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

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**VOLUME 10**

The Arthropoda – The Pycnogonida  
The Crustacea Part 1 – The Decapoda and Mysidacea

**ORDER DECAPODA**

by

Joel W. Martin and Todd L. Zimmerman



**SANTA BARBARA MUSEUM OF NATURAL HISTORY**

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Santa Barbara, California

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**TAXONOMIC ATLAS OF THE BENTHIC FAUNA OF  
THE SANTA MARIA BASIN AND WESTERN SANTA  
BARBARA CHANNEL. Volume 10.**

The Arthropoda - The Pycnogonida

The Crustacea Part 1 - The Decapoda and Mysidacea.

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# SUBPHYLUM CRUSTACEA

## 2. ORDER DECAPODA

by

Joel W. Martin<sup>1</sup> and Todd L. Zimmerman<sup>2</sup>

### Introduction

Decapod crustaceans are among the most common and easily recognized invertebrate groups, representing a large number of species found in many habitats. Because of their popularity, and because some groups are of considerable economic importance, there are numerous guides to the identification and natural history of decapods. However, most of these guides are restricted either to specific areas outside southern California (e.g., Austin Williams' 1984 guide to the decapods of the east coast of the United States) or, if pertaining to southern California, are restricted to one or two families or genera (e.g. Zmarzly's 1992 review of the pinnotherid crab genus *Pinnixa*). It is surprising that for the California coast, an area that has been subjected to much study, no updated and thorough treatment of the Decapoda exists subsequent to Waldo Schmitt's (1921) classic (but now outdated, and long out of print) volume *The Marine Decapod Crustacea of California*. Several guides to, or treatments of, the west coast decapods have appeared since Schmitt's publication (e.g. Kozloff, 1987; Allen, 1980; Jensen, 1995, etc.), but these tend to include only those species restricted to more shallow waters (and therefore more likely to be seen and collected by naturalists), and so they are of limited use in identification of the deeper fauna.

The most surprising result from the present study of the MMS collections is the relatively small number of species encountered, most of which are relatively well known, compared to those anticipated (for expected source pool see Wicksten, 1989). For many of the taxa encountered, the descriptions and biological information have been summarized from older literature, such as Garth's (1958) monograph on Pacific "Oxyryncha".

One of the most valuable assets in identification and taxonomy of California invertebrates are the members of the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT). These biologists have been responsible for publishing numerous new records and taxonomic changes to the knowledge of southern California species. Primarily because of the active input of information from that group, the present list should not be considered a definitive checklist of the fauna of the Santa Maria Basin. Despite the size of most decapods and the interest they generate, it is clear that there still is much to learn about them, even from such populated regions as southern California.

The current report is a list of species identifications and a corresponding compilation of information that stems primarily from preexisting literature. For that reason and by way of this disclaimer, this report is not to be considered to have met the criteria for publication as outlined in Article 8 of the International Code of Zoological Nomenclature, third edition (1985).

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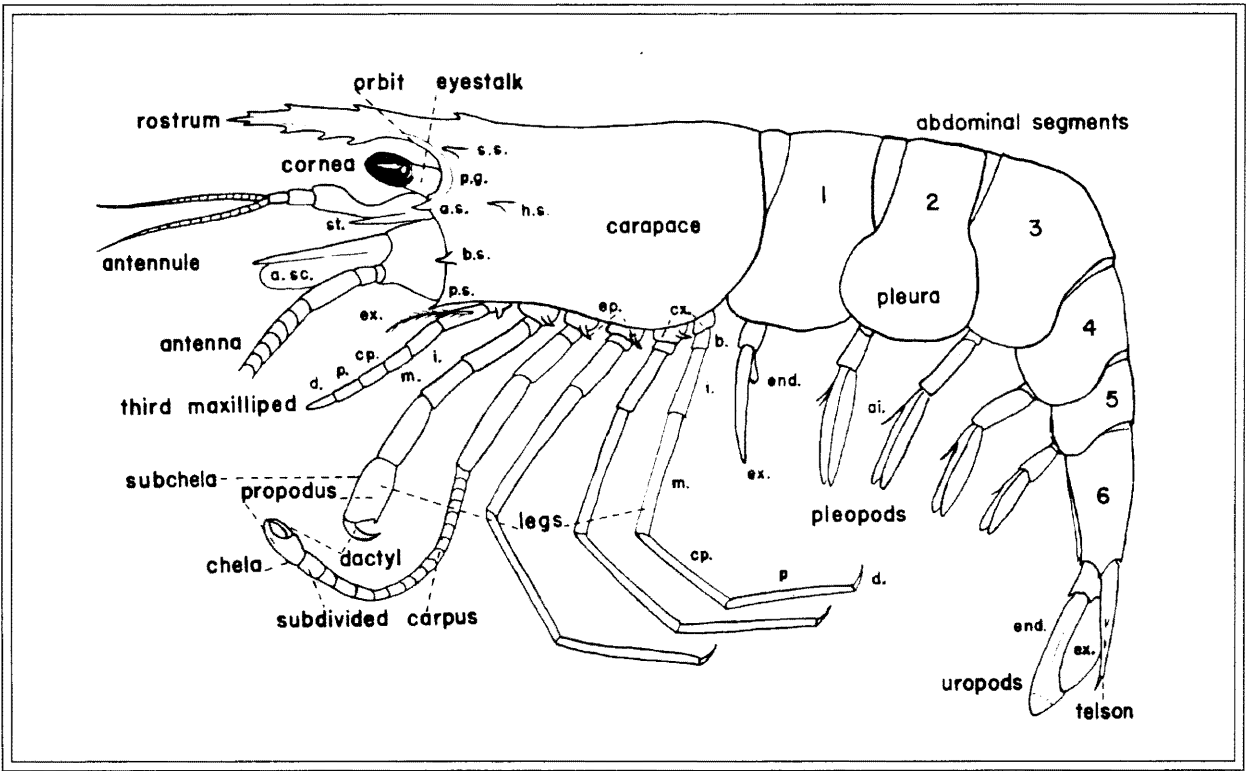
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## General Biology and Ecology

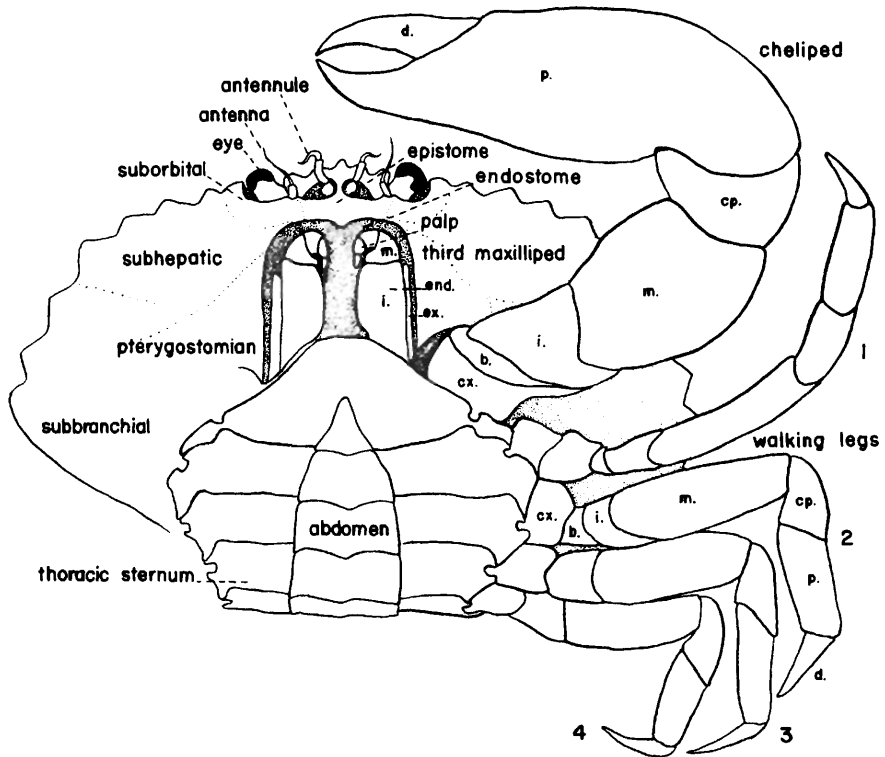
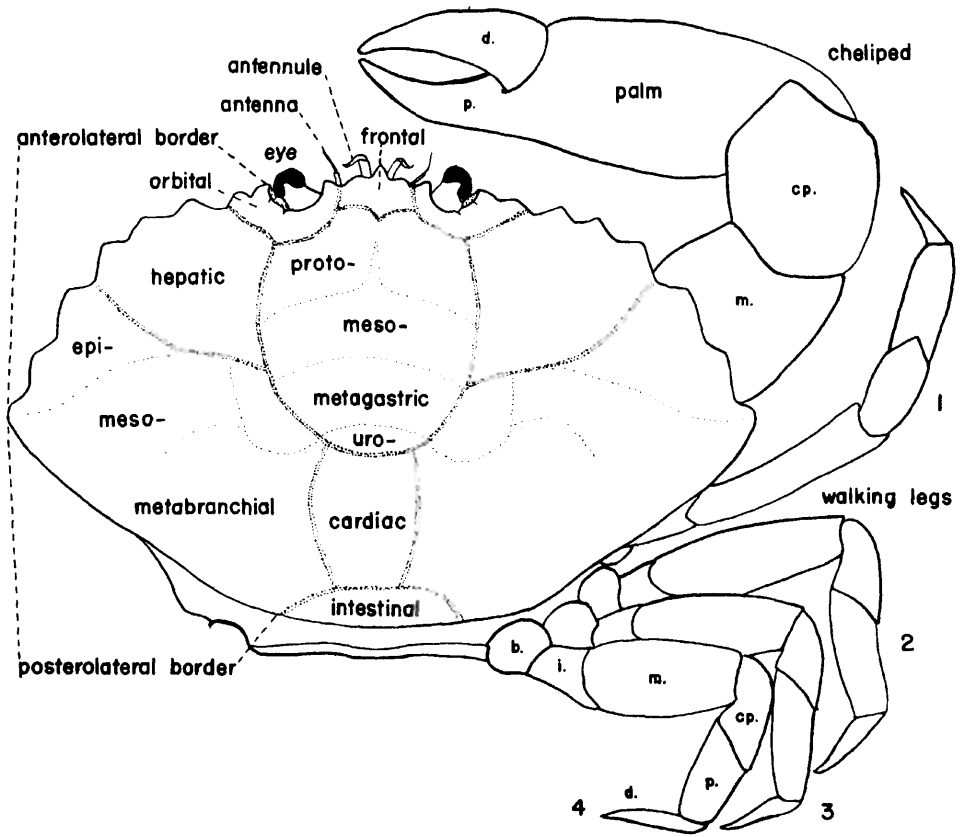
Decapods occupy such a wide range of habitats and ecological “niches” that no general statements of their biology and ecology can be made without many caveats inserted. The group includes scavengers, strict herbivores, predators (both sit-and-wait predators as well as hunters), filter feeders, symbionts, and probably any other feeding mode that could be imagined. The majority are benthic, although many species, particularly among the shrimp, are pelagic, at least during part of the life cycle; there are of course freshwater, terrestrial and semiterrestrial species as well, but these need not be mentioned for purposes of this report. Most of the species mentioned in this report are benthic, macrophagous animals, as might be guessed from where and how they were collected (see Volume 1 of this series). In general the group might best be described as opportunistic scavengers, meaning that, from what little we know, they will eat just about anything they happen upon. Some of the species in this report are almost certainly more specialized in their feeding habits than the above statement would seem to indicate. Commensal pinnotherid crabs, as one example, are often highly dependent upon their “host” as a source of nutrition, yet for some no host is known. Although many species of decapods will eat shrimp and just about any other proffered food item in captivity, it is not always appropriate to extend observations made in the laboratory to what might be happening in the field.

## Terminology and Glossary

For decapod crustaceans, the glossary of Williams (1984), although written to assist in the identification of decapods from the east coast of the United States, serves equally well for identifying characters used in the taxonomy of west coast decapods. We have borrowed *verbatim* the glossary found in his introductory section (Williams, 1984: 8-17), and his schematic labeled diagrams of a shrimp and crab are reproduced here as Figures 1 and 2. We have added to Williams’ glossary the relatively few terms used in this report that are not found in his glossary. In the following section, any word and its definition taken directly from Williams (1984) is followed by the notation [ABW]. Other terms and definitions have been taken from various sources, among which are McLaughlin (1980) [McL] and Moore and McCormick (1969, in Glaessner, 1969) [M&M], which are also good starting points for learning the terminology of other crustacean taxa. Some of the more descriptive terms are included here as well, and definitions for some of these have been taken from the American Heritage Dictionary of the English Language [AHD]. When no concise definition could be located, we have used our own; these are designated as [M&Z]. Figures referred to in the definitions are those of Williams (1984) and not of the current report.



**Figure 2.1.** Schematic drawing of shrimp in lateral view: ai, appendix interna; as, antennal spine; asc, antennal scale; b, basis; bs branchiostegal spine; cp, carpus; cx, coxa; d, dactyl; end, endopod; ep, epipod; ex, exopod; hs, hepatic spine; i, ischium; m, merus; p, propodus; pg, postorbital groove; ps, pterygostomian spine; ss supraorbital spine; st, stylocerite (from Williams 1984, modified from Holthuis 1955; Schmitt 1921).





## Glossary

- Abdomen.** Trunk somites (tagma) between thorax and telson; somites with or without limbs; syn., **pleon**. [McL]
- Acicle.** Antennal scale reduced to a spine. [ABW]
- Afferent channels.** Openings through which water passes to gills. In brachyuran crabs, usually opening behind pterygostomian regions and in front of chelipeds except in certain Oxystomata in which they open at anterolateral angles of palate or endostome. [ABW]
- Apodeme.** Any cuticular ingrowth of body wall. [ABW]
- Appendix interna.** Small separate branch on mesial side of pleopodal endopodite, usually tipped with hooks which interlock with opposite member in swimming. [ABW]
- Appendix masculina.** Accessory male organ located mesially on second pair of pleopods between endopodite and appendix interna. [ABW]
- Arthrobranchiae.** Gills attached to articular membrane between coxa of appendage and body wall. [ABW]
- Antepenultimate.** Second from the last; third from the end in a series. [AHD]
- Antenna(e).** One of a pair of appendages of the second cephalic somite; syn., *2nd antenna*. [McL]
- Antennal scale.** See stylocerite.
- Antennule.** One of a pair of appendages of the first cephalic somite; syn., *1st antenna*. [McL]
- Areolation.** Demarcated and usually elevated regions of the brachyuran carapace (see M. J. Rathbun, 1930, page 6). [M&Z]
- Basis (basipodite).** Second article (from body) of leg or maxilliped. Sixth segment from distal end of limb. [ABW]
- Basicerite.** Spine on dorsal side of basis of antenna; sometimes more lateral than dorsal. [ABW]
- Branchiocardiac groove.** Groove separating branchial and cardiac regions. [ABW]
- Branchiostegal spine.** Spine on anterior edge of carapace, or near it, immediately below branchiostegal groove (Fig. 2). [ABW]
- Branchiostegite.** Part of carapace not coalesced ventrally with thoracic somites, but overhanging on each side as covering for gill chamber. [ABW]
- Buccal cavity.** Cavity on ventral surface of body in which mouthparts are situated; bounded anteriorly by epistome, laterally by free edges of carapace. Within this "frame" lie the mouthparts, which in most Brachyura are covered by operculiform third maxillipeds. [ABW]
- Capitate.** Enlarged or globular at end. [AHD]
- Carina.** Keel-like ridge or prominence. [ABW]
- Carpus (carpopodite).** Third article from distal end of leg. [ABW]

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**Figure 2.2.** Schematic drawing of brachyuran crab in: A—dorsal view; areas of carapace indicated; legs of right side only shown; b, basis; cp, carpus; d, dactylus; i, ischium; m, merus; p, propodus. B—ventral view; areas of carapace indicated; legs of left side only shown; b, basis; cp, carpus; cx, coxa; d, dactylus; end, endognath; ex, exognath; i, ischium; m, merus; p, propodus (from Williams, 1984).

- Chela.** Arrangement of distal 2 articles of crustacean limb in which terminal article is opposed to article preceding it in an adaptation for grasping. In true chela, terminal 2 articles shaped as fingers, one closing against other. In subchela, terminal article (dactyl) usually closes against distal surface of penultimate article (propodus). [ABW]
- Chelipeds.** Pair or pairs of thoracic legs behind maxillipeds; bearing chelae, or pincer-like claws, and often stouter, sometimes much stouter, than other legs. [ABW]
- Coxa (coxopodite).** First or proximal article of leg or maxilliped. [ABW]
- Dactyl (dactylus or dactylopodite).** Terminal or distal article of leg; movable finger of cheliped. [ABW]
- Efferent channels.** Channels through which water passes from gills. Openings at sides of endostome, except in Section Oxystomata in which they open at middle of endostome. [ABW]
- Endognath.** Inner or principal branch of a maxilliped. [ABW]
- Endopodite.** Mesial ramus of biramous appendage. [ABW]
- Endostome.** Part of epistome forming palate in brachyurans and usually separated from epistome proper by transverse ridge. [ABW]
- Epibranchial (epibranchial region).** Part of porcellanid (crab) carapace situated behind orbit and above metabranchial region. Region situated between cervical groove and *linea anomurica*. Often a strong spine on region, referred to as epibranchial spine. [ABW]
- Epigastric lobes.** Anterior lobes or subregions of gastric regions. [ABW]
- Epimere.** Lateral part of wall of body somites situated between tergum and insertion of appendages. [ABW]
- Epipodite.** Outgrowth of first 7 thoracic coxae. [ABW]
- Epistome.** Antennal sternum mainly represented by epistome, a plate of varying shape lying between labrum and bases of antennae. In shrimps, comparatively narrow and separated on each side from lateral portions of carapace by exhalant branchial channels. In Astacidea and Anomura, broad and in contact with carapace on each side; in Brachyura, becoming firmly united with carapace. The epistome forms the anterior part of the buccal frame. [ABW]
- Exognath.** Lateral or secondary branch of maxilliped. [ABW]
- Exopod.** see Exopodite.
- Exopodite.** Lateral ramus of biramous appendage. [ABW]
- Fingers (digits).** Narrow scissorlike blades of pincer end of cheliped, movable finger being dactyl, and fixed finger the terminal part of propodus. [ABW]
- Flagellum.** Multiarticulate distal portion of antennule, antenna, or exopod. [McL.]
- Front.** Frontal portion of carapace; that portion of crab carapace lying between orbits. [ABW]
- Frontal teeth.** True frontal teeth; those teeth originating on front but exclusive of inner orbital teeth. [ABW]
- Gastric region.** Large median area, in crab carapace, bounded behind by cervical suture, laterally by hepatic regions, and anteriorly by frontoorbital regions. Divisible into following subregions or lobes: epigastric, protogastric, mesogastric, metagastric, and urogastric. [ABW]
- Genital region.** See urogastric lobe. [ABW]
- Gonopore.** Outlet for genital products; syn., *sexual pore*. [McL.]
- Hand (chela).** Propodus and dactyl of cheliped. [ABW]

- Hepatic region.** Small (paired) subtriangular, anterolateral region, wedged between branchial and gastric regions, and either margin of carapace or margin of orbit in Brachyura. [ABW]
- Hepatic spine.** Spine on hepatic region in shrimps (Fig. 2). [ABW]
- Holotype.** The single specimen used as the basis of the original published description of a species and later designated as the type specimen. [AHD]
- Incisor process.** Biting portion of gnathal lobe of mandible; syn., *pars incisiva*. [McL.]
- Ischium (ischiopodite).** Fifth article from distal end of leg; usually first large article of maxilliped. [ABW]
- Keel.** see Carina.
- Lacinia(e).** Inner distal spiny lobe of second segment of maxillule. [McL.]
- Linea anomurica, L. homolica, L. thalassinica.** Longitudinal groove or uncalcified line on carapace which may form a hinge; such lines found in various groups, from which come the names. [ABW]
- Mandible.** One of the third pair of cephalic appendages, used to masticate food. [McL.]
- Mandibular palp.** Distal articulated part of mandible used in feeding or cleaning. [McL.]
- Manus.** Broad proximal part of propodal cheliped; syn., *palm*. [McL.]
- Maxillipeds.** Paired appendages modified for feeding on 1st, up to 3rd, thoracic somites, usually fused to cephalon. [McL.]
- Maxillule.** One of a pair of the 4th cephalic appendages, usually serving as a mouthpart; syn., *1st maxilla*. [McL.]
- Merus (meropodite).** Fourth article from distal end of leg; sometimes called arm of cheliped. [AW]
- Mesogastric lobe.** Median lobe or subregion of gastric region; pentagonal in form, and with long, narrow, anterior prolongation. [ABW]
- Metabranial (metabranial region).** That region of porcellanid (crab) carapace situated below *linea anomurica* and, therefore, not completely united with main part of carapace. [ABW]
- Metagastric lobe.** Posterolateral lobe or subregion of gastric region; often not defined. [ABW]
- Molar process.** Grinding portion of gnathal lobe of mandible; syn., *pars molaris*. [McL.]
- Obsolescent.** Vestigial. [AHD]
- Ocellus.** Little eye, distinct from main organ of vision. [ABW]
- Ocular peduncle.** Eyestalk. [ABW]
- Orbit.** Cavity in carapace containing eye. [ABW]
- Orbital fissure.** see orbital hiatus.
- Orbital hiatus.** Gap in orbital margin of carapace at its lower (inner) angle. [M&M]
- Orbital region.** Narrow space bordering upper margin of orbit; not always distinguishable. [ABW]
- Palate.** Roof of buccal cavity in crabs. [ABW]
- Palm.** Proximal part of propodus of chela. [ABW]
- Palp.** Usually one ramus (endopod), sometimes both, and basis, reduced distally to 1 to 3 segments, associated with mouthparts. [McL.]
- Peduncle.** A stalklike structure. [AHD]
- Pereiopod** (also spelled peracopod or pereopod). Thoracic appendage used in locomotion; syn., ambulatory leg, walking leg. [McL.]
- Petasma.** Endopodite of first pleopods in male Penaeidae; a complicated membranous plate bearing coupling hooks mesially which interlock with those on member of opposite side; may terminate distally in various complex-shaped lobes. [ABW]
- Phyllobranchia(e).** Gill with leaflike filaments. [McL.]

**Pleurobranchia(e).** Gills attached to lateral wall of body dorsal to articulation of appendage. [ABW]

**Pleuron.** See epimere.

**Podobranchiae.** Gills attached to coxa of appendage. [ABW]

**Postorbital groove.** Groove on carapace behind orbit and more or less parallel to margin of orbit (Fig. 2). [ABW]

**Propodus (propodite).** Second article from distal end of leg. Propodus of cheliped consists of palm and narrower fixed finger. [ABW]

**Prosartema (dorsal eye brush).** Long, thin, ciliated lobe arising dorsally from proximomesial border of first antennular segment and extending anteriorly; found in Penaeidae. [ABW]

**Protogastric lobe.** Anterolateral lobe of subregion of gastric region. [ABW]

**Protopodite.** Peduncle of an appendage; in unmodified form, consisting of one coxal and one basal article. [ABW]

**Pterygostomian region.** Triangular space on ventral surface of carapace, on either side of buccal cavity in Brachyura. Region at anterolateral corner of carapace in shrimps. [ABW]

**Pterygostomian spine.** Spine at anterolateral (anteroventral) corner or border of carapace in shrimps (Fig. 2). [ABW]

**Pubescence.** A covering of down or short hairs. [AHD]

**Rugose.** Having a rough or ridged surface. [AHD]

**Scaphocerite.** Antennal scale (Fig. 2). [ABW]

**Stylocerite.** Spine or rounded lobe on lateral aspect of basal article of antennule. [ABW]

**Subhepatic region.** Area below hepatic region and anterolateral border of carapace. [ABW]

**Suborbital spine.** Spine on lower rim of orbit (Fig. 2). [ABW]

**Sulcus, sulci.** Groove or furrow. [McL.]

**Suture.** Weakly calcified areas of integument separating at ecdysis. [McL]

**Supraorbital spine.** Spine above and behind orbit (Fig. 2). [ABW]

**Telson.** Terminal somite of abdomen. [ABW]

**Tergite.** Dorsal plate of segment. [ABW]

**Thelycum.** External seminal receptacle, variously developed, lying on sternum of thorax and formed by outgrowths from last and next to last thoracic somites. [ABW]

**Urogastric lobe.** Posteromedian lobe or subregion of gastric region, sometimes called genital region. [ABW]

## Methods of Preservation

Ideally, decapods should be initially fixed in buffered formalin. Commercially available “full strength” formalin represents a 37% solution of formaldehyde; a 1:20 mixture of this solution with water will result in a very strong fixative that is commonly referred to as “5% formaldehyde” (actually 5% formalin). Stronger solutions may be used but those exceeding 10% often result in very brittle specimens. Decapods tend to cast off appendages when subjected to severe shocks, such as immersion in formalin. This tendency often can be moderated by euthanizing them, either by using initially a slightly weaker solution (1-2%) of formalin and gradually increasing the percent of formalin to 5-10%, or by chilling them in ice water prior to fixation. The latter technique has the added advantage that color of the integument is retained. Smaller specimens (e.g. less than 100 mm carapace width for crabs and 100 mm carapace length for shrimp and lobsters) may be placed directly into the fixative solution. For larger specimens, it is best to use a syringe to inject this solution into the major body cavities, gill chambers, and even into the joints of the appendages to assure proper fixation, prior to placing the entire specimen in a 10% solution. Several workers (e.g. see Lincoln and Sheals, 1979: 63) then recommend addition of small amounts of glycerol to the fixative at this time to keep specimens from becoming too brittle. After fixation for at least 24 hours (and up to 3 or 4 days for large specimens), they should be thoroughly rinsed in fresh water and transferred to 70% ethyl-alcohol for long-term storage. Specimens with detailed collection information (including date of collection, depth, habitat, method of capture, etc.) should be deposited in a major and reputable institution that is committed to the long term care of marine invertebrates (e.g., the Natural History Museum of Los Angeles County).

## List of Families, Genera, and Species

### Order Decapoda

#### Dendrobranchiata

##### Penaeidea

Family Sicyoniidae Ortmann, 1898

*Sicyonia ingentis* (Burkenroad, 1938)

#### Pleocyemata

##### Caridea

Family Crangonidae Haworth, 1825

*Neocrangon zaca* (Chace, 1937)

*Neocrangon resima* (Rathbun, 1902)

*Neocrangon communis* (Rathbun, 1899)

*Crangon alaskensis* Lockington, 1877

*Metacrangon spinosissima* (Rathbun, 1902)

Family Alpheidae Rafinesque, 1815

*Alpheus bellimanus* Lockington, 1877

Family Hippolytidae Dana, 1852

*Eualus lineatus* Wicksten and Butler, 1983

*Spirontocaris sica* Rathbun, 1902

*Spirontocaris holmesi* Holthuis, 1947

Family Palaemonidae Rafinesque, 1815

*Pseudocoutierea elegans* Holthuis, 1951

Thalassinidea

Family Axiidae Huxley, 1879

*Acanthaxius spinulicaudus* (Rathbun, 1902)

*Calocarides quinqueseriatum* (Rathbun, 1902)

*Calocarides* sp.

Anomura

Family Paguridae Latreille, 1803

*Paguristes ulreyi* Schmitt, 1921

*Parapagurodes laurentae* McLaughlin and Haig, 1973

Family Galatheididae Samouelle, 1819

*Munida quadrispina* Benedict, 1902

*Pleuroncodes planipes* Stimpson, 1860

Family Lithodidae Samouelle, 1819

*Paralomis multispina* (Benedict, 1894)

Brachyura

Family Homolidae De Haan, 1839

*Moloha faxoni* (Schmitt, 1921)

Family Xanthidae MacLeay, 1838

*Lophopanopeus bellus diegensis* (Rathbun, 1900)

Family Parthenopidae Alcock, 1895

*Heterocrypta occidentalis* (Dana, 1854)

Family Majidae Samouelle, 1819

*Erileptus spinosus* Rathbun, 1893

Family Pinnotheridae De Haan, 1833

*Pinnixa occidentalis* Rathbun, 1893

*Pinnixa scamit* Martin and Zmarzly, 1994

## Key to Families and Species

Williams (1984) presented a key to the 48 families of decapods known from the east coast of the United States. While some families in that key have no west coast representatives, the west coast families are a subset of those 48. Further, the key is updated to correct family names, authors, and dates, and is thus preferable to the older key of Schmitt (1921) or the various popularized guides to west coast fauna (e.g. Kozloff, 1987; Allen, 1980; Jensen, 1995, etc.). Because that key was constructed to help in the identification of east coast species, it was never intended to be used in other geographic regions, and reliance upon it for identification of west coast species without some modification of the couplets could present problems.

The following key is a modified subset of Williams' (1984) key to families, and includes *only those families and species mentioned in this report*. This is of course very misleading, in that if a species belonging to a family or genus not among those in our report is found for the first time in this study area, it will not be possible to identify it using the following key. In fact, even species known to occur in this area will not always be identifiable using such an artificial key. For example, a worker attempting to identify commercially important penaeid shrimp or a species of the crab genus *Cancer* will have no luck. Even though penaeids and species of the family Cancridae are commonly encountered in California waters, and occur in our study area, none was found in this particular survey. The reader is referred to more specific keys to the particular families or genera in question, such as that of Zmarzly (1992) for the pinnotherid genus *Pinnixa* or that of Wicksten (1990) for the shrimp family Hippolytidae, or to more encompassing and more general guides to decapods outside this immediate study, when similar problems present themselves. Specific couplets for separating species within families are taken from earlier published sources, such as Word and Charwat (1976) and Butler (1980), or are newly created by us.

1A.	General form shrimplike, usually compressed. Pleura of second abdominal segment never overlapping those of first segment. First 3 pairs of legs chelate. [Suborder Dendrobranchiata; infraorder Penaeidea] .....	Family Sicyoniidae: <i>Sicyonia ingentis</i>
1B.	General form shrimplike, lobsterlike, or crablike; if shrimplike then with pleura of second abdominal segment overlapping those of first segment. Of first three pairs of legs, third not chelate .....	Suborder Pleocyemata ..... 2
2A.	Form shrimplike, usually with body compressed .....	Infraorder Caridea ..... 3
2B.	Form lobsterlike or crablike .....	12
3A.	First pair of legs chelate .....	8
3B.	First pair of legs subchelate .....	Family Crangonidae .. 4
4A.	Gastric region of carapace depressed below general level of the carapace ....	<i>Metacrangon spinosissima</i>
4B.	Gastric region of carapace not depressed below general level of carapace .....	5
5A.	Carapace with only one median gastric spine .....	<i>Crangon alaskensis</i>
5B.	Carapace with two median gastric spines .....	6

- 6A. The rostrum tilts up at an angle of 45 degrees; the tip of the rostrum has a small flag-like structure (not evident in specimens less than 20 mm TL) ..... *Neocrangon resima*
- 6B. The rostrum may be tilted upward, but not at a 45 degree angle; flag-like structure at tip absent .. 7
- 7A. All abdominal segments except first and second carinate on dorsal surface, with two carinae separated by median sulcus on sixth abdominal segment ..... *Neocrangon communis*
- 7B. Only sixth abdominal segment carinate on dorsal surface, with two carinae separated by median sulcus ..... *Neocrangon zaca*
- 8A. Carpus of second legs entire ..... Family Palaemonidae: *Pseudocoutierea elegans*
- 8B. Carpus of second legs subdivided into two or more joints; first pair of legs with chelae asymmetrical ....  
..... 9
- 9A. Chelae of first legs very large and distinct, at least on one side; eyestalks short and covered by carapace ..... Family Alpheidae: *Alpheus bellimanus*
- 9B. Chelae of first legs not obviously large and distinct; eyestalks not covered by carapace .....  
..... Family Hippolytidae ..... 10
- 10A. Carapace without supraorbital spines ..... *Eualus lineatus*
- 10B. Carapace with two or more supraorbital spines ..... 11
- 11A. Carapace with three median spines, which blend together with the rostral teeth .... *Spirontocaris holmesi*
- 11B. Carapace with two median spines, which are slightly anterior to the midline ..... *Spirontocaris* sp.
- 12A. Either lobster-like or crab-like; abdomen extended, bent upon itself, or flexed beneath thorax; last thoracic sternite free; uropods present; carapace not fused with epistome; first, second, or first 2 pairs of legs chelate or subchelate ..... Infraorders Thalassinidea and Anomura ..... 13
- 12B. Crab-like, abdomen permanently flexed beneath carapace; last thoracic sternite fused with preceding; uropods rarely present, never biramous; carapace fused with epistome; first pair of legs chelate or subchelate ..... Infraorder Brachyura ..... 20
- 13A. Abdomen asymmetrical ..... 14
- 13B. Abdomen symmetrical ..... 16
- 14A. Abdomen membranous and with uropods adapted for holding body in hollow objects ..... 15
- 14B. Abdomen asymmetrical and sclerotized, flexed under body ... Family Lithodidae: *Paralomis multispina*
- 15A. Third maxillipeds approximated at base; antennae setose, moth-like .....  
..... Family Diogenidae: *Paguristes ulreyi*
- 15B. Third maxillipeds widely separated at base by sternum; antennae sparsely setose .....  
..... Family Paguridae: *Parapagurodes laurentae*



- 16A. Body subcylindrical; first 2 pairs of legs chelate or subchelate; abdomen extended .....  
 ..... Infraorder Thalassinidea, Family Axiidae ..... 17
- 16B. Body depressed; only first legs chelate; abdomen bent under thorax ..... Family Galatheidae .. 19
- 17A. Eyes pigmented ..... *Acanthaxius spinulicaudus*
- 17B. Eyes pale, without pigment ..... 18
- 18A. Distoventral spines present on carpus of second leg ..... *Calocarides* sp.
- 18B. Distoventral spines absent on carpus of second leg ..... *Calocarides quinqueseriatum*
- 19A. Lateroinferior edges of carapace greatly swollen so that epimeral structures, sides of carapace, are visible in dorsal view; pereopods flattened for swimming ..... *Pleuroncodes planipes*
- 19B. Lateroinferior edges not greatly swollen; pereopods more cylindrical for walking .....  
 ..... *Munida quadrispina*
- 20A. Linea homolica present on carapace laterally; 5th pereopods carried dorsally or subdorsally .....  
 ..... Family Homolidae: *Moloha faxoni*
- 20B. Linea homolica absent; 5th pereopods carried laterally, as other pereopods ..... 21
- 21A. Body conspicuously narrowed in front; rostrum distinct ..... 22
- 21B. Body moderate to broad in front; rostrum absent ..... 23
- 22A. Chelipeds with fingers straight; hooked hairs present ..... Family Majidae: *Erileptus spinosus*
- 22B. Chelipeds with fingers deflexed; hooked hairs absent .....  
 ..... Family Parthenopidae: *Heterocrypta occidentalis*
- 23A. Carpus of third maxilliped articulating at or near anterointernal angle of merus; lateral margins of mouth frame parallel or divergent ..... Family Xanthidae: *Lophopanopeus bellus diegensis*
- 23B. Carpus of third maxilliped not articulating at or near anterointernal angle of merus; lateral margins of mouth frame convergent, becoming ellipsoid ..... Family Pinnotheridae ..... 24
- 24A. Propodus of pereopod 4 nearly as broad as long ..... *Pinnixa occidentalis*
- 24B. Propodus of pereopod 4 approximately 2.6 times longer than broad ..... *Pinnixa scamit*

# Descriptions of Species

## Order Decapoda Latreille, 1803

### Suborder Dendrobranchiata Bate, 1888

#### Infraorder Penaeidea de Haan, 1849

Family Sicyoniidae Ortman, 1898

#### *Sicyonia ingentis* (Burkenroad, 1938)

Figure 2.3

*Eusicyonia ingentis* Burkenroad, 1938:

*Sicyonia ingentis*.—Word and Charwat, 1976:19.—Perez Farfante, 1988:25, Fig. 41A-C.—Jensen, 1995:79.

**Material Examined.** One small (carapace length = 4.4 mm including rostrum, total length = 12.4 mm) juvenile, USNM Phase I voucher, 073-BSR, 03-TX.

**Description.** Postrostral carina with 1 tooth posterior to level of hepatic spine. Dorsomedial carina on first abdominal segment produced into tooth smaller or only slightly larger than posterior tooth on carapace. Petasma with distal projections of dorsolateral lobules divergent and produced in short filament. Thelycum with posterior component of median plate bearing paired short lateral bosses cut by transverse suture (adapted from Perez Farfante, 1988, key).

Color in life not reported.

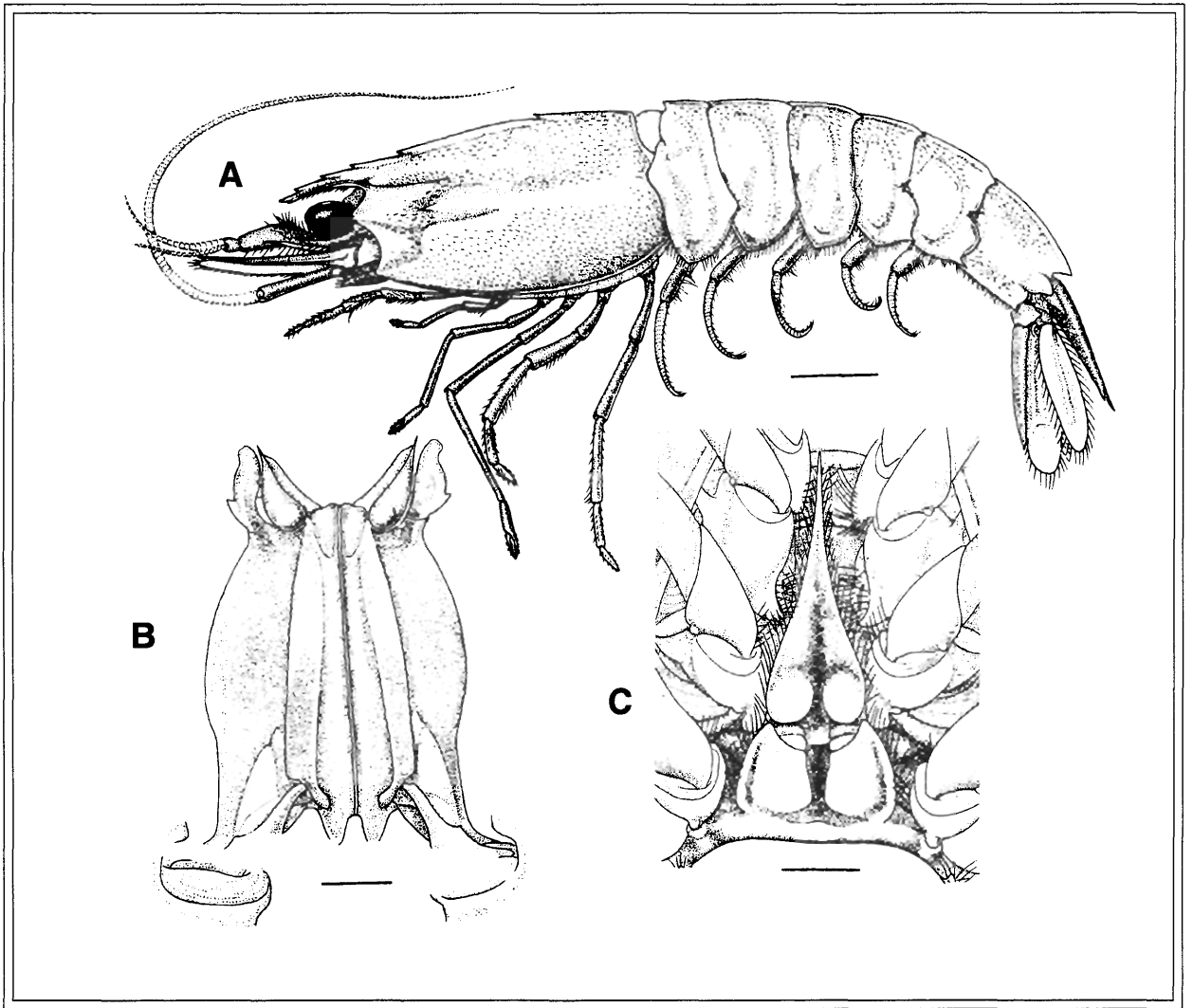
Commonly referred to as the ridge backed prawn, rock shrimp, Pacific rock shrimp, camaron de piedra, and cacahuete.

**Biology.** Commercially harvested between Santa Barbara and Ventura, California (Frey, 1971). Attains a total length of 157 mm (males) to about 180 mm (females) (Perez Farfante, 1988).

**Taxonomic Remarks.** The single specimen examined was small and in poor condition, with carapace, telson, and appendages slightly damaged. Assignment to *S. ingentis* is therefore tentative, although *S. ingentis* is the only species in the genus reported from as far north as California. *Sicyonia ingentis* is one of only 4 eastern Pacific members of this genus that are of commercial importance (Perez Farfante, 1988), the other 3 being *S. brevirostris* Stimpson, 1874, *S. penicillata* Lockington, 1879, and *S. disdorsalis* (Burkenroad, 1934). However, other species in the genus, not of commercial importance, are also present (e.g., see Perez Farfante and Boothe, 1981). Spination on the dorsal keel of the carapace of our specimen agrees most closely with descriptions of *S. ingentis*, based on the key of Perez Farfante (1988).

**Type Locality and Type Specimens.** Station 127, Dredge 1, off east coast of Cedros Island, west coast of Baja California, in 76-120 m. Type and Cotypes, Cat. No. 361,025, Department of Tropical Research, New York Zoological Society (6 males, 4 females).

**Distribution.** Isla Maria Madre and throughout the Gulf of California (Perez Farfante, 1988), including Cedros Island, Baja California (Burkenroad, 1938), north to Santa Barbara, California, including Santa Catalina Island (Carlisle, 1969; Frey, 1971; Word and Charwat, 1976) and to Monterey Bay (Perez Farfante, 1988). From 5 to 183 m, occasionally to 293-307 m (Perez Farfante, 1988).



**Figure 2.3.** *Sicyonia ingentis* (Burkenroad, 1938): A, lateral view; B, dorsal view of petasma; C, thelycum; scale for B = 1mm, scale for C = 2mm (after Perez-Farfante, 1988).

The northern range record for this species, Monterey Bay, California, was first given by a footnote in Perez Farfante and Booth (1981:424), based on a single female archived at the California Academy of Sciences (CAS 009269). The present record is the second report of *S. ingentis* north of Pt. Conception, California, which was the northern range of the species given by Frey (1971).

## Suborder Pleocyemata Burkenroad, 1963

### Infraorder Caridea Dana, 1852

Family Crangonidae Haworth, 1825

*Neocrangon zaca* (Chace 1937)

Figure 2.4

*Crango zaca* Chace, 1937:136, Fig. 9.

*Crangon communis*.—Rathbun, 1904 in part.

*Crangon zaca*.—Word and Charwat, 1976:93, Fig. 5-3

*Neocrangon zaca*.—Kuris and Carlton, 1977:554.—Wicksten, 1980:39.—Wicksten and Hendrickx, 1992:6.

**Material Examined.** USNM 073-BSR-02-TX Phase I primary voucher, 1 specimen; SBMNH 058-BSS-01-TX Phase I secondary voucher, 1 specimen; MMS Phase II voucher, *M/V Aloha*, Cruise 1-3, Station R-4, 91 m, 3 specimens, largest - female, carapace length 7.2 mm including rostrum; MMS Phase II voucher, *M/V Aloha*, Cruise 1-1, Station PJ-15, 155 m, 1 specimen.

**Description.** Gastric region not depressed below general outline of carapace. Two spines on dorsal midline of carapace, posterior one in front of midpoint of carapace. A pair of lateral spines in line with anterior dorsal spine. Rostrum moderately ascendent, narrowly rounded at tip, not reaching as far forward as eyes. Abdomen with no carina on first five somites, sixth somite with parallel carinae divided by median sulcus. Blade of antennal scale exceeded by outer spine. Chelae of first legs more than three times as long as wide.

Carapace to base of rostrum about one-fourth as long as abdomen. Gastric region not depressed below the general outline of the carapace. Two spines in dorsal midline, posterior one much longer, arising in front of middle of carapace. A strong lateral spine present in line with anterior dorsal spine. Anterior margin with two spines, one at lower orbital angle, other at antero-lateral angle of carapace.

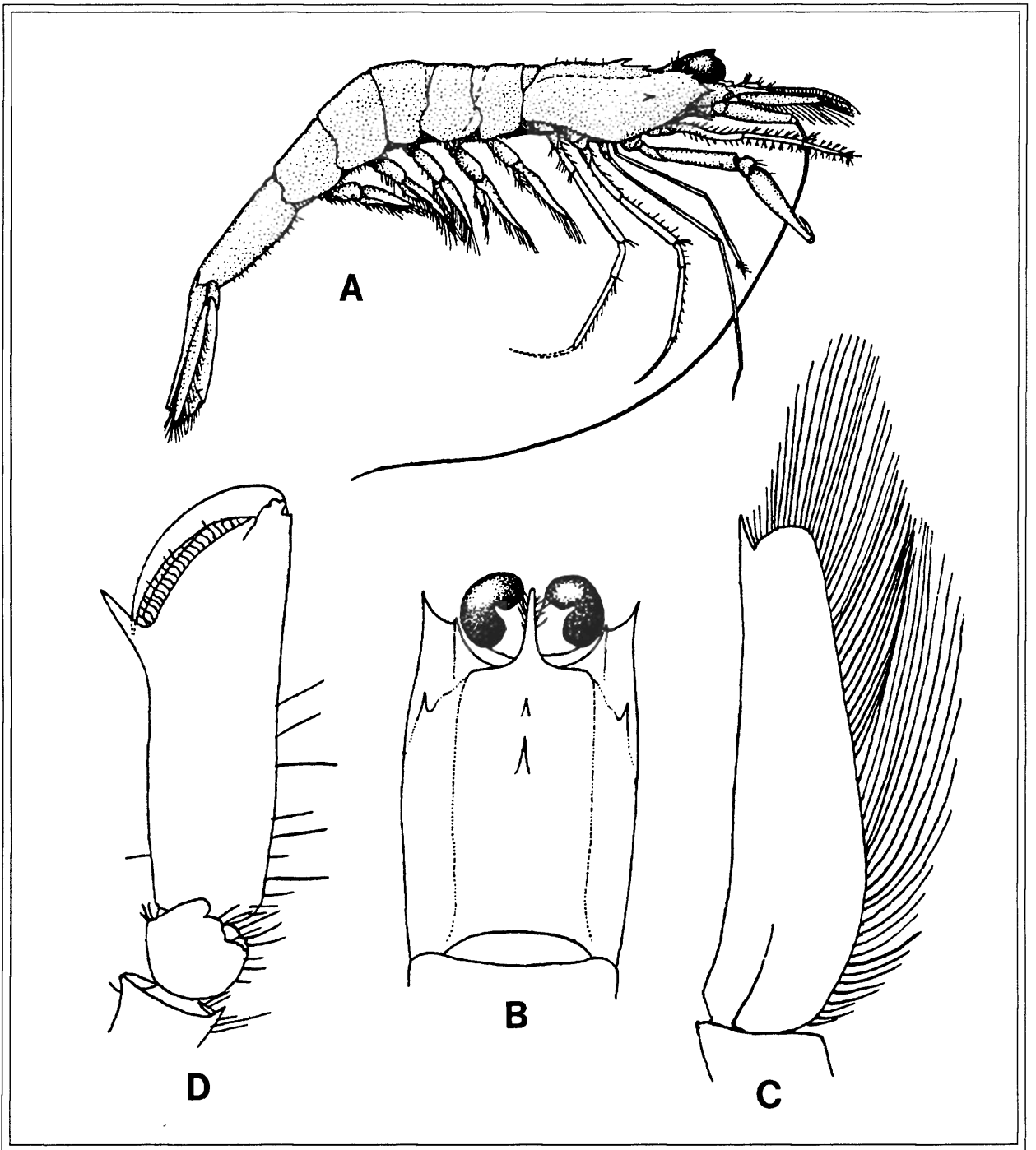
Rostrum ascends at slight angle which varies somewhat, but never becoming as great as 45°, bearing pronounced dorsal sulcus, tapering to blunt point, never reaching as far forward as eyes.

The abdomen without carina on first five somites. Posterior portions of first two segments slightly elevated; elevations preceded by broad, shallow, transverse sulci. Sixth segment about one and two-thirds times as long as fifth, bearing pair of dorsal longitudinal carinae separated by median sulcus and bounded on outer side by shallower sulci. Telson longer than sixth somite; with two pairs of dorsolateral spinules.

The eyes large and black.

Second segment of antennular peduncle about twice as long as third. Flagella extending to ends of hairs fringing antennal scale; latter about three and one-half times as long as wide, with outer spine easily exceeding blade in length.

Third maxillipeds extending slightly beyond antennular flagella. First legs exceed antennal scale but not reaching as far as terminal fringe of the latter. A spine present at outer angle of distal end of merus. Palm almost three and one-third times as long as wide, and dactyl closes very obliquely. Second pair of legs shorter than the first. Third pair extending well beyond third maxillipeds and fourth falls just short of latter.



**Figure 2.4.** *Neocrangon zaca* (Chace, 1937): A, Female holotype, lateral view; B, female holotype, dorsal view of carapace; C, paratype, antennal scale; D, paratype, chela of first pereiopod (from Chace, 1937).

Color in life: Body semi-translucent, mottled finely with greenish-brown and scarlet on dorsal and lateral surfaces; ventral surface white. Antennae banded with scarlet and white; eye mottled greenish and black; uropods and telson same color as body; remaining appendages translucent white (after Chace, 1937).

**Biology.** Wicksten (1980) states that specimens from 105 stations in southern California and Baja California, Mexico in the collections of the Allan Hancock Foundation were taken at depths ranging from shore to 572 m from bottoms ranging from mud to coralline algae.

**Taxonomic Remarks.** Chace (1937) states that this species is closely allied to *N. communis* (Rathbun), *N. resima* (Rathbun), and *N. abyssorum* (Rathbun). It is distinguished from the latter by the smaller eyes, longer palm of the first leg and lack of a carina on the fifth abdominal somite. It differs from *N. resima* in the differently shaped and less ascendent rostrum and longer palm. *N. zacaе* most closely resembles *N. communis* but differs in the total absence of a carina on any but the sixth segment of the abdomen.

Zarenkov (1965) proposed a separation of the genus *Crangon* into the subgenera *Crangon* s. s. and *Neocrangon*. Kuris and Carlton (1977) elevated *Neocrangon* to generic status and although Wicksten (1980) and Wicksten and Hendrickx (1992) refer to the above species as *Neocrangon zacaе*, Butler (1980) did not feel that Zarenkov's diagnosis for *Neocrangon* was valid.

Dr. M. Wicksten, Texas A & M University, feels that this species and the following one (*N. resima*) are synonymous and has a paper submitted to that effect (pers. comm.). Without having seen that manuscript, we still feel comfortable with the recognition of the two species.

Specimens of *N. zacaе* seen by us, including the material from the Santa Barbara Channel, appear to differ consistently from specimens of *N. resima* by the setation on the extremity of the rostrum, which is restricted to a distal tuft in *N. resima* but is more widely scattered along both sides of the rostrum in *N. zacaе*. This distinction holds true also for local specimens (D. Cadien, pers. comm.). However, the illustration of the holotype of *N. zacaе* (reproduced here as Fig. 4B) shows setae of the local "*resima*" form. Further investigation of this character might be warranted.

**Type Locality and Type Specimens.** Station 125, D-1, East of Cedros Island, 28°13'N., 115° 07'W., 88 m, on a muddy bottom, 27 March, 1936. Holotype female, Cat. No. 36,1096, Department of Tropical Research, New York Zoological Society.

**Distribution.** Monterey Bay, California, U.S.A., to Cedros Island, Baja California Norte, Mexico; off Gonzaga Bay, Gulf of California, Mexico; Clarion Island; north of Gorgona Island, Columbia (Wicksten and Hendrickx, 1992)

### *Neocrangon resima* (Rathbun, 1902)

Figure 2.5

*Crangon resima* Rathbun, 1902:889; 1904:124, Fig. 65.

*Crago resima*.—Schmitt, 1921:96, Fig. 64.—Goodwin, 1952:171.

*Crangon resima*.—Butler, 1980:95.—Word and Charwat, 1976:87

*Neocrangon resima*.—Kuris and Carlton, 1977:554.—Jensen, 1987b:402, Fig. 19.16.

**Material Examined.** M/V *Aloha* Station PJ-1, May, 1987, 1 ovigerous female, carapace length 10.8 including rostrum.

**Description.** First five abdominal segments smooth. First and second segments with thickened band along posterior margin, in front of which a slight transverse depression. Fifth segment with an obscure median carina, with short depression on either side at anterior end. Sixth segment has two prominent carinae and corresponding median depression. Telson with a slight median sulcus. Eyes of moderate size. Second segment

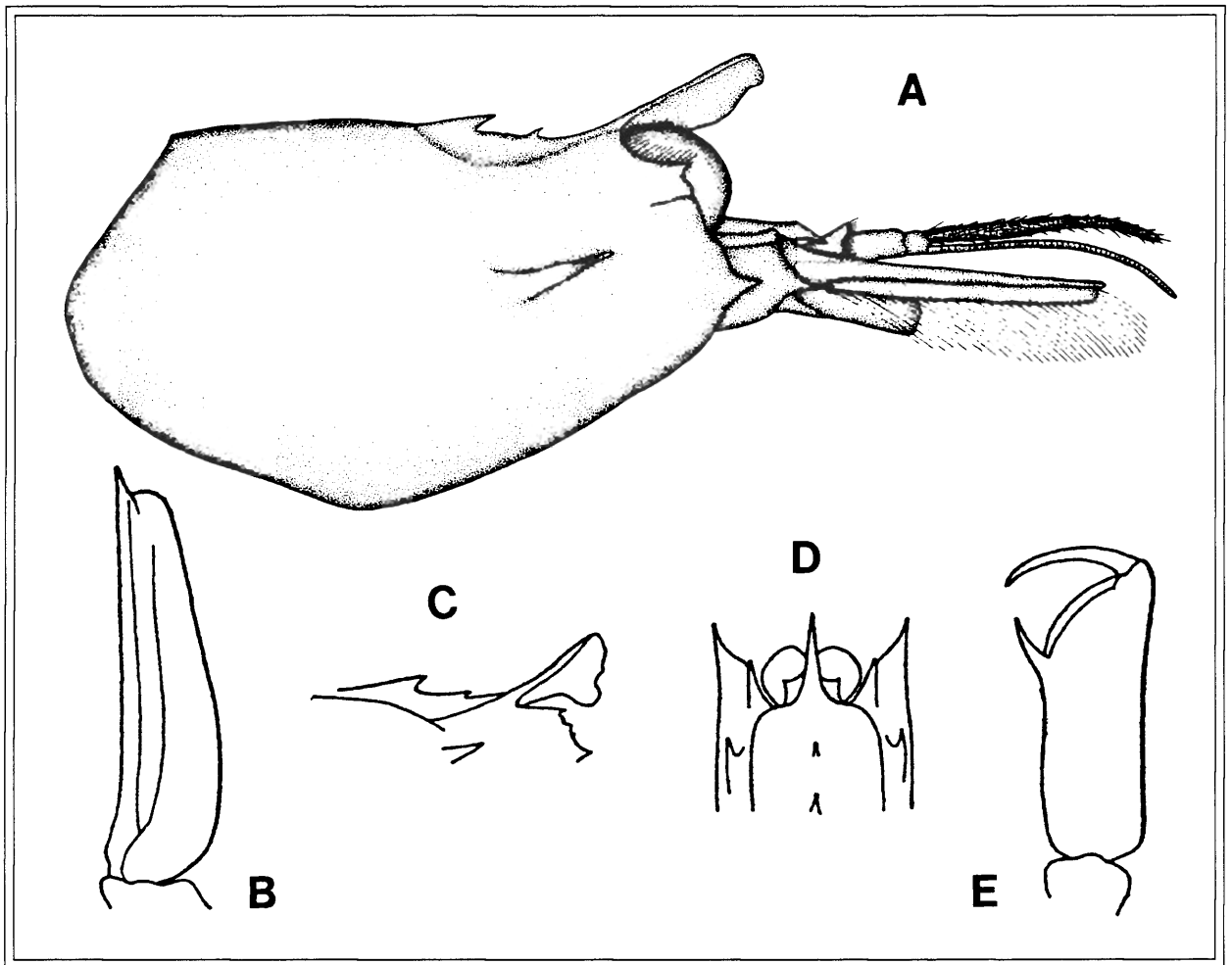
of antennular peduncle three times as long as third. Rostrum long, narrow, pointed, advanced beyond eyes, ascending at an angle of about 45°, slightly curved, and prolonged downward in thin, compressed plate, which appears spatulate in side view. The development of this plate is dependent on age; specimens 20 mm long show no evidence of it. Hands shorter than in *N. communis*, about three times as long as wide, anterior margin also more longitudinal than in *N. communis*. Antennal scale about four-fifths length of carapace, exclusive of rostrum; spine exceeding blade (after Schmitt, 1921).

**Biology.** According to Schmitt (1921) three specimens of *Neocrangon resima* were taken at D5788 in San Francisco Bay, and were associated with *Neocrangon communis*, *Crangon alaskensis*, and *Metacrangon spinosissima*.

**Taxonomic Remarks.** See remarks for *Neocrangon zaca*

**Type Locality and Type Specimens.** Off San Diego, California, 124 fathoms (227 m) Albatross Station 2935 (Rathbun, 1904).

**Distribution.** Monterey Bay, California, to San Domingo Point, Baja California, 44-266 fathoms (80 to 486 m) (Rathbun, 1904).



**Figure 2.5.** *Neocrangon resima* (Rathbun, 1902): A, lateral view of carapace; B, antennal scale; C, anterodorsal view of carapace; D, chela (A from Word and Charvat, 1976; B-D from Rathbun, 1904).

*Neocrangon communis* (Rathbun, 1899)

Figure 2.6

*Crangon communis* Rathbun, 1899:556: 1904:112 (key), 123, Fig. 64.—de Man 1920.—Word and Charwat 1976:77.—Butler 1980:110, Plate 5D.

*Crango communis*.—Schmitt, 1921:95, Fig. 63.—Goodwin, 1952:171.

*Sclerocrangon communis*.—Derjugin and Kobjakowa, 1935:84.—Vinogradov, 1950:256.

*Crangon* (*Neocrangon*) *communis*.—Zarenkov, 1965.

*Neocrangon communis*.—Kuris and Carlton, 1977:554.—Jensen, 1987b:402, Fig. 19.17.

**Material Examined.** USNM 018-BSS-01-TX Phase I primary voucher, 1 specimen, carapace length 18.5mm including rostrum; SBMNH 014-BSS-01-TX Phase I secondary voucher, 1 specimen.

**Description.** Body slender, depressed. Shell thin, pubescence on anterior part of carapace, and in abdominal sulci. Rostrum short, about 0.2 carapace length, median sulcus, ascending, tip rounded.

Carapace spines: 2 median in anterior half of carapace, anterior spine slightly smaller; median dorsal carina, ahead of anterior spine extending to posterior half of carapace; antennal moderate, with supporting carina; branchiostegal strong, with carina; pterygostomial weak; hepatic strong; lateral margin of rostrum extending posteriorly over orbital fissure as ridge above and beyond hepatic spine. Eye moderately large; cornea well developed; weak tubercle.

Antennule: peduncle short, second segment over twice length of first, latter with dorsal distal lobe; stylocerite short; inner flagellum longer than outer, and extending beyond antennal scale.

Antenna: scale shorter than telson, spine exceeding lamella; basicerite, upper lateral lobe, lower oblique spine; peduncle long; flagellum about as long as body.

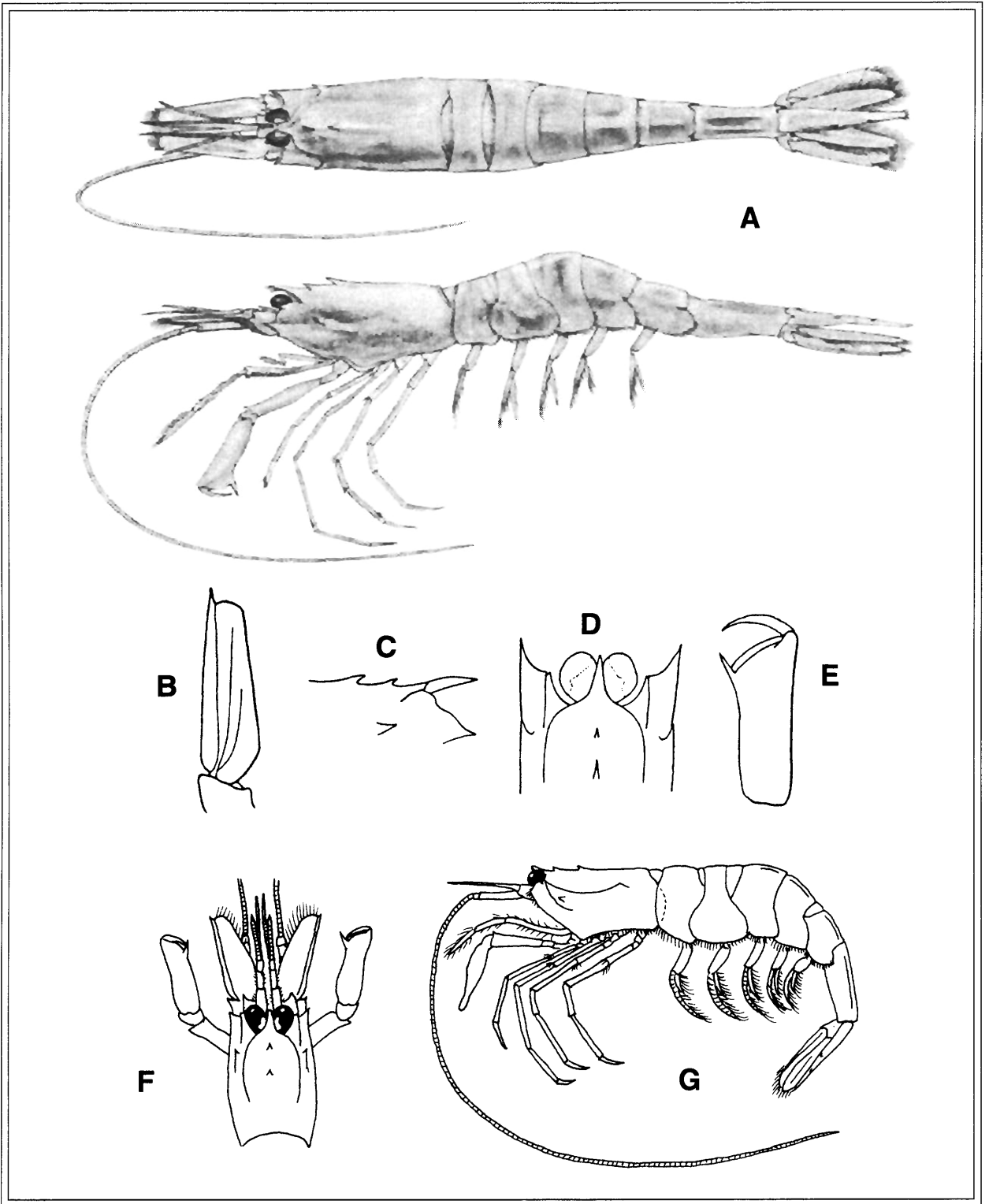
Third maxilliped: long, slender; distal part of antepenultimate segment twisted; exopod long, with lash.

Pereiopod 1 as long as third maxilliped, stout except for ischium and proximal portion of merus. Merus with strong distal spine. Carpus with 2 weak distal spines. Propodus widens distally, fixed finger long and stout. Dactylus obliquely transverse when flexed. Pereiopod 2 shorter than 1, slender, chelate. Pereiopod 3 longer than 2 and as slender. Dactylus slender, about 0.5 times propodus length. Pereiopod 4 shorter than 3, stouter. Dactylus slender, about 0.65 times propodus length. Pereiopod 5 shorter than 4, slightly stouter. Dactylus slender, about 0.8 times propodus length.

Abdomen: all sulci filled with sparse short pubescence easily rubbed off. First and second somites, each with long transverse sulcus. Third to fifth somites each with wide median dorsal carina; third with an anterior transverse sulcus through carina and a wide vertical sulcus below carina. Fourth somite with 2 transverse sulci, one at each end of carina. Fifth somite with an anterior transverse sulcus through carina, and a wide sulcus or depression on each side of carina. Pleuron of fourth somite with a moderate posteroventral spine. Fifth pleuron with a moderate posterolateral spine. Sixth pleuron with 2 median dorsal carinae, a sulcus on outer side of each carina, and a weak posteroventral spine. Telson moderately wide, tapering to rounded tip. Median sulcus of telson with 2 pairs of dorsolateral spines. Inner uropod longer than outer with neither reaching end of telson.

Color in life: Medium gray background over most of body. More or less uniform brown over branchial region of carapace, overlaid with pale yellow spots, and fine brown to charcoal dots over rest of carapace. Abdomen has brown spots and blotches, light yellow spots, more intense along midlateral line of first to fourth, and sixth somites; ventral margins of all somites bordered by magenta mottling. Magenta on pleopods, and chela of pereiopod I, which also has brown spots. Other pereiopods with magenta to rust patches; latter color repeated distally on antennal flagellum. Brown spots on telson and uropods; outer margin of outer uropod magenta (from Butler, 1980)





**Figure 2.6.** *Neocrangon communis* (Rathbun 1899): A, dorsal and lateral views (from Butler 1980); B, antennal scale; C, anterolateral view of carapace; D, anterodorsal view of carapace; E, chela (B-

**Biology.** Butler (1980) states that “this species may rank as the most common local shrimp [along the Pacific coast of Canada]. It occurs coastwide on mud bottoms from the shallow sublittoral to the lower continental slope. On grounds where *Pandalopsis dispar*, *Pandalus jordani*, and *P. borealis* are trawled commercially, *N. communis* is the most abundant associated shrimp species. In addition to capture by bottom trawls, it also has been collected by midwater trawls. At one locality off Active Pass at maximum depths of 128-161 m, specimens were caught at intermediate depths from 20-67 m.

Ovigerous females, 9.1-13.9 mm carapace length, occurred in January, February, May, and June to September.

Known parasites are the branchial isopod, *Argeia pugettensis* and the rhizocephalalan, *Mycetomorpha vancouverensis*.”

**Taxonomic Remarks.** Rathbun (1904) noted some variation in rostral morphology caused by breakage and subsequent regrowth of the rostrum. See remarks for *Neocrangon zaca*.

**Type Locality and Type Specimens.** Off Pribilof Islands, Bearing Sea, 94 m *Albatross* Station 3441. Holotype female length 64 mm, carapace length 16 mm, antennal scale length 10.5 mm.

**Distribution.** Bering Sea to San Diego, California (including Puget Sound and Strait of Juan de Fuca), 20 - 309 fathoms (37 to 565 m) (Rathbun, 1904).

### *Crangon alaskensis* Lockington, 1877

Figure 2.7

*Crangon alaskensis* Lockington, 1877:170 in part.—Rathbun, 1904:112 (key), 114, Figs. 52, 53.—Butler, 1980:108, Plate 3E in part.—Kuris and Carlton, 1977:553.—Jensen, 1995:40, Plate 59.

*Crangon nigricauda*.—Lockington, 1878:229, 465-480, in part.

*Crangon crangon affinis*.—Ortman, 1895:173 in part.

*Crangon vulgaris*.—Kingsley, 1899:709 in part.

*Crangon alaskensis elongata* Rathbun, 1902:888; 1904:112 (key), 115, Fig. 54.—de Man, 1920

*Crango alaskensis elongata*.—Schmitt, 1921:88, Fig. 58

*Crango alaskensis*.—Carlisle, 1969:237.

**Material Examined.** 1 specimen, MV *Aloha* Station R-8, Oct., 1988.

**Description.** Our specimen more closely resembles the “*elongata*” form previously treated as a subspecies by various authors. This form differs from the typical form as follows: longer and narrower rostrum; outer antennular flagellum not reaching to end of antennal scale; longer antennal scale, as long as carapace; faint dorsal median carina on fourth somite; tip of telson more acute.

Description of *C. alaskensis* typical form: Body slender, depressed. Shell thin surface smooth. Rostrum short, about 0.2 times carapace length, with median sulcus, ascending, tip rounded.

Carapace spines: 1 median in anterior third of carapace; antennal moderate; hepatic moderate, with short oblique supporting carina, anterior to median; branchiostegal strong with supporting carina, almost to end of basicerite of antenna; pterygostomial moderate; lateral margin of rostrum extending posteriorly over orbital fissure as ridge almost to center of carapace. Band around ventral margin of carapace, widening to lobe adjacent to bases of pereopods 1 and 2.

Eye moderately large, cornea well developed, weak tubercle.

Antennule: peduncle moderately long, third segment subequal to second; stylocerite short; outer flagellum extending to about end of antennal scale, inner longer.

Antenna: scale 0.8-1.0 times carapace length, as long as or slightly shorter than telson, tip of lamella rounded, spine exceeding lamina somewhat; basicerite, 2 lateral spines; peduncle moderately long; flagellum shorter than body.

Third maxilliped: moderately long and slender, short exopod with lash.

Pereiopod 1 longer than third maxilliped, stout. Merus with inner spine in proximal half, and a strong distal spine. Propodus oblong, moderately long, 2.6-3.0 times average width, fixed finger moderate, slender. Dactylus transverse when flexed obliquely. Pereiopod 2 about as long as 1, slender and chelate. Pereiopod 3 longer than 2, slender, about 0.55 times length of propodus. Pereiopod 4 longer than 3, slightly stouter; dactylus slender, about 0.8 times propodus length.

Abdomen: ventral margins of pleura of first and second somites concave. Fifth somite with faint dorsal median carina and short transverse sulcus at anterior end. Sixth somite with faint median dorsal sulcus, moderate posteroventral spine, and ventral sulcus. Telson narrow, tapering to acute tip, dorsal distally flattened with two lateral spines evenly spaced with respect to tip of telson. Inner uropod narrower, as long as or longer than outer, former reaching tip of telson (after Butler, 1980).

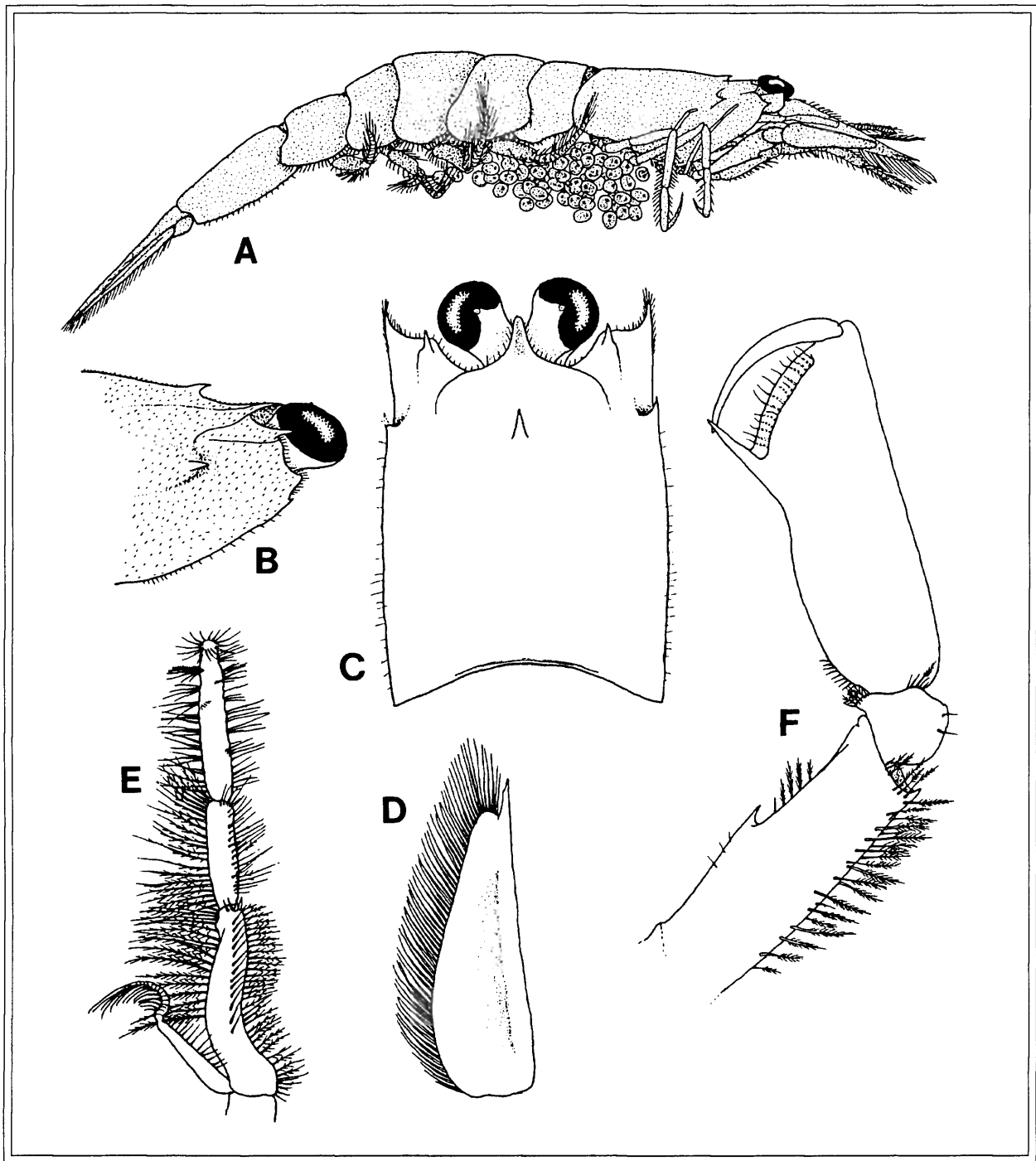
Color in life: Light brownish gray background over almost entire shrimp, lighter on most appendages; closely spaced dark gray and brown spots over body, pleopods, pereiopods, and all parts of antenna. Scattered spots of pale yellow, white, and light brown on carapace and abdomen. Pale yellow spots on antennal peduncle, proximal segments of pereiopods 2, 4, and 5, basipodites of pleopods. With a dense covering of fine black dots on posterior midline of carapace, around posterior margin of sixth somite, and on telson and uropods. Tip of inner uropod orange (Butler, 1980, Plate 3E; Jensen, 1995, Plate 59).

**Biology.** Very common along the west coast of the United States (Rathbun, 1904:115).

**Taxonomic Remarks.** Butler (1980) chose not to recognize the subdivision into two subspecies first suggested by Rathbun (1902, 1904) for specimens from Canadian waters, instead attributing the slight morphological differences between those “forms” to intraspecific variability. Rathbun (1904) discussed rostral variation in the “elongata” form. The specimen illustrated here is from the Los Angeles Harbor area and adheres most closely to the “elongata” form.

**Type Locality and Type Specimens.** For *C. a. elongata*, off Santa Barbara, California, 29 fathoms (53 m), Albatross Stations 2970, 2971 (Rathbun, 1904:115).

**Distribution.** East part of Bering Sea and along the Aleutian Islands, south to off Wilmington, California (Rathbun, 1904, as *C. alaskensis elongata*). 3.25 to 41 fathoms (6 to 75 m) (Rathbun, 1904).



**Figure 2.7.** *Crangon alaskensis* Lockington, 1877: A, lateral view of ovigerous female; B, anterolateral view of carapace; C, dorsal view of carapace; D, antennal scale; E, third maxilliped; F, chela. Original illustration from specimen taken from Los Angeles Harbor.

*Metacrangon spinosissima* (Rathbun, 1902)

Figure 2.8

*Crangon spinosissima* Rathbun, 1902:891; 1904:112 (key), 130, Fig. 70.—deMan, 1920:217.—Wicksten, 1977:282.—Word and Charwat, 1976:89, Fig. 5-2.

*Crango spinisissima* Schmitt, 1921:100, Fig. 69.—Goodwin, 1952:171.—Butler, 1950:50.

*Metacrangon spinosissima* Zarenkov, 1965:298.—Jensen, 1987b:400.—Butler, 1980:115, Plate 1B.

**Material Examined.** USNM 038-BSS-01-TX Phase I primary voucher, 1 specimen, carapace length 6.2 mm including rostrum.

**Description.** Body stout, depressed. Shell thick, mainly rugose, depressed portion of carapace pubescent. Rostrum short, 0.15-0.2 carapace length, median sulcus, ascending, tip acute or rounded, Carapace spines: 2 median, anterior larger, just posterior to rostrum, posterior in posterior half of carapace, the 2 joined by a median carina; submedian, about center of carapace, with supporting carina; hepatic with supporting carina; antennal strong, ascending; postorbital moderate, confluent with antennal; weak spine below antennal; branchiostegal strong, with supporting carina; pterostomial weak; fine carina extending from slight fissure below antennal spine posteriorly across depression in carapace. Band around ventral margin of carapace, widening as pronounced lobe adjacent to base of pereopod 2 or 3.

Eyes small, corneas well developed, stalks taper distally, deflected obliquely.

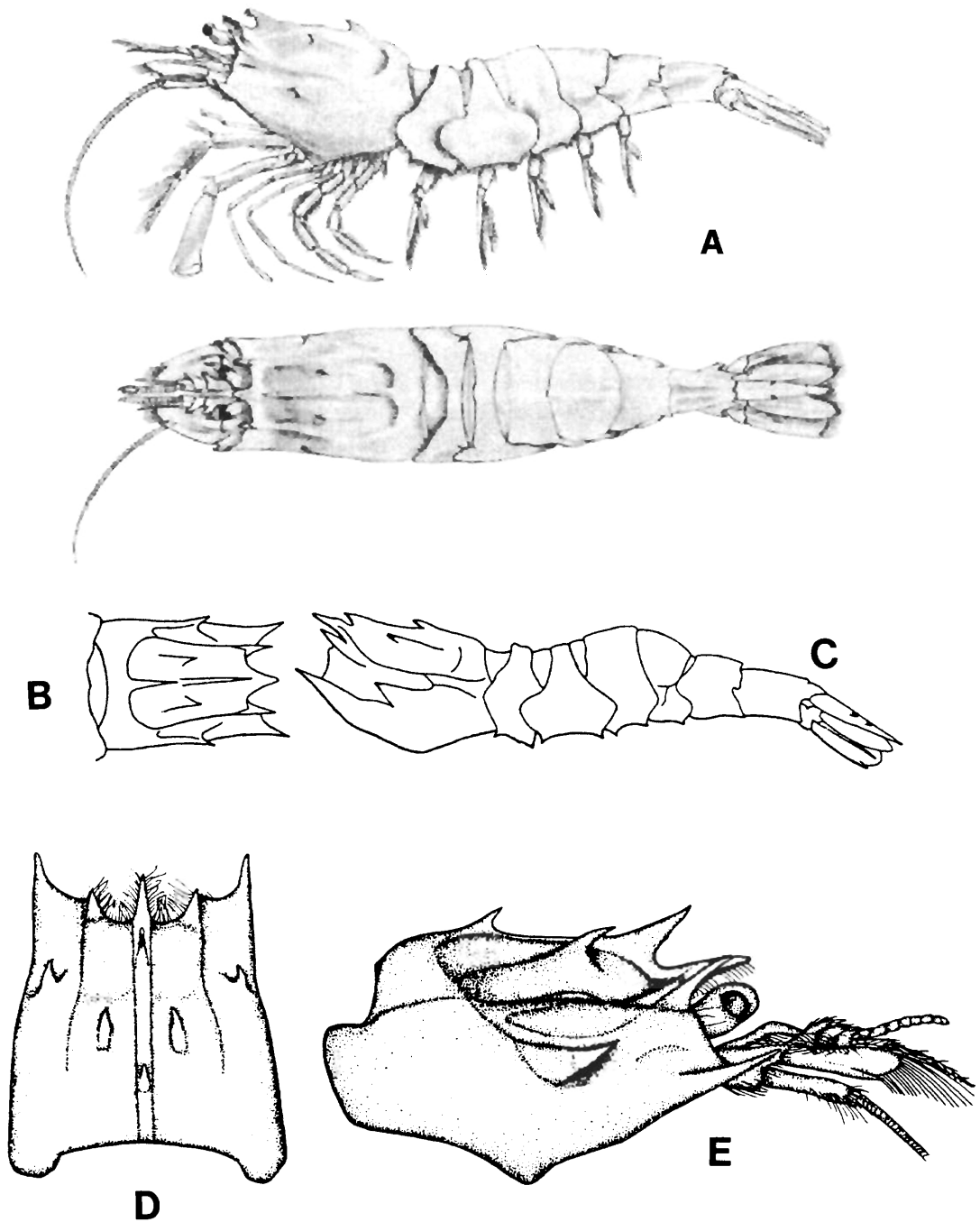
Antennule: Peduncle long, second segment longer than third, first and second each with distal lateral spine; stylocerite moderately long, broad, pointed laterally; inner flagellum longer than outer, both exceed antennal scale.

Antenna: Scale shorter than telson, lamella exceeds spine; basicerite, 2 blunt lateral spines; peduncle long; flagellum longer than body, with plumose setae.

Third maxilliped: Moderately long, slender, except antepenultimate segment, setiferous; exopod long, with lash.

Pereopod 1 longer than third maxilliped, stout. Merus with ventral longitudinal carina. Propodus widens distally, length 3.6-4.0 times average width, fixed finger moderate. Dactylus obliquely transvers when flexed. Pereopod 2 longer than 1, slender and chelate. Pereopod 3 longer than 2, as slender; dactylus slender and about 0.44 times propodus length. Pereopod 4 shorter than 3, moderately stout and setiferous. Dactylus flattened, about 0.9 times propodus length. Pereopod 5 shorter than 4, moderately stout and setiferous; dactylus flattened, about 0.55 times propodus length.

Abdomen: Pleura of first 3 somites each with 2 ventral spines. Fourth to sixth somite each with moderate posteroventral spine. Sixth somite with strong spine at dorsoposterior margin. Depressions in pleura of first and third somites accommodate pleuron of second. First to third somites each with faint median dorsal carina. Dorsal anterior margin of first deeply concave. Second with dorsal transverse furrow, adjacent anterior margin produced, forming slight hood over furrow. Third with dorsal transverse sulcus through median carina. Dorsal median carina on posterior half of fourth, lateral carina in line with articular knobs. Fifth with transverse sulcus through anterior end of faint median dorsal carina, lateral carina extending to middle of somite from articular knob. Sixth with 2 prominent dorsal carinae, shorter than somite, lateral carina extending obliquely from articular knob toward dorsal margin. Posteroventral regions of sixth flared strongly giving a wing-like appearance in dorsal view. Telson narrow, tapering to acute tip. Median dorsal sulcus of telson with 2 pairs of widely spaced dorsolateral spines. Inner uropods longer than outer, and exceeding tip of telson.



**Figure 2.8.** *Metacrangon spinosissima* (Rathbun, 1902): A, dorsal and lateral views (from Butler, 1980); B, dorsal view of carapace (from Rathbun 1904); C, lateral view (from Rathbun, 1904); D, dorsal view of carapace; E, anterolateral view (D and E from Word and Charwat, 1976).

Color in life: Background of body and appendages buff. Brownish mottling blending with background on posterior branchial region of carapace. Other brown patches occur at bases of median spines and bordering anterolateral margin. Light brown patches on pleura of first to third abdominal somites. Darker areas are found dorsally on first abdominal somite and lateral surfaces of fourth to sixth somites. This borders conspicuous light swath and rectangular patch near ventral margin of second pleuron. Light brown transverse bars are on telson and inner uropods. Pleopods are light red to pink. Third maxilliped and pereopods 1, 4, and 5 are light rust. Latter appendages, anterolateral margin of carapace, and anterior appendages, with light rust setae (Butler, 1980, Plate 1B).

**Biology.** Butler (1980: 116) notes that the shape of first and second abdominal somite of this shrimp allows it to assume a “defensive cataleptic position as in *Argis levior* and *Lebbeus schrencki*.” He also notes that it is common off the southwest coast of Vancouver Island and in the southern Strait of Georgia, is often trawled over mud bottoms (depths of 97-157 m), and has been found ovigerous in February, March, April, and August in that region.

**Taxonomic Remarks.** Distinguished from other species in the genus by having 1 or 2 ventral spines on each of the first to fifth pleura and a transverse furrow on the second abdominal somite, with the adjacent margin produced as a hood over this furrow (Butler, 1980: 116).

**Type Locality and Type Specimens.** Off Point Arena, California, 51 fathoms (93 m) (*Albatross Station 3351*) (Rathbun, 1904).

**Distribution.** From Nootka Sound, Alaska (Butler, 1980), southward to Isla San Martin, Baja California (Wicksten, 1977), at a depth of 51 to 96 fathoms (93 to 176 m) (Rathbun 1904).

## Family Alpheidae Rafinesque, 1815

### *Alpheus bellimanus* Lockington, 1877

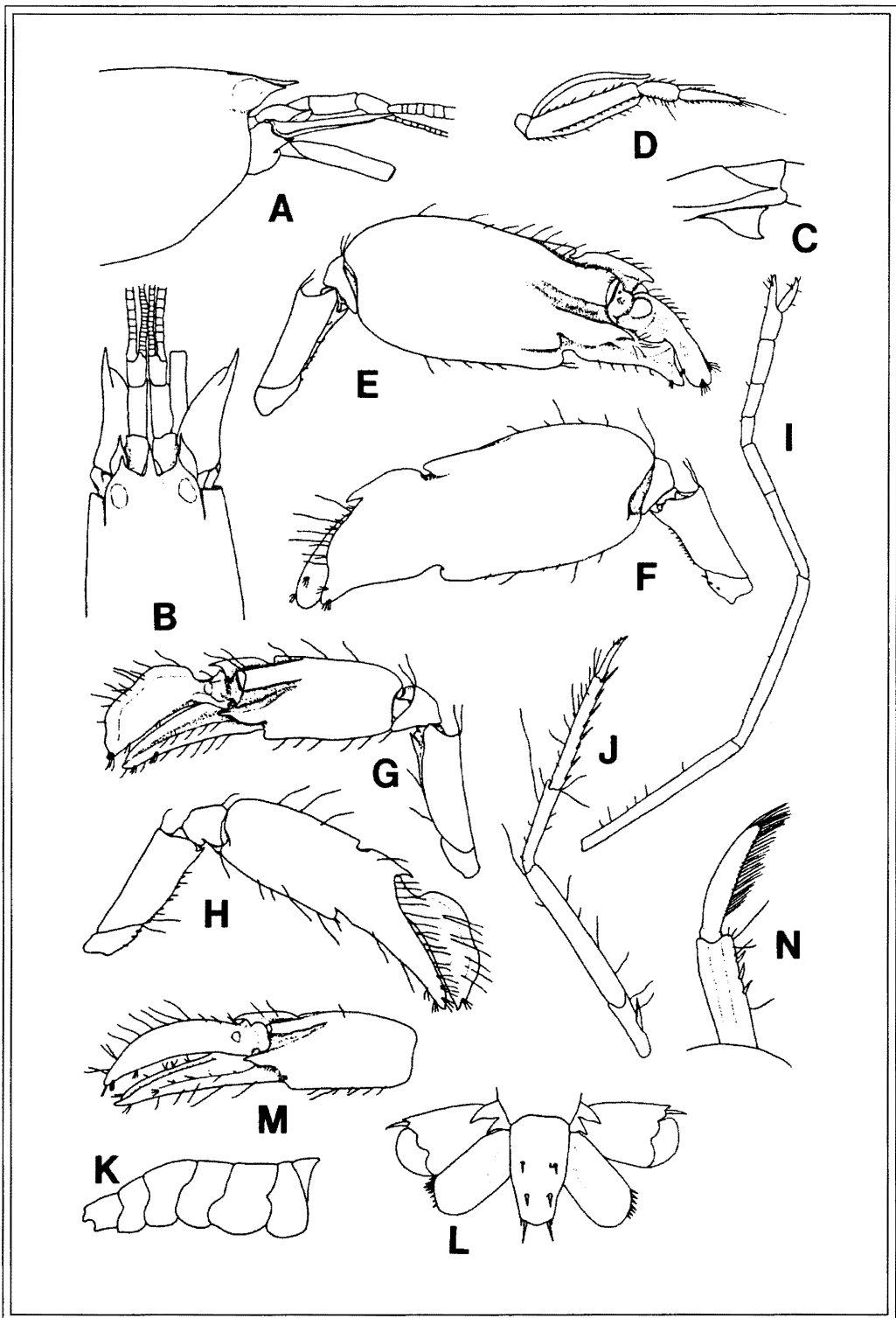
#### Figure 2.9

*Alpheus bellimanus* Lockington, 1877:34; 1878:470.—Kingsley, 1878a:199; 1878b:59; 1883:111; 1899:716.—Bate, 1888:54.—Sharp, 1893:112.—Coutiere, 1899:28.—Holmes, 1900:184, Plate 2. Fig. 41.—Rathbun, 1904:108.—Word and Charwat, 1976:42.—Luke, 1977:4.—Brusca, 1980:252.—Wicksten, 1983:41; 1984:189.—Kim and Abele, 1988:13, Fig. 5.—Jensen, 1995:44, Plate 70.

*Crangon bellimanus*.—Schmitt, 1921:75, Fig.51.—Chace, 1937:188.

**Material Examined.** USNM 006-BRS-02-TX Phase I primary voucher, 3 specimens, largest - male, carapace length 9.3 mm; SBMNH 004-BRA-04-TX Phase I secondary voucher, 2 specimens.

**Description.** Major chela with sinuous inferior margin (distal to inferior transverse groove) sinuous because of deep transverse groove; movable finger of major chela shallowly arched along proximal two-thirds of superior margin, and then regularly arched distally, tip stout, often bulbous; appendix masculina subequal to or slightly overreaching distal end of appendix interna. Rostrum long, far overreaching middle of visible part of first antennular segment; movable finger of minor chela laminate in male; merus of major first pereopod bearing 6 to 10 small movable spines on inferior inner margin and a strong, acute immovable spine at the distal end, ischium likewise armed with 3 to 4 spines on inner margin. Palm of major chela with deep transverse groove on superior margin and with deep, distinct superior and inferior grooves on outer face. Stylocerite narrowing to a long sharp point, almost reaching to distal margin of first antennular segment. Basicerite with sharp lateral spine; spine broad at base. Ocular hood with sharp tooth directed slightly inward and downward (modified from key and description of Kim and Abele 1988).



**Figure 2.9.** *Alpheus bellimanus* Lockington, 1877: male, carapace length 5.2 mm; A, anterolateral view; B, anterodorsal view; C, carina below first antennular segment; D, right third maxilliped; E, outer face of major first pereiopod; F, inner face of same; G, outer face of minor first pereiopod; H, inner face of same; I, left second pereiopod; J, right third pereiopod; K, abdomen; L, telson and uropods; M, outer face of minor chela from first pereiopod of ovigerous female (carapace length 6.5mm); N, right second pleopod (female, carapace length 4.6 mm)(from Kim and Abele, 1988).



Color in life: Body uniformly blood red changing to olive green after capture (Jensen, 1995:44, Plate 70), orange at tip of tail fan; tips of chelae and branchial regions orange; white mark on palm of major chela (Wicksten, 1983:42).

**Biology.** Found in the lowest intertidal zones to 300 m, usually dredged on sand, rocks, soft mud, fine gravel or among corallines (Kim and Abele, 1988).

**Taxonomic Remarks.** Belongs to the *Macrocheles* (= *Megacheles*) group of species of this very diverse genus (Kim and Abele, 1988).

**Type Locality and Type Specimens.** San Diego, California (Kim and Abele, 1988). Types probably lost in the San Francisco fire of 1906 (M. Wicksten, pers. comm.)

**Distribution.** Monterey, California, south along outer coast of Baja California, Mexico; southern Gulf of California, Islas Socorro and Clarion; western Mexico; Panama; Chile; Colombia; Galapagos Islands (Kim and Abele, 1988).

## Family Hippolytidae Dana, 1852

### *Eualus lineatus* Wicksten and Butler, 1983

#### Figure 2.10

*Spirontocaris herdmani*.—Rathbun, 1904:100 (in part).

*Eualus herdmani*.—Holthuis, 1947:11 in part.—Hobson and Chess, 1974:579.—Word and Charwat, 1976:103 in part.—Butler, 1980: 197-198 (in part).

*Eualus lineatus* Wicksten and Butler, 1983:1, Figs 1-2.—Jensen, 1987a:399; 1995:45.

**Material Examined.** USNM 016-BRA-01-TX Phase I primary voucher, 3 specimens; SBMNH 016-BRS-04-TX Phase I secondary voucher, 1 specimen.

**Description.** Rostrum short, reaching second segment of antennular peduncle, straight, with 3-6 dorsal teeth and 1-3 ventral teeth, all of dorsal margin toothed.

Carapace smooth, dorsum straight, small suborbital spine, moderate antennal spine with supporting carina, moderate pterygostomial spine.

Abdomen smooth. Pleura of segments 1-3 rounded, pleura of fourth segment with weak posterolateral spine, fifth with strong posterolateral spine. Median dorsal margin of third segment strongly produced posteriorly. Telson with 3 pairs dorsolateral spines.

Eyes moderately large, darkly pigmented.

Stylocerite reaching end of first segment of antennular peduncle. First segment with 3 moderate dorsal spines. Second segment about 0.5 times length of first, with 2 strong spines. Third segment shorter than second, with 2 spines. Inner flagellum more than 2 times length of outer.

Basis of second antenna with sharp ventral spine, large blunt upper lobe. Scaphocerite oblong, shorter than carapace, lamella slightly longer than spine. Flagellum slightly exceeding body length.

Mandible with slender incisor process, ending in small teeth. Molar process with spinules. Two-jointed palp present. First maxilla with lower endite slender, upper broad; palp faintly bilobed, Second maxilla with lower endite reduced, upper endite larger, bilobed; palp and scaphognathite well developed. First maxilliped with exopod and 2-jointed palp; epipod bilobed, caridean lobe very small; endites of coxa and basis separated by notch. Second maxilliped with exopod, podobranch, and epipod. Third maxilliped with exopod and epipod, exceeding antennular peduncle, stout and setose.

First pereopod shorter than third maxilliped, stout, with epipod. Fingers of chela less than 0.5 times length of palm. Carpus slightly shorter than palm. Merus about 2 times length of carpus. Ischium less than 0.5 times merus. Second pereopod chelate, longer than first pereopod, with epipod. Fingers shorter than length of palm. Carpus with 7 segments, the third and fourth the longest. Merus about 0.6 times length of carpus, slightly longer than ischium. Third pereopod slightly longer than second, with epipod. Dactyl stout, about 0.2 times length of propodus, with 5 spines. Propodus with 16-19 spinules in 2-3 rows. Carpus about 0.4 times length of propodus. Merus about same length as propodus, with 3 spines. Ischium less than 0.5 times length of merus. Fourth pereopod about as long as third. Dactyl stout, similar to that of third pereopod, Propodus with 15 spinules in single row. Merus with 2-3 spines. Fifth pereopod as long as fourth. Dactyl about 0.2 times length of propodus, with 4-5 small spines. Propodus with 14-22 spinules in 1 or 3 rows. Merus with 0-1 spine. No epipods on pereopods 3-5.

Second pleopod with appendix interna. Appendix masculina little more than half length of appendix interna, stout, apex truncated, with 8 long spinules. Uropods reaching end of telson, with long tooth on outer margin (from Wicksten and Butler, 1983).

Color in life: Red diagonal lines on carapace and first and second abdominal segments; red spots and blotches on third to sixth abdominal segments, telson, uropods, and protopodites of pleopods; smaller red spots on all anterior appendages, including eye stalk and pereopods (from Wicksten and Butler, 1983; Butler, 1980; color Plate 1C, as *Eualus herdmani*).

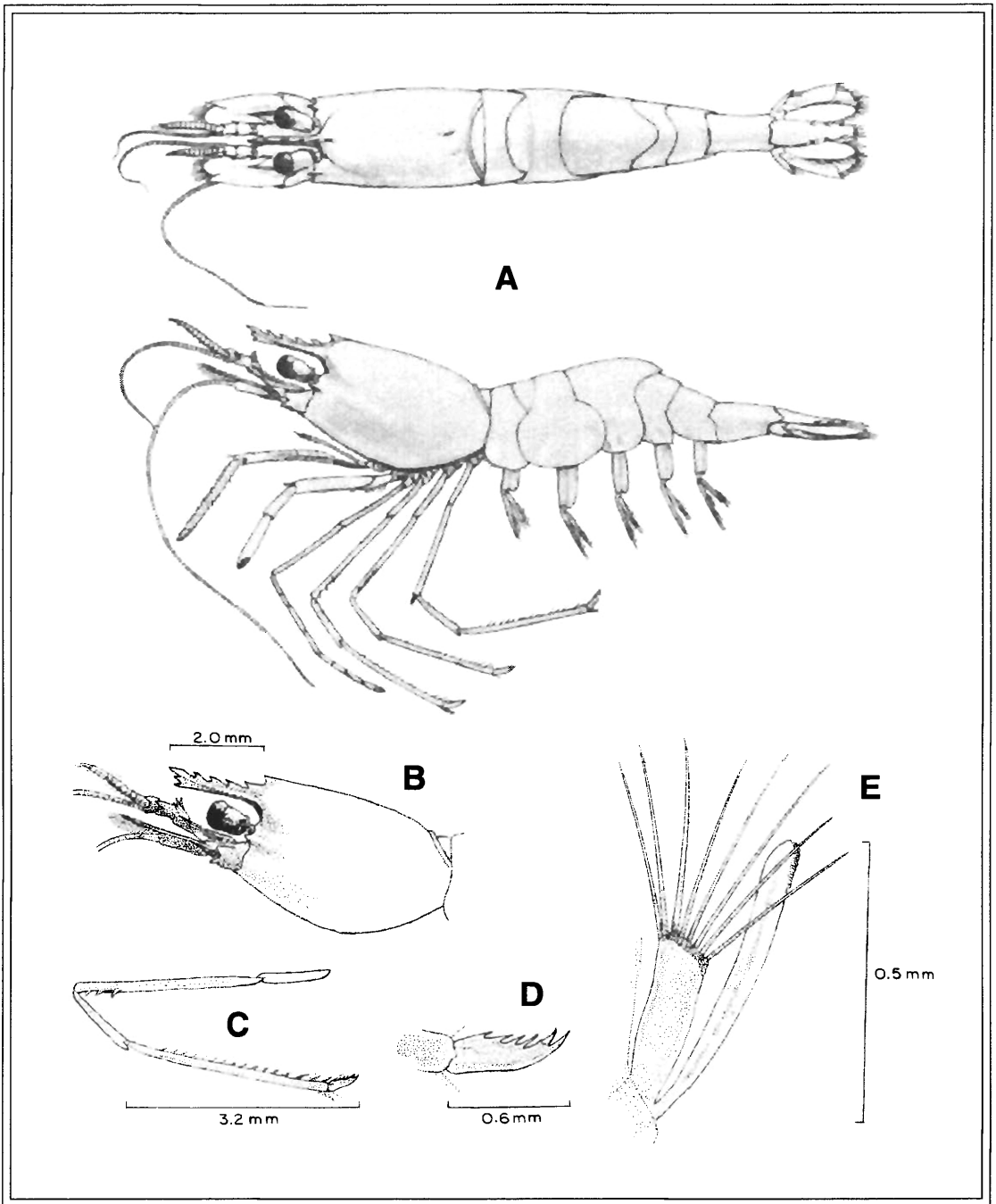
**Biology.** This species has been found in rocky rubble below 18 m (Jensen, 1995). Most specimens have been taken by trawl. One specimen was collected by a SCUBA diver on the wreck of the *Olympic*, off Long Beach, California. A first stage larva of the species has been hatched in the laboratory (Butler, 1980). The species is eaten by rockfishes of the genus *Sebastes* off Santa Catalina Island, California (Hobson and Chess, 1974).

Some individuals have been found to be parasitized by *Bopyroides hippolytes* (Butler, 1980).

**Taxonomic Remarks.** *Eualus lineatus* is related to *E. avinus* (Rathbun), *E. pusiolus* (Kroyer), and *E. berkeleyorum* Butler in having epipods on the first 3 pereopods. In *E. avinus* the rostrum is arched over the eye, and bears 12-14 upper teeth and 1-3 ventral teeth. The dactyl of the third pereopod is slender and simple. *Eualus pusiolus* has a straight rostrum shorter than the second segment of the antennular peduncle, with 2-5 upper teeth and at most 1 lower tooth. The dactyl of the third pereopod is stout. *Eualus berkeleyorum* has a straight rostrum with 8-11 dorsal teeth and 2-5 ventral teeth. The dactyls of its third pereopods are slender and simple. It does not have a ventral spine on the pleura of the fourth abdominal segment (Wicksten and Butler 1983).

**Type Locality and Type Specimens.** 1.5 mi. SW of Gulf Island, off Santa Cruz Island, California (33°56'00"N, 119°50'55"W), 89 m, mud and sponge bottom, 8 Nov 1941, *Velero III* Sta 1435-41. Holotype female total length 21.0mm; AHF type number 4129.

**Distribution.** Sitka, Alaska to Puget Sound (Butler, 1980); Santa Monica Bay, Palos Verde Peninsula, Santa Catalina Island, and Point Loma California (Word and Charwat, 1976).



**Figure 2.10.** *Eualus lineatus* Wicksten and Butler, 1983: A, dorsal and lateral views; B, anterolateral view of female (carapace length 3.1 mm); C, left third pereiopod of same; D, dactyl of left third pereiopod of same; E, appendix masculina of male (carapace length 4.1 mm)(from Wicksten and Butler, 1983).

*Spirontocaris sica* Rathbun, 1902

Figure 2.11

*Spirontocaris sica* Rathbun, 1902:894.—Rathbun, 1904:69, Fig. 25.—Schmitt, 1921:55, Fig. 32.—Holthuis, 1947:37.—Word and Charwat, 1976:154.—Butler, 1980:167, Plate 7D.—Wicksten, 1990:590.

**Material Examined.** USNM 055-BSS-01-TX Phase I primary voucher, 1 specimen, carapace length including rostrum 10.5 mm, rostrum length 4.7 mm.

**Description.** Body slender and somewhat compressed. Rostrum moderately long, 0.9-1.2 times carapace length, constricted at base, median section as broad blade, lower limb broader and tapering sharply, distal portion as long ascending styliform process, tip acute.

Carapace spines: 2 supraorbitals, widely space, with upper spine stronger; suborbital strong and rounded; antennal moderate with carina; pterigostomian weak or obsolescent.

Eye: Large and cornea well developed.

Antennule: Peduncle long, third segment half length of second, dorsal distal spine present on each; stylocerite moderately long and knifelike; inner flagellum longer than rostrum, outer extending slightly beyond antennal scale.

Antenna: Scale slightly shorter than telson, lamella exceeds spine somewhat; basicerite with two lateral lobes; peduncle moderately long; flagellum longer than body.

Third Maxilliped: Moderately long, moderately stout with an epipod and an exopod.

Pereiopod 1 shorter than third maxilliped and a little stouter, chelate, epipod present.

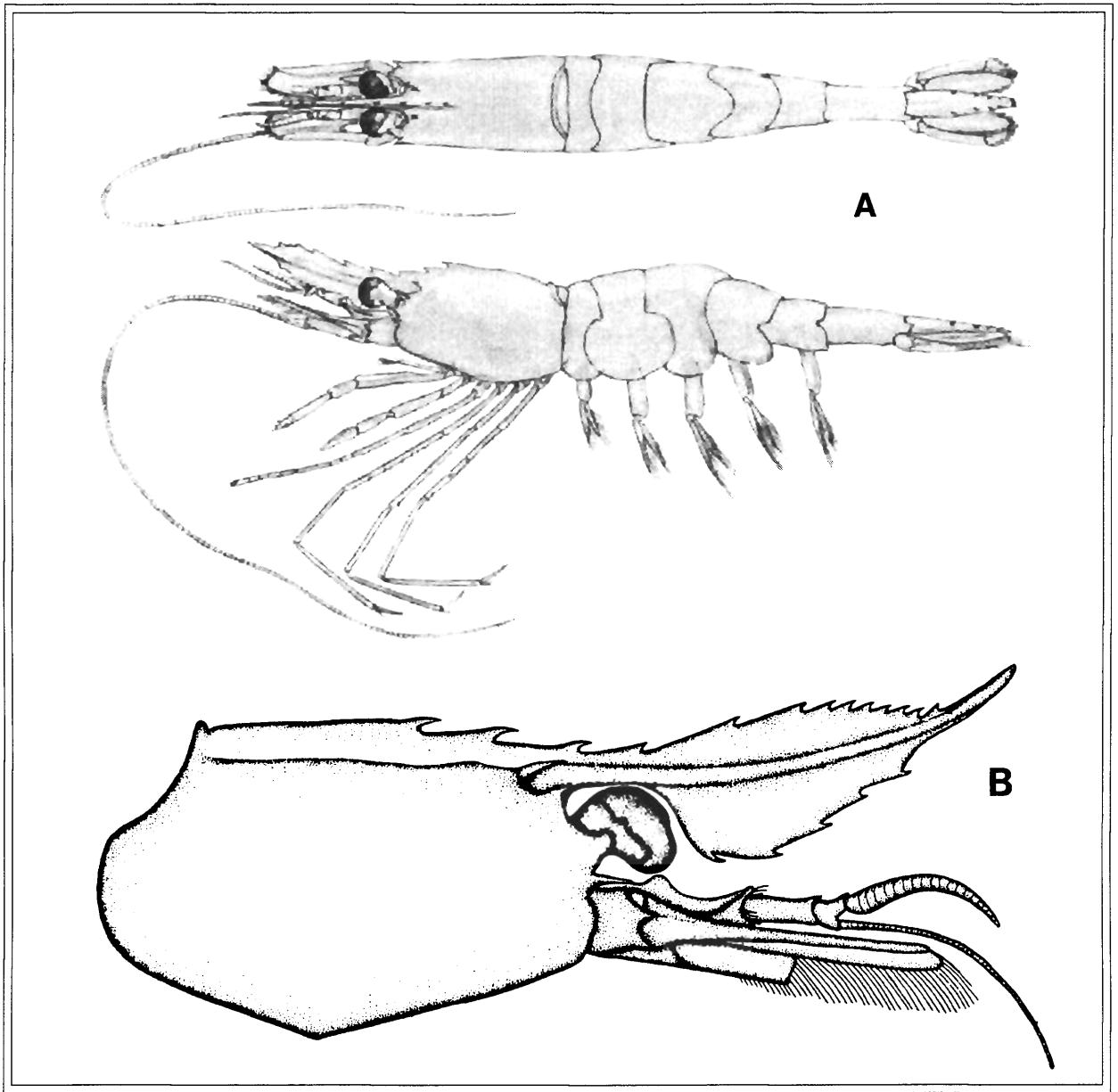
Pereiopod 2, chelate, slender and longer than 1, carpus with 7 segments. Pereiopod 3 longer and stouter than 2, merus with 5-9 spines, propodus with 4 spinules and a distal fringe of setae, dactylus slender. Pereiopod 4 slightly longer than 3, merus with 6-8 spines, propodus with 4-7 spinules, setae as in 3. Pereiopod 5 shorter than 4, merus with 4-7 spines, propodus with 1-8 spinules, long setal band around distal end.

Abdomen: Ventral margin of pleuron of second somite broadly convex; posterodistal margins of fourth and fifth deeply recessed at articular knobs; fifth with weak posterolateral spine; sixth about as long as telson, slender with moderate posteroventral spine; telson narrow, tapering to acute tip, 4 pairs of dorsolateral spines; uropods about same length as telson, extending to tip (after Butler, 1980).

Color in life: Background of body milkish white to dull yellow. Carapace with red blotches, large specimens with red band along ventral margin, large red area on branchial region. Most have a pinkish dorsal patch. Rostrum with a few red dots on the midrib. Antennule, basicerite and base of antennal scale pinkish. Lateral surface of first five abdominal somites with fine red spots. Telson and uropods pinkish. Pereiopods deep red (Butler, 1980: Plate 7D).

**Biology.** Butler (1980) states that in almost all cases along the western coast of Canada this species has been found in coastal inlets, and that as an adult may be pelagic rather than demersal. It is parasitized by the branchial isopod *Bopyroides hippolytes*.

**Taxonomic Remarks.** This specimen was sent to us with a tentative identification as *S. dalli* Rathbun, 1902, a species whose southern most range is Sitka, Alaska except for a single record from near Los Angeles (Word and Charwat 1976). We felt comfortable with this identification based upon rostral characteristics and the key of Word and Charwat (1976). However, upon review of this manuscript both D. Cadien and M. Wicksten suggested that this specimen probably is not *S. dalli*. In fact if rostral characteristics are ignored this specimen seems to be *S. sica*, Rathbun, 1902 based on the keys of Schmitt (1921), Holthuis (1947), Butler (1981), and Wicksten (1990). This specimen differs from typical specimens in that the rostrum is lacking the long ascending styliform process and instead terminates in a short triangular point. Defining characteristics



**Figure 2.11.** *Spirontocaris sica* Rathbun, 1902: A, dorsal and lateral views; B, anterolateral view (A, from Butler, 1980; B, from Word and Charwat, 1976).

that place our specimen with *S. sica* are as follows: Carapace with 2 supraorbital spines; pleurae of abdominal segments 1 and 2 rounded; epipod on first pereiopod only (after Holthuis, 1947). *Spirontocaris holmesi* (see below), on the other hand, has epipods on both the first and second pereiopods.

**Type Locality and Type Specimen.** Holotype female: total length 58 mm; carapace length 24.8 mm including rostrum; rostral length 12.8mm. Type locality: Santa Barbara Channel, 265 fms (485 m) *Albatross* station 3200.

**Distribution.** Restoration Bay, British Columbia to between San Benito Islands and Cedros Island, Baja California; 88-849 m (Wicksten, 1990)

*Spirontocaris holmesi* Holthuis, 1947

Figure 2.12

*Spirontocaris bispinosa* Holmes, 1900:128.—Rathbun 1904:219, Fig. 23.—Schmitt, 1921:54, Fig. 30.—Goodwin, 1952:170.

*Hippolyte bispinosus*.—Williamson 1915.

*Spirontocaris holmesi* Holthuis, 1947:129.—Word and Charwat, 1976:149.—Butler, 1980:159 (key), 165, Plate 6E.—Jensen, 1987a:399.—Wicksten, 1990:590.

**Material Examined.** USNM 007-BSS-01-TX Phase I primary voucher, 1 specimen, carapace length including rostrum 12.4 mm, rostrum length 6.0 mm; SBMNH 103-BSS-01-TX Phase I secondary voucher, 1 specimen.

**Description.** Body slender and compressed. Shell thin and smooth. Rostrum moderately long, 1.0-1.5 times carapace length, constricted at base. Median section of rostrum broad blade with lower limb broader and rounded. Distal portion slender, ascending, styliiform process with a solitary distal ventral spine.

Carapace spines: 2 supraorbitals widely separated, upper spine stronger; suborbital moderate, pointed; antennal moderate; pterygostomian weak or obsolescent.

Eyes large, corneas well developed.

Antennule: peduncle moderately long, third segment shorter than second, each with dorsal distal spine; stylocerite moderately long, inner flagellum shorter than rostrum, outer extending beyond antennal scale slightly.

Antenna: scale shorter than telson, lamella exceeds spine somewhat; basicerite with 2 weak lateral spines; peduncle long; flagellum longer than body.

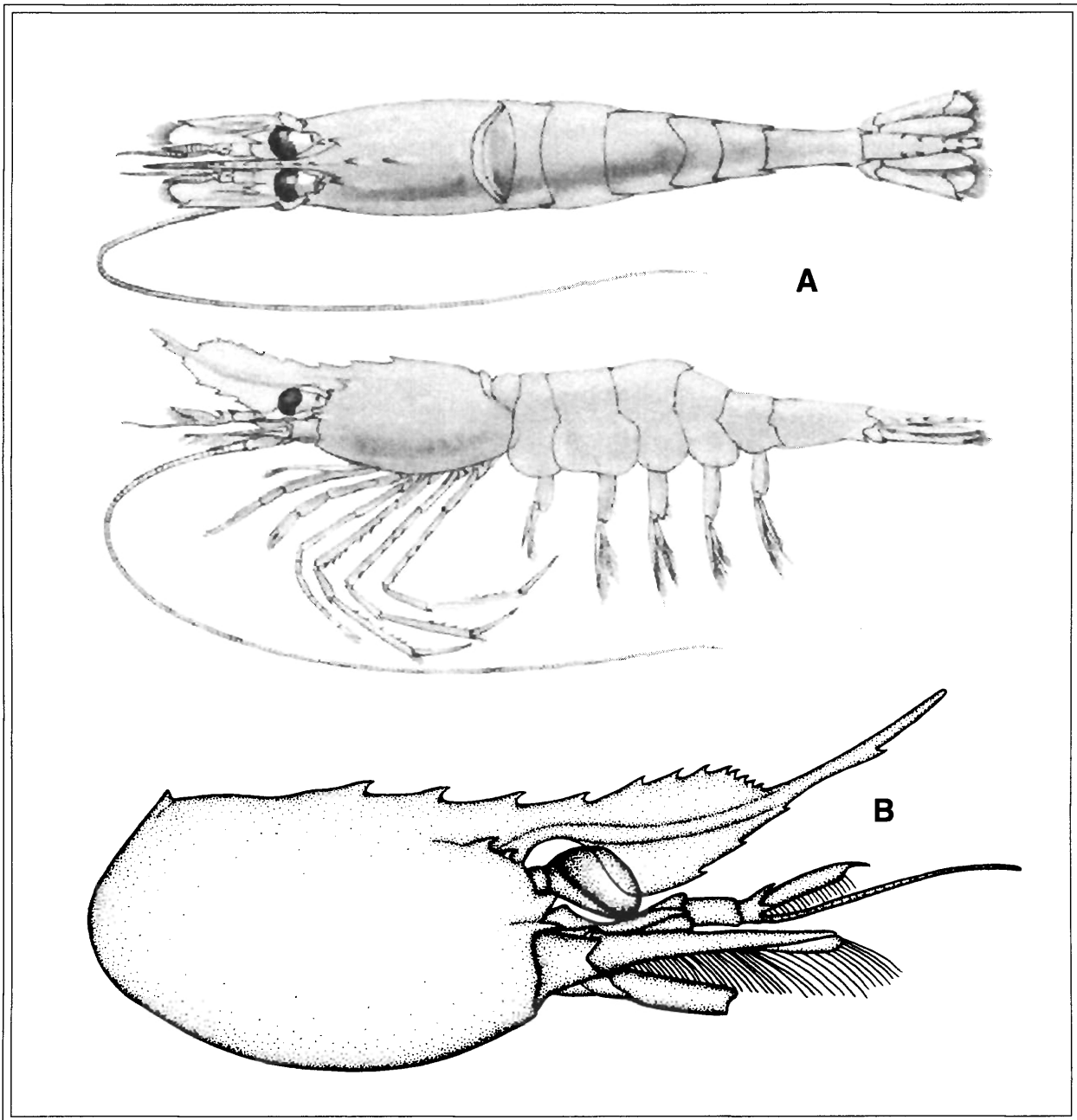
Third maxilliped: moderately long, stout, with an exopod and an epipod.

Pereiopod 1 shorter than third maxilliped, a little stouter, chelate, with epipod. Pereiopod 2 longer than 1, slender and chelate, carpus with 7 segments, epipod present. Pereiopod 3 longer than 2 and a little stouter, merus with 6 or 7 spines, propodus with 4-8 spinules, distal fringe of setae present. Dactylus slender, about 0.6 times propodus length, tip acute. Pereiopod 4 about as long as 3 and as slender, merus with 5-8 spines, propodus with about 4 spinules, distal fringe of setae present. Dactylus slender, about 0.6 times propodus length, tip acute. Pereiopod 5 shorter than 4 and as slender. Merus with 4 or 5 spines, propodus with 3-6 spinules, distal fringe of setae present. Dactylus slender, about 0.55 times propodus length, tip acute.

Abdomen: ventral margin of pleuron of second somite mainly straight or slightly concave. Fifth somite posterolateral margin widely recessed at articular knob, and with moderate spine. Sixth somite with moderate posteroventral spine, and small lobe above it. Telson narrow, tapering to rounded tip, with 3 or 4 pairs of dorsolateral spines. Uropods about same length, reaching to tip of telson.

Color in life: Background of body yellowish wash; carapace, 2 oblique red lines starting in branchial region, meeting wide red bar along ventral margin adjacent to third maxilliped and pereiopods 1 and 2; patches of red posterior to antennal spine; large patch of red dots in gastric and cardiac regions; rostrum mainly transparent with fine red dots on lower limb; antenna, basicerite, and scale with red patches; peduncle and flagellum pinkish; third maxilliped and pereiopods, red spots on milkish base; red blotches on abdomen, mainly on lateral surfaces; faint, fine red speckling on telson and uropods; pleopods with distinctive red lines on basiopodites. (from Butler, 1980: Plate 6E)

**Biology.** According to Butler (1980), this species "almost invariably forms part of the catches of dredge or shrimp trawl hauls made at 70 m and deeper" in coastal areas of southwestern Canada. See Butler (1980) for data on density, ovigery, and parasitic isopods infesting this species in that region.



**Figure 2.12.** *Spirontocaris holmesi* Holthuis, 1947: A, dorsal and lateral views; B, anterolateral view (A, from Butler, 1980; B, from Word and Charwat, 1976).

**Taxonomic Remarks.** Characterized by having a very slender body, bladelike rostrum with styliform projection armed with solitary ventral spine, 2 widely spaced suborbital spines, and epipods on pereopods 1 and 2 (Butler, 1980).

**Type Locality and Type Specimens.** Puget Sound.

**Distribution.** Yes Bay, Alaska, to San Diego, California (Schmitt, 1921; Butler, 1980).

*Pseudocoutierea elegans* Holthuis, 1951

Figure 2.13

*Pseudocoutierea elegans* Holthuis, 1951:182, Plate 57.—Holthuis, 1955:75, Fig. 46d.—Word and Charwat, 1976; 171.—Wicksten, 1983a:19; 1992:8.—Abele, 1976:71.

**Material Examined.** USNM 001-BRA-02-TX Phase I primary voucher, 3 specimens, largest - carapace length including rostrum 5.2 mm, rostrum length 2.9 mm.

**Description.** Genus description: Body more or less compressed. Distal part of rostrum cylindrical and unarmed. Basal part wing-like expanded and partly covers eyestalks. These wing-like expansions end anteriorly in sharp supraocular tooth. Carapace smooth. Antennal spines present, but postorbital and pterygostomial spines lacking. Branchiostegal groove runs over length of lateral part of carapace.

Abdomen with pleurae of third to fifth segments ending in sharp tooth. Posterior margin of telson bears three pairs of spines.

Scaphocerite is well developed.

Mandible without palp, incisor process well developed. Laciniae of maxillula rather broad. No exopods present on second and third maxillipeds. Only caridean lobe present on first maxilliped, but no flagellum is visible.

The carpus of first pereopod not segmented. Second legs very unequal in size, but about equal in shape. Last three legs rather slender. Dactylus is simple, without basal protuberance.

Second to fifth pleopods with appendix interna. An appendix masculina present on endopod of second pleopod of male.

The uropodal exopod has the outer margin ending in tooth, which at inner side bears movable spine (after Holthuis, 1951:182).

Color in life: Not recorded (but see below).

**Biology.** Associated with and colored to match the red gorgonian *Muricia californica* where it occurs with *Heptacarpus kincaidi* (pers. comm., D. Montagne via D. Cadien). Ovigerous females among the 8 specimens examined by Holthuis ranged from 9 to 16 mm total length (Holthuis, 1951).

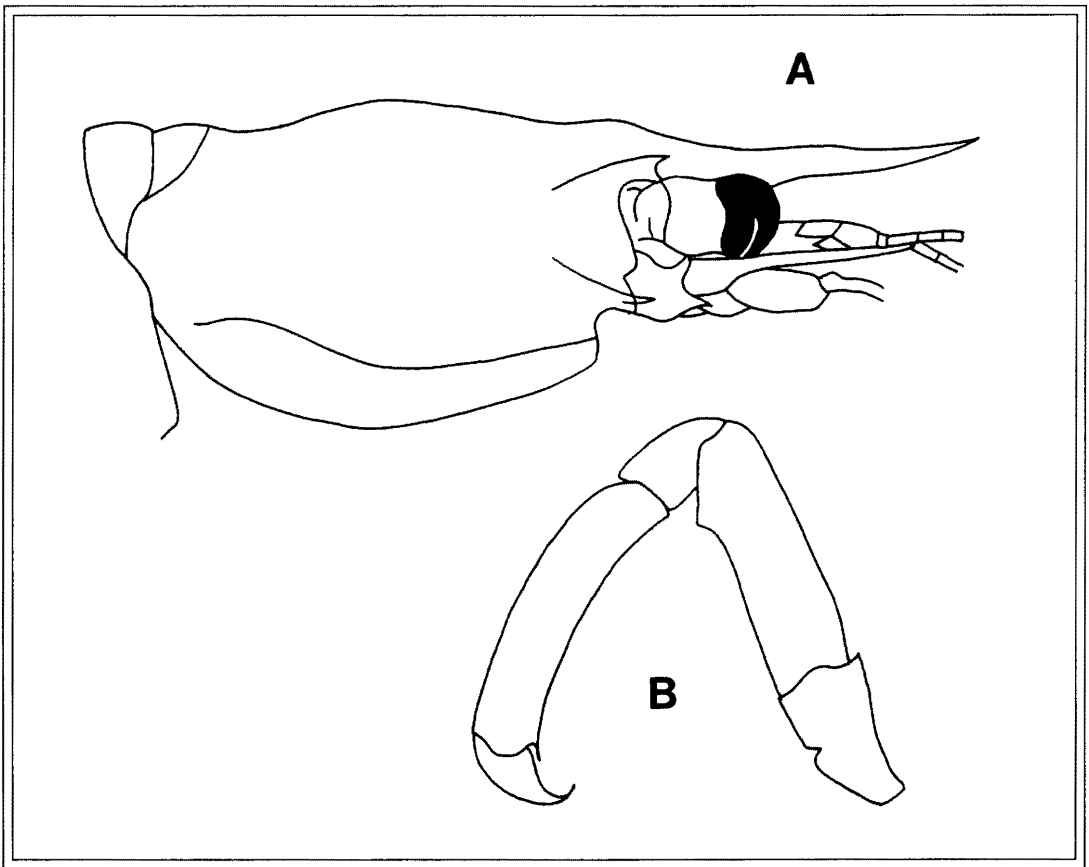
**Taxonomic Remarks.** This species is the sole member of the genus *Pseudocoutierea* Holthuis. Subsequent to the original description (Holthuis, 1951), wherein 8 specimens were listed from Allan Hancock Expeditions in 1934, 1935, 1937, and 1941, there have been no reports of this species in the literature.

An unfortunate error exists in the original description (Holthuis, 1951), where the illustrations of this species (Plate 55) were switched with those of *Anchistioides antiguensis* (Plate 57).

**Type Locality and Type Specimens.** Holotype is an ovigerous female, 16 mm long, from off Santa Catalina Island, California (*Blake* Station 1405-41) (AHF, now part of LACM collection) (Holthuis, 1951). Additional paratypes exist in the LACM collections and at the USNM (AHF No. 411, according to Holthuis, 1951:185).

**Distribution.** Santa Catalina Island, California, south along the west coast of Baja, California, to the Galapagos Islands, from 20 to 50 fathoms (37 to 91 m) (Holthuis, 1951:185). This report extends the range northward to the Santa Barbara Channel.





**Figure 2.13.** *Pseudocoutierea elegans* Holthuis, 1951: A, anterolateral view; B, third pereiopod (both from Holthuis, 1951).

## Infraorder Thalassinidea Latreille, 1831

### Family Axiidae Huxley, 1879

#### *Acanthaxius spinulicaudus* (Rathbun, 1902)

##### Figure 2.14

*Axius spinulicauda* Rathbun, 1902:886; 1904:149, Fig. 90

*Axius* (*Paraxius*) *spinulicauda*.—Borradaile, 1903:538.

*Axiopsis spinulicauda*.—Schmitt, 1921:111, Fig. 74.—Hart, 1982:44, Fig. 8.—Kozloff, 1987:404.

*Axiopsis* (*Axiopsis*) *spinulicauda*.—de Man, 1925:69.

*Acanthaxius spinulicaudus*.—Sakai and St. Laurent, 1989:66.

**Material Examined.** USNM073-BSR-03-TX Phase I primary voucher, 1 specimen; MMS California OCS Phase II, voucher lot, Cruise 3-1, station R-1, Rep:3, 35°05.8'N, 120°49.2'W, 91 m, one female, carapace length = 17.8 mm, including 3.5 mm rostrum.

**Description.** Rostrum reaching middle of second joint of antennular peduncle, slightly deflexed, longitudinally channeled; armed on either side with five to six teeth. Gastric region of carapace traversed by five carinae, all of which fade out before reaching cervical groove; median one extending along basal third of rostrum, and armed with four spines just behind line of the orbits; outer carinae a continuation of side margins of the rostrum; outer and intermediate carinae unarmed; in front of the narrow median posterior lobe of the carapace, the surface is compressed or pinched to form a short smooth ridge. Eyes black, of same diameter as stalk, not reaching middle of basal antennular segment. Outer maxillipeds reaching end of antennal peduncle. Abdomen smooth above; pleura sculptured and pubescent (Schmitt, 1921).

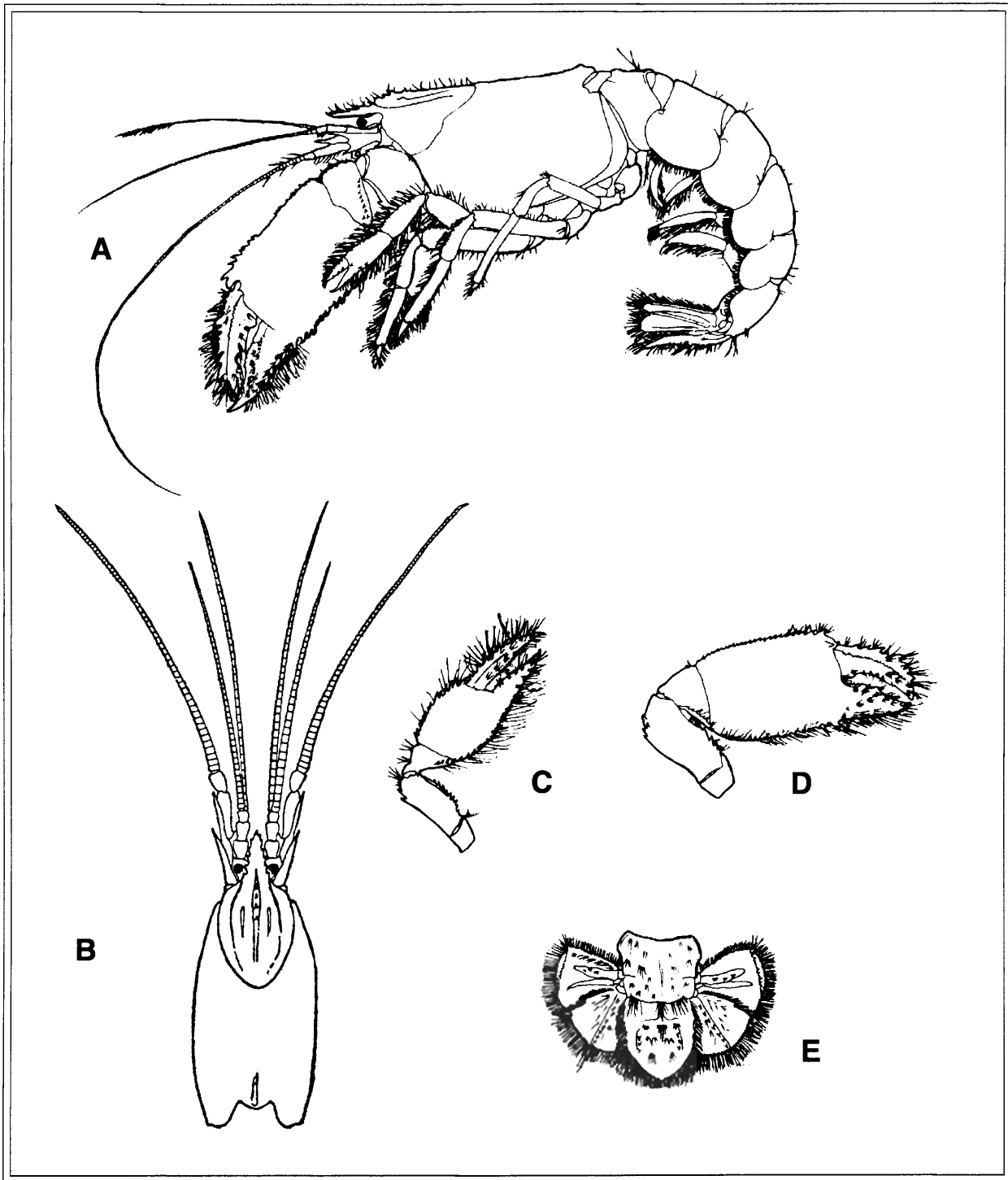
Color in life: Carapace translucent pink with coral rostrum and ridges with greenish tinge laterally. Antennules and antennae pale pink and white with yellowish flagella. Eyestalks translucent, corneas black. Chelipeds with shell-pink and white ischium and merus, coral red carpus and hand, and orange teeth. Walking legs pink, coral and white. Abdomen with pleopods and tail fan orange with patches of pale orange or pink (Hart, 1982).

**Biology.** According to Hart (1982), in British Columbia this species burrows in subtidal mud substrate especially in fjords. Very little concerning the natural history of this species has been published.

**Taxonomic Remarks.** The illustrations of male and female major chela by Hart (1982, Fig. 8 c and d) are mislabeled in that they are reversed from her description. We have taken this into account and corrected the labeling in Fig. 12.1.

**Type Locality and Type Specimens.** Off Bodega Head, California, 62 fathoms (113 m), *Albatross* Station 3172. Holotype female, carapace length (including rostrum) = 19.6 mm, rostrum length = 3.5 mm, abdomen = 31.5 mm.

**Distribution.** Schmitt (1921) and Sakai and de Saint Laurent (1989) mention only the type locality (off Bodega Head, California); there are additional unpublished records from other southern California localities.



**Figure 2.14.** *Acanthaxius spinulicauda* (Rathbun, 1902): A, male, lateral view; B, carapace dorsal view; C, female, right cheliped; D, male, right cheliped; E, tail fan. (A,C,D modified from Hart, 1982, see text; B,E from Rathbun, 1904).

*Calocarides quinqueseriatus* (Rathbun, 1902)

Figure 2.15

*Calastacus quinqueseriatus* Rathbun, 1902:887; 1904:151, Fig. 91.—Schmitt, 1921:113, Fig. 76.—Balss, 1925:209.—Goodwin, 1952:175.

*Calocaris (Calastacus) quinqueseriatus*.—Borradaile, 1903:539.—de Man, 1925:118.—Hart, 1982: 50, Fig. 11.—Kozloff, 1987:404.

*Calastacus rostriserratus* Andrade and Baez, 1977:65, text-Fig. 1.

*Calocarides quinqueseriatus*.—Sakai and St. Laurent, 1989:79.

**Material Examined.** Male, SBMNH Phase I secondary voucher collection, 005-BSS-01-TX, carapace length (including rostrum) = 23.7 mm, abdomen length = 37.8 mm.

Juvenile, MMS California OCS Phase II voucher lot, Cruise 2-4, Station R-6, Rep. 2, 34°41.4'N, 120°57.9'W, 410 m, carapace length = 7.2 mm, abdomen length undetermined (damaged specimen).

Juvenile, MMS California OCS Phase II voucher lot, Cruise 1-2, Station R-6, Rep. 1, 34°41.4'N, 120°57.9'W, 410 m, carapace length = 5.9 mm, abdomen length = 9.3 mm.

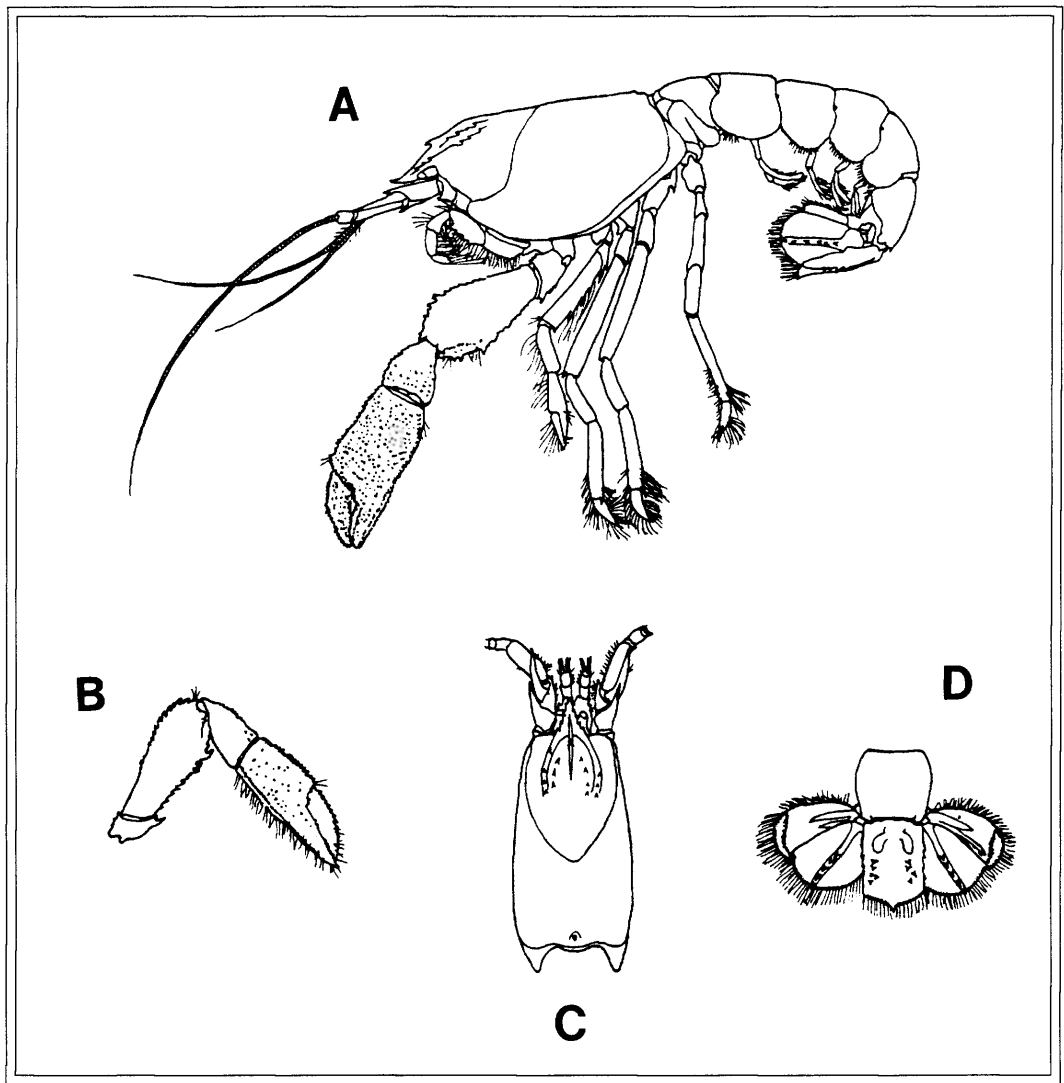
**Description.** Carapace surface smooth, cervical groove deep. Rostrum flattened, with toothed margins continuing as ridges on gastric area. Median ridge spined from mid-rostrum to gastric area. These ridges are separated by 2 more short, spined ridges, making 5 in all. Eyestalk short and cornea without dark pigment. Antenna with relatively short projections or “thorns” on 2nd and 3rd segment of peduncle. Unequal, elongated chelipeds with toothed margins and surface of hands covered with numerous small sharp granules. A slight gape proximally between fingers of large cheliped but none on smaller. 1st walking leg short and chelate, with spines on posterior margin of merus and ischium. Others long and slender with setae terminally. Abdomen stout, pleura broad and lateral margins rounded. Tail fan with telson only slightly longer than 6th abdominal segment: Lateral margins parallel and toothed, distal margin curved and with a median tooth. Two spined ridges on telson and 1 on endopod of uropod. No pleopod on 1st abdominal segment. Slender biramous pleopods on 2nd to 5th segments with appendix interna. In male 2nd pleopod has an appendix masculina as well (Hart, 1982).

**Biology.** According to Schmitt's (1921) key, known only from depths of 200 fathoms (366 m) or greater, although in his list of distributions he included a depth of only 160 fathoms off San Simeon Bay. Hart (1982) lists the habitat type as abyssal mud, 288-2200 m.

**Taxonomic Remarks.** Differs from *C. investigatoris* (now known as *Lophaxius rathbunae* Kensley, 1989, family Calocarididae), which is known from Alaska to San Diego (Schmitt, 1921:113), in having a carapace that is not granulate and in having 5 rows of spines posterior to the rostrum (Schmitt, 1921).

**Type Locality and Type Specimens.** Off San Luis Obispo Bay, 200 fathoms (370 m), *Albatross* Station 3196 (Schmitt, 1921). Type is a male, length of carapace and rostrum 28 mm, length of abdomen 41 mm (Schmitt, 1921).

**Distribution.** Point Sur, California, south to the Santa Barbara Channel, including Anacapa Island and San Nicolas Island, at depths greater than 160 fathoms (293 m) (Schmitt, 1921).



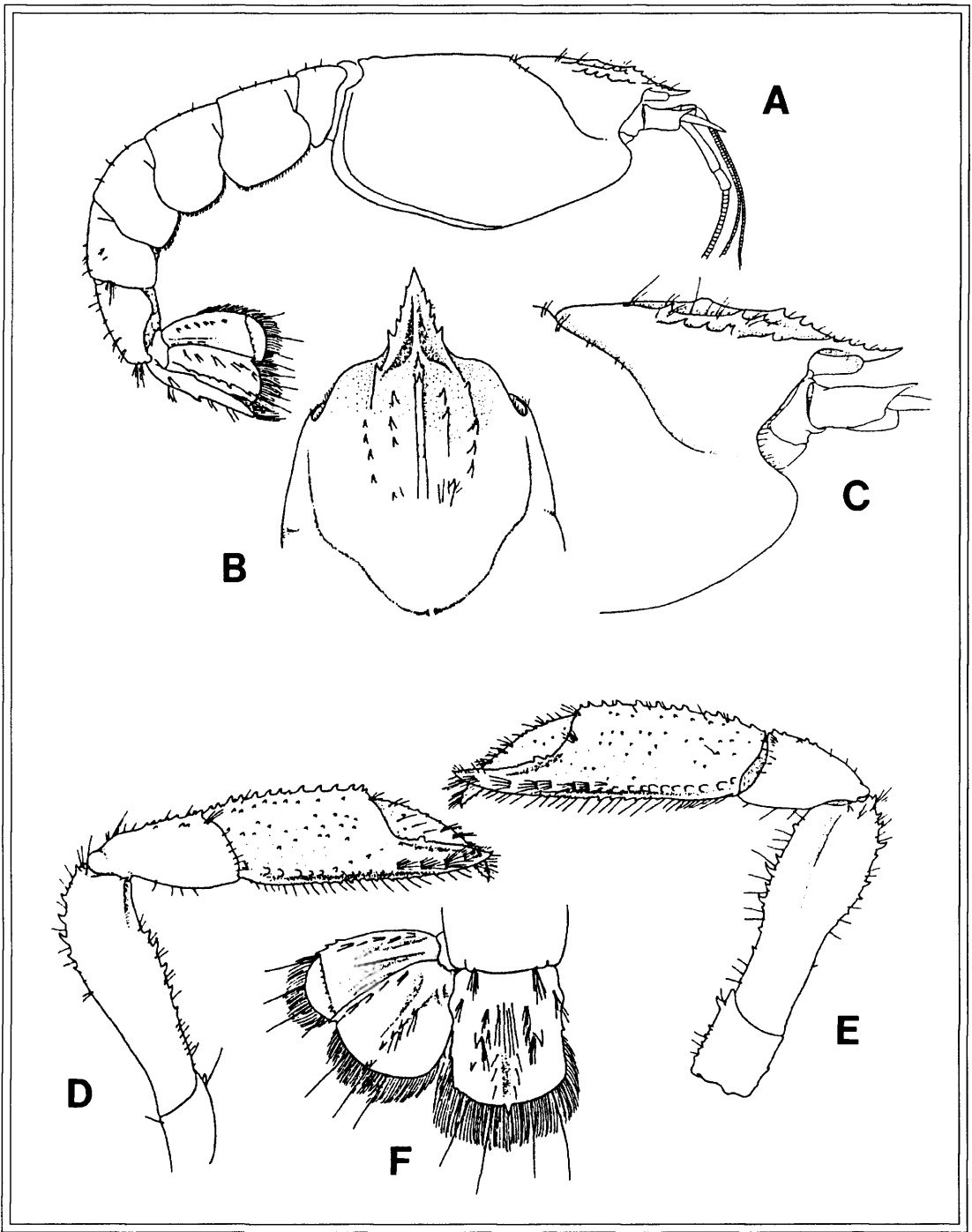
**Figure 2.15.** *Calocarides quinqueseriatum* (Rathbun, 1902): A, male, lateral view; B, male, right cheliped; C, male, carapace, dorsal view; D, tailfan (from Hart, 1982).

***Calocarides* sp.**

Figure 2.16

**Material Examined.** Male, USNM Phase I primary voucher collection, 082-BSR-02-TX, carapace length (including rostrum) = 22.3 mm, abdomen length = 30.5 mm.

**Remarks.** Among the specimens sent to us as *Calocarides quinqueseriatum* was one specimen (illustrated) that differed significantly from that species in several morphological characters, most notably the shape of the first and second pereiopods and relative length of the carapace and abdomen. Consultation with Brian Kensley, Smithsonian Institution, confirms that this is most likely an undescribed species of *Calocarides*. The species complex along the west coast of the United States is currently undergoing investigation by J. Martin and D. Cadien. Pending the results of their findings, which have indicated thus far that either additional west coast species remain undescribed or that the species displays considerable morphological plasticity, this specimen is referred to here as *Calocarides* sp..



**Figure 2.16.** *Calocarides* sp. A.: A, lateral view; B, dorsal view of rostrum and anterior carapace; C, lateral view of rostrum and anterior carapace; D, right cheliped; E, left cheliped; F, telson and left uropod.

## Infraorder Anomura Milne Edwards, 1832

### Family Diogenidae Ortmann, 1892

#### *Paguristes ulreyi* Schmitt, 1921

Figure 2.17

*Paguristes ulreyi* Schmitt, 1921:125, Plate 18, Figs. 3-5, 7.—Hart, 1982:106, Fig. 37.—Gotshall, 1994:62, Plate 145.—Jensen, 1995:67, Plate 128.

*Paguristes occator* Listed as a synonym by Hart (1982) but not cited.

**Material Examined.** USNM 013-BRC-02-TX Phase I primary voucher, 1 specimen; SBMNH 095-BSS-01-TX Phase I secondary voucher, 2 specimens, largest - shield length 12.1 mm.

**Description.** Anterior portion of carapace longer than wide; front tridentate, rostriform tooth triangular, acute, extending forward at least to base of the eye scales, exceeding lateral teeth by one-half their length; lateral teeth blunt and somewhat tuberculiform. Eye-stalks comparatively very long and slender, length measured from orbital margin about as long as greatest width of anterior portion of carapace, or slightly longer; eye scales each with four to five spiniform teeth at tip; third segment of antennular peduncle exceeds cornea by one-fourth its length. Antennae thickly long-haired beneath, few short hairs above.

Chelipeds equal, hairy; merus spined on upper or anterior edge and on inner border of lower face, outer border of lower face of merus in occasional specimens slightly rugose, and in one specimen from Monterey somewhat spinulose; carpus with five stout spines on upper inner edge; upper surface of hand well spined dark tipped spines, which are larger on the outer anterior edge of the immovable finger; inner edge of palm behind the dactyl armed with three prominent spines, with two much smaller ones below on inner face, and intermediate between them. Hands somewhat like those of *P. turgidus*, one-third to sometimes nearly one-half longer than wide, but with fingers less acuminate.

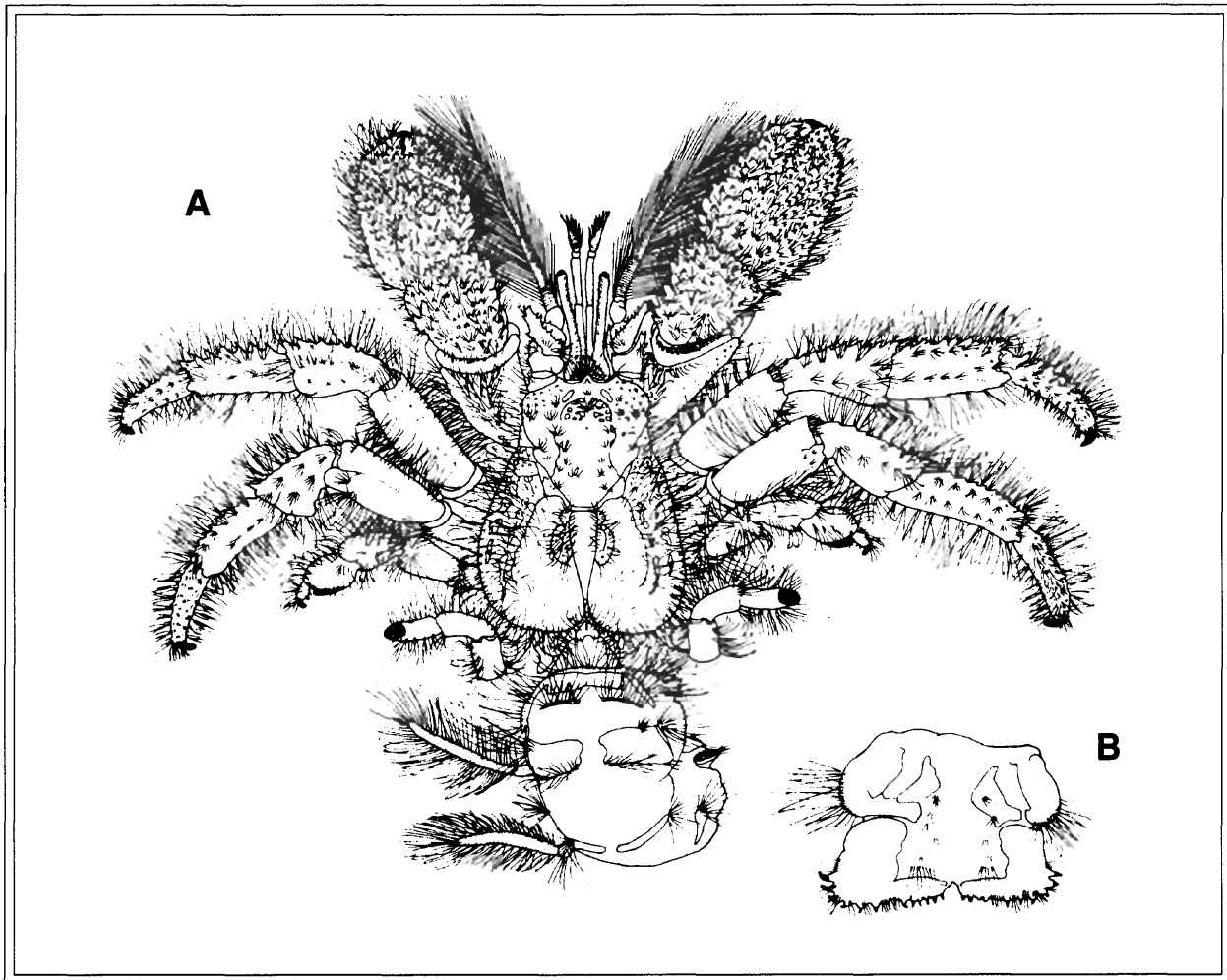
Ambulatory legs very hairy on inner or anterior face of dactylus and propodus, anterior pair more so than in any of the species listed in Schmitt, (1921); armature of anterior pair much as in *P. bakeri* (from Schmitt, 1921:125).

Color in life: Carapace red-brown with 3 irregular lighter stripes on shield and 1 on each branchial area. Chelipeds white with orange, light and dark red bands; fingers pink and white with black tips. Walking legs rust and white, with black claws. Abdomen mottled red and white. Antennule white with dark red streaks and flagellum red ventrally. Antenna pink and red base; flagellum dark red with light areas at joints and setae light colored. Eystalk white with dark red, almost black stripes dorsolaterally and ventrally; cornea black (after Hart, 1982; Jensen, 1995:67, Plate 128).

**Biology.** This species is often found intertidally in rock crevices on exposed shores and subtidally in rocky and graveled areas (Hart, 1982).

**Taxonomic Remarks.** *Paguristes ulreyi* differs from *P. perrieri* in having the eye scales toothed or incised and not entire, longer antennular peduncles, which exceed the eye-stalks instead of being considerably shorter, and in having the antennal flagella well haired beneath instead of sparsely so (Schmitt, 1921).

*Paguristes ulreyi* differs from *P. turgidus* by the antennal flagellum being densely setose ventrally and sparsely dorsally, eystalks proportionately long and more slender, nearly as long as shield and hand with dark corneous teeth only at tips of fingers. Brood pouch of female subrectangular (Hart, 1982).



**Figure 2.17.** *Paguristes ulreyi* Schmitt, 1921: A, male, dorsal view; B, telson (from Hart, 1982).

**Type Locality and Type Specimens.** Holotype (USNM 50427) is a 59 mm male (carapace length 22 mm), from off Point Loma, California, *Albatross* Station 4304, 25 fathoms (46 m) (Schmitt, 1921). Schmitt gives additional measurements and mentions paratypes, which we assume are also housed at the USNM.

**Distribution.** Monterey to off San Diego, California, and San Geronimo Island, Baja California, to a depth of 59 m (Schmitt, 1921).



*Parapagurodes laurentae* McLaughlin and Haig, 1973

Figure 2.18

?*Pagurus* [sp]: —Menzies and Miller, 1954:153.

*Parapagurodes laurentae* —McLaughlin and Haig, 1973:129, Figs. 4b, 9-11.

**Material Examined.** USNM 006-BSS-01-TX Phase I primary voucher, 1 ovigerous female, shield length 1.3 mm, 11 eggs (near hatching), diameter about 0.45 mm each.

**Description.** Palm of right cheliped with dorsal surface armed proximally with four or five irregular rows of widely spaced, strong, tubular spines, not extending onto fixed finger. Palm of left cheliped with dorsal surface having single or double row of strong, tubular spines, not extending onto fixed finger. Palm of left cheliped with dorsal surface having single or double row of strong tubular spines.

Eleven pairs of phyllobranchiate gills. Third maxilliped with basis-ischium fusion incomplete; ischium with crista dentata well developed, one accessory tooth; merus and carpus each with spine at dorsodistal margin. Maxillule with proximal endite tapered; endopodite with external lobe moderately well-developed, not recurved. Ocular peduncles short or moderately short, stout, with corneae dilated. Ocular acicles slender to moderately broad, triangular or subtriangular, terminal spine submarginal. Antennal peduncles with one or two short setae on dorsodistal surface of ultimate segment. Chelipeds unequal, right larger than left. Second and third pereopods with dactyl moderately elongate, slender, not strongly twisted. Fourth pereopods subchelate or not subchelate; dactyls usually with preungual process (cf. de Saint Laurent, 1970) on lateral face; propodal rasp weakly or moderately well-developed. Males with coxae of fifth pereopods symmetrical, right with short sexual tube; no paired pleopods, pleopods 3 through 5 biramous with rami weakly developed, or absent. Females with paired gonopores; no paired pleopods, biramous pleopods, pleopods 2 through 4 weakly or moderately well-developed, pleopod 5 weakly developed or absent. Uropods asymmetrical. Telson with terminal margins generally straight, slightly concave, or slightly oblique, with a row of small spines or spinules. Sternite of third pereopods with anterior margin unarmed (from McLaughlin and Haig, 1973).

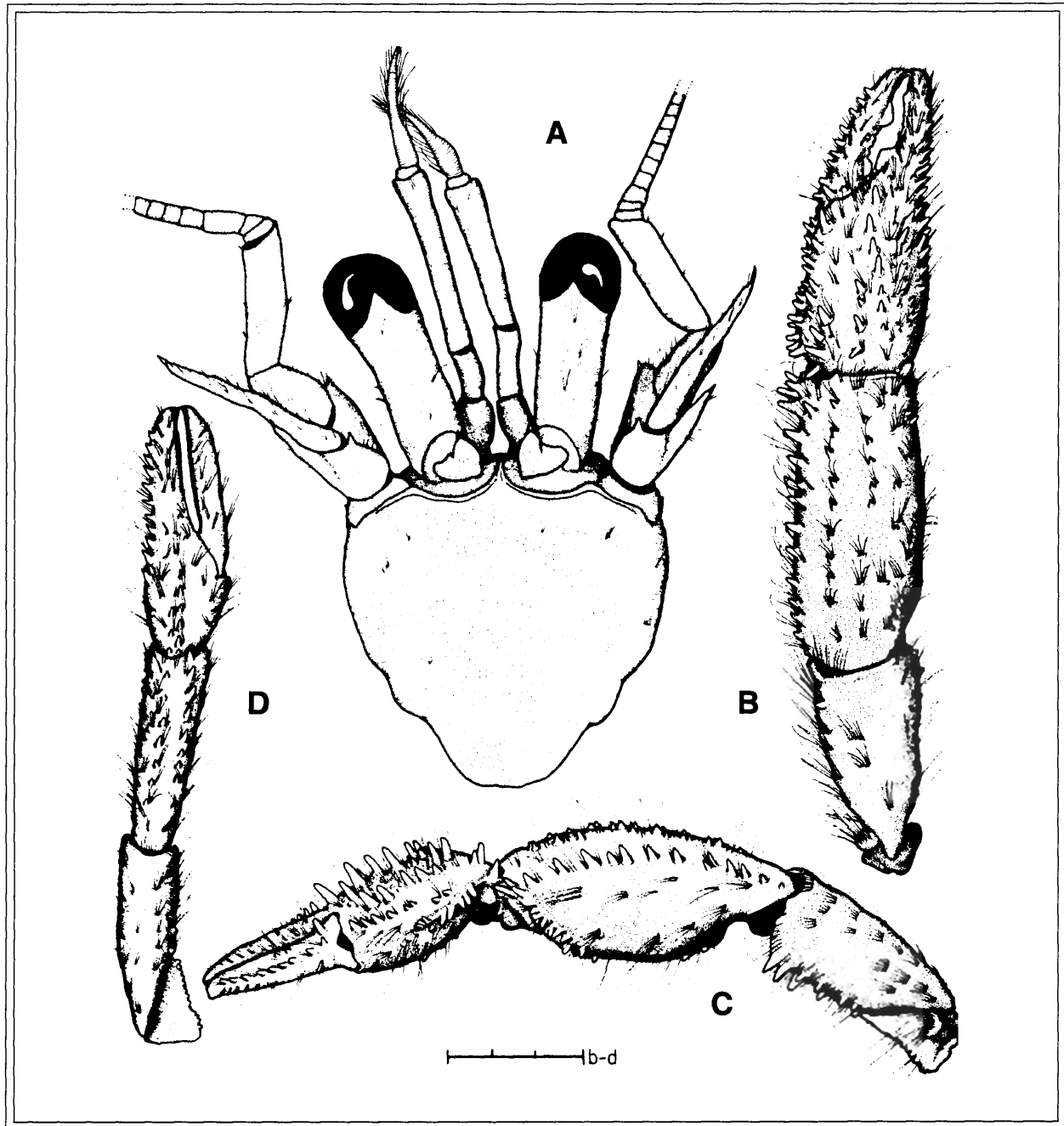
Color in life: Carapace translucent gray. Pereiopods with two broad bands at mid propodus (D. Cadien, pers. comm.).

**Biology.** Often found infested with a bopyrid isopod of the genus *Stegophryxus*.

**Taxonomic Remarks.** According to McLaughlin and Haig (1973), although *Parapagurodes laurentae* is most closely related to *P. makarovi*, its superficial resemblance to an undescribed species of *Pagurus* may cause mistakes in identification. To avoid such mistakes, distinguishing characters of *P. laurentae* include the presence of sexual tubes in the males, the lack of spines on the distal portions of the dorsal surfaces of the dactyls of the chelipeds, the moderately long and relatively slender dactyls of the second and third pereopods, and the lack of regular setation on the articles of the antennal flagella (after McLaughlin and Haig, 1973). In freshly preserved or living material, *P. laurentae* and *P. makarovi* are easily separated by color pattern. In *P. laurentae* red bands circle the propodus of the pereopods, whereas in *P. makarovi* red stripes extend the length of both the carpus and propodus (D. Cadien, pers. comm.).

**Type Locality and Type Specimens.** 2.5 mi SE of Seal Rocks, Santa Catalina I., California, 33° 16' 20" N, 118° 15' 20" W, *Velero III* Station 1429-41, 159-174 m. Holotype: Male (shield length = 3.5 mm), AHF 4127. Paratypes listed in McLaughlin and Haig, 1973: Table 3.

**Distribution.** Southern California, Channel Islands to west coast of Baja California, Mexico; Gulf of California; 16 to 475 m (McLaughlin and Haig, 1973).



**Figure 2.18.** *Parapagurodes laurentae* McLaughlin and Haig, 1973: male paratype - A, shield; B, mesial view of right cheliped; C, dorsal view of right cheliped; D, mesial view of left cheliped (modified from McLaughlin and Haig, 1973).

*Munida quadrispina* Benedict, 1902

Figure 2.19

*Munida quadrispina* Benedict, 1902:269, Fig. 17.—Rathbun, 1904:166.—Schmitt, 1921:165, Fig. 105 (after Benedict).—Hart, 1982:168, Fig. 66.—Kozloff, 1987:411, Fig. 19.20.—Gotshall, 1994:65, Plate 154.—Jensen, 1995:73, Plate 145.

**Material Examined.** USNM 004-BRA-04-TX Phase I primary voucher, 4 specimens, largest - carapace length including rostrum 10.2 mm, rostrum length 3.2 mm.

**Description.** Abdomen unarmed. Rostrum long, slender, spine-like, laterally compressed, unarmed, moderately serrate above and slightly so below. The straight, slender supraocular spines do not reach quite to the ends of the eyes and are united to the rostrum for nearly one-half their length. The marginal spines of the carapace vary from eight to ten on a side; there are six spines on the gastric area, four in a line behind the supraocular spines, and one on each side near the hepatic region; the terminal spines of the line are very weak and small, but one spine occupies the anterior branchial region; posterior margin unarmed. Chelipeds well set with spines and spinules, not hairy (after Schmitt, 1921).

Carapace longer than wide. 6 spines on gastric area; 4 in one line, and 1 on each side of the ridge near the hepatic region. 8 to 10 marginal spines. Rostrum long and compressed and minutely spined. Chelipeds with numerous spines and narrow fingers. Walking legs compressed and armed with short spines. Abdomen ridged but not spined except for minute spines on tail fan. Males with paired uniramous gonopods on 1st and 2nd abdominal segments. Female with small paired pleopods on segments 2 to 5.

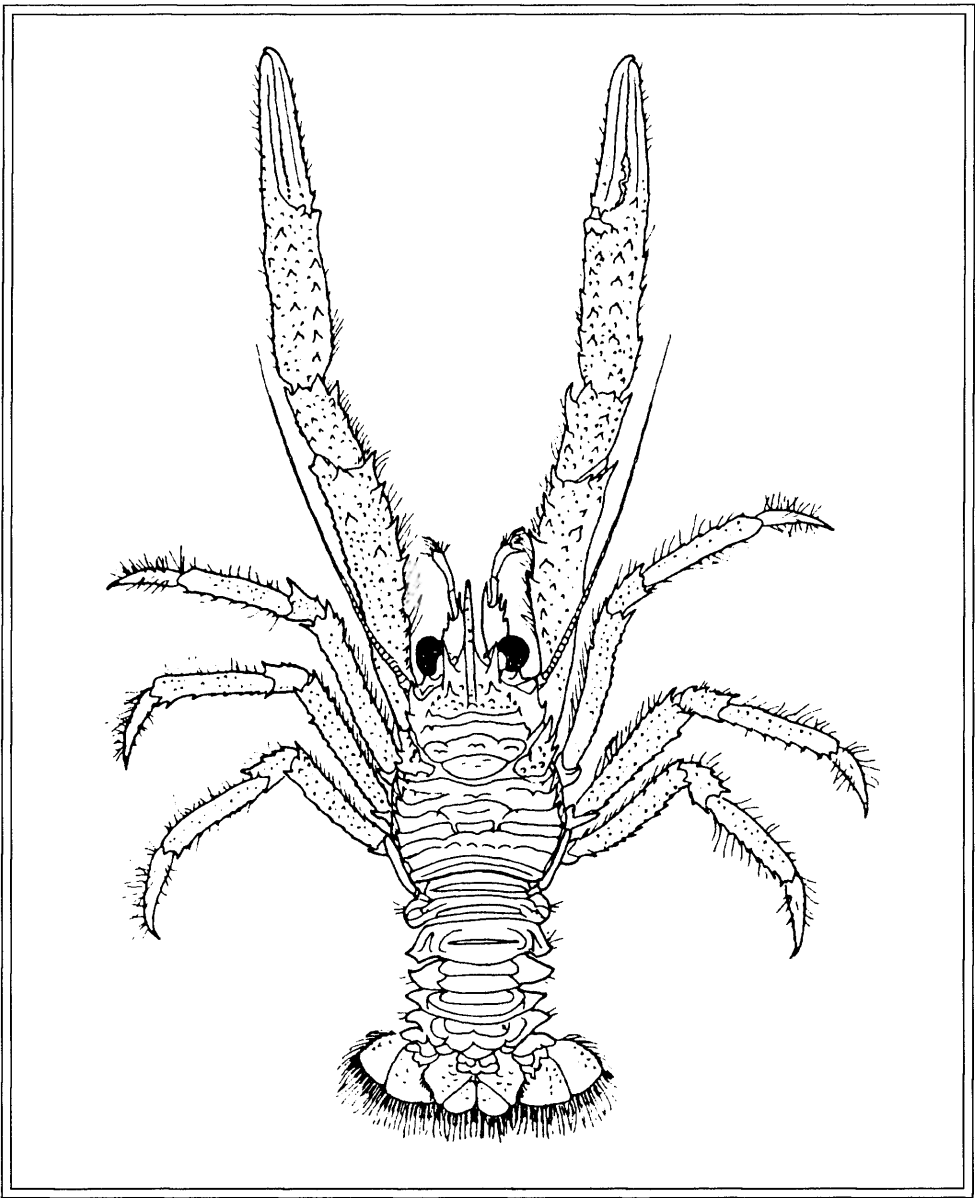
Color in life: Carapace and abdomen red-brown overall, ventrally lighter or white; ridges red with grooves white, and blue spots in cervical groove. Chelipeds with red spines; fingers red with distinct white tips. Walking legs with irregular light bands. Tail fan light colored (after Hart, 1982; Jensen, 1995:73, Plate 145).

**Biology.** These animals inhabit rocky areas, gravel, mud, and sponge beds. They are predators on other Crustacea and can do considerable damage in shrimp traps (Hart, 1982).

**Taxonomic Remarks.** Commonly referred to as a squat lobster. Rathbun (1904:166) remarked that this is “probably the species designated by Owen (1839?) as *M. gregaria*.”

**Type Locality and Type Specimens.** Holotype is a 35 mm long individual from off Cape Beale, Vancouver Island, British Columbia, 66 fathoms (121 m), *Albatross* Station 2878 (Schmitt, 1921).

**Distribution.** Sitka, Alaska, to San Diego, California, 50 to 559 fathoms (91 to 1,022 m) (Rathbun, 1904; Schmitt, 1921).



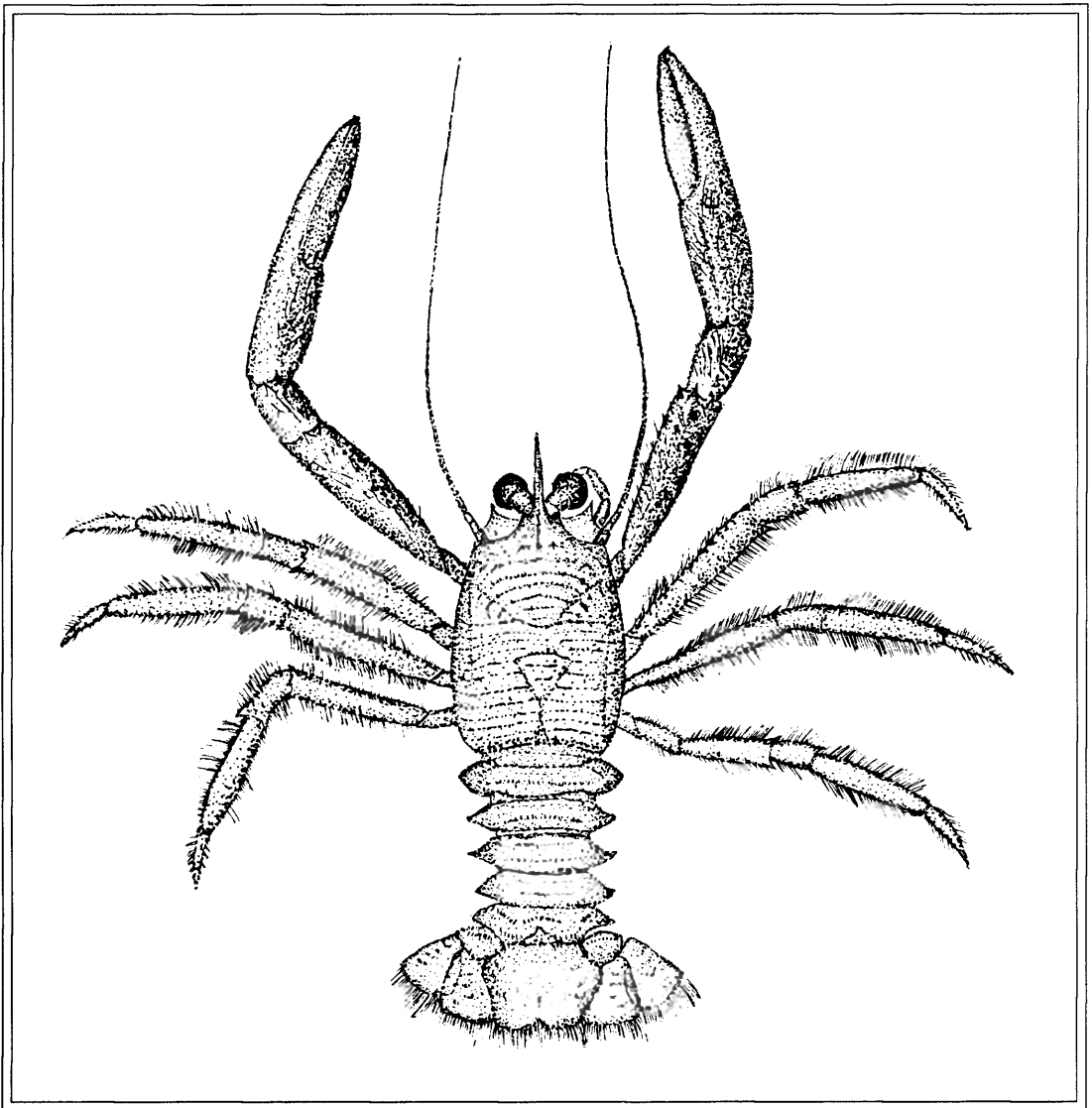
**Figure 2.19.** *Munida quadrispina* Benedict, 1902: male, dorsal view (from Hart, 1982).

***Pleuroncodes planipes* Stimpson, 1860**

Figure 2.20

*Pleuroncodes planipes* Stimpson, 1860:245.—Holmes, 1900:112.—Rathbun, 1904:166.—Schmitt, 1921:163, Plate 31, Fig. 2.—Boyd, 1967:394, Figs. 1-4.—Gotshall, 1994:64, Plate 153.—Jensen, 1995:74, Plate 146.

**Material Examined.** USNM 102-BSS-01-TX Phase I primary voucher lot; SBMNH 023-BSR-02-TX Phase I secondary voucher lot.



**Figure 2.20.** *Pleuroncodes planipes* Stimpson, 1860: male, dorsal view (from Boyd, 1967).

**Description.** Carapace more or less convex, tapering anteriorly, transversely rugose, anterior edges of rugae fringed with closely set short hairs; with the exception of a few spinules behind the supraorbital teeth, carapace is devoid of spines above; there is a spine at the rounded anterolateral angle, behind which there are a few spines on the lateral margin. Rostrum long and slender, scabrous above, and continued on the carapace as a carina; supraorbital teeth spine-like, confluent at base with rostrum. Chelipeds slightly hairy; ambulatory legs scabrous, with penultimate joints distinctly flattened and ciliated (Schmitt, 1921).

Color in life: Red (Jensen, 1995:74, Plate 146)

**Biology.** One of the most common species in southern California, *P. planipes* is usually encountered as a pelagic species in huge schools which occasionally wash ashore in vast numbers. Boyd (1967) however, found that this species is partially benthic during its first two years and wholly benthic after this time with densities measuring as high as 9 to 11 individuals per m<sup>2</sup>. Animals were dredged and trawled at depths ranging from 70 to 900 m on gray muddy sand and gray mud along the western coast of Baja California, Mexico. Boyd (1967) states that this species is a voracious omnivore that is in turn fed upon by large oceanic game

fishes such as albacore, yellowfin tuna, and skipjack tuna, and is also fed upon by kelp-bed fishes. During its pelagic phase, *P. planipes* is a filter feeder near the surface. It spreads its setae-fringed legs to form a filter basket and slowly sinks through the water column collecting particulates, small zooplankters, and perhaps larger phytoplankton. These are ingested as the legs are groomed, and the animal swims back to the surface to repeat its slow feeding descent (D. Cadien, pers. comm., based on his observations from the Texas A&M University submarine *Diaphus*, in the Santa Maria Basin). Schmitt (1921) reports that a mass stranding which occurred in 1859 was the source of specimens for the species description by Stimpson in 1860; subsequent reports of this phenomenon are numerous.

**Taxonomic Remarks.** This species is often referred to as the tuna crab or red crab. It is also included with those species known as squat lobsters.

**Type Locality and Type Specimens.** Schmitt (1921) gives two type localities: Monterey, California, and a latitude and longitude of 24°N 130°W, Pacific Ocean (Schmitt, 1921:163).

**Distribution.** From 90 miles southwest of San Francisco, California, to 150 miles southwest of Cape St. Lucas, Lower (Baja) California (Rathbun, 1904; Schmitt, 1921).

## Family Lithodidae Samouelle, 1819

### *Paralomis multispina* (Benedict, 1894)

#### Figure 2.21

*Leptolithodes multispinus* Benedict, 1894:484.—Rathbun, 1904:165.

*Paralomis multispina*.—Bouvier, 1896:25.—Schmitt, 1921:159, Plate 23, 30, Figs. 7-8.—Goodwin, 1952:176, Fig. 8.—Hart, 1982:88, Fig. 28.—Kozloff, 1987:408.—MacPherson, 1988:76.

**Material Examined.** USNM 013-BRA-04-TX Phase I primary voucher, 1 specimen, carapace length including anterior and posterior spines 3.02 mm, without spines 2.57 mm, carapace width with spines 2.57 mm, without spines 2.13 mm; SBMNH 016-BRA-01-TX Phase I secondary voucher, 1 specimen.

**Description.** Carapace about as broad as long; areolations well defined. Median line at summit of gastric region has a sharp spine about 4 mm in length. The lateral margins are armed with from twelve to sixteen spines about 3 mm in length. In young and in some adults there are small spines on the branchial region. A semicircular line of six or seven spines marks the limits of the branchial and intestinal regions. Carapace thickly studded with blunt spines, each terminating in a flattened face or surface cut obliquely to the surface of the carapace; this face is encircled by a fringe of short, stiff bristles. Rostrum consists of simple median spine with two basal spines. Under the rostrum proper there is a very short, conical spine homologous with the subrostral spine of *Lithodes*; behind the spine are one or more spinules. Abdomen in male composed, after the second segment, of several rows of leathery plates; second segment better calcified and harder. Abdomen of female twisted to the right as in *Lithodes*.

Chelipeds moderately slender, extending almost to distal end of carpal joints. Spines on inner margin of carpal segments the most prominent. Ambulatory legs long and slender, thickly set with spines. Spines of merus not so distinctly arranged in rows as on carpal and propodal segments; there is, however, a distinct row on the upper margin. Spines of carpus arranged in eight more or less distinct rows; on the propodal segment the spines are arranged in six full rows and two half rows. There are four short rows of spines on the proximal end of the dactylus. Dactyli compressed, slightly bent, a little twisted (Schmitt, 1921:159, after Benedict).

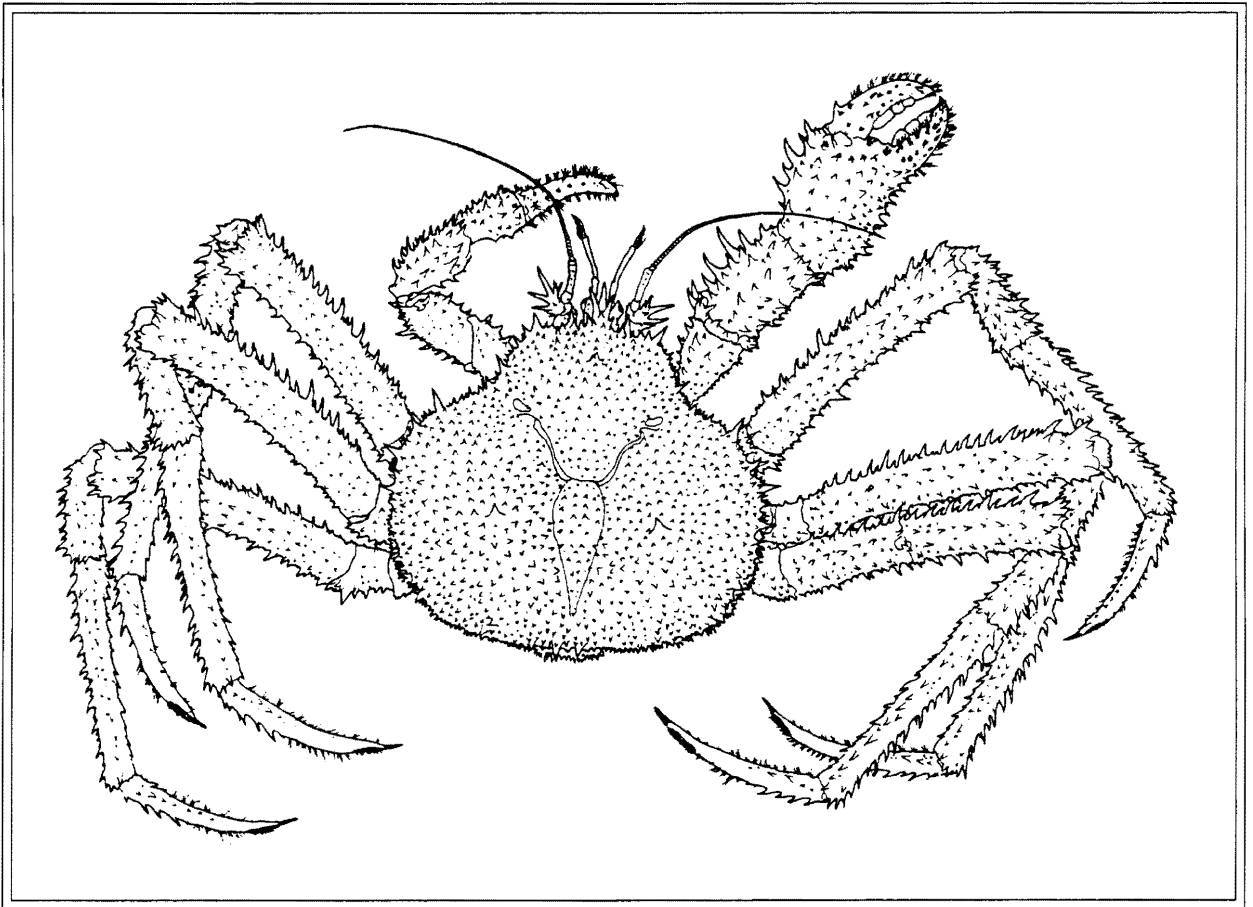
Color in life: Carapace scarlet with spines dark and nodules light. Chelipeds and walking legs scarlet with lighter colored spines and tips of fingers. Eyestalks scarlet; corneas black. Antennal flagellum scarlet (Hart, 1982).

**Biology.** Hart (1982) reports habitat as deep sea mud.

**Taxonomic Remarks.** According to MacPherson (1988:76), there are 24 species of this genus in the Pacific (including Antarctic waters). Off California only two species occur, *P. multispina* and *P. verrilli* (Benedict, 1894). The species are easily separated by the more spiny carapace and legs of *P. multispina* (compare Plates 23 and 24 of Schmitt, 1921). The correct date of Benedict's description is apparently 1895, although the date appearing on the frontispiece of that volume is 1894 (Dawson, 1989).

**Type Locality and Type Specimens.** Off Queen Charlotte Islands, British Columbia, 876 fathoms (1,602 m), *Albatross* Station 2860.

**Distribution.** From off Shumagin Bank, Alaska, to off San Diego, California, 625 to 876 fathoms (1,143 to 1,602 m) (Schmitt, 1921, after Rathbun, 1904); Japan to Gulf of California, deep water (Dawson, 1989).



**Figure 2.21.** *Paralomis multispina* (Benedict, 1894): male, dorsal view (from Hart, 1982).

## Infraorder Brachyura Latreille, 1803

### Family Homolidae De Haan, 1839

#### *Moloha faxoni* (Schmitt, 1921)

##### Figure 2.22

*Homola faxoni* Schmitt, 1921, Plate 31, Fig. 7.

*Paromola faxoni*.—Rathbun, 1937: 68-69, Plate 18; Plate 19, Fig. 1; Table 19.—Crane, 1937: 107.—Church, 1971: 113 (color photograph, presumably this species).—Luke, 1977: 32.—Wicksten, 1983b: 185, Fig. 1b (drawing based on Church's (1971) photograph). Kuck and Martin, 1994: 178, Figs. 1-4.

*Moloha faxoni*.—Guinot and Richer de Forges, 1995: 383, Fig. 33 c-d, g-h.

**Material Examined.** California: Santa Maria Basin, 250 m, MMS BioSurvey Station 1 C/D. One male, carapace length (including 4.9 mm rostrum) 35.8 mm; carapace width = 31.2 mm (USNM 001-BRC-02-TX).

**Type Locality and Type Specimens.** Off Point Loma, California, 67 to 73 fathoms (123 to 134 meters), *Albatross* Station 4309, 03 March 1904. Type specimen USNM 53331, female.

**Description.** Carapace: Very short covering of setae over entire carapace, but not obscuring surface (i.e., not with "entire surface more or less obscured by a rather thick, short pubescence" [Schmitt, 1921]). Supraorbital spines directed outward, with two (sometimes one; e.g., MMS 1 C/D) small, hooked spines. Branchial and hepatic regions distinctly inflated; body subrectangular in cross section, becoming more inflated with increased size of crab. Lateral margins with row of 4-6 spines. Linea homolica visible along dorsolateral margins (see Martin and Abele [1986: 587; 1988: 32] for discussion of lineae of decapods; see McLaughlin [1980: 167] for definitions of types of lineae found in decapods). Small tubercles of varying number and size covering carapace both dorsally and laterally, largest concentration on dorsal branchial region (Kuck and Martin, 1994).

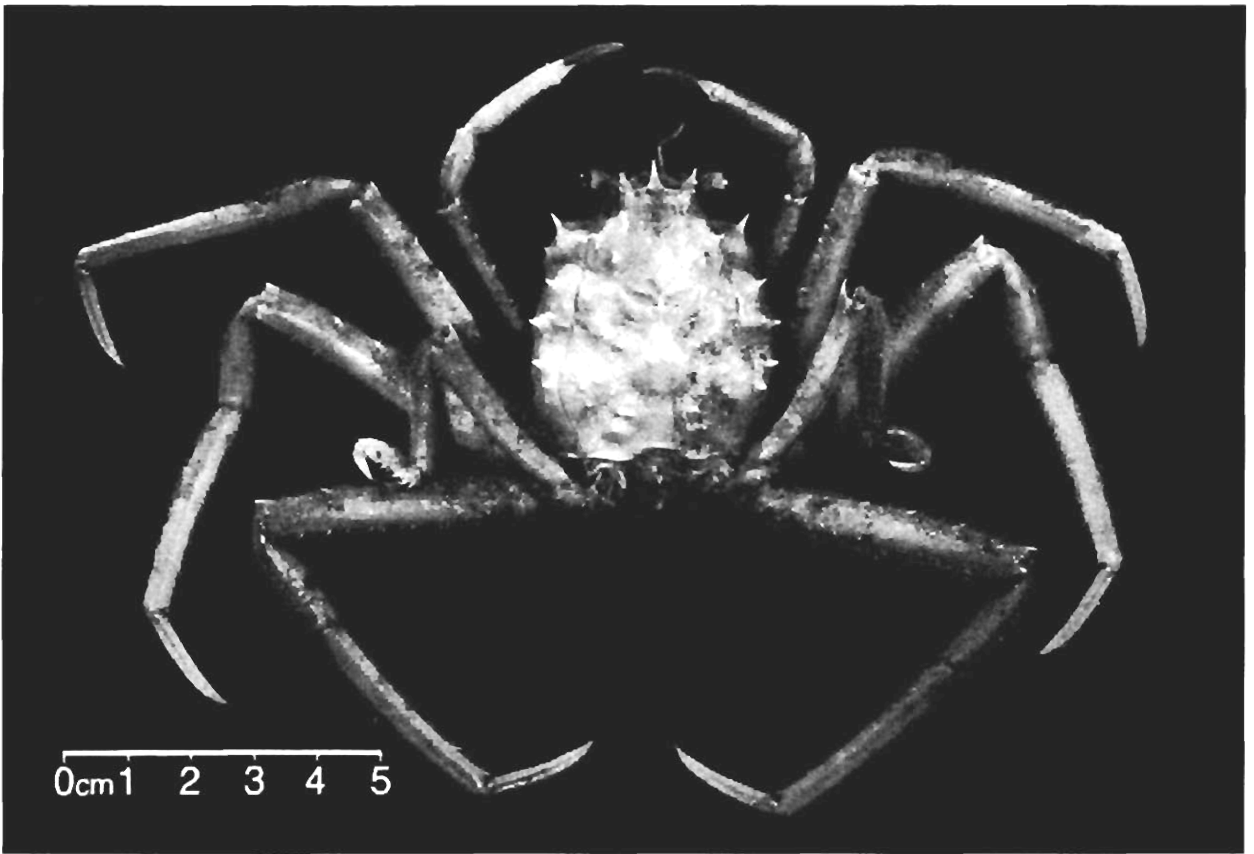
Chelipeds: Long, slender, equal in length; covered with dense, short setation; merus with row of 5-8 spines dorsally in females. Six specimens with variously sized, darkly pigmented, subcircular spot distally on both sides of propodus (LACM 62-204.1 has spots only on inner side of propodus; CMM 86.26.001 has spot on inner side of right propodus only.) Nature of this spot, and why it appears in only some specimens of both sexes, is unknown. Fingers with non-serrate, acute inner margins; dactyl crossing propodus inwardly at tip (except one chela of specimen from MMS 1 C/D); with patches of long, thick setae in most specimens; finger pigmentation (preservation in 70% ethanol) ranging from white to brown to black.

Pereiopods: Pereiopods 2-4 with row of 15-22 corneous spines on inner (ventral) margin of dactyl; merus with 6-9 dorsal and 3-12 ventral spines along margins; Pereiopod 5 dactyl with 5-8, and propodus with 7-10 (proximal 5-6 in circular pattern) corneous spines on inner margin. Dorsal and lateral surfaces of propodus densely covered with short setae; ventral surfaces of dactyl and propodus mostly devoid of setae.

Abdomen: Seven-segmented; large tubercle at posterior margin of first, and in center of second, segments; occasionally, small tubercle at anterior margin of first, large or small tubercle in center of third, and small tubercle on anterior margin of fourth, segments.

Male: Chelipeds more robust; larger specimens with propodus and carpus covered with prominent tubercles, fewer and sometimes absent in smaller males and in females. Merus with 9 to 19 dorsal spines; occasionally, additional parallel row of up to 11 spines in larger specimens. Abdomen with tubercle along horizontally raised posterior border of sixth segment (also found in small female from LACM 41-33.9);





**Figure 2.22.** *Moloha faxoni* (Schmitt, 1921): Holotype female (carapace width 39.60 mm) USNM 53331, dorsal view (from Kuck and Martin, 1994).

anterior half to two-thirds of seventh segment generally narrower at base than in females. Pleopod 1 large, robust, minutely crenulate at distolateral tip; overlapping ventral folds with long setae covering posterior opening. Pleopod 2 as in Fig. 3c. Pleopods 1 and 2 becoming more robust and better defined with increased size of specimen.

Small individuals (e.g., LACM 41-33.9): Carapace with spines longer and sharper than in adults; virtually no setae dorsally, except at tips of largest lateral, gastric, and hepatic spines; short hooked setae along some margins; rostrum, supraocular spines, pereiopods, antennae, and eyestalks with long, slender, irregularly spaced setae; very few well-spaced setae covering chelipeds. Supraocular spines directed forward with small, hooked dorsal spines sometimes lacking (e.g., LACM 40-148.1). Chelipeds with 5 dorsal spines on merus; fingers without pigmentation. Pereiopods 2-4 proportionately longer and more slender, and with fewer and less prominent spines along dorsal and ventral margins of merus, than in adults. Pereiopod 5 dactyl with 6 and propodus with 8 spines.

Color: All specimens examined by Kuck and Martin (1991) appeared uniformly light to dark cream (preservation in 70% ethanol) except for LACM 66-371.1, which had a whitish carapace. See “chelipeds” above for description of cheliped spots and finger pigmentation. Crane (1937) describes “color in life” as “entirely buff, except anterior part of carapace which is suffused with scarlet”(Kuck and Martin, 1991).

**Biology.** Very little is known about the basic biology of *M. faxoni*, as is the case for many deep-sea brachyurans. They have been recovered from vase-shaped hexactinellid sponges off Point Loma, California, and were loath to leave the sponges' protective cover once collected (pers. comm., R. Velarde, via D. Cadien). The reduced and subchelate fifth pereopods suggest a carrying behavior, as has been seen in members of the closely related genus *Paromola* (e.g., Wicksten, 1985, for *P. japonica*), with these legs holding some object(s) over the back of the carapace for protection or camouflage. Wicksten (1983b: fig. 1b) shows what is probably a *M. faxoni* "from southern California" carrying a sponge; her drawing was based on a color photograph in Church (1971) of a "10-inch-long [specimen] at a depth of 1,200 feet [366 m] off San Diego." Based on pereopod morphology, Guinot and Richer de Forges (1981) and Wicksten (1985, 1986) inferred carrying behavior in all species of the family Homolidae. Similar behavior has been documented or inferred for other crabs with chelate or subchelate posterior pereopods (e.g., Dromiidae, Latreillidae, and Dorippidae).

Only one ovigerous female exists in examined collections (LACM 62-205.1). A second was collected off San Diego, California, on 28 January 1992 by the Pt. Loma Biology Laboratory (OMP), but was discarded. We know of only four *M. faxoni* that have been held successfully in aquaria (three females at the Cabrillo Marine Museum, and one male at the Scripps Institution of Oceanography). The only behavioral notes available are from observations by S. Vogel (CMM; pers. comm.) of crabs in aquaria carrying gorgonians with the fifth pereopods, and by R. McConnaughey (SIO; pers. comm.) of a crab that lived in an aquarium (5-10°C) from 05 May to October 1992. McConnaughey noted that the crab maintained the fifth pereopods in an elevated position, but no obvious carrying behavior was observed (although shells and other items were introduced). The species has also been found when trawled to still carry a gorgonian colony not otherwise represented in the trawl (and thus not likely to have been picked up after capture) (pers. comm., R. Velarde via D. Cadien).

**Taxonomic Remarks.** In a recent revision of the family Homolidae, D. Guinot and B. Richer de Forges (1995) transferred several species formerly treated as *Paromola* into other genera. One of those species was *Paromola faxoni* (Schmitt, 1921) which they transferred to the genus *Moloha* Barnard, previously considered a subgenus of *Paromola* (see Guinot and Richer de Forges 1995: 376).

Although the holotype (USNM 53331) is a female, and is the only specimen mentioned by Schmitt (1921), his figure (Plate 31, Fig. 7) was erroneously referred to as a male in the accompanying figure legend. Rathbun (1937) used the same photograph, but correctly referred to it as a female (holotype), and also included a photograph of the holotype in ventral view (clearly showing it to be female). Rathbun (1937: 72, Table 18) listed the five previously known specimens, all of which were collected by the *Albatross* in 1904 and are housed at the USNM (R.B. Manning, pers. comm.).

The male first and second pleopods have been illustrated for relatively few species of *Moloha* or species formerly treated as *Paromola* prior to the Guinot and Richer de Forges (1995) revision. Griffin (1965: Figs. 1-4) provided figures for *Paromola spinimana* (now treated as *Yaldwynopsis*), as did Serene and Lohavanijaya (1973: figs. 36-37) for *P. alcocki faughni* (now *Moloha*), and Guinot and Richer de Forges (1981: Figs. 5A, A1 and 5C, C1) for *P.* (now *Gordonopsis*) *profundorum* and *?P. japonica* Parisi, 1915. The general shapes of the pleopods of these species and those of *M. faxoni* are quite similar, including the distinctive overlapping ventral folds of the first pleopod (Fig. 3a; ventral view not shown in Serene and Lohavanijaya, 1973). The apex of the first pleopod is distinctive in these species, as in many brachyurans, and most likely provides a good distinguishing characteristic among males of *Moloha*, *Paromola*, and related genera (see Guinot and Richer de Forges, 1995).

**Distribution.** All five specimens of *M. faxoni* listed by Schmitt (1921) (as *H. faxoni*) and again by Rathbun (1937) (as *P. faxoni*) were taken off Point Loma, California, in depths from 123 to 247 m. Wicksten (1985) examined another specimen housed at the Allan Hancock Foundation (AHF), Los Angeles, California, where we found nine additional unreported specimens (Tables 1 and 2) distributed from Tajiguas, California (approximately 27 miles east of Point Conception, Santa Barbara County, CA), to Isla Cedros, Baja California, Mexico. The only other published record for this species is a collection catalog by Luke (1977) documenting

ten specimens (six males, three females, and one juvenile) housed at the Scripps Institution of Oceanography and distributed from La Jolla, California, to Cabo Colonet, Baja California, Mexico. According to staff of the Monterey Bay Aquarium Research Institute (MBARI), Monterey, California, there have been no sightings of *M. faxoni* in the area during the past four years either by personnel or in extensive video footage (J. Berry, J. Connor, L. Lewis, pers. comm.). Queries to the California Academy of Sciences (CAS; R. Van Syoc, pers. comm.), San Francisco, California, and to the Universidad Nacional Autonoma de Mexico (UNAM; M. Hendrickx, pers. comm.), Mazatlan, Mexico, did not result in any additional specimens. Additionally, Hendrickx (1992) did not list *M. faxoni* as occurring in the Gulf of California, Mexico. Therefore, it is likely that the geographic distribution of *M. faxoni* does not greatly exceed the boundaries defined by present specimen collections, although distribution of the species west to Point Conception, CA (northernmost border of the California Province; e.g., Brusca and Wallerstein, 1979:73), is highly probable.

The report of Kuck and Martin (1991) extended the range of *M. faxoni* northward to Tajiguas, California, and southward to Isla Cedros, Baja California, Mexico, and extends the depth range to 18-460 m.

### Family Xanthidae MacLeay, 1838

#### *Lophopanopeus bellus diegensis* (Rathbun, 1900)

##### Figure 2.23

*Lophopanopeus diegensis* Rathbun, 1900:37; 1904:184, Plate 9, Fig. 3; 1930:327, Plate 153, Figs. 6-7, 10, text-Fig. 49.—Weymouth, 1910:52, Plate 12, Fig. 39.—Schmitt, 1921:245, text-Fig. 146, Plate 37, Fig. 5.—Johnson and Snook, 1935:387.

*Lophopanopeus bellus diegensis*.—Menzies, 1948:7, Figs. 6-8, (male hypotype, AHF Station 1407-40).—Allen, 1980:238, Plate 35, Figs. 402, 405.—Hart, 1982:200, Fig. 81.—Jensen, 1995:19, Plate 7.

*Lophopanopeus bellus*.—Charwat, 1977:71.

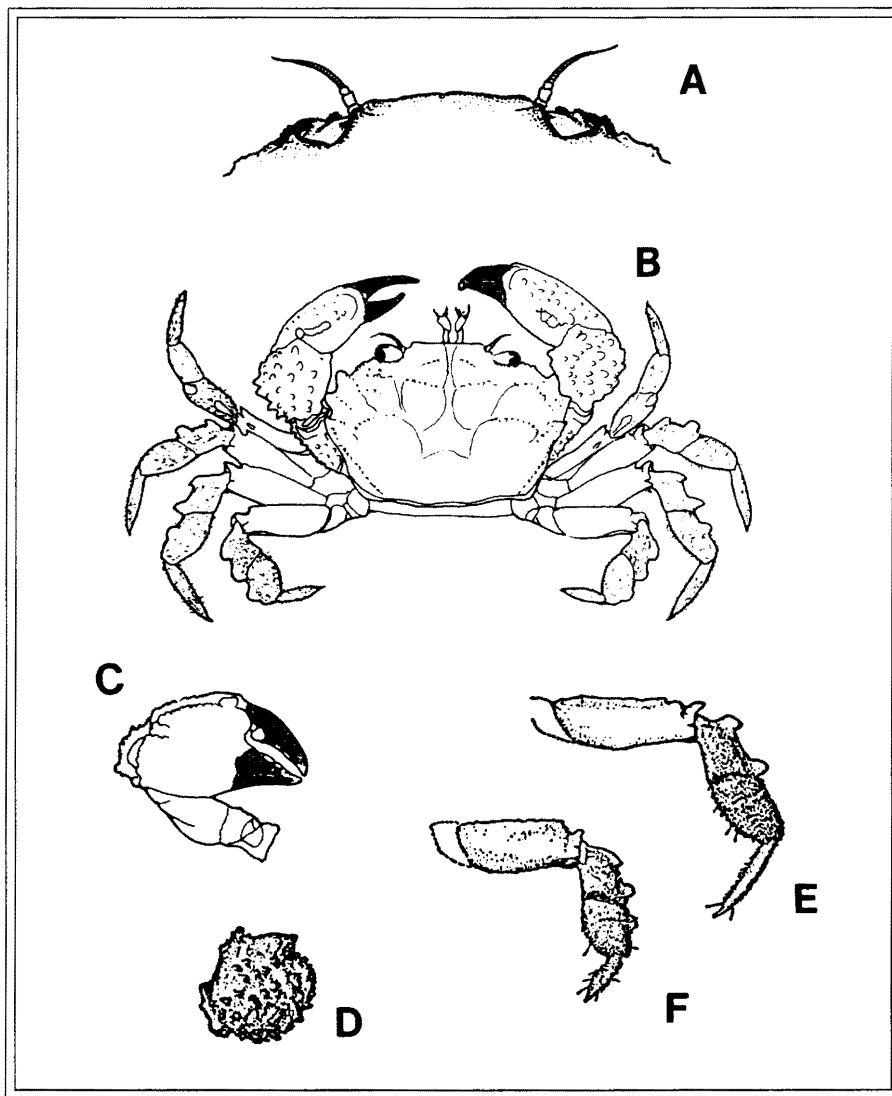
**Material Examined.** USNM 013-BRA, 04-TX Phase I primary voucher, 1 immature female; carapace length = 3.3 mm, carapace width = 4.2 mm. SBMNH 001-BRC, 02-TX Phase 1 primary voucher, one immature male, carapace length = 2.8 mm, carapace width = 3.9 mm.

**Description.** Ambulatory legs with dorsal and lateral surfaces, except on the lobations, covered with a pubescence; carpus markedly bilobed. Carpus of cheliped covered with irregular generally isolated elevated bumps; carpal number for bumps 4-6; a deep sulcus is located on dorsal surface of carpus near its anterolateral margin. Lobe at proximomedial part of dorsal surface of manus small. An enlarged tooth is present at the proximal end of cutting edge of dactylus of major cheliped. Dorsal surface of carapace pubescent as in *L. b. bellus*. Morphology of tip of flagellum of male identical with that of *L. b. bellus* (after Menzies, 1948:7).

Original description: Upper margin of meral joints of ambulatory legs not spinulose. Hands with one or more lobes or teeth on upper margin. Carpus of cheliped very rough. Carpal joints of ambulatory legs strongly bilobed. Carpus of chelipeds covered with tubercles (Rathbun 1900:137).

Discussion of constant features: Only two characters, (1) the presence of irregular, elevated, isolated bumps on the dorsal surface of the carpus of the cheliped and (2) the presence of markedly bilobed carpal segments of the ambulatory legs, serve to distinguish this species from *L. bellus bellus* (Menzies, 1948).

Color in life: Color and pattern variable ranging from purple and orange to brown, white, or mottled (Jensen, 1995:19, Plate 7).



**Figure 2.23.** *Lophopanopeus bellus diegensis* Rathbun, 1900: A, anterodorsal margin of carapace; B, male, dorsal view; C, male, lateral view of right cheliped; D, male holotype, dorsal view of right carpus; E, male holotype, lateral view of second ambulatory leg; F, male holotype, lateral view of fourth ambulatory leg (A, from Allen, 1980; B,C, from Hart, 1982; D-F, from Menzies, 1948).

**Biology.** This species has been collected from various habitats ranging from unprotected rocky shores to protected bays at depths ranging from intertidal to 100 fathoms (185 m), on bottoms ranging from mud to coarse sand to rock. Below 20 fathoms (37 m) *L. bellus diegensis* is frequently taken with *L. leucomanus leucomanus*. Intertidal specimens are in general much larger than those found below 10 fathoms (Menzies, 1948).

Ovigerous females have been found from February to July and also in September.

**Taxonomic Remarks.** This subspecies of *Lophopanopeus bellus* was initially described by Rathbun (1900) as a distinct species, *L. diegensis*. Menzies (1948) considered it a subspecies of *L. bellus* and described the differences between this and the other, more northern, subspecies, *L. bellus bellus*. However, Menzies noted several problems, including areas of geographic and morphological overlap (see Menzies, 1948).

In the two juveniles in these collections, the pubescence of the pereopods and carapace that Menzies (1948) employed in his key is not readily evident. However, the distinctive nature of the bilobed crest on the carpus of the walking legs, and the irregular raised bumps of the cheliped carpus, are evident even at these early developmental stages.

Adult specimens of *L. bellus diegenensis* average approximately one half the size in carapace width of adults of *L. bellus bellus*.

**Type Locality and Type Specimens.** San Diego, 10 fathoms (18.3 m), holotype male (Rathbun's (1900) *L. diegenensis*), USNM 4281. Hypotype, AHF Station 1407-40.

**Distribution.** *Lophopanopeus bellus diegenensis* is the southern form of the species and ranges from Mission Bay to Monterey Bay, California. A sharp intergradation zone between *L. b. diegenensis* and *L. b. bellus* is found between Point Conception and Point Sur, California, but specimens of *L. b. diegenensis* have been identified from as far north as Washington and Alaska (Menzies, 1948). In some areas near Tacoma, Washington, in Puget Sound, *L. b. diegenensis* far outnumber *L. b. bellus*, with both forms occurring in a single sample (D. Cadien, pers. comm.). This suggests to us that specific rather than subspecific status may be warranted.

## Family Parthenopidae Alcock, 1895

### *Heterocrypta occidentalis* (Dana, 1854)

Figure 2.24

*Cryptopodia occidentalis* Dana, 1854:430.—Stimpson, 1857:458.—Lockington, 1877b:78.—A. Milne Edwards, 1878:169.

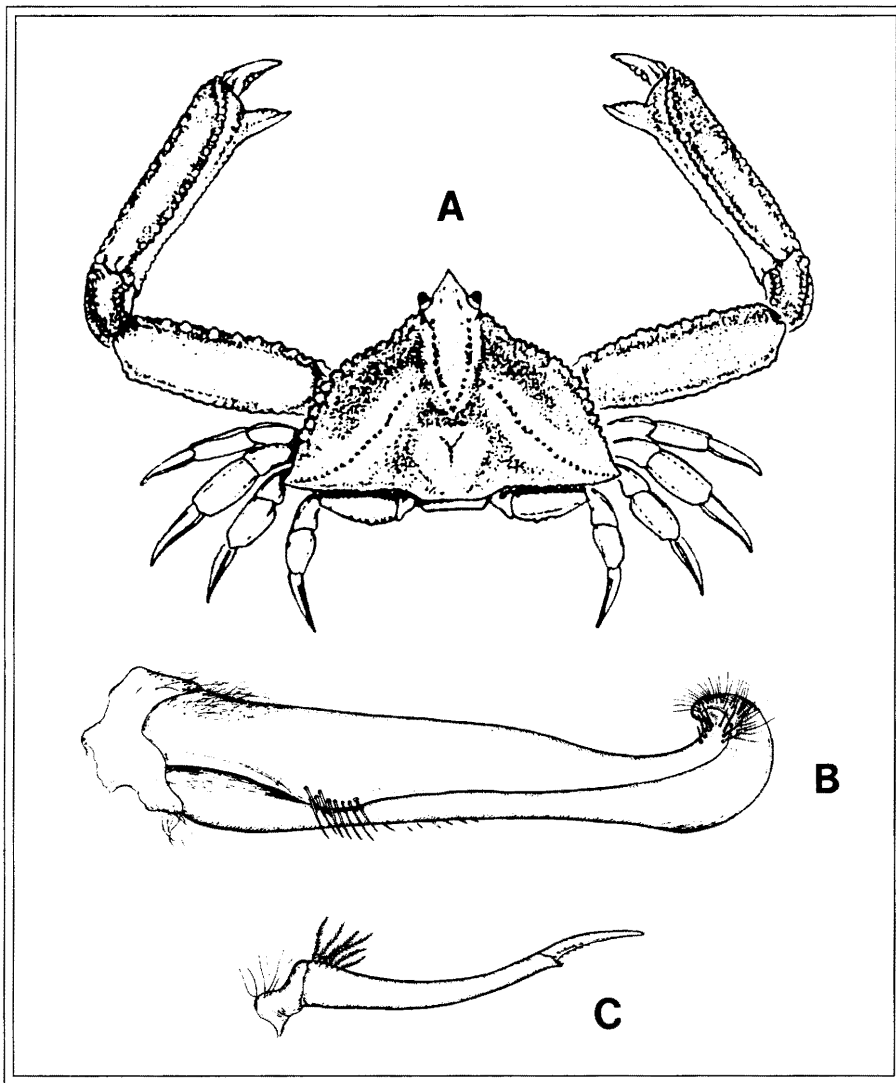
*Lambrus frons-acutis* Lockington, 1877a:31. Type locality, Santa Catalina Island, California; type not extant (destroyed in San Francisco fire).

*Heterocrypta occidentalis*.—Holmes, 1900:44.—Rathbun, 1904:170; 1925:559, Plates 204, 205; 1926:28.—Weymouth, 1910:21, Plate 2, Figs 4, 5.—Hilton, 1916:71, Fig. 7.—Nininger, 1918:36, Fig. 1.—Schmitt, 1921:192, Fig. 119. Johnson and Snook, 1927:363, Fig. 316.—Ricketts and Calvin, 1939:182, Plate 35.—Garth, 1958:476, Plate Z<sub>4</sub>, Figs. 14 and 14a, Plate 55, Fig. 2.—Allen, 1980:236, Plate 32, Fig. 379.—Gotshall, 1994:69, Plate 165.—Jensen, 1995:34, Plate 53.

**Material Examined.** One juvenile, damaged, possessing only left pereopod 1 (cheliped) and right pereopod 5, carapace length = 2.9 mm, carapace width = 2.8 mm, USNM 021-BSR, 02-TX Phase I primary voucher.

**Description.** Size to 21.0 mm carapace length, 34.0 mm carapace width. Branchial ridges sinuous, terminating at lateral angle, and not continuing on gastric region, marked by two ridges coming to a point posteriorly. Fingers short, making a distinct angle, though less than a right angle, with palm. Male first pleopod thick, capitate, contorted, tapering to "neck" then flaring; longer setae on lip of groove, in two rows in concavity of terminal portion, and marginally. Male second pleopod little more than half the length of first, reflexed, corneous tip marginally denticulate; a subterminal cluster of denticles.

Carapace broadly triangular; median region narrow, the flattened upper surface bounded by two granulated ridges, converging to a point behind. Cardiac region furnished with a three-sided, pyramidal elevation, the edges usually granulated. Posterolateral regions large, and furnished with an S-shaped, granulated crest, extending from near the posterior end of the median region to the acute lateral angles on the carapace; in front of the anterior bend of this crest a pair of minute tubercles. Rostrum triangular, subacute, not depressed.



**Figure 2.24.** *Heterocrypta occidentalis* (Dana, 1854): A, dorsal view; B, male, first pleopod; C, male, second pleopod (A, from Allen, 1980; B-C, from Garth, 1958).

Anterolateral margins straight or slightly concave in front, convex near the middle, the posterior portion passing outwards and backwards, arching over the legs; the teeth on the anterior part small and irregular, but becoming larger posteriorly, there furnished with secondary denticles. Posterolateral margins transverse; posterior margin not produced over the abdominal segments. Ischium of the maxillipeds smooth, the anterointernal angle produced; merus small, the surface concave and bearing a prominent tooth near the middle.

Chelipeds long, trigonal; the sides of the merus convex, the edge sharply granulate to dentate; carpus with three or four granulate lines; hand about as long as the merus. The angles prominent and dentate and the sides concave; pollex short, deflexed; dactyl short, but longer than long axis of the hand. Ambulatory legs compressed, strongly carinated above; dactyls narrow, strongly sulcate, and corneous-tipped (Garth, 1958:476, modified from Holmes, 1900:44).

A long triangular concave area extends from the subhepatic region back to the afferent branchial openings. It includes the exognath and is surrounded by a fringe of hair; outside this area, and above the ischium of the cheliped, a raised, level, oval area against which the inner surface of the manus contacts when the cheliped is flexed (modified from Rathbun, 1925:559).

Color in life: Tips of tubercles white, with ridges bearing tubercles light purpleish, and remainder of carapace mottled with numerous minute spots of white and purplish, giving a pink effect which often closely approaches white. Ambulatory legs usually a light yellow (Weymouth, 1910:21) (see Gotshall 1994, Plate 165; Jensen, 1995:34, Plate 53). A specimen collected on SCUBA off of Malibu by one of us (TLZ) had the following coloration; carapace white, raised regions gray with purple ridges.

**Biology.** This species has been found on sand, sand and shell, algae, gravel, mud, rock with kelp, algae, and coralline substrates. Often associated with sponges, worm tubes, and/or urchins.

Collected from depths normally ranging from 4-57 fathoms ( 7-105 m) with extreme records being intertidal and 95 fathoms (175 m).

Ovigerous females have been taken from February through May, and July through September. In February at San Diego, 38 of 44 females were with ova, and in April off Newport Beach, 51 of 51 females were in this condition (Garth, 1958:476).

**Taxonomic Remarks.** Garth (1958) states that this species is most abundant off Huntington Beach and in Newport Harbor. Many large males were found in the 20 mm range, but none were found over 21 mm. Young under 10 mm are considered to be immature, but individuals can be sexed at 5 mm. Often a sharp rostrum is present and encrustations of barnacles occur on carapaces and chelipeds of older specimens.

**Type Locality and Type Specimens.** Monterey, California, carapace width = 31.7 mm, sex not stated, "probably in Yale Museum" (Garth, 1958, after Rathbun, 1925).

**Distribution.** Gulf of Farallones to San Diego, California, and Los Coronados Islands, 13 to 36 fathoms (24 to 66 m) (Rathbun, 1904) (see Garth, 1958, for additional records).

## Family Majidae Samouelle, 1819

### *Erileptus spinosus* Rathbun, 1893

#### Figure 2.25

*Anasimus rostratus* Rathbun, 1893:227; 1904:171, Plate 10, Fig. 4.—Weymouth, 1910:27.

*Anasimus spinosus*.—Schmitt, 1921:196, Fig. 121.

*Erileptus spinosus* Rathbun, 1893:227; 1904:171, Plate 10, Fig. 1; 1925:68, Plates 212, 213, Fig. 18.—Holmes, 1900:21.—Weymouth, 1910:27, Plate 3, Fig. 7.—Crane, 1937:54.—Garth, 1958:91, Plate E, Fig. 8; Plate 5, Fig. 2.—Jensen, 1995:27, Plate 28, Fig. 6.

**Material Examined.** One ovigerous female, carapace length (including 1.4 mm rostrum) 7.1 mm, carapace width = 4.7 mm. Specimen number 027-BRA, 02-TX, Phase I Voucher specimen, USNM. One ovigerous female, carapace length = 4.9 mm (including rostrum, broken at tip), SBMNH Phase I secondary voucher collection, 006-BRA, 02-TX. One juvenile male, carapace length = 4.2 mm (including rostrum, which is broken at tip) in vial with two other, smaller (unidentified), majids, labeled "Majid sp. 1," MMS California OCS Phase II, voucher lot, Cruise 3-4, Station R-4, rep. 3, 34°43.0'N, 120°47.4'W, 91 m.

**Description.** Size to 11.5 mm (Rathbun, 1925). Carapace pyriform, convex, regions well defined; rostrum simple, slender; postorbital and supraorbital spines present. Basal article of antennae long and narrow, with spine at distal end. Anterointernal lobe of ischium of outer maxilliped large and strongly advanced; merus subtriangular, the anterior margin the longest; outer, or principal, margin of next article nearly as long as outer margin of merus and almost straight until near distal end where it forms an elbow; terminal article unusually long.

Sexes markedly dissimilar. Rostrum a slender spine half as long as postrostral portion of carapace in male, shorter in female. Two median spines, one gastric, one cardiac; one long branchial spine. Postorbital spine small. Chelipeds very long, from three to four times length of carapace in male, only one and a half times carapace length in female. A spine on first abdominal somite.

**Male:** Carapace spinous; two spines on the median line, one on posterior part of the gastric region and the other on the cardiac region; one long spine on the branchial region, with a small one in front of it and two on the margin; a spine on the margin of the hepatic region and two very small ones arranged transversely on the gastric region; a slender spine on the orbital arch. Rostrum slender, spinulose on the margins, about one-half the length of the postfrontal portion of the carapace. Postorbital spine small, at some distance behind eye. Abdomen bearing a spine on the first segment. Chelipeds nearly three times as long as carapace, granulate; merus one-spined above at the anterior margin; hand slender, slightly flattened vertically, increasing in width toward the distal end; dactyl and pollex arched, gaping for one-half length. Ambulatory legs decreasing regularly in length from the first to the fourth; fourth pair a little more than one-half the length of the first (Rathbun 1893).

**Female:** Carapace with two median spines, one on the posterior part of the gastric region and one on the cardiac region. Two spines on each branchial region and, almost in line with these, one on each protogastric lobe, Lateral margins spinulose. Surface pubescent. rostrum slender, spinulose on the margins, curving upwards for its distal half. A prominent supraorbital spine. The first article of the abdomen carrying a spine; a slender spine above near the carpus; hand granulous; fingers nearly as long as palm, in contact. Ambulatory legs slender, pubescent, decreasing slightly in length from the first to the fourth pair; dactyls spinulose below (modified from Rathbun, 1893 [of *Anasimus rostratus*]).

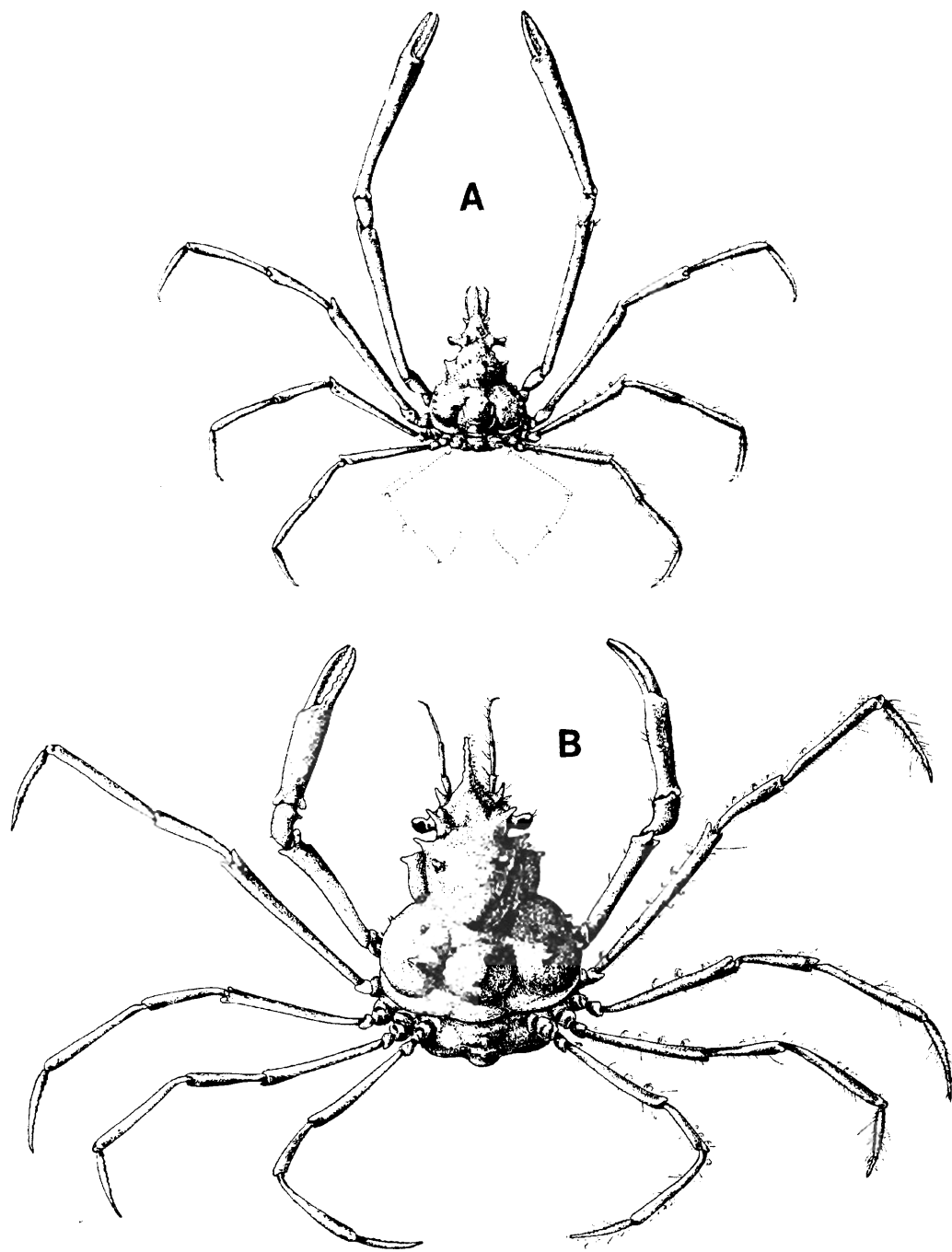
The length of the rostrum is subject to considerable variation. The females of the species, with their shorter legs, are difficult to tell from *Inachoides laevis*, but the ranges of these species only overlap in the Gulf of California (Garth, 1958:91).

Color in life: Cryptic, nondiscript tan carapace (Jensen, 1995:26, Plate 28). In alcohol, chelipeds and legs conspicuously banded and marbled (Crane, 1937).

**Biology.** This species has been recorded from sand, mud, rock, coral, and "coralline" [algae], with the majority of recordings (fully one third of the cases reviewed by Garth, 1958) coming from shell [debris] associated with sand. *Velero III* specimens came from depths ranging from 2 to 300 fathoms (4-554 m). Oviparous females have been recorded in every month of the year along the coasts of southern California and northern Baja California, although there is a seasonal trend with lows in the frequency curve in January, a rise in April, and highs in August and September (Garth, 1958).

**Taxonomic Remarks.** The rostrum for small females has never been drawn adequately; existing figures do not depict adequate spination. Marked sexual dimorphism and variation within a given sex has led to taxonomic confusion such that the different sexes were originally assigned to separate genera. Specimens are often covered with debris and attached material.





**Figure 2.25.** *Erileptus spinosus* Rathbun, 1893: A, male; B, female (A and B after Rathbun, 1904, as *Erileptus spinosus* and *Anasimus rostratus* respectively).

Three MMS voucher lots bore the label "Majid sp. 1" and were not identified further. Collection data is the same for all vials, differing only in the "Rep:" field on the label. Of these, the lot mentioned above (Rep: 3) contained three individuals, the largest of which is a small male *E. spinosus*. The other two specimens in that lot are too undeveloped to allow confident identification. This is also the case with the other two lots (identical collection data as above, except that one vial is Rep: 1, the other Rep: 2), although the sole juvenile in the lot marked Rep: 2 (CL= 3.4 mm including strongly bifurcate rostrum), while clearly a majid, definitely is not a young *E. spinosus*.

**Type Locality and Type Specimens.** Marked sexual dimorphism led to the sexes being treated by Rathbun (1893b) as separate species, the male assigned to *Erileptus spinosus*, the female to *Anasimus rostratus*, each with a designated holotype (see Garth, 1958).

Type material: Holotype USNM 17341, male, carapace length = 10 mm, carapace width = 6 mm, off San Diego, California, 36 fathoms (66 m), *Albatross* Station 2934. Female holotype (of *Anasimus rostratus*) USNM 17340, northwest of Cedros Island, off Baja California, 58 fathoms (106 m).

**Distribution.** Broadly distributed off southern California, from San Miguel Island and Point Santa Barbara in the northern part of its range to Entrada Point, Magdalena Bay, Baja California, Mexico, and in the Gulf of California from Rocky Point, Sonora, to Gorda Banks (Garth, 1958). A single specimen from south of the Ladrone Islands, Panama, was reported by Garth (1958). The present report extends the range northward into the Santa Maria Basin.

## Family Pinnotheridae De Haan, 1833

### *Pinnixa occidentalis* Rathbun, 1893

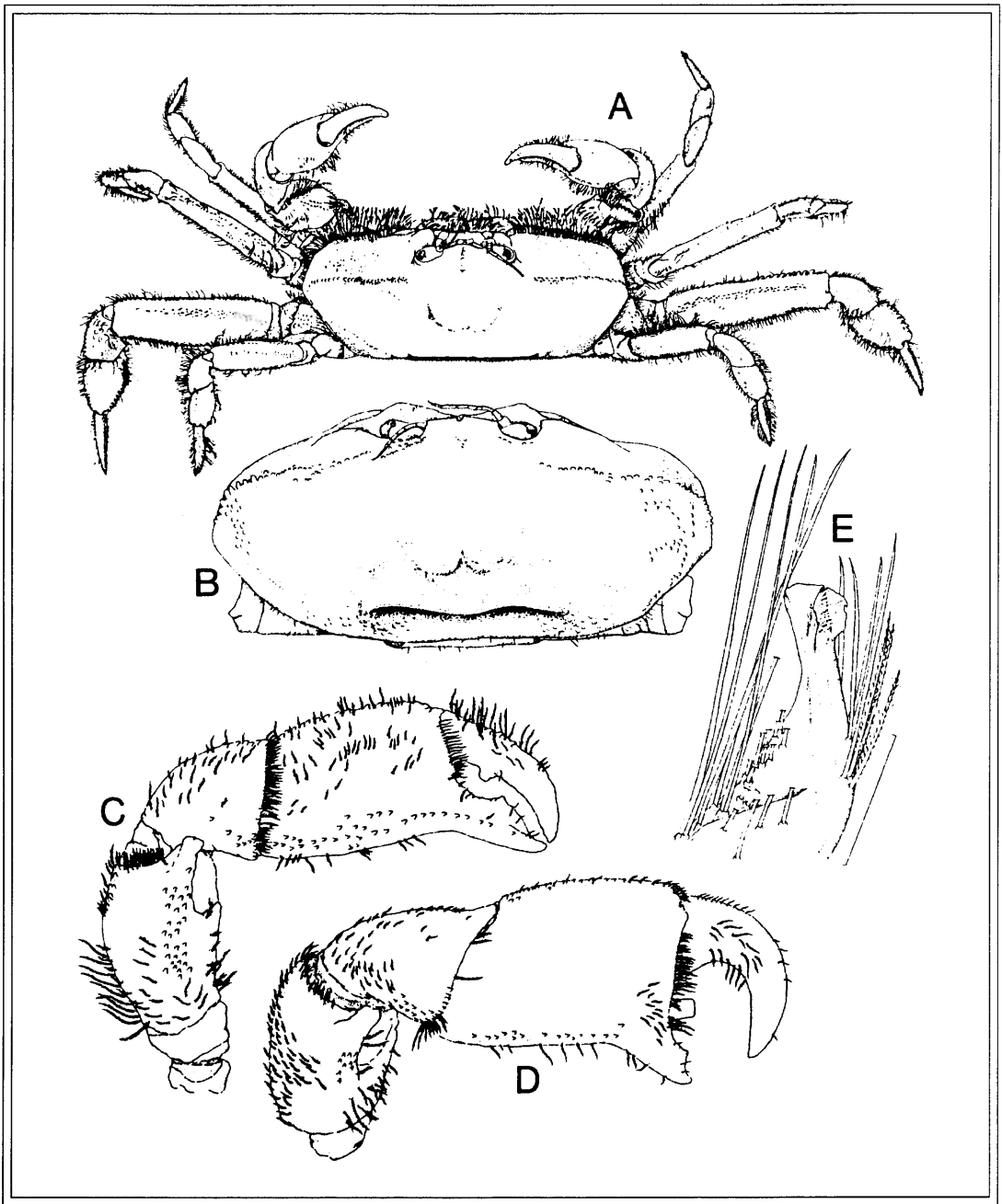
#### Figure 2.26

*Pinnixa occidentalis* Rathbun, 1893:248, Fig. 12 (in part; not the specimen from San Diego); 1904:187, Plate 7, Fig. 4; Plate 9, Figs. 6, 6a (in part; not specimens from Cape Fox); 1918:155, text Fig. 96, Plate 34, Fig. 1.—Holmes, 1900:89.—Weymouth, 1910: 56 text Fig. 3.—Schmitt, 1921:262, Fig. 156.—Roesijadi, 1978:259 (larval physiology).—Hart, 1982:242, Fig. 101 (ecology).—Kozloff, 1987:417.—Zmarzly, 1992:677, Fig. 1 (map), Fig. 12.

*Pinnixa californiensis* Rathbun, 1893:249.—Holmes, 1900:90.—Rathbun, 1904:187, Plate 7, Fig. 3.—Weymouth, 1910:56 (in part; not young female from Pacific Grove).

**Material Examined.** Two males, (USNM 071-BSS-01-TX, and SBMNH 018-BSS-01-TX) (one from 91 m, no depth info on other specimen) [identification confirmed by D. Zmarzly]; USNM Phase I primary voucher collection, 071-BSS-01-TX, 29 November 1983, one mature female, carapace length = 3.8 mm, carapace width = 7.7 mm; one juvenile, carapace length = 1.9 mm, carapace width = 3.4; SBMNH Phase I secondary voucher collection, 018-BSS-01-TX, one male, (carapace length = 2.7 mm, carapace width = 5.2 mm), two females, three juveniles.

**Description.** Large species to 19.5 mm carapace width, males, 20.5 mm carapace width, females (Rathbun 1918). Carapace 2.0-2.2 times wider than long in adults, 1.6-1.9 times wider in juveniles. Dorsal surface pitted and highly irregular. Longitudinal median groove extending from frontal margin to mesogastric region. Hepatic region delineated by grooves; cervical groove well developed, connection with deep gastric depression. Sharp transverse ridge in cardiac region; cardiac ridge formed of two crescent-shaped ridges, appearing bilobed in male, not as acute or as bilobed in female. Anterolateral margin with granulate ridge. Granules sometimes also present dorsolaterally on carapace, behind ridge. Ventral margin of anterolateral region granulate, with long plumose setae.



**Figure 2.26.** *Pinnixa occidentalis* Rathbun, 1893: A, anterodorsal view of male; B, anterodorsal view of carapace (juvenile male); C, anterior face of female cheliped; D, anterior face of male cheliped; E, abdominal face of right gonopod (A-E from Zmarzly, 1992).

Chelae robust, sexually dimorphic, distinctive among California species due to deflection and form of fixed finger. In males, fixed finger short, about one-quarter length of palm, stout, and strongly deflexed; inner margin with large flat tooth proximally and small triangular tooth, occasionally worn flat, distally. Dactylus becoming increasingly curved with age, strongly hooked in mature males; fingers gaping when closed. Dorsal margin of dactylus smooth, sparsely setose; inner margin of dactylus typically toothless; some specimens with

small triangular tooth at midpoint. Dactylar tooth usually present in small males and those regenerating chelae; persisting in some mature males. Presence of dactylar tooth in mature males apparently unrelated to size of animal or geographic occurrence. Dorsal margin of palm granulate; line of granules above ventral margin of palm on anterior face.

Female chela more slender than that of male. Fixed finger longer, about 0.4 length of palm; obviously deflexed, but less so than in male; inner margin paralleling ventral margin proximally; small triangular tooth at midpoint, followed by row of sharp transparent teeth that precede the upwardly curving distal tip. Dactylus of female not as strongly curved as in male; dorsal margin granulate, setose; inner margin with large triangular tooth, occasionally worn flat, at midpoint, row of small transparent teeth between triangular tooth and distal tip, meeting row of similar teeth on opposing margin of fixed finger when fingers closed. Anterior face of propodus with several rows of granules running entire length just above ventral margin.

In adults, ambulatory legs fringed with plumose setae. Pereiopod 2 with ventral margin of merus granulate to tuberculate; distal half of ventral margin of propodus with sharp spines; dactylus as long as propodus, with longitudinal row of 4 or 5 spines. In ventral view, ischium with single tubercle on posterior margin. On pereiopod 3, posteroventral margin of ischium with several small tubercles; dorsal and ventral margins of merus and dorsal margins of carpus and propodus granulate to tuberculate; ventral margin of propodus with sharp spines on distal half. Dactylus as long as propodus, with longitudinal carina on each side and 2 longitudinal rows of sharp spines on ventral margin. On pereiopod 4, dorsal and ventral margins of merus heavily granulate to tuberculate; ventral margin of propodus bicarinate, carina serrate. Dactylus about as long as propodus, with 2 longitudinal carinae laterally and 5 longitudinal rows of spines: 1 on dorsal margin, 2 on ventral margin, and 2 laterally. On pereiopod 5, ischium and merus with granulate margins; dactylus as long as propodus. Dorsal and ventral margins of dactylus with rows of spines; setose. Distal tip of dactylus of pereiopod 5 reaching well beyond distal edge of merus of pereiopod 4 when both legs extended.

In specimens (greater than or equal to) 8 mm carapace width, ambulatory legs very slender; dactyls also slender, cylindrical, nearly straight, as long as or longer than propodus on each leg. With maturity, density of granules on all legs increasing; size relationships of ambulatory legs changing dramatically; robustness of pereiopod 4 increasing allometrically

Male and female abdomen consisting of 7 free somites (after Zmarzly, 1992).

**Biology.** Found subtidally in burrows of the echiurid worm *Echiurus echiurus alaskanus* at northern extreme of *P. occidentalis* range, also found free living (Hart, 1982; Zmarzly, 1992). On soft mud substrates in Puget Sound (Lie, 1968).

**Taxonomic Remarks.** Although southern California specimens tend to be slightly smaller than Alaska specimens (D. Zmarzly, pers. comm.), there appears to be little morphological difference between specimens from these two areas. Hart (1982) cautioned that this may be a species complex in light of its wide geographic and bathymetric range. This was reiterated by Martin and Zmarzly (1994) when they recognized a new species in this complex (see below, *P. scamit*).

**Type Locality and Type Specimens.** South of Unimak Island, Alaska, 61 fathoms (112 m). Holotype male, USNM 17474, carapace length = 9.5 mm; carapace width = 19.5 mm.

**Distribution.** Alaska to Bahia Magdalena, west coast of Baja California, Mexico; intertidal to 238 fathoms (435 m) (Schmitt, 1921; Hart, 1982; Zmarzly, 1992).

Figure 2.27

**Material Examined.** USNM 267500, and USNM 267501, see holotype and paratype below.

**Description.** Carapace highly sculptured, with anterolateral ridge bearing pronounced and slightly anteriorly-curved teeth; frontal margin with deep median cleft; cardiac ridge present, granular, not sharp. Fixed finger on major cheliped slightly deflexed; both fingers of major cheliped with single stout tooth located almost at midlength on inner margin. All ambulatory pereopods with markedly serrate and setose dorsal and especially ventral margins. Propodus of pereopod 4 at least 2.5 times longer than wide (Martin and Zmarzly, 1994).

**Biology.** Nothing is known.

**Taxonomic Remarks.** Most California species of *Pinnixa* White, 1846, have a ridge, which may be granular to tuberculate, along the anterolateral margin of the carapace. Exceptions include *P. faba* (Dana 1851), *P. longipes* (Lockington 1876), *P. tubicola* Holmes, 1894, and *P. weymouthi* Rathbun, 1918, where an anterolateral ridge is either absent or at best very weakly developed. Other exceptions are *P. forficulimanus* Zmarzly, 1992, *P. minuscula* Zmarzly, 1992, and *P. littoralis* Holmes, 1894, where the ridge is absent (Zmarzly 1992). In the remaining California species of *Pinnixa*, this ridge is obvious in dorsal view, and sometimes is as pronounced as in *P. scamit*. Juvenile stages of two species, *P. occidentalis* Rathbun, 1893, and *P. franciscana* Rathbun, 1918, sometimes exhibit acute teeth on the anterolateral ridge; however, this feature changes dramatically between the juvenile and adult stages. In addition, *P. scamit* has relatively slender legs with acute marginal serrations as an adult, which is also characteristic only of juvenile stages in *P. occidentalis* and *P. franciscana*. Thus *P. scamit* appears to have retained several “juvenile” characters in the adult stage (from Martin and Zmarzly, 1994).

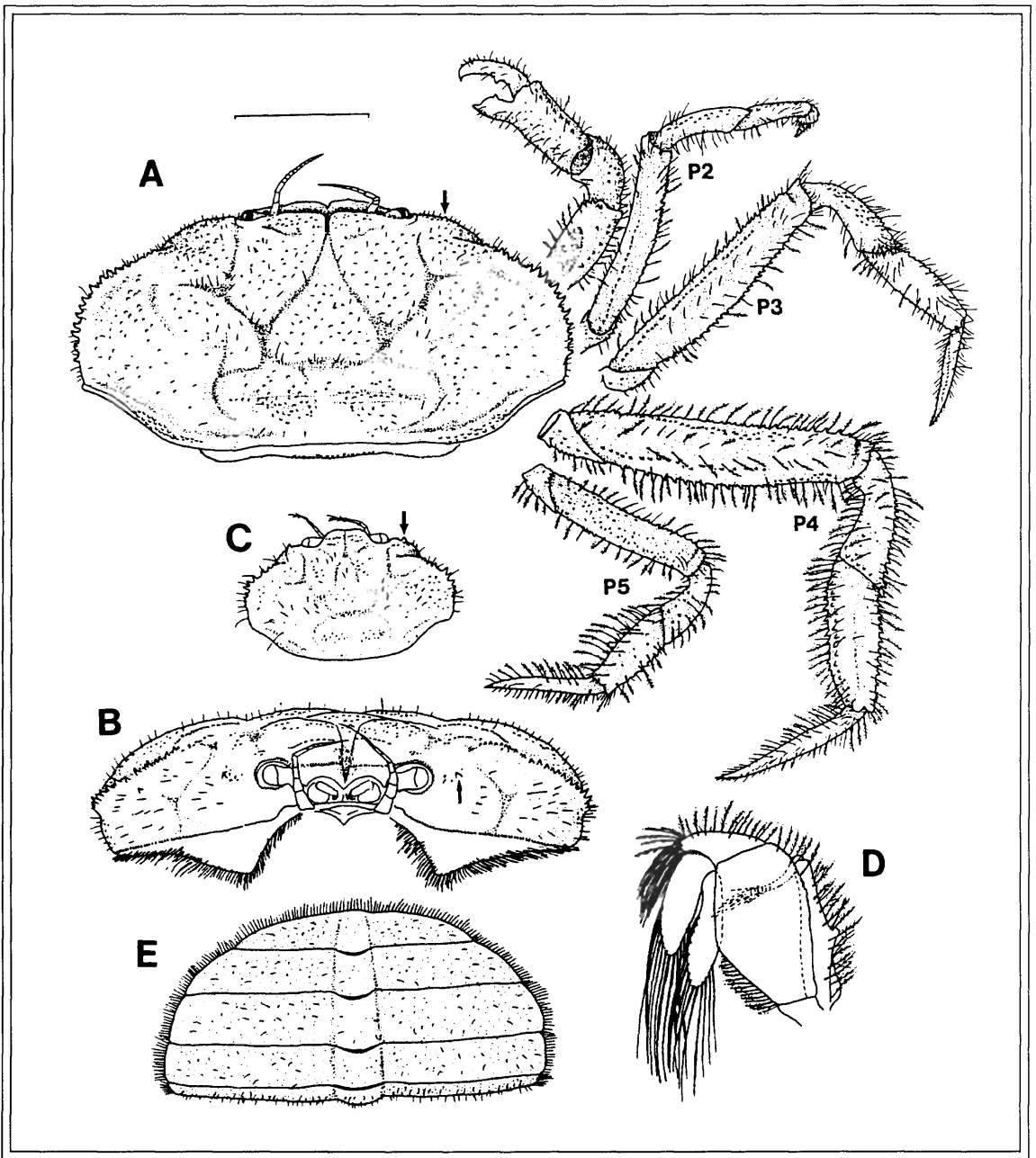
All other California species are easily distinguished from *P. scamit* by the length:width ratio of the propodus of pereopod 4. In true *P. occidentalis* Rathbun, the species to which *P. scamit* appears to be most closely allied, the propodus of P4 is distinctly broader, nearly as broad as long. In contrast, in *P. scamit* the propodus of pereopod 4 is approximately 2.6 times longer than wide.

**Type Locality and Type Specimens.** MMS station data 071-BSS-01-TX, 34°29.040'N, 120°44.013'W, western Santa Barbara Channel, just seaward of, and SSW of, Pt. Arguello, California; 311 m. Holotype female USNM 267500, carapace width 7.4 mm, carapace length 3.7 mm 29 Nov 1983. Paratype juvenile, USNM 267501 (sex indeterminate), carapace width 3.4 mm, carapace length 2.1 mm, same collecting data as holotype (Martin and Zmarzly, 1994).

**Distribution.** Presently known only from the type locality.

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**Figure 2.27.** *Pinnixa scamit* Martin and Zmarzly, 1994: USNM 267500, and USNM 267501 (C only), western Santa Barbara Channel, California. A, female holotype, dorsal view of carapace and right side appendages, pereopods 1-3 drawn in situ, pereopods 4 and 5 removed and figured separately (to ensure correct proportions): B, same specimen, frontal view showing sculpturing of carapace and subhepatic tooth (arrow): C, dorsal view of immature paratype; note that subhepatic tooth (arrow) and acute serrations along anterolateral margin are already present at this size: D, third maxilliped of holotype, left side, outer view; E, abdomen of holotype, ventral view illustrated in situ (first two segments not visible, and segment 3 shortened due to curvature of abdomen). Scale bar = 2.0 mm for A-C, E; 1.0 mm for D (from Martin and Zmarzly, 1994).

## Literature Cited

- Abele, L. G. 1976. Comparative species composition and relative abundance of decapod crustaceans in marine habitats of Panama. *Marine Biology* 38:263-278.
- Abele, L. G., and W. Kim. 1988. The snapping shrimp genus *Alpheus* from the Eastern Pacific (Decapoda: Caridea: Alpheidae). *Smithsonian Contributions to Zoology* No. 454:1-119.
- Alcock, A. W. 1895. Materials for a carcinological fauna of India. No. 1., The Brachyura Oxyrhyncha. *Journal of the Asiatic Society of Bengal* 69:157-291, Plates 3-5.
- Allen, R. K. 1980. *Common Intertidal Invertebrates of Southern California*. Peek Publications, Palo Alto, California, 1-316.
- Andrade, H. V., and P. R. Baez. 1977. *Calastacus rostriserratus* n. sp. (Crustacea, Decapoda, Macrura, Axiidae). *Anales del Museo de Historia Natural de Valparaiso* 10:65-67.
- Balss, H. 1925. *Macrura* der Deutschen Tiefsee-Exped. 20:189-216, 16 text-figs, Plates 18-19.
- Bate, C. 1888. Report on the Crustacea Macrura collected by *H. M. S. Challenger* during the years 1873-1876. *In: Report on the Scientific Results of the Voyage of the H.M.S. Challenger During the Years 1873-1876*, 24: 942 pages, 76 figs., 157 Plates.
- Benedict, J. E. 1894. *Proceedings of the U. S. National Museum* 17:484.
- Benedict, J. E. 1902. Description of a new genus and forty-six new species of crustaceans of the family Galatheidae with a list of the known marine species. *Proceedings of the U. S. National Museum* 26:243-334, text-figs 1-47.
- Borradaile, L. A. 1903. On the classification of the Thalassinidea. *Ann. Mag. Nat. Hist., series 7(53):534-551*.
- Borradaile, L. A. 1907. On the classification of the decapod crustaceans. *Annals and Magazine of Natural History, Series 7, 19(144):457-486*.
- Bouvier, E. L. 1896. Sur la classification des Lithodines et sur leur distribution dans les oceans. *Annales Scientifique Natureles, Zoologica* (8)1:1-46.
- Boyd, C. M. 1967. The benthic and pelagic habits of the red crab, *Pleuroncodes planipes*. *Pacific Science* 21:394-403.
- Brusca, R. C. 1980. *Common Intertidal Invertebrates of the Gulf of California*. University of Arizona Press, Tucson, Arizona, 1-513.
- Brusca, R. C., and B. R. Wallerstein. 1979. 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.
- Burkenroad, M. D. 1934. Littoral Penaeidea chiefly from the Bingham Oceanographic Collection, with a revision of *Penaeopsis* and descriptions of two new genera and eleven new American species. *Bulletin of the Bingham Oceanographic Collection, Yale University* 4(7):1-109.
- Burkenroad, M. D. 1938. The Templeton Crocker Expedition, Part 13: Penaeidae from the region of Lower California and Clarion Island, with descriptions of four new species. *Zoologica (New York)* 23:55-91.

- Butler, T. H. 1980. Shrimps of the Pacific coast of Canada. *Canadian Bulletin of Fisheries and Aquatic Sciences* 202:1-280.
- Butler, T. H. 1950. Two records of shrimps from English Bay, B. C. *Can. Field Nat.* 64:188.
- Carlisle, J. G. Jr. 1969. Invertebrates taken in a six year trawl study in Santa Monica Bay. *Veliger* 11:237-242.
- Chace, F. A. 1937. The Templeton Crocker Expedition. VII. Caridean decapod Crustacea from the Gulf of California and the west coast of Lower California. *Zoologica (New York)* 22:109-138.
- Charwat, D. K. 1976. Key to Xanthidae. In Word, J. Q., and D. K. Charwat. Invertebrates of Southern California Coastal Waters I. Select Groups of Annelids, Arthropods, Echinoderms, and Mollusks. Southern California Coastal Water Research Project, El Segundo, California. 1-164.
- Church, R. 1971. *Deepstar* explores the ocean floor. *National Geographic* 139:67-105
- Coutiere, H. 1899. Les Alpheidae, morphologie externe et interne, formes larvaires, bionomie. *Annales de Scientifique Naturelle, Zoologie, Series 8, Vol. 9*, pp 1-559.
- Crane, J. 1937. The Templeton Crocker Expedition. III. Brachygnathous crabs from the Gulf of California and the west coast of Lower California. *Zoologica (New York)* 23:69-95, text-figs. 1-3
- Dana, J. D. 1851. *Conspectus crustaceorum quae in orbis terrarum circumnavigatione, Carolo Wilkes e classe Reipublicae Foederatae duce, lexit et descripsit.* *Proceedings of the Academy of Natural Sciences, Philadelphia* 5:247-254.
- Dana, J.D. 1854. Description of a new Species of *Cryptopodia* from California. *American Journal of Science, Series 2*, 18:430, woodcut.
- Dawson, E. W. 1989. King crabs of the world: A comprehensive bibliography. New Zealand Oceanographic Institute, Miscellaneous Publication 101:1-338.
- Derjugin, K. M., and S. Kobjakowa. 1935. Dekapoden Fauna des Japanischen Meeres. *Zool. Anz.* 112(5/6):141-147.
- Frey, H. 1971. California's living marine resources and their utilization. California Fish and Game, Resources Agency.
- Garth, J. S. 1958, Brachyura of the Pacific coast of America: Oxyrhyncha. *Allan Hancock Pacific Expeditions*, 21(Parts 1 and 2):1-854.
- Glaesner, M. F. 1969. Decapoda. In Raymond C. Moore, ed., *Treatise on Invertebrate Paleontology*, Part R (Arthropoda), 4:399-533, Figures 217-340. Lawrence, Kansas: University of Kansas Press for Geological Society of America.
- Goodwin, D. G. 1952. Crustacea collected during the 1950 bottom-fish investigations of the M. V. N. B. Scofield. *California Fish and Game* 38:163-181, text figs 1-11.
- Gotshall, D.W. 1994. Guide to Marine Invertebrates: Alaska to Baja California. Sea Challengers, Monterey California.
- Guinot, D., and B. Richer de Forges. 1981. Homolidae, rares ou nouveaux, de l'Indo-Pacifique (Crustacea, Decapoda, Brachyura). *Bulletin du Museum National d'Histoire Naturelle, Paris*, 4e ser., 3, section A, no. 2:523-581.



- Guinot, D., and B. Richer de Forges. 1995. Crustacea Decapoda Brachyura: Revision de la famille des Homolidae de Haan, 1839. Resultats des Campagnes Musorstum vol 13: 283-517.
- Hart, J. F. L. 1982. Crabs and their relatives of British Columbia. British Columbia Provincial Museum, Handbook 40:1-267.
- Henderson, J. R. 1888. Report on the Anomura collected by H. M. S. Challenger during the years 1873-73. Report on the scientific results of the H. M. S. Challenger during the years 1873-76. Zoology 27:i-x, 1-221, 21 Plates.
- Hilton, W. A. 1916. Crustacea from Laguna Beach. Journal of Entomology and Zoology, 8:65-73, text-figs. 1-19.
- Hobson, E. S., and J. R. Chess. 1976. Trophic interactions among fishes and zooplankters near shore at Santa Catalina Island, California. U. S. National Marine Fisheries Service Fishery Bulletin 74(3):567-598.
- Holmes, S. J. 1894. Notes on West American Crustacea. Proceedings of the California Academy of Sciences, Series 2, 4:563-588.
- Holmes, S. J. 1900. Synopsis of the California stalk-eyed Crustacea. Occasional Papers of the California Academy of Science 7:1-262, Plates 1-4.
- Holthuis, L. B. 1947. the Decapoda of the Siboga Expedition, Part 9: The Hippolytidae and Rhynchocinetidae collections by the Siboga and Snellus Expeditions with remarks on other species. Siboga Expeditie, Vol. 23, Part 9.
- Holthuis, L. B. 1951. A General revision of the Palaemonidae (Crustacea Decapoda Natantia) of the Americas, part 1: The subfamilies Euryrhynchinae and Pontoniinae. Allan Hancock Foundation Occasional Paper No. 11, 1-332, Plates 1-63.
- Holthuis, L. B. 1955. The recent genera of caridean and stenopodidian shrimps (Class Crustacea, Order Decapoda, Supersection Natantia) with keys for their determination, Zoologische Verhandelingen 34:173-181.
- Huxley, T. H. 1879. On the Classification and the Distribution of the Crayfishes. Proceedings of the Zoological Society of London 1878:752-788.
- Jensen, G. C. 1987a. Family Hippolytidae. In Kozloff, E. N., Marine Invertebrates of the Pacific Northwest. University of Washington Press, Seattle, Washington. pp.397-400. Figs. 19.6-19.11.
- Jensen, G. C. 1987b. Family Crangonidae. In Kozloff, E. N., Marine Invertebrates of the Pacific Northwest. University of Washington Press, Seattle, Washington. pp.400-402. Figs. 19.12-19.18.
- Jensen, G. C. 1995. Pacific Coast Crabs and Shrimps. Sea Challengers, Monterey, California. pp.1-87.
- Johnson, M. E., and H. J. Snook. 1927 (reprinted in 1937). Seashore animals of the Pacific Coast. The Macmillan Co., New York, Pp.(xiv) 659, Plates 1-11, frontis., text-figs.1-700 New York.
- Kensley, B. 1989. New genera in the thalassinidean families Calocarididae and Axiidae (Crustacea: Decapoda). Proceedings of the Biological Society of Washington 102:960-967.
- Kim, W., and L. G. Abele. 1988. The snapping shrimp genus *Alpheus* from the eastern Pacific (Decapoda: Caridea: Alpheidae). Smithsonian Contributions to Zoology, No. 454:119 pp.
- Kingsley, J. S. 1878a. A synopsis of the North American species of the Genus *Alpheus*. Bulletin of the United States Geological Survey 4(1):189-199.

- Kingsley, J. S. 1878b. List of North American Crustacea belonging to the Suborder Caridea. Essex Institute, Salem Massachusetts, Bulletin, 10:50-71.
- Kingsley, J. S. 1883. Carcinological Notes: Number V. Essex Institute, Salem Massachusetts, Bulletin 14:105-132, Plates 1-2.
- Kingsley, J. S. 1899. The Caridea of North America: A synopsis of North American invertebrates, III. The American Naturalist 33:709-720, Figs. 1-57.
- Kozloff, E. N. 1987. Marine Invertebrates of the Pacific Northwest. University of Washington Press, Seattle, Washington. pp. 1-510.
- Kuck, H. G., and J. W. Martin. 1994. Redescription of the male, and new distribution records for the homolid crab *Paramola faxoni* (Schmitt) in the eastern Pacific Ocean. Journal of Crustacean Biology 14:177-187.
- Kuris, A. M., and J. T. Carlton. 1977. Descriptions of a new species, *Crangon handi*, and new genus, *Lissocrangon*, of crangonid shrimps (Crustacea: Caridea:) from the California coast, with notes on adaptation in body shape and coloration. Biological Bulletin 153:540-559.
- Lie, U. 1968. A quantitative study of the benthic infauna in Puget Sound, Washington, U. S. A., in 1963-1964. Fiskeridirektoratets Skrifter, Serie Havunderokelser, 14:229-556.
- Lincoln, R. J., and J. G. Sheals. 1979. Invertebrate Animals, collection and preservation. British Museum of Natural History and Cambridge University Press, 150 pp.
- Lockington, W. N. 1876. Description of a new genus and species of decapod crustacean. Proceedings of the California Academy of Sciences 1877, series 1, 7:55-57.
- Lockington, W. N. 1877a. 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. 1877b. Remarks on the Crustacea of the Pacific coast, including a catalogue of the species in the museum of the California Academy of Sciences, San Francisco. Proceedings of the California Academy of Sciences 7:63-78.
- Lockington, W. N. 1878. Remarks on some new Alpehi, with a synopsis of the North American Species. The Annals and Magazine of Natural History, Series 5, 1:229, 465-480.
- Lockington, W. N. 1879. Notes on Pacific Coast Crustacea. Bulletin of the Essex Institute 10:159-165.
- Luke, S. R. 1977. Catalog of the benthic invertebrate collections. I-Decapod Crustacea and Stomatopoda. Scripps Institution of Oceanography Reference Series, Reference No. 77-9:1-72.
- MacPherson, E. 1988. Revision of the family Lithodidae Samouelle, 1819 (Crustacea, Decapoda, Anomura) in the Atlantic Ocean. Monographias de Zoologia Marina 2:1-153.
- Man, J. G. de. 1920. Decapoda of the Siboga Expedition, Part 4: Families Pasiphaeidae, Stylodactylidae, Hoplophoiidae, Nematocarcinidae, Thalallocaridae, Pandalidae, Psalidopodidae, Gnathophyllidae, Processidae, Glyphocrangonidae, and Crangonidae. Siboga Expeditie, Vol. 20, part 4.
- Man, J. G. de. 1925. Decapoda of the Siboga Expedition, Part 6: The Axiidae collected by the Siboga Expedition. Siboga Expeditie, Vol. 20, part 6.
- Martin, J. W., and L. G. Abele. 1986. External morphology of the genus *Aegla* (Crustacea, Anomura, Aeglidae). Smithsonian Contributions to Zoology 453: 1-46.

- Martin, J. W. and D. L. Zmarzly. 1994. *Pinnixa scamit*, a new species of pinnotherid crab (Decapoda: Brachyura) from the continental slope off California. *Proceedings of the Biological Society of Washington* 107:354-359.
- McLaughlin, P. A. 1980. *Comparative Morphology of Recent Crustacea*. W.H. Freeman and Co., San Francisco. viii + 177 pp.
- McLaughlin, P. A., and J. Haig. 1973. On the status of *Pagurus mertensii* Brandt, with descriptions of a new genus and two new species from California (Crustacea: Decapoda: Paguridae). *Bulletin of the Southern California Academy of Sciences* 72:113-136.
- Menzies, R. J. 1948. A revision of the brachyuran genus *Lophopanopeus*. Allan Hancock Foundation Occasional Papers 4:1-45, Plates 1-6
- Menzies, R. J., and M. A. Miller. 1954. Isopoda. *In* R. I. Smith, *et al.*, Intertidal invertebrates of the central California coast. S. F. Light's laboratory and field text in invertebrate zoology. University of California Press, xiv + 446 pp.
- Milne Edwards, A. 1878. Etudes sur les Xiphosures et les Crustaces de la Region Mexicaine. *In* Mission Scientifique au Mexique en dans l' Amerique centrale, Part 5, No.4:121-184, Plates 21-27, 29-30.
- Nininger, H. H. 1918. Crabs taken at Laguna Beach in the summer of 1916. *Journal of Entomology and Zoology* 10:36-42, text-figs 1-31.
- Ortman, A. E. 1895. A study of the systematic and geographic distribution of the decapod family Crangonidae Bate. *Proceedings of the Academy of Natural Sciences of Philadelphia* 47:173-197.
- Owen, R. 1839. The zoology of Captain Beechey's voyage;...during a voyage to the Pacific and Behring's Straits... H. G. Bohn, pp. 77-92.
- Perez Farfante, I. 1988. Illustrated Key to Penaeoid Shrimps of Commerce in the Americas. NOAA Technical Report NMFS 64:1-32.
- Perez Farfante, I., and Boothe, B. B. Jr. 1981. *Sicyonia martini*, a new rock shrimp (Decapoda: Penaeoidea) from the American Pacific. *Journal of Crustacean Biology* 1:424-432.
- Rathbun, M. J. 1893. Scientific results of explorations by the U. S. Fish Commission steamer *Albatross*. XXIV. Descriptions of new genera and species of crabs from the west coast of North America and the Sandwich Islands. *Proceedings of the U. S. National Museum* 16:223-260.
- Rathbun, M. J. 1899. List of the crustaceans known to occur on or near the Pribilof Islands. The fur seals and fur seal islands of the North Pacific Ocean, Part 3. Washington.
- Rathbun, M. J. 1900. Synopses of North-American Invertebrates. VII. The cyclometopous or cancrioid crabs of North America. *The American Naturalist* 34:131-143.
- Rathbun, M. J. 1902. Descriptions of new decapod crustaceans from the west coast of North America. *Proceedings of the U. S. National Museum* 24:885-905.
- Rathbun, M. J. 1904. Decapod crustaceans of the northwest coast of North America. Harriman Alaska Expedition, 10, 1-210, Plates 1-10, text figures 1-95.
- Rathbun, M. J. 1918. The grapsoid crabs of North America. *Bulletin of the U. S. National Museum* 97:1-444, Plates 1-159, figs. 1-172.
- Rathbun, M. J. 1925. The spider crabs of America. *U. S. National Museum Bulletin No.* 129:1-613.

- Rathbun, M. J. 1930. The Cancroid crabs of America of the families Euryalidae, Portunidae, Atelecyclidae, Cancridae and Xanthidae. U. S. National Museum Bulletin No. 152:1-609.
- Rathbun, M. J. 1937. The oxystomous and allied crabs of America. U. S. National Museum Bulletin No. 166:1-278.
- Ricketts, E. F., J. Calvin, J.W. Hedgepeth, and D. W. Phillips. 1985. *Between Pacific Tides*. Stanford University Press, Stanford, California. 652 pp.
- Roesijadi, G. 1978. Water turnover rates in the megalopa and crab stages I-V of *Pinnixa occidentalis*. *Comparative Biochemistry and Physiology A* 59:259-260.
- Sakai, K., and M. de Saint Laurent. 1989. A check list of Axiidae (Decapoda, Crustacea, Thalassinidea, Anomura), with remarks and in addition descriptions of one new subfamily, eleven new genera and two new species. *Naturalists* 3:1-104, Publication of the Tokushima Biological Laboratory, Shikoku Woman's University, Tokushima, Japan.
- Saint Laurent, M. de 1970. Revision des genres *Catapaguroides* et *Cestopaguroides* et description de quatre genres nouveaux. III *Acanthopagurus* de Saint Laurent (Crustaces Decapodes Paguridae). *Bull. Mus. Nat'l. Hist. Nat. Paris* (2)41(6):1448-1458.
- Schmitt, W. L. 1921. The marine decapod Crustacea of California. *University of California Publications in Zoology* 23:1-470.
- Serene, R., and P. Lohavanijaya. 1973. The Brachyura (Crustacea: Decapoda) collected by the Naga Expedition, including a review of the Homolidae. *Naga Report. Scientific results of marine investigations of the South China Sea and the Gulf of Thailand 1959-1961* 4(4):1-187.
- Sharp, B. 1893. Catalogue of the crustaceans in the Museum of the Academy of Natural Sciences of Philadelphia. *Proceedings of the Academy of Natural Sciences of Philadelphia* 1893:104-127.
- Stimpson, W. 1860. Notes on North American Crustacea, in the Museum of the Smithsonian Institution. No. III. *Annals of the Lyceum of Natural History of New York*, 10:92-136.
- Stimpson, W. 1857. On the Crustacea and Echinodermata of the Pacific shores of North America. Part I. Crustacea. *Journal of the Boston Society of Natural History* 6:444-532, Plates 18-23.
- Vinogradov, L. G. 1950. The classification of shrimps, crabs and other decapods from the Far East. *Izv. Tikhookean. Nauchno Issled. Inst. Rybn. Khoz. Okeanogr.* 33:179-358. (In Russian)
- Wicksten, M. K. 1977. Range extensions of four species of crangonid shrimps from California and Baja California, with a key to the genera (Natantia: Crangonidae). *Proceedings of the Biological Society of Washington* 90:963-967.
- Wicksten, M. K. 1980. Range extensions of four species of crangonid shrimps in the eastern Pacific Ocean. *Bulletin of the Southern California Academy of Sciences* 79:38-41.
- Wicksten, M. K. 1983a. A monograph on the shallow water caridean shrimps of the Gulf of California. *Allan Hancock Monographs in Marine Biology* 13:1-59.
- Wicksten, M. K. 1983b. Camouflage in marine invertebrates. *Oceanography and Marine Biology Annual Review* 21:177-193.
- Wicksten, M. K. 1985. Carrying behavior in the Homolidae (Decapoda, Brachyura). *Journal of Crustacean Biology* 5:476-479.

- Wicksten, M. K. 1986. Carrying behavior in Brachyuran crabs. *Journal of Crustacean Biology* 6:364-369.
- Wicksten, M. K. 1989. Ranges of offshore decapod crustaceans in the eastern Pacific Ocean. *Transactions of the San Diego Society of Natural History* 21:291-316.
- Wicksten, M. K. 1990. Key to the hippolytid shrimp of the eastern Pacific Ocean. *Fishery Bulletin* 88:587-598.
- Wicksten, M. K., and T. H. Butler. 1983. Description of *Eualus lineatus* new species, with a redescription of *Heptacarpus herdmani* (Walker) (Caridea: Hippolytidae). *Proceedings of the Biological Society of Washington* 96:1-6.
- Wicksten M. K., and M. E. Hendrickx. 1992. Checklist of penaeoid and caridean shrimps (Decapoda: Penaeoidea, Caridea) from the eastern tropical Pacific. *Proceedings of the San Diego Society of Natural History* 9:1-11.
- Williams, A. B. 1984. *Shrimps, Lobsters and Crabs of the Atlantic Coast of The Eastern United States, Maine to Florida*. Smithsonian Institution Press. Washington D. C.. 550 pp.
- Williams, A. B. 1988. *Lobsters of the World - An Illustrated Guide*. Osprey Books, Huntington, New York, 1-186.
- Williamson, H. C. 1915. Crustacea Decapoden Larven. *In: Nordisches Plankton Zoologisches Teil*, vol 3: Crustacea, pp. 315-588. Leipzig, Germany: Von Lipsius and Tischer (1927 ed.).
- Weymouth, F. W. 1910. Synopsis of the true crabs (Brachyura) of Monterey Bay, California. *Leyland Stanford Junior University Publications University Series No. 4:1-65, Plates 1-14, text figs.1-9*.
- Word, J. Q., and D. K. Charwat. 1976. Invertebrates of Southern California Coastal Waters II. Natantia. *Southern California Coastal Water Research Project, El Segundo, California*. 1-238.
- Zarenkov, N. A. 1965. Revision of the Genera *Crangon* Fabricius and *Sclerocrangon* G.O. Sars (Decapoda, Crustacea). *Zool. Zh.* 44:1761-775, (Transl. from Russian by Fish. Res. Board Can. Transl. Serv. 1465, 1970).
- Zmarzly, D. L. 1992. Taxonomic review of pea crabs in the genus *Pinnixa* (Decapoda: Brachyura: Pinnotheridae) occurring on the California shelf, with descriptions of two new species. *Journal of Crustacean Biology* 12:677-713.