulate. Maxilla 1, palp 1-articulate. Inner plate of maxilla 2 ordinary. Inner plates of maxillipeds well separated. Gnathopods 1-2 subchelate, different from each other in size and shape, gnathopod 1 small, subchelate, palm oblique and as long as posterior margin of propodus, merus barely chelate, carpus as long as propodus, barely lobed, propodus expanded. Gnathopod 2 enlarged, palm almost transverse, almost chelate, carpus short, lobed. Pereopods 5-6 with rectolinear article 2, pereopod 7 with slightly expanded and lobate article 2. Pereonite 4 ordinary. Pleonite 4 not extending posterodorsally. Telson ordinary, flat.

Remarks. 7 species.

***Stenothoides bicoma* Barnard, 1962**

Figure 2.87

Stenothoides bicoma Barnard, 1962c: 136-139, figure 8.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 4, 393 m (1 male, 1 female).

Description (modified from Barnard, 1962c). Female 3.5 mm, male, 1.5-4.0 mm. Antennae subequal in length. Mandible lacking palp. Gnathopod 1, article 5 longer than article 6, article 7 simple, not setose, article 4 scarcely produced. Gnathopod 2, palm oblique, bearing a large multitoothed process near finger hinge and a large, acute defining process, (pattern of teeth is variable depending on size and sex) with quadrate excavation between them, in the male. Last two urosomal segments fused. Telson bearing three lateral spines on each side.

Remarks. Both specimens agree well with *S. bicoma* of Barnard (1962c) but no mention is made of the paired spines surrounding the acute defining process on the palm of gnathopod 2 in the female. Gnathopod 1, carpus is subequal or shorter than propodus in the female we examined, but in the male, carpus is longer than propodus, raising some question about the validity of this character in species diagnoses.

Stenula Barnard, 1962

Type Species. *Stenothoides latipes* Chevreux and Fage, 1925, original designation.

Diagnosis. Antenna 1 lacking nasiform process on article 1. Accessory flagellum absent. Mandibular palp 1-articulate. Maxilla 1, palp 1-articulate. Inner plate of maxilla 2 ordinary. Inner plates of maxillipeds well separated. Gnathopod 1 small, almost simple, merus barely chelate, carpus elongate, unlobed, propodus almost linear. Gnathopod 2 slightly enlarged, palm weakly oblique, carpus short, lobed. Pereopod 5 with rectolinear article 2, pereopod 6-7, article 2 expanded and lobate. Pereonite 4 ordinary. Pleonite 4 not extending posterodorsally. Telson ordinary, flat.

Remarks. 11 species.

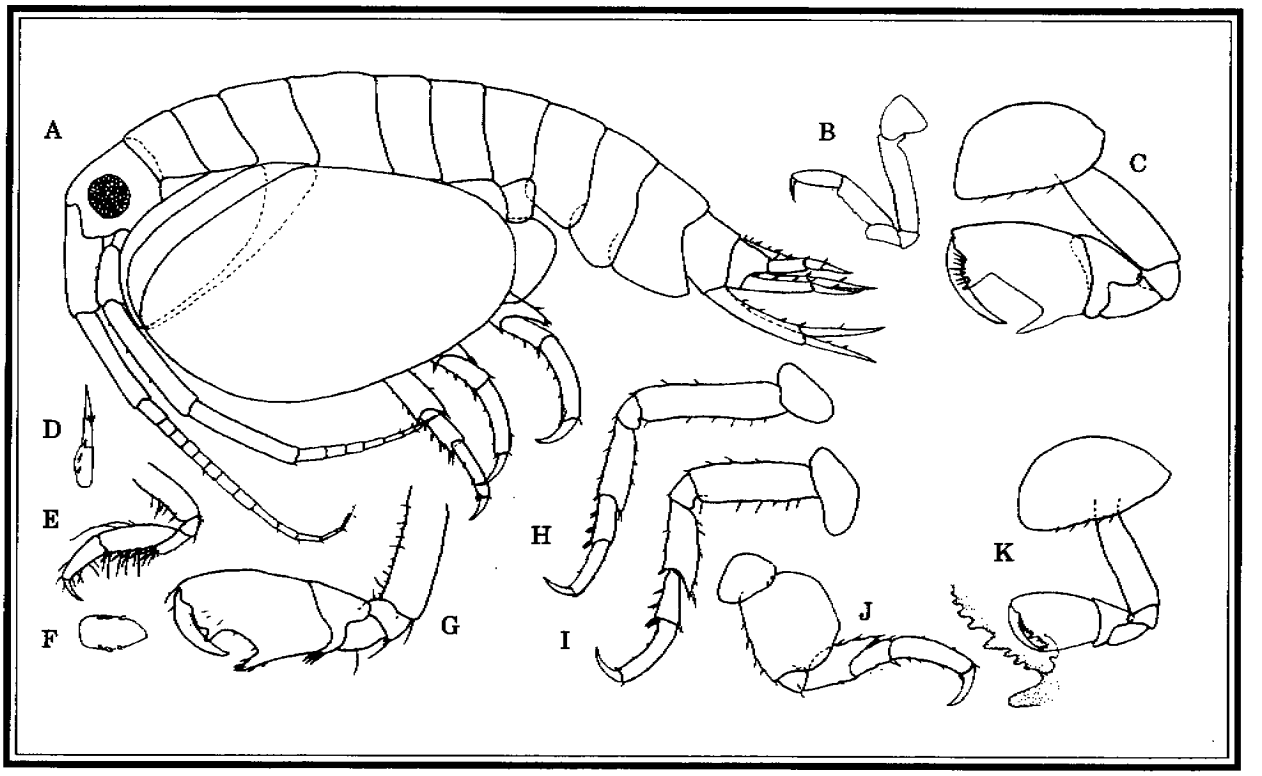

Figure 2.87. *Stenothoides bicoma*, male, 1.5 mm; A, Lateral view; B, Gnathopod 1; C, Gnathopod 2; D, Uropod 3; E, Gnathopod 1; F, Telson; G, Gnathopod 2; H, Pereopod 6; I, Pereopod 5; J, Pereopod 7; K, Gnathopod 2, minus setae, with close-up of palm, female, 3.5 mm; B,C, male, 4 mm (from Barnard, 1962c).

Stenula modosa Barnard, 1962

Figure 2.88

Stenula modosa Barnard, 1962c: 137-139, figure 9.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 42, 100 m, January 1984, (8 specimens), Phase II, Sta. R4, 92 m, October 1988, (83 specimens).

Description (from Barnard, 1962c). Female 2 mm. Eyes very large, round, occupying almost entire side of the head. Body not carinate. Gnathopod 1 simple, the posterior edge of propodus with slender setae, the dactyl bearing slender setae on its hind edge. Palp of mandible as long as width of mandibular apex, slender. Pereopods 5-7, article 4 not strongly produced posteriorly. Uropod 3 ramus, article 1 longer than peduncle. Uropod 3 lacking spines except for one at articulation of peduncle and article 1 of ramus. Telson tongue shaped, unarmed.

Remarks. The male of *S. modosa* remains to be described. The size of the eyes and the simple palm and small size of gnathopod 1 help distinguish this species, however our specimens had moderately-sized eyes. In *S. modosa*, pereopod 5-7, article 4 is long and slender and not strongly produced posteriorly, unlike a similar California species, *S. incola* Barnard, 1969c in which pereopods 5-7 have a short article 4, strongly produced posteriorly.

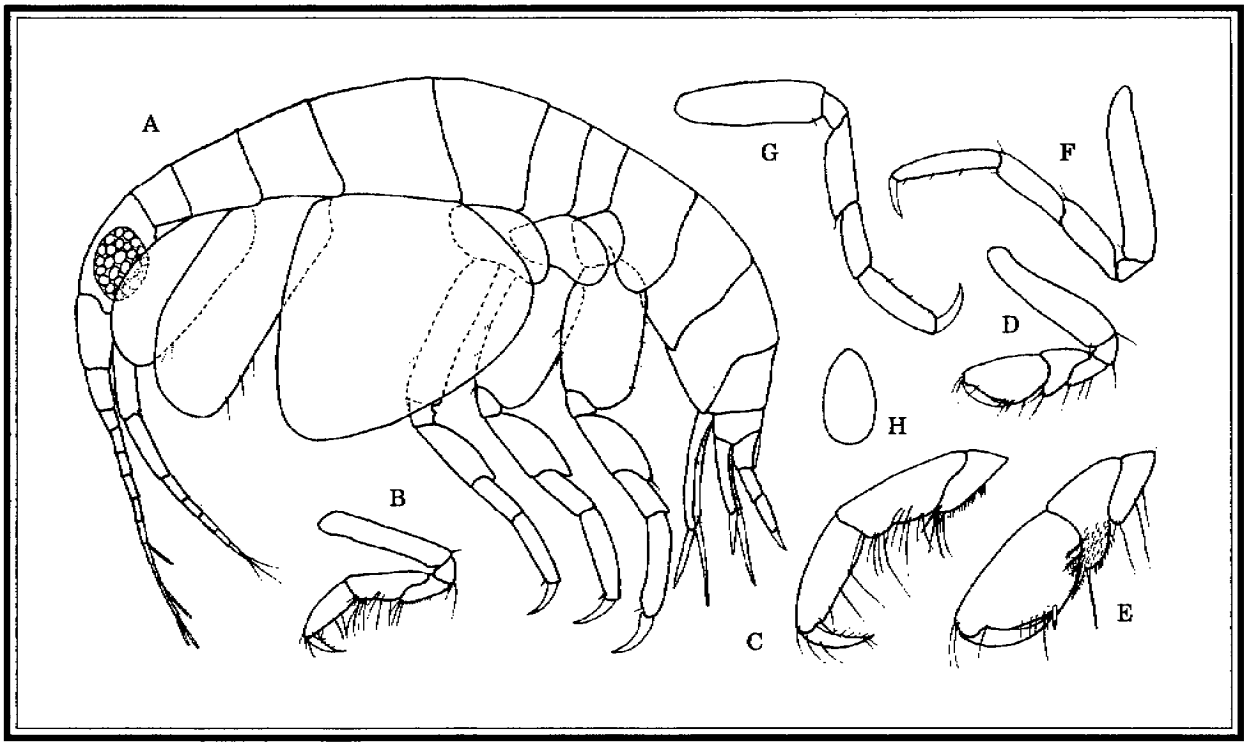

Figure 2.88. *Stenula modosa*, female, 2 mm; A, Lateral view; B and C, Gnathopod 1; D and E, Gnathopod 2; F and G, Pereopods 3 and 4; H, Telson (from Barnard, 1962c).

Type Specimen and Locality. Holotype AHF No. 5728, female, 2 mm. Station 4821, near Pt. Conception, 34°25'48"N, 120°14'40"W, green mud, 92 m.

Distribution and Habitat. Southern California, 60-100 m.

Family Stilipedidae Holmes, 1908
(formerly Astyridae)

Diagnosis (from Barnard and Karaman, 1991). Antenna 1 shorter than antenna 2. Accessory flagellum 0-2-articulate. Mandible flat, molar simple or absent, mandibular palp present. Coxa 1 broader than 2 or 3, expanded distally, occasionally tending to acumination but never sharp, coxa 4 excavate posteriorly. Gnathopods feeble, simple, carpus dominant. Pereopod 7, article 2 distinct from article 2 of pereopods 5-6. Uropod 3 with short peduncle, very long rami (often one or both lost). Urosomite 1 with dorsal carina. Telson short, cleft or entire.

Remarks. 7 genera, 16 species.

Astyra Boeck, 1871

Type Species. *Astyra abyssi* Boeck, 1871.

Diagnosis (from Barnard and Karaman, 1991). Lobes of lower lip widely separated. Upper lip scarcely incised. Mandibles narrow, very flat, twisted, a thin lamina, incisor narrow, deeply toothed, right

lacinia mobilis absent, left present, raker row well developed, molar long, conical, simple, setose. Maxillae 1-2 almost ordinary, not immensely broadened though inner plate of maxilla 2 broader than ordinary, palp of maxilla 1, 2-articulate. Maxilliped outer plates broad, conspicuous, palp exceeding apex of outer plate. Gnathopods 1-2, carpus weakly lobate or moderately carpochelate. Pereopods 5-6, article 2 with setose lateral ridge extending ventrally to form weak posteroventral lobe. Pereopod 7, article 2 simple, lobate, lacking setose ridge, posterior margin straight. Sexual dimorphism not apparent.

Remarks. 7 species.

Astyra abyssi Boeck, 1871

Figure 2.89

Astyra abyssi Boeck, 1871: 53.—Sars, 1895: 214-215, plate 73.—Barnard, 1969: 159-161, figure 66.

Material Examined. ?Santa Maria Basin, California, Phase I, Sta. 63, 930 m, (1 specimen).

Description. Female to 8 mm. Eyes absent. Ventral corner of head produced, extending almost to end of article 1, antenna 1. Coxa 4 enlarged, posterior margin oblique, straight. Urosomite 1, carina followed by a deep sinus. Telson cleft half its length.

Remarks. Based on the material at hand (1 flattened, damaged specimen) we are unable to make a definitive identification beyond *Astyra* sp. The specimen represents the first record of the genus in California waters.

Type Specimen and Locality. Hardangerfjord, Norway.

Distribution and Habitat. Arctic Ocean; Atlantic: Faeroe Islands, Iceland, West coast of Norway to Vadsø; Pacific from ?southern California, on clay, 183-930 m.

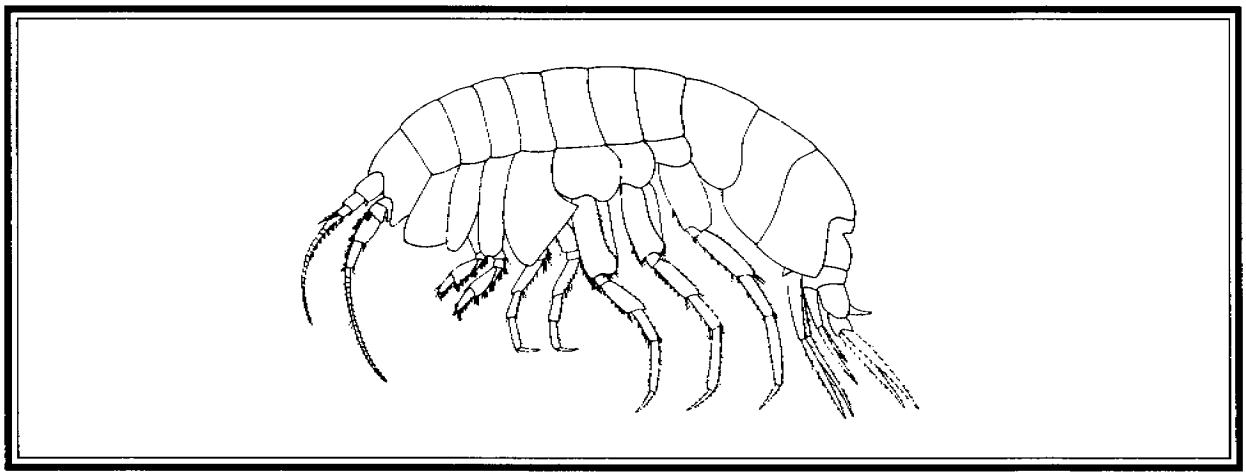

Figure 2.89. *Astyra abyssi* Boeck, 1871 (from Barnard and Karaman, 1991).

Family Synopiidae Dana, 1855

Diagnosis (from Barnard and Karaman, 1991). Gammaridean with helmet-like head or with plough-shaped protuberance on forehead. Antenna 1, accessory flagellum large, multiarticulate. Upper lip fleshy, ventrally truncate, rounded or weakly incised, usually with small marginal hairs. Mandibles with 3-articulate palp (3 exceptions), molar present and never amalgamated with spine row, latter often vestigial. Lower lip with well-developed mandibular lobes, inner lobes present and separate from each other, no extraordinarily wide space occurring between outer lobes; maxillae 1-2 well developed but setation variable, palp of maxilla 1, 2-articulate. Maxilliped, inner and outer plates and palp well developed, palp usually 4-articulate, rarely 3. Coxae 1 and 2 large and unhidden by posterior coxae, except coxa 1 rarely narrowed. Gnathopod 1, 7-articulate. Gnathopods not sexually dimorphic, gnathopod 2 not enlarged. Pereopods 3-5 basic, pereopod 7 not grossly longer than 6 in contrast to Oedicerotidae. Uropod 1-3 strongly biramous.

Remarks. 17 genera, 82 species.

Key to the Synopiidae of the Santa Maria Basin

1A. Enlarged dorsal crest on pereonites 3-7, pleonites 1-3; telson entire or almost so ..... *Bruzelia tuberculata*

1B. Dorsal crests on pereonites and pleonites lacking; Telson cleft 2

2A. Gnathopod propodus with serrate spines giving it a chelate appearance, palms transverse 3

2B. Gnathopods simple or imperfectly subchelate, propodus without spines, palms oblique ..... (*Tiron*) 4

3A. Coxa 4 much shorter and smaller than coxa 3 (pelagont) ..... *Syrrhoe longifrons*

3B. Coxa 4 as long as and slightly broader than coxa 3 (not pelagont) ..... *Garosyrrhoe disjuncta*

4A. Telson with medial row of spines; pleonite 6 with dorsal spine; dactyls short, recurved ..... *Tiron tropakis*

4B. Telson bare; pleonite 6 without spine but with posteriorly produced tooth; dactyls normal, long ..... *Tiron biocellata*

Bruzelia Boeck, 1871

Type Species. *Bruzelia typica* Boeck, 1871.

Diagnosis (from Barnard and Karaman, 1991). Forehead weakly protuberant in type but not in others, lateral cephalic lobe not sharp. Eyes absent. Mandible with palp, molar greatly enlarged, not triturative, fuzzy; mouthparts basic. Antenna 1, articles 1-2 basic. Coxa 1 ordinary. Coxa 3 not strongly expanded distally except for acute anteroventral cusp, not posteriorly excavate, coxa 4 variable, excavate posteriorly (rarely weak), and slightly smaller or slightly larger than coxa 3. Gnathopods typically subchelate, palms oblique, defined by 1-2 serrate spines, second spine if present occasionally simple. Dactyl of gnathopod 2 normal. Perepods 5-7 weakly to strongly elongate, dactyls weakly elongate, article 2 of pereopod 7 typically

rounded posteroventrally but truncate in *B. tuberculata* Sars, 1883 and *B. popolocan* Barnard, 1972b. Pleonites 1-3 posterodorsal margins not denticulate. Uropod 3 not exceeding uropods 1-2, peduncle typically short but elongate in *B. tuberculata* and *B. popolocan*. Telson elongate, entire.

Remarks. 10 species.

Bruzelia tuberculata Sars, 1883

Figure 2.90

Bruzelia tuberculata Sars, 1883: 95, plate 4, figure 7.—Sars, 1895: 397-398, plate 139, figure 2.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 53, 196 m, January 1984, (1 specimen), Phase II, Sta. PJ15, 155 m, October 1986, (1 specimen), Sta. R4, 92 m, May 1987, (1 specimen).

Description (modified from Sars, 1895). 5-6 mm. Lateral cephalic lobe large and deep, helmet-like. Granular area where eyes normally appear. Pereonites 3-7 and pleonites with a mid-dorsal crest increasing in size posteriorly. Pleonites 1 and 2 with blunt, lateral carinae terminating in a sharp angular projection of the epimeral plate. Epimera 2 and 3 produced into a hook postero-ventrally, coarsely serrated ventrally. Telson entire.

Remarks. Of the material we examined from southern California, this is the only tuberculate species in the family, making it easily recognizable.

Type Specimen and Locality. 5 mm, Lofoten Isles and Bejan, Norway.

Distribution and Habitat. Norway, Faeroe Islands, and California (1 specimen at 900 m), 92-900 m.

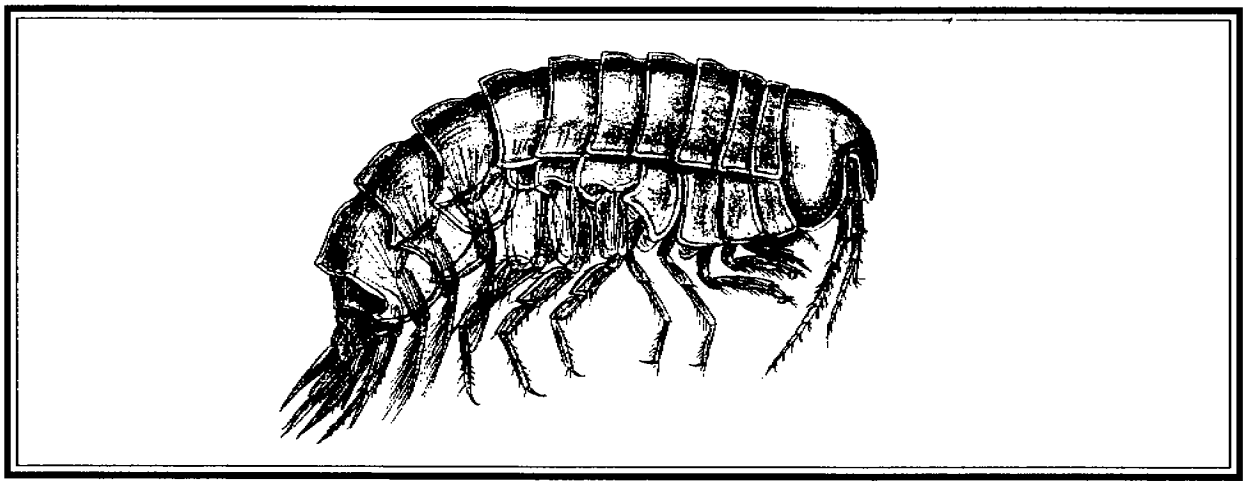

Figure 2.90. *Bruzelia tuberculata*, female; Lateral view (from Sars, 1895).

Garosyrrhoe Barnard, 1964

Type Species. *Syrrhoites bigarra* Barnard, 1962b, original designation.

Diagnosis (from Barnard and Karaman, 1991). Forehead not protuberant. Lateral cephalic lobe not sharp. Mandible with palp, molar of medium size, weakly triturative or fuzzy; mouthparts basic. Antenna 1, articles 1-2, basic. Coxa 1 ordinary. Coxa 4 larger than 3 (not pelagont). Coxa 3 softly rectangular,

posterior margin nearly parallel with anterior, and nonexcavate, coxa 4 expanded midposteriorly, posterodorsal margin sloping, not concave but appearing excavate, Gnathopods subchelate, palms nearly transverse, defined by large serrate spine giving propodus chelate appearance. Gnathopod 2, dactyl normal. Pereopods 5-7 elongate, dactyls elongate, article 2 of pereopod 7 rounded posteroventrally. Pleonites 1-3, posterodorsal margins not denticulate or very weakly so. Uropod 3 not exceeding uropods 1-2, peduncle elongate. Telson elongate, deeply cleft.

Remarks. 2 species.

Garosyrrhoe disjuncta Barnard, 1969

Garosyrrhoe disjuncta Barnard, 1969: 224-225, figure 30.

Material Examined. Reported from this study, but specimens unavailable.

Description (from Barnard, 1969). Rostrum well-defined, acute, strongly projecting ventrally. Pereonite 7 and pleonites 1-2, posterodorsal edges with pair of blunt dorsolateral teeth, each with medial hook and separated by shallow excavation, these teeth less prominent on pleonite 3, dorsolateral edges of these segments also with small hooked teeth. Epimeron 3, teeth of posterior edge much stronger than in *G. bigarra* (Barnard, 1962b). Pereopod 3, article 5 about four-fifths as long as article 4, poorly setose posteriorly, article 2 bulging anterodistally.

Remarks. The species can be distinguished from *G. bigarra* by the longer more acute rostrum and by the presence of 2 dorsal teeth on pereonite 7 and pleonites 1-2 vs 1 tooth in *G. bigarra* (Barnard, 1969).

Type Specimen and Locality. USNM No. 111467, juvenile 3 mm, BLA SIO-X, Piedras Ahogadas, 0.5 miles south of Isla Ventana, Gulf of California, shell hash, pebbles, 24 m.

Distribution and Habitat. Gulf of California, usually on coarse substrate, rocky intertidal to 25 m.

Syrrhoe Goes, 1866

Type Species. *Syrrhoe crenulata* Goes, 1866, selected by Boeck, 1876.

Diagnosis (from Barnard and Karaman, 1991). Forehead in type species not protuberant but strongly so in 3 other species, lateral cephalic lobe sharp in type but rounded in species with protuberant forehead and others. Eyes typically present but occasionally absent, accessory eyes absent. Mandible with palp, molar small, weakly triturative; mouthparts basic. Antenna 1, articles 1-2 usually basic but in type article 1 bearing large posteroterminal tooth, peduncle slightly elongate (female). Coxa 1 ordinary. Coxa 3 larger than 4 (pelagont). Gnathopods with transverse or subtransverse palms bearing enlarged serrate defining spine giving chelate appearance to propodus. Gnathopod 2, dactyl normal. Pereopods 5-7 elongate, dactyls elongate, second articles heavily serrate or not, article 2 of pereopod 7 typically rounded posteroventrally but in few other species becoming truncate. Pleonites 1-3 typically denticulate dorsally but often smooth or bearing single dorsal tooth, uropod 3 not exceeding apices of uropods 1-2 (possible exception in *S. longifrons* Shoemaker, 1964 group), peduncle short (except *S. nodulosa* K. H. Barnard, 1932). Telson elongate, deeply cleft.

Remarks. 11 species.

Syrrhoe longifrons Shoemaker ,1964

Figure 2.91

Syrrhoe longifrons Shoemaker, 1964: 404, figure 7.—Barnard, 1972b: 53.

Material Examined. Santa Maria Basin, California, Sta. R2, 161 m, May 1987, (4 specimens), October 1986, (3 specimens), Sta. 74, 201 m, January 1985, (3 specimens).

Description (from Shoemaker, 1964). Male 10 mm. Eyes huge, reddish brown in alcohol, united above and extending half length of head. Head elongate, about as long as first 5 body segments, produced slightly forward, evenly rounded. Forehead protuberant, rostrum pointed downward and backward. Coxae 1-3, distal corner produced anteriorly. Pereopod 5-7, article 2 almost triangular, produced posteriorly, coarsely serrate on posterior edge. Telson long, cleft three-quarters of its length.

Remarks. This species differs from another local species, *S. crenulata* Goës, 1866 in having a protruding forehead, antenna 1, article 1 and 2 with a small anterodistal tooth (*S. crenulata* has a posterodistal tooth on article 1 only), more produced coxal plates, lateral angle of head truncate rather than angular, pereopods 3-5 more angularly produced behind (Shoemaker, 1964 and Barnard, 1972b).

Type Specimen and Locality. Holotype USNM No. 94235, male, 10 mm, Mittelnacht, Vancouver Island, British Columbia.

Distribution and Habitat. Vancouver Island, British Columbia, to southern California, 0-200 m.

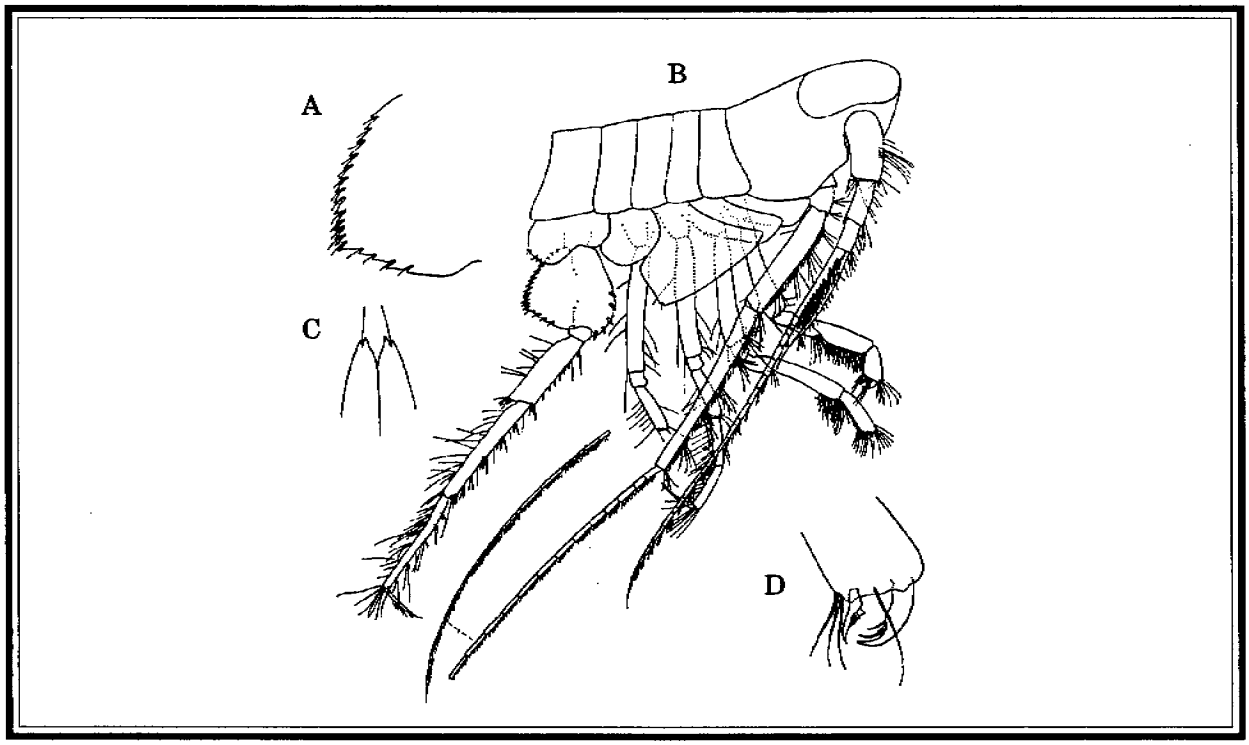

Figure 2.91. *Syrrhoe longifrons*, male, 10 mm; A, Pereopod 5, posterior margin article 2; B, Anterior with pereonites 1-5; C, Telson, distal tip; D, Gnathopod 1, distal tip (from Shoemaker, 1964).

Tiron Liljeborg, 1865a

Type Species. *Lysianassa spinifera* Stimpson, 1853.

Diagnosis (from Barnard and Karaman, 1991). Forehead protuberant or not (type species). Eyes present and accessory eyes usually present. Mandible with palp (exception: *T. tropakis* Barnard, 1972b), molar of medium size, strongly projecting, columnar and triturative; mouthparts basic. Antenna 1, articles 1-2 basic. Coxa 1 ordinary, coxa 3 softly rectangular, posterior margin almost parallel, with anterior margin adze-shaped and almost as long as coxa 3, surface area of latter nearly equal to coxa 4, rarely coxa 4 distinctly shorter and smaller than 3 and weakly comma-shaped. Gnathopods simple, propodus elongate, linear, lacking distinct spines. Gnathopod 2, dactyl normal. Pereopods 5-7 very short, dactyls typically very short, clawlike and bearing large inner wire-seta, but occasionally dactyls slightly elongate and poorly armed. Pereopod 7, article 2 posteroventrally rounded. Pleonites 1-3 typically denticulate dorsally but apparently smooth in 3 species. Uropod 3 greatly exceeding apices of uropods 1-2, peduncle short. Telson elongate, deeply cleft.

Tiron biocellata Barnard, 1962

Figure 2.92

Tiron biocellata Barnard, 1962b: 75-76, figure 2.—Barnard, 1972b: 84-85, figure 44.

Material Examined. Reported from this study, but specimens unavailable.

Description. Female 4.4-4.6 mm. Forehead not protuberant. Lateral cephalic lobes blunt. Accessory eyes present. Mandible with palp. Coxa 4 smaller than 3, comma shaped. Pleonites weakly crenulate dorsally, 4-6 produced posteriorly into a dorsal tooth. Telson lacking spines (occasionally 1 subterminal spine occurring on each lobe).

Type Specimen and Locality. AHF No. 5617, female 4.4 mm. Station 4787, Pt. Conception, 34°26'30"N, 120°26'00"W, on the bottom of rock and with polychaetes of the genera *Diopatra* and *Nothria* (Barnard, 1962b), 24 m.

Distribution and Habitat. Pacific: Monterey Bay, California to San Cristobal Bay, Baja California; Caribbean Sea: Cuba, occasionally in algae, 0-180 m (most abundant < 30 m).

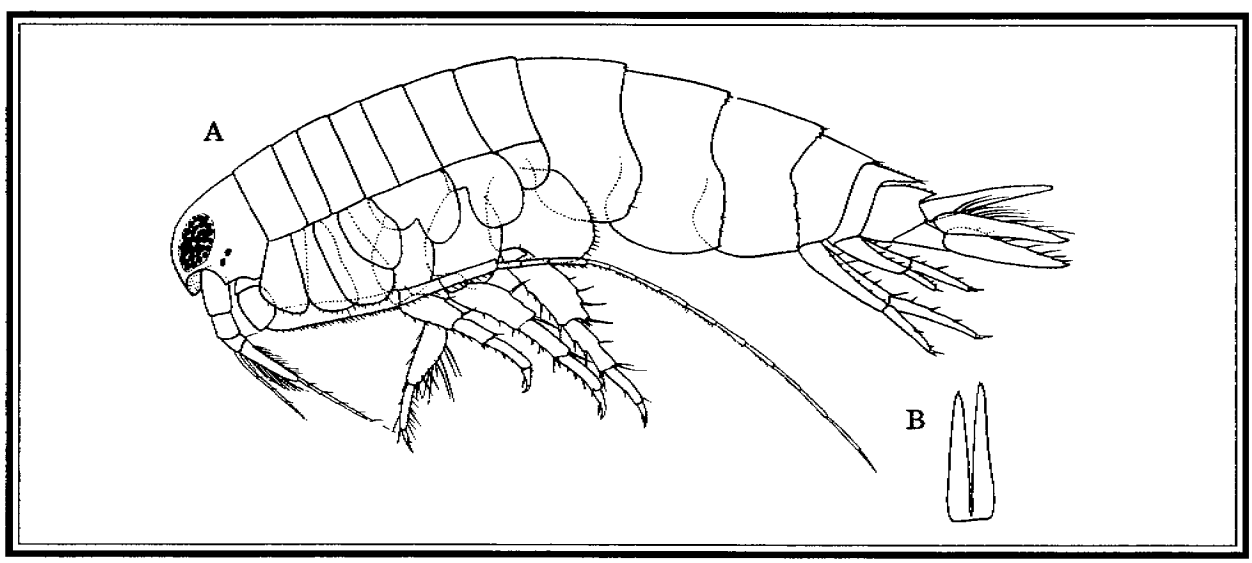

Figure 2.92. *Tiron biocellata*, male, 3.5 mm; A, Lateral view; B, Telson (from Barnard, 1962b).

Tiron tropakis Barnard, 1972

Figure 2.93

Tiron tropakis Barnard, 1972b: 86-89, figures 45-46.

Material Examined. Reported from this study, but specimens unavailable.

Description. Both sexes to 6 mm. Forehead not protuberant. Lateral cephalic lobes angular, but blunt. Accessory eyes present. Mandible without palp. Coxa 4 smaller than 3, comma shaped. Pleonites crenulate dorsally, produced backward into a tooth on pleonites 4 and 5. Pleonite 6 with a dorsal spine. Telson with numerous spines arranged in medial row.

Remarks. Barnard (1972b) notes that large specimens (from 5-6 mm) of *T. tropakis* lose serrations on pleonal epimera.

Type Specimen and Locality. Holotype AHF No. 663, female, 4.9 mm. Velero 6688, California, 34°24'00"N, 119°50'45"W, 9 m.

Distribution and Habitat. Cosmopolitan. Pacific: California to Peru; Atlantic: Virginia to Caribbean and Venezuela, on sand, 3-157 m.

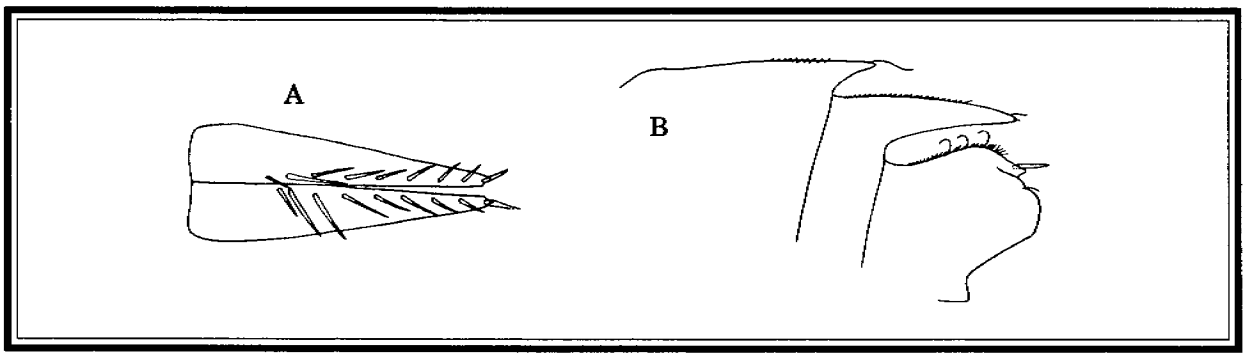

Figure 2.93. *Tiron tropakis*, female, 4.9 mm; A, Telson; B, Urosomites 1-3 showing dorsal teeth (from Barnard, 1972b).

Family Urothoidae Bousfield, 1978

Diagnosis (from Barnard and Karaman, 1991). Head short, ventral cheek strongly developed and projecting ventrally. Antennae 1, articles 1-3 elongate, geniculate, flagella short. Antenna 2, article 4 scarcely expanded, with spines either absent or in seriate ranks, all spines on article 4 apicad, no disjunct spine group basad, ventral margin with elongate plume setae and smaller penicillate setae, ventral glassy spines poorly developed or absent, article 5 slightly shorter and narrower than article 4, flagellum variable, usually short in female, but male often greatly elongate flagellum, and part of peduncle frequently with calceoli. Mandibles bearing poorly toothed incisors; molar minutely fuzzy, almost non-triturative, lacking significant accessory chopper. Gnathopods feeble. Pereopods 6-7 alike (*Urothoe*) or pereopod 7 with article 2 broadly expanded and posteroventrally lobate, remainder of articles thin, whole appendage somewhat shortened in comparison to pereopod 6. Peduncles of pleopods slightly to significantly wider than long, coupling hooks paired on each pleopod. Coxal gills on segments 2-5 or 2-6. Antenna 2 with strong sexual dimorphism in several taxa.

Remarks. 6 genera, 52 species.

Urothoe Dana, 1852

Type Species. *Urothoe irrostrata* Dana, 1853.

Diagnosis (from Barnard and Karaman, 1991). Pereopod 7 not of phoxocephalid form, article 2 not shield-like (but often large and ovate) and rest of leg not slender and short combined. Uropod 3, biramous, long and slender. Telson ordinary, deeply cleft. Males rarely described, peduncles of antennae 1-2 with short male setal tufts, flagellum of antennae 2 elongate, articles elongate, armaments well developed, calceoli present on peduncle and flagellum.

Remarks. 36 species.

Urothoe elegans Bate, 1857

Figure 2.94

Urothoe elegans Bate, 1857b: 145.—Gurjanova, 1953: figures 141a, 141b.—Gurjanova, 1962: 426-428, Figure 142.—Lincoln, 1979: 328, figures 153, c-e, 154.
Urothoe norvegica Sars, 1895: 138-139, plate 47.

Material Examined. Santa Maria Basin, California, Phase I, Sta. 79, 98 m, (3 specimens).

Description. Both sexes to 6 mm. Eyes small (large in male). Lateral cephalic lobe strongly projected, but not reaching edge of antenna 2, article 2. Antenna 2 with a row of heavy, blunt, setae and a row of spines laterally on article 4 and 5. Gnathopods 1 and 2 without locking spines? Pereopod 3-4, articles 5 and 6 robustly spinose. Pereopod 5, article 2 not broadened distally? Uropod 3 rami broad with few setae. Telson cleft to the base, with an apical spine and seta on each lobe.

Remarks. Using features such as the type and pattern of setae on pereopods 5-6 and the presence of spines (*U. varvarini* Gurjanova, 1953) vs setae (*U. elegans*) on the ventral margin of coxa 1 (Gurjanova, 1962), in species identification can be problematical (thus the question marks in the diagnoses), such characters potentially varying among individuals of the same species. Our specimens have characteristics of both species including, spines on coxa 1 (characteristic of *U. varvarini*), pereopod 6 with 7 plumose setae posteromedially and a group of 7-8 setae ventrally, pereopod 5, article 2 is not distally broadened or rounded (characteristic of *U. elegans*), and the lateral cephalic lobe is moderately projected, not reaching the end of article 2, antenna 2 (*U. elegans*) (it is greatly projecting in *U. varvarini*). Until better diagnostic characters are defined we relegate our specimens to *U. elegans*.

Type Specimen and Locality. Plymouth, England.

Distribution and Habitat. Northeast Atlantic: Great Britain, Norway, Denmark, Shetland Islands, common in the North sea, European coast from Norway to the Mediterranean; Red Sea; ?North Africa to Senegal and Mozambique, South Africa; North Pacific: Sea of Okhotsk, on sandy clay, and fine sediments, 10-500 m.

Urothoe varvarini Gurjanova, 1953

Urothoe varvarini Gurjanova, 1953: 219-221, figures 3, 4.—Barnard, 1957: 82-84.—Gurjanova, 1962: 426-428, figure 142.

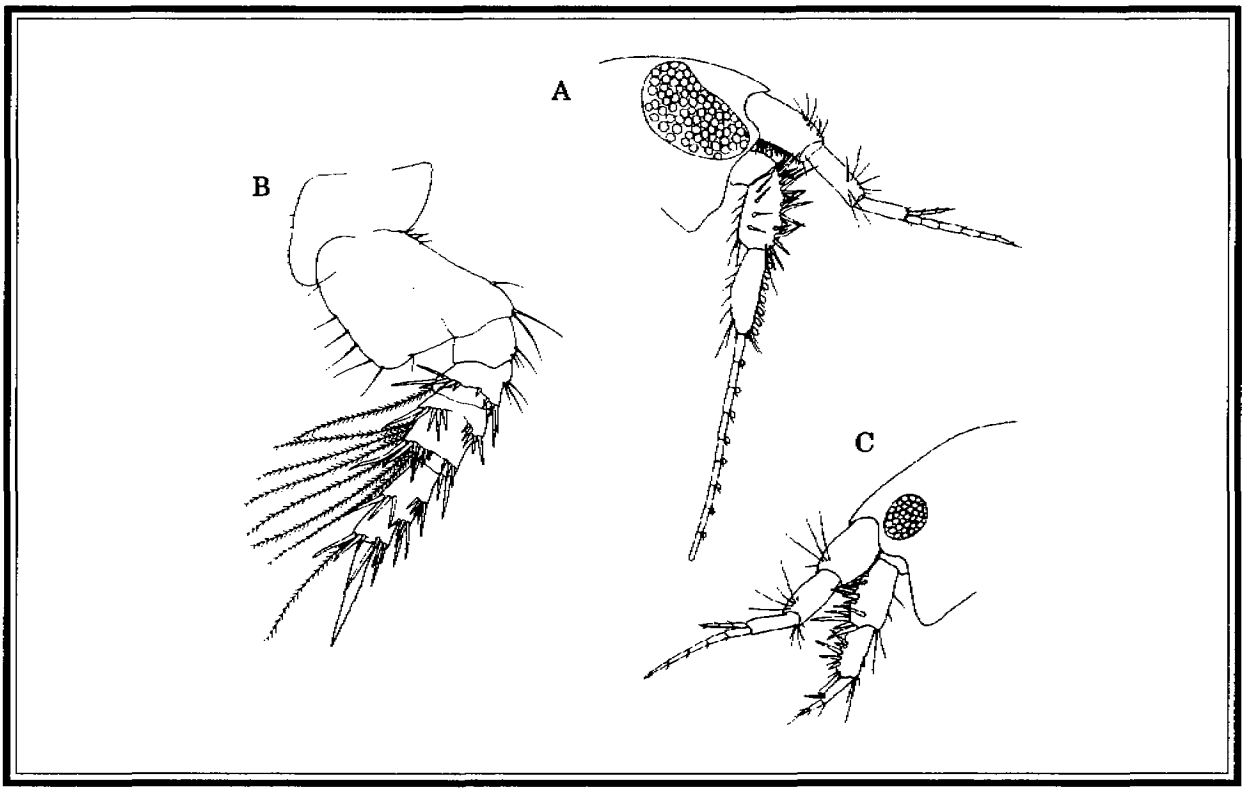

Figure 2.94. *Urothoe elegans*; A, Head, male; B, Pereopod 5, female; C, Head (from Lincoln, 1979).

Material Examined. Reported from this study, but not supported by collections.

Description. Female 5 mm. Eyes small (in female only?). Lateral cephalic lobe strongly projected, reaching edge of antenna 2, article 2? Antenna 2 with a row of heavy, blunt, setae and a row of spines laterally on article 4 and 5. Gnathopods 1 and 2 with a strong, thick locking spines? Slightly serrated distal spines on pereopod 3 and 4. Coxal gill on segments 2-?5. Pereopod 5, article 2 distinctly broadened distally? Uropod 3 rami with 2 apical setae. Telson cleft nearly two-thirds its length, with an apical spine on each lobe.

Remarks. This species is closely related to *U. elegans* Bate, (1857b) from which it differs by a few slight differences in setal patterns not clearly defined in the literature (Gurjanova, 1953 and Barnard, 1957). On the basis of the cleft telson alone, our material could not be *U. varvarini* (but see Lincoln, 1979 who defines the entire genus as having a telson cleft to the base). However, California material exhibits some setal patterns reported in the literature as characteristic of *U. varvarini* and as the latter species has previously been reported from California, we have included a limited description here (see Remarks under *U. elegans*).

Type Specimen and Locality. Female, 5 mm, former USSR, 100 m.

Distribution and Habitat. Northwestern Pacific Ocean, Japan Sea, the former USSR from Okhotsk Sea to Sakhalin, California, from Monterey Bay to Pt. Loma, on silty sand, 5-1292 m.

Acknowledgements

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Literature Cited

Abildgaard, P. C. 1789. Zoologia Danica seu animalium Daniae et Norvegiae rariorum ac minus notorum. Descriptiones et Historia, 3:71 pages, 120 plates.

Alderman, A. L. 1936. Some new or little known amphipods of California. University of California Publications in Zoology, 41: 53-74, 51 figs.

Barnard, J. L. 1954. Marine Amphipoda of Oregon. Oregon State Monographs, Studies in Zoology, 8:103 pages, 1 figure [unnumbered], 33 plates.

Barnard, J. L. 1957. A New Genus of Haustoriid Amphipod from the Northeastern Pacific Ocean and the Southern Distribution of *Urothoe varvarini* Gurjanova. Bulletin of the Southern California Academy of Sciences, 56:81-84, plate 16.

Barnard, J. L. 1958. A New Genus of Dexaminid Amphipod (Marine Crustacea) from California. Bulletin of the Southern California Academy of Sciences, 56:130-132, plates 26, 27.

Barnard, J. L. 1959a. Estuarine Amphipoda in:Ecology of Amphipoda and Polychaeta of Newport Bay, California. Allan Hancock Foundation Publications, Occasional Paper, 21:13-69, 14 plates.

Barnard, J. L. 1959b. The Common Pardaliscid Amphipoda of Southern California, with a Revision of the Family. Pacific Naturalist, 1(12):36-43, 4 figures.

Barnard, J. L. 1960. The Amphipod Family Phoxocephalidae in the Eastern Pacific Ocean, with Analyses of Other Species and Notes for a Revision of the Family. Allan Hancock Pacific Expeditions, 18:175-368, 75 plates, 1 chart.

Barnard, J. L. 1961. Gammaridean Amphipoda from depths of 400 to 6000 Meters. Galathea Report, 5:23-128, 83 figures. 1961b. Relationship of Californian Amphipod Faunas in Newport Bay and in the Open Sea. Pacific Naturalist, 2:166-186, 2 figures.

Barnard, J. L. 1962a. Benthic Marine Amphipoda of Southern California:Families Aoridae, Photidae, Ischyroceridae, Corophiidae, Podoceridae. Pacific Naturalist, 3:1-72, 32 figures.

Barnard, J. L. 1962b. Benthic Marine Amphipoda of Southern California:Families Tironidae to Gammaridae. Pacific Naturalist, 3:73-115, 23 figures.

Barnard, J. L. 1962c. Benthic Marine Amphipoda of Southern California:Families Amphilochidae, Leucothoidae, Stenothoidae, Argissidae, Hyalidae. Pacific Naturalist, 3:116-163, 23 figures.

Barnard, J. L. 1962d. South Atlantic Abyssal Amphipods Collected by R.V. Vema. Abyssal Crustacea, Vema Research Series, 1:1-78, 79 figures.

Barnard, J. L. 1962e. Benthic Marine Amphipoda of Southern California:Family Oedicerotidae. Pacific Naturalist, 3:349-371, 10 figures.

Barnard, J. L. 1964a. Deep-Sea Amphipoda (Crustacea) Collected by the R/V "Vema" in the Eastern Pacific Ocean and the Caribbean and Mediterranean Seas. Bulletin of the American Museum of Natural History, 127:3-46, 33 figures, 1 table.

Barnard, J. L. 1964b. Marine Amphipoda of Bahia de San Quintin, Baja California. Pacific Naturalist, 4:55-139, 21 figures, 17 charts, 13 tables.

Barnard, J. L. 1966a. Submarine Canyons of Southern California Part V Systematics:Amphipoda. Allan Hancock Pacific Expeditions, 27(5):166 pages, 46 figures.

Barnard, J. L. 1966b. Benthic Amphipoda of Monterey Bay, California. Proceedings of the United States National Museum, 119(3541):41 pages, 7 figures.

Barnard, J. L. 1967. Bathyal and Abyssal Gammaridean Amphipoda of Cedros Trench, Baja California. United States National Museum, Bulletin, 260:205 pages, 92 figures.

Barnard, J. L. 1969a. A Biological Survey of Bahia de Los Angeles Gulf of California, Mexico, IV. Benthic Amphipoda (Crustacea). Transactions of the San Diego Society of Natural History:15:175-228, 30 figures.

Barnard, J. L. 1969b. The families and genera of marine gammaridean Amphipoda. Bulletin of the United States National Museum 271:1-535, 173 figures.

Barnard, J. L. 1969c. Gammaridean Amphipoda of the rocky intertidal of California: Monterey Bay to La Jolla. Bulletin of the United States National Museum 258: 1-230, 65 figures.

Barnard, J. L. 1970. The Identity of *Dexamonica* and *Prinassus* with a Revision of Dexaminidae (Amphipoda). Crustaceana, 19:161-180, 5 figures.

Barnard, J. L. 1971. Gammaridean Amphipoda from a Deep-Sea Transect off Oregon. Smithsonian Contributions to Zoology, 61:86 pages, 48 figures.

Barnard, J. L. 1972a. The Marine Fauna of New Zealand:Algae-living Littoral Gammaridea (Crustacea Amphipoda). New Zealand Oceanographic Institute Memoir, 62:7-216, 109 figures.

Barnard, J. L. 1972b. A Review of the Family Synopiidae (=Tironidae), Mainly Distributed in the Deep Sea (Crustacea:Amphipoda). Smithsonian Contributions to Zoology, 124:94 pages, 46 figures.

Barnard, J. L. 1979a. Revision of American Species of the Marine Amphipod Genus *Paraphoxus* (Gammaridea:Phoxocephalidae). Proceedings of the Biological Society of Washington, 92:368-379.

Barnard, J. L. 1979b. Littoral Gammaridean Amphipoda from the Gulf of California and the Galapagos Islands. Smithsonian Contributions to Zoology, 271:vi and 149 pages, 74 figures.

Barnard, J. L. and C. M. Barnard. 1981. The Amphipod Genera *Eobrolgus* and *Eyakia* (Crustacea:Phoxocephalidae) in the Pacific Ocean. Proceedings of the Biological Society of Washington, 94:295-313, 1 figure.

Barnard, J. L. and C. M. Barnard. 1982a. Revision of *Foxiphalus* and *Eobrolgus* (Crustacea:Amphipoda: Phoxocephalidae) from American Oceans. Smithsonian Contributions to Zoology, 372:35 pages, 5 figures.

Barnard, J. L. and C. M. Barnard. 1982b. The Genus *Rhepoxynius* (Crustacea: Amphipoda:Phoxocephalidae) in American Seas. Smithsonian Contributions to Zoology, 357:49 pages, 6 figures.

Barnard, J. L. and C. M. Barnard. 1983. Freshwater Amphipoda of the World, I. Evolutionary Patterns and II. Handbook and Bibliography. xix and 830 pages, 50 figures, 7 graphs, 98 maps, 12 tables. Mt. Vernon, Virginia, Hayfield Associates.

Barnard, J. L., and G. S. Karaman. 1991. The Families and Genera of Marine Gammaridean Amphipoda (Except Marine Gammaroids), Supplement 13, Part I, 417 pages, 85 figures, and Part II, 447 pages, 47 figures.

Barnard, K. H., 1932. Amphipoda. Discovery Reports 5: 1-326, 174 figures, 1 plate.

Bate, C. S. 1857a. On a New Amphipod. The Natural History Review, 4:229-230, plate 16. 1857c. British Amphipoda. Annals and Magazine of Natural History, series 2, 19:271.

Bate, C. S. 1857b. A synopsis of the British Edriophthalmous Crustacea. Annals and Magazine of Natural History, series 2, 19:135-152, 2 figures.

Bate, C. S. 1862. Catalogue orf the specimens of amphipodous Crustacea in the collection of the British Museum, iv + 399 pp., pls 1, 1a, 2-58. London: British Museum of Natural History.

Boeck, A. 1861. Bemaerkninger Angaaende de Ved de Norske Kyster forekommende Amphipoder. Forhandlinger Skandinaviske Naturforskeres Ottende, 8:631-677.

Boeck, A. 1871. Crustacea Amphipoda Borealia et Arctica. Forhandlinger i Videnskabs-Selskabet i Christiania, 1870:83-280.

Boeck, A. 1876. De Skandinaviske og Artiske Amphipoder. iv and 712 pages, 32 plates. Christiania:A.W. Brogger.

Bonnier, J. 1896. Edriophthalmes. Resultats scientifques de lacampagne du "Caudan" dans le Golfe de Gascogne. Annales de la Universite de Lyon 26:527-689, plates 28-40.

Bousfield, E. L. 1973. Shallow-water Gammaridean Amphipoda of New England. vii-xii, 312 pages, 13 figures, 69 plates. Ithaca and London:Cornell University Press.

Bousfield, E. L. 1978. A Revised Classification and Phylogeny of Amphipod Crustaceans. Transactions of the Royal Society of Canada, 4:343-390, 6 figures.

Bruzelius, R.M. 1859. Bidrag till kannedomen om skandinaviens Amphipoda Gammaridea. Kongliga Svenska Vetenskaps-Akademiens Handlingar, new series, 3:104 pages, 4 plates.

Chevreux, E. 1887a. Catalogue des crustaces amphipodes marins du sud-ouest de la Bretagne, suivi d'un apercu de la distribution geographique des amphipodes sur les cotes de France. Bulletin de la Societe Zoologique de France, 12:288-340, 8 figures, plate 5.

Chevreux, E. 1887b. Crustaces amphipodes nouveaux dragues par l'Hirondelle, pendant sa campagne de 1886. Bulletin de la Societe Zoologique de France, 12:566-580.

Chevreux, E. 1900. Amphipodes provenant des campagnes de l'Hirondelle (1885-1888). Resultats des Campagnes Scientifiques Accomplies par le Prince Albert I. Monaco, 16:iv and 195 pages, 18 plates.

Chevreux, E., and L. Fage. 1925. Amphipodes. Faune de France, 9:488 pages, 438 figures.

Costa, A. 1851. Pp. 44-47, fig.2. In Gugl. Hope's Catalogo dei Crostacei Italiani e di Molti Altri del Mediterraneo. Napoli: Azzolino. 1851-1853. Fauna del Regno di Napoli [and catalogo de' Crostacei del Regno di Napoli. Miscellaneous pp. of incomplete editions seen: see Stebbing, 1888: 247-250].

Dana, J. D. 1852. On the Classification of the Crustacea Choristopoda or Tetradecapoda. American Journal of Sciences and Arts, series 2, 14[appendix]:297-316.

Dana, J. D. 1853. Crustacea. Part II. United States Exploring Expedition, 14:689-1618, atlas of 96 plates.

Dana, J. D. 1856. Catalogue and Descriptions of Crustacea Collected in California by Dr. John L. Le Conte. Proceedings of the Philadelphia Academy of Natural Science, 7:175-177.

Enequist, P. 1949. Studies on the Soft-Bottom Amphipods of the Skagerak. Zoologii Bidrag fran Uppsala, 28:297-492, 67 figures.

Goes, A. 1866. Crustacea Amphipoda maris Spetsvergiam alluentis, cum speciebus aliis arcticis enumerat. Ofversigt af Kongelige Vetenskaps-Akademiens Forhandligar 1865: 517-536, pls 36-41.

Grube, A. E. 1864. Die Insel Lussin und ihre Meeresfauna. Nach einem sechswochentlichen Aufenthalte:116 pages, 1 plate.

Gurjanova, E. F. 1938. Amphipoda, Gammaroidea of Siaukhu Bay and Sudzukhe Bay (Japan Sea). Reports of the Japan Sea Hydrobiological Expedition of the Zoological Institute of the Academy of Sciences USSR in 1934, 1:241-404, 59 figures. [In Russian.]

Gurjanova, E. F. 1951. Bokoplavy morej SSSR i sopredel'nykh vod (Amphipoda-Gammaridea). Akademiia Nauk SSSR, Opredeliteli po Faune SSSR, 41:1029 pages, 705 figures.

Gurjanova, E. F. 1953. Novye dopolnenija k dal'nevostochnoi faune morskik bokoplavov. Akademiia Nauk SSSR, Trudy Zoologicheskogo Institute, 13:216-241, 19 figures.

Gurjanova, E. F. 1962. Bokoplavy severnoi chasti Tixogo Okeana (Amphipoda-Gammaridea) chast' 1. Akademii Nauk SSSR, Opredeliteli po Faune SSSR, 74:440 pages, 143 figures.

Gurjanova, E. F. 1977. Some New Data in Taxonomy of Family Phoxocephalidae sensu lato (Amphipoda-Gammaridea). Report I. Akademija Nauk SSSR, Zoologicheskii Institut, Issledovanija Fauny Morei, 21(29):67-87, 9 figures.

Hansen, H. J. 1888. Malacostraca marina Groenlandiae occidentalis. Oversigt over det vestlige Gronlands fauna af Malakostrake Havkrebsdyr. Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening, Kjobenhavn, 1887:5-226, plates 2-7.

Heller, C. 1867. Beitrage zur naheren Kenntniss der Amphipoden des adriatischen Meeres. Denkschriften der Kaiserlichen Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Classe Wien, 26(2):62 pages, 4 plates.

Hirayama, A. 1983. Taxonomic studies on the shallow water gammaridean Amphipoda of West Kyushu, Japan. I. Acanthonotozomatidae, Ampeliscidae, Ampithoidae Amphilochidae, Anamixidae, Argissidae, Atylidae and Colomastigidae. Publications of the Seto Marine Biological Laboratory 28: 75-150, 42 figures.

Hirayama, A. 1985b. Taxonomic Studies on the Shallow Water Gammaridean Amphipoda of West Kyushu, Japan IV. Dexaminidae (Guernea), Eophiliantidae [sic], Eusiridae, Haustoriidae, Hyalidae, Ischyroceridae. Publications of the Seto Marine Biological Laboratory, 30:1-53, figures 124-161.

Holman, H. and L. Watling. 1983. Amphipoda from the southern ocean: families Colomastigidae, Dexaminidae, Leucothoidae, Liljeborgiidae, and Sebidae. Biology of the Antarctic Seas XIII, Antarctic Research Series 38: 215-262, 35 figs.

Holmes, S. J. 1905. The Amphipoda of Southern New England. Bulletin of the United States Bureau of Fisheries, 24:459-529, numerous unnumbered figures, 13 plates.

Holmes, S. J. 1908. The Amphipoda Collected by the United States Bureau of Fisheries Steamer, "Albatross", Off the West Coast of North America, in 1903 and 1904, With Descriptions of a New Family and Several New Genera and Species. Proceedings of the United States National Museum, 35:489-543, 46 figures.

Hurley, D. E. 1956. A New Species of *Stegocephalus* (Amphipoda Gammaridea) from California. Bulletin of the Southern California Academy of Sciences, 55:28-34, plates 9-11.

Just, J. 1980. Amphipoda (Crustacea) of the Thule Area, Northwest Greenland: Faunistics and Taxonomy. Greenland Bioscience, 2:1-61, 58 figures.

Karaman, G. S. 1973. The Phoxocephalidae Family of the Adriatic Sea. Glasnik Republickog Zavoda za Zastitu Pirode [= Prirodnjackog Muzeja Titograd], 5:47-101, 28 figures.

Karaman, G. S. 1974. Revision of the Family Pardaliscidae with Diagnosis of Genera, Distribution of Species and Bibliography. Acta Adriatica, Institut za Oceanografiju i Ribarstvo, 15(7):3-46.

Krapp-Schickel, G. 1975. Revision of Mediterranean *Leucothoe* species (Crustacea, Amphipoda). Bollettino del Museo Civico di Storia Naturale, Verona 2: 91-118, 15 figures.

Krøyer, H. 1842. Une nordiske Slaegter og Arter af Amfipodernes Orden, henhorende til Familien Gammarina. (Forelobigt Uddrag af et storre Arbejde). Naturhistorisk Tidsskrift, 4:141-166.

Krøyer, H. 1845. Karcinologiske Bidrag. Naturhistorisk Tidsskrift, (NS) 1:283-345, 3 plates; 403, 453-638, plates 6, 7.

Krøyer, H. 1846. Atlas voyages de la commission scientifique du nord; en Scandinavie, en Laponie, au Spitzberg et aux Fero, pendant les annees 1838-1840, sur la corvette la Recherche, commandee par M. Fabvre. Plates 10-11, 13-20, 22-23. Paris:M. Paul Gaimard.

Laubitz, D. R. 1977. A Revision of the Genera Dulichia Kroyer and Paradulichia Boeck (Amphipoda, Podoceridae). Canadian Journal of Zoology, 55:942-982, 20 figures, 12 maps.

Leach, W. E. 1814. Crustaceology. Appendix. The Edinburgh Encyclopaedia, 7:429-434.

Ledoyer, M. 1973. Amphipodes gammariens nouveaux ou peu connus de la region de Marseille. Tethys 4:881-898, 13 plates.

Ledoyer, M. 1983. Les Oedicerotidae (Crustacea, Amphipoda) de la Mer Mediterranee. Bollettino del Museo Civico di Storia Naturale, Verona, 9:45-84, 7 figures.

Ledoyer, M. 1986. Crustaces amphipodes gammariens. Faune De Madagascar, 59(2):599-1112, figures 227-415.

Lepechin, I. 1780. Tres oniscorum species descriptae. Acta Academiae Scientiarum Imperialis Petropolitanae, 1778:[pages unknown] [not seen, see Stebbing, 1888].

Liljeborg, V. [or W.]. 1865a. Bidrag till kannedomen om underfamiljen *Lysianassina* inom underordningen *Amphipoda* bland kraftdjuren. ["Nova Acta Regiae Societatis Scientiarum Upsaliensis III Serie"] [journal title from Stebbing, 1888, only an unattributed reprint seen].

Liljeborg, V. [or W.]. 1865b. On the *Lysianassa magellanica* H. Milne Edwards, and on the Crustacea of the suborder *Amphipoda* and Subfamily *Lysianassina* found an [sic] the Coast of Sweden and Norway. Nova Acta Regiae Societatis Scientiarum Upsaliensis, series 3, 6:1-38, 5 plates.

Lincoln, R. J. 1979. British Marine Amphipoda:Gammaridea, v-vvi and 658 pages, 280 figures, 3 plates. London:British Museum (Natural History).

Malm, A. W. 1871. Om tva for Vetenskapen nya Amfipod-Species fran Bohuslan, af Hvilka det Ena ar Typ for ett nytt Genus inom Pontoporeinernas Grupp. Ofversigt Kongliga Vetenskaps-Akademien Forhandlingar, 1870, 27:543-548, plate 5.

McCloskey, L. R. 1970. A New Species of *Dulichia* (Amphipoda, Podoceridae) Commensal with a Sea Urchin. Pacific Science, 24:90-98, 18 figures.

Metzger, A. 1875. Crustaceen aus den Ordnungen Edriophthalmata und Podophthalmata. V. Zoologische Ergbnisse der Nordseefahrt vom 21. Juli bis 9. September 1872. Jahresbericht der Commission zur Wissenschaftlichen Untersuchung der Deutschen Meere in Kiel fur die Jahre 1872.1873 [sic] II. und III. Jahrgang. pages 277-309, figures 7-10, plate 6.

Mills, E. L. 1962. Amphipod Crustaceans of the Pacific Coast of Canada. II. Family Oedicerotidae. Natural History Papers National Museum of Canada, 15:1-21, 6 figures.

Montagu, G. 1804. Description of Several Marine Animals Found on the South Coast of Devonshire. Transactions of the Linnean Society of London, 7:61-85, plates 6-7.

Montagu, G. 808. Description of Several Marine Animals Found on the South Coast of Devonshire. Transactions of the Linnean Society of London, 9:81-114, plates 2-8.

Murdoch, J. 1885. Description of Seven New Species of Crustacea and One Worm from Arctic Alaska. Proceedings of the United States National Museum, 7:518-522.

Nagata, K. 1965. Studies on Marine Gammaridean Amphipoda of the Seto Inland Sea. II. Publications of the Seto Marine Biological Laboratory, 13:171-186, figures 16-26.

Norman, A. M. 1869. Shetland Final Dredging Report.—Part II. On the Crustacea, Tunicata, Polyzoa, Echinodermata, Actinozoa, Hydrozoa, and Porifera. Report of the Thirty-eighth Meeting of the British Association for the Advancement of Science, 1868:247-336.

Pearse, A. S. 1912. Notes on certain amphipods from the Gulf of Mexico, with descriptions of new genera and new species. Proceedings of the United States National Museum 43(1936):369-379, 8 figures.

Pirlot, J.M. 1932. Les amphipodes de l'expedition du Siboga. Deuxieme partie. Les amphipodes gammarides. I. - Les amphipodes fouisseurs. Phoxocephalidae, Oedicerotidae, Siboga-Expedition, Monographie 33b: 57-113, figs 12-34.

Sars, G. O. 1879. Crustacea et Pycnogonida nova in itinere 2do et 3tio expeditionis Norvegicae anno 1877 and 78 collecta. (Prodromus descriptionis). Archiv for Mathmatik og Naturvidenskab, 4:427-476.

Sars, G. O. 1883. Oversigt af Norges Crustaceer med forelobige Bemaerkninger over de nye eller Mindre bekjendte Arter. I. (Podophthalmata—Cumacea—Isopoda— Amphipoda). Forhandlinger Videnskabsselskabs i Christiania, 18:124 pages, 6 plates.

Sars, G. O. 1895. Amphipoda. An Account of the Crustacea of Norway With Short Descriptions and Figures of All the Species, 1:viii and 711 pages, 240 plates, 8 supplementary plates.

Schellenberg, A. 1931. Gammariden und Caprelliden des Magellangebietes, Sudgeorgiens und der Westantarktis. Further Zoological Results of the Swedish Antarctic Expedition 1901-1903, 2(6):290 pages, 1 plate, 136 figures.

Scott, T. 1890. Additions to the fauna of the Firth of Forth. Annual Report of the Fisheries Board of Scotland 8: 312-333, pls 12, 13.

Shoemaker, C. R. 1925. The Amphipoda Collected by the United States Fisheries Steamer 'Albatross' in 1911, Chiefly in the Gulf of California. Bulletin of the American Museum of Natural History, 52:21-61, 26 figures.

Shoemaker, C. R. 1930. The Amphipoda of the Cheticamp Expedition of 1917. Contributions to Canadian Biology and Fisheries, new series, 5(10):221-359, 54 figures. [Also in reprint of 141 pages.]

Shoemaker, C. R. 1938. Two New Species of Amphipod Crustaceans from the East Coast of the United States. Journal of the Washington Academy of Sciences, 28:326-332.

Shoemaker, C. R. 1955. Amphipoda Collected at the Arctic Laboratory, Office of Naval Research, Point Barrow, Alaska, by G.E. MacGinitie. Smithsonian Miscellaneous Collections, 128(1):1-78, 20 figures.

Shoemaker, C. R. 1964. Seven New Amphipods from the West Coast of North America with Notes on Some Unusual Species. Proceedings of the United States National Museum, 115:391-430, 15 figures.

Smith, S. I. 1883. List of the Crustacea Dredged on the Coast of Labrador by the Expedition Under the Direction of W.A. Stearns, in 1882. Proceedings of the United States National Museum, 7:218-222.

Stebbing, T. R. R. 1888. Report on the Amphipoda Collected by H.M.S. Challenger During the Years 1873-76. Report on the Scientific Results of the Voyage of H.M.S. Challenger During the Years 1873-1876, Zoology, 29:xxiv and 1737 pages, 210 plates. London:Eyre and Spottiswoodie.

Stebbing, T. R. R. 1899. Revision of Amphipoda (continued). Annals and Magazine of Natural History, series 7, 4:205-211.

Stebbing, T. R. R. 1906. Amphipoda I. Gammaridea. Das Tierreich, 21:806 pages, 127 figures.

Stephensen, K. 1925. Crustacea Malacostraca. VI. (Amphipoda. II). Danish Ingolf-Expedition, 3:101-178, figures 23-53.

Stephensen, K. 1931. Crustacea Malacostraca VII. (Amphipoda, III.). Danish Ingolf-Expedition 3: 179-290, figs 54-81.

Stephensen, K. 1944. Crustacea Malacostraca VIII. (Amphipoda IV). Danish Ingolf-Expedition, 3(13):51 pages, 38 figures.

Stimpson, W. 1853. Synopsis of the Marine Invertebrata of Grand Manan:or the Region About the Mouth of the Bay of Fundy, New Brunswick. Smithsonian Contributions to Knowledge, 6:i-iv, 5-66, 3 plates.

Stout, 1913. Studies in Laguna Amphipoda. Zoologische Jahrbucher, Systematik 34: 633-659, 3 figs.

Thomson, G. M. 1879. Additions to the Amphipodous Crustacea of New Zealand. Annals and Magazine of Natural History, series 5, 4:329-333, plate 16.

Thurston, M. H. 1974. Crustacea Amphipoda from Graham Land and the Scotia Arc, Collected by Operation Tabarin and the Falkland Islands Dependencies Survey, 1944-59. British Antarctic Survey Scientific Reports, 85:89 pages, 28 figures.

Thurston, M. H. 1976. New Pelagic Amphipods (Crustacea:Amphipoda) collected on the Sond Cruise. Journal of the Marine Biological Association, United Kingdom, 56:143-159, 6 figures.

Vanhoffen, E. 1907. Crustaceen aus dem kleinen Karajakfjord in West-Gronland. Zoologische Jahrbucher, Systematik 25:507-524, plates 20-22.

Walker, A. O. 1896. On Two New Species of Amphipoda Gammarina. Annals and Magazine of Natural History, series 6, 17:343-346, plate 16.

Walker, A. O. 1903. Amphipoda of the 'Southern Cross' Antarctic Expedition. Journal of the Linnean Society of London, 29:38-64, plates 7-11.

Walker, A. O. 1904. Report on the Amphipoda Collected by Professor Herdman, at Ceylon, in 1902. Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manaar, Supplementary Report, 17:229-300, 8 plates.

3. The Families Ampeliscidae, Amphilochidae, Liljeborgiidae, and Pleustidae

by

Les Watling[1]

Family Ampeliscidae Costa, 1957

Diagnosis. (after Barnard and Karaman, 1991). Urosomites 2-3 coalesced. Pereopods 5-6 alike but pereopod 7 of distinct structure. Pereopod 7 article 2 with distinct, usually broad posteroventral lobe; article 2 of pereopods 5-6 rhomboid or diamond shaped and poorly lobed. Eyes when present composed of internal pigment masses served by 2-4 external cuticular lenses. Accessory flagellum absent. Article 4 of pereopods 3-4 elongate, article 6 much shorter than 4 and article 5 much shorter than 6, these pereopods glandular. Gnathopod feeble. Uropod 3 biramous.

Remarks. Members of this family have a body form that is conservative across the family and quite distinct from all other families. Most species occupy the upper end of vertical, laterally flattened tubes.

Key to the Genera of the Ampelisicidae

(from Dickinson, 1983)

1A. Head as deep as long; basal lobe of pereopod 7 not expanded distally, posterior margin nearly vertical ..... *Haploops*

1B. Head longer than deep; basal lobe of pereopod 7 expanded distally, posterior margin oblique 2

2A. Anteroventral corner of head not excavate; pereopod 7 anterior edge of posteroventral lobe on article 2 lacking setae near junction with article 3; dactyl of pereopod 7 broad at base, not spine-like ..... *Ampelisca*

2B. Anteroventral corner of head excavate for insertion of antenna 2; pereopod 7 anterior edge of posteroventral lobe on article 2 bearing setae near junction with article 3; dactyl of pereopod 7 spine-like ..... *Byblis*

Genus *Ampelisca* Krøyer, 1842

Type Species. *Ampelisca eschrichti* Krøyer, 1842.

Diagnosis. Flagella of antennae 1-2 with 5 or more articles. Maxilliped inner plate short and broad, palp article 3 unproduced. Pereopods 3-4, article 5 short and often partially overhung by article 4. Pereopods 5-6, dactyls very short and hook-like. Pereopod 7 article 2 with posterior margin oblique and expanding ventrally, rarely parallel to anterior margin, area near junction of lobe with anterior part of article not setose; dactyl wide at base, not spine-like. Telson longer than broad, cleft more than half its length.

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Remarks. This is a large and diverse genus, containing 153 species, all with a very conservative body morphology. Most of the differences among the species are found on the appendages, with additional characters utilizing features of the urosome and pleonal side plate 3.

Key to the Species of *Ampelisca* from the Santa Maria Basin.

1A. Pleon epimeral plate 3 with tooth on posterior corner 2

1B. Pleon epimeral plate 3 quadrate, or bluntly rounded, without tooth on posterior corner 8

2A. Pereopod 7, article 5 longer and wider than article 6 ..... *Ampelisca eoa*

2B. Pereopod 7, article 5 slightly wider but never longer than article 6 3

3A. Pereopod 7, article 5 with notch in anterior margin, article 4 with very large posterior lobe; uropod 1 not reaching beyond mid-part of uropod 2 rami ..... *Ampelisca pugetica*

3B. Pereopod 7, article 5 without notch in anterior margin; uropod 1 reaches nearly to end of uropod 1 4

4A. Pereopod 7, article 6 nearly as wide as article 5 at base, nearly twice the length of article 5 .... *Ampelisca unsocalae*

4B. Pereopod 7, article 6 narrower, and just slightly longer, than article 5 5

5A. Pereopod 6, article 5 with only a single spine-seta group on posterior margin; pereopod 7 dactyl only slightly longer than wide ..... *Ampelisca hancocki*

5B. Pereopod 6, article 5 with at least 2 spine-seta groups on posterior margin 6

6A. Pereopod 6, article 6 setae on anterior margin shorter than article is wide .... *Ampelisca brevisimulata*

6B. Pereopod 6, article 6 setae on anterior margin longer than article width 7

7A. Urosomite 1 with broad, dorsally rounded, lamellar carina ..... *Ampelisca cristata*

7B. Urosomite 1 with dorsal depression followed by sub-acute carina in front of posterior margin .... *Ampelisca pacifica*

8A. Antenna 1 shorter than peduncle of antenna 2; urosomite 1 carina highest in mid-segment .... *Ampelisca agassizi*

8B. Antenna 1 extends beyond peduncle of antenna 2; urosomite 1 carina highest posteriorly on segment 9

9A. Pereopod 7, article 5 distal part of anterior margin notched; urosomite 1 carina overhangs slight anterior elevation of urosomites 2-3 ..... *Ampelisca romigi*

9B. Pereopod 7, article 5 anterior margin not notched; urosomite 1 posterior elevation united with anterior elevation of urosomite 2-3 to form broadly rounded carina ..... *Ampelisca lobata*

Key to Figure Abbreviations

A1, antenna 1
CX 1, coxa 1
CX 2, coxa 2
CX 1-4, coxae 1-4
EP 1-3, epimeral plates 1-3
EP 3, epimeral plate 3
EP3 and URS, epimeral plate 3 and urosome
GN1, gnathopod 1
GN2, gnathopod 2
HD, head
FT, left
MD, mandible
LP3, pereopod 3
P4, pereopod 4
P5, pereopod 5
P6, pereopod 6
P7, pereopod 7
RT, right
T, telson
UR1, uropod 1
UR2, uropod 2
UR3, uropod 3

Ampelisca eoa Gurjanova, 1951

Figure 3.1

Ampelisca catalinensis J.L. Barnard, 1954

Material Examined. California: off Pt. Purisima, St. 46, 597 m, muddy sand (1 specimen).

Description. Head, corneal lenses absent. Antenna 1 reaching well beyond end of peduncle of antenna 2; second peduncle article twice length of first. Antenna 2 nearly equal to length of body; peduncle article 4 longest. Pereopod 5 posterior margin of article 5 naked. Pereopod 7 article 2 posterior lobe moderately deep, extends halfway along article 4; article 3 subequal to article 4; articles 5 and 6 subequal in length; article 7 with curved tip. Uropod 1 not reaching to end of uropod 2. Telson lobes apices notched; dorsal surface with 1-3 setae.

Remarks. This species has been found several times throughout its range, but as noted by Barnard in 1960, it still needs redescription to include the details of the head, antenna 1, pleonite 4, and uropods 1 and 2.

Distribution and Habitat. An inhabitant of slope and shelf depths from northern Japan (north of 34°N) through the Bering Sea to southern California, 230-1833 m.

Ampelisca pugetica Stimpson, 1864

Figure 3.2

Ampelisca californica Holmes, 1908
Ampelisca gnathia J.L. Barnard, 1954

Material Examined. California: off Pt. Buchon. St. 15, 393 m, 83% silt (1); off Pt. Arguello, St. 71, 306 m, silt-sand (1); off Pt. Purisima, St. R-4, 92 m, 80% silt, Cruise 1-2 (4) and Cruise 1-3 (3).

Description. Antenna 1 short, not reaching end of antenna 2 peduncle; second peduncle article about twice length of article 1. Antenna 2 about equal to length of body; peduncle article 4 the longest. Mandible palp article 2 setose along much of its length. Coxae 1-2 with small slit at posteroventral corner.

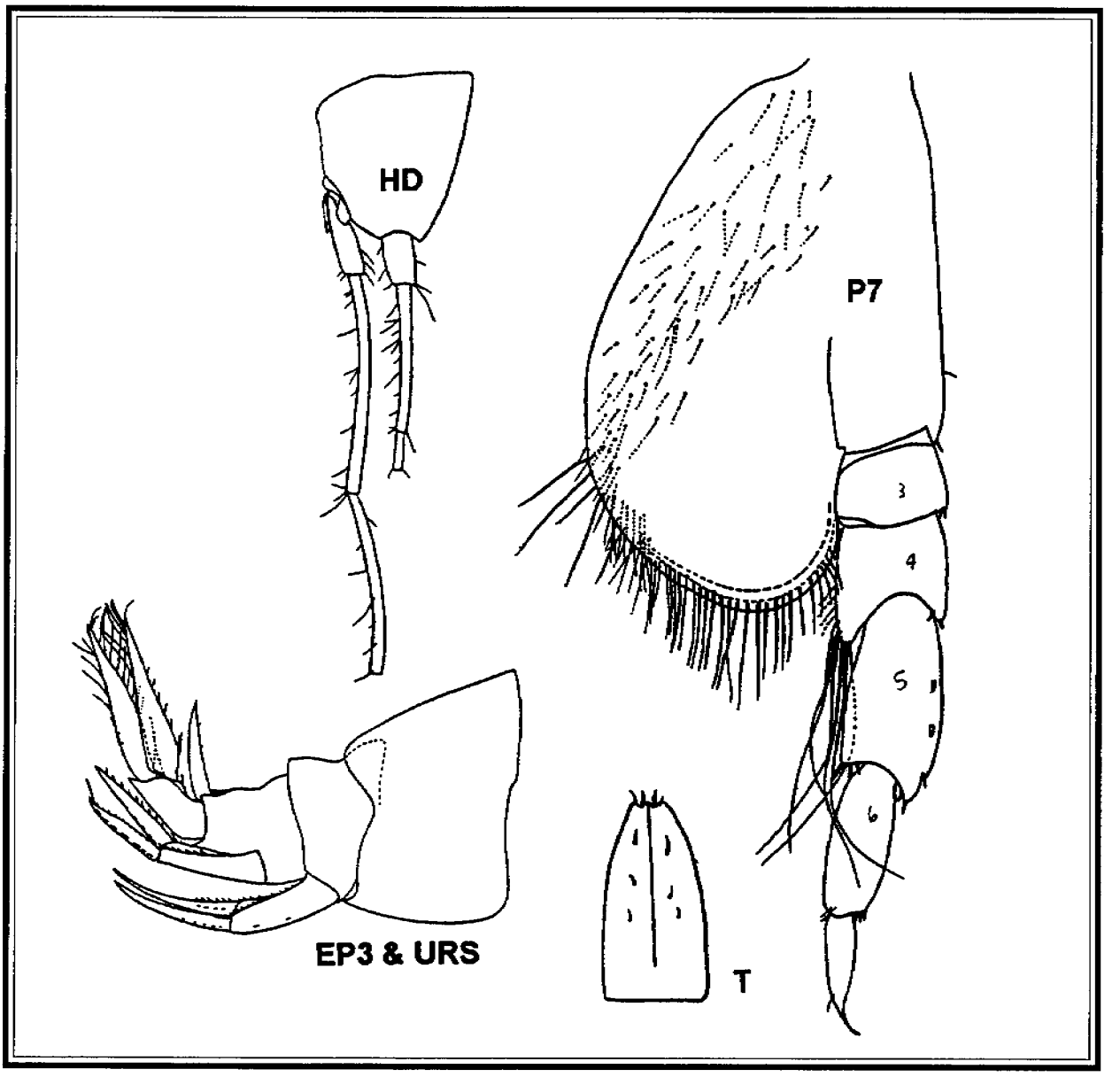

Figure 3.1. *Ampelisca eoa* (from Barnard, 1954).

Pereopods 5-6 posterior margin of article 5 with 2-3 sets of comb setae. Pereopod 7 article 2 ventral margin broadly rounded; article 3 subequal to article 4 in length; article 4 with broad posteroventral setose lobe; article 5 with small notch near ventral edge of anterior margin; article 6 slightly inflated and longer than article 5. Uropod 1 reaching only halfway along rami of uropod 2. Urosomite 1 with terminal and subterminal carina. Telson lobes pointed at apex, with posterolateral broad notches bearing 3-5 setae; dorsal surface of each lobe with 3-6 long setae.

Remarks. This species is easily distinguished by the combination of distinct urosomite 1, shape of pereopod 7, and length of uropod 1.

Distribution and Habitat. An inhabitant of silt and sandy bottoms on the continental shelf from Prince William Sound, Alaska to Baja California, at depths of 0-225 m.

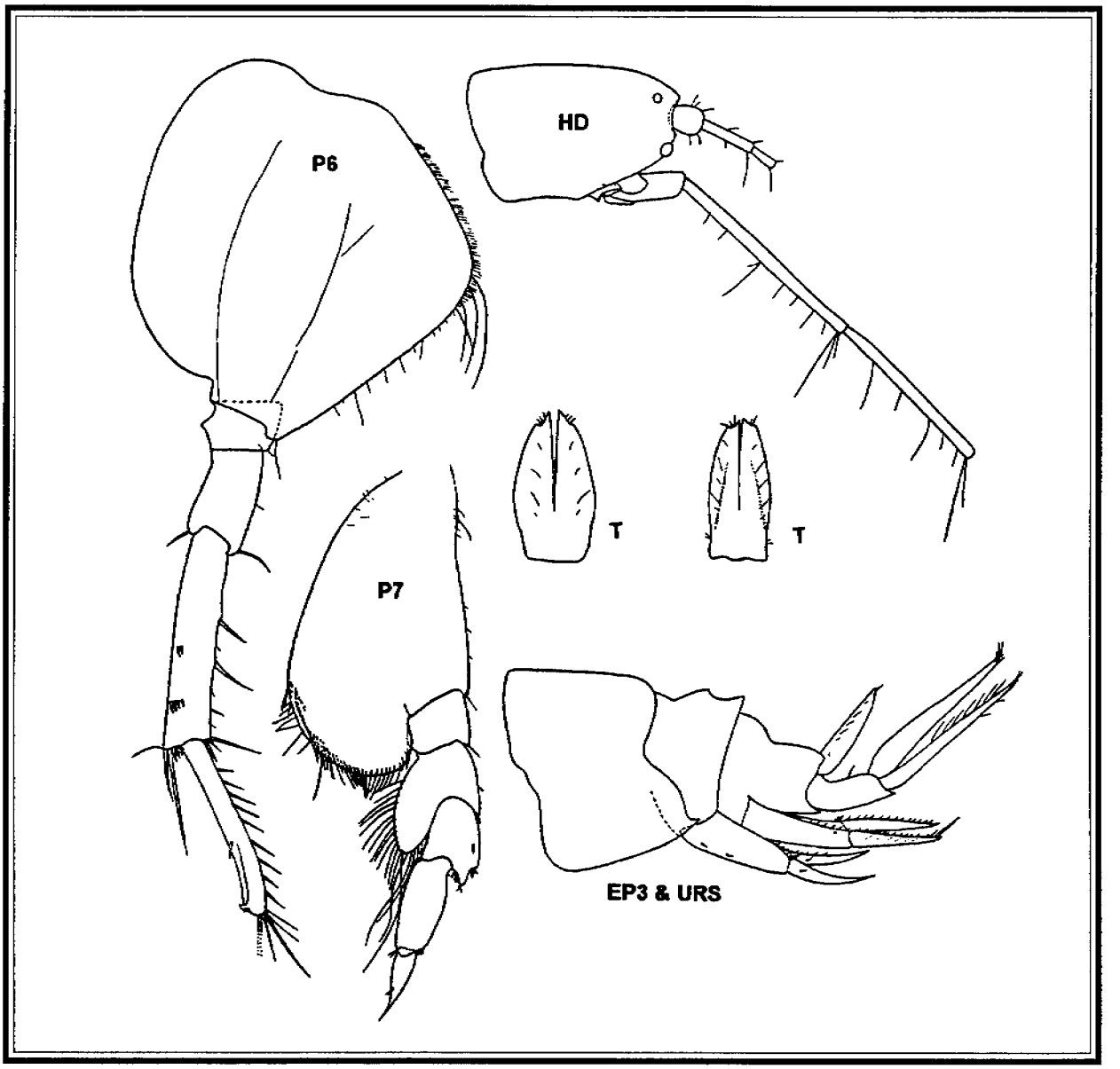

Figure 3.2. *Ampelisca pugetica* (from Barnard, 1954).

Ampelisca unsocalae J.L. Barnard, 1960

Figure 3.3

Ampelisca macrocephala unsocalae J.L. Barnard, 1960
Ampelisca careyi Dickinson, 1982

Material Examined. California: off Pt. Purisima, St. 46, 597 m, 83% sand (13), St. R-4, 92 m, 80% (7); off Pt. Arguello, St. 55, 590 m, silty-sand (25), St. 74, 201 m, sandy-silt (8); off Pt. San Luis, St. R-3, 409 m, 81% silt (6).

Description. Antenna 1 short, not reaching end of peduncle of antenna 2, second peduncle article twice length of first. Antenna 2 nearly equal to length of body, peduncle article 4 longest. Mandible palp

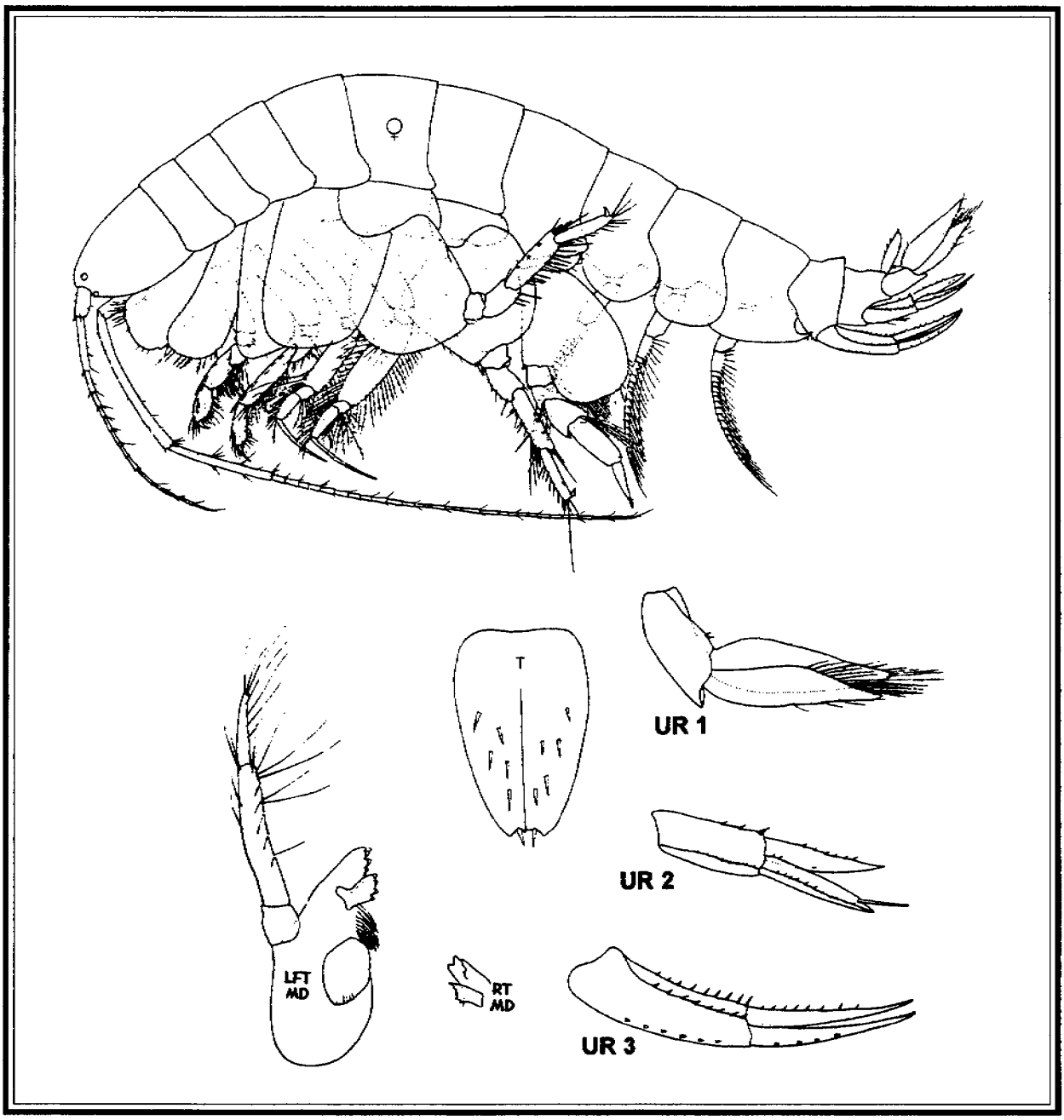

Figure 3.3. *Ampelisca unsocalae* (from Dickinson, 1982).

article 2 setose distally. Coxae 1-3 with small tooth on posteroventral corner. Pereopods 5-6 posterior margin of article 5 with 3 sets of short stiff setae. Pereopod 7 article 2 posterior lobe deep, extends to article 4; article 3 subequal to article 4; article 4 with setose posterior lobe extending half length of article 5; article 6 nearly twice length of article 5; article 7 often with curved tip. Uropod 1 reaching end of uropod 2. Telson lobes with notched apex bearing small stiff seta, dorsal surface with 4-5 setae.

Remarks. Dickinson (1982) elevated *unsocalae* from subspecific to full species status, using the shape of telson apices, head shape, and form of epimeral plate 3 tooth as distinguishing features. *A. careyi* was further distinguished from *A. unsocalae* on the basis of head shape (a little longer), length of tooth on the third epimeral plate (a little shorter), relative length of antenna 1 (longer than antenna 2 peduncle), and

position of the apical notch on the telson (just laterad of the median slit, rather than at the median slit). An examination of several specimens has shown that all of these features are gradational in nature and may be representative of a latitudinal or depth gradient. Specimens from the Santa Maria Basin region possessed the telson feature of Dickinson's *careyi* combined with the short antenna 1 of *unsocalae*. Consequently, it is felt here there exist no consistent characters which can be used to unerringly diagnose *A. careyi*.

Distribution and Habitat. An inhabitant of silt-clay bottoms of the continental slope (50-1700 m, primarily 100-600 m) from Dixon Entrance to off San Diego (J.L. Barnard 1971, Dickinson 1982).

Ampelisca hancocki J.L. Barnard, 1954

Figure 3.4

Material Examined. California: east of Pt. Conception, St. 85, 113 m, 72% sand (1); off Pt. Purisima, St. R-4, 92 m, 80% silt (10); off Pt. Sal, St. PJ-18, 158 m, silt (4).

Description. Body small (4-6 mm). Antenna 1 short, not reaching beyond end of antenna 2, peduncle articles 1 and 2 subequal in length. Antenna 2 about length of body, peduncle article 4 longest. Mandible palp article 2 setose along distal half. Coxae 1-3 posteroventral corner toothed. Pereopods 5-6 article 5 posterior margin with single seta. Pereopod 7 article 2 posterior lobe broadly rounded; articles 3 and 4 subequal in length; article 4 with tapering posterior setose lobe; article 6 inflated and slightly longer than article 5; article 7 very short. Epimeral plate 3 with straight posterior margin leading to medium-sized posteroventral tooth. Uropod 1 rami reaching to end of uropod 2. Telson lobes with minutely notched apices bearing single seta; dorsal surface with 2 pairs of short setae.

Remarks. This species is distinguished by its small size, short dactyl of pereopod 7, and straight posterior margin of epimeral plate 3.

Distribution and Habitat. An inhabitant of fine sand and silt from Ocean Falls, British Columbia (52°20'N) to Costa Rica at depths of 9-200 m.

Ampelisca brevisimulata J.L. Barnard, 1954

Figure 3.5

Material Examined. California: off Pt. San Luis, St. 21, 49 m, 75% silt (4); off Pt. Sal, St. PJ-18, 158 m, silt (1); off Pt. Purisima, St. R-4, 92 m, 80% silt (3); off Pt. Conception, St. 79, 98 m, 84% sand (4).

Description. Antenna 1 short, not reaching end of peduncle of antenna 2; peduncle article 2 more than twice length of article 1. Antenna 2 about two-thirds of body length; peduncle article 4 longer than 5. Mandible palp article 2 sparsely setose along whole length. Coxa 1 with small tooth at posteroventral corner. Pereopods 5-6 article 5 posterior margin with 4-5 groups of comb setae. Pereopod 7 article 2 posterior lobe broadly rounded; article 3 subequal to article 4; article 4 with slender setose posterior lobe; articles 5 and 6 inflated, subequal in length; article 7 subequal to article 6 in length. Epimeral plate 3 produced posteriorly into large rounded hump above posteroventral tooth. Uropod 1 extending beyond end of uropod 2. Telson lobes tapering to narrow unnotched apices, dorsal surface with 6-12 scattered setae.

Remarks. This species, like *A. hancocki*, is relatively small as an adult, and is somewhat similar to the latter in general features. It can be distinguished from *A. hancocki*, however, in the shape of epimeral plate 3 and the number of seta groups on the posterior margin of pereopods 5 and 6 article 5.

Distribution and Habitat. An inhabitant of sand and silt bottoms from southeast Alaska (Lynn Canal, near Juneau) to Panama at depths of 20-400 m.

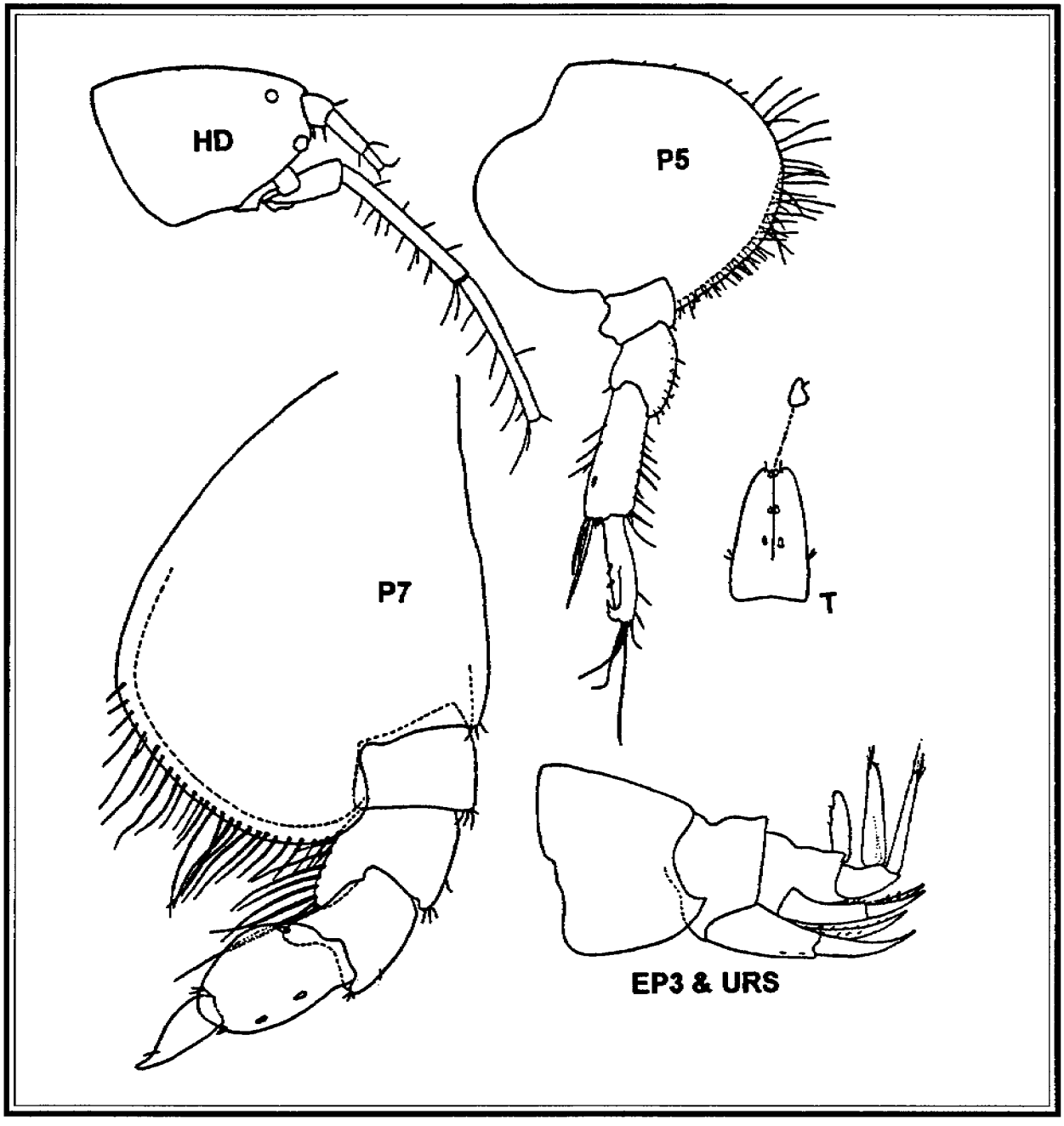

Figure 3.4. *Ampelisca hancocki* (from Barnard, 1954).

Ampelisca cristata Holmes, 1908

Figure 3.6

Material Examined. California: recorded from MMS Phase I, but not seen by me.

Description. Body large (12-17 mm). Antenna 1 short, not reaching end of peduncle of antenna 2, peduncle articles 1 and 2 subequal in length. Antenna 2 about three-fourths length of body, peduncle article 4 longest. Mandible palp article 2 sparsely setose along whole length. Coxa 1 posteroventral corner with small tooth. Pereopods 5-6 article 5 posterior margin with 3-4 groups of setae. Pereopod 7 article 2 posterior

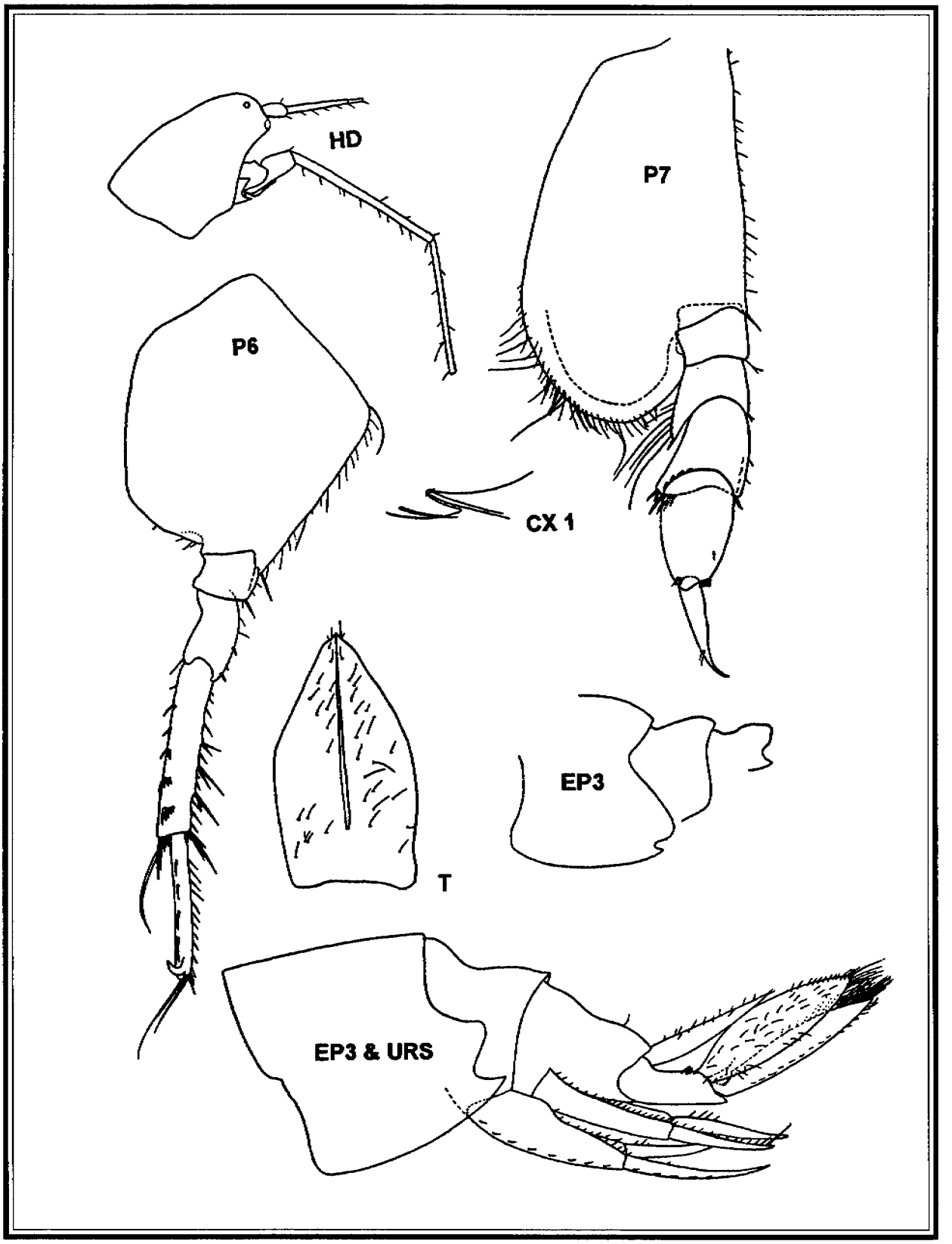

Figure 3.5. *Ampelisca brevisimulata* (from Barnard, 1954).

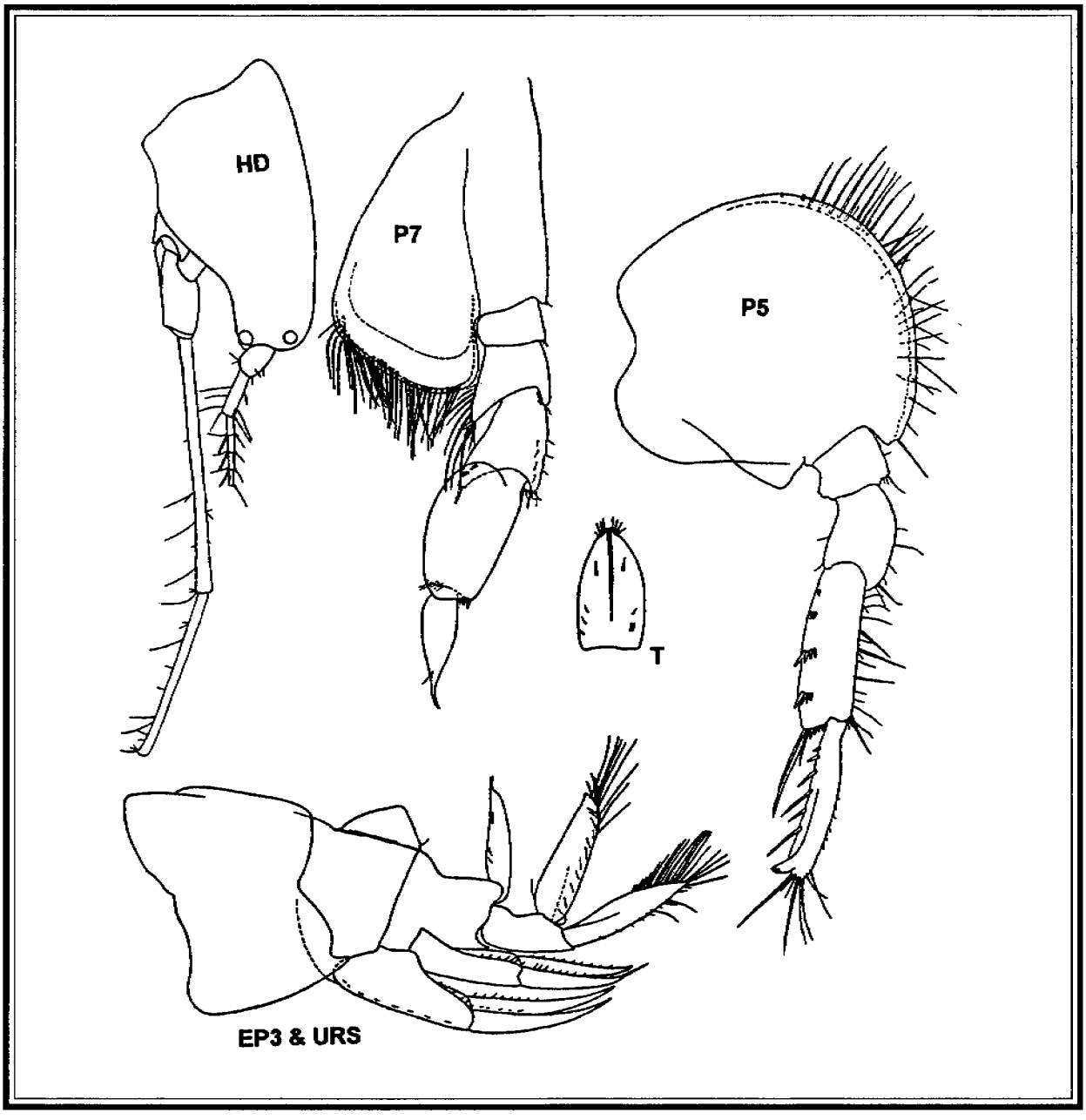

Figure 3.6. *Ampelisca cristata* (from Barnard, 1954).

lobe lower margin obliquely nearly straight; article 3 shorter than article 4; article 4 with small posterior setose lobe; article 6 inflated and longer than articles 5 and 7. Epimeral plate 3 with gently curving posterior margin leading to small posteroventral tooth. Urosomite 1 with large rounded carina. Uropod 1 rami nearly reaching to end of uropod 2. Telson lobes with apices notched laterally and bearing 3-4 setae; dorsal surface with 2-4 pairs of centrally located setae.

Remarks. The large, rounded, carina on urosomite 1 alone serves to distinguish this species from all others in the region.

Distribution and Habitat. Alexander Archipelago (southeast Alaska) to Costa Rica in coarse sand at depths 0-152 m.

Ampelisca pacifica Holmes, 1908

Figure 3.7

Material Examined. California: off Pt. Arguello, St. 70, 200 m, sandy-silt (4), St. 74, 201 m, sandy-silt (2); off Purisima Pt., St. R-5, 154 m, silty-sand (14); off Pt. Sal, St. PJ-18, 158 m, silt (7).

Description. Body moderately large (12 mm). Antenna 1 not reaching beyond end of peduncle of antenna 2, peduncle article 2 more than twice length of article 1. Antenna 2 about three-fourths length of body, peduncle article 4 longest. Mandible palp article 2 heavily setose along whole length. Coxae 1-3 posteroventral corner with small slit. Pereopods 5-6 article 5 posterior margin with 2-3 groups of setae. Pereopod 7 article 2 posterior lobe lower margin broadly rounded; article 3 subequal in length to article 4; article 4 with small posterior setose lobe; articles 5 and 6 subequal in length. Epimeral plate 3 with curving posterior margin leading to large posteroventral tooth. Urosomite 1 with subterminal carina. Uropod 1 rami reaching to end of uropod 2. Telson lobes with apices notched laterally and bearing 3-4 setae; dorsal surface with 4-6 centrally located bifid setae.

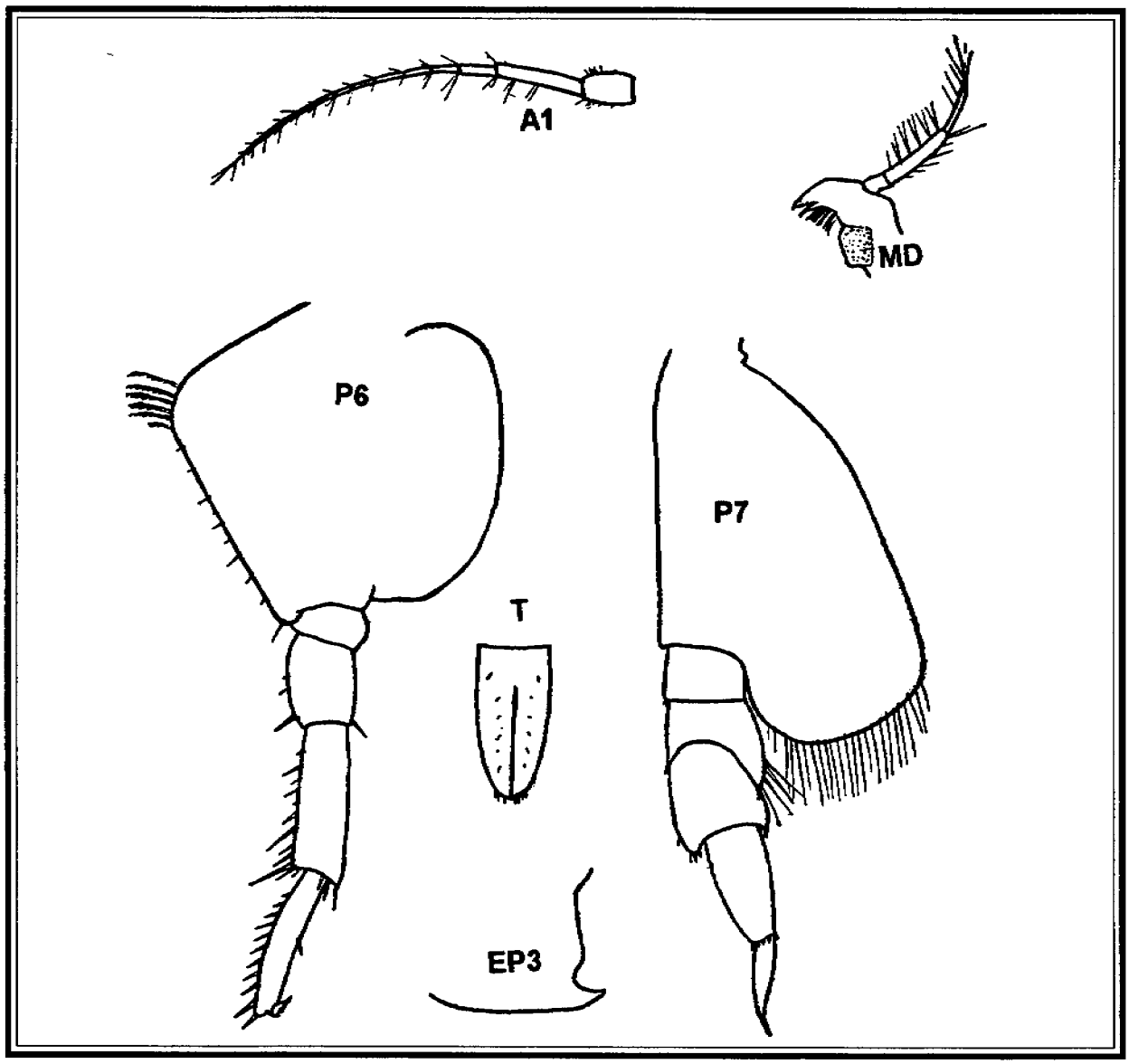

Figure 3.7. *Ampelisca pacifica* (from Holmes, 1908).

Remarks. This species appears to be the southernmost member of a group of large ampeliscids which includes *A. macrocephala* at the northernmost extreme and *A. unsocalae* in the middle. *A. pacifica* differs from the two above mentioned species primarily in the details of pereopod 7 and the shape of the carina on urosomite 1.

Distribution and Habitat. A shelf and slope species found from Monterey, California to Panama, 5-1821 m.

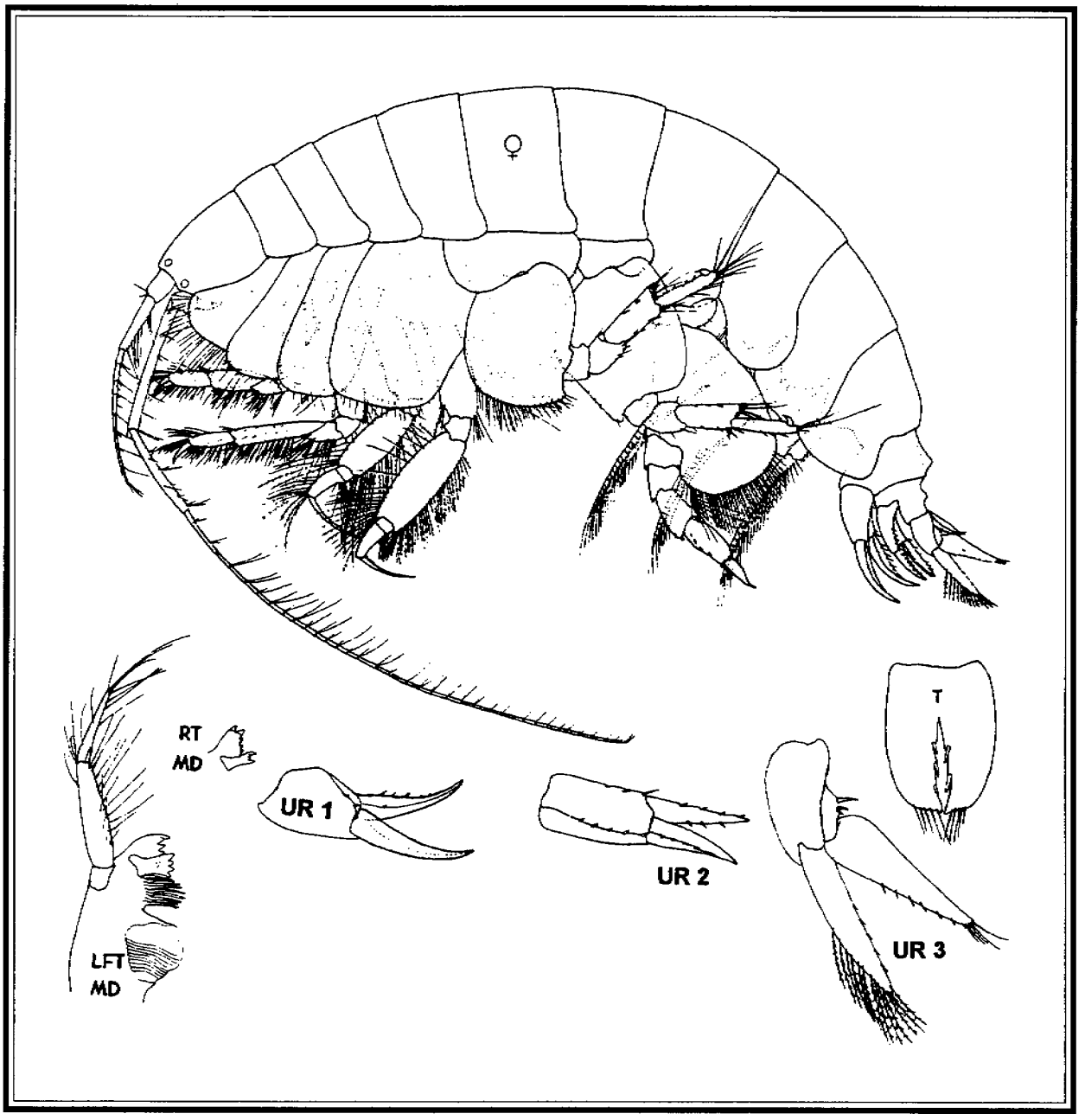

Figure 3.8. *Ampelisca agassizi* (from Dickinson, 1982).

Ampelisca agassizi (Judd, 1896)

Figure 3.8

Ampelisca vera J.L. Barnard, 1954

Material Examined. California: off Point Conception, St. 80, 196 m, sandy-silt (4).

Description. Body small to medium-sized (8-11 mm). Antenna 1 not reaching end of peduncle of antenna 2, peduncle article 2 twice length of article 1. Antenna 2 about as long as body, peduncle article 4 longest. Mandible palp article 2 heavily setose along whole length. Coxae 1-3 posteroventral corner without small slit or tooth. Pereopods 5-6 article 5 posterior margin with 2-3 weak groups of setae. Pereopod 7 article 2 posterior lobe lower margin broadly rounded; article 3 subequal in length to article 4; article 4 with posterior setose lobe extending nearly along whole of article 5; article 6 longer than article 5. Epimeral plate 3 with curving posterior margin leading to rounded posteroventral corner. Urosomite 1 with well developed carina. Uropod 1 rami reaching to end of uropod 2. Telson lobes with apices blunt and bearing 4-5 setae; dorsal surface with 2-3 pairs of setae along cleft.

Remarks. Of the species found in this area that do not have a tooth on the posteroventral corner of epimeral plate 3, *A. agassizi* is easily distinguished by its very short first antenna.

Distribution and Habitat. This species is the most widespread ampeliscid found in the region. It occurs from Nova Scotia to the Caribbean in the North Atlantic and from the Queen Charlotte Islands to Ecuador in the Pacifc at depths from 5-450 m.

Ampelisca romigi J.L. Barnard, 1954

Figure 3.9

Ampelisca isocornea J.L. Barnard 1954
Ampelisca ciego J.L. Barnard 1966

Material Examined. California: SW of Pt. Estero, St. 8, 308 m, sandy-silt (1); off Point Conception, St. 79, 98 m, 84% sand (4); off Pt. Arguello, St. R-5, 154 m, silty-sand (1).

Description. Body small to medium-sized (8-11 mm). Antenna 1 reaching beyond end of peduncle of antenna 2, peduncle article 2 1.5 times length of article 1. Antenna 2 about as long as body, peduncle article 4 longest. Mandible palp article 2 setose along distal half. Coxae 1-3 posteroventral corner with small slit. Pereopods 5-6 article 5 posterior margin with 2-3 weak groups of setae. Pereopod 7 article 2 posterior lobe lower margin obliquely rounded, reaching junction of articles 4 and 5; article 3 slightly longer than article 4 (not including posterior lobe); article 4 with posterior setose lobe extending half length of article 5; article 5 with distal notch on anterior margin; article 6 longer than article 5. Epimeral plate 3 with curving posterior margin leading to quadrate posteroventral corner. Urosomite 1 with weak carina. Uropod 1 rami reaching to end of uropod 2. Telson lobes with apices blunt and bearing a single seta; dorsal surface with 2-3 pairs of setae.

Remarks. *A. romigi* is closest in general form to *A. agassizi* and *A. lobata* from which it is distinguished by the presence of a notch on the anterodistal portion of pereopod 7 article 5 and its lack of a distinct carina on urosomite 1.

Distribution and Habitat. This species is an inhabitant of coarse sand and rubble substrates in the eastern Pacific from Monterey Bay, California, to Santa Elena Bay, Ecuador at depths of 3-504 m.

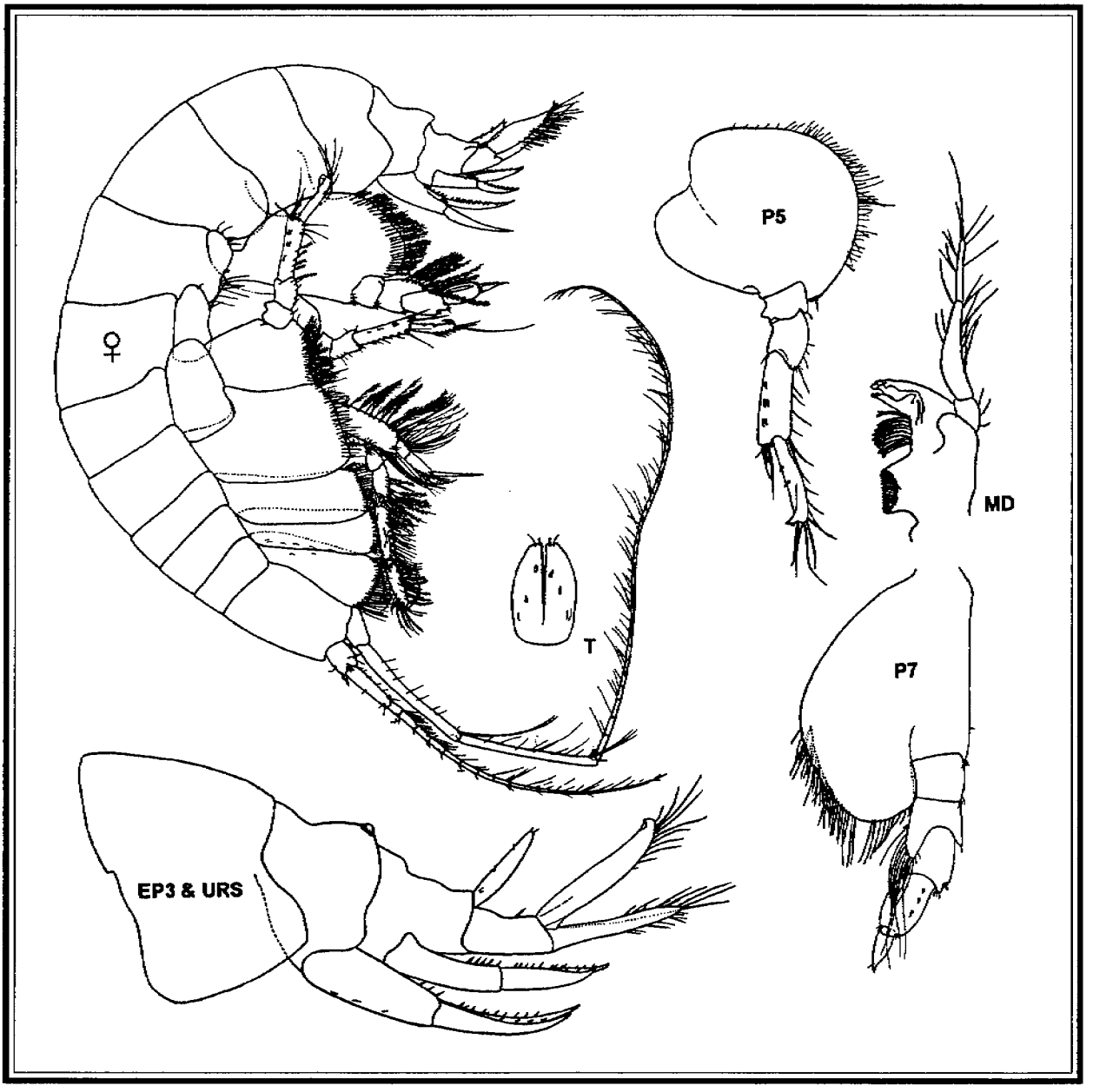

Figure 3.9. *Ampelisca romigi* (from Barnard, 1954, 1966).

Ampelisca lobata Holmes, 1908

Figure 3.10

Ampelisca articulata Stout, 1913

Material Examined. California: S of Pt. Estero, St. 6, 109 m, 82% silt (5); off Pt. Buchon, St. 16, 591 m, 85% silt (11).

Description. Body small to medium-sized (7-9 mm). Antenna 1 reaching beyond end of peduncle

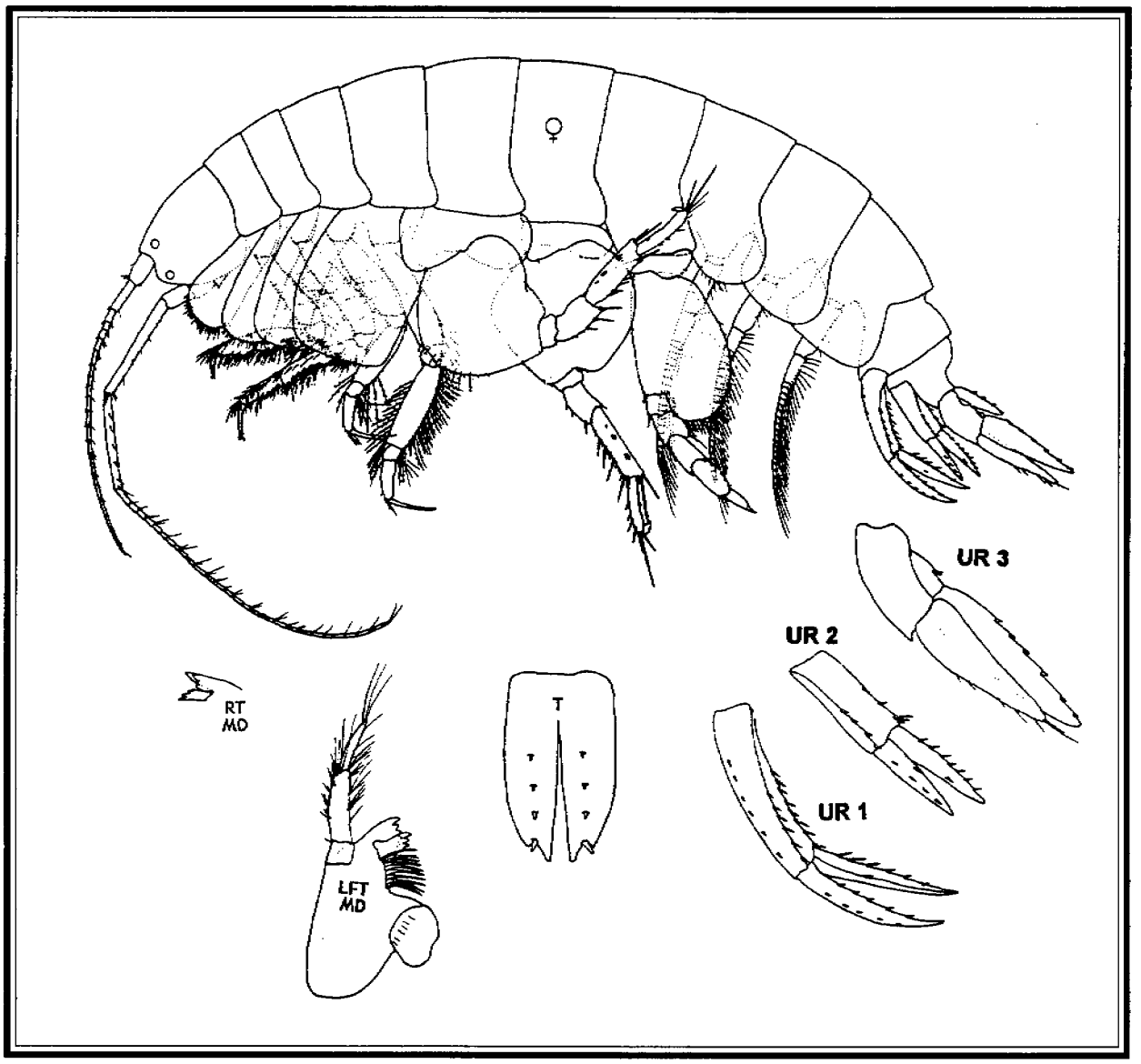

Figure 3.10. *Ampelisca lobata* (from Dickinson, 1982).

of antenna 2, peduncle articles 1 and 2 subequal. Antenna 2 about two-thirds length of body, peduncle article 4 longest. Mandible palp article 2 setose along distal two-thirds. Coxae 1-3 posteroventral corner with small slit. Pereopods 5-6 article 5 posterior margin with 3 groups of setae. Pereopod 7 article 2 posterior lobe deep and slender, not reaching junction of articles 4 and 5; article 3 shorter than article 4 (not including posterior lobe); article 4 with small posterior setose lobe; article 5 without distal notch on anterior margin, subequal in length to article 6. Epimeral plate 3 with curving posterior margin leading to quadrate posteroventral corner. Urosomite 1 with slight rounded carina, posterior of which meets raised anterior margin of urosomite 2. Uropod 1 rami reaching beyond end of uropod 2. Telson lobes with apices notched laterally and bearing a single seta; dorsal surface with 2-3 pairs of setae.

Remarks. The shape of the urosome, having a carina-like structure incorporating both urosomites 1 and 2 is very distinctive.

Distribution and Habitat. This species is an inhabitant of mixed bottoms of rock and sand, and may be associated with algae in the littoral zone. It has been found from the Queen Charlotte Islands, British Columbia to Lobos de Afeuras Islands, Peru, and the Galapagos, at depths from the littoral to 591 m, with most records shallower than 40 m.

Genus *Byblis* Boeck, 1871

Type Species. *Ampeilisia* [sic] *gaimardii* Krøyer, 1846

Diagnosis. Flagella of antennae 1-2 with 5 or more articles. Maxilliped inner plate slender and slightly elongate, palp article 3 unproduced. Pereopods 3-4, article 5 not greatly reduced in length. Pereopods 5-6, dactyls of medium length and simple. Pereopod 7 article 2 expanded distally, posterior margin oblique, anterior margin of lobe fully setose near junction with article 3; dactyl reduced and spine-like. Telson short in female, elongate in pelagic male, cleft one-fourth to three-fourth length.

Remarks. Two features on pereopod 7, viz., the presence of setae on the posterior lobe of article 2 near its junction with article 3, and the spine-like dactyl, serve to distinguish species in this genus from those in *Ampelisca*. There are currently 56 species in this genus, but it is likely that additional deep-water species are yet to be found. In the Santa Maria Basin region, the genus is well covered by the work of Barnard (1966, 1967, 1971) and Dickinson (1983).

Key to the Species of *Byblis* from the Santa Maria Basin (from Dickinson, 1983)

1A. Posterodistal corner of coxae 2-3 obliquely truncated; ventral margin of coxae 1-3 very weakly serrated ..... *Byblis veleronis*

1B. Posterodistal corner of coxae 2-3 not truncated; ventral margin of coxae 1-3 strongly serrated 2

2A. Antenna 1 extending well beyond end of peduncle of antenna 2 ..... *Byblis bathyalis*

2B. Antenna 1 just reaching end of peduncle of antenna 2 3

3A. Eyes well developed; rami of uropod 1 subequal in length ..... *Byblis millsi*

3B. Eyes lacking; inner ramus of uropod 1 distinctly shorter than outer ramus ..... *Byblis barbarensis*

Byblis veleronis J.L. Barnard, 1954

Figure 3.11

Material Examined. California: off Pt. Purisima, St. 42, 100 m, sandy silt (1).

Description. Eyes well developed. Antenna 1 reaching beyond end of antenna 2 peduncle. Antenna 2 about length of body. Coxae 1-3 ventral margin very weakly serrated. Coxa 1 weakly expanded distally, posterodistal corner strongly truncated. Coxae 2-3 posterodistal corner strongly truncated. Basis of gnathopods 1-2 serrate posterodistally. Pereopod 6 article 5 without comb setae on anterior margin. Pereopod 7 article 4 one-half length of article 5; article 6 with 2 groups of setae on anterior margin. Uropod 1 outer ramus without setae, longer than inner ramus which bears stiff setae.

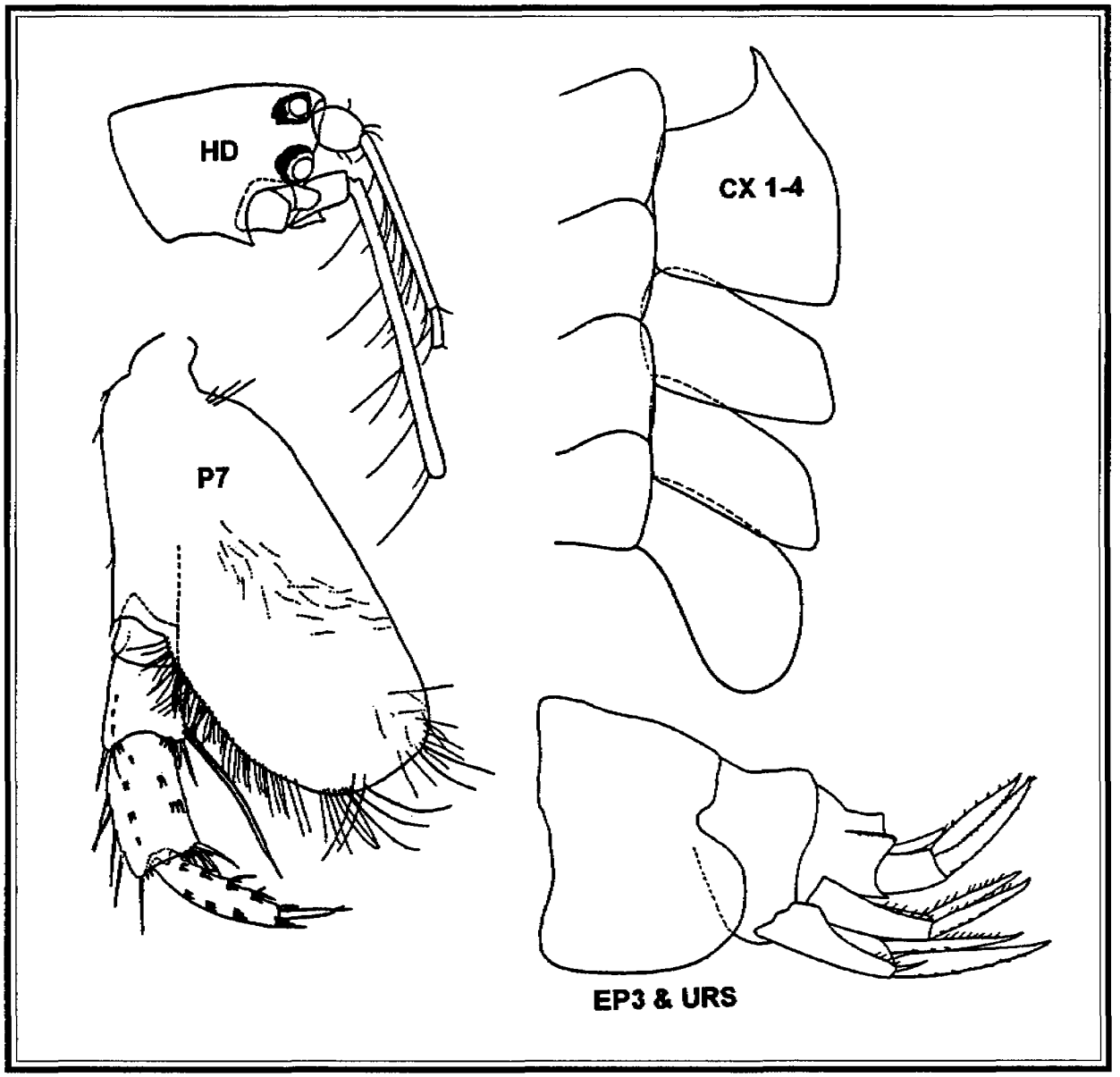

Figure 3.11. *Byblis veleronis* (from Barnard, 1954).

Remarks. This species is distinguished chiefly by the shape of coxae 1-3, and inhaving the outer ramus of uropod 1 unarmed. Dickinson (1983), having examined a large amount of previously identified material, noted that this species has apparently been confused with a closely related species, which he named *B. millsi*. As a consequence, it is difficult to know much about the biology of either.

Distribution and Habitat. A widely distributed species ranging from the Queen Charlotte Islands, British Columbia to Clarion Island and the Gulf of California, Mexico at depths of 5-300 m.

Byblis bathyalis J.L. Barnard, 1966

Figure 3.12

Material Examined. California: off Pt. Estero, St. 3, 291 m, silt and sand (1) [Voucher specimen identified as *B. veleronis*]; off Pt. Arguello, St. 55, 590 m, silty sand (1).

Description. Eyes well developed. Antenna 1 reaching nearly to end of antenna 2. Antenna 2 nearly body length. Coxae 1-3 ventral margin strongly serrated. Coxa 1 moderately expanded distally, posterodistal corner not strongly truncated. Coxae 2-3 posterodistal corner not truncated. Basis of gnathopods 1-2 heavily setose. Pereopod 6 article 5 with many setae on anterior margin. Pereopod 7 article 4 one-half length of article 5; article 6 with 3 groups of setae on anterior margin. Uropod 1 inner ramus slightly shorter than outer, both rami with stiff setae.

Remarks. This species is distinguished from all others in the region primarily in the degree to which all appendages are setose and the length of antenna 1.

Distribution and Habitat. Known to date only from off Oregon and California at bathyal depths, 400-950 m.

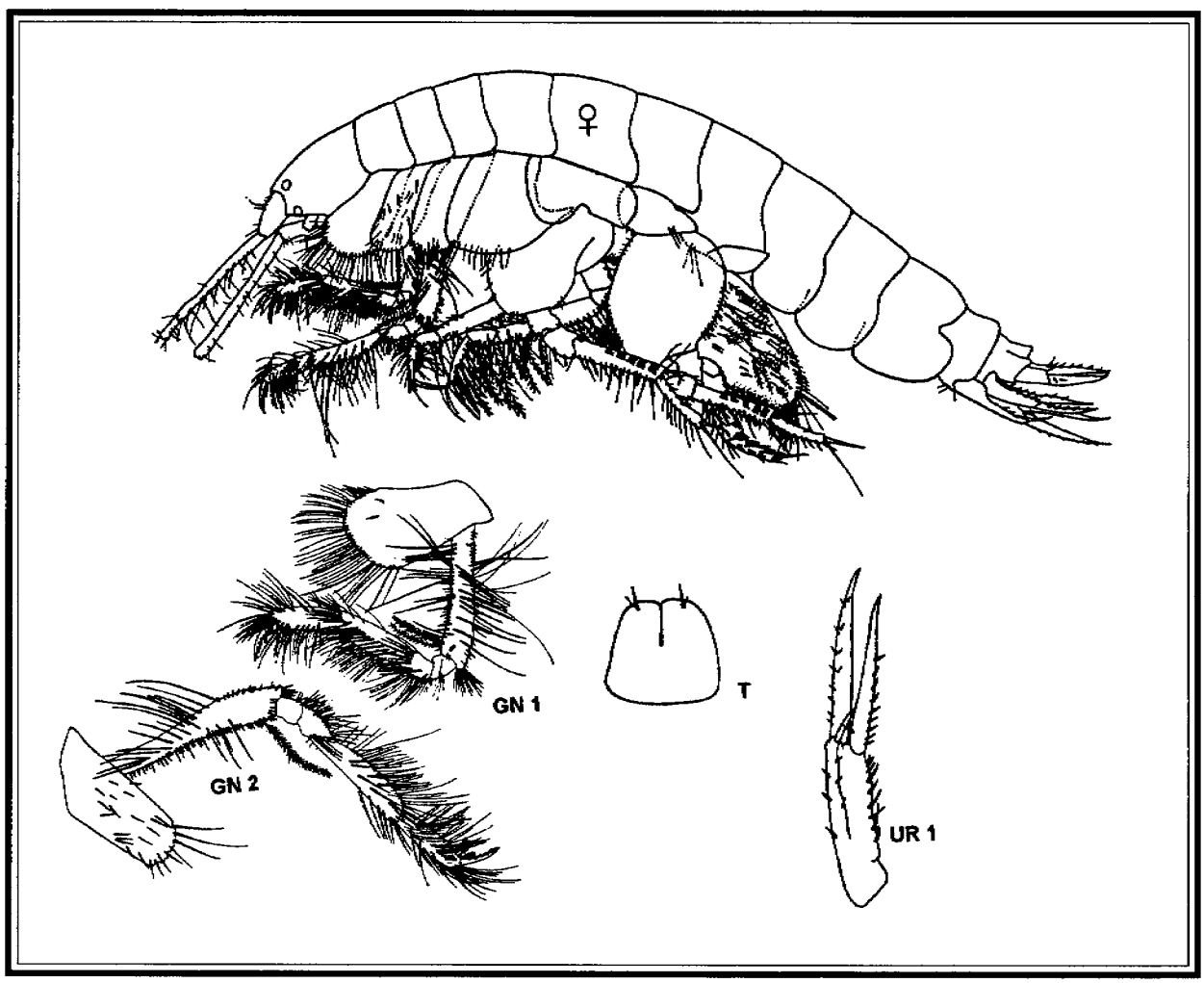

Figure 3.12. *Byblis bathyalis* (from Barnard, 1966).

Byblis millsi Dickinson, 1983

Figure 3.13

Material Examined. California: off Pt. Purisima, St. R-4, 92 m, silt (6); off Pt. Sal, St. PJ-1, 145 m, silt (1).

Description. Eyes well developed. Antenna 1 reaching end of antenna 2 peduncle. Antenna 2 about two-thirds of body length. Coxae 1-3 ventral margin strongly serrated. Coxa 1 moderately expanded distally, posterodistal corner not strongly truncated. Coxae 2-3 posterodistal corner not truncated. Basis of gnathopods 1-2 serrate distally. Pereopod 6 article 5 with several comb setae on anterior margin. Pereopod 7 article 4 three-fourths length article 5; article 6 with 2-3 groups of setae on anterior margin. Uropod 1 rami subequal in length, both rami with stiff setae.

Remarks. This species is closest in its affinities to *B. veleronis*, from which it differs in having a shorter first antenna, the presence of comb setae on the anterior margin of pereopod 6 article 5, and the outer ramus of uropod 1 bearing setae.

Distribution and Habitat. An inhabitant of sandy bottoms from the Queen Charlotte Islands to southern California at depths of 0-100 m.

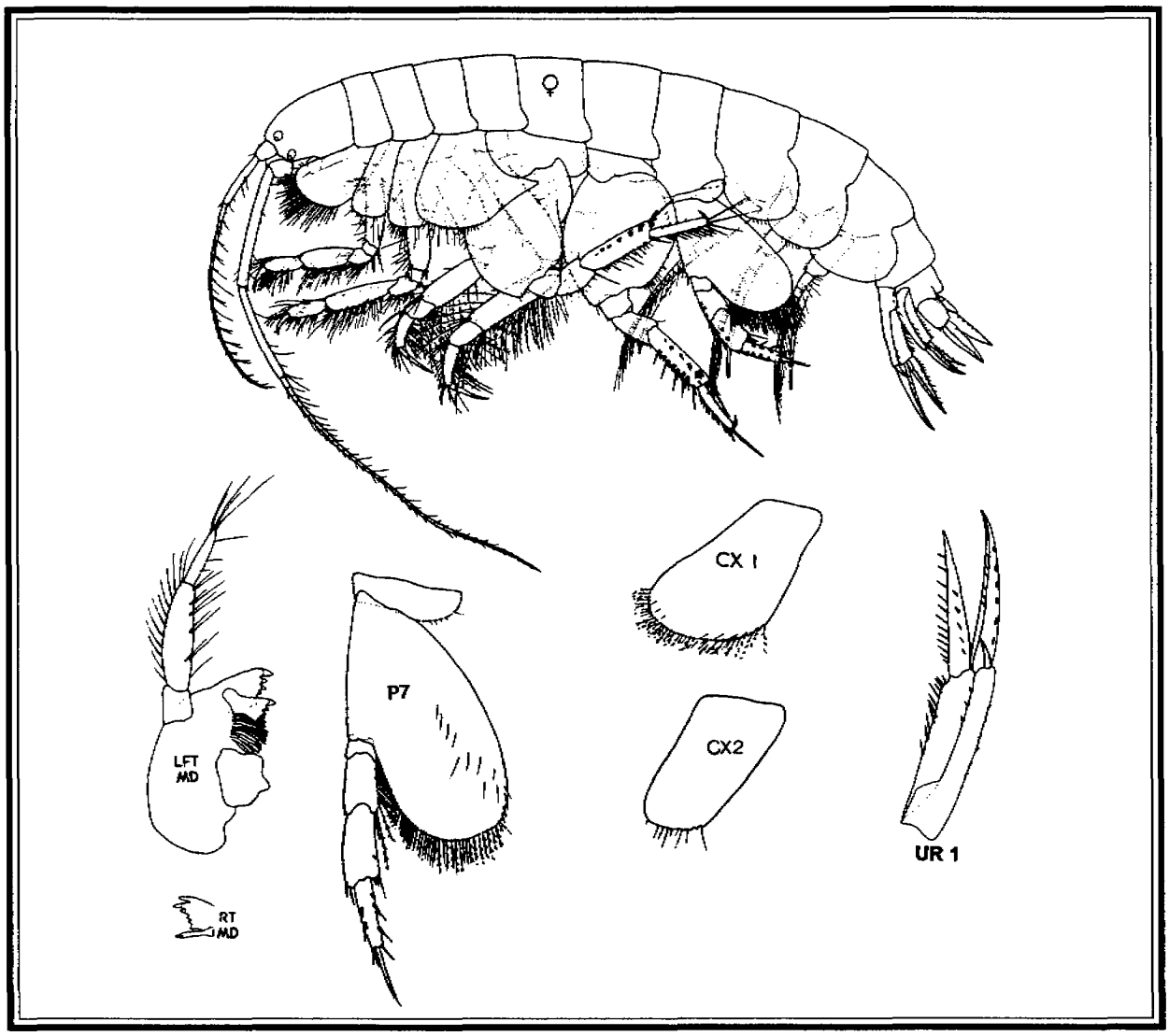

Figure 3.13. *Byblis millsi* (from Dickinson, 1983).

Byblis barbarensis J.L. Barnard, 1960

Figure 3.14

Material Examined. California: off Pt. Arguello, St. 55, 590 m, silty sand (15); off Pt. San Luis, St. 26, 590 m, clayey silt, (10); off Pt. Sal, St. R-7, 565 m, clayey silt, (4).

Description. Eyes and corneal lenses absent. Antenna 1 reaching end of antenna 2 peduncle. Antenna 2 longer than body. Coxae 1-3 ventral margin strongly serrated. Coxa 1 moderately expanded distally, posterodistal corner not strongly truncated. Coxae 2-3 posterodistal corner not truncated. Basis of gnathopods 1-2 serrate distally. Pereopod 6 article 5 with single seta group on anterior margin. Pereopod 7 article 4 one-half length of article 5; article 6 with single seta group on anterior margin. Uropod 1 inner ramus shorter than outer, both rami with few stiff setae.

Remarks. This is the only blind species found thus far in the Santa Maria Basin region. It is also the only species regularly found in very fine sediment.

Distribution and Habitat. Known only from off Oregon and California at depths of 496-1225 m.

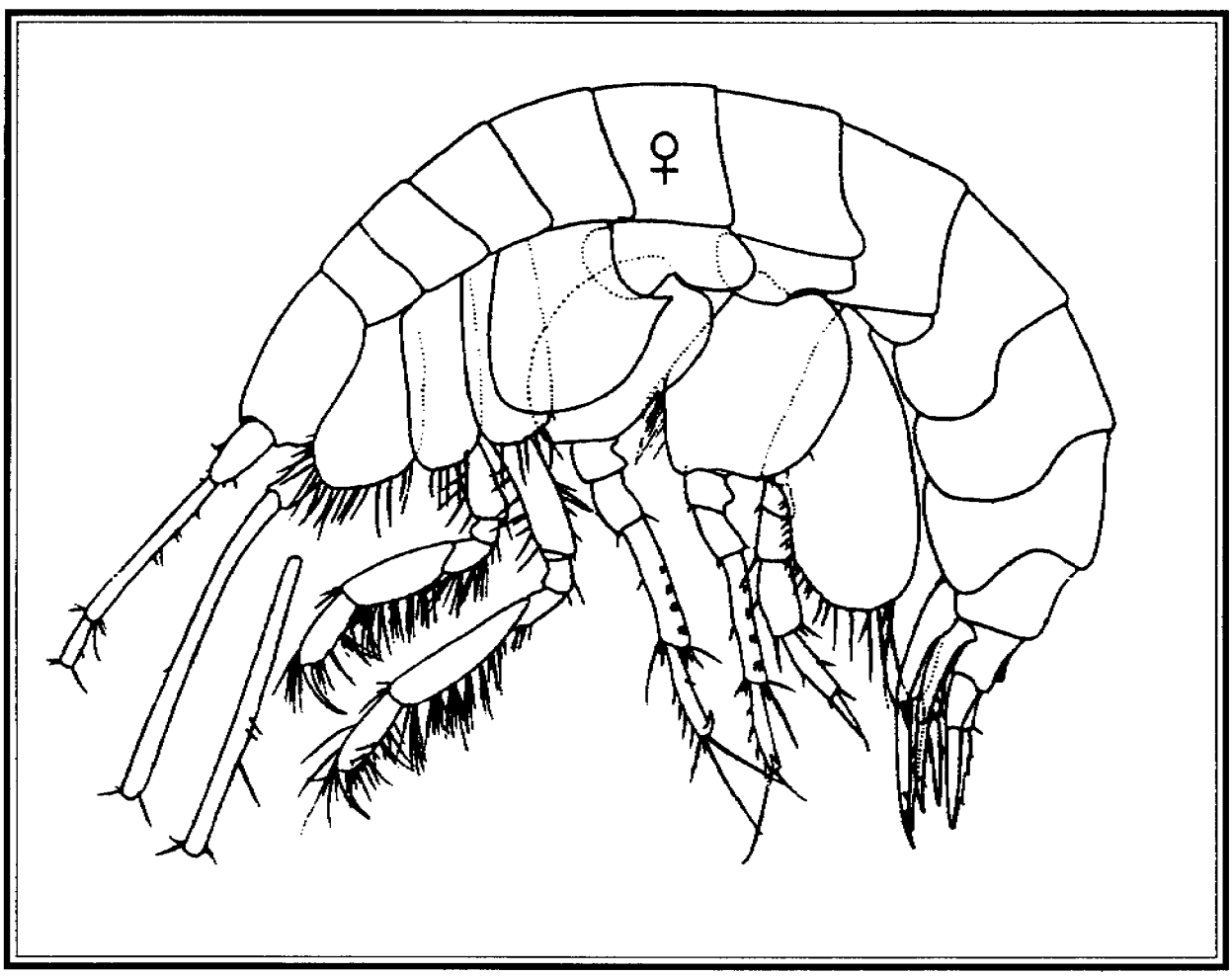

Figure 3.14. *Byblis barbarensis* (from Barnard, 1960).

Genus *Haploops* Liljeborg, 1856

Type Species. *Haploops tubicola* Liljeborg, 1856

Diagnosis. Maxilliped inner plate slender and elongate, palp article 3 produced or inflated. Pereopods 3-4, article 5 not greatly reduced in length. Pereopod 5-6, dactyls medium length and simple. Pereopod 7 article 2 not greatly expanded distally, posterior margin nearly parallel to anterior; article 6 often shorter than article 5; article 7 spine-like. Telson short in female and elongate in pelagic male.

Remarks. The shape of the basal lobe on pereopod 7 serves as the main distinguishing feature for this genus. Thus far 14 species are known, only one of which has been found in the Santa Maria Basin region.

***Haploops tubicola* Liljeborg, 1856**

Figure 3.15

Material Examined. California: off Pt. Arguello, St. 59, 216 m, clayey silt (1).

Description. Head with dorsofrontal eye only. Antenna 1 nearly as long as antenna 2. Mandible palp articles 2 and 3 subequal in length. Coxa 1 expanded distally with maximum width being less than one-half total length. Pereopod 7 article 5 produced distally into anterior and posterior lobes; article 6 as wide as but slightly shorter than article 5.

Distribution and Habitat. This is a circumpolar species found in both the North Atlantic and North Pacific. The southernmost point in its distribution on the U.S. west coast is in the Santa Maria Basin region.

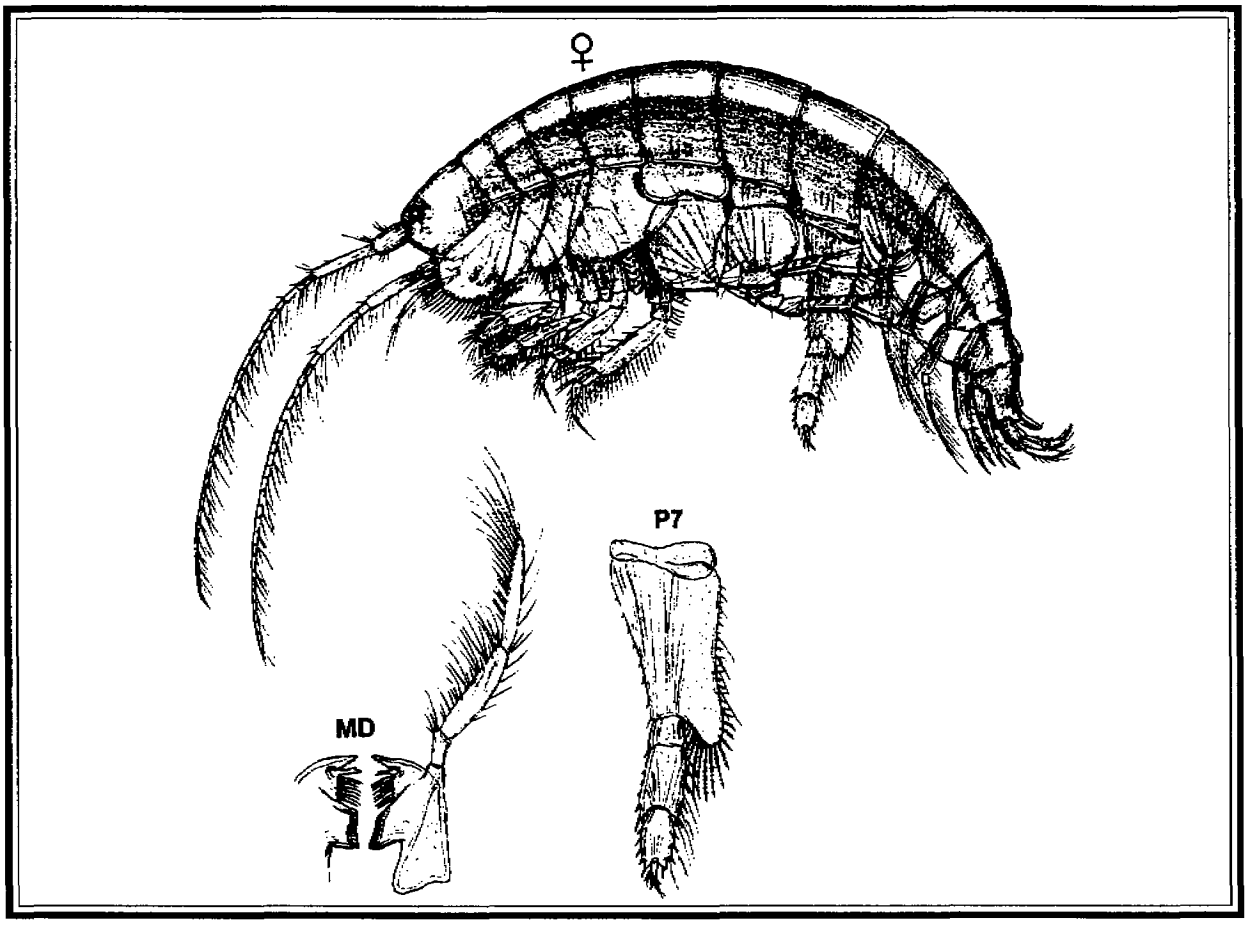

Figure 3.15. *Haploops tubicola* (from Sars, 1895).

Family Amphilochidae Boeck, 1871

Diagnosis. (after Barnard and Karaman, 1991) Accessory flagellum vestigial or absent. Rostrum well developed. Coxa 4 immensely broadened; coxae 2-4 with contiguous margins overlapping, not rabbeted (i.e., without groove on one coxa and tongue or projection on adjacent coxa); coxa 2 not hidden; coxa 1 very small and hidden by coxa 2. Peduncle of uropod 3 elongate. Telson entire, elongate.

Remarks. This is a family of primarily very small species, many of which probably have specialised life styles (mandibles can be quite variable across genera). Little, however, is known regarding the biology of the constituent species, however.

Key to Species of Amphilochidae from the Santa Maria Basin

1A. Gnathopods 1 and 2, propodus distally expanded, palm distinct ..... *Amphilochus picadurus*

1B. Gnathopods 1 and 2, propodus not expanded distally, palm indistinct ..... *Gitana calitemplado*

Genus *Amphilochus* Bate, 1862

Type Species. *Amphilochus manudens* Bate, 1862

Diagnosis. (from Barnard and Karaman, 1991) Mandibular molar small, columnar, conical or weakly bulbous, poorly or not triturative. Lower lip ordinary. Palp of maxilla 1 2-articulate. Maxilla 2 ordinary, or outer plate as long as inner but inner much wider, well setose. Outer plate of maxilliped not excavate, palp article 1 subequal to or longer than (type) article 2. Gnathopods 1-2 large to small, diverse or not, subchelate, palm straight or weakly convex subtransverse, dactyl lacking nodiform process. Gnathopods more or less carpochelate. Urosomite 3 poorly alate.

Remarks. This is a widespread genus of cold-water continental shelves currently containing 20 species.

Amphilochus picadurus J.L. Barnard, 1962

Figure 3.16

Amphilochus picadurus J.L. Barnard, 1962a.

Material Examined. California: off Pt. Buchon, St. 6, 109 m, (1); St. 16, 591 m, silt (1).

Description. (from Barnard, 1962a) Eyes medium size, subcircular, formed of darkly pigmented centers surrounded by pale ommatidea. Antenna 1 reaching only to end of peduncle on antenna 2. Gnathopod 1 subchelate, palm oblique, projecting lobe of article 5 reaching about halfway along hind margin of article 6. Gnathopod 2 considerably larger than 1, propodus moderately stout, less than 70% broad as long, palm nearly transverse, hind lobe of article 5 projecting almost fully along hind margin of article 6; propodus of gnathopod 2 bearing a small cusp at anterodistal end; dactyls of gnathopods not attenuated at extreme tips. Coxa 1 long, rectangular, lobate below. Telson considerably shorter than peduncle of uropod 3.

Remarks. Barnard (1962a) suggested this species was a synonym of *A. spencebatei* "from which it differs only by the small anterodistal cusp of the hand on the second gnathopod." However, in Barnard and Karaman (1991) *A. spencebatei* is recognized as a distinct species, possibly containing *A. brunneus*. The mandibular molar of *A. picadurus* is much longer and sharper than in other Californian *Amphilochus* species (Barnard, 1962a). This species is also very similar to *Gitanopsis baciroa* except in the structure of the mandible and the wavy serrations on the palm of gnathopod 2 (Barnard, 1979).

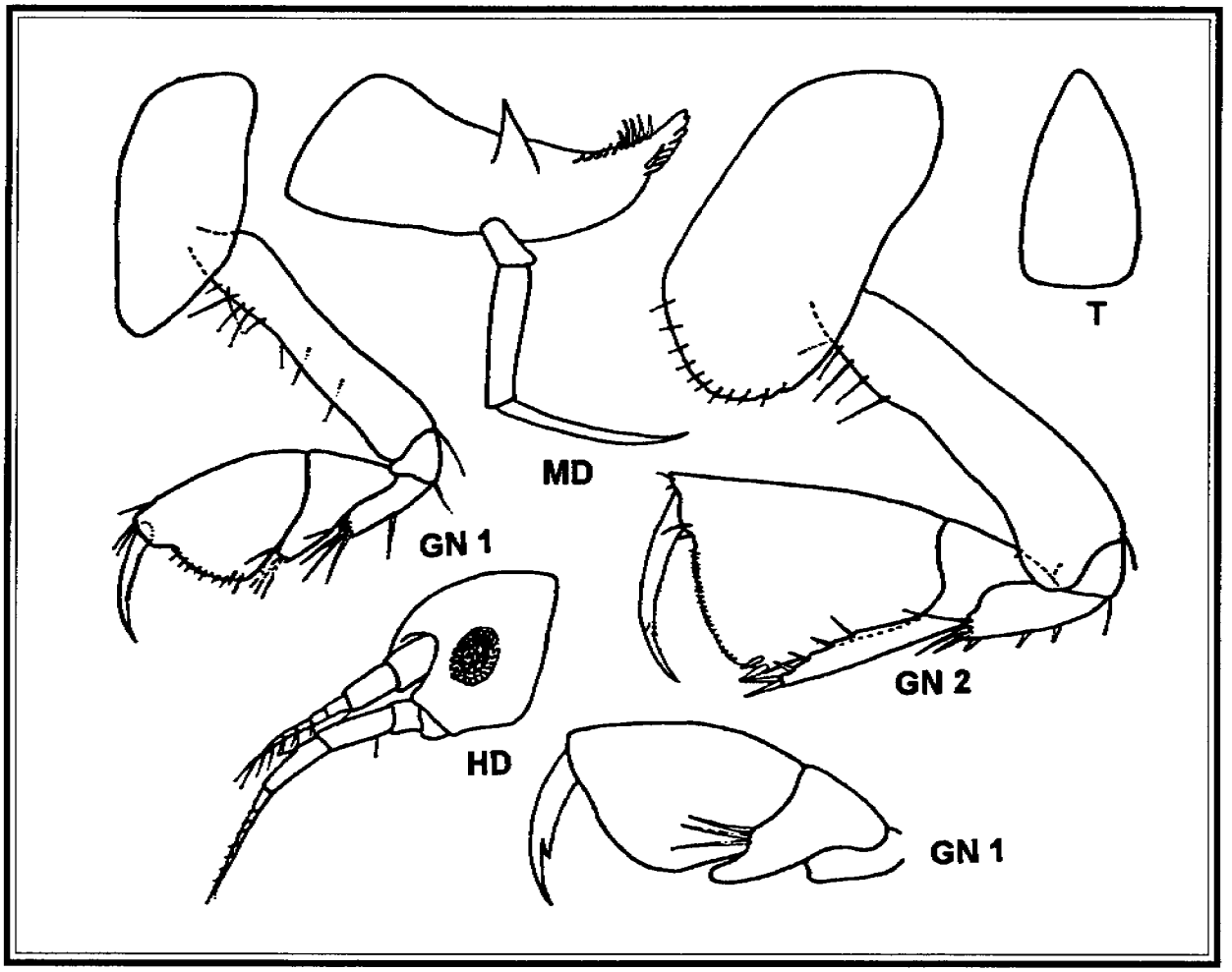

Figure 3.16. *Amphilochus picadurus* (from Barnard, 1962a).

Distribution and Habitat. Northeastern Pacific, Mediterranean Sea, Goleto, California south to Gulf of California at Bahía San Evaristo and Bahía Concepción, on *Macrocystis* holdfasts, rocky bottoms, 0-41 m. The material examined here represent major depth extensions for this species.

Genus *Gitana* Boeck, 1871

Type Species. *Gitana sarsi* Boeck, 1871.

Diagnosis. (from Barnard and Karaman, 1991) Mandibular molar large, cushion shaped, triturative. Lower lip ordinary. Palp of maxilla 1 uniarticulate. Maxilla 2 ordinary. Outer plate of maxilliped weakly excavate or not, palp article 1 equal to or subequal to article 2, or latter longer. Gnathopods 1-2 small, poorly subchelate or almost simple, palm very oblique, dactyl lacking large inner nodiform process. Gnathopods more or less carpochelate. Urosome 3 poorly alate.

Remarks. Species in this genus superficially resemble those in *Amphilochus*, but are readily distinguished by the feeble gnathopods. At present the genus contains 8 species inhabiting the shelves and upper slopes of the Northern Atlantic and Pacific Oceans.

Gitana calitemplado J.L. Barnard, 1962

Figure 3.17

Gitana calitemplado J.L. Barnard, 1962a.

Material Examined. California: off Pt. Purisima, St. R-4, 92 m, silt, (7).

Description. (from Barnard, 1962a) Sixth articles of gnathopods 1 and 2 about 1.7 times length fifth articles; article 5 of gnathopod 1 with posterior lobe short, not opposing hind edge of article 6; article 5 of gnathopod 2 produced into a slender but short lobe, apposed to posterior edge of article 6 for about one fourth of its length, lobe blunt, not acute. Article 6 of pereopods 1 and 2 about 1.5 times as long as article 5.

Remarks. This is the only species of *Gitana* so far known from the eastern Pacific.

Distribution and Habitat. North eastern Pacific, Pt. Conception, California to San Cristóbal Bay, Baja California, rare, 9-84 m.

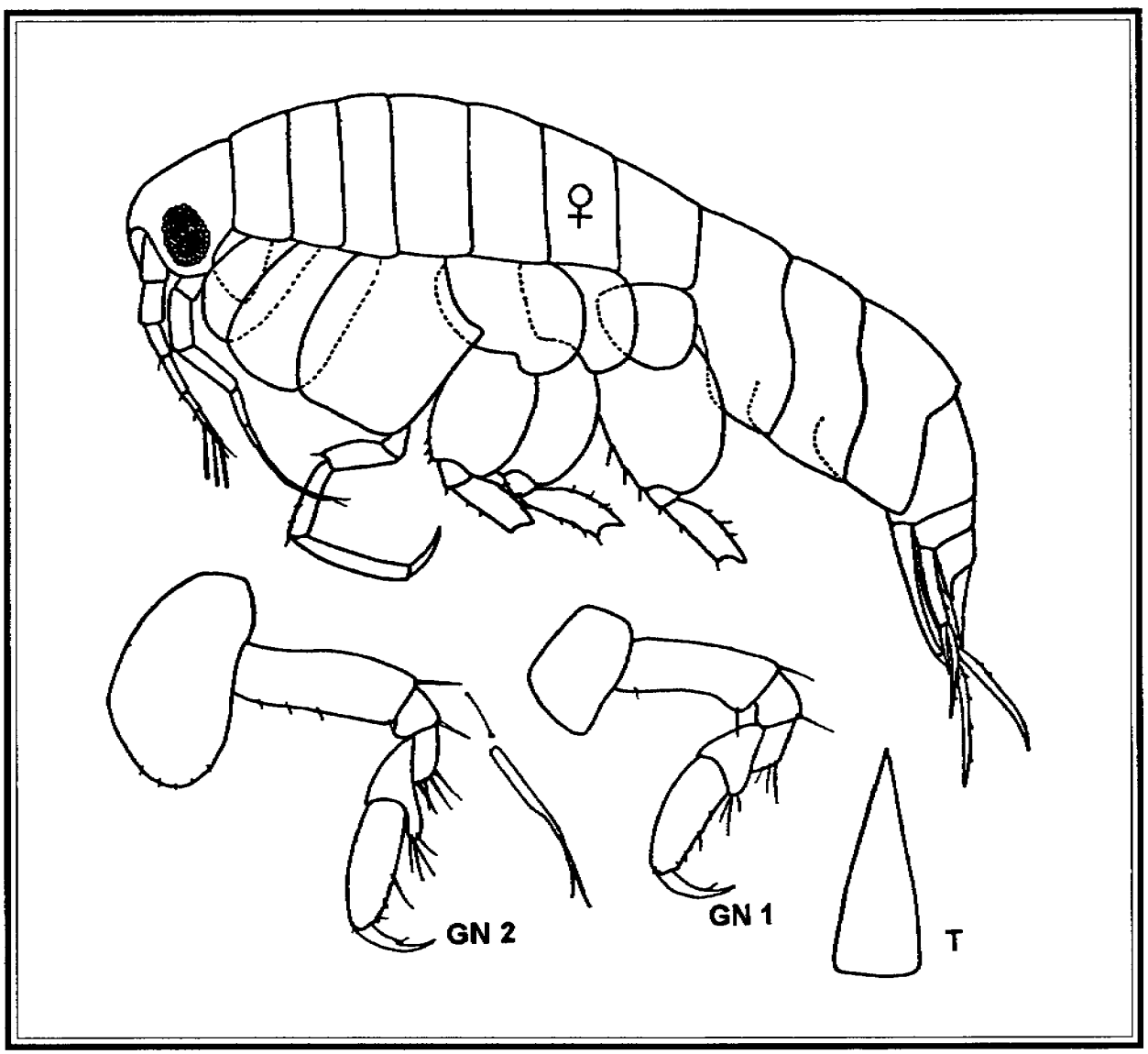

Figure 3.17. *Gitana calitemplado* (from Barnard, 1962a).

Family Liljeborgiidae Stebbing, 1899

Diagnosis. (from Barnard and Karaman, 1991) Accessory flagellum 2+-articulate. Molar of mandible feeble, not triturative. Plates of maxilliped only moderately developed. Gnathopods powerful, carpus of at least 1 pair well produced. Telson cleft, each apex with spine(s) in notch.

Remarks. The combination of feeble molar and long accessory flagellum distinguishes this family from all others in the Santa Maria Basin region. There is also a characteristic aspect to the general body shape of liljeborgiids which, to a certain extent, is accentuated by the curvature of the antennae.

Key to the Species of Liljeborgiidae from the Santa Maria Basin

1A. Article 5 of gnathopods 1-2 strongly produced, slender and elongate; outer ramus of uropod 3 simple 2

1B. Article 5 of gnathopods 1-2 weakly produced, thick and blunt, outer ramus of uropod 3 composed of 2 articles 3

2A. Blind; telson cleft one-third length ..... *Liljeborgia cota*

2B. Eye large, dark; telson cleft four-fifths length ..... *Liljeborgia pallida*

3A. Body colorless; eyes absent ..... *Listriella albina*

3B. Body with varying amount of pigment; eyes present 4

4A. Uropod 3 outer ramus much less than half length of inner ..... *Listriella eriopisa*

4B. Uropod 3 outer ramus more than half length of inner 5

5A. Antenna 2 article 4 longer than article 5; antenna 1 with pigment spot on article 2 ..... *Listriella melanica*

5B. Antenna 2 article 4 as long as article 5; antenna 1 with or without weak pigment spot on article 2 6

6A. Antenna 1 peduncle article 1 more than 3 times as long as wide ..... *Listriella goleta*

6B. Antenna 1 peduncle article 1 less than twice as long as wide ..... *Listriella diffusa*

Genus *Liljeborgia* Bate, 1862

Type Species. *Gammarus brevicornis* Bruzelius, 1859.

Diagnosis. (from Barnard and Karaman, 1991) Accessory flagellum 4+-articulate. Epistome poorly produced. Article 1 of mandibular palp elongate, molar simple. Coxae 1-4 ordinary. Gnathopod 2 not smaller than gnathopod 1, propodus and carpus of gnathopods not setose anteriorly; carpus of gnathopods 1-2 strongly produced. Outer ramus of uropod 3 1-articulate. Each lobe of telson with 1 apical spine.

Liljeborgia cota J.L. Barnard, 1962

Figure 3.18

Material Examined. California: off Pt. Buchon, St. 15, 393 m, silt (2); off Pt. San Luis, St. 25, 390 m, silt (3); off Pt. San Luis, St. R-3, 409 m, silt, (5).

Description. (modified from Barnard, 1962b) Eyes absent. Lateral head lobe strongly produced, rounded; epistome produced and rounded in front. Accessory flagellum on antenna 1 with at most 5 articles. Coxa 4 with 2 notches on posterior edge and one at lower corner. Gnathopods 1 and 2, palms without dentitions, dactyls with 1-7 notches located proximally. Pereopods 3 and 4 articles 5 and 6 with short stiff setae; pereopods 5-7 article 2 laterally straight, without noticeable serrations. Posterior edge of third pleonite with a mid-dorsal tooth; each of the first 5 pleonal segments generally with a small tooth, strongest on 2, 4 and 5, but pattern on pleonites 4 and 5 variable, from nearly obsolete to very strongly developed. Telson split about a third of its length. Inner edge of peduncle on uropod 1 with 2-3 large spines.

Remarks. This species exhibits highly variable pleonal tooth patterns (Barnard, 1962b) demonstrating the difficulty in basing specific identifications on such armature.

Distribution and Habitat. Gulf of Alaska to Southern California, on green clay, 366-2000 m.

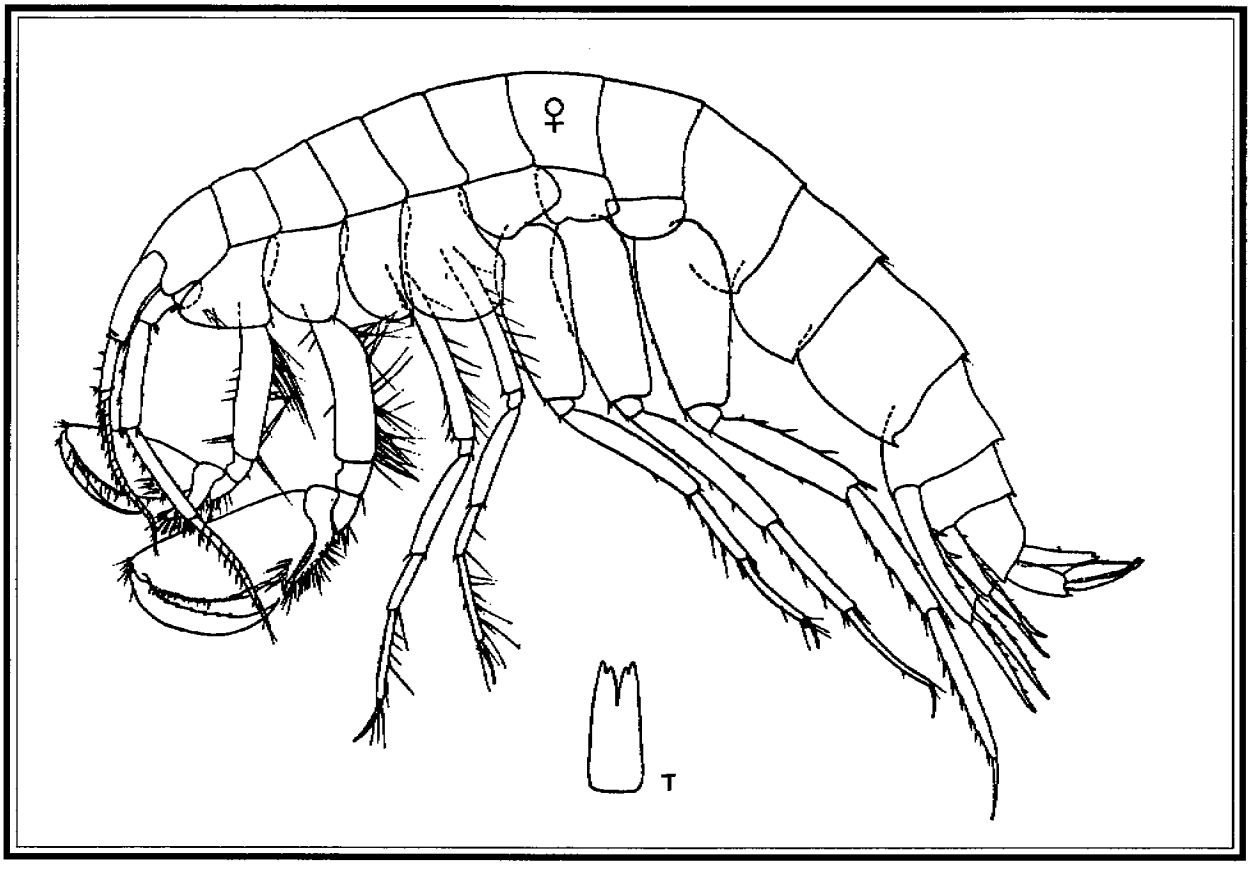

Figure 3.18. *Liljeborgia cota* (from Barnard, 1962b).

Liljeborgia pallida (Bate, 1857)

Figure 3.19

Gammarus pallidus Bate, 1857
Lilljeborgia pallida Sars, 1895
Liljeborgia brevicornis Holmes 1908.—J.L. Barnard 1962b

Material Examined. California: off Pt. Buchon, St. 6, 109 m, (2); off Pt. San Luis, St. 27, 611 m, sandy silt, (2).

Description. (modified from Sars, 1895) Eyes, large, oval quadrangular, with very black pigment. Lateral headlobe projected and obliquely rounded; epistome not produced. Accessory flagellum with approximately 10 articles. Fourth coxa with the posterior expansion transversely truncated. Gnathopods 1 and 2 dactyl with 6-12 serrations extending all the way to the tip. Pereopods 3 and 4 articles 5 and 6 with long

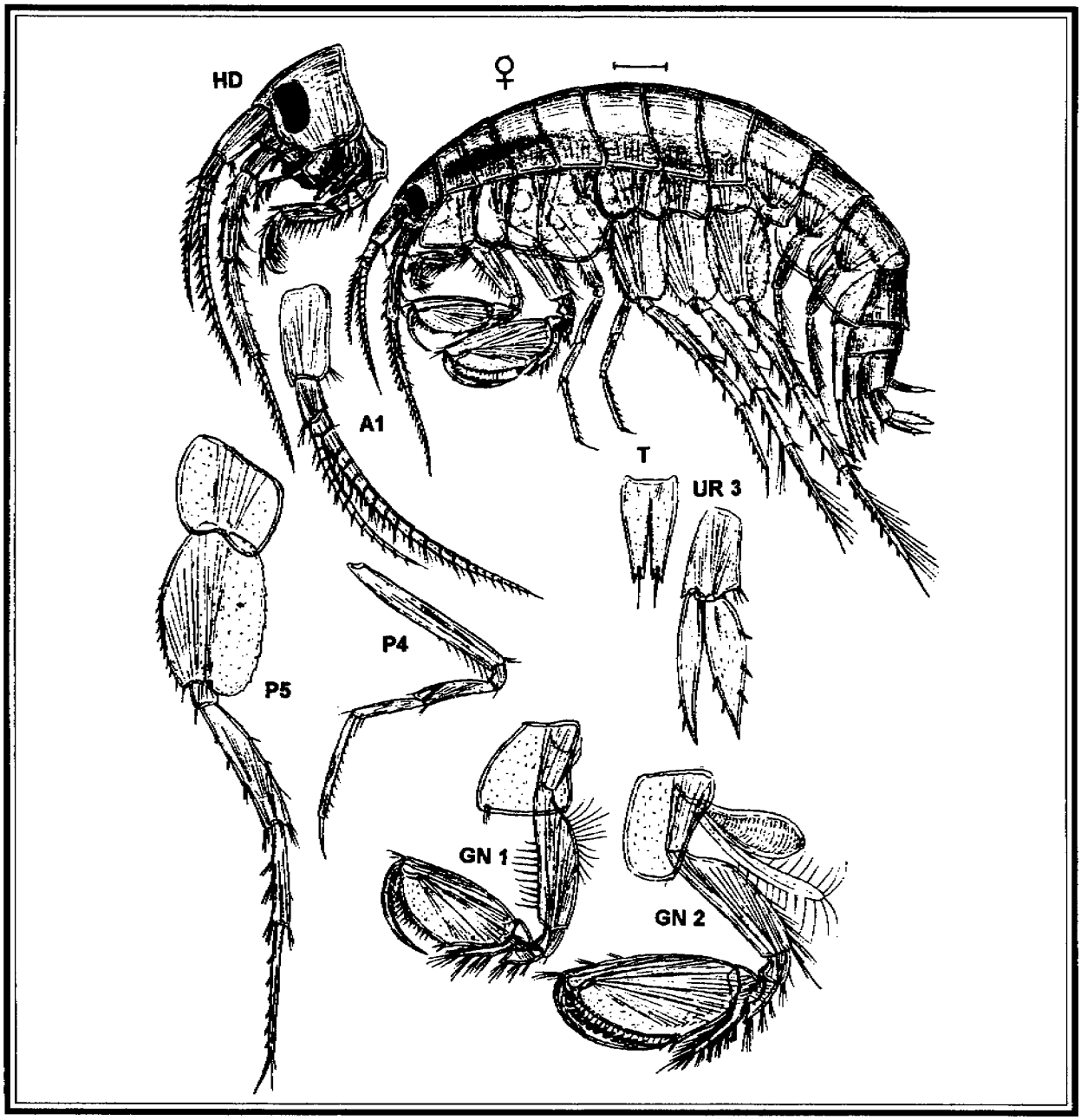

Figure 3.19. *Liljeborgia pallida* (from Sars, 1895).

setae; pereopods 5-7 article 2 laterally convex with distinct serrations on posterior margin. Pleonites 1-5 usually with dorsal tooth. Telson split nearly to base. Uropod 3, inner margin of endopod with 3-4 spines.

Remarks. This is the only large-eyed member of this genus found in the region.

Distribution and Habitat. Norway, British Isles to coast of France, Algeria, Tunisia, and Mediterranean, rare in eastern Pacific, 40-549 m. The present records extend the depth range to 611 m.

Genus *Listriella* J.L. Barnard, 1959

Type Species. *Listriella goleta* J.L. Barnard, 1959

Diagnosis. (from Barnard and Karaman, 1991) Accessory flagellum usually 2- (rarely 4) articulate. Epistome poorly produced. Article 1 of mandibular palp elongate, molar simple. Coxae 1-4 ordinary. Gnathopods variable, either dominant; propodus and carpus not setose anteriorly; carpus of gnathopods 1-2 moderately to poorly produced. Outer ramus of uropod 3 1- or 2-articulate. Each lobe of telson with 2 apical spines.

Remarks. In shallow water all of these species are distinguishable by their pigment patterns (Barnard, 1959). In deeper water one must rely on other, sometimes variable characters to make identifications.

Listriella albina J.L. Barnard, 1959

Figure 3.20

Material Examined. California: off Pt. San Luis, St. 25, 390 m, silt, (2); off Pt. Arguello, St. 54, 396 m, silty sand, (1); off Pt. San Luis, St. R-3, 409 m, silt, (3); off Pt. Sal, St. R-9, 410 m, silt, (1).

Description and Habitat. (modified from Barnard, 1959) Female 3-4 mm, male 3.5- 5.4 mm. Body colorless, without pigment. Eyes absent. Gnathopods 1-2 with oblique palms. Antennae 1 and 2 short, extending about one-third length of body (sometimes slightly longer). Article 6 of gnathopod 1 with strongly diverging margins, anterior one straight. Pereopod 5 with article 6 slightly paddle-shaped, article 7 long. Third pleonite with convex posterior edge and notch at lower corner. Uropod 3 in both sexes with outer ramus slightly shorter than inner ramus.

Remarks. Lack of pigment and lack of eyes distinguishes this species from similar California species.

Distribution and Habitat. Oregon to Baja California, in silt, 16-721 m.

Listriella diffusa J.L. Barnard, 1959

Figure 3.21

Material Examined. California: off Pt. Sal, St. R-8, 90 m, silty sand, (1).

Description. (modified from Barnard, 1959) Darkly pigmented in diffuse pattern; specimens bleached in alcohol with article 2 of antenna 1 lacking pigment; article 3 of antenna 1 usually retaining a very small amount pigment. Eyes well developed, enclosed in a distinct capsule. Antennae 1 and 2 short, extending <one-third length of body. Gnathopods 1-2 with palms of article 6 slightly more blunt and transverse than in other southern California species (except *L. melanica*). Anterior edge of article 6 gnathopod 1, slightly more convex than in other local species. Gnathopods darkly pigmented. Pereopod 5 with article 6 tending slightly to a paddle shape, article 7 slender. Third pleonite with convex posterior edge sweeping ventrally to a notch at lower corner. Uropod 3 in females bearing short, equal sized rami.

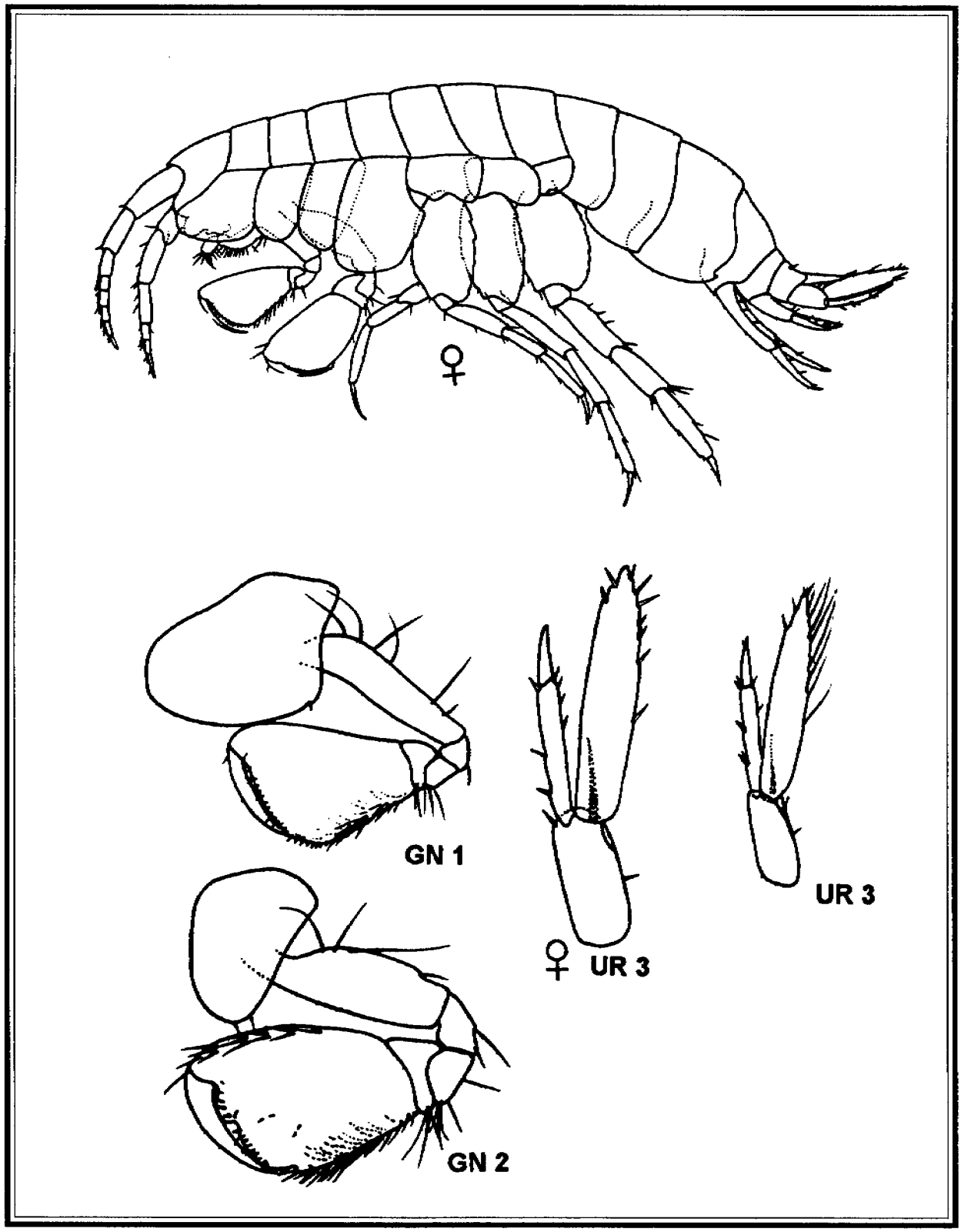

Figure 3.20. *Listriella albina* (from Barnard, 1959).

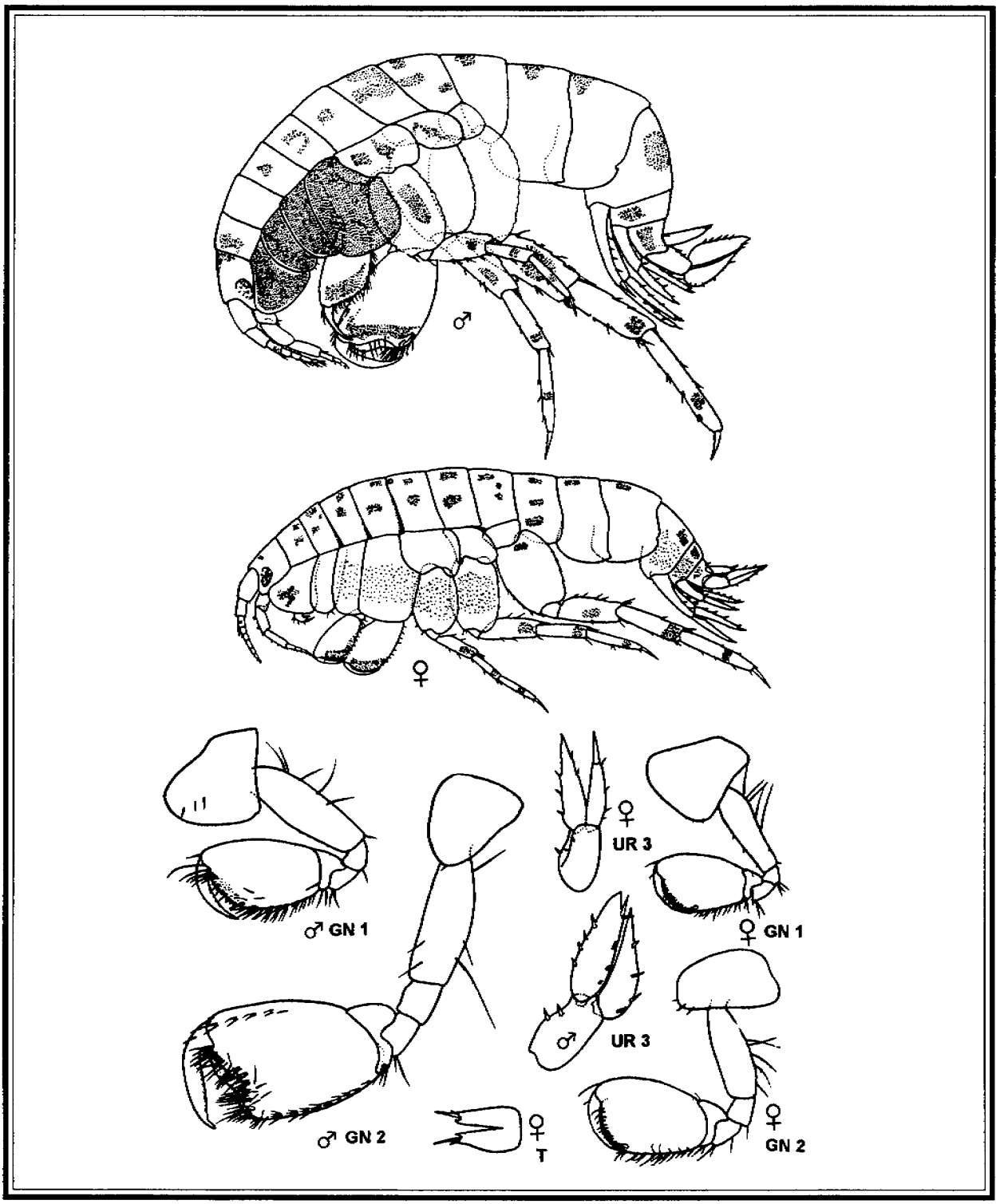

Figure 3.21. *Listriella diffusa* (from Barnard, 1959).

Remarks. This species is quite close to *L. melanica*, but differs from the latter by its short peduncle article 4 on antenna 2.

Distribution and Habitat. Monterey Bay to San Cristóbal Bay, Baja California, sandy sediments, 12-172 m.

Listriella eriopisa J.L. Barnard, 1959

Figure 3.22

Material Examined. California: S of Pt. San Luis, St. 21, 49 m, sandy silt, (2); off Pt. Sal, St. R-8, 90 m, silty sand, (1).

Description. (modified from Barnard, 1959a) Body with series of bold stripes; dorsal part of head bearing a cap of pigment. Eyes poorly developed, composed of ommatidea widely scattered, not in a distinct capsule. Antennae 1 and 2 short extending only one-third length of body. Gnathopods 1-2 with palms very oblique; gnathopod 2 much larger than 1; gnathopod 1 with anterior edge of article 1 nearly straight; gnathopods not darkly pigmented. Pereopod 5 moderately to strongly paddle-shaped, with article 7 quite short. Third pleonite with posterior edges nearly straight, notch at lower corner nearly obsolete in adults, better developed in juveniles. Uropod 3 in both sexes with inner ramus elongated, outer ramus about one third as long as inner ramus, with second article nearly obsolete.

Remarks. The unusually large size of uropod endopod 3 clearly identifies this species.

Distribution and Habitat. Southern California, in silt beds, 11-560 m.

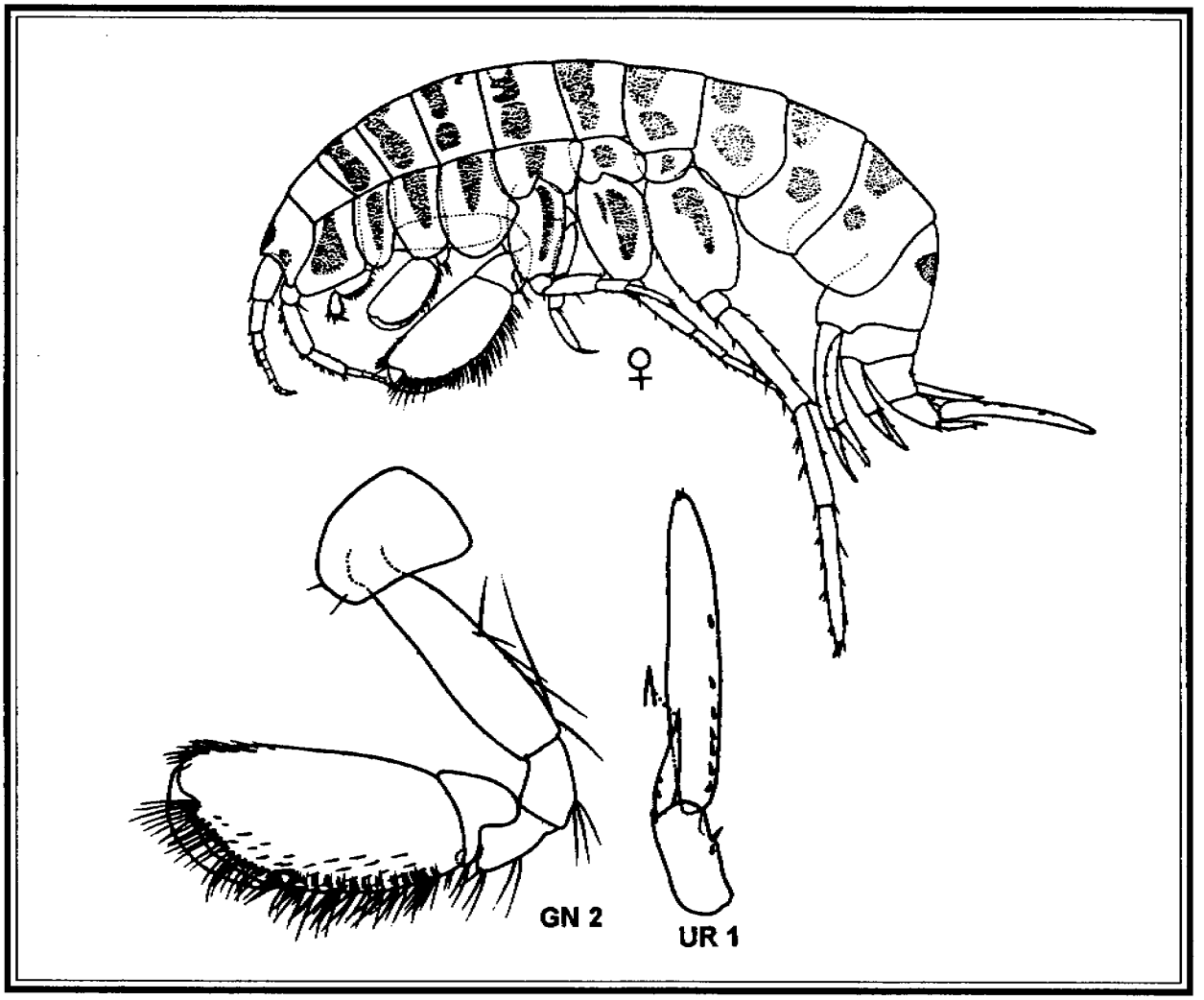

Figure 3.22. *Listriella eriopisa* (from Barnard, 1959).

Listriella goleta J.L. Barnard, 1959

Figure 3.23

Material Examined. California: off Pt. San Luis, St. R-1, 90 m, silt, (1); St. R-2, 161 m, silt, (1).

Description. (from Barnard, 1959a) Diffusely pigmented with characteristic bands; head with small hourglass-shaped pigment mark. Eyes well developed, enclosed in a distinct capsule. Antennae 1 and 2 extending to abdomen, about two-thirds of length of body. Gnathopods not darkly pigmented, with oblique palms; anterior edge of article 6 of gnathopod 1 nearly straight. Pereopod 5 with slender sixth and seventh articles. Third pleonite with convex posterior edge and notch at lower corner. Uropod 3 in both sexes with equal sized rami, outer ramus tending to be slightly shortened in large adults.

Remarks. This is the most widespread species in the genus. It is readily distinguished by the elongate antennae.

Distribution and Habitat. Oregon to San Cristòbal Bay, Baja California, in silt, 12-459 m.

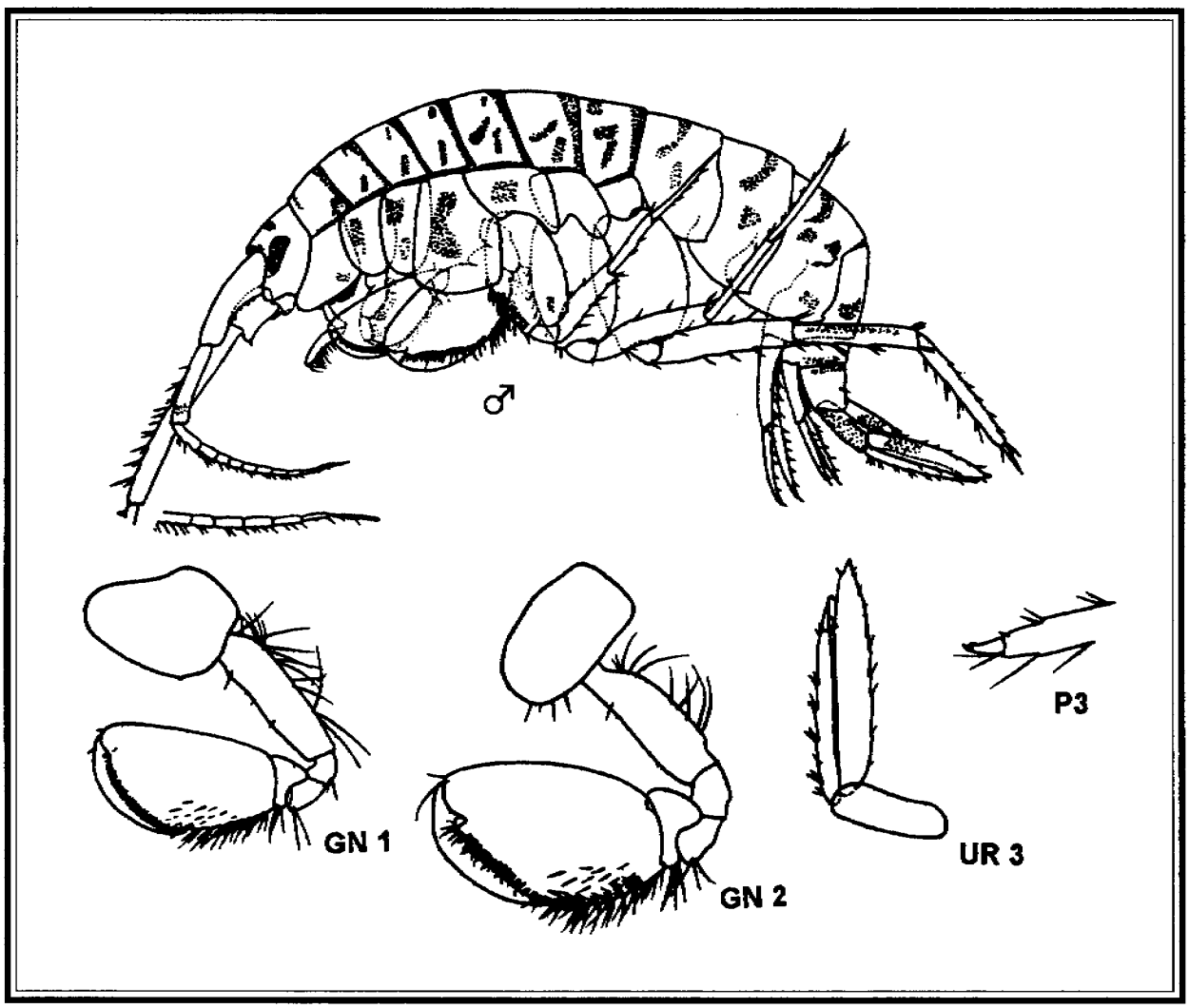

Figure 3.23. *Listriella goleta* (from Barnard, 1959).

Listriella melanica J.L. Barnard, 1959

Figure 3.24

Material Examined. California: off Pt. Sal, St. PJ-1, 145 m, silt, (1).

Description. (from Barnard, 1959a) Darkly pigmented in characteristic pattern; head without pigment marks. Eyes well developed. Antennae 1 and 2 short, extending only to pereonite 4. Gnathopods darkly pigmented, with nearly transverse palms; anterior edge of article 6 of gnathopod 1 nearly straight. Pereopod 5 with slender sixth and seventh articles. Third epimer with convex posterior edge and notch at lower corner. Uropod 3 in both sexes with equal sized rami, outer ramus tending to be slightly shortened in large adults.

Remarks. This species can be confused with *L. diffusa*, but can be separated on the basis of the pigment pattern (if the specimens are relatively fresh) and the shape of pereopod 5 article 6.

Distribution and Habitat. Southern California to Mexico.

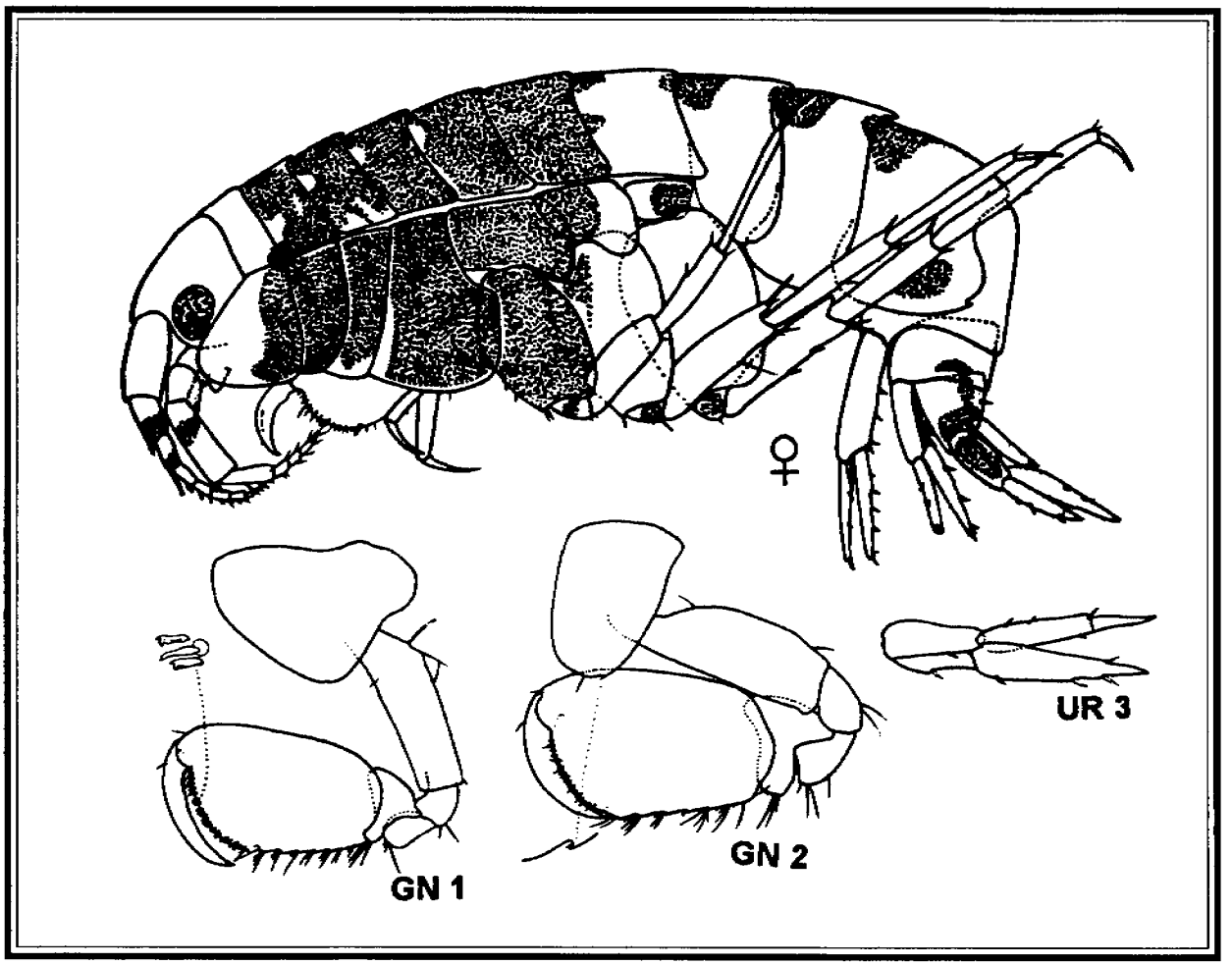

Figure 3.24. *Listriella melanica* (from Barnard, 1959).

Family Pleustidae Buchholz, 1874

Diagnosis. (from Barnard and Karaman, 1991) Accessory flagellum 1-articulate or absent. Lower lip of special form, inner lobes wide (fused or not), outer lobes especially tilted inward, mandibular lobes short. Outer rami of uropods 1-2 usually shortened. Telson entire or weakly cleft.

Remarks. Pleustids may closely resemble iphimediids and eusirids. The diversity of pleustids in southern California is quite high, but because of their often inquilinous nature, and their association with other marine invertebrates, they are not well represented in the Santa Maria Basin survey.

Key to the Species of Pleustidae from the Santa Maria Basin

1A. Rostrum very large, as long as rest of head; body with dosolateral carinae..... *Pleustes depressa*

1B. Rostrum not significant in size; body without carinae 2

2A. Mandible molar obsolescent; third epimeral plate without tooth ..... *Parapleustes pugettensis*

2B. Mandible molar large; third epimeral plate with large tooth 3

3A. Antenna 1 article 1 with distal tooth; coxae 1-3 with 1-3 posteroventral serrations .... *Pleusymptes coquilla*

3B. Antenna 1 article 1 without distal tooth; coxae 1-3 smooth posteroventrally .... *Pleusymptes subglaber*

Genus *Parapleustes* Buchholz, 1874

Type Species. *Parapleustes gracilis* Buchholz, 1874

Diagnosis. (from Barnard and Karaman, 1991) Body smooth or keeled. Rostrum short. Peduncular article 2 of antenna 1 shorter than article 1. Accessory flagellum obsolescent. Mandibular molar feeble, conical, nontriturative. Plates of maxilliped short, palp 4-articulate, powerful, article 3 without distal tubercle, dactyl well developed. Gnathopods 1-2 moderately stout to slender, subchelate, equal, or gnathopod 2 stout, article 5 shorter than article 6, lobes present (except in *P. oculatus* and *P. longimanus*), much shorter than article 6, propodus moderately expanded. Rami of uropods 1-3 lanceolate, outer shortened, peduncle of uropod 3 without long tooth. Telson entire.

Remarks. In the Santa Maria Basin region, this is the only genus of Pleustidae with obsolescent mandibular molar. A comprehensive treatment of the Californian species is provided in J.L. Barnard (1969).

***Parapleustes pugettensis* (Dana, 1853)**

Figure 3.25

Iphimedia pugettensis Dana, 1853
Parapleustes pugettensis J.L. Barnard, 1952.—J.L. Barnard and Given, 1960
Parapleustes bairdi J.L. Barnard, 1956
Incisocalliope newportensis J.L. Barnard, 1959

Material Examined. California: off Pt. Buchon, St. 6, 109 m, (1); St. 20, 396 m, silt, (1); off Pt. Sal, St. PJ-1, 145 m, silt, (1).

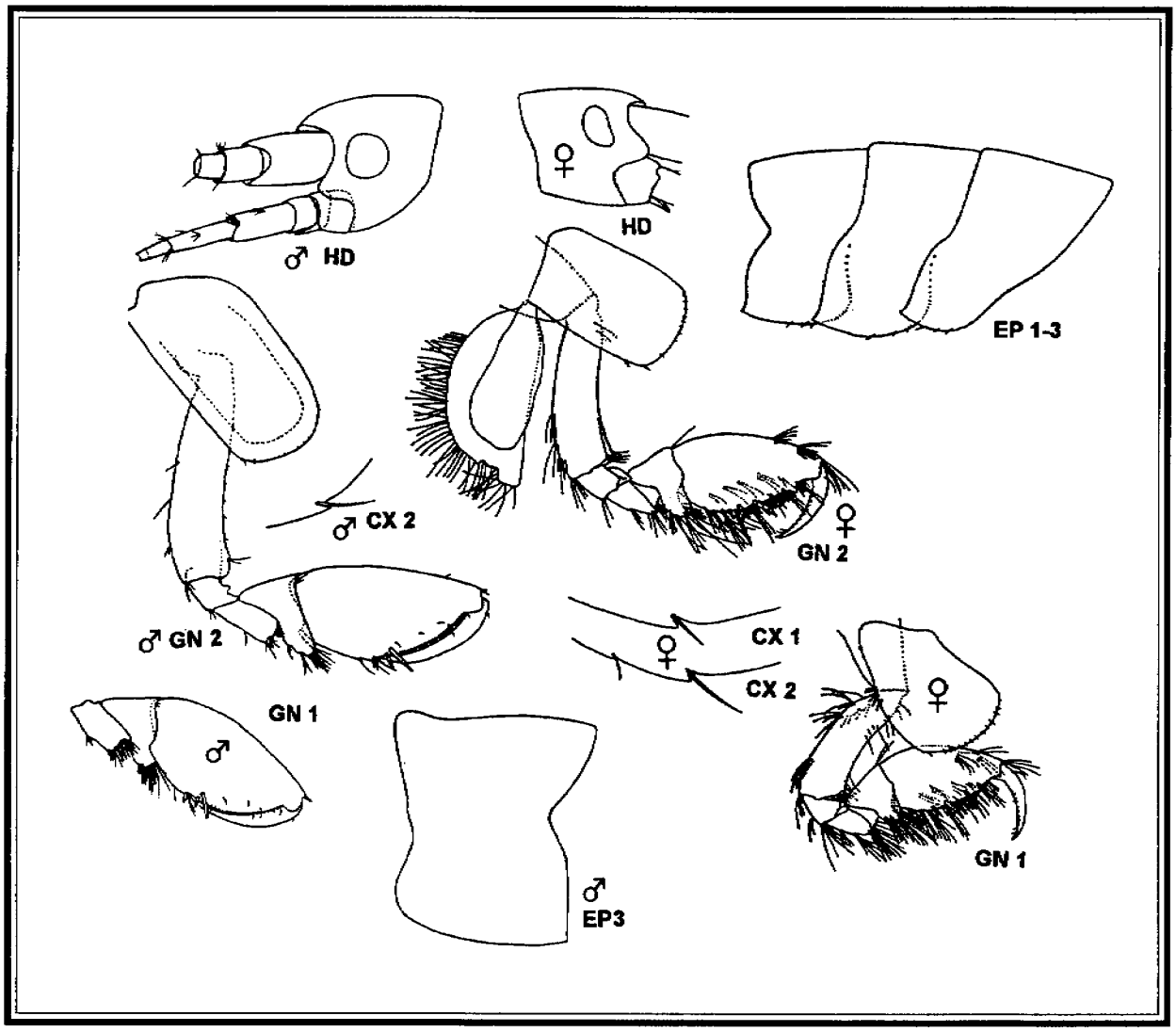

Figure 3.25. *Parapleustes pugettensis* (from Barnard, 1952; Shoemaker, 1964).

Description. (modified from Barnard, 1952) Both sexes 4-9 mm. Large asymmetrical eyes. Body without keel. Rostrum short. Antennae long. Gnathopods 1 and 2 normal size with small tooth on distal edge of palm. Coxae 1-3 with a small tooth on posterolateral corner. Pleonites without mid-dorsal carina.

Remarks. According to Shoemaker (1964) there is a great deal of variability in this species, small specimens being much less setose and spinose than larger animals.

Distribution and Habitat. Alaska to southern California, abundant on bottoms dominated by the polychaete *Diopatra sp.*, 0-183 m.

Genus *Pleustes* Bate, 1858

Type Species. *Pleustes tuberculata* Bate, 1858 (=*Amphithoe panopla* Krøyer, 1838)

Diagnosis. (from Barnard and Karaman, 1991) Body keeled. Rostrum long. Peduncular article 2 of antenna 1 shorter than article 1. Accessory flagellum obsolescent. Mandibular molar feeble, conical, nontriturative. Plates of maxilliped short, palp 4-articulate, powerful, article 3 without distal tubercle, dactyl

well developed. Gnathopods 1-2 stout, subchelate, equal, article 5 stout, much shorter than article 6, lobes well developed but much shorter than article 6, propodus expanded. Rami of uropods 1-3 lanceolate, outer shortened, peduncle of uropod 3 without long tooth. Telson entire.

Remarks. This is the only tuberculate or carinate pleustid genus in the Santa Maria Basin region.

Pleustes depressa Alderman, 1936

Figure 3.26

Material examined. California: reported from MMS Phase I but not seen by me.

Description. (modified from Alderman, 1936) Eyes black and round; rostrum long, extending beyond end of peduncle of first antennae, rounded above, keeled below (duck billed). Mid-dorsal and two dorsolateral rounded carinae beginning on pereonite 6 or 7 and extending to second pleonite, lateral carina extending to last pleonite. Coxae 1-3 long and rectangular; coxa 4 with an acute angle on posterior margin; telson flattened.

Remarks. This species is very similar to *Pleustes platypa*. The presence of animals with intermediate features between the two species suggests they may interbreed (Barnard, 1969). However, it is also seen that *p. depressa* occurs primarily north of Point conception and *P. platypa* primarily to the south of this major biogeographic barrier.

Distribution and Habitat. Washington to southern California, on algae and under rocks, 0-4 m.

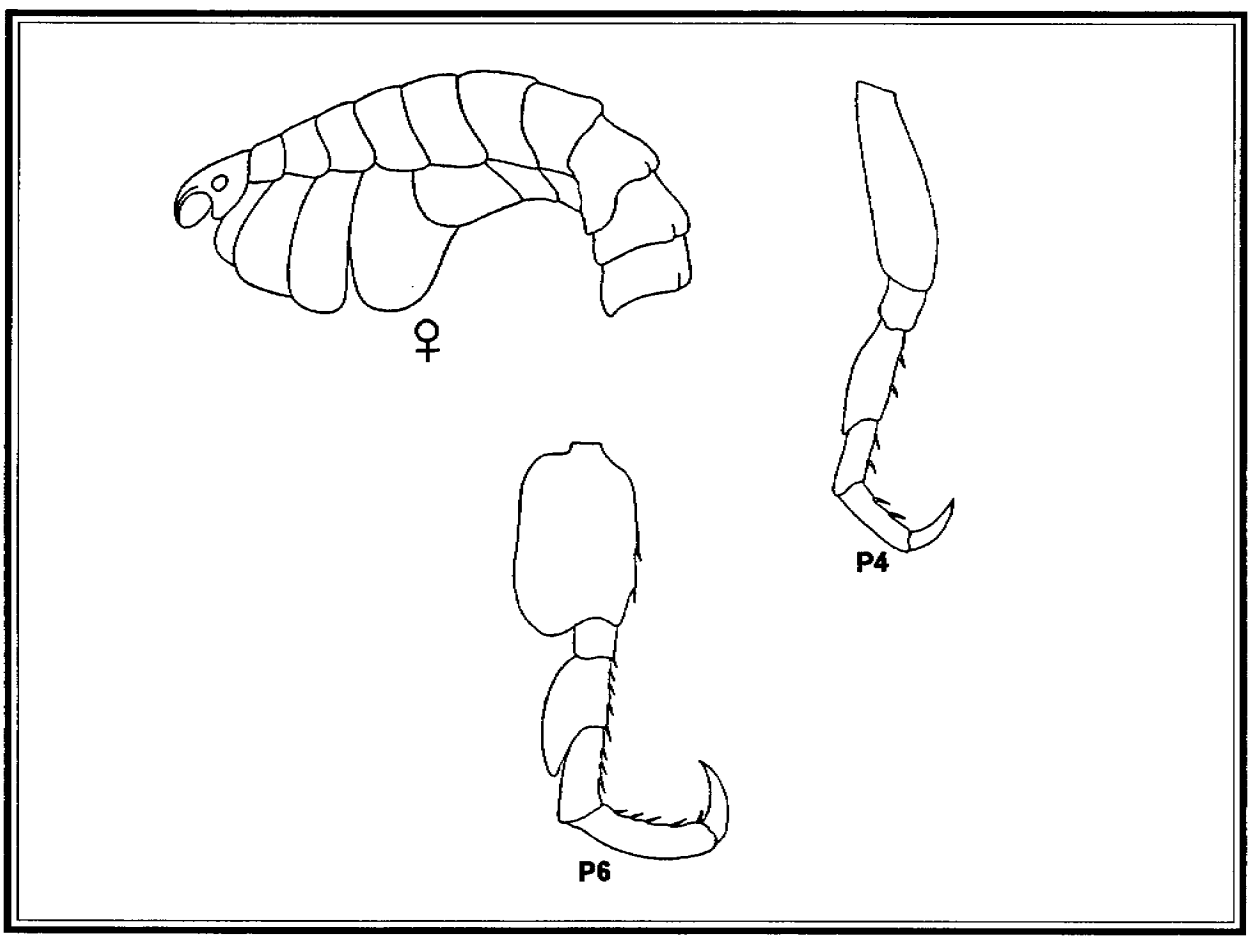

Figure 3.26. *Pleustes depressa* (from Alderman, 1936).

Genus *Pleusymptes* J.L. Barnard, 1969

Type Species. *Amphithopsis glaber* Boeck, 1861

Diagnosis. (from Barnard and Karaman, 1991) Body smooth or keeled. Rostrum short. Peduncular article 2 antenna 1 shorter than article 1. Accessory flagellum obsolescent. Mandibular molar large, triturative. Plates of maxilliped short, palp 4-articulate, powerful, article 3 without distal tubercle, dactyl well developed. Gnathopods 1-2 moderately stout, or slender, subchelate, often unequal; gnathopod 1 slender, article 5 slightly longer or shorter than article 6, lobe weak or absent, propodus weakly expanded. Gnathopod 2 often stout, article 5 shorter or longer than article 6, lobe moderately large, propodus often expanded. Rami of uropods 1-3 lanceolate, outer shortened, peduncle of uropod 3 without long tooth. Telson entire.

Remarks. This is a large circum-Arctic to boreal genus with species found to about 36°N in the eastern and western Atlantic and Pacific Oceans.

Pleusymptes coquilla J.L. Barnard, 1971

Figure 3.27

Material Examined. California: off Pt. Arguello, St. 66, 201 m, sandy silt, (1).

Description. (modified from Barnard, 1971b) Article 1 of antenna 1 with distal coniform process. Body lacking dorsal teeth or carinae. Gnathopods 1-2 relatively small, sixth article subovate, palms convex, each with tiny medial cusp. Pleonites 2-3 with weakly sinuous posterior margins but each posteroventral corner with large tooth. Coxae 1-3 each with 1-3 posteroventral serrations. Dactyls of pereopods 1-5 elongate.

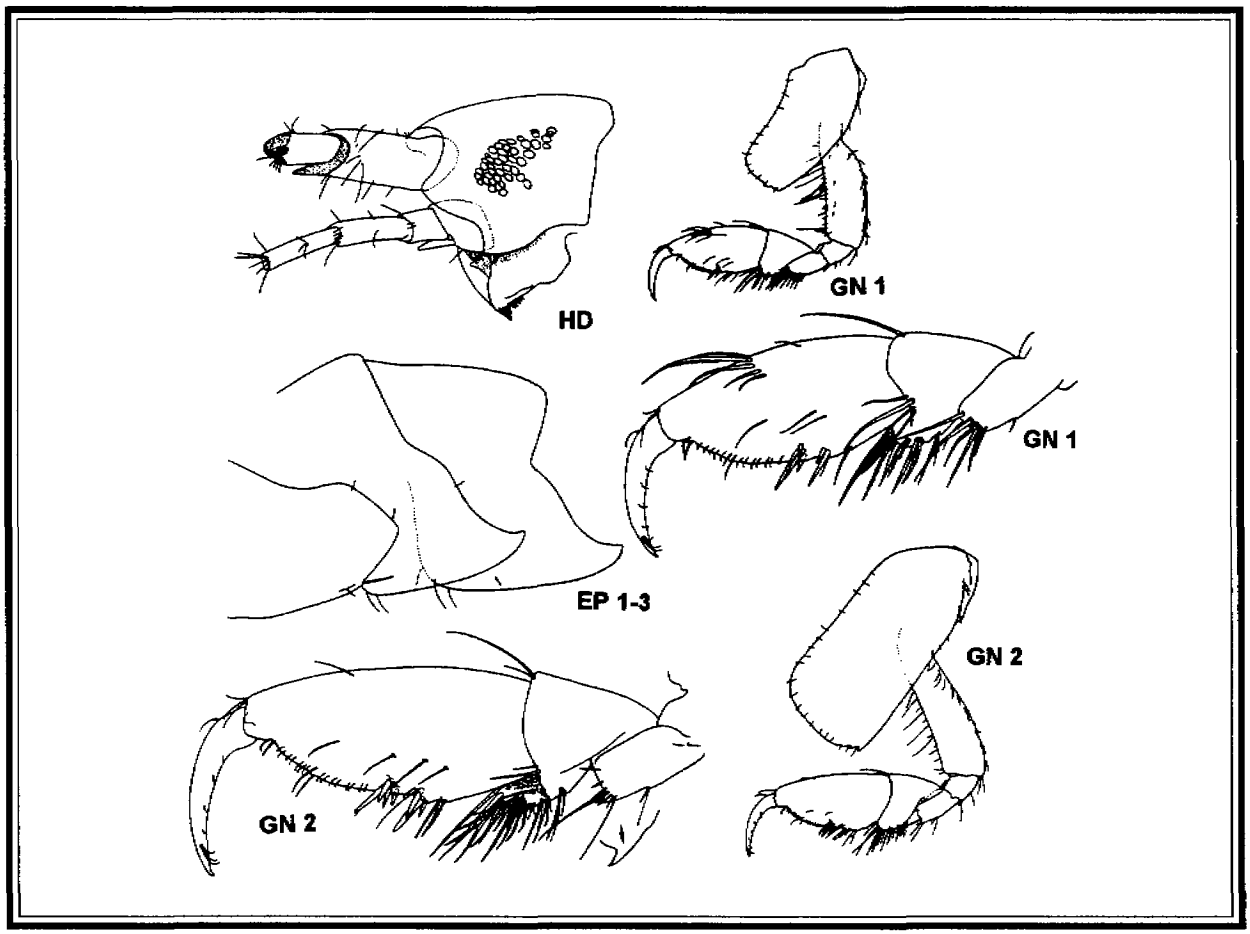

Figure 3.27. *Pleusymptes coquilla* (from Barnard, 1971).

Remarks. This species can be distinguished from *P. subglaber* by the weaker sinuation and larger tooth on pleonites 2 and 3, the serrations on the coxae and the presence of an antennal tooth on article 1 (Barnard, 1971b).

Distribution and Habitat. Eureka, California north to Cape Flattery Washington, 150-200 m.

Pleusymptes subglaber (Barnard and Given, 1960)

Figure 3.28

Material Examined. California: off Pt. Purisima, St. R-4, 92 m, silt, (1).

Description. (modified form Barnard and Given, 1960) Female 4 mm. Article 1 of antennae 1 lacking a distal process. Body lacking dorsal teeth or carinae. Gnathopods 1 and 2 relatively small, the sixth articles oval, palms convex, each with small medial process. Third pleonite with very sinuous posterior margin and large posteroventral tooth. Coxae 1-3 without posteroventral serrations. Dactyls of pereopods 3-7 normal.

Remarks. See under species above.

Distribution and Habitat. Pt Conception, southern California, south to Ensenada, Baja California, rare, often found in association with the brittle star *Amphiodia urtica*, in fine green sand, 18-116 m.

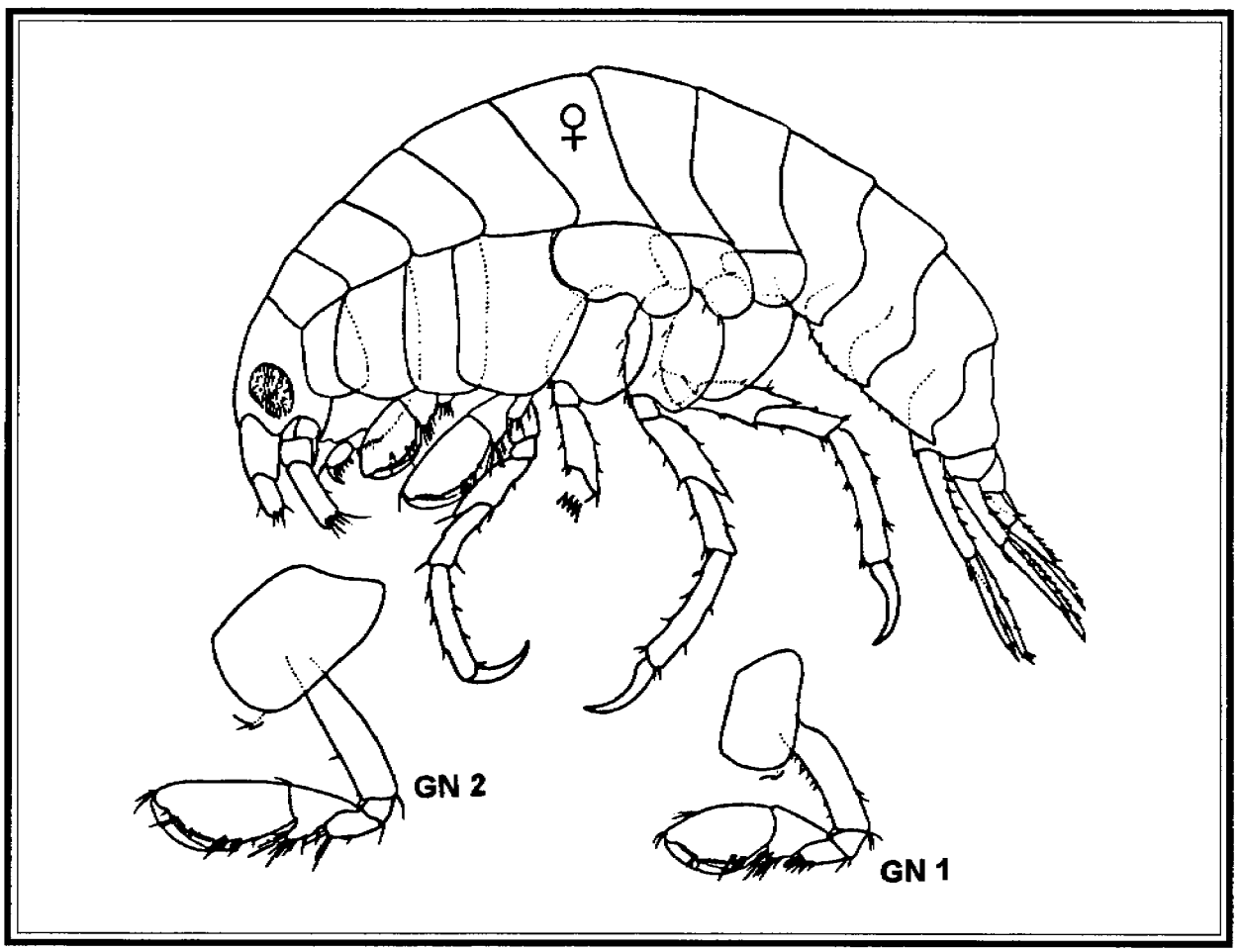

Figure 3.28. *Pleusymptes subglaber* (from Barnard and Given, 1960).

Acknowledgements

I would like to thank Linda McCann and Marsha Hostetter for their efforts in putting together the materials for this study. This paper is dedicated to the memory of my good friend and mentor, J.L. Barnard, without whose prior work this paper could not have been written.

Literature Cited

Alderman, A.L. 1936. Some new and little known amphipods of California. University of California Publications in Zoology 41: 53-74.

Barnard, J.L. 1952. Some Amphipoda from Central California. The Wasmann Journal of Biology. 10: 9-36.

Barnard, J.L. 1954. Amphipoda of the Family Ampeliscidae collected in the eastern Pacific Ocean by the *Velereo III* and *Velero IV*. Allan Hancock Pacific Expeditions 18(1): 1-137.

Barnard, J.L. 1956. Two rare amphipods from Southern California with notes on the genus *Atylus*. Bulletin of the Southern California Academy of Sciences 55: 35-43.

Barnard, J.L. 1959. Liljeborgiid amphipods of Southern California coastal bottoms, with a revision of the family. Pacific Naturalist 1 (4): 12-28.

Barnard, J.L. 1960. New bathyal and sublittoral ampeliscid amphipods from California, with an illustrated key to *Ampelisca*. Pacific Naturalist 1 (16): 1-36.

Barnard, J.L. 1962a. Benthic marine Amphipoda of Southern California: families Amphilochidae, Leucothoidae, Stenothoidae, Argissidae, Hyalidae. Pacific Naturalist 3: 116-163.

Barnard, J.L. 1962b. Benthic marine Amphipoda of Southern California: families Tironidae to Gammaridae. Pacific Naturalist 3: 73-115.

Barnard, J.L. 1966. Submarine canyons of Southern California. Part V. Systematics: Amphipoda. Allan Hancock Pacific Expeditions 27 (5): 1-166.

Barnard, J.L. 1967. New species and records of Pacific Ampeliscidae (Crustacea: Amphipoda). Proceedings of the United States National Museum 121 (3576): 1-20.

Barnard, J.L. 1969. Gammaridean Amphipoda of the rocky intertidal of California: Monterey Bay to La Jolla. United States National Museum Bulletin 258: 1-230.

Barnard, J.L. 1971. Gammaridean Amphipoda from a deep-sea transect off Oregon. Smithsonian Contributions to Zoology 61: 1-86.

Barnard, J.L. 1979. Littoral gammaridean Amphipoda from the Gulf of California and the Galapagos Islands. Smithsonian Contributions to Zoology 271: 1-149.

Barnard, J.L. and R.R. Given. 1960. Common pleustid amphipods of Southern California with a projected revision of the family. Pacific Naturalist 1 (17): 37-48.

Barnard, J.L. and G.S. Karaman. 1991. The families and genera of marine gammaridean Amphipoda (except marine gammaroids). Records of the Australian Museum, Supplement 13: 1-866.

Bate, C.S. 1857. A synopsis of the British edriophthalmous Crustacea. Annals and Magazine of Natural History, series 2, 19: 135-152.

Dana, J.D. 1853. Crustacea. Part II. United States Exploring Expedition 14: 689-1618.

Dickinson, J.J. 1982. The systematics and distributional ecology of the family Ampeliscidae (Amphipoda: Gammaridea) in the northeastern Pacific region. I. The genus *Ampelisca*. National Museums of Canada, Publications in Biological Oceanography 10: 1-39.

Dickinson, J.J. 1983. The systematics and distributional ecology of the Superfamily Ampeliscoidea (Amphipoda: Gammaridea) in the northeastern Pacific region. II. the genera *Byblis* and *Haploops*. National Museums of Canada, Publications in the Natural Sciences, 1: 38.

Gurjanova, E.F. 1951. Bokoplavy morej SSSR I sopredel'nykh vod (Amphipoda-Gammaridea). Akademia Nauk SSSR, Opredeliteli po Faune SSSR 41: 1-1029.

Holmes, S.J. 1908. The Amphipoda collected by the U.S. Bureau of Fisheries Steamer "Albatross" off the west coast of North America, in 1903 and 1904, with descriptions of a new family and several new genera and species. Proceedings of the United States National Museum 35 (1654): 489-543.

Sars, G.O. 1895. Amphipoda. An Account of the Crustacea of Norway With Short Descriptions and Figures of All the Species 1: 1-711.

Shoemaker, C.R. 1964. Seven new amphipods from the west coast of North America with notes on some unusual species. Proceedings of the United States National Museum 115: 391-430.

Stimpson, W. 1864. Descriptions of new species of marine Invertebrata from Puget Sound, collected by the naturalists of the North-West Boundary Commission, A.H. Campbell, esq., commissioner. Proceedings of the Academy of Natural Sciences, Philadelphia 16: 153-165.

Stout, V.R. 1913. Studies in laguna Amphipoda. Zoologische Jahrbucher. Systematik 34: 633-659.

4. Superfamily Corophioidea

by

Kathleen E. Conlan[1]

Introduction to the Superfamily Corophioidea

Diagnostic characteristics. Corophioidean amphipods are bound as a superfamily by the entire, fleshy telson, which J.L. Barnard and Karaman (1991) describe as being thickly attached at the base and relatively immobile. The telson can be bilobed, but is never separate. Often the telson is tipped at the apex of each lobe or swelling by a spine, cusp, or nipple. Most corophioideans live in tubes, which they construct with a lipoprotein thread secreted through the tips of the dactyls of peraeopods 3 and 4. The glands for production of this film are situated in the bases of these peraeopods, and they are often expanded for this purpose.

Systematics. The most recent taxonomic assessments of the Corophioidea have been made by J.L. Barnard and Karaman (1991) and J.L. Barnard (1973). They recognize 867 species within the families Corophiidae + Ischyroceridae (660 species), Siphonoectinae (29 species), Ampithoidae (96 species), Podoceridae (78 species), and Cheluridae (4 species). They have merged the Isaeidae, Aoridae, Photidae, and Neomegamphopidae within the Corophiidae. However, not all taxonomists accept this merging (Myers, 1988; E. L. Bousfield, pers. comm.), and the separate families are used here to indicated taxonomic distinctions. J.L. Barnard (1973) has assessed morphological relationships of the genera, and Conlan (1982, 1983, 1988) and Conlan and Bousfield (1982a,b) have applied phenetic analyses to the Ampithoidae and *Microjassa* Stebbing, and northeastern Pacific Aoridae, Ampithoidae, and Isaeidae while Myers (1983) has analyzed *Microdeutopus* Costa. More recently, cladistic analyses have been applied to the Aorinae by Myers (1988), *Microjassa* by Conlan (in press), and the northeastern Pacific species of *Peramphithoe* by Conlan and Chess (1992).

Distribution. Most corophioideans live in tropical or temperate oceans, intertidally to 100 m depth. However, they can be found in both arctic and antarctic waters as well, and have been recorded to 6324 m depth. Some species penetrate brackish and fresh waters, and a few have been found in marine caves.

Ecology. Most corophioideans live in soft, pliable tubes which have bits of detritus and algae incorporated into their matrix. They may attach to algae, hydroids, bryozoans, shells, stones, pilings, docks, etc., or build within or on top of sediment. Scrapings of subtidal rock faces or the undersides of floating docks will often yield large numbers of *Jassa* Leach, *Corophium* Latreille, *Ischyrocerus* Krøyer, and *Ampithoe* Leach (Witman, 1985; Franz, 1989). Some corophioideans live in chambers constructed by other biota or on the outside of their tube secretions. Species of *Peramphithoe* Conlan and Bousfield and *Amphitholina* Ruffo burrow into kelp stipes (Myers, 1974; Conlan and Chess, 1992; Chess, 1993). *Pseudoamphithoides incurvaria* (Just) stitches itself inside pieces of chemically defended algae with which it gains defense from fish predation (Hay et al. 1990). Similarly, *Photis conchicola* Alderman uses empty gastropod shells as portable domiciles, probably gaining defense from predation also (Carter, 1982). Species of the Cheluridae are wood scrapers, invading holes of the isopod *Limnoria* spp. and enlarging them into galleries (J.L. Barnard and Karaman, 1991). Species of *Isaea* Milne Edwards and *Pagurisaea* Moore are commensals of crabs and lobsters (Moore, 1983). *Isaeopsis tenax* K. H. Barnard has been found on shrimp eggs (K. H. Barnard,

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1916). *Pterunciola spinipes* Just occurs in the empty shells of a pteropod (Just, 1977). Some species of *Dulichia* Krøyer and *Dyopedos* Bate live on rods which they extend from the tips of sea urchin spines or other upright substrates (McCloskey, 1970; Mattson and Cedhagen, 1989).

Corophioideans that colonize man-made structures have some commercial importance as foulers. Foulers can also disperse by rafting, and therefore may be introduced as exotics. *Corophium curvispinum* G. O. Sars has recently become of concern in Europe because of its rapidly expanding range and high densities, which have precluded settlement by other species (den Hartog et al. 1992). Some species of *Peramphithoe* have been implicated in mortalities of kelp beds (Tegner and Dayton, 1987; Chess, 1993).

Corophioideans are not full-time tube dwellers. Juveniles are often found in the plankton, and adults, particularly males, will leave their tubes to rove in search of mates (e.g. Borowsky, 1983, 1985; Conlan, 1991). Because most Corophioidea live in relatively shallow waters, and because they can achieve extremely high densities (Boates and Smith, 1989; van den Brink and van der Velde, 1991), they can become major prey of whales, seabirds, and fish (Oliver and Slattery, 1985; Wilson, 1989; Holmlund et al., 1990). Community interactions have been well studied on *Corophium volutator* (Pallas) and *C. arenarium* Crawford (Ólafsson and Persson, 1986; Jensen and Kristensen, 1990). A number of species of amphipods have become standard test organisms for anthropogenic toxins. *Corophium volutator* has been used in Europe and the U.K. (Bryant, 1985), *Paracorophium excavatum* Thompson has been used in New Zealand (Hickey and Roper, 1992), and *Ampithoe valida* Smith has been used in North America (Lee, 1977). *Corophium volutator* has also been found to be a sensitive field indicator for anthropogenic disturbances (McLusky, 1987; Esselink et al., 1989; Raffaelli et al., 1991). A general review of amphipod ecology in relation to environmental disturbance can be found in Conlan (1994a).

Abbreviations Used in the Figures

A, antenna
ABD, abdomen
EP, epistome
GN, gnathopod
HD, head
INT SEX, intersex
JV, juvenile
LL, lower lip
LFT, left
MD, mandible
MX, maxilla
MXPD, maxilliped
P, peraeopod
PL, plate
RT, right
T, telson
UL, upper lip
U, uropod
UR, urosome

Key to Genera and Species of Corophioidea[2]

1A. Gnathopod 1, both sexes, larger than gnathopod 2. Adult male gnathopod 1, merus extending as long tooth below carpus (Fig. 4.1A) ..... Genus *Aoroides* 2

1B. Gnathopod 1, both sexes, smaller than gnathopod 2. Adult male gnathopod 1, merus small, not extending as tooth below carpus (Fig. 4.1B) 3

[2] Other species of Corophoidea that were not found in the Santa Maria Basin collections but which may occur in this area are listed in Attachment 1 along with sources for their identification.

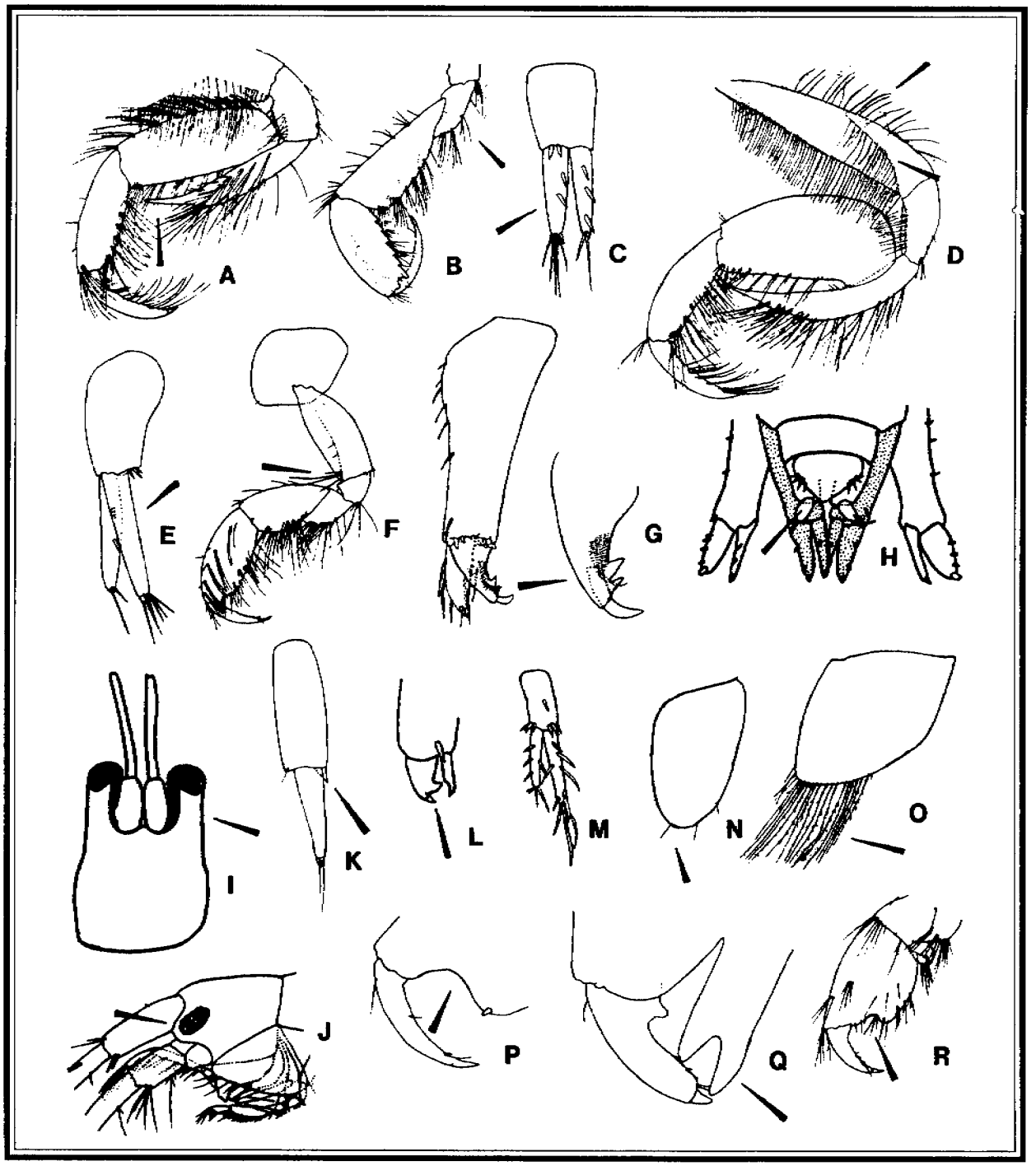

Figure 4.1. A, *Aoroides inermis* adult male gnathopod 1; B, *Protomedeia prudens* adult male gnathopod 1; C, *Aoroides exilis* adult male uropod 3; D, *Aoroides exilis* adult male gnathopod 1; E, *Aoroides inermis* adult male uropod 3; F, *Aoroides inermis* adult female gnathopod 1; G, *Jassa slatteryi* adult male uropod 3; H, *Ampelisciphotis podophthalma* adult female urosome and uropod 3; I, *Ampelisciphotis podophthalma* adult female head; J, *Protomedeia articulata* adult male head; K, *Photis lacia* adult male uropod 3; L, *Photis conchicola* J. L. Barnard, 1962 peraeopod 5 dactyl (left) and locking spine (right); M, *Protomedeia articulata* adult male uropod 3; N, *Photis bifurcata* adult male coxa 2; O, *Photis brevipes* adult male coxa 2; P, *Photis bifurcata* adult male gnathopod 1; Q, *Photis bifurcata* adult male gnathopod 2; R, *Photis bifurcata* adult female gnathopod 2.

2A. Uropod 3, both sexes, outer ramus with 1-3 spines (Fig. 4.1C). Adult female and juvenile gnathopod 1, basis without cluster of long setae anterodistally. Adult male gnathopod 1, basis with both lateral and posterior fringe of long setae (Fig. 4.1D) ..... *Aoroides exilis* (Fig. 4.3)

2B. Uropod 3, both sexes, outer ramus usually bare, rarely with 1-2 small spines (Fig. 4.1E). Adult female and juvenile gnathopod 1, basis with cluster of long setae anterodistally (Fig. 4.1F). Adult male gnathopod 1, basis laterally setose, but lacking setae on posterior margin ..... *Aoroides inermis* (Fig. 4.4)

3A. Uropod 3, both sexes, outer ramus bearing spines or setae, but not terminating in dorsal hooks (Figs. 1C,E) 4

3B. Uropod 3, both sexes, outer ramus without spines or setae, terminating in dorsal hooks or cusps (these may be microscopic) (Fig. 4.1G) 16

4A. Uropod 3, both sexes, with only one ramus (Fig. 4.1H). Eye lobes projecting beyond end of antenna 1 peduncle article 1 (Fig. 4.1I) ..... *Ampelisciphotis podophthalma* (Fig. 4.5)

4B. Uropod 3, both sexes, with two rami. Eye lobes not projecting beyond antenna 1 peduncle article 1 (Fig. 4.1J) 5

5A. Uropod 3, both sexes, inner ramus very small compared with outer; outer ramus terminating in one or more setae (Fig. 4.1K). Peraeopod 5, propodus with single long spine next to origin of dactyl, dactyl cusped (Fig. 4.1L) ..... Genus *Photis* 6

5B. Uropod 3, both sexes, rami about equal in length; outer ramus terminating in spines (Fig. 4.1M). Peraeopod 5, propodus with several spines along margin, dactyl not cusped 12

6A. Without eyes ..... *Photis typhlops* (Fig.6)

6B. Eyes black, clearly visible 7

7A. Gnathopod 2, coxa, both sexes, setae on lower margin numbering 5 or less, their length only about quarter width of coxa (Fig. 4.1N) 8

7B. Gnathopod 2, coxa, both sexes, setae on lower margin more than 5 in number, and nearly as long as width of coxa (Fig. 4.1O) 9

8A. Adult male gnathopod 1, palm concave (Fig. 4.1P). Adult male gnathopod 2, palm defined by long, bifid tooth (Fig. 4.1Q). Adult female and juvenile gnathopod 2, palm concave (Fig. 4.1R) ..... *Photis bifurcata* (Fig. 4.7)

8B. Adult male gnathopod 1, palm convex (Fig. 4.2A). Adult male gnathopod 2, palm defined by short, single tooth (Fig. 4.2B). Female and juvenile gnathopod 2, palm convex (Fig. 4.2C) ..... *Photis lacia* (Fig. 4.8)

9A. Adult male gnathopod 2, palm not incised, not defined by tooth ..... *Photis linearmanus* (Fig. 4.9)

9B. Adult male gnathopod 2, palm incised, defined by tooth (Fig. 4.2D,E) 10

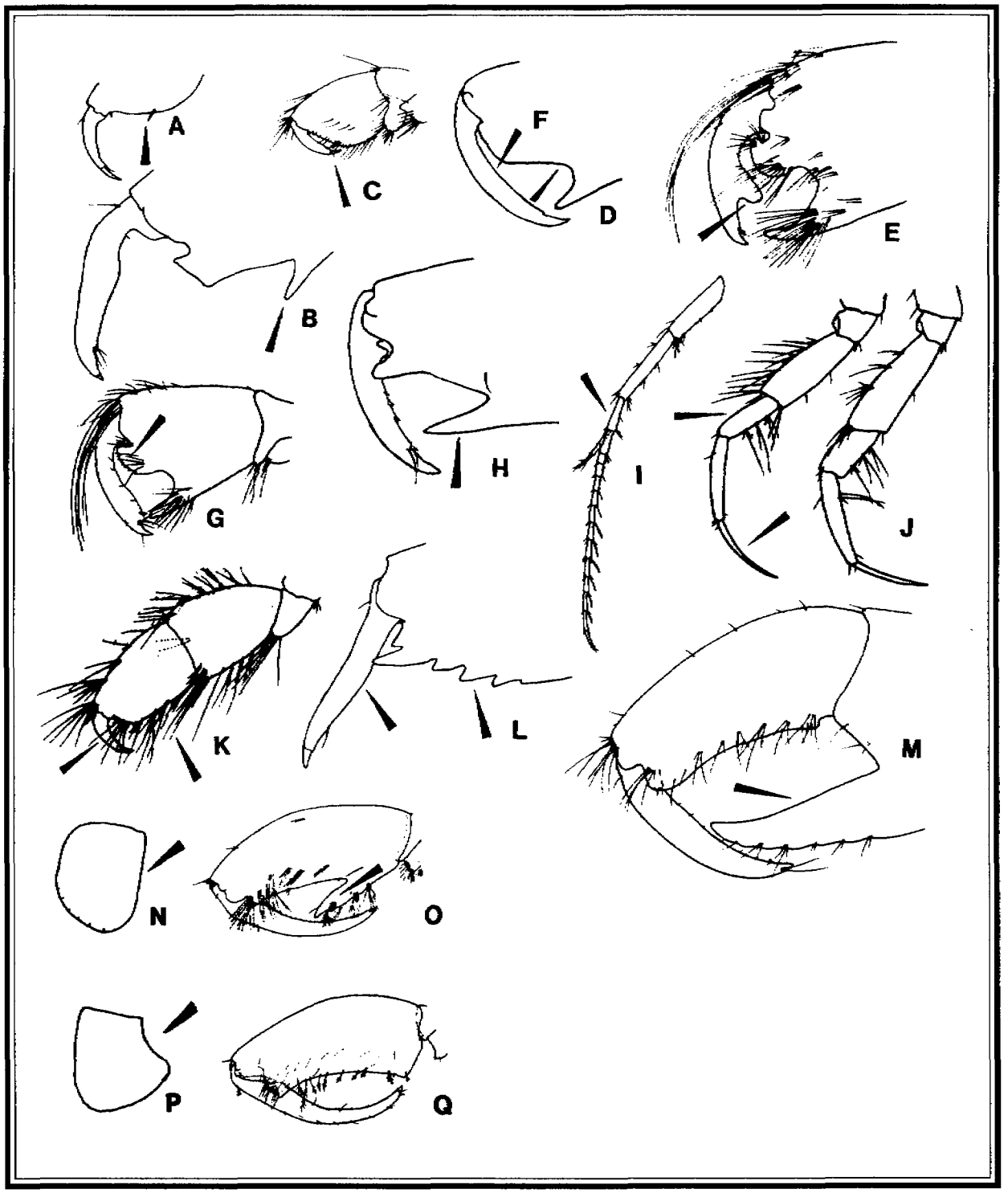

Figure 4.2. A, *Photis lacia* adult male gnathopod 1; B, *Photis lacia* adult male gnathopod 2; C, *Photis lacia* adult female gnathopod 2; D, *Photis lacia* adult male gnathopod 2; E, *Photis brevipes* adult male gnathopod 2; F, *Photis lacia* adult male gnathopod 2; G, *Photis californica* adult male gnathopod 2; H, *Photis macrotica* adult male gnathopod 2; I, *Protomedeia prudens* adult male antenna 1; J, *Protomedeia articulata* adult male peraeopods 3 and 4; K, *Protomedeia articulata* adult male gnathopod 2; L, *Protomedeia prudens* adult male gnathopod 2; M, *Ericthonius rubricornis* adult male gnthopod 2; N, *Jassa slatteryi* adult male coxa 4; O, *Jassa slatteryi* adult male gnathopod 2; P, *Microjassa* sp. A, adult male coxa 4; Q, *Microjassa* sp. A, adult male gnathopod 2.

10A. Adult male gnathopod 2, dactyl, inner margin with tooth projecting into palm (Fig. 4.2E) .... *Photis brevipes* (Fig. 4.10)

10B. Adult male gnathopod 2, dactyl, inner margin without tooth (Fig. 4.2F) 11

11A. Eyes normal. Adult male gnathopod 2, palmar tooth adjacent to dactyl hinge rounded or squared, palmar incision rounded or squared, palmar defining tooth extending to level of dactyl hinge or beyond (Fig. 4.2G). Adult female and juvenile gnathopod 1, palm shallowly concave (Fig. 4.1P) .... *Photis californica* (Figs. 11,12)

11B. Eyes large. Adult male gnathopod 2, palmar tooth adjacent to dactyl hinge pointed, palmar incision triangular, palmar defining tooth not extending to level of dactyl hinge (Fig. 4.2H). Adult female and juvenile gnathopod 1, palm convex (Fig. 4.2A) ..... *Photis macrotica* (Fig. 4.13)

12A. Antenna 1, both sexes, peduncle article 3 shorter than article 1 (Fig. 4.2I). Peraeopods 3 and 4, dactyls longer than dactyls of peraeopods 5-7 (Fig. 4.2J) ..... Genus *Protomedeia* 13

12B. Antenna 1, both sexes, peduncle article 3 as long as article 1. Peraeopods 3 and 4, dactyls as long as or shorter than dactyls of peraeopods 5-7 ..... Genus *Gammaropsis* 14

13A. Adult male gnathopod 1, carpus and propodus nearly equal in length. Adult male gnathopod 2, propodus, posterior margin not toothed, dactyl curved (Fig. 4.2K) .... *Protomedeia articulata* (Fig. 4.14)

13B. Adult male gnathopod 1, carpus quarter longer than propodus. Adult male gnathopod 2, propodus, posterior margin toothed, dactyl straight or sinuous (Fig. 4.2L) .... *Protomedeia prudens* (Fig. 4.15)

14A. Antenna 1, both sexes, accessory flagellum long and multiarticulate (Fig. 4.2I). Eye kidney shaped. Urosome segments 1 and 2 dorsally cusped .... *Gammaropsis (Gammaropsis) thompsoni* (Fig. 4.16)

14B. Antenna 1, both sexes, accessory flagellum microscopic. Eye oval. Urosome segments 1 and 2 not dorsally cusped ..... Genus *Gammaropsis (Podoceropsis)* 15

15A. Eye facets unpigmented. Gnathopod 2, adult male, propodus about length of articles 5 and 6 combined of gnathopod 1, dactyl half length of propodus .... *Gammaropsis (Podoceropsis) ocellata* (Fig. 4.17)

15B. Eye facets black. Gnathopod 2, adult male, propodus as long as or longer than articles 5 and 6 combined of gnathopod 1, dactyl as long as propodus .... *Gammaropsis (Podoceropsis) ociosa* (Fig. 4.18)

16A. Uropod 3, both sexes, with one ramus. Gnathopod 2, both sexes, posterior lobe of carpus extending below propodus, forming tooth in adult male (Fig. 4.2M) ..... *Ericthonius rubricornis* (Fig. 4.19)

16B. Uropod 3, both sexes, with two rami. Gnathopod 2, posterior lobe of carpus not extending below propodus 17

17A. Uropod 3, both sexes, peduncle not spinose mid-dorsally, spines present only on distal margin at origin of rami. Coxae 2 to 5 shallower than or about same depth as body; coxa 4 not posteriorly excavate (Fig. 4.2N). Gnathopod 2, adult male, palm incised to form thumb-like protuberance on posterior margin (Fig. 4.2O). Gnathopod 2, adult female and juvenile, more than twice size of gnathopod 1, palm concave ..... *Jassa slatteryi* (Fig. 4.20)

17B. Uropod 3, both sexes, peduncle spinose mid-dorsally as well as distally. Coxae 2 to 5 deeper than body; coxa 4 posteriorly excavate (Fig. 4.2P). Gnathopod 2, adult male, palm evenly concave, without thumb-like protuberance on posterior margin (Fig. 4.2Q). Gnathopod 2, adult female and juvenile, less than twice size of gnathopod 1, palm convex ..... *Microjassa* sp. A (Fig. 4.21)

Descriptions of Species

Superfamily Corophioidea

Family Aoridae

Aoroides exilis Conlan and Bousfield, 1982

Figure 4.3

Aoroides exilis Conlan and Bousfield, 1982b:92-93, fig. 9.

Material Examined. California: Santa Maria Basin, Sta. 65, 107 m, 2 juveniles; Sta. 80, 196 m, 1 juvenile; Sta. R-4, Rep. 1, 92 m, 4 adult females, 7 juveniles; Cruise 1-3, Sta. R-4, Rep. 3, 92 m, 1 juvenile; Cruise 2-5, Sta. R-4, Rep. 2, 92 m, 1 adult male, 7 adult females, 52 juveniles; Cruise 2-5, Sta. R-4, Rep. 3, 92 m, 1 adult male, 9 adult females, 15 juveniles.

Description. Body length up to 5.5 mm (adult male), 2.5-6.0 mm (adult female). Head lobe rounded or squared. Eye black, oval. Antenna 1 1.5 to 2 times length of antenna 2. Antenna 1 weakly setose, article 3 one-half length of article 1; accessory flagellum microscopic button. Antenna 2 moderately setose, flagellum pediform, shorter than article 5, distally spinose. Upper lip, epistome rounded. Mandible with 2-3 raker spines; molar without flake or seta; palp slender, rod-like, article 2 without setae, article 3 longer than article 2, with 4-6 setae. Lower lip, outer lobes spinose. Maxilla 1, inner plate with long seta; palp broader than outer plate. Maxilla 2, inner plate slenderer than outer, with facial setae. Maxilliped, inner plate reaching to end of article 4; outer plate reaching to end of article 5; unguis (article 8) much shorter than article 7. Sternal plate 1 with shallow bump. Peraeopods 1-4, coxae, ventral margins with few minute setae. Gnathopod 1 larger than gnathopod 2. Gnathopod 1 (adult male), coxa narrow and lengthened, basis inserted at distal margin; basis with fringe of long setae on anterior, lateral, and posterior margins; merus extended as long tooth under full length of carpus; carpus, anterior margin lacking thick fringe of setae, not expanded under propodus; propodus without palm; dactyl as long as propodus, posterior (inner) margin fringed with long setae. Gnathopod 1 (adult female and juvenile) similar in shape to gnathopod 2 (adult female and juvenile), although with longer dactyl; basis without cluster of long setae at anterior junction with ischium. Gnathopod 2 (adult male) similar in shape to that of adult female and juvenile; basis without stridulation ridges on anterior margin; carpus not toothed; propodus, palm transverse, without teeth, setae at dactyl hinge less than half length of propodus. Gnathopod 2 (adult female and juvenile) somewhat smaller than gnathopod 1; carpus about as long as propodus, posterior lobe wide, not expanded under propodus; propodus, palm transverse. Adult female brood plates wide, setae without hook at each tip. Peraeopod 3 (adult male) without stridulation

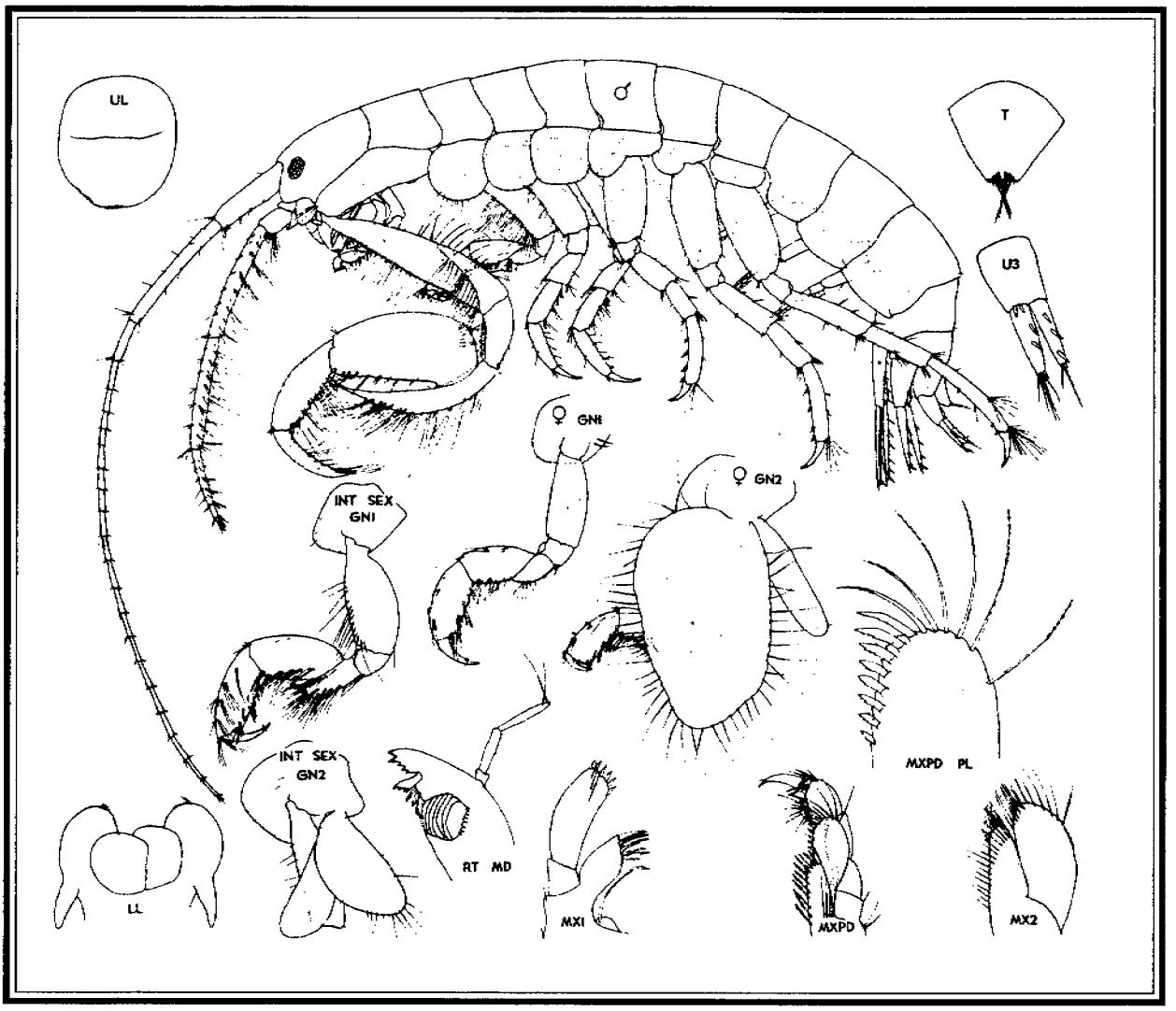

Figure 4.3. *Aoroides exilis*. Holotype, adult male, 4.0 mm; allotype, adult female, 5.0 mm; paratype, intersex, 5.5 mm. Individual appendages in this and subsequent figures are from the male unless noted otherwise; scale 0.1 mm (from Conlan and Bousfield, 1982b).

ridges on ventral margin. Coxa 4, posterior margin not excavate. Peraeopods 3 and 4, basis not expanded; merus not anteriorly produced over carpus; dactyl shorter than propodus. Peraeopod 5, coxa somewhat shallower than coxa 4; basis slender, not posteriorly excavate; merus not posteriorly excavate; merus and carpus not spinose; propodus with several spines along anterior margin; dactyl without pronounced cusp at junction of unguis. Peraeopods 6 and 7, coxae smaller than coxa 5; otherwise peraeopods 6 and 7 similar in shape to peraeopod 5. Epimera 1-3 with ridge and small notch and seta in posterodistal corner, but without cusp. Pleon segment 3 with pair of erect setae dorsally. Urosome segment 1 with pair of erect setae dorsally, but without accompanying cusps. Uropod 1, peduncle with lateral ecdysial spine proximally and tooth-like process extending ventrally below rami; rami tipped by 2 or 3 spines. Uropod 3, peduncle not spinose along dorsal margin except at junction of rami; rami as long as peduncle and of equal length, both rami with 2 or 3 spines on dorsal margin, outer ramus terminating in cluster of long setae, inner ramus terminating in 1 or 2 long setae. Telson apices marked by cluster of 2-3 long setae and small knob.

Distribution and Biology. *Aoroides exilis* has been recorded from Klokachef Island, Alaska (57°25'N, 123°52'W) south to Santa Maria Basin, California. It has been found among algae, eelgrass, and sponges under stones and in tide pools on sand and gravel beaches in the low intertidal zone, to 196 m depth. This species is abundant on high salinity exposed coasts and in semi- and well protected waters. Adult females have been found ovigerous from May to August.

Remarks. Adult male *Aoroides exilis* can be distinguished from *Aoroides inermis* by the presence of long setae on the posterior margin of the basis of gnathopod 1 and lack of such setae on the anterior margin of the carpus. Adult female and juvenile *Aoroides exilis* lack the cluster of long setae on the anterodistal margin of the basis of gnathopods 1 and 2 at the junction of the ischium. In both sexes both the outer and inner rami bear spines, whereas in *Aoroides inermis* the outer ramus usually lacks spines. The species also differ in pigmentation in life: in *Aoroides exilis* the flagellum article 1 of antenna 2 is not red banded, and the body segments are dark banded, with the head and parts of segments 6 and 7 white, giving a "saddleback" pattern.

Aoroides inermis Conlan and Bousfield, 1982

Figure 4.4

Aoroides inermis Conlan and Bousfield, 1982b:86-87, fig. 4.

Material Examined. California: Santa Maria Basin, Sta. PJ-6, Rep. 1, 148 m, 1 adult female.

Description. Body length up to 6.0 mm (adult male), 3.0-6.5 mm (adult female). Head lobe rounded or squared. Eye black, oval. Antenna 1 about 1.5 times length of antenna 2. Antenna 1 weakly setose, article 3 one-half length of article 1; accessory flagellum microscopic button. Antenna 2 moderately setose, flagellum pediform, shorter than article 5, distally spinose. Upper lip, epistome rounded. Mandible with 2-3 raker spines; molar without flake or seta; palp slender, rod-like, article 2 with 1-3 setae, article 3 longer than article 2, with 4-6 setae. Lower lip, outer lobes spinose. Maxilla 1, inner plate with long seta; palp broader than outer plate. Maxilla 2, inner plate slenderer than outer, with facial setae. Maxilliped, inner plate reaching to end of article 4; outer plate reaching beyond article 5; unguis (article 8) much shorter than article 7. Sternal plate 1 with shallow bump. Peraeopods 1-4, coxae, ventral margins with few minute setae. Gnathopod 1 larger than gnathopod 2. Gnathopod 1 (adult male), coxa narrow and lengthened, basis inserted at ventral margin; basis with fringe of long setae on anterior and lateral margins; merus extended as long tooth under full length of carpus; carpus, anterior margin with thick fringe of setae, not expanded under propodus; propodus without palm; dactyl as long as propodus, posterior (inner) margin fringed with long setae and without cusps. Gnathopod 1 (adult female and juvenile) similar in shape to gnathopod 2, although with longer dactyl; basis with cluster of long setae at anterior junction with ischium. Gnathopod 2 (adult male) similar in shape to that of adult female and juvenile; basis without stridulation ridges on anterior margin. Gnathopod 2 (adult female and juvenile) somewhat smaller than gnathopod 1; carpus about as long as propodus, posterior lobe wide, not toothed; propodus, palm transverse, setae at dactyl hinge less than half length of propodus; dactyl scarcely overlapping palm, not toothed. Adult female brood plates wide, setae without hook at each tip. Peraeopod 3 (adult male) without stridulation ridges on ventral margin. Peraeopod 4, posterior margin not excavate. Peraeopods 3 and 4, basis not expanded; merus not anteriorly produced over carpus; dactyl shorter than propodus. Peraeopod 5, coxa similar in depth to coxa 4; basis slender, not posteriorly excavate; merus not posteriorly excavate; merus and carpus not spinose; propodus with several spines along anterior margin; dactyl without pronounced cusp at junction of unguis. Peraeopods 6 and 7, coxae smaller than coxa 5; otherwise articles similar in shape to peraeopod 5. Epimera 1-3 with small notch and seta in posterodistal corner. Pleon segment 3 with pair of erect setae dorsally. Urosome segment 1 with pair of erect setae dorsally, but without accompanying cusps. Uropod 1, peduncle with lateral ecdysial spine proximally and tooth-like process extending ventrally below rami; rami tipped by 2 or 3 spines. Uropod 3, peduncle not

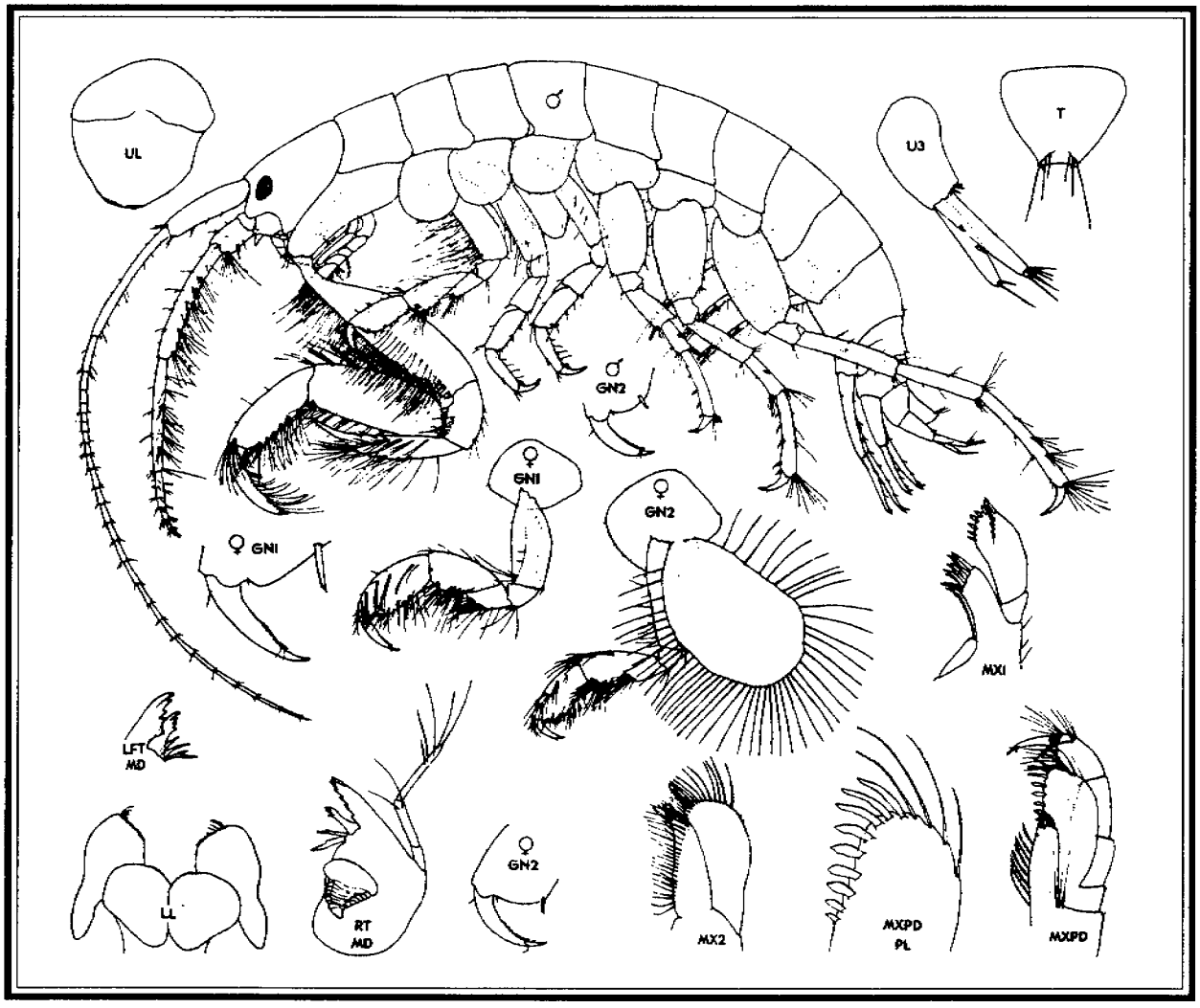

Figure 4.4. *Aoroides inermis*. Holotype, adult male, 5.0 mm. Allotype, adult female, 5.5 mm (from Conlan and Bousfield, 1982b).

spinose mid-dorsally but only at junction of rami; rami as long as peduncle and of equal length, inner ramus with 2 or 3 spines on dorsal margin, but outer ramus usually without spines; outer ramus terminating in cluster of long setae, inner ramus terminating in 1 or 2 long setae. Telson apices marked by cluster of 2-3 long setae and small knob.

Distribution and Biology. *Aoroides inermis* has been recorded from Goose Island, British Columbia (51°56'N, 128°26'W) south to Santa Maria Basin, California. It has been found primarily on sand bottoms in the low intertidal zone and subtidally to 148 m depth on high salinity exposed and protected coasts. Adult females have been found ovigerous from May to November.

Remarks. Adult male *Aoroides inermis* can be distinguished from *Aoroides exilis* by the lack of long setae on the posterior margin of the basis of gnathopod 1 and presence of such setae on the anterior margin of the carpus. Adult female and juvenile *Aoroides inermis* also bear a cluster of long setae on the anterodistal corner of the basis of gnathopods 1 and 2 at the junction of the ischium. In both sexes the outer ramus of uropod 3 usually lacks spines, whereas in *Aoroides exilis* the outer ramus is always spinose. The species also differ in pigmentation in life: in *Aoroides inermis* flagellum article 1 of antenna 2 is red banded. The body segments are speckled throughout, with pigment concentrating in the lower posterior corners of body segments 1-5.

Family Isaeidae

Ampelisciphotis podophthalma (J.L. Barnard, 1958)

Figure 4.5

Gaviota podophthalma J.L. Barnard, 1958:87-89, pls. 26 and 27; 1973:15 (synonymy).—J.L. Barnard and Karaman, 1991:159-160, pls. 41, 43.

Material Examined. California: Santa Maria Basin, Sta. 64, 59 m, 1 juvenile; Cruise 1-2, Sta. R-8, Rep. 2, 90 m, juvenile; Cruise 2-4, Sta. R-8, Rep. 3, 90 m, 1 adult male, 1 juvenile.

Description. Body length up to 4.5 mm (adult male), 4.5 mm (adult female). Head lobe strongly produced, extending beyond end of article 1 of antenna 1. Eye black, round, covering end of head lobe. Antennae 1 and 2 about equal in length. Antenna 1 moderately setose, article 3 longer than article 1; accessory flagellum absent. Antenna 2 moderately setose, flagellum not pediform, longer than article 5, not distally spinose. Upper lip, epistome rectangular. Mandible with 4-6 raker spines; molar flake present; palp slender, article 3 hardly wider distally than proximally, both articles 2 and 3 with numerous setae, article 2 hardly longer than article 3. Lower lip, outer lobes not spinose. Maxilla 1, inner plate without setae; palp narrower than outer plate. Maxilla 2, inner plate wider than outer, with facial setae. Maxilliped, inner plate reaching to end of article 4; outer plate reaching to end of article 5; unguis (article 8) shorter than article 7. Sternal plate 1 not produced. Peraeopods 1-4, coxae, ventral margins with abundant long setae. Gnathopod 1 smaller than gnathopod 2. Gnathopod 1 (adult male), coxa narrower but otherwise not different in shape from coxa 2, basis inserted proximally on inner face; basis with cluster of long setae anteriorly; merus not extended as tooth under carpus; carpus about equal in length to propodus, anterior margin setose only at anterior junction with propodus, posterior lobe not expanded under propodus; propodus, palm convex, defined by row of 3 long spines; dactyl only as long as palm of propodus, posterior (inner) margin with several short setae and cusps. Gnathopod 1 (adult female and juvenile) similar in shape to male gnathopod 1. Gnathopod 2 (adult male) similar to and no larger than that of adult female and juvenile; basis without stridulation ridges; carpus nearly as long as propodus, not toothed; propodus, palm convex, defined by row of 4 spines, setae at dactyl hinge more than half length of propodus; dactyl as long as palm, with cusp only. Gnathopod 2 (adult female and juvenile) somewhat larger than gnathopod 1; carpus shorter than propodus, posterior lobe two-thirds length of anterior margin; propodus, palm convex. Adult female brood plates unknown. Peraeopod 3 (adult male) without stridulation ridges. Peraeopod 4, coxa, posterior margin not excavate. Peraeopods 3 and 4, basis moderately expanded, merus wider than carpus and anteriorly produced over one-third of carpus; dactyl shorter than propodus. Peraeopod 5, coxa similar in depth to coxa 4; basis broad, not posteriorly excavate; merus not posteriorly excavate; merus and carpus not spinose; propodus with only single short spine at anterodistal corner; dactyl with 2 pronounced cusps at junction of unguis. Peraeopod 7, coxa smaller than coxa 6; otherwise peraeopods 6 and 7 similar in shape to peraeopod 5, although bases narrower in peraeopod 7. Epimera 1-3 not posterodistally notched. Pleon and urosome without dorsally erect setae or cusps. Uropod 1, peduncle without lateral ecdysial spine or tooth-like process extending ventrally below rami; rami tipped by 1 short spine. Uropod 3, peduncle not spinose; outer ramus shorter than peduncle and tipped by 1-2 long setae, inner ramus absent. Telson apices marked by 2-3 long setae and small knob.

Distribution and Biology. *Ampelisciphotis podophthalma* has been recorded from Point Sal to Point Mugu, California, from 12 to 90 m depth.

Remarks. *Ampelisciphotis podophthalma* is not sexually dimorphic. The species is readily recognized in this collection by the long projecting headlobes.

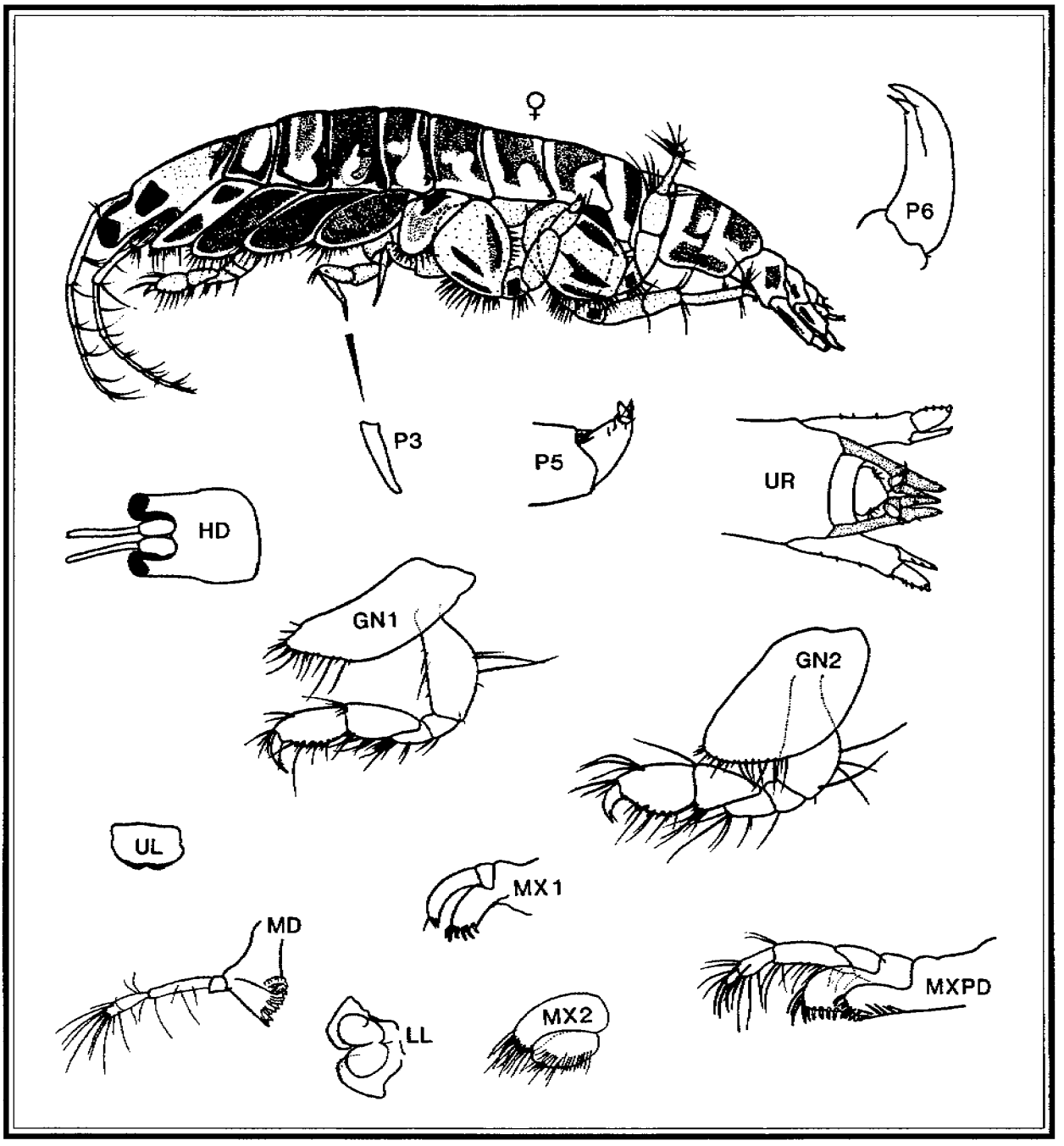

Figure 4.5. *Ampelisciphotis podophthalma.* Holotype, adult female, 4.5 mm (whole body); paratype, adult female, 4.5 mm (individual appendages) (from J. L. Barnard, 1958).

Photis typhlops Conlan, 1994[3]

Figure 4.6

Photis typhlops Conlan, 1994b:68-70, fig. 1.

Material Examined. California: Santa Maria Basin, Sta. 20, 396 m, 1 juvenile; Sta. 25, 390 m, 1 subadult female, 9 juveniles; Sta. 50, 591 m, 2 adult females, 4 juveniles; Sta. 55, 590 m, 2 adult females, 7 juveniles. Off San Francisco (37°22.31'N, 123°19.24'W), 990 m, Sta. 3-18, 26.829, 9-19, 15 Sept. 1991, J. A. Blake, collector, about 200 specimens (type).

Description. Body length up to 3.2 mm (adult male), 3.4 mm (adult female). Head lobe triangular. Eye lacking. Antennae 1 and 2 about equal in length. Antenna 1 weakly setose, article 3 longer than article 1; accessory flagellum microscopic button. Antenna 2 moderately setose, flagellum not pediform, longer than article 5, distally spinose. Upper lip, epistome triangular. Mandible with 3-4 raker spines; molar flake present; palp strong, article 3 hardly wider distally than proximally, both articles 2 and 3 with numerous setae, article 2 longer than article 3. Lower lip, outer lobes not spinose. Maxilla 1, inner plate without setae; palp narrower than outer plate. Maxilla 2, inner plate about same width as outer, with facial setae. Maxilliped, inner plate not reaching to end of article 4; outer plate not reaching to end of article 5; unguis (article 8) about equal in length to article 7. Sternal plate 1 not produced. Peraeopods 1-4, ventral margins of coxae with 0-2 long setae each. Gnathopod 1 smaller than gnathopod 2. Gnathopod 1 (adult male), coxa more anterodistally produced than coxa 2, basis inserted mid-proximally on inner face; basis not densely setose; merus not extended as tooth under carpus; carpus about equal in length to propodus, anterior margin distally setose, posterior lobe not expanded under propodus; propodus, palm shallowly excavate, defined by single spine; dactyl longer than palm of propodus, posterior (inner) margin with few short setae and cusps. Gnathopod 1 (adult female and juvenile) similar in shape to gnathopod 2, although basis with long setae on both anterior and posterior margins, carpus slightly longer than propodus, and palm of propodus oblique; basis without cluster of long setae at anterior junction with ischium. Gnathopod 2 (adult male) larger than and different in shape from that of adult female and juvenile; basis, lateral face with row of stridulation ridges; carpus shorter than propodus, not toothed; propodus, palm transverse, with 2 excavations and tooth and spine at defining corner, setae at dactyl hinge less than half length of propodus; dactyl overlapping palm by length of unguis, without tooth, with spine and setal cluster proximal of unguis. Gnathopod 2 (adult female and juvenile) somewhat larger than gnathopod 1; carpus shorter than propodus, posterior lobe narrow; propodus, palm convex. Adult female brood plates moderately wide, setae without hook at each tip. Peraeopod 3 (adult male), coxa with row of stridulation ridges on ventral margin. Peraeopod 4, coxa, posterior margin not excavate. Peraeopods 3 and 4, basis not expanded, merus wider than carpus and produced anteriorly over less than one-fourth of carpus; dactyl shorter than propodus. Peraeopod 5, coxa similar in depth to coxa 4; basis broad, not posteriorly excavate; merus not posteriorly excavate; merus and carpus not spinose; propodus with only single long spine at anterodistal corner; dactyl with 2 pronounced cusps at junction of unguis. Peraeopods 6 and 7, coxae smaller than coxa 5; otherwise articles similar in shape to peraeopod 5, although bases narrower and dactyl not cusped. Epimera 1-3 not posterodistally notched. Pleon and urosome without dorsally erect setae or cusps. Uropod 1, peduncle without lateral ecdysial spine proximally or tooth-like process extending ventrally below rami; rami tipped by 1-2 short spines. Uropod 3, peduncle not spinose; outer ramus nearly as long as peduncle and tipped by 1-2 long setae, inner ramus about one-fourth length of outer, tipped by single short spine. Telson apices marked by single long seta and small knob.

Distribution and Biology. *Photis typhlops* has been collected from 390-2005 m off Santa Barbara and San Francisco. In the San Francisco collections, *Photis typhlops* was found from 812 m to 2005 m depth, with density peaking at 9500 individuals m^{-2} at 1770 to 1990 m depth. At this density the tubes of the

[3] All species of *Photis* treated in this paper are in the subgenus *Photis*.

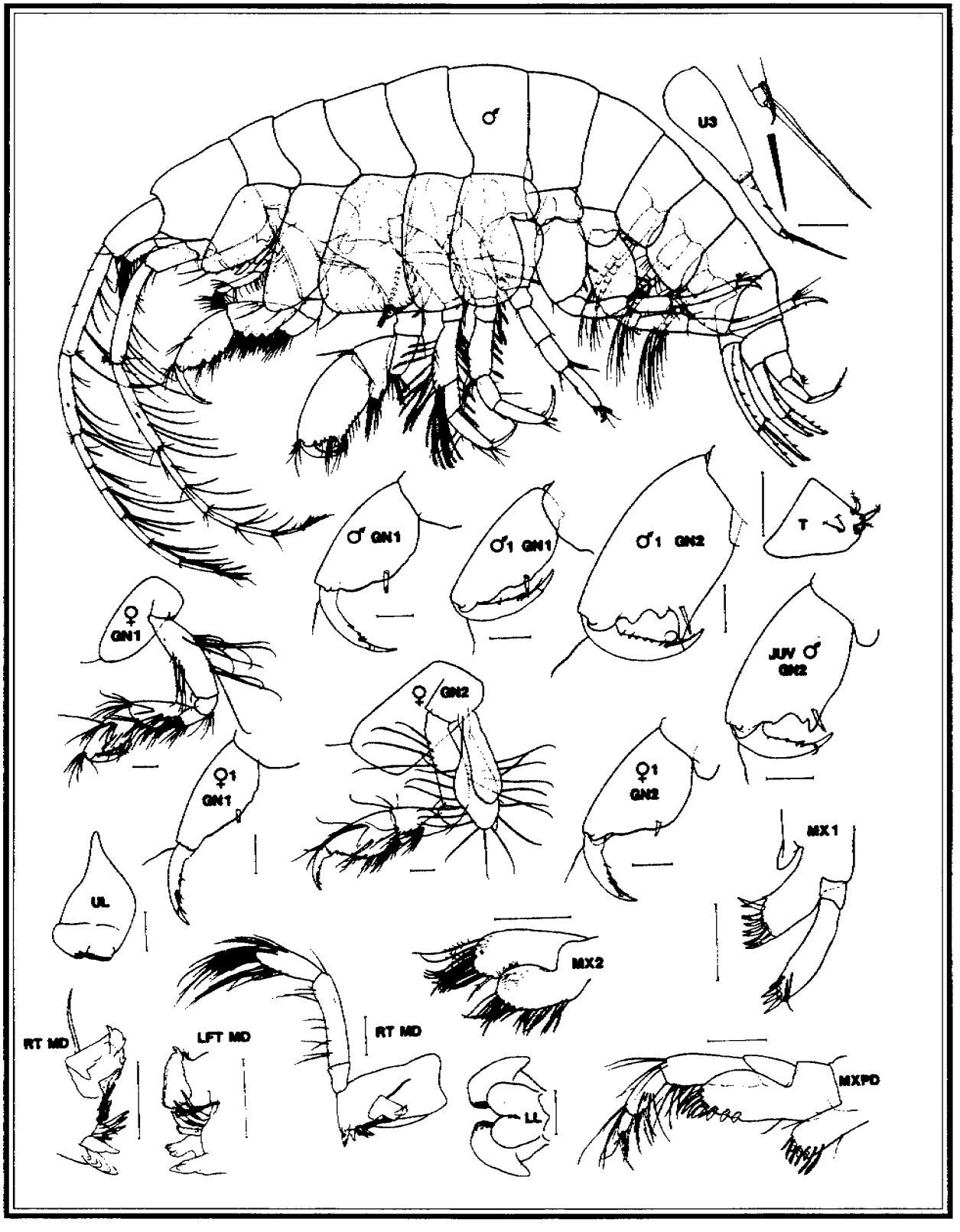

Figure 4.6. *Photis typhlops.* Holotype, adult male, 3.2 mm; allotype, adult female, 3.4 mm; paratypes, adult male, 3.4 mm, juvenile male, 2.9 mm, adult female, 3.3 mm (from Conlan, 1994b).

amphipods were clearly visible as a dense mat concentrated at the sediment surface. This is the first known record of a deep water amphipod mat (J. A. Blake, pers. comm., 7 Dec. 1992).

Remarks. Two other blind species of *Photis* are known to occur in the North Pacific: *Photis (Photis) kurilica* Gurjanova, 1955 and *Photis (Cedrophotis) malinalco* J.L. Barnard, 1967. *Photis kurilica* differs from *P. typhlops* in the following respects. Head lobe rounded ventrally. Antenna 1, flagellum 8 articles, slightly longer than the peduncle. Antenna 2, peduncle article 4, 3 times as long as article 3. Male gnathopod 1, basis, anterior and posterior margins covered with abundant plumose setae; carpus equal in length to the propodus; propodus, palm concave. Male gnathopod 2, coxa with 9 long setae on the ventral margin; basis with abundant short, stout setae anteriorly and long, slender setae posteriorly; propodus, palm concave, without a tooth. Female gnathopod 2, propodus, palm shallowly concave. Uropod 1 with 8-11 lateral spines on the peduncle and rami. Uropod 2 with 2-12 lateral spines on the peduncle and rami. *Photis kurilica* has only been recorded from the east coast of Russia.

Photis (Cedrophotis) malinalco, from the Cedros Trench, Baja California, has a much longer inner ramus on the third uropod (half the length of the outer - a defining character of the subgenus), slenderer propodus of gnathopods 1 and 2, broader coxa 1, and less spinose uropods 1 and 2.

Another species of *Photis* that is blind is the South Atlantic abyssal *Photis (Photis) coeca* J.L. Barnard, 1962. This species differs from *P. typhlops* as follows. Antenna 1, article 3 only slightly longer than article 1; female gnathopod 1, coxa square; basis with 3 long setae anteriorly and 1 posteriorly; female gnathopod 2, coxa square; propodus much narrower than wide; peraeopod 3, coxa covering only one-third of the basis; peraeopod 5, basis, width three-fourths of length; uropod 1 rami, outer ramus with 1 spine, inner ramus with 0.

All four blind species have longer antennae than has been seen in eyed species of *Photis*, a characteristic, therefore, which may correlate with lack of eyesight.

Photis bifurcata J.L. Barnard, 1962

Figure 4.7

Photis bifurcata J.L. Barnard, 1962:30-31, fig. 10; 1964:240.—Conlan, 1983:46-49, fig. 23.

Material Examined. California: Santa Maria Basin, Sta. BRA-16, 91.5-123 m, 2 adult males, 4 adult females, 11 juveniles; Sta. 6, 109 m, 1 adult male, 3 adult females, 22 juveniles; Cruise 1-3, Sta. R-8, Rep. 1, 90 m, 1 adult male, 1 adult female, 6 juveniles; Cruise 1-3, Sta. R-8, Rep. 2, 90 m, 1 adult female.—Western Santa Barbara Channel, Sta. BRC-1, 73.5-78 m, 1 adult male, 1 adult female

Description. Body length up to 4.0 mm (adult male), 2.0-3.5 mm (adult female). Head lobe triangular. Eye black, oval. Antennae 1 and 2 about equal in length. Antenna 1 weakly setose, article 3 equal in length to article 1; accessory flagellum microscopic button. Antenna 2 moderately setose, flagellum not pediform, longer than article 5, distally spinose. Upper lip, epistome triangular. Mandible with 3 raker spines; molar flake present; palp strong, article 3 hardly wider distally than proximally, both articles 2 and 3 with numerous setae, article 2 longer than article 3. Lower lip, outer lobes not spinose. Maxilla 1, inner plate without setae; palp narrower than outer plate. Maxilla 2, inner plate about same width as outer, with facial setae. Maxilliped, inner plate not reaching to end of article 4; outer plate not reaching to end of article 5; unguis (article 8) about equal in length to article 7. Sternal plate 1 not produced. Peraeopods 1-4, ventral margins of coxae with few long setae only. Gnathopod 1 smaller than gnathopod 2. Gnathopod 1 (adult male), coxa not different in shape from coxa 2, basis inserted midway on inner face; basis not densely setose; merus not extended as tooth under carpus; carpus longer than propodus, anterior margin setose only at anterior junction with propodus, posterior lobe not expanded under propodus; propodus, palm concave, defined by single small spine; dactyl only as long as palm of propodus, posterior (inner) margin with few short setae

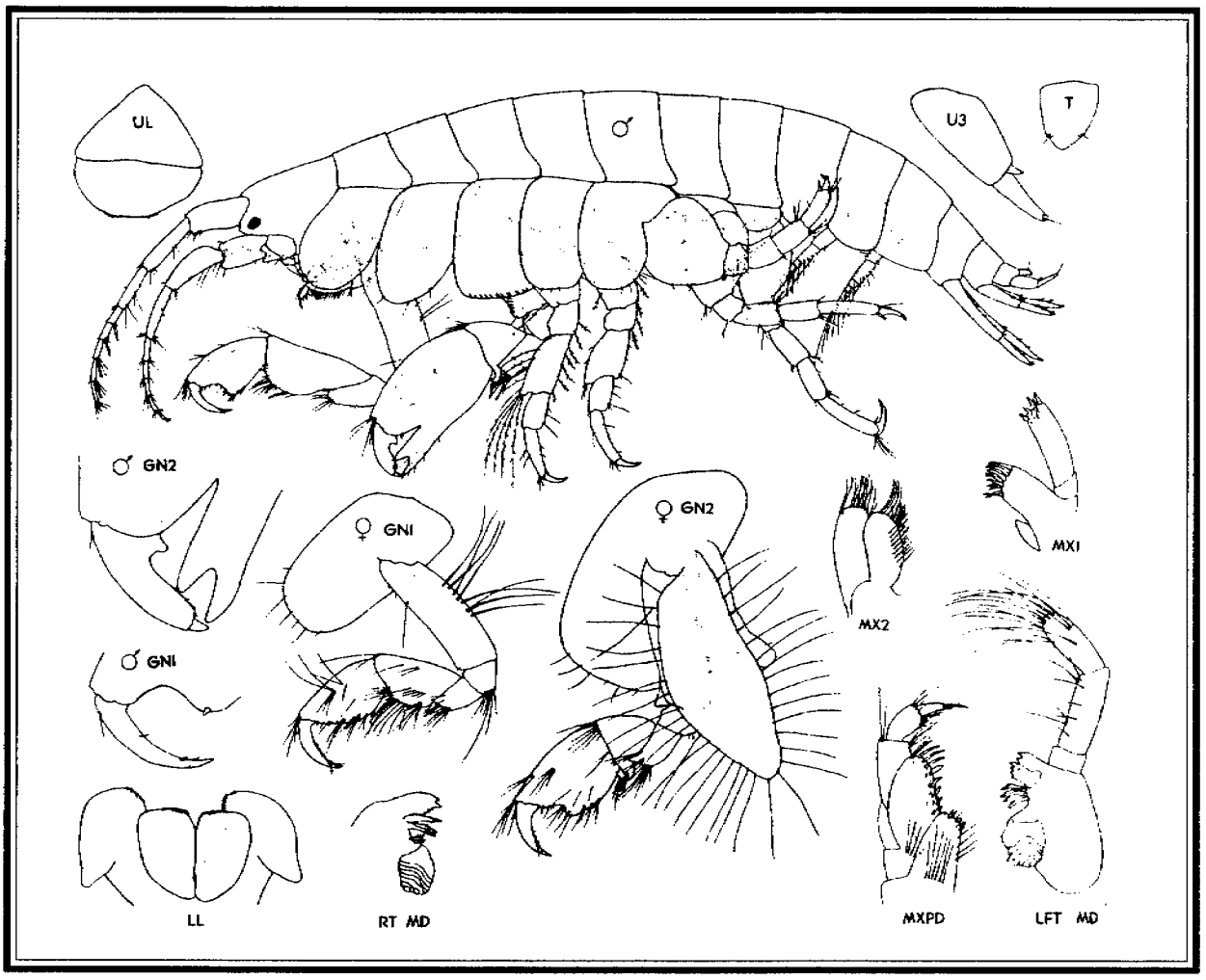

Figure 4.7. *Photis bifurcata.* Adult male, 3.5 mm; adult female, 3.5 mm (from Conlan, 1983).

and cusps. Gnathopod 1 (adult female and juvenile) similar in shape to gnathopod 2, although carpus about equal in length to propodus, and palm of propodus convex; basis without cluster of long setae at anterior junction with ischium. Gnathopod 2 (adult male) larger and different in shape from that of adult female and juvenile; basis, lateral face with row of stridulation ridges; carpus shorter than propodus, not toothed; propodus, palm basically transverse, centrally incised and defined by long bifurcate tooth which extends beyond position of origin of dactyl, setae at dactyl hinge less than half length of propodus; dactyl scarcely overlapping palm, with tooth adjacent to origin, and spine and setal cluster proximal of unguis. Gnathopod 2 (adult female and juvenile) somewhat larger than gnathopod 1; carpus shorter than propodus, posterior lobe narrow; propodus, palm shallowly concave. Adult female brood plates moderately wide, setae without hook at each tip. Peraeopod 3 (adult male), coxa with row of stridulation ridges on ventral margin. Peraeopod 4, coxa, posterior margin not excavate. Peraeopods 3 and 4, basis not expanded, merus wider than carpus and produced anteriorly over about one-fourth of carpus; dactyl shorter than propodus. Peraeopod 5, coxa similar in depth to coxa 4; basis broad, not posteriorly excavate; merus not posteriorly excavate; merus and carpus not spinose; propodus with only single long spine at anterodistal corner; dactyl with 2 pronounced cusps at junction of unguis. Peraeopods 6 and 7, coxae smaller than coxa 5; otherwise articles similar in shape to peraeopod 5, although bases narrower and dactyls not cusped. Epimera 1-3 not posterodistally notched. Pleon and urosome

without dorsally erect setae or cusps. Uropod 1, peduncle without lateral ecdysial spine proximally or tooth-like process extending ventrally below rami; rami tipped by 1-2 short spines. Uropod 3, peduncle not spinose; outer ramus nearly as long as peduncle and tipped by 1-2 long setae, inner ramus about one-fourth length of outer, tipped by single short spine. Telson apices marked by seta and small knob.

Distribution and Biology. *Photis bifurcata* has been recorded from Chichagof Island, Alaska (57°47'N, 136°18'W) south to Bahía de San Cristóbal, Baja California. It has been found on bedrock, sand, and sandy mud on exposed and semi-protected coasts at low water level to a depth 109 m. Adult females have been found ovigerous from May to August.

Remarks. In both sexes the coxae bear few setae, a feature that would distinguish this species from *Photis brevipes*, *P. californica*, and *P. macrotica*. Adult male *Photis bifurcata* can be distinguished from the other local adult males of the genus by the distinctive bifurcate tooth on the second gnathopod and the elongate carpus of gnathopod 1. Adult female and juveniles are not distinctive in gnathopod appearance.

Photis lacia J.L. Barnard, 1962

Figure 4.8

Photis lacia J.L. Barnard, 1962:42-44, fig. 18.—Conlan, 1983:52-53, fig. 26.

Material Examined. California: Santa Maria Basin, Sta. 65, 107 m, 2 adult males, 4 adult females, 37 juveniles; Cruise 1-3, Sta. R-3, Rep. 1, 92 m, 50 adult males, 75 adult females, 290 juveniles; Cruise 1-3, Sta. R-4, Rep. 2, 92 m, 11 adult females, 13 juveniles; Cruise 1-3, Sta. R-4, Rep. 3, 92 m, 42 adult males, 90 adult females, 327 juveniles; Cruise 1-1, Sta. PJ-20, Rep. 1, 148 m, 4 adult males, 6 adult females, 15 juveniles.

Description. Body length up to 3.0 mm (adult male), 2.0-3.3 mm (adult female). Head lobe triangular. Eye black, oval. Antennae 1 and 2 about equal in length. Antenna 1 weakly setose, article 3 equal in length to article 1; accessory flagellum microscopic button. Antenna 2 weakly setose, flagellum not pediform, longer than article 5, distally spinose. Upper lip, epistome triangular. Mandible with 3 raker spines; molar flake present; palp strong, article 3 hardly wider distally than proximally, both articles 2 and 3 with numerous setae, article 2 longer than article 3. Lower lip, outer lobes not spinose. Maxilla 1, inner plate without setae; palp narrower than outer plate. Maxilla 2, inner plate about same width as outer, with facial setae. Maxilliped, inner plate not reaching end of article 4; outer plate not reaching end of article 5; unguis (article 8) about equal in length to article 7. Sternal plate 1 not produced. Peraeopods 1-4, coxae, ventral margins of coxae with few long setae only. Gnathopod 1 smaller than gnathopod 2. Gnathopod 1 (adult male), coxa not different in shape from coxa 2; basis inserted midway on inner face; basis, anterior margin not densely setose; merus not extended as tooth under carpus; carpus shorter than propodus, anterior margin setose only at anterior junction with propodus, posterior lobe not expanded under propodus; propodus, palm concave, defined by single small spine; dactyl only as long as palm of propodus, posterior (inner) margin with few short setae and cusps. Gnathopod 1 (adult female and juvenile) similar in shape to gnathopod 2, carpus shorter than propodus, and palm of propodus convex; basis without cluster of long setae at anterior junction with ischium. Gnathopod 2 (adult male) larger and different in shape from that of adult female and juvenile; basis, lateral face with row of stridulation ridges; carpus shorter than propodus, not toothed; propodus, palm basically transverse, with shallow rectangular process and short, narrow defining tooth, setae at dactyl hinge nearly as long as propodus; dactyl scarcely overlapping palm, inner margin sinuous, with spine and setal cluster proximal of unguis. Gnathopod 2 (adult female and juvenile) somewhat larger than gnathopod 1; carpus shorter than propodus, posterior lobe narrow; propodus, palm convex. Adult female brood plates moderately wide, setae without hook at each tip. Peraeopod 3 (adult male), coxa with row of stridulation ridges on ventral margin. Peraeopod 4, coxa, posterior margin not excavate. Peraeopods 3 and 4, basis not expanded, merus wider than carpus and produced anteriorly over about one-fourth of carpus; dactyl shorter

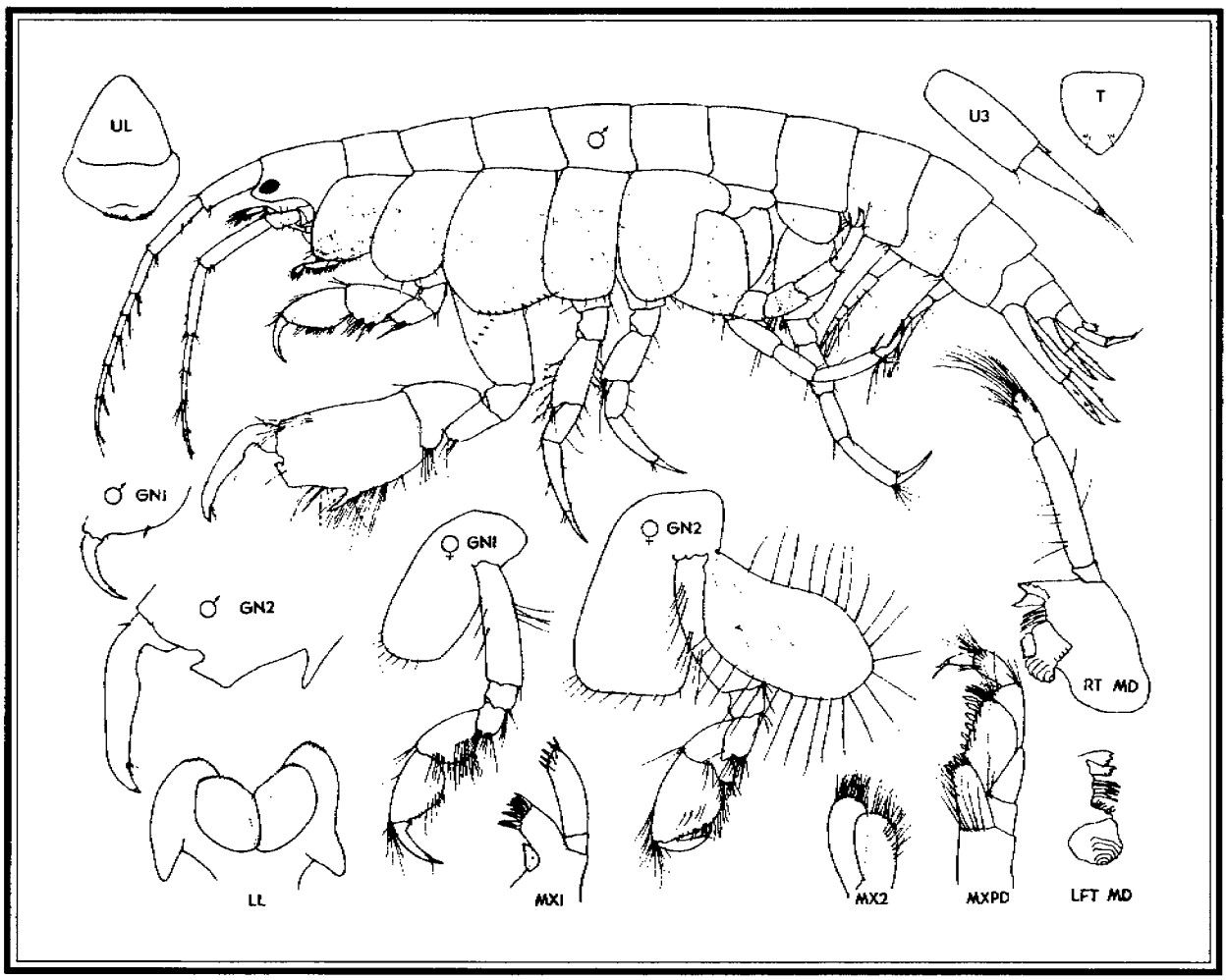

Figure 4.8. *Photis lacia*. Adult male, 3.0 mm, adult female, 3.3 mm (from Conlan, 1983).

than propodus. Peraeopod 5, coxa similar in depth to coxa 4; basis broad, not posteriorly excavate; merus not posteriorly excavate; merus and carpus not spinose; propodus with only single long spine at anterodistal corner; dactyl with 2 pronounced cusps at junction of unguis. Peraeopods 6 and 7, coxae smaller than coxa 5; otherwise articles similar in shape to peraeopod 5, although bases narrower and dactyls not cusped. Epimera 1-3 not posterodistally notched. Pleon and urosome without dorsally erect setae or cusps. Uropod 1, peduncle without lateral ecdysial spine or tooth-like process extending ventrally below rami; rami tipped by 1 or 2 short spines. Uropod 3, peduncle not spinose; outer ramus nearly as long as peduncle and tipped by 1 or 2 long setae, inner ramus about one-fourth length of outer, tipped by single short spine. Telson apices marked by single long seta and small knob.

Distribution and Biology. *Photis lacia* has been recorded from Goose Island, British Columbia (51°56'N, 128°26'W) south to the Santa Maria Basin area of California. It has been found only subtidally from 7 to 148 m depth in sandy sediments on exposed coasts. Adult females have been found ovigerous from June to July.

Remarks. In both sexes the coxae bear few setae, a feature that would distinguish this species from *Photis brevipes*, *P. californica*, and *P. macrotica*. Adult male *Photis lacia* can be distinguished from the other local adult males of the genus by the shape of the second gnathopod. Adult females and juveniles are distinctive from all but *Photis typhlops* by the convex palm of gnathopod 2, and can be distinguished from that species by the presence of eyes.

Photis linearmanus Conlan, 1994

Figure 4.9

Photis linearmanus Conlan, 1994b:70-71, fig. 2.

Material Examined. California: Santa Maria Basin, Cruise 1-3, Sta. R-4, Rep. 1, 92 m, 1 adult male (type).

Description. Body length 3.4 mm (adult male), adult female unknown. Head lobe triangular. Eye black, oval. Antennae missing. Upper lip, epistome triangular. Mandible with 3 raker spines; molar flake present; palp strong, article 3 hardly wider distally than proximally, both articles 2 and 3 with numerous setae, article 2 longer than article 3. Lower lip, outer lobes not spinose. Maxilla 1, inner plate without setae; palp narrower than outer plate. Maxilla 2, inner plate about same width as outer, with facial setae. Maxilliped, inner plate not reaching end of article 4; outer plate not reaching end of article 5; unguis (article 8) about equal in length to article 7. Sternal plate 1 not produced. Peraeopods 1-4, ventral margin of coxa 2 with 11 long setae, coxae 1, 3, and 4 with 2-5. Gnathopod 1 smaller than gnathopod 2. Gnathopod 1 (adult male), coxa 1 different in shape from coxa 2, narrowed distally; basis inserted midway on inner face, not densely setose; merus not extended as tooth under carpus; carpus shorter than propodus, anterior margin setose only at anterior junction with propodus, posterior lobe not expanded under propodus; propodus, palm concave, defined by single small spine; dactyl only as long as palm of propodus, posterior (inner) margin with few short setae

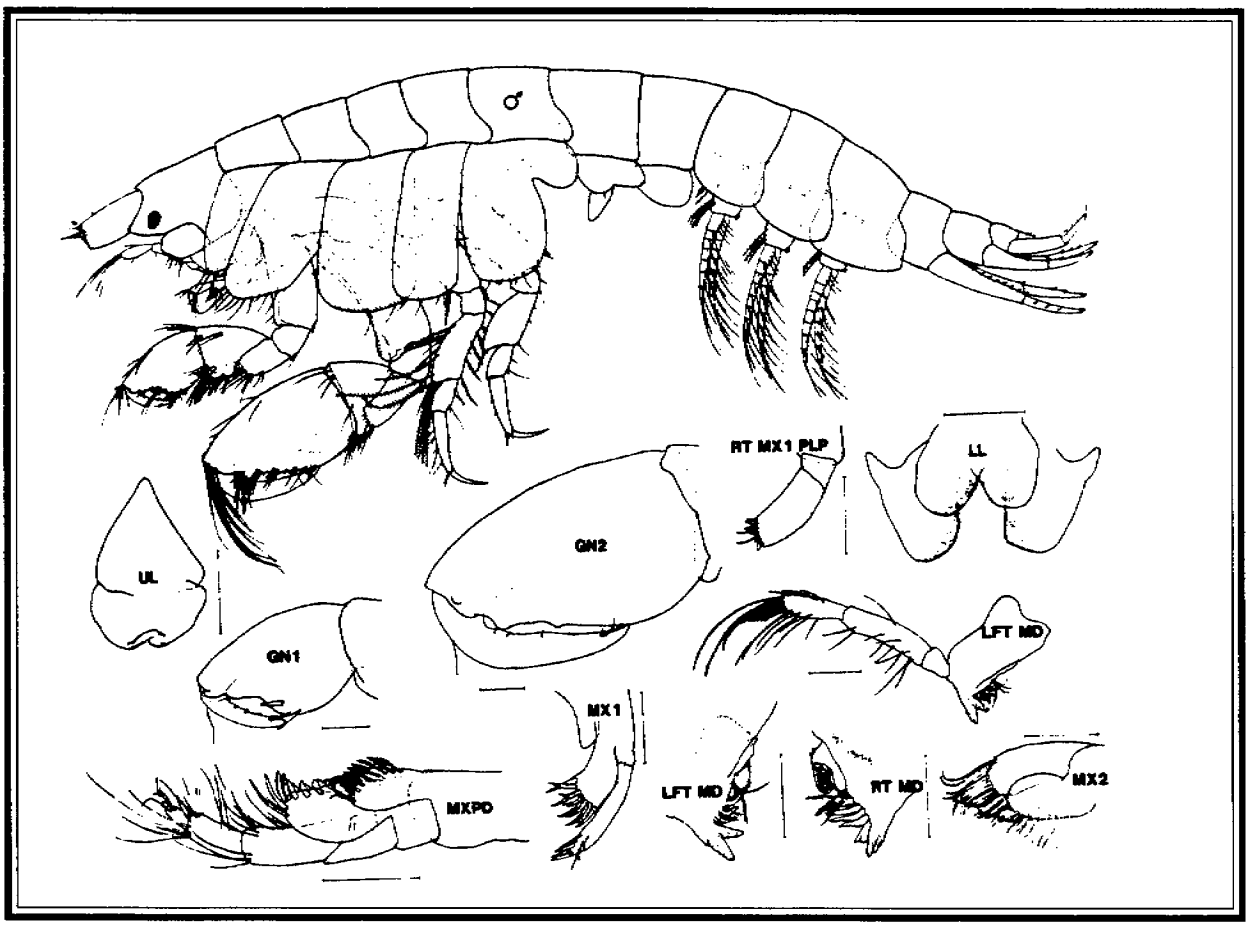

Figure 4.9. *Photis linearmanus.* Holotype, adult male, 3.4 mm (from Conlan, 1994b).

and cusps. Gnathopod 2 (adult male), basis, anterodistal margin with few stridulation ridges; carpus shorter than propodus, not toothed; propodus, palm oblique, with shelf at dactyl and shallow protuberance midway, setae at dactyl hinge nearly as long as propodus; dactyl scarcely overlapping palm, inner margin evenly curved, with spine and setal cluster proximal of unguis. Peraeopod 3 (adult male), coxa with row of stridulation ridges on ventral margin. Peraeopod 4, coxa, posterior margin not excavate. Peraeopods 3 and 4, basis not expanded, merus wider than carpus and produced anteriorly over about one-fourth of carpus; dactyl shorter than propodus. Peraeopod 5, coxa similar in depth to coxa 4. Peraeopods 6 and 7, coxae smaller than coxa 5; other articles of peraeopods 5-7 lacking. Epimera 1-3 not posterodistally notched. Pleon and urosome without dorsally erect setae or cusps. Uropod 1, peduncle without lateral ecdysial spine proximally or tooth-like process extending ventrally below rami; rami tipped by 1 short spine. Uropod 3, peduncle with single spine ventrally at origin of rami; outer ramus two-thirds length of peduncle and tipped by 1 long seta, inner ramus about one-fourth length of outer, tipped by single short spine. Telson apices marked by single long seta and small knob.

Distribution and Biology. *Photis linearmanus* is only known from this one collection in Santa Maria Basin at 92 m depth.

Remarks. This is the only species of *Photis* from this collection where the palm of the propodus of the adult male second gnathopod is oblique and lacks a tooth at the defining corner. The relative sparsity of setae on the ventral margins of the coxae, the cluster of long setae at the origin of the dactyl on the male's gnathopod 2, and the concave palm of the male's gnathopod 1 are also distinctive, although not unique among regional species. The female is unknown.

Photis brevipes Shoemaker, 1942

Figure 4.10

Photis brevipes Shoemaker, 1942:25-27, fig. 9.—J.L. Barnard, 1962:31-33, fig. 11; 1964: 240-241; 1969a:148-151.—Conlan, 1983:47-49, fig. 23.
Photis californica: J.L. Barnard, 1954:26-27, pls. 23, 24 (not Stout, 1913).

Material Examined. California: Santa Maria Basin, Sta. BRC-13,88.5-110.5 m, 1 adult male, 1 adult female; Sta. BRA-16, 91.5-123 m, 2 adult females 1 juvenile; Sta. 34, 492 m, 1 adult male, 1 adult female; Cruise 1-3, Sta. R-2, Rep. 1, 161 m, 1 adult male, 1 adult female, 11 juveniles; Cruise 1-3, Sta. R-2, Rep. 2, 161 m, 1 adult male, 1 adult female, 5 juveniles; Cruise 1-1, Sta. PJ-15, Rep. 2, 155 m, 2 adult males, 1 adult female, 3 juveniles; Cruise 1-1, Sta. PJ-19, Rep. 1, 167 m, 3 adult males, 3 adult females, 2 juveniles.

Description. Body length up to 7.0 mm (adult male), 2.5-6.0 mm (adult female). Head lobe triangular. Eye black, oval. Antenna 1 somewhat shorter than antenna 2. Antenna 1 weakly setose, article 3 equal in length to article 1; accessory flagellum microscopic button. Antenna 2 weakly setose, flagellum not pediform, longer than article 5, distally spinose. Upper lip, epistome triangular. Mandible with 2-4 raker spines; molar flake present; palp strong, article 3 hardly wider distally than proximally, both articles 2 and 3 with numerous setae, article 2 longer than article 3. Lower lip, outer lobes not spinose. Maxilla 1, inner plate without setae; palp narrower than outer plate. Maxilla 2, inner plate about same width as outer, with facial setae. Maxilliped, inner plate not reaching end of article 4; outer plate not reaching end of article 5; unguis (article 8) about equal in length to article 7. Sternal plate 1 not produced. Peraeopods 1-4, coxae, ventral margins with numerous long setae. Gnathopod 1 smaller than gnathopod 2. Gnathopod 1 (adult male), coxa similar in shape to coxa 2 but more anteriorly produced; basis inserted mid-distally on inner face; basis, anterior margin not densely setose; merus not extended as tooth under carpus; carpus slightly longer than propodus, anterior margin setose, posterior lobe not expanded under propodus; propodus, palm shallowly concave, defined by single small spine; dactyl only as long as palm of propodus, posterior (inner) margin with few short setae and cusps. Gnathopod 1 (adult female and juvenile) similar in shape to gnathopod 2, although

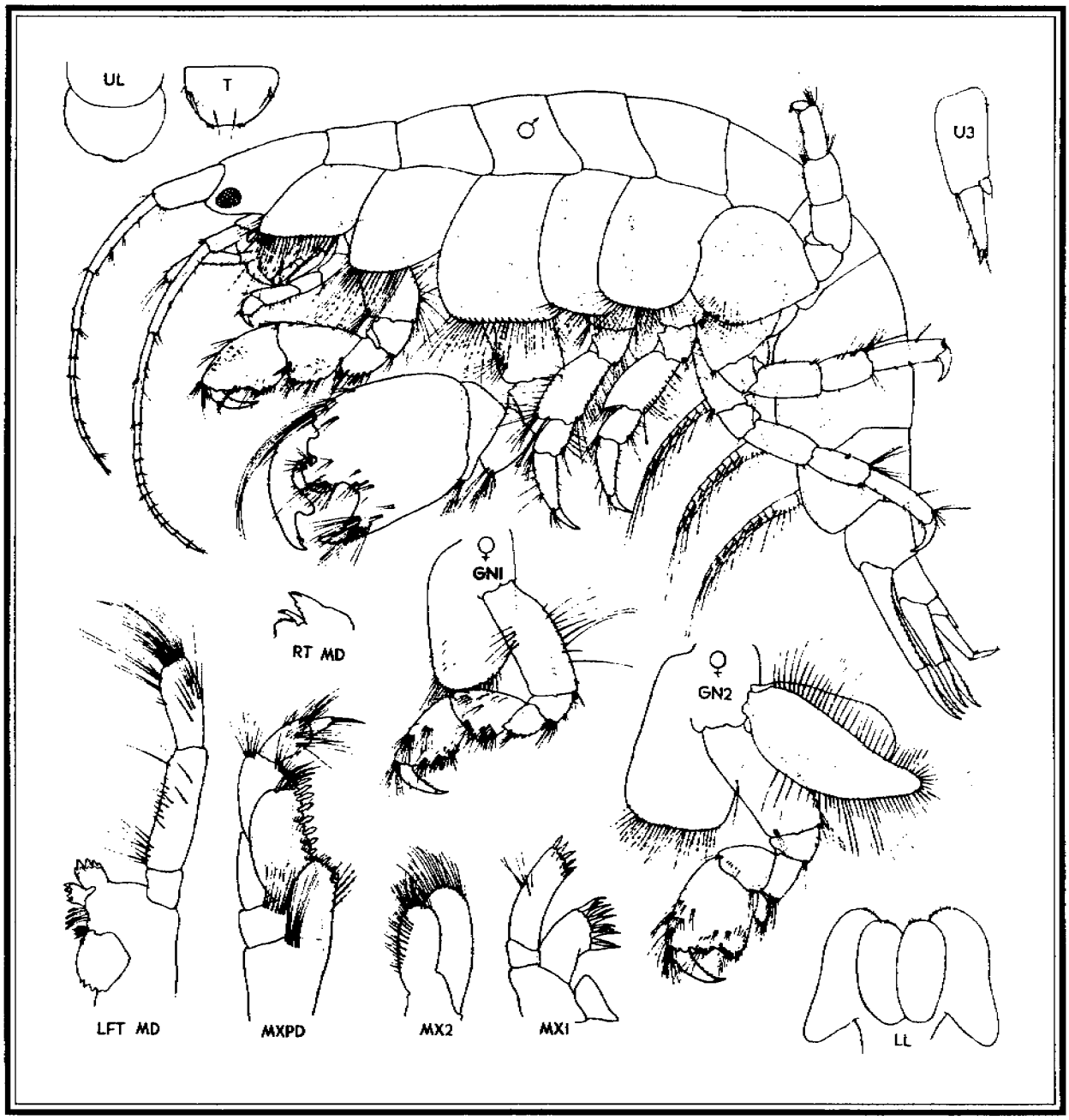

Figure 4.10. *Photis brevipes.* Adult male, 4.5 mm; adult female, 3.5 mm (from Conlan, 1983).

carpus as long as propodus, and palm of propodus convex; basis without cluster of long setae at anterior junction with ischium. Gnathopod 2 (adult male) larger than and different in shape from that of adult female and juvenile; basis, lateral face with row of stridulation ridges; carpus shorter than propodus, not toothed; propodus, palm basically transverse, with flat, round, or pointed protuberance followed by large, circular, or triangular excavation to form tooth at defining corner, this tooth extending as far as or farther than palmar protuberance, setae at dactyl hinge nearly as long as or longer than propodus; dactyl just overlapping palm, inner margin with rounded tooth extending into palmar excavation. Gnathopod 2 (adult female and juvenile) somewhat larger than gnathopod 1; carpus shorter than propodus, posterior lobe narrow; propodus, palm concave or appearing transverse and shallowly excavate. Adult female brood plates moderately wide, setae

without hook at each tip. Peraeopod 3 (adult male), coxa with row of stridulation ridges on ventral margin. Peraeopod 4, coxa, posterior margin not excavate. Peraeopods 3 and 4, basis not expanded, merus wider than carpus and produced anteriorly over about one-fourth of carpus; dactyl shorter than propodus. Peraeopod 5, coxa similar in depth to coxa 4; basis broad, not posteriorly excavate; merus not posteriorly excavate; merus and carpus not spinose; propodus with only single long spine at anterodistal corner; dactyl with 2 pronounced cusps at junction of unguis. Peraeopods 6 and 7, coxae smaller than coxa 5; otherwise articles similar in shape to peraeopod 5, although bases narrower and dactyls not cusped. Epimera 1-3 not posterodistally notched. Pleon and urosome without dorsally erect setae or cusps. Uropod 1, peduncle without lateral ecdysial spine or tooth-like process extending ventrally below rami; rami tipped by 1 short spine. Uropod 3, peduncle not spinose; outer ramus shorter than peduncle and tipped by 1 or 2 long setae, inner ramus about one-fourth length of outer, tipped by single short spine. Telson apices marked by single long seta and small knob.

Distribution and Biology. *Photis brevipes* is widely distibuted in the northeastern Pacific, having been recorded from Prince William Sound, Alaska (60°46'N, 146°31'W) south to Bahía Magdalena, Baja California (26°42'N, 113°34'W). It has been found in high salinity protected and exposed coasts predominately on sandy sediments at low water level to 492 m depth. Adult females have been found ovigerous from May to November.

Remarks. Of the northeastern Pacific species of *Photis*, *P. brevipes* is closest in appearance to *P. californica*. In *P. californica* the peduncle article 3 of antenna 1 is longer than article 1, and in the adult male second gnathopod the dactyl lacks the protuberance that is present in *P. brevipes*. In *P. brevipes* the position of the dactyl protuberance is variable, being adjacent to the unguis in small males and more central in large males. The appearance of the palmar protuberance also varies, being rounded or flat in large males and pointed in small males. In addition the palmar excavation is large and rounded in large males but narrowly incised in small males. Juvenile males also resemble *P. parvidons* Conlan, 1983, and can only be differentiated on the basis of size.

Photis californica Stout, 1913

Figures 4.11 and 4.12

Photis californica Stout, 1913:654-656.—J.L. Barnard, 1962:33-36, figs 12, 13; (not J.L. Barnard, 1954: 26-27, pls. 23, 24).

Material Examined. California: Santa Maria Basin, Sta. 65, 107 m, 2 adult males, 4 adult females, 9 juveniles; Cruise 1-3, Sta. R-4, Rep. 1, 92 m, 13 adult males, 12 adult females, 53 juveniles; Cruise 1-3, Sta. R-4, Rep. 2, 92 m, 17 adult males, 19 adult females, 96 juveniles; Cruise 1-3, Sta. PJ-10, Rep. 2, 147 m, 9 adult males, 6 adult females, 29 juveniles; Cruise 1-1, Sta. PJ-16, Rep. 2, 130 m, 2 adult females, 12 juveniles.

Description. Body length up to 4.5 mm (adult male), 3.0-5.5 mm (adult female). Head lobe triangular. Eye black, oval. Antenna 1 somewhat shorter than antenna 2. Antenna 1 weakly setose, article 3 longer than article 1; accessory flagellum microscopic button. Antenna 2 weakly setose, flagellum not pediform, longer than article 5, distally spinose. Upper lip, epistome triangular. Mandible with 2-4 raker spines; molar flake present; palp strong, article 3 hardly wider distally than proximally, both articles 2 and 3 with numerous setae, article 2 longer than article 3. Lower lip, outer lobes not spinose. Maxilla 1, inner plate without setae; palp narrower than outer plate. Maxilla 2, inner plate about same width as outer, with facial setae. Maxilliped, inner plate not reaching end of article 4; outer plate not reaching end of article 5; unguis (article 8) about equal in length to article 7. Sternal plate 1 not produced. Peraeopods 1-4, coxae, ventral margins with numerous long setae. Gnathopod 1 smaller than gnathopod 2. Gnathopod 1 (adult male), coxa similar in shape to coxa 2 but anteriorly produced; basis inserted midway on inner face; basis, anterior margin not densely setose; merus not extended as tooth under carpus; carpus longer than propodus, anterior margin

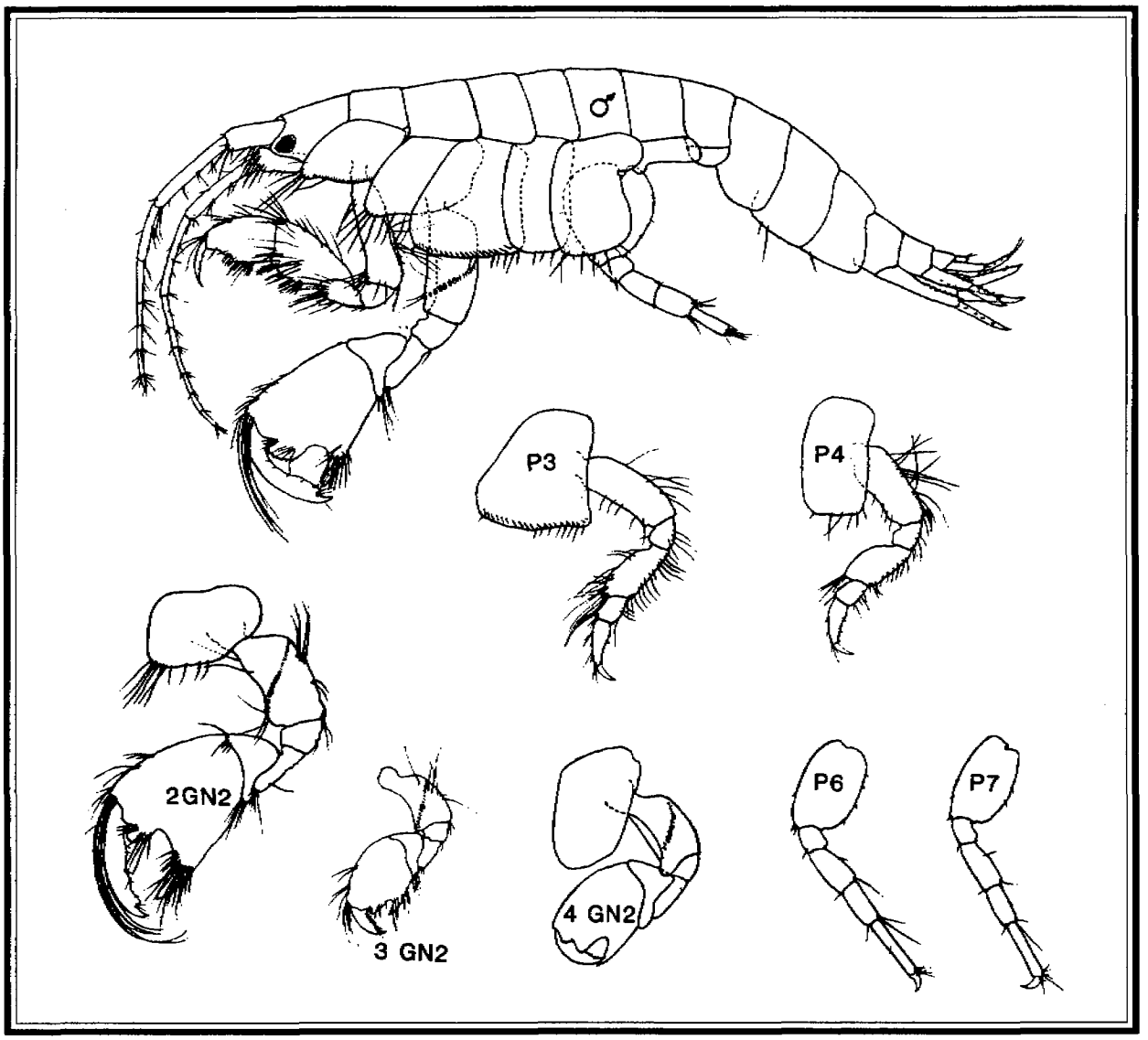

Figure 4.11. *Photis californica.* Adult male, 4.3 mm; adult male 2, 4.0 mm; juvenile male 3, 4.0 mm; juvenile male 4, 3.0 mm; peraeopods 3-7 from adult male, 4.3 mm (from J. L. Barnard, 1962).

setose, posterior lobe not expanded under propodus; propodus, palm concave, defined by single spine; dactyl only as long as palm of propodus, posterior (inner) margin with few short setae and several cusps. Gnathopod 1 (adult female and juvenile) similar in shape to gnathopod 2, although carpus slightly longer than propodus, and palm of propodus convex; basis without cluster of long setae at anterior junction with ischium. Gnathopod 2 (adult male) larger than and different in shape from that of adult female and juvenile; basis, lateral face with row of stridulation ridges; carpus shorter than propodus, not toothed; propodus, palm basically transverse, with flat, rounded, or pointed tooth proximally or centrally followed by circular or triangular excavation to form tooth at defining corner, this tooth extending as far as or farther than palmar tooth, setae at dactyl hinge as long as or longer than propodus; dactyl just overlapping palm, with shallow protuberance facing palmar protuberance and spine and setal cluster just proximal of unguis, but without tooth extending into palm. Gnathopod 2 (adult female and juvenile) somewhat larger than gnathopod 1; carpus shorter than propodus, posterior lobe narrow; propodus, palm shallowly concave. Adult female brood plates moderately wide, setae without hook at each tip. Peraeopod 3 (adult male), coxa with row of stridulation ridges on ventral margin.

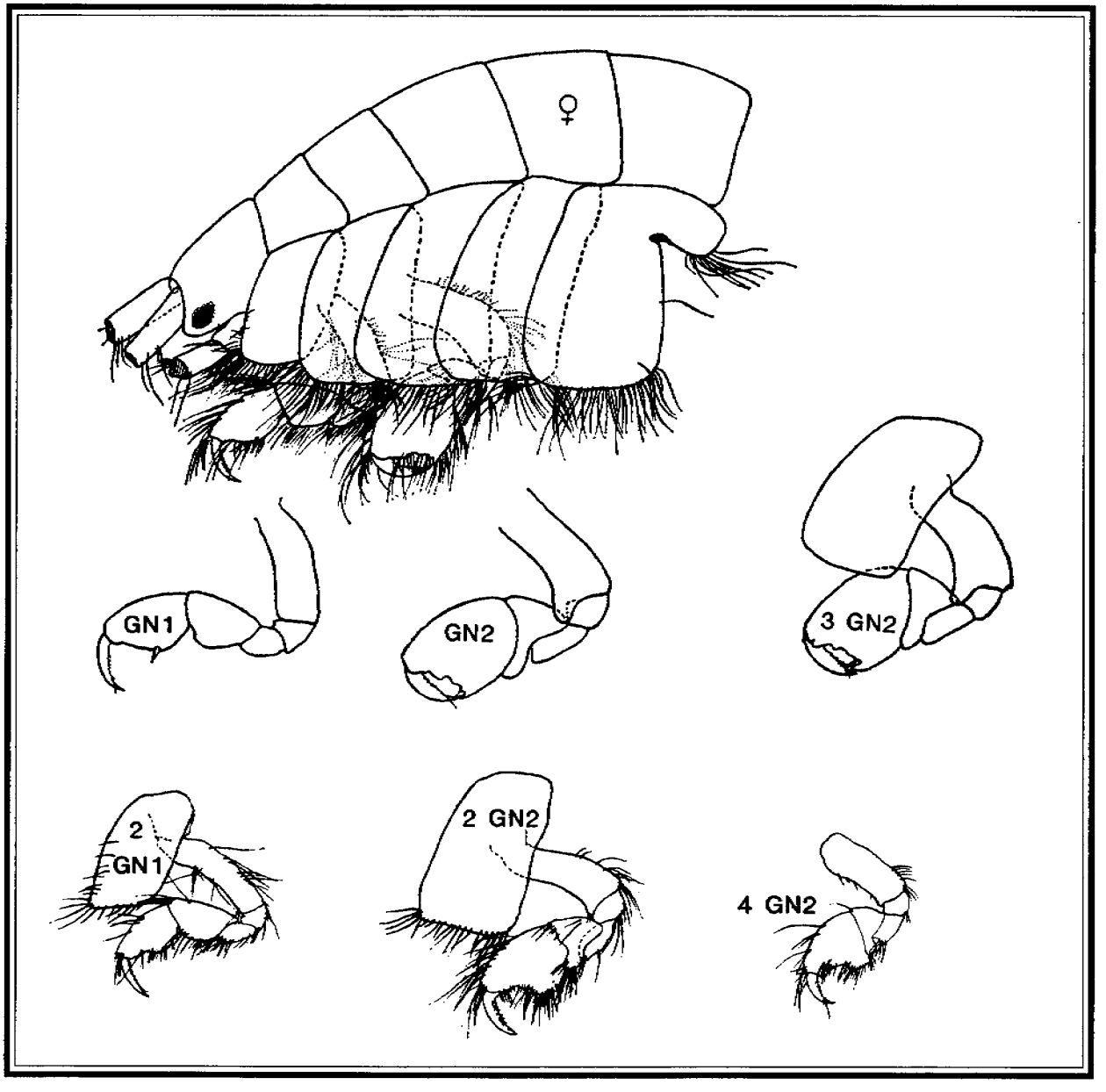

Figure 4.12. *Photis californica.* Adult female, 6.0 mm (isolated gnathopods 1 and 2 without setae); adult female 2, 5.3 mm; juvenile female 3, 3.0 mm (without setae); adult female 4, 3.0 mm (from J. L. Barnard, 1962).

Peraeopod 4, coxa, posterior margin not excavate. Peraeopods 3 and 4, basis not expanded, merus wider than carpus and produced anteriorly over about one-fourth of carpus; dactyl shorter than propodus. Peraeopod 5, coxa similar in depth to coxa 4; basis broad, not posteriorly excavate; merus not posteriorly excavate; merus and carpus not spinose; propodus with only single long spine at anterodistal corner; dactyl with 2 pronounced cusps at junction of unguis. Peraeopods 6 and 7, coxae smaller than coxa 5; otherwise articles similar in shape to peraeopod 5, although bases narrower and dactyls not cusped. Epimera 1-3 not posterodistally notched. Pleon and urosome without dorsally erect setae or cusps. Uropod 1, peduncle without lateral ecdysial spine or tooth-like process extending ventrally below rami; rami tipped by 1 short spine. Uropod 3, peduncle not spinose; outer ramus shorter than peduncle and tipped by spine and 1 or 2 long setae, inner ramus about one-fourth length of outer, tipped by single short spine. Telson apices marked by single long seta and small knob.

Distribution and Biology. *Photis californica* has been found only from Monterey Bay, California to San Cristobal Bay, Baja California, from the low intertidal zone to 147 m depth.

Remarks. See comments for *P. brevipes*.

Photis macrotica J.L. Barnard, 1962

Figure 4.13

Photis macrotica J.L. Barnard, 1962:44-45, fig. 19.

Material Examined. California: Santa Maria Basin, Sta. BRA-17, 160-168 m, 1 adult male, 13 juveniles; Cruise 1-1, Sta. PJ-16, Rep. 2, 130 m, 1 juvenile.

Description. Body length up to 3.5 mm (adult male), 3.0 mm (adult female). Head lobe triangular. Eye black, circular, large for genus. Antenna 1 somewhat shorter than antenna 2. Antenna 1 weakly setose, article 3 longer than article 1; accessory flagellum microscopic button. Antenna 2 weakly setose, flagellum not pediform, longer than article 5, distally spinose. Upper lip, epistome triangular. Mandible with 2-4 raker spines; molar flake present; palp strong, article 3 hardly wider distally than proximally, both articles 2 and 3 with numerous setae, article 2 longer than article 3. Lower lip, outer lobes not spinose. Maxilla 1, inner plate without setae; palp narrower than outer plate. Maxilla 2, inner plate about same width as outer, with facial setae. Maxilliped, inner plate not reaching end of article 4; outer plate not reaching end of article 5; unguis (article 8) about equal in length to article 7. Sternal plate 1 not produced. Peraeopods 1-4, coxae, ventral margins with 0-4 long setae. Gnathopod 1 smaller than gnathopod 2. Gnathopod 1 (adult male), coxa similar in shape to coxa 2 but distally pointed; basis inserted proximally on inner face; basis, anterior margin not densely setose; merus not extended as tooth under carpus; carpus longer than propodus, anterior margin setose, posterior lobe not expanded under propodus; propodus, palm shallowly concave, defined by single spine; dactyl only as long as palm of propodus, posterior (inner) margin with few short setae and cusps. Gnathopod 1 (adult female and juvenile) similar in shape to gnathopod 2, although carpus slightly longer than propodus, and palm of propodus convex; basis without cluster of long setae at anterior junction with ischium. Gnathopod 2 (adult male) larger than and different in shape from that of adult female and juvenile; basis, lateral face with row of stridulation ridges; carpus shorter than propodus, not toothed; propodus, palm basically transverse, with pointed tooth proximally or centrally followed by triangular excavation to form tooth at defining corner, this tooth not extending as far as palmar tooth, setae at dactyl hinge shorter than propodus; dactyl just overlapping palm, with small tooth proximally and spine and setal cluster just proximal of unguis, but without tooth extending into palm. Gnathopod 2 (adult female and juvenile) somewhat larger than gnathopod 1; carpus shorter than propodus, posterior lobe narrow; propodus, palm shallowly concave. Adult female brood plates moderately wide, setae without hook at each tip. Peraeopod 3 (adult male), coxa with row of stridulation ridges on ventral margin. Peraeopod 4, coxa, posterior margin not excavate. Peraeopods 3 and 4, basis not expanded, merus wider than carpus and produced anteriorly over about one-fourth of carpus; dactyl shorter than propodus. Peraeopod 5, coxa similar in depth to coxa 4; basis broad, not posteriorly excavate; merus not posteriorly excavate; merus and carpus not spinose; propodus with only single long spine at anterodistal corner; dactyl with 2 pronounced cusps at junction of unguis. Peraeopods 6 and 7, coxae smaller than coxa 5; otherwise articles similar in shape to peraeopod 5, although bases narrower and dactyls not cusped. Epimera 1-3 not posterodistally notched. Pleon and urosome without dorsally erect setae or cusps. Uropod 1, peduncle without lateral ecdysial spine or tooth-like process extending ventrally below rami; rami tipped by 1 short spine. Uropod 3, peduncle not spinose; outer ramus shorter than peduncle and tipped by long seta, inner ramus about one-fourth length of outer, tipped by single short spine. Telson apices marked by single long seta and small knob.

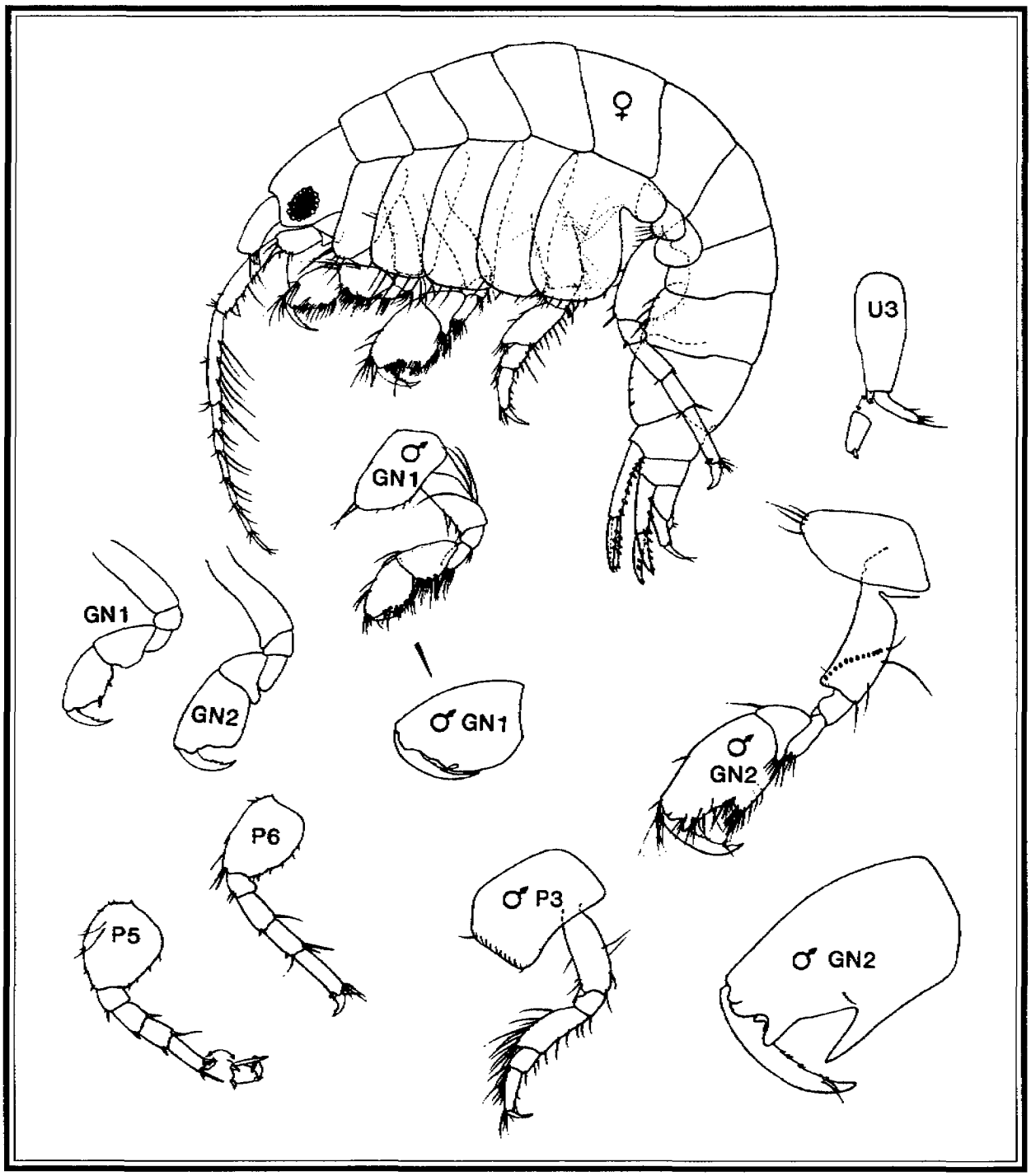

Figure 4.13. *Photis macrotica.* Adult female, 3.0 mm; adult male, holotype, 3.3 mm (from J. L. Barnard, 1962).

Distribution and Biology. *Photis macrotica* has been found only from Monterey Bay, California to San Cristobal Bay, Baja California, from 55 to 160 m depth.

Remarks. *Photis macrotica* has larger eyes than other California species of *Photis*. Other distinguishing characteristics in combination are the small number of long setae on the ventral margins of the coxae (both sexes), and, in the adult male's second gnathopod, the shortness of the setal cluster at the junction of propodus and dactyl, the shortness of the palmar defining tooth, the pointed palmar tooth, and the lack of a central tooth on the dactyl.

Protomedeia articulata J.L. Barnard, 1962

Figure 4.14

Protomedeia articulata J.L. Barnard, 1962:48-50, fig. 21.—Conlan, 1983:27, fig. 12.

Material Examined. California: Santa Maria Basin, Cruise 1-1, Sta. R-2, Rep. 3, 161 m, 3 adult males, 1 adult female.

Description. Body length up to 8.0 mm (adult male), 5.0-7.0 mm (adult female). Head lobe squared. Eye black, oval. Antenna 1 somewhat longer than antenna 2. Antenna 1 weakly setose, article 3 shorter than article 1; accessory flagellum 4 articles. Antenna 2 moderately setose, flagellum pediform, equal in length to article 5, not distally spinose. Upper lip, epistome roundly triangular. Mandible with 2-3 raker spines; molar flake present; palp strong, article 3 not wider distally than proximally, both articles 2 and 3 with numerous setae, article 2 longer than article 3. Lower lip, outer lobes not spinose. Maxilla 1, inner plate setose; palp wider than outer plate. Maxilla 2, inner plate about same width as outer, without facial setae. Maxilliped, inner plate reaching beyond end of article 4; outer plate nearly reaching to end of article 5; unguis (article 8) about equal in length to article 7. Sternal plate 1 not produced. Peraeopods 1-4, coxae, ventral margins with few long setae only (coxa 1 more so than other coxae). Gnathopod 1 smaller than gnathopod 2. Gnathopod 1 (adult male), coxa anteriorly produced; basis inserted distally on inner face; basis not densely setose; merus not extended as tooth under carpus; carpus longer than propodus, anterior margin with two clusters of setae and third at anterior junction with propodus, posterior lobe not expanded under propodus; propodus, palm transverse, defined by single long spine; dactyl longer than palm of propodus, posterior (inner) margin with few short setae and cusps. Gnathopod 1 (adult female and juvenile) similar in shape to adult male gnathopod 1, anterior margin of basis and carpus more setose. Gnathopod 2 (adult male) larger than and different in shape from that of adult female and juvenile; basis without stridulation ridges; carpus longer than propodus, not toothed; propodus, palm transverse, defined by strong spine, setae at dactyl hinge less than half length of propodus; dactyl not toothed, overlapping palm, but not as much so as in gnathopod 1. Gnathopod 2 (adult female and juvenile) somewhat larger than gnathopod 1; carpus as long as propodus, posterior lobe broad; propodus, palm oblique. Adult female brood plates narrow, setae without hook at each tip. Peraeopod 3 (adult male), without stridulation ridges on ventral margin. Peraeopod 4, coxa, posterior margin not excavate. Peraeopods 3 and 4, basis not expanded, merus wider than carpus, but not produced over carpus; dactyl elongate, nearly as long as propodus. Peraeopod 5, coxa deeper than coxa 4; basis moderately broad, not posteriorly excavate; merus not posteriorly excavate, not spinose; carpus with cluster of spines at posterior junction of propodus; propodus with few slender spines along anterior margin; dactyl not cusped. Peraeopods 6 and 7, coxae smaller than coxa 5; otherwise articles similar in shape to peraeopod 5, although bases wider. Epimera 1-3 with small notch and setae posterodistally. Urosome segments 1 and 2 with pair of dorsally erect setae but without cusps. Uropod 1, peduncle with row of lateral ecdysial spines proximally and tooth-like process extending ventrally below rami; rami tipped by 2-4 long spines. Uropod 3, peduncle dorsally spinose; outer ramus longer than peduncle and tipped by cluster of spine-like setae, inner ramus two-thirds length of outer, tipped by cluster of spines. Telson apices marked by cluster of setae and nipple.

Distribution and Biology. *Protomedeia articulata* has been recorded from Oregon (46°13'N, 124°90'W) to La Jolla, California (32°52'N, 117°16'W) from 9 to 200 m depth on the exposed coastal shelf and in submarine canyons. According to Barnard (1971), the single record of this species from 906 m is suspect, due to uncertain identification. Adult females have been found ovigerous in July.

Remarks. Adult males of *Protomedeia articulata* differ from *P. prudens* in both the first and second gnathopod: in *P. articulata* the carpus is hardly longer than the propodus and the dactyl is about half the length of the propodus and not recurved on the propodus as in *P. prudens*. The posterior margin of the propodus of the second gnathopod is not cusped, and the dactyl is not elongate or straight as in *P. prudens*. Unfortunately juveniles and adult females of the two species are difficult to distinguish.

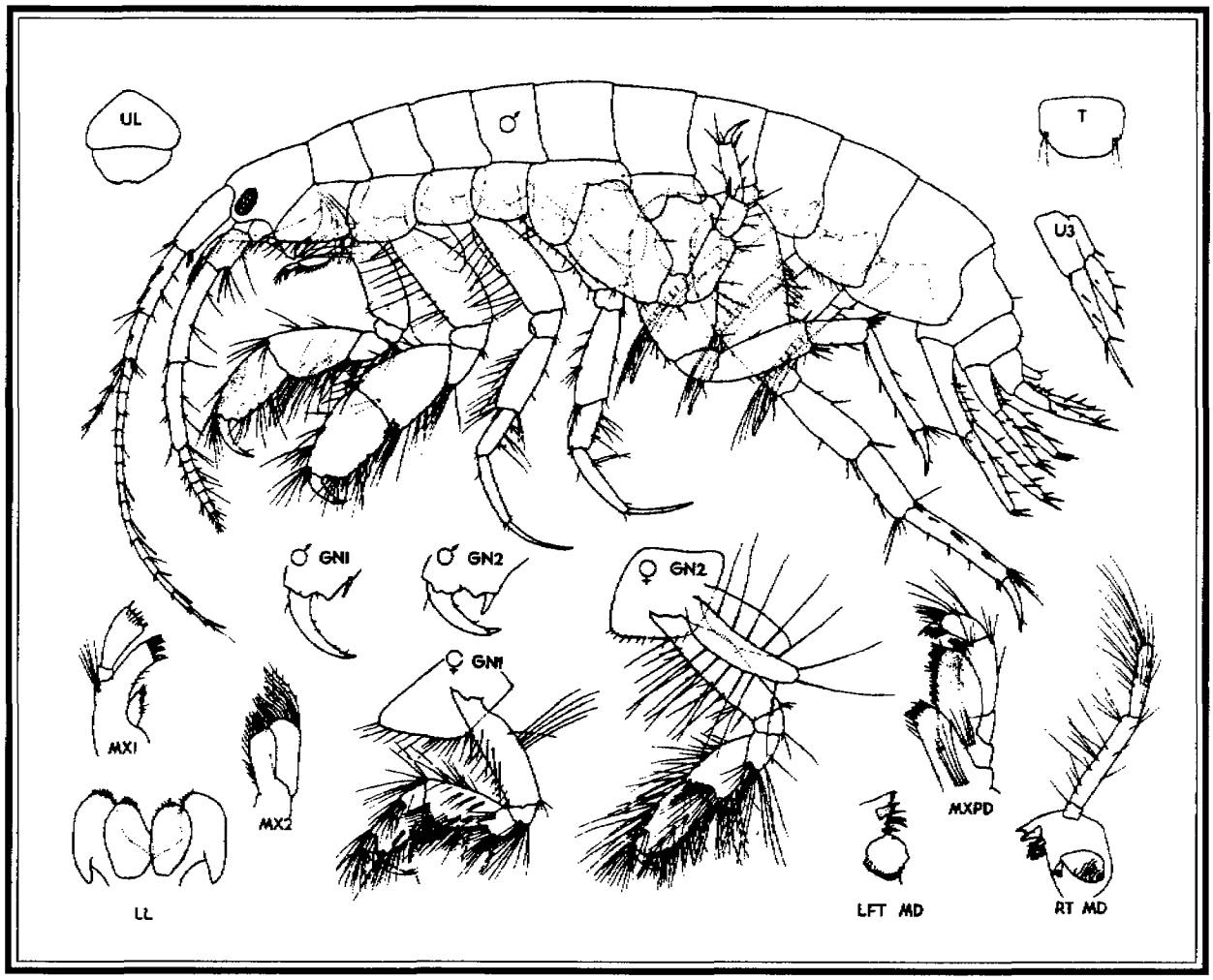

Figure 4.14. *Protomedeia articulata.* Adult male, 4.5 mm (antenna 1 from juvenile male, 3.5 mm); adult female, 7.0 mm (from Conlan, 1983).

Protomedeia prudens J.L. Barnard, 1966

Figure 4.15

Protomedeia prudens J.L. Barnard, 1966:83, fig. 36; 1971:15-17, figs. 11, 12.—Conlan, 1983:31-33, figs. 15, 16.

Material Examined. California: Santa Maria Basin, Cruise 1-3, Sta. R-3, Rep. 2, 409 m, 1 adult male, 1 adult female, 2 juveniles.

Description. Body length up to 6.0 mm (adult male), 4.5-7.5 mm (adult female). Head lobe squared. Eye black, oval. Antenna 1 somewhat longer than antenna 2. Antenna 1 weakly setose, article 3 shorter than article 1; accessory flagellum 4-6 articles. Antenna 2 moderately setose, flagellum pediform, somewhat shorter than article 5, not distally spinose. Upper lip, epistome roundly triangular. Mandible with 2-3 raker spines; molar flake present; palp strong, article 3 not wider distally than proximally, both articles 2 and 3 with numerous setae, article 2 longer than article 3. Lower lip, outer lobes not spinose. Maxilla 1, inner plate setose; palp wider than outer plate. Maxilla 2, inner plate about same width as outer, without facial

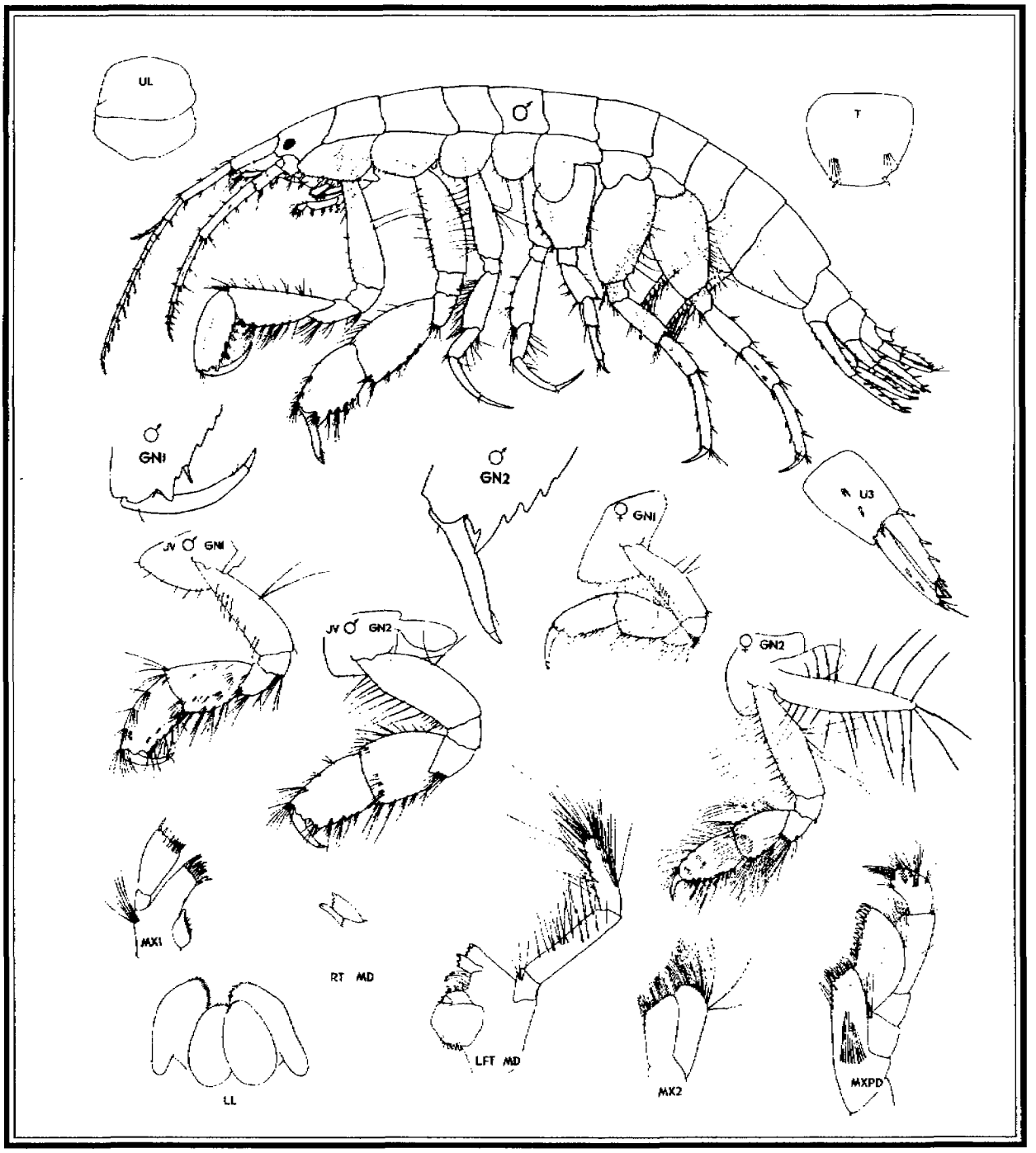

Figure 4.15. *Protomedeia prudens.* Adult male, 6.0 mm; juvenile male, 4.5 mm; adult female, 7.0 mm (from Conlan, 1983).

setae. Maxilliped, inner plate reaching beyond end of article 4; outer plate nearly reaching to end of article 5; unguis (article 8) about equal in length to article 7. Sternal plate 1 not produced. Peraeopods 1-4, coxae, ventral margins with numerous short setae (coxa 1 more so than other coxae). Gnathopod 1 smaller than gnathopod 2. Gnathopod 1 (adult male), coxa anteriorly produced; basis inserted distally on inner face; basis not densely setose; merus not extended as tooth under carpus; carpus longer than propodus, anterior margin with numerous clusters of setae along anterior margin, posterior lobe not expanded under propodus; propodus,

palm transverse, defined by tooth distally and spine proximally; dactyl longer than palm of propodus, posterior (inner) margin with few short setae but without cusps. Gnathopod 1 (adult female and juvenile) similar in shape to adult male gnathopod 1, but coxa and basis with longer setae, carpus shorter in relation to propodus and both articles wider, palm of propodus not defined by tooth, and dactyl shorter. Gnathopod 2 (adult male) larger than and different in shape from that of adult female and juvenile; basis without stridulation ridges; carpus longer than propodus, not toothed; propodus, palm transverse, defined by tooth, setae at dactyl hinge less than half length of propodus; dactyl not toothed, straight or slightly sinuous, 3-4 times length of palm. Gnathopod 2 (adult female and juvenile) somewhat larger than gnathopod 1; basis, carpus, and propodus clothed in abundant long setae; carpus nearly as long as propodus, posterior lobe broad; propodus, palm oblique, dactyl not extending much beyond palmar defining spine. Adult female brood plates narrow, setae without hook at each tip. Peraeopod 3 (adult male), without stridulation ridges on ventral margin. Peraeopod 4, coxa, posterior margin not excavate. Peraeopods 3 and 4, basis not expanded, merus wider than carpus, but not produced over carpus; dactyl elongate, nearly as long as propodus. Peraeopod 5, coxa deeper than coxa 4; basis moderately broad, not posteriorly excavate; merus not posteriorly excavate, not spinose; carpus with cluster of spines at posterior junction of propodus; propodus with few slender spines along anterior margin; dactyl not cusped. Peraeopods 6 and 7, coxae smaller than coxa 5, otherwise articles similar in shape to peraeopod 5, although bases not bulging anteriorly. Epimera 1-3 with facial crease. Urosome segments 1 and 2 with pair of dorsally erect setae but without cusps. Uropod 1, peduncle with row of lateral ecdysial spines proximally and tooth-like process extending ventrally below rami; rami tipped by 2-4 long spines. Uropod 3, peduncle dorsally spinose; outer ramus longer than peduncle and tipped by cluster of spine-like setae, inner ramus more than three-fourths length of outer, tipped by cluster of spines. Telson apices marked by cluster of setae and nipple.

Distribution and Biology. *Protomedeia prudens* has been recorded from the Queen Charlotte Islands, British Columbia (53°14'N, 131°54'W) to La Jolla, California (32°52'N, 117°16'W) from low water level to 409 m depth on the exposed coastal shelf and in submarine canyons. Adult females have been found ovigerous from April to August.

Remarks. The basis of peraeopod 5 may not be as anteriorly bulged as figured here, and there may be several clusters of spines on the carpus of peraeopods 5-7. In large males the carpus of gnathopods 1 and 2 may be almost twice as long as the propodus. See also remarks for *Protomedeia articulata*.

Gammaropsis (Gammaropsis) thompsoni (Walker, 1898)

Figure 4.16

Maeroides thompsoni Walker, 1898:283-384, pl. 16, figs. 3-6.
Gammaropsis tenuicornis Holmes, 1904:239-240, fig. 124.
Fimbriella robusta Stout, 1913:642-644.
Podoceropsis concava Shoemaker, 1931:5-8, figs. 3, 4; 1942:28, fig. 10
Eurystheus thompsoni (Walker, 1898): Shoemaker, 1955:59.—J.L. Barnard, 1959:36, plate 11.
Gammaropsis thompsoni: J.L. Barnard, 1969b:271; Conlan, 1983:11-13, Fig. 4.

Material Examined. California: Santa Maria Basin, Sta. BRA-16, 91.5-123 m, replicate 2 with 4 adult males, 13 juveniles, replicate 3 with 2 adult females, 6 juveniles.

Description. Body length up to 11.5 mm (adult male), 4.5-10.0 mm (adult female). Head lobe triangular, anteriorly acute. Eye black, reniform. Antennae 1 and 2 about equal in length. Antenna 1 moderately setose with long setae posteriorly, article 3 as long as article 1; accessory flagellum 8 articles. Antenna 2 moderately setose, with long setae also, flagellum not pediform, longer than article 5, not distally spinose. Upper lip, epistome acutely produced. Mandible with 6-7 raker spines; molar flake present; palp strong, article 3 hardly wider distally than proximally, both articles 2 and 3 with numerous setae, article 2

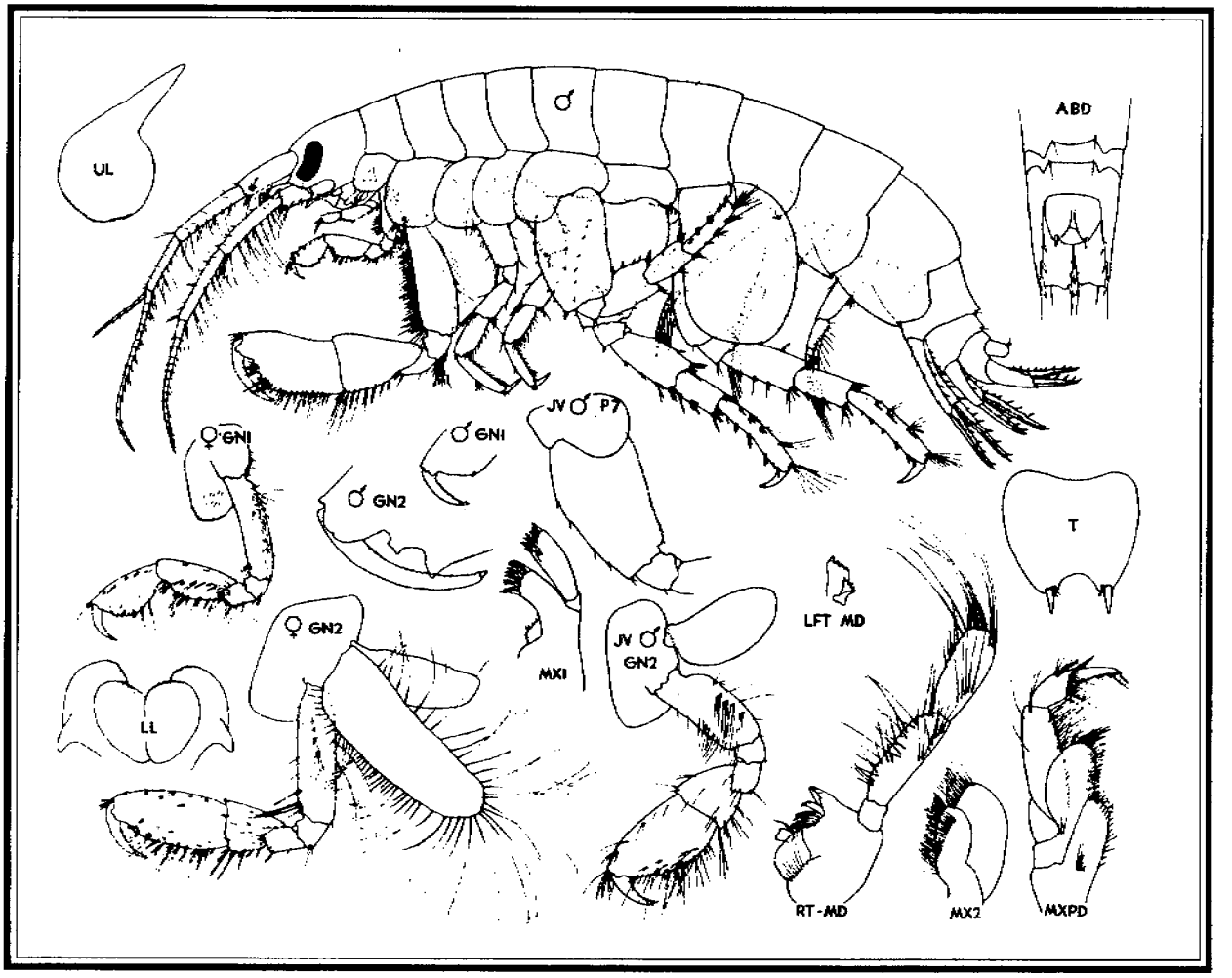

Figure 4.16. *Gammaropsis (Gammaropsis) thompsoni.* Adult male, 10.0 mm; juvenile male, 4.5 mm; adult female, 8.5 mm (from Conlan, 1983).

longer than article 3. Lower lip, outer lobes not spinose. Maxilla 1, inner plate setose; palp about as wide as outer plate. Maxilla 2, inner plate narrower than outer, with row of facial setae. Maxilliped, inner plate reaching to end of article 4; outer plate not reaching end of article 5; unguis (article 8) shorter than article 7. Sternal plate 1 not produced. Peraeopods 1-4, coxae, ventral margins with minute setae only. Gnathopod 1 smaller than gnathopod 2. Gnathopod 1 (adult male), coxa similar in shape to but half depth of coxa 2; basis inserted midway on inner face, densely setose anterodistally; merus not extended as tooth under carpus; carpus somewhat shorter than propodus, anterior margin without setae, posterior lobe not expanded under propodus; propodus, palm oblique, defined by single small spine; dactyl only as long as palm of propodus, posterior (inner) margin with few short setae and cusps. Gnathopod 1 (adult female and juvenile), coxa three-fourths depth of coxa 2, but otherwise similar in shape to adult male gnathopod 1. Gnathopod 2 (adult male) larger than and different in shape from that of adult female and juvenile; basis without stridulation ridges; carpus nearly as long as propodus, not toothed; propodus, palm transverse, with protuberance centrally and another at corner, but without palmar defining spine, setae at dactyl hinge about one-fourth length of propodus; dactyl not toothed, overlapping palm. Gnathopod 2 (adult female and juvenile) larger than gnathopod 1; carpus shorter than propodus, posterior lobe about one-half length of anterior margin; propodus, palm oblique. Adult female brood plates moderately wide, setae with hook at each tip. Peraeopod 3 (adult male), coxa without stridulation ridges on ventral margin. Peraeopod 4, coxa, posterior margin not excavate.

Peraeopods 3 and 4, basis not expanded, merus not wider than and not produced over carpus; dactyl not elongate, much shorter than propodus. Peraeopod 5, coxa as deep as coxa 4; basis moderately broad, shallowly concave; merus not posteriorly excavate; merus and carpus with cluster of spines at posterior junction of propodus; propodus strongly spinose along anterior margin; dactyl not cusped. Peraeopod 7, coxa (adult male) more than 3 times depth of coxa 6; coxa 7 (adult female and juvenile) not enlarged; otherwise peraeopods 6 and 7 similar in shape to peraeopod 5, although bases wider. Epimera 1-3 with facial crease and small cusp posterodistally. Urosome segments 1 and 2 with pair of dorsally erect setae and cusps. Uropod 1, peduncle with row of lateral ecdysial spines and tooth-like process extending ventrally below rami; rami tipped by 2-4 spines. Uropod 3, peduncle dorsally spinose; outer ramus somewhat shorter than peduncle and tipped by 1-2 spines, inner ramus as long as outer, tipped by 1-2 spines. Telson apices marked by strong spine and short setae.

Distribution and Biology. *Gammaropsis (Gammaropsis) thompsoni* has been recorded from southeastern Alaska (57°29'N, 135°58'W) to the San Diego shelf (33°N, 118°W) from the low intertidal zone to 91 m depth on high salinity exposed and semi-protected coasts. Adult females have been found ovigerous from May to August.

Remarks. The reniform eye makes *Gammaropsis (Gammaropsis) thompsoni* distinctive from other species described in this section. Other distinctive features are the acutely produced headlobe and cusped urosome segments 1 and 2.

Gammaropsis (Podoceropsis) ocellata Conlan, 1994

Figure 4.17

Gammaropsis (Podoceropsis) ocellata Conlan, 1994b:72-73, fig. 3.

Material Examined. California: Santa Maria Basin, Sta. 55, 590 m, 1 adult male, 7 adult females, 11 juveniles (type).

Description. Body length up to 3.8 mm (adult male), 4.4 mm (adult female). Head lobe triangular, but not anteriorly acute. Eye unpigmented, oval. Antennae 1 and 2 equal in length. Antenna 1 moderately setose with long setae posteriorly, article 3 longer than article 1; accessory flagellum microscopic button. Antenna 2 moderately setose, with long setae also, flagellum not pediform, longer than article 5, distally spinose. Upper lip, epistome acutely produced. Mandible with 5 raker spines; molar flake present; palp strong, article 3 hardly wider distally than proximally, both articles 2 and 3 with numerous setae, article 2 longer than article 3. Lower lip, outer lobes not spinose. Maxilla 1, inner plate with single long seta; palp somewhat narrower than outer plate. Maxilla 2, inner plate nearly as wide as outer, with row of facial setae. Maxilliped, inner plate nearly reaching end of article 4; outer plate not reaching end of article 5; unguis (article 8) as long as article 7. Sternal plate 1 not produced. Peraeopods 1-4, coxae, ventral margins with minute setae only. Gnathopod 1 smaller than gnathopod 2. Gnathopod 1 (adult male), coxa similar in shape to and not shallower than coxa 2; basis inserted mid-distally on inner face, not setose anterodistally; merus not extended as tooth under carpus; carpus longer than propodus, with anterodistal cluster of setae, posterior lobe not expanded under propodus; propodus nearly simple, palm indistinct, defined by single long spine; dactyl much longer than palm of propodus, posterior (inner) margin with several short setae and cusps. Gnathopod 1 (adult female and juvenile) similar in shape to adult male gnathopod 1. Gnathopod 2 (adult male) larger than and different in shape from that of adult female and juvenile; basis without stridulation ridges; carpus shorter than propodus, not toothed; propodus, palm nearly transverse, with protuberance near origin of dactyl followed by an oval incision, spine at palmar corner, setae at dactyl hinge about one-half length of propodus; dactyl not toothed, only as long as palm. Gnathopod 2 (adult female and juvenile) larger than gnathopod 1; carpus shorter than propodus, posterior lobe about one-half length of anterior margin; propodus, palm shallowly excavate. Adult female brood plates moderately wide, setae with hook at each tip. Peraeopod 3 (adult

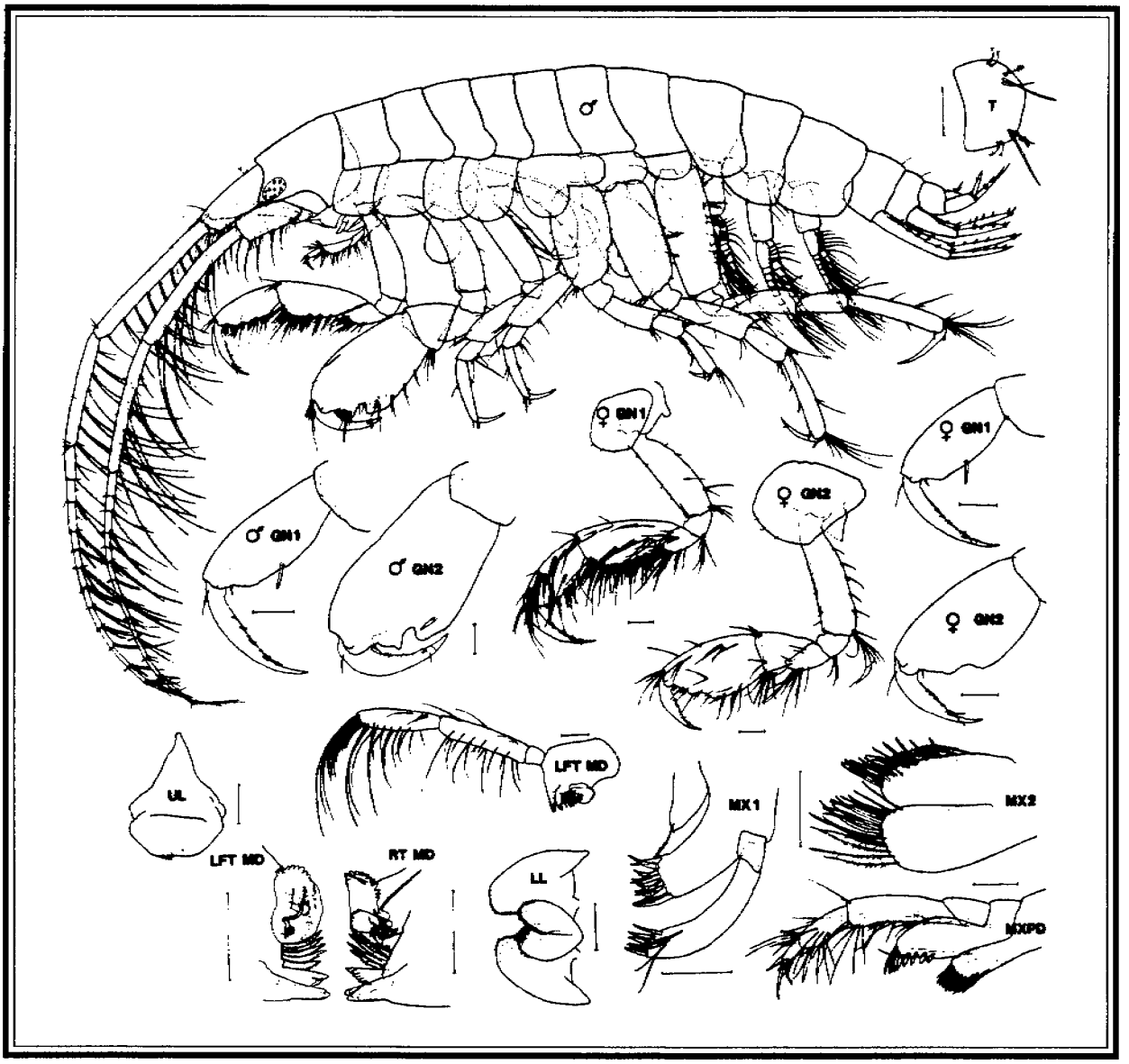

Figure 4.17. *Gammaropsis (Podoceropsis) ocellata.* Holotype, adult male, 3.4 mm; allotype, adult female, 4.4 mm (from Conlan, 1994b).

male), coxa without stridulation ridges on ventral margin. Peraeopod 4, coxa, posterior margin not excavate. Peraeopods 3 and 4, basis not expanded, merus wider than but hardly produced over carpus; dactyl not elongate, much shorter than propodus. Peraeopod 5, coxa as deep as coxa 4; basis moderately broad, shallowly posteriorly excavate in adult male; merus shallowly concave posteriorly; carpus with cluster of spines at posterior junction of propodus; propodus with few spines along anterior margin; dactyl not cusped. Peraeopod 7, coxa not expanded. Peraeopods 6 and 7 similar in shape to peraeopod 5, although bases narrower. Epimera 1-3 with few minute setae posterodistally but without cusps or ridges. Urosome segments 1 and 2 with pair of dorsally erect setae but without cusps. Uropod 1, peduncle without lateral ecdysial spines, but with tooth-like process extending ventrally below rami; rami tipped by 2-3 spines. Uropod 3, peduncle spinose dorsally at origin of rami; outer ramus nearly as long as peduncle and tipped by 1-2 long setae, inner ramus as long as outer, tipped by 1 spine. Telson apices marked by nipple and setal cluster.

Distribution and Biology. *Gammaropsis (Podoceropsis) ocellata* has only been found at one location in the Santa Maria Basin at 590 m depth.

Remarks. The unpigmented eye makes *Gammaropsis (Podoceropsis) ocellata* distinctive from other members of the subgenus. *Gammaropsis (Podoceropsis) ocellata* most closely resembles *G. (P). barnardi*, which has been described from the southern and western Sakhalin, Russia (50°N, 145°W) and Vancouver Island, British Columbia (48°48'N, 125°12.5'W) (Kudryashov and Tzvetkova, 1975; Conlan, 1983). *Gammaropsis (Podoceropsis) ocellata* differs from *G. (P). barnardi* in having an unpigmented eye, more transverse male gnathopod 2 palm, more concave female gnathopod 2 palm, and less excavate male peraeopod 5 basis.

Gammaropsis (Podoceropsis) ociosa (J.L. Barnard, 1962)

Figure 4.18

Kermystheus ociosa J.L. Barnard, 1962:23, fig. 8.
Podoceropsis ociosa: J.L. Barnard and G.S. Karaman, 1991.

Material Examined. California: Santa Maria Basin, Cruise 1-2, Sta. R-2, Rep. 3, 161 m, 2 adult males, 3 adult females, 12 juveniles; Cruise 1-2, Sta. R-5, Rep. 2, 154 m, 1 adult male, 2 adult females, 3 juveniles; Cruise 3-1, Sta. R-5, Rep. 1, 154 m, 1 adult male, 1 adult female.

Description. Body length up to 5.2 mm (adult male), 4.5 mm (adult female). Head lobe triangular, but not anteriorly acute. Eye black, oval. Antenna 1 about equal in length to antenna 2. Antenna 1 moderately setose with long setae posteriorly, article 3 longer than article 1; accessory flagellum microscopic button. Antenna 2 moderately setose, with long setae also, flagellum not pediform, longer than article 5, not distally spinose. Upper lip, epistome acutely produced. Mandible with 5-6 raker spines; molar flake present; palp strong, article 3 wider distally than proximally, both articles 2 and 3 with numerous setae, article 2 longer than article 3. Lower lip, outer lobes not spinose. Maxilla 1, inner plate setose; palp about as wide as outer plate. Maxilla 2, inner plate as wide as outer, with row of facial setae. Maxilliped, inner plate not reaching end of article 4; outer plate not reaching end of article 5; unguis (article 8) as long as article 7. Sternal plate 1 not produced. Peraeopods 1-4, coxae, ventral margins with minute setae only. Gnathopod 1 smaller than gnathopod 2. Gnathopod 1 (adult male), coxa similar in shape to and not shallower than coxa 2; basis inserted mid-distally on inner face, not setose anterodistally; merus not extended as tooth under carpus; carpus longer than propodus, anterior margin with 1 group of setae at anterodistal junction of propodus, posterior lobe not expanded under propodus; propodus nearly simple, palm indistinct, not defined by spine; dactyl much longer than palm of propodus, posterior (inner) margin with several short setae and cusps. Gnathopod 1 (adult female and juvenile) similar in shape to adult male gnathopod 1. Gnathopod 2 (adult male) larger and different in shape from that of adult female and juvenile; basis without stridulation ridges; carpus shorter than propodus, not toothed; propodus, palm transverse, with shelf followed by narrow incision to give defining corner appearance of tooth, setae at dactyl hinge less than one-fourth length of propodus; dactyl as long as propodus, inner margin sinuous, with broad expansion near origin. Gnathopod 2 (adult female and juvenile) larger than gnathopod 1; carpus shorter than propodus, posterior lobe about one-half length of anterior margin; propodus, palm concave. Adult female brood plates moderately wide, setae with hook at each tip. Peraeopod 3 (adult male), coxa without stridulation ridges on ventral margin. Peraeopod 4, coxa, posterior margin not excavate. Peraeopods 3 and 4, basis not expanded, merus wider than but hardly produced over carpus; dactyl not elongate, much shorter than propodus. Peraeopod 5, coxa as deep as coxa 4; basis moderately broad, posteriorly excavate in adult male; merus posteriorly excavate; carpus with cluster of spines at posterior junction of propodus; propodus with several spines marginally and long spine at origin of dactyl; dactyl cusped. Peraeopods 6 and 7, coxae smaller than coxa 5, otherwise articles similar in shape to peraeopod 5,

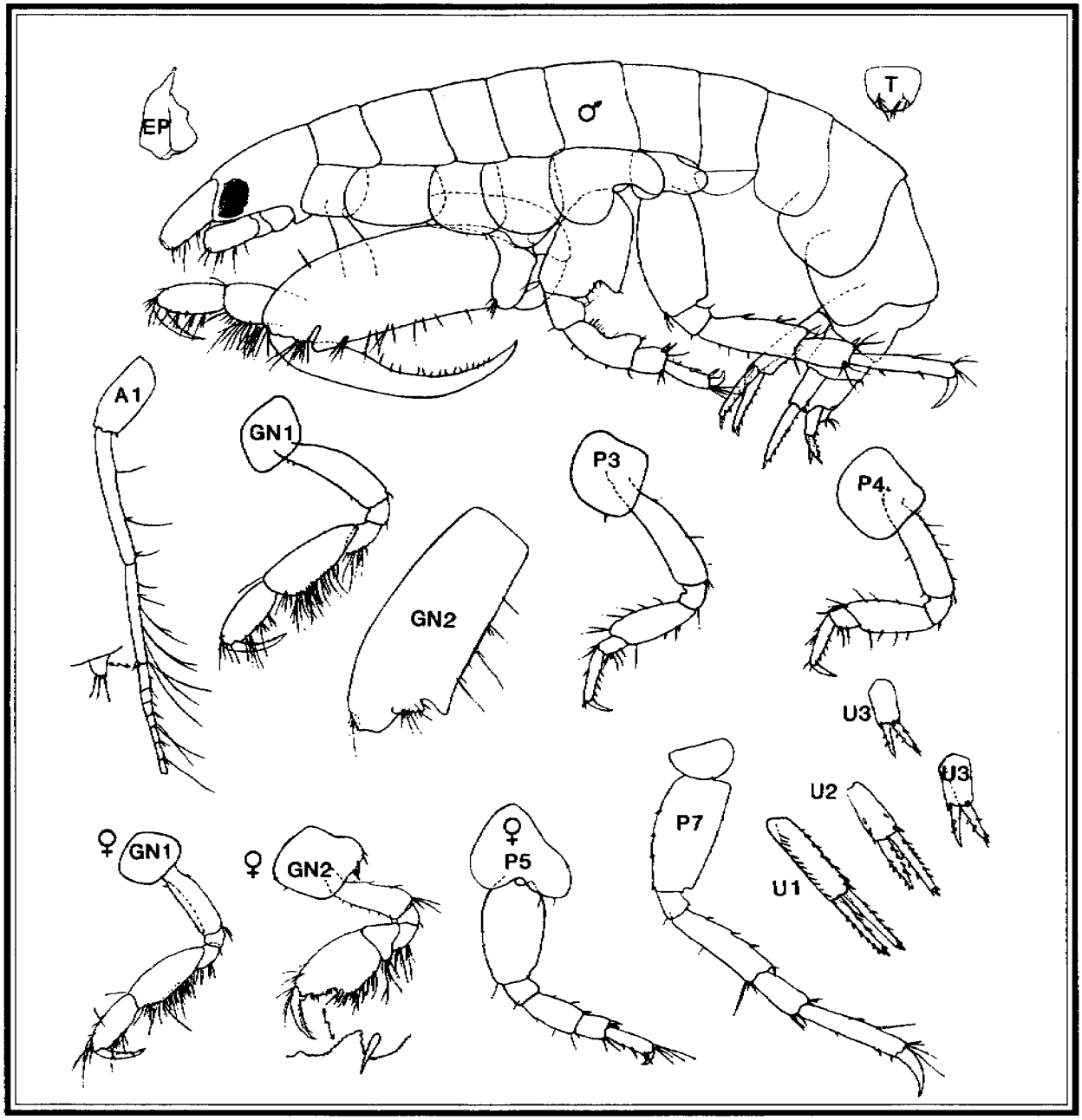

Figure 4.18. *Gammaropsis (Podoceropsis) ociosa.* Adult male, holotype, 5.2 mm; adult male, 4.5 mm (antenna 1, propodus of gnathopod 2, peraeopod 7); adult female, 4.5 mm (from J. L. Barnard, 1962).

although bases narrower, basis and merus not excavate, and propodus with few short spines along anterior margin. Epimera 1-3 with small seta posterodistally but without cusps or ridges. Urosome segments 1 and 2 with pair of dorsally erect setae but without cusps. Uropod 1, peduncle without ecdysial spines, but with tooth-like process extending ventrally below rami; rami tipped by 2-3 spines. Uropod 3, peduncle spinose dorsally at origin of rami; outer ramus nearly as long as peduncle and tipped by 1-2 long setae, inner ramus as long as outer, tipped by 1 spine. Telson apices marked by nipple and setal cluster.

Distribution and Biology. *Gammaroposis (Podoceropsis) ociosa* has been recorded from 27 to 410 m on the California coast between Point Conception and San Diego.

Remarks. The large, rectangular shaped male second gnathopod with transverse palm distinguishes this species from others in the subgenus.

Family Ischyroceridae

***Ericthonius rubricornis* (Stimpson, 1853)**

Figure 4.19

Cerapus rubricornis Stimpson, 1853:46, fig. 33.
Cerapus hunteri Bate, 1862:264, Pl. 45, fig. 3.
Ericthonius difformis: Lincoln, 1979:560, fig. 269.
Ericthonius rubricornis: Myers and McGrath, 1984:388-393, figs. 7-9.

Material Examined. California: Santa Maria Basin, Sta. BRA-16, 91.5-123 m, 2 adult males, 1 juvenile; Cruise 3-1, Sta. R-6, Rep. 3, 410 m, 1 juvenile; Cruise 3-4, Sta. R-3, Rep. 2, 409 m, 15 juveniles.—western Santa Barbara Channel, off Point Arguello, Sta. BRA-04, 168-237 m, 1 adult male, 4 juveniles.

Description. Body length up to 10.0 mm (adult male), 5.0-8.0 mm (adult female). Head lobe triangular, anteriorly acute. Eye black, circular. Antennae 1 and 2 about equal in length. Antenna 1 moderately setose with long setae posteriorly, article 3 longer than article 1; accessory flagellum microscopic button. Antenna 2 moderately setose, with long setae also, flagellum not pediform, longer than article 5, distally spinose. Upper lip, epistome triangular. Mandible with 7-9 raker spines; molar flake present; palp strong, article 3 wider distally than proximally, both articles 2 and 3 with numerous setae, article 2 longer than article 3. Lower lip, outer lobes not spinose. Maxilla 1, inner plate setose; palp somewhat narrower than outer plate. Maxilla 2, inner plate as wide as outer, with row of facial setae. Maxilliped, inner plate not reaching end of article 4; outer plate reaching end of article 5; unguis (article 8) as long as article 7. Sternal plate 1 not produced. Peraeopods 1-4, coxae, ventral margins with small setae only. Gnathopod 1 smaller than gnathopod 2. Gnathopod 1 (adult male), coxa similar in shape to and somewhat shallower than coxa 2; basis inserted mid-distally on inner face, not setose anterodistally; merus not extended as tooth under carpus; carpus longer than propodus, anterior margin with cluster of setae at junction of propodus, posterior lobe expanded under propodus; propodus, palm convex, defined by single narrow spine; dactyl as long as palm of propodus, posterior (inner) margin with few short setae and cusps. Gnathopod 1 (adult female and juvenile) similar in shape to adult male gnathopod 1. Gnathopod 2 (adult male) larger than and different in shape from that of adult female and juvenile; basis without stridulation ridges; carpus longer than propodus, extended under propodus as tooth; propodus, palm nearly simple, posterior margin in some males with shelf-like protuberance, setae at dactyl hinge about one-fourth length of propodus; dactyl not toothed, overlapping palm and carpal tooth. Gnathopod 2 (adult female and juvenile) larger than gnathopod 1; carpus shorter than propodus, posterior lobe extending under one-half propodus; propodus, palm convex. Adult female brood plates moderately wide, setae with hook at each tip. Peraeopod 3 (adult male), coxa without stridulation ridges on ventral margin. Peraeopod 4, coxa, posterior margin not excavate. Peraeopods 3 and 4, basis expanded, merus wider than but hardly produced over carpus; dactyl not elongate, much shorter than propodus. Peraeopod 5, coxa twice as deep as coxa 4; basis moderately broad, not posteriorly excavate; merus not posteriorly excavate; merus and carpus without cluster of spines at posterior junction of propodus; propodus with spine only at junction of dactyl; dactyl cusped. Peraeopods 6 and 7, coxae smaller than coxa 5; otherwise articles similar in shape to peraeopod 5, although merus of peraeopod 5 shorter in relation to other articles than in peraeopods 6 and 7. Epimera 1-3 with several setae along posterior margin but without cusps or ridges. Urosome segments 1 and 2 with pair of dorsally erect setae but without cusps. Uropod 1, peduncle without ecdysial spines or tooth-like process extending ventrally below rami; rami tipped by 1 long and 2-3 short spines. Uropod 3, peduncle not spinose; outer ramus shorter than peduncle and tipped by 2 cusps, inner ramus absent. Telson apices marked by seta and cluster of numerous cusps.

Distribution and Biology. Specimens from the Santa Maria Basin closely resemble those described and illustrated from the U.K. by Myers and McGrath (1984), which is the most recent analysis of the genus.

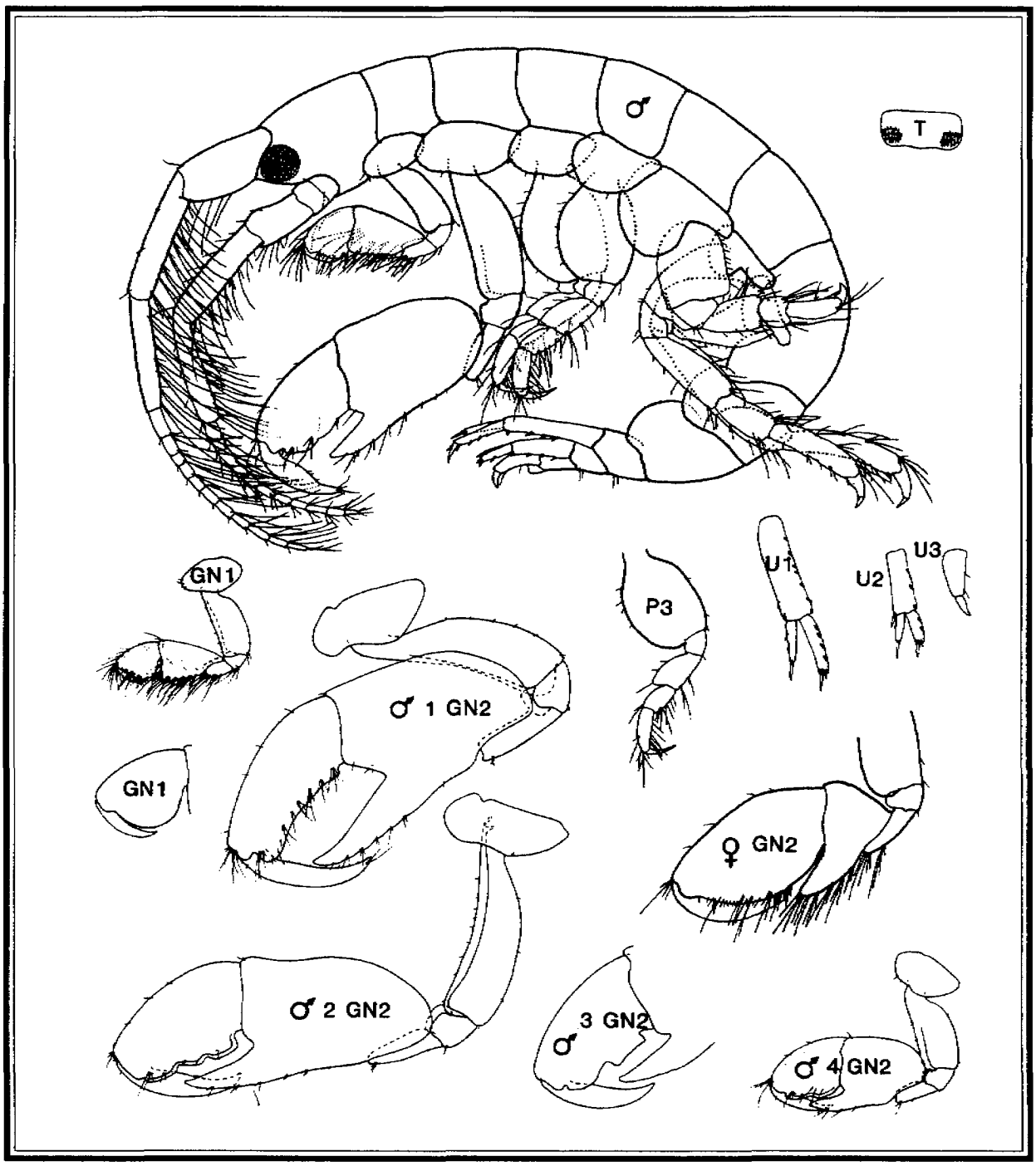

Figure 4.19. *Ericthonius rubricornis*. Adult male (length unknown) (gnathopod 1, propodus and dactyl without setae); adult male 1, 9.0 mm; adult male 2, 8.0 mm; adult male 3, 7.0 mm (without setae); juvenile male 4, 4.0 mm (from Myers and McGrath, 1984); adult female gnathopod 2 (length unknown) (from Lincoln, 1979).

Myers and McGrath (1984) list *E. rubricornis* as only occurring in the Arctic and boreal Atlantic. It is probable that *E. rubricornis* ranges widely in the Pacific as well, but a systematic analysis of all northeastern Pacific collections of the genus is required before a definitive summary can be given.

Remarks. Similarities between species in male gnathopod 2 morphology are convergent and not reliable identifiers. The most closely related species listed by Myers and McGrath (1984) is *E. megalops*. This differs from *E. rubricornis* in having a slenderer peraeopod 3 basis (length almost twice width, as opposed to length about one and a half times width), and the greatest width of the gnathopod 1 propodus being situated medio-distally, rather than medially.

Jassa slatteryi Conlan, 1990

Figure 4.20

Jassa slatteryi Conlan, 1990:2058-2059, fig. 20.

Material Examined. California: western Santa Barbara Channel, off Point Arguello, Sta. BRA-4, 168-237 m, 2 adult females.

Description. Body length 4.0-7.4 mm (adult male), 2.3-5.7 mm (adult female). Head lobe triangular, but not anteriorly acute. Eye black, circular. Antenna 1 about one-third shorter than antenna 2 (one-fourth in adult female and juvenile). Antenna 1 moderately setose with long setae posteriorly, article 3 longer than article 1; accessory flagellum 2 articles, second microscopic button. Antenna 2 moderately setose, with long setae also, flagellum pediform, slightly shorter than article 5, distally spinose. Upper lip, epistome triangular. Mandible with 2-3 raker spines; molar flake present; palp strong, article 3 wider distally than proximally, both articles 2 and 3 with numerous setae, article 2 longer than article 3. Lower lip, outer lobes not spinose. Maxilla 1, inner plate setose; palp somewhat narrower than outer plate. Maxilla 2, inner plate narrower than outer, without row of facial setae. Maxilliped, inner plate not reaching end of article 4; outer plate not reaching end of article 5; unguis (article 8) as long as article 7. Sternal plate 1 not produced. Peraeopods 1-4, coxae, ventral margins with minute setae only. Gnathopod 1 smaller than gnathopod 2. Gnathopod 1 (adult male), coxa anteriorly produced; basis inserted midway on inner face, not setose anterodistally; merus not extended as tooth under carpus; carpus shorter than propodus, anterior margin with 1 or 2 long setae at junction of propodus, posterior lobe not expanded under propodus; propodus, palm convex, defined by 3 (rarely 2 or 4) spines arranged in medial-lateral-medial sequence; dactyl as long as palm of propodus, posterior (inner) margin with few short setae and cusps. Gnathopod 1 (adult female and juvenile) similar in shape to adult male gnathopod 1. Gnathopod 2 (adult male) larger than and different in shape from that of adult female and juvenile; basis without stridulation ridges; carpus shorter than propodus, not toothed; propodus, palm with small tooth next to origin of dactyl and long thumb-like tooth defining palm, setae at dactyl hinge less than one-fourth length of propodus; dactyl nearly as long as propodus, inner margin sinuous, with broad expansion proximally. Gnathopod 2 (adult female and juvenile) larger than gnathopod 1; carpus shorter than propodus, posterior lobe narrow; propodus, palm concave. Adult female brood plates moderately wide, setae with hook at each tip. Peraeopod 3 (adult male), coxa without stridulation ridges on ventral margin. Peraeopod 4, coxa, posterior margin not excavate. Peraeopods 3 and 4, basis moderately expanded (more so in female), merus wider than carpus and produced over its full length; dactyl not elongate, much shorter than propodus. Peraeopod 5, coxa not deeper than coxa 4; basis moderately broad, not posteriorly excavate; merus not posteriorly excavate; merus and carpus without cluster of spines at posterior junction of propodus; propodus with few spines on anterior margin; dactyl not cusped. Peraeopods 6 and 7, coxae smaller than coxa 5; otherwise articles similar in shape to peraeopod 5. Epimera 1-3 with minute setae and small indentation on posterodistal margin but without cusps or ridges. Urosome segment 1 with pair of dorsally erect setae but without cusps. Uropod 1, peduncle without ecdysial spines, but with tooth-like process extending ventrally below rami; rami tipped by 1 long and 2-3 short spines. Uropod 3, peduncle spinose only distally at origin of rami; outer ramus shorter than peduncle and tipped by 2 cusps and basally immersed, dorsally recurved spine, inner ramus with small spine at apex. Telson apices marked by seta and nob.

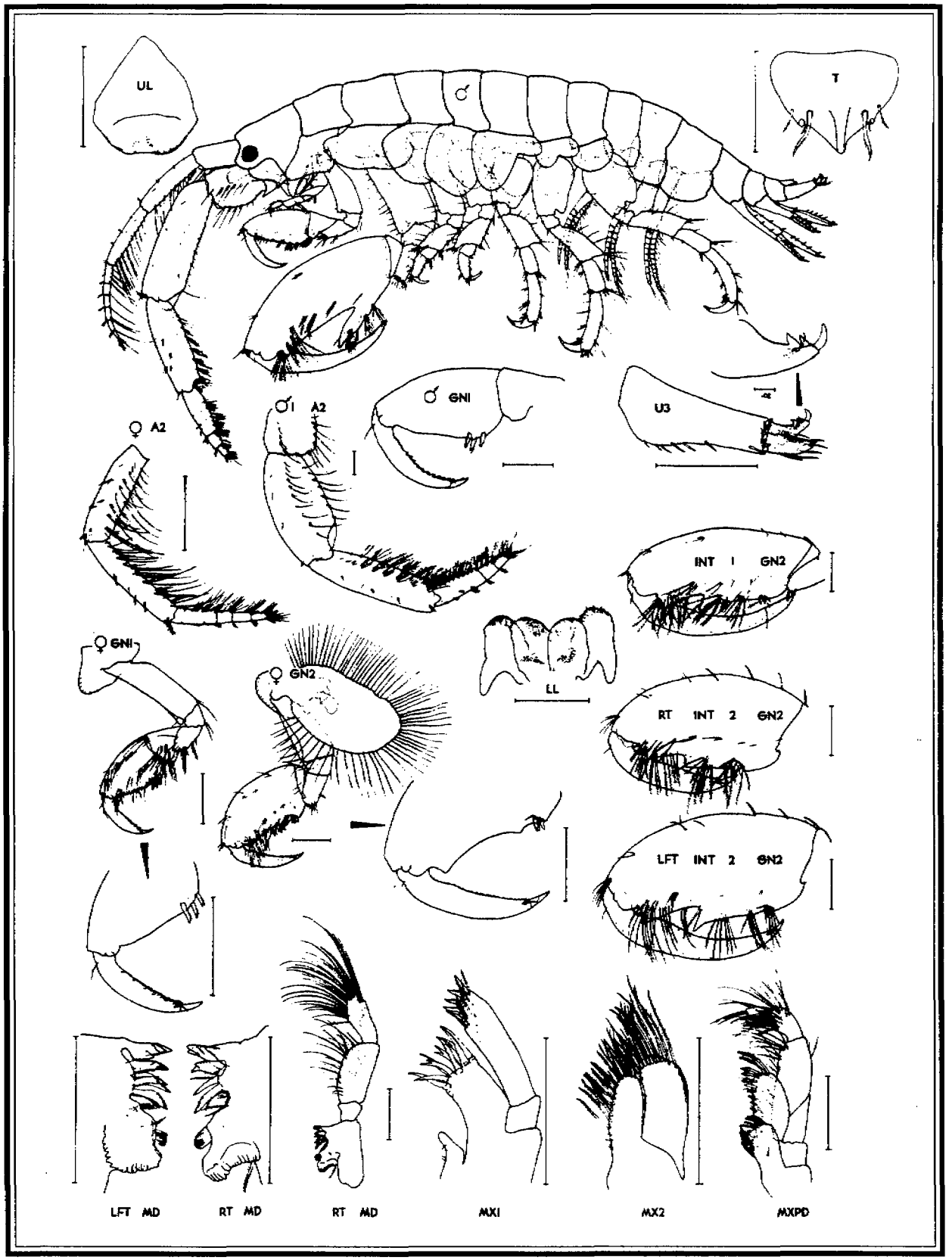

Figure 4.20. *Jassa slatteryi.* Adult male, holotype, 5.1 mm; adult female, allotype, 4.1 mm; intersex 1, 4.6 mm; intersex 2, 5.6 mm (from Conlan, 1990)

Distribution and Biology. *Jassa slatteryi* is widespread, probably as a result of introductions by ship. Valid reports of this species are from the Pacific coast of North America (Queen Charlotte Islands to Bahía de Los Angeles), Ireland, France, Yugoslavia, Japan, South Korea, Galapagos Islands, Chile, Brazil, South Africa, Australia, and New Zealand (Conlan, 1990).

Remarks. *Jassa staudei* Conlan, 1990 may also occur in the Santa Barbara area. *Jassa staudei* differs from *J. slatteryi* in lacking the setal cluster on the anterodistal corner of the carpus of gnathopod 1 (both sexes, all ages). Keys, descriptions, and illustrations for these and other species of *Jassa* that occur on the Pacific coast of North America are in Conlan (1990). The Santa Maria Basin collection in 168-237 m is the deepest record for *Jassa slatteryi*. This species is commonly found among algae, hydroids, and bryozoans on floating docks and on rocky shores in the low intertidal zone and subtidally.

Microjassa sp. A

Figure 4.21

Microjassa new species. Conlan, 1995

Material Examined. California: Santa Maria Basin, Cruise 1, Sta. R-2, Rep. 2, 161 m, 1 adult male, 1 adult female, 1 juvenile; Cruise 1-1, Sta. R-5, Rep. 3, 154 m, 2 adult males; Cruise 1-2, Sta. PJ-7, Rep. 1, 123 m, 1 adult male, 1 adult female, Sta. R-4, Rep. 1, 92 m, 1 adult male, 3 adult females, 4 juveniles; Cruise 1-3, Sta. R-1, Rep. 2, 91 m, 1 adult male, 1 adult female, 1 juvenile, Sta. R-2, Rep. 1, 161 m, 1 adult male, 1 juvenile, Sta. R-4, Rep. 1, 92 m, 1 adult male, 4 adult females, 11 juveniles (type), Sta. R-5, Rep. 1, 154 m, 2 adult males, 5 adult females, 9 juveniles (type); Cruise 2-3, Sta. R-4, Rep. 1, 92 m, 1 adult male, 1 adult female, 5 juveniles (type); Cruise 2-5, Sta. R-4, Rep. 1, 92 m, 1 adult male, 2 adult females, 16 juveniles; Cruise 3-1, Sta. R-2, Rep. 3, 161 m, 1 adult male, 2 adult females, 1 juvenile, Sta. R-4, Rep. 2, 92 m, 1 adult male, 10 adult females, 24 juveniles; Cruise 3-4, Sta. R-2, Rep. 1, 161 m, 1 adult male, Sta. R-8, Rep. 3, 90 m, 1 adult male, 1 adult female, 6 juveniles.

Description. Body length up to 2.3 mm (adult male), 2.0 mm (adult female). Head lobe triangular. Eye black, oval. Antennae 1 and 2 missing (in other northeastern species of *Microjassa*, antennae about equal in length or antenna 2 up to twice length of antenna 1; antenna 1 weakly setose, article 3 equal in length to article 1; accessory flagellum 1 article. Antenna 2 weakly setose, flagellum pediform in some species, equal to or shorter than article 5, distally spinose). Upper lip, epistome triangular. Mandible with 2-3 raker spines; molar flake present; palp strong, article 3 wider centrally than distally or proximally, both articles 2 and 3 with numerous setae, article 2 longer than article 3. Lower lip, outer lobes not spinose. Maxilla 1, inner plate without setae; palp as wide as or somewhat wider than outer plate. Maxilla 2, inner plate narrower than outer, without facial setae. Maxilliped, inner plate not reaching to end of article 4; outer plate not reaching to end of article 5; unguis (article 8) longer than article 7. Sternal plate 1 not produced. Peraeopods 1-4, coxae, ventral margins with few minute setae only. Gnathopod 1 smaller than gnathopod 2. Gnathopod 1 (adult male), narrower than and one-third depth of coxa 2, basis inserted midway on inner face; basis not densely setose; merus not extended as tooth under carpus; carpus shorter than propodus, anterior margin not setose anteriorly, posterior lobe not expanded under propodus; propodus, palm convex, defined by cluster of 3 spines arranged in medial-lateral-medial) sequence; dactyl only as long as palm of propodus, posterior (inner) margin with few short setae. Gnathopod 1 (adult female and juvenile) similar in shape to gnathopod 2, carpus shorter than propodus, and palm of propodus convex; basis without cluster of long setae at anterior junction with ischium. Gnathopod 2 (adult male) larger than and different in shape from that of adult female and juvenile; basis, anterodorsal face covered in small nodules, presumably for stridulation; carpus shorter than propodus, not toothed; propodus, palm shallowly concave, with tooth at dactyl hinge and minute spine at defining corner; dactyl as long as palm, nearly as long as propodus, inner margin sinuous, with an expansion proximally. Gnathopod 2 (adult female and juvenile) somewhat larger than gnathopod 1; carpus shorter than propodus,

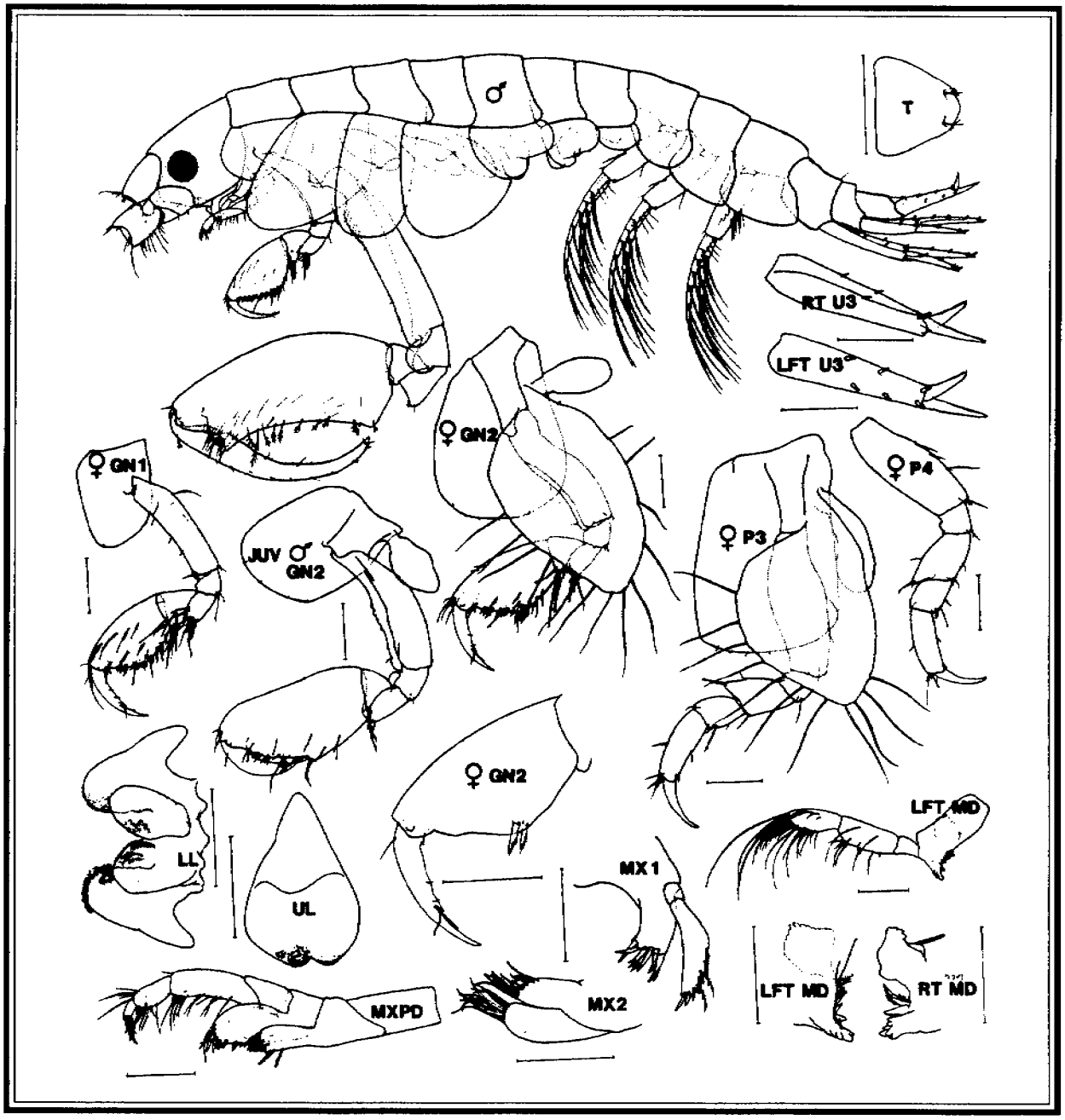

Figure 4.21. *Microjassa* sp. A. (from Conlan, 1995).

posterior lobe narrow; propodus, palm convex. Adult female brood plates, setae without hook at each tip. Peraeopod 3 (adult male), coxa with fine striations on the medial face, presumably for stridulation. Peraeopod 4, coxa, posterior margin excavate. Peraeopods 3 and 4, basis somewhat expanded, merus wider than carpus and shallowly anteriorly produced over carpus; dactyl shorter than propodus. Pereopod 5, coxa one-half depth of coxa 4. Peraeopods 5-7 lacking (in other northeastern Pacific species of *Microjassa*, basis broad, not posteriorly excavate; merus not posteriorly excavate; carpus not spinose; propodus with few long spines along anterior margin; dactyl without pronounced cusps at junction of unguis. Peraeopods 6 and 7, coxae smaller than coxa 5; otherwise articles similar in shape to peraeopod 5, basis not narrower). Epimera 1-3 not posterodistally notched. Urosome 1 with pair of dorsally erect setae, but without cusps. Uropod 1,

peduncle without ecdysial spines, but with tooth-like process extending ventrally below rami, rami tipped by 1-3 short spines. Uropod 3, peduncle spinose; rami equal in length, less than one-half length of peduncle; outer ramus with row of minute cusps along dorsal margin and small spine at tip; inner ramus without cusps but with minute spine at tip. Telson apices marked by single long seta and 2 small cusps.

Distribution and Biology. *Microjassa* sp. A has only been recorded from the above sites in the Santa Maria Basin area of California.

Remarks. *Microjassa* sp. A is new to science and being formally described and named in a separate publication (Conlan, 1995). The shape and setation of the adult male's second gnathopod distinguishes this species from the other northeastern Pacific species of *Microjassa*, *M. litotes* J.L. Barnard, 1954, *M. boreopacifica* Conlan (1995), *M. barnardi* Conlan (1995), and *M. macrocoxa* Shoemaker, 1942. Adult females and juveniles are not readily distinguishable. *Microjassa* sp. A most closely resembles *M. barnardi* in the appearance of the adult male second gnathopod, but can be distinguished by lacking the row of spine-like setae on the anterior margin of the propod and by the convex palm of the propod of the adult male first gnathopod and adult female and juvenile first and second gnathopods. Conlan (in press) presents a phylogenetic and biogeographic analysis of the genus *Microjassa*.

Acknowledgements

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Literature Cited

Barnard, J.L. 1954. Marine Amphipoda of Oregon. Oregon State Monographs, Studies in Zoology 8: 1-103.

Barnard, J.L. 1958. A remarkable new genus of corophiid amphipod from coastal marine bottoms of southern California. Bulletin of the Southern California Academy of Sciences 57: 85-90.

Barnard, J.L. 1959. Estuarine Amphipoda. *In*: Ecology of Amphipoda and Polychaeta of Newport Bay, California. Occasional paper of the Allan Hancock Foundation Publications 21: 13-69.

Barnard, J.L. 1962. Benthic marine Amphipoda of southern California: families Aoridae, Photidae, Ischyroceridae, Corophiidae, Podoceridae. Pacific Naturalist 3: 1-72.

Barnard, J.L. 1964. Los anfipodos bentonicos marinos de la costa occidental de Baja California. Revista de la Sociedad Mexicana de Historia Natural 24: 205-274.

Barnard, J.L. 1966. Submarine canyons of southern California part V systematics: Amphipoda. Allan Hancock Pacific Expeditions 27(5): 1-166.

Barnard, J.L. 1969a. Gammaridean Amphipoda of the rocky intertidal of California: Monterey Bay to La Jolla. Bulletin of the United States National Museum 258: 1-230.

Barnard, J.L. 1969b. The families and genera of marine gammaridean Amphipoda. Bulletin of the United States National Museum 271: 1-535.

Barnard, J.L. 1971. Gammaridean Amphipoda from a deep-sea transect off Oregon. Smithsonian Contributions to Zoology 61: 1-86.

Barnard, J.L. 1973. Revision of Corophiidae and related families (Amphipoda). Smithsonian Contributions to Zoology 151: 1-27.

Barnard, J.L. and G. S. Karaman. 1991. The families and genera of marine gammaridean Amphipoda (except marine gammaroids). Parts 1 and 2. Records of the Australian Museum 13: 1-866.

Barnard, K. H. 1916. Contributions to the crustacean fauna of South Africa. 5. The Amphipoda. Annals of the South African Museum 15: 105-302.

Bate, C. S. 1862. Catalogue of the specimens of amphipodous Crustacea in the collection of the British Museum. 399 pp. London.

Boates, J. S. and P. C. Smith. 1989. Crawling behaviour of the amphipod *Corophium volutator* and foraging by Semipalmated Sandpipers, *Calidris pusilla*. Canadian Journal of Zoology 67: 457-462.

Borowsky, B. 1983. Behaviors associated with tube-sharing in *Microdeutopus gryllotalpa* (Costa) (Crustacea: Amphipoda). Journal of Experimental Marine Biology and Ecology 68: 39-51.

Borowsky, B. 1985. Differences in reproductive behavior between two male morphs of the amphipod crustacean *Jassa falcata* Montagu. Physiological Zoology 58: 497-502.

Bousfield, E. L. 1973. Shallow-water gammaridean Amphipoda of New England. Cornell University Press, Ithaca and London. 312 pp.

Brink, F. W. B. van den and G. van der Velde. 1991. Amphipod invasion on the Rhine. Nature 352: 576.

Bryant, V. 1985. Effect of temperature and salinity on the toxicity of arsenic to three estuarine invertebrates (*Corophium volutator*, *Macoma balthica*, *Tubifex costatus*). Marine Ecology Progress Series 24: 129-137.

Carter, J. W. 1982. Natural history observations on the gastropod shell-using amphipod *Photis conchicola* Alderman, 1936. Journal of Crustacean Biology 2: 328-341.

Chess, J. R. 1993. Effects of the stipe-boring amphipod *Peramphithoe stypotrupetes* (Corophioidea: Ampithoidae) and grazing gastropods on the kelp *Laminaria setchellii*. Journal of Crustacean Biology 13: 638-646.

Conlan, K. E. 1982. Revision of the gammaridean amphipod family Ampithoidae using numerical analytical methods. Canadian Journal of Zoology 60: 2015-2027.

Conlan, K. E. 1983. The amphipod superfamily Corophioidea in the northeastern Pacific region. 3. Family Isaeidae: systematics and distributional ecology. National Museums of Canada, National Museum of Natural Sciences, Publications in Natural Sciences: 1-75.

Conlan, K. E. 1988. Phenetic and cladistic methods applied to a small genus (Corophioidea: Ischyroceridae: *Microjassa*) and a larger outgroup. Crustaceana, Supplement 13: 143-166.

Conlan, K. E. 1990. Revision of the crustacean amphipod genus *Jassa* Leach (Corophioidea: Ischyroceridae). Canadian Journal of Zoology 68: 2031-2075.

Conlan, K. E. 1991. Precopulatory mating behavior and sexual dimorphism in the amphipod Crustacea. Hydrobiologia 223: 255-282.

Conlan, K. E. 1994a. Amphipod crustaceans and environmental disturbance: a review. Journal of Natural History 28: 519-554.

Conlan, K.E. 1994b. New species of the crustacean amphipod genera *Photis* and *Gammaropsis* (Corophioidea) from California. Amphipacifica 1(3):67-74.

Conlan, K. E., 1995. Thumbing doesn't always make the genus: revision of *Microjassa* Stebbing (Crustacea: Amphipoda: Ischyroceridae). Bulletin of Marine Science 57: 331-375.

Conlan, K. E. In Press. Thumb evolution in the amphipod genus *Microjassa* Stebbing (Corophioidea: Ischyroceridae). Journal of Crustacean Biology.15(4).

Conlan, K. E. and E. L. Bousfield. 1982a. The superfamily Corophioidea in the North Pacific region. Family Ampithoidae: systematics and distributional ecology. National Museums of Canada, National Museum of Natural Sciences, Publications in Biological Oceanography 10: 41-75.

Conlan, K. E. and E. L. Bousfield. 1982b. The superfamily Corophioidea in the North Pacific region. Family Aoridae: systematics and distributional ecology. National Museums of Canada, National Museum of Natural Sciences, Publications in Biological Oceanography 10: 77-101.

Conlan, K. E. and J. R. Chess. 1992. Phylogeny and ecology of a kelp-boring amphipod, *Peramphithoe stypotrupetes*, new species (Corophioidea: Ampithoidae). Journal of Crustacean Biology 12: 410-422.

Esselink, P., J. van Belkum, and K. Essink. 1989. The effect of organic pollution on local distribution of *Nereis diversicolor* and *Corophium volutator*. Netherlands Journal of Sea Research 23: 323-332.

Franz, D. R. 1989. Population density and demography of a fouling community amphipod. Journal of Experimental Marine Biology and Ecology 125: 117-136.

Hartog, C. den, F. W. B. van den Brink, and G. van der Velde. 1992. Why was the invasion of the river Rhine by *Corophium curvispinum* and *Corbicula* species so successful? *Journal of Natural History* 26: 1121-1129.

Hay, M. E., J. E. Duffy, and W. Fenical. 1990. Host-plant specialization decreases predation on a marine amphipod: an herbivore in plant's clothing. Ecology 71: 733-743.

Hickey, C. W. and D. S. Roper. 1992. Acute toxicity of cadmium to two species of infaunal marine amphipods (tube-dwelling and burrowing) from New Zealand. Bulletin of Environmental Contamination and Toxicology 49: 165-170.

Holmes, S. J. 1904. On some new or imperfectly known species of West American Crustacea. Proceedings of the California Academy of Sciences, series 3 (Zoology), 3: 307-328.

Holmlund, M. B., C. H. Peterson, and M. E. Hay. 1990. Does algal morphology affect amphipod susceptibility to fish predation? Journal of Experimental Marine Biology and Ecology 139: 65-83.

Jensen, K. T. and L. D. Kristensen. 1990. A field experiment on competition between *Corophium volutator* (Pallas) and *Corophium arenarium* Crawford (Crustacea: Amphipoda): effects on survival, reproduction and recruitment. Journal of Experimental Marine Biology and Ecology 137: 1-24.

Just, J. 1977. A new genus and species of corophiid Amphipoda from pteropod shells of the bathyal western Atlantic, with notes on related genera (Crustacea). Steenstrupia 4: 131-138.

Lee, W. Y. 1977. Some laboratory cultured crustaceans for marine pollution studies. Marine Pollution Bulletin 8: 258-260.

Lincoln, R. J. 1979. British marine Amphipoda: Gammaridea. 658 pp. London: British Museum (Natural History).

Mattson, S., and T. Cedhagen. 1989. Aspects of the behaviour and ecology of *Dyopedos monacanthus* (Metzger) and *D. porrectus* Bate, with comparative notes on *Dulichia tuberculata* Boeck (Crustacea: Amphipoda: Podoceridae). Journal of Experimental Marine Biology and Ecology 127: 253-272.

McCloskey, L. R. 1970. A new species of *Dulichia* (Amphipoda, Podoceridae) commensal with a sea urchin. Pacific Science 224: 90-98.

McLusky, D. S., 1987. Intertidal habitats and benthic macrofauna of the Forth estuary, Scotland. Proceedings of the Royal Society of Edinburgh 93B: 389-399.

Moore, P. G. 1983. *Pagurisaea schembrii* gen. et sp. n. (Crustacea, Amphipoda) associated with New Zealand hermit crabs, with notes on *Isaea elmhirsti* Patience. Zoologica Scripta 12: 47-56.

Myers, A. A. 1974. *Amphitholina cuniculus* (Stebbing), a little-known marine amphipod crustacean new to Ireland. Proceedings of the Royal Irish Academy 74: 463-469.

Myers, A. A. 1983. Probable polyphyly in the amphipod genus *Microdeutopus* Costa, with an analysis of phenetic relationships in some related genera. Selected Papers on Crustacea, The Aquarium, Trivandrum, 163-172.

Myers, A. A. 1988. A cladistic and biogeographic analysis of the Aorinae subfamily nov. Crustaceana, Supplement 13: 167-192.

Myers, A. A. and D. McGrath. 1984. A revision of the north-east Atlantic species of *Ericthonius* (Crustacea: Amphipoda). Journal of the marine biological Association of the U. K. 64: 379-400.

Ólafsson, E. B. and L. -E. Persson. 1986. The interaction between *Nereis diversicolor* O. F. Müller and *Corophium volutator* Pallas as a structuring force in a shallow brackish sediment. Journal of Experimental Marine Biology and Ecology 103: 103-117.

Oliver, J. S. and P. N. Slattery. 1985. Destruction and opportunity on the sea floor: effects of gray whale feeding. Ecology 66: 1965-1975.

Raffaelli, D., J. Limia, S. Hull, and S. Pont. 1991. Interactions between the amphipod *Corophium volutator* and macroalgal mats on estuarine mudflats. Journal of the marine biological Association of the United Kingdom 71: 899-908.

Shoemaker, C. R. 1931. A new species of amphipod crustacean (Acanthonotozomatidae) from California, and notes on *Eurystheus tenuicornis*. Proceedings of the U. S. National Museum 78: 1-8.

Shoemaker, C. R. 1934. Two new species of *Corophium* from the west coast of America. Journal of the Washingon Academy of Sciences 24: 356-360.

Shoemaker, C. R. 1942. Amphipod crustaceans collected on the Presidential cruise of 1938. Smithsonian Miscellaneous Collections 101: 1-52.

Shoemaker, C. R. 1955. Amphipoda collected at the Arctic Laboratory, Office of Naval Research, Point Barrow, Alaska, by G. E. MacGinitie. Smithsonian Miscellaneous Collections 128: 1-78.

Stimpson, W., 1853. Synopsis of the marine Invertebrata of Grand Manan: or the region about the mouth of the Bay of Fundy, New Brunswick. Smithsonian Contributions to Knowledge 6: 5-66.

Stout, V. R. 1913. Studies in Laguna Amphpoda. II. Zoologische Jahrbucher Abteilungfür Systematik Oekologie und Geographie der Tiere 34: 633-659.

Tegner, M. J. and P. K. Dayton. 1987. El Niño effects on Southern California kelp forest communities. Advances in Ecological Research 17: 243-279.

Walker, A. O. 1898. Crustacea collected by W. A. Herdman, F.R.S., in Puget Sound, Pacific coast of North America. Transactions of the Liverpool Biological Society 12: 268-287.

Wilson, W. H., Jr. 1989. Predation and the mediation of intraspecific competition in an infaunal community in the Bay of Fundy. Journal of Experimental Marine Biology and Ecology 132: 221-245.

Witman, J. D. 1985. Refuges, biological disturbance, and rocky subtidal community structure in New England. Ecological Monographs 55: 421-445.

Attachment 1. Species of Corophioidea not in Santa Maria Basin collections but which may occur in the study area

This list includes all species whose geographic range encompasses the Santa Maria Basin area and that have been recorded within the depth range of Santa Maria Basin (deeper than 50m and shallower than 1000m). Some species occur elsewhere, sometimes broadly.

Acuminodeutopus heteruropus J.L. Barnard, 1959. Point Conception to Bahía de San Cristóbal, Baja California, 1-82 m (J.L. Barnard, 1959).

Amphideutopus oculatus J.L. Barnard, 1959. Point Conception to Bahía de San Cristóbal, Baja California, 2-162 m (J.L. Barnard, 1959).

Aoroides intermedia Conlan and Bousfield, 1982b, *A. columbiae* Walker, 1898, and *A. spinosa* Conlan and Bousfield, 1982b have not been recorded in California but have the same distribution records as *A. inermis* and *A. exilis*, which had not previously been recorded in California either (Conlan and Bousfield, 1982b).

Bemlos audbettius J.L. Barnard, 1962. Off Santa Barbara, 54m (J.L. Barnard, 1962).

Cheirimediea zotea J.L. Barnard, 1962. British Columbia to Monterey Bay, 0-113 m (J.L. Barnard, 1962; Conlan, 1983).

Corophium baconi Shoemaker, 1934. Bering Sea to Peru, and into the Gulf of California, common on benthos of coastal shelf of southern California, 0-55 m (Shoemaker, 1934).

Corophium californianum. Shoemaker, 1934. Two records. Monterey Bay from holdfast of waterlogged kelp, 88 m; Goleta, from submerged log, 8 m (Shoemaker, 1934).

Gammaropsis martesia (J.L. Barnard, 1964). Carmel to Bahía de San Cristóbal, Baja California, 0-84 m (J.L. Barnard, 1964).

Jassa staudei Conlan, 1990. Alaska to Morro Bay, low intertidal to 82 m (Conlan, 1990).

Neoischyrocerus claustris (J.L. Barnard, 1969a). Carmel to Bahía de San Cristóbal, Baja California, low intertidal to 157 m (J.L. Barnard, 1969a; Conlan, in press).

Peramphithoe humeralis (Stimpson, 1864). Prince William Sound, Alaska to Guadalupe Island, Baja California, low intertidal to 70 m (Conlan and Bousfield, 1982a).

Peramphithoe tea (J.L. Barnard, 1965). Prince William Sound, Alaska to Baja California, low intertidal to 67 m (Conlan and Bousfield, 1982a).

Photis parvidons Conlan, 1983. British Columbia to Albion Cove, Mendocino, 0-54 m (Conlan, 1983).

Rudilemboides stenopropodus J.L. Barnard, 1959. Point Conception to Bahía de San Quintín, Baja California, 1-68 m (J.L. Barnard, 1959).

5. The Suborder Caprellidea

by

Les Watling[1]

Introduction

Caprellids differ from other amphipods considered in this volume by showing strong reductions of much of the posterior end of the body. In the Caprellidea pereopods 3 and 4 are frequently reduced to a few articles or are lost completely and the abdominal segments and associated appendages are generally reduced to small nubs. There are a few genera which do not exhibit such strong reductions, but they have not yet been found in the Santa Maria Basin region.

Suborder Caprellidea

Diagnosis. (from Laubitz, 1993) Body slender and cylindrical (in free-living forms) or greatly depressed (in parasitic forms). Head almost spherical, rounded anteriorly, and completely, partially, or not fused with pereonite 1. Mouthparts ventral, variously developed; lower lip outer lobe with mandibular process. Coxal plates very small or absent. Gnathopod 1 propodus smaller than that of gnathopod 2. Gills usually 2, occasionally 1 or 3 pairs; always on pereonite 3, usually on pereonite 4, and occasionally on pereonite 2. Oostegites on pereonites 3 and 4 only. Pereopods 6 and 7 usually strongly prehensile. Abdomen of no more than 5 segments, pleopods and uropods reduced, rudimentary, or absent.

Remarks. Until the recent revision of caprellid families by Laubitz (1993), the taxonomy of caprellids had remained virtually unchanged since the early seminal work of Mayer (1882, 1890, 1903). McCain (1970) proposed a familial arrangement for all caprellids following the lead of Vassilenko (1968), although Vassilenko (1974) later offered her own arrangement. However, the characters used were basically those established by Mayer along with the addition of some mandibular features. Laubitz (1993) reduced in significance a few of Mayer's characters, incorporated McCain's mandible features, and added characters from maxilla 1 and the lower lip. While Laubitz (1993) states that her familial divisions are "both preliminary and speculative", they are basically similar to, and in fact augment, those established by Vassilenko (1974). Since they fall more in line with familial concepts seen in other groups of amphipods, they are, for the most part, adopted here in preference to the classification of McCain (1970).

Key to the Caprellidea of the Santa Maria Basin region

1A. Pereopods 3 and 4 composed of six articles ..... *Hemiproto wigleyi*

1B. Pereopods 3 and 4 reduced to 3 articles or fewer, or absent 2

2A. Pereopod 5 composed of fewer than 6 articles 3

2B. Pereopod 5 composed of 6 or more articles 4

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3A. Pereopod 5 terminal article a normal recurved dactyl ..... *Perotripus brevis*
3B. Pereopod 5 terminal article short, blunt, with terminal plumose seta ..... *Mayerella banksia*

4A. Head with mid-dorsal spine 5
4B. Head with spine anteriorly (rostral) or without spine 6

5A. Pereonite 2 with mid-dorsal spine ..... *Deutella venenosa*
5B. Pereonite 2 with, at most, low tubercle mid-dorsally ..... *Deutella californica*

6A. Pereonites 2 and 3 with anteriorly-directed tubercles on anterior margin 7
6B. Pereonites 2 and 3 without such tubercles 8

7A. Antenna 2 flagellum stout, with short setae ..... *Tritella laevis*
7B. Antenna 2 flagellum slender, with long setae ..... *Tritella pilimana*

8A. Pereopods 3 and 4 uniarticulate ..... *Tritella tenuissima*
8B. Pereopods 3 and 4 absent 9

9A. Head with rostral spine; antenna 2 longer than antenna 1 peduncle ..... *Caprella natalensis*
9B. Head without rostral spine; antenna 2 usually much shorter than antenna 1 peduncle 10

10A. Pereonite 5 with lateral projections anteriorly; gnathopod 2 with large lateral spines at base .... *Caprella equilibra*
10B. Pereonite 5 without lateral projections anteriorly; gnathopod 2 lateral spines at base small or absent 11

11A. Gnathopod 2 dactyl, antenna 1 and 2 distal peduncle articles setose ..... *Caprella pilidigita*
11B. Gnathopod 2 dactyl, antenna 1 and 2 distal peduncle articles naked ..... *Caprella mendax*

Descriptions of Species

Family Phtiscidae Vassilenko, 1968

Diagnosis. (from Laubitz, 1993) Antenna 2 with 2-14 articles, setose at apex. Mandible molar absent; incisor 5,6-toothed; lacinia with accessory plates; setal row with many setae; palp usually 3-articulate. Maxilla 1 with 6, occasionally dentate spiniform setae on outer plate; palp armature extensive apically. Maxilliped outer and inner plates broad, subequal; apex of inner plate with strong ctenoid teeth. Lower lips inner lobes well demarcated. Gnathopod 1 propodus strongly triangular, setose; palm defined by prominent process with many spines. Three pairs of gills present. Pereopods 3 and 4 with all articles (Phtiscinae) or pereopod 3 variable and pereopod 4 absent (Dodecadinae). Pereopod 5 reduced in size or articles, dactyl present. Pereopods 6 and 7 normal. Abdomen unsegmented; male with 1 pair rudimentary pleopods; genital papillae poorly developed.

Remarks. The family is readily recognized by its unique combination of mouthpart morphology features, *i.e.,* mandible with no molar and strong seta row, and maxilliped outer and inner plates subequal in size. Two genera, *Hemiproto* and *Perotripus*, are known from the coast of California. *Perotripus* was included in the Caprellidae by Laubitz (1970) and the Phtiscidae Dodecadinae by McCain (1970), but was moved, with question, by Laubitz (1993) to her new family Caprellinoididae. In this paper its position in the Dodecadinae has been retained.

Subfamily Phtiscinae Vassilenko, 1968

Diagnosis. Pereopods 3 and 4 fully articulate. Pereopod 5 reduced in size and/or articles, but with dactyl.

Genus *Hemiproto* McCain, 1968

Type Species. *Hemiproto wigleyi* McCain, 1968

Diagnosis. (from McCain, 1968) Antenna 2 flagellum 2- to 4-articulate; natatory setae absent. Mandibular palp 3-articulate; terminal article setal formula 1-1-1 or 1-x-1; molar absent. Maxilliped outer lobe equal to inner lobe. Gills present on pereonites 2-4. Pereopods 3 and 4 6-articulate; pereopod 5 5-articulate. Abdomen of male with 2 pairs of small uniarticulate appendages and one pair of nonsetose lobes; female with one pair of uniarticulate appendages.

Remarks. McCain (1968) noted this genus to be closely related to *Protomima* Mayer, differing from the latter in the details of the male abdominal appendages. In *Protomima* these appendages are biarticulate (rather than uniarticulate) and are positioned near the posterior part of the abdomen. The only known species in this genus, *H. wigleyi*, was described from shallow waters of Florida and the Carribean; the present record is the first of the genus from the Pacific.

***Hemiproto wigleyi* McCain, 1968**

Figure 5.1

Material Examined. California: Off Purisima Pt., St. R-4, 92 m, (6 specimens).

Description. (after McCain, 1968) Body smooth. Eyes large, dark. Antenna 1 of immature male and female about half as long as body, in mature male about equal to body length, number of flagellar articles unknown. Antenna 2 not extending beyond antenna 1 peduncle article 3. Propodus of gnathopod 1 triangular, with 3 grasping setae, 1 large and proximal to the others, grasping margin very finely serrate, dactyl not serrate. Male gnathopod 2 carpus extremely elongate, about half length of very long basis; propodus-carpus junction indistinct; propodus with 3 grasping setae, 1 large and proximal to the others, grasping margin with several small setae. In female and immature male, gnathopod 2 carpus about twice length of merus, propodus similar to mature male. Gills on pereonites 2-4, increasing in length posteriorly. Pereopods 3 and 4 6-articulate, propodus with 1 or 2 grasping setae, grasping margin less than half length of posterior propodal margin. Pereopod 5 5-articulate, propodus without grasping setae. Pereopods 6 and 7 unknown in adults; in juvenile with 6 articles, propodus with single grasping seta. Abdomen with 2 pairs of uniarticulate appendages and pair of non-setose lobes in males, with one pair of uniarticulate appendages and pair of lobes in female.

Remarks. Small individuals of this species resemble *Phtisica marina*, but the latter also bears two pairs of quite elongate abdominal appendages. McCain (1968) noted that the Japanese genus *Protomima* also showed an excessively elongate male gnathopod 2 carpus, but his genus *Hemiproto* differed from the former in the details of the abdominal appendages. It seems clear that the three genera, *Phtisica*, *Protomima*,

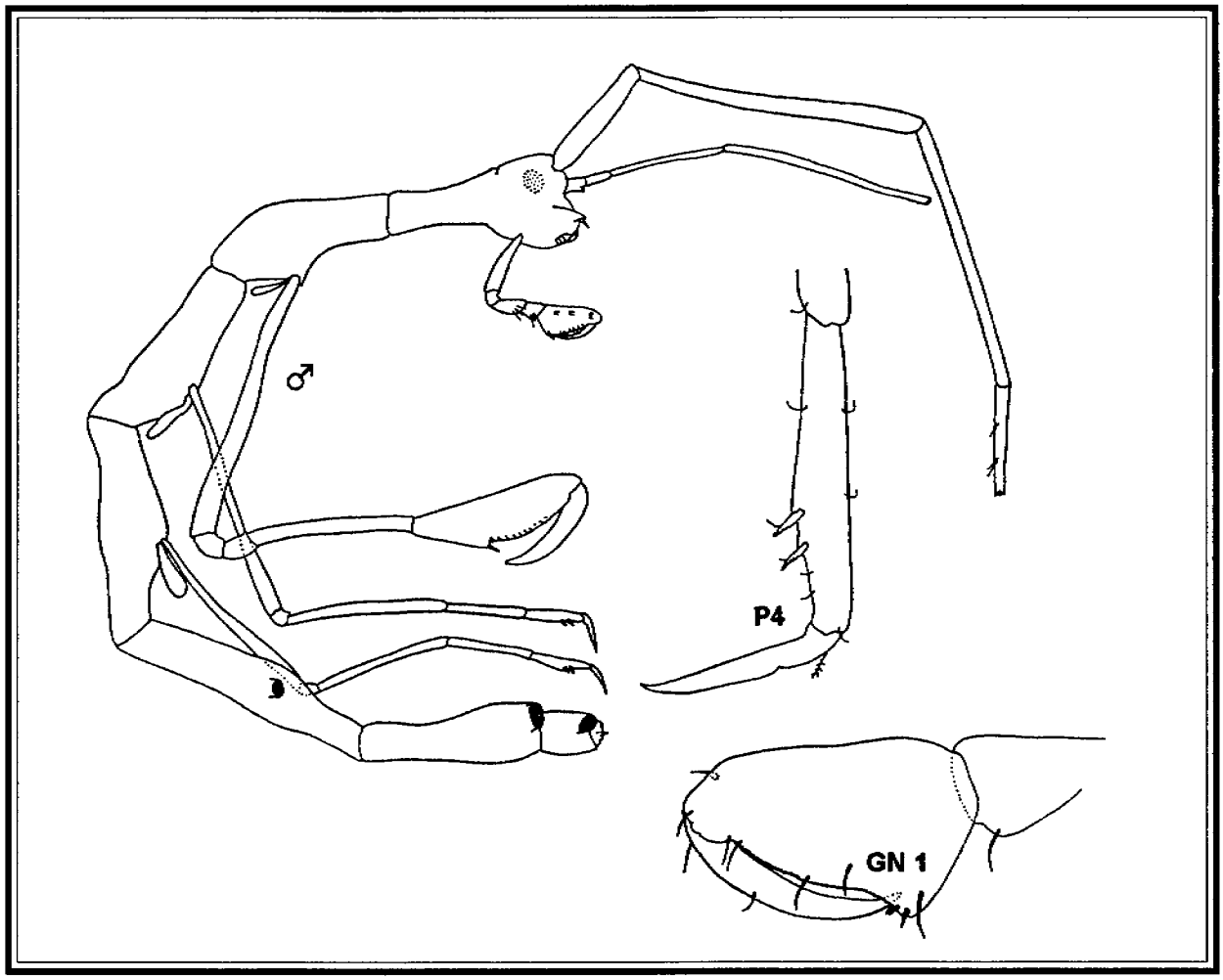

Figure 5.1. *Hemiproto wigleyi* (from McCain, 1968)

and *Hemiproto*, are closely related and specimens with elongate pereopods 3 and 4 and gnathopod 2 will require close examination of the abdominal appendages and possibly also the mouthparts before correct generic placement can be made. The specimens examined here were identified as *Hemiproto* sp. A in the MMS surveys.

Distribution. Known previously from 30-60 m off southern Florida and Venezuela; the present record is a significant range extension which suggests that the species has been introduced into either the western Atlantic or eastern Pacific, or that it is a pre-isthmian relict. Resolution of these opposing ideas will need additional data.

Subfamily Dodecadinae Vassilenko, 1968

Diagnosis. (after McCain, 1970) Pereopods 3 and 4 variably reduced. Pereopod 5 reduced, with dactyl.

Genus *Perotripus* Dougherty and Steinberg, 1953

Diagnosis. (after Laubitz, 1970) Antenna 2 without natatory setae; flagellum biarticulate. Mandibular palp of 3 articles; molar absent. Maxilliped outer lobe equal to or larger than inner, both minute. Gills on pereonites 2-4. Pereopod 3 of 3 articles; 4 uniarticulate; and 5 of 3 articles. Abdomen of male with one pair of uniarticulate appendages plus one pair of setose lobes; of female with one pair of setose lobes.

***Perotripus brevis* (La Follette, 1915)**

Figure 5.2

Paedaridium breve La Follette, 1915
Perotripus brevis: Dougherty and Steinberg, 1953

Material Examined. California: Off Pt. Estero, St. 1, 98 m (2); St. 6, 109 m (2).

Description. (after Laubitz, 1970) Body smooth; cephalon and pereonites 2 and 3 equal in length; pereonite 4 longer than 3. Antenna 2 slightly shorter than antenna 1 peduncle; article 3 and 4 sparsely setose. Mandible palp 3-articulate, middle and terminal articles each with one minute seta. Maxilliped inner lobe convex distally, with 2 median setae and outer tooth-like projection; outer lobe with slightly serrate apical margin bearing setae. Gnathopod 1 propodus triangular, ventral surface with serrate-edged proximal projection, four grasping spine-setae; palmar surface convex and bearing spine-setae and a few small setae. Gnathopod 2 propodus twice as long as broad, with proximal ventral projection bearing two pairs of grasping spine-setae. Pereopods 3 and 4 attached at base of gill. Pereopod 5 third article shaped like large claw. Pereopods 6 and 7 with 6 articles.

Remarks. Laubitz (1970) notes that in general collections of unsorted material this species is readily detected due to its characteristic body outline, which is bent in an S-shape on preservation.

Distribution. Described originally from Laguna Beach, California, and found north to Prince William Sound, Alaska.

Family Caprellidae White, 1847

Diagnosis. (from Laubitz, 1993) Antenna 2 with 2 articles, setose at apex. Mandible molar present; incisor 5-toothed; lacinia 5-toothed; setal row with 2-3 setae; palp 3-articulate, reduced, or absent. Maxilla 1 with 7, occasionally dentate spiniform setae on outer plate; palp armature moderate. Maxilliped outer plate larger than inner; apex of inner plate with plumose setae and spine-setae. Lower lips inner lobes well demarcated. Gnathopod 1 propodus triangular, strongly setose; palm defined by paired spine-setae. Two pairs of gills present. Pereopods 3 and 4 absent. Pereopod 5 normal, reduced, or absent. Pereopods 6 and 7 normal. Abdomen unsegmented; appendages variable.

Remarks. This is the most ubiquitous family of caprellids. Laubitz notes that most of the genera within the family have a well-developed suture between the head and pereonite 1 and bear long paired setae on antenna 2. The reader should note that the definition of this family according to Laubitz (1993) includes the family Aeginellidae subfamily Aeginellinae as adopted by McCain (1968, 1970), while McCain's subfamily Protellinae is elevated to family rank. Most of the genera previously assigned to the Caprellidae, for example, by McCain (1970), are distributed by Laubitz (1993) into her new family Pariambidae.

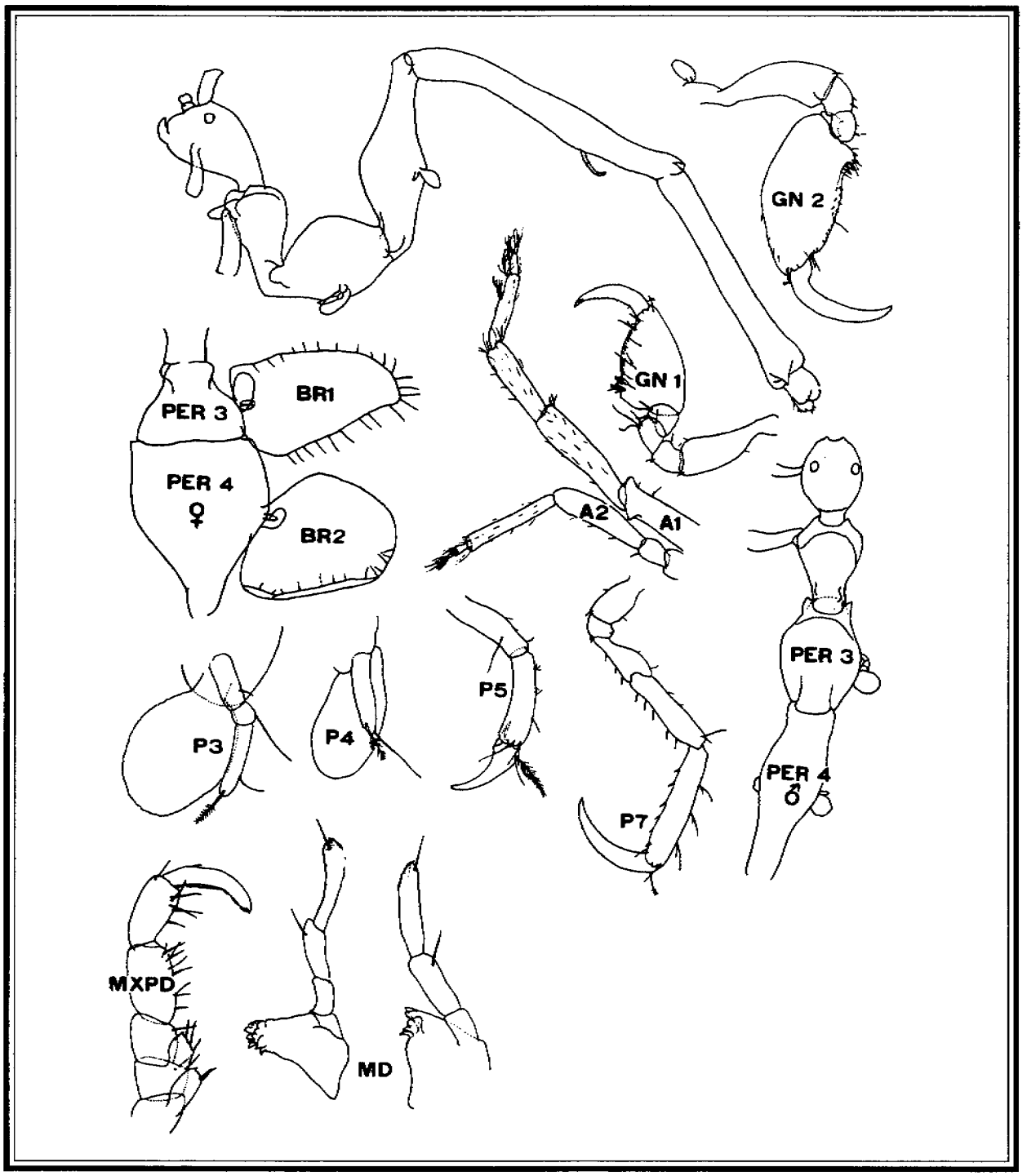

Figure 5.2. *Perotripus brevis* (from Laubitz, 1970)

Genus *Caprella* Lamarck, 1801

Diagnosis. (after Laubitz, 1970) Antenna 2 with natatory setae; flagellum biarticulate. Mandibular palp absent; molar present. Maxilliped outer lobe equal to or larger than inner. Gills on pereonites 3-4. Pereopods 3 and 4 absent; pereopod 5 of 6 articles. Abdomen of male with one pair of appendages plus one pair of lobes; of female with one pair of lobes.

Remarks. This is the largest genus of all the caprellids, with over 80 species worldwide. There are at least 15 species known from California, most having intertidal to shallow subtidal distributions. The five species considered here represent most of the deeper-dwelling species so far known from these waters.

Caprella natalensis Mayer, 1903

Figure 5.3

Caprella acutifrons var. *natalensis* Mayer, 1903
Caprella penantis var. *natalensis* K.H. Barnard, 1916
(?) *Caprella angusta*: Dougherty and Steinberg, 1953
Caprella angusta: Laubitz, 1970

Material Examined. California: Off Pt. Estero, St. 1, 98 m (1); off Pt. Sal, St. PJ-7, 123 m (1).

Description. (after Laubitz, 1970) Head with median anteriorly pointing process. Pereonites smooth or with small paired dorsal tuberculations, especially posteriorly. Antenna 1 as long as or slightly longer than cephalon plus pereonite 2; flagellum equal to peduncle; with 9 (female) to 12 (male) articles. Antenna 2 longer than antenna 1 peduncle; flagellum with short setae. Gnathopod 1 with serrate grasping margin on propodus and dactylus. Gnathopod 2 propodus twice as long as broad; dactylus thickened proximally, tapered distally. Pereopods 5 to 7, propodus palm concave, grasping spines proximal.

Remarks. In 1970, Laubitz decided that *C. angusta* differed sufficiently from *C. penantis* that it should be given separate specific status. In 1972, she noted that the *C. angusta* material examined by her was found to be essentially similar to specimens of *C. acutifrons* f. *natalense*. Accordingly, she decided that the name *C. natalense* be recognized at specific level. Her decision is followed here, for the simplest reason that any ecological data associated with this name will not be lost in the global morass associated with the almost ubiquitous *C. penantis* and *C. acutifrons*. The combination of rostral spine and long antenna 2 distinguish this species from the others considered in this study.

Distribution. Known previously from Dillon Beach, California, to the Queen Charlotte Islands, British Columbia.

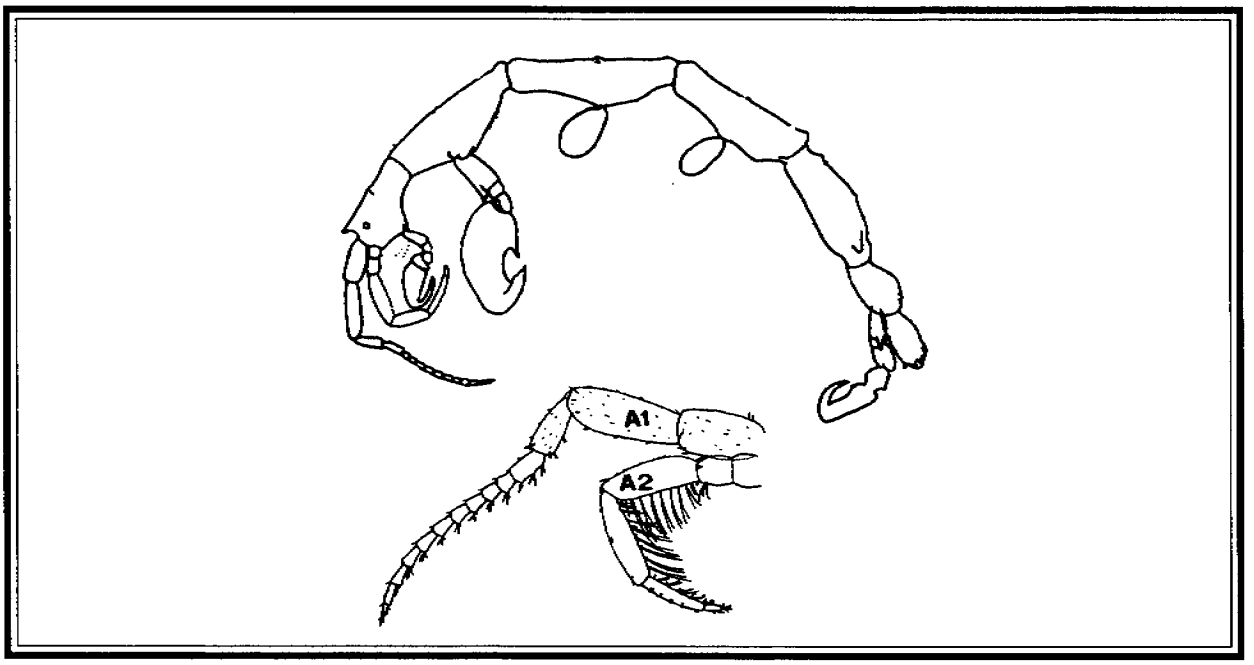

Figure 5.3. *Caprella natalensis* (from Laubitz, 1970)

Caprella equilibra Say, 1818

Figure 5.4

Material Examined. California: Off Purisima Pt., St. 42, 100 m (1); off Pt. Sal, St. PJ-1, 145 m (1).

Description. (from Laubitz, 1970) Head and body smooth dorsally except pereonite 5 which may have small paired dorsal spines; pereonites 3 and 4 with anterolateral spines; pereonite 2 with large ventral spine between gnathopods. Antenna 1 as long as or slightly longer than cephalon plus pereonite 2; flagellum much shorter than peduncle. Antenna 2 shorter than antenna 1 peduncle articles 1 and 2; flagellum with short setae. Gnathopod 1 with barely serrate grasping margin on propodus and dactylus. Gnathopod 2 propodus twice as long as broad, with proximal grasping spine; dactylus evenly tapered distally. Pereopods 5 to 7, propodus palm concave, grasping spines proximal.

Remarks. The other two species possessing a ventral spine between the bases of gnathopod 2, *C. mendax* and *C. pilidigita*, are both much longer than *C. equilibra* and have completely smooth pereonites. Laubitz (1970) summarizes other differences among the three species, noting especially the patterns of setation on antenna 1 peduncle, length of antenna 1 relative to anterior pereonites, and spination of pereonites 3 and 4.

Distribution. A widespread, nearly ubiquitous, globally distributed species; in California found all along the coast.

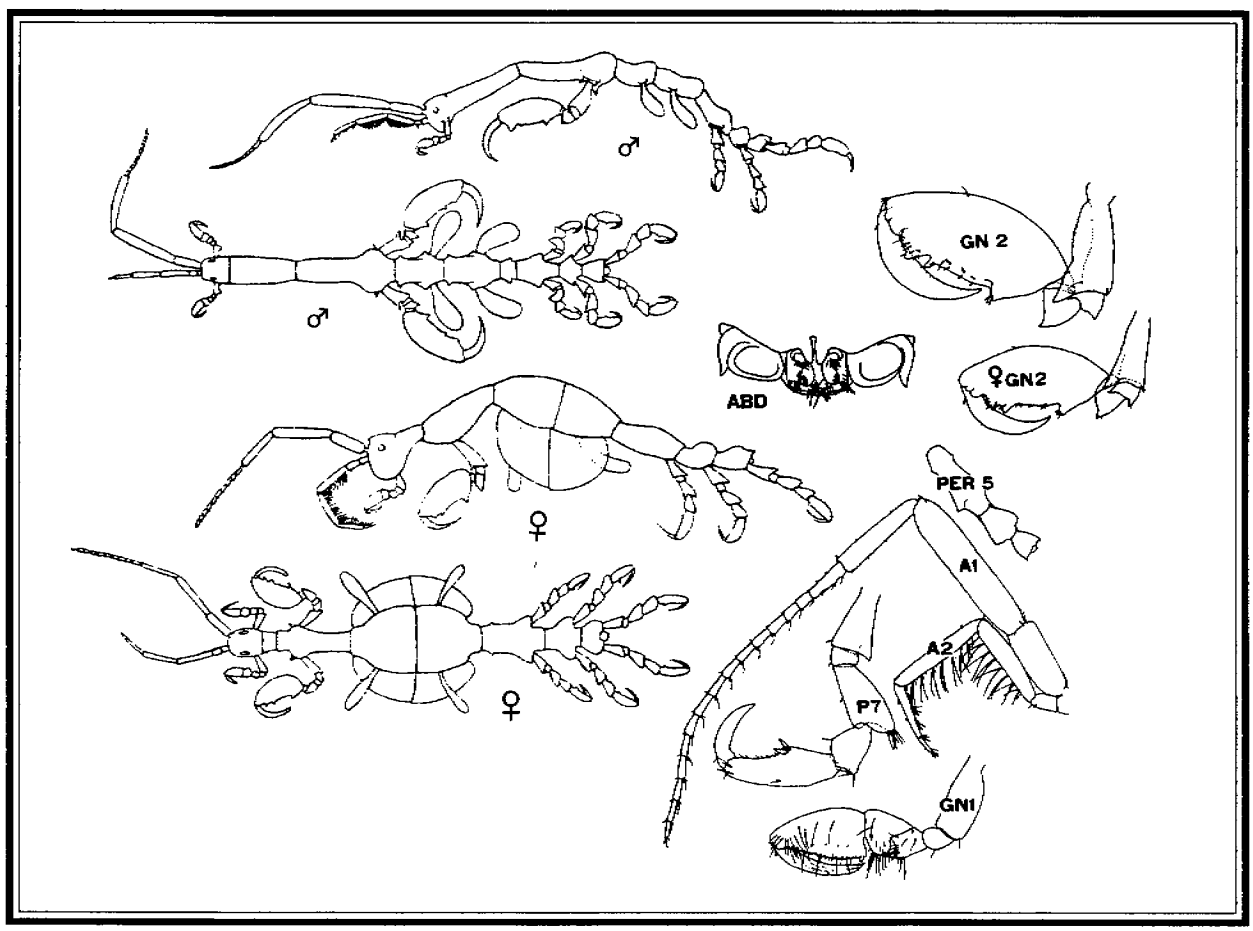

Figure 5.4. *Caprella equilibra* (from Mayer, 1882; Laubitz, 1970)

Caprella mendax Mayer, 1903

Figure 5.5

Material Examined. California: Off Pt. Sal, St. PJ-1, 145 m (1); off Purisima Pt., St. R-5, 154 m (15).

Description. (from Laubitz, 1970) Head and body smooth; pereonite 2 with large ventral spine between gnathopods. Antenna 1 longer than cephalon plus pereonites 2 and 3; flagellum shorter than peduncle articles 1 and 2. Antenna 2 shorter than antenna 1 peduncle articles 1 and 2; flagellum with short setae. Gnathopod 1 with slightly serrate grasping margin on propodus and dactylus. Gnathopod 2 propodus one and a half times as long as broad, with proximal grasping spine and distal triangular projection; dactylus evenly tapered distally. Pereopods 5 to 7, propodus palm concave, grasping spines proximal.

Remarks. See under *C. equilibra*.

Distribution. Previously known from central California to Hecate Strait, British Columbia.

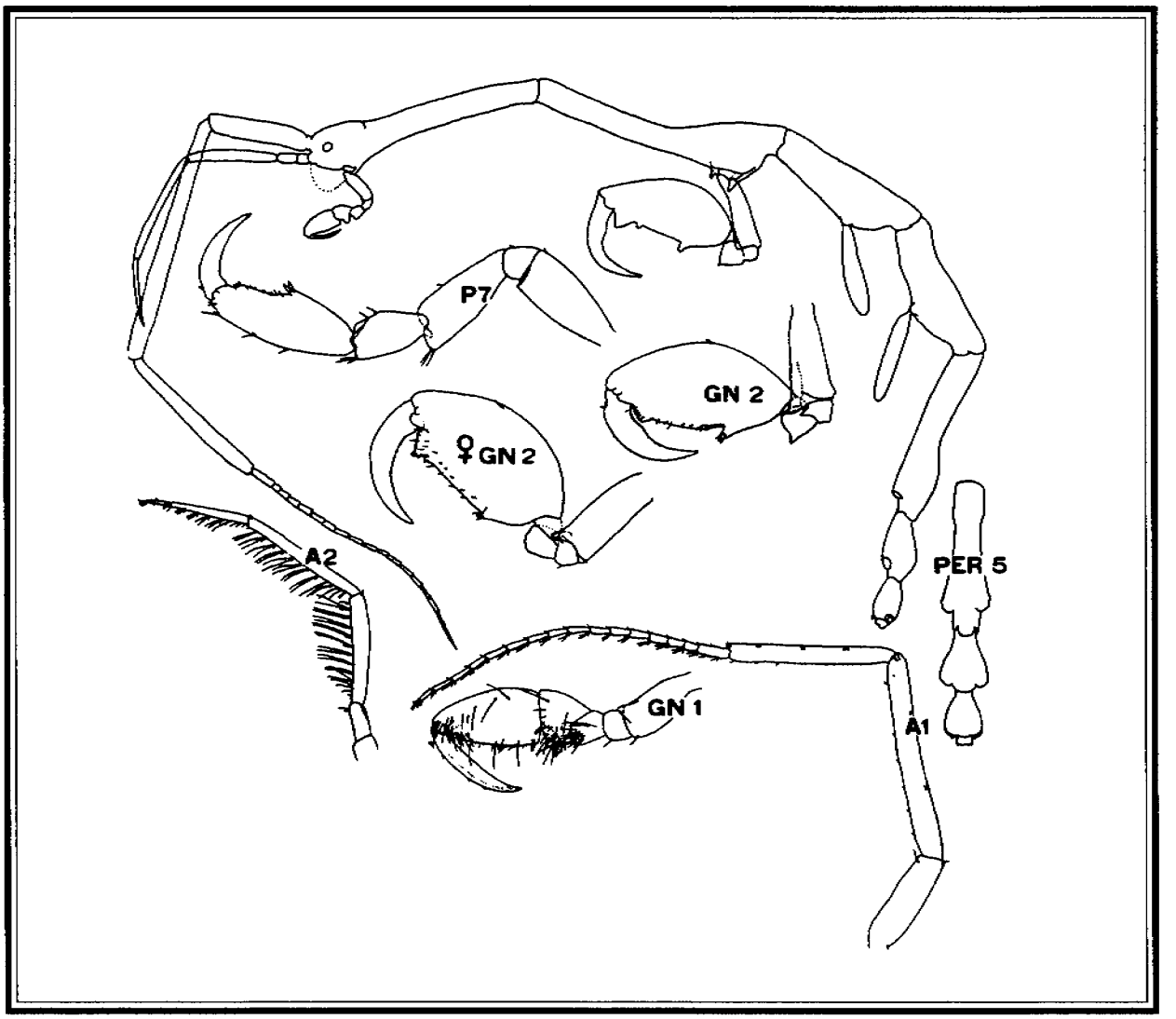

Figure 5.5. *Caprella mendax* (from Laubitz, 1970)

Caprella pilidigita Laubitz, 1970

Figure 5.6

Material Examined. California: Off Pt. Sal, St. PJ-5, 145 m (2).

Description. (from Laubitz, 1970) Head and body smooth; pereonite 2 with large ventral spine between gnathopods. Antenna 1 longer than cephalon plus pereonites 2 and 3; flagellum equal to peduncle article 2; distal portion of peduncle article 3 strongly setose. Antenna 2 shorter than antenna 1 peduncle articles 1 and 2; flagellum with short setae. Gnathopod 1 with slightly serrate grasping margin on propodus and dactylus. Gnathopod 2 propodus twice as long as broad, with proximal grasping spine and distal triangular projection; dactylus evenly tapered distally, with fine setae along inner margin. Pereopods 5 to 7, propodus palm concave, with many setae; grasping spine proximal.

Remarks. See under *C. equilibra*.

Distribution. Previously known from the British Columbia coast.

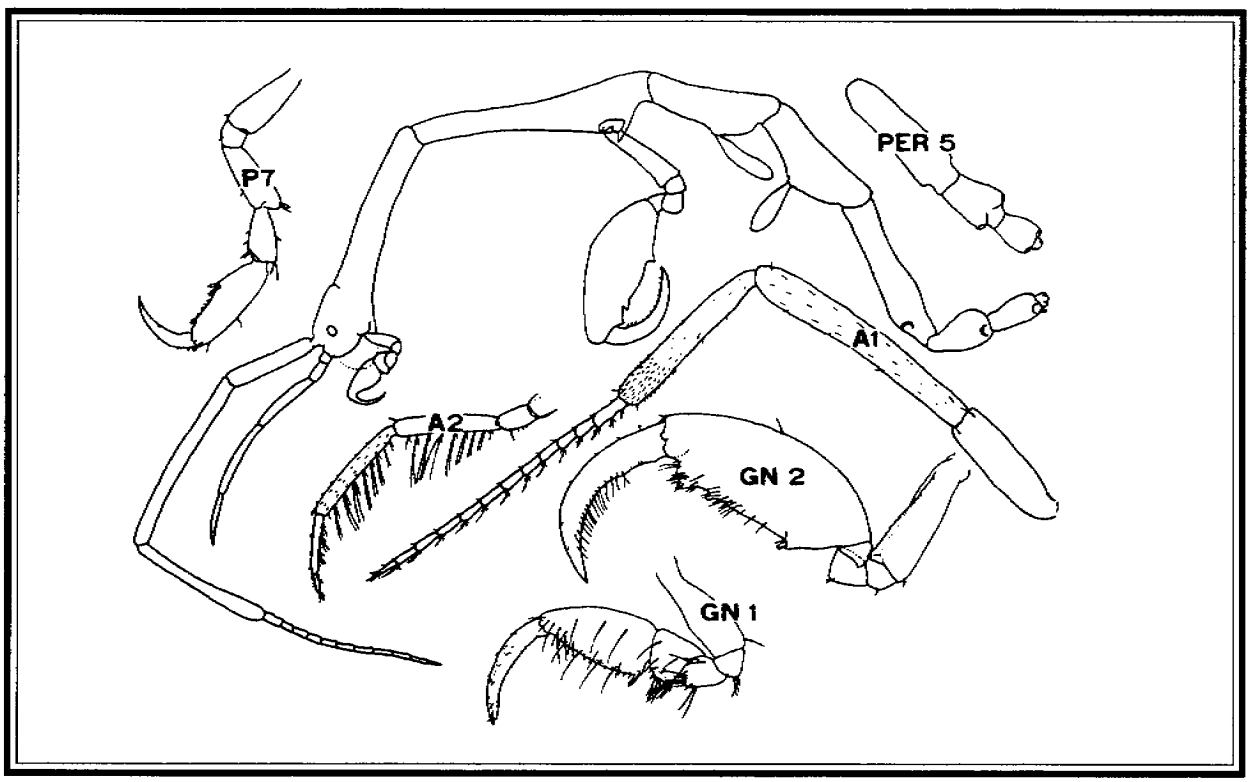

Figure 5.6. *Caprella pilidigita* (from Laubitz, 1970)

Family Pariambidae Laubitz, 1993

Diagnosis. (from Laubitz, 1993) Antenna 2 with 2 articles, heavy setae at apex. Mandible molar present; incisor 5-toothed; left lacinia 5-toothed, right lacinia serrate or broadly 3-toothed; setal row with 2-3 setae; palp 3-articulate or absent. Maxilla 1 with 6 spiniform setae on outer plate; palp with few setae. Maxilliped outer plate larger than inner; apex of inner plate truncate with few apical setae. Lower lips inner lobes well demarcated. Gnathopod 1 propodus triangular to slender, setose; palm defined by paired spine-setae. Two pairs of gills present. Pereopods 3 and 4 greatly reduced. Pereopod 5 small and weak, or reduced. Pereopods 6 and 7 normal. Abdomen unsegmented; appendages small or absent.

Remarks. See under Caprellidae, above.

Genus *Deutella* Mayer, 1890

Diagnosis. (from Laubitz, 1970) Antenna 2 without natatory setae; flagellum biarticulate. Mandibular palp 3-articulate; molar present. Maxilliped outer lobe larger than inner. Gills on pereonites 3-4. Pereopods 3 and 4 2-articulate; pereopod 5 with 6 articles. Abdomen of male with one pair of uniarticulate appendages plus one pair of setose lobes; of female with one pair of setose lobes.

Deutella californica Mayer 1890

Figure 5.7

Material Examined. California: Off Pt. Estero, St. 1, 98 m (18); St. 6, 109 m (9).

Description. (from Laubitz, 1970) Head bearing small dorsomedian spine; pereonite 2 with anterolateral anteriorly pointing projections. Antenna 1 equal to about half body length. Antenna 2 shorter than antenna 1 peduncle articles 1 and 2. Mandible palp 3-articulate. Gnathopod 2 propodus nearly rectangular in male, subovoid in female, bearing many fine setae in both; palm surface with poison spine located midway along margin and separated by deep cleft in male, poison spine and cleft absent in female, . Pereopods 3 and 4 small, similar, 2-articulate, with ring of setae at distal end of article 1. Pereopods 5-7 with 6 articles; propodus with concave palmar surface and proximal series of knobs and grasping setae.

Remarks. This species differs from the following chiefly in the nature of its body armature, bearing low tubercles where *D. venenosa* possess spines.

Distribution. Known previously from Monterey Bay, California to Prince William Sound, Alaska.

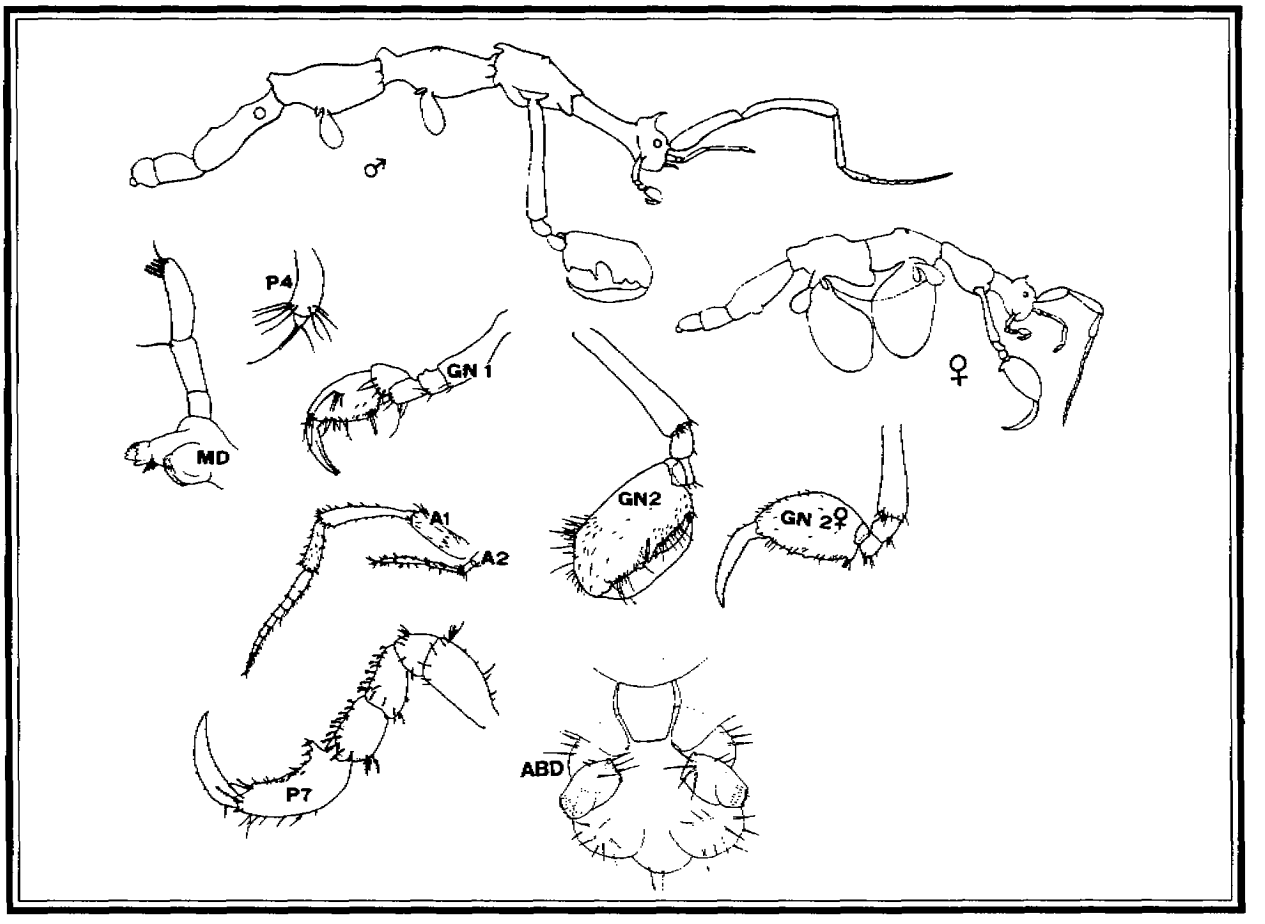

Figure 5.7. *Deutella californica* (from Mayer, 1890; Laubitz, 1970)

Deutella venenosa Mayer, 1890

Figure 5.8

Material Examined. No specimens were examined by me for this study.

Description. (from Mayer, 1890) Head bearing large dorsomedian spine; pereonite 2 with anterolateral and mid-dorsal anteriorly pointing projections. Antenna 1 equal to about half body length. Antenna 2 shorter than antenna 1 peduncle articles 1 and 2. Mandible palp 3-articulate. Gnathopod 2 propodus broadly rounded dorsally in male, subovoid in female, bearing many fine setae in both; palm surface with poison spine located midway along margin and separated by deep cleft in young male, poison spine and cleft absent in female. Pereopods 3 and 4 small, similar, 2-articulate, with ring of setae at distal end of article 1 and 2-3 setae on article 2. Pereopods 5-7 with 6 articles; propodus with concave palmar surface and proximal series of knobs and grasping setae.

Distribution. Known from the California subtidal.

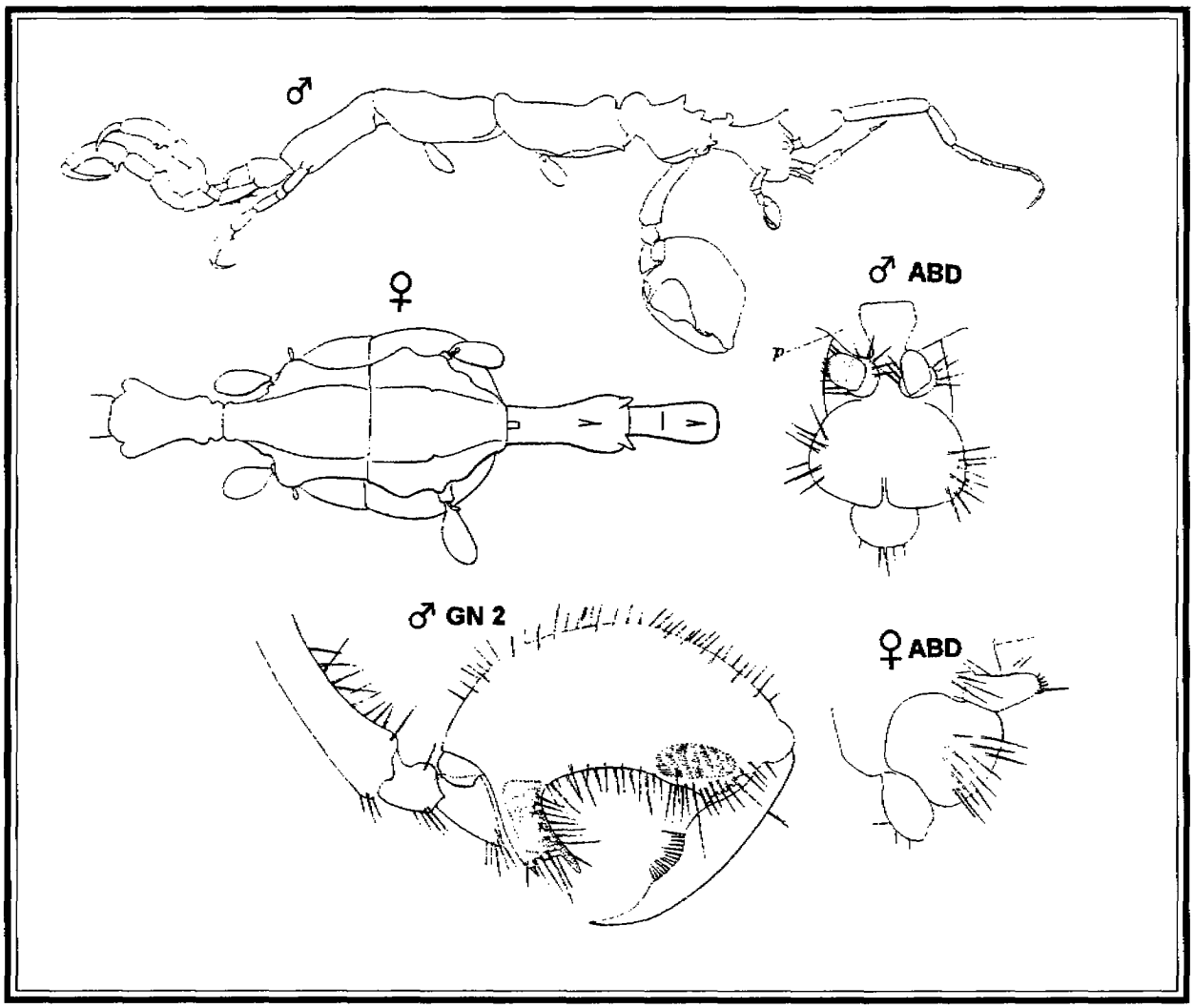

Figure 5.8. *Deutella venenosa* (from Mayer, 1890)

Family Protellidae McCain, 1970

Diagnosis. (from Laubitz, 1993) Antenna 2 with 2 articles, heavy setae at apex. Mandible molar present; incisor 5-toothed; left lacinia 5-toothed, right lacinia serrate or complexly toothed; setal row with 2-3 setae; palp 3-articulate. Maxilla 1 with 7 spiniform setae on outer plate; palp with few setae. Maxilliped outer plate larger than inner; apex of inner plate with plumose setae. Lower lips inner lobes well demarcated. Gnathopod 1 propodus triangular, setose; palm defined by single spine-seta. Two pairs of gills present. Pereopods 3 and 4 greatly reduced. Pereopod 5 normal but small, or reduced. Pereopods 6 and 7 normal. Abdomen unsegmented; appendages present.

Remarks. This group was originally proposed by McCain (1970) as a subfamily in the Aeginellidae, and has been elevated to family status by Laubitz (1993) with most of the genera listed by McCain.

Genus *Mayerella* Huntsman, 1915

Diagnosis. (from Laubitz, 1970) Antenna 2 without natatory setae; flagellum biarticulate. Mandibular palp 3-articulate; molar present. Maxilliped outer lobe larger than inner. Gills on pereonites 3-4. Pereopods 3 and 4 with 2 articles; pereopod 5 with 3 articles. Abdomen of male with one pair of uniarticulate appendages plus one pair of lobes; of female with one pair of lobes.

***Mayerella banksia* Laubitz, 1970**

Figure 5.9

Material Examined. California: Off Pt. Sal, St. 36, 492 m (1), St. 42, 100 m (2), St. PJ-1, 145 m (2); off Purisima Pt., St. R-4, 92 m (15).

Description. (from Laubitz, 1970) Body smooth except for small anterolateral projections on pereonites 2 and 3. Antenna 1 shorter than cephalon and pereonite 2. Antenna 2 equal in length to antenna 1 peduncle. Mandible palp 3-articulate. Gnathopod 2 propodus three times as long as broad; palm surface with proximal protrusion bearing grasping seta, male with distal poison spine separated by anterior cleft, female without poison spine. Pereopods 3 and 4 small, similar, 2-articulate, with 2 setae at distal end of article 1. Pereopod 5 articles 1 and 2 nearly devoid of setae. Pereopods 6 and 7 with 6 articles; propodus with slightly developed palmar surface.

Remarks. The combination of 2-articulate pereopods 3 and 4 with 3-articulate pereopod 5 serves to distinguish this species from all other caprellids in the Santa Maria Basin region.

Distribution. Known previously from the British Columbia and southern Alaska coasts.

Genus *Tritella* Mayer, 1890

Diagnosis. (from Laubitz, 1970) Antenna 2 with natatory setae; flagellum biarticulate. Mandibular palp 3-articulate; molar present. Maxilliped outer lobe larger than inner. Gills on pereonites 3-4. Pereopods 3 and 4 uniarticulate; pereopod 5 with 6 articles. Abdomen of male and female with one pair of setose lobes.

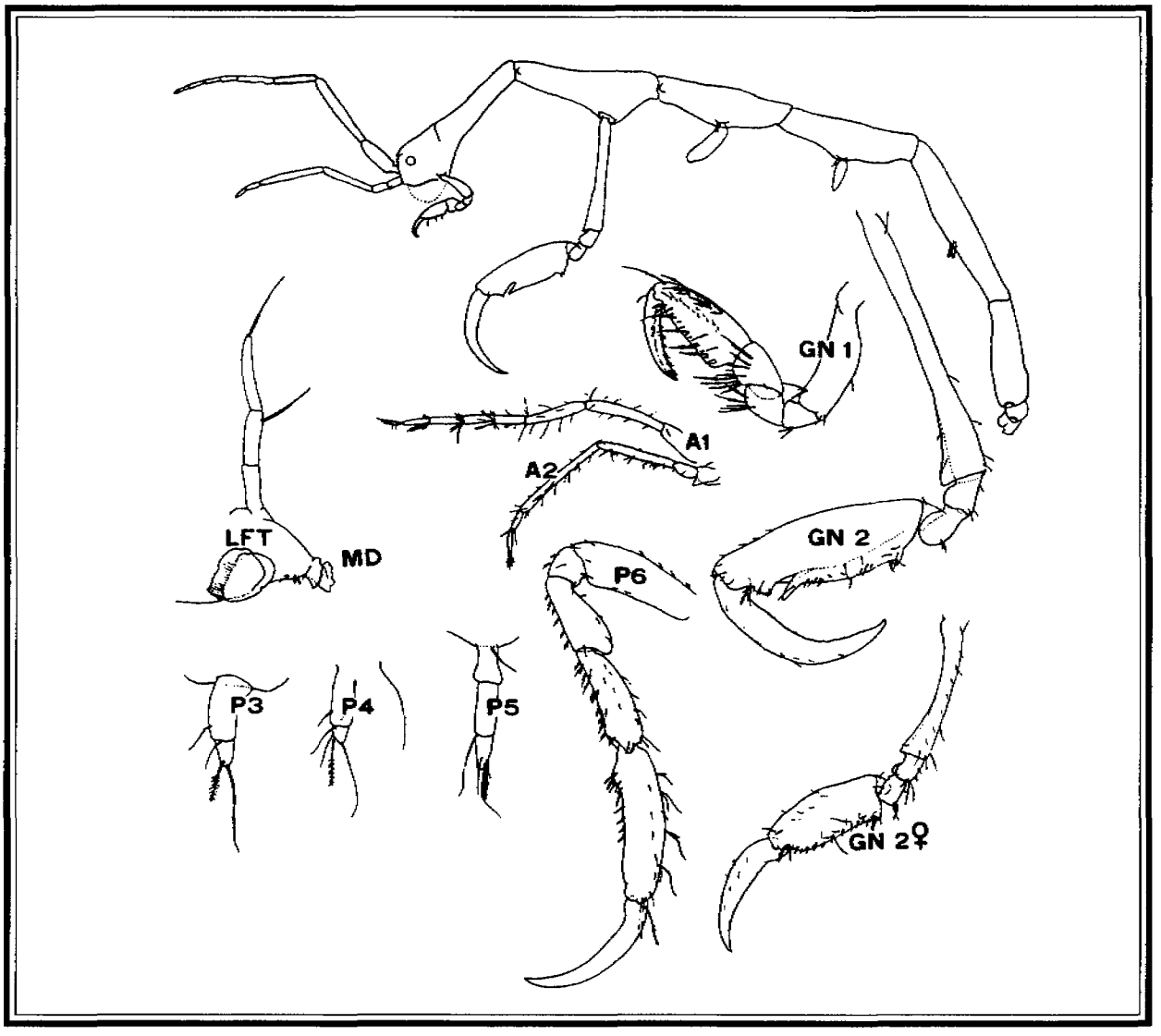

Figure 5.9. *Mayerella banksia* (from Laubitz, 1970)

Tritella laevis Mayer, 1903

Figure 5.10

Material Examined. No specimens examined by me.

Description. (from Laubitz, 1970) Body smooth dorsally, with anteriorly directed anterolateral projections on pereonites 2-4. Antenna 1 longer than cephalon and pereonite 2. Antenna 2 slightly longer than antenna 1 peduncle; flagellum stout with heavy setae. Maxilliped outer plate with 1 or 2 apical plumose setae, 1 tooth, and denticulate medial margin. Gnathopod 2, in male, propodus 2 times as long as broad; palm surface with proximal protrusion bearing grasping seta and poison spine, in female propodus broader and with minute poison spine. Pereopods 3 and 4 similar, with 3 apical setae. Pereopods 5, 6, and 7 normal; propodus with palmar knobs supporting grasping setae.

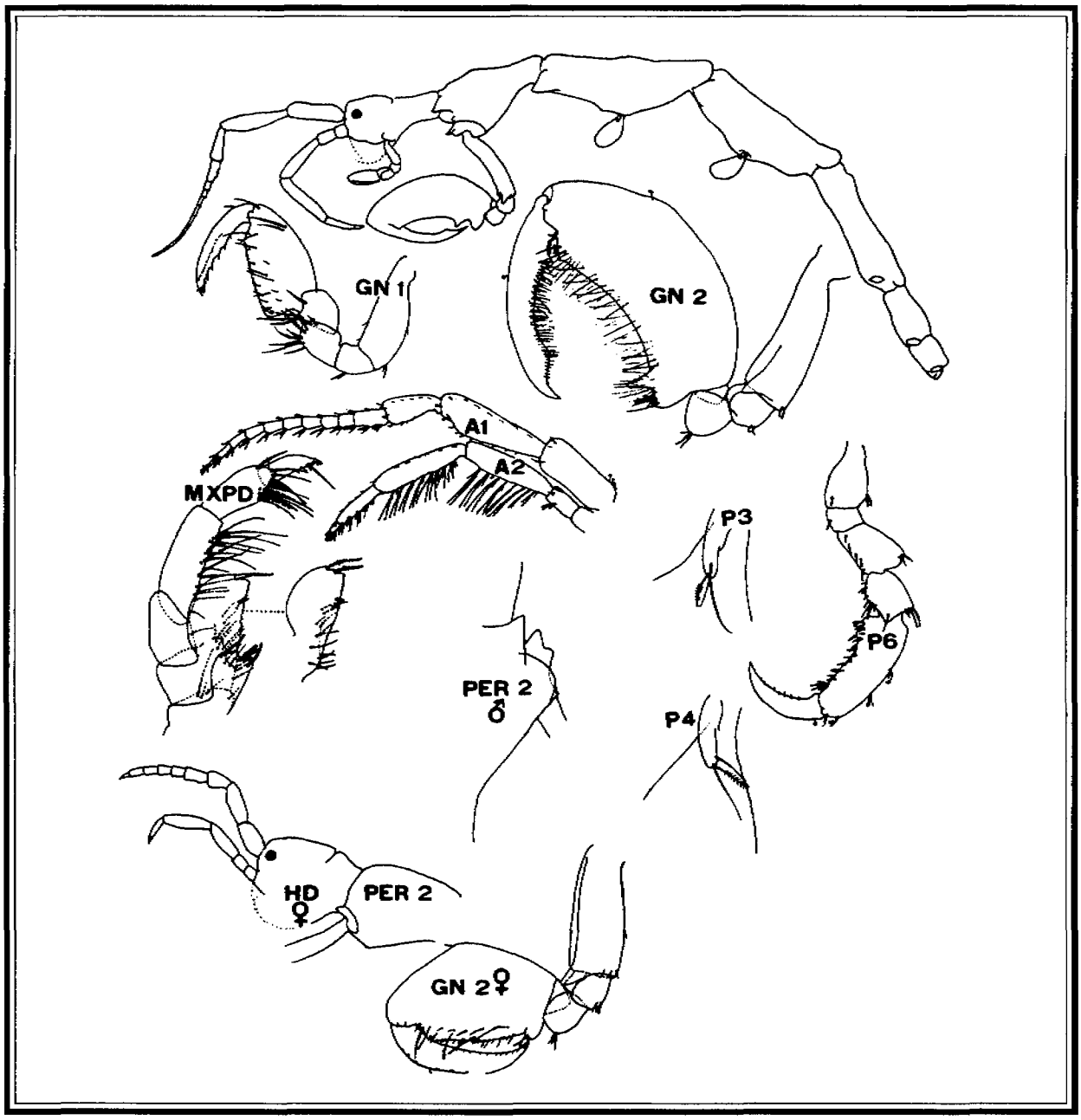

Figure 5.10. *Tritella laevis* (from Laubitz, 1970)

Remarks. This species is distinguished from the following, *T. pilimana*, most easily by the stoutness of antenna 2 and the better developed palm on pereopods 5-7.

Distribution. Known from California north of Point Conception to the Queen Charlotte Islands, British Columbia.

Tritella pilimana Mayer, 1890

Figure 5.11

Material Examined. California: Off Pt. Sal, St. PJ-1, 145 m (3); off Purisima Pt., St. R-4, 92 m (15).

Description. (from Laubitz, 1970) Body smooth dorsally, with laterally directed anterolateral projections on pereonites 2-4. Antenna 1 nearly as long as cephalon and pereonites 2 and 3. Antenna 2 shorter than antenna 1 peduncle, slender, with swimming setae. Maxilliped outer plate with 1 apical plumose seta, 1 tooth, and serrate medial margin. Gnathopod 2, in male, propodus 2 times as long as broad; palm surface with proximal protrusion bearing grasping seta and poison spine, in female propodus broader and with minute poison spine. Pereopods 3 and 4, similar, with 3 apical setae. Pereopods 5, 6, and 7 normal; propodus palm ill-defined, with palmar knobs supporting grasping setae.

Remarks. See under *T. laevis*.

Distribution. Known from California north of Point Conception to Prince William Sound, Alaska.

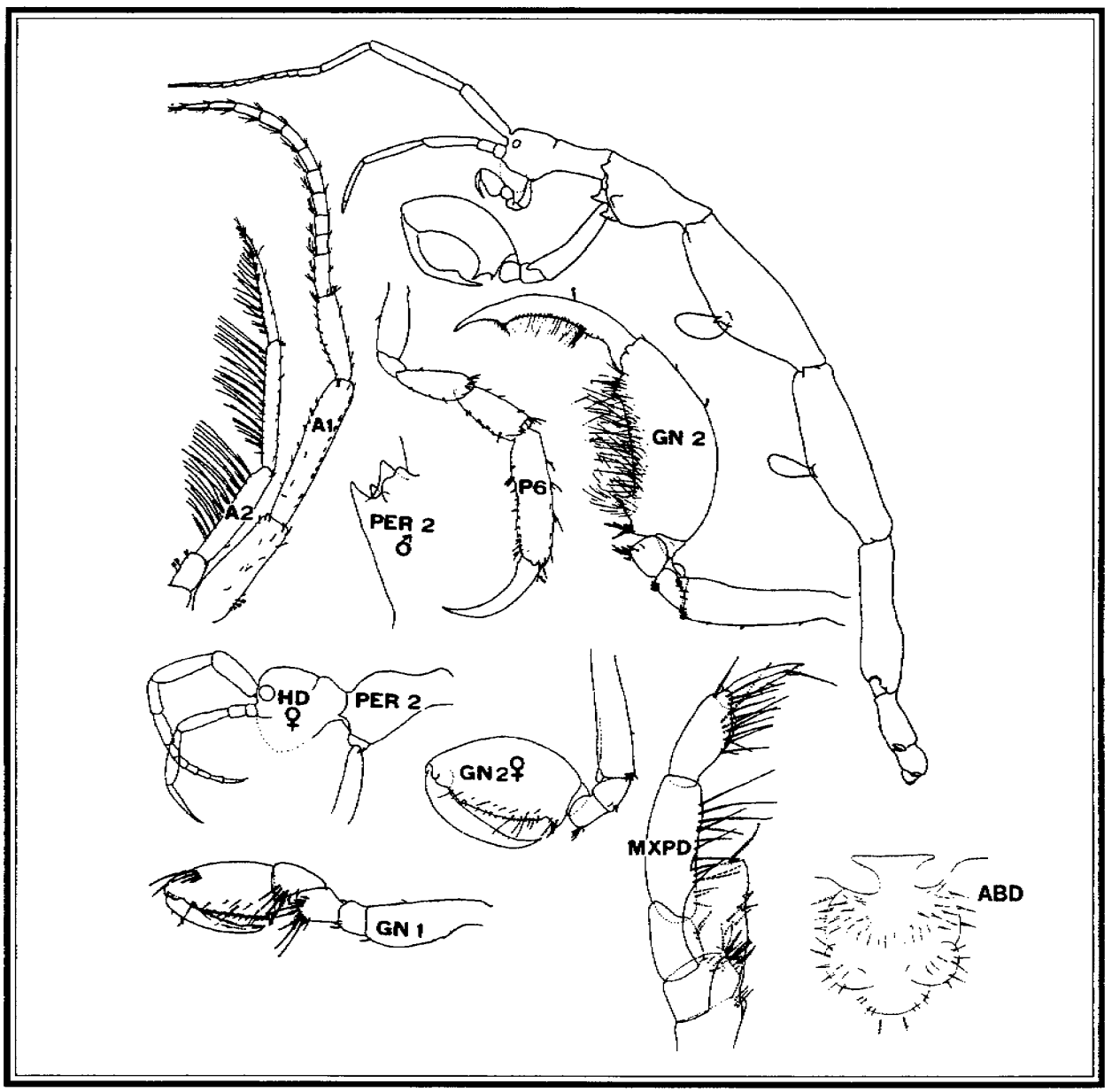

Figure 5.11. *Tritella pilimana* (from Laubitz, 1970; Mayer, 1890)

Tritella tenuissima Dougherty and Steinberg, 1953

Figure 5.12

Material Examined. California: Off Pt. Arguello, St. 61, 345 m (2); off Purisima Pt., St. R-5, 154 m (9).

Description. (from Dougherty and Steinberg, 1953) Body very much elongated and smooth. Antenna 1 as long as cephalon and pereonites 2 and 3. Antenna 2 longer than antenna 1 peduncle, without swimming setae. Maxilliped outer plate with 1 apical plumose seta, 1 tooth, and serrate medial margin. Gnathopod 2, in male, propodus 3 times as long as broad; palm surface with proximal protrusion bearing grasping seta, poison spine located midway along palm, anterior part of palm separated from posterior by strong cleft; in female propodus broader and with minute poison spine. Pereopods 3 and 4 similar, with 3 apical setae. Pereopod 5, palm ill-defined; pereopods 6 and 7 normal.

Remarks. This species is longer and more slender than the two other species of *Tritella* from this region.

Distribution. Known so far only from California.

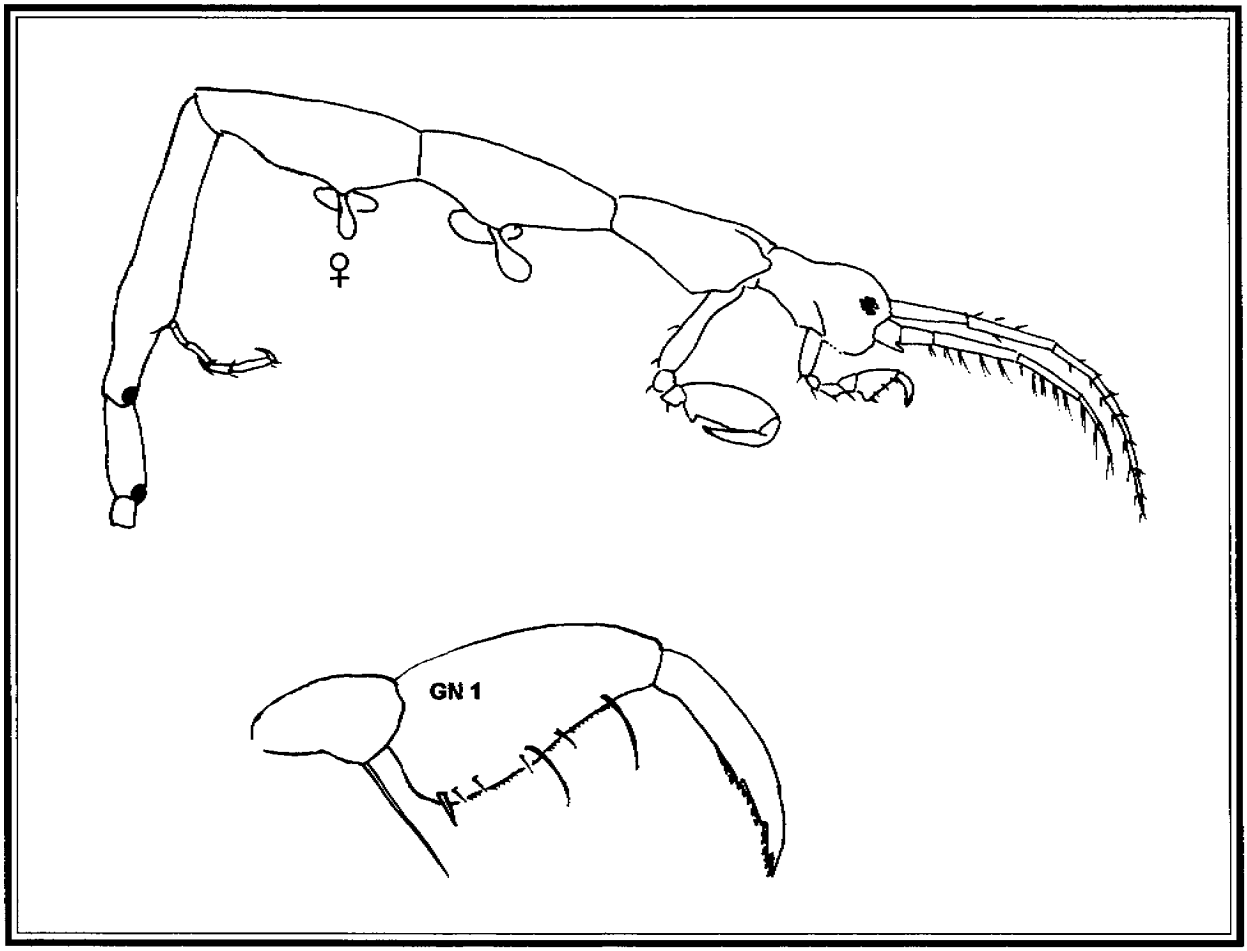

Figure 5.12. *Tritella tenuissima* (original)

Literature Cited

Barnard, K.H. 1916. Contributions to the crustacean fauna of South Africa. 5. The Amphipoda. Annals of the South African Museum 15: 105-302.

Dougherty, E.C. and J.E. Steinberg. 1953. Notes on the skeleton shrimps (Crustacea: Caprellidae) of California. Proceedings of the Biological Society of Washington 66: 39-50.

La Follette, R. 1915. Caprellidae from Laguna Beach. Part II. Journal of Entomology and Zoology, Pomona College, California 7: 55-63.

Laubitz, D.R. 1970. Studies on the Caprellidae (Crustacea, Amphipoda) of the American North Pacific. National Museum of Natural Sciences, Canada, Publications in Biological Oceanography, No. 1, pp. 1-89.

Laubitz, D.R. 1972. The Caprellidae (Crustacea, Amphipoda) of Atlantic and Arctic Canada. National Museum of Natural Sciences, Canada, Publications in Biological Oceanography, No. 4, pp. 1-82.

Laubitz, D.R. 1993. Caprellidea (Crustacea: Amphipoda): towards a new synthesis. Journal of Natural History 27: 965-976.

Mayer, P. 1882. Die Caprelliden des Golfes von Neapel und der angrenzenden Meeres-Abschnitte. Eine Monographie. Fauna und Flora des Golfes von Neapel 6: 1-201.

Mayer, P. 1890. Die Caprelliden des Golfes von Neapel. Nachtrag zur Monographie derselben. Fauna und Flora des Golfes von Neapel 17: 1-157.

Mayer, P. 1903. Die Caprellidae der Siboga-Expedition. Siboga Expedition 34: 1-160.

McCain, J.C. 1968. The Caprellidae (Crustacea: Amphipoda) of the western North Atlantic. Bulletin of the United States National Museum 278: 1-147.

McCain, J.C. 1970. Familial taxa within the Caprellidae (Crustacea: Amphipoda). Proceedings of the Biological Society of Washington 82: 837-842.

Vassilenko, S.V. 1968. On the question of systematics and the basic lines of development in the family Caprellidae. Doklady Akademii Nauk S.S.S.R. 183: 1461-1464. [In Russian]

Vassilenko, S.V. 1974. Caprellids of the seas of the USSR and adjacent waters. Opredeleliteli po Faune SSSR 107: 1-287. [In Russian]

Appendix

Lists and Maps of Stations

Table A.1. Position of soft-substrate stations taken during the Phase I Reconnaissance.

Station	Latitude	Longitude	Depth (m)
1	35°27.86′N	121°05.33′W	98
2	35°27.70′N	121°06.52′W	200
3	35°27.07′N	121°10.20′W	291
4	35°26.56′N	121°14.93′W	393
5	35°25.77′N	121°21.69′W	585
6	35°20.88′N	120°59.62′W	109
7	35°20.65′N	121°02.57′W	197
8	35°20.00′N	121°06.58′W	308
9	35°19.48′N	121°10.06′W	398
10	35°18.28′N	121°18.65′W	591
11	35°17.80′N	121°22.13′W	690
12	35°15.03′N	120°57.31′W	98
13	35°14.54′N	120°59.77′W	197
14	35°14.15′N	121°02.04′W	299
15	35°13.98′N	121°04.54′W	393
16	35°12.23′N	121°16.29′W	591
17	35°11.61′N	121°22.55′W	654
18	35°09.08′N	120°56.55′W	197
19	35°08.93′N	120°59.66′W	296
20	35°15.72′N	121°04.68′W	396
21	35°06.11′N	120°44.82′W	49
22	35°05.85′N	120°50.23′W	99
23	35°05.60′N	120°55.18′W	195
25	35°05.07′N	121°00.75′W	390
26	35°04.38′N	121°15.99′W	590
27	35°04.30′N	121°19.27′W	611
28	35°04.22′N	121°19.65′W	603
30	34°54.19′N	120°47.07′W	98
31	34°53.76′N	120°52.96′W	200
32	34°53.56′N	120°56.81′W	297
33	34°53.43′N	120°59.66′W	396
34	34°53.15′N	121°04.40′W	492
35	34°52.96′N	121°10.30′W	548
36	34°52.77′N	121°15.37′W	492
38	34°49.81′N	120°52.66′W	197
39	34°49.53′N	120°56.85′W	294
40	34°49.24′N	121°00.81′W	392
41	34°48.35′N	121°19.14′W	495
42	34°48.04′N	120°47.50′W	100
43	34°46.59′N	120°52.92′W	197
45	34°44.91′N	120°59.59′W	395
46	34°41.22′N	121°13.56′W	597
47	34°41.99′N	121°10.81′W	378
48	34°45.11′N	120°52.85′W	196
49	34°45.03′N	120°56.31′W	290
50	34°37.80′N	121°01.66′W	591
52	34°39.56′N	120°47.64′W	98
53	34°37.69′N	120°50.38′W	196
54	34°36.57′N	120°52.02′W	396
55	34°33.66′N	120°56.31′W	590
56	34°30.32′N	121°01.02′W	900

Table A.1 (Continued)

Station	Latitude	Longitude	Depth (m)
58	34°34.35′N	120°45.18′W	99
59	34°33.65′N	120°47.18′W	216
60	34°33.25′N	120°48.34′W	275
61	34°33.01′N	120°48.89′W	345
62	34°30.46′N	120°52.13′W	582
63	34°26.29′N	120°58.08′W	930
64	34°33.15′N	120°40.90′W	59
65	34°31.27′N	120°43.27′W	107
66	34°30.46′N	120°44.55′W	201
67	34°30.29′N	120°45.50′W	282
68	34°29.24′N	120°45.99′W	390
69	34°22.88′N	120°54.20′W	927
70	34°29.67′N	120°43.70′W	200
71	34°29.04′N	120°44.01′W	306
72	34°28.41′N	120°44.76′W	401
73	34°28.21′N	120°36.80′W	98
74	34°26.84′N	120°38.61′W	201
75	34°26.08′N	120°39.65′W	293
76	34°25.59′N	120°40.98′W	387
77	34°22.62′N	120°44.02′W	578
78	34°18.78′N	120°49.30′W	762
79	34°24.12′N	120°28.32′W	98
80	34°22.86′N	120°28.34′W	196
81	34°21.26′N	120°28.83′W	294
82	34°18.71′N	120°29.55′W	394
83	34°17.20′N	120°30.20′W	444
84	34°13.54′N	120°31.19′W	394
85	34°25.88′N	120°16.31′W	113
86	34°24.45′N	120°17.02′W	197
87	34°21.60′N	120°17.11′W	299
88	34°17.89′N	120°16.86′W	393
89	34°13.79′N	120°16.56′W	471
90	34°09.44′N	120°16.30′W	375
91	34°11.73′N	120°07.43′W	540
92	34°08.70′N	120°07.50′W	444
93	34°07.63′N	120°07.51′W	357
96	34°22.91′N	120°05.42′W	296
94	34°24.54′N	120°05.47′W	96
95	34°23.70′N	120°05.47′W	198
97	34°22.28′N	120°05.49′W	393
98	34°12.87′N	120°05.59′W	561
99	34°11.22′N	120°05.86′W	540
100	34°08.67′N	120°05.50′W	443
101	34°07.51′N	120°05.65′W	357
102	34°59.71′N	120°48.22′W	99
103	34°59.63′N	120°53.56′W	197
104	34°59.45′N	120°56.49′W	294
105	34°59.23′N	120°59.60′W	392
106	34°58.95′N	121°04.42′W	492
107	34°58.65′N	121°15.08′W	573
108	34°58.21′N	121°17.88′W	492

Note: Sample labels from the Soft-substrate stations have several identification codes which include a station number, sample type, replicate number, and analysis type. These are as follows: 001 to 200 = the range of station numbers; BSS = Benthic Sediment Single (i.e., a non-replicated station); BSR = Benthic Sediment Replicate (three replicates taken at this station); BSV = Benthic Sediment Variance (subsamples); 01-09 = replicate numbers; TX = a taxonomy sample. Sample labels having the designation BRA, represents a sample from rocks taken as part of the hard bottom survey.

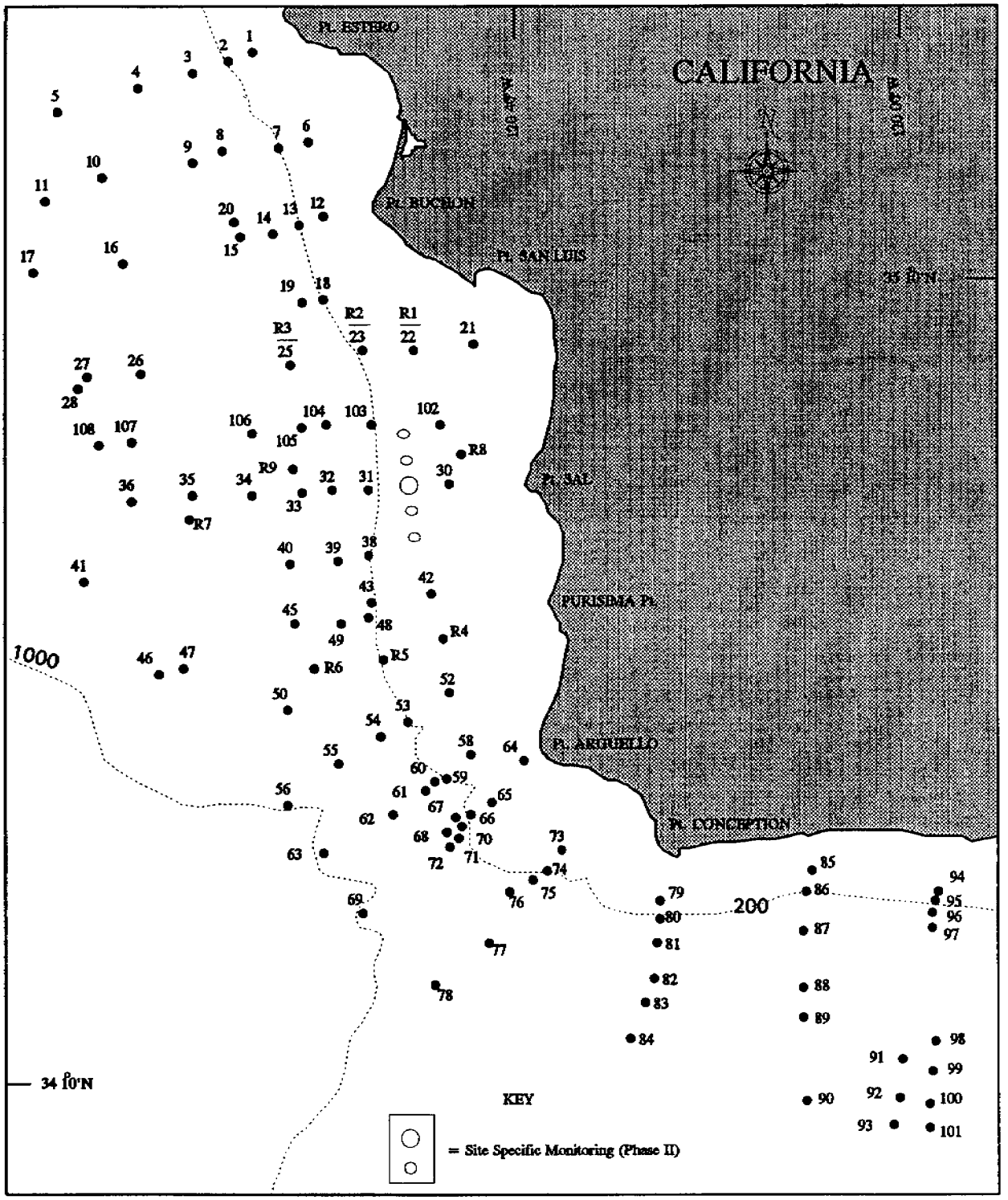

Figure A.1. Map showing location of soft substrate stations from Phase I and Phase II MMS Reconnaissance and Monitoring Programs.

Table A.2. Location of soft-substrate stations taken during the Phase II Monitoring Program.

Station	Latitude	Longitude	Depth (m)
R-1	35°05.83'N	120°49.16'W	91
R-2	35°05.50'N	120°53.40'W	161
R-3	35°05.30'N	121°00.90'W	409
R-4	34°43.01'N	120°47.39'W	92
R-5	34°42.69'N	120°50.83'W	154
R-6	34°41.40'N	120°57.90'W	410
R-7	34°52.90'N	121°10.30'W	565
R-8	34°55.30'N	120°45.87'W	90
R-9	34°53.68'N	120°59.12'W	410
PJ-1	34°55.79'N	120°49.91'W	145
PJ-2	34°55.32'N	120°49.59'W	142
PJ-3	34°56.26'N	120°49.58'W	138
PJ-4	34°56.26'N	120°50.24'W	150
PJ-5	34°55.32'N	120°50.24'W	152
PJ-6	34°54.71'N	120°49.91'W	148
PJ-7	34°55.79'N	120°48.60'W	123
PJ-8	34°56.87'N	120°49.91'W	142
PJ-9	34°55.79'N	120°51.23'W	169
PJ-10	34°53.63'N	120°49.91'W	147
PJ-11	34°57.95'N	120°49.91'W	136
PJ-12	34°55.58'N	120°49.91'W	145
PJ-13	34°56.01'N	120°49.91'W	144
PJ-14	34°55.79'N	120°49.26'W	134
PJ-15	34°55.79'N	120°50.57'W	155
PJ-16	34°55.03'N	120°48.99'W	130
PJ-17	34°56.56'N	120°48.98'W	126
PJ-18	34°56.56'N	120°50.84'W	158
PJ-19	34°55.03'N	120°50.84'W	167
PJ-20	34°50.38'N	120°49.91'W	148
PJ-21	35°01.23'N	120°51.15'W	143
PJ-22	34°55.25'N	120°49.93'W	143
PJ-23	34°56.33'N	120°49.90'W	143

Table A.3. Sampling dates of MMS Phase II Monitoring Program.

Cruise	Date
1-1	October 1986
1-2	June 1987
1-3	May 1987
1-4	July 1987
2-1	October 1987
2-2	January 1988
2-3	May 1988
3-1	October 1988
3-2	May 1988

Table A.4. MMS Phase I - Locations of hard-substrate transects.

Station	Beginning Latitude	Longitude	End Latitude	Longitude	Depth (m)
1 A/B	34°24.454′N	120°01.876′W	34°24.464′N	120°00.878′W	69-73.5
1 C/D	34°24.076′N	120°00.443′W	34°24.184′N	120°01.480′W	73.5-78
2 A/B	34°11.377′N	120°29.318′W	34°11.289′N	120°28.774′W	110-126
2 C/D	34°10.984′N	120°28.094′W	34°10.780′N	120°27.554′W	120-123
4 A/B	34°27.539′N	120°40.364′W	34°28.162′N	120°40.189′W	168-237
6 A/B	34°30.246′N	120°35.555′W	— —.—	— —.—	54-63
6 C/D	— —.—	— —.—	34°30.421′N	120°34.315′W	54-63
13 A/B	34°42.570′N	120°47.899′W	34°42.107′N	120°48.253′W	92-100
13 C/D	34°42.556′N	120°48.147′W	34°42.974′N	120°47.424′W	88.5-100.5
14 A/B	34°43.589′N	120°49.093′W	34°42.826′N	120°48.370′W	96-105
14 C/D	34°43.244′N	120°49.406′W	34°42.893′N	120°48.822′W	105-117
16 A/B	34°46.544′N	120°50.197′W	34°45.912′N	120°49.726′W	91.5-123
17 A/B	34°49.382′N	120°50.768′W	34°49.600′N	120°50.688′W	160.5-168
19 A/B	34°47.833′N	120°51.425′W	34°47.097′N	120°50.793′W	148.5-177
20 A/B	34°46.470′N	120°50.289′W	34°46.140′N	120°49.885′W	90-130.5
21 A/B	34°47.335′N	120°45.903′W	34°47.548′N	120°46.123′W	75-90
22 A/B	34°50.365′N	120°48.221′W	34°50.990′N	120°48.365′W	114-115.5
23 A/B	34°49.868′N	120°47.393′W	34°50.003′N	120°47.480′W	93-102
25 A/B	35°05.662′N	120°47.562′W	35°06.036′N	120°47.652′W	64.5-72
26 C/D	35°11.586′N	120°55.556′W	35°11.555′N	120°55.233′W	108-111
27 A/B	35°20.906′N	120°59.657′W	35°21.035′N	120°59.603′W	96-126
28 A/B	35°21.539′N	120°59.641′W	35°21.867′N	120°59.299′W	96-105
29 A/B	35°27.864′N	121°05.331′W	35°27.805′N	121°05.277′W	102-106.5

Table A.5. MMS Phase II - Locations of hard-substrate photosurvey stations.

Station	Latitude	Longitude	Depth (m)
PH-E	34°30.26′N	120°42.76′W	119
PH-F	34°30.81′N	120°42.36′W	105
PH-I	34°29.96′N	120°41.68′W	107
PH-J	34°29.82′N	120°41.82′W	117
PH-K	34°29.37′N	120°42.26′W	160
PH-N	34°29.21′N	120°42.05′W	166
PH-R	34°29.11′N	120°42.67′W	213
PH-U	34°31.48′N	120°43.51′W	113
PH-W	34°31.52′N	120°45.86′W	195

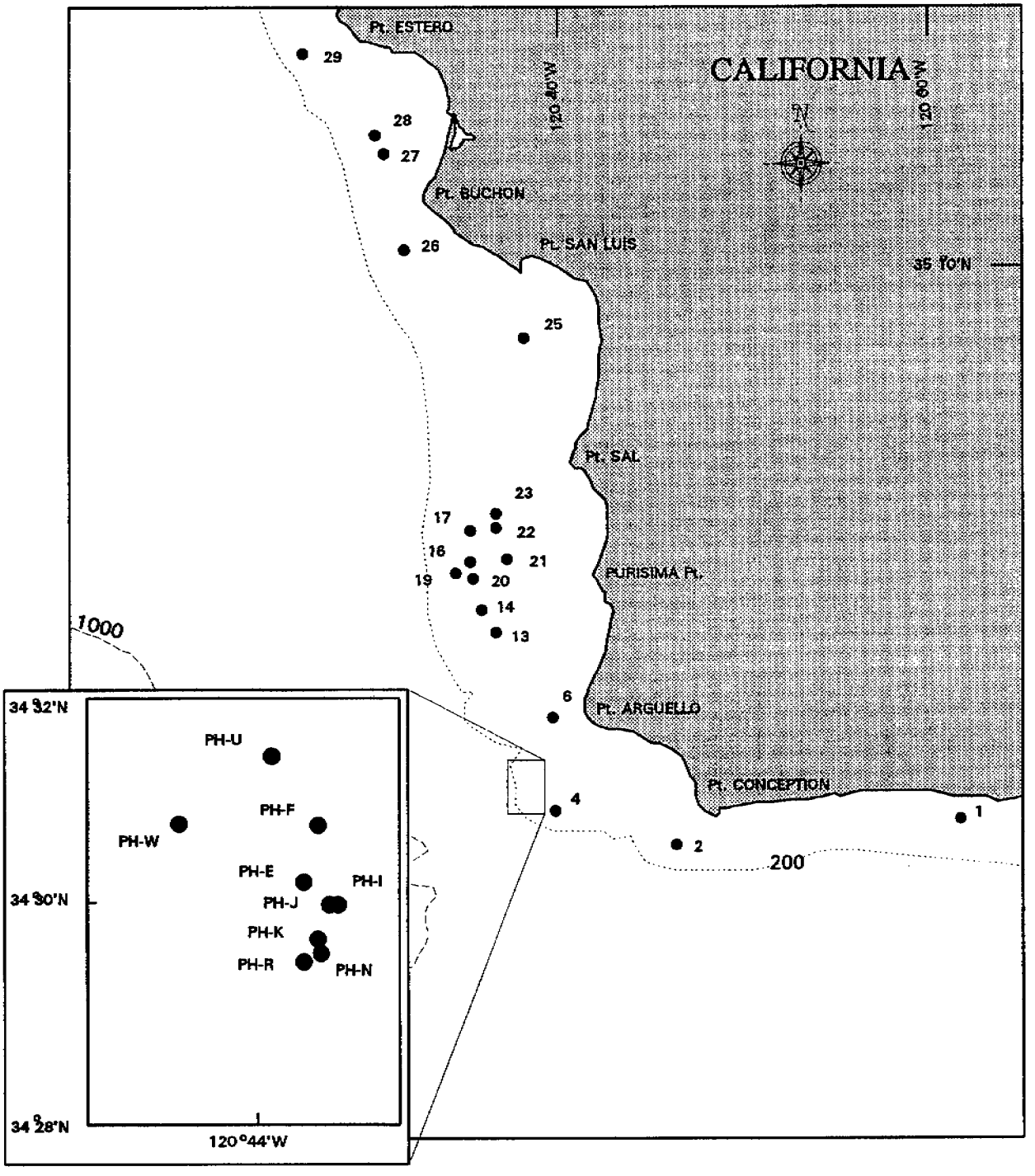

Figure A.2 Map showing locations of hard substrate stations from Phase I and Phase II MMS Reconnaissance and Monitoring Programs.

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Royalty Management Program** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.