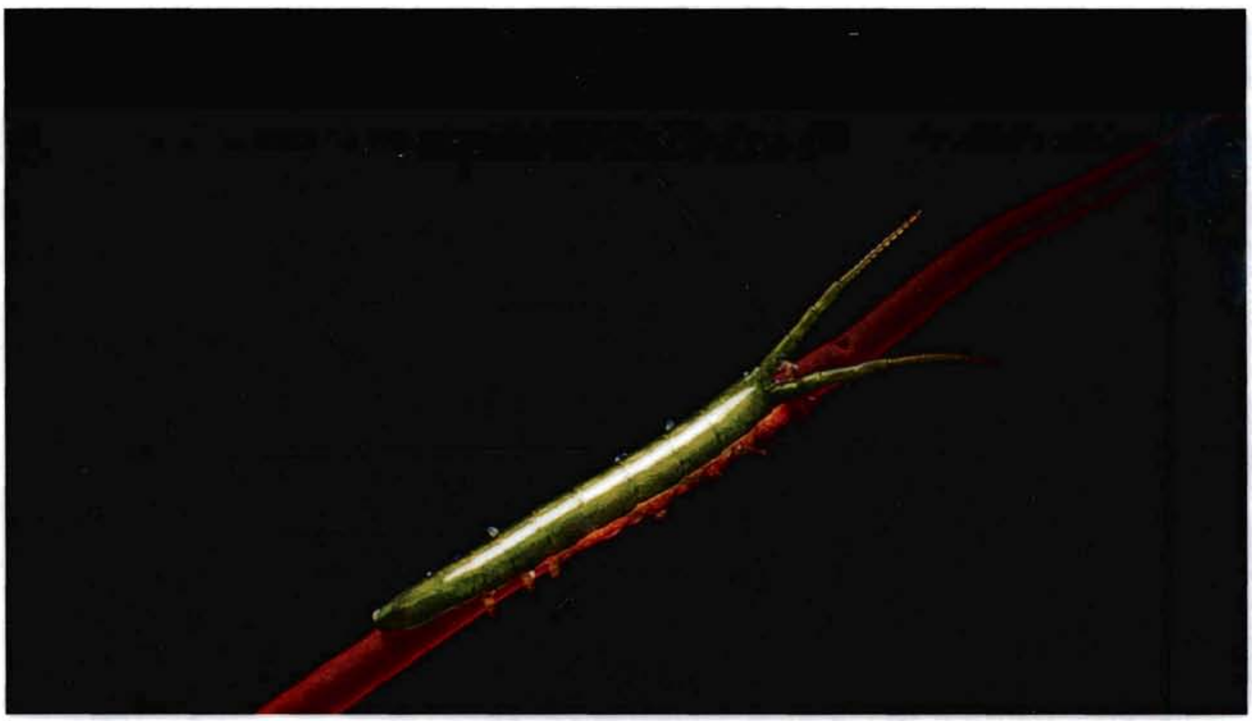
Taxonomic Atlas
of the Benthic Fauna of the Santa Maria Basin and Western Santa Barbara Channel

Volume 11 — The Crustacea Part 2

The Isopoda, Cumacea and Tanaidacea



Santa Barbara Museum of Natural History

Santa Barbara, California

Research Published in this Volume was Supported by

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

770 Paseo Camarillo
Camarillo, California 93010

Under
Contract No. 14-35-0001-30484

TAXONOMIC ATLAS

OF THE BENTHIC FAUNA OF THE SANTA MARIA BASIN AND WESTERN SANTA BARBARA CHANNEL

VOLUME 11

The Crustacea Part 2
The Isopoda, Cumacea and Tanaidacea

Edited by

James A. Blake

and

Paul H. Scott

SANTA BARBARA MUSEUM OF NATURAL HISTORY

Santa Barbara, California

TAXONOMIC ATLAS OF THE BENTHIC FAUNA OF THE SANTA MARIA BASIN AND WESTERN SANTA BARBARA CHANNEL

Volume 11
The Crustacea Part 2 – The Isopoda, Cumacea and Tanaidacea

Santa Barbara Museum of Natural History
2559 Puesta del Sol Road
Santa Barbara, California 93105-2936
Original Date of Publication: **20 May 1997**

Printed and bound by Alternative Graphics, Goleta, California
Production editor, Adele Smith
Layout by Marie Murphy
Cover photograph by Ron McPeak: An undescribed species of Idoteidae from central California. Photograph digitally enhanced by Marie Murphy and Paul Scott.

Library of Congress Cataloging in Publication Data

Library of Congress Catalog Card Number 94-68651
ISBN 0-936494-16-6 (Volume 11)
ISBN 0-936494-21-2 (14 Volume Set)

Table of Contents

Acknowledgments

This study was funded by the Pacific Outer Continental Shelf Region of the U.S. Department of the Interior, Minerals Management Service, Washington, D.C., under Contract No. 14-35-0001-30484. We deeply appreciate the continual support and patience of the staff at the Santa Barbara Museum of Natural History, as well as Fred Piltz and Frank Manago of the Minerals Management Service, Pacific OCS Region, without whom this series would not have been possible.

List of Acronyms

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.
CAS	California Academy of Sciences, Department of Invertebrate Zoology, San Francisco, California, USA.
LACM	Natural History Museum of Los Angeles County, Los Angeles, California, USA.
MMS	United States Minerals Management Service.
SCAMIT	Southern California Association of Marine Invertebrate Taxonomists.
SBMNH	Santa Barbara Museum of Natural History, Santa Barbara, California, USA.
SDNHM	San Diego Natural History Museum, San Diego, California, USA.
USNM	United States National Museum. A historical designation for the National Museum of Natural History (NMNH), Smithsonian Institution, Washington, D.C., USA.

1.0 The Order Isopoda

1.1 Introduction to the Marine Isopoda

by

Regina Wetzer[1], Richard C. Brusca[2]
and George D.F. Wilson[3]

Introduction

The order Isopoda is one of ten orders in the crustacean superorder Peracarida. Peracarids are distinguished from other eumalacostracan superorders (Hoplocarida, Syncarida, Eucarida) by the following combination of characters: absence of caudal rami on the telson; maxillipedal basis typically produced into an anteriorly directed, bladelike endite; mandibles with an articulated accessory process in adults, between the molar and incisor processes (the *lacinia mobilis*); carapace, when present, not fused with posterior pereonites and usually reduced in size; females with unique thoracic coxal endites, called *oostegites*, that form a ventral brood pouch, or marsupium (except in Thermosbaenacea); and, in most groups, young hatching as mancas (a pre-juvenile stage lacking the last pair of thoracopods). All peracarids undergo direct development with brooding, hence true larval forms do not occur in this superorder. About 20,000 species of peracarids have been described.

Although we have tried to keep the amount of terminology in this chapter to a minimum, use of certain standard crustacean terminology is unavoidable. Most of these terms are defined below. An extensive and detailed description of isopod morphology can be found in Brusca and Wilson (1991).

Synonymies are not provided, but they can be found in the key references listed for all taxa. Several general guides to marine isopods of North and middle America have been published. These are: Richardson, 1905 (still a highly valuable reference, although obviously rather out-of-date), Menzies and Frankenberg, 1966, Schultz, 1969 (covers all of North America; many errors - use with caution), Miller, 1975 (good key to common intertidal California species), Brusca, 1980 (keys to Gulf of California fauna), Brusca and Iverson, 1985 (only summary treatment available for the tropical eastern Pacific region), Kensley and Schotte, 1989 (excellent, with keys and figures of Caribbean and many Gulf of Mexico species, supersedes Menzies and Glynn, 1968). Two other general works are also useful. The first is an English translation of Birstein's northwest Pacific deep-water monograph (Birstein, 1973). The second is a three volume compendium on temperate northern hemisphere marine isopods by Kussakin (1979, 1982a, 1988). These latter works are in Russian and compiled entirely from the literature.

The California marine isopod fauna numbers about 176 valid named species, representing 30 families in 8 suborders. The U. S. Department of the Interior, Minerals Management Service (MMS), soft-bottom benthic macroinvertebrate faunal surveys in the Santa Maria Basin and the Western Santa Barbara Channel (hereafter referred to as the "MMS survey") recovered 37 species, 14 of which are undescribed. Where possible, type material was examined and illustrated for the present study (indicated in the figure legends).

---

[1] University of South Carolina, Columbia, South Carolina 29208

[2] Grice Marine Biological Laboratory, University of Charleston, 205 Fort Johnson, Charleston, South Carolina 29412

[3] Division of Invertebrate Zoology, Australian Museum, 6 College Street, Sydney South, New South Wales 2000, Australia

Illustrations were prepared by John Simpson, Frances Runyan, and the authors. This work was accomplished with the assistance of funding from the MMS, and grants to R. C. Brusca and G. D. Wilson from the National Science Foundation.

Summary of Isopod Research in Northeast Pacific Region

The earliest studies on northeast Pacific marine isopods are recorded in the publications of Dana (1853, 1854), Lockington (1876, 1877), Benedict (1897, 1898a-b), and Boone (1918, 1923). However, it was the pioneering 25-year systematic research program of Harriet Richardson that laid the foundation of our modern knowledge regarding this fauna (Richardson, 1897, 1898, 1899a-b, 1900, 1904a-b, 1905a-b, 1906, 1908, 1909). Miller, Schultz, and especially Menzies built on Richardson's foundation through the 1950's, 1960's, and early 1970's (Miller, 1940, 1941, 1968, 1975; Miller and Lee, 1970; Miller and Menzies, 1952; Menzies 1950a-b, 1951a-e, 1952a-b, 1954a-b, 1958, 1961, 1962; Menzies and Barnard, 1951, 1959; Menzies and Bowman, 1956; Menzies and Miller, 1972; Menzies and Mohr, 1952, 1962; Menzies, Mohr, and Wakeman, 1963; Menzies and Waidzunas, 1948; Menzies and Widrig, 1955; Schultz, 1964, 1966, 1972, 1973, 1977; Bowman and Schultz, 1974; Sassaman, Schultz, and Garthwaite, 1984). Research on northeast Pacific isopods by R. Brusca and G. D. Wilson began in the mid-1970's and continues today (Brusca, 1977, 1978a-b, 1980, 1981, 1983a-b, 1984, 1987; Brusca and France, 1992; Brusca and Gilligan, 1983; Brusca and Iverson, 1985; Brusca and Ninos, 1978; Brusca and Wallerstein, 1977, 1979a-b; Brusca and Weinberg, 1987; Brusca and Wilson, 1991; Brusca *et al.*, 1995: Bruce, *et al.*, 1982; Cadien and Brusca, 1993; Delaney and Brusca, 1985; Guzman, *et al.*, 1988; Perry and Brusca, 1989; Stepien and Brusca, 1985; Thun and Brusca, 1980; Wallerstein and Brusca, 1982; Wetzer, *et al.*, 1987; Wilson, 1976, 1982a; Wilson, *et al.*, 1989).

General Isopod Anatomy

The order Isopoda Latreille, 1817, is distinguished from the other eight orders of Peracarida by the following combination of characters (see Figures 1.1 and 1.2):

First thoracomere fused to cephalon, and rarely the second as well. Without a carapace (i.e. with only a cephalic shield). Body usually dorsoventrally depressed, cylindrical (tubular) in some suborders. Antennules and antennae uniramous, but with a minute scale ("squama") in a few taxa. Eyes unstalked but on lobes in some Asellota, Gnathiidea and Valvifera. Mandible usually with a 1- to 3-articulate palp and a multidentate incisor process; left and right lacinia often differ; molar process highly variable. Maxillule and maxilla both without palps. Thoracic appendages uniramous (without exopods). First thoracopods modified as maxillipeds; with a short coxa and usually a short anteriorly-directed lamellar epipod; basis flattened and produced into bladelike anteriorly-directed endite, often with coupling spines; palp of up to 5 articles. Second thoracopods modified as maxillipeds (pylopods) only in Gnathiidea. Pereopodal coxae small and simple, or more-or-less fused with body somites and forming lateral extensions on pereonites (coxal plates); line of dorsal fusion usually demarcated on pereonites II-VII (occasionally pereonite I). Pleon short, in many with various segments fused; telson always fused with last pleonite to form a pleotelson. Pleopods biramous, flattened, specialized for respiration and/or swimming; endopods of second pair typically with stylets in males ("appendix masculinae"). Uropodal rami uniarticulate. Heart located primarily in pleon; usually with 2 pairs of ostia and 5 pairs of lateral arteries. Maxillary glands usually present in adults. Young leave marsupium before appearance of last pair of pereopods (as "manca"). Isopods exhibit biphasic molting.

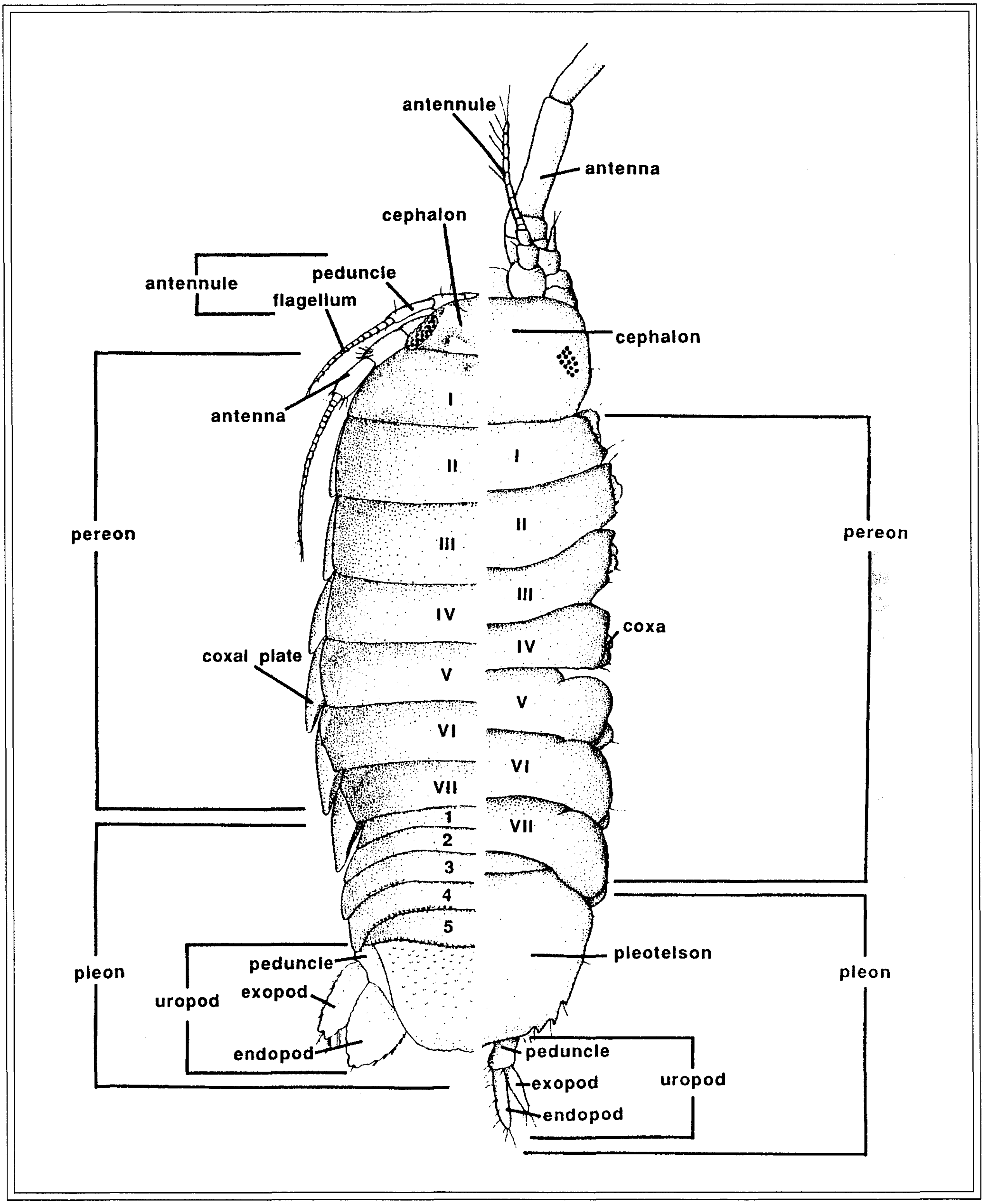


Figure 1.1. Basic isopod morphology. Dorsal aspect of a female *Tridentella glutacantha*, a flabelliferan (left), and *Ianiropsis tridens*, an asellotan (right).

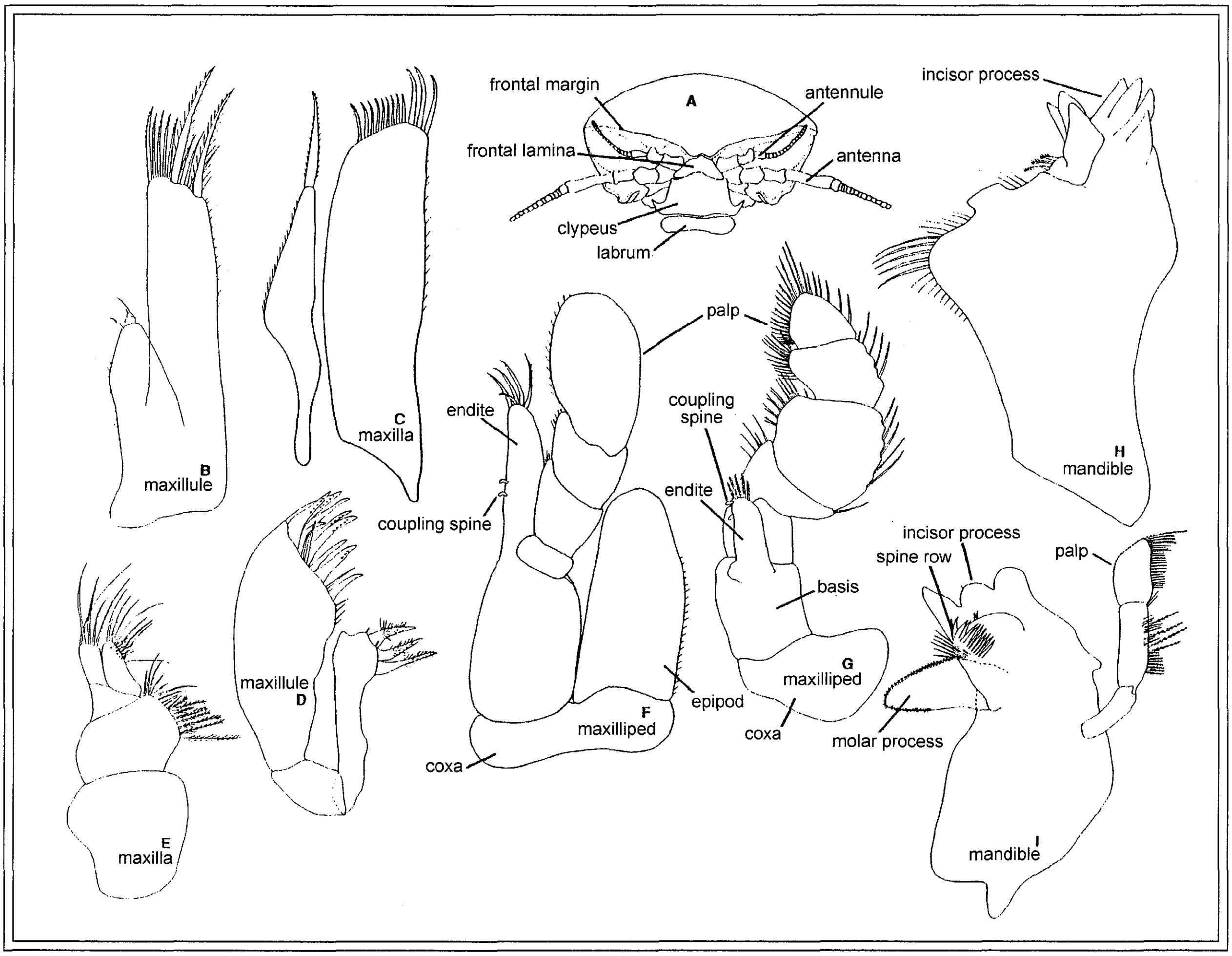


Figure 1.2. Nomenclature of isopod cephalon (A). Examples of isopod mouth appendages: Idoteidae (B, C, F, H); Cirolanidae (D, E, G, I).

Brusca and Wilson (1991) recognize two basic isopod morphologies, "long-tailed" and "short-tailed". Long-tailed isopods have the telsonic region of the pleotelson greatly elongated, thus the anus and origin of the uropods are positioned basally on the pleotelson (Flabellifera, Anthuridea, Gnathiidea, Epicaridea, Valvifera). In the short-tailed isopods, the telsonic region is greatly reduced or vestigial, positioning the anus and uropods terminally or subterminally on the pleotelson (Phreatoicidea, Asellota, Microcerberidea, Oniscidea, Calabozoidea).

Isopods can be sexed in several ways. If oostegites, or marsupium, are present, one is obviously looking at a female. The openings of the oviducts in females (near the base of the legs on the 6th thoracomere) are extremely difficult to observe. If oostegites are absent, males can be distinguished by the presence of paired penes on the sternum of pereonite VII (or pleonite 1) and/or the presence of appendix masculinae on the endopods of the second pleopods. Absence of penes, appendix masculinae, and oostegites indicates the specimen is either a female or a juvenile that has not yet developed secondary sexual features.

Glossary of Technical Terms

aesthetasc. Thin-walled chemosensory seta usually found on antennular flagellum.

antennules. Antennae 1 or first antennae; anteriormost paired appendages of head (= antennula).

antennae. Antennae 2 or second antennae; second paired appendages of head.

appendix masculina. Copulatory stylet arising from medial margin of male pleopod 2 endopod, used for transfer of spermatophores in at least some species. (Pl. appendices masculinae)

biramous. Composed of two rami or branches.

carina. A keel, or acute ridge.

cephalon. Head; strictly speaking the cephalon of an isopod is a cephalothorax, as it is always fused with the first thoracomere (and also with the second thoracomere in the Gnathiidea).

chelate. Having a chela; the propodus and dactylus forming a pincerlike structure wherein the latter articulates submedially on the former to produce a "moveable and fixed finger" arrangement. (True chelae are extremely rare in isopods.)

coupling spine(s). When present, coupling spines (or hooks) occur on the maxillipedal endites and pleopodal peduncles, and serve to lock the opposing appendages together, allowing them to function as a single unit.

coxa. Basal article of an appendage.

coxal plates. Coxae of the pereopods laterally expanded into flattened lamellar structures extending freely (as "plates") to overhang the coxa-basis hinge of the leg.

clypeus. In most (but not all) isopods the labrum consists of two pieces; the anteriormost (proximal) piece is referred to as the clypeus, the posteriormost (distal) piece as the labrum proper.

distal. Situated away from the base or point of origin or attachment.

endite. A lobe on the inner (medial) margin of the protopod of an arthropod limb; enlarged anteriorly directed lobe of the basis of an isopod maxilliped.

endopod. Inner (medial) ramus of an appendage.

exopod. Outer (lateral) ramus of an appendage.

flagellum. Narrow distal part of antenna or antennule, usually multiarticulate, occasionally reduced to one or a few articles, without intrinsic musculature.

frontal margin. Separates the upper surface of the cephalon from the frontal lamina; anterior margin of cephalon.

frontal lamina. A sternal plate arising between the bases of the antennae and probably homologous to the epistome of other arthropods; in many isopods the frontal lamina may extend anteriorly to be visible in the dorsal aspect; in many Valvifera the upper and lower regions of this structure may be separately elevated and visible in the dorsal aspect as two distinct structures (frontal lamina 1 and frontal lamina 2).

frontal process. The lower region of the epistomal plate or sclerite, which in some Valvifera projects outward to become visible in the dorsal aspect as a protuberance lying above the frontal lamina.

gnathopod. A loosely used term usually referring to chelate or subchelate pereopods associated with the head region and used for food handling. This term is rarely used for isopods.

incisor process. Grasping, piercing or slicing structure arising apically on body of mandible.

labium. The posterior border of the buccal field; the "lower lip" (see paragnath).

labrum. Flaplike structure posterior to and borne upon the frontal lamina or clypeus, usually free but occasionally fused to head; the "upper lip" (see clypeus).

lacinia mobilis. Small, usually toothed, process articulating at base of incisor of left or both mandibles; present in most isopod groups.

lamina dentata. Serrate platelike structure on the mandible of anthurideans, presumed to have been formed by the fusion of spines of the spine-row.

manca. Young of most peracarids (including isopods), lacking last (eighth) thoracic appendages at time of release from broodpouch.

mandible. Third pair of head appendages; first (anteriormost) pair of mouthparts functioning as jaws and typically sclerotized.

marsupium. Structure in which eggs and embryos are retained and brooded by female; the broodpouch. Isopod marsupia are typically formed by overlapping medial plates (oostegites) arising from certain pereonal coxae in females; in a few groups the oostegites have been reduced or lost in lieu of internal brooding.

maxillules. Fourth pair of head appendages, functioning as mouthparts, immediately posterior to mandibles (= first maxillae).

maxillae. Fifth pair of head appendages, functioning as mouthparts, immediately posterior to maxillules (= second maxillae).

maxillipeds. Modified first pair of thoracopods, functioning as mouthparts.

molar process. Grinding, or piercing or slicing structure, arising mid-basally on body of mandible; pars molaris.

oostegite. Thin ventromedial plates, born on coxae of some pereopods in female peracarids forming the marsupium, or broodpouch.

palp. Articulated ramus consisting of one to three articles on the mandible, and up to five articles on the maxilliped. (Palps do not occur on the maxillules or maxillae of isopods.)

paragnath. In isopods, the labium is usually produced and cleft into a large bilobed structure, and hence more commonly referred to as the paragnath (= hypostome, metastome, hypopharynx).

peduncle. Enlarged proximal, or basalmost region of an isopod antennule, antenna, pleopod, or uropod; contains intrinsic musculature.

penes. Paired (occasionally fused) submedian processes from vas deferens on sternum of male pereonite VII or pleonite 1. (Sing. penis)

pereon. Those thoracic segments not fused to the cephalon.

pereonite. A segment of the pereon (= pereomere).

pereopods. The paired legs of each pereonite.

pleon. Abdomen.

pleonite. A segment of the pleon (= pleomere).

pleopods. The biramous, paired, lamellar appendages of each pleonite.

pleotelson. In all isopods the sixth pleonite is fused to the telson to form a pleotelson. In anthurideans the line of fusion is often visible as a deep dorsal groove or fold.

praniza. Juvenile, immature stage of gnathiideans.

prehensile. Appendages (usually pereopods) adapted for holding or clinging, the dactyl is as long or longer than the propodus, strongly developed and recurved.

protandrous. In sequential hermaphroditic forms, becoming a functional male (producing spermatozoa) before becoming a functional female (producing eggs).

protogynous. In sequential hermaphroditic forms, becoming a functional female (producing eggs) before becoming a functional male (producing spermatozoa).

proximal. Situated near the base or point of attachment.

pylopods. Second pair of maxillipeds in gnathiids (appendages of the second thoracomere).

rostrum. Anteromedial projection of frontal margin of cephalon.

scale. A small articulate piece occurring on the antennules or antennae in some crustaceans, thought to be a remnant of the second ramus (presumably the exopod). Scales rarely occur in isopods.

spine row. Spinose lobe on the mandible, between the molar and incisor processes.

statocyst. Small saclike sensory organ, usually containing a granule(s), used to indicate to the animal its orientation; present singly or paired on the pleotelson of some anthurideans.

subchelate. Having a subchela; forming a pincerlike structure by the dactylus folding back on the propodus.

tergite. Dorsal sclerite of exoskeleton on arthropods.

uropods. The paired biramous appendages of the isopod pleotelson, representing the appendages of the fused sixth pleonite.

Phyletic Key to the Suborders of Isopod (Adults)

1A. With only 5 pairs of pereopods (thoracomere 2 entirely fused to cephalon, with its appendages [pylopods] functioning as a second pair of maxillipeds; thoracomere 8 reduced, without legs); adult males with mandibles grossly enlarged, forceps-like, projecting in front of head; adult females without mandibles .... Gnathiidea

1B. With 7 pairs of pereopods (thoracomere 2 not fused to cephalon, with 1 pair of maxillipeds and 7 pairs of pereopods); males without projecting, forceps-like mandibles; females with mandibles 2

2A. Adults obligate parasites on other crustaceans; bilateral symmetry reduced or lost in females; male a small bilaterally symmetrical symbiont living on the body of the female; antennae vestigial; antennules reduced to 3 or fewer articles; without maxillules .... Epicaridea

2B. Not obligate parasites on other crustaceans; bilateral symmetry retained in both sexes; male not as above; antennae not vestigial; antennules variable; usually with maxillules 3

3A. Body cylindrical or tubular in cross-section, but often appearing laterally compressed (amphipod-like) due to ventrally elongated abdominal pleura; with distinct row of filter setae along medial margin of maxilla; penes located on coxae of male pereopod VII; apex of pleotelson curves dorsally; pleonite 5 elongate, markedly longer than any other pleonites (known only from southern hemisphere and India) .... Phreatoicidea

3B. Body variable, but not appearing laterally compressed as above; without row of filter setae along medial margin of maxilla; penes on sternum of male pereonite VII (or on sternum of pleonite 1); apex of pleotelson does not curve dorsally; pleonite 5 rarely elongate (markedly longer than other pleonites only in Limnoriidae) 4

4A. Anus and articulating base of uropods positioned terminally (or subterminally) on pleotelson; uropods styliform (in the oniscidean family Tylidae the uropods are modified into flattened ventral plates that cover the anal chamber) 5

4B. Anus and articulating base of uropods positioned at base of pleotelson; uropods flattened 8

5A. With lateral coxal plates; antenna peduncle 5-articulate; antennule reduced to 5 or fewer articles; maxillipeds without coupling spines; penes of male arise from articulation between pereonite VII and pleonite 1; mandible without palp; pleopodal exopods broad and opercular to the thick tumescent endopods; female pleopod 1 present 6

5B. Without lateral coxal plates (pereopodal coxae small); antenna peduncle 6-articulate; antennule reduced or not reduced; maxillipeds with or without coupling spines; penes of male arise on sternum of pereonite VII; mandible with palp; pleopods not as above; female pleopod 1 absent 7

6A. Exoskeleton of pleonites 1 and 2 reduced to only sternal plates; uropodal rami fused to peduncle; blind groundwater animals (known only from ground waters in Venezuela) .... Calabozoidea

6B. Pleonites 1 and 2 not reduced as above; one or both uropodal rami articulate on peduncle; with or without eyes .... Oniscidea

7A. Minute, usually less than 3 mm long; long and slender, length about 6 times width; antennal peduncle without a scale; antennule reduced, peduncle indistinguishable from flagellum; maxilliped without coupling spines on endite; female pleopod 2 biramous; male pleopod 2 endopod not geniculate; interstitial .... Microcerberidea

7B. Rarely minute, usually greater than 4 mm long; body not elongate (length less than 6 times width); antennal peduncle usually with a scale; antennule rarely reduced, peduncle and flagellum distinct; maxilliped almost always with coupling spines on endite; female pleopod 2 uniramous; male pleopod 2 endopod large and geniculate; rarely interstitial .... Asellota

8A. Body elongate, length usually more than 6 times width; uropodal exopod curving dorsally over pleotelson; coxae of maxillipeds fused to head (i.e. not freely articulating); mandible with unique lamina dentata (in lieu of spine row and lacinia mobilis; lamina dentata, spine row and lacinia mobilis lacking in Paranthuridae); maxillule an elongate stylet with apical hooks or serrate margin; maxilla vestigial and fused with paragnath (or absent) .... Anthuridea

8B. Body not markedly elongate, length usually less than 4 times width; uropodal exopod not as above; coxae of maxillipeds not fused to head; mandible without lamina dentata; maxillule variable; maxilla well developed, never fused with paragnath 9

9A. Uropods modified as a pair of ventral opercula covering the entire pleopodal chamber; males with penes arising on sternum of pleonite 1, or on articulation between pereonite VII and pleonite 1; mandibular molar process a stout, flattened grinding structure .... Valvifera

9B. Uropods not modified as ventral opercula covering pleopods; males with penes arising on sternum of pereonite VII; mandibular molar process usually a thin, bladelike, cutting structure, or absent (flattened only in Sphaeromatidae) .... Flabellifera

1.2 Descriptions of the Species of the Suborders Anthuridea, Epicaridea, Flabellifera, Gnathiidea, and Valvifera

by

Regina Wetzer[4], and Richard C. Brusca[5]

Suborder Anthuridea Leach, 1814

Description. Body long, slender, subcylindrical; circular in cross-section; length 6-15 times width. Antennules short except in males of some species, uniramous (without scale), usually with 3 peduncular articles; some species with only 3 antennular articles, setation suggesting loss of 1 peduncular article as well as most flagellar articles. Antennae short, uniramous (without scale), peduncle 5-articulate, with few flagellar articles. Mandible without distinct lacinia mobilis or spine row, instead usually with a dentate lobe or plate (the "lamina dentata"); palp of 1-3 articles, or absent. Maxillule with inner ramus reduced, outer ramus a slender stylet with terminal spines (spines often reduced to a row of short denticles). Maxillae rudimentary, usually fused with paragnath. Maxillipeds more-or-less fused to head, usually with small endite; without coupling spines; palp of 1-5 articles; apex of palp acute or rounded. Pereonites mostly longer than wide (in contrast to most isopods, in which the reverse is true); dorsum often with distinct ridges, grooves or chromatophore patterns; distinct coxal plates rarely evident. Pereopods I-III (especially pereopod I) tend towards subchelate form; pereopods IV-VII generally ambulatory. Pleonites 1-5 free or fused; pleonite 6 fused with telson, but often demarcated from the telson by a deep dorsal groove or fluting; pleopods 1-5 similar, or pleopod 1 modified as an operculum. Uropods attached laterally at base of pleotelson, but exopods curve dorsally to arch over pleotelson; often with one or two telsonic statocysts.

Remarks. In all isopods the sixth pleonite is fused to the telson to form a pleotelson. In anthurideans the sixth pleonite is often distinctly demarcated by a dorsal groove giving the illusion of an articulation and 6 free pleonites. However, histological studies have so far failed to reveal any anthuridean species in which the telson freely articulates on the 6th pleonite.

Four families of Anthuridea are currently recognized, distinguished primarily by characters of the mouthparts and pleon: Anthuridae Leach, 1814; Paranthuridae Menzies and Glynn, 1968; Hyssuridae Wägele, 1981; and, Antheluridae Poore and Lew Ton, 1988. The family Anthuridae possess 1 or 2 telsonic statocysts (or no statocysts), operculate first pleopods, and broad maxillipedal palps that tend to be operculiform and have a reduced number of articles. The family Paranthuridae has 0 or 1 telsonic statocysts and operculate first pleopods. Species of Hyssuridae have very long bodies (about 15 times longer than wide), no telsonic statocysts, long free pleonites, and lack operculiform pleopods. Antheluridae are defined by the exceptional width of the maxillipedal endite and palp (Wägele 1981). Anthuridae and Paranthuridae have been previously reported from California waters. The MMS project also collected a new species of Hyssuridae.

---

[4] University of South Carolina, Columbia, South Carolina 29208

[5] Grice Marine Biological Laboratory, University of Charleston, 205 Fort Johnson, Charleston, South Carolina 29412

Anthurideans appear to be primarily carnivores, feeding on small worms and arthropods of various kinds. Most inhabit littoral or shallow shelf environments, although some deep benthic (and some freshwater) species are also known. Many species are known to be protogynous, and males have not yet been reported for several of these. Fewer than 200 species of anthurideans have been named, but many more remain to be described.

Literature. Richardson, 1905; Miller, 1975; Poore, 1980; Wägele, 1981a-b; Poore and Lew Ton, 1988a-c; Kensley and Schotte, 1989; Cadien and Brusca, 1993.

Key to the Families of Anthuridea Known from California Waters

1A. Mouthparts adapted for piercing and sucking, together forming a conelike structure; mandible usually with an untoothed styliform incisor, but lacking molar process and lamina dentata .... Paranthuridae

1B. Mouthparts adapted for cutting and chewing; mandible usually with a molar process and lamina dentata, incisor usually toothed 2

2A. At most, pereopod I subchelate, with propodus expanded; pleonites generally fused, if free, much shorter than wide; first pleopods operculate; with 0, 1, or 2 telsonic statocysts .... Anthuridae

2B. Pereopods I-III subchelate, subsimilar; pleonites free, often as long as wide; first pleopods not operculate; never with telsonic statocysts .... Hyssuridae

Family Anthuridae Leach, 1814

Description. Mandibular palp apically rounded, incisor usually toothed; lamina dentata and molar process usually present. Maxilliped no more than 5-articulate, with palp as broad as basis and last article smaller than preceding articles; palp often broad and somewhat operculiform to other mouthparts. Pereopods I-VII with very few sensory setae, usually only 1 distal spine on carpus and propodus; pereopod I usually subchelate, with propodus inflated; pereopods II and III never subchelate. Pleon short; pleonites free or fused (at least dorsally). Pleopod 1 larger than pleopods 2-5, with operculiform exopod and smaller endopod. Uropodal endopod usually shorter than basis; with a pair of telsonic statocysts, or single medial statocyst, or lacking statocysts. Sexual dimorphism is common and males often have longer pleonites than females.

Remarks. Five species, representing 5 of the 33 described genera of Anthuridae, are known from California waters. The MMS survey recovered 3 of these 5 species; Cadien and Brusca, 1993.

Literature. Menzies, 1951a; Menzies and Barnard, 1959; Schultz, 1977; Wägele, 1979, 1981; Kensley, 1982; Poore and Lew Ton, 1986; Kensley and Schotte, 1989.

Key to the Genera of Anthuridae Collected as Part of the MMS Surveys

1A. Pleopodal endopod 1 with marginal setae 2
1B. Pleopodal endopod 1 without marginal setae .... *Cyathura*

2A. Pereopods IV-VII with triangular carpus; maxilliped 5-articulate, article 3 wider than long; endite usually reduced or absent; mandibles symmetrical .... *Amakusanthura*
2B. Pereopods IV-VII with rectangular carpus; maxilliped 4-articulate, article 4 smaller than 3; mandibles asymmetrical, left molar with small tooth which is absent on right molar .... *Haliophasma*

Genus *Amakusanthura* Nunomura, 1977

Apanthuretta Wägele, 1981.

Description. Dorsum smooth, sometimes pigmented; eyes present, or not visible. Antennular flagellum short, of 3 articles, the last short and bearing 3 aesthethascs. Antennal flagellum short, of 2-4 articles. Mandibles symmetrical, not sexually dimorphic; incisor, lamina dentata and blunt molar process present; palp 3-articulate, article 3 one-third length of article 2 and with 3-4 terminal setae. Maxilliped bearing an acute filamentous endite with a terminal seta; palp of 3 articles, article 1 wider than long; article 2 usually with a row of mesial setae; article 3 oblique, subterminal, much smaller than 2, with 4-5 apical setae. Pereopod 1, propodal palm stepped (sometimes weakly toothed), with stout mesial setae. Pereopods 2 and 3 with propodus only a little more robust than on posterior pereopods. Pereopods 4-7 with triangular-trapeziform carpus, with free anterior margin. Pleon longer than wide; pleonites fused or often pleonites 1-4 separated dorsally by shallow integumental grooves, 4-5 fused dorsally. Uropodal endopod as long as peduncle, its margins setose; exopod narrow and with a sinuous dorsal margin, or with an obscure dorsal lobe.

Males. Male head smaller than in juvenile, with broadened flattened rostrum, antenna 1 flagellum with more than 10 isometric articles each bearing numerous aesthetascs, much longer than head. Male pereopod 1 not grossly modified. Pleotelson narrower, with mid-dorsal longitudinal depression.

Remarks. *Amakusanthura* can be distinguished from the very similar *Apanthura* by a more elongate pleon and by a long male antennal flagellum. For recent reviews of *Amakusanthura* see Poore and Lew Ton (1985 and 1988d). The latter paper provides keys to the Australian species in this and related genera, and reassigns several species from *Apanthura* to *Amakusanthura*, including *Apanthura californiensis* Schultz, 1964.

Literature. Nunomura, 1977; Poore and Lew Ton, 1985, 1988d.

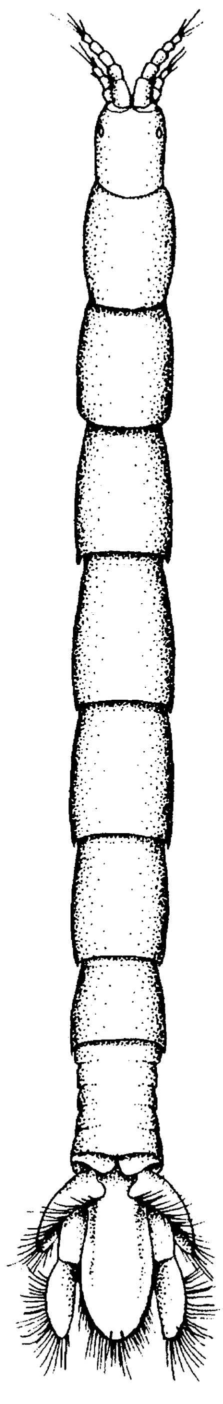


Figure 1.3. *Amakusanthura californiensis* (Schultz, 1964). Holotype LACM 55-35.1 (female). California, Los Angeles Co., off Santa Monica Pier, mud, 73 m., 06 February 1955, coll. R/V *Velero IV*, AHF 2988-55.

Amakusanthura californiensis (Schultz, 1964)

Figure 1.3

Apanthura californiensis Schultz, 1964.

Description. Length to 11 mm. Eyes present, but small. Frontal margin of head forms acute medial projection, but not extending as far forward as anterolateral projections. Antennules and antennae (of males) each 8-articulate. Maxilliped with 5 (4 free) articles; endite broad and lobelike. Pereon without dorsal coloration, pits, or keels. Pereonite VII about half length of pereonite VI; pereopod VII propodus and dactylus with row of short stout spinelike setae along inferior margin; propodus with 1 large spine at distal inferior angle. Pleonites 1-5 distinct laterally, but fused medially. Uropodal endopod longer than pleotelson; pleotelson and both uropodal rami with row of many setae along minutely serrated margins. Appendix masculinum of male arises 1/5 distance from base of endopod.

Remarks. Schultz's (1964) original description had several errors: pleonites 1-5 are fused medially (based on examination of the holotype), the maxillipedal endite is broad and lobelike (not acute), and the apex of the maxillule is truncate (not angular).

Distribution. Known only from type-locality (off Santa Monica, California, 80 m), and from the present study.

Literature. Schultz, 1964.

Genus *Cyathura* Norman and Stebbing, 1886

Description. Dorsum often pigmented. Eyes present or absent. Antennular flagellum 1-3 articulate in females, up to 5-articulate in males. Antennal flagellum short, 1-3 articulate. Mandibles symmetrical; with incisor, lamina dentata, molar process, and 3-articulate palp. Maxilliped of 4 articles (3 free); endite absent or reduced. Pereopod I subchelate, propodus inflated, with a tooth on the palm. Pereopods IV-VII with triangular carpi. Pleon short, about as long as pereonite VII; pleonites 1-5 short, fused; fusion of pleonite 5 to pleonite 6 and to telson often dorsally demarked. Pleopod 1 exopod operculiform, endopod without marginal setae. Pleopods 2-5 with endopods each bearing 1 seta. Uropodal endopod short, more or less square or triangular. Telson with 2 basal statocysts; with long apical setae, but without long dorsal setae.

Remarks. *Cyathura* contains more species than any other New World anthuridean genus. Many *Cyathura* are blind hypogean interstitial species. Of the 8 species now known from the New World, only 2 occur in the Pacific (*C. munda* Menzies, 1951 and *C. guaroensis* Brusca and Iverson, 1985). *C. munda* is known only from California, and *C. guaroensis* is known only from Pacific Costa Rica.

Literature. Richardson, 1905; Wägele, 1979; Kensley, 1982; Brusca and Iverson, 1985; Kensley and Schotte, 1989.

Cyathura munda Menzies, 1951

Figure 1.4

Description. Body length exceeding 9 times width. Most specimens white with scattered patches of black chromatophores. Frontal margin of cephalon produced as short subacute rostrum, projecting forward about same distance as anterolateral angles. Eyes small. Antennular peduncle 3-articulate; male with 4-articulate flagellum with long brushlike setae; female with 2- to 3-articulate flagellum with cluster of apical setae on terminal article; basalmost flagellar article of female minute. Antennal peduncle 5-articulate; flagellum of 2-4 minute setigerous articles. Maxillipedal palp 3-articulate, broad, rounded, middle article longest, apical

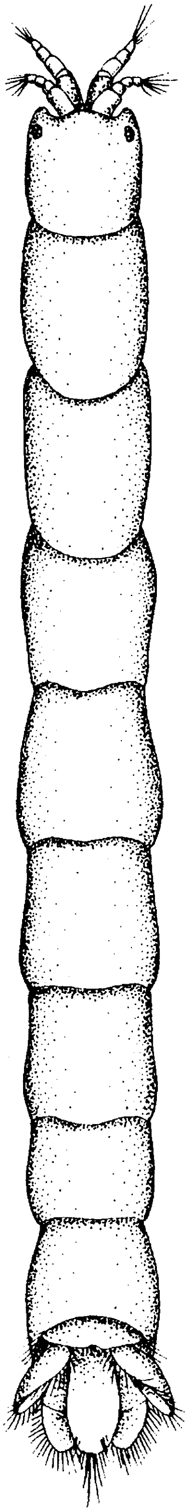


Figure 1.4. *Cyathura munda* Menzies, 1951. Based on Menzies' holotype drawing (male) and paratype material LACM 48-62.3 (mancas). Manca paratype material from California, Marin Co., Tomales Bluff, intertidal, 23 May 1948, coll. R. J. Menzies, AHF 48-621.

article small. Pereonites I-VI similar in length; pereonite VII slightly shorter than pereonite VI; pereonites II and III each with transverse anterior dorsal groove for reception of posterior margin of preceding pereonite. Pleonites 1-5 entirely fused, without obvious lateral incisions; musculature of pleonites visible through cuticle creating illusion of freely articulating pleonites; pleonite 6 with pronounced transverse dorsal ridges demarcating lines of fusion with pleonite 5 and telson. Telson lateral margins smooth, posterior margin slightly concave; paired statocysts present anteriorly.

Remarks. *Cyathura munda* closely resembles *C. guaroensis* (known only from Pacific Costa Rica). The latter can be distinguished by its dorsal pigment pattern, the setal pattern and lack of a tooth on the inferior margin of the propodus of pereopod I, and the possession of large uropodal endopods extending beyond the posterior margin of the pleotelson.

Distribution. Marin County, California to the Mexican border and Gulf of California, intertidal (on *Egregia* and *Laminaria* holdfasts) to 132 m.

Literature. Menzies, 1951a; Menzies and Barnard, 1959; Miller, 1975.

Genus *Haliophasma* Haswell, 1881

Silophasma Schultz, 1977.

Description. Eyes well-developed. Antennule with 3-articulate flagellum, basal flagellar article minute. Antenna with 4- to 7-articulate flagellum. Mandibles asymmetrical, left molar with small tooth which is absent on right molar; palp 3-articulate; palp article 3 with 1 seta, or with transverse or oblique row of 2 to many setae. Maxilliped 4-articulate, article 4 smaller than 3. Pereon with dorsolateral grooves and sometimes additional pitting or sculpture; pereonites IV-VI with dorsal pits. Pereopod I stout, propodus expanded and very broad; pereopods II and III with propodus elongate and subrectangular; pereopods IV-VII with carpi subrectangular and not underriding propodus, carpus about half as long as propodus. Pleonites 1-5 fused at least medially; pleonite 6 demarcated from telson by transverse dorsal ridge. Pleopod 1 exopod more or less indurate, operculiform. Uropodal endopod shorter than telson, exopod folding alongside or over telson. Telson thick, more or less indurate and usually dorsally sculptured; pair of statocysts present (but not always obvious).

Male characterized by more elongate body form, less pronounced dorsal sculpture, antennule with multiarticulate highly setose flagellum, larger eyes, and elongate pereopods, telson and uropods. Appendix masculinum simple.

Remarks. *Haliophasma* is primarily a tropical genus, and only a single species has been reported from North America north of Mexico. Females bearing oostegites have not been reported for this genus.

Literature. Schultz, 1977; Poore 1975; Wägele, 1984; Poore and Lew Ton, 1988b.

Haliophasma geminatum Menzies and Barnard, 1959

Figures 1.5 and 1.6

Silophasma geminatum of Schultz, 1977.

Description of female. Cephalon smooth, slightly longer than wide, rectangular in outline, widest at position of eyes. Rounded rostrum as long as anterolateral lobes. Pereonal tergites rectangular, lateral body walls visible in dorsal aspect. Lateral body margins ornamented with pits and depressions. Bases of pereopods I-VI fit into lateral grooves in body wall; grooves directed posteriorly on pereonite I-III, directed anteriorly on pereonites IV-VI. Pereonite I anterior margin medially scalloped, lateral margins extend anteriorly to acute points, posterior margin straight; anterior margin of pereonites II and III deeply excavated to receive preceding

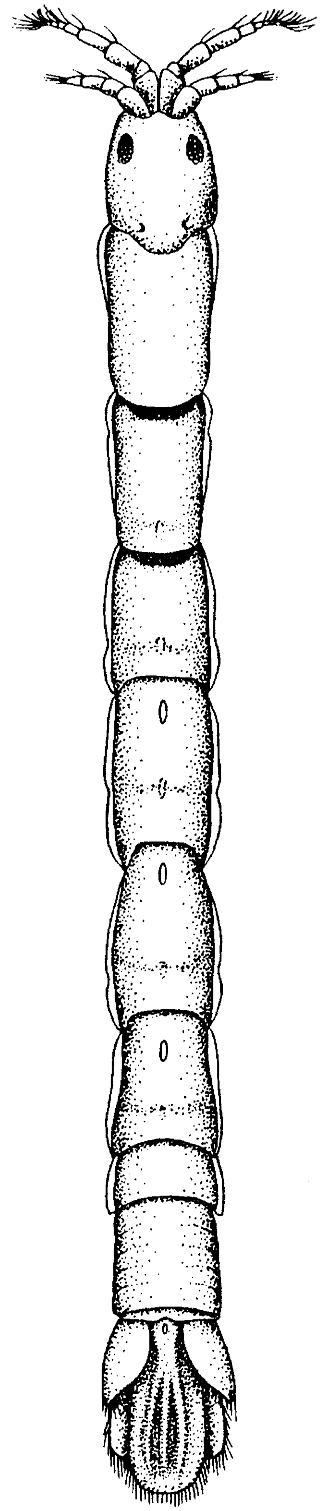


Figure 1.5. *Haliophasma geminatum* Menzies and Barnard, 1959. Female. California, San Diego Co., Oceanside, 20 February 1957, coll. R/V *Velero IV*, AHF 4868-57.

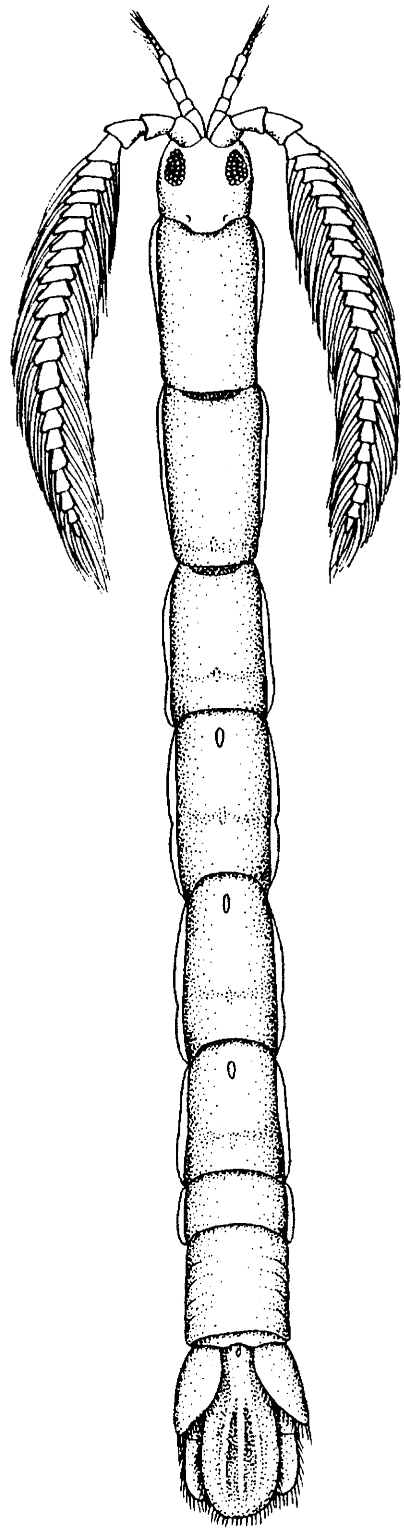


Figure 1.6. *Haliophasma geminatum* Menzies and Barnard, 1959. Male. California, San Diego Co., Oceanside, 20 February 1957, coll. R/V *Velero IV*, AHF 4868-57.

pereonites; pereonites IV-VII weakly excavated; pereonites II-V each with 1 posterior transverse groove containing deep medial pit; depth of transverse groove and medial pit gradually decreases posteriorly; pereonites IV-VII with medial oblong (sometimes keyhole-shaped) pit located on anterior third of pereonite (barely visible on pereonite VII); pereonite VII half as long as pereonite VI. Pleon with 4 lateral sutures, scarcely visible medially, indicating 5 fused segments; short sixth pleonite demarcated dorsally. Pleopod 1 exopod operculiform and pitted. Telson spatulate, sculptured with a long median carina and 2 shorter more pronounced lateral carinae; all 3 carinae fuse to form an elevated plate anteriorly, the anterior margin of which bears a pit that aligns with the posterior notch of pleonite 6. Paired statocysts near base of telson. Uropodal endopod extending nearly to posterior margin of telson and longer than wide, apex blunt, both margins distinctly serrated; exopod pyriform, outer margin sinusoidal, denticulate, slightly shorter than uropodal peduncle.

Description of male. Antennular peduncle 3-articulate; flagellum very setose extending to posterior margin of pereonite II. Antennal peduncle 4-articulate followed by 4 flagellar articles. Median telsonic carina less developed than in females. Appendix masculinum tubular, with simple apex, not extending beyond tip of pleopod 2.

Distribution. Reported from Monterey Bay to central west Baja California, Mexico; coastal shelves, slopes and submarine canyons, 9 to 512 m. MMS survey voucher material from stations R-4 and R-8 was examined.

Literature. Menzies and Barnard, 1959; Menzies, 1962; Iverson, 1974; Poore, 1975; Schultz, 1977; Poore and Lew Ton, 1988b.

Family Hyssuridae Wägele, 1981

Description. Body small and slender. Mouthparts compact, not piercing. Mandibular lamina dentata usually present; molar process forms an acute or blunt spine, or is reduced; palp of 1 or 3 articles. Maxilliped narrow; endite present, short or reaching to second palp article; palp of 5 free articles or single article. Pereopods I-III subchelate; pereopod II as large as or larger than pereopod I, basis linear, carpus produced posterodistally; pereopods IV-VII carpus triangular (rectangular in *Hyssura*), with 0-2 posterior carpal spines and 0-2 posterior propodal spines. Pleonites 1-5 freely articulating, relatively elongate. Pleopods 1-5 of equal length; pleopod 1 not operculiform. Uropodal peduncle short, about one-third total length of uropod; exopod attached basally on peduncle. Telsonic statocysts absent.

Remarks. Hyssuridae contains 6 genera. The MMS survey collected one species which best fits into the genus *Kupellonura*.

Literature. Wägele, 1981ab; Negoescu and Wägele, 1984; Poore and Lew Ton, 1988c; Kensley and Schotte, 1989.

Genus *Kupellonura* Barnard, 1925

Description. Eyes present or absent; enlarged in males. Antennule with brush-like flagellum in male; flagellum 4-articulate, with one aesthetasc on terminal article and occasionally one on 2nd article. Antennal flagellum 8-articulate; peduncle without stout plumose setae. Mouth appendages of the "normal biting type," not piercing or formed into a conelike bundle. Mandibular molar process forms a simple blunt tooth (spine). Maxilliped with endite reaching third palp article; palp 5-articulate. Pereon without dorsolateral keels or dorsal pits. Pereopod 1 with straight palm; ungui short. Pereopods 2 and 3 with 5th article acutely projecting inferiorly; 6th article ovate; palm axial, with marginal spines. Pereopods 4-7 carpus triangular; carpus and propodus each with one posterodistal spine. Pleon elongate, segments distinct. Pleopod 1 not larger than others, and with both rami equally developed. Most or all pleopodal rami with several marginal setae. Pleotelson shorter than pleonites 1-5, thin, dorsally flat, not indurated, with small statocysts. Uropods not indurate; endopod free, longer than peduncle; exopod large, broad, and with lateral margin widely convex or lobed; exopods hinged transversely, folding dorsally and overlapping broadly over pleotelson. Pleotelson spatulate, about as long as uropods; without statocysts.

Remarks. Synonyms include *Horolanthura* (of Kensley, 1975 in part), *Kensleyanthura* Wägele, 1981, and *Belizanthura* Kensley, 1982. The complex synonymy is described in Kensley (1982), Negoescu and Wägele (1984), and Poore and Lew Ton (1988c). This genus was previously known from the Atlantic, Mediterranean, New Zealand, and Caribbean. Poore and Lew Ton (1988c) list "uropodal exopod with a lateral lobe" as the single synapomorphy for this genus, and we agree that this may be the single unique feature that can be used to unambiguously distinguish it from the closely related genera *Hyssura* Barnard and *Neohyssura* Amar. It is most easily confused with *Hyssura*, from which it can be most quickly distinguished by its wide, lobed uropodal exopods (more narrow, and unlobed in *Hyssura*) and triangular pereopod IV-VII carpus (rectangular in *Hyssura*). Poore and Lew Ton (1988c) also note that the genus is most easily recognized by the uropodal exopods, which are "held obliquely erect in preserved material and usually bear a lateral lobe." About a dozen species are currently recognized.

Literature. Barnard, 1925; Wägele, 1981; Poore and Lew Ton, 1988c.

Kupellonura sp. A

Figure 1.7

Description. Without eyes. Anterolateral lobes of cephalon small, rounded; rostrum not extending beyond anterolateral lobes. Basal peduncular articles of antennule broad and subquadrate, flagellum 4-articulate. Mandibular molar process long and acute, with ridge of large spines. Maxillipedal endite reaches second palp article. Pereonites II-III with anterior depression to receive preceding pereonites I-II, respectively. Dorsum of pereonite V slightly raised. Lateral body walls of pereonites III-VI barely visible in dorsal aspect (lateral body walls slightly exaggerated in Fig. 10.1.7). Pereonite VII with small dorsal posterior ridge. Pereopods IV-VII with triangular carpus. Pleonites 1-5 free. Uropodal exopods subrectangular, with distinct lateral lobe, and overlapping broadly to almost entirely obscure pleotelson; both uropodal rami almost reaching posterior margin of pleotelson. Pleotelson slightly convex dorsally, ornamented with two lateral carinae.

Remarks. This problematic species has features of both *Kupellonura* and *Hyssura*. We assign it to the former genus because of the presence of lobes on the lateral margins of the uropodal exopods, a unique synapomorphy for this genus. It also possess a triangular carpus in pereopods IV-VII, whereas the carpus of *Hyssura* species is rectangular in shape. However, the mouth parts are more characteristic of *Hyssura* in that the mandibular molar process is acute (not blunt, as is characteristic of *Kupellonura*), and the maxillipedal endite is short, reaching only the second palp article (rather than the third article, as is typical of *Kupellonura*). One of the two specimens of this species we examined had a 4-articulate flagellum on the left antenna and an 8-articulate flagellum on the right.

Distribution. The above description is based upon an examination of MMS survey voucher material (USNM specimen no. BRC-14; SBMNH specimen no. BRA-14).

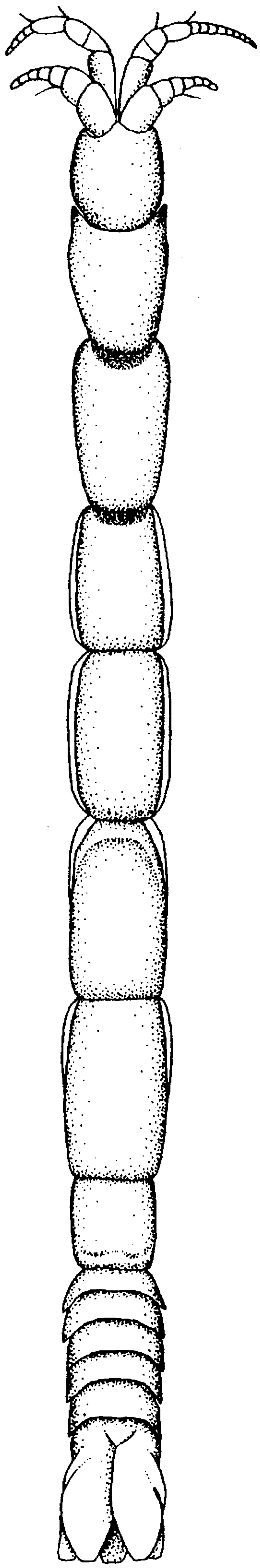


Figure 1.7. *Kupellonura* sp. A. Sta. BRC-14, USNM Phase 1 primary voucher collection.

Family Paranthuridae Menzies and Glynn, 1968

Description. With or without eyes. Mouthparts together form an elongate cone adapted for piercing and sucking. Mandible usually with untoothed, styliform incisor; without a molar process or lamina dentata; palp of 0-3 articles. Maxillules long and slender, with distal barbs or serrations. Maxillae reduced. Maxilliped long and tapering, palp with 0-3 articles, basis long and slender, endite longer than one half palp length, or smaller and reduced. Pereopods with several sensory setae on carpus and propodus; pereopods I, or I-III subchelate. Pleonites 1-6 usually demarcated dorsally (except in *Calathura* and *Pseudanthura*); telson tongue-shaped (except in *Paranthura bellicauda* and related species). Pleopod 1 larger than pleopods 2-5, with large operculiform exopod and small endopod. Pleotelson with 0 or 1 statocyst.

Remarks. Five species of Paranthuridae, representing 3 of the 16 genera of the family, occur in California waters. One of these species was recovered by the MMS survey.

Literature. Poore, 1980, 1984a; Wägele, 1981; Kensley, 1982; Negoescu and Wägele, 1984.

Genus *Paranthura* Bate and Westwood, 1868

Description. Eyes present. Antennular flagellum short, never longer than peduncle, of fewer than 10 articles in female; brushlike in male. Antennal flagellum usually forms a short flat setose plate of fused articles, shorter than peduncle. Mandible with an acute incisor and 3-articulate palp; distal palp article with a comb of about 12 setae. Maxilla forms a sharp, weakly-serrate spine. Maxilliped elongate; endite lacking; palp of 1-2 articles, the terminal article minute if present; palp with a proximal seta, a dorsal seta and 12-13 terminal setae; suture between maxillipedal basis and cephalon distinct. Pereon with feeble ornamentation, otherwise smooth. Pereonites IV-VI without dorsal pits. Pereopod I subchelate, palm axial or moderately oblique, with a mesial cutting edge; pereopods IV-VII carpi rectangular. Pleonites usually separate and distinct; pleonite 6 usually dorsally demarcated from telson; rarely 2-5 fused dorsally. Pleopod 1 exopod operculiform, but only slightly indurate. Uropods with narrow or moderately broad exopods folding over telson; uropodal endopod usually reaching apex of telson. Telson thin, narrow, not indurate, and with long terminal setae; without statocyst.

Remarks. This is the largest of the paranthurid genera. The 50+ species of *Paranthura* are all very similar, distinctions being made on subtle morphological differences in the shape and proportions of the articles of the pereopods, uropods, and telson. Species of *Paranthura* are common in shallow temperate and tropical waters. Two species occur in California waters, *P. elegans* Menzies, 1951 and *P. linearis* Boone, 1923; the status of the latter is uncertain.

Literature. Richardson, 1905; Miller and Menzies, 1952; Poore, 1984a.

Paranthura elegans Menzies, 1951

Figure 1.8

Description. Body length exceeding 9 times width, to 9.5 mm in length (to 15 mm in southernmost part of range); dorsum mostly unornamented; eyes large. Anterolateral angles of cephalon only slightly longer than rostrum. Antennule 8-articulate; article 4 deeply immersed in article 3. Antennal peduncle 5-articulate with first article divided, basal 3 articles partially fused with one another; flagellum composed of a single setigerous, clavate article bearing about 3 small indistinct articles distally; flagellum about one half length of 5th peduncular article. Maxilliped 2-articulate, distal article tapering to very narrow point. Pereonite II slightly longer than pereonite I; pereonites II and III with dorsal anterior depression to receive posterior margin of preceding pereonites; pereonite III slightly wider than long; pereonites IV-V similar in length, roughly one fourth longer than pereonite III; pereonite VI with anterior transverse ridge; pereonite VII one half length of pereonite VI. Pleonites apparently free, but articulations very faint medially; pleonite 5 three times length of pleonite 4; pleonite 6 with sinuate posterior margin and pronounced median cleft. Apex of uropodal endopod extends beyond apex of telson. Telson elongate, with evenly convex setigerous posterior margin and finely serrate posterolateral borders.

Remarks. This is one of the most commonly encountered anthurideans in California waters.

Distribution. Marin County, California to Bahía San Quintin, Baja California, Mexico and into the Gulf of California, intertidal and to 55 m. Found on soft bottom substrates, boat docks, and low rocky intertidal areas with loose sediments.

Literature. Menzies, 1951a; Menzies and Barnard, 1959.

Suborder Epicaridea Latreille, 1831

Description. Ectoparasites of other crustaceans (ostracods, copepods, cirripeds, and malacostracans). Eyes usually present in males, typically reduced or absent in females. Antennules very reduced, usually of 2-3 articles; 3-articulate peduncle generally apparent only in larval stages. Antennae vestigial in adults. Mouthparts reduced, forming a suctorial cone with a pair of piercing stylets formed from the mandibles; mandibular palp absent. Maxillules and maxillae reduced or lost. Females usually greatly distorted but with oostegites retained; body reduced to little more than an unsegmented egg sac in some forms. Males small and not distorted, usually living upon body of female.

Remarks. There are no good references on the Epicaridea as a whole, although Strømberg (1971) reviews the embryology (including several California species), and Jay (1989) cites several other papers containing general information. Overall, the quantity and quality of published work on the Epicaridea lags far behind that of the other isopod suborders. Some authors place the 4 recognized families in 2 superfamilies, Bopyroidea (Bopyridae, Dajidae and Entoniscidae) and Cryptoniscoidea (Cryptoniscidae). The cryptoniscids are parasites on ostracods, cirripeds, mysidaceans, amphipods, cumaceans and other isopods. They are probably all protandrous hermaphrodites. The Dajidae are parasites of pelagic mysidaceans, euphasiaceans, and caridean shrimp. The Entoniscidae are internal parasites of various decapods. Bopyridae parasitize a wide range of decapod crustaceans.

Literature. Richardson, 1905; Nierstrasz and Brender á Brandis, 1923; Strømberg, 1971; Markham, 1975, 1985, 1988; Miller, 1975; Bourdon, 1980; Upton, 1987a-b; Jay 1989; Kensley and Schotte, 1989.

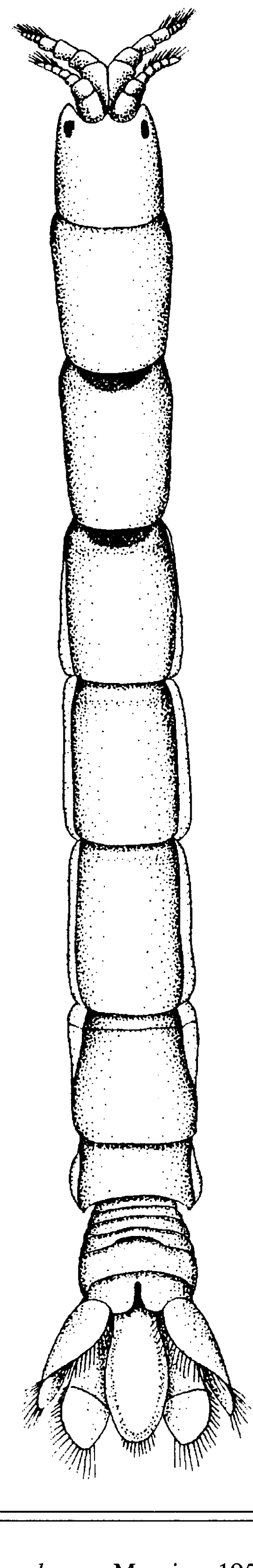


Figure 1.8. *Paranthura elegans* Menzies, 1951. Paratype LACM 48-62.2. California, Marin Co., Tomales Bluff, intertidal, 23 May 1948, coll. R. J. Menzies.

Family Bopyridae Rafinesque, 1815

Description of female. With complete, or at least partial body segmentation. Body slightly to greatly asymmetrical, flattened dorsally. Posteroventral margin of head usually with 1-2 lateral projections on each side. Eyes, if present, are small irregular dorsal pigment spots. Pereon generally with all 7 pereonites distinct, although first (and sometimes second) pereonite occasionally partially fused to cephalon. Pereopods prehensile but reduced, all 7 pairs usually present on at least one side, up to 6 being absent on other side; 5 (rarely 7) pairs of oostegites. Pleon of 2-5 free pleomeres, plus pleotelson; sides of pleomeres often produced as large lateral plates, or epimeres (often resembling pleopodal rami). Pleopods well-developed or rudimentary, but usually present, occasionally absent on posteriormost pleonites. Uropods, when present, uniramous or biramous, often resembling pleopods.

Description of male. Very small, at least twice as long as wide, symmetrical and distinctly segmented. Cephalon rounded anteriorly, occasionally more-or-less fused with first pereonite. Antennae often prominent. Eyes as in females. Pereon of 7 distinct pereonites, each usually with a pair of prehensile pereopods. Pleon of 1-5 pleonites, plus pleotelson (if unsegmented, lacking appendages; if multisegmented, often with uniramous pleopods or at least with ventral tubercles on all but the last pleonite). Uropods, if present, uniramous.

Remarks. Adult bopyrids are parasites either on the abdomen or in the branchial chamber of decapod crustacean hosts. In branchial parasites, the female attaches ventrally to the host's branchiostegite, inducing a bulge in the host's carapace. Males are much smaller and are usually found on the ventral side of the pleon of the female isopod. Females brood many small eggs in an oostegial brood pouch, that hatch as a free-swimming epicaridium stage. The epicaridium attaches to an intermediate host, a calanoid copepod. Once on the copepod, the isopod molts into a microniscus stage, and then into the cryptoniscus stage. The cryptoniscus detaches from the copepod, is free-swimming, and eventually attaches to the definitive host. Bopyrids are sequential hermaphrodites. Upon attachment to the definitive host, the cryptoniscus develops into a female; a second cryptoniscus settles on the host and develops into a male. The family Bopyridae contains nearly 500 described species in 10 subfamilies world-wide, all but one of which are parasites on decapod crustaceans. Thirteen species are known to occur on the Pacific coast of North America north of Mexico.

The cyptoniscus stage of the family Bopyridae possess complex antennules of uncertain homologization. The first article, and often the second, typically bear toothed "gnathobasic margins" that are important in species-level taxonomy. One to 3 lobes may arise from the third article, each invested with bundles of long setae. It is these sensory lobes that Bonnier (1900) and Calman (1909) presumably interpreted as scales, or vestigial rami or flagella. The antennules of adult bopyrids are greatly reduced or their articulation is obscure, and "antennular scales" are absent.

Literature. Richardson, 1905; Markham, 1974, 1975.

Genus *Munidion* Hansen, 1897

Description of female. Body smoothly ovate in outline, with 7 free pereonites and 5 free pleonites (plus the pleotelson); bilateral body axis distortion generally less than 30°. Cephalon subtriangular, medially extending deeply into pereonite I; posterolateral border of cephalon with 2 blunt to sharp processes on each side, and sometimes with small dentate processes near central point of cephalic processes. Maxilliped without palp. All pereonites (or only anterior pereonites) with dorsolateral bosses. Coxal plates distinct. Pereopods similar, slightly larger posteriorly; base produced into blunt carina. Pleonites with distinct epimeres, ranging from narrow pointed projections to leaflike petiolate expansions. Five pairs of biramous pleopods, varying from narrow lanceolate projections to broad foliate structures. Pleotelson forms knoblike or lanceolate process. Uropods similar to pleopods.

Description of male. Cephalon wider than long, occasionally fused with pereonite I. Eyes absent or minute. Body much longer than wide. Antennule and antenna each of 3 articles. Pereonites frequently with midventral tubercle. All pleonites fused into one subtriangular piece; usually without pleopods or uropods.

Remarks. *Munidion* contains 7 species, all of which are parasitic on galatheid crabs of the genera *Munida* and *Pleuroncodes*.

Literature. Hansen, 1897; Richardson, 1905; Markham, 1975.

Munidion pleuroncodis Markham, 1975

Figures 1.9 and 1.10

Description of female. Length to 9.8 mm; bilateral body axis distortion approximately 18°; body shape subpyriform. Without eyes. Cephalon much broader than long, subpentagonal with broad frontal margin; anterior margin slightly convex; posteroventral border of cephalon with 2 lateral digitate processes and a series of dentate processes across the medial margin. Antennules and antennae obscurely 3-articulate, distalmost article minute. Antennae separated by a "frontal plate". Maxilliped subtriangular, obscurely segmented. Coxal plates large, well-developed on all pereonites, extending far beyond edges of pereon and overlapping each other. Pereonites with lobelike dorsolateral tergal projections, increasing in size posteriorly. Pleonites distinct, although pleon obscured by large ovate epimeres and by long biramous lanceolate pleopods. Coxal plates and pleonal epimeres resembling the large thin, leaflike oostegites.

Remarks. The male is typically found attached ventrally to the pleon or posterior oostegites of the female. *M. pleuroncodis* is very similar to *M. princeps* Hansen, 1897, a parasite on *Munida refulgens* Faxon, 1893, which occurs off Cocos Island and the coast of Ecuador. *M. pleuroncodis* can be most easily distinguished by the shape of the pleopodal endopods, which are lanceolate in the former but oval in *M. princeps*, and the coxal plates, which are expanded laterally in the former but pressed against the sides of the pereon in *M. princeps*. The cephalon of *M. pleuroncodis* is fused to the first pereonite in males, but free in *M. princeps*.

Distribution. Central California to (at least) central Mexico, infesting only the pelagic galatheid "red crab" *Pleuroncodis planipes* Stimpson. Markham (1975) described this species from collections made by the Inter-American Tropical Tuna Commission from the R/V *David Starr Jordan* off Baja California, Mexico in 1966, and from specimens washed ashore at Pacific Grove,California in 1973. The host is a member of the tropical west American fauna and records from north of central Baja California presumably correspond to northward extensions of warm coastal waters, such as occur during El Niño events.

Literature. Markham, 1975.

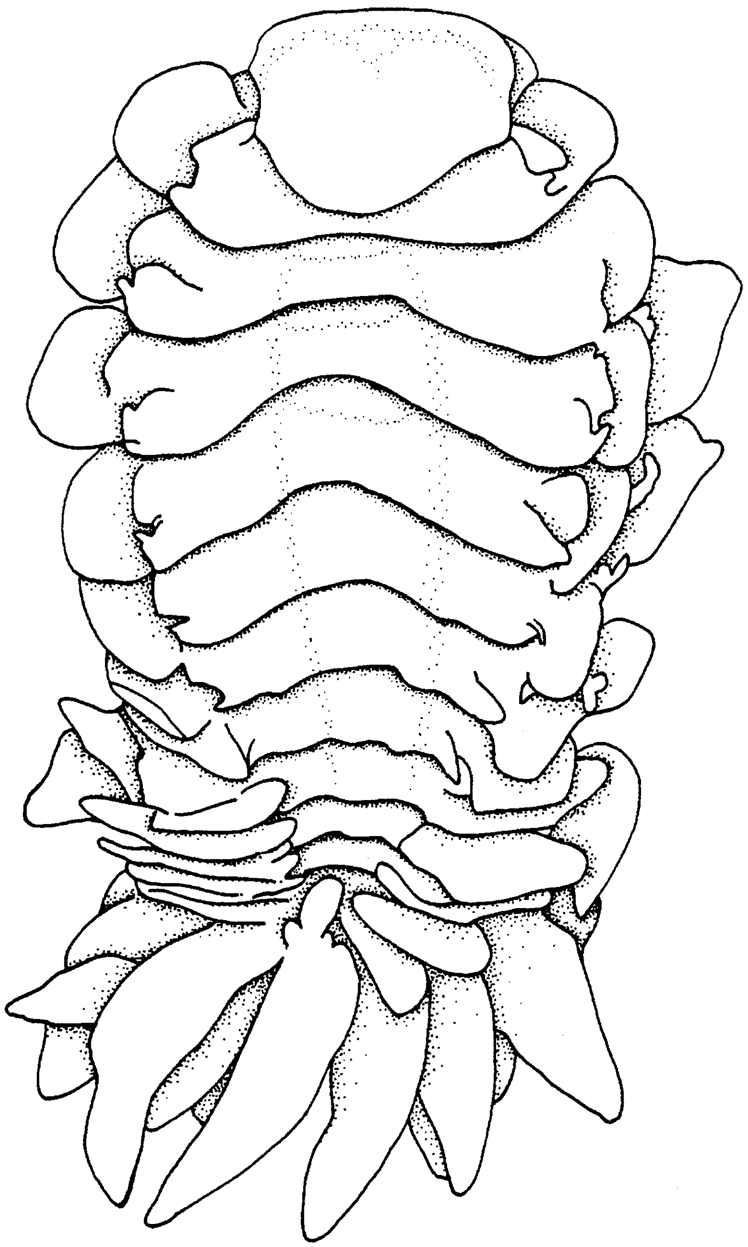


Figure 1.9. *Munidion pleuroncodis* Markham, 1975. Holotype USNM 141597 (female). Mexico, off Baja California, 26°22'N, 115°05'W, 19-21 November 1966, coll. W. C. Klawe, R/V *David Starr Jordan*, Sta. 69.

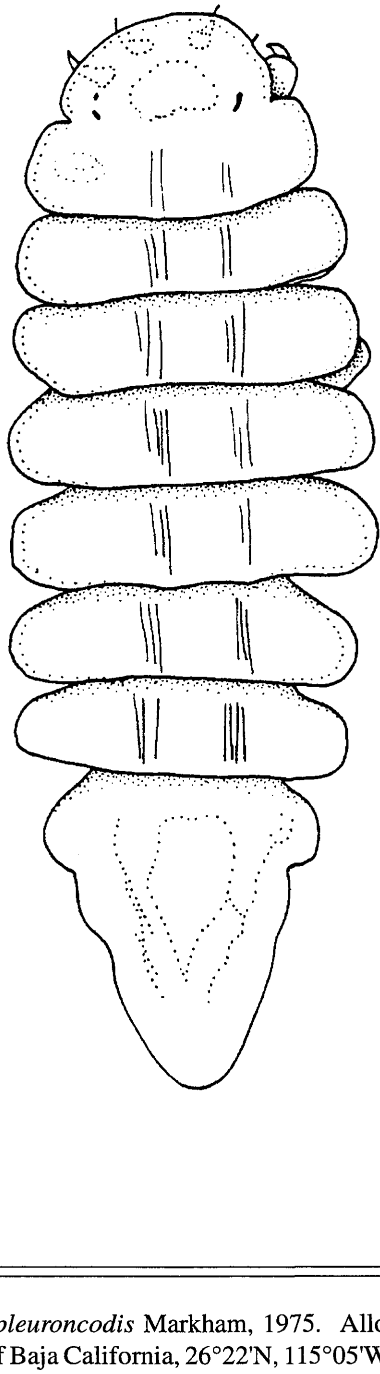


Figure 1.10. *Munidion pleuroncodis* Markham, 1975. Allotype USNM 141598 (male). Mexico, off Baja California, 26°22'N, 115°05'W, 19-21 November 1966, coll. W. C. Klawe, R/V *David Starr Jordan*, Sta. 69.

Suborder Flabellifera G.O. Sars, 1882

Description. Eyes usually well-developed; reduced or absent in cave and deep-sea forms. Antennules usually uniramous, without a scale (except in the cirolanid genus *Bathynomus*), peduncle 3-articulate (4-articulate in Serolidae and Phorotopodidae); antennule reduction occurs in some families. Antennal peduncle commonly 5-articulate, (questionably 6-articulate in some). Frontal lamina, clypeus, and labrum usually well-developed; in groups with the antennae set very close together, the frontal lamina is reduced to a narrow ridge (e.g. Anuropidae, some Aegidae) or a minute plate (e.g. Serolidae). Mandibles usually robust, adapted for cutting and grinding, occasionally for piercing; lacinia mobilis, spine row and molar process usually present, but often reduced or modified in various families; usually with a 3-articulate palp. Maxillule biramous, sometimes adapted for piercing. Maxilla biramous, outer ramus usually consisting of 2 lobes. Pereopods generally ambulatory, sometimes prehensile; pereopods I-II subchelate only in Serolidae, some Sphaeromatidae (Ancininae), and some Cirolanidae; posterior pereopods sometimes secondarily natatory (some cirolanids). Pleon of 0 to 5 free segments, plus pleotelson. Usually 5 pairs of pleopods present. Uropods arise laterally, usually forming a tailfan with pleotelson (except in Anuropidae).

Remarks. The Flabellifera is a diverse and probably non-monophyletic taxon currently containing about 3,000 described species in 180 genera and 15 families. Nearly 60 species, in 9 families, have been reported from California waters. The MMS survey recovered 4 of these species, in 4 families. The largest flabelliferan family, Sphaeromatidae (with about 50 species described from North America north of Mexico), is largely restricted to shallow water and the littoral region.

Literature. Richardson, 1905; Miller, 1975.

Key to the Families of Flabellifera Known from California Waters

1A. Uropods directed ventrally, identical to and functioning with pleopods; body greatly inflated and globular; parasitic on gelatinous zooplankton; antennules greatly modified, 2-articulate, distal artical greatly expanded and scalloped .... Anuropidae

1B. Uropods unlike pleopods, associated with pleotelson; body not greatly inflated and globular; not parasitic on gelatinous zooplankton; antennules not as described above 2

2A. Uropods greatly reduced, with very small, often clawlike exopod; body less than 4 mm long; burrowing in wood or algal holdfasts .... Limnoriidae

2B. Uropods not greatly reduced; body rarely less than 3 mm long; rarely burrowing in wood or algae (a few species of Sphaeromatidae burrow into coastal wood structures, but they are large animals) .. 3

3A. Pleon composed of 3 or less dorsally visible free pleonites, plus the pleotelson 4

3B. Pleon composed of 4-5 free dorsally visible pleonites, plus the pleotelson 5

4A. Pleon composed of 3 dorsally visible free (complete) pleonites, plus pleotelson; cephalon fused medially with pereonite I; body strongly depressed and expanded laterally; pereonite VII tergite incomplete or absent; antennae set very close together, frontal lamina reduced to a small triangular plate visible only by pushing aside antennal bases; pleopods 1-3 small and natatory, basis elongated; pleopods 4-5 large, broadly ovate, suboperculiform .... Serolidae

4B. Pleon composed of 1-2 dorsally visible free (complete) segments, plus pleotelson; cephalon not fused with pereonite I (except in *Ancinus* and *Bathycopea*); body convex dorsally, not strongly depressed; pereonite VII tergite complete; antennae not set close together, frontal lamina large and distinct; pleopods subequal, of modest size, basis not elongated; pleopods 4-5 ovate but not operculiform ... . Sphaeromatidae

5A. All pereopods prehensile (dactyls longer than propodi); antennae reduced, without clear distinction between peduncle and flagellum; maxillipedal palp 2-articulate .... Cymothoidae

5B. Pereopods IV-VII ambulatory (dactyls shorter than propodi); antennae not as above, with clear distinction between peduncle and flagellum; maxillipedal palp of 2-5 articles 6

6A. Maxillipeds, maxillules, and maxillae with stout, recurved, apical spines; lacinia or molar process of mandible reduced or absent; maxilla reduced to a single slender stylet .... Aegidae

6B. Maxilliped without stout, recurved spines; mandible with or without lacinia and molar process; maxilla not a slender stylet 7

7A. Mandible with distinct lacinia and large "articulated" bladelike molar process; mandibular incisor generally broad, 3-dentate; maxillule lateral (outer) lobe often with several (10-14) stout spines, never styletlike or falcate; maxillae well-developed; pereopods I-III not prehensile (dactyls not longer than propodi) .... Cirolanidae

7B. Mandible with lacinia and molar process reduced, vestigial, or absent; mandibular incisor narrow; maxillule lateral (outer) lobe styletlike or falcate; maxillae reduced; pereopods I-III usually prehensile (occasionally ambulatory) 8

8A. Maxillule lateral (outer) lobe slender, styletlike, apex with 3-5 stout, hooked spines, smaller spines subapically; maxilliped with conspicuous endite .... Tridentellidae

8B. Maxillule not as above, simple and falcate; maxilliped without an endite (the female of at least one species, *Excorallana houstoni* has a small endite) .... Corallanidae

Family Aegidae Dana, 1853

Description. Body cirolanid-like. Dorsum evenly vaulted or quite depressed; smooth. Eyes, when present, usually large, not uncommonly nearly contiguous (entirely contiguous in a few species). Both antennules and antennae well-developed, division between peduncle and flagellum distinct, flagellum multi-articulate; antennule with 3 peduncular articles; antenna with 5 peduncular articles. Maxillipedal palp of 2, 3 or 5 articles; terminal articles with spines and/or stout setae. Mandible elongate, incisor narrow, with reduced, vestigial, or no lacinia mobilis, spine row and molar process; palp of 3 articles. Coxal plates of pereonites II-VI large and distinct. Pereopods I-III prehensile (i.e. dactyls as long as, or longer than, propodi and strongly recurved); pereopods IV-VII ambulatory (i.e. dactyls shorter than propodi). Pleon with 4-5 free pleonites, plus pleotelson. Uropods flattened, forming a tailfan with pleotelson.

Remarks. The family Aegidae comprises 6 genera. All species are temporary parasites on marine fishes. Adults engorge themselves with blood from their hosts, then dislodge and sit on the bottom to digest their meal. Nine species, in 2 genera, have been reported from Pacific North America north of Mexico, 6 of which inhabit California waters. Only one species was recovered by the MMS survey.

Literature. Richardson, 1905; Miller, 1975; Brusca,1983; Bruce, 1988; Kensley and Schotte, 1989; Brusca and France, 1992.

Genus *Rocinela* Leach, 1815

Description. Body less compact and more depressed than in *Aega*. Eyes well-developed. Anterior margin of cephalon usually extended to form a short rostrum covering all or part of antennular peduncle. Frontal lamina small, narrow, or arrowhead-shaped, indistinctly fused broad flat with clypeus; labrum free. Antennules much shorter than antennae; peduncular articles of antennules not expanded. Mandibles with incisor narrow, not denticulate; palp of 3 articles, middle article subequal or barely longer than first article, which is greatly elongated. Maxilliped with 2- or 3-articulate palp, if 3-articulate the terminal article is very small; endite greatly reduced. Pereopods I-III often with propodi expanded into a spine-bearing lobe.

Remarks. Four species of *Rocinela* occur in California waters: *R. murilloi* Brusca and Iverson,1985, *R. laticauda* Hanson, 1897, *R. angustata* Richardson, 1904, *R. belliceps* (Stimpson, 1864). Only *R. angustata* was collected by the MMS project, but it is highly likely that *R. murilloi* occurs in the area as it is proving to be the most common *Rocinela* in museum collections. There has never been a world-wide monographic treatment of this genus. Species are poorly known and misidentifications are common. The description and key provided below are based on characters different from those traditionally used, and both are based on observations of type material of all known Pacific species.

Literature. Richardson, 1898, 1905; Brusca and Iverson, 1985; Kensley and Schotte, 1989; Brusca and France, 1992.

Key to California Species of *Rocinela*

1A. Medial process of uropodal peduncle extended greater than 50% length of endopod; spines on merus of pereopod I-III blunt; pereopod III merus with 3 spines, on inferior margin; uropodal endopod longer than exopod .... *Rocinela belliceps*

1B. Medial process of uropodal peduncle extended less than 33% length of endopod; spines on merus of pereopod I-III acute; pereopod III merus with 4-8 spines on inferior margin; uropodal endopod shorter than exopod 2

2A. Propodi of pereopods I-III with 4 stout recurved acute spines; merus of pereopod III with 5-8 acute spines (3-5 distal and 2-3 proximal spines) .... *Rocinela angustata*

2B. Propodi of pereopods I-III with 4-6 acute spines; merus of pereopod III with 4 acute spines (3 distal and 1 proximal spine) 3

3A. Propodi of pereopods I-III with 5 thin straight acute spines; apical article of maxillipedal palp with thin, nearly straight, acute spines .... *R. laticauda*

3B. Propodi of pereopods I-III with 4-6 stout, recurved, acute spines; apical article of maxillipedal palp with stout, recurved, acute spines .... *Rocinela murilloi*

Rocinela angustata Richardson, 1904

Figure 1.11

Description. Body about 2.5 times longer than wide. Cephalon subtriangular, 2.0 to 2.7 times wider than long. Eyes large, separated by about 1 eye-width. Rostrum truncate, extended well beyond bases of antennae. Frontal lamina narrow, not expanded. Antennae extended to, or past, pereonite II. Maxillule styliform tapered to apical tooth. Mandibular palp article 2 more than twice as long as article 3, with 13 spines and 3 setae. Maxilla with setose medial margin; inner lobe fingerlike with 2 stout, recurved spines, 1 apical and 1 subbasal; outer lobe broadly rounded with 2 small, recurved spines on disto-medial edge. Pereonite I longest; pereonite IV or V widest; coxae not visible, or occasionally posteriormost coxae visible, in dorsal aspect. Pereopod I dactyl greatly elongate, as long as carpus and propodus combined; propodus with expanded palm, with 4 stout, acute curved spines (rarely with acute, slender, straight spines); carpus with 1 spine; merus with 3-6 acute spines, 2-5 distal spines set among setae (distalmost spine distinctly longer than others) and 1 proximal spine. Pereopod III merus with 5-8 acute spines, 3-5 distal spines set among setae (2 distalmost spines distinctly longer than others) and 2-3 proximal spines, otherwise as pereopod I. Pereopods IV-VII with short dactyls, much shorter than propodi; ischium, merus, and carpus with fringe of long acute spines on distal margin and acute spines along inferior margin. Pleonite 1 covered by pereonite VII; pleonites 2-4 subequal in length and width; pleonites 1 and 5 narrower than pereonites. Uropods extended slightly beyond posterior margin of pleotelson; inner angle of peduncle extended less than 33% length of endopod; endopod elongate-ovate, terminally truncate, with about 11 spines (7 lateral and 4 on distolateral border); exopod much wider and slightly longer than endopod. Pleotelson broadly rounded, wider than pleonite 5.

Remarks. In 1898 Richardson published a redescription of *Rocinela laticauda* Hansen, based on material collected by the U.S. Fish Commission's *Albatross* expeditions in the north Pacific. Hansen's original description of this species was still in press at the time. Unfortunately, all of the *Albatross* material upon which Richardson based her redescription eventually proved not to be *R. laticauda*. Hansen's type of the latter came from Acapulco, Mexico; Richardson's collections were from Alaska, Canada and California. Recognizing her mistake, Richardson later (1904) established a new species for the *Albatross* material, *R. angustata* (including in the type series one syntype collected in Honshu, Japan).

Rocinela angustata is often misidentified as *R. cornuta*, *R. belliceps* or *R. laticauda* in museum and environmental research collections. It is also extremely similar to the recently described *R. murilloi*. Although the latter species was described from the tropics (Costa Rica) recent work has shown it to be the most common species of *Rocinela* occurring south of 32°N on the Pacific coast of North America.

Distribution. Bering Sea, Alaska south along coast of western North America to Cedros Island, Baja California, Mexico; 30 to 2214 m taken from fishes, or from soft bottom habitats.

Literature. Richardson, 1904, 1905; Birstein, 1973; Brusca and France, 1992.

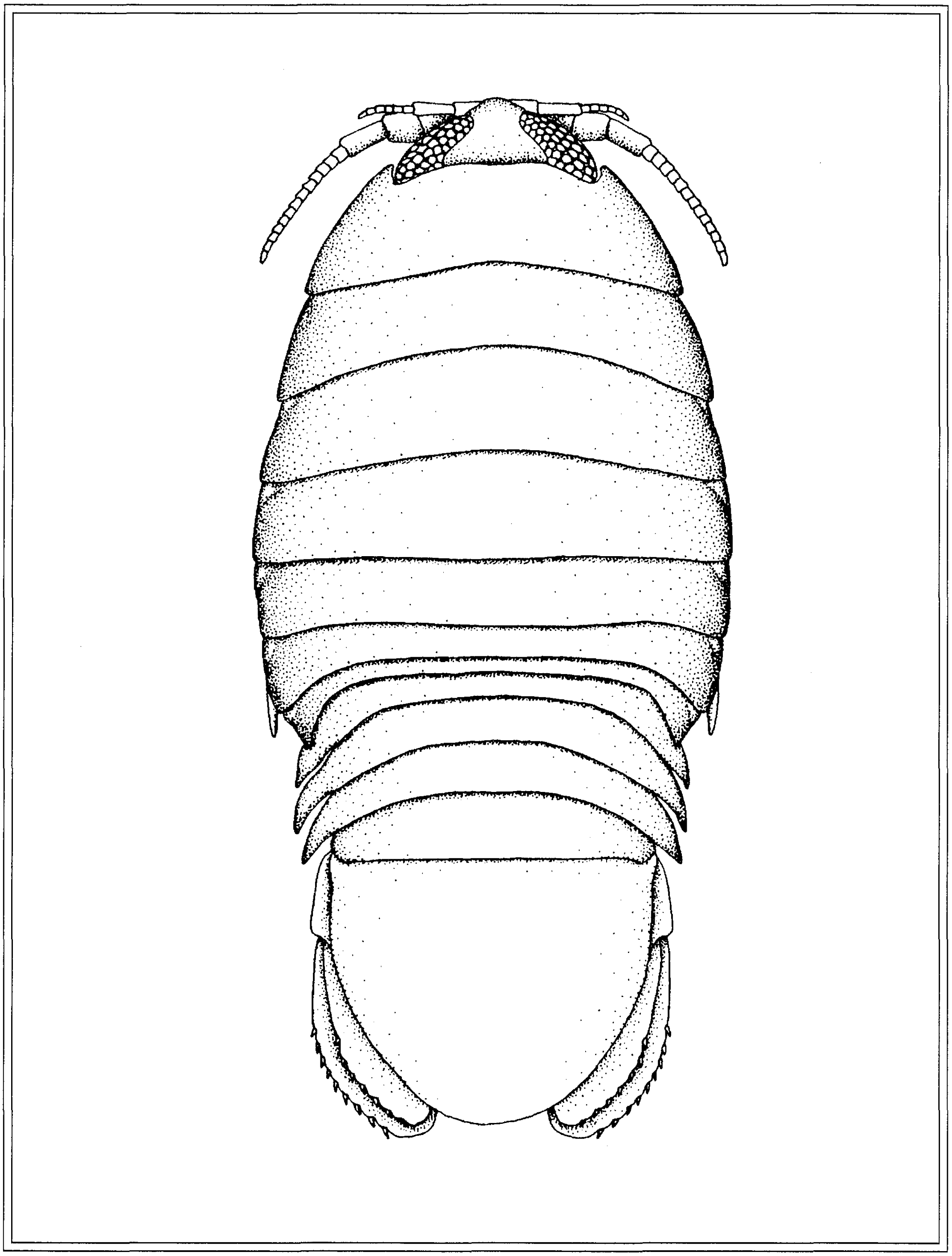


Figure 1.11. *Rocinela angustata* Richardson, 1904. Syntype USNM 22710 (female). Alaska, Bering Sea, N. W. of Unimak Island.

Family Cirolanidae Dana, 1853

Description. Body sleek and symmetrical, 2-6.5 times longer that wide; with well-developed coxal plates on pereonites II-VII, separated from body by distinct sutures. Frontal margin of cephalon evenly convex or produced into short rostrum; distinct frontal lamina present. Antennular peduncle 3-articulate, but occasionally some articles may coalesce to produce 2 free peduncular articles. Antennal peduncle 4- or 5-articulate. Mandible with tridentate incisor, well-developed lobe-like spine row, spinose bladelike "articulated" molar process, and 3-articulate palp. Maxillule outer lobe with 10-14 apical spines; inner lobe with 3-4 apical circumplumose spines. Maxilla setose, bilobed. Maxillipedal palp typically 5-articulate, articles never with hooked or strongly recurved spines; with distinct, minute to large, endite. Pereopods ambulatory; I-III tend towards a grasping form, with dactyls well-developed. Pleon usually with 5 distinct pleonites plus pleotelson, although fusion/ reduction of free pleonites occurs in several genera; pleonite 5 often overlapped laterally by pleonite 4; pleopods membranous; posterior pleopods often lacking PMS on endopods, especially pleopod 5. Uropods usually with both rami well-developed, lamellar, forming a "tail fan" with pleotelson; exopod absent or reduced in some genera.

Remarks. The family Cirolanidae is large, comprising about 52 described genera. Surprisingly, of the 8 species (in 6 genera) of Cirolanidae known from California waters, the MMS soft-bottom survey recovered only one species.

Literature. Richardson, 1905; Miller, 1975; Brusca and Iverson, 1985; Bruce 1986; Brusca *et al.*, 1995.

Genus *Metacirolana* Kussakin, 1979

Description. Cephalon with small to moderate-sized rostral process. Frontal lamina anteriorly dilated, freely projecting, often visible in dorsal aspect; clypeus with ventrally-projecting triangular blade; labrum subequal to clypeus in width, but longer than clypeus. Antennule short, not extended beyond pereonite I; peduncle 3-articulate; basal article not articulating at right angle to others. Mandible with broad tridentate incisor, with small accessory tooth on medial margin of right mandible; molar process and spine row well-developed. Maxilliped slender, endite with 1-2 coupling spines. Pleon with 5 free somites; lateral margins of pleonite 5 not overlapped by pleonite 4. Pleopods 1-2 similar to each other; appendix masculina inserted subbasally (about one-third distance form base) on pleopod 2. Uropods with inner angle of peduncle acutely produced.

Remarks. Species of *Metacirolana* can be most readily distinguished from other, similar genera of Cirolanidae by the freely projecting clypeus, dilated frontal lamina (often visible in dorsal view), pleonal and mouthpart morphology. The genus contains about 2 dozen species, only one of which is currently known from Pacific North America north of Mexico.

Literature. Bruce, 1981, 1986; Botosaneanu, *et al.*, 1986; Brusca et al., 1995.

Metacirolana joanneae (Schultz, 1966)

Figure 1.12

Description. Small, adults 3-5 mm long. Eyes moderate-sized. Antennule extending almost to pereonite II. Antenna extending almost to pereonite IV. Coxal plates well-developed, II-VII visible in dorsal aspect, expanded laterally and with acute posterior angle. Pleomeres 2-5 with large, well-developed epimeres, expanded laterally and with acute posterior angles. Pleotelson with strong, medial, longitudinal ridge; margins of pleotelson and uropodal rami notched. Uropodal exopod about one half width of endopod; both rami subsimilar in length, extending barely beyond posterior margin of pleotelson.

Remarks. The antennular flagellum tends to be slightly longer in males, and males are often more slender than the females.

Distribution. Submarine canyons and basins off central and southern California. The northernmost published record is from 36°41'N, 122°W (off Monterey) at 218 m.

Literature. Schultz, 1966.

Family Serolidae Leach, 1814

Description. Body strongly depressed, broad, with large expanded coxal plates. Cephalon deeply immersed in pereon. Some species quite large (to 80 mm). Eyes present or absent. Antennules with 4 peduncular articles. Antennae with 5 peduncular articles. Mandible with 3-articulate palp; incisor process well-developed, with 2 subterminal movable spines (presumably 1 representing the lacinia mobilis); molar process absent. Maxilliped with 3-articulate palp; without coupling spines on endite. Pereonite I fused dorsally (at least medially) with cephalon and encompassing cephalon laterally; pereonite VII tergite indistinct dorsally, shortened and fused to pereonite VI. Pereopod I of both sexes, and also pereopod II of most adult males, subchelate, with dactyl folding back upon an inflated propodus. Pereopods III-VII ambulatory. Pleon of 3 free pleonites, at least first pleonite narrow, not reaching the lateral margins of the body; pleotelson large (pleonites 4-6 fused with telson). Pleopods 1-3 peduncles elongate, rami subelliptical; exopod of pleopod 4 indurate, operculate, covering endopod and pleopod 5. Uropods small, rami narrow, peduncle and endopod coalesced in some species, in which case the exopod may be greatly reduced.

Remarks. The Serolidae is principally cold-water and southern hemisphere in distribution. Deep-sea species often have reduced eyes, or are blind. Serolids are carnivores, scavengers, or omnivores. They are epibenthic, highly motile animals, capable of shallow burrowing. *Serolis* is the largest of the 21 described genera, and is the only genus represented in the northern hemisphere.

Literature. Richardson, 1905; Nordenstam, 1933; Sheppard, 1933; Menzies and Barnard, 1959; Harrison and Poore, 1984; Brandt, 1988; Wägele, 1994.

Genus *Serolis* Leach, 1818

Description. Maxillule lateral (outer) lobe a flattened blade with large apical spines, medial (inner) lobe a smaller blade with few apical spines. Maxilla lateral (outer) lobe biramous, (medial) inner lobe a flattened blade, both with long apical setae. Pereonites VI and VII often medially shortened; pereonite VII (tergite) medially fused to pereonite VI (also, pereonite VI occasionally fused to pereonite V). Coxal plates well-developed; those of pereonites III-V marked off by distinct sutures. Pereopod II subchelate in males, ambulatory in females. Uropods lateral, lamellar, and usually with articulating rami.

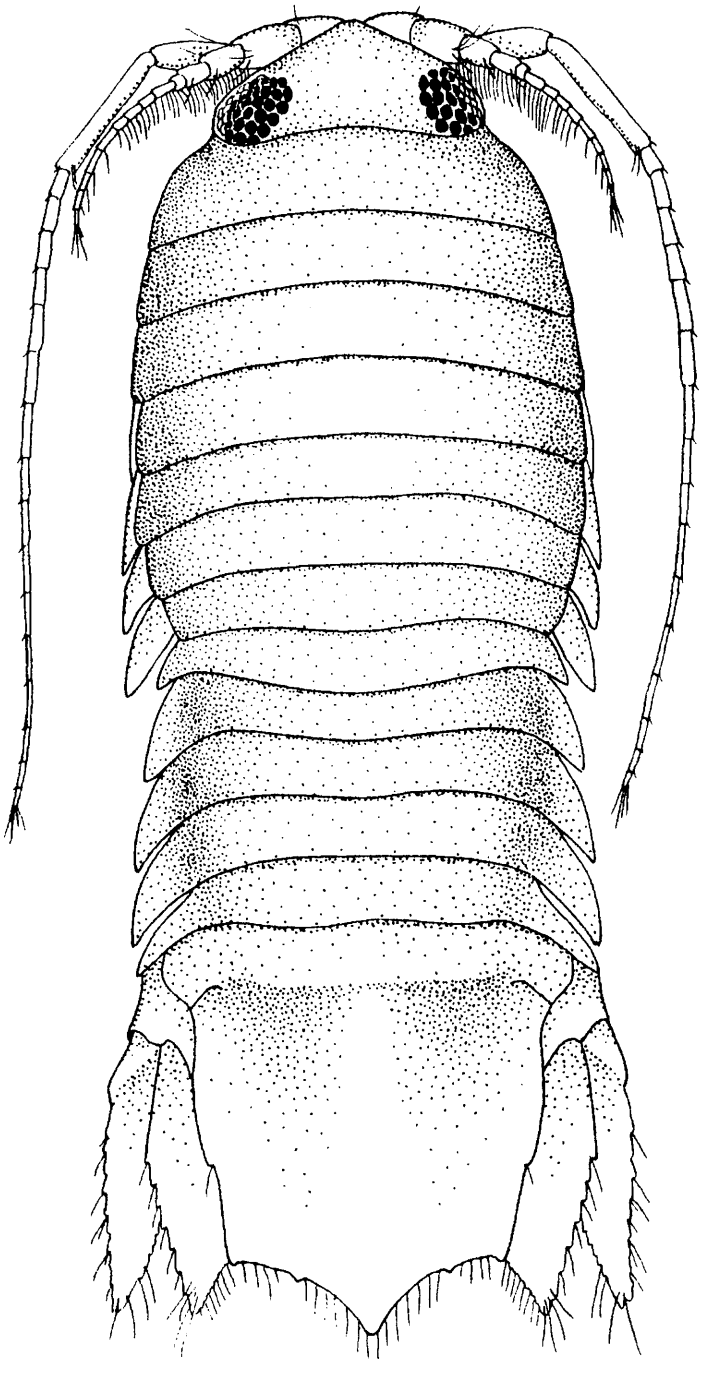


Figure 1.12. *Metacirolana joannae* (Schultz, 1966).

Remarks. See Sheppard (1933) for an excellent review of morphology and taxonomy (including a key to all species known at the time). A single species of *Serolis*, *S. carinata*, is known from Pacific North America north of Mexico.

Literature. Richardson, 1905; Sheppard, 1933; Harrison and Poore, 1984.

Serolis carinata Lockington, 1877

Figure 1.13

Description. Body broadly ovate; males slightly broader than females. Cephalon approximately as broad as long, anterior margin excavated at base of antennules, forming small rostrum. Eyes well-developed, posterolaterally positioned on cephalon, reniform, with black pigment. Cephalon, pereonites, and pleonites all with pronounced mediodorsal carina, forming median keel produced posteriorly on each segment as a short spine. Pleotelson posterior margin with deep medial notch. Uropodal rami subequal in length and width, rounded distally, reaching posterior margin of pleotelson.

Distribution. Southern California to Baja California, Mexico and into the Gulf of California; low intertidal to 98 m from soft bottom habitats. Southern records are usually in deeper water, suggesting these isopods may conform to the latitudinal submersion phenomenon. Specimens collected by the City of San Diego Ocean Monitoring Program at Pt. Loma have extended this species recorded depth range.

Literature. Lockington, 1877; Richardson,1905; Sheppard, 1933; Menzies and Barnard, 1959.

Family Tridentellidae Bruce, 1984

Description. Eyes well-developed. Body often with dorsal spines, tubercles, or carinae (always better developed in the male of the species). Antennular peduncle 3-articulate, basal article not enlarged. Antennal peduncle 5-articulate, articles 4 and 5 elongate. Frontal lamina narrow, pentagonal; clypeus short, broad, inverted V-shaped, lateral angles produced to, or almost to, base of mandibles; labrum small, partly or largely encompassed by clypeus. Mandible with short, acute incisor; molar process vestigial, weakly sclerotized (often lost in dissection); lacinia absent; palp 3-articulate. Maxillule lateral (outer) lobe styliform, slightly curved, tapering toward apex, with 3-5 stout hooked apical spines and smaller subapical spines; medial (inner) lobe simple, greatly reduced. Maxilla uniramous, stout, 2-articulate; distal region of conical second article with small spines and/or scalelike setae. Maxillipedal palp 5-articulate, middle article not elongate; endite elongate, with or without coupling spines. Pereopods I-III subprehensile; pereopods IV-VII ambulatory. Pleopods 1-4 peduncles with 4-6 coupling spines on medial margin; rami lamellar, with plumose marginal setae on all but endopod of pleopod 5. Appendix masculina of male pleopod 2 rodlike, simple, arising from proximal medial margin of endopod.

Remarks. Tridentellidae is a monogeneric family closely related to Corallanidae, Aegidae, Cymothoidae and Cirolanidae. It is most often confused with Corallanidae, but can be most easily recognized by the presence of a large maxillipedal endite (lacking in corallanids).

Literature. Bruce, 1984; Delaney and Brusca, 1985.

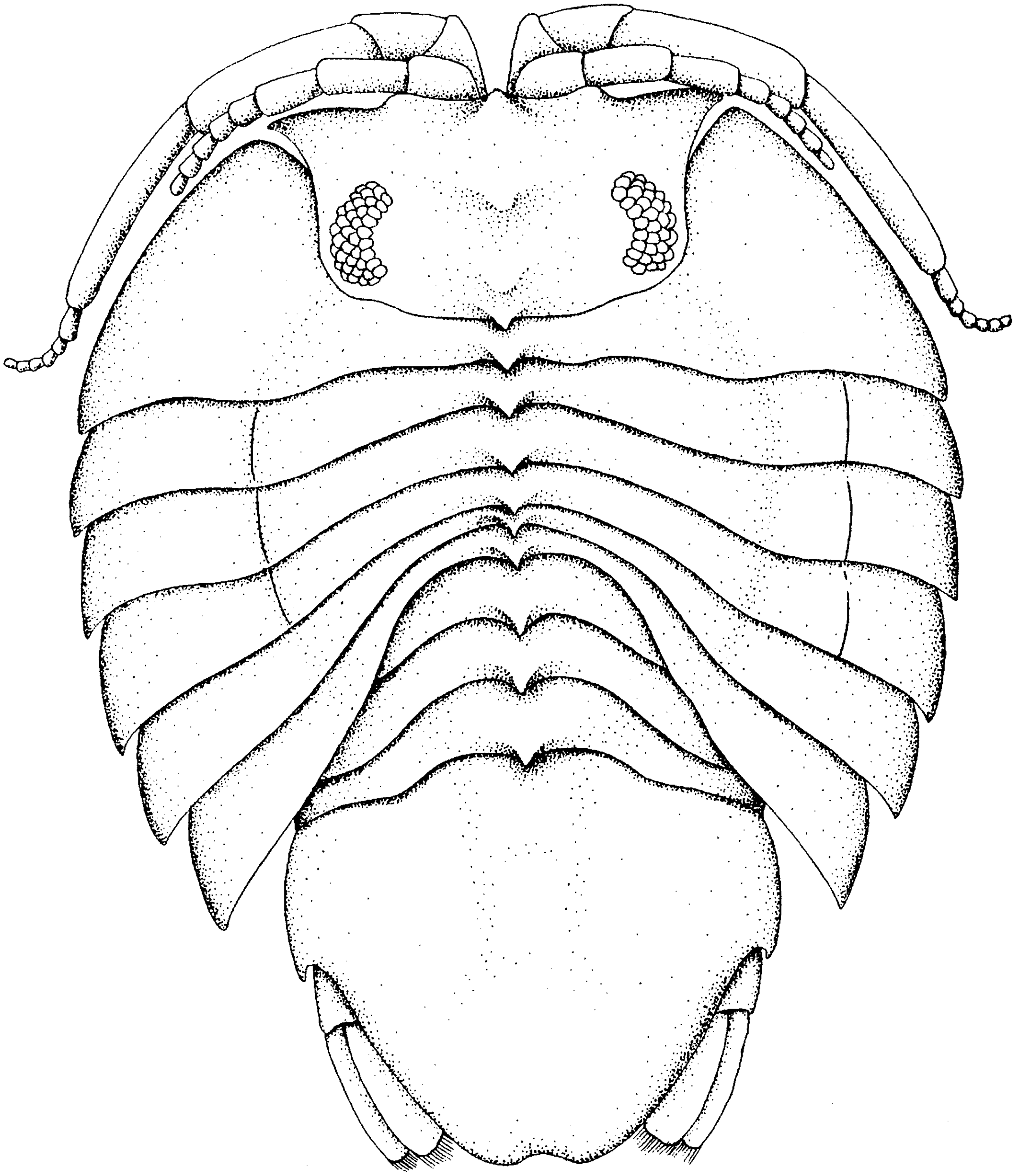


Figure 1.13. *Serolis carinata* Lockington, 1877. California, San Diego Co., Pt. Loma, 47 m, 20 July 1989, coll. Pt. Loma Biology Lab, Sta. A-14, SDNHM A.0014.

Genus *Tridentella* Richardson, 1905

Smicrostoma Hale, 1925.

Description. See family description.

Remarks. *Tridentella* is a cosmopolitan genus reported from shallow (11 m) to bathyal (935 m) depths. It is a small genus of only 14 described species. Most occur in temperate waters, but at least three occur in tropical seas. The bladelike slicing mandibles, and the hooked spines on the maxillules and maxillae, suggest that adults may be predators and/or scavenging carnivores and several species have been reported as "parasites" on various marine fishes. Two species have been reported from California waters, *T. quinicornis* Delaney and Brusca, 1985 and *T. glutacantha* Delaney and Brusca, 1985. Richardson's (1905) record of *T. virginiana* Richardson, 1900 from Santa Barbara Island (*Albatross* Station 4417) almost certainly was based on *T. quinicornis*.

Literature. Richardson, 1905; Menzies, 1962; Schultz, 1969; Kussakin, 1979; Bruce, 1984; Delaney and Brusca, 1985; Delaney, 1990.

Tridentella glutacantha Delaney and Brusca, 1985

Figures 1.14 and 1.15

Description of male. Dorsum highly sculptured. Cephalon with frontal margin produced into large upturned process, and smaller ventrally projecting rostrum that meets the broad frontal lamina. Clypeus short and very broad. Labrum small, partly encompassed by clypeus. Antennular flagellum of 16-17 articles, extending to middle of pereonite I. Antennal flagellum of 25-28 articles, extending to posterior margin of pereonite IV. Maxilliped with large endite, extending to apical palp article and bearing 5-6 coupling spines. Dorsum of pereonite I with 3 large processes; all pereonites with numerous dorsal tubercles, increasing in size posteriorly, becoming spinelike on posterior pereonites and pleon, and extending onto coxae. Pereonites III-VII and all pleonites with row of large tubercles along posterior margin, these also increasing in size posteriorly. Coxal plates large, increasing in size posteriorly and extending beyond posterior margins of their respective pereonites; coxal plates with 2 oblique carinae, increasing in size posteriorly. Large, unfused penes on sternite of pereonite VII, extending nearly to pleonite 2. Pleotelson with longitudinal rows of large spinelike tubercles. Uropods extending barely beyond posterior margin of pleotelson; endopod width about 2 times exopod width; endopod longer than exopod.

Description of female. The female of this species is generally much less spinose than the male, lacks the pronounced large upturned process of the frontal margin and the horns of the cephalon and pereonite I.

Remarks. This species appears to inhabit both rock and mud bottoms. *T. glutacantha* is easily recognized by its 3 large cephalic horns, and 3 large hornlike tubercles on pereonite I. Only the northwest Pacific species *T. cornuta* is similarly horned; however, *T. cornuta* lacks the robust spination of *T. glutacantha*. The MMS primary voucher material includes 1 male, 7, females, 1 manca, and 1 postmanca. The secondary voucher specimen is an intersex individual (but not a mid-molt individual), with a female cephalon and pereonite I, minute penes, well-developed appendix masculina, and typical male pleon. *T. glutacantha* can be quickly distinguished from its California congener *T. quinicornis* by the dorsal cuticular spines (lacking in the latter) and by the dorsal cephalic processes of males (2 posterolateral horns, plus a large rostrum in the former; 5 small cephalic processes in the latter).

Distribution. *T. glutacantha* is known from central California (Farallon Is.) to Los Angeles. Previous known records for *T. glutacantha* were based solely on the type series, which was from near the Farallon Islands (bottom dredge on green mud; 128 to 231 m), near Catalina Island (loose rock bottom; 304 to 310 m), and near the Los Angeles breakwater light (large boulders; 320 to 360 m).

Literature. Delaney and Brusca, 1985.

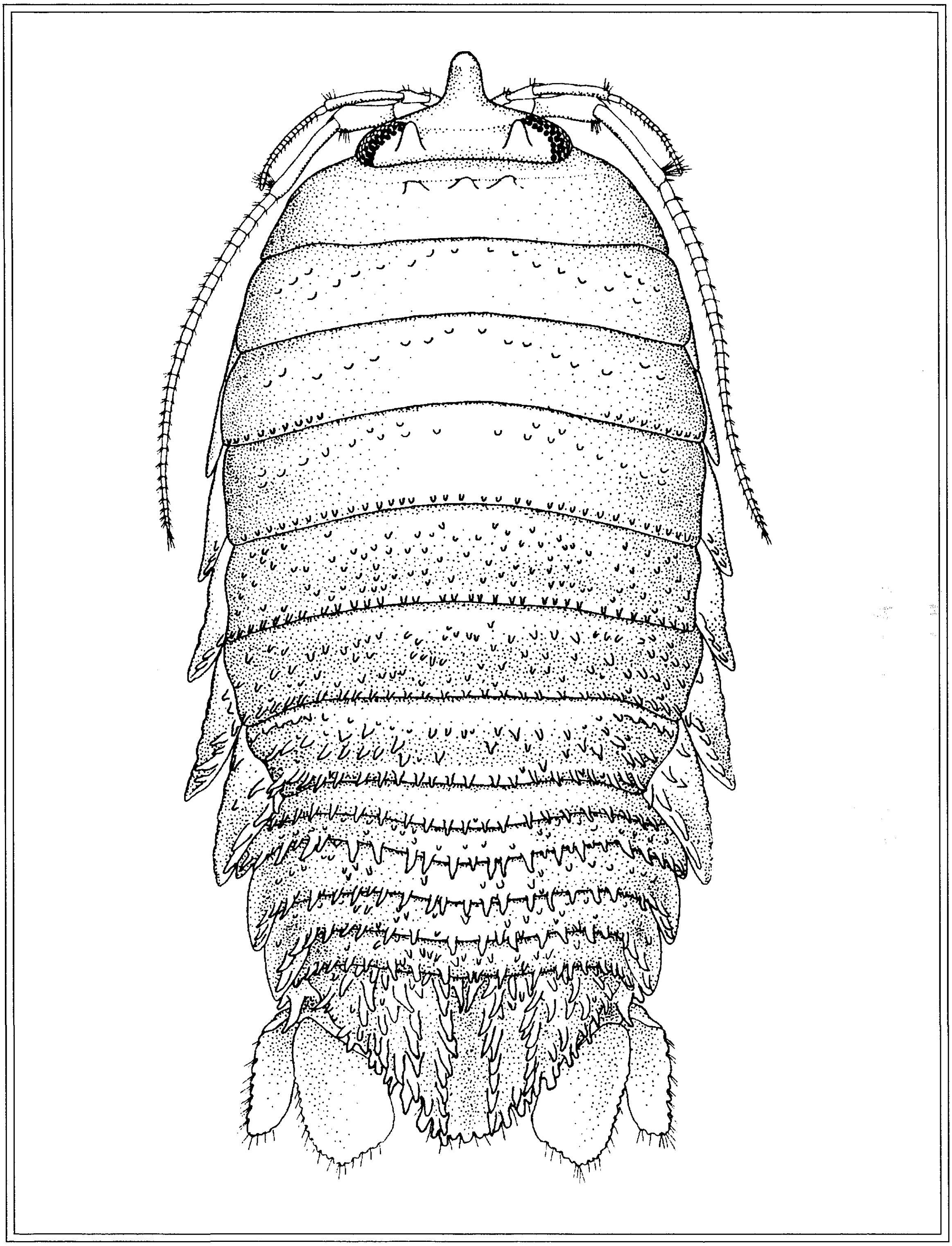


Figure 1.14. *Tridentella glutacantha* Delaney and Brusca, 1985. Holotype CASIZ 025948 (male). California, Los Angeles Co., off Los Angeles breakwater light, loose rock, 320-360 m, 1953, coll. R/V *Velero IV*, Sta. 2413-53.

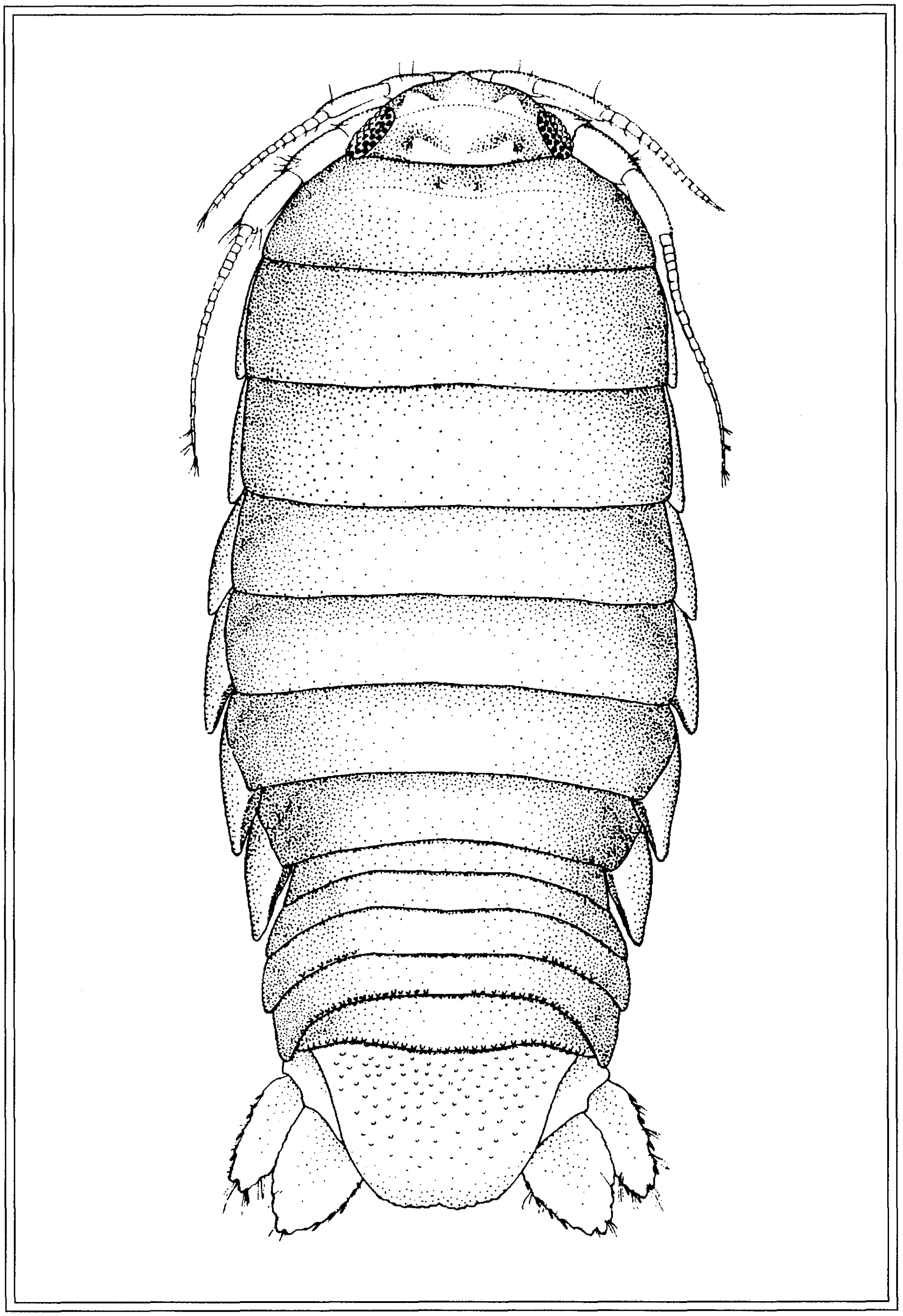


Figure 1.15. *Tridentella glutacantha* Delaney and Brusca, 1985. Allotype LACM 53-113.1 (female). California, Los Angeles Co., Santa Catalina Island, loose rock bottom, 304-310 m, 18 May 1941, coll. R/V *Velero III*, Sta. 1323-41.

Suborder Gnathiidea Leach, 1814

Description. Eyes usually well-developed, in some species on short processes (ocular lobes, or ocular peduncles). Cephalon in males broad and flattened, often with tubercles or bosses; cephalon in females small and narrow. Antennular peduncle 3-articulate, (rarely 2-articulate), usually with well-developed flagellum. Antennal peduncle 5-articulate; both antennules and antennae uniramous, without a scale. Males with rudimentary maxillae and greatly enlarged mandibles (reminiscent of certain ant or termite castes); mandibular palp absent. Females without mandibles or maxillae. Both sexes with only 6 free pereonites and 5 pairs of pereopods. Female pereon large and rotund, with pereonites III-V partly or largely fused. Pereonite I entirely fused with cephalon in males, its pereopods forming a second pair of maxillipeds (the pylopods) that cover the buccal field. Pereonite I only partly incorporated into the cephalon in females, but first pereopods still form a second pair of maxillipeds (pylopods). In both sexes pereonite VII is greatly reduced and lacking pereopods (in males pereonite VII is narrow and the same width as the pleonites, in females pereonite VII is generally not discernible). Pleon abruptly narrower than pereon, with 5 free pleonites plus pleotelson. Pleopods tend to be simple, saclike structures, often without marginal setae, the rami positioned side-by-side (rather than as flattened overlapping plates as in most other isopods). Pleotelson triangular or T-shaped. Uropods biramous and attached laterally to form a "tail fan" in conjunction with pleotelson.

Remarks. The reduced number of pereonites and pereopods, unusual male mandibles (which are not used in feeding), and distinctive pleotelson, quickly distinguish gnathiids. Females incubate their embryos internally, and when gravid nearly the entire body cavity is filled with developing embryos, the internal organs being hardly discernible. Gnathiids occur from the littoral zone to the deep sea, and they are often quite numerous in shallow soft-bottom benthic samples. Adults probably do not feed, and they are often found in association with sponges. Adults are benthic but the juvenile stage (the "praniza") is a temporary parasite on marine fishes, although they are also often collected free-living in benthic samples. Praniza are good swimmers, whereas adults apparently have only limited swimming capabilities. The mouth parts of praniza are styliform, with acute anteriorly-projecting mandibles. Data are not yet available to allow identification of females and juveniles to species, and the taxonomy of this suborder is based entirely on males. About 125 species, in one family, and 10 genera, have been described. Only *Gnathia* is known from California waters.

Literature. Richardson, 1905; Monod, 1926; Menzies and Barnard, 1959; Menzies, 1962; Miller, 1975; Holdich and Harrison, 1980; Juilfs and Wägele, 1987; Wägele, 1987; Camp, 1988.

Genus *Gnathia* Leach, 1814

Description. Gnathiids with male pylopod 2- or 3-articulate, the first article being large and operculate, with the outer (straight) margin much longer than the second article, and the third article (if present) much smaller than the second article.

Remarks. The MMS survey recovered 4 of the 8 species known to occur in California waters. The following key allows for the identification of all known California species.

Literature. See above.

Key to the California Species of *Gnathia* (adult males)

1A. Pleotelson triangular or subtriangular in outline 2

1B. Pleotelson T-shaped 5

2A. Mandible with large, distinct tooth on outer margin; no epimeres visible on pleonites in dorsal aspect 3

2B. Mandible without an outer tooth, or with a minute weakly-developed outer tooth; pleonites with weak or distinct epimeres, either small, truncate, and ventrally directed, or subacute and laterally directed 4

3A. Frontal margin of cephalon with pronounced medial lobe, larger than other frontal lobes; mandible with large outer tooth, and with small scooplike inner region bearing a crenulate margin; dorsum of cephalon not tuberculate; pereon more-or-less straight-sided (pereonites all about same width); eyes may be on ocular lobes .... *Gnathia steveni*, Menzies, 1962

3B. Frontal margin of cephalon with medial lobe no larger than other lobes; mandible with modest outer tooth, and with broad scooplike inner region with several large marginal cusps; dorsum of cephalon weakly tuberculate; pereon tapering posteriorly (pereonites narrowing posteriorly); eyes never on lobes or stalks .... *Gnathia tridens*

4A. Without eyes; frontal margin of cephalon trilobed; pleonal epimeres small, truncate, and ventrally-directed .... *Gnathia coronadoensis*, Schultz, 1966

4B. With eyes; frontal margin of cephalon not lobed, but minutely crenulate; pleonal epimeres subacute, laterally directed .... *Gnathia crenulatifrons*

5A. Eyes set on distinct ocular peduncles; frontal margin of cephalon 4-lobed; pleonal epimeres in double pairs (a pair of ventrally-directed and a dorsally-directed epimeres on each pleomere) .... *Gnathia clementensis*, Schultz, 1966

5B. Eyes not on ocular peduncles; frontal margin of cephalon 1 or 3-lobed; pleonal epimeres in single pairs (double pairs may be present in *Gnathia sanctaecrucis*) 6

6A. Pleonal epimeres occur as doublets (2 pairs of epimeres, a dorsal and a ventral, on each pleonite); frontal margin of cephalon produced into a single large lobe; dorsum of cephalon (and entire body) strongly hirsute; pleotelson with a pair of large subapical setae; pleonal epimeres truncate .... *Gnathia sanctaecrucis*

6B. Pleonal epimeres occur as a single pair on each pleonite; frontal margin of cephalon trilobed; dorsum of cephalon weakly hirsute; pleotelson with or without a pair of subapical setae; pleonal epimeres subacute 7

7A. Mandible outer margin without crenulations or setae; pleotelson without a pair of large apical setae .... *Gnathia trilobata*, Schultz, 1966

7B. Mandible outer margin with setose crenulations; pleotelson with a pair of large subapical setae (not set side-by-side in transverse line, but off-set from one another) .... *Gnathia productatridens*

Gnathia crenulatifrons Monod, 1926

Figure 1.16

Description of male. Body about 3.3 to 3.7 times as long as broad; sides parallel. Eyes present, never on lobes or peduncles. Frontal margin of cephalon broad, slightly convex, minutely crenulate, not produced into distinct lobes. Inner margins of mandibles with 3 teeth, sometimes obliterated; tooth on outer margin weakly developed. Pylopods 3-articulate. Body with distinct separation between free pereonites II and III. Pleonal epimeres subacute, laterally directed.

Distribution. Santa Cruz Point, Monterey Bay to Pt. Loma, San Diego County, 9 to 1300 m; coastal shelves, slopes, and submarine canyons. This species has been collected by the City of San Diego Ocean Monitoring Program at Pt. Loma, thereby extending its known range. Specimens have been collected from gray sand, green mud, and green mud with hydrogen sulfide. MMS survey voucher material was examined from PJ-7 and PS-14.

Literature. Monod, 1926; Menzies and Barnard, 1959; Schultz, 1964, 1966; Iverson, 1974.

Gnathia productatridens Menzies and Barnard, 1959

Figure 1.17

Description of male. Body about 3 to 3.5 times as long as broad, sides parallel. Eyes present, never on lobes or peduncles. Dorsum of cephalon tuberculate; frontal margin produced, trilobed. Inner margins of mandibles with 4-5 small teeth; outer margins with a series of 3-5 setose crenulations. Pylopod 3-articulate, distal article minute. Pleon small. Pleotelson with a pair of submedian subapical setae (not set side-by-side in transverse line, but off-set from one another).

Distribution. Until this time, this species had been reported from Point Conception to the Southern California Bight in 20 to 164 m. The type material is from green silt. MMS survey voucher material was examined from station R-5.

Literature. Menzies and Barnard, 1959.

Gnathia sanctaecrucis Schultz, 1972

Figure 1.18

Gnathia hirsuta Schultz, 1966 (not *G. hirsutus* of G.O. Sars, 1870).

Description of male. Body about 3 to 3.75 times as long as broad. Cephalon wider than long, covered with many dorsal tubercles; frontal margin with acutely rounded medial projection and some lateral crenulations. Eyes present, never on ocular peduncles or lobes. Maxilliped with many plumose setae along lateral margin; endite with 2 coupling spines. Pylopod 3-articulate, apical article minute. Mandible acutely pointed with few inner teeth and with smooth, toothless outer margin. Entire body, especially anterior pereonites, covered with long hairlike setae. Each pleonite with 2 pairs of lateral epimeres, a dorsal and a ventral pair on each side; pleonites with stiff, hairlike setae arising from posterior margin. Pleotelson long, with 2 pairs of large submedian setae, one apical pair and one subapical pair. Uropodal rami both with large plumose setae; endopod slightly longer than exopod and just reaching posterior margin of pleotelson.

Remarks. Schultz (1966) originally described this species as *Gnathia hirsuta* (as it also appears in his 1969 handbook). This name, however, was preoccupied (*Gnathia hirsutus* G.O. Sars, 1870), and in 1972 Schultz proposed the new replacement name, *Gnathia sanctaecrucis*, for this species.

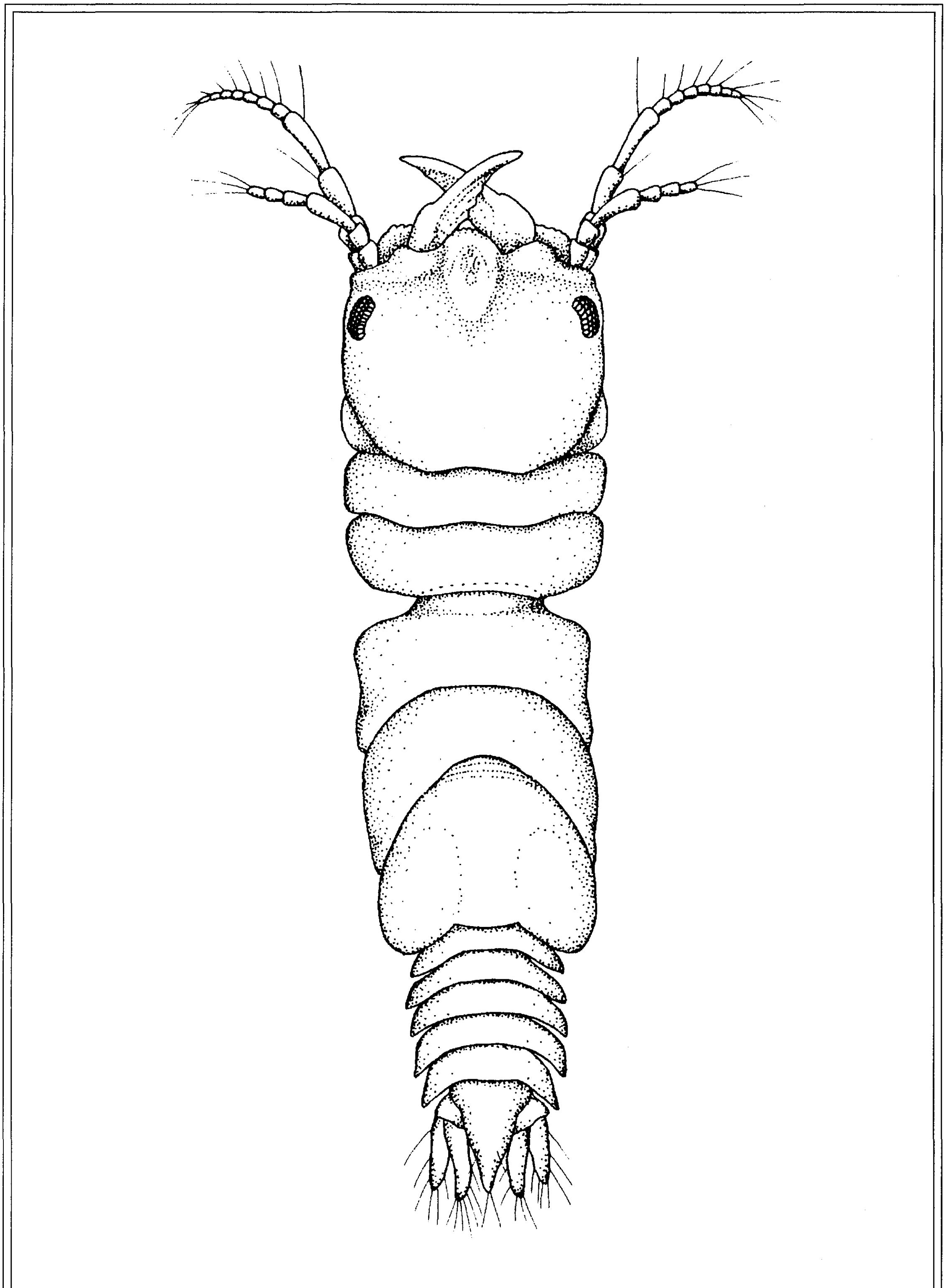


Figure 1.16. *Gnathia crenulatifrons* Monod, 1926. Male. California, San Diego, Co., off Pt. Loma outfall, 05 October 1989, coll. Pt. Loma Biology Lab, Sta. A-5, SDNHM A.0114

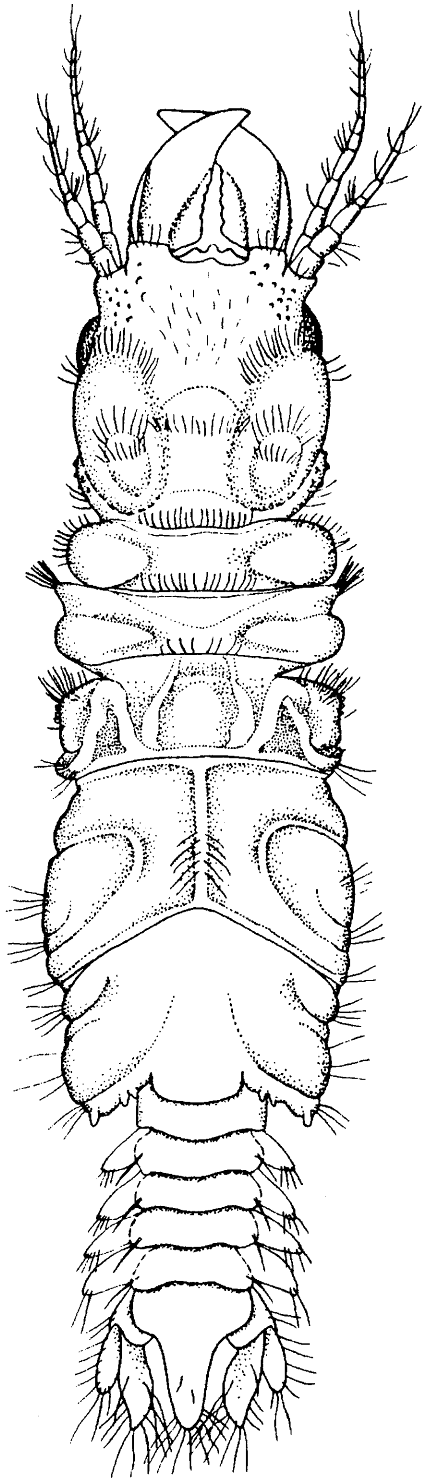


Figure 1.17. *Gnathia productatridens* Menzies and Barnard, 1959. Holotype AHF 5712 (male). California, Santa Barbara Co., off Santa Barbara Pt. Light, green silt, 89 m, 03 July 1957, coll. R/V *Velero IV*, Sta. 5173-57.

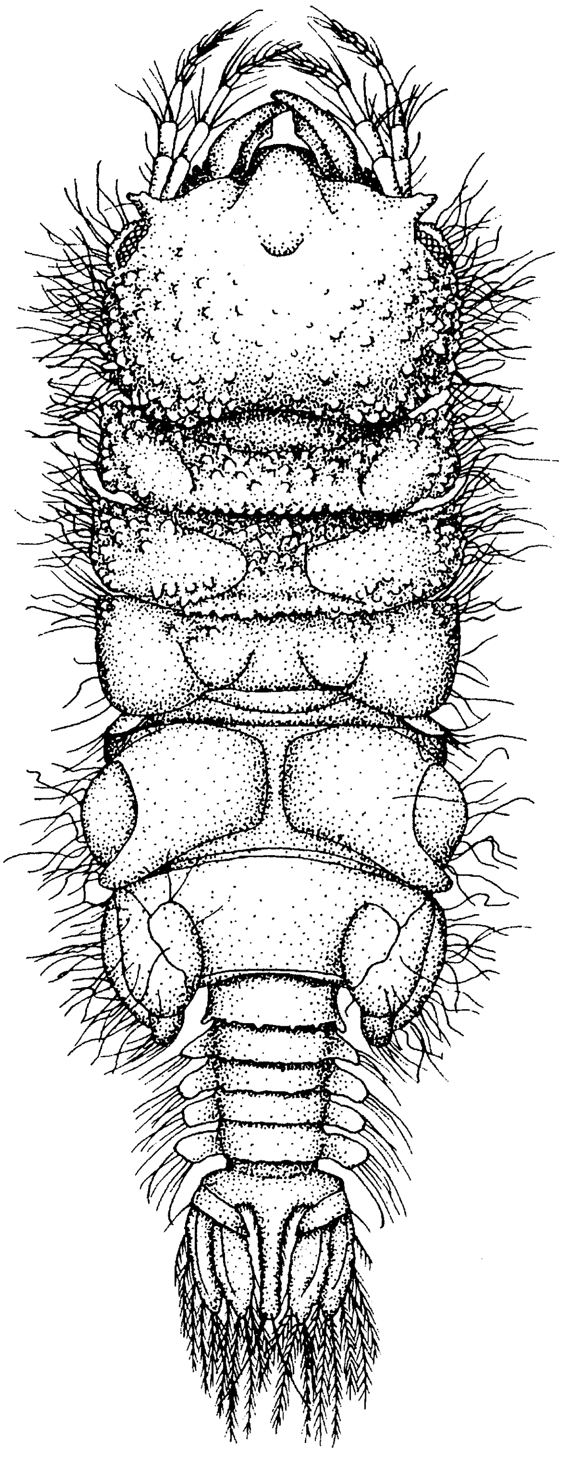


Figure 1.18. *Gnathia sanctaecrucis* Schultz, 1972. Holotype AHF 5927 (male). California, Channel Islands, Santa Cruz Channel, green sand, 201 m, 22 December 1959, coll. R/V *Velero IV*, Sta. 6805-59.

Distribution. Santa Maria Basin to Southern California Bight. The type material is from Santa Cruz Canyon, from a depth of 218 m and a bottom substratum characterized as rocks and green sand.

Literature. Schultz, 1966, 1972.

Gnathia tridens Menzies and Barnard, 1959

Figures 1.19 and 1.20

Description of male. Body about 2.5 to 3.1 times longer than broad, tapering in width posteriorly. Eyes present, never on lobes or peduncles. Mandible outer margin with modest-sized tooth, without crenulations; inner margin with 6-7 small teeth. Pylopod 3-articulate. Dorsum of cephalon weakly tuberculate; frontal margin produced, trilobed. Body separated or not separated between free pereonites II and III. Pleotelson with pair of submedian subapical setae, and pair of submedian apical setae.

Distribution. Specimens of this species have been collected from Point Conception (11 to 27 m) and San Clemente (14 m). The type material was from a benthic sample containing dead kelp fragments and red algae.

Literature. Menzies and Barnard, 1959.

Suborder Valvifera G.O. Sars, 1882

Description. Antennular peduncle 3-articulate, uniramous (without a scale), flagellum reduced to one or a few vestigial articles. Antenna uniramous, peduncle 5-articulate, flagellum multiarticulate or uniarticulate. Frontal lamina, clypeus, and labrum well-developed; mandible with or without 3-articulate palp. Maxillipedal palp of 3-5 articles. Coxal plates prominent. Vas deferens (and penes) of male opening on pleonite 1 or on articulation of pleonite 1 and pereonite VII (rather than on the thorax, as in all other marine isopods). Pleonites variously fused, of 4 or fewer free segments (plus the pleotelson). Uropods biramous or uniramous, attached laterally on pleotelson, but modified as ventral opercular plates covering pleopods.

Remarks. The suborder is composed of 7 families. Valviferans are characterized by the absence of mandibular palps (except in Holognathidae); the presence of penes on pleonite 1; the unique possession of uropods opercular to the pleopods; flagellum of antennule reduced to 1 or a few vestigial articles; pleon of 4 or fewer free somites (plus the pleotelson); uropods biramous or uniramous. Thirty-two species are known to occur in California waters, representing 3 families. The MMS survey recovered 4 species from 2 families.

Literature. Sheppard, 1957; Miller, 1975; Brusca, 1984; Poore, 1985; Poore and Lew Ton, 1990.

Key to the California Families of Valvifera

1A Body cylindrical, often geniculate, flexed between pereonites IV and V; anterior pereopods setose for feeding, posterior pereopods ambulatory; pereonite IV manifestly enlarged or elongated; first pleopods of males with accessory gonopod; cephalon usually fused medially to pereonite I .... Arcturidae

1B. Body not cylindrical or geniculate; pereopods not as above; pereonite 4 not as above; first pleopods of males without accessory gonopod; cephalon not fused medially to pereonite I .... Idoteidae

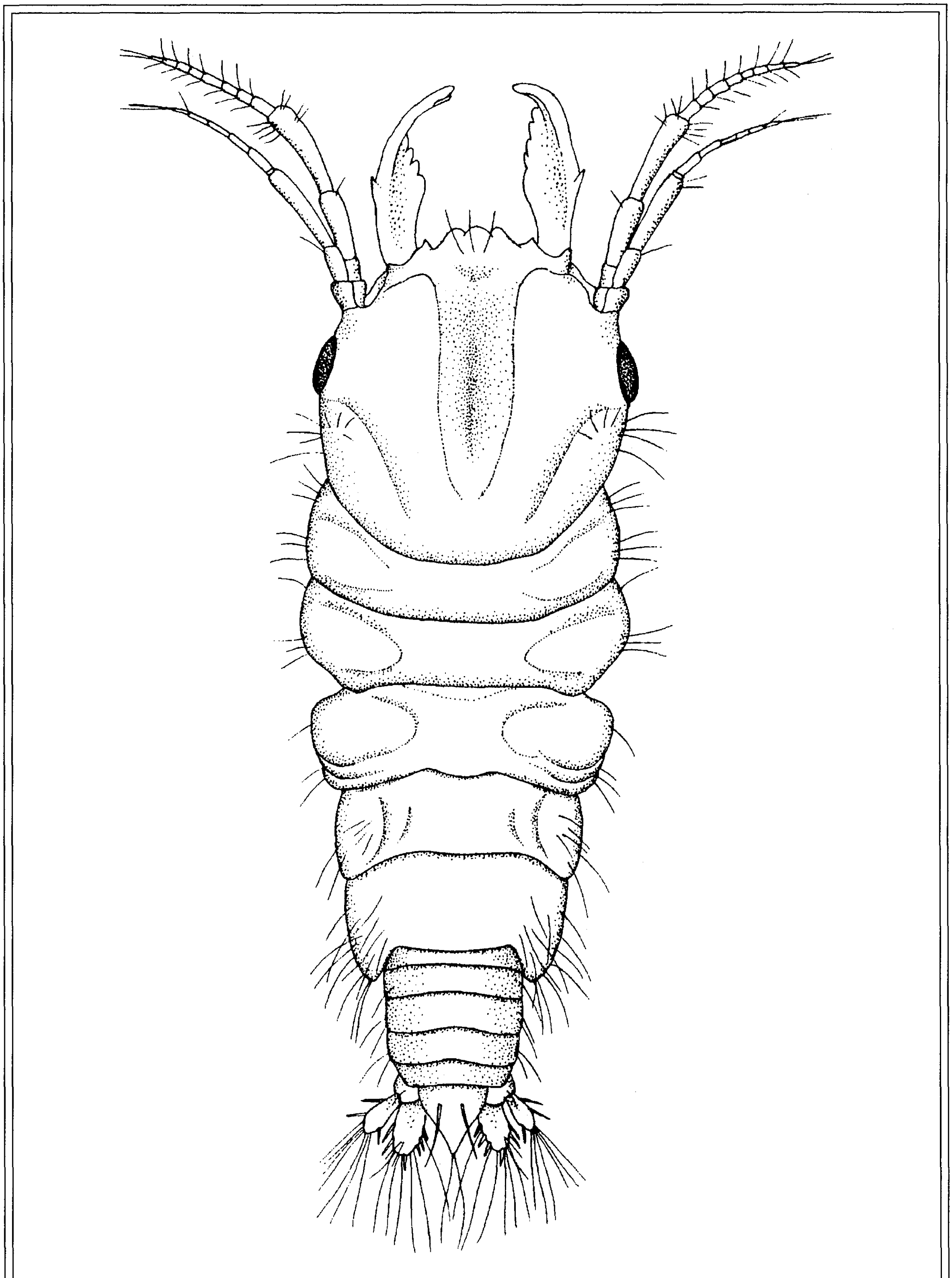


Figure 1.19. *Gnathia tridens* Menzies and Barnard, 1959. Holotype AHF 5711 (male). California, Santa Barbara Co., off Santa Barbara Point Light, 16 m, 17 January 1957, coll. R/V *Velero IV*, Sta. 4822-57.

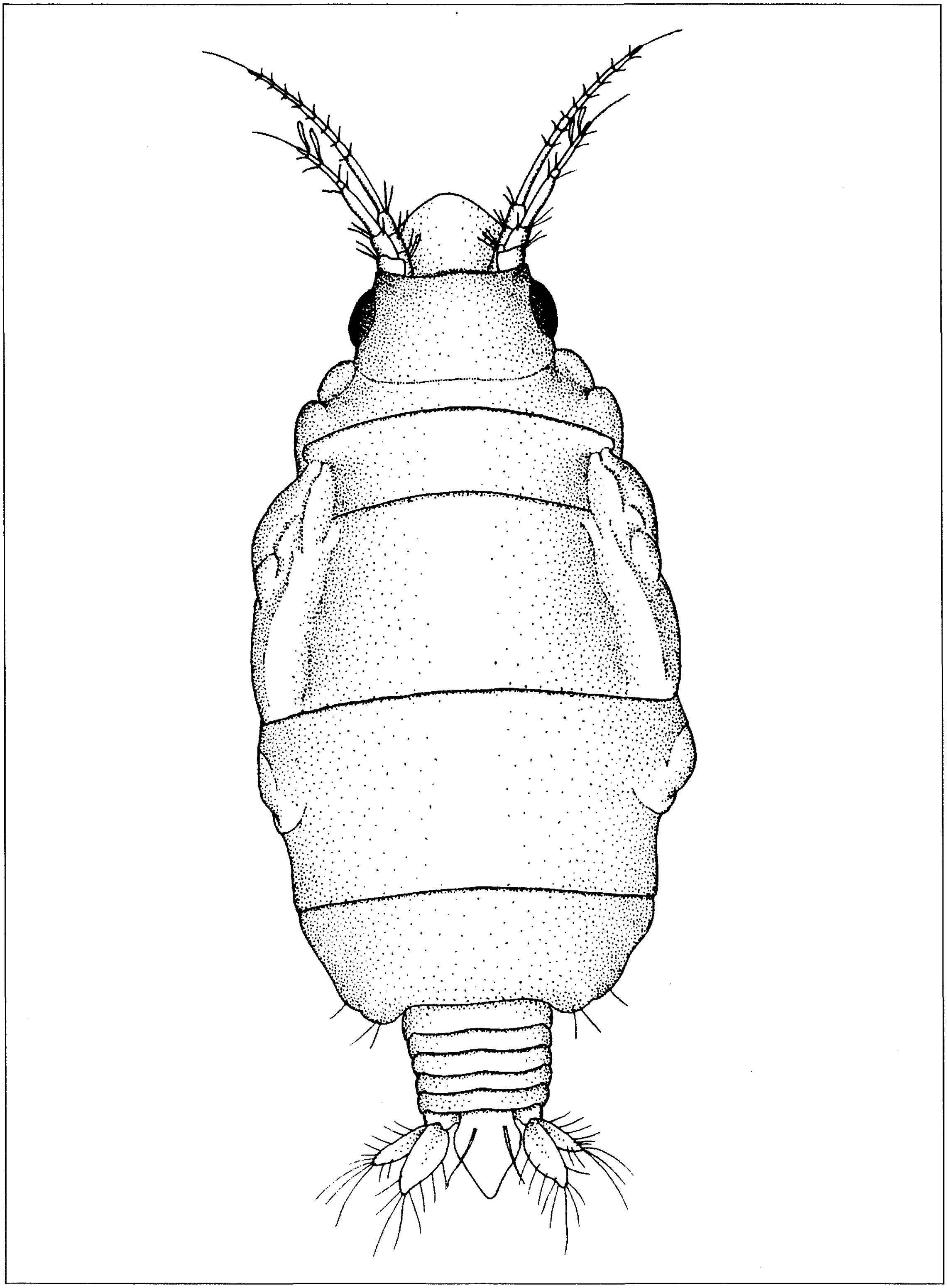


Figure 1.20. *Gnathia tridens* Menzies and Barnard, 1959. Paratype AHF 5711 (female). California, Santa Barbara Co., off Santa Barbara Point Light, 16 m, 17 January 1957, coll. R/V *Velero IV*, Sta. 5164-57.

Family Arcturidae G.O. Sars, 1897

Astacillidae G.O. Sars.

Description. Body cylindrical or tubular, often geniculate (bent between pereonites IV and V, except in *Pleuroprion, Neoarcturus* and *Idarcturus*). Antennal flagellum either 2- to 3-articulate (*Astacilla, Neastacilla, Arcturella, Pleuroprion, Arcturopsis, Arcturina, Neoarcturus, Pseudarcturella* and *Idarcturus*) or of many articles (most other genera). Mandible without palp. Pereonite I either distinct, or completely or incompletely fused with cephalon. Pereonite IV generally manifestly enlarged or elongated. Pereopods I-IV directed anteriorly and setose for feeding; pereopods V-VII directed posteriorly and ambulatory. Male pleopod 1 with elongated peduncle and accessory appendix masculina. Uropods usually biramous, with minute endopod concealed by larger exopod. Sexual dimorphism often marked.

Remarks. Four species, representing three genera of astacillids occur in California waters: *Microarcturus* Nordenstam, 1933, *Neastacilla* Tattersall, 1921, and *Idarcturus* Barnard, 1914. The MMS survey recovered one species.

Literature. G.O. Sars, 1897a; Richardson, 1905; Nordenstam, 1933; Sheppard, 1957; Menzies and Barnard, 1959; Brusca, 1984.

Genus *Idarcturus* Barnard, 1914

Description. Body not geniculate. Cephalon fused with pereonite I, sutures visible laterally. Only distalmost flagellar article of antennule with aesthetascs. Antennal flagellum 2-articulate; flagellum shorter than 5th peduncular article; flagellum often 4-articulate in male. Maxillipedal palp usually 5-articulate. Pereonite IV longer than others. All pleonal segments fused into one piece. Penes fused in male.

Remarks. The original diagnosis of the genus is superficial at best and has not been revised since it was created.

Literature. Barnard, 1914; Nordenstam, 1933; Menzies and Barnard, 1959.

Idarcturus allelomorphus Menzies and Barnard, 1959

Figures 1.21 and 1.22

Description. Eyes lateral and bulging. Antennules not reaching third antennal peduncular article. Cephalon indistinguishably fused with pereonite I, narrow, lateral margins nearly parallel, with two prominent horns located medially just slightly posterior to eyes. Maxilliped with 2 coupling spines; palp 5-articulate. Pereonites II-VII, each with 1 pair of spines set medially on dorsum near posterior margin of each pereonite; pereonites V-VII also with paired lateral spines. Pereopod V dactyl with secondary unguis, in some specimens often badly worn or sometimes completely absent. Pleon with 1 pair of medial spines. Lateral margins of pleotelson with 2 posteriorly directed medium-sized, angulate spines; posterior margin produced, apex blunt.

Remarks. *I. allelomorphus* is easily distinguished from *I. hedgpethi* Menzies, 1951, its only congener in California waters, by its comparatively weakly ornamented dorsum and longer cephalon. *I. hedgpethi* is easily distinguished by the large triangulate anterolateral extensions on pereonites I-VI and large acute posterolateral spines on pereonites IV-VI.

Distribution. Monterey to Pt. Loma (San Diego County), including Cortes and Tanner Banks; 12 to 92 m. A common mud bottom species. MMS survey voucher material was examined from station R-5. This species has been collected by the City of San Diego Ocean Monitoring Program at Pt. Loma, thereby extending its known range.

Literature. Menzies and Barnard, 1959.

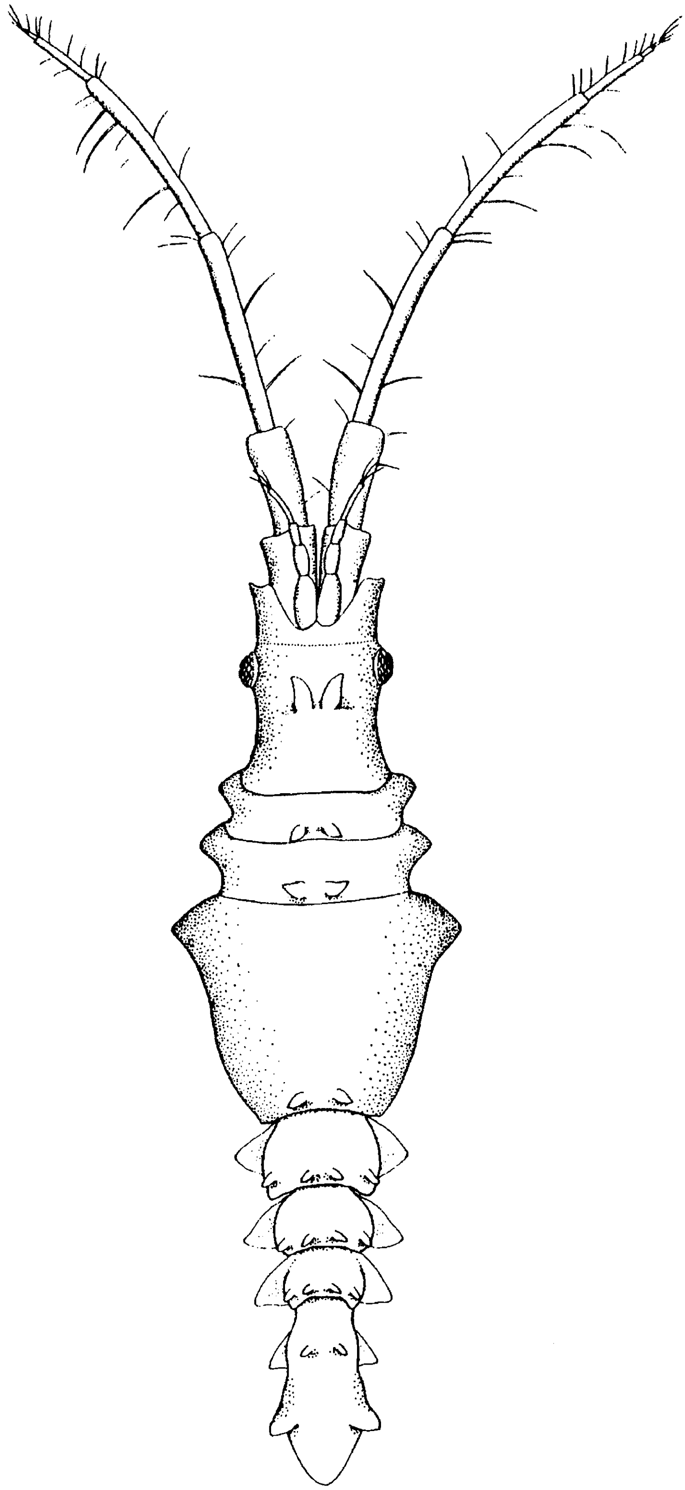


Figure 1.21. *Idarcturus allelomorphus* Menzies and Barnard, 1959. Holotype AHF 5713. California, Santa Barbara Co., off Goleta, medium-coarse gray sand, 17 m, 09 April 1957, coll. R/V *Velero IV*, Sta. 4938-57.

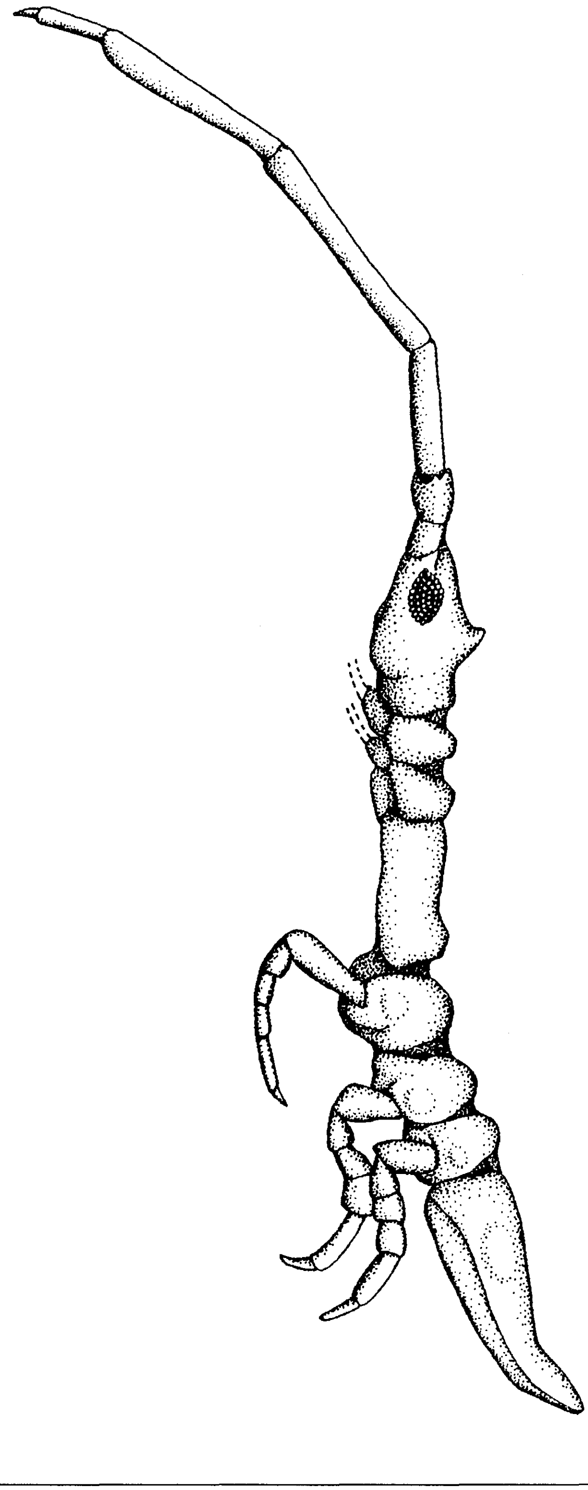


Figure 1.22. *Idarcturus allelomorphus* Menzies and Barnard, 1959. California, San Diego Co., off Bird Rock, 32°49.25'N, 117°19.60'W, sandy silt, 60 m, 19 October 1989, coll. Pt. Loma Biology Lab, Sta. B-5, SDNHM A.0014.

Family Idoteidae Fabricius, 1798

Description. Body slightly to strongly depressed. Cephalon not fused medially to pereonite I. Antennules usually shorter than antenna, and with flagellum reduced to 1-4 minute articles. Antennal flagellum either multiarticulate, reduced to one or a few vestigial articles, or reduced to a large clavate article (occasionally with minute terminal articles). Mandible without palp. Maxillipedal palp of 3-5 articles. Coxal plates usually splayed, ovate, sometimes reduced. Pereopods subequal in length, ambulatory; pereopods I-III more or less anteriorly directed; pereopods IV-VII more or less directed posteriorly. Pleonites tend to fuse; pleon with at most 3 pleonites defined laterally, 2 or fewer articulating or marked dorsally; all pleonites fused in some genera. Pleopods 1 and 2 with short apical plumose marginal setae. Uropods uniramous or biramous. Penes fused basally, or rarely free at base (only in *Idotea* and *Lyidotea*).

Remarks. Idoteids are some of the most common isopods of temperate waters, but they are rare in tropical seas. Most occur in shallow water, and few species are found at depths greater than 30 m. Idoteids usually live somewhat solitary lives. They are omnivores, many feeding primarily on the marine plants to which they cling. Several species which are known to occur on red, green and brown marine plants are capable of undergoing color change when transferred to plants of another color. This phenomenon has been documented for the California species *Idotea resecata* Stimpson, 1857 and *I. montereyensis* Maloney, 1933. Twenty-seven species of idoteids, in 6 of the 26 known genera, have been reported from California waters. Some of those ranging into the Pacific Northwest are included in Kozloff's (1987) key to the idoteids. Three species in 2 genera, were recovered by the MMS survey.

Literature. Richardson, 1905; Menzies, 1950a; Sheppard, 1957; Menzies and Barnard, 1959; Lee, 1966a, b, 1972; Lee and Gilchrist, 1972, 1975; Brusca and Wallerstein, 1979a; Wallerstein and Brusca, 1982; Brusca, 1983, 1984; Kozloff, 1987.

Key to the Genera of Idoteidae Collected as part of the MMS Surveys

1A. Maxillipedal palp 4- or 5-articulate; pleon with 3 discernible pleonites, with lateral sutures present at base of pleotelson .... *Idotea*

1B. Maxillipedal palp 3-articulate; pleon with all pleonites fused, with 1 distinct pair of anteriorly placed lateral incisions (or lateral incisions barely discernible) .... *Synidotea*

Genus *Idotea* Fabricius, 1799

Description. Antennal flagellum multi-articulate. Maxillipedal palp composed of 4 or 5 articles. All coxal plates except the coxal plate of pereonite I, distinctly separated from pereonites by deep dorsal groove. Pleon three segmented, with lateral sutures present at base of terminal segment, indicating another partly coaslesced segment.

Remarks. Menzies (1950a) synonymized *Pentidotea* Richardson, 1905 with *Idotea* (reducing the former to a subgenus) because he felt that the single character, 4-articulate (*Idotea*) and 5-articulate (*Pentidotea*) maxillipedal palp did not warrant generic status. Recent unpublished studies by G.C.B. Poore suggest this synonymy may be incorrect, and both genera may once again be recognized.

Literature. Richardson, 1905; Menzies, 1950a; Brusca, 1984.

Idotea (Idotea) rufescens Fee, 1926

Figure 1.23

Description. Anterior margin of cephalon very slightly concave, frontal process apically blunt or notched; frontal lamina 1 semicircular and medially shorter than frontal process; frontal lamina 2 not visible in dorsal view. Eyes large, ovoid. Maxilliped with 1 coupling spine; palp 4-articulate. Posterior pleotelson margin concave in outline.

Remarks. *Idotea rufescens* can be distinguished from the closely related species *I. resecata* by its very slightly concave frontal margin (distinctly concave in *I. resecata*), ovoid rather than pyriform eyes, elongate frontal process (apex blunt rather than acute) and more compressed and ovate maxillipedal palp articles in *I. resecata*. Also, the carpus of pereopod VII is considerably longer in *I. resecata* than in *I. rufescens*, with the largest propodal seta located a considerable distance from the inferior proximal angle (in *I. rufescens* the largest propodal seta occurs at the inferior proximal angle).

Distribution. British Columbia to Central California from shallow-water algal habitats, intertidal to 82 m. Specimens have also been collected at Santa Catalina Island. MMS survey voucher material was examined from station R-5.

Literature. Fee, 1926; Menzies, 1950a; Iverson, 1974; Miller, 1975.

Genus *Synidotea* Harger, 1878

Description. Antennal flagellum multiarticulate. Mandible with molar process. Maxillipedal palp 3-articulate. Pleon with all segments fused; with 1 distinct pair of anteriorly placed lateral incision lines or lateral incisions barely discernible. Uropods uniramous.

Remarks. Species in this genus (approximately 40 species worldwide) occur from the littoral zone to depths of nearly 3000 m. Ten species have been reported from California, 2 of which were collected by the MMS survey. A good key to the eastern Pacific species can be found in Menzies and Miller, 1972.

Literature. Benedict, 1897; Richardson, 1905; Iverson, 1972; Menzies and Miller, 1972; Miller, 1975; Brusca, 1984.

Key to Species of *Synidotea* Collected in the Santa Maria Basin

1A. Dorsal maxillipedal region of cephalon slightly raised; inner anterior cephalic tubercles shorter than posterior cephalic tubercles; coxae of pereonite I entire; pleotelson with several (usually 3 or more) minute posterolateral serrations; pleon without clearly discernible lateral incisions; pleotelson convex, spatulate, evenly rounded, widest medially .... *Synidotea calcarea*

1B. Dorsal maxillipedal region of cephalon with 1 medial tubercle; inner anterior cephalic tubercles taller than posterior cephalic tubercles; coxae of pereonite I notched; pleon with 1 distinct pair of lateral incisions; pleotelson with only 1 or 2 minute posterolateral serrations, straight-sided or weakly convex, widest anteriorly .... *Synidotea media*

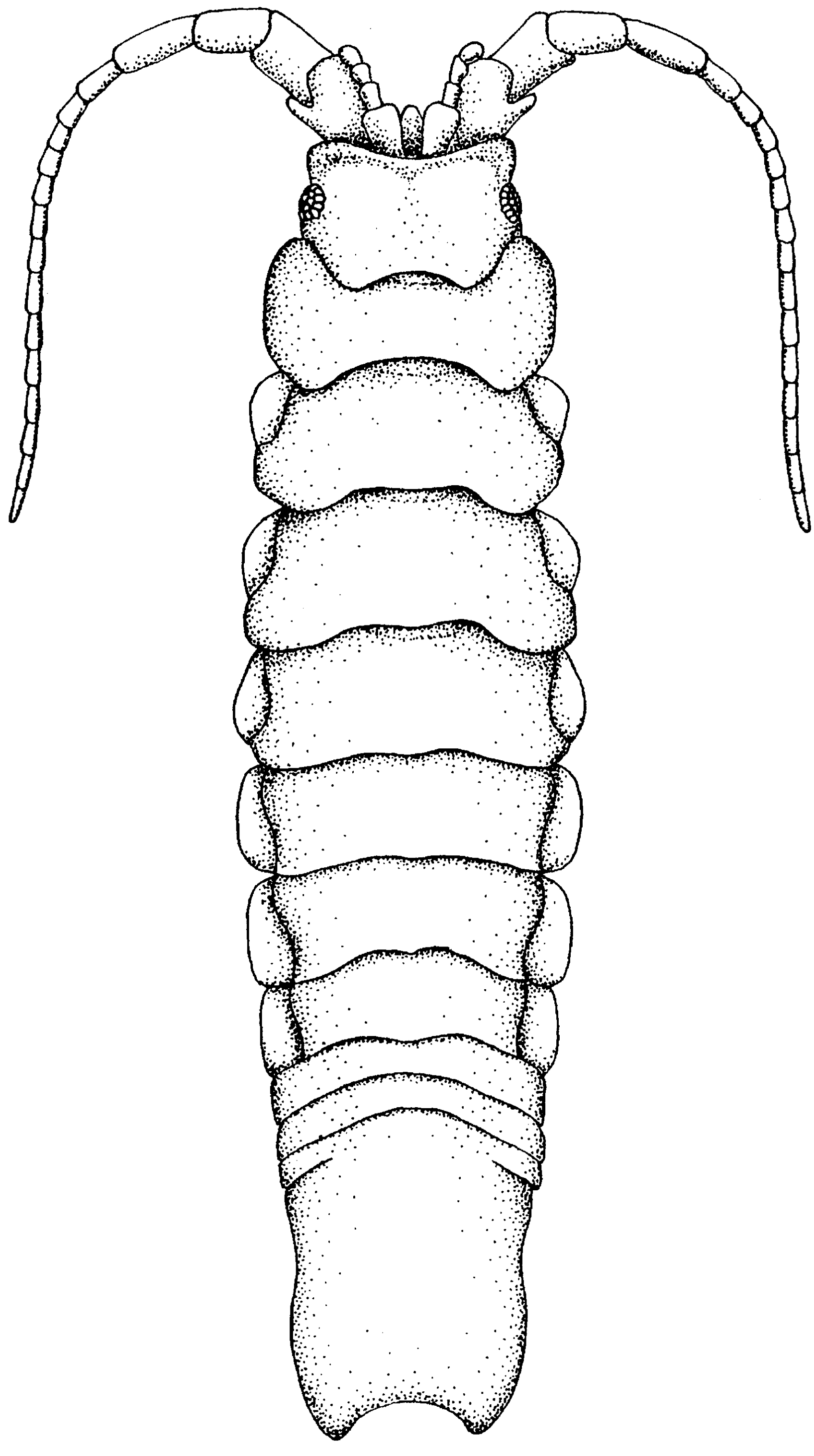


Figure 1.23. *Idotea rufescens* Fee, 1926. Female. Mexico, Baja California, Coronado Is, 08 November 1946, coll. C. C. Hubbs, H46-118, LACM 46-57.1

Synidotea calcarea Schultz, 1966

Figure 1.24

Description. Eyes on very small ocular lobes; lightly pigmented. Cephalon with anterolateral lobes forming shallow, broad, weakly concave frontal margin; each anterolateral lobe with 1 small tubercle near its base; 1 pair of anteriorly-positioned submedian tubercles just behind frontal margin, narrowly rounded, tall; 1 pair of posteriorly-positioned submedian tubercles between eyes, broad and conical. Dorsal maxillipedal region slightly raised. Each pereonite with a tall medial conical tubercle and slightly smaller paired lateral tubercles. Lateral margin of pereonite I coxae entire, not notched. Entire body covered with very fine short setae. Pleon without clearly discernible lateral incisions. Pleotelson convex, widest medially, spatulate, evenly rounded, with several (usually 3 or more) minute posterolateral serrations.

Remarks. *S. calcarea* can be distinguished from the similar appearing *S. magnifica* by its lightly pigmented eyes with few ocelli (eyes darkly pigmented with many ocelli in *S. magnifica*) and the presence of 2 large, conical interocular tubercles on the cephalon (small interocular tubercles in *S. magnifica*).

Distribution. Tanner and Santa Rosa Canyons at depths of 54 to 813 m.

Literature. Schultz, 1966; Iverson, 1972; Menzies and Miller, 1972.

Synidotea media Iverson, 1972

Figure 1.25

Description. Eyes not raised on ocular peduncles or lobes; heavily pigmented. Cephalon with anterolateral lobes forming shallow, broad concave frontal margin; each anterolateral lobe with 1 stout tubercle near its base; 1 pair of anteriorly-positioned submedian tubercles just behind frontal margin, narrowly rounded, tall; 1 pair of posteriorly-positioned submedian tubercles between eyes, large, broad and conical. Dorsal maxillipedal region with 1 medial tubercle. Pereonites I-IV each with 1 anterior and 1 posterior medial tubercle; 1 pair of more laterally-positioned submedian tubercles near posterior margin of pereonite set between lateral concentric ridges and the medial tubercles; pereonites V-VII with less pronounced lateral concentric ridges and 1 medial posteriorly-positioned tubercle. Lateral margin of pereonite I coxa notched. Pleon with 1 distinct pair of anteriorly placed lateral incisions. Pleotelson straight-sided or weakly convex, widest anteriorly; posterolateral margin with 1-2 minute serrations.

Remarks. *S. media* is very similar in appearance to *S. magnifica* and *S. calcarea*; Iverson (1972) provides a table of distinguishing characters.

Distribution. Off Pt. Soberanes, California, 36°25'W to 36°26'N; 183 m. MMS survey voucher material was examined from stations R-4, R-6 and R-8.

Literature. Iverson, 1972; Menzies and Miller, 1972.

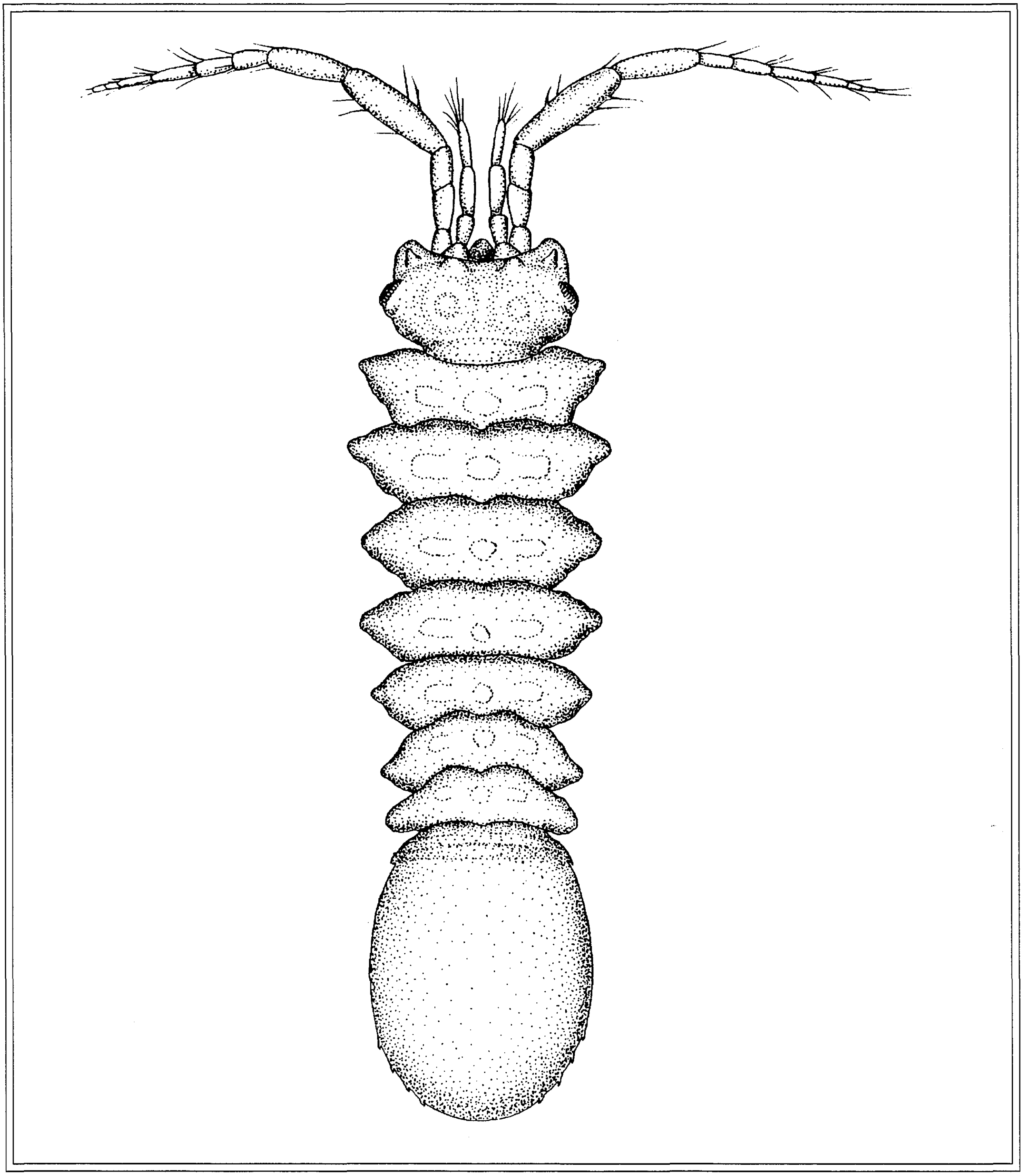


Figure 1.24. *Synidotea calcarea* Schultz, 1966. Holotype AHF 6833-60 (female). California, Channel Islands, Tanner Canyon, San Clemente Island, green muddy sand, 792 m, 19 January 1960, coll. R/V *Velero IV*, Sta. 6833-60.

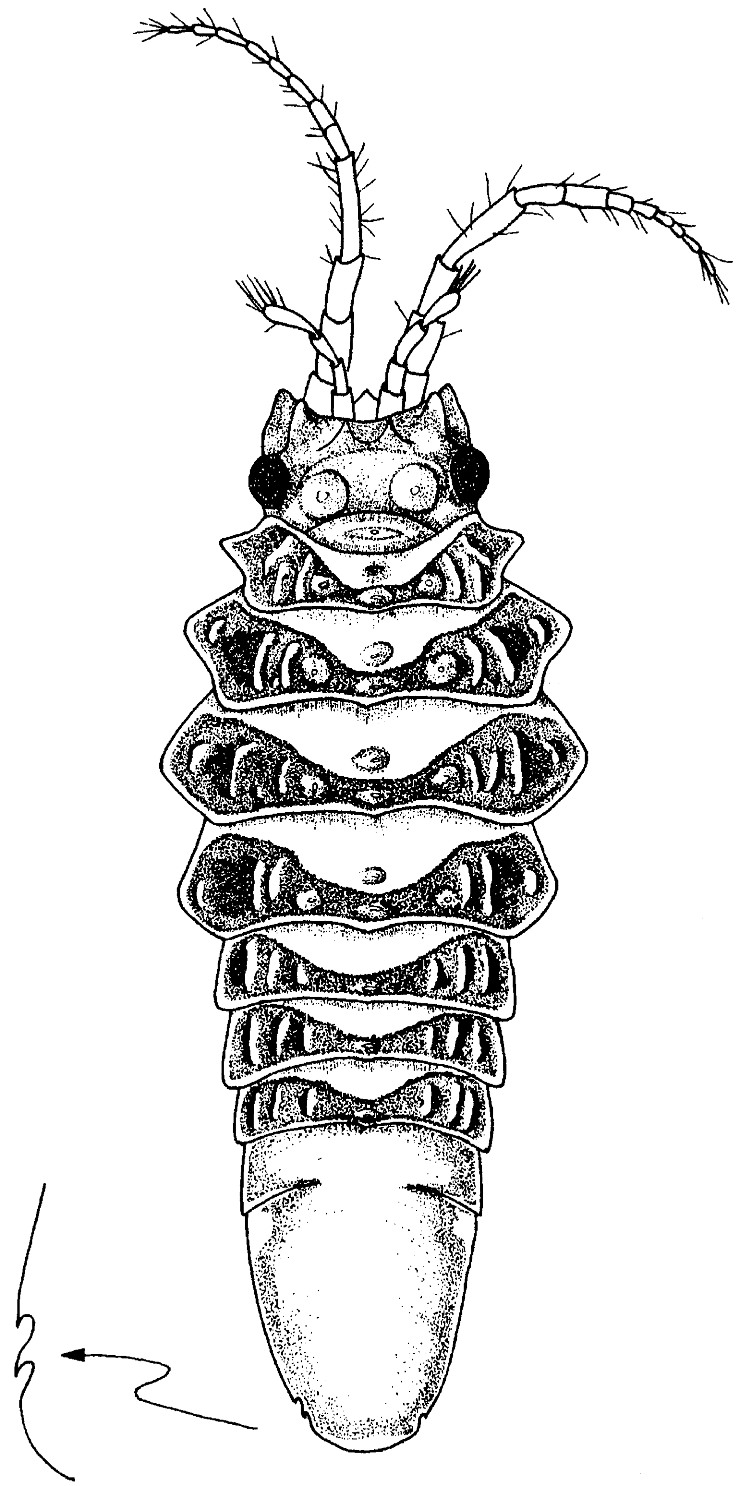


Figure 1.25. *Synidotea media* Iverson, 1972. Holotype CAS 563 (female). California, Monterey Co., off Pt. Soberanes, 183 m, July 1971, coll. R/V *Searcher*.

1.3 The Suborder Asellota

by

George D.F. Wilson[6]

Introduction[7]

The Asellota are the one of the most diverse group of isopod families, comprising approximately 25% of the total. The asellotes have colonized all environments other than the land, which seems to be the domain of the Oniscidea and a few Phreatoicidea. Asellota are, however, most successful and diverse in the deep-sea (Wilson, 1989). This work introduces an interesting assemblage of Asellota from the edge of the deep-sea in the Santa Maria Basin, including depths from the shallow lighted realm down to nearly 1000 meters. As a consequence, species illustrated here have both shallow-water and deep-sea origins.

The Asellota are perhaps the easiest isopods to define owing to their specialized copulatory apparatus. To make it clear what is meant by Asellota, I offer the following list of features as a definition:

1. Pleonites 4-5, and often always pleonite 3, fused to pleotelson, making an enlarged, often wide terminal segment.
2. Pleonites 1-2, and rarely 3, if distinct from pleotelson, are only small rings or cuticular bars visible ventrally.
3. Either pleopods I, II, or III will form a distinct operculum over more posterior branchial pleopods (Asellota never swim with their pleopods).
4. Male pleopods II with specialized copulatory apparatus consisting of an enlarged protopod, a geniculate (knee-like) endopod, and typically well-muscled exopod.
5. Antenna with a distinct basal (precoxal) segment (sometimes fused in advanced groups).
6. Pereopodal coxae, if visible, lack coxal plates but may have coxal epimera or spines, so that the coxae will still be visible if viewed laterally.
7. Uropods generally have narrow rami, and tubular protopods.
8. As far as is known, Asellota have a specialized sperm conduit in the female alternatively named either the cuticular organ or the spermathecal duct. The opening to this duct will either be adjacent to the oopore on pereonite 5 or on the anterolateral or anterodorsal surface of pereonite 5 (Wilson, 1991).

---

[6] Division of Invertebrate Zoology, Australian Museum, 6 College Street, Sydney, New South Wales 2000, Australia

[7] A Disclaimer. The descriptions included in this work are not complete taxonomic descriptions and should not be used as such. They contain insufficient information to unambiguously identify each species within the context of the global deep-sea asellote fauna. This work is intended to be only an identification guide for the fauna of the Santa Maria Basin, and will be less accurate outside the confines of this geographic area. Because deep-sea asellote species tend to be highly provincial, workers should expect to find different species of each genus in basins other than the Santa Maria Basin. Moreover, not all species from the Santa Maria Basin will be covered in this work, simply because they have not been collected. Most deep-sea Asellota, are rare, and therefore may have a low probability of appearing in samples.

This definition excludes the families Atlantasellidae (living in saltwater caves on islands) and Microcerberidae (living interstitially on beaches). Both families lack the distinctive male copulatory apparatus found in the Asellota (on the male pleopod II: a geniculate endopod and a strong exopod with a copulatory hook). In addition, the pleonites 1-2 are larger and much more distinct in these two families than they are in most Asellota (Stenasellidae can also have large segments). The Atlantasellidae and Microcerberidae should be classified tentatively in the suborder Microcerberidea (Brusca and Wilson, 1991).

General Morphology

See general isopod morphology in this chapter, (Section 1.1 and Figures 1.1 and 1.2). A glossary of more specific to Asellota may be found in Wilson (1989).

Collection and Preservation

Unlike other more robust isopod groups, Asellota are extremely fragile and will be recovered only as fragments if handled harshly during sampling. Some groups, like the Desmosomatidae, are nearly impossible to identify without their anterior legs or uropods. Consequently, it is essential that care be taken to prevent mechanical fragmentation and poor preservation during sample processing. The following suggestions assume that one is sampling soft sediments with a grab or box corer. Other samplers or sediment types may require some adjustments of the procedures, although the principles are the same.

If possible, use a 300μ screen. Many Asellota are around 1 mm long. This means that they will be less than 0.5 mm wide in frontal profile, and will go through a standard 500μ screen. Even in shallow water, small body size seems to be the rule with most Asellota. A 300μ screen will insure that practically all Asellota, including mancas, will be retained.

Subject the specimens to as little washing as possible prior to fixation. Try to wash any benthic sediment samples gently: elutriation or gentle water flows up through screens. Do not use a strong water spray on the screen! If you try to force the sediment through the screen, you will also force the animals through, too. A gentle flow either from above or below the screen is sufficient. For quantitative box corer samples, don't wash the top water and top 1 cm of the samples until after the material has been in fixative for a while. Put the upper parts of the sample directly into buffered 4% formaldehyde solution. Don't screen the upper sections of the sample until you transfer the material to alcohol. Most of the animals will be in the upper few centimeters of the sample. For shallower water, they may occur deeper, although these sediments will also be much oozier. A good rule of thumb is that if the sediment is liquified, it will have the highest percentage of animals, and should be fixed without washing. The bulk parts of a sample can be washed in an elutriation kettle or gently on screens, depending on the mechanical characteristics of the sample.

Fix the specimens as soon as possible after sampling. As soon as samples are brought to the surface, many animals will be dead or dying, mostly due to thermal shock. Once they are dead, the animals' own enzymes will start to degrade their bodies; the end result is that the specimens will literally fall to pieces. Therefore, the sooner you get the specimens in fixative, the better. The formaldehyde will crosslink the proteins and make the specimens much tougher and able to hang together during washing and manipulation. Do not let a sample sit in the sun while deploying the next lowering. If manpower restraints prevent you from dealing with a sample immediately after recovery, then put the sample in a cold room at less than 4°C. This will slow the degradation of the specimens. The formaldehyde fixative should be well buffered to prevent dissolution of the calcium carbonate in the isopod exoskeleton. Some workers use sodium borate which achieves a pH of around 8, while others prefer sodium bicarbonate which makes a solution just above neutral. In all cases, the solution be mixed with sea water.

Transfer the specimens to ethanol in such a way as to avoid salt precipitates or osmotic distortion. This is a dual problem, because (1) insoluble salt crystals precipitate on your specimens if you simply dump sea water covered specimens into 70-80% ethanol, and (2) if the specimens are left in fresh water too long, they will blow up like little balloons and pop off their legs, heads, etc. Both of these effects make the Asellota specimens difficult to identify. This procedure seems to work reasonably well: first wash away excess sediment with gentle screening in sea water. Then, briefly wash the sample with fresh water. Next, give the sample a wash of 25% ethanol. Finally, wash the sample into bottles using 70-80% ethanol. This achieves a slow transfer from sea-water to ethanol without a prolonged exposure to pure fresh water. The timings will depend on the bulk of the sample: bulky samples will require more time, top water samples can be processed in less than a minute.

Laboratory Methods

Although there are as many different ways to sort benthic samples as there are laboratories in this business, a few comments are in order. The fragility of the Asellota should also be taken into account when it comes time to handle them in the laboratory. Hard forceps may damage or break the specimens, especially if one is rushed to finish a job. If possible, pick them up with wide mouth pipettes, Erwin loops (the meiofauna specialists know about them), or spring forceps which deform under very weak pressures. Pipettes are best, though. Do not squash the specimens with large folded labels (as were many of the voucher specimens used in this study). Trying to identify asellote pizza is not fun! If you cannot double vial the specimens (who has the time for that?), use small labels that are not in contact with the top and the bottom and do not have sharp edges. If you still must use large folded labels, at least put the label in the vial *first*, push it all the way to the bottom, and then put in the specimens. Rolling the labels doesn't work because the label will expand to the inner circumference of the vial, and then by Murphy's Law, the specimens will get between the label and vial wall. More pizza! The ideal label is one that has a rounded points at either end, is narrower than the diameter of the vial, and is shorter than its interior length.

Despite your most careful processing efforts, some specimens will be fragmented. Save these fragments because they may be identifiable. This is especially true for small quantitative samples, where most species will be represented by only one or two specimens. For example, Ischnomesidae practically always lose their legs and antennae, but my experience has been that different species of ischnomesids in an area may have decidedly different cuticular textures. So match up the fragmented bits by texture and size, and *voila*, you may be able to reassemble your fragmented specimens. If you are reasonably cautious about your assignments, you can make the identification process much easier. Also if you or anyone else plans to make taxonomic descriptions of the Asellota, these parts will be invaluable.

Glossary and Terminology

A detailed glossary specific for janiroidean Asellota (but largely applicable to most isopods) can be found in Wilson (1989). The terminological notes below touch on a few points that the reader might find different between this section and the others in this chapter.

Setae and Spines. Setal morphology, although not a central part of the taxonomy in this Atlas, may be more important in isopod systematics once detailed comparative studies are done. A difficulty observed in most isopod works is the confusion of the terms "seta" and "spine." Oshel and Steele (1988) argue that the use of "spine" to indicate setae confounds the ontogenetic and phylogenetic origins of both structures. Poore (1991) has a similar opinion. Often sensillate setae are found in a morphological series on the same animal that start at hair-like structure and terminate in robust toothed spine-like setae. Often, authors will call the former "a seta" and the latter "the spine," even though one can easily find intermediate forms. Even worse, some authors will call the same structure something "a seta" at one magnification and "a spine" at a higher magnification. To avoid this confusion, "spine" will be used *only* for simple epidermal outgrowths, and "seta" will refer to a complex epidermal organ that consists of a proximally articulated shaft at the cuticular surface and a variety of distal terminations, mostly pointed. Most setae have nerve extensions and are sensory in at least one modality. Spines, on the other hand, have only mechanical functions.

Numbering of Body Parts. This work follows previous isopod authors (Wolff, 1962; Hessler, 1970; Kussakin, 1979; 1982b; 1988; Wilson, 1989) in numbering body or limb segments with Arabic Numerals and limbs themselves with Roman numerals. The primary purpose of this convention is to avoid confusion segments and limbs in descriptions. The convention also has the advantage that one can abbreviate a reference to the carpus of the first pereopod as PerI5.

Key to the Families of the Asellota and the Species Collected in the Santa Maria Basin

For the purposes of completeness, I here provide a key to all families of the Asellota. The classification follows Brusca and Wilson (1991) in excluding the Atlantasellidae and the Microcerberidae from the Asellota and putting them instead in the Microcerberidea (see diagnosis of Asellota). In addition, it uses new data from Just and Poore (1992) for completeness. Although only 21 species are listed in this work, the asellote fauna off California, including the deep sea, could exceed 100 species with representatives in all marine families. Most of the isopod diversity will be in the janiroidean families. With the addition of shallow water animals and fresh water contaminants, any family below could be represented in a collection. Although my goal was to divide the key on the basis of external characters alone, in some cases it will be necessary to dissect off the mandible (see above). For the first few couplets, it may also be necessary to carefully dissect off the male pleopods I and II to determine the morphology and organization of the sperm transfer apparatus. If this is to be done, first note how many distinct pleonites are present in ventral and dorsal view. Some families, such as the Janiridae, are extremely diverse and not well defined, so it was necessary to make several entries into the key for these families. I would be grateful if anyone using this key could contact me on encountering difficulties in keying out families. This key should be regarded as preliminary, and will be updated as time goes on. This key also includes the species, either in the main part where only one species of a family has been found, or toward the end where confamilial species are separated.

1A. Pleopods I-II may be opercular (completely covering more posterior pleopods) in males, pleopod II fused and practically always opercular in the female 5

1B. Pleopods III are opercular in both sexes, pleopods I-II small and non-opercular 2

2A. Pleopods I in male and pleopods II in female completely separate 3

2B. Pleopods I in male and pleopods II in female fused at least basally into single unit 4

3A. Endopod of male pleopod II fused into a single unit with a bulbous tip; pleonites 1-2 short, indistinct .... Asellidae [fresh-water habitats only]

3B. Endopod of male pleopod II distinctly biarticulate separate with an often complex coiled tip; pleonites 1-2 large, easily seen dorsally .... Stenasellidae [fresh-water habitats only, generally in caves]

4A. Male pleopods I with protopods separate from rami ....
.... Stenetriidae [cosmopolitan marine]: *Stenetrium* sp. A

4B. Male pleopods I with protopods fused to rami .... Pseudojaniridae [southern hemisphere marine]

5A. Male pleopod II exopods with two distinct segments 6

5B. Male pleopod II exopods fused into a single hook-like or curved segment 7

6A. Male pleopods I protopods completely fused to distal rami; endopod of male pleopod II pointed, sometimes curved, with either a sperm groove or sperm tube ....
.... Protojaniridae [fresh water, cavernicolous habitats]

6B. Male pleopods I protopod distinct from distal rami; endopod of male pleopod II either complex or blunt, but lacking distinct sperm tub .... Gnathostenetroididae [interstitial and cryptic marine habitats]

7A. Male pleopods I with median sperm tube closed ventrally; male penes apparently well separated from pereopod VII coxa .... [Janiroidea *sensu* stricto] 9

7B. Male pleopods I with median sperm groove open ventrally; penes clearly associated with medial process from the pereopod VII coxa or on coxa (interstitially-living asellotes with small, largely non-opercular pleopods) 8

8A. Uropodal exopod inserts subdistally, separate from endopod; pleonite 3 not visible ventrally, completely fused to pleotelson; pleotelson as long as or longer than posterior pereonites ....
.... "Microparasellidae" [partial, including only genera *Angeliera*, *Paracharon*, and *Microcharon*]

8B. Uropodal exopod inserts distally, adjacent to endopod; pleonite 3 present ventrally, separate from pleotelson; pleotelson shorter than posterior pereonites ....
.... Vermeciadidae [southern hemisphere on isolated subantarctic island beaches]

9A. Pereopod I distinctly subchelate with dactylus and propodus opposing each other; eyes, if present, often on stalks; antennulae with short flagellae, always with less than 14 articles total 10

9B. Pereopod I often leg-like but if subchelate, with propodus and carpus opposing each other and dactylus short; eyes, if present, may protrude laterally but are never found on elongate stalks; antennulae may be long or short 13

10A. Anus always terminal, without terminal projections of pleotelson; if visible, female spermathecal duct opening on ventral surface of pereonite 5 and closely associated with oopore (to see this special preparation may be required); eyes, if present, sometimes large with many ommatidia 11

10B. Anus never terminal, with distinct, often pointed, terminal projections of pleotelson; female spermathecal duct opening on dorsal surface of pereonite 5; eyes, if present, with few ommatidia, never large and distinct 12

11A. Body compact, pleotelson often held at angle to rest of body; protopod of uropod absent or tiny; mandibular palp generally large .... Munnidae: *Munna* sp. A [primarily cosmopolitan shallow water with a few deep-sea taxa; a few brackish water taxa]

11B. Body more normal, sometimes elongate, pleotelson typically held in line with rest of body; protopod of uropod distinct, often elongate; mandibular palp absent .... Santiidae [cryptic habitats, cosmopolitan shallow water]

12A Protopod of uropod distinct, often elongate; antennal article 3 always short but may have a large anteromedial setose projection .... Pleurocopidae [cryptic habitats, tropical to temperate shallow water]

12B. Protopod of uropod absent or tiny; antennal article 3 enlarged, and generally much longer than other basal articles .... Paramunnidae [cosmopolitan shallow water, with moderate number of deep-sea taxa] 44

13A. Posterior part of body arranged as a distinctive natasome, consisting of partially or completely fused pereonites 5-7 and pleotelson in most groups; pereopods V-VII with enlarged, paddle-like carpi and propodi that have articulated plumose setae on their margins; most dactyli with specialized paired terminal claws that enclose the distal sensillae .... Munnopsididae [blind deep-sea cosmopolitan family with emergent shallow water taxa; contains several subfamilies including the Eurycopinae and the Ilyarachninae] 33

13B. Posterior part of body never with a distinct natasome; pereopods V-VII carpi and propodi rarely expanded and natatory (except in some Desmosomatidae, e.g. *Eugerda*) and never with articulated plumose setae; pereopodal dactyli various, but never with specialized paired terminal claws that enclose the distal sensillae 14

14A. Uropods with elongate protopod, often longer than pleotelson; if uropods missing, uropodal socket on pleotelson large and projecting 15

14B. Uropodal protopod not elongate; uropodal socket not obvious if uropods missing 20

15A. Anterior pereonites compressed into heavy fossorial unit; body never with dorsal or lateral spines; anterior pereopods fossorial (strong, with many heavy setae), projecting laterally .... Macrostylidae Hansen, 1916 [blind, deep-sea cosmopolitan; some emergent taxa]

15B. Anterior pereonites distinctly separate; body may be dorsally or laterally spiny; pereopods ambulatory, never fossorial, generally projecting ventrally 16

16A. Body moderately narrow to very narrow and elongate; pereonites often distinctly set apart laterally; mandibular molar distally broad and truncate 17

16B. Body broad, somewhat flattened; cephalon and pereonites often with laterally projecting tergal processes or lappets; mandibular molar may be narrow and finger-like 19

17A. Pereonites 4 and 5 distinctly elongate 23

17B. Pereonites 4 and 5 near length of other pereonites 18

18A. Body stiff and thick, never attenuated and spider-like; pleotelson never reflexed dorsally; uropodal rami tiny or absent, protopod inserting laterally .... Echinothambematidae [blind, rare deep-sea endemic group]

18B. Body sometimes attenuated and spider-like; pleotelson often reflexed dorsally; uropodal rami large, generally biramous, protopod inserting dorsolaterally on pleotelson .... Dendrotiidae [rare shallow-water taxa with small eyes to blind deep-sea cosmopolitan]

19A. Maxillipedal palp with 4 articles; pereopod I setochelate (using seta on propodus as fixed finger) .. .. Katianiridae [blind, deep-sea cosmopolitan]

19B. Maxillipedal palp with 5 articles; pereopod I not setochelate .... Acanthaspidiidae [some with eyes, shallow-water to deep-sea]

20A. Pereopodal dactyli with 3 distinct claws: two large distal claws and one large subdistal accessory claw 21

20B. Pereopodal dactyli with 1 or 2 distinct claws, third accessory claw tiny or absent 22

21A. Uropods short with thick protopod and button-like rami; uropods inserting posteromedially, almost touching; cephalon with distinctive rounded rostrum inserting in concave frontal margin; antennae compact, geniculate .... Joeropsididae [primarily shallow-water group, eyes well-developed to absent] 37

21B. Uropods various, but protopod generally narrow, not substantially larger than rami; uropods separated by well-defined anal region; rostrum, if present, elongate and not inserting in concave frontal margin; antennae generally straight, elongate .... Janiridae [not monophyletic - taxonomy in poor state; primarily shallow-water with some deep-sea genera; eyes well-developed to absent] 38

22A. Narrow elongate, sometimes flattened bodies 23

22B. Broad, thick bodies 28

23A. Cephalon well set into and generally fused with pereonite 1; pereonites 4 and 5 elongate; uropods uniramous .... Ischnomesidae [blind, deep-sea cosmopolitan; some emergent taxa]

23B. Cephalon separate from pereonite 1; pereonites 4 and 5 approximately same length as other pereonites; uropods biramous 24

24A. Mandible with small, triangular, setose molar 25

24B. Mandible with truncate molar 27

25A. Anus inside pleopodal cavity; uropods terminal and adjacent .... Microparasellidae [*sensu stricto*, Genus *Microparasellus*; blind, shallow-water interstitial]

25B. Anus separate from pleopodal cavity; uropods separated by well-defined anal area 26

26A. Major anterolateral seta on pereonites 2-4 on the coxa, not the tergite .... Desmosomatidae [blind, deep-sea cosmopolitan; some emergent taxa] 42

26B. Major anterolateral seta on pereonites 2-4 on the tergite, not the coxa .... Nannoniscidae [blind, deep-sea cosmopolitan; some emergent taxa]: *Nannonisconus latipleonus*

27A. Body extremely long and thin; pereonal ventral surface often broadly "V" shaped .... Thambematidae [blind, deep-sea cosmopolitan]

27B. Body more normal; ventral surface rounded 28

28A. Cephalon may have eyes; penes not elongate; pleotelson flattened, pleonite 1 generally distinct 21B

28B. Cephalon without eyes; penes fused; pleonite 1 elongate; pleotelson dorsally and laterally ovoid 32B

29A. Tergal surfaces with no dorsal or lateral spination; anus clearly external to pleopodal chamber; bodies often capable of enrolling or folding .... Haploniscidae [blind, deep-sea cosmopolitan; some emergent taxa]

29B. Tergal surfaces often tuberculate or spiny with lateral lappets or spines; anus generally covered by pleopods; bodies not capable of enrolling or folding 30

30A. Body without large lateral projections or lappets, spines only; body always deep, never flattened ... . Haplomunnidae [blind, deep-sea cosmopolitan]

30B. Body with large lateral projections or lappets; body broad, somewhat flattened to narrow 31

31A. Lateral projections or lappets on cephalon; male penes short .... Janirellidae [blind, deep-sea cosmopolitan]

31B. Cephalon rounded laterally, lacking projections or lappets; male penes elongate 32

32A. Spiny body; pleotelson with lateral projections .... Mesosignidae [blind, deep-sea cosmopolitan]

32B. Relatively smooth body; pleotelson without lateral projections .... Mictosomatidae [blind, rare deep-sea]

33A. Cephalon with rostrum projecting anteriorly between antennulae 34

33B. Cephalon without rostrum or anterior projections 35

34A. Cephalic rostrum narrow, roundly pointed, not bilobed; natasome robust and deep; pereonite 7 larger than pereonites 5 or 6 (except in manca stages 1 and 2); uropodal exopod greater than half length of endopod, easy to see .... *Eurycope californiensis*

34B. Cephalic rostrum broad, distinctly bilobed; natasome flattened, tapering; pereonite 7 smaller than pereonites 5 or 6; uropod exopod tiny, difficult to see .... *Belonectes* sp. A

35A. Natasome not triangular, with flexible somites, pleotelson inflated; pereonite 7 near size of pereonites 5 and 6; uropodal protopod small, tubular 36

35B. Natasome triangular and only stiffly articulating somites; pereonite 7 distinctly narrower than pereonites 5 and 6; uropodal protopod large, flattened .... *Ilyarachna acarina*

36A. Small species, body length of adults less than 2mm; cephalon as broad as pereonite 1, vaulted posteriorly, with flattened frons; dorsal mandibular muscle insertions in cephalon few and large .... *Munnopsurus* sp. A

36B. Large species, body length of adults reaching 7mm; cephalon huge, distinctly broader than pereonite 1, dorsal mandibular muscle insertions in cephalon many and small .... *Munnopsurus* sp. B

37A. Cephalon with distinct indentation on lateral margin below eyes; cephalic lateral margin not produced, into lateral plate, with only small denticulae; ventral midline of pereon with distinct ridges; body narrow, with few setae and devoid of pigment .... *Joeropsis concava*

37B. Cephalon lateral margin not indented, with large anteriorly curved spines, substantially produced laterally forming large plate; ventral midline of pereon without distinct ridges; body broad, devoid of pigment, but with numerous fine setae .... *Joeropsis* sp. A

38A. Anterior pereonites 2 and 3 with paired lappets of varying sizes; pereopod I propodus with proximoventral denticles .... [Genus *Janiralata*] .. 39

38B. Anterior pereonites 2 and 3 with or without paired lappets of varying sizes; pereopod I propodus without proximoventral denticles .... Other Janiridae not included here [likely genera include *Ianiropsis*, *Iais*].

39A. Cephalon with distinct rostrum; lappets on pereonites 2 and 3 large; pleotelson with distolateral spines 40

39B. Cephalon without distinct rostrum; lappets on pereonites 2 and 3 small or indistinct; pleotelson without distolateral spines 41

40A. Body with diffuse pigmented anastomosing chromatophores, with pigment anterior to eyes on cephalon; obtuse rostral point of cephalon not extending anteriorly beyond anterior spines on lateral margin .. .. *Janiralata* sp. A

40B. Body completely devoid of pigment; cephalon of adults with pointed rostrum extending well beyond anterior limits of pointed lateral margins .... *Janiralata* sp. B

41A. Broad body completely devoid of pigment; lateral margins of cephalon broad, not near bulging eyes; pleotelson distinctly trilobed posteriorly .... *Janiralata* sp. C

41B. Narrow body with dense pigmented chromatophores on most dorsal parts of the body; lateral margins of cephalon narrow, near large bulging eyes; pletotelson posteriorly rounded, without lateral lobes .... *Janiralata* sp. D

42A. Pereonite 1 distinctly larger than pereonite 2 (synapomorphy of Eugerdellatinae), with large ventral median spine. Pereonites 3 and 7 with posteriorly curving ventral median spines. Pereopod I with robust setochelate carpus .... *Prochelator* sp. A

42B. Pereonite 1 subequal or smaller than pereonite 2, without ventral median spines on any pereonites. Pereopod I carpus not robust, not setochelate 43

43A. Pereonite 1 subequal to pereonite 2; cephalon with anterolateral spines; uropodal exopod present ... . *Momedossa symmetrica*

43B. Pereonite 1 smaller than pereonite 2; cephalon lacking anterolateral spines; uropodal exopod absent .... *Desmosoma* sp. A

44A. Cephalon with small eyes below the antennulae; coxae rounded, only slightly visible in dorsal view .... *Austrosignum tillerae*

44B. Cephalon with no trace of eyes; coxae with long spines clearly visible in dorsal view 45

45A. Antennula article 1 lacking denticulate distal lateral lobe .... *Pleurogonium californiense*

45B. Antennula article 1 with denticulate distal lateral lobe .... *Pleurogonium* sp. A

Description of Asellotan Species

Family Stenetriidae Hansen, 1905

Genus *Stenetrium* Haswell, 1881

Description (modified from Serov and Wilson, 1994). Head with large, reniform anterolateral eyes; frontal margin with both lateral and antennal spines; lateral spines generally extending past antennal spines. Body lateral margins angular or quadrate with coxal extensions visible in dorsal view; pereonite 1 longer than remaining pereonites. Antennal article 1 with acutely pointed lateral spine. Male pereopod I robust with blades or teeth on propodal palm and without denticulate setae or large terminal seta; dactylus subequal to or longer than propodal palm width. Male pleopod I evenly rounded on lateral margins. Male pleopod II protopod distal tip produced, length subequal to exopod; endopod and exopod positioned on distomedial margin. Male pleopod II appendix masculina with one or more distal spines. Pleotelson with prominent posterolateral spines and 2 free pleonites.

Stenetrium sp. A

Figure 1.26

Material Examined. California, Santa Maria Basin, off Purisima Point, Sta. BRA-20, 90-130.5 m, copulatory male (illustrated), early preparatory female.

Description. Body elongate, unpigmented; all lateral margins with long simple setae; dorsal surface lacking long setae. Cephalon distinctly broader than long, without projecting rostrum; frontal area with arched supraclypeal ridge; clypeus semicircular in dorsal view; weakly convex with subtriangular anterolateral points. Eyes on cephalon lightly pigmented, not on lateral margin, situated just behind insertions of antennae. Pereonite 1 with fused pointed coxa in male and preadult female. Pereonite 2 with thin pointed anterior lappet. Pereonites 3-4 with both anterior and posterior small lappets separated by broad gap exposing coxae. Pereonites 4-5 shortest along medial axis than other pereonites. Pleonites 1-2 distinct dorsally and ventrally. Pleonite 3 visible as distinct plate ventrally. Pleotelson shield-like, widest anteriorly, lateral margins slightly convex and curving down to small posterolateral spines; distomedial margin rounded, projecting posteriorly between uropodal insertions. Antennula of male with around 12 articles, article 3 longer than articles 1-2. Antennal scale with elongate setae, some exceeding length of article 1 of antennula. Pereopod I of male strongly subchelate with subquadrate projection on propodus opposing dactylar teeth; many elongate simple setae on the following parts: proximomedial side of dactylus, distoventral margin of propodus, proximoventral margin of propodus, ventral margin of carpus, distoventral and distodorsal margins of merus; merus with elongate dorsal spine extending well beyond distal margin of carpus; dorsal margin of ischium also projecting distally somewhat, with several short teeth and elongate setae. Coxae II-VI visible and distinctly bilobed in dorsal view between pereonal lappets. Male pleopod II endopod article 2 longer than medial margin of protopod, distal tip broader than proximal part, grooved and setose, with small spine-bearing finger-like projection curving dorsolaterally from distal tip; exopod with distinct suture demarcating two articles on ventral side only. Uropodal rami with many distally curved thin setae; exopod subequal to protopod length; endopod longer than protopod.

Biology. As usual, little is known about stenetriids. The male copulatory apparatus is rather different from most Asellota, in that the exopod of pleopod II is not endowed with large fan-like muscles, suggesting that the form of copulation in this group may also be different than assumed for most Asellota (Wilson, 1991).

Remarks. This species of *Stenetrium* can be separated easily from all others by the distinct thick projection on pereopod I of the male and the presence of many elongate thin setae on the male pereopod I segments 4-7. Pereonal lappets are better developed in this species than in most stenetriids, and the distal finger-like projection on the appendix masculina is somewhat unusual. The body of this species, however, is generally similar to other stenetriids collected from deep and cold waters. Although it is typically not illustrated or noted by other authors, readers should be alert to the fact that this species has visible ventral sutures for pleonite 3, whereas other species have lost this plesiomorphic feature (e.g. see *Stenetrium dagama* pleotelson illustration in Wilson, 1987).

Type Locality and Type Specimens. None. This species is undescribed.

Distribution. Santa Maria Basin, 90-130.5 m.

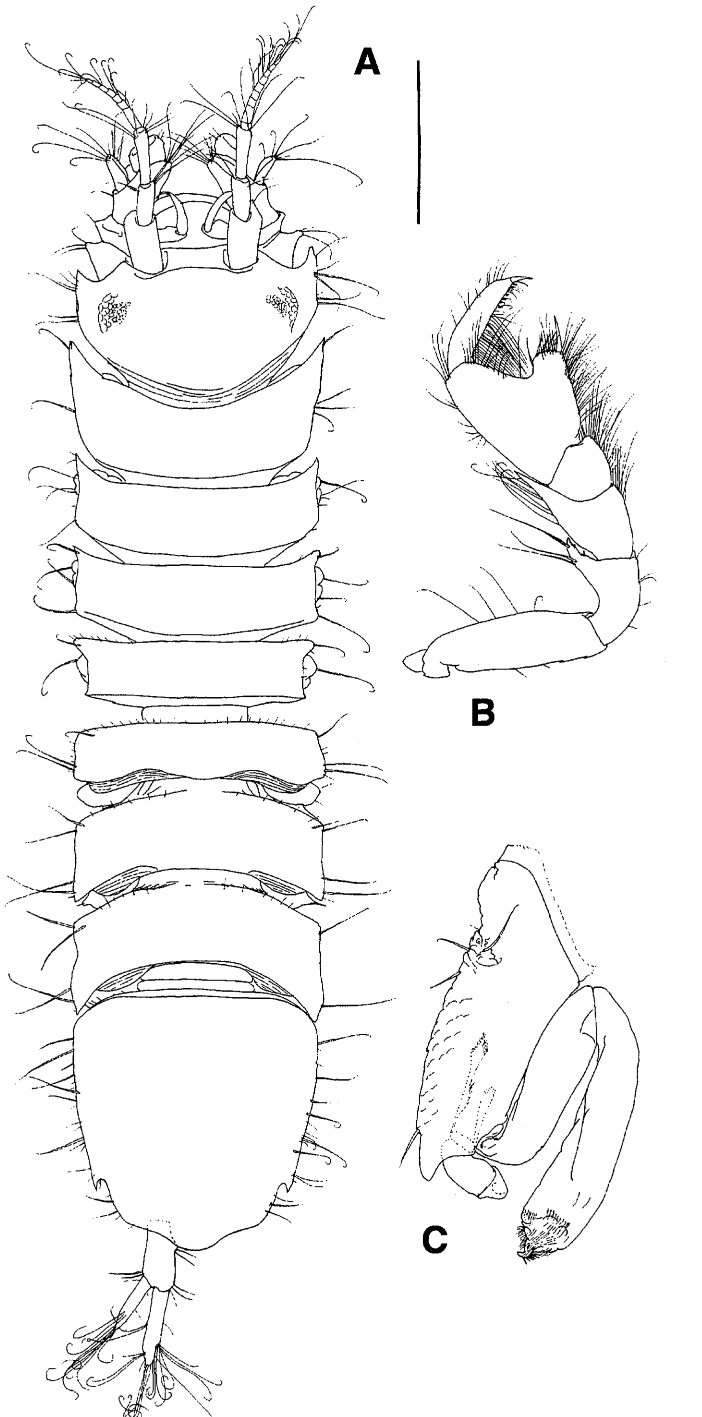


Figure 1.26. *Stenetrium* sp. A. Copulatory male from Phase I Sta BRA-20. A, dorsal view, scale bar = 1mm. B, right pereopod I. C, right pleopod II.

Family Munnidae Sars, 1897

Genus *Munna* Krøyer, 1839

Description (modified from Poore, 1984b). Munnidae with numerous dorsal setae often with setae on head, pleon and opercular pleopods. Antennula distal article minute, distal two articles with single aesthetasc. Mandibular molar strong and subcylindrical, distally truncate, bearing accessory setae; palp extending beyond incisor process, normally armed with second article bearing 1-2 serrate setae. Maxillipedal epipod apex acute. Pereopod I sexually dimorphic, enlarged in male, sometimes carposubchelate. Pereopods II-VII not substantially dimorphic; dactyli with two claws, anterior claw largest. Pleopod I of male with acute lateral lobes. Pleopod III with broad second article distinctly longer than endopod.

Munna sp. A

Figure 1.27

Material Examined. California, Santa Maria Basin, off Purisima Point, Sta. BRC-14, 105-117 m, 1 brooding female, illustrated; off Point Arguello, Sta. BRA-04, 168-237 m, 5 individuals, illustrated male pleopod;

Description (generic features modified from Poore, 1984b). Munnidae with large well-developed rounded eyes, projecting laterally as far as width of pereonite 2. All dorsal surfaces covered with fine simple setae. Frontal margin of cephalon forming smooth quadrate arc in dorsal view. Pereonites axially compressed, medial pereon length subequal to pleotelson length. Pereonites projecting radially from body centre, so that pereonite 1 extends anteriorly under cephalon and pereonite 7 extends posteriorly under pleotelson. Pereonite 1 shorter and narrower than pereonite 2 in both sexes. Pleotelson with enlarged posterior subanal projection no wider than anus, not extending under uropods. Antennula with tiny distal article and two aesthetascs. Mandible with normal, functional palp, extending beyond incisor process with curved distal article having cleaning setae. Pereopods II-VII longer than body, lengthening posteriorly so that pereopod VII nearly 3 body lengths. Male pleopods I-II not opercular, not covering exopod of pleopod III; female pleopod II opercular. Male pleopod I distally flared and truncate with pointed laterally projecting lateral lobes. Pleopod III endopod broad and elongate, extending well beyond endopod, forming operculum for pleopods IV and V in the male. Uropodal protopod absent; exopod tiny with only one large simple seta; endopod tapering distally with around 5 penicillate setae and several simple setae; endopodal distal tip lacking claws, spines, or large denticles.

Biology. Munnids are small, agile janiroideans that seem to favor hard substrates, especially in the long legged forms such as described here, but can be found in many different micro habitats. Not much is known of their life history, other than some behavioral information in Hessler and Strømberg (1989). Large males are known to sequester manca 3 females in a lengthy precopula (*ibid*).

Remarks. The best entry into the literature on munnids is Poore (1984b), which places most described species in the genera *Munna* and *Uromunna* (a few exceptions could not be placed). Of the Northeastern Pacific species of *Munna*, this species can be distinguished from *M. stephenseni* by no large lateral spine-like sensillate setae on the pleotelson and no spines on the uropodal endopod; from *M. chromatocephala* by a more compact body and no spines on the uropodal endopod; from *M. halei* by a subanal shelf that does not extend under the uropods; from *M. spinifrons* by no large robust sensillate setae on the cephalon frons and coxae; from *M. fernaldi* by no large sensillate setae on the pleopods I and II and by much longer legs and a more compact body. Of these, *Munna* sp. A is most similar to *M. fernaldi*.

Type Locality and Type Specimens. None. This species is not formally described.

Distribution. Santa Maria Basin, hard substrates, 105-237 m.

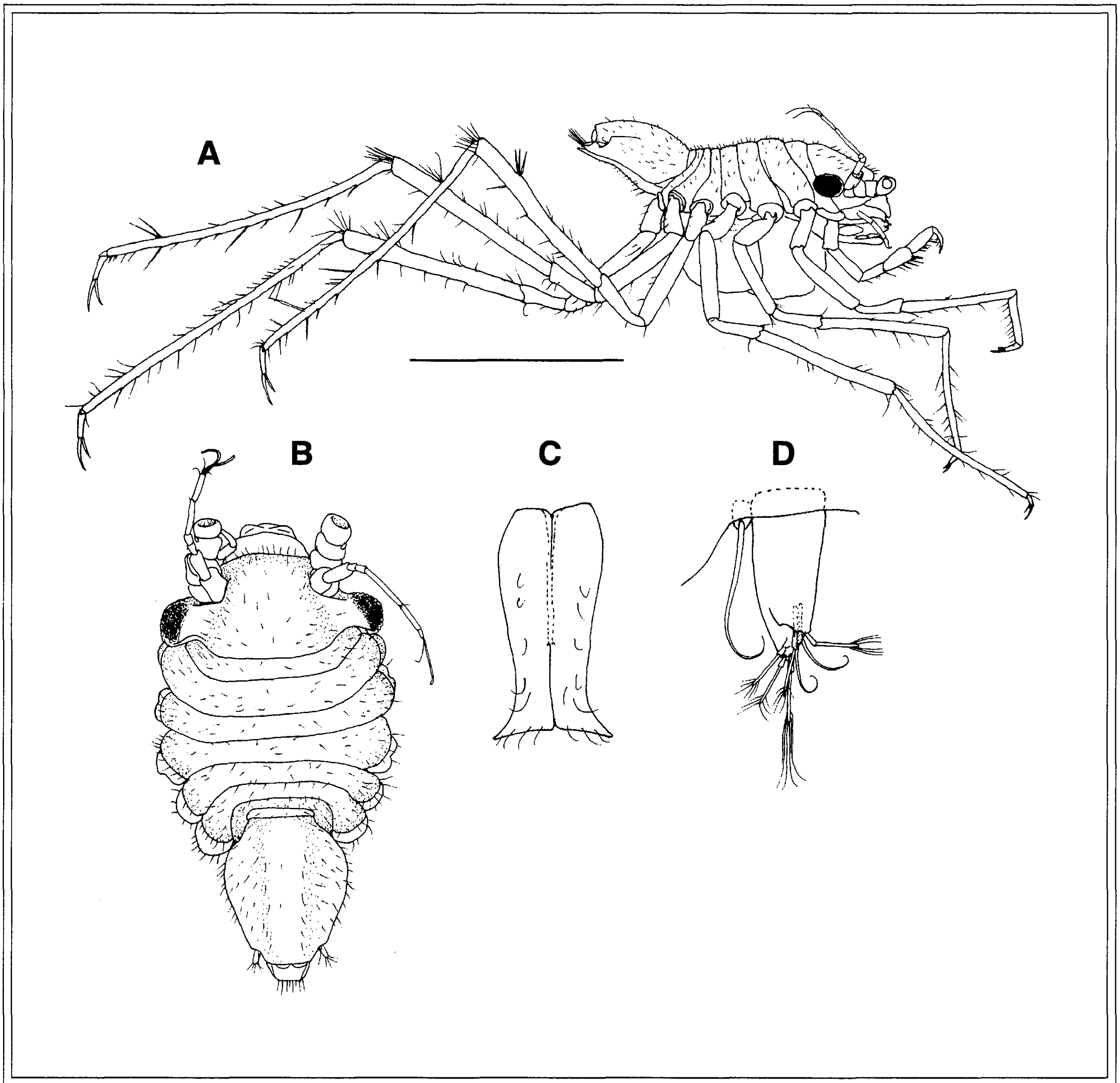


Figure 1.27. *Munna* sp. A. A-B, brooding female from Phase I Sta. BRC-14, lateral and dorsal views, scale bar = 1 mm. C, right uropod, lateral view, brooding female. D, pleopod I, ventral view, male from Sta. BRA-4.

Family Paramunnidae Vanhöffen, 1914

Genus *Munnogonium* George and Strömberg, 1968

Description. Head partially recessed into first pereonite; eyes, if present, with few ocelli, placed below antennulae on small lateral bumps. Body ovate, without laterally projecting tergal spines or plates, coxae II-VII visible in dorsal view lacking spines. Females with dorsal spermathecal duct on pereonite 5 well separated from articular membrane between pereonites. Pleotelson lenticular, distally pointed; pleonite one large, length subequal to pereonite 7. Antennulae short, with six articles and with one terminal aesthetasc. Antennae short, never longer than body, strongly geniculate: articles 1-3 projecting medially, article 4 dorsolaterally and remaining articles laterally; article 3 distinctly longer than articles 1,2, or 4, without large spines or projections. Mandibular molar process distally broad and quadrate, palp absent. Pereopod I prehensile with major hinges between dactylus and propodus; carpus narrow, longer than broad, participating in grasping by robust sensillate setae and spines. Pereopods II-VII ambulatory, paucisetose. Male pleopod I sagittate distally, smooth ventrally with tufts of small setae on lateral corners; vas deferens entering pleopodal medial sperm duct internally. Uropods tiny, biramous; protopod absent. Anus ventral, covered by opercular pleopods, anal cavity confluent with pleopodal cavity.

Munnogonium cf. *tillerae* (Menzies and Barnard, 1959)

Figure 1.28

Synonymy (assuming *M. tillerae* = *M. erratum*).

Austrosignum tillerae Menzies and Barnard, 1959:8-9.

Austrosignum erratum Schultz, 1966:307,309-310.

Munnogonium tillerae Bowman and Schultz, 1974:270; Wetzer *et al.*, 1991:15-16.

Munnogonium erratum Bowman and Schultz, 1974:270; Wetzer *et al.*, 1991:15.

Material Examined. MMS Collections: California, Santa Maria Basin, off Point Estero, Sta. 1, from rock, 98 m (1); off Morro Bay, Sta. 6, 109 m (2); Sta. BRA-27, 96-126 m (1); off Point Sal, Sta. PJ-17, 158 m (2); off Purisima Point, Sta. R-4, 92 m (20, 17); off Point Arguello, Sta.BRA-6, 54-63m (22).—Other collections: LACM cat. no. 56-26.2: R/V *Velero IV* station 4753 (type locality), *M. tillerae* brooding female paratype, illustrated pereopod I, (Holotype missing, see Type data). LACM cat. no. 57-132.2: *M. tillerae*, paratype male from off Pt. Conception, dissected parts only. LACM cat. no. 57-228.2: *M. tillerae*, paratype brooding female from Pt. Santa Barbara, decalcified. LACM cat. no. 57-22.2: *M. tillerae*, paratype from Pt. Arguello, nothing in vial, perhaps dissected by Bowman and Schultz. LACM cat. no. 58-166.1: R/V *Velero IV* station 6003, *M. erratum*, holotype male, apparently dissected by previous authors, only a few limbs in vial.

Description. Body broad, ovate. Cephalon somewhat recessed into first pereonite. Eyes situated on short bumps ventral to antennulae, small, with few ocelli. Pleotelson lenticular, distally pointed. Anus ventral, covered by opercular pleopods, anal cavity confluent with pleopodal cavity. Antennulae short, with six articles and one terminal aesthetasc. Antennae shorter than body length; article 3 distinctly longer that articles 1,2, or 4; antenna strongly geniculate: articles 1-3 projecting medially, article 4 dorsolaterally and remaining articles laterally. Mandibular palp absent; molar process distally broad and quadrate. Pereopodal coxae laterally rounded, only slightly visible in dorsal view. Pereopod I prehensile with major hinges between dactylus and propodus; carpus also participating in grasping with robust sensillate setae. Pereopod II of mature male with robust subtriangular projection on basis distoventral corner and proximal projection on ischium; juveniles and females lacking such lobes on proximal articles of pereopod II. Pereopods II-VII ambulatory, paucisetose. Male pleopod I always sagittate distally, smooth ventrally with tufts of small setae on lateral corners. Uropods tiny, biramous, protopod absent.

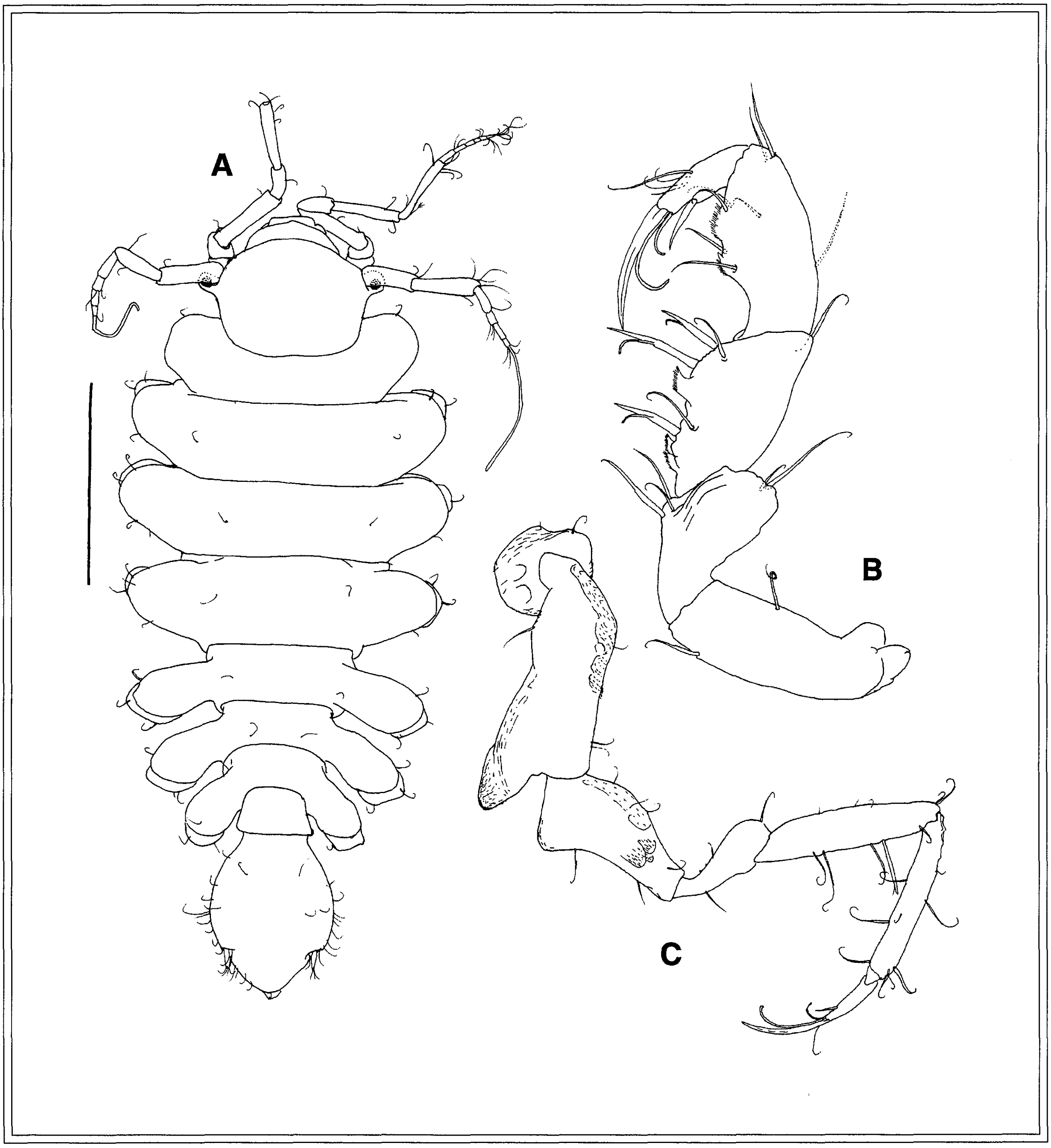


Figure 1.28. *Munnogonium* cf. *tillerae*. A and C, male (from Phase II, Sta. R-4). A, dorsal view, scale bar = 0.5 mm. B, left pereopod I, brooding female (LACM cat. no. 56-26.2). C, right pereopod II.

Biology. Like most janiroideans, species of *Munnogonium* appear to be epibenthic detritivores. I have observed *M. waldronense* alive at Friday Harbor Labs in the San Juan Archipelago. When alive, this species appears to be a small ball of detritus with legs, owing to its habit of sticking material from the bottom on the dorsal surface. This species seems to be clumsy and slow, perhaps relying on its camouflage for protection from predators instead of nimbleness (like *Munna*). The various populations of *M. tillerae*, however, are much less covered with detritus in the samples, so perhaps their methods of defence are different. The males of the Northern California sites have a unique enlargements on the basis and ischium of pereopod II. These lobes may be used in precopula, of which *M. waldronense* is known to practice a passive form (Wilson, 1991).

Remarks. Bowman and Schultz (1974), in addition to combining *Munnogonium waldronense* with *Austrosignum tillerae*, assert that the following *Austrosignum* species should be assigned to *Munnogonium* owing to an absent mandibular palp: *grande*, *erratum*, *tillerae*, *globifrons*, *maltinii*. The problem here is that *grande* (=*glaciale*) is the type for *Austrosignum*, and that it probably *does* have a mandibular palp, since the female *glaciale* has the palp. Hodgson (1910) never said the palp of *grande* was absent - he only said it was "not observed." Moreover, in the pleopod part of his descriptions, Hodgson (1910) describes male pleopods for *grande* and female pleopods for *glaciale* (some crustacean taxonomists at the turn of the century didn't understand the sexual dimorphism in asellote pleopods). The length of the eye stalks might make a good character for separating *Austrosignum* and *Munnogonium*. Concerning the composition of *Munnogonium*, Hooker (1985) adds another species, *M. wilsoni*, to *Munnogonium*, and gives a key to the species of the genus in which he also includes a Kensley species *subtilis*. Both *wilsoni* and *maltini* probably should be transferred to *Metamunna* Tattersall, 1905 (which should be removed from *Paramunna*) because of their overall resemblance to *M. typica* (the type specimens, unfortunately, are probably lost (R. Lincoln, pers. comm.). Other species that possibly should be included in *Metamunna* are *subtilis* Kensley, 1976, *Paramunna simplex* Menzies, *P. kerguelensis* Vanhöffen, *Munnogonium polynesiensis* Müller, 1989, possibly *Austrimunna serrata* Richardson, possibly *P. dubia* Hale, and possibly *Heterosignum mutsuensis* Gamo, 1976. An undescribed species of *Metamunna* also was found in the La Jolla area by Eric Vetter, Scripps Institution of Oceanography.

The following species can be definitely assigned to *Munnogonium*: *erratum*, *tillerae*, *globifrons*, and *waldronense*. I am not sufficiently convinced that *M. waldronense* should be synonymised into *tillerae* as proposed by Bowman and Schultz (1974) because they did not discuss specimens from the San Juan Archipelago. *M. erratum* is not distinct from the Northern California form of *M. tillerae*. Much of the confusion in the *Munnogonium* species *tillerae*, *waldronense*, and *erratum* arises from the distinct elongation of males over two to three adult (copulatory) molts from the more compact female form. Furthermore, if the specimens are exposed to fresh water during fixations, the segments are telescoped, giving a strong separation of the posterior segments. Schultz's (1966) specimen of *M. erratum* clearly shows everted articular membranes along the margins of the pereonites, suggesting his holotype is damaged in this way. Therefore, the elongation and separation of the lateral pereonites is *not* a useful character for defining species in this genus. Bowman and Schultz (1974) indicated that this was the primary character separating *M. tillerae* from *M. erratum*. Consequently, we must consider the two species identical for the purposes of this Atlas. Additional species-specific characters were not found by previous authors, probably because these species are so tiny. This problem will require complete redescriptions of material from near the type localities of all three species. Unfortunately, the type material has been so badly depleted by previous descriptions that the types will not provide sufficient information. Male types of both *M.tillerae* and *M. erratum* are lost or are thoroughly dissected, many parts of which are missing. The eyes of the northern California population of *M. tillerae* may have larger and darker ocelli than those of the San Diego specimens. The two populations may differ in the size of the antennulae, as well. Because quantitative data are not yet available, I have no choice but to provisionally synonymize *M. erratum* with *M. tillerae*. If sufficient evidence is found to separate the northern and southern populations at the species level, then the northern population will be called *M. erratum*, and the southern population will be called *M. tillerae*.

Type Locality and Type Specimens. Holotype lost (note in vial left by Bowman and Schultz; see also Wetzer *et al.*, 1991:16). Brooding female paratype, 1.0 mm, LACM cat. no. 56-26.2: R/V *Velero* IV station 4753, 8 December 1956: 5.2 miles at 294° True from Pt. Loma Light, San Diego Co., California, 32°41.8'N, 117°20.4'W, 101 m, sediment green mud (data from LACM label). Other paratypes listed by Menzies and Barnard (1959) and Bowman and Schultz (1974) should not be considered representative of the holotype because they are not from the San Diego type locality. Unfortunately the latter authors do not identify the source of the paratype illustrations in their paper.

Distribution. Waters off San Diego County to central California (provisional), 18-135 m.

Genus *Pleurogonium* Sars, 1883

Description. Head partially recessed into first pereonite; eyes always absent. Body ovate, sometimes with laterally projecting spines; coxae II-VII visible in dorsal view with lateral spines. Females with dorsal spermathecal duct on pereonite 5 well separated from articular membrane between pereonites. Pleotelson lenticular, distally pointed; pleonite one large, distinct, ring-like. Antennulae short, with six articles and with one terminal aesthetasc. Antennae short, never longer than body, strongly geniculate: articles 1-3 projecting medially, article 4 dorsolaterally and remaining articles laterally; article 3 distinctly longer that articles 1,2, or 4, without large spines or projections. Mandibular molar process distally narrow with 1-2 spines and 1-2 curved setulate setae; palp absent. Pereopod I prehensile with major hinges between dactylus and propodus; carpus enlarged, as broad or broader than long, participating in grasping with robust sensillate setae and short spines. Pereopods II-VII ambulatory, paucisetose. Male pleopod I sagittate distally, smooth ventrally with tufts of small setae on lateral corners; vas deferens entering pleopodal medial sperm duct internally. Uropods tiny, biramous; protopod absent. Anus ventral, covered by opercular pleopods, anal cavity confluent with pleopodal cavity.

Pleurogonium californiense Menzies, 1951

Figure 1.29

Pleurogonium californiense Menzies, 1951a:139, figs. 25-26; Menzies and Barnard, 1959:14, fig. 8; Kussakin, 1962:99; Schultz, 1966:12; Schultz, 1969:291.

Material Examined. California, Santa Maria Basin, off Port San Luis, Sta. R-1, 91 m (15); off Purisima Point, Sta. 42, 100 m (7); off Purisima Point, Sta. R-4, 92 m (17); Sta R-5, 154 m (1).—Western Santa Barbara Channel, off Point Conception, Sta. 79, 98 m (4).

Description. Body broad, ovate. Cephalon somewhat recessed into first pereonite. Cephalon without eyes or eye stalks. Pereon and pleotelson with rounded lateral margins lacking large teeth or serrations. Pereonite 1 of males (not intersexes) distinctly longer and more robust than that of females. Cuticle on body and limbs smooth to lightly scaled. Antennulae without anterior projection on distal margin. Mandible lacking palp; molar process thin, finger-like, with rounded distal tip having only one distal spine and one seta. Pereonal coxae visible in dorsal view with single projecting spines; spine on coxa VII reduced or absent. Uropods biramous, positioned dorsolaterally on pleotelson, protopod absent.

Biology. Populations of this benthic species often may be protogynous hermaphrodites. Fully hermaphroditic populations will exhibit small primary males, and larger secondary males that were females in a previous moult. The large secondary males (approximately the size of a brooding female) are broad and have a highly depressed lateral profile and a concave ventral surface, probably retained from the brooding condition. The smaller primary males have a more normal, convex ventral surface. Preparatory and brooding

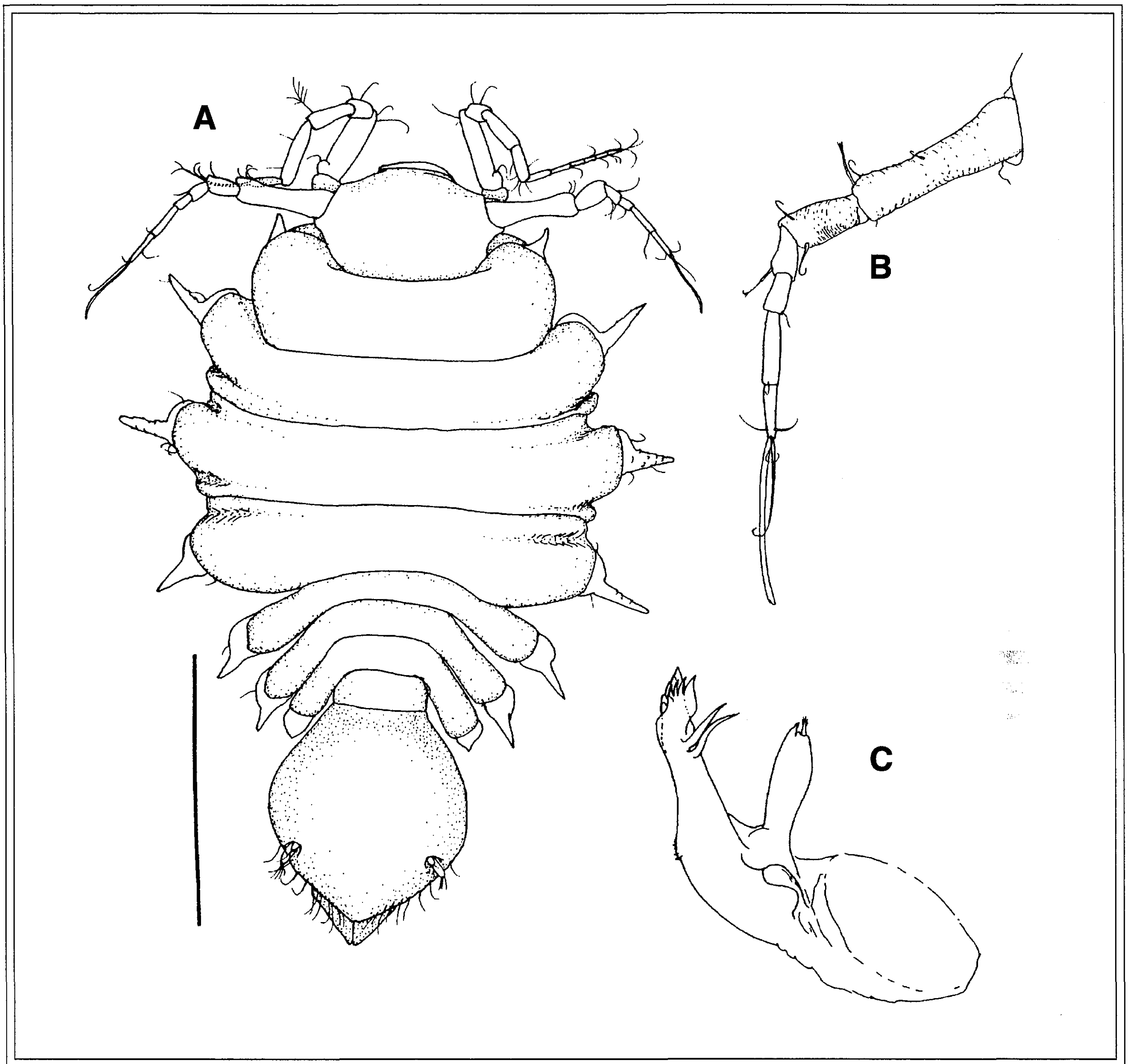


Figure 1.29. *Pleurogonium californiense* Menzies, 1951. A, Dorsal view of hermaphroditic brooding female, Phase II Sta. R-4, scale bar = 0.5 mm. B, left antennula. C, left mandible, dorsal view.

females generally have either developing or fully mature male pleopods. Currently, it is unknown whether the testes are active in these transitional females. Surprisingly, some populations (e.g. those in the MMS Phase I Sta. 42) seems to lack hermaphrodites, indicating that this feature of their sexual biology may be facultative.

Pleurogonium sp. A could also be a different morphotype of *P. californiense*. Such a hypothesis, however, must accommodate the presence of these differing morphotypes at all life stages as well as the differences in the antennules, cuticle, and mandibular molar. These types of differences have not been encountered before in one species, so at the moment they are classified as separate species.

Both species may be relatively recent siblings judging from their overall morphological similarity. If this is so, their sympatry is all the more interesting. If they are indeed separate species, then the unusual protuberance (not seen in any other *Pleurogonium*) on the antennule of *Pleurogonium* sp. A may provide an effective signal to prevent interspecific matings and concomitant gamete wastage.

Remarks. *Pleurogonium californiense* co-occurs with *Pleurogonium* sp. A., so the two similar species must be carefully differentiated. *P. californiense* lacks large projections on the first antennular article, thereby providing an easy identification character for separation from *P.* sp. A. *Pleurogonium californiense* can be further verified by noting its smoother cuticle, its shorter antennulae, and (if dissections are made) the lack of a second short spine on mandibular molar process. The original description of *P. californiense* shows a male with a much longer antennular article 2 than seen in the current collection. This suggests that the populations of this species North of San Francisco may be somewhat differentiated from those to the South. A comparison of the type material with the Santa Maria Basin material seems necessary to verify this feature.

Type Locality and Type Specimens. "Holotype (U.S.N.M. no. 87412), allotype (U.S.N.M. no. 87413), and 1 male paratype (U.S.N.M. no. 87414), collected at type locality, 3 miles west of mouth of Russian River, Sonoma County., Calif., July 13, 1947, by R.J. Waidzunas and Paul B. Quyle; found in fine mud with the sea-star *Luidia foliata* Grube ..." (Menzies, 1951a:143).

Distribution. Off northern and central California, 90-154 m.

***Pleurogonium* sp. A**

Figure 1.30

Material Examined. California, Santa Maria Basin, off Purisima Point, Sta. 42, 100 m (1); off Purisima Point, Sta. R-4, 92 m (13); Sta. R-5, 154 m (1).—Western Santa Barbara Channel, off Point Conception, Sta. 79, 98 m (6);

Description. Body broad, ovate. Cephalon somewhat recessed into first pereonite. Cephalon without eyes or eye stalks. Pereon and pleotelson with rounded lateral margins lacking large teeth or serrations. Pereonite 1 of males (not intersexes) distinctly longer and more robust than that of females. Cuticle on body and limbs rough with apparent microscales on all surfaces. Antennulae with large curved anterolateral projection on distal margin. Mandible lacking palp; molar process thin, finger-like, with rounded distal tip having two distal spines and one seta. Pereonal coxae visible in dorsal view each with single projecting spines; spine on coxa VII large. Uropods biramous, positioned dorsolaterally on pleotelson, protopod absent.

Biology. Populations of this benthic species may contain protogynous hermaphrodites. See remarks above under *Pleurogonium californiense*.

Remarks. *Pleurogonium* n.sp. A. co-occurs with *Pleurogonium californiense*, so the two similar species must be carefully differentiated. *P. californiense* lacks large projections on the first antennular article found in this species, thereby providing an easy identification character for separation of the two species. *P.* n.sp. A. can be further verified by noting its rougher cuticle, its longer antennulae, and (if dissections are made) the presence of a second short spine on mandibular molar process.

Type Locality and Type Specimens. None. This species is undescribed.

Distribution. Santa Maria Basin and western Santa Barbara Channel, 90-154 m.

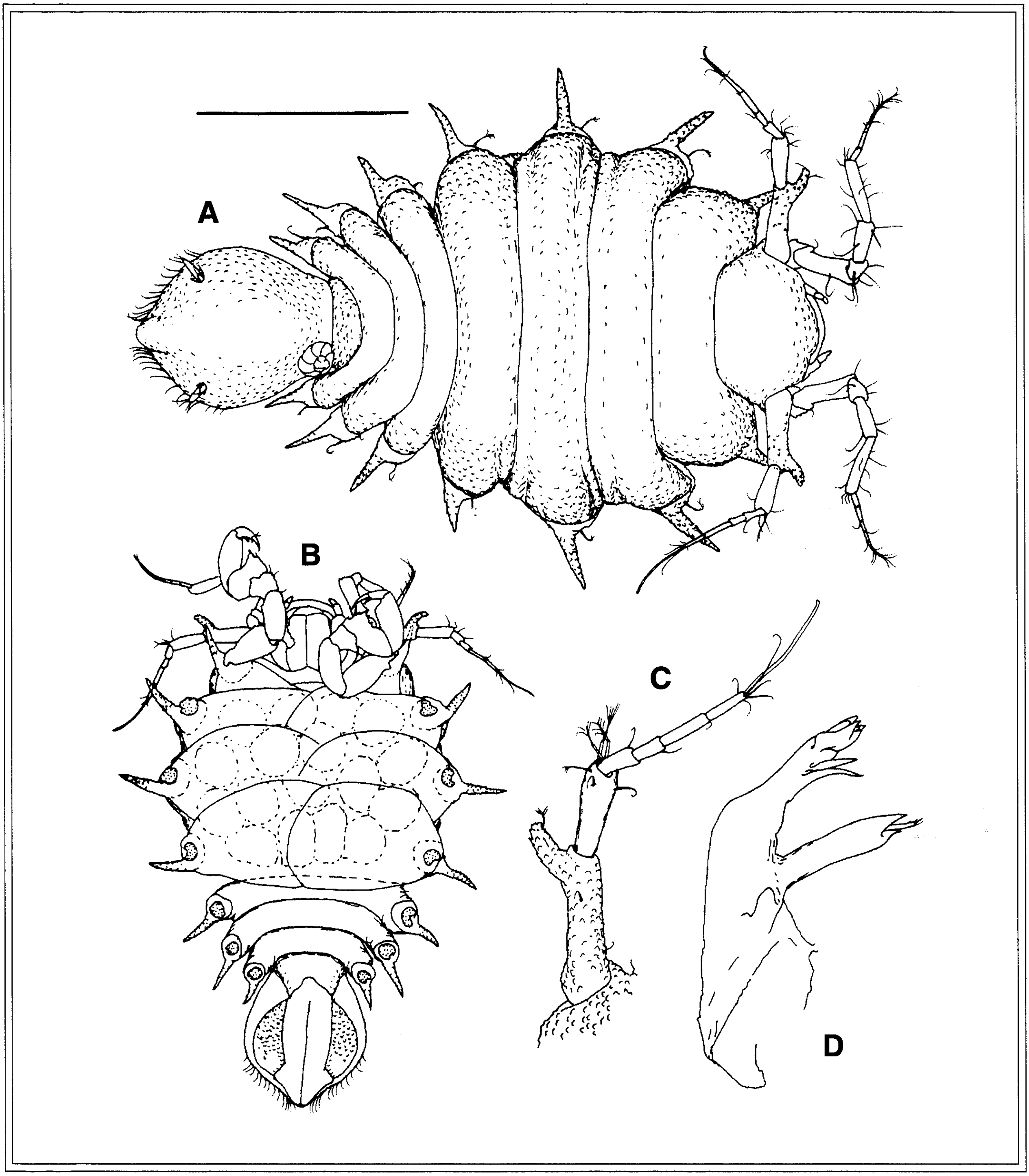


Figure 1.30. *Pleurogonium* sp. A. A-B, Dorsal view of hermaphroditic brooding female, Phase II Sta. R-4, scale bar = 0.5 mm. C, left antennula. D, left mandible, dorsal view.

Family Janiridae Sars, 1897

Genus *Janiralata* Menzies, 1951b

Description (modified from Wilson and Wägele, 1994). Head with dorsal eyes; lateral margins straight, with anterolateral points or spines; vertex obtusely pointed to rostrate. Body broad and flattened. Lateral margins of pereonites 2-3 divided into 2 lobes by deep cleft or broad niche, coxae visible on dorsal view; pereonite 1 with coxal lappet dorsally visible on anterolateral border. Pleonite 1 short, visible dorsally, much narrower than pereonite 7 or pleotelson. Pleotelson near width of pereonite 7. Antennulae multiarticulate, with approximately 12-20 flagellar articles; antennal article 1 longer than wide. Antenna article 3 with conspicuous scale (exopod); basal article 1-4 subequal; articles 5-6 long, distinctly longer than basal articles 1-4; flagellum multiarticulate, with more than 20 articles; basal articles of flagellum wider than long but not conjoint. Mandibular molar process truncate; palp long, article 3 elongate, curved and setose. Maxillipedal endite longer than wide, width subequal to palp; palp articles 4-5 narrow, straight sided, distinctly narrower than broad articles 1-3, palp article 3 distally broad, setose, not tapering, near width of article 2. Pereopod I carposubchelate, dactylus short, with 2 claws; propodus on proximal inferior border serrated, carpus with 2 rows of short spine-like setae on ventral margin. Pereopod II-VII dactylus with two subequal claws, with subdistal accessory seta enlarged into third claw. Male pleopod I distal tips laterally expanded, with projecting subtriangular lateral lobes, and broad setose medial lobes merging smoothly into lateral lobes. Male pleopod II distal tip of protopod blunt, setiferous; basal article of endopod only somewhat wider than maximum width of stylet, but not inflated; stylet elongate, curved, longer than sympod. Female pleopod II broad, ovate, with distal median concavity. Pleopod III endopod with 3 plumose setae having distinct gap between medial seta and two lateral setae; exopod narrower and longer than endopod; exopod with 2 segments, with distal plumose setae. Uropods biramous, rami subequal; exopod inserting apically; protopod subequal to rami.

***Janiralata* sp. A**

Figure 1.31

Material Examined. California, Santa Maria Basin, off Point Sal, Sta. BRA-17, 160.6-168 m (1 preparatory female).

Description. Body broad and flattened, with large dark-pigmented diffuse chromatophores on all dorsal surfaces, including cephalon anterior to eyes. Dorsal surfaces with many fine setae. Cephalon with large dorsal eyes, well separated from lateral margins; lateral margins convexly curved, with triangular anterolateral points; anterior margin with obtuse rostral point not extending anteriorly beyond lateral points. Lateral margins of pereonites 2-3 divided into 2 lappets with broad notches bearing coxae, anterior lappets approximately 2 times length of associated coxal lobes in dorsal view. Pereonite 1 bearing only posterior lappet shorter than associated coxa; pereonites 4-7 bearing anterior lappets, with that of pereonite 4 being relatively narrow and that of pereonites 5-7 being broad and laterally rounded; lappets of pereonites 6-7 with distinct posterolateral projections. Tergite 5 distinctly shorter medially than other tergites. Pleotelson with semicircular lateral margins, posterolateral medially curving spines, and posterior margin being obtusely rounded; margin between posterolateral spines and distal tip slightly convex, not concave; tip of pleotelson extending beyond posterior limits of posterolateral spines. Antennula article 3 distinctly longer than wide; flagellum with around 12 articles, distal article tiny. Antenna with conspicuous pointed scale. Mandibular article 3 elongate, longer than palp article 1. Articles 1-3 of maxillipedal palp expanded. Pereopod I carposubchelate; dactylus short, with 2 claws; propodus with 9 denticles on proximoventral border, carpus with 2 rows of short spine-like sensillate setae on ventral margin and fine fringe of cuticular comb-like spinules. Coxa I bluntly pointed, large, longer than pereonal lappet. Coxae II-V laterally bilobed in dorsal

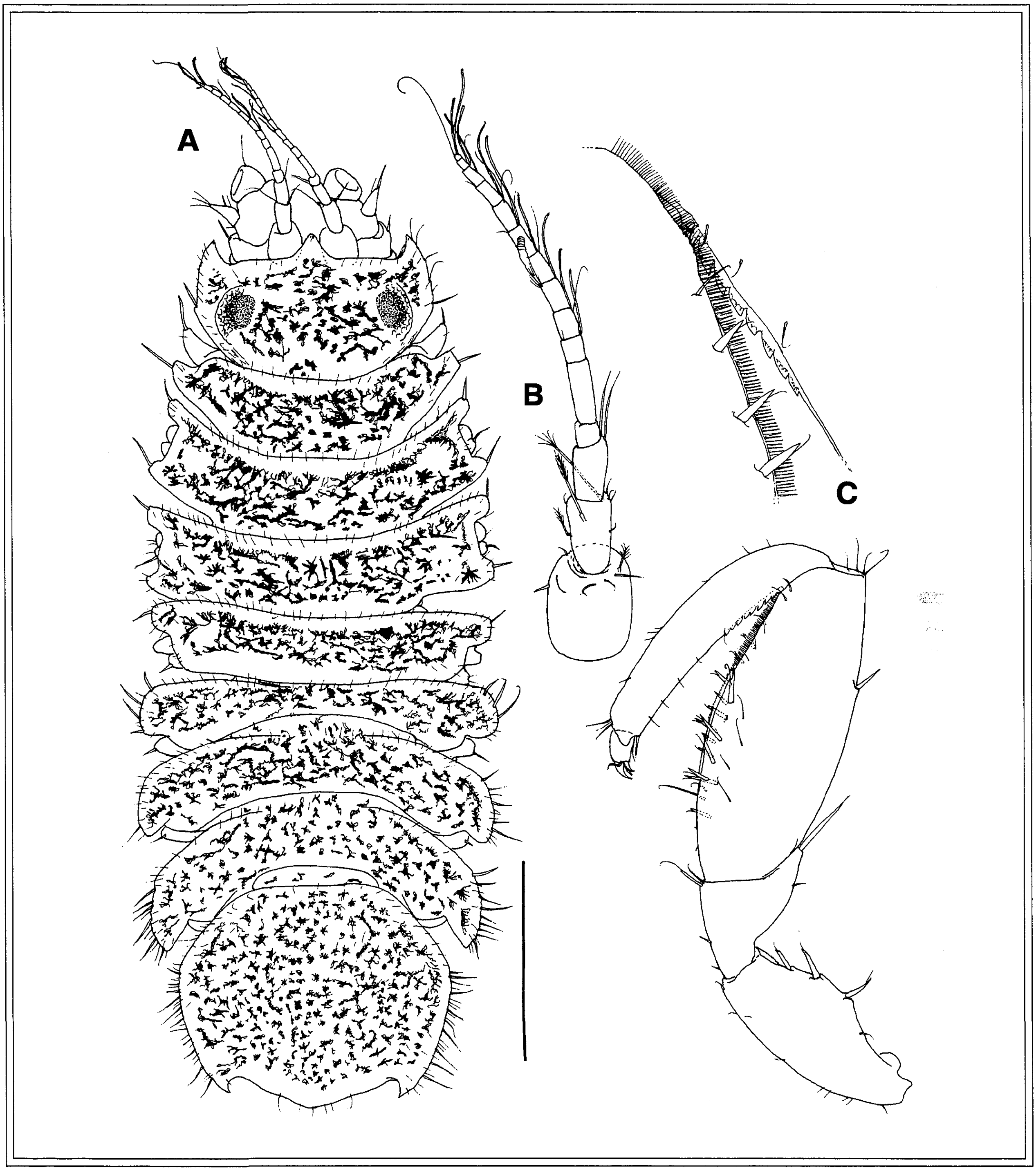


Figure 1.31. *Janiralata* sp. A., preparatory female, MMS Phase I Sta. BRA-17. A, dorsal body view, scale bar = 1 mm. B, left antennula. C, left pereopod I, with enlargement of opposing margins of propodus and carpus.

view, length of both lobes coxae II-III subequal. Female operculum broad ovate, distally with median concavity. Male pleopods I-II unknown. Uropods (unknown in this species) probably biramous with branches of subsimilar length, sympod about as long as rami.

Biology. Little is known about the biology of *Janiralata* species in general, although they seem to favor hard substrates and are quite agile. *Janiralata occidentalis* is especially quick: it is difficult to capture with forceps from a petri dish during live sorting because it easily avoids the forceps tips by scampering under debris and clinging tightly. *J. solasteri* is found as a commensal in the ambulacral groove of the asteroid, *Solaster* species, where it typically co-habits with other commensals like polynoid scale worms. The dense gut contents of the specimen examined here suggests that, like most janiroideans, this species is a detritivore.

Remarks. This species is very similar to *Janiralata occidentalis* (Walker, 1898). Specimens of *J. occidentalis* from the San Juan Archipelago (Menzies, 1951a), and some fresh specimens from the same general locality collected by the author suggest that the two species can easily be separated by their pigmentation. *J. occidentalis* has dense, non-anastomosing chromatophores that are absent from the region anterior to the eyes, while *J.* sp. A has diffuse anastomosing chromatophores that extend into the region anterior to the eyes. *J.* sp. A also has a thinner, more elongate antennula. Readers should be aware, however, that the two species are nearly identical in most other features, including the rostrum. The rostrum of *J. occidentalis* is shown much less prominent in (Menzies, 1951a) than it actually is, possibly because Menzies illustrated the specimen with the cephalon angling down anteriorly. Additionally *J.* sp. A has fewer proximoventral denticles on propodus of pereopod I.

Type Locality and Type Specimens. None. This species is undescribed.

Distribution. Santa Maria Basin, 160-168 m.

Janiralata sp. B

Figure 1.32

Material Examined. California, Santa Maria Basin, off Point Arguello, Sta. BRA-4, 168-237 m, 1 brooding female, 2 juvenile females, 1 manca.

Description. Brooding female only. Body broad and flattened, with no pigment on any dorsal surface. Dorsal surfaces with many fine setae. Cephalon with rostrum extending well beyond anterior limits of pointed lateral margins; anterior margin with lateral medially-curving flattened spines adjacent to distinct concave indentations; eyes large, bulging but not near lateral margin except in early juveniles and mancas. Lateral margins of pereonites 2-3 divided into 2 lappets with broad notches bearing coxae, anterior lappets approximately 2 times length of associated coxal lobes in dorsal view. Pereonite 1 bearing only posterior lappet shorter than associated coxa; pereonites 4-7 bearing anterior lappets, with that of pereonite 4 being relatively narrow and that of pereonites 5-7 being broad and laterally rounded; lappets of pereonites 6-7 with distinct posterolateral projections. Tergite 5 distinctly shorter medially than other tergites. Pleotelson with nearly straight lateral margins, with posterolateral medially curving spines, and with posterior margin being obtusely rounded; margin between posterolateral spines and distal tip slightly convex, not concave; tip of pleotelson extending beyond posterior limits of posterolateral spines. Antennula article 3 distinctly longer than wide; flagellum with around 12 articles, distal article tiny. Antenna with conspicuous pointed scale. Mandibular article 3 elongate, longer than palp article 1. Articles 1-3 of maxillipedal palp expanded. Pereopod I carposubchelate; dactylus short, with 2 claws; propodus with 17 denticles on proximoventral border, carpus with 2 rows of short spine-like sensillate setae on ventral margin and fine fringe of cuticular comb-like spinules. Coxa I bluntly pointed, large, longer than pereonal lappet. Coxae II-V laterally bilobed in dorsal view, length of both lobes of coxae II-III subequal. Female operculum broad, ovate, distally with median concavity. Male pleopods I-II unknown. Uropods (known only in early juvenile) biramous with branches of subsimilar length, sympod about as long as rami.

Biology. See remarks under *Janiralata* sp. A.

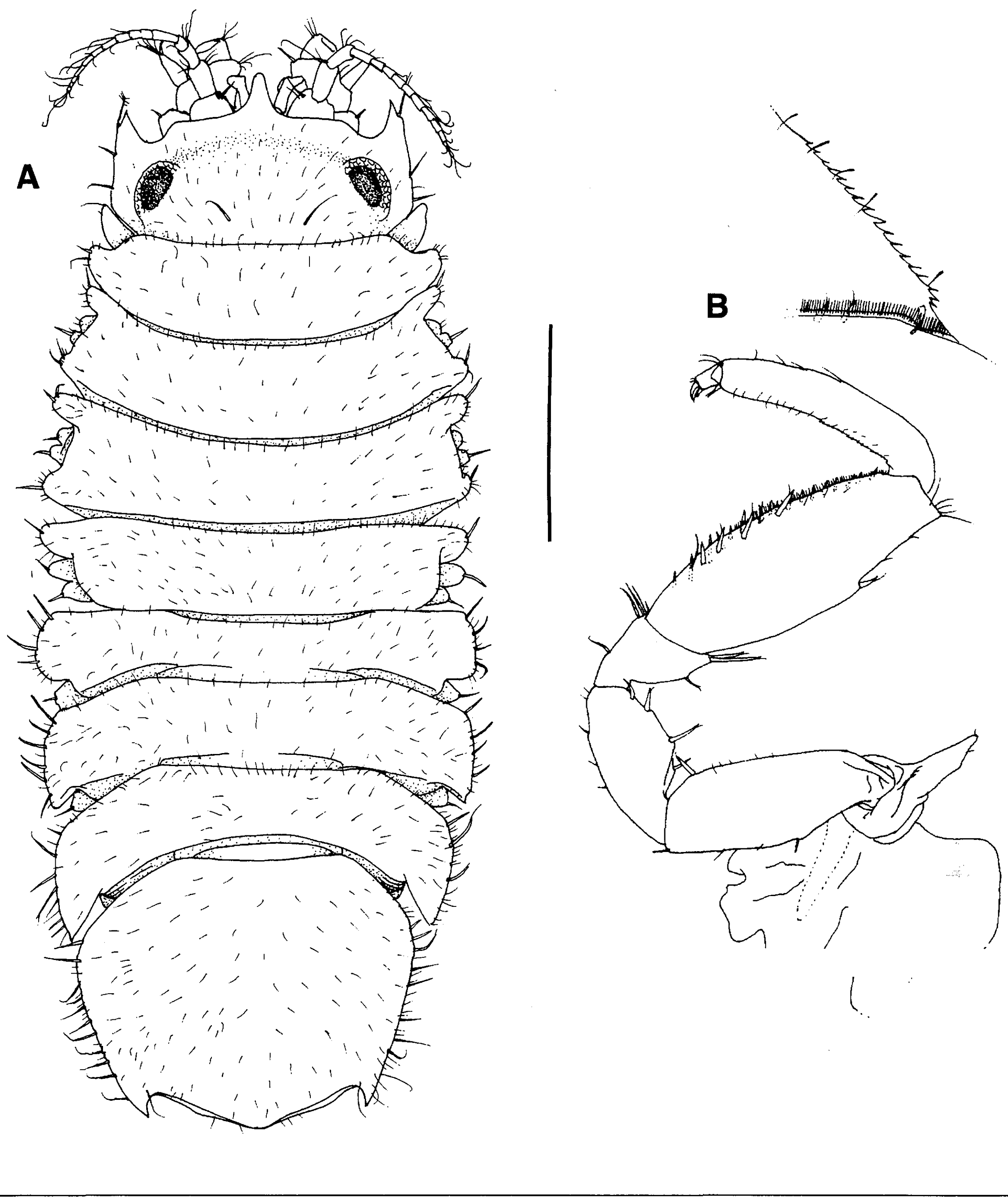


Figure 1.32. *Janiralata* sp. B, brooding female, MMS Phase I Sta. BRA-4. A, dorsal view, scale bar = 1 mm. B, pereopod II with enlargement of proximoventral denticles on propodus.

Remarks. *Janiralata* sp. B is most similar to *J.* sp. A, *J. occidentalis* and *J. solasteri*, but has a different combination of features. Unlike *J.* sp. A and *J. occidentalis*, this species lacks pigment and has a decidedly longer rostrum in the adult. Juveniles, however, have much shorter rostra than in adults and could be confused with other species on this character alone. *J.* spp. A and B have nearly identical antennulae, so readers can consult the plate for the former species for the antennular form of the latter. *J.* sp B. differs from *J. solasteri* in having different lengths of coxal projections on pereopods II and III, the relative lengths of antennular articles 2-3, the terminal extension of the pleotelson beyond the posterior limits of the posterolateral spines, and the number of proximoventral denticles on propodus I in the adult.

Type Locality and Type Specimens. None. This species is undescribed.

Distribution. Santa Maria Basin, 168-237

Janiralata sp. C

Figure 1.33

Material Examined. California, Santa Maria Basin, off, Purisima Point, Sta. BRA-16, 91.5-123 m, 1 preparatory female, illustrated, and another 9 individuals, parts of 1 male illustrated.

Description. Body broad and flattened, with no pigment on any dorsal surface. Dorsal surfaces with many fine setae. Cephalon with no rostrum, anterior margin smoothly convex or with slight medial rounded point, margin posterior to limits of anterolateral angles; anterolateral margin broad flattened angle, not spine-like; lateral margin only slightly curved; eyes large, bulging, but not near lateral margins. Lateral margins of pereonites 2-3 with 2 short lappets, posterior lappets indistinct, separated by broad indentations only slightly exposing coxae in dorsal view. Pereonite 1 with no posterior lappet; pereonites 5-7 laterally broad and rounded, with no obvious anterior lappets. Pereonite 4 with short, broad anterior lappet. Tergite 5 distinctly shorter medially than other tergites. Pleotelson broad with smoothly rounded margins, with no posterolateral spines, and with indistinctly trilobed posterior margin; margin between posterolateral lobes and rounded distal tip concave; tip of pleotelson extending only slightly beyond posterior limits of posterolateral lobes. Antennula article 3 distinctly longer than wide; flagellum with around 6 articles, distal article small, but easily seen. Antenna with conspicuous pointed scale. Mandibular article 3 elongate, longer than palp article 1. Articles 1-3 of maxillipedal palp expanded. Pereopod I carposubchelate; dactylus short, with 2 claws; propodus with 6 denticles on proximoventral border, carpus with 2 rows of short spine-like sensillate setae on ventral margin (3 on lateral side and 10 on medial side) and fine fringe of cuticular comb-like spinules. Coxa I bluntly pointed, large. Coxae II-V not obviously bilobed, barely visible in dorsal view. Female operculum broad, ovate, distally with median concavity. Male pleopod I with elongate laterally-pointed copulatory horns and broad truncate medial lobes. Male pleopod II with short stylet not exceeding length of protopod. Uropods unknown, probably biramous with branches of similar length and sympod about as long as rami.

Biology. See remarks under *Janiralata* sp. A.

Remarks. *Janiralata* sp. C is most similar to *J. koreaensis* Jang, 1991 although this new species lacks pigment, has a broader pleotelson, has fewer articles in the antennula, and has much smaller lappets on pereonites 1-4. In this last regard, *J.* sp C is similar to *J. rajata* Menzies, 1951, although the width of the body immediately separates the two species. In Menzies' (1951a) key, this species will key out to *J. erostrata*, although again pereonal lappets and coxal projections immediately distinguish the two species.

Type Locality and Type Specimens. None. This species is undescribed.

Distribution. Santa Maria Basin, 91.5-123 m.

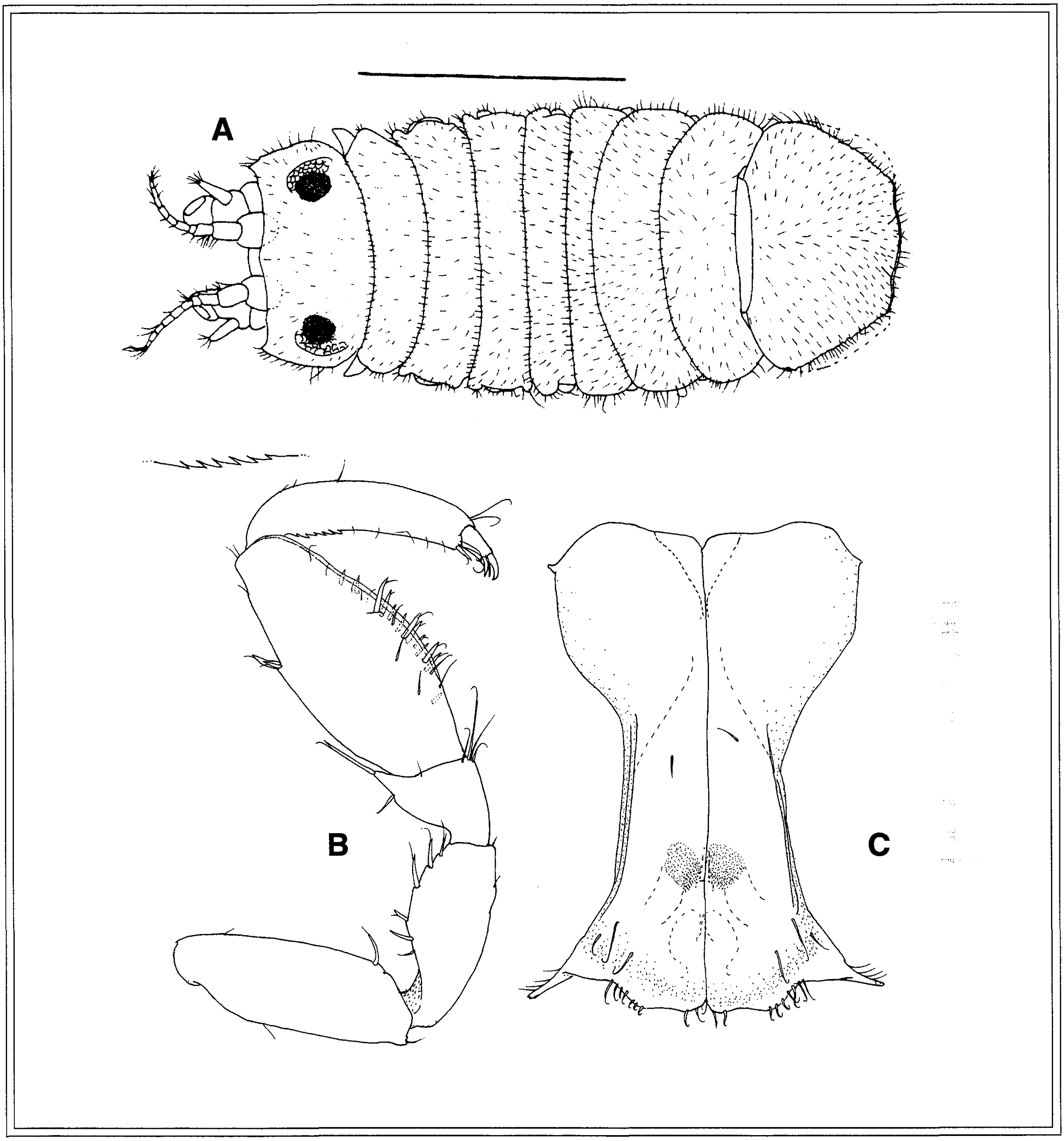


Figure 1.33. *Janiralata* sp. C. A, dorsal view, preparatory female (MMS Phase I Sta. BRA-16), pleotelson slightly damaged, scale bar = 1 mm. B-D, copulatory male (MMS Phase I Sta. BRA-16). B, right pereopod I, with enlargement of proximoventral spines on propodus. D, pleopod I.

Janiralata sp. D (cf. *rajata*)

Figure 1.34

Material Examined. California, Santa Maria Basin, off Purisima Point, Sta. BRA-16, 91.5-123 m, 1 preparatory female body length 3.7 mm.

Description. Body narrow, with numerous dark-pigmented chromatophores on dorsal surfaces. Dorsal surfaces with few fine setae. Cephalon with no rostrum, anterior margin with slight medial rounded point; anterolateral margins rounded, not spine-like, not projecting anteriorly, with single sensillate seta; lateral margin narrow, only slightly curved, with single sensillate seta adjacent to eyes; eyes large, bulging, extending to lateral margins. Lateral margins of pereonites 2-3 with very short lappets, posterior lappets indistinct, separated by broad indentations only slightly exposing coxae in dorsal view. Pereonite 1 with no posterior lappet; pereonites 5-7 laterally broad and rounded, with no obvious anterior lappets. Pereonite 4 with short, narrow anterior lappet. Tergite 5 only slightly shorter medially than other tergites. Pleotelson with smoothly rounded margins, lacking posterolateral spines or lobes; posteromedial tip rounded, most posterior part of body. Antennula article 3 distinctly longer than wide; with 12-13 articles, distal article small, but easily seen. Antenna with conspicuous pointed scale. Mandibular article 3 elongate, longer than palp article 1. Articles 1-3 of maxillipedal palp expanded. Pereopod I carposubchelate; dactylus short, with 2 claws; propodus with 18 denticles on proximoventral border, carpus with 2 rows of short spine-like sensillate setae on ventral margin (5 on lateral side and 18 on medial side) and fine fringe of cuticular comb-like spinules. Coxa I triangular, pointed. Coxae II-V weakly bilobed, barely visible in dorsal view. Female operculum broad, ovate, with median concavity distally. Male pleopods I-II unknown. Uropods unknown, probably biramous with branches of similar length and sympod about as long as rami.

Biology. See remarks under *Janiralata* sp. A

Remarks. This species is very similar to *Janiralata rajata* Menzies, 1951a, especially in body form. *J.* sp. D differs from *J. rajata* in the following: the eyes are smaller, the body has numerous dense chromatophores, the antennula is longer, and the propodus of pereopod I has more proximoventral denticles (18 instead of 12 or 13). Nevertheless, this new specimen and the male holotype of *J. rajata* are near the same size. Males from the Santa Maria Basin population must be collected to establish more differences.

Type Locality and Type Specimens. None. This species is undescribed.

Distribution. Santa Maria Basin, 91.5-123m.

Family Joeropsididae Nordenstam, 1933
(originally Jaeropsini)

Genus *Joeropsis* Koehler, 1885

Description (derived from data of Wilson, 1994). Body broad; pereonal tergites laterally rounded, coxae not visible in dorsal view. Head wider than long; frons wide with distinct vertex, rostrum projecting anteriorly between antennulae. Pleotelson with posterolateral spines; pleonite 1 fused to pleotelson. Antennular first article length greater than width, with spines on distolateral margin, flagellum with less than 5 articles. Antennal flagellum with more than 12 articles but proximal articles conjoint; articles 5-6 longer than 1-4, article 5 with broad lateral flange; article 3 not especially enlarged compared to articles 1-2 and 4, scale absent. Mandibular molar thin, elongate, distally tapering. Maxillipedal palp slender, endite extremely broad, more than twice as broad as palp. Pereopod I ambulatory, not subchelate, carpus and propodus with few setae. Pereopods II-VII dactyli with 2 subequal claws, accessory seta claw-like. Penes situated medially on

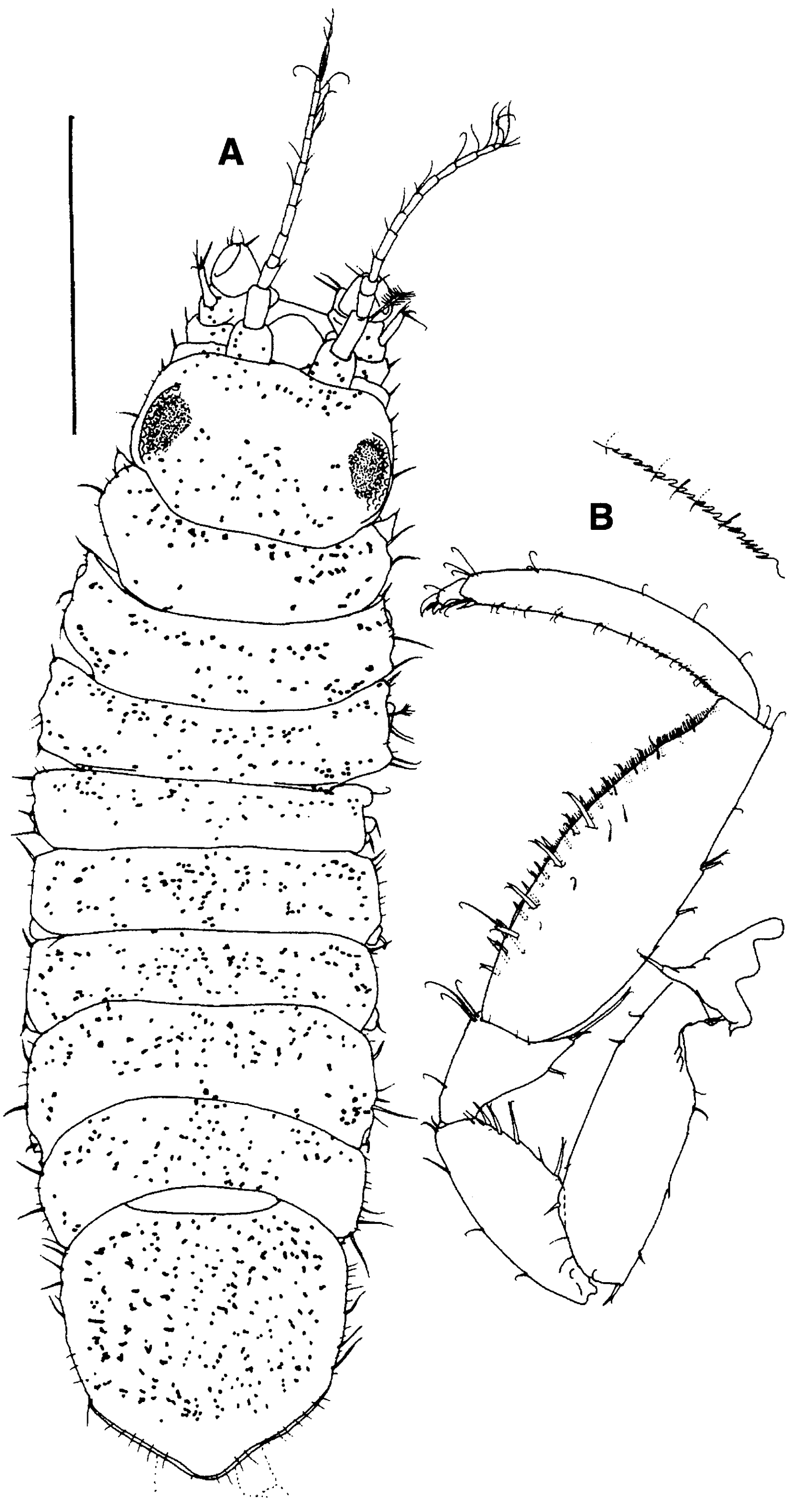


Figure 1.34. *Janiralata* sp. D (cf. *rajata*), MMS Phase I Sta. BRA-16, preparatory female. A, dorsal view of body, scale bar = 1 mm. B, right pereopod I with enlargement of proximoventral denticles on propodus, lateral view.

pereonite 7 sternum. Pleopod III endopod with 3 plumose setae; exopod narrower and longer than endopod, lacking plumose setae, with 2 free articles. Uropods squat, inserting terminally on pleotelson, rami distinctly shorter than protopod, exopod shorter than endopod; enlarged protopod with distinctive medial claw.

Joeropsis concava (Schultz, 1966)

Figure 1.35

Material Examined. California, Santa Maria Basin, off Purisima Point, Sta. BRA-16, 91.5-123 m (5).—Western Santa Barbara Channel, Sta. BRC-2, 120-123 m (3).

Description. Body devoid of pigment, but covered with numerous fine simple setae. Body elongate and parallel-sided; all segments width subequal, body length exceeding 4 times body width. All lateral margins with small denticulae, and pleotelson with 7 large posteriorly curved spines. Cephalic lateral margin with distinct indentation below eyes; eyes small, with fewer than 10 ocelli. Antennula with 5 distinct articles (Schultz, 1966, reports 6 - see remarks below) article 1 with large distolateral projection bearing around 6 sharp, flat spines curving toward article 2; article 2 distinctly longer than wide. Male pleopod II with distinctly separate medial and lateral lobes; medial lobes longest, with medially converging sides. Uropodal protopod with distinct distomedial spine; rami with short setae no longer than protopod.

Biology. Living joeropsidids look like slow-moving little tanks. They are relatively well calcified compared to other more speedy shallow-water janiroideans, such as *Ianiropsis*. Shallow-water species are usually well pigmented although this deep-water form seems to lack any pigment.

Remarks. Several species of *Joeropsis* are substantially similar to *J. concava* in many details, especially *J. brevicornis* Koehler, *J. dubia* Menzies, 1951, and *J. paucispinis* Menzies, 1951 (varieties and subspecies of previous authors should be considered separate species unless clear evidence for their conspecific nature is given). *J. concava* differs from all of these species by having a more elongate body, no pigment, and a distinctive indentation in the cephalic margin below the eyes.

The specimens illustrated here from the Santa Maria Basin conform with Schultz's (1966) description of *Joeropsis concava* in practically all points, but their identification must be considered tentative because the antennulae do not match. Schultz (1966) illustrates a 6 articled antennula with the terminal sixth article being elongate and pointed, while these specimens clearly have 5-articled antennulae, with the presumptive sixth article being fused to the 5 article. Some joeropsidids may have a free sixth article, but it is always tiny and truncate, never elongate and pointed. Other species illustrated in Schultz (1966) are sometimes inaccurate on details of this scale, so the illustration and his description may be erroneous. Alternatively, the type specimen could be simply a deviation from the common joeropsidid form. The types of this species must be examined to settle this problem.

The ventral surface of this species showed distinctive ridges on the ventral midline, that were not present in *J.* sp. A (see next description). Formal descriptions of joeropsidid species nearly always ignore the ventral surface of the body, so these features could not be included here. For the future, however, taxonomists of this morphologically conservative group should be aware that important characters may be obtained from the lateral and ventral sides of the body.

Type Locality and Type Specimens. Holotype male, 3.1 mm long, R/V *Velero IV* station 6806: 33°56.1'N, 118°52.28'W, Santa Cruz Canyon, 221 m, 22 December 1959, rocks and coarse green sand (from Schultz, 1966).

Distribution. Central to southern California, 60-221m. Additional specimens of this species have been collected by the City of San Diego Ocean Monitoring Program at Station B5 (32°49.25'N, 117°19.60'W, 60m).

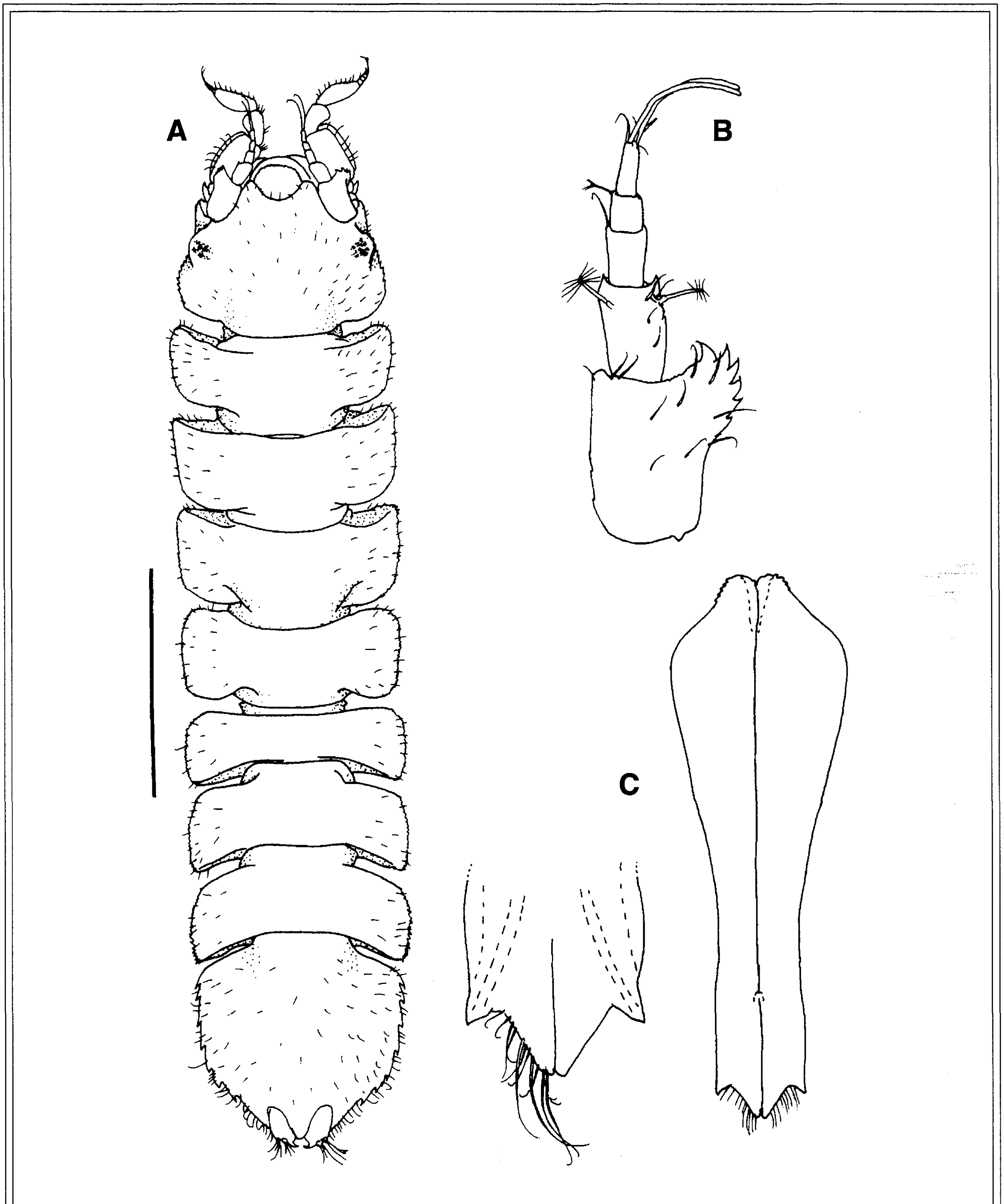


Figure 1.35. *Joeropsis concava* Schultz, 1966, male from Phase I Sta. BRA-16. A, body dorsal view, scale bar = 1 mm. B, antennula. C, male pleopod I with enlargement of distal tip.

Joeropsis sp. A

Figure 1.36

Material Examined. California, Santa Maria Basin, off Purisima Point, 90-130.5 m, Sta. BRA-20, 90-130.5 m (1); off Point Arguello, 54-63 m, Sta. BRA-6, 4 individuals, illustrated brooding female and copulatory male.

Description. Body devoid of pigment, but covered with numerous fine and some longer simple setae. Body broad and laterally curved; pereonites 3 and 4 widest, body length between 2.5 and 3 times body width; all pereonites with tergites extending much further than ventral insertions of pereopods. All lateral margins with small denticulae, pleotelson with 8 large posteriorly curved spines. Cephalic lateral margin with large anteriorly curved spines, substantially produced laterally forming large lateral plate; eyes small, with approximately 10 ocelli. Antennula with 5 distinct articles; article 1 with small distolateral projection bearing several laterally curving flat spines; article 1 with small medial projection with several denticulae; article 2 distinctly longer than wide. Male pleopod II with distinctly separate medial and lateral lobes; medial lobes longest, with medially converging, straight sides; medial margin of lateral lobe distinctly arc-like. Uropodal protopod with distinct distomedial spine; rami with elongate setae longer than protopod.

Biology. See general remarks above, *J. concava.*

Remarks. This new species is most like *Joeropsis lata* Kussakin, but differs in the following respects (*J. lata* in parentheses): the antennulae have large distinct denticulae (only tiny denticulae) and article 2 is much longer than broad (length and width approximately equal); male pleopod I medial lobe on the distal tip straight sided (not curved). This species of *Joeropsis* is also similar to *J. setosa* George and Strömberg, although the latter is largely denticle-free on all margins, and seems to have more obvious dorsal setae. George and Strömberg (1968) provide a useful key to species of *Joeropsis*, although it is out of date now that the number of species in the genus has nearly doubled.

Type Locality and Type Specimens. None. This species is undescribed.

Distribution. Santa Maria Basin, 54-130.5 m.

Family Munnopsidae Sars, 1869

Subfamily Eurycopinae Hansen, 1916

Genus *Eurycope* G.O. Sars, 1864

Description (from Wilson, 1982b). Eurycopinae with deep, vaulted and rounded natasome; venter with no enlarged or recessed area; body without dorsal or lateral spines. Tergal articulations of pereonites 5-7 distinct; pereonite 7 subequal to or longer than pereonites 5 and 6. Rostrum and frons distinct; clypeus narrow, striplike; labrum longer than clypeus. Pleotelson posterolateral margin parallel to pleotelson longitudinal axis or angled downward in lateral view. Antennular first article broad, with well-developed medial lobe. Mandibular molar triturating surface broad, oval, with tiny denticles and small setae on posterior edge; ventral edge flattened into angular blade. Mandibular palp well-developed and functional; flattened distal article strongly curled laterally. Bases of pereopods I-IV subequal to body depth. Bases of pereopods V-VII subequal, short, and robust. Uropods short, biramous; protopod broad or tubular, not leaflike; exopod subequal to or shorter than endopod.

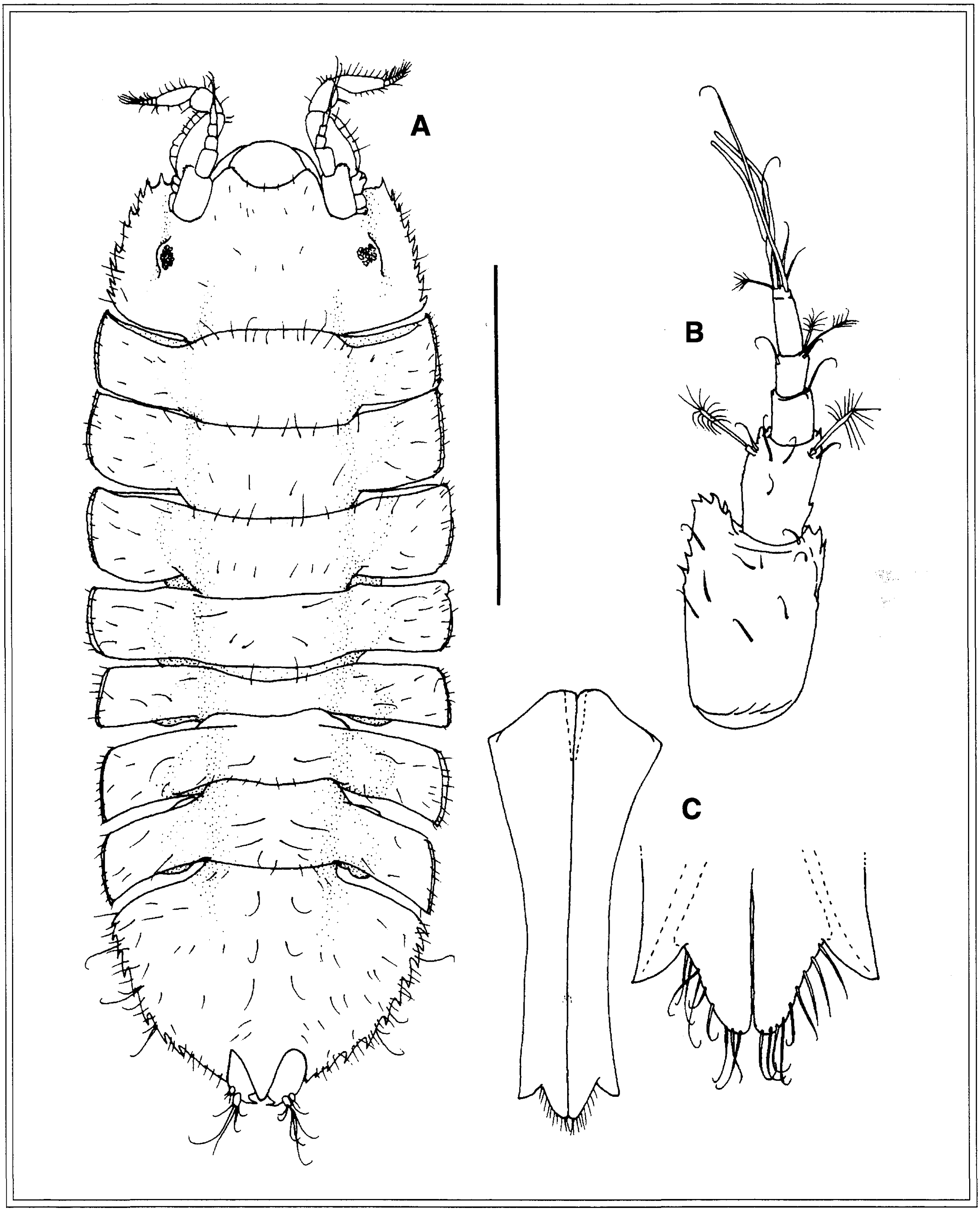


Figure 1.36. *Joeropsis* sp. A. A-B, brooding female from Phase I Sta. BRA-6. A, body dorsal view, scale bar = 1 mm. B, antennula. C, male pleopod I with enlargement of distal tip, male specimen from same station.

Eurycope californiensis Schultz, 1966

Figure 1.37

Eurycope californiensis: Schultz, 1966:4, 8, 28-29.

Material Examined. California, Santa Maria Basin, off Point Sal, Sta. R-7, 565 m (1 female, illustrated; another female); off Purisima Point, Sta. 50, 591 m, (3, illustrated male); off Point Arguello, Sta. 63, 930 m, (1 female).

Description. *Eurycope* (Eurycopinae) with deep, vaulted, and rounded natasome. Venter of natasome with no enlarged or recessed areas; tergal articulations dorsally distinct. Pereonite 7 medially longer than pereonites 5-6; bullae on the ventrolateral surface of pereonite 7 indistinct. Pleotelson posterolateral margin only slightly angled downward compared in lateral view to anterolateral margin. Rostrum of cephalon broadly acute, anteriorly rounded, only slightly overhanging frons, lacking setae, spines, or lateral keels. Body without dorsal or lateral spines. Antennular first article broad, medial lobe with around 4 sensillate setae, lateral lobe with short, conical setae. Mandible with narrow molar process having numerous distal denticles surrounding triturating surface. Mandibular palp large, well-developed, with distal article strongly curled laterally. Maxilliped with normal 5 articled palp. Pereopod I-IV bases subequal and elongate, lengths longer than axial length of cephalon and pereonites 1-4. Pereopod V-VII bases robust, short and subequal, basis VII with only one small seta. Male pleopod II protopod lateral fields only slightly recurved ventrally; distal tip with short narrow projection. Uropods robust and biramous; protopod with modest medial lobe and distoventral fringe of sensillate setae, length subequal width; exopod longer than half length of endopod; both rami with distal tufts of sensillate setae; endopod with several penicillate setae.

Biology. Genera and species of the Eurycopinae are strongly swimming, epibenthic animals, usually found on soft deep-water substrates. Hessler and Strömberg (1989) review most of what is known about their behavior. Compared to other asellotes, members of the genus *Eurycope* are often large, with much higher biomass concentrations than other more abundant but smaller species. Analyses of their population biology (Wilson, 1981, 1983a-b) suggests that some abyssal members of *Eurycope* may grow rapidly to an adult size (as evidenced by the rarity of intermediate life stages) and reproduce multiple times as adults (shown by various sizes of copulatory adults as well as a strong and broad modal distribution of adults).

Remarks. *Eurycope californiensis* resembles members of the *Eurycope complanata* complex (see Wilson, 1983a). However, it differs from that group in the following features: rostrum distally rounded, lacking a distinct anterior notch; no distinct bullae on the ventrolateral surface of pereonite 7; lateral fields of pleopods II not strongly recurved; and uropodal protopod not broader than long. Schultz (1966) described this species with a reduced palp. Actually, the palp is quite normal but is often broken off during collection and processing. The specimens that lack the palp can be seen to have a distinct socket where the palp was prior to breaking off.

Type Locality and Type Specimens. Holotype female, body length 3.5mm. R/V *Velero IV* station 7032. Newport Canyon, 33°31.29'N, 117°54.95'W, 478m. Collected with green mud and gray sand, some very coarse.

Distribution. Newport Canyon to Santa Maria Basin, upper and middle slope depths, 478 to 930m.

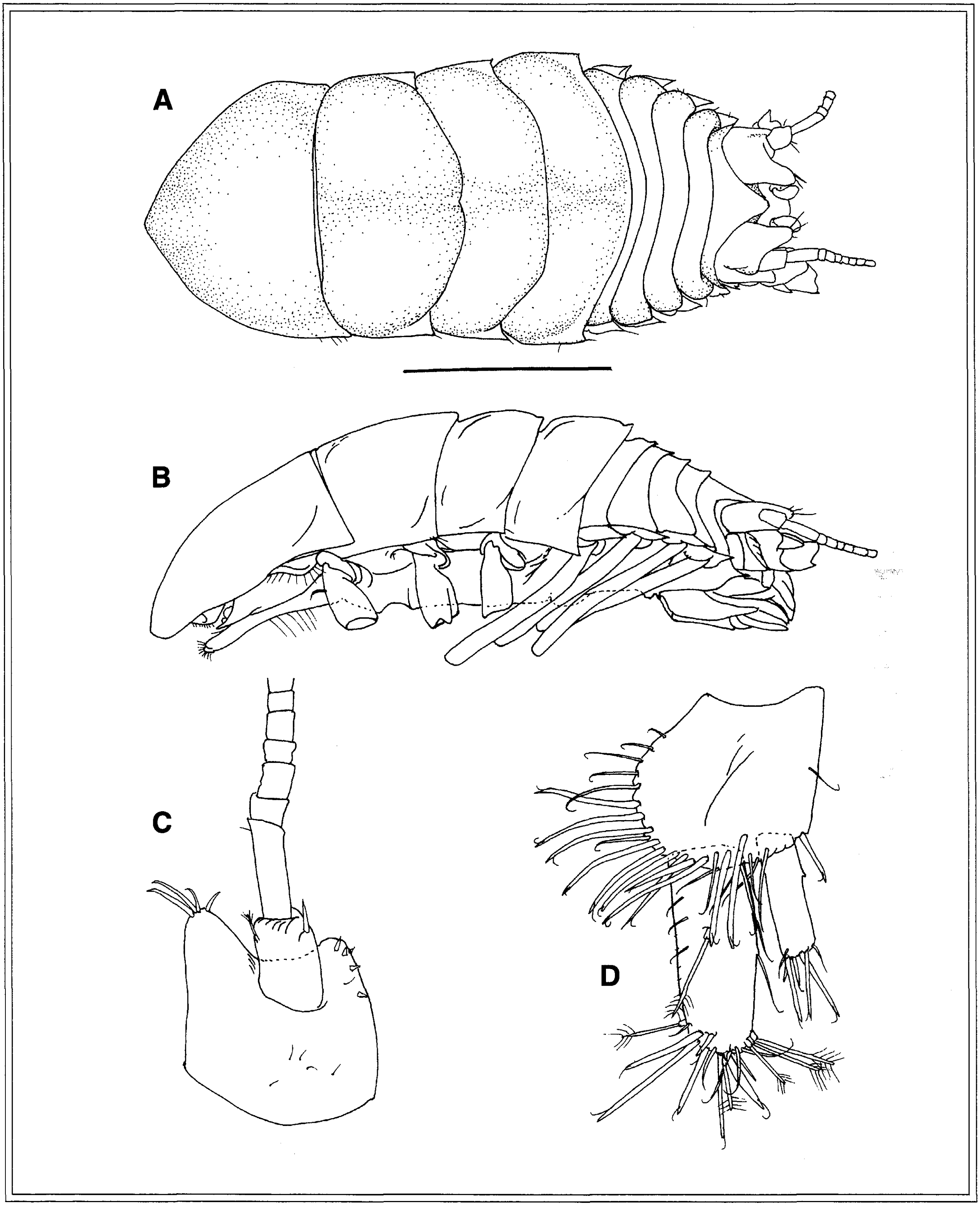


Figure 1.37. *Eurycope californiensis* Schultz, 1966. A-C, copulatory male (Phase I Sta. 50), dorsal lateral views of body (scale bar = 1 mm), and enlargement of antennular basal article. D, preparatory female (Phase II Cruise 3-4, Sta. R7), left uropod, ventral view.

Genus *Belonectes* Wilson and Hessler, 1981

Description (from Wilson and Hessler, 1981). Eurycopinae with elongate, streamlined natasome; venter with pronounced medial bump at posterior margin of pereonite 5, becoming abruptly recessed dorsally posterior to bump. Pereonite 4 with distinct ventromedial bump. Pereonites 5 and 6 fused dorsally, pereonite 7 smaller and narrower than combined pereonites 5 and 6. Rostrum of cephalon broad, quadrate, sloping directly into low frons; clypeus dorsally prominent, approximately half length of labrum. Pleon posterolateral margin angles distinctly upward in lateral view. Antennular first article trapezoidal, lacking medial lobe. Mandibular molar thin, obliquely truncate distally; ventral margin flattened into angular blade; posterior margin with tiny denticles and small setae. Mandibular condyle shorter than molar process. Mandibular palp distal article somewhat reduced, curled approximately 90° laterally. Bases of pereopods I-IV elongate and subequal; bases of natatory pereopods differing from one another; pereopod V basis shortest and widest, pereopod VI longest but intermediate in width, pereopod VII basis thinnest but intermediate in length. Uropods short, biramous protopod, tubular; exopod tiny; endopod more than twice length of protopod.

Belonectes sp. A

Figure 1.38

Material Examined. California, Santa Maria Basin, off Point Arguello, Sta. 72, 401 m (1 preparatory female, illustrated).

Description. *Belonectes* (Eurycopinae) with elongate, streamlined natasome, distinctly narrowing at pereonite 7. Rostrum of cephalon broad, sloping medially to low frons but with laterally flaring anterior lobes with thin fringes. Clypeus of cephalon prominent in dorsal view. Ventromedial surface of pereonite 5 with distinct bump, becoming recessed posterior to bump. Pereonites 5 and 6 fused dorsally, pereonite 7 smaller and narrower than pereonites 5 and 6. Pleotelson posterolateral margin angling distinctly upward in lateral view. Pleonal preanal ridge not enlarged and prominent. Antennular first article oval, wider proximally than distally. Bases of pereopods I-IV elongated and subequal. Pereopod bases V-VII differing in length and width: basis V shortest and widest, basis VI longest, basis VII thinnest. Uropods short, biramous; protopod parallel sided; exopod very small; endopod less than twice length of protopod.

Biology. See remarks under *Eurycope californiensis*. *Belonectes* tend to be much smaller both in body size and in population size than *Eurycope*, and therefore comprise a much smaller part of the benthic biomass.

Remarks. Unlike any of the known species or undescribed species of *Belonectes* from the Atlantic (see Wilson and Hessler, 1981), this species has a distinctive broad and laterally flaring rostral area of the cephalon. Unfortunately the only specimen examined had a damaged pleotelson, so the illustrated shape should not be trusted for accuracy. Within the Santa Maria Basin, this eurycopine species is distinctive with broad indented and laterally flaring rostrum, waisted pereonite 7 and narrow uropods with tiny exopods.

Type Locality and Type Specimens. No type locality - this species is undescribed.

Distribution. Santa Maria Basin, 401 m.

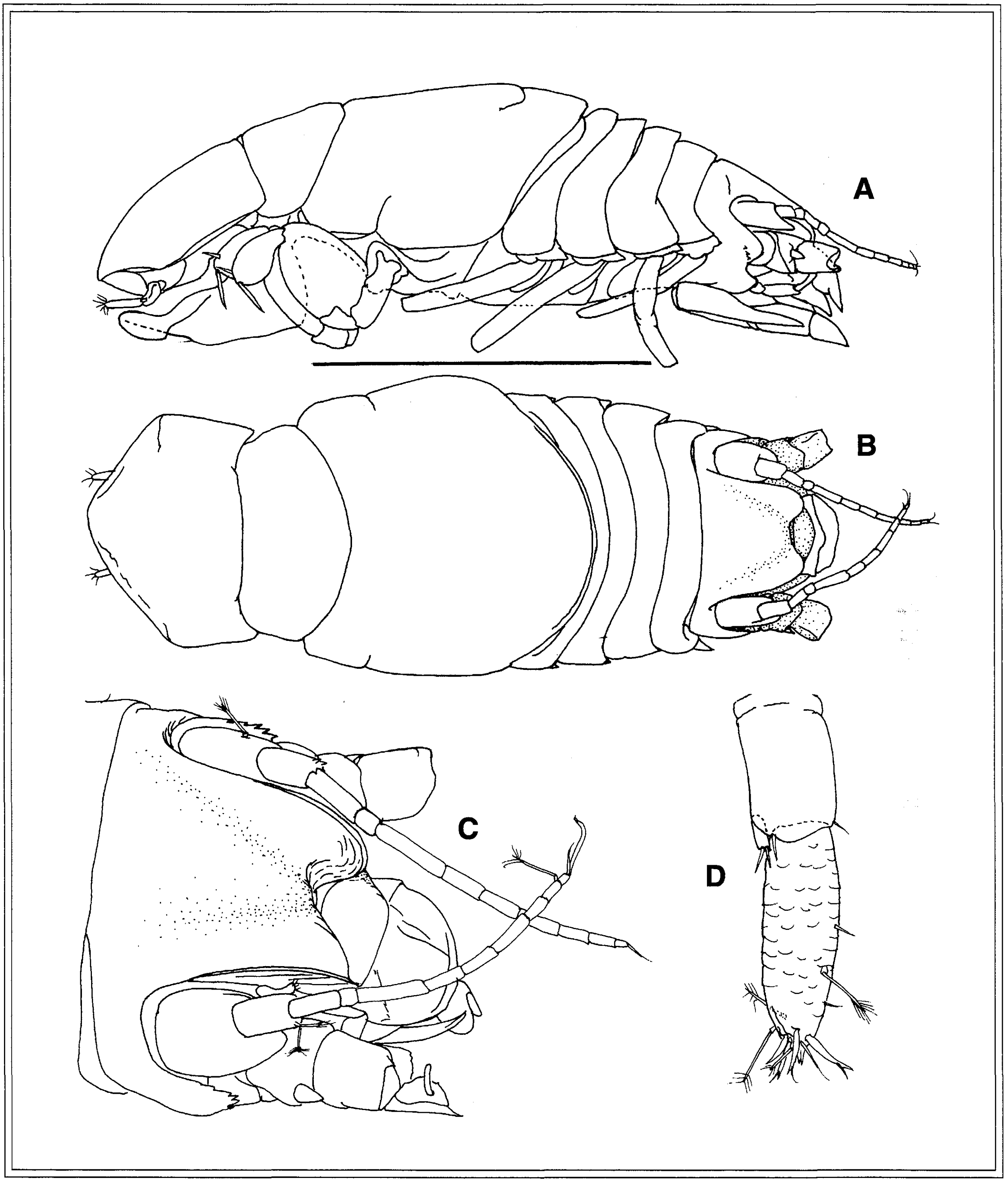


Figure 1.38. *Belonectes* sp. A, preparatory female, Phase I Sta. 072. A-B, body, dorsal and lateral views, scale bar = 1 mm. C, cephalon, lateral oblique view. D, right uropod, ventral view.

Subfamily Ilyarachninae Hansen, 1916

Genus *Ilyarachna* Sars, 1870

Description. Head much broader than long, with flattened frons, lacking rostal projections, antennulae medially adjacent; clypeus and labrum reduced, much narrower than head. Body with distinct natasome, natasome without stout dorsal setae. Pleonite 1 distinct dorsally. Pleotelson dorsally subtriangular. Antennulae with multiarticulate flagellum. Mandibular incisor process robust, teeth broad rounded; molar process reduced, distally tapering and setose; dorsal condyle elongate, curving; palp shorter than mandibular body, with 3 articles. Pereopods I-II length subequal, both prehensile. Pereopods III-IV extremely long, ambulatory, bases short and robust, lengths nearly as short as wide. Pereopods V-VI carpus-propodus paddle-like, fringed with plumose setae. Pereopod VII carpus-propodus narrow, but fringed with plumose setae. Uropodal protopod flattened and foliacious, longer than rami; exopod tiny or absent.

Ilyarachna acarina Menzies and Barnard, 1959

Figure 1.39

Ilyarachna acarina: Menzies and Barnard, 1959:9-10; Menzies, 1962:136; Wolff, 1962:96-97; Schultz, 1964:310; Schultz, 1966:9; Hessler and Thistle, 1975:157; Thistle, 1979:382-384.

Material Examined. Off Purisima Point, Sta. R-5, 154 m (14, illustrated 1 large female with most legs intact; 10 from another replicate; 3 damaged specimens from another sample).—Western Santa Barbara Channel, Sta. 87, 299 m (2 damaged specimens).

Description. Head short and broad, with decidedly projecting lateral cheeks bearing mandibular articulations; cephalic dorsal vertex with 10-15 stout setae in adult. Pereonites 1-4 freely articulated, with 11-16 large pedestal setae on anterior dorsal margins; pereonite 4 with distinct anterolateral projection with several setae. Pereonites 5-7 with visible sutures, narrowing posteriorly. Tergites 5-7 and pleotelson with scattered fine setae dorsally. Pereonal sternum lacking spines. Pleotelson subtriangular in dorsal view, with uropods projecting posteriorly. Antennula article 1 with several setae; article 2 length subequal article 3. Antenna basal article with lateral projection having 3-4 setae. Mandible heavily sclerotized, incisor process massive, molar process reduced to small setose flap; mandibular palp present but reduced; distal article not curled, paucisetose. Pereopods I-II short, somewhat prehensile, pereopods III-IV extremely elongate with bases only slightly longer than wide. Pereopod I coxal plate with 2-3 setae; pereopod II coxal plate with 1-2 setae. Pereopod II basis fringed by long setae on anterior and posterior surfaces. Pereopods V-VII decreasingly natatory toward the posterior end of the body, with pereopod VII nearly completely ambulatory. Female operculum with setose median keel. Male pleopod I elongate, tapering to narrow distal tip with narrow projecting lateral lobes and non-projecting medial lobes with 6-7 setae. Uropodal protopod broad, flattened, leaf-like; exopod completely fused to protopod and reduced to two setae on protopod.

Biology. Ilyarachnines are interesting because they are known to burrow despite their munnopsid abilities of swimming (Hessler and Strömberg, 1989). They walk on soft substrates with on elongate pereopods III and IV, probing with the anterior 2 pairs of pereopods. They can burrow into the mud posteriorly, pushing sediment with their "natatory" pereopods, and are often found at rest with their entire body in the mud with only their long antennae and pereopods III-IV protruding radially from surface. If sufficiently disturbed, they will take to the water with short spasmodic strokes. This, however, does not last for long and they will settle to the bottom and either walk away or burrow into the sediment. Like *Munnopsurus*, their powerful jaws suggest that they can feed on shelly or hard food items. Males seem to be much smaller than females in this species: the illustrated preparatory female was 3.9mm long, while a fully adult male was only 2.0mm long.

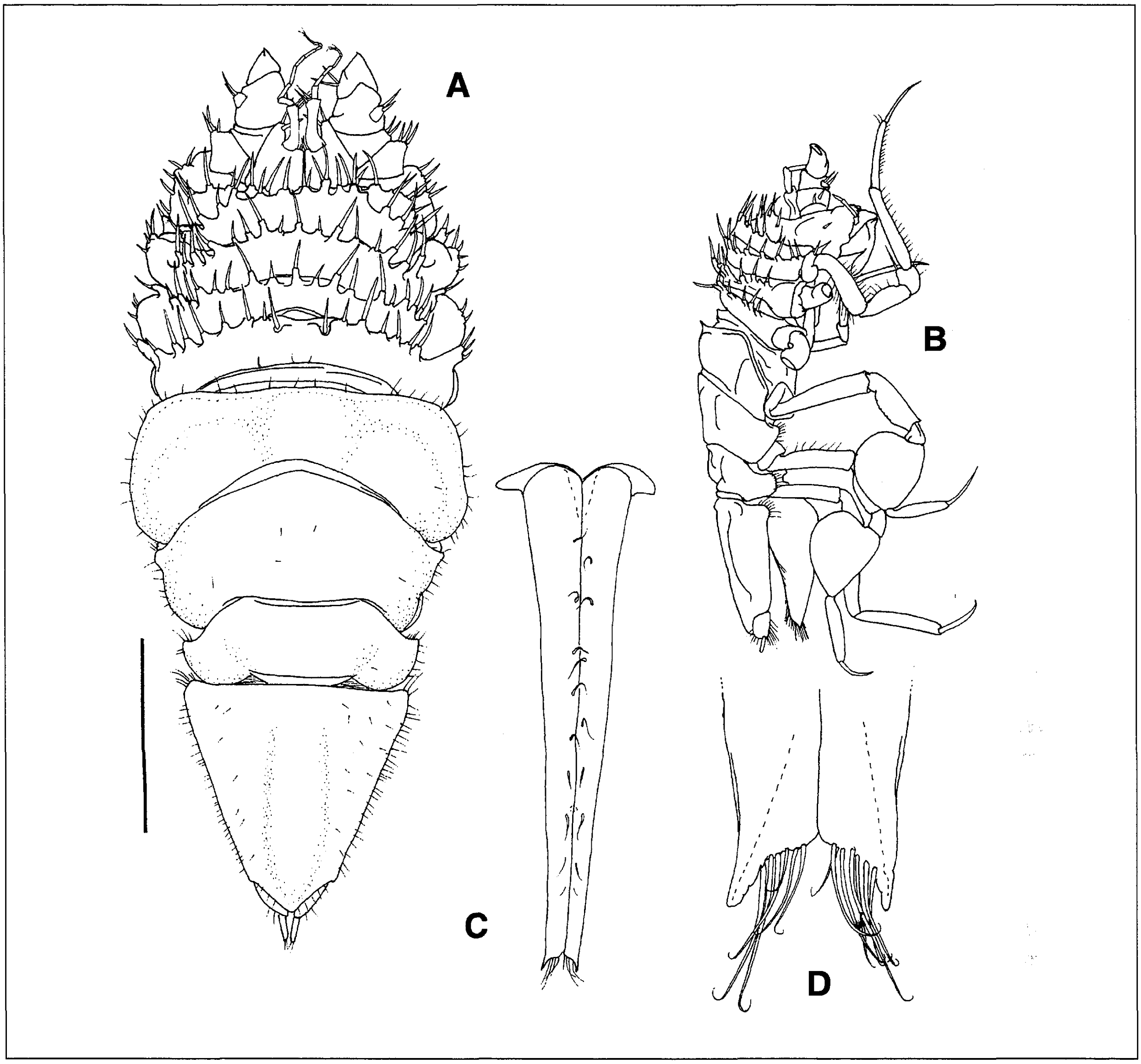


Figure 1.39. *Ilyarachna acarina* Menzies and Barnard, 1959. A-B, body lateral and dorsal views, scale bar = 1 mm, preparatory female from MMS Phase II, Cruise 3-4, Sta. R-5. C-D, male pleopod II ventral view and distal tip, male from same station.

Remarks. Thistle (1979) provides sufficient information to separate *Ilyarachna acarina* from *I. profunda* Schultz, 1966, both found in Californian waters. The best character that allows distinguishing both two species is the large pedestal setae on the anterior margin of pereonites 1-4 in *I. acarina*; *I. profunda.* has much smaller non-pedestal setae on anterior pereonite margins. Menzies and Barnard (1959) thought their species was similar to *I. denticulata* Sars, 1897b, although *I. acarina* has considerably larger pedestal setae on the anterior margins, and has distinct anterolateral projections on pereonite 4. Mancas of *I. acarina*, however, lack pedestal setae or have few of them, so one should check the developmental stage of specimens before arriving at an identification.

Type Locality and Type Specimens. Holotype brooding female, 4.3mm long, Allan Hancock Foundation collection number 578. Off coast of California, R/V *Velero* Sta. 4980, 34°15.8'N, 119°34.5'W, 92m.

Distribution. Off Southern California from Santa Maria Basin to off Pt. Loma, 73-1118m.

Subfamily *incertae sedis*

Genus *Munnopsurus* Richardson, 1912

Description. Head broad, vaulted, frons flattened with heavily cuticularized frontal arch; clypeus angled sharply dorsally, subtriangular in anterior view, laterally extending near lateral margins of head; vertex distinctly separating antennular insertions dorsally. Pereonites 1-4 freely articulated. Body with distinct natasome, natasomal somites free, including pleonite 1. Pleotelson broad, rounded, often inflated. Antennular article 1 flattened, longer than wide, lacking distinct medial lobe. Mandibular incisor molar process broad, heavily cuticularized, wider than long; dorsal condyle elongate, curving. Pereopod I slender, not prehensile. Pereopods II-IV elongate, thin, paucisetose, subequal; bases many times longer than wide. Pereopods V-VII carpus-propodus paddle-like, fringed with plumose setae. Uropod small, biramous; protopod tubular, shorter than rami.

Munnopsurus sp. A

Figure 1.40

Material Examined. California, Santa Maria Basin, off Point Buchon, Sta. 15, 393 m (1 preparatory female); off Point Sal, Sta. R-9, 410 m (3, including 2 males, 1 with Per IV, and 1 female; second sample with 3 individuals: 1 male, 1 mashed female, and 1 manca stage 3); Sta. R-7, 565 m (1 brooding female); off Point Arguello, Sta. 62, 582 m (1, brooding female).

Description (generic characters modified from Wolff, 1962). Small body size, adults with body length around 1.8 mm. Head as broad as pereonite 1, vaulted posteriorly, with flattened frons; frontal arch strongly calcified, semicircular; labrum and clypeus triangular. Dorsal surfaces of body with scattered fine simple setae. Pereonites 1-4 free and loosely articulated. Pereonites 5-7 lengths subequal and freely articulated. Pleotelson rounded in dorsal view, somewhat inflated. Antennula with no medial projection, distally flattened; flagellum in both sexes short with few articles, antennular article count 15 or less; article 2 with no medial projection, inserting around quarter length of article 1 from distal tip. Molar process of mandible broad and simple, but distinctly projecting; mandibular palp article 3 fully functional, curved and setose. Maxillipedal second article with strongly oblique anterior margin. Pereopod I not prehensile, elongate and thin. Pereopods II-IV long and slender, more than twice body length. Pereopods V-VII short, with carpi no longer than depth of body. Male pleopod I elongate and narrow, distinctly waisted proximally and broadening distally; lateral lobe on distal tip broadly recurved, projecting distally approximately half distance of medial. Male pleopod II with endopod and exopod reduced, placed distally in last fifth of protopod. Uropods short, biramous, somewhat inflated; exopod distinctly longer than protopod.

Biology. Little is known about the biology of species of *Munnopsurus*. Their somewhat reduced natapods suggests a reduction in the swimming lifestyle, while their elongate legs (typical in munnopsids) is in line with a soft bottom, deep-water habitat. The distinctive feature of the genus, the powerful mouthparts, suggests an adaptation for crushing large hard objects, such as foraminifera (as suggested for *Amuletta*; see Wilson and Thistle, 1985). This species has more eurycopine-like mouthparts and therefore is probably somewhat more of a generalist.

Remarks. *Munnopsurus* sp. A is most similar to *M. minutus* Gurjanova, 1933, although it differs by being distinctly smaller with body lengths around 2 mm (a 7mm deep-sea asellote isopod is not *minute*, so one wonders why Gurjanova gave it this name), by the lack of dorsal tubercles on pereonites 5-7, by having a somewhat inflated and rounded pleotelson, and in having somewhat more articles in the antennula. *M. minutus* Gurjanova, *M. atlanticus* Beddard, and *M.* sp. A are some what different from the remainder of *Munnopsurus*

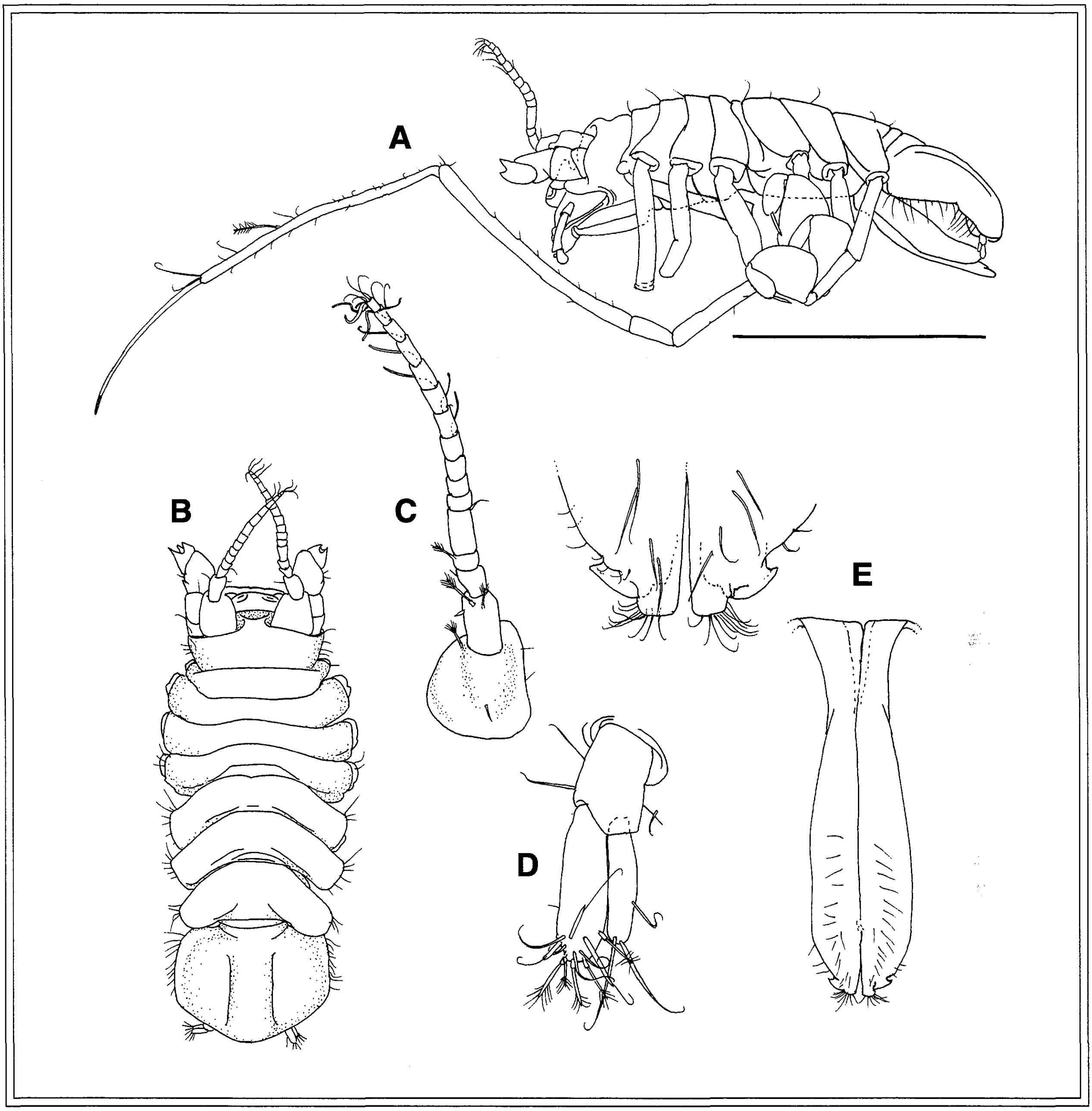


Figure 1.40. *Munnopsurus* sp. A. A-B, body dorsal and lateral views, scale bar = 1 mm, copulatory male, Phase II, Cruise 1-2, Sta. R-9. C, right antennula. D-E, male pleopod I, ventral view with enlargement of distal tip. F, left uropod, ventral view.

species in having a more plesiomorphic eurycopine-like mandible with a functional mandibular palp and a strengthened but not massive mandibular molar and incisor. See remarks under *Munnopsurus* sp. B for separating the two congeners within the Santa Maria Basin.

Type Locality and Type Specimens. None. This species is not described.

Distribution. Santa Maria Basin, 393-582m.

Munnopsurus sp. B

Figure 1.41

Material Examined. California, Santa Maria Basin, off Point Arguello, Sta. 63, 930 m (2, adult male, juvenile female, both specimens squashed by labels in vial).

Description (generic characters modified from Wolff, 1962). Large body size, adults with body length around 7 mm. Head huge, distinctly broader than pereonite 1, vaulted posteriorly, with flattened frons; frontal arch heavily calcified, semicircular, distinctly projecting; labrum and clypeus triangular. Dorsal surfaces of body smooth, with few simple setae. Pereonites 1-4 free and loosely articulated. Pereonites 5-7 lengths subequal and freely articulated. Pleotelson rounded in dorsal view, somewhat inflated. Antennula with no medial projection, distally flattened; flagellum in both sexes elongate, antennular article count much more than 15 (around 45 in male); flagellar articles of male conjoint proximally, intermediate articles wider than long; article 2 with small medial projection, inserting around half length of article 1 from distal tip. Mandible huge, heavily cuticularized; incisor process blunt; molar process broad and simple, not projecting; mandibular palp article 3 thin, reduced, not curved or setose. Maxillipedal second article with strongly oblique anterior margin; basis with 6 coupling hooks. Pereopod I not prehensile, elongate and thin. Pereopods II-IV long and slender. Male pleopod I elongate and narrow, more or less parallel-sided; lateral lobe on distal tip laterally straight, not recurved, projecting distally as far as medial lobe. Male pleopod II with endopod and exopod reduced, placed distally in last fifth of protopod. Uropods thin, biramous; exopod approximately same length as protopod.

Biology. See remarks on the biology of *Munnopsurus* sp. A. The huge jaws of this species indicates they can crush fairly heavy things.

Remarks. *Munnopsurus* sp. B is somewhat similar to *M. longipes* (Tattersall, 1905), although the male pleopods are different. Unlike *Munnopsurus giganteus* (Sars, 1879) or *M. ochotensis* (Gurjanova, 1933), *M.* sp. B has a larger and wider cephalon (Both the first two taxa are considered by most authors to be subspecies of *M. giganteus* (Sars), although there is no evidence for their being conspecific. Therefore, they should be thought of as distinct species.). The huge mouth parts of *M.* sp. B makes this species a member of *Munnopsurus* sensu stricto. Although not listed in the description, the dorsal mandibular muscle insertions attachments provide an easy way to separate cephalon fragments of *M.* sp. A and *M.* sp. B: if they are few and large, the fragment is sp. A, and if they are many and small, it is sp. B. This sorting character will work only within this basin where these two species may appear in the same series of samples. Outside of the Santa Maria Basin, other species may have similar patterns of dorsal mandibular muscle insertions.

Type Locality and Type Specimens. None. This species is not formally described.

Distribution. Santa Maria Basin, 930 m.

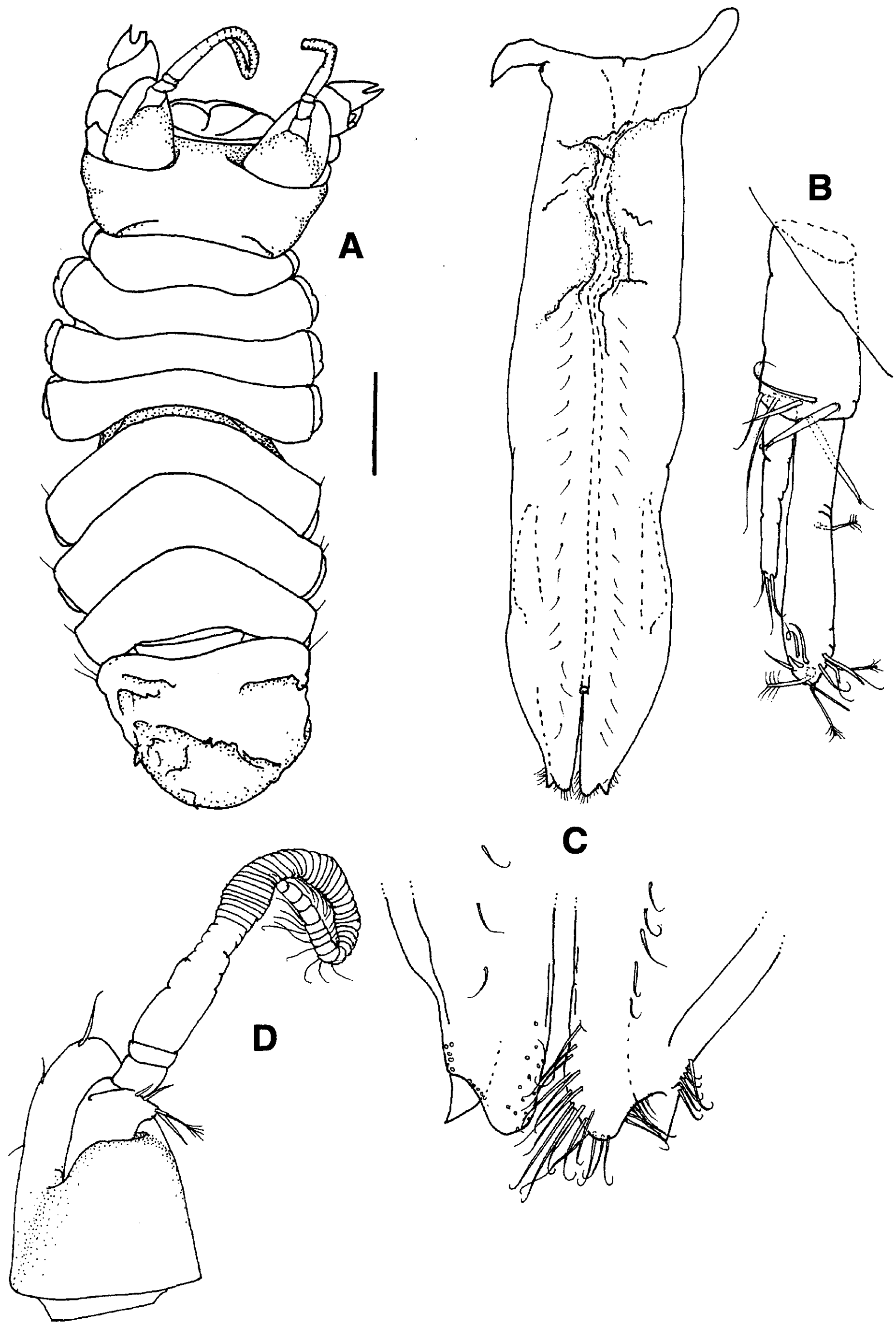


Figure 1.41. *Munnopsurus* sp. B. A, copulatory male (Phase I, Sta. 63), dorsal view, pleotelson damaged, scale bar = 1 mm. B, left antennula. C, male pleopod I, ventral side, and enlargement of distal tip. D, right uropod, ventral view.

Family Nannoniscidae Hansen, 1916

Genus *Nannonisconus* Schultz, 1966

Description. (from Schultz, 1966, 1969 and Siebenaller and Hessler, 1981) Antennula extending only slightly anterior of cephalon; 5-segmented, with bulbous distal article. Cephalon without anterolateral lobes. Pereonite 7 fused with pleon. Pleon of single somite and at widest point wider than cephalon or pereon. Lateral outline of body concave. Male pleopods I not apically pointed; proximal part much narrower than the medial or distal part. Uropods biramous.

Nannonisconus latipleonus Schultz, 1966

Figure 1.42

Nannonisconus latipleonus: Schultz, 1966:3, 11, 35; Siebenaller and Hessler, 1981:248-249.

Material Examined. California, Western Santa Barbara Channel, off Point Conception, Sta. 81, 294 m (1 manca stage 3 individual).

Description. Broad-bodied Nannoniscidae with pereonite 6-7 and pleotelson fused medially. Rostrum distinct with small lateral keels. Lateral flanges on margins of pereonites and pleotelson. Pleotelson with distinct posterolateral spines, somewhat confluent with lateral flanges; anal region distinctly projecting from remainder of pleotelson. Venter of pereonites without large spines, although pereonite 6 may have small spine projecting from anterior margin. Pleon at widest point wider than cephalon or pereon. Lateral outline of body concave in dorsal view. First antenna with 5 articles, distal article bulbous. Female pleopod large, covering almost entire ventral surface of pleotelson. Uropodal exopod more than two thirds length of endopod.

Biology. Typical for all nannoniscids, *Nannonisconus latipleonus* is likely to be a generalized detritivore that lives on soft bottoms or perhaps is associated with biogenic substrates (Levin *et al.*, 1986). Sexual dimorphism is common in the family, and although the manca stage 3 specimen illustrated here is largely similar to the male specimen illustrated by Schultz (1966), a fully mature male may have broader lateral flanges on the pereonites and pleotelson. Although detailed quantitative surveys have not been made at the localities described herein, the rarity of specimens (2 to date) suggests that this species is not a dominant component of the benthic community.

Remarks. *Nannonisconus carinatus* Mezhov, 1986 may be conspecific with *N. latipleonus*. Schultz (1966) does not appear to have described a fully mature male because the appendix masculina on the pleopod II, as illustrated in his plate 6, is short and blunt. The appendix masculina should be long and distally thin in a fully mature male as in *N. carinatus*. All apparent differences between the two species, such as broader lateral flanges on the body, could be explained by ontogenetic changes taking place during the maturation to the male moult. Neither type has been examined at this point so it is not possible to demonstrate this with certainty, although the reader should be aware of this problem when making identifications. If the two names are indeed conspecific, then the total distribution extends from Southern California to Alaska Bay.

Type Locality and Type Specimens. Holotype male, 2.8 mm long, R/V *Velero IV* station 2793: 33°48.0'N, 118°32.0'W, Redondo Canyon, 465 m, 22 May 1954, blue-gray mud and large rocks (from Schultz, 1966).

Distribution. Shallow bathyal slopes of Southern and Central California (but see remarks above), collected at only 2 stations 190 km apart.

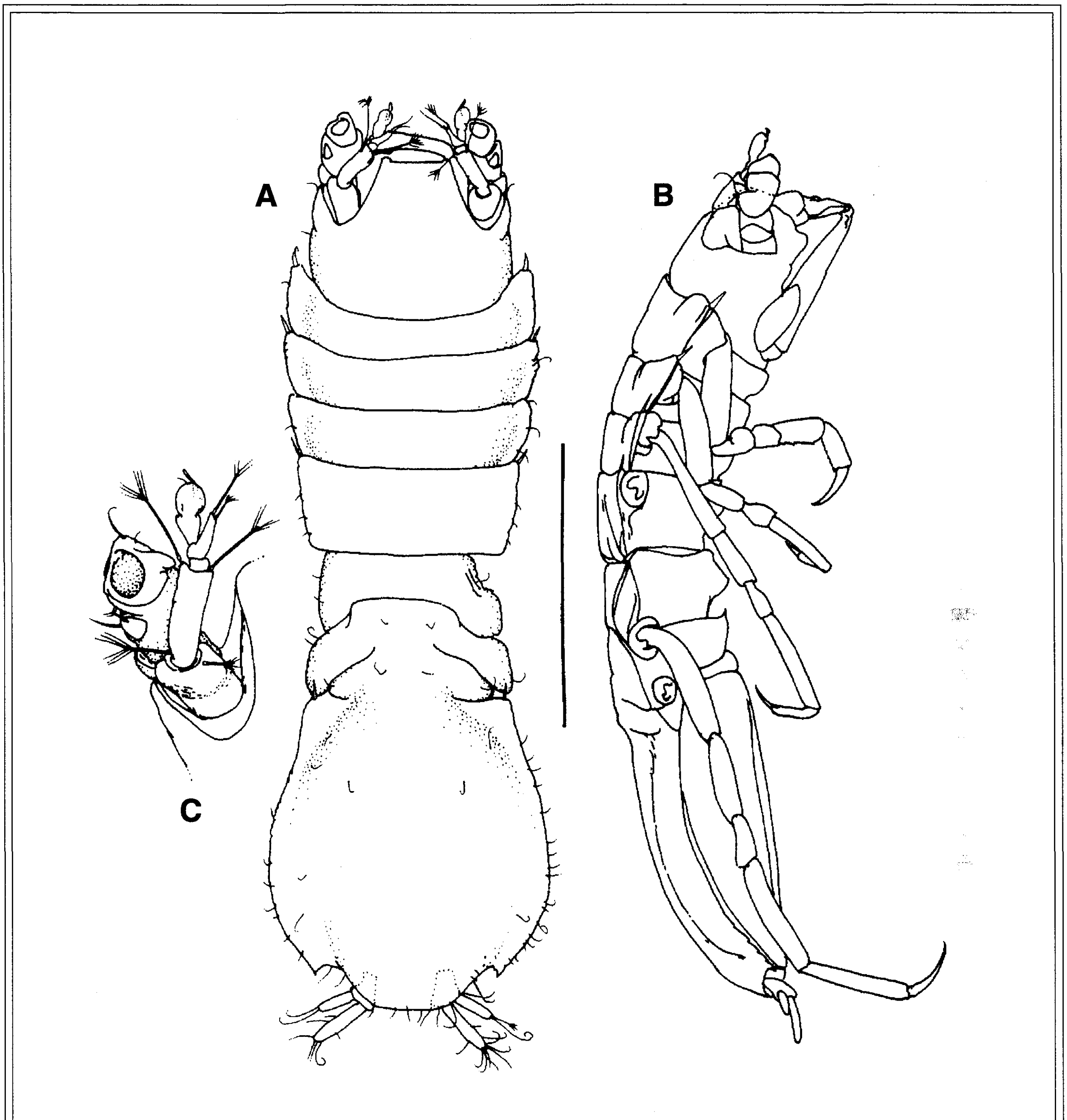


Figure 1.42. *Nannonisconus latipleonus* Schultz, 1966. Manca stage 3 specimen, Phase I Sta. 81, body length 1.5 mm, scale bar = 0.5 mm. A, body, dorsal view. B, body, lateral view. C, enlargement of antennula and base of antenna, in situ on head.

Family Desmosomatidae Sars, 1897

Genus *Momedossa* Hessler, 1970

Description. (from Hessler, 1970) Pleotelson with posterolateral spines, in female widest anteriorly. Uropod biramous. Cuticle of body well sclerotized. Pereonites 1 and 2 subequal in size. Pereopods long. Pereopod I moderately reduced; carpus and propodus somewhat attenuated; propodus without major setae; carpus with row of major setae only ventrally. Coxae of pereopods I-IV in female only moderately produced. Sexual dimorphism modest; in known copulatory males (*M. profunda, M. symmetrica*) coxae of pereopods I-IV somewhat more strongly produced and pleotelson widest at posterolateral spines.

Momedossa symmetrica (Schultz, 1966)

Figure 1.43

Desmosoma symmetrica: Schultz, 1966:3, 5, 7, 26-27.

Momedossa symmetrica: Hessler, 1970:62, 77.

Material Examined. California, off San Francisco, Gulf of the Farallones, numerous specimens collected Aug 1990, R/V *Farnella*, by J.A. Blake, as part of U.S. Navy 103 survey of proposed deep-water disposal site: Sta. S-19, 37°38.41'N, 123°24.36'W, 2580m, 13 Aug 90; Sta. I-19, 37°38.38'N, 123°27.77'W, 2835m, 13 Aug 90; Sta. E-19, 37°38.40'N, 123°29.21'W, 2955m, 14 Aug 90; Sta. K-15, 37°39.38'N, 123°27.23'W, 2830m, 14 Aug 90; Sta. E-07, 37°41.64'N, 123°29.16'W, 2462m, 15 Aug 90.

Description. Head with spines projecting lateral to antennulae and antennae; dorsal surface of head without longitudinal furrows. Pleotelson with posterolateral spines; pleotelson sexually dimorphic: broadest anteriorly in female, posterolateral spines larger and more distinct in male, and pleotelson more vaulted in male. Cuticle of body well sclerotized. Pereonites 1 and 2 subequal in width and length. Pereonite 5 laterally convex in dorsal view. Coxae of pereopods I-IV with distinct anterior spines, larger in male. Pereopod lengths distinctly greater than half body length. Pereopod I only moderately reduced but distinctly smaller than pereopod II, propodus without major setae; carpus with ventral row of major sensillate setae only, most distal sensillate seta longer than adjacent penultimate sensillate seta (synapomorphies of the Desmosomatinae). Pereopods II-III similar, propodi and carpi somewhat broadened with rows of both dorsal and ventral sensillate setae. Ventral margins of meri and ischia I-III with no more than 3 sensillate setae. Pereopods V-VII carpi and propodi with distinctly fewer than 10 setae. Uropod biramous, exopod tiny compared to long thin endopod.

Biology. Desmosomatids are epibenthic or shallow burrowing detritivores (Thistle and Wilson, 1987; Hessler and Strömberg, 1989), a pattern expected for *Momedossa symmetrica*. The anterior limbs may be used for burrowing in the sediment, because they are held laterally and have many lateral facing setae. This species is abundant compared to other deep water Janiroidea, and may be a dominant benthic taxon in the Santa Maria Basin. Sexual dimorphism is apparent in this species, resulting in the female being larger than the male, a typical pattern for many skinny desmosomatids.

Remarks. Although this species does not appear in the voucher collection for the Santa Maria Basin, it is included to prevent further misidentifications of the species. The male illustrated here adds to the female illustrated by Schultz (1966). Desmosomatids should be viewed on the lateral side, especially examining the head where useful characters are typically found, such as the cephalic spines. These cephalic spines are the chief feature to identify this species from most other desmosomatines, as well as from *Momodossa profunda* Hessler, 1970. Other features separating *M. symmetrica* from *M. profunda* are the convex lateral margins of pereonite 5 in dorsal view, the generally fewer setae on the pereopods and the longer posterolateral spines on

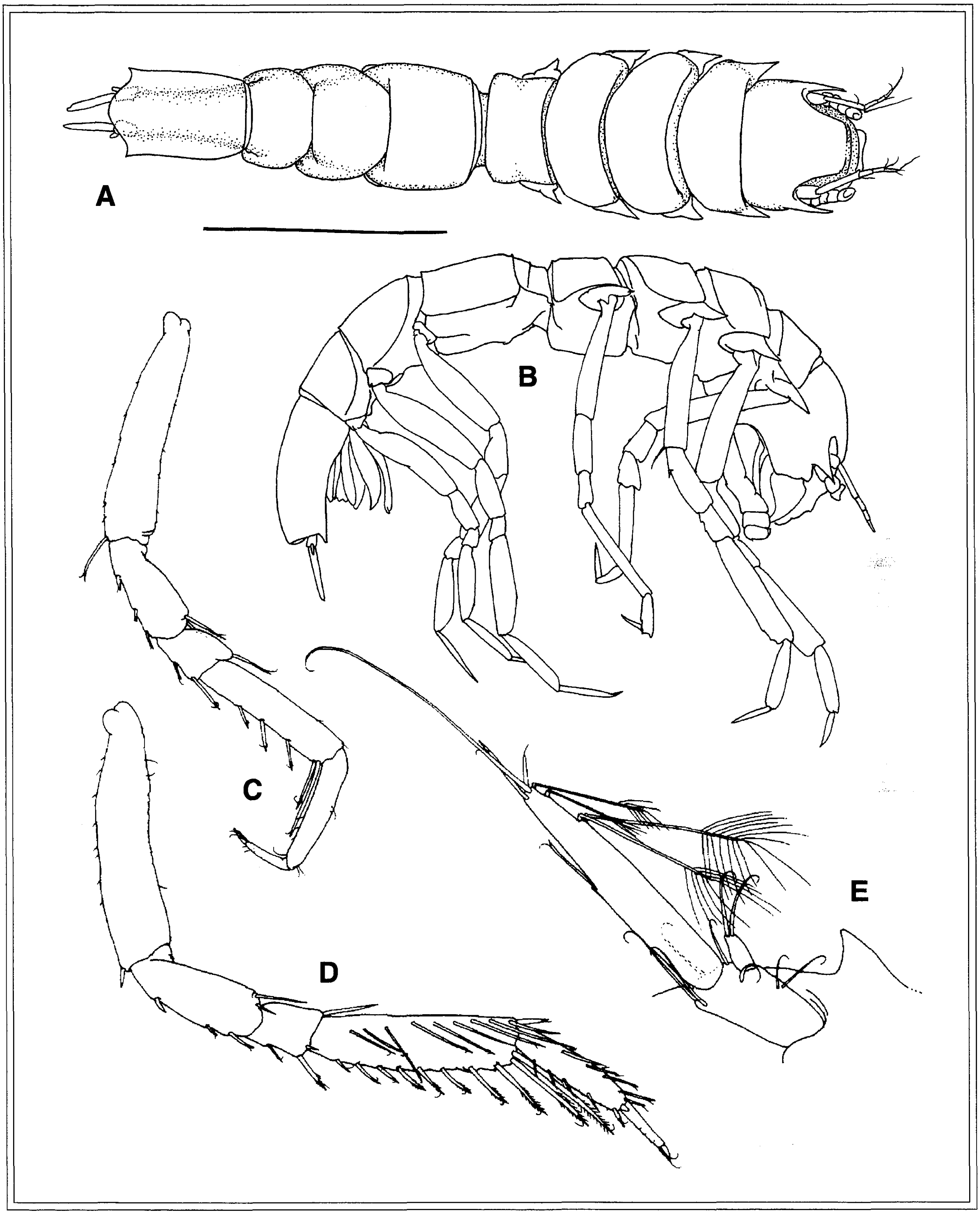


Figure 1.43. *Momedossa symmetrica* (Schultz, 1966), copulatory male (Navy 103 station). A-B, body, dorsal and lateral views, scale bar = 1 mm. C-D, pereopods I and II, right, lateral view. E, uropod, right, ventral view.

the pleotelson. The uropodal exopods, however, are similar. Biologists new to identifying Desmosomatidae should also know that this species appears to be similar to *Eugerdella cornuta* Hessler, 1970, primarily due to the cephalic and pleotelsonic spines, as well as the fewer setae on the pereopods (compared to *M. profunda*). The features of the first pereopod, such as its size and its setation that separate the Desmosomatinae from the Eugerdellatinae apply here quite clearly: the pereopod I is smaller than pereopod II and the pereopod I carpus has a distal ventral seta that is larger than the penultimate seta. The opposite situations apply for *Eugerdella cornuta*. Another desmosomatid found in the Santa Maria Basin (*Desmosoma* sp. A), is easily separated from this species by the lack of the uropodal exopods and the cephalic spines.

Type Locality and Type Specimens. Holotype brooding female, body length 3.2 mm (no paratypes). Tanner Canyon, R/V *Velero IV* station 2793: 32°36'N, 119°05.3'W, 469m, 29 January 1960, green mud with shale fragments (Schultz, 1966).

Distribution. California continental slope and submarine canyons, 469-2955 m.

Genus *Desmosoma* G.O. Sars, 1864

Description. (from Hessler, 1970) Pleotelson without posterolateral spines, broadest anteriorly. Uropod uniramous; protopod may or may not be abundantly setose. Pereonite 1 moderately to much smaller than pereonite 2. Pereopod I moderately reduced; carpus and propodus moderately attenuated; propodus devoid of major setae; carpus without major dorsal setae, but usually with ventral row of slender setae. Carpus of pereopod II broad, abundantly setose. Sexual dimorphism moderate to slight; in copulatory males pereonites 5-7 and pleotelson may be broader; coxae of pereopods I-IV may be moderately more strongly produced. In female, coxae of pereopods I-IV only modestly produced.

***Desmosoma* sp. A**

Figure 1.44

Material Examined. California, Santa Maria Basin, off Point Estero, Sta. 3, 291 m (preparatory female, brooding female); off Point Buchon, Sta. 14, Phase I Sta. 14, 299 m (3 brooding females).

Description. (All specimens in poor condition). Body long, attenuated, with thin cuticle. Frons sloping, mouth parts somewhat prognathous, without large frons-clypeal furrow (feature of the Desmosomatinae). Pereonite 1 distinctly shorter than pereonite 2. Pleotelson without posterolateral spines, at least in female. Pereopods I-IV with triangular coxae in dorsal view, basis of pereopod I subequal in length and size to basis II. Bases V-VII enlarged, muscular. Uropod elongate and uniramous, with many penicillate setae on endopod and approximately 8-10 long coil-tip setae on lateral margin; uropod length greater than half pleotelson length.

Biology. Too little material of this species was available to comment here, other than to refer the reader to the general remarks under *Momedossa symmetrica* above.

Remarks. These specimens were originally classified in the Santa Maria voucher collection as *Momedossa symmetrica*, but are easily separated from that species by the lack in *Desmosoma* spp. of the uropodal exopod and the lack of the cephalic spines seen in *M. symmetrica*. Although no specimens had pereopods, the specimens are provisionally classified in *Desmosoma* for the following reasons: (1) pereonite 1 is much smaller than pereonite 2, suggesting that the associated pereopod is at least somewhat attenuated; (2) the uropod is uniramous; and (3) the bases of pereopods V-VII are large suggesting that this species has enlarged natatory posterior pereopods, common among species of *Desmosoma*. This species, however, is unlike any other described species in *Desmosoma*, primarily because of its unusual setation of the uropod. Biologists studying this area should be aware that several undescribed species of *Desmosoma sensu stricto*

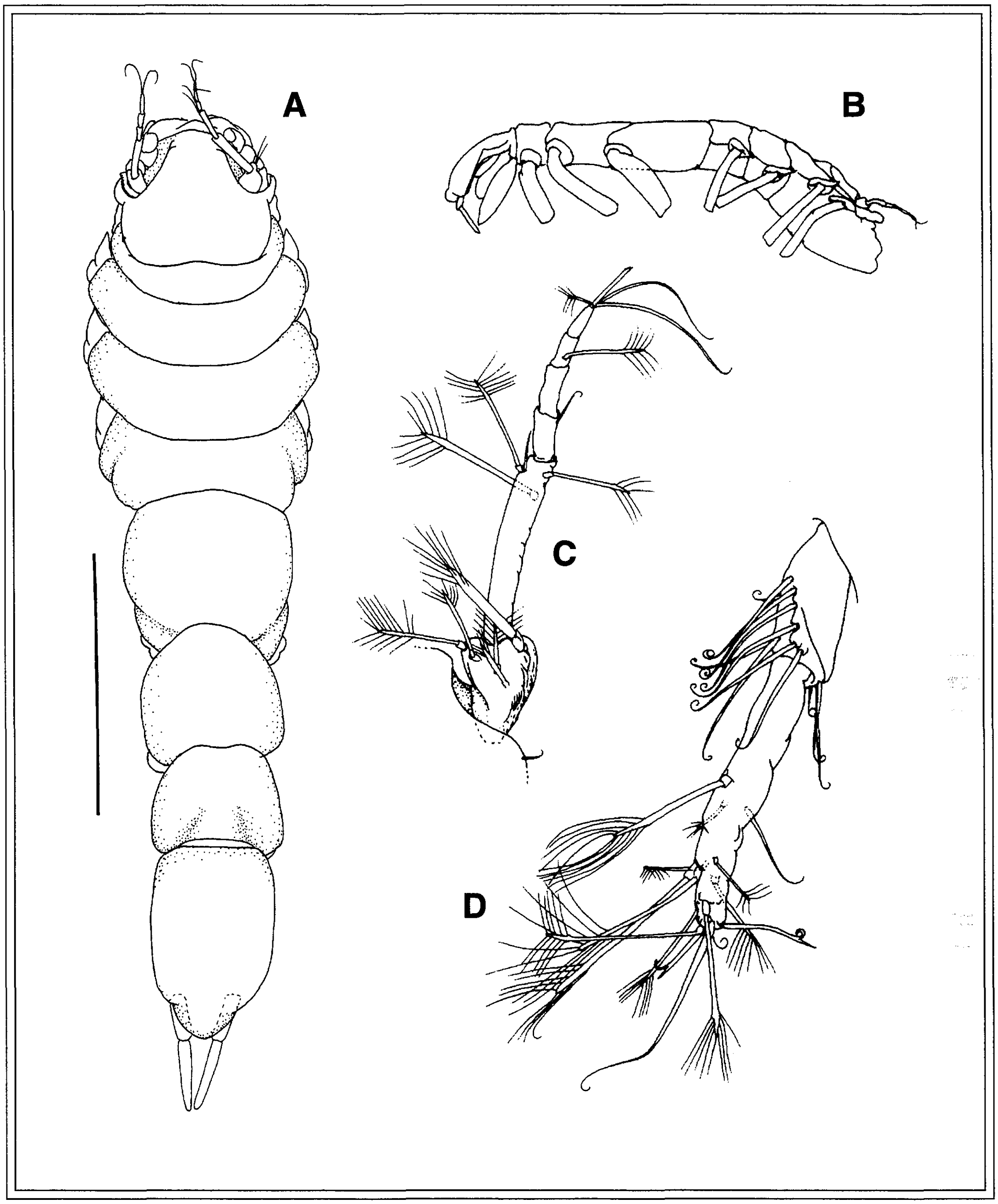


Figure 1.44. *Desmosoma* sp. A, Brooding female, dorsal view, composite illustration of several specimens (Phase I Sta. 14), scale bar = 1 mm. B, brooding female, lateral view, brood plates and mouth part detail omitted. C, right antennula, dorsal view. D, right uropod, ventral view.

are present in the California Continental Borderland. This species can be separated from another species known to this author by a setose lateral margin of the uropod, a smaller and narrower body, and a smaller pereonite 1 in comparison with pereonite 2.

Type Locality and Type Specimens. This species is not formally described.

Distribution. Currently known only from the Santa Maria Basin, ca. 290 m.

Genus *Prochelator* Hessler, 1970

Description. (from Hessler, 1970) First pereopod large, chelate; dactylus and enlarged, specialized propodus together comprising movable finger which acts in opposition to immovable claw formed by large seta on distal end of ventral margin of enlarged carpus. Carpus usually not produced at base of claw. Ventral margin of carpus with two accessory setae: a short, stout, unequally bifid seta located midway along margin and somewhat longer, more slender seta located at base of fixed claw, just proximal to it. Pereonite 1 as large as or larger than pereonite 2. Pleotelson with posterolateral spines, sometimes obscure. Uropods nearly always biramous. Most dorsal tooth on lacinia mobilis reduced or absent; next tooth in line considerably enlarged. Joints surrounding palp segment 1 of maxilliped nearly straight; segment 3 with long lateral margin. Coxae of pereopods I-IV anterolaterally angular, but not produced. Head with transverse ridge on frons and with frons-clypeal furrow.

Prochelator sp. A

Figure 1.45

Material Examined. California, off San Francisco, Gulf of the Farallones, numerous specimens collected Aug 1990, R/V *Farnella*, by J.A. Blake, as part of survey of proposed U.S. Navy 103 deep-water disposal site: Sta. S-19, 37°38.41'N, 123°24.36'W, 2580m, 13 Aug 90 (10); Sta. I-19, 37°38.38'N, 123°27.77'W, 2835m, 13 Aug 90 (3); Sta. E-19, 37°38.40'N, 123°29.21'W, 2955m, 14 Aug 90 (1); Sta. F-17, 37°38.96'N, 123°28.83'W, 2945m, 14 Aug 90 (2); Sta. K-15, 37°39.38'N, 123°27.23'W, 2830m, 14 Aug 90 (2); Sta. L-17, 37°38.94'N, 123°26.85'W, 2855m, 14 Aug 90 (61); Sta. E-07, 37°41.64'N, 123°29.16'W, 2462m, 15 Aug 90 (29); Sta. J-13, 37°40.01'N, 123°27.45'W, 2770m, 15 Aug 90 (1); Sta. N-13, 37°40.01'N, 123°26.06'W, 2623m, 15 Aug 90 (10).—Santa Maria Basin, off Point Estero, Sta. 2, 200 m (2, female and male); off Port San Luis, Sta. 22, (2 brooding females, illustrated 1 specimen); off Purisima Point, Sta. R-5, 154 m (74; plus 1 male from another sample, illustrated).

Description. Head with pointed spines lateral to antennae; frons clypeal ridge and clypeal furrow small but present. Pereonite 1 distinctly larger than pereonite 2 (feature of Eugerdellatinae), with large ventral spine. Pereonites 3 and 7 with posteriorly curving spines. Pereonite 5 of male with anterolateral posteriorly curving spine. Pereonite 5 of female distinctly convex, lacking a recurved spine. Pleotelson posteriorly rounded, with large subdistal ventrolateral spines. Pereopod I with robust setochelate carpus not produced at base of distal seta (feature of *Prochelator*), with penultimate accessory seta adjacent to elongate strong sensillate seta on distoventral corner of carpus (synapomorphy of Eugerdellatinae); shorter sensillate seta in middle of carpus ventral margin. Pereopod II robust with 4 elongate distally fringed sensillate setae on ventral margin, and 2 simple setae on dorsal margin of carpus. Male pleopod II with distinct laterally recurved spine on distal tip. Uropod biramous, exopod approximately third length of endopod with seta longer than uropod on exopod tip.

Biology. Although members of this species are tiny, they are among the most abundant of the Asellota studied from the Santa Maria Basin. Their rather more powerful anterior pereopods and anteriorly blunt faces suggest they are strongly burrowing forms. See also general remarks under *Momedossa symmetrica*.

Remarks. This undescribed species of *Prochelator* is most like *P. uncatus* Hessler, 1970, but has several distinctive features that separate the two species. Most important, sexual dimorphism is evident in the species, while *P. uncatus* is nearly monomorphic. Other features of this species not seen in *P. uncatus* include: ventral midline spines on pereonites 1, 3, and 7; recurved lateral spines on the distal tip of male pleopod I; and a convex lateral margin of pereonite 5 in dorsal view of the female. The recurved lateral spine on pereonite 5 includes a large amount of variability, both sexual and ontogenetic. The spine is distinct in males, and largely absent in females. Juvenile males may show a gradation from the absent (female) condition to distinct and

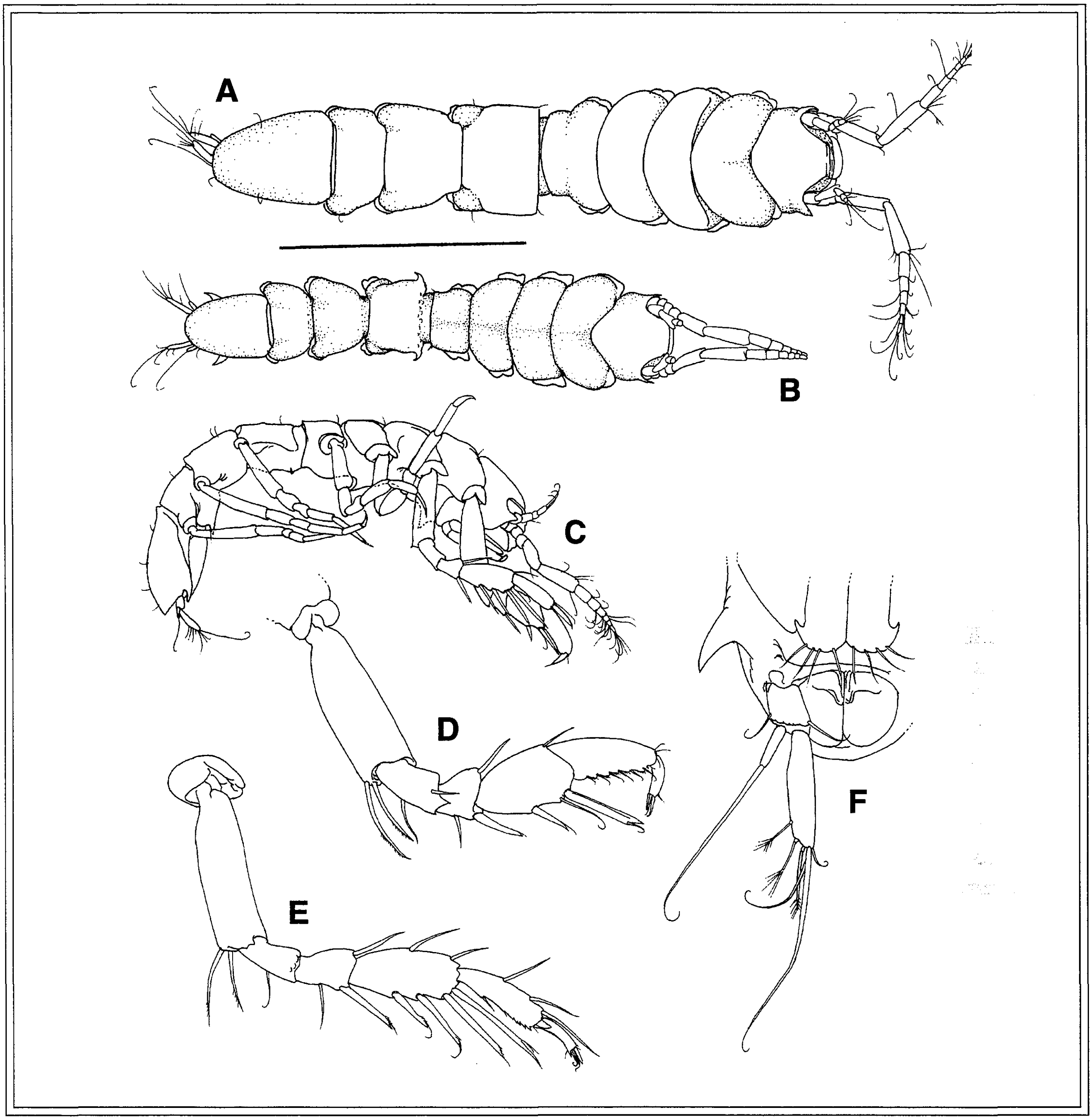


Figure 1.45. *Prochelator* sp. A. A, brooding female (Phase I Sta. 22), body dorsal view, scale bar = 1 mm. B-C, copulatory male, body lateral and dorsal view. D-E, pereopods I-II, right, copulatory male (Phase II, Cruise 3-4 Sta. R-5). F, uropod, tip of pleopod I and right pleotelson posterolateral spine, copulatory male.

large. Biologists sorting samples from this area should be aware that another rare and undescribed species of *Prochelator* was found at the Navy103 site. This second species is easy to distinguish because it lacks the recurved spine on pereonite 5, has pointed coxal spines on pereopods 1-3, and has a uniramous uropod.

Type Locality and Type Specimens. None. This species is undescribed.

Distribution. Santa Maria Basin to off San Francisco, 99-2955 m.

Literature Cited

Barnard, K.H. 1914. Contributions to the Crustacean fauna of South Africa. Annals of the South African Museum 10(11):325-446.

Benedict, J.E. 1897. A revision of the genus *Synidotea*. Proceedings of the Academy of Natural Sciences of Philadelphia 49:389-404.

Benedict, J.E. 1898a. Two new isopods of the genus *Idotea* from the coast of California. Proceedings of the Biological Society of Washington 22:53-55.

Benedict, J.E. 1898b. The Arcturidae in the U. S. National Museum. Proceedings of the Biological Society of Washington 22:41-51.

Birstein, I.A. 1973. Deep water isopods (Crustacea, Isopoda) of the north-western Pacific Ocean. Izdatel'stvo Akademii Nauk SSSR, Moskva. [Translated from the Russian for the Smithsonian Institution and N.S.F. by the Indian National Scientific Documentation Center, New Delhi. 316 pp.]

Bonnier, J. 1900. Contribution à l'étude des Épicarides: Les Bopyridae. Travaux de la Station Zoologique de Wimereux, VIII. 396 pp.

Boone, P.L. 1918. Descriptions of ten new isopods. Proceedings of the U.S. National Museum 54:591-604.

Boone, P.L. 1923. New marine tanaid and isopod Crustacea from California. Proceedings of the Biological Society of Washington 36:147-156.

Botosaneanu L., N.L. Bruce, and J. Notenboom. 1986. Isopoda: Cirolanidae. In, L. Botosaneanu (Ed.), Stygofauna Mundi: A faunistic, distributional, and ecological synthesis of the world fauna inhabiting subterranean waters (including the marine interstitial). pp. 412-421.

Bourdon, R. 1980. Les espèces du genre *Bopyrella* J. Bonnier (Crustacea, Isopoda, Bopyridae). Bulletin de la Musée nationale d'Histoire naturelle, Paris, 4 sér., 2, section A, 1:185-236.

Bowman, T.E. and G.A. Schultz. 1974. The isopod crustacean genus *Munnogonium* George and Strømberg, 1968 (Munnidae, Asellota). Proceedings of the Biological Society of Washington 87(25):265-272.

Brandt, A. 1988. Antarctic Serolidae and Cirolanidae (Crustacea: Isopoda). Theses Zoologicae. Koeltz Scientific Books, Koenigstein. Vol. 10. 143 pp.

Bruce, N.L. 1981. Cirolanidae (Crustacea: Isopoda) of Australia: Diagnoses of *Cirolana* Leach, *Metacirolana* Nierstrasz, *Neocirolana* Hale, *Anopsilana* Paulian and Debouteville, and three new genera—*Natatolana*, *Politolana* and *Cartetolana*. Australian Journal of Marine and Freshwater Research 32:945-966.

Bruce, N.L., R.C. Brusca, and P.M. Delaney. 1982. The status of the isopod families Corallanidae Hansen, 1890 and Excorallanidae Stebbing, 1904 (Flabellifera). Journal Crustacean Biology 2(3):464-468.

Bruce, N.L. 1984. A new family for the isopod crustacean genus *Tridentella* Richardson, 1905, with description of a new species from Fiji. Zoological Journal of the Linnean Society 80:447-455.

Bruce, N.L. 1986. Cirolanidae (Crustacea: Isopoda) of Australia. Records of the Australian Museum, Suppl. 6, 239 pp.

Bruce, N.L. 1988. *Aega leptonica*, a new species of aegid isopod crustacean from the tropical western Atlantic, with notes on *Rocinela oculata* Harger and *Rocinela kapala*, new species. Proceedings of the Biological Society of Washington 101(1):95-101.

Brusca, R.C. 1977. Range extensions and new host records of cymothoid isopods (Isopoda: Cymothoidae) in the east Pacific. Bulletin of the California Academy of Sciences 76(2): 128-131.

Brusca, R.C. 1978a. Studies on the cymothoid fish symbionts of the eastern Pacific (Isopoda: Cymothoidae). I. Biology of *Nerocila californica*. Crustaceana 34(2):141-154.

Brusca, R.C. 1978b. Studies on the cymothoid fish symbionts of the eastern Pacific (Crustacea: Isopoda: Cymothoidae). II. Biology and systematics of *Lironeca vulgaris* Stimpson, 1857. Occasional Papers of the Allan Hancock Foundation (n. ser.) 2:1-19.

Brusca, R.C. and B.R. Wallerstein. 1977. The marine isopod Crustacea of the Gulf of California. I. Family Idoteidae. American Museum Novitates 2643:1-17.

Brusca, R.C. 1980. Common Intertidal Invertebrates of the Gulf of California. Second, revised edition. University of Arizona Press, Tucson, Arizona. 513 pp.

Brusca, R.C. 1981. A monograph on the Isopoda Cymothoidae (Crustacea) of the eastern Pacific. Zoological Journal of the Linnean Society 73(2):117-199.

Brusca, R.C. 1983a. A monograph of the isopod family Aegidae in the tropical eastern Pacific. I. The genus *Aega*. Allan Hancock Monographs in Marine Biology 12:1-39.

Brusca, R.C. 1983b. Two new idoteid isopods from Baja California and the Gulf of California (Mexico) and an analysis of the evolutionary history of the genus *Colidotea* (Crustacea: Isopoda: Idoteidae). Transactions of the San Diego Society of Natural History 29(4):69-79.

Brusca, R.C. 1984. Phylogeny, evolution and biogeography of the marine isopod Subfamily Idoteinae (Crustacea: Isopoda: Idoteidae). Transactions of the San Diego Society of Natural History 20(7):99-134.

Brusca, R.C. 1987. Biogeographic relationships of Galapagos marine isopod crustaceans. Bulletin of Marine Science 4(2):268-281.

Brusca, R.C. and S.C. France. 1992. The genus *Rocinela* (Crustacea: Isopoda: Aegidae) in the tropical eastern Pacific. Zoological Journal of the Linnean Society (London) 106:231-275.

Brusca, R.C. and M.R. Gilligan. 1983. Tongue replacement in a marine fish (*Lutjanus guttatus*) by a parasitic isopod (Crustacea: Isopoda). Copeia 3:813-816.

Brusca, R.C. and E.W. Iverson. 1985. A guide to the marine isopod Crustacea of Pacific Costa Rica. Revisa de Biologia Tropical 33 (Supplement 1):1-77.

Brusca, R.C. and M. Ninos. 1978. The status of *Cirolana californiensis* Schultz, and *C. deminuta* Menzies and George, with a key to the California species of *Cirolana* (Isopoda: Cirolanidae). Proceedings of the Biological Society of Washington 91(2):379-385.

Brusca, R.C. and B.R. Wallerstein. 1979a. The marine isopod crustaceans of the Gulf of California II. Idoteidae: new genus and species, range extensions, and comments on evolution and taxonomy within the family. Proceedings of the Biological Society of Washington 92(2):253-271.

Brusca, R.C. and B.R. Wallerstein. 1979b. Zoogeographic patterns of idoteid isopods in the northeast Pacific, with a review of shallow water zoogeography of the area. Bulletin of the Biological Society of Washington 3:67-105.

Brusca, R.C., R. Wetzer and S.C. France. 1995. Cirolanidae (Crustacea: Isopoda: Flabellifera) of the tropical eastern pacific. Proceedings of the San Diego Natural History Museum, 30:1-96.

Brusca, R.C. and J.R. Weinberg. 1987. A new isopod crustacean from Pacific Panama, *Excirolana chamensis* new species (Isopoda: Flabellifera: Cirolanidae). Contributions in Science, Natural History Museum of Los Angeles County 392:11-17.

Brusca, R.C. and G.D.F. Wilson. 1991. A phylogenetic analysis of the Isopoda with some classifactory recommendations. Memoirs of the Queensland Museum 31:143-204.

Cadien, D. and R.C. Brusca. 1993. Anthuridean isopods of California and the temperate northeast Pacific. SCAMIT Newsletter 12 (6): 1-26.

Calman, W.T. 1909. Crustacea. In, R. Lankester, Ed. A Treatise on Zoology. London, Adam and Charles Black. 346 pp.

Camp, D.K. 1988. *Bythognathia yucatanensis*, new genus, new species, from abyssal depths in the Caribbean Sea, with a list of the gnathiid species described since 1926 (Isopoda: Gnathiidea). Journal of Crustacean Biology 8(4):668-678.

Dana, J.D. 1853. United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842, under the command of Charles Wilkes, U.S.N. Vol. XIII. Crustacea. Part II:692-1618.

Dana, J.D. 1854. Catalogue and descriptions of Crustacea collected in California by Dr. John L. LeConte. Proceedings of the Academy of Natural Sciences of Philadelphia 7:175-177.

Delaney, P.M. and R.C. Brusca. 1985. Two new species of *Tridentella* Richardson, 1905 (Isopoda: Flabellifera: Tridentellidae) from California, with a rediagnosis and comments on the family, and a key to the genera of Tridentellidae and Corallanidae. Journal of Crustacean Biology 5(4):728-742.

Delaney, P.M. 1990. *Tridentella williamsi*, a new species of isopod crustacean from the British Virgin Islands, Western Atlantic (Flabellifera: Tridentellidae). Proceedings of the Biological Society of Washington 103(3):643-648.

Fee, A.R. 1926. The Isopoda of Departure Bay and vicinity, with descriptions of new species, variations, and colour notes. Contributions to Canadian Biology and Fisheries (n. ser.) 3(2):15-46.

George, R.Y., and J.-O. Strömberg. 1968. Some new species and new records of marine isopods from San Juan Archipelago, Washington, U.S.A. Crustaceana 14(3):225-254.

Gurjanova, E. 1933. Contributions to the Isopoda-fauna of the Pacific. Issledovaniia Moriya SSSR (Exploration of the Sea of the USSR). Leningrad 19:79- 91.

Hansen, H.J. 1897. Reports on the dredging operations off the west coast of central America to the Galapagos, to the west coast of Mexico and in the Gulf of California, in charge of Alexander Agassiz, carried on by the U.S. Fish Commission Steamer *Albatross* during 1891, Lieut. Commander Z. L. Tanner, U.S.N., commanding. XII. The Isopoda. Bulletin of the Museum of Comparative Zoology, Harvard 31(5):95-129.

Harrison, K. and G.C.B. Poore. 1984. *Serolis* (Crustacea, Isopoda, Serolidae) from Australia, with a new species from Victoria. Memoirs of the Museum of Victoria 45:13-31.

Hessler, R.R. 1970. The Desmosomatidae (Isopoda, Asellota) of the Gay Head-Bermuda Transect. Bulletin of the Scripps Institution of Oceanography 15:1-185.

Hessler, R.R. and J.-O. Strömberg. 1989. Behavior of janiroidean isopods (Asellota), with special reference to deep-sea genera. Sarsia 74:145-59.

Hodgson, T.V. 1910. Crustacea. IX. Isopoda. National Antarctic Expedition, Natural History 5:1-77.

Holdich, D.M. and K. Harrison. 1980. The crustacean isopod genus *Gnathia* Leach from Queensland waters with descriptions of nine new species. Australian Journal of Marine and Freshwater Research 31:215-240.

Hooker, A. 1985. New species of Isopoda from the Florida Middlegrounds (Crustacea: Peracarida). Proceedings of the Biological Society of Washington 98:255-280.

Iverson, E.W. 1972. A new subtidal *Synidotea* from Central California (Crustacea: Isopoda). Proceedings of the Biological Society of Washington 85(47):541-548.

Iverson, E.W. 1974. Range extensions for some California marine isopod crustaceans. Bulletin of the Southern California Academy of Sciences 73(3):164-169.

Jay, C.V. 1989. Prevalence, size and fecundity of the parasitic isopod *Argeia pugettensis* on its host shrimp *Crangon francisorum*. American Midland Naturalist 121:68-77.

Juilfs, H.B. and J.-W. Wägele. 1987. Symbiotic bacteria in the gut of the blood-sucking Antarctic fish parasite *Gnathia calva* (Crustacea: Isopoda). Marine Biology 95:493-499.

Just, J. 1990. Abyssianiridae, a synonym of Paramunnidae (Crustacea: Isopoda: Asellota), with two new species of *Abyssianira* from South-Eastern Australia. Memoirs of the Museum Victoria 50(2), 403-415.

Just, J., and G.C.B. Poore. 1992. Vermectiadidae, a new primitive asellote isopod family with important phylogenetic implications. Journal of Crustacean Biology 12(1):125-145.

Kensley, B. 1979. New species of anthurideans from the Cook and Fiji Islands (Crustacea: Isopoda: Anthuridea). Proceedings of the Biological Society of Washington 92(4):814-836.

Kensley, B. 1982. Revision of the southern African Anthuridea (Crustacea, Isopoda). Annals of the South African Museum 90(3):95-200.

Kensley, B. and M. Schotte. 1989. Guide to the Marine Isopod Crustaceans of the Caribbean. Smithsonian Institution Press, Washington, D. C. 308 pp.

Kozloff, E.N. 1987. Marine Invertebrates of the Pacific Northwest. University of Washington Press, Washington. 511 pp.

Kussakin, O.G. 1962. On the fauna of Janiridae (Isopoda, Asellota) from the seas of the USSR. Trudy Zoologischeskogo Instituta Akademiya Nauk SSSR, 30:17-65 (in Russian).

Kussakin, O.G. 1979. Marine and brackish-water Isopoda of cold and temperate (boreal) waters of the Northern Hemisphere. Part 1. (Flabellifera, Valvifera, and Tyloidea). [in Russian]. Opredeliteli po faune SSSR, Akad. nauk SSSR [Acad. Sci. USSR, Zool., Leningrad], No. 122, 472 pp.

Kussakin, O.G. 1982a. Marine and brackish-water Isopoda of cold and temperate (boreal) waters of the Northern Hemisphere. Part 2. (Anthuridea, Microcerberidea, Valvifera, and Tyloidea). [in Russian]. Opredeliteli po faune SSSR, Akad. nauk SSSR [Acad. Sci. USSR, Zool., Leningrad], No. 131, 461 pp.

Kussakin, O.G. 1982b. Supplement to the isopod crustacean fauna from the shelf zones of the Antarctic (From the material of the Soviet Antarctic Expedition 1965-1968). In, Fauna and Distribution of Crustaceans from the Southern and Antarctic Waters. [in Russian] Akademiya Nauk CCCP, Dal'nevostochnyi Nauchyi Tsentr (Far East Science Center), Vladivostok. pp. 73-105.

Kussakin, O.G. 1988. Marine and brackish-water Isopoda of cold and temperate (boreal) waters of the Northern Hemisphere. Part 3. (Asellota. 1.). [in Russian]. Opredeliteli po faune SSSR, Akad. nauk SSSR [Acad. Sci. USSR, Zool., Leningrad], No. 152, 500 pp.

Lee, W.L. 1966a. Pigmentation of the marine isopod *Idotea montereyensis*. Comparative Biochemistry and Physiology 18:17-36.

Lee, W.L. 1966b. Color change and the ecology of the marine isopod *Idotea (Pentidotea) montereyensis* Maloney, 1933. Ecology 47(6):930-941.

Lee, W.L. 1972. Chromatophores and their role in color change in the marine isopod *Idotea montereyensis* Maloney. Journal of Experimental Marine Biology and Ecology 8(3):201-215.

Lee, W.L. and B.M. Gilchrist. 1972. Pigmentation, color change and the ecology of the marine isopod *Idotea resecata* Stimpson. Journal of Experimental Marine Biology and Ecology 10:1-27.

Lee, W.L. and B.M. Gilchrist. 1975. Monohydroxy carotenoids in *Idotea* (Crustacea: Isopoda). Comparative Biochemistry and Physiology 51B:247-253.

Levin, L.A., D.J. DeMaster, L.D. McCann, and C.L. Thomas. 1986. Effect of giant protozoans (class: Xenophyophorea) on deep-seamount benthos. Marine Ecology Progress Series 29:99-104.

Lockington, W.N. 1876. Remarks on the Crustacea of the Pacific Coast, with descriptions of some new species. Proceedings of the California Academy of Sciences 7:28-36.

Lockington, W.N. 1877. Description of seventeen new species of Crustacea. Proceedings of the California Academy of Sciences 7:41-48.

Markham, J.C. 1974. A new species of *Pleurocrypta* (Isopoda, Bopyridae), the first known from the western Atlantic. Crustaceana 26(3):267-272.

Markham, J.C. 1975. A review of the bopyrid isopod genus *Munidion* Hansen, 1897, parasitic on galatheid crabs in the Atlantic and Pacific Oceans. Bulletin of Marine Science 25(3):422-441.

Markham, J.C. 1988. Descriptions and revisions of some species of Isopoda Bopyridae of the northwestern Atlantic coast. Zoologische Verhandelingen 246:1-63.

Menzies, R.J. 1950a. The taxonomy, ecology and distribution of northern California isopods of the genus *Idotea* with the description of a new species. The Wasmann Journal of Biology 8(2):155-195.

Menzies, R.J. 1950b. A remarkable new species of marine isopod, *Erichsonella crenulata* n. sp., from Newport Bay, California. Bulletin of the Southern California Academy of Sciences 49(1):29-35.

Menzies, R.J. 1951a. New marine isopods, chiefly from northern California, with notes on related forms. Proceedings of the United States National Museum 101(3273):105-156.

Menzies, R.J. 1951b. A new species of *Limnoria* (Crustacea: Isopoda) from Southern California, 50(2):86-88.

Menzies, R.J. 1951c. A new subspecies of marine isopod from Texas. Proceedings of the United States National Museum 101(3289):575-579.

Menzies, R.J. 1951d. A new genus and new species of asellote isopod, *Caecijaera horvathi*, from Los Angeles-Long Beach Harbor. American Museum Novitates 1542:1-7.

Menzies, R.J. 1951e. Notes on the structure of the marine asellote isopod *Ianiropsis breviremis* G.O. Sars. Meddeleser fra det Zoologiske Museum, Oslo 57:153-155.

Menzies, R.J. and J.L. Barnard. 1951. The isopodan genus *Iais* (Crustacea). Bulletin of the Southern California Academy of Sciences 50(3):136-151.

Menzies, R.J. 1952a. The occurrence of a terrestrial isopod in plankton. Ecology 33(2):303.

Menzies, R.J. 1952b. Some marine asellote isopods from Northern California, with descriptions of nine new species. Proceedings of the United States National Museum 102(3293):117-159.

Menzies, R.J. 1954a. A review of the systematics and ecology of the genus *Exosphaeroma*, with the description of a new genus, a new species, and a new subspecies (Crustacea, Isopoda, Sphaeromatidae). American Museum Novitates 1683:1-24.

Menzies, R.J. 1954b. The comparative biology of reproduction in the wood-boring isopod crustacean *Limnoria*. Bulletin of the Museum of Comparative Zoology 112(5):364-388.

Menzies, R.J. 1958. The distribution of wood-boring *Limnoria* in California. Proceedings of the California Academy of Sciences 29(7):267-272.

Menzies, R.J. 1961. Suggestion of night-time migration by the wood-borer Limnoria. Oikos 12(1):170-172.

Menzies, R.J. 1962. The marine isopod fauna of Bahía de San Quintin, Baja California, Mexico. Pacific Naturalist 3(11):337-348.

Menzies, R.J. and J.L. Barnard. 1959. Marine Isopoda on coastal shelf bottoms of southern California: systematics and ecology. Pacific Naturalist 1(11-12):1-44.

Menzies, R.J. and T.E. Bowman. 1956. Emended description and assignment to the new genus *Ronalea* of the idoteid isopod *Erichsonella pseudoculata* Boone. Proceedings of the United States National Museum 106(3371):339-343.

Menzies, R.J. and D. Frankenberg. 1966. Handbook on the Common Marine Isopod Crustacea of Georgia. University of Georgia Press, Athens, Georgia. 93 pp.

Menzies, R.J. and P.W. Glynn. 1968. The common marine isopod Crustacea of Puerto Rico. Studies on the fauna of Curaçao and other Caribbean Islands, Vol. 27. The Hague, Martinus Nijhoff. 133 pp.

Menzies, R.J. and M.A. Miller. 1972. Systematics and zoogeography of the genus *Synidotea* (Crustacea: Isopoda) with and account of California species. Smithsonian Contributions to Zoology 102:1-33.

Menzies, R.J. and J.L. Mohr. 1952. The occurence of the wood-boring crustacean *Limnoria* and of Nebaliacea in Morro Bay, California. The Wasmann Journal of Biology 10(1):81-86.

Menzies, R.J. and J.L. Mohr. 1962. Benthic Tanaidacea and Isopoda from the Alaskan Arctic and the Polar Basin. Crustaceana 3(2):192-202.

Menzies, R.J., J.L. Mohr, and C.M. Wakeman. 1963. The seasonal settlement of wood-borers in Los Angeles-Long Beach Harbors. The Wasmann Journal of Biology 21(2):97-120.

Menzies, R.J. and R.J. Waidzunas. 1948. Postembryonic growth changes in the isopod *Pentidotea resecata* (Stimpson) with remarks on their taxonomic significance. Biological Bulletin 95(1):107-113.

Menzies, R.J. and T.M. Widrig. 1955. Aggregation by the marine wood-boring isopod, *Limnoria*. Oikos 6(2):149-152.

Mezhov, B.V. 1986. Bathyal and abyssal Nannoniscidae and Desmosomatidae (Isopoda, Asellota) from Alaska Bay. [in Russian]. Archives of the Zoological Museum, Moscow State University 24:126-167.

Miller, M.A. 1940. The isopod Crustacea of the Hawaiian Islands (Chelifera and Valivera). Occasional Papers of Bernice P. Bishop Museum 15(26):295-321.

Miller, M.A. 1941. The isopod Crustacea of the Hawaiian Islands, II. Asellota. Occasional Papers of Bernice P. Bishop Museum 16(13):305-320.

Miller, M.A. 1968. Isopoda and Tanaidacea from buoys in costal waters of the continental United States, Hawaii, and the Bahamas (Crustacea). Proceedings of the Biological Society of Washington 125:1-53.

Miller, M.A. 1975. Isopoda and Tanaidacea. In, R. I. Smith and J. T. Carlton, Eds. Light's Manual: Intertidal Invertebrates of the Central California Coast. University of California Press, Berkeley, California. pp. 277-312.

Miller, M.A. and W.L. Lee. 1970. A new idoteid isopod, *Idotea (Pentidotea) kirchanskii*, from central California (Crustacea). Proceedings of the Biological Society of Washington 82(61):789-798.

Miller, M.A. and R.J. Menzies. 1952. The isopod Crustacea of the Hawaiian Islands, III. Superfamily Flabellifera, Family Anthuridae. Occasional Papers of the Bernice P. Bishop Museum 21(1):1-15.

Monod, T. 1926. Les Gnathiidae, essai monographique (Morphologie, Biologie, Systématique). Mèmoires de la Société des Sciences Naturelles du Maroc 13:1-668.

Negoescu, I. and J.-W. Wägele. 1984. World list of the anthuridean isopods. Extrait des Travaux du Muséum d'Histoire Naturelle Grigore Antipa, 25:99-146.

Nierstrasz, H.F. and G.A. Brender á Brandis. 1923. Die Isopoden der Siboga-Expedition. II. Isopoda Genuina. I. Epicaridea. Siboga-Expeditie 32b:57-122. E.J. Brill, Leiden.

Nordenstam, A. 1933. Marine Isopoda of the families Serolidae, Idoteidae, Pseudidoteidae, Arcturidae, Parasellidae and Stenetriidae mainly from the South Atlantic. Further Zoological Results of the Swedish Antarctic Expedition, 1901-1903, 3(1):1-284.

Oshel, P.E. and D.H. Steele. 1988. Comparative morphology of amphipod setae, and a proposed classification of setal types. Crustaceana (Suppl. 13, Studies on Amphipoda):90-99.

Poore, G.C.B. 1980. A revision of the genera of the Paranthuridae (Crustacea: Isopoda: Anthuridea) with a catalogue of species. Zoological Journal of the Linnean Society 68(1):53-67.

Poore, G.C.B. 1984a. *Paranthura* (Crustacea, Isopoda, Paranthuridae) from south-eastern Australia. Memoirs of the Museum Victoria 45:33-69.

Poore, G.C.B. 1984b. Redefinition of *Munna* and *Uromunna* (Crustacea: Isopoda: Munnidae), with descriptions of five species from coastal Victoria. Proceedings of the Royal Society of Victoria 96(2):61-81.

Poore, G.C.B. 1985. Australian chaetiliids (Crustacea: Isopoda: Valvifera): A new genus, new species and remarks on the family. Memoirs of the Museum Victoria 46:153-171.

Poore, G.C.B. 1991. Book review "Brandt, Angelika. 1990. Antarctic valviferans (Crustacea, Isopoda, Valvifera). New genera, new species and redescriptions. E.J. Brill, Leiden. Pp. 1-176, 92 figs.". Journal of Crustacean Biology 11(3):477-478.

Poore, G.C.B. and H.M. Lew Ton. 1985. New species of *Cyathura* (Crustacea: Isopoda: Anthuridae) from estuaries of Eastern Australia. Memoirs of the Museum Victoria 46:89-101.

Poore, G.C.B. and H.M. Lew Ton. 1986. *Mesanthura* (Crustacea: Isopoda: Anthuridae) from south-eastern Australia. Memoirs of the Museum Victoria 47(1):87-104.

Poore, G.C.B. and H.M. Lew Ton. 1988a. Antheluridae, a new family of Crustacea (Isopoda: Anthuridea) with new species from Australia. Journal of Natural History 22:489-506.

Poore, G.C.B. and H.M. Lew Ton. 1988b. More Australian species of *Haliophasma* (Crustacea: Isopoda: Anthuridae). Memoirs of the Museum of Victoria 49(1):85-106.

Poore, G.C.B. and H.M. Lew Ton. 1988c. A generic review of the Hyssuridae (Crustacea: Isopoda) with a new genus and new species from Australia. Memoirs of the Museum of Victoria 49(1):169-193.

Poore, G.C.B. and H.M. Lew Ton. 1988d. *Amakusanthura* and *Apanthura* (Crustacea: Isopoda: Anthuridea) with new species from tropical Austrailia. Memoirs of the Museum of Victoria 49:170-147.

Poore, G.C.B. and H.M. Lew Ton. 1990. The Holognathidae (Crustacea: Isopoda: Valvifera) expanded and redefined on the basis of body-plan. Invertebrate Taxonomy 4:55-80.

Richardson, H. 1897. Description of a new genus and species of Sphaeromatidae from Alaskan waters. Proceedings of the Biological Society of Washington 11:181-183.

Richardson, H. 1898. Description of four new species of *Rocinela*, with a synopsis of the genus. Proceedings of the American Philosophical Society 37:8-17.

Richardson, H. 1899a. Key to the isopods of the Pacific coast of North America, with descriptions of twenty-two new species. Proceedings of the United States National Museum 21:815-869.

Richardson, H. 1899b. Key to the isopods of the Pacific coast of North America, with descriptions of twenty-two new species. Annals and Magazine of Natural History 7(4):157-187; 260-277; 321-338.

Richardson, H. 1900. Synopses of North-American invertebrates. VIII. The Isopoda. Part 1. Chelifera, Flabellifera, Valvifera. The American Scientist 34:207-230.

Richardson, H. 1904a. Contributions to the natural history of the Isopoda. Parts I-IV. Proceedings of the United States National Museum 27:1-89. Parts V-VI. Proceedings of the United States National Museum 27:657-681.

Richardson, H. 1904b. Isopod crustaceans of the northwest coast of North America. Harriman Alaska Expeditions 10:213-230.

Richardson, H. 1905a. A monograph on the isopods of North America. Bulletin of the United States National Museum 54:1-727.

Richardson, H. 1905b. Further changes in crustacean nomenclature. Proceedings of the Biological Society of Washington 18:9-10.

Richardson, H. 1906. Descriptions of new isopod crustaceans of the family Sphaeromatidae. Proceedings of the United States National Museum 31:1-22.

Richardson, H. 1908. On some isopods of the family Dajidae from the northwest Pacific Ocean, with descriptions of a new genus and two new species. Proceedings of the United States National Museum 33:689-696.

Richardson, H. 1909. Isopods collected in the northwest Pacific by the U. S. Bureau of Fisheries Steamer *Albatross* in 1906. Proceedings of the United States National Museum 37:75-129.

Sars, G.O. 1870. Nye Dybuandscrustaceer fra Lofoten Forhandlinger I Videnskabs-Selskabet I Kristiania 1869: 145-286

Sars, G.O. 1879. Crustacea et Pycnogonida nova in itinere 2do et 3tio expeditionis norvegicae anno 1877 and 78 collecta. Arch. Math. Naturv. 4:427-476.

Sars, G.O. 1883. Oversigt af Norges Crustaceer med forelúbige Bemaerkninger over de nye eller mindre bekjendte Arter. I. (Podophthalmata-Cumacea-Isopoda-Amphipoda). Forhandlinger I Videnskabs-Selskabet I Kristiania 1882(18): 1-124.

Sars, G.O. 1897a. Isopoda. Part V, VI. Idotheidae, Arcturidae, Asellidae, Ianiridae, Munnidae. Bergen, Norway: Bergen Museum, (An Account of the Crustacea of Norway with Short Descriptions and Figures of All the Species; II) (Plates XXXIII-XLIX).

Sars, G.O. 1897b. Isopoda. Part VII, VIII. Desmosomidae, Munnopsidae. Bergen, Norway: Bergen Museum, (An Account of the Crustacea of Norway with Short Descriptions and Figures of All the Species; II) (Plates L-LXIII).

Sars, G.O. 1898. Isopoda. Part IX, X. Munnopsidae (concluded), Ligiidae, Trichoniscidae, Oniscidae (part). (An Account of the Crustacea of Norway with Short Descriptions and Figures of All the Species, II.) Bergen Museum, Bergen, Norway. (Plates LXIV-LXXXIV).

Sars, G.O. 1899. Isopoda. (An Account of the Crustacea of Norway with short descriptions and figures of all the species, II.) Bergen Museum, Bergen, Norway. i-x pages. (Preface Only).

Sars, G.O. 1899. Isopoda. Part XIII, XIV. Cryptoniscidae, Appendix. (An Account of the Crustacea of Norway with Short Descriptions and Figures of All the Species, II.) Bergen Museum, Bergen, Norway. 233-270 pages. (Plates XCVII-C, Suppl. Pl. I-IV).

Sassaman, C., G.A. Schultz and R. Garthwaite. 1984. Host, synonymy, and parasitic incidence of *Bopyrella calmani* (Richardson) from central California (Isopoda: Epicaridea: Bopyridae). Proceedings of the Biological Society of Washington 97(3):645-654.

Schultz, G.A. 1964. Some marine isopod crustaceans from off the southern California coast. Pacific Science 28(3):307-314.

Schultz, G.A. 1966. Submarine canyons of southern California. Part IV. Systematics: Isopoda. Allan Hancock Pacific Expeditions 27(4):1-56.

Schultz, G.A. 1969. The Marine Isopod Crustaceans. Wm. C. Brown Company, Dubuque, Iowa. 359 pp.

Schultz, G.A. 1972. *Gnathia sanctaecrucis* nom. nov., substituted for the preoccupied name *Gnathia hirsuta* Schultz, 1966, from southern California (Isopoda, Gnathiidae). Crustaceana 23(Part 1):112.

Schultz, G.A. 1973. *Ancinus* H. Milne Edwards in the New World (Isopoda, Flabellifera). Crustaceana 25(3):267-275.

Schultz, G.A. 1977. Anthurids from the west coast of North America, including a new species and three new genera (Crustacea, Isopoda). Proceedings of the Biological Society of Washington 90(4):839-848.

Serov, P., and G.D.F. Wilson. 1995. A review of the Stenetriidae (Crustacea: Isopoda: Asellota). Records of the Australian Museum 47:39-82.

Sheppard, E.M. 1933. Isopod Crustacea. Part I. The family Serolidae. Discovery Report 7:253-362.

Sheppard, E.M. 1957. Isopod Crustacea. Part II. The suborder Valvifera. Families: Idoteidae, Pseudidotheidae and Xenarcturidae fam. n. with a supplement to isopod Crustacea, Part I. The family Serolidae. Discovery Report 29:141-198.

Strömberg, J.-O. 1971. Contribution to the embryology of bopyrid isopods with special reference to *Bopyroides*, *Hemiarthrus*, and *Pseudione* (Isopoda, Epicaridea). Sarsia 47:1-46.

Tattersall, W.M. 1905. The marine fauna of the coast of Ireland. Part V. Isopoda. Great Britain, Reports of the Department of Agriculture and Technical Instruction for Ireland, Scientific Investigations of the Fisheries Branch, 1904 II(1905):1-90.

Thistle, D. 1979. A redescription of two species of *Ilyarachna* (Asellota: Janiroidea) from off California (Crustacea: Isopoda). Zoological Journal of the Linnean Society 67:381-386.

Thistle, D. 1980. A revision of *Ilyarachna* (Crustacea, Isopoda) in the Atlantic with four new species. Journal of Natural History, 14:111-143.

Thistle, D. and G. Wilson. 1987. A hydrodynamically modified, abyssal isopod fauna. Deep-Sea Research 34:73-87.

Thun, M.A. and R.C. Brusca. 1980. On the status of the eastern Pacific cymothoid fish parasite *Braga occidentalis* Boone, and its synonymy with *B. patagonica* Schioedte and Meinert (Crustacea: Isopoda: Cymothoidae). Bulletin of the Southern California Academy of Sciences 79(3):130-132.

Upton, N.P.D. 1987a. Asynchronous male and female life cycles in the sexually dimorphic, harem-forming *Paragnathia formica* (Crustacea: Isopoda). Journal of Zoology, London 212:677-690.

Upton, N.P.D. 1987b. Gregarious larval settlement within a restricted intertidal zone and sex differences in subsequent mortality in the polygynous saltmarsh isopod *Paragnathia formica* (Crustacea: Isopoda). Journal of the Marine Biological Association of the United Kingdom 67(3):663-678.

Walker, A.O. 1898. Crustacea collected by W.A. Herdman F.R.S. in Puget Sound, Pacific Coast of North America, September 1897. Liverpool Biological Society, Proceedings and Transactions 12:268-287, 1896-1899.

Wallerstein, B.R. and R.C. Brusca. 1982. Fish predation: a preliminary study of its role in the zoogeography and evolution of shallow water idoteid isopods (Crustacea: Isopoda: Idoteidae). Journal of Biogeography 9:135-150.

Wägele, J.-W. 1979. Die Homologie der Mundwerkzeuge von *Cyathura carinata* (Krøyer, 1847) (Crustacean, Isopoda, Anthuridea). Zoologische Anzeige, Jena 203(5/6):334-341.

Wägele J.-W. 1981a. Zur Phylogenie der Anthuridea (Crustacea, Isopoda). Mit Beiträgen zur Lebensweise, Morphologie, Anatomie and Taxonomie. Zoologica (Stuttgart) 45(2)132:1-127.

Wägele, J.-W. 1981b. Study of the Hyssuridae (Crustacea: Isopoda: Anthuridea) from the Mediterranean and the Red Sea. Israel Journal of Zoology 30:47-87.

Wägele, J.-W. 1987. Description of the postembryonal stages of the Antarctic fish parasite *Gnathia calva* Vanhöffen (Crustacea: Isopoda) and synonymy with *Heterognathia* Amar & Roman. Polar Biology 7:77-92.

Wägele, J.-W. 1994. Notes on Antarctic and South American Serolidae, with remarks on the phylogenetic biogeography and a description of new genera. Zoologisches Jahrbuch der Systematik 121:3-69.

Wetzer, R., H.G. Kuck, P. Baéz R., R.C. Brusca and L.M. Jurkevics. 1991. Catalog of the isopod Crustacea type collection of the Natural History Museum of Los Angeles County. Technical Report Number 3:1-59.

Wetzer, R., P.M. Delaney, and R.C. Brusca. 1987. *Politolana wickstenae* new species of cirolanid isopod from the Gulf of Mexico, and a review of the "*Conilera* genus-group" of Bruce (1986). Contributions in Science, Natural History Museum of Los Angeles County 392:1-10.

Wilson, G. 1976. The systematics and evolution of *Haplomunna* and its relatives (Isopods, Haplomunnidae, new family). Journal of Natural History 10:569-580.

Wilson, G. 1981. Taxonomy and postmarsupial development of a dominant deep-sea eurycopid isopod (Crustacea). Proceedings of the Biological Society of Washington 94(1):276-294.

Wilson, G. 1982a. Two new natatory asellote isopods (Crustacea) from the San Juan Archipelago, *Baeonectes improvisus* n. gen., n. sp. and *Acanthamunnopsis milleri* n. sp., with a revised description of *A. hystrix* Schultz. Canadian Journal of Zoology 60(12):3332-3343.

Wilson, G. 1982b. Systematics of a species complex in the deep-sea genus *Eurycope*, with a revision of six previously described species (Crustacea, Isopoda, Eurycopidae). Bulletin of the Scripps Institution of Oceanography, University of California Press. Berkeley, Los Angeles, London. 64 pages.

Wilson, G. 1983a. An unusual species complex in the genus *Eurycope* (Crustacea: Isopoda: Asellota) from the deep North Atlantic Ocean. Proceedings of the Biological Society of Washington 96(3):452-467.

Wilson, G. 1983b. Systematics of a species complex in the deep-sea genus *Eurycope*, with a revision of six previously described species (Crustacea, Isopoda, Eurycopidae). Bulletin of the Scripps Institution of Oceanography 25:1-63.

Wilson, G. 1983c. Variation in the deep-sea isopod, *Eurycope iphthima* (Asellota, Eurycopidae). Depth related clines in rostral morphology and in population structure. Journal of Crustacean Biology 3:127-140.

Wilson, G. 1987. The road to the Janiroidea: the comparative morphology and evolution of the asellote isopods. Zeitschrift für zoologische Systematik und Evolutionsforschung 25:257-280.

Wilson, G. 1989. A systematic revision of the deep-sea subfamily Lipomerinae of the isopod crustacean family Munnopsidae. Bulletin of the Scripps Institution of Oceanography 27:1-138

Wilson, G. 1991. Functional morphology and evolution of isopod genitalia. In, R. Bauer and J. Martin (Eds.). Crustacean Sexual Biology. University of Columbia Press. pp. 228-245.

Wilson, G.D.F. 1994. A phylogenetic analysis of the isopod family Janiridae (Asellota). Invertebrate Taxonomy 8:749-766.

Wilson, G.D.F. and J.-W. Wägele. 1994. A systematic review of the family Janiridae (Isopoda, Asellota). Invertebrate Taxonomy 8:683-747.Wilson, G. and R.R. Hessler. 1981. A revision of the genus *Eurycope* (Isopoda, Asellota) with descriptions of three new genera. Journal of Crustacean Biology 1(3):401-423.

Wilson, G., O. Kussakin and G. Vasina. 1989. A revision of the genus *Microprotus* Richardson with descriptions of two new species, *M. acutispinatces* and *M. lobispinatus* (Asellota, Isopoda, Crustacea). Proceedings of the Biological Society of Washington 102(2):339-361.

Wilson, G. and D. Thistle. 1985. *Amuletta*, a new genus for *Ilyarachna abyssorum* Richardson 1911 (Isopoda, Asellota, Eurycopidae). Journal of Crustacean Biology 5(2):350-360.

Wolff, T. 1962. The systematics and biology of bathyal and abyssal Isopoda Asellota. Galathea Report 6: 1-320.

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.

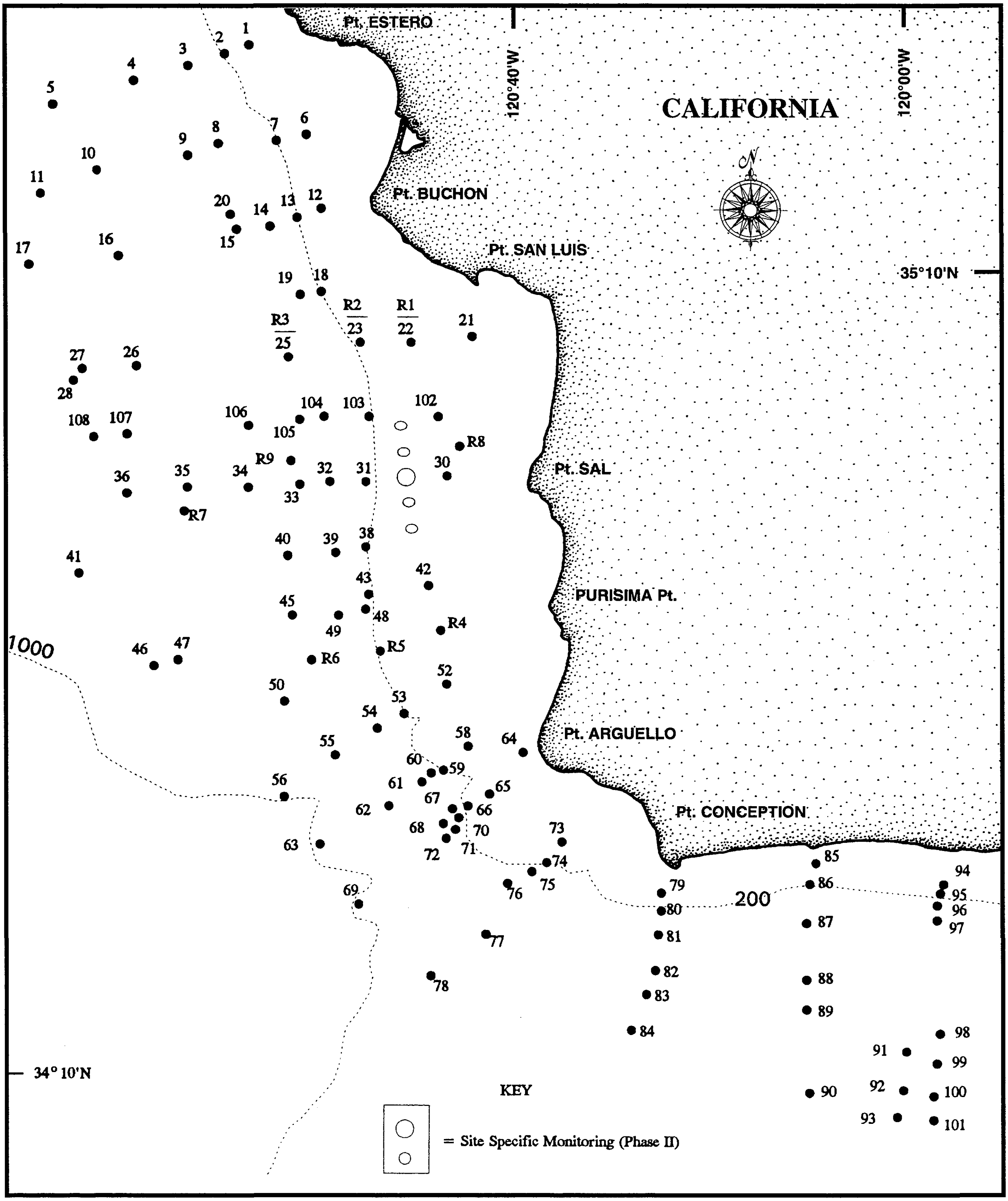


Figure 1.1. Map showing location of soft-substrate stations from the Phase I Reconnaissance and Phase II Monitoring Programs.

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	January 1987
1-3	May 1987
2-1	July 1987
2-3	October 1987
2-4	January 1988
2-5	May 1988
3-1	October 1988
3-4	May 1989

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

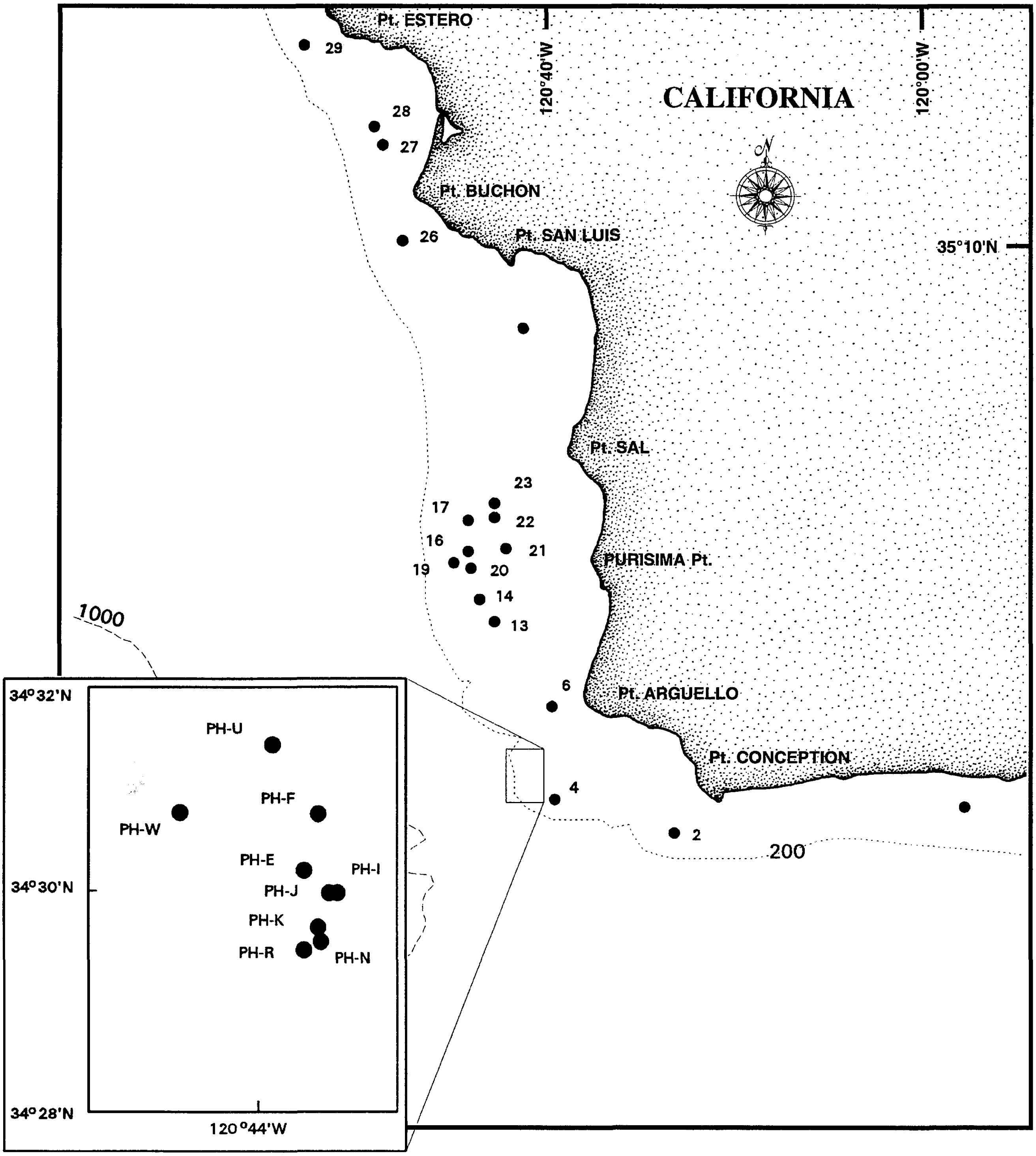


Figure 1.2. Map showing location of hard-substrate stations from the Phase I Reconnaissance and

Index

E

F

G

H

I

J

K

L

M

T

U

V

W

Z