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Decapod Crustacea of the Californian and Oregonian Zoogeographic Provinces

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Abstract

Approximately 325 species of decapod crustaceans are reported from the Californian and Oregonian zoogeographic provinces, a figure that includes all freshwater, estuarine, and marine (intertidal zone to 4000 m) decapods from the area. At least six of these species have not been reported from California since 1921, three species cannot be recognized from their descriptions and lack type material and illustrations and another five species may have been reported from mistaken localities or are the result of misidentification.

The area is mostly inhabited by cold-temperate species. Genera endemic to the northeastern Pacific include the anomurans *Janetogalatea* (Galatheidae), *Acantholithodes*, *Phyllolithodes*, and *Rhinolithodes* (Lithodidae); and the brachyurans *Mimulus* (Epiplatidae), *Loxorhynchus*, and *Scyra* (Pisidae). Families that are particularly diverse in species include carideans of the families Thoridae, Pandalidae, and Crangonidae; anomurans of the families Hapalogasteridae, Lithodidae, and Paguridae and brachyurans of the families Epiplatidae, Cancridae, and Pinnotheridae. Crayfishes of the genus *Pacifastacus* (Astacidae) were endemic to the area prior to human introductions elsewhere. At least three estuarine and two freshwater decapods belonging to the families Palaemonidae, Cambaridae, Panopeidae and Varunidae have been introduced into the area and maintain reproducing populations.

Keys are provided to all the families, genera, and species treated. A major synonymy, short description, and information on habitat, biogeography, type locality, and color in life are provided for each species. References are provided to the original descriptions of all taxa mentioned. Additional remarks on taxonomy, symbiotic associations, characteristic behavior, and other information that may help in identification also are given.

New generic designations for *Hippolyte affinis* Owen, 1839 and *H. layi* Owen, 1839 (Thoridae) are supported. Expanded diagnoses are given for *Heptacarpus franciscanus* (Schmitt, 1921) (Thoridae), *Isocheles pilosus* (Holmes, 1900), and *Paguristes parvus* Holmes, 1900 (Diogenidae).

Key words: Decapoda, Dendrobranchiata, Penaeoidea, Sergestoidea, Pleocyemata, Stenopodidea, Caridea, Astacidea, Palinura, Polychelida, Axiidea, Gebiidea, Anomura, Brachyura, Californian zoogeographic province, Oregonian zoogeographic province.

Introduction

Approximately 325 species of decapod crustaceans live along the west coast of North America between Puget Sound, Washington, U.S.A. and Magdalena Bay, Baja California, Mexico, the Californian and Oregonian zoogeographic provinces. Garth & Wicksten (1993) gave an account of the history of crustacean studies in the area. Studies of northeastern Pacific decapods started in the early 1800's. The last complete guide to the decapods of California was *Marine Decapod Crustacea of California*, by W.L. Schmitt (1921). Schmitt's pioneering book, largely based on collections by the U.S. Fisheries steamer *Albatross*, is now badly out of date. Shallow-water decapods are also mentioned in more recent guidebooks to intertidal animals, such as those by Morris *et al.* (1980), Ricketts *et al.* (1985), and Carlton (2007). Jensen (1995) published good color photographs of shallow-water species, along with brief information on range and identifying features. These more recent works nevertheless provide limited information on the species. There are few recent works on the species of deeper benthic habitats (outside of the range of scuba diving, or 40 m). Wicksten (2002) listed pelagic species. Revisions of the nomenclature, new systematic interpretations of families and higher taxa, descriptions of new species, range extensions, and natural history information published since 1921 are scattered in the literature of at least seven nations and written in four languages. Many valuable works on decapods are old and unavailable except through major libraries. Even with the use of the Internet, information may be difficult to find because many works have not been scanned.

Starting in 1991, J. Haig and J. Garth of the University of Southern California and I initiated plans to write an updated synthesis on the decapods of California. Changes in editors, loss of funding, constant changes in computer format and other problems delayed publication. Other potential co-authors declined to undertake the task of writing the sections of the manuscript after the deaths of Garth and Haig. I eventually enlarged and updated the original manuscript to include areas to the north and south of California. The Scripps Institution of Oceanography Library produced the manuscript as a website (<http://repositories.cdlib.org/sio/lib/26>) in 2008. The present work updates, corrects, and expands on the material in the website in a format suitable for publication.

Methods and Coverage

Presented here is information on all decapods that have been reported from Puget Sound, Washington to Magdalena Bay, Baja California. Included are species of freshwater habitats and marine and estuarine intertidal zones from the upper intertidal zone to the upper abyssal plain and lower mesopelagic zone.

Pelagic species that might be collected within the territorial waters of the United States and northwestern Mexico are also included. Resident species in the area are discussed in detail. Also included are species which generally occur from southern Baja California southward but have been reported from California during an El Niño period, as well as species mentioned by Schmitt (1921) but that have not been found in California since then. Species that are known from only a single record, misidentifications, non-reproducing populations and questionable or unverified records are included in the accounts of each family.

The geographic area covered encompasses the Oregonian zoogeographic province, from Puget Sound to Point Conception, California; and the Californian zoogeographic province, from Point Conception to roughly Magdalena Bay (Brusca & Wallerstein 1979). Kozloff (1974), Butler (1980), and Hart (1982) should be consulted for species of decapods found in Puget Sound and farther to the north. Hendrickx (1996, 1997, 1999) and Hendrickx & Estrada-Navarrete (1996) gave general accounts of the decapods of northwestern Mexico and the tropical eastern Pacific. Hendrickx (1995b, 1995c), Hendrickx & Harvey (1999) and Wicksten & Hendrickx (2003) produced checklists of various decapod groups of western Mexico and the Tropical Eastern Pacific.

The format of the text follows that of Williams (1984). Genera within a family are presented in alphabetical order for the sake of convenience. Keys are provided for all families and for species if more than one species is included in a family. Keys are based on those given by Schmitt (1921), Butler (1980), Holthuis (1993), Pérez Farfante & Kensley (1997) and others as mentioned in the text. J. Haig wrote the previously unpublished keys to the hermit crabs and chirostylids. Parts of the keys to midwater carideans are based on an unpublished key by J. Yaldwyn (University of Wellington, New Zealand). The keys are based on features that can be used to distinguish between the families and species in the area of coverage, so that they are not applicable to species in other parts of the world.

Recent attempts to classify and list all the decapods of North America and elsewhere include Bowman & Abele (1982), Hendrickx (1999), Martin & Davis (2001), McLaughlin *et al.* (2005), and De Grave *et al.* (2009). The order of presentation of the families here generally follows Martin & Davies (2001) with the inclusion of some more recent changes in nomenclature. Pérez Farfante & Kensley (1997) provided the most recent revision of penaeoid and sergestoid shrimps of the world. Holthuis (1993) gave an illustrated worldwide key to the genera of caridean and stenopodidean shrimps, but Christoffersen (1988a) is followed for the families formerly included in the Hippolytidae. The former infraorder Thalassinidea has been broken into separate infraorders following De Grave *et al.* (2009). The classification of Anomura follows De Grave *et al.* (2009) with the incorporation of changes in the galatheoid families (Ahyong *et al.* 2010). The designation of brachyuran families follows Ng *et al.* (2008) except as noted. Other changes are mentioned in the sections on the appropriate families. Common and scientific names for many North American decapod species have been compiled in McLaughlin *et al.* (2005). Common names are not consistently included here because many species have not been given such names, taxonomic changes have caused confusion between species, or a common name is frequently used for entire family or superfamily instead of a species. Dates for descriptions of William Stimpson follow Manning (1993).

Major synonymies are provided for each species. These include the citation of the original description, major systematic works, widely used checklists, textbooks and guidebooks, and shorter papers containing information on range, natural history or first records of occurrence in the area. References are given to more extensive synonymies. References based only on lists are not included, nor are yet to be described species.

The identity of some of the species reported from California remains questionable. Some of the species are known from a few specimens in poor condition. There are no illustrations for *Micropanope latimanus* (Lockington, 1877) (Xanthidae). Practically all species whose holotypes were preserved either in the Chicago Academy of Sciences or California Academy of Sciences prior to 1906 were destroyed by fire. A few duplicate specimens of species described by William Stimpson exist in the Natural History Museum in London and the Zoological Museum in Copenhagen (Manning 1993). Records and descriptions of certain species have been copied *verbatim* through the years. Possible synonyms for these species or correct generic assignments are proposed.

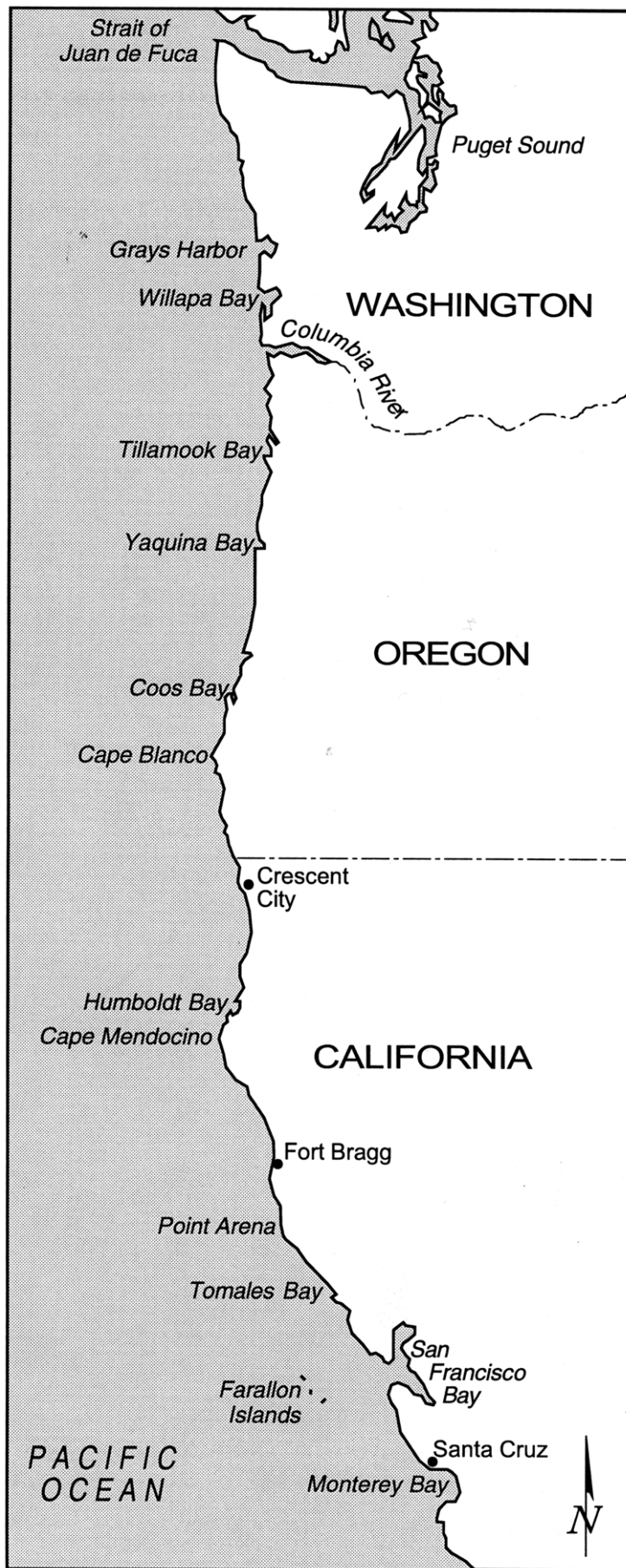


FIGURE 1. Northern area of coverage.

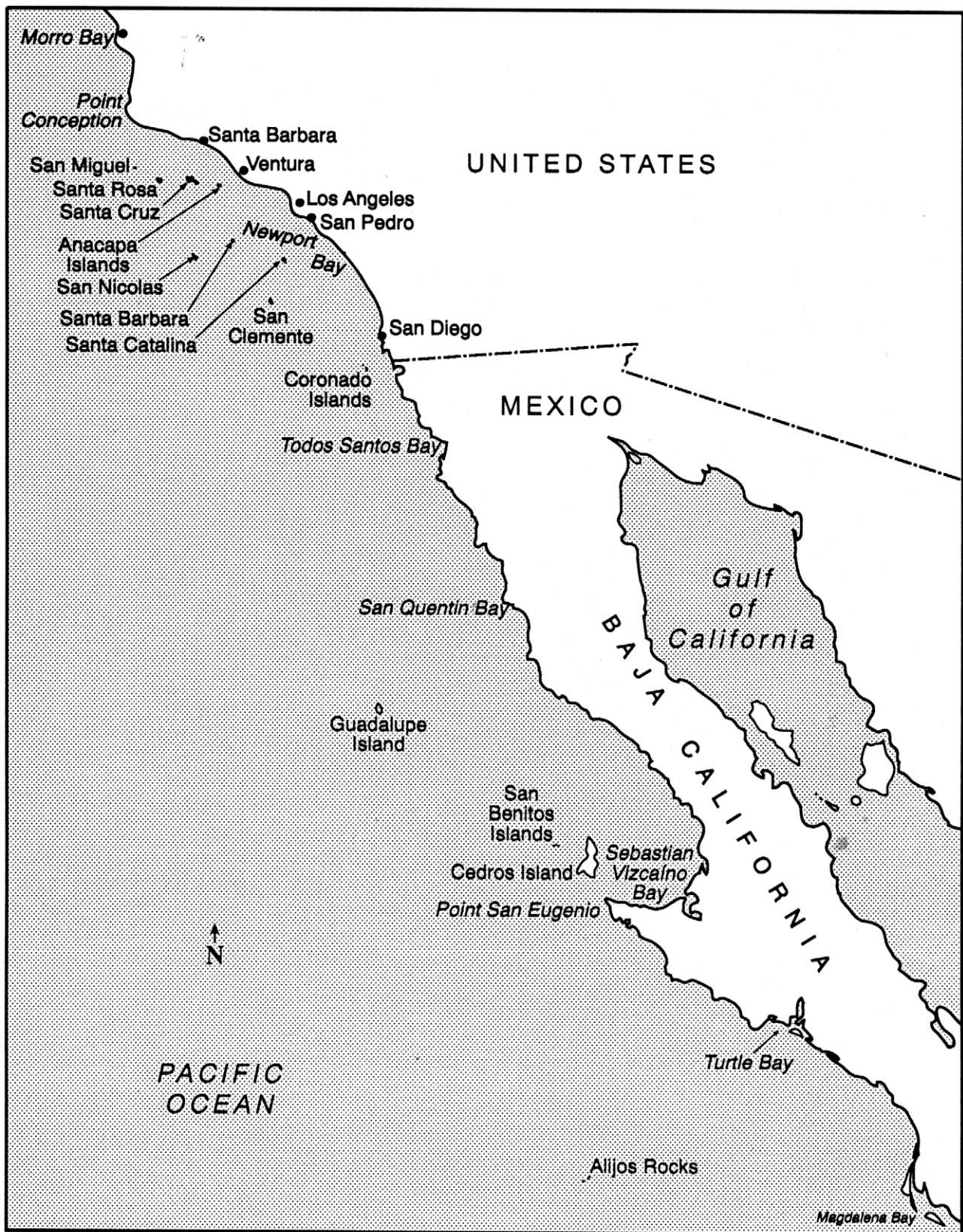


FIGURE 2. Southern area of coverage.

Diagnoses are based on published works as mentioned in the synonymies as well as examination of specimens in the collections of the California Academy of Sciences (CAS), Los Angeles County Museum of Natural History (LACM, repository of the collections of the Allan Hancock Foundation of the University of Southern California), Scripps Institution of Oceanography (SIO), and United States Museum of Natural History, Smithsonian Institution

(USNM). Most of the species were examined in life or as freshly caught individuals. The descriptions present diagnostic characters, which are useful for identification under the light microscope or by eye.

Size ranges listed are as given in the literature, where their basis (if either average, maximum, or based on a single specimen) was usually not given. For shrimps and lobster-like decapods, some authors provided carapace lengths whereas others gave total lengths. Carapace lengths are generally preferred because the abdomen of preserved specimens is typically curved.

The diagnoses vary in their length and degree of complexity. The original description is given for species that were described only briefly and have not been re-examined. Specimens were examined and checked against the written description whenever possible. Diagnoses are summarized when the original description was lengthy. A more detailed diagnosis is given for three species for which existing descriptions are so brief as to be inadequate. For species that are almost identical except for one or more pertinent features, a lengthy diagnosis is given for a well-studied species and a short diagnosis given for others.

Most taxonomic work on North Pacific decapods remains based on morphology. The systematics of many common and species-rich groups is poorly known and is largely based on studies done as much as a century ago. Many older specimens of northeastern Pacific decapods were obtained by destructive sampling by trawls or dredges, now prohibited or strictly regulated in many areas. With few exceptions, there has been little new sampling effort in subtidal habitats. Cryptic decapods living on rocky substrates at depths of over 40 m, beyond the limit of standard scuba diving, are difficult to collect and are especially poorly known.

Molecular studies of the decapods of the Pacific coast of North America remain in their infancy as of this writing. Most of the older specimens collected in large-scale sampling were preserved in 10% formalin before being transferred to ethanol, and thus are not suitable for commonly used molecular techniques. Curators are justifiably wary of allowing destructive sampling of rare specimens. Molecular techniques, when properly done, are likely to prove illuminating in distinguishing between polymorphic, widespread species and species complexes.

Illustrations, either clear photographs or line drawings or both, are included for all but a few species. Most illustrations were taken from published works as credited in the captions. The author provided illustrations and photographs without credits. The reproduced illustrations vary in quality. Rathbun (1917, 1925, 1930, 1937), Schmitt (1921), Garth (1958) and Haig (1960) commonly used photographs. Some of the photographs were reproduced at such a small size that resolution is poor and distinctive diagnostic features are difficult to see. Some species, such as *Pachycheles holosericus* Schmitt, 1921 (Porcellanidae), have never been illustrated except in photographs.

Color in life is based on published color plates, photographs and descriptions as well as field notes and the author's photographs. Color plates are included showing fresh specimens and living animals photographed in the wild or in aquaria. The author took all of the photographs in the color plates in California except as noted. Photographs particularly show color patterns, some instances of behaviors, and other details that either were not published or were artificially arranged in previous publications. Many of the photographs in Morris *et al.* (1980), for instance, are faded or show dead animals (especially the shrimps).

Range, depth and habitat are similarly based on published information and the author's field notes and records. Latitude and longitude are only given for locations away from easily located shore features. Any previously unpublished records include a station or collection catalog number. Information on behavior, habitat, or associations with other species that is not credited is based on the author's unpublished observations in the field or in aquaria.

Locality data and type locations are given as precisely as possible. Some of the early biologists, such as F. Brandt and R. Owen, reported collecting localities that are easy to locate on a map today. Others reported vague locations such "California" or did not indicate a type locality. Such notations were reported in the 1800's when expeditions did not keep good records, the distinctions between territories and countries were not exact, and labels were lost or confused. Even today, California, U.S.A. and Baja California and the Gulf of California, Mexico can be confused in locality data. Some early records of deep benthic or pelagic species listed "Hawaii" among the localities. Because no distinction was made between the island of Hawaii and the Hawaiian Islands as a whole, these records are presented here as "Hawaiian Is." The type locality is given as written in the original description, or by using quotation marks for locations that I believe are vague or probably in error.

Remarks on range, taxonomy and natural history are included where such information will aid in identifying a species. A few species have undergone extensive taxonomic revision; others have peculiar behavior, morphological

features or characteristic ecological relationships. If several species are very similar in appearance and habitat, the diagnosis of the best-studied species is presented in detail and other species are compared to it.

Many species, as mentioned in the text, can be variable in features such as the number of spines, length of the rostrum, and size and shape of the chelipeds. The specific and even generic designation of some decapods remains in question. The diligent biologist may find unknown variants within a species, previously unknown species, or synonyms. The faunas of the continental slopes and abyssal plains have been studied only in widely separated locations, and new studies are likely to yield further range extensions.

Zoogeography

The Oregonian and Californian provinces are rich in species belonging to families characteristic of cold water. There are 23 genera endemic to the North Pacific, of which 10 are monotypic. Among species-rich families in general are carideans of the families Crangonidae, Pandalidae, and Thoridae; anomurans of the superfamily Lithoidea and brachyurans of the families Epialtidae, Oregoniidae, and Cancridae.

TABLE 1. Zoogeographic distributions of families and genera

Number of species endemic to North Pacific (Japan, Korea, Russia, Aleutian Is. to northwestern Mexico) and Bering Sea:
Atyidae: <i>Syncaris</i> (2, California)
Thoridae: <i>Heptacarpus</i> (35).
Crangonidae: <i>Lissocrangon stylirostris</i> (monotypic genus, eastern Pacific), <i>Mesocrangon munitella</i> (monotypic genus, eastern Pacific), <i>Rhynocrangon</i> (2)
Galatheidae: <i>Janetogalatea californiensis</i> (monotypic genus, eastern Pacific)
Haplogasteridae: family endemic to region (5 genera, 8 species)
Lithodidae: <i>Cryptolithodes</i> (2), <i>Phyllolithodes papillosus</i> (monotypic genus), <i>Rhinolithodes wosnessenskii</i> (monotypic genus)
Epialtidae: <i>Mimulus foliatus</i> (monotypic genus, eastern Pacific), <i>Pugettia</i> (19)
Oregoniidae: <i>Oregonia</i> (2)
Pisidae: <i>Chorilia</i> (2), <i>Loxorhynchus</i> (3, eastern Pacific), <i>Scyra</i> (3)
Cancridae: <i>Glebocarcinus</i> (2)
Panopeidae: <i>Malacoplax californiensis</i> (monotypic genus, eastern Pacific)
Pinnotheridae: <i>Enigmatheres canfeldi</i> (monotypic genus, eastern Pacific), <i>Opisthopus transversus</i> (monotypic genus, eastern Pacific), <i>Scleroplax granulata</i> (monotypic genus, eastern Pacific)
Extending from North Pacific into Arctic Ocean and/or North Atlantic:
Thoridae: <i>Spirontocaris</i> (24, only 2 Atlantic)
Pandalidae: <i>Pandalus</i> (20, only 1 Atlantic)
Crangonidae: <i>Argis</i> (12, one of which extends into North Atlantic), <i>Sclerocrangon</i> (6 species, 1 circumboreal), <i>Crangon</i> (15–20 species but some taxonomic confusion, 3 in Atlantic)
Oregoniidae: <i>Chionoecetes</i> (7, 1 circumboreal), <i>Hyas</i> (5, 1 circumboreal, 1 Atlantic)
Extending from North Pacific to Pacific coasts of Central or South America:
Alpheidae: <i>Betaeus</i> (11, 2 South Pacific)
Crangonidae: <i>Paracrangon</i> (2, 1 North Pacific, 1 South Pacific), <i>Neocrangon</i> (3, 1 extending to South Pacific)
Munidae: <i>Pleuroncodes</i> (2, 1 North Pacific, 1 South Pacific)
Lithodidae: <i>Glyptolithodes cristatipes</i> (monotypic genus), <i>Lopholithodes</i> (4, 3 North Pacific, 1 South Pacific)
Epialtidae: <i>Talipeus</i> (3, 1 North Pacific, 2 South Pacific)
Families widespread in cold or deep water but most diverse in North Pacific:
Thoridae: <i>Eualus</i> (27, 18 North Pacific, 4 circumboreal, 2 Europe-Mediterranean, 3 southern hemisphere, some taxonomic confusion)
Cancridae: <i>Metacarcinus</i> (5, 3 North Pacific, 1 South America, 1 New Zealand), <i>Romaleon</i> (7, 5 North Pacific, 1 South America, 1 western Pacific)
Families represented by only one or two species in northeastern Pacific:
Caridea: Glyphocrangonidae, Hippolytidae, Lysmatidae, Nematocarcinidae, Ogyrididae, Processidae, Stylodactylidae
Stenopodidea: Stenopodidae
Axiidea: Axiidae, Ctenochelidae, Eiconaxiidae
Palinura: Panuliridae
Polychelida: Polychelidae
Gebiidea: Laomediidae
Anomura: Blepharipodidae, Hippidae, Parapaguridae
Brachyura: Calappidae, Cyclodorippidae, Dromiidae, Homolidae, Inachoididae, Leucosiidae, Palicidae, Parthenopidae, Pilumnidae, Ocypodidae

The North Pacific contains three endemic genera of the Crangonidae, two of which are confined to the eastern Pacific; another three genera are best represented in the North Pacific but range into the Atlantic. Two genera range from the North Pacific into Central or South America. Of the six tropical genera mentioned by Chace (1984), only one species of *Pontophilus* is reported from the Californian province.

Species of *Pandalus* are particularly common in the entire North Pacific. Of the 20 species of *Pandalus*, only two occur in the North Atlantic (De Grave & Fransen 2011). Two species of *Pandalopsis* and one of *Plesionika* are native to the Oregonian and Californian provinces, but members of the other 18 genera of the Pandalidae are either rare visitors during El Niño events or do not occur there at all.

The family Thoridae is especially species-rich in the North Pacific. All 33 species of *Heptacarpus* are endemic to the North Pacific, ranging from Japan to northwestern Mexico. Only two of 21 species of *Spirontocaris* range into the Atlantic. The rest are found in the North Pacific and in the Arctic Ocean. Of the 37 species of *Eualus*, 19 are found in the North Pacific. Species of *Lebbeus* are found worldwide in cold or deep waters, but the greatest morphological species diversity is in the North Pacific. Of the other three genera included in the Thoridae by Christoffersen (1988a) or since described, the genus *Thoralus* has since been synonymized with *Eualus* (De Grave & Fransen 2011). *Birulia* contains only two species in the northwestern Pacific. The two species of *Paralebbeus* live in the Indian Ocean and Indonesia (Chace 1997). The 13 or more species of *Thor* are distributed in the Caribbean and Western Atlantic, Indo-West Pacific, and tropical eastern Pacific south of the Gulf of California (Chace 1997, De Grave & Fransen 2011).

The superfamily Lithoidea is well represented in the North Pacific. The eight species of the Hapalogasteridae are confined to the North Pacific, from Japan to southern California. Five of the species are so far known from the western Pacific or, if they occur in the eastern Pacific, do not occur as far south as the Oregonian province. Of the remaining three species, *Acantholithodes hispidus* (Stimpson, 1860) ranges from Alaska to southern California, *Oedignathus inermis* (Stimpson, 1860), from Korea to California; and *Hapalogaster cavicauda* Stimpson, 1859 is endemic to the Oregonian and Californian provinces (Dawson 1989).

Five genera of the Lithodidae are unique to the North Pacific. Of these, the monotypic genus *Sculptolithodes* is restricted to the western Pacific. Three of the five species of *Paralithodes* do not range as far south as the Oregonian province, and the remaining three North Pacific endemic genera contain species that range across the northwestern Pacific as far south as the Californian province. Another seven genera of the Lithodidae include North Pacific, Arctic Ocean and North Atlantic species. Species of seven genera are found in the North Pacific as well as Central or South America, including the monotypic *Glyptolithodes*. *Lopholithodes* is entirely Pacific, with one species from off Japan, another in the eastern Pacific from Panama to Peru and two from Alaska to California. The remaining three genera, *Lithodes* (17 species), *Neolithodes* (10 species), and *Paralomis* (42 species), occur in deep water (Dawson 1989).

The Epialtidae is well represented in the Californian and Oregonian provinces, but only *Mimulus foliatus* Stimpson, 1860 is endemic to the eastern Pacific. The other 20 or more genera are mostly tropical. The Oregoniidae is confined to the northern hemisphere. Of its four genera and 15 species, all but three are native to the North Pacific. *Glebocarcinus* (Cancridae) is restricted to the North Pacific, as are most species of *Romaleon* and *Metacarcinus*. Species of *Cancer* s.s. are widespread in cold water (Ng *et al.* 2008).

Members of 24 families are represented in the Oregonian and Californian provinces by only one or two species. Seven of these families are deep-water groups generally found at more than 500 m. The Panuliridae, Dromiidae, Calappidae, Leucosiidae, Parthenopidae, Pilmunidae, Palicidae and Ocypodidae tend to be more common in warm temperate to tropical areas. The caridean families Alpheidae and Palaemonidae are particularly poorly represented. There are perhaps 76 species of alpheids and 60 species of palaemonids reported from the eastern tropical Pacific (Wicksten & Hendrickx 2003) compared to 13 species of alpheids, seven of them species of *Betaeus*; and five native species of palaemonids in the Oregonian and Californian provinces.

Native decapod species of the area under consideration tend to have extensive ranges. One hundred three species range from the Bering Sea, Aleutian Is., mainland Alaska or British Columbia south into the Oregonian and Californian provinces. Another 84 species are endemic to the two provinces. The remaining species tend to fall into three distributional patterns: from California south to the tropical Eastern Pacific, including the Gulf of California; south to western South America, including the Galapagos Is., and west to the northwestern Pacific. Of the shallow-water species, the brachyuran crab *Platymera gaudichaudii* H. Milne-Edwards, 1837 (Calappidae) has the greatest north-south range, from Oregon to Chile.

The most wide-ranging decapods are pelagic shrimps of the families Benthescymidae, Sergestidae, Oplophoridae and Pasiphaeidae. Twelve species of these families occur almost worldwide, eight species range widely across the Indo-West Pacific and eastern Pacific regions, and another twelve have extensive ranges in the North or eastern Pacific. *Hymenodora gracilis* Smith, 1886 (Oplophoridae) seems to be circumpolar and circumboreal in the northern hemisphere. *Hymenodora glacialis* (Buchholz, 1874) is circumpolar and circumboreal in both hemispheres (Pequegnat & Wicksten 2006).

Deep-water benthic decapods also tend to have extensive ranges. At least eight species range from California to Peru or Chile (Wicksten 1989b). A study of presence or absence of species by five degree squares of latitude and longitude from the Aleutian Is. to Chile indicated clustering of species at depth intervals of 500–1000 m, 1000–1500 m, and 1500 m and deeper. At depths of 1500 m or less, species ranging from the Aleutian Is. to Washington tended to cluster with species ranging from Oregon to southern California, as opposed to species found from western Baja California southward. At 1500 m or more, species found from southern California and the Gulf of California tended to cluster with species taken off Nicaragua, Costa Rica, and the Gulf of Panama to Peru. Except for a few species such as the shrimp *Benthescymus tanneri* Faxon, 1893 (Benthescymidae), the flatback lobster *Polycheles pacificus* Faxon, 1893 (Polychelidae), and the anomuran *Munidopsis scabra* Faxon, 1893 (Munidopsidae), the deep benthos of North and South America seem to have no species in common.

Brusca & Wallerstein (1979) summarized the zoogeography of neritic and shelf species in the northeastern Pacific. They discussed various definitions for previously advanced provinces and subprovinces (Valentine 1966, Briggs 1974). Valentine (1966) referred to distinct zoogeographic areas as "provinces" or "subprovinces." Brusca & Wallerstein (1979) defined "regions" according to water temperatures, and "provinces" according to their biotas. Both Valentine (1966) and Brusca & Wallerstein (1979) divided the biota of the area under consideration into the cold-temperate Oregonian province and the warm temperate Californian province. Briggs (1974), using data derived largely from fishes, linked the biota of southern California with that of the Gulf of California, but crustacean specialists generally follow the designations of Brusca & Wallerstein (1979) or do not divide the zoogeographical regions into provinces at all.

The Oregonian province, north of Point Conception, California, rarely has maximum water temperatures above 20° C. Valentine (1966) pointed out some discontinuities in the molluscan fauna in the region between Cape Mendocino and Monterey, California, and thus distinguished two subprovinces, the northern Mendocinian and a southern Montereyan, within the Oregonian province. Ranges of certain decapods offer some support for the subprovincial designations. The brachyurans *Oregonia gracilis* Dana, 1851 (Oregoniidae) and *Glebocarcinus oregonensis* (Dana, 1852) (Cancridae), for example, are rarely found south of Point Arena, California.

Some cold-water decapods may be found rarely south of Point Conception in deep water or in areas with strong upwelling. The shrimps *Eualus barbatus* (Rathbun, 1899) and *Spirontocaris lamellicornis* (Dana, 1852) (Thoridae) are usually reported from north of Point Conception, but both have been found in submarine canyons in Santa Monica Bay. The hermit crab *Pagurus hemphilli* (Benedict, 1892) (Paguridae) and a few other northern decapods are found regularly along the coast of San Miguel Is.

The Californian province has its northern boundary in the vicinity of Point Conception, where the coast takes an abrupt southeast bend. A large eddy system tends to be present just south of Point Conception. These features tend to form a barrier between the faunas of the adjacent provinces. The Californian province tends to be warmer, where waters rarely drop below 10° C. Beds of giant kelp, *Macrocystis pyrifera* (Linnaeus, 1771), are characteristic (Brusca & Wallerstein 1979). The spiny lobster, *Panulirus interruptus* Randall, 1840 (Palinuridae), reaches its northern limit here, as do brachyuran crabs of the families Ocypodidae, Pilumnidae and Portunidae. The shrimp *Heptacarpus brevirostris* (Dana, 1852) (Thoridae) and anomuran crabs *Petrolisthes cinctipes* (Randall, 1840) (Porcellanidae) and *Pagurus hirsutiussculus* (Dana, 1851) (Paguridae), common north of Point Conception, are replaced by *Heptacarpus palpator* (Owen, 1839), *Petrolisthes cabrilloi* Glassell, 1945; and *Pagurus venturensis* Coffin, 1957, which occupy much the same intertidal habitats.

During years of unusually warm currents (El Niño events), southern California is subject to short-term colonization by Tropical Eastern Pacific species, such as the pelagic anomuran crab *Pleuroncodes planipes* Stimpson, 1860 (Munididae), the arrow crab *Stenorhynchus debilis* (Smith, 1871) (Inachidae) and the shrimps *Plesionika mexicana* Chace, 1937 (Pandalidae) and *Solenocera mutator* Burkenroad, 1938 (Solenoceridae). Engle & Richards (2001) and Montagne & Cadien (2001) list warm-water species of decapods recently reported in California. There are no good data to indicate if the reproducing populations of any of these species are gradually

extending their range northward as a result of global warming. There also are no data to indicate if the ranges of warm-temperate shrimps of the families Thoridae and Crangonidae or brachyurans of the family Cancridae are moving northward, or if members of these or other families are being displaced by tropical species of the shrimps of the family Palaemonidae or brachyurans of the families Xanthidae or Panopeidae.

Particular substrate types and water temperatures influence the marine biota of southern California. The sea floor off the islands of southern California tends to be steep, with rocks and shelly sand instead of a more gradual slope and sand mixed with silt. The shrimps *Argis californiensis* (Rathbun, 1902) (Crangonidae) and *Heptacarpus brachydactylus* (Rathbun, 1902) (Thoridae), the hermit crabs *Haigia diegenesis* (Scanland & Hopkins, 1969) and *Phimochirus californiensis* (Benedict, 1892) (Paguridae) and the brachyuran crabs *Erileptus spinosus* Rathbun, 1893 (Inachidae) and *Epialtoides hiltoni* (Rathbun, 1923) (Epialtidae) are more commonly found along the islands than on the mainland coast. The only species only known from the offshore islands of southern California and northern Baja California is *Heptacarpus fuscimaculatus* Wicksten, 1986 (Thoridae). The penaeoid shrimp *Sicyonia ingentis* (Burkenroad, 1938) (Sicyoniidae) is more common along the mainland. Differences in seasonal water temperatures, upwelling, the amount of silt or coarse-grained substrate, local bathymetry, patterns of currents, and human habitat alteration may further contribute to these differences in distribution.

It is difficult to place an exact southern limit to the Californian province because the coast does not show an abrupt discontinuity such as Point Conception. Most coastal temperate species range to Punta Eugenia or Magdalena Bay in Baja California, where rocky shores may experience upwelling. Patches of kelp beds (*M. pyrifera*) and their associated cool-water species can be found intermingled with sandy bays inhabited by subtropical species along the central coast of Baja California. Local changes in current patterns and upwelling as well as small-scale changes in topography create changes in the patterns of the inhabitants from year to year (Garth 1955, Brusca & Wallerstein 1979). A mixture of Californian and subtropical species occurs at least as far south as the Alijos Rocks off southwestern Baja California (Wicksten 1996b). There is a less well-defined change in the deep benthic fauna along the Pacific coast of Baja California. Cold-water shrimps such as *Spirontocaris sica* Rathbun, 1902 (Thoridae) tend to drop out of the biota and deep tropical shrimps such as species of *Plesionika* and *Heterocarpus* (Pandalidae) become more abundant.

Before widespread human activities, freshwater decapods ranged from California to Washington. There are no records of freshwater decapods from northern Baja California prior to the twentieth century. Two species of *Syncaris* (Atyidae), freshwater shrimps endemic to California, occurred in coastal streams. Native crayfishes were restricted to four species of *Pacifastacus*, which ranged into streams and rivers of the coast, Sierra Nevada and Cascade Ranges as far east as Idaho. The nearest relatives of these cold-water crayfishes live in Eurasia.

Habitats

Most decapods are restricted to particular habitats and depth ranges. Table 2 summarizes some common species found in particular marine habitats by depth and substrate. Some of the species may be more abundant in sheltered areas under seaweeds, on rock walls or other microhabitats within these habitats. Many species of rocky reefs or kelp beds, although most abundant in these subtidal habitats, may at times be found in the lowest intertidal zones. Subtidal benthic species may at times range into shallower zones of upwelling or migrate up and down seasonally.

Except as larval stages, few decapods live at the surface of the open sea. Brachyuran crabs of the genus *Planes* (Grapsidae) cling to driftwood or sea turtles at or near the surface. Shrimps of the families Benthescymidae, Ophlophoridae, Pasiphaeidae, and Sergestidae typically inhabit the mesopelagic region. These shrimps usually are caught in trawls or nets but sometimes are caught in baited traps. Many of these species migrate vertically, being found at lesser depths by night.

Ebeling *et al.* (1970) designated the shrimps *Eusergestes similis* (Hansen, 1903) (Sergestidae) and *Pasiphaea chacei* Yaldwyn, 1962 (Pasiphaeidae) as mesopelagic (above 500 m). The former associated with vertically migrating fishes and crustaceans while *P. chacei* associated with middle mesopelagic fishes. *Pasiphaea emarginata* Rathbun, 1902 (Pasiphaeidae) and *Hymenodora frontalis* Rathbun, 1902 (Ophlophoridae) were considered bathypelagic (500–800 m). Percy & Forss (1966), Wasmer (1972b), and Krygier & Percy (1981) gave accounts of the vertical and horizontal distribution of midwater decapods, especially species collected off Oregon.

TABLE 2. Characteristic Decapods of Marine Habitats**Intertidal rocky shores:**

Caridea: *Alpheus clamator*, *Betaeus longidactylus* (Alpheidae); *Lysmata californica* (Lysmatidae), *Heptacarpus sitchensis*, *H. brevirostris*, *H. taylori*, *H. palpator* (Thoridae)

Anomura: *Pagurus hemphilli*, *Pagurus samuelis* (Paguridae); *Petrolisthes* spp. (Porcellanidae)

Brachyura: *Cancer productus*, *Metacarcinus anthonyi*, *Romaleon antennarius* (Cancridae); *Pugettia producta* (Epiplatidae), *Pachygrapsus crassipes* (Grapsidae), *Lophopanopeus* spp. (Panopeidae), *Hemigrapsus nudus* (Varunidae)

Shallow rocky reefs and kelp beds (0-50 m):

Caridea: *Alpheus bellimanus* (Alpheidae), *Lissocrangon handi*, *Metacrangon munitellus* (Crangonidae); *Eualus subtilis*, *Heptacarpus fuscimaculatus*, *Lebbeus lagunae*, *Spirontocaris prionota* (Thoridae); *Hippolyte clarki* (Hippolytidae)

Palinura: *Panulirus interruptus* (Palinuridae)

Anomura: *Paguristes ulreyi* (Diogenidae), *Cryptolithodes sitchensis* (Lithodidae), *Phimochirus californiensis* (Paguridae)

Brachyura: *Mimulus foliatus* (Epiplatidae), *Loxorhynchus crispatus*, *L. grandis*, *Pelia tumida*, *Scyra acutifrons* (Pisidae), *Oregonia gracilis* (Oregoniidae)

Sandy and muddy shores:

Caridea: *Crangon nigricauda*, *Lissocrangon stylirostris* (Crangonidae)

Axiidea: family Callianassidae

Gebiidea: family Upogebiidae

Anomura: *Emerita analoga* (Hippidae), *Blepharipoda occidentalis* (Blepharipodidae), *Isocheles pilosus* (Diogenidae), *Pagurus hirsutiusculus*, *P. venturensis* (Paguridae)

Brachyura: *Randallia ornata* (Leucosiidae), *Uca crenulata* (Ocypodidae), *Malacoplax californiensis* (Panopeidae), *Latolambrus occidentalis* (Parthenopidae), family Pinnotheridae, *Portunus xantusii* (Portunidae), *Hemigrapsus oregonensis* (Varunidae)

Sea grass beds:

Caridea: family Crangonidae, *Hippolyte californiensis* (Hippolytidae), *Heptacarpus paludicola* (Thoridae)

Subtidal sandy areas and continental shelf:

Penaeidea: *Sicyonia ingentis* (Sicyoniidae)

Caridea: *Argis californiensis*, *Crangon alaskensis*, *C. franciscana*, *C. nigromaculata*, *Mesocrangon communis*, *M. resima* (Crangonidae); *Pandalus jordani* (Pandalidae), *Spirontocaris lamellicornis*, *S. sica* (Thoridae)

Anomura: *Pagurus armatus*, *P. spilocarpus* (Paguridae)

Brachyura: *Metacarcinus gracilis*, *M. magister* (Cancridae); *Chorilia longipes* (Pisidae)

Continental slope (200–1,000 m):

Caridea: *Metacrangon variabilis* (Crangonidae), *Pandalus platyceros* (Pandalidae); *Spirontocaris holmesi* (Thoridae)

Anomura: *Janetogalatea californiensis* (Galatheidae), *Paralithodes californiensis* (Lithodidae), *Munida hystrix* (Munididae)

Brachyura: *Chionoecetes tanneri* (Oregoniidae)

Deep sea benthos (from 1000 m):

Caridea: *Neocrangon abyssorum* (Crangonidae), *Glyphocrangon* spp. (Glyphocrangonidae), *Nematocarcinus exilis* (Nematocarcinidae), *Bathystylodactylus echinus* (Stylodactylidae), *Lebbeus washingtonianus* (Thoridae)

Polychelida: *Polycheles pacificus* (Polychelidae)

Anomura: family Chirostylidae, *Paralomis multispina* (Lithodidae), *Munidopsis* spp. (Munidopsidae), *Pagurus tanneri* (Paguridae), *Parapagurus benedicti* (Parapaguridae)

Symbiotic species

The North Pacific does not have as many symbiotic crustaceans as tropical areas to the south (Wicksten & Hernandez 2000). *Ascidonia californica* (Rathbun, 1902) (Palaemonidae) lives inside the branchial baskets of large ascidians. *Pseudocoutierea elegans* Holthuis, 1951 (Palaemonidae) lives on the gorgonian *Leptogorgia chilensis* Verrill, 1868. *Betaeus* spp. (Alpheidae) may be associated with sea urchins, large gastropod mollusks, porcelain crabs or ghost shrimp. Members of the family Pinnotheridae (Brachyura) are symbionts of mollusks, echinoderms, burrowing decapods and various types of worms. Deep-water anomurans of the family Chirostylidae tend to associate with colonial corals (Antipatharia and Gorgonacea).

Introduced species

Bays and harbors receive introduced species from deliberate attempts by fishermen or bait gatherers to produce useful harvests, careless disposal of left over catches or shipments, or dumping of ballast water. Carlton & Cohen (2007) gave a summary of means of introduction of species, their recognition, and ecological effects with particular reference to the California. Habitats that are vulnerable to introductions generally show a great deal of disturbance by humans. Species that tolerate such activities and are able to disperse into the area and reproduce successfully may come to dominate an area. San Francisco Bay in particular has suffered repeated introductions of non-native species (Cohen & Carlton 1995). In much of the bay, it is very difficult to find a benthic community that contains its original species composition. The Oriental shrimp *Palaemon macrodactylus* (Rathbun, 1902) (Palaemonidae) has been found over decades in San Francisco Bay, and seems to be the best established of these introductions. The green crab *Carcinus maenas* (Linnaeus, 1758) (Portunidae) is spreading from a point of introduction in San Francisco Bay northward. The Chinese mitten crab *Eriocheir sinensis* H. Milne-Edwards, 1853 (Varunidae) is a major pest in the San Francisco Bay area. The effects of these decapods on native shrimps of the caridean families Thoridae and Crangonidae and brachyurans of the families Cancridae and Varunidae remain unknown. Introduction of Atlantic mollusks, however, has provided a bonanza of shells for the native hermit crab *Pagurus hirsutiussculus* in San Francisco Bay (Wicksten 1977c).

Freshwater streams abound with the introduced crayfish *Procambarus clarkii* (Girard, 1852) (Cambaridae), native to the eastern U.S.A., but a native species, *Pacifastacus leniusculus* (Dana, 1852) (Astacidae) also has been spread far outside of its native range. The introduction of *Orconectes viridis* (Hagen, 1870) and other exotic crayfishes has imperiled the Shasta crayfish, *Pacifastacus fortis* (Faxon, 1914) (Eng & Daniels 1982). Non-native predatory fishes have limited the range of the freshwater shrimp *Syncaris pacifica* (Holmes, 1895) (Atyidae) (Eng 1981).

THE SHRIMPS

Earlier works classified all shrimp-shaped decapod crustaceans into one suborder, the Natantia (meaning "swimmers"). Studies of larval stages and gill types, as well as molecular comparisons no longer support the idea that all of the shrimp-like decapods are closely related. In the United Kingdom and other countries, the word "prawn" is commonly used to indicate a large, edible "shrimp." The word is defined vaguely in the U.S.A. It may mean a "large, edible shrimp" but perhaps also a lobster-like decapod. The word "prawn" in the U.S.A. is generally used in the seafood industry and has no taxonomic value. When referring to more than one species, the word "shrimps" is preferred to "shrimp."

Of the shrimp-like decapods, the suborder Dendrobranchiata contains taxa with dendrobranchiate gills. The first three pereopods are chelate, and the pereopods may bear exopods. The pleura of abdominal somite 2 do not overlap somite 1 along the anterior margin. The male bears a copulatory organ, the petasma, formed by modified endopods of first pleopods. (See, for example, fig. 4F, G). The female has a distinct genital area, the thelycum, which is a sperm receptacle formed by the sternal plates of seventh and eighth thoracic somites (Fig 4D,) and does not brood the eggs below the abdomen. A nauplius larval stage is present. See McLaughlin (1980) for an illustrated guide to the anatomy of shrimps and other decapods. Most Californian and Oregonian dendrobranchiates live in midwater or in deep benthic habitats, but two species are regularly found near shore or on the continental shelf.

The suborder Pleocyemata contains shrimp-, lobster- and crab-like species. None have dendrobranchiate gills. The female broods the eggs beneath the abdomen and the nauplius stage is passed in the developing egg. Although copulatory structures may be present, they are not in the form of a thelycum or petasma. Most shrimps and other decapods of California and Oregon belong to this suborder, which inhabits both marine and freshwater habitats.

Shrimps of the suborder Pleocyemata are further divided into two infraorders. In the Stenopodidea, the gills are trichobranchiate. The first three pairs of pereopods are chelate, but without exopods; pereopods 3 are large and lobster-like. The pleura of abdominal somite 2 do not overlap the first, and the carapace has a row of spines across the dorsal surface. The only stenopodid in California inhabits deep-sea sponges.

The most common shrimps in the Californian and Oregonian provinces belong to the infraorder Caridea. These shrimps have phyllobranchiate gills. In all but a few rare species (absent in the area), only pereopods 1, 2 bear

chelae. Exopods are found on the pereopods of some deep-sea species, but are absent on most common coastal carideans. The pleura of abdominal somite 2 overlap somite 1; somite 3 often forms a sharp bend or hump along the posterior margin. Freshwater shrimps of the family Atyidae can occur in coastal streams in California, but the majority of carideans are marine. Holthuis (1993) gave a key to all the known families and genera of the Caridea and Stenopodidea worldwide. De Grave & Fransen (2011) compiled a worldwide species list of carideans. Previous taxonomic works and keys have interchanged the words "spine" and "tooth" for pointed processes of the exoskeleton of shrimp-shaped decapods. The name "spine" is used herein to refer to a sharp process that inserts into a socket, whether or not there is evidence that the structure is movable. A pointed process that does not insert into a socket is called a tooth.

Key to the families of shrimps

1. Pleura of abdominal somite 2 not overlapping those of first and third pleura. Pereopod 3 chelate 2
- Pleura of abdominal somite 2 overlapping those of first and third pleura. Pereopod 3 not chelate 7
2. Male with petasma, female with thelycum. Pereopod 3 not larger than pereopod 1 or 2 3
- Male without petasma, female without thelycum. Pereopod 3 larger than pereopod 1 or 2 Stenopodidae
3. Pereopods 1–3 chelate, pereopods 4, 5 well developed, male without antennular flagellum modified as clasping organ. 4
- Pereopod 1 not chelate, pereopods 4, 5 reduced, male with antennular flagellum modified as clasping organ. Sergestidae
4. Rostrum with ventral teeth. No postorbital tooth, abdominal somites without prominent dorsal carinae. Penaeidae
- Rostrum without ventral teeth. Postorbital tooth present or absent, abdominal somites with or without prominent dorsal carinae 5
5. Postorbital tooth present, abdominal somites without prominent carinae Solenoceridae
- Postorbital tooth absent, abdominal somites with or without prominent carinae 6
6. Abdominal somites, carapace with prominent carinae, often with enlarged teeth, exoskeleton well calcified. Near-shore sandy or muddy bottoms or continental shelf Sicyoniidae
- Abdominal somites, carapace without prominent carinae, usually without teeth, exoskeleton thin. Continental slopes and pelagic habitats Benthescymidae
7. Fingers of chelae with conspicuous terminal brushes of setae. Inhabiting freshwater streams Atyidae
- Fingers of chelae without conspicuous terminal brushes of setae. Marine or estuarine 8
8. Pereopods with exopods 9
- Pereopods without exopods. 11
9. Chelae with slender fingers lined with comb-like spinules; rostrum absent or represented by small, short spine. . . Pasiphaeidae
- Chelae with fingers stout to slender, but not lined with comb-like spinules; rostrum short to long, toothed 10
10. Pereopods 3–5 not conspicuously lengthened, carpus of these legs distinctly shorter than propodus Oplophoridae
- Pereopods 3–5 conspicuously lengthened, carpus several times longer than propodus Nematocarcinidae
11. Pereopod 1 subchelate. Benthic species, capable of digging into substrate 12
- Pereopod 1 chelate. Usually epibenthic species resting on sea floor but not capable of digging into substrate. 13
12. Pereopod 2 with carpus subdivided into articles. Carapace with prominent spines, ridges. Continental slopes only Glyphocrangonidae
- Pereopod 2 with carpus not divided into articles. Carapace with smaller spines, ridges if any. Intertidal to continental slopes Crangonidae
13. Carpus of pereopod 2 not divided into articles 14
- Carpus of pereopod 2 divided into 3 to many articles. 15
14. Pereopods 1, 2 nearly equal in size, shape; fingers of chelae long, slender, without teeth but with long setae. In area of coverage, only on deep slopes or abyssal plains Stylodactylidae
- Pereopod 2 often larger, heavier than pereopod 1; fingers of chelae not particularly long or slender, teeth may be present, without long setae. In area of coverage, in fresh water and shallow marine habitats Palaemonidae
15. Pereopod 1 heavy, strongly chelate. Carapace with posterior notch. Rostrum absent or reduced to small tooth. Alpheidae
- Pereopods 1 not as heavy, chelae smaller. Carapace without posterior notch. Rostrum usually toothed and elongated 16
16. Eyestalk elongated, anterior dorsal part of carapace with numerous small spines Ogyrididae
- Eyestalk not as long, anterior dorsal part of carapace with at most few pairs supraorbital teeth 17
17. Rostrum with spines, often long, curved upward Pandalidae
- Rostrum without spines, length, shape variable 18
18. Rostrum very short, at most barely as long as eye, with no dorsal or ventral teeth. Santa Monica Bay, California southward; living in sand or mud Processidae
- Rostrum short to long, with dorsal and/or ventral teeth. Throughout area of coverage; living on or in diverse substrates . . . 19
19. Carpus of pereopod 2 with more than 20 articles. Antennular flagella as long as body or more when intact Lysmatidae
- Carpus of pereopod 2 with 7 or fewer articles. Antennular flagella short, setose. 20
20. Carpus of pereopod 2 with three articles. One supraorbital tooth. Hippolytidae
- Carpus of second pereopod with seven articles. 0–4 supraorbital teeth Thoridae

SUBORDER DENDROBRANCHIATA Bate, 1888

All dendrobranchiates were included until recently in two families: Penaeidae and Sergestidae. A revision (Pérez Farfante & Kensley 1997) split what once were subfamilies into families of their own. This authoritative work provides a detailed discussion of the dendrobranchiate decapods.

The key given here is modified from Pérez Farfante & Kensley (1997). Hendrickx (1996) and Hendrickx & Estrada-Navarrete (1996) cover the species found in the southwestern Pacific coast of Baja California.

SUPERFAMILY PENAEOIDEA Rafinesque, 1815

Family Benthescymidae Wood-Mason, 1891

Species of this family occur on the continental slopes and in the offshore water column. The exoskeleton is thin and membranous. Many species are colored orange to dark red. Although features of the telson and carapace may be characteristic of certain species, the soft exoskeleton is often torn or twisted during collection. Definitive identification relies on examination of the genital apparatus, especially among midwater species. The key follows that given by Wasmer (1972b) for the identification of the species of *Gennadas*.

Species of *Benthescymus* are the largest members of this family in the area. These benthic shrimps inhabit muddy areas of the continental slopes and abyssal plains. Species of *Gennadas* and *Bentheogennema* live in midwater, where they undergo vertical migrations. They feed primarily on copepods, ostracods, and other small crustaceans (Heffernan & Hopkins 1981). Information included here from the San Pedro Basin is based on unpublished records and color notes by J. C. Yaldwyn (University of Wellington, New Zealand).

Key to species of family Benthescymidae

1. Endopods of second maxillipeds slender. Usually benthic 2
- Endopods of second maxillipeds with merus thin, broad, compressed. Usually pelagic 4
2. Posterior margin of abdominal somite 4 armed with comb-like denticles, teeth *Benthescymus laciniatus*
- Posterior margin of abdominal somite 4 not armed with comb-like denticles or teeth 3
3. Median carina of abdominal somites 5, 6 terminating posteriorly in small acute tooth *Benthescymus tanneri*
- Median carina of abdominal somites 5, 6 not terminating in teeth; sixth somite ending in upturned transverse ridge *Benthescymus altus*
4. Podobranchs absent on pereopods 1–3. Telson with single pair mobile lateral spines 5
- Podobranchs present on pereopods 1–3. Telson with more than single pair mobile lateral spines 8
5. Female with orifices of seminal receptacles opening independently, not included in common atrium. Male with distolateral lobe of petasma undivided. 6
- Female with orifices of seminal receptacles lying within common atrium. Male with distolateral lobe of petasma divided . . . 7
6. Female with subtriangular structure present between pereopods 4; two symmetrical protuberances transversely located just anterior of this structure from posterior margin of fifth thoracic sternite, male with external lobe of petasma undivided; distoventral lobe of petasma divided *Gennadas tinayrei*
- Female without such structure, male with external distoventral lobe of petasma undivided *Gennadas sordidus*
7. Female with thelycum provided with subrectangular, tong-shaped projection extending forward from between pereopods 4, reaching to posterior edge of thoracic sternite 6; male with external lobe of petasma much longer than median lobe *Gennadas incertus*
- Female without such subrectangular structure, but subtriangular structure on thoracic sternite 5, between pereopods 2; strong transverse crest on anterior part of sternite XIV. Male with external lobe of petasma shorter than median lobe. *Gennadas propinquus*
8. Cervical and post-cervical sutures not closely approaching each other on dorsal midline *Bentheogennema borealis*
- Cervical and post-cervical sutures closely approaching each other on dorsal midline. 9
9. Petasma with large accessory lobe; in mature male, with terminal hook; thelycum with elevated triangular plate on sixth sternite. Telson with only 1 pair terminal-lateral spines *Bentheogennema burkenroadi*
- Petasma with smaller accessory lobe, without terminal hook; thelycum without elevated triangular plate on sixth sternite. Telson with 1–3 pairs terminal-lateral spines. *Bentheogennema pasithea*

***Benthesicymus* Bate, 1881**

***Benthesicymus altus* Bate, 1881**

(Fig. 3A–F)

Benthesicymus altus Bate, 1881: 191. — Faxon 1895: 203. — Schmitt 1921: 22, pl. 11, fig. 2. — Anderson & Lindner 1943: 298. — Wicksten 1989b: 311. — Kikuchi & Nemoto 1991: 85, figs. 14, 15. — Hendrickx 1996: 9, fig. 10 (extensive synonymy). — Pérez Farfante & Kensley 1997: 60. — Guzmán & Wicksten 2000: 927, fig. 2. — Hendrickx & Wicksten 2003: 57; 2004: 139.

Diagnosis. Similar to *B. tanneri* but carapace without hepatic spine. Last segment of third maxilliped with 1 strong spine, 4–5 spinules. Abdominal somite 4 with slight dorsal carina, somite 5 with posterior dorsal carina, somite 6 with strong dorsal carina ending in upturned margin. Telson with 4 pairs lateral spines. Total length 120 mm.

Color in life. Not reported.

Habitat and depth. Continental slopes, usually benthic, 923–4120 m.

Range. Western Pacific from Japan to Fiji, eastern Pacific from San Nicolas I. to Chile, South Atlantic, Indian Ocean off Maldives and Comoro Is. Type locality "between Australia and New Guinea" (*Challenger* sta. 184).

***Benthesicymus laciniatus* Rathbun, 1906**

(Fig. 3J–L)

Benthesicymus laciniatus Rathbun, 1906: 906, fig. 59, pl. XIX, fig. 3. — Hayashi 1983: 441, fig. 62. — Kikuchi & Nemoto 1991: 65. — Pérez Farfante & Kensley 1997: 61. — Wicksten 2004: 93 (extensive synonymy).
Gemadax pectinatus Schmitt, 1921: 25, fig. 12; pl. 11, fig. 1. — Pérez Farfante & Kensley 1997: 66. — Wicksten 2002: 128.

Diagnosis. Rostrum slightly ascending, with 1 or 2 dorsal teeth, sharp apex, continuing posteriorly as dorsal carina to cervical groove. Carapace with antennal, branchiostegal teeth; cervical groove, Y-shaped lateral groove running posteriorly. Eye without pigment, eyestalk with tubercle. Scaphocerite with rounded blade, exceeding lateral tooth. Second maxilliped broad, flattened. Pereopods 1–3 short, strong, chelate; pereopods 4, 5 long slender. Pleopods with exceptionally long endopods, exopods. Abdominal somites 1–4 rounded, fourth with comb-like structure of teeth spinules along posterior margin. Somites 5, 6 with dorsal carina small posterolateral tooth, carina of somite 5 ending in sharp tooth. Telson shorter than uropods, with 4 pairs lateral spines. Carapace length to 42 mm.

Color in life. Orange. The color note is from a specimen taken off the Hawaiian Is.

Habitat and depth. Lower continental slope and abyssal plains, 1471–4028 m.

Range. Cosmopolitan: Madagascar, Reunion, Saya de Malha Bank, Japan, Hawaiian Is., off Santa Catalina I., California; off Baja California, Mexico; Azores, Canary Is. Type locality off Kauai, Hawaiian Is.

***Benthesicymus tanneri* Faxon, 1893**

(Fig. 3G–I)

Benthesicymus tanneri Faxon, 1893: 215; 1895: 205, pl. H. — Rathbun 1904: 147. — Schmitt 1921: 23, fig. 10. — Anderson & Lindner 1943: 298. — Méndez 1981: 31, pl. 8, figs. 61, 61a, 62a, b. — Wicksten 1989b: 311. — Kikuchi & Nemoto 1991: 65. — Hendrickx 1996: 12, fig. 5 (extensive synonymy). — Pérez Farfante & Kensley 1997: 61. — Guzmán & Wicksten 2000: 926. — Wicksten & Hendrickx 2003: 57.

Diagnosis. Exoskeleton smooth, membranous. Rostrum short, raised into crest with 2 dorsal, no ventral teeth, continued on carapace as dorsal carina to cervical groove. Carapace with lower orbital angle prominent but blunt, prominent branchiostegal tooth continuing into carina, sharp pterygostomial angle without tooth; hepatic spine, gastro-hepatic, cervical grooves, ridge along branchial region. Eye pigmented. Stylocerite shorter than first segment of antennular peduncle, with tooth at distal external angle. Scaphocerite tapered. Last segment of third maxilliped with 4 spines, exopod present. Pereopods slender, without exopods. Abdominal somites 1–3 without carinae, somite 4 with faint dorsal carina, somites 5, 6 with dorsal carina armed with posterior tooth. Telson short, convex above, with 3 pairs lateral spines. Total length to 112 mm.

Color in life. Deep red, sometimes with patch of blue on abdominal somites 2–4.

Habitat and depth. Continental slopes, usually benthic, 484–1300 m

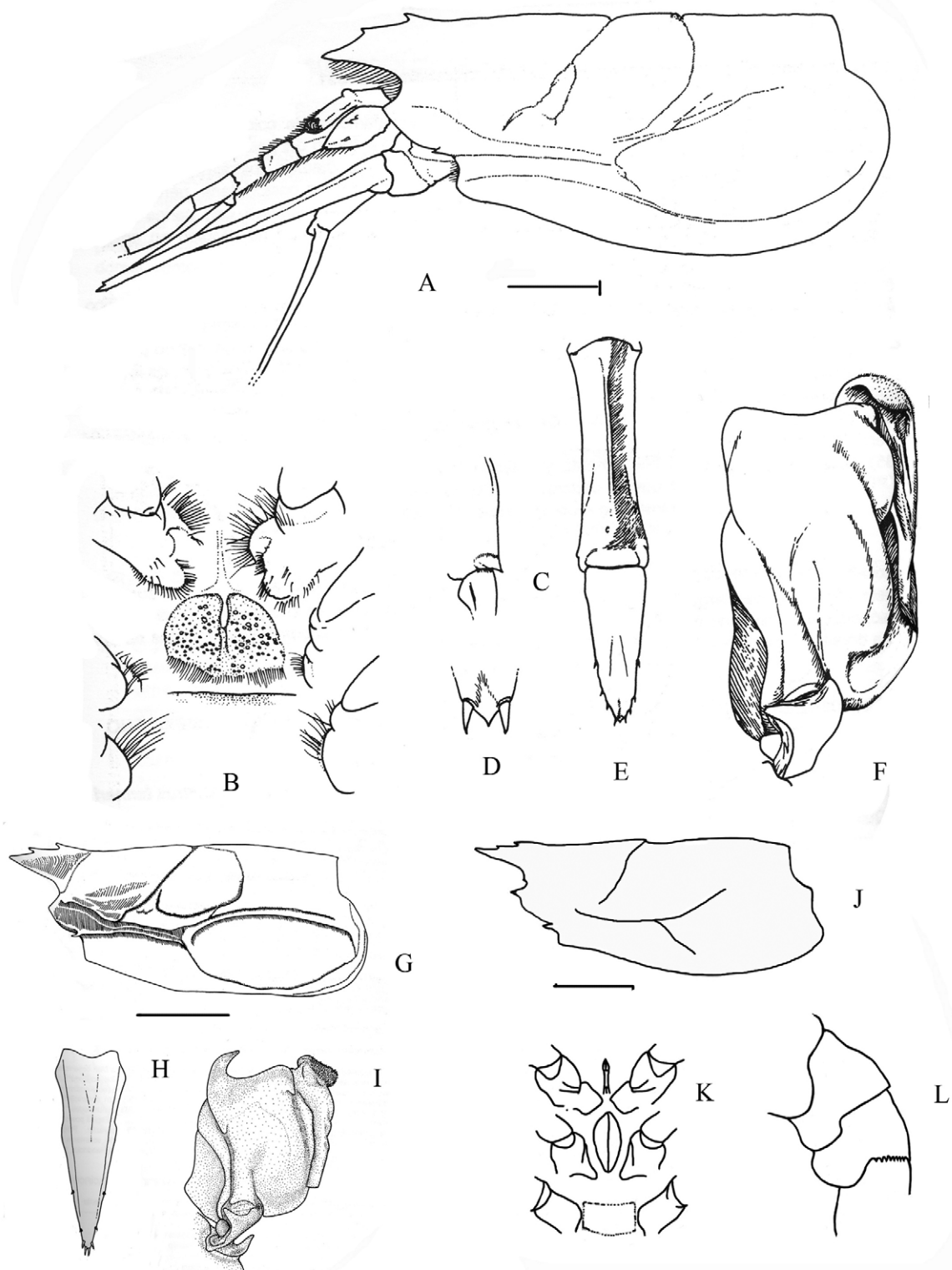


FIGURE 3. Family Benthescymidae. A–F, *Benthescymus altus* Bate, 1881; A, carapace and frontal region in lateral view; B, thelycum; C, distal point of abdominal somite 6; D, apex of telson; E, abdominal somite 6 and telson; F, petasma. G–I, *Benthescymus tanneri* Faxon, 1893; G, carapace in lateral view; H, telson; I, petasma. J–L, *Benthescymus laciniatus* Rathbun, 1906; J, carapace in lateral view; K, thelycum; L, abdominal somite 5 in lateral view. Scale = 10 mm. A–I from Hendrickx 1996, J–L from Schmitt 1921 as *Gennadas pectinatus*.

Range. San Diego, California to northern Chile. Type locality 75 mi. SW of Guaymas, central Gulf of California (*Albatross* sta. 3436).

***Bentheogennema* Burkenroad, 1936**

***Bentheogennema borealis* (Rathbun, 1902)**

(Fig. 4A–D)

Gennadas borealis Rathbun, 1902a: 24; 1904: 147, figs. 88–89. — Schmitt 1921: 24, fig. 11. — Kobayakova 1937: 141, fig. 9. — Goodwin 1952: 393. — Kozloff 1974: 162.

Bentheogennema borealis. — Anderson & Lindner 1943: 295. — Percy & Forss 1966: 1137. — Butler 1980: 41. — Krygier & Percy 1981: 77. — Hendrickx & Estrada-Navarrete 1989: 106; 1996: 13, fig. 3 (extensive synonymy) — Pérez Farfante & Kensley 1997: 58. — Wicksten 2002: 129.

Diagnosis. Exoskeleton membranous, smooth. Rostrum short, with dorsal tooth, acute apex, extending posteriorly as mid-dorsal carina. Carapace with suborbital tooth rounded, low antennal tooth, branchiostegal tooth strong, extending posteriorly into carina, pterygostomial margin rounded, cervical, postcervical grooves widely separated on dorsal midline; antennal, branchial carinae extending posteriorly, meeting hepatic carina. Eye pigmented, with tubercle on eyestalk. Stylocerite short, with wide base. Scaphocerite rounded, scale exceeding lateral tooth. Kink in flagellum of antenna. Second maxilliped flattened, setose. Third maxilliped longer than second, flattened, setose; dactyl flat, twisted; with exopod, podobranch. Pereopods 1–3 chelate, sturdy, with epipods, podobranchs. Pereopods 4, 5 slender, with simple dactyls. Abdominal somites with small grooves, pleura blunt to rounded. Somite 6 with dorsal carina. Telson shorter than uropods, narrow, truncate, with 2 pairs movable spines, dorsal groove. Total length 58–64 mm.

Color in life. Red.

Habitat and depth. Pelagic, 100–2560 m, maximum density at 600–1000 m.

Range. Japan and Bering Sea to Coronado Is., Baja California. Type locality Medny I., off Copper I.; Kamchatka.

***Bentheogennema burkenroadi* Krygier & Wasmer, 1975**

(Fig. 4E–I)

Bentheogennema burkenroadi Krygier & Wasmer, 1975: 737, figs. 1–3. — Butler 1980: 43. — Krygier & Percy 1981: 76. — Hendrickx & Estrada-Navarrete 1989: 106. — Hendrickx & Estrada-Navarrete 1996: 16, fig. 5 (extensive synonymy). — Pérez Farfante & Kensley, 1997: 58. — Wicksten 2002: 129.

Diagnosis. Similar to *B. borealis* except small tubercle on dorsal carina posterior to rostrum. Cervical, post-cervical grooves approaching each other closely on middorsal midline, interrupting middorsal carina. Third maxilliped with strong spine on last segment. Petasma with characteristic large accessory lobe, with terminal hook in adult. Thelycum with pentagonal plate on eighth thoracic sternite, elevated triangular plate on sixth sternite. Telson with pair movable spines. Total length 59–66 mm.

Color in life. Deep to medium red, small flecks of purple on third maxilliped, pereopods, ventral surfaces of abdominal somites, bases of pleopods.

Habitat and depth. Pelagic, 0–2000 m, most abundant between 100–500 m.

Range. British Columbia to Seamount 350 (23°5.4' N, 124°56.9' W) off Baja California and mid-North Pacific. Type locality west of British Columbia (51°26' N, 128°28' W).

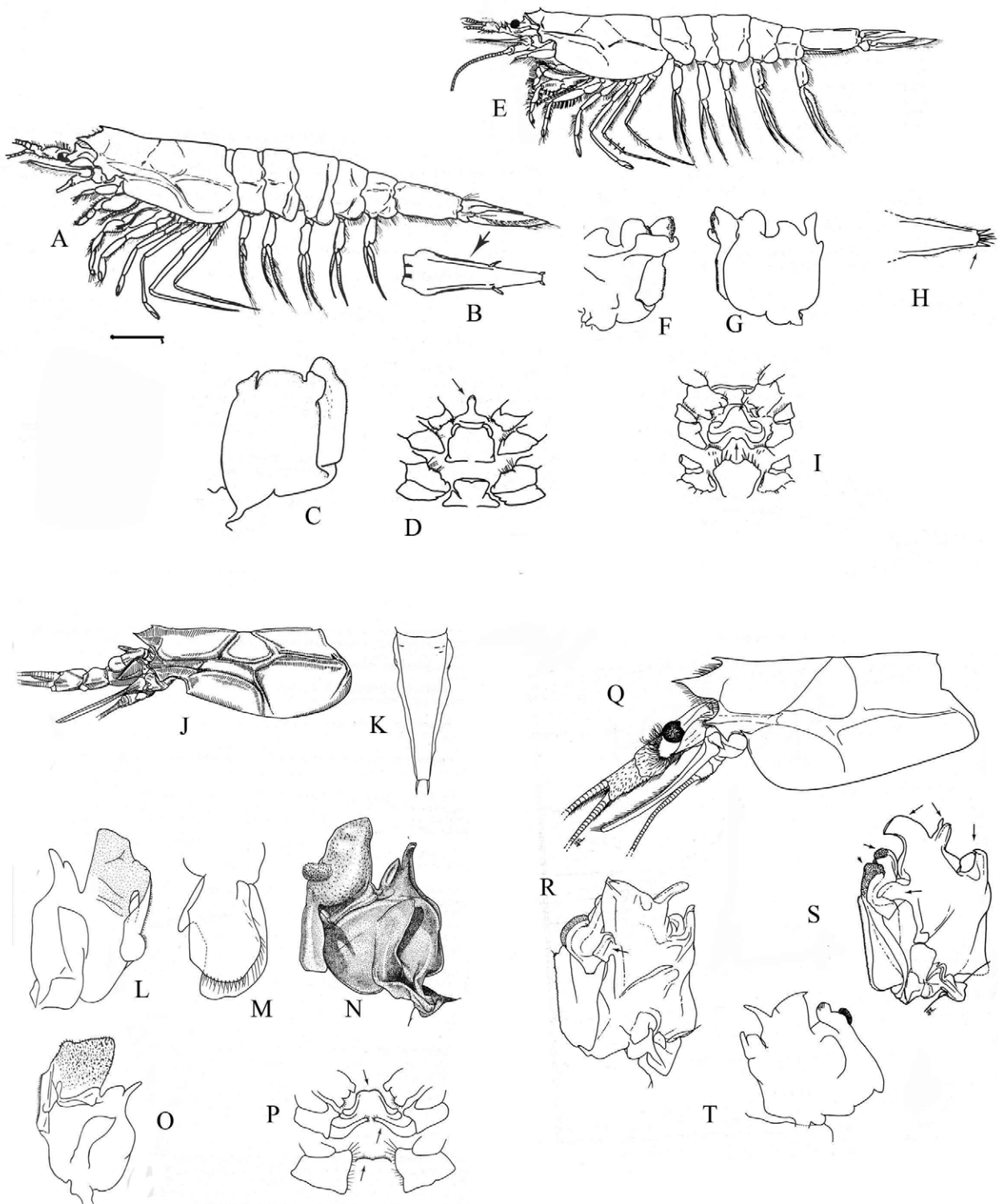


FIGURE 4. Family Benthescymidae. A–D, *Benthogennema borealis* (Rathbun, 1902); A, entire animal in lateral view; B, dorsal view of telson; C, petasma; D, thelycum. E–I, *Benthogennema burkenroadi* Krygier & Wasmer, 1975; E, entire animal in lateral view; F, petasma in anterior view; G, petasma in posterior view; H, detail of telson; I, thelycum. J–P, *Benthogennema pasithea* (de Man, 1907); J, carapace, eye and antennae in lateral view; K, telson in dorsal view; L, N, O, petasma in different orientations; M, detail of appendix masculina; P, thelycum. Q–T, *Gennadas propinquus* Rathbun, 1906; Q, carapace, antennae and eye in lateral view; R–T, petasma in different orientations. Scale = 3 mm. Arrows indicate distinctive features. Adapted from Hendrickx & Estrada-Navrrete 1996.

***Bentheogennema pasithea* (de Man, 1907)**

(Fig. 4J–P)

Gennadas pasithea de Man, 1907: 146.

Bentheogennema pasithea. — Anderson & Lindner 1943: 295. — Ebeling *et al.* 1969: 12. — Crosnier 1978: 31, figs. 13c, d. — Hendrickx & Estrada-Navarrete 1989: 106. — Hendrickx & Estrada-Navarrete 1996: 18, fig. 6. — Pérez Farfante & Kensley 1997: 129. — Guzmán & Wicksten 2000: 927. — Wicksten 2002: 129.

Diagnosis. Similar to *B. borealis* except small tubercle on dorsal midline posterior to rostrum. Cervical, post-cervical grooves approaching each other on dorsal surface, interrupting mid-dorsal carina. Petasma with smaller accessory lobe, without terminal hook. Thelycum with rectangular-rounded plates on sixth, eighth thoracic sternites. Telson with 1–3 pairs terminal-lateral spines. Total length 41 mm.

Color in life. Red with blue spots on appendages.

Habitat and depth. Pelagic, below 1000 m.

Range. Indo-West Pacific, off Santa Catalina I., California (*Velero IV* sta. 10696-65, LACM) south to Dowd Tablemount (13° 9' N, 119° 48' W) off western Mexico; Chile. Type locality "off Indonesia."

Gennadas Bate, 1881

***Gennadas incertus* (Balss, 1927)**

(Fig. 5A, B, G)

Amalopenaeus incertus Balss, 1927: 265, figs. 24-29.

Gennadas incertus. — Anderson & Lindner 1943: 294. — Percy & Forss 1966: 1137. — Ebeling *et al.* 1969: 12. — Kensley 1972: 12, 14, figs. 4i, 5j. — Crosnier 1978: 37, figs. 15b, 19a. — Krygier & Percy 1981: 78. — Hendrickx & Estrada-Navarrete 1989: 107. — Hendrickx & Estrada-Navarrete 1996: 27, fig. 13 (extensive synonymy). — Pérez Farfante & Kensley 1997: 66. — Guzmán & Wicksten 2000: 928. — Wicksten 2002: 129.

Diagnosis (translated from Balss 1927). Carapace with branchiostegal tooth. Median carina of carapace extending to posterior margin. Abdominal somite 6 with dorsal carina. Petasma characteristic, with external lobe in two parts, forming 2 long points; of two parts of medial lobe, outer one small, narrow; inner part more broad. Accessory lobe well developed. Hooks on inner border equally shaped, of same length. Total length 25 mm.

Color in life. Bright red, with blue spots on appendages. Petasma may have purple tinge.

Habitat and depth. Pelagic, by day, 400–900 m, by night, 100–200 m; usually at 500–1000 m off Oregon.

Range. Indo-West Pacific, off Oregon to southern Baja California, Chile. Type locality not specified, near the Seychelles Is., Indian Ocean (4° 34' S, 53° 42' E and 4° 45' S, 48° 58' E).

***Gennadas propinquus* Rathbun, 1906**

(Fig. 4Q–T, 5 H)

Gennadas propinquus Rathbun, 1906: 907, fig. 61a,b. — Anderson & Lindner 1943: 295. — Percy & Forss 1966: 1137. — Ebeling *et al.* 1969: 12. — Crosnier 1978: 38, figs. 16b, 18d,e. — Krygier & Percy 1981: 77. — Hendrickx & Estrada-Navarrete 1989: 107; 1996: 29, fig. 15 (extensive synonymy). — Pérez Farfante & Kensley 1997: 66. — Guzmán & Wicksten 2000: 927. — Wicksten 2002: 130.

Diagnosis. Similar to *G. sordidus* except rostrum, gastric tooth slender. Stylocerite slender. Antennular peduncle pubescent. Thelycum with large subtriangular shield between bases of pereopods 3, followed by narrow transverse plate and then subcordate disk between pereopods 5. Total length 32 mm.

Color in life. Bright red, blue spots on appendages.

Habitat and depth. Pelagic, surface to 1200 m, by day, above 100 m and below 500 m at night, usually at 200–1000 m off Oregon.

Range. Indo-West Pacific, Oregon to vicinity of Magdalena Bay, Baja California; Chile, eastern Atlantic, off South Africa. Common in southern California. Type locality between Erben Bank and Kaiwi Channel, Hawaiian Is.

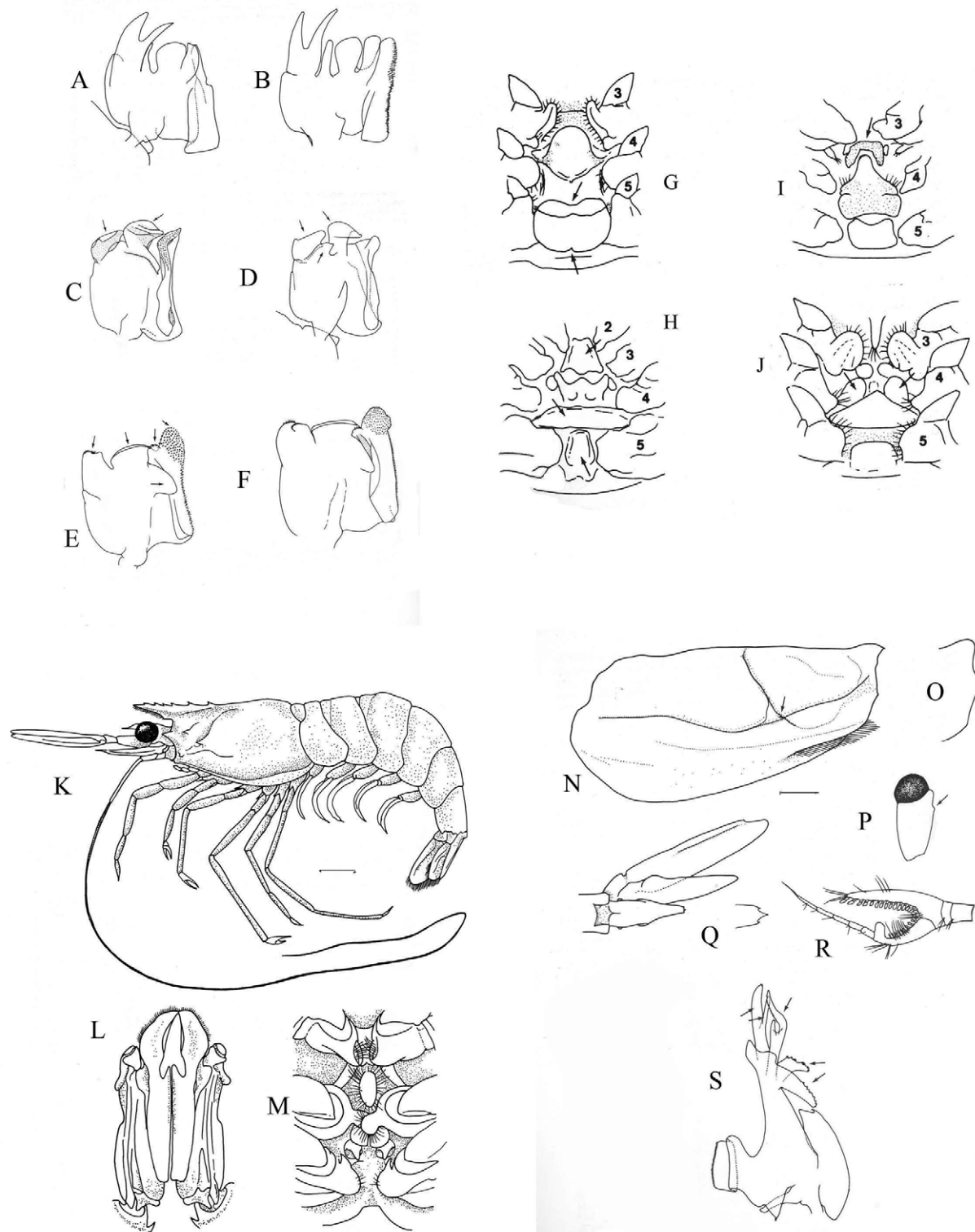


FIGURE 5. Families Benthesciymidae and Sergestidae. A, B, G, *Gennadas incertus* (Balss, 1927); A, B, petasma; F, G, thelycum. C, D, I, *Gennadas sordidus* Kemp, 1910; C, D, petasma; I, thelycum. E, F, J, *Gennadas tinayrei* Bouvier, 1906; E, petasma; J, thelycum. H, *Gennadas propinquus* Rathbun, 1906; thelycum. K–M, *Solenocera mutator* Burkenroad, 1938; K, shrimp in lateral view; L, petasma; M, thelycum. N–S, *Petalidium suspiciosum* Burkenroad, 1937; N, carapace in lateral view; O, detail of front; P, ocular peduncle; Q, telson and uropod with detail of tip of telson; R, lower antennular flagellum; S, petasma. Scales: N = 2mm, K = 10 mm. A–J, N–S from Hendrickx & Estrada-Navarrete 1996; K–M from Hendrickx 1996.

***Gennadas sordidus* Kemp, 1910**

(Fig. 5C, D)

Gennadas sordidus Kemp, 1910: 177, pl. 13, fig. 13. — Anderson & Lindner 1943: 291. — Ebeling *et al.* 1969: 12. — Hendrickx & Estrada-Navarrete 1989: 107; 1996: 34, fig. 19. — Pérez Farfante & Kensley 1997: 66. — Guzmán & Wicksten 2000: 929. — Wicksten 2002: 130.

Diagnosis. Rostrum short, with one dorsal tooth, acute apex. Carapace with blunt antennal angle, sharp infra-antennal angle, small branchiostegal tooth. Cervical, post-cervical grooves separated on dorsal midline by distance equal to 0.2 times distance from post-cervical groove to posterior margin of carapace. Mid-dorsal carina inconspicuous posterior to post-cervical groove. Scaphocerite 3 times as long as wide and terminating in small tooth, blade exceeding lateral tooth. Pereopod 1 chela as long as carpus, chela of pereopod 2, 0.66 times length of carpus; chela of pereopod 3, 0.5 times length of carpus. Abdominal somite 6 with dorsal carina. Apex of telson truncate, with 4 or 5 pairs plumose setae. Petasma with distinctive spoon-shaped portion directed forward from middle of distal margin of each lobe. Male total length to 24 mm, female not reported.

Color in life. Bright red, with blue spots on appendages.

Habitat and depth. Pelagic, 0–915 m.

Range. Indian Ocean, San Pedro Basin, California to Revillagigedo Is.; Gulf of California, Chile. Syntypes came from off Laccadive Is. and northeast of Ceylon (Sri Lanka).

***Gennadas tinayrei* Bouvier, 1906**

(Fig. 5E, F, J)

Gennadas tinayrei Bouvier, 1906. — Anderson & Lindner 1943: 293. — Kensley 1972: 12, figs. 4b, 5c. — Crosnier & Forest 1973: 281. — Crosnier 1978: 44, figs. 17b, 19d. — Krygier & Percy 1981: 78. — Hendrickx & Estrada-Navarrete 1989: 107; 1996: 36, fig. 9, 21, 23A. — Pérez Farfante & Kensley 1997: 66. — Guzmán & Wicksten 2000: 929. — Wicksten 2002: 130.

Diagnosis. Similar to *G. sordidus* except thelycum with posteriorly directed tongue-like process on fifth thoracic sternite. Petasma with median lobe undivided, convex; external lobe divided with division marked by closely approximated blunt lobules. Total length 20 mm.

Color in life. Not reported.

Habitat and depth. Pelagic, 90–1400 m.

Range. Off Oregon to Baja California, Chile, Atlantic and Indian oceans. Type locality Cape Verde Is.

Family Penaeidae Rafinesque, 1815

The family Penaeidae includes many of the large, edible shrimps taken commercially by trawling. They are common from the Gulf of California to Peru. Hendrickx (1996) provided keys, illustrations and information on range, depth and key characteristics of eastern Pacific species. Only one species, *Farfantepenaeus californiensis* (Holmes, 1900) occurs regularly in California. Although it is large and edible, it rarely occurs in California in sufficient quantities to support a fishery. Montagne & Cadien (2001) reported a single specimen of *Metapenaeopsis mineri* Burkenroad, 1834 from off the mouth of the Tijuana River in San Diego County, California in 1998. This species is much smaller than *F. californiensis* and lacks ventral teeth on the rostrum.

***Farfantepenaeus* Pérez Farfante & Kensley, 1997**

***Farfantepenaeus californiensis* (Holmes, 1900)**

(Pl. 1C)

Penaeus californiensis Holmes, 1900: 218, pl. 4, figs. 64–69. — Anderson & Lindner 1943: 307. — Word & Charwat 1976: 17.

— Kerstitch 1989: 82, fig. 201. — Jensen 1995: 79, fig. 162,
Penaeus (Farfantepenaeus) californiensis. — Méndez 1981: 50, pl. 14, figs. 111–113. — Von Sternberg & Motoh 1995: 146.
— Hendrickx 1996: 35, fig. 17.
Farfantepenaeus californiensis. — Pérez Farfante & Kensley 1997: 79. — Wicksten & Hendrickx 2003: 57.
Penaeus brevirostris Rathbun 1904: 146. — Schmitt 1921: 21, fig. 9 [not *Penaeus brevirostris* Kingsley, 1878; tropical eastern Pacific species].

Diagnosis. Rostrum longer than eye, with 9–11 dorsal and 2 or 3 ventral teeth, extending posteriorly as carina along dorsal midline of carapace, grooves parallel to rostrum and carina. Carapace with antennal tooth, pterygostomian margin produced forward into blunt knob, carina running posteriorly from antennal tooth, grooves posterior to orbit and near hepatic spine. Stylocerite longer than eye. Scaphocerite with tapered apex. Third maxilliped with long exopod, pereopods with exopods. Pereopods 1–3 chelate, pereopods 4, 5 with simple dactyls. Pleura of abdominal somites 1–5 blunt, that of somite 6 with posterodorsal and posterolateral points, part of abdominal somite 4 and all of abdominal somites 5, 6 with dorsal carina. Telson shorter than uropods, with dorsal groove. Total length 88–201 mm.

Color in life. Rose brown, sometimes with dull brown vertical stripes on abdominal somites.

Habitat and depth. Sand and mud bottoms of bays to continental shelf, 2–180 m.

Range. San Francisco Bay, California to Callao, Peru, but uncommon in California. Type locality Anaheim and San Francisco bays, California.

Remarks. *Farfantepenaeus californiensis* usually occurs north of Point Conception in years of particularly warm currents. The species has been found in channels of cooling waters from steam-generating power plants.

Family Sicyonidae Ortmann, 1898

Sometimes called rock shrimps, members of this family usually have a well-calcified exoskeleton. The dorsal midline of the carapace and abdomen bear a carina, often with prominent teeth. The rostrum is conspicuous. In life, these shrimps bury into sand or shelly sand. They are edible, and are fished commercially in many warm-temperate areas worldwide.

The only species of this family resident in the area is *Sicyonia ingentis*. Two other species have been collected in southern California during El Niño periods. *Sicyonia penicillata* Lockington, 1879 has been collected from the Palos Verdes Peninsula to off Torrey Pines State Beach, San Diego County (Montagne & Cadien 2001, fig. 1.) This species has a large dark spot on the branchial region of the carapace. Divers have photographed occasional individuals of *S. picta* Faxon, 1893 off Santa Catalina I., California. This species has a large eye-like marking on the posterolateral part of the carapace. Unlike *S. penicillata*, *S. picta* has no tooth on the dorsal midpoint of the carapace. See Hendrickx (1996: figs. 56, 58) for illustrations. Both of these species usually range from the Gulf of California and the southern end of Baja California, Mexico southward.

Sicyonia H. Milne Edwards, 1830

Sicyonia ingentis (Burkenroad, 1938)

(Pl. 1A)

Eusicyonia ingentis Burkenroad, 1938: 88, figs. 31–34. — Anderson & Lindner 1945: 318.

Sicyonia ingentis. — Word & Charwat 1976: 19. — Wicksten 1980c: 360. — Pérez Farfante 1985: 69, figs. 52, 57–60. — Hendrickx 1996: 94, fig. 48, pl. 2B. — Pérez Farfante & Kensley 1997: 156. — Wicksten & Hendrickx 2003: 58.

Diagnosis. Rostrum longer than cornea of eye, with 3 dorsal, 2–3 apical teeth. Carapace with dorsomedial carina bearing small tooth posterior to mid-carapace, with antennal tooth, hepatic spine; postorbital, hepatic grooves; hepatic, branchiocardiac carinae. Stylocerite longer than eye. Scaphocerite with lateral tooth exceeding blade, blade rounded. Third maxilliped slender, setose. Pereopods 1–3 chelate, third longest of them; pereopods 4, 5 with simple dactyls. Abdominal somite 1 with small dorsal tooth on anterior margin, all abdominal somites with vertical grooves, dorsomedial carinae. Pleura of abdominal somites 1–3 rounded to slightly pointed, pleura of somites 4–6

ending in sharp posterolateral teeth. Abdominal somite 6 with carina ending in sharp point. Telson shorter than uropods, with deep median groove, pair small subterminal spines. Total length 157–180 mm.

Color in life. Reddish-brown, bases of pereopods banded with brick red, distal parts of pereopods yellow; light vertical yellow lines along margins of first to fourth abdominal pleura.

Habitat and depth. Usually sandy substrates, but also on shell or mud, 5–307 m, in California, most abundant at 55–82 m.

Range. Monterey Bay, California to Maria Madre I., Nayarit, Mexico, including central and southern Gulf of California. Type locality off east coast of Cedros I., Baja California.

Remarks. Holthuis (1952c) validated the use of the generic name *Sicyonia* instead of *Eusicyonia*.

It seems odd that Schmitt (1921) made no mention of *S. ingentis* in his work on decapods of California. Today, *S. ingentis* is commonly taken in trawls off southern California and has at times supported a commercial fishery. The abundance of the species has varied over the past 30 years (D. Cadien, Los Angeles County Sanitation district, pers. comm.)

Family Solenoceridae Wood-Mason, 1891

Species of this family bear a unique postorbital tooth. In life, the flagella of the antenna are as long as the body. Only one species occasionally occurs in California. Most records come from the Gulf of California and farther south along the coasts of Mexico and Central America.

Solenocera Lucas, 1850

Solenocera mutator Burkenroad, 1938

(Fig. 5K–M)

Solenocera mutator Burkenroad, 1938: 6, figs. 2–5. — Anderson & Lindner 1943: 288. — Méndez 1981: 57, pl. 21, figs. 169–171. — Wicksten 1988: 241. — Hendrickx 1996: 126, fig. 64. — Pérez Farfante & Kensley 1997: 182. — Wicksten & Hendrickx 2003: 59.

Diagnosis. Rostrum about as long as eye, with 7 dorsal, no ventral teeth, acute apex.

Carapace with postorbital, antennal, pterygostomial teeth, grooves near base of rostrum, cervical groove. Stylocerite about as long as eye. Antennular flagellum flattened. Stylocerite with tapered apex. Third maxillipeds long, slender. All pereopods with exopods. Pereopods 1–3 shorter than pereopods 4,5, chelate; pereopods 4,5 very slender with simple dactyls. Pleura of abdominal somites 1–3 rounded, pleura of somites 4,5 with acute distolateral margins, sixth ending in small distolateral spine. Telson shorter than uropods. Total length 42.5–61 mm.

Color in life. Not reported.

Habitat and depth. Sand or mud, 11–190 m.

Range. Off Santa Barbara Point, California to Lobos de Tierra I., Peru. Type locality southern Baja California, Mexico.

SUPERFAMILY SERGESTOIDEA Dana, 1852

Family Sergestidae Dana, 1852

Sergestids are widespread pelagic shrimp. The second abdominal somite does not overlap the first. Males have a petasma, females have a sperm receptacle between the third or third and fourth pereopods. In the male, the inner antennular flagellum is modified as a prehensile clasping organ used in copulation. The rostrum is short. Neither the third maxilliped nor the pereopods bear exopods. Pereopods 4, 5 are shorter than the anterior pereopods.

Two color patterns are common among the species: partly pigmented, with red pigment in the anterior body and translucent appendages and abdomen with small pigment spots; and solid bright red. The partly pigmented

species occur at lesser depths than the bright red ones, which often live at depths of 500 m or more. Many species carry on daily vertical migrations, occurring at lesser depths during the night than by day.

Sergestids have extremely long antennal flagella in life. In *Eusergestes similis*, the antennae are extended during swimming. These flagella bear a kink at about half the length of the flagella. The antennae are well supplied with small sensory endings, which may detect prey by vibration or chemosensation, or may provide warning of approaching predators (Cowles 1994). Sergestids are primarily predators, especially of copepods. They also eat ostracods, euphausiids, pteropods, chaetognaths and cnidarians (Flock & Hopkins 1992).

Much of the classification of sergestids is based on the shape of the copulatory structures. The key given here follows those of Wasmer (1972) and Kensley (1972), but also applies the nomenclature of the genera given by Judkins & Kensley (2008).

Key to species of family Sergestidae

1. Arthrobranches of up to 13 rami, lamellae relatively large and independent in appearance; petasma with processus ventralis forked *Petalidium suspiriosum*
- Arthrobranches with more than 13 rami, lamellae small and closely spaced; petasma with processus ventralis not forked 2
2. Organs of Pesta present, without dermal photophores. Ovary confined to cephalothorax. Supraorbital and hepatic spines present or absent 3
- Organs of Pesta absent, with or without dermal photophores. Ovary may extend into abdomen. Supraorbital and hepatic spines absent 6
3. Third maxilliped at least as long as pereopod 3 4
- Third maxilliped not as long as pereopod 3 *Eusergestes similis*
4. Third maxilliped as long as entire body anterior to posterior half of abdominal somite 6 *Parasergestes halia*
- Third maxilliped not as long as entire body anterior to posterior half of abdominal somite 6 5
5. Basal segment of third maxilliped swollen. Inner uropod without setose margin *Allosergestes pestifer*
- Basal segment of third maxilliped slender. Inner uropod with setose margin *Neosergestes consobrinus* (Milne)
6. Dermal photophores absent 7
- Dermal photophores present 8
7. Posterior to cervical groove, lateral groove of carapace having dorsal branch. Cornea of eye not much wider than eyestalk *Sergia japonica*
- Posterior to cervical groove, lateral groove of carapace without dorsal branch. Cornea of eye wider than eyestalk *Sergia laminata*
8. Body slender. Second and third segments of antennular peduncle not short, thick *Sergia tenuiremis*
- Body compact. Second and third segments of antennular peduncle short, thick *Sergia phorca*

Allosergestes Judkins & Kensley, 2008

Allosergestes pestifer (Burkenroad, 1937)

(Fig. 6A–E)

Sergestes pestifer Burkenroad, 1937: 318, figs. 1–3. — Ebeling *et al.* 1969: 12. — Hendrickx & Navarrete 1989: 109; 1996: 56, fig. 36. — Pérez Farfante & Kensey 1997: 197.

Allosergestes pestifer. — Judkins & Kensley 2008: 75.

Diagnosis. Carapace with supraorbital tooth, hepatic spine. Distal articles of antennular peduncle long, slender, shorter than basal segment. Third maxilliped long, basally swollen, ultimate segment shorter than penultimate, both with many spines on 1 side but few on other; dactyl with 5 subsegments, inner margin of antepenultimate subsegment with 8 spines in male, 11–12 in female. Ischium of pereopods 1, 2 with spine on outer margin. Carpus of first legs shorter than propodus. Pereopods 2, 3 minutely chelate, fixed finger shorter than mobile finger, palm with longitudinal series of long setae. Precoxa of pereopod 3 of female with spur. Pereopod 5 with distal 2 segments setose on both margins. Telson with terminal point, 1 pair dorsolateral spinules. External uropods with setose margin 1.5 times length of area without setae, without tooth or spinule. Total length 37 mm.

Color in life. Partly transparent, with red chromatophores mostly on cephalothorax.

Habitat. Pelagic to 1100 m.

Range. Off Santa Catalina I., California (*Velero IV* sta. 8031-62), outer coast of Baja California, to Galapagos Is. Type locality north of Clarion I., Mexico (20°36' N, 115° 7' W).

***Eusergestes* Judkins & Kensley, 2008**

***Eusergestes similis* (Hansen, 1903)**

(Fig. 6F–N)

Sergestes similis Hansen, 1903: 60, pl. 11, figs. 6a–d. — Schmitt 1921: 19, fig. 8. — Burkenroad 1937: 321. — Ebeling *et al.* 1969: 12. — Percy & Forss 1969: 755. — Word & Charwat 1976: 29. — Butler 1980: 47. — Krygier & Percy 1981: 73. — Hendrickx & Estrada-Navarrete 1989: 109; 1996: 61, fig. 39. — Pérez Farfante & Kensley 1997: 197. — Wicksten 2002: 131.

Eusergestes similis.—Judkins & Kensley 2008: 76.

Diagnosis (after Butler 1980). Rostrum sharply pointed, angled upward obliquely. Carapace with prominent supraorbital tooth, moderate hepatic spine. Five organs of Pesta present: prominent anterolateral pair, lateral midgastric pair, single posterolateral organ. Antennular peduncle slender. Scaphocerite not reaching end of third segment of antennular peduncle. Second maxilliped short, stout. Third maxilliped barely longer than third pereopod; dactyl of third maxilliped with 8 subsegments. Pereopods slender, pereopod 3 longer than others. Pereopods 4, 5 setose, each without dactyl. Abdominal somites with lateral sulci (difficult to see in preserved material). Telson shorter than uropods, with acute apex. Outer uropod without setae on outer margin. Total length 57–61 mm.

Color in life. Transparent with orange-red spots over carapace and abdomen, telson, uropods and bases of appendages (Butler 1980, color plate 1).

Habitat and depth. Pelagic, 50–2400 m, usually above 1000 m, between 200–600 m by day and 50–200 m by night.

Range. Japan, Bering Sea to Gulf of California, off Chile, eastern South Atlantic in Benguela Current. Type locality "off Japan."

Remarks. This is one of the most common sergestids in California and Oregon. Cowles (1994) provided a detailed account of its swimming behavior.

***Neosergestes* Judkins & Kensley, 2008**

***Neosergestes consobrinus* (Milne, 1968)**

(Fig. 6O–R)

Sergestes consobrinus Milne, 1968: 26, figs. 5–9. — Walters 1976: 813. — Judkins 1978: 16, figs. 9–11 (extensive synonymy). — Hendrickx & Estrada-Navarrete 1989: 108; 1996: 45, fig. 27. — Pérez Farfante & Kensley 1997: 196. — Wicksten 2002: 131.

Neosergestes consobrinus. — Judkins & Kensley 2008: 76.

Diagnosis. Exoskeleton fragile. Rostrum short, with single terminal tooth barely reaching beyond base of eyestalk. Carapace with hepatic spine, surpaorbital tooth, branchial, hepatic, anterior ridges; weak cervical, postcervical grooves. Eye pigmented. Antennular peduncle long, slender; basal segment wider than other segments. Scaphocerite long, tapering, with small terminal point. Third maxilliped longer, stouter than pereopod 3, propodus with 2 subsegments, dactyl with 6 subsegments. Pereopods 1–3 slender, increasing in size posteriorly, with weak chelae. Pereopods 4, 5 laterally flattened, setose. Organs of Pesta consisting of single anterior midventral organ, 3 pairs located anterolaterally, midlaterally, posterolaterally. Abdominal pleura with rounded margins bearing setae, sixth somite ending in weak point. Telson shorter than uropods, without spines, with rounded apex. Outer uropod with setae along entire outer margin. Total length 18 mm.

Color in life. Partly red, especially cephalothorax, and partially transparent.

Habitat and depth. Pelagic, 20–400 m, maximal abundance at 120 m. Walters (1976) reported that the majority of captures of this species off the Hawaiian Is., were made during shallow night tows from the surface to 75 m. The shrimp was broadly distributed from 450 to 725 m during daylight hours.

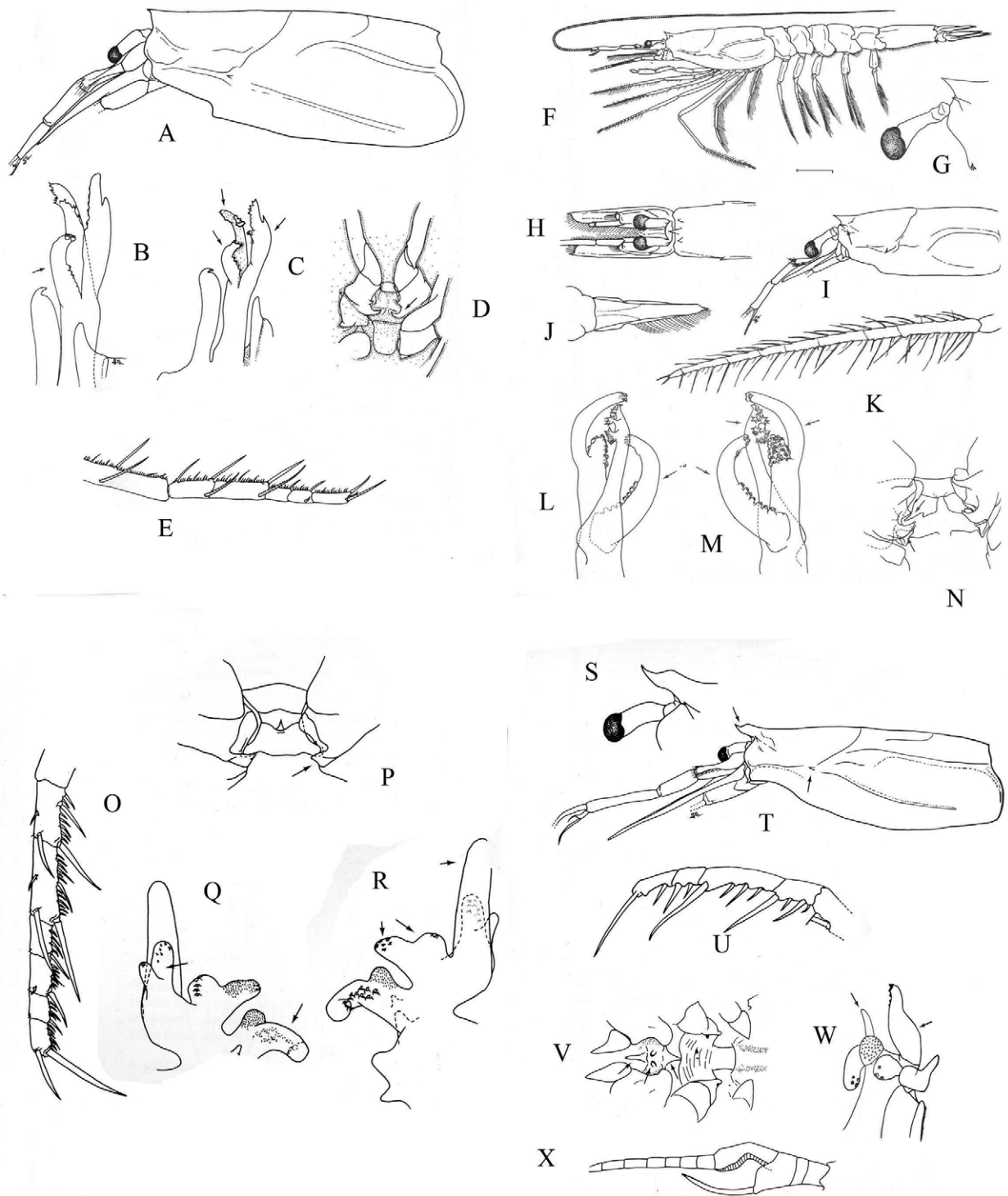


FIGURE 6. Family Sergestidae. A–E, *Allosergestes pestifer* Burkenroad, 1937; A, carapace, eye and antennae in lateral view; B, C, petasma; D, thelycum; E, dactyl of third maxilliped. F–N, *Eusergestes similis* (Hansen, 1903); F, entire shrimp in lateral view; G, ocular peduncle; H, frontal region in dorsal view; I, frontal region in lateral view; J, telson in dorsal view; K, dactyl of third maxilliped; L–M, petasma; N, thelycum. O–R, *Neosergestes consobrinus* (Milne, 1968); O, dactyl of third maxilliped; P, thelycum; Q, R, petasma. S–X, *Parasergestes halia* (Faxon, 1893); S, detail of ocular peduncle and rostrum; T, carapace, eye and antennae in lateral view; U, dactyl of third maxilliped; V, thelycum; W, petasma; X, lower antennular flagellum. Scale F= 20 mm. From Hendrickx & Estrada-Navarrete 1996.

Range. California Current and central Pacific between 41° (northern California) and 17° N (state of Michoacan, Mexico); northwestern Pacific. Type locality off southern California (33° 44' N, 124° 53' W).

Remarks. This species has been confused with *Sergestes edwardsi* Kröyer, 1855 (now considered to inhabit the Atlantic). Judkins (1978) provided a more detailed description.

***Parasergestes* Judkins & Kensley, 2008**

***Parasergestes halia* (Faxon, 1893)**

(Fig. 6S–X)

Sergestes halia Faxon, 1893: 217. — Burkenroad 1937: 320, text figs. 4–5. — Hendrickx & Estrada-Navarrete 1989: 108; 1996: 49, fig. 32. — Pérez Farfante & Kensley 1997: 197.

Sergestes edwardsii Faxon 1895: 212, pl. 51, fig. 1 [not *Sergestes edwardsi* Kröyer, 1855, Atlantic species].

Parasergestes halia. — Judkins & Kensley 2008: 77.

Diagnosis. Body slender, smooth. Rostrum short, obliquely pointed, ending in tiny tooth. Carapace with supraorbital tooth, hepatic spine, antennal, branchial carinae; gastro-hepatic groove faint on dorsal part of carapace, dorsal part of cervical groove faint. Eye pigmented. Scaphocerite narrow, elongate, spine slightly longer than very narrow distal end of blade. Second, third maxillipeds robust, third especially long, greatly exceeding pereopods. Pereopods 1–3 slender, chelate; pereopods 4, 5 slender, pereopod 5 very short. Abdominal somites rounded. Telson with dorsal groove, blunt apex. No setae on outer margin of outer uropod. Total length 37 mm.

Color in life. Not reported.

Habitat and depth. Pelagic, surface to 1617 m.

Range. Southern California (LACM, unpublished record), Gulf of California to Gulf of Panama. Type material came from various stations in the Gulf of Panama.

Remarks. The illustration given by Faxon (1895, pl. 51) shows a blunt rostrum, but both the figures by Burkenroad (1937) and a specimen examined from off Socorro I., Mexico had a rostrum ending in a small tooth.

***Petalidium* Bate, 1881**

***Petalidium suspiriosum* Burkenroad, 1937**

(Fig. 5 N–S)

Petalidium suspiriosum Burkenroad, 1937: 325, figs. 8–12. — Ebeling *et al.* 1969:12. — Walters 1976: 824. — Word & Charwat 1976: 27. — Krygier & Percy 1981: 76. — Hendrickx & Estrada-Navarrete 1989: 110; 1996: 75, fig. 47. — Pérez Farfante & Kensley 1997: 193. — Wicksten 2002: 131.

Diagnosis. Rostrum short, with 1 or 2 terminal teeth, rising abruptly from plane of carapace. Carapace with hepatic spine, points at antennal, branchiostegal, pterygostomial angles; strong carina running posteriorly from eyestalk toward posterior margin; cervical, gastro-cardiac grooves present. Eye pigmented. First segment of antennular peduncle concave, male with hooked antennular flagellum. Scaphocerite with blade exceeding blunt spine. Antennal flagellum long. Second maxilliped with strong, dense, dark setae along margin of last two segments. Third maxilliped and pereopods with very long setae. Abdominal somite 6 ending in terminal point, another point on ventrolateral margin. Telson with pair lateral points near acute apex. Outer uropod without setae on outer margin. Total length 38 mm.

Color in life. Red to purplish red; black pigment fleck present in dorsal view on ocular segment between eye.

Habitat and depth. Pelagic, 150–1750 m, maximum population density off Oregon at 600–1000 m. Walters (1976) reported that off the Hawaiian Is. this species was non-migratory and usually lived below 800 m.

Range. Hawaiian Is., northwestern Pacific Ocean, Oregon to Clarion I., Mexico. Type locality north of Clarion I.: 20° 36' N, 115° 07' W.

Remarks. This may be the species reported as "*Sergestes* sp. indet." by Rathbun (1904) and Schmitt (1921).

Sergia Stimpson, 1859

Sergia japonica (Bate, 1881)

(Fig. 7B–D)

Sergestes japonicus Bate, 1881: 194.

Sergestes (*Sergia*) *japonicus*. — Crosnier & Forest 1973: 341, figs. 113c, 117 (extensive synonymy).

Sergia japonicus. — Krygier & Percy 1981: 76. — Flock & Hopkins 1992: 214.

Sergia japonica. — Pérez Farfante & Kensley 1997: 200. — Wicksten 2002: 131.

Diagnosis. Similar to *S. tenuiremis* except rostrum short, blunt. Eyestalk long, overreaching stylocerite; cornea small. Carapace with cervical groove reaching from middorsal surface to lateral groove, lateral groove divided posterior to cervical groove with dorsal section extending nearly to posterior of carapace, ventral groove ending short of ventral margin. Telson as long as endopod of uropods. Female total length about 75 mm.

Color in life. Not reported.

Habitat and depth. Pelagic, 0–1000 m but usually deeper than 500 m. Taken at 850–1000 m off Oregon.

Range. Japan to Philippines, New Zealand, off British Columbia and Oregon, Newfoundland to Gulf of Mexico, west of Scotland to off Angola, Mediterranean. Type locality "south of Japan."

Sergia laminata (Burkenroad, 1940)

(Fig. 7E–H)

Sergestes laminatus Burkenroad, 1940: 53. — Ebeling *et al.* 1969: 12. — Kensley 1971: 251, figs. 18a–f.

Sergia laminata. — Hendrickx & Estrada-Navarrete 1989: 109; 1996: 69, fig. 43. — Pérez Farfante & Kensley 1997: 200. — Wicksten 2002: 132.

Sergia laminatus. — Wasmer 1993: 60, fig. 10.

Diagnosis. Similar to *S. tenuiremis* except dermal photophores absent. Rostrum blunt. Cornea of eye wider than eyestalk. Carapace with small hepatic tooth in juvenile, no supraorbital tooth. Cervical groove extending across dorsal surface of carapace. Anterolateral groove of carapace not quite meeting cervical groove, posterolateral groove ascending gradually toward posterior margin of carapace, without any branches; faint ventrolateral groove. Antennular peduncle slender. Scaphocerite not reaching end of third segment of antennular peduncle. Third maxilliped slender, not as long as third pereopod. Posterior pereopods slender, setose. Telson almost as long as inner uropod. Total length 36 mm.

Color in life. Red to purplish red, without black pigment fleck on ocular segment.

Habitat and depth. Pelagic, 0–1416 m.

Range. Indo-West Pacific, Japan, Tasman Sea, south of Australia, San Pedro Basin, California to Baja California; off west coast of Africa. Type locality off Baja California (*Dana* station 3933I).

Sergia phorca (Faxon, 1893)

(Fig. 7 I–K)

Sergestes phorcus Faxon, 1893: 217. — Burkenroad 1937: 323, figs. 6–7. — Ebeling *et al.* 1969: 12. — Méndez 1981: 59, pl. 22, figs. 172–176.

Sergestes bisulcatus: Faxon 1895: 210, pl. 52 [not *Sergestes bisulcatus* Wood-Mason, 1891, Indo-West Pacific species].

Sergia phorca. — Hendrickx & Estrada-Navarrete 1989: 110; 1996: 73, fig. 45.

Diagnosis. Exoskeleton smooth and membranous. Rostrum short, with tiny apical tooth. Carapace without supraorbital tooth and hepatic spine, with cervical, gastro-hepatic grooves; suprabranchial carina. Antennular peduncle stout, male with inner flagellum modified as prehensile organ. Scaphocerite with lateral tooth exceeding blade. Third maxilliped longer than first pereopod but shorter than third, dactyl with 8 subsegments. Pereopods 1–3 chelate, slender and setose, pereopods 4, 5 flattened, heavily setose. No organs of Pesta, photophores on ventral

surface of body. Ovary of female extending into abdomen. Faint carinae, grooves on lateral surfaces of abdominal somites, somite 6 with dorsal carina ending in small tooth. Telson shorter than uropods, with dorsal groove triangular apex, 2 or 3 pairs dorsolateral spines. Outer margin of outer exopod without setae. Total length 82 mm.

Color in life. Red with purple photophores.

Habitat and depth. Pelagic, 0–1100 m.

Range. Off Santa Catalina I., California (*Velero IV* sta. 7299-61, LACM) to Peru. Type locality came from five stations between east of Galapagos Is. (0° 59' 0" S, 86° 46' 0" W. *Albatross* sta. 3401) to south of Guaymas, Gulf of California (*Albatross* sta. 3437).

***Sergia tenuiremis* (Kröyer, 1855)**

(Fig. 7A)

Sergestes tenuiremis Kröyer, 1855: 30. — Illig 1927: 283, figs. 6–10.

Sergestes kroyeri Bate, 1881: 193.

Sergia kroyeri. — Krygier & Wasmer 1988: 72. — Hendrickx & Estrada-Navarrete 1989: 110.

Sergia tenuiremis. — Percy & Forss 1966: 1137. — Walters 1976: 823. — Butler 1980: 49. — Krygier & Percy 1981: 75. — Pérez-Farfante & Kensley 1997: 200.

Diagnosis (after Butler 1980). Body slender and compressed. Rostrum short, barely projecting beyond frontal margin, with apex blunt to acute, at times with small tooth on posterior dorsal surface. Carapace with lateral carina extending from branchiostegal to hepatic region, suprabranchial carina extending almost to posterior margin, sometimes branching ventrally and posteriorly above ventral margin of carapace, cervical sulcus conspicuous. Ventral margin of carapace concave. Eye moderately large, cornea well developed, with tubercle on inner margin of stalk. Peduncle of first antenna exceeding scaphocerite, stout, dorsal tubercle on first segment. Stylocerite short. Scaphocerite narrow, lateral tooth exceeding blade, basicerite with upper rounded lobe. Third maxilliped with setae on propodus, dactyl; dactyl with about 8 short, tapering segments. Pereopod 1 shorter than third maxilliped, slender, propodus and dactyl with setae on both margins, dactyl with 1 or 2 distal setae. Pereopod 2 slender but longer than first, propodus slender, with about 13 segments, minutely chelate. Pereopod 3 slightly longer than second, slender, propodus with setae, about 12 segments, minutely chelate. Pereopod 4 shorter than third, slender, with setae, propodus with blunt apex, no dactyl. Pereopod 5 shorter than pereopod 4, as slender, setose; propodus with blunt apex, no dactyl. Abdominal somite 1 with oblique lateral carina, somite 2 with short lateral carina, faint transverse sulcus, somite 3 with dorsoventral carina, transverse sulcus; somite 4 with v-shaped sulcus, somite 5 with arched lateral carina, oblique sulcus; somite 6 with dorsal posterior spine with slight carina, lateral carina, carina along ventral margin. Telson shorter than uropods, narrowing, with acute apex, 2 or 3 pairs dorsal spines, apex of inner uropod not reaching distolateral spine of outer uropod. Male total length about 63 mm, female 75 mm.

Color in life. Vermillion, darker red over most of telson and uropods.

Habitat and depth. Pelagic, 570–1000 m. Walters (1976) reported that off the Hawaiian Is., immature shrimp (carapace length less than 15 mm) were vertical migrators but most of the adults remained below 800 m.

Range. Northeast of New Zealand, Hawaiian Is., west coast of Vancouver I., off Oregon south to off Point Loma Light, San Diego County, California (*Velero IV* sta. 10996-66, LACM), Atlantic and Indian oceans. Type locality Greenland.

SUBORDER PLEOCYEMATA BURKENROAD, 1963

INFRAORDER STENOPODIDEA BATE, 1888

Family Stenopodidae Claus, 1872

The family includes the brightly colored coral shrimps (*Stenopus*) of tropical coral reefs. Only one member of the family has been found along the west coast of the United States. Related species occur in the eastern Pacific from the southern Gulf of California to the Galapagos Is.

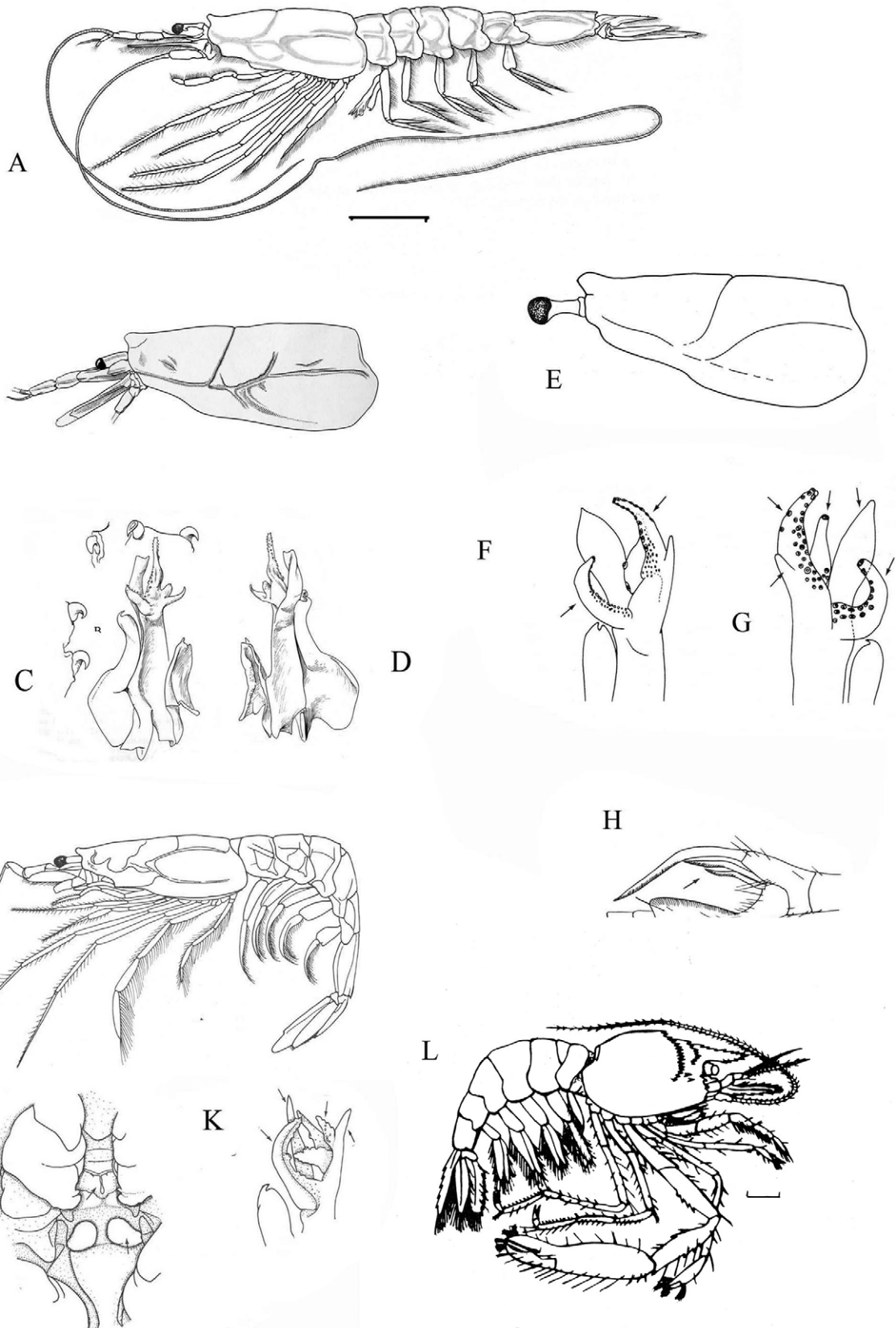


FIGURE 7. Families Sergestidae and Stenopodidae. A, *Sergia tenuiremis* (Kröyer, 1855); B–D, *Sergia japonica* (Bate, 1881); B, carapace, eye and antennae; C, D, petasma and details. E–H, *Sergia laminata* (Burkenroad, 1940); E, carapace and eye; F–G, petasma; H, lower antennular flagellum. I–K, *Sergia phorca* (Faxon, 1893); I, entire shrimp in lateral view; J, thelycum; K, petasma. L, *Odontozona spongicola* (Alcock & Anderson, 1899). Scales: L= 1 mm, A=10 mm. A from Butler 1980; B–D from Crosnier & Forest 1973, E–K from Hendrickx & Estrada-Navarrete 1996, L from Goy 1992.

Pereopod 3 is unusually large and heavily chelate in stenopodids. Individuals can be mistaken for small lobsters at first glance. The body often has rows of spines. The rostrum is toothed. Stenopodids often live in pairs, with a male and female occupying the same host sponge or shelter.

***Odontozona* Holthuis, 1946**

***Odontozona spongicola* (Alcock & Anderson, 1899)**

(Fig. 7 L)

?*Richardina spongicola* Alcock & Anderson, 1899: 291.

Richardina spongicola. — Alcock 1899: pl. 42, figs. 4, 4a.

Odontozona spongicola. — Holthuis 1946: 40. — Wicksten 1982c: 134. — Goy 1992: 2, fig. 1C.

Odontozona ? spongicola. — Wicksten 1989b: 311.

Diagnosis. Rostrum reaching end of antennular peduncle, with 6 dorsal and 4 ventral spines. Carapace with 3 teeth on anterior border, spines at base of rostrum, row of teeth at cervical groove, 2 hepatic spines. Eye without pigment, eyestalk with spinules. Scaphocerite with spinules. Third maxillipeds about as long as first pereopods. Pereopods 1–3 chelate, the third stronger, heavier than anterior two pairs. Pereopods without spines except for spinules on merus, carpus of pereopod 3. Pereopods 4, 5 having dactyls with 2 strong hooks. Abdominal somites smooth, rounded. Telson and outer uropod with spinules. Total length 17.2 mm.

Color in life. White to yellowish.

Habitat and depth. Symbiotic with deep-sea hexactinellid sponges, 496–900 m.

Range. Indian Ocean, northern Australia, Santa Catalina Is., California. Type locality Andaman Sea.

Remarks. One dredged specimen of *Odontozona spongicola* has been collected in California. The host sponge species was not reported.

INFRAORDER CARIDEA Dana, 1852

SUPERFAMILY PASIPHAEOIDEA Dana, 1852

Family Pasiphaeidae Dana, 1852

Pasiphaeids, sometimes called comb shrimps, get their common name from the unusual pectinate chelae, which have elongated fingers lined with comb-like rows of small spines. A few small tropical species live near the surface, but the species in the northeastern Pacific are generally found at 100 m or deeper. Some species migrate vertically to shallow depths at night. Color notes are from an unpublished key by J. Yaldwyn and fresh specimens from California unless otherwise noted.

Key to species of family Pasiphaeidae

- 1. Rostrum in form of postfrontal or epigastric tooth, carapace with branchiostegal tooth 2
- Rostrum arising from frontal margin of carapace, carapace without branchiostegal tooth 8
- 2. Carapace with middorsal carina not reaching posterior half *Pasiphaea affinis*
- Carapace with middorsal carina extending at least to posterior 0.66 of carapace 3
- 3. Telson truncate, not forked or notched 4
- Telson forked or notched 5
- 4. Abdominal somites 2–5 with dorsal carina *Pasiphaea magna*
- Abdominal somites 2–5 without dorsal carina *Pasiphaea chacei*
- 5. Branchiostegal tooth over angle of anterolateral sinus, not on or near anterior margin of carapace *Pasiphaea pacifica*
- Branchiostegal tooth near or on anterior margin of carapace and extending beyond it 6
- 6. Knob-like projection anterior to postfrontal tooth of carapace *Pasiphaea emarginata*
- No knob-like projection anterior to postfrontal tooth of carapace 7

7. Dorsal and ventral margins of carapace convex, postfrontal tooth horizontal *Pasiphaea tarda*
 – Dorsal and ventral margins of carapace straight and angled, postfrontal tooth almost vertical *Pasiphaea corteziana*
 8. Carapace with small teeth along entire dorsal midline *Eupasiphae serrata*
 – Carapace without small teeth along entire dorsal midline 9
 9. Dorsal carina of carapace with at most 1 or 2 teeth, fingers of second chela distinctly longer than palm
 *Parapasiphae cristata*
 – Dorsal carina of carapace without teeth, fingers of second chela not longer than palm *Parapasiphae sulcatifrons*

***Eupasiphae* Wood-Mason & Alcock, 1893**

***Eupasiphae serrata* (Rathbun, 1902)**

(Fig. 8 C)

Parapasiphae serrata Rathbun, 1902a: 904; 1904: 25, fig. 7. — Schmitt 1921: 31, fig. 18.

Eupasiphae serrata. — Crosnier 1988: 788, fig. 2b. — Hendrickx & Estrada-Navarrete 1989: 112. — Wicksten 2002: 133.

Diagnosis. Rostrum short, not exceeding eyestalk. Dorsal margin of carapace carinate to posterior 0.2 of its length, 16 small spinules, posterior dorsal groove, lateral carina running posteriorly from branchiostegal region, nearly joining another carina running horizontally along branchial region. Stylocerite much longer than eye. Scaphocerite with lateral tooth longer than blade. Third maxillipeds stout, shorter than first pereopod. Pereopods 1, 2 stout, chelate, with spinules on propodus and merus. Pereopod 3 thread-like, pereopods 4, 5 short, with flat dactyls. Abdominal somites 1–3 not carinate, somite 4 with carina, notch above strong posterodorsal tooth. Somite 5 not carinate, somite 6 not carinate but with longitudinal groove. Telson shorter than uropods, apex truncate. Total length 65 mm.

Color in life. Not reported.

Habitat and depth. Pelagic, 970–1800 m.

Range. Off Cortez Bank, California; southeast Atlantic. Type locality off Cortez Bank, California.

Remarks. Burukovsky (1987) and Guzmán & Wicksten (1998) noted that juveniles of a related species, *E. gilessi*, show strong morphological changes as they age. The shape of the carapace, number of rostral teeth, shape of the rostrum and size of the mandibular palp change as the shrimp grows. Very small individuals may not have a mandibular palp, which will cause them to be identified as species of *Pasiphaea* in the key to the genera of the Pasiphaeidae by Holthuis (1993). One should use caution in identifying juveniles of *E. serrata* or other pasiphaeids.

***Parapasiphae* Smith, 1884**

***Parapasiphae cristata* Smith, 1884**

(Fig. 8A)

Parapasiphae cristata Smith, 1884: 388, pl. V, fig. 3. — Word & Charwat 1976: 193. — Krygier & Percy 1981: 81. — Hendrickx & Estrada-Navarrete 1989: 112. — Wicksten 2002: 133.

Diagnosis. Rostrum extending to cornea of eye. Dorsal carina of carapace with at most 1 or 2 teeth. Groove along branchial region. Cornea of eye lightly pigmented. Eyestalk terminating in distinct curved tubercle. Exopods of maxillipeds, pereopods heavy, prominent. Pereopods 1, 2 chelate, merus of each with minute spinules. Fingers of chela of pereopod 2 longer than palm. Pereopods 3–5 reduced. Most abdominal somites without carina, somite 4 with dorsal carina ending in posterior tooth. Telson slightly shorter than inner uropod. Total length 86.9 mm. (Diagnosis based on specimen from *Velero IV* station 10675, off Guadalupe I., Mexico, LACM).

Color in life. Not reported.

Habitat and depth. Pelagic, 400–2870 m (Krygier & Percy 1981).

Range. Oregon to Baja California, Mexico; North Atlantic. Type locality off New Jersey.

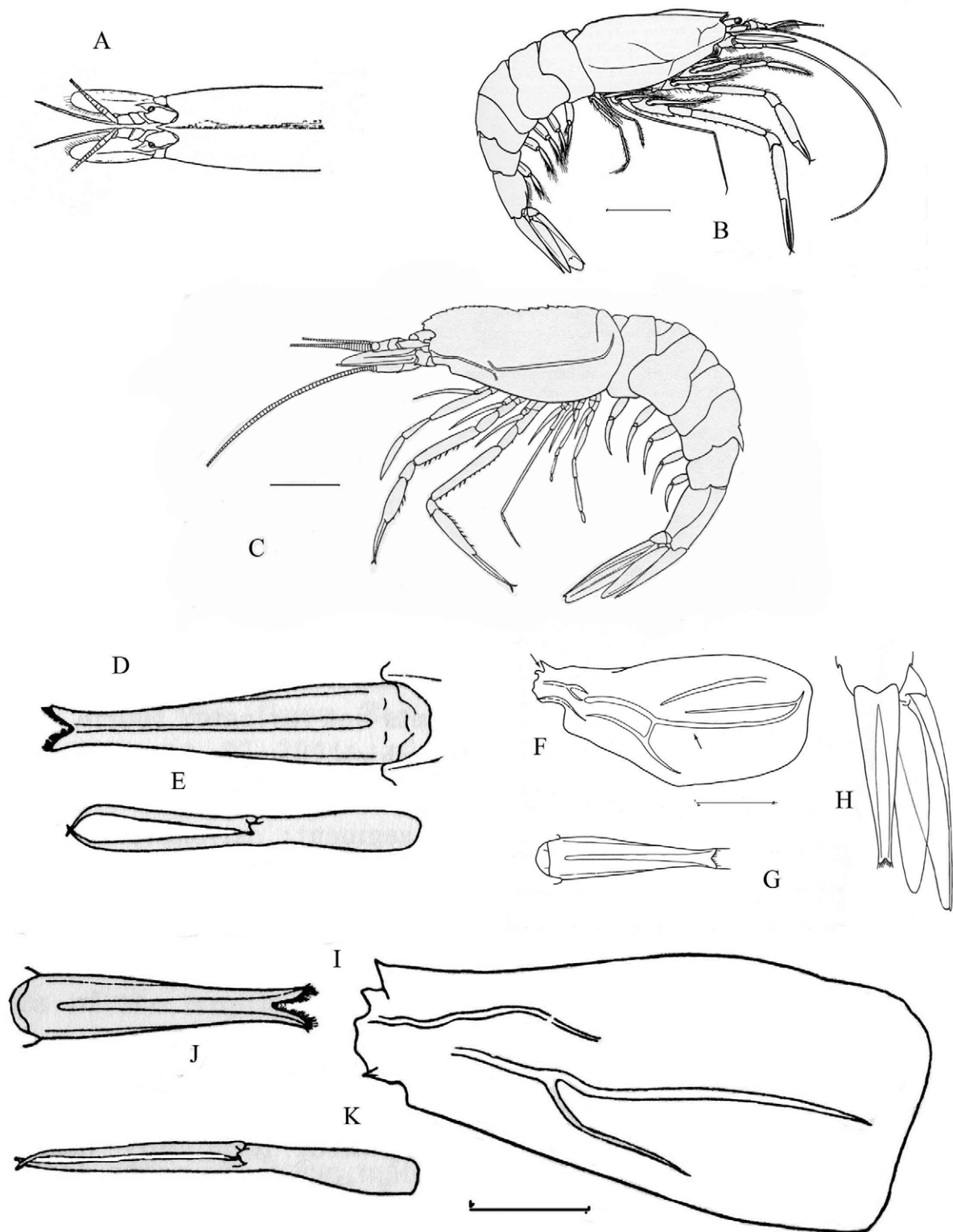


FIGURE 8. Family Pasiphaeidae. A, *Parapasiphae cristata* Smith, 1884; dorsal view of carapace and frontal region. B, *Parapasiphae sulcatifrons* Smith, 1884. C, *Eupasiphae serrata* (Rathbun, 1902). D, E, *Pasiphaea affinis* Rathbun, 1902; D, telson; E, major chela. F–H, *Pasiphaea emarginata* Rathbun, 1902; F, carapace in lateral view; G, telson; H, telson and uropod. I–K, *Pasiphaea corteziana* Rathbun, 1902; I, carapace; J, telson; K, major chela. Scales = 10 mm. A, from Smith 1884, B, from Chace 1940, C–K from Schmitt 1921, C as *Parapasiphae serrata*.

***Parapasiphae sulcatifrons* Smith, 1884**

(Fig. 8 B)

Parapasiphae sulcatifrons Smith, 1884: 384, pl. 5, fig. 4, pl. 6, figs. 1–7. — Chace 1940: 127, text fig. 6. — Ebeling *et al.* 1969: 12. — Word & Charwat 1976: 197. — Crosnier & Forest 1973: 142, fig. 1. — Butler 1980: 58. — Krygier & Percy 1981: 81. — Hendrickx & Estrada-Navarrete 1989: 112; 1996: 99, fig. 62. — Guzmán & Wicksten 1998: 205. — Wicksten 2002: 133.

Diagnosis. Exoskeleton rather thin. Rostrum shorter than eyestalk, slightly ascending, apex acute. Carapace with middorsal carina not quite extending to posterior margin, with Y-shaped carina running along branchial region, carina running postero-ventrally from orbital region. Stylocerite acute, longer than eye. Base of thickened flagellum of antennule particularly broad. Scaphocerite with lateral tooth exceeding blade. Third maxilliped setose. Pereopods 1, 2 chelate, pereopod 1 setose, pereopod 2 with strong spines on carpus, merus and ischium; fingers of chelae shorter than palm, crossing at apices. Pereopod 3 thread-like, pereopods 4, 5 short, with blade-shaped dactyls. Only abdominal somite 4 with dorsal carina, extending into posterior tooth. Telson with dorsal groove, rounded apex armed with 6–9 spines, shorter than uropods. Male total length 70 mm, female to 93 mm.

Color in life. Scarlet, eye amber to bronze (Butler 1980).

Habitat and depth. Pelagic, 500–1300 m.

Range. Indo-West Pacific, Canada to Baja California, Chile, Atlantic Ocean. Type locality "east coast of United States."

***Pasiphaea* Savigny, 1816**

***Pasiphaea affinis* Rathbun, 1902**

(Fig. 8D, E)

Pasiphaea affinis Rathbun, 1902a: 905; 1904: 24, fig. 6. — Schmitt 1921: 31, fig. 17. — Word & Charwat 1976: 199. — Hendrickx & Estrada-Navarrete 1989: 111. — Wicksten 2002: 133.

Diagnosis. Postfrontal tooth nearly vertical to angled upward. Carapace not carinated beyond gastric tooth, branchiostegal tooth present, carina extending horizontally posteriorly from antennal region and another Y-shaped carina running posteriorly along branchial regions. Eye large, rounded. Stylocerite reaching cornea of eye, not as long as first segment of antennular peduncle. Scaphocerite exceeding antennular peduncle. Third maxilliped, all pereopods with large, obvious exopods. Pereopods 1, 2 heavy, chelate, apices of fingers of second chela crossing. Merus and ischium of pereopod 2 with sharp spines. Pereopod 3 slender, pereopod 4 reduced, pereopod 5 short. Abdominal somites 2–6 with dorsal carina, sixth somite ending in distal point. Telson with V-shaped notch, with dorsal groove. Male total length 67 mm, female 55 mm.

Color in life. Not reported.

Habitat and depth. Pelagic, 1800 m.

Range. Known only from type locality, near Cortez Bank, California (32° 28' 44" N, 119° 12' 54" W).

***Pasiphaea chacei* Yaldwyn, 1962**

(Fig. 9 A–D)

Pasiphaea chacei Yaldwyn, 1962: 18, figs. 1–19. — Ebeling *et al.* 1969: 12. — Krygier & Percy 1981: 70. — Hendrickx & Estrada-Navarrete 1989: 111; 1996: 87, fig. 53. — Guzmán & Wicksten 1998: 2004. — Wicksten 2002: 133.

Diagnosis. Postfrontal tooth prominent, long, slender and acute. Carapace with dorsal carina on anterior 0.6 of surface, with suprbranchial carina; anterior margin produced dorsally into blunt, convex lobe, sinuous ventrally, branchiostegal tooth prominent. Eye well developed, pigmented. Antennular peduncle with narrow stylocerite. Basiscerite with strong lateral tooth, scaphocerite reaching beyond antennular peduncle, with lateral tooth longer than blade. Third maxilliped reaching beyond scaphocerite, with exopod. All pereopods with exopods. Pereopod 1

with 0–12 meral spines, carpus with distoventral spine, slender chela. Pereopod 2 with 6–23 meral spines, carpus with distoventral spine, chela with fingers elongated, apices curved, capable of crossing one another. Pereopod 3 slender, pereopod 4 short, slender; pereopod 5 longer than pereopod, with broad dactyl. Abdominal somites without dorsal carina. Abdominal pleura rounded to concave. Telson somewhat shorter than abdominal somite 6, with longitudinal groove, truncate distal margin armed with 4 pairs spinules. Total length about 55 mm.

Color in life. Transparent with lightly scattered red chromatophores.

Habitat and depth. 0–1236 m, usually at 100–850 m.

Range. Oregon to Baja California, Mexico; northern Chile. Type locality San Pedro Basin, California.

***Pasiphaea corteziana* Rathbun, 1902**

(Fig. 8I–K)

Pasiphaea corteziana Rathbun, 1902a: 905; 1904: 24, fig. 5. — Schmitt 1921: 30, fig. 16. — Word & Charwat 1976: 203. — Hendrickx & Estrada-Navarrete 1989: 112. — Wicksten 2002: 133.

Diagnosis. Postfrontal tooth nearly vertical. Carapace with blunt mid-dorsal carina, small branchiostegal tooth (may be blunt or reduced in larger specimens), Y-shaped horizontal carina along branchial region, carina extending posteriorly from antennal region. Pereopods 1, 2 with long, slender chelae. Pereopod 2 with row of spinules along merus. Pereopod 3 slender, pereopod 4 short, with blunt dactyl; pereopod 5 longer, with blunt dactyl. Abdominal somites without middorsal carina. Abdominal somite 6 with small tooth on posterodorsal margin. Telson with dorsal groove, deep posterior notch. Outer uropod longer than inner. Total length to 105 mm. (Diagnosis based on specimens from *Velero IV* station 11965, off San Nicolas I., California; LACM).

Color in life. Not reported.

Habitat and depth. Pelagic, 1400–1630 m.

Range. Santa Cruz I., San Nicolas I., southern California to Cortez Bank, California. Type locality near Cortez Bank.

***Pasiphaea emarginata* Rathbun, 1902**

(Fig. 8F–H)

Pasiphaea emarginata Rathbun, 1902a: 905; 1904: 22, fig. 4. — Schmitt 1921: 30, fig. 15. — Ebeling *et al.* 1969: 12. — Word & Charwat 1976: 205. — Hendrickx & Estrada-Navarrete 1989: 112; 1996: 96, fig. 60. — Wicksten 2002: 134.

Diagnosis. Postfrontal projection spine-like, directed obliquely upward. Carapace with small knob anterior to postfrontal tooth, small branchiostegal tooth supported by carina, dorsal carina extending to posterior margin, lateral H-shaped carina extending posteriorly along branchial region, two smaller carina parallel to this carina but dorsal to it, small Y-shaped carina near antennal region. Appendages similar to those of *P. pacifica*. Abdominal somites 1–5 slightly carinate, somite 6 with faint carina. Telson with dorsal groove, V-shaped posterior notch. Total length 81 mm.

Color in life. Translucent, scattered red chromatophores on much of body; telson, uropods, antennae, maxillipeds with red tint.

Habitat and depth. Mostly pelagic, 0–1600 m. Rarely taken in bottom trawls.

Range. Santa Barbara Channel, California to Concepcion Bay, Gulf of California. Type locality off Concepcion Bay, Gulf of California.

***Pasiphaea magna* Faxon, 1893**

(Fig. 9 E)

Pasiphaea magna Faxon, 1893: 24; 1895: 176, pl. 45, fig. 2. — Word & Charwat 1976: 207. — Méndez 1981: 64, figs. 190–192. — Krygier & Pearcy 1981: 81. — Hendrickx & Estrada-Navarrete 1989: 11; 1996: 91, figs. 56, 57. — Wehrtmann & Carvacho 1997: 50. — Guzmán & Wicksten 1998: 205. — Wicksten 2002: 134.

Diagnosis. Anterior margin of carapace forming blade-shaped tooth. Carapace with dorsal carina extending along entire midline, small knob above eyestalk, small branchiostegal tooth, Y-shaped carina running horizontally from antennal region nearly to posterior margin. Stylocerite longer than eye. Scaphocerite with lateral tooth exceeding blade. Third maxilliped shorter than first pereopod, setose. Pereopods 1, 2 chelate, long, pereopod 1 shorter than pereopod 2, chelae slender carpus of pereopod 2 with distal spine. Pereopod 3 slender and thread-like, pereopod 4 very short, with blade-shaped dactyl; pereopod 5 longer than pereopod 4 but shorter than pereopod 3, with blade-shaped dactyl. All abdominal somites with dorsal carina, but carina faint on first somite. Telson with truncate margin ending in spinules, with dorsal groove, shorter than uropods. Total length 145 mm.

Color in life. Bright red.

Habitat and depth. Mostly pelagic, 700–1000 m, rarely taken in benthic trawls.

Range. Oregon to northern Chile. Type locality Gulf of Panama.

Pasiphaea pacifica Rathbun, 1902

(Fig. 9F–I)

Pasiphaea pacifica Rathbun, 1902a: 905; 1904: 20, fig. 2. — Schmitt 1921: 29, fig. 14. — Kobyakova 1937: 97, fig. 1. — Goodwin 1952: 393. — Kobyakova 1967: 20. — Word & Charwat 1976: 209. — Butler 1980: 55. — Krygier & Percy 1981: 79. — Wicksten 1982b: 245; 2002: 134. — Hendrickx & Estrada-Navarrete 1989: 111; 1996: 93, fig. 59.

Diagnosis. Exoskeleton thin. Postfrontal tooth directed anteriorly, acute. Carapace with dorsal carina extending nearly to posterior margin, with strong branchiostegal tooth and supporting carina, lateral carina extending from antennal region posteriorly. Stylocerite longer than eye. Scaphocerite with lateral tooth exceeding blade. Flagella of both pairs antennae very long when intact. Third maxilliped setose, shorter than first pereopod. Pereopods 1, 2 chelate, chelae slender. Fingers of chela of pereopod 1 crossing. Pereopod 2 with spine on carpus, row of spinules on merus. Pereopod 3 slender, thread-like. Pereopod 4 short, with flat dactyl. Pereopod 5 longer than pereopod 4, with flat, setose dactyl. Abdominal somites 2–6 with dorsal carina, pleura rounded to blunt. Telson with dorsal groove, deep posterior notch, shorter than uropods. Male total length 81 mm, female 73 mm.

Color in life. Translucent, with scattered red chromatophores, especially on gastric region, dorsal midline of abdominal somites 3–6, telson, uropods.

Habitat and depth. Epipelagic, 0–1076 m but usually between 75–500 m, may be caught in bottom trawls (Krygier & Percy 1981).

Range. Australia, Siberia, Alaska to Gulf of California, South Africa. Type locality off Point Sur, California.

Pasiphaea tarda Kröyer, 1845

(Fig. 9 J–N)

Pasiphaea tarda Kröyer, 1845: 434. — Butler 1980: 56. — Krygier & Percy 1981: 79. — Baba *et al.* 1986: 99, fig. 58. — Hendrickx & Estrada-Navarrete 1989: 112; 1996: 96, fig. 60. — Wicksten 2002: 134.

Diagnosis. Exoskeleton thin. Postfrontal tooth extending forward as blade-like extension of carapace. Carapace with middorsal carina extending along entire dorsal midline, with small branchiostegal tooth supported by short carina, Y-shaped carina along branchial region but not reaching posterior margin, slight carina dorsal to Y-shaped carina. Stylocerite longer than eye. Scaphocerite with lateral tooth exceeding blade. Pereopods 1, 2 particularly stout, heavy, both with spinules on merus. All abdominal somites with distinct dorsal carina. Telson with dorsal groove, V-shaped posterior notch, not as long as uropods. Male total length 152 mm, female 215 mm.

Color in life. Crimson (Baba *et al.* 1986: fig. 58).

Habitat and depth. Pelagic, 0–2400 m, usually at 200–2000 m (Krygier & Percy 1981).

Range. Arctic to Hokkaido, Japan; Unalaska to Ecuador, Arctic to Greenland in Atlantic. Type locality off Greenland.

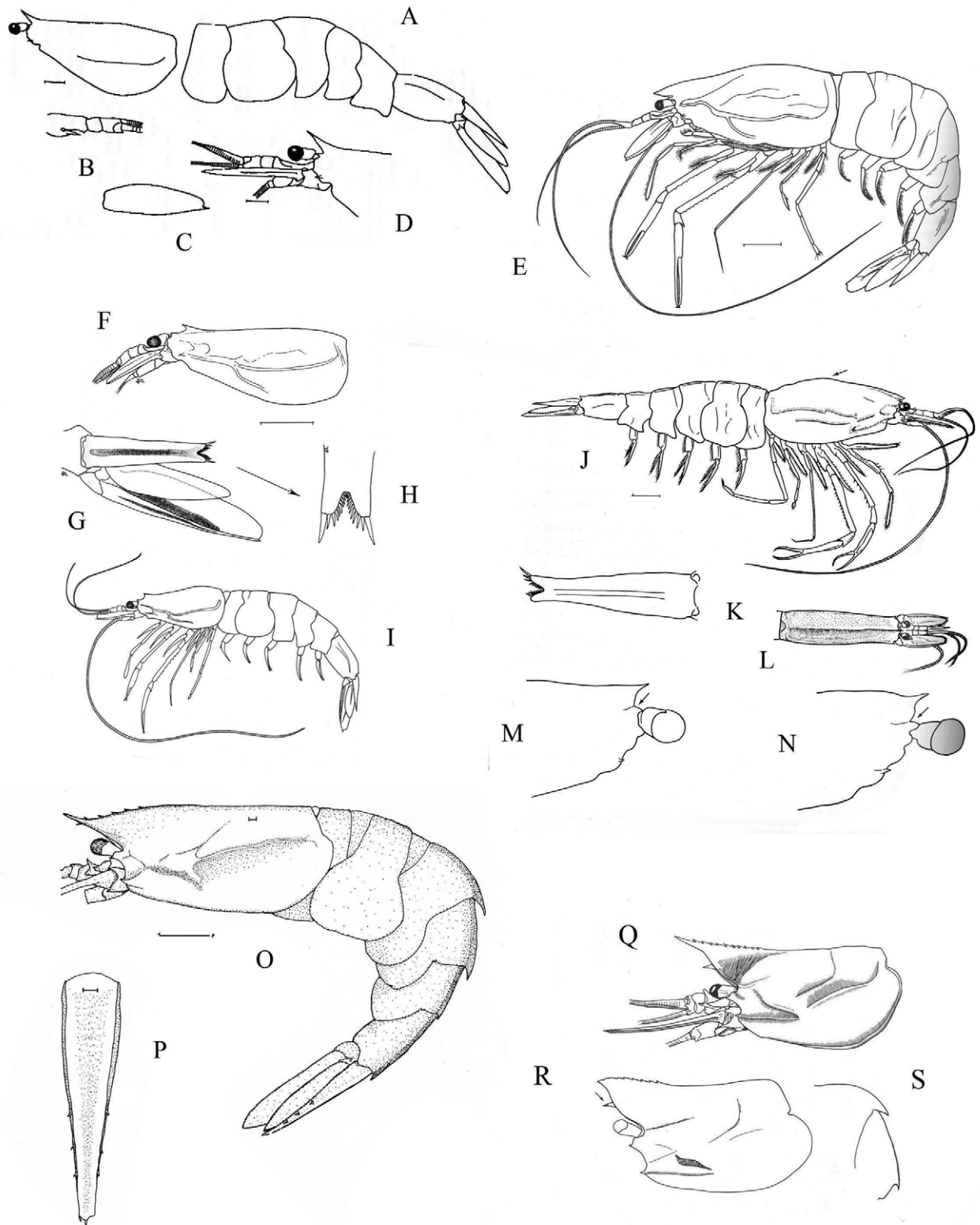


FIGURE 9. Families Pasiphaeidae and Oplophoridae. A–D, *Pasiphaea chacei* Yaldwyn, 1962; A, carapace and abdominal regions in lateral view; B, antennule; C, scaphocerite; D, anterior carapace, eye and antennae. E, *Pasiphaea magna* Faxon, 1893. F–I, *Pasiphaea pacifica* Rathbun, 1902; F, carapace and antennae in lateral view; G, H, telson and uropod with detail of telson; I, entire animal in lateral view. J–N, *Pasiphaea tarda* Kröyer, 1845; J, lateral view; K, telson; L, carapace and front in dorsal view; M, N, variation in fronto-lateral area of carapace. O, P, *Acanthephyra chacei* Krygier & Forss, 1981; O, lateral view; P, telson. Q–S, *Acanthephyra curtirostris* Wood-Mason, 1891; Q, carapace, eye and antennae; R, variation of carapace; S, distal end of abdominal somite 3. Scales: D= 1 mm, A= 3 mm, E, F, J, O, R = 10 mm. A–D from Yaldwyn 1962, E–N, Q–S from Hendrickx & Estrada-Navarrete 1996, O, P from Krygier & Forss 1981.

SUPERFAMILY OPLOPHOROIDEA Dana, 1852

Family Oplophoridae Dana, 1852

Most oplophorids are pelagic, often with a thin carapace and bright orange to red color. The toothed rostrum varies from short to long. The carapace may bear teeth and carinae. Some species also have teeth on the dorsal midline of the abdominal somites. Eyes may be pigmented or not. Pereopods 1, 2 are chelate and shorter than pereopods 3–5. The maxillipeds and pereopods bear exopods.

Little is known about most oplophorids of the area of coverage. *Systellaspis debilis* (Milne-Edwards, 1881) produces a luminous cloud. Other species have photophores (light-producing cells). Traps being brought up to the surface have captured oplophorids, suggesting that they were scavenging on the bait. Species of *Notostomus* and *Systellaspis* may feed on pelagic cnidarians such as jellyfishes of the genus *Atolla* (Moore *et al.* 1993).

Many oplophorid species are thought to be nearly cosmopolitan or at least in both the Atlantic and Pacific oceans. The key given here is based on the work by Chace (1986), which provides additional descriptive information, especially of Indo-West Pacific species.

Ebeling *et al.* (1969: 12) reported *Notostomus elegans* A. Milne-Edwards, 1881 (as *N. patentissimus* Bate, 1888) from the San Pedro Basin, California, but this is believed to be an Indo-West Pacific species (Crosnier & Forest 1973).

Key to Species of family Oplophoridae

1. Abdomen with carina present at least on dorsal midline of posterior 4 abdominal somites; eggs small to medium-sized, numerous 2
- Abdomen without carina on dorsal midline of posterior 4 abdominal somites; eggs large, few 7
2. Carapace without lateral carina extending from near orbit to near posterior margin, posterior margin of hepatic groove usually not abruptly delimited by oblique carina. 3
- Carapace with lateral carina extending from near orbit to near posterior margin, posterior margin of hepatic groove abruptly delimited by oblique carina. 6
3. Carapace with prominent carina on posterior 0.33 of dorsal midline *AcanthePHYra eximia*
- Carapace without prominent carina on posterior 0.33 of dorsal midline 4
4. Rostrum armed ventrally with 1 or 2 teeth 5
- Rostrum armed ventrally with 3–7 teeth *AcanthePHYra quadrispinosa*
5. Carapace with strong carina extending from branchiostegal tooth posteriorly to hepatic groove, no ridge on posterior half of lateral surface *AcanthePHYra curtirostris*
- Carapace without strong carina extending from branchiostegal tooth, with well-marked ridge on posterior half of lateral surface *AcanthePHYra chacei*
6. Carapace with single lateral longitudinal carina, abdominal somite 1 without median dorsal carina *Meningodora mollis*
- Carapace with more than one lateral longitudinal carina, abdominal somite 1 with median dorsal carina *Notostomus japonicus*
7. Eye large, pigmented, anterior margin of abdominal somite 1 armed with distinct lobe or tooth overlapping posterior margin of carapace, telson with acute apex 8
- Eye small, weakly pigmented, anterior margin of abdominal somite 1 not armed with distinct lobe or tooth, telson with truncate, spinose apex 10
8. Carapace without sinuous lateral ridge extending posteriorly from orbital region nearly to posterior margin; telson armed laterally with single row small spines totaling at most 10 spines on each side *Systellaspis debilis*
- Carapace with sinuous lateral ridge extending posteriorly from orbital region nearly to posterior margin; telson armed laterally with 2 or more rows small spines totaling at least 20 on each side. 9
9. Rostrum triangular in lateral aspect, dorsal posterior margin of abdominal somite 3 without median tooth *Systellaspis braueri*
- Rostrum slender, dorsal posterior margin of abdominal somite 3 with median tooth *Systellaspis cristata*
10. Rostrum reaching to or beyond distal end of antennular peduncle *Hymenodora frontalis*
- Rostrum reaching little beyond cornea of eye 11
11. Anterior part of carapace near rostrum swollen *Hymenodora glacialis*
- Anterior part of carapace near rostrum not swollen 12
12. Anterior margin of first abdominal somite forming lobe overlapping posterior margin of carapace *Hymenodora acanthitelsonis*
- Anterior margin of first abdominal somite not forming lobe overlapping posterior margin of carapace *Hymenodora gracilis*

***AcanthePHYra* A. Milne-Edwards, 1881**

***AcanthePHYra chacei* Krygier & Forss, 1981**

(Fig. 9O–P)

AcanthePHYra chacei Krygier & Forss 1981: 96, figs. 1, 2. — Chace 1986: 9. — Wicksten 2002: 135.

Diagnosis. Exoskeleton membranous. Rostrum with 5–9 dorsal teeth, usually one ventral tooth, triangular in shape, descending from gastric region, then ascending past cornea of eye. Eye pigmented. Carapace dorsally carinate, without cervical groove, with strong lateral ridge bifurcating at anterior margin; deep depression marking branchial cavity. Branchiostegal tooth on short rise, not on carina. Antennular peduncle less than 0.5 length of scaphocerite, stylocerite short. Scaphocerite with lateral tooth exceeding blade, blade with mid-longitudinal ridge. Third maxilliped setose, with exopod. All pereopods with exopods. Pereopod 1 chelate, short; merus with 1 or 2 spines. Pereopod 2 chelate, longer than first, merus with 1–6 spines, ischium with 0–7 spines. Pereopod 3 extremely long, dactyl small, simple, with numerous spines on carpus, merus, ischium. Pereopod 4 slender, with 5–17 spines on ischium. Pereopod 5 shorter, dactyl simple, with numerous spines on carpus, merus, ischium. Abdominal somites 3–6 dorsally carinate, each ending in tooth. Telson about as long as uropod, sulcate dorsally, usually armed with 3 pairs dorsolateral spines; with terminal spine flanked by 3 pairs lateral spines. Male carapace length 37 mm, female to 36.7.

Color in life. Scarlet.

Habitat and depth. Bathypelagic, 1500–2400 m.

Range. Southern tip of Alaskan peninsula to off the coast of Oregon. Type locality off Oregon, 44°45.2' N, 127°44.0' W.

***AcanthePHYra curtirostris* Wood-Mason, 1891**

(Fig. 9Q–S)

AcanthePHYra curtirostris Wood-Mason, 1891: 195. — Faxon 1895: 164, pl. 43, figs. 25. — Rathbun 1904: 27. — Schmitt 1921: 33, fig. 19. — Chace 1940: 143, text fig. 21; 1986: 17, figs. 2i, 4i, 5i, 6g, 8h. — Goodwin 1952: 394. — Crosnier & Forest 1973: 39, fig. 8a. — Butler 1980: 61. — Méndez 1981: 89, figs. 273–275. — Krygier & Percy 1981: 81. — Hendrickx & Estrada-Navarrete 1989: 114; 1996: 113, fig. 70. — Wicksten 2002: 135. — Hendrickx & Wicksten 2004: 140.

Diagnosis. Rostrum triangular in lateral view, as long as antennular peduncle, with 6–9 small dorsal, 1 or 2 ventral teeth; extending posteriorly as carina on anterior 0.66 of carapace. Carapace with prominent carina extending posteriorly from branchiostegal tooth, grooves extending posteriorly from orbit, antennal region; also y-shaped groove on posterior lateral region. Eye small, pigmented. Antennular peduncle short, scaphocerite long, with lateral tooth exceeding blade. Third maxilliped stout, distal segment with longitudinal ridge. Pereopods 1, 2 short, chelate; pereopods 3–5 with simple dactyls. Abdominal somites 2–6 with strong dorsal carina, somites 3–5 ending in posterior dorsal tooth; third tooth strongest. Telson with truncate apex, 8–12 lateral spines, 4 pairs distal spines. Male total length 69 mm, female to 79 mm.

Color in life. Crimson.

Habitat and depth. Bathypelagic, 300–2000 m, greatest catches at 600–900 m, does not seem to migrate daily.

Range. Indo-West Pacific, Vancouver I. to Peru, Gulf of Mexico and Atlantic Ocean. Type locality Bay of Bengal.

***AcanthePHYra eximia* Smith, 1884**

(Pl. 1B)

AcanthePHYra eximia Smith, 1884: 376. — Chace 1940: 147, text fig. 24; 1986: 18, figs. 2j, 4j, 5j, 6h, 9a. — Crosnier & Forest 1973: 34, fig. 7c. — Baba *et al.* 1986: 86, fig. 46. — Hendrickx & Estrada-Navarrete 1989: 114. — Wicksten 2002: 135.

Diagnosis. Exoskeleton firm. Rostrum as long as scaphocerite, narrow, with 8 dorsal teeth, space between them and apex of rostrum, 4 ventral teeth. Carapace with dorsomedial carina, antennal, branchiostegal teeth. Eyes pigmented. Antennular peduncle short. Scaphocerite with narrow blade exceeding lateral tooth. Third maxilliped, all pereopods with prominent exopods. Pereopods 1, 2 with slender chelae, pereopods 3–5 with simple dactyls, row of spinules along merus. All but abdominal somite 1 with dorsomedial carina, with posterior median tooth on somites 3–6, tooth of somite 3 largest. Telson with faint dorsal carina, 3–5 pairs lateral spines. Carapace length to 41 mm.

Color in life. Crimson.

Habitat and depth. Pelagic or benthic, 200–4700 m.

Range. Indo-West Pacific, southern California, Gulf of Mexico, Caribbean Sea, and Atlantic Ocean. Type locality off Cape Hatteras, North Carolina.

Acanthephyra quadrispinosa Kemp, 1939

(Fig. 10A)

Acanthephyra quadrispinosa Kemp, 1939: 571. — Krygier & Percy 1981: 83. — Chace 1986: 26, figs. 3h, 4t, 7g, 10c, 14. — Hendrickx & Estrada-Navarrete 1989: 114. — Wicksten 2002: 135.

Diagnosis. Exoskeleton firm. Rostrum longer than carapace, with 3–7 dorsal, 6 ventral teeth. Carapace with blunt carina near rostrum, small antennal tooth, branchiostegal tooth with short posterior carina. Third maxilliped longer than first or second pereopods. Pereopods 3–5 setose, with few spines on merus, ischium. Abdominal somites 2–6 with dorsomedial carina, median tooth on somites 3–6, somite 6 with distolateral tooth. Telson with dorsal groove, 4 pairs lateral, terminal spines. Total length 40 mm.

Color in life. Red. The color note is from a specimen taken off Oahu, Hawaiian Is.

Habitat and depth. Pelagic, 250–5040 m; may migrate between 180–1500 m.

Range. Indo-West Pacific, Oregon, and Atlantic Ocean. Type locality south and eastern Africa.

Hymenodora Sars, 1877

Hymenodora acanthitelsonis Wasmer, 1972

(Fig. 10B–F)

Hymenodora acanthitelsonis Wasmer, 1972: 87, figs. 1–8. — Krygier & Percy 1981: 87. — Wicksten 2002: 136.

Diagnosis. Exoskeleton firm. Rostrum about equal to eye, with 6 dorsal teeth, continuing posteriorly as carina of carapace. Anterior carapace not inflated; carapace with weak cervical groove, also supra-branchial, subhepatic grooves, small pterygostomial tooth. Eye with tubercle at base of cornea. Scaphocerite blade tapered, lateral tooth exceeding blade. Abdominal somite 1 with anterolateral lobe overlapping posterior margin of carapace. Telson with 6–7 pairs dorsolateral spines, lobate end with numerous small spines. Total length about 50 mm.

Color in life. Not reported.

Habitat and depth. Pelagic, 2400–3000 m.

Range. Off Oregon coast. Type locality off Oregon coast, 45° 18.0' N, 125° 43.2' W–45° 17.2' N, 125° 48.3' W.

Hymenodora frontalis Rathbun, 1902

(Fig. 10G)

Hymenodora frontalis Rathbun, 1902a: 904; 1904: 28, fig. 8. — Schmitt 1921: 34, fig. 20. — Kobyakova 1937: 98, fig. 2. — Goodwin 1952: 394. — Ebeling *et al.* 1969: 12. — Kozloff 1974: 163. — Butler 1980: 70. — Krygier & Percy 1981: 83. — Chace 1986: 42, figs. 21 f–j. — Hendrickx & Estrada-Navarrete 1989: 115. — Wicksten 2002: 136.

Diagnosis. Exoskeleton thin, not pitted. Rostrum shorter than scaphocerite, with 3–6 dorsal, no ventral teeth, acute apex. Carapace with suborbital, antennal teeth fused into lobe, moderate branchiostegal tooth merging into carina which extends nearly to posterior margin of carapace, orbital carina running obliquely posteriorly to v-shaped notch, then running horizontally toward posterior margin. Eye without pigment or pale amber. Stylocerite shorter than eye. Scaphocerite with lateral tooth longer than blade. Third maxilliped with proximal segment somewhat concave, setose; longer than first pereopod. Exopods of third maxilliped, pereopods about same length. Pereopods 1, 2 chelate, short. Pereopods 3, 4 with simple dactyls, spinules on merus, ischium. Pereopod 5 shorter than fourth, with very short dactyl. Abdominal somites rounded, no lateral or dorsal teeth. Telson longer than uropods, with 6–9 pairs posterolateral spines, 6 distal spines near apex, truncate distally. Male total length 58 mm, female 53 mm.

Color in life. Orange-red.

Habitat and depth. Pelagic, 200–2400 m, maximum abundance at 600–1300 m. Very common in its depth range.

Range. Sea of Okhotsk and Bering Sea to southern California. Type locality west of Unalaska, Aleutian Is..

***Hymenodora glacialis* (Buchholz, 1874)**

(Fig. 10H, I)

Pasiphae glacialis Buchholz, 1874: 279, pl. 1, fig. 2.

Hymenodora glacialis. — Faxon 1895: 168. — Kobyakova 1937: 99, fig. 3. — Havens & Rork 1969: 19. — Crosnier & Forest 1973: 84, fig. 25b. — Butler 1980: 72. — Krygier & Percy 1981: 86. — Chace 1986: 42, figs. 21K–O. — Hendrickx & Estrada-Navarrete 1989: 115. — Hendrickx & Estrada-Navarrete 1996: 117, fig. 72. — Wicksten 2002: 136.

Diagnosis. Similar to *H. frontalis* except exoskeleton membranous, finely pitted. Anterior part of carapace swollen, rostrum barely longer than eye, lower margin convex, with 2–5 dorsal, 0–1 ventral teeth. Carpus of pereopod 1 with conspicuous distal tubercle. Telson with 5–6 pairs dorsolateral spines. Male total length 48 mm, female 45 mm. Havens & Rork (1969) provided a comparison of *H. glacialis* and *H. gracilis*.

Color in life. Blood red.

Habitat and depth. Pelagic, rarely near surface in polar seas but more common at 350–1000 m; at 2000–5610 m off Oregon.

Range. Sea of Okhotsk and Bering Sea to Gulf of Panama, Chile and sub-Antarctic Pacific, Arctic region, North Atlantic; western South Atlantic, southwestern Indian Ocean. Type locality eastern Greenland, 74° N, near edge of pack ice.

***Hymenodora gracilis* Smith, 1886**

(Fig. 10J–L)

Hymenodora gracilis Smith, 1886: 680, pl. 12, fig. 6. — Chace 1940: 175, text fig. 46; 1986: 43, figs. 21 p–t. — Crosnier & Forest 1973: 83, fig. 25a. — Butler 1980: 69. — Hendrickx & Estrada-Navarrete 1989: 115; 1996: 119, fig. 73. — Wicksten 2002: 136.

Diagnosis. Similar to *H. frontalis* except exoskeleton soft, membranous. Rostrum slightly longer than eye, with 4 dorsal, no ventral teeth, apex acute. Carapace with groove running obliquely posteriorly from orbit, with hepatic, branchial branches. Blade, lateral tooth of scaphocerite same length. Telson with 3 pairs anterolateral spines. Total length about 50 mm.

Color in life. Bright scarlet to red.

Habitat and depth. Pelagic, 300–4730 m, maximum abundance at 1250–2000 m.

Range. Oregon to Baja California; off Chile and sub-Antarctic waters of Pacific Ocean, Gulf of Mexico, Atlantic and Indian oceans. Type locality off New Jersey to Maryland; 40° 26' 40" N, 67° 05' 15" W–37° 12' 20" N, 69° 36' 00" W.

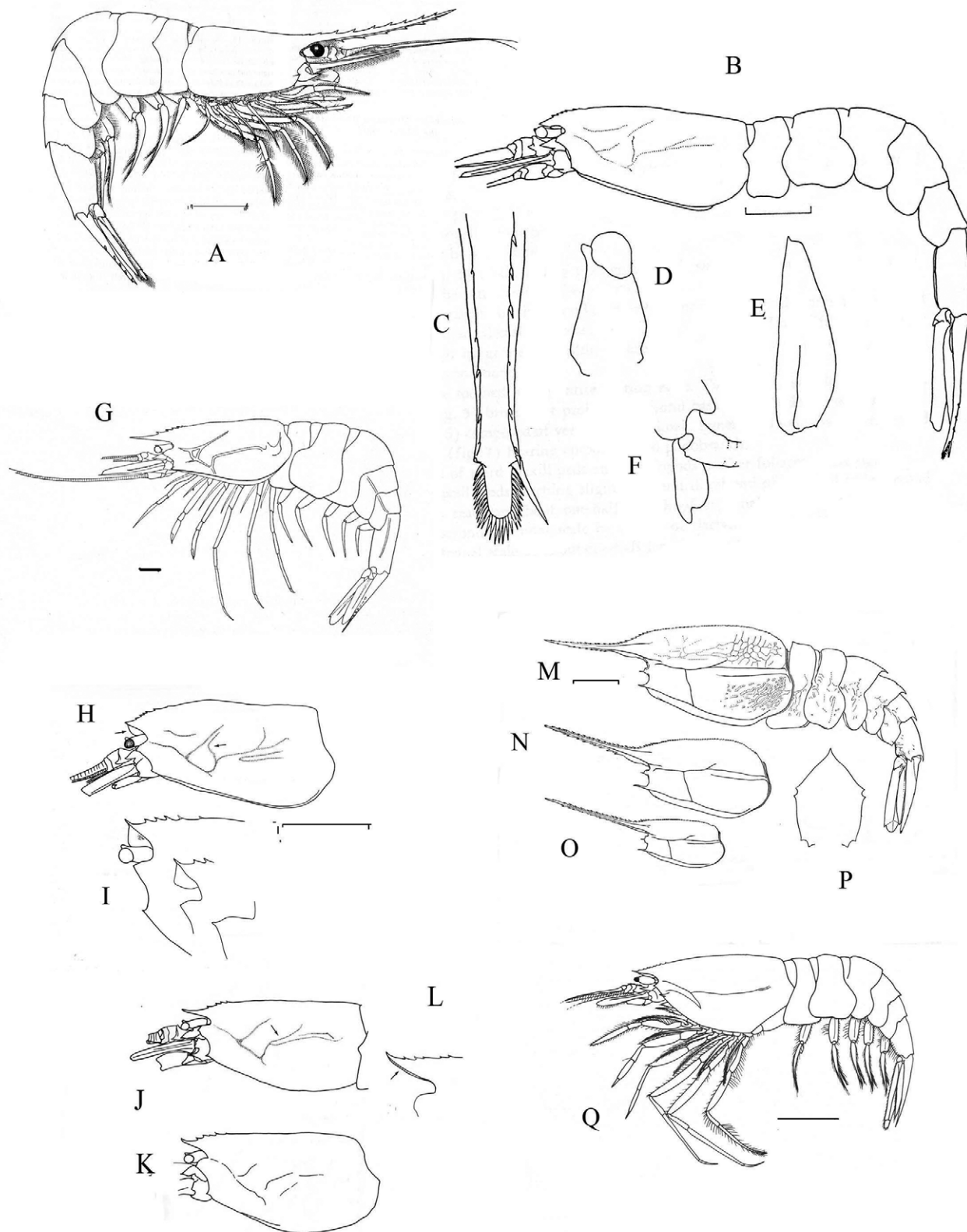


FIGURE 10. Family Oplophoridae. A, *Acanthephyra quadrispinosa* Kemp, 1939. B–F, *Hymenodora acanthitelsonis* Wasmer, 1972; B, carapace, frontal region and abdomen in lateral view; C, telson; D, ocular peduncle; E, scaphocerite; F, endopod of pleopod 1. G, *Hymenodora frontalis* Rathbun, 1902. H, I, *Hymenodora glacialis* (Buchholz, 1874); carapace and variations of frontal region. J–L, *Hymenodora gracilis* Smith, 1887; J–K, variations of carapace, L, rostrum. M–P, *Notostomus japonicus* Bate, 1888; M, carapace and abdomen in lateral view; N, O, variations of rostrum; P, carapace in cross section. Q, *Meningodora mollis*. Scales: B = 5 mm, A, G, H, J, K, M, N, O, = 10 mm. A from Chace 1986, B–F from Wasmer 1972, G from Schmitt 1921, H–L, Q from Hendrickx & Estrada-Navarrete 1996, M–P from Stevens & Chace 1965.

***Meningodora* Smith, 1882**

***Meningodora mollis* Smith, 1882**

(Fig. 10 Q)

Meningodora mollis Smith, 1882: 74, pl. 11, figs. 8, 8a, 9, pl. 12, figs. 5, 5a, 6–9. — Crosnier & Forest 1973: 44, fig. 10c. — Krygier & Pearcy 1981: 83. — Chace 1986: 50, figs. 26a–k. — Hendrickx & Estrada-Navarrete 1989: 115; 1996: 122, fig. 75. — Wicksten 2002: 136.

Notostomus fragilis Faxon, 1893: 207; 1895: 170, pl. 44, figs. 2a, b.

Notostomus mollis. — Chace 1940: 164, text fig. 38.

Diagnosis. Exoskeleton soft, fragile. Rostrum with 7–9 small dorsal, no ventral teeth, barely exceeding eye. Carapace somewhat inflated, with antennal tooth, branchiostegal tooth with short carina, lateral carina extending from orbit nearly to posterior margin. Eyes small, pigmented. Antennular peduncle short. Scaphocerite with blade exceeding lateral tooth. Third maxilliped shorter than first, second pereopods, setose. Pereopods 2, 3 chelate, pereopods 3–5 with simple dactyls, pereopod 5 especially setose. Abdominal somites 3–6 with dorsomedial carina, posterior dorsal tooth on somites 4–6. Telson without lateral spines. Total length 70 mm.

Color in life. Cephalothorax maroon tinged with black, abdomen, appendages red.

Habitat and depth. Pelagic, surface to 2000 m, usually 500–1150 m.

Range. Oregon to Galapagos Is., Gulf of Mexico, Atlantic and Indian oceans. Type locality east of Cape Lookout, North Carolina.

***Notostomus* A. Milne-Edwards, 1881**

***Notostomus japonicus* Bate, 1888**

(Figs. 10M–P)

Notostomus japonicus Bate, 1888: 830, pl. 135, fig. 1. — Kozloff 1974: 163. — Butler 1980: 63. — Krygier & Pearcy 1981: 83. — Chace 1986: 53, figs. 28j–l, 29 h–i. — Hendrickx & Estrada-Navarrete 1989: 115. — Wicksten 2002: 136.

Diagnosis. Exoskeleton thin. Rostrum longer than scaphocerite, slender, with 55–83 small teeth extending posteriorly on most of carapace, 10–18 ventral teeth. Carapace arched in anterior portion, with antennal, branchiostegal teeth, two lateral carinae running posteriorly from rostrum, elongated anterior lateral carina, two posterior carinae running length of carapace from orbit to posterior margin, branchial carina extending from branchiostegal tooth to posterior margin, vertical carina between anterior part of branchial carina, carina posterior to eye. Antennular peduncle short. Scaphocerite with broad blade, lateral tooth exceeding blade. Third maxilliped longer than first pereopod. Pereopods 1, 2 shorter than pereopods 3–5, which have simple dactyls, pereopod 5 with more setose dactyl than anterior two pairs pereopods. All abdominal somites with dorsomedial carina, somites 3–6 with posterior dorsal tooth. Telson with dorsal groove, 3 or 4 pairs dorsolateral spines, blunt apex with 5 distal spines. Male total length 151 mm, female 153 mm.

Color in life. Crimson, carinae darker.

Habitat and depth. Pelagic, 450–5380 m.

Range. Japan, Hawaiian Is., Oregon. Type locality off Honshu, Japan.

***Systellaspis* Bate, 1888**

***Systellaspis braueri paucispinosa* Crosnier, 1987**

(Fig. 11A, B)

Systellaspis braueri paucispinosa Crosnier, 1987: 954, fig. 3b. — Hendrickx & Estrada-Navarrete 1989: 116; 1996: 125, fig. 77. — Wicksten 2002: 137.

Systellaspis braueri. — Butler 1980: 65. — Krygier & Pearcy 1981: 87.

Diagnosis. Exoskeleton thin, smooth. Rostrum short, triangular, with 11–12 dorsal, 1–4 ventral teeth, anterior third without teeth. Carapace with moderate antennal, branchiostegal teeth, the latter with supporting carina; orbito-hepatic, branchial carinae; groove below branchial carina. Eye small, pigmented. Stylocerite shorter than eye. Scaphocerite with lateral tooth, blade about equal in length. Third maxilliped setose, longer than pereopod 1. Exopod of third maxilliped, pereopods about same length, size. Pereopods 1, 2 short, chelate; pereopods 3, 4 long, with simple, slender dactyls, pereopod 5 very short, with blunt dactyl; propodus, merus, ischium of each of last three pereopods with spinules. Abdominal somite 3 with strong posterior dorsal tooth, carina, somite 4 with smaller tooth, carina. Abdominal pleura blunt to rounded. Posterolateral margins of somites 4, 5 with small notch, fifth somite with posterolateral tooth. Telson slightly longer than uropods, with 20–30 lateral spines. Male total length 110 mm. female 138 mm.

Color in life. Deep red to red-brown.

Habitat and depth. Pelagic, 500–2000 m, maximum concentration at 900–2000 m.

Range. North and South Pacific Ocean, Indonesia, Oregon to Central America;. Type locality east of Japan, 31° 59' 08" N, 158° 04' 04" E.

Systellaspis cristata (Faxon, 1893)

(Fig. 11C, D)

Acanthephyra cristata Faxon, 1893: 206; 1895: 162, pl. 43, fig. 1. — Goodwin 1952: 394.

Systellaspis cristata. — Butler 1980: 67. — Crosnier & Forest 1973: 94, figs. 26d, 27d. — Méndez 1981: 84, figs. 258–262. — Krygier & Percy 1981: 89. — Chace 1986: 64, figs. 34d–f, 35c. — Hendrickx & Estrada-Navarrete 1989: 116. — Wicksten 2002: 137.

Diagnosis. Exoskeleton thin, minutely pitted. Rostrum about as long as blade of scaphocerite, with 10–14 dorsal, 4–8 ventral teeth, apex acute; may be raised into convex crest posterior to orbit. Carapace with weak suborbital, moderate antennal, strong branchiostegal teeth, latter with supporting carina; gastro-orbital, submarginal carinae. Eyes pigmented. Stylocerite slightly longer than eye. Scaphocerite with lateral tooth longer than blade. Third maxilliped longer than first or second pereopod, setose. Third maxilliped, all pereopods with exopods of similar size. Pereopods 1, 2 short, chelate; pereopods 3–5 longer, pereopods 3, 4 with long dactyls, pereopod 5 with short, broad dactyl; propodus, merus, ischium of each bearing spinules. Abdominal pleura rounded or bluntly angular, dorsal surface of somite 3 with strong posterior tooth, carina; somite 4 with smaller tooth; small lateral spinules on pleura of somites 4, 5. Abdominal somite 6 longer than telson. Telson with 7–9 pairs spines on dorsal surface, 18–21 pairs small lateral spines, 1 pair strong lateral spines. Uropods slightly shorter than telson. Male total length 81 mm, female total length 169.

Color in life. Crimson.

Habitat and depth. Pelagic, 0–2500 m; usually below 200 m.

Range. Western Canada to Gulf of Panama, Atlantic and Indian oceans. Type locality south of Panama.

Systellaspis debilis (A. Milne-Edwards, 1881)

(Fig. 11E)

Acanthephyra debilis A. Milne-Edwards, 1881: 13.

Systellaspis debilis. — Chace 1940: 181, text fig. 51; 1986: 65, figs. 34g–i, 35e, f. — Crosnier & Forest 1973: 87, figs. 26b, 27b. — Krygier & Percy 1981: 89. — Baba *et al.* 1986: 90, fig. 50. — Hendrickx & Estrada-Navarrete 1989: 116. — Wicksten 2002: 137.

Diagnosis. Rostrum elongated, much longer than scaphocerite, with 14 dorsal, 9 ventral teeth, acute apex. Carapace with antennal, branchiostegal teeth. Eye pigmented. Stylocerite about as long as eye. Scaphocerite with lateral tooth longer than blade. Third maxilliped about as long as first pereopod. Exopods of third maxilliped, all pereopods about same length. Pereopods 1, 2 short, chelate; pereopods 3, 4 longer, with simple dactyls, pereopod 5 shorter, with paddle-like dactyl, pereopods 3–5 with spinules on propodus, merus, ischium. Abdominal somites

with rounded to blunt pleura. Abdominal somite 3 with large posterior dorsal tooth, carina; somite 4 with smaller tooth, carina. Posterior margins of somites 3, 4 armed with spinules. Somite 6 with posterolateral point. Telson nearly as long as uropods, with 5–6 pairs lateral spinules. Carapace length to 17 mm.

Color in life. Adult scarlet-red, appendages tinged with salmon-orange; line of dark photophores along ventrolateral surface of carapace, scattered photophores on lateral surface of carapace and abdominal pleura. Hardy (1970 pl. 17-7) illustrated a juvenile with the anterior part of the body scarlet and the rostrum and posterior parts fading to translucent.

Habitat and depth. Pelagic, 0–1500 m, concentrated at 150 m by night, 650–800 m by day.

Range. Indo-West Pacific, Oregon, Gulf of Mexico, Caribbean Sea, Atlantic Ocean. Type locality Bahamas Channel.

Remarks. This is one of the most common midwater shrimp.

SUPERFAMILY NEMATOCARCINOIDEA Smith, 1884

Family Nematocarcinidae Smith, 1884

Sometimes called thread-leg shrimps, these deep-sea crustaceans are characterized by very long and thin pereopods, which often break off when collected. Studies on Atlantic species suggest that they are generalist feeders on benthic organisms. Females produce enormous numbers of eggs (2,400–15,500 per female) (Wenner 1979). Species are widespread in tropical to temperate seas.

Nematocarcinus A. Milne-Edwards, 1881

Nematocarcinus exilis (Bate, 1888)

(Fig. 11G)

Stochasmus exilis Bate, 1888: 823, pl. 132, fig. 14.

Nematocarcinus ensifer var. *exilis*. — de Man 1920: 75.

Nematocarcinus exilis. — Crosnier & Forest 1973: 116, figs. 32d, e; 33d–f. — Krygier & Percy 1981: 89.

Diagnosis. Length of rostrum about 0.4–0.5 times as long as length of carapace, more or less straight, with 20–25 dorsal, no ventral teeth. Carapace relatively smooth, with sharp antennal, pterygostomian teeth. Stylocerite shorter than first segment of antennular peduncle. Basicerite with sharp lateral tooth, scaphocerite with lateral tooth slightly exceeding blade. Third maxilliped elongated, with exopod, strap-like epipod. Pereopods 1–4 with exopods, strap-like epipods; pereopods 1, 2 chelate, without divided carpus; pereopods 3–5 very long, with simple dactyls. Abdominal somite 3 overlapping somite 4 on posterodorsal end, pleura of abdominal somite 5 with point. Telson not longer than uropods. Carapace length 11–23 mm.

Color in life. Not reported.

Habitat and depth. Epibenthic, 1200–4000 m.

Range. Off Oregon, Eastern Atlantic from southeast of Ireland to Morocco and Mediterranean. Type locality off Canary Is. (30°38' N, 18°38' W).

Remarks. Krygier & Percy (1981) based their identification of *N. exilis* on the features given by Crosnier & Forest (1973) for differentiating *N. exilis* from *N. ensifer* (Smith, 1882). *Nematocarcinus ensifer*, however, is the species reported previously from the eastern Pacific by Faxon (1895) and Burukovsky (2001). Further study of these two polymorphic species is needed to determine the American distributions of the species, especially in the northeastern Pacific.

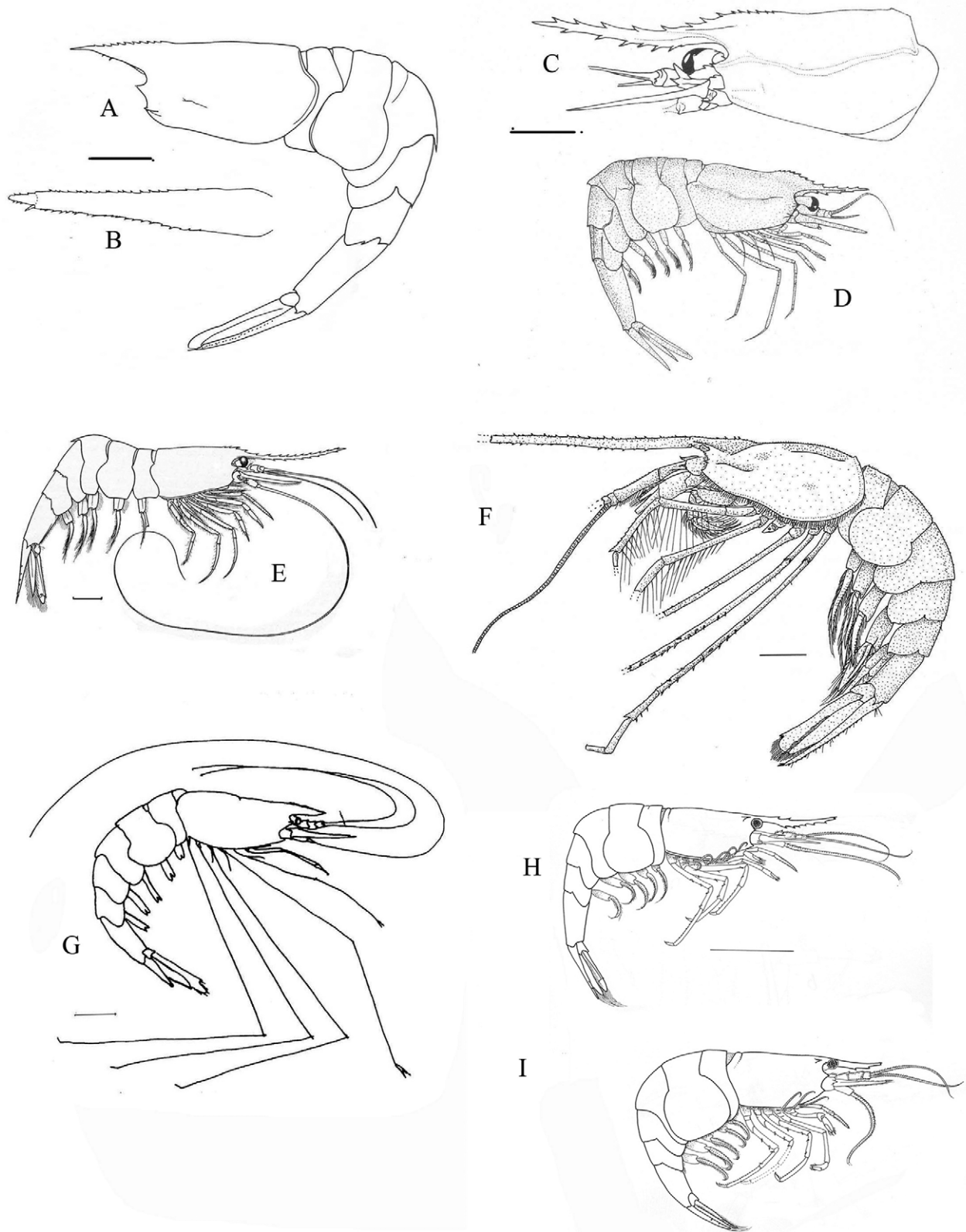


FIGURE 11. Families Oplophoridae, Nematocarcinidae, Stylodactylidae and Atyidae. A, B, *Systellaspis braueri paucispinosa* Crosnier, 1987; A, carapace and abdomen; B, telson. C, D, *Systellaspis cristata* (Faxon, 1893); C, carapace and abdomen in lateral view; D, entire shrimp. E, *Systellaspis debilis* (A. Milne-Edwards, 1881). F, *Bathystylodactylus echinus* Wicksten & Martin, 2004. G, *Nematocarcinus exilis* (Bate, 1888). H, *Syncaris pacifica* (Holmes, 1895). I, *Syncaris pasadenae* (Kingsley, 1897). Scales A, E–I = 10 mm; C = 5 mm. A, B from Hendrickx & Estrada-Navarrete 1996, C, D from Méndez 1981, E from Chace 1940, F from Wicksten & Martin 2004, G from Crosnier & Forest 1973, H, I from Martin & Wicksten 2004.

SUPERFAMILY STYLODACTYLOIDEA Bate, 1888

Family Stylodactylidae Bate, 1888

These shrimps are recognizable by the long setose fingers of the chelae of the first and second pereopods. Members of the family usually are found on the lower continental shelf and deeper.

Bathystylodactylus Hanamura & Takeda, 1996

Bathystylodactylus echinus Wicksten & Martin, 2004

(Fig. 11F)

Bathystylodactylus echinus Wicksten & Martin, 2004: 377, figs. 1–5.

Diagnosis. Rostrum nearly straight, its length nearly twice length of carapace or more, with 23–27 dorsal, 18–25 ventral spines; series of 7–9 minute spinules on carapace just posterior to rostrum proper. Carapace, abdomen with small spinules along dorsal, lateral surfaces. Stylocerite slender, not reaching middle of first segment of antennular peduncle. Basicerite bearing strong lateral tooth. Scaphocerite covered by minute spinules, reaching second segment of antennular peduncle. Third maxilliped setose, with arthropod but without exopod. Pereopods all lacking exopods or epipods. Pereopods 1, 2 chelate, similar in size, shape. Fingers of chelae elongated, without teeth, with long setae, shorter spine-like setae along cutting edges. Pereopods 3–5 elongated with few scattered setae. Abdominal somite 3 weakly carinate dorsally, pleura of somites 4, 5 with sharp posteroventral tooth. Telson with 11–13 pairs dorsolateral spines located on weak ridges. Carapace length to 41.4 mm.

Color in life. Not reported. Preserved specimens dirty chalk white with brown silt caught on setae, spinules.

Habitat and depth. Abyssal plains, 3427–3689 m.

Range. Patton Escarpment off California to basin off Magdalena Bay, Baja California, Mexico. Type locality basin off Magdalena Bay (24° 35' N, 113° 25' W).

SUPERFAMILY ATYOIDEA de Haan, 1849

Family Atyidae de Haan, 1849

The Atyidae are freshwater shrimps, usually found in flowing water. The fingers of the chelae end in brushes of setae, which are used to scrape food particles from rocks and sand. Although there are numerous tropical atyids, only two species have been found in California.

Key to Species of family Atyidae

1. Rostrum with 1 or 2 teeth on upper margin of rostrum. Marin, Napa and Sonoma counties, California *Syncaris pacifica*
- Rostrum without teeth on upper margin of rostrum. Los Angeles and San Bernardino Counties, California; extinct
..... *Syncaris pasadenae*

Syncaris Holmes, 1900

Syncaris pacifica (Holmes, 1895)

(Fig. 11H)

Miersia pacifica Holmes, 1895: 577.

Syncaris pacifica. — Holmes 1900: 211. — Hedgpeth 1968: 511, figs. 1, 2. — Standing 1981: 775. — Eng 1981: 1, fig. 1. — Martin & Wicksten 2004: 447, figs. 6–9 (extensive synonymy). — Kuris *et al.* 2007: 638, pl. 316C, 318 I.

Diagnosis. Body slender. Rostrum with 1–2 dorsal, 5–9 ventral teeth, slender, about as long as carapace. Carapace with supraorbital, antennal, pterygostomian teeth. Stylocerite longer than first segment of antennular peduncle. Scaphocerite about as long as rostrum. Pereopods 1–4 with exopods, epipods; pereopod 5 without exopods. Pereopod 1 short, carpus short, distally widened, concave; chela when flexed folding against concavity of carpus. Pereopod 2 longer than pereopod 1, carpus shorter than chela. Pereopods 3–5 subequal, dactyls short, with spinules; merus of pereopod 3 with 3 spines, merus of pereopods 4, 5 with 2 spines each. Abdominal somites rounded. Telson with truncate or broadly rounded apex, with 2 short dorsolateral spines, 2 pairs terminal spines. Total length 50 mm.

Color in life. Transparent to rust-colored, with scattered chromatophores, pale band at base of tail fan.

Habitat and depth. Coastal streams, shallow water.

Original range. Napa, Sonoma and Marin counties, California (see Martin & Wicksten 2004 for map). Type locality Sonoma County, California.

Remarks. *Syncaris pacifica*, the California freshwater shrimp, is endangered due to habitat destruction and introduction of predatory fishes. The shrimp usually occur in slower reaches of streams, where they cling to aquatic vegetation and roots (Hedgpeth 1968, Eng 1981).

Syncaris pasadenae (Kingsley, 1897)

(Fig. 111)

Caridina pasadenae Kingsley, 1897: 98, pl. 3, figs. 1–7. — Holmes 1900: 214.

Syncaris Trewi Holmes, 1900: 213.

Syncaris pasadenae. — Hedgpeth 1968: 516. — Holthuis 1993: 63, fig.50. — Martin & Wicksten 2004: 447 (extensive synonymy).

Diagnosis. More robust than *S. pacifica*. Rostrum without dorsal teeth, bifid at apex, with 3–5 ventral teeth. Carapace with supraorbital, antennal, pterygostomian teeth. Stylocerite longer than first segment of antennular peduncle. Scaphocerite rounded, blade exceeding lateral tooth, not as long as rostrum. Pereopods 1–4 with exopods, epipods. Pereopod 1 with chela, fingers gaping, ending in tufts of setae. Pereopod 2 with carpus longer than chela, fingers of chela ending in tufts of setae. Pereopods 3–5 elongated, with slender dactyls, dactyls with spinules. Merus of third pereopod with 1 spine. Abdominal pleura 1–4 rounded, fifth pleuron with spine or point. Telson tapering to round or truncate apex, with 2 pairs dorsolateral spines, 2 pairs terminal spines. Uropods longer than telson. Total length 32–40 mm.

Color in life. Not reported.

Habitat and depth. Streams of Los Angeles and San Bernardino Counties, especially Los Angeles River drainage; shallow water.

Range. Los Angeles River drainage, streams near San Gabriel and Pasadena, and Warm Creek, San Bernardino County, California. See Hedgpeth (1968) for distribution map. Type locality streams near Pasadena.

Remarks. The last verified collection of this species was in 1933. Despite extensive searching, it has not been found again. The streams in which it lived have undergone extensive habitat destruction, which probably contributed to the extinction of the species.

SUPERFAMILY PALAEMONOIDEA Rafinesque, 1815

Family Palaemonidae Rafinesque, 1815

The family Palaemonidae includes a diverse array of tropical species inhabiting coral reefs, estuaries, rivers and caves. Many are specialized and are symbionts of cnidarians, mollusks, echinoderms or tunicates. Being primarily inhabitants of warmer regions, few range as far north as California. One species has been introduced into bays of California and Oregon from the Orient. All of the other resident species in California are marine. Wicksten (1989a) gave a key to all species of the eastern Pacific and nearby freshwater drainages.

Both the first and second pereopods bear chelae. The carpus of the second pereopod is entire, not divided into three or more articles. The second pereopods are especially large and heavy in adult males.

Four additional introduced species have been found California. As of this writing, it is uncertain whether any of them has established a breeding population in the area. *Exopalaemon carinicauda* (Holthuis, 1950) has been collected in southern San Francisco Bay (Wicksten 1997: 43, fig. 1), and *E. modestus* (Heller, 1862) at the mouth of the Columbia River and lower Snake River (Haskell *et al.* 2006: 311, fig. 1). These estuarine species are native to the Asian coast from Siberia to China and Korea. The two species can be distinguished by the key of Kuris *et al.* (2007). *Macrobrachium rosenbergii* (de Man, 1879), widely raised in aquaculture, occasionally escapes into the San Francisco Bay drainage. It is widespread in freshwater areas of the Indo-West Pacific region, and can tolerate salt water for short periods of time. *Palaemonetes kadiakensis* Rathbun, 1902 has been found in freshwater streams draining into San Diego Bay and in marshes and streams around the Salton Sea (St. Amant & Day 1972: 54, as *P. paludosus* [Gibbes, 1850]). It is native to the eastern United States. Holthuis (1952: pl. 51 k–n) provided illustrations of this species.

Key to Species of family Palaemonidae

- | | | |
|----|--|---------------------------------|
| 1. | Posterior margin of telson with 2 pairs spines. Pleurobranch on third maxilliped. Rostrum always with teeth. | 2 |
| – | Posterior margin of telson with 3 pairs spines. No pleurobranch on third maxilliped. Rostrum with or without teeth | 4 |
| 2. | Carpus of pereopod 2 distinctly shorter than chela. San Diego, California south | <i>Palaemon ritteri</i> |
| – | Carpus of pereopod 2 longer than chela. San Francisco Bay south | 3 |
| 3. | Rostrum with subapical tooth, mandible with palp. Total length can exceed 25 mm. | <i>Palaemon macrodactylus</i> |
| – | Rostrum without subapical tooth, mandible without palp. Total length reaching 25 mm | <i>Palaemonetes hiltoni</i> |
| 4. | Rostrum without dorsal teeth | 5 |
| – | Rostrum with dorsal teeth | 6 |
| 5. | Body stout, major chelipeds heavy, lobster-like. Symbiotic with ascidians | <i>Ascidonia californiensis</i> |
| – | Body, major chelipeds slender. Not symbiotic with ascidians | <i>Pseudocoutierea elegans</i> |
| 6. | Rostrum arched over eye, carapace without supraorbital teeth. | <i>Periclimenes infraspinis</i> |
| – | Rostrum not arched over eye, carapace with supraorbital teeth | <i>Palaemonella holmesi</i> |

Ascidonia Fransen, 2002

Ascidonia californiensis (Rathbun, 1902)

(Fig. 13A, B)

Pontonia californiensis Rathbun, 1902a: 902; 1904: 33, fig. 11. — Schmitt 1921: 38, fig. 23. — Holthuis 1951: 145, pl. 46, figs. a–i, pl. 47, figs. a–c. — Word & Charwat 1976b: 169. — Standing 1981: 778. — Wicksten 1989a: 18.
Ascidonia californiensis. — Fransen 2002: 203, figs. 129–137.

Diagnosis. Rostrum about as long as first segment of antennular peduncle, flattened, without teeth. Carapace without teeth. Stylocerite short, blunt, first segment of antennular peduncle with very small distolateral spine. Scaphocerite oval in shape, blade about as long as inwardly curved lateral tooth. Pereopod 1 short, slender, chelate. Pereopod 2 more robust, unequal in size, shape; larger chela with 2 teeth closing against each other on dactyl, propodus; smaller chela without teeth, fingers slender, gaping. Pereopods 3–5 with hooked, biunguiculate dactyls. Abdominal pleura rounded, may be widely spread in ovigerous female. Telson with 2 pairs large dorsolateral spines, 3 pairs small terminal spines. Total length to 29 mm.

Color in life. Yellowish white or dull orange brown.

Habitat and depth. Subtidal rocky areas, commensal in ascidians, to 55 m.

Range. Carmel, Santa Cruz and Santa Rosa Is., off Palos Verdes Point, California. Type locality off Santa Cruz I., California.

Remarks. This symbiotic shrimp has been found in the branchial basket of the large solitary ascidian *Ascidia vermiformis*.

Palaemon Weber, 1795

Palaemon macrodactylus (Rathbun, 1902)

(Fig. 12A, Pl. 1D)

Leander macrodactylus Rathbun, 1902b: 52, fig. 24.

Leander macrodactyla. — Kobyakova 1937: 99.

Palaemon macrodactylus. — Newman 1963: 119, fig. 1. — Kobyakova 1967: 238. — Chace & Abbott 1980: 570, fig. 23.1. — Standing 1981: 777. — Wicksten 1989a: 14. — Jensen 1995: 52, fig. 95. — Kuris *et al.* 2007: 638, pl. 316 E. — D'Udekem d'Acoz *et al.* 2005: 95, Figs. 1, 5 d, j, n, s, 6.

Diagnosis. Similar to *P. ritteri* but much larger. Rostrum as long as scaphocerite, with 9–15 dorsal teeth, bare space near apex, 3–4 ventral teeth including subapical tooth. Carapace with antennal, branchiostegal teeth. First segment of antennular peduncle broad, flattened, with prominent distolateral spine, small proximal spine. Basicerite with distolateral tooth, carpocerite shorter than antennular peduncle. Third maxilliped slender, setose. Pereopod 1 slender, chelate. Pereopod 2 longer than pereopod 1, carpus about as long as merus, carpus nearly as long as entire chela. Pereopods 3–5 slender, with simple dactyls. Abdominal pleura 1–4 rounded, fifth with distolateral point, sixth with distolateral, ventrolateral points. Telson shorter than uropods, with 2 pairs dorsolateral spines. Total length 58 mm. Detailed illustrations are given by D'Udekem d'Acoz *et al.* (2005: figs. 1, 5, 6).

Color in life. Translucent brown to greenish or olive, may have oblique transverse stripes on carapace.

Habitat and depth. Docks, pilings, shores of bays, intertidal zone to 1 m.

Range. Native to coast of Korea, China and Japan. Introduced into Australia, San Francisco Bay, Moss Landing, Elkhorn Slough, Malibu Lagoon, Long Beach Harbor and San Diego county, California; Spain, England, southern North Sea in Belgium and the Netherlands. Type locality Aomiri, Rikuoku, Japan.

Remarks. This large shrimp can be common among rocks and cobble along the coast of San Francisco Bay. Although it can inhabit estuarine areas, it also occurs in normal ocean salinities (35 ppt) in San Francisco Bay.

Palaemon ritteri Holmes, 1895

(Fig. 12B–D)

Palaemon ritteri Holmes, 1895: 579, pl. 21, figs. 29–35; 1900: 216. — Rathbun 1904: 29. — Schmitt 1921: 35, fig. 21. — Holthuis 1952a: 173, pl. 44, figs. a–g. — Word & Charwat 1976: 163. — Chace & Abbott 1980: 569. — Méndez 1981: 73, fig. 252. — Wicksten 1983b: 10; 1989a: 14; 2006: 6. — Kerstitch 1989: 76, fig. 184. — Wicksten & Hendrickx 2003: 60.

Diagnosis. Rostrum as long as or longer than scaphocerite, with 8–10 dorsal, 3–4 ventral teeth, distal part unarmed. Carapace with antennal, branchiostegal teeth. Basal segment of antennular peduncle with anterolateral tooth, small distolateral tooth. Scaphocerite with blade overreaching lateral tooth. Pereopod 1 chelate, shorter than pereopod 2. Carpus of pereopod 2 shorter than chela proper. Pereopods 3–5 with simple dactyls. Pleura of abdominal somites 1–4 rounded, pleura of somite 5 with anterolateral tooth. Telson with 2 pairs anterolateral spines. Total length 40 mm.

Color in life. Translucent with scattered dark chromatophores or banded with brown.

Habitat and depth. Tide pools, bays, usually intertidal.

Range. San Diego, California to Galapagos Is. Type locality San Diego. Although Chace & Abbott (1980: 569) reported this species as occurring naturally in California, I know of no specimens of this species reported in California since the type was collected.

Remarks. *Palaemon ritteri* has been collected on the western coast of Baja California at Estero de Punta Banda and Magdalena Bay (Wicksten 1983, 2006). The species is common in tide pools of the Gulf of California and farther south (Holthuis 1952a).

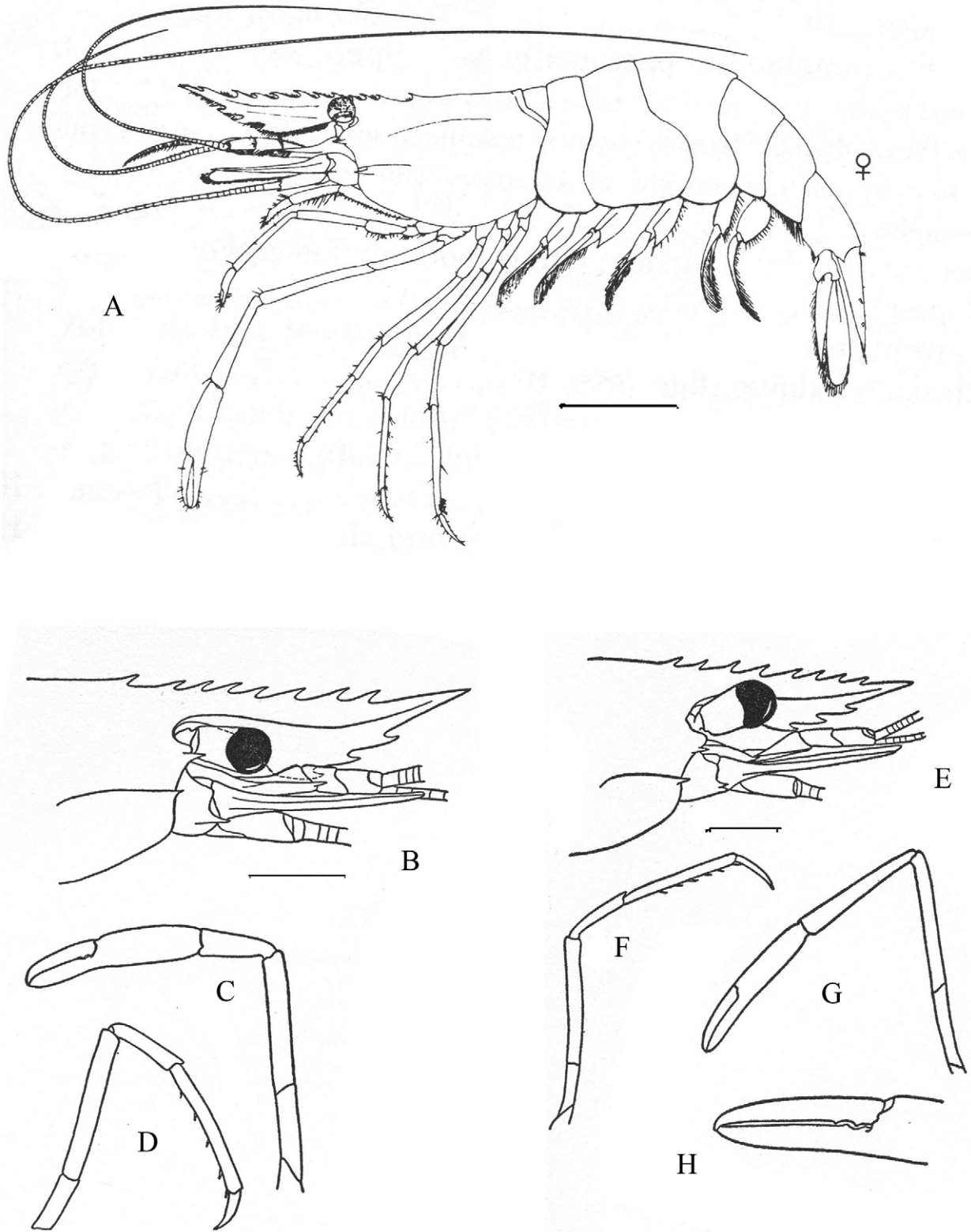


FIGURE 12. Family Palaemonidae. A, *Palaemon macrodactylus* (Rathbun, 1902). B–D, *Palaemon ritteri* Holmes, 1895; B, frontal region in lateral view; C, pereopod 2; D, pereopod 3. E–H, *Palaemonetes hiltoni* Schmitt, 1921; E, frontal region in lateral view; F, pereopod 3; G, pereopod 2; H, detail of chela of pereopod 2. Scales: B = 5 mm, A = 10 mm, E = 20mm. A from Newman 1963, B–H from Holthuis 1952a.

Palaemonella Dana, 1852

Palaemonella holmesi (Nobili, 1907)

(Fig. 13F–J)

Periclimenes holmesi Nobili, 1907: 5.

Anchista tenuipes Holmes, 1900: 216.

Periclimenes tenuipes. — Rathbun 1904: 34, fig. 12. — Schmitt 1921: 39, fig. 24.

Palaemonella holmesi. — Holthuis 1951: 13, pl. 3, figs. a–h; pl. 4, figs. a–i. — Word & Charwat 1976: 165. — Chace & Abbott 1980: 569. — Wicksten 1983b: 13; Wicksten 1989a: 16. — Kerstitch 1989: 78, fig. 190. — Jensen 1995: 53, fig. 96. — Wicksten & Hendrickx 2003: 61.

Diagnosis. Rostrum exceeding scaphocerite, with 6–9 dorsal, 2–4 ventral teeth. Carapace with supraorbital, antennal, hepatic teeth. Stylocerite strong, pointed, reaching middle of basal segment of antennular peduncle, which bears anterolateral tooth. Scaphocerite with tooth exceeding blade. Pereopod 1 slender, chelate. Pereopod 2 sexually dimorphic: in mature males, very elongated, with one large tooth, 4 smaller teeth on fingers of chelae (but may be worn in old animals), gape present; more slender, shorter in females. Pereopods 3–5 slender, with simple dactyls. Abdominal somites rounded. Telson with 2 pairs dorsolateral spines, 3 pairs posterior spines. Total length to 50 mm.

Color in life. Translucent golden-brown.

Habitat and depth. Subtidal sandy or rocky bottoms, 2–90 m.

Range. San Pedro and Santa Catalina I., California to Ecuador. Type locality Santa Catalina I., California.

Remarks. Although not common, this species seems to be a resident in southern California.

Palaemonetes Heller, 1869

Palaemonetes hiltoni Schmitt, 1921

(Fig. 12E–H)

Palaemonetes hiltoni Schmitt, 1921: 36, pl. 12, fig. 5. — Holthuis 1952a: 227, pl. 53, figs. n–s. — Chace & Abbott 1980: 569. — Wicksten 1983b: 11; Wicksten 1989a: 15. — Wicksten & Hendrickx 2003: 62.

Diagnosis. Rostrum as long as scaphocerite, with 8–11 dorsal, 2–3 ventral teeth. Carapace with antennal, branchiostegal teeth. Basal segment of antennular peduncle with lateral tooth, small subapical tooth. Scaphocerite with scale exceeding lateral tooth. Pereopod 1 chelate, shorter than pereopod 2. Carpus of pereopod 2 as long as palm of chela. Pereopods 3–5 slender, with simple dactyls. Pleura of abdominal somites 1–4 rounded, somite 5 with posterolateral spine. Telson with 2 pairs spines on posterior margin. Total length 24 mm.

Color in life. Translucent.

Habitat and depth. Bays, estuaries, shallow water.

Range. San Pedro and Del Mar, California; Gulf of California in Sonora and Sinaloa, Buenaventura Bay, Colombia. Type locality San Pedro, California. Chace & Abbott (1980: 569) mentioned this species as occurring naturally in California, but *Palaemonetes hiltoni* has not been reported in California since its original description.

Periclimenes Costa, 1844

Periclimenes infraspinis (Rathbun, 1902)

(Fig. 13C–E)

Urocaris infraspinis Rathbun, 1902a: 903; 1904: 31, fig. 10. — Schmitt 1921: 37, fig. 22.

Periclimenes infraspinis. — Holthuis 1951: 46, pl. 13, figs. a–l. — Word & Charwat 1976b: 167. — Chace & Abbott 1980: 569. — Wicksten 1983b: 14; 1989a: 17. — Wicksten & Hendrickx 2003: 62.

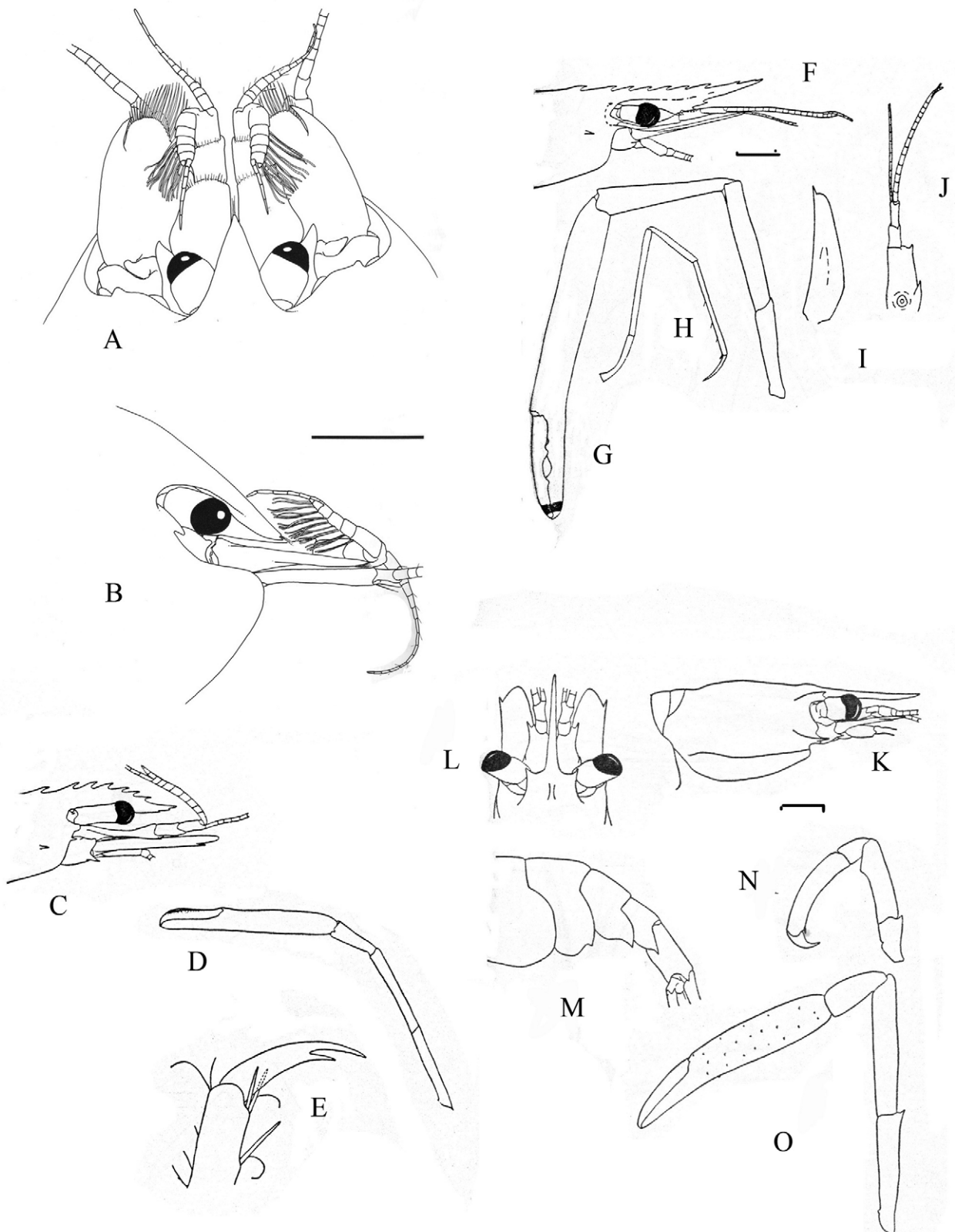


FIGURE 13. Family Palaemonidae. A, B, *Ascidonia californiensis* (Rathbun, 1902); A, anterior appendages, dorsal view; B, anterior appendages, lateral view. C–E, *Periclimenes infraspinis* (Rathbun, 1902); C, frontal region in lateral view; D, pereopod 2; E, dactyl of pereopod 3. F–J, *Palaemonella holmesi* (Nobili, 1907); F, frontal region in lateral view; G, pereopod 2 of male; H, pereopod 3; I, scaphocerite; J, antennule. K–O, *Pseudocoutierea elegans* Holthuis, 1952; K, frontal region in dorsal view; L, frontal region in lateral view; M, abdomen; N, pereopod 3; O, pereopod 2. Scales: A, B=2 mm; C, F, L =10 mm. A, B from Fransen 2002, C–O from Holthuis 1951.

Diagnosis. Rostrum reaching third segment of antennular peduncle, arched over eye, with 5–7 dorsal, 1–2 ventral teeth. Carapace with antennal, hepatic teeth. Stylocerite slender, reaching middle of basal segment of antennular peduncle, this segment with distolateral tooth. Scaphocerite with blade exceeding tooth. Pereopod 1 slender, chelate. Pereopod 2 longer, chelate, unequal in size, shape in adult; larger chela with 2 teeth on dactyl, smaller chela without teeth on dactyl. Pereopods 3–5 slender, with biunguiculate dactyls. Abdominal pleura rounded or ending in blunt points. Telson with 2 pairs dorsolateral spines, 3 pairs terminal spines. Total length 23 mm.

Color in life. Translucent, pale brown.

Habitat and depth. Subtidal among rock, sand, algae or cnidarians, to 150 m.

Range. San Diego Bay, California to Galapagos Is. Type locality Concepcion Bay, Baja California, Mexico. Word & Charwat (1976b) reported this species from "Engel's Bank, California" (without latitude or longitude). One specimen was taken at Scammon's Lagoon in western Baja California in 1953 (Wicksten 1983). The records from San Diego are from Rathbun (1902, 1904). Most records are from the Gulf of California and farther south (Holthuis 1951).

Pseudocoutierea Holthuis, 1951

Pseudocoutierea elegans Holthuis, 1951

(Fig. 13K–O)

Pseudocoutierea elegans Holthuis, 1951: 183, pl. 57, figs. a–r. — Word & Charwat 1976b: 171. — Wicksten 1983b: 19; 1989a: 15. — Wicksten & Hernández 2000: 96. — Wicksten & Hendrickx 2003: 62.

Diagnosis. Rostrum reaching or exceeding antennular peduncle, without teeth. Carapace with enlarged supraocular teeth which partially cover eystalk, also antennal tooth, branchiostegal groove. Stylocerite sharp, slender, reaching middle of basal segment of antennular peduncle, which bears anterolateral tooth. Scaphocerite with lateral tooth longer than blade. Pereopod 1 slender, chelate. Pereopod 2 larger than pereopod 1, chelate, unequal in size; larger cheliped bearing 1 tooth in larger specimens, smaller cheliped without tooth, with more elongated fingers. Pereopods 3–5 with hooked dactyls. Abdominal pleura 1, 2 rounded, abdominal pleura 3–6 with sharp posterolateral points. Telson with 2 pairs dorsolateral spines, 3 pairs posterolateral spines. Total length 16 mm.

Color in life. Orange-red.

Habitat and depth. Subtidal rocky substrates, usually with gorgonians, to 92 m.

Range. Santa Catalina I., California to Punta Sal, Peru and Galapagos Is. Type locality off Santa Catalina I.

Remarks. A specimen from Santa Catalina I. was found with the gorgonian *Leptogorgia chilensis*, which also is colored orange-red.

SUPERFAMILY ALPHEOIDEA Rafinesque, 1815

Having chelae on pereopod 1 and a multi-articulate carpus of pereopod 2 characterize this diverse superfamily. Until recently, members of the families Lysmatidae, Thoridae and Hippolytidae were grouped into a single family, the Hippolytidae. Christoffersen (1988a), using a morphological cladistic approach, split the family but assigned the Lysmatidae to the superfamily Crangonoidea and the other families to the Alpheoidea, a classification followed here. The Lysmatidae, however, is considered to belong to the Alpheoidea based on the shape of the chelae of pereopod 1. Chace (1992) removed the family Processidae from the Alpheoidea and assigned it to its own superfamily, the Processoidea, based on the structure of the first maxilliped and features of the chelae and rostrum.

Chace (1997) provided keys to genera of the Hippolytidae (in the broad sense) and Processidae, and a list of species of hippolytoids known at that time. The emphasis was on Indo-West Pacific species, especially those taken by the *Albatross* Philippine Expedition. For most species, only the type locality was provided. Chace seems to have based his list of the work of Holthuis (1947) with the addition of some more recently described species.

Family Alpheidae Rafinesque, 1815

The snapping shrimps, family Alpheidae, are reminiscent of small lobsters. At least one of the first pereopods is heavily chelate. The carpus of the second pereopod is divided into articles. The eye may be exposed or covered by the front of the carapace. Most snapping shrimps hide in burrows, tubes or cracks by day and are active at night.

Most snapping shrimps are much more diverse in the tropics than in temperate regions. Wicksten & Hendrickx (2003) reported 76 species of this family in the Eastern Tropical Pacific, but only 15 species have been reported from San Diego northward. Species of *Betaeus*, the visored shrimps, range as far north as Alaska.

There have been few studies of the natural history of snapping shrimps in California. Species of *Automate* and *Alpheopsis* usually have been taken subtidally in box cores or grab samples, which suggests that they are burrowers. Species of *Alpheus* live under rocks, in cracks or holdfasts or among worm tubes. *Alpheus clamator* Lockington, 1877; *A. bellimanus* Lockington, 1877; and *Synalpheus lockingtoni* Coutière, 1909 are abundant from lower intertidal areas to offshore kelp beds, shale reefs and rocky areas. *Alpheus californiensis* most often occurs in protected bays. Species of *Betaeus* live in pairs in tide pools or as associates of other invertebrates.

Species of *Alpheus* are noted for the loud snaps, clicks and pops produced when the enlarged tooth of the dactyl of the major chela strikes the palm. The sounds function in territorial defense, prey capture and distraction of predators (Schein 1977; Versluis *et al.* 2000).

Many species of alpheids are sexually dimorphic, with males often having larger chelae. In species of *Alpheus*, the chelae of males often have better-developed ridges, rows of setae and teeth than do those of females. Males of *Alpheopsis* and *Betaeus* tend to have a gape between the fingers of the chela than do females.

Several specimens of an unidentified species of *Salmoneus* Holthuis, 1955, have been found in Long Beach Harbor, California (D. Cadien, pers. comm.) Species of this genus have a large, flat rostrum and chelae with unusually inflated areas proximal to the fingers. Banner & Banner (1981: 52–54) gave a key to all known species of *Salmoneus*. Diagnoses of species of *Alpheus* given here follow Kim & Abele (1988); those of species of *Betaeus*, Hart (1964).

Key to species of family Alpheidae

1. Triangular movable plate articulated at posterolateral angle of abdominal somite 6 lateral to base of uropod 2
- No triangular movable plate articulated at posterolateral angle of abdominal somite 6 lateral to base of uropod 9
2. Rostrum prominent, orbital hoods armed with teeth *Alpheopsis equidactylus*
- Rostrum absent, front without teeth 3
3. Dactyls of preopods 2–5 slender, simple 4
- Dactyls of pereopods 2–5 stout, bifid 6
4. Chela of pereopod 1 with fingers longer than palm. Large male with gaping fingers of chelipeds *Betaeus longidactylus*
- Chela of pereopod 1 with fingers not longer than palm. Large male without gaping fingers 5
5. Blade of scaphocerite broad distally. Fixed finger of pereopod 1 decreasing in width evenly to sharp curved apex *Betaeus harrimani*
- Blade of scaphocerite narrow distally. Fixed finger of pereopod 1 truncate distal to sharp curved apex ... *Betaeus ensenadensis*
6. Front curved, not emarginate. Symbiotic with sea urchins (*Strongylocentrotus* spp.) *Betaeus macginitieae*
- Front emarginate. Symbiotic with abalone or crabs or free-living 7
7. Emargination of front shallow. Telson with posterolateral spines small or missing. Symbiotic with abalones (*Haliotis* spp.) .. *Betaeus harfordi*
- Emargination of front deep. Telson with posterolateral spines well developed. Not symbiotic with abalones 8
8. Peduncle of antennule less than 0.5 carapace length. Merus of cheliped with lower inner ridge with long bristles, upper ridge ending in sharp tooth; chela 3 times as long as wide, fingers subequal to palm *Betaeus gracilis*
- Peduncle of antennule subequal to carapace length. Merus of cheliped with lower inner ridge usually tuberculate, upper ridge with tuft of hair; chela 2 times as long as wide, fingers longer than palm *Betaeus setosus*
9. Eye fully exposed dorsally *Automate dolichognatha*
- Eye covered by carapace 10
10. Pereopods without epipods. Dactyls of pereopods 3–5 bifid *Synalpheus lockingtoni*
- Pereopods with epipods. Dactyls of pereopods 3–5 with simple apices 11
11. Dactyl of major chela closing horizontally. Merus of pereopod 3 with prominent inferior tooth *Alpheus clamator*
- Dactyl of major chela closing vertically. Merus of pereopod 3 without prominent inferior tooth 12
12. Orbital hoods with teeth. Minor chela with prominent tooth posterior to movable finger, movable finger flattened (lamellate) .. *Alpheus bellimanus*
- Orbital hoods without teeth. Minor chela without prominent tooth posterior to movable finger, movable finger not flattened .. *Alpheus californiensis*

Alpheopsis Coutière, 1896

Alpheopsis equidactylus (Lockington, 1877)

(Fig. 14 A)

Alpheus equidactylus Lockington, 1877a: 35. — Holmes 1900: 187; pl. 3, figs. 45–46. — Rathbun 1904: 10.
Crangon equidactylus. — Schmitt 1921: 76, fig. 53. — Johnson & Snook 1927: 309.
Alpheopsis equidactylus. — Word & Charwat 1976: 37. — Wicksten 1984a: 186; 1994: 120. — Chace 1988: 4.

Diagnosis. Front trispinose, rostrum narrow, shorter than first segment of antennular peduncle. Ocular teeth acute, shorter than rostrum. Stylocerite reaching end of second segment of antennular peduncle. Scaphocerite with broad blade, lateral tooth exceeding blade. Basicerite with small tooth on dorsal margin, 1 small outer lateral tooth, large basolateral tooth. Carpocerite exceeding blade of scaphocerite. Carapace with posterolateral notch. Pereopods 1 similar in size, shape. Chela with transverse groove extending along upper edge almost to posterior margin, dactyl closing vertically. Propodus with 2 teeth on cutting edge. Carpus of pereopod 2 with 5 articles, article 1 as long as next 4 combined. Pereopods 3–5 slender, with long dactyls; 1–2 small spines on ischium of pereopods 3, 4. Pleura of abdominal somites 1–4 rounded, those of 5, 6 pointed. Telson with 2 pairs dorsolateral, one pair long terminal spines. Total length 19.1 mm.

Color in life. Carapace and abdomen with broad red stripes, appendages red to orange, telson and uropods translucent with broad red stripe distal to articulation with abdomen. The color is based on a photograph of a shrimp at Redondo Beach, California.

Habitat and depth. Sand and mud, subtidal to 85 m.

Range. Monterey to Cortez Bank, California. Type locality Monterey, California.

Remarks. Schmitt (1921: 77) mentioned that "according to Coutière" this is *Alpheopsis trispinosus* Stimpson, 1860. *Alpheopsis trispinosus* ranges from New South Wales to Tasmania (Banner & Banner 1973). Chace (1988: 4) stated that *A. equidactylus* might "be distinct" from *A. trispinosus* but did not compare material from the two species. *Alpheopsis trispinosus* has a broader rostrum than does *A. equidactylus*. The carpocerite of *A. trispinosus* does not extend beyond the scaphocerite. The basicerite of *A. trispinosus* lacks a small tooth between the upper margin and the larger lower tooth. There are two small teeth on the dactyl of the major chela as well as a large one in adult *A. trispinosus*. Pereopod 3 dactyl is relatively shorter in *A. trispinosus* than in *A. equidactylus*.

The original description of *A. equidactylus* was not accompanied by illustrations. The only previous illustration of this species is a crude line drawing of the chela by Holmes (1900) without the characteristic dorsal notch. Figure 14A shows the gross anatomy of the species but not the setae, spines or other fine details of the appendages and telson.

Alpheus Fabricius, 1798

Alpheus bellimanus Lockington, 1877

(PL. 3 G)

Alpheus bellimanus Lockington, 1877a: 34. — Holmes 1900: 184. — Rathbun 1904: 108. — Word & Charwat 1976: 41. — Wicksten 1983b: 41; 1984a: 188; 1994: 120. — Kim & Abele 1988: 13, fig. 5. — Jensen 1995: 44, fig. 70. — Wicksten & Hendrickx 2003: 64. — Kuris *et al.* 2007: 637, pl. 317 A2.
Crangon bellimanus. — Schmitt 1921: 75, fig. 51. — Johnson & Snook 1927: 309.

Diagnosis. Rostrum narrowly triangular, not clearly carinate posteriorly, far overreaching middle of visible part of first segment of antennular peduncle. Ocular hoods armed with teeth. Second segment of antennular peduncle the longest, stylocerite almost reaching distal margin of first segment. Scaphocerite with blade reaching to middle of distal tooth, tooth overreaching distal end of antennular peduncle. Basicerite with sharp lateral tooth. Major chela of pereopod 1 with movable finger opening, closing in obliquely horizontal plane, finger with bulbous apex. Palm with superior, palmar, inferior grooves, strong tooth flanking base of dactyl, notches on superior and inferior margins. Merus of cheliped with 6–10 small spines on inferior margin, acute immovable tooth at distal end. Minor chela of pereopod 1 similar to major chela, but movable finger laterally compressed, forming lamellar expansion.

Merus of minor pereopod 1 with 6–7 spines. Carpus of pereopod 2 with 5 articles, article 1 longest. Pereopod 3 slender, with simple dactyl, propodus with 7 movable spines, no tooth at end of merus, ischium with strong movable spine. Pereopods 4, 5 similar to third, but more slender. Telson with 2 pairs dorsal spines, posterior margin shallowly triangular, armed with pair spines on each lateral margin. Total length to 30.3 mm.

Color in life. Body ranging in color chestnut-brown to rich scarlet. Major chela mottled with yellow, tan; fingers with white apices. Minor chela orange. Posterior pereopods lightly banded with red, orange.

Habitat and depth. Among rocks, coralline algae or kelp holdfasts, low intertidal zone to 95 m.

Range. Monterey, California to Galapagos Is., but seldom reported north of Point Conception, California. Type locality San Diego, California. Coutière (1899) reported the species from Chile, but there have been no further reports of the species south of Colombia and the Galapagos Is.

***Alpheus californiensis* Holmes, 1900**

(Fig. 14B–D)

Alpheus californiensis Holmes, 1900: 186, pl. 2, fig. 42, pl. 3, figs. 43–44. — Rathbun 1904: 108. — Word & Charwat 1976: 43. — Wicksten 1984a: 188. — Chace & Abbott 1980: 569. — Ricketts *et al.* 1985: 189, 348. — Kim & Abele 1988: 70, fig. 29.

Crangon californiensis. — Schmitt 1921: 76, fig. 52. — MacGinitie & MacGinitie 1968: 276, figs. 126–127.

Diagnosis. Rostrum sharply triangular, carinate posteriorly, reaching to middle of visible part of first segment of antennular peduncle. Ocular hoods slightly inflated, without teeth. Second segment of antennular peduncle the longest, stylocerite scarcely reaching distal margin of first segment. Scaphocerite with distal tooth overreaching distal end of antennular peduncle, blade not reaching to distal end of antennular peduncle. Basicerite with small lateral tooth. Major chela of pereopod 1 with fingers closing vertically, acutely rounded at apex. Palm with superior transverse grooves on each faces, shallow inferior depressions, grooves; superior surface bearing shallow notch, inferior margin produced into shoulder. Merus of major pereopod bearing small tooth at distal end. Minor chela of pereopod 1 sexually dimorphic, in male bearing fringes of setae on both fingers; in female, setose, but without such fringes. Finger with acute apex, palm bearing grooves, notches similar to major chela, but more shallow. Pereopod 2 with 5 carpal articles, article 1 longest. Pereopod 3 slender, with simple dactyl, propodus with 7 movable spines, merus without tooth or spines, ischium with movable spine or slender spinule. Pereopods 4,5 similar to pereopod 3, but more slender. Telson with 2 pairs dorsal spines, posterior margin convex, armed with pair spines at each lateral margin. Total length 39 mm.

Color in life. Not reported, but black-and-white photograph by MacGinitie & MacGinitie (1968 fig. 127) shows animal to be mostly dark.

Habitat and depth. Shallow rocky areas, burrows in mud of bays, mostly intertidal.

Range. San Pedro, California to Magdalena Bay, Baja California. Type locality San Pedro, California. I examined specimens from Newport and San Diego bays. There have been no reports of the species from San Pedro since its original description.

Remarks. *Alpheus californiensis* often lives in pairs in burrows. The shrimp builds complex systems of burrows in subtidal mud in San Diego Bay.

***Alpheus clamator* Lockington, 1877**

(Fig. 14E–H)

Alpheus clamator Lockington 1877b: 43. — Kingsley 1878a: 197. — Holmes 1900: 182, pl. 2, figs. 38–40. — Holthuis 1952b: 49. — Word & Charwat 1976: 45. — Chace & Abbott 1980: 570, fig. 23.2. — Wicksten 1984a: 187; 1990a: 100; 1994: 120. — Ricketts *et al.* 1985: 188, fig. 161. — Kim & Abele 1988: 21, fig. 8. — Jensen 1995: 44, fig. 69. — Kuris *et al.* 2007: 637, pl. 317 A1.

?*Alpheus barbara* Lockington, 1878: 471.

Alpheus dentipes: Rathbun 1904: 10 [not *Alpheus dentipes* Guerin, 1832, eastern Atlantic species].

Crangon dentipes. — Schmitt 1921: 74, fig. 50. — Johnson & Snook 1927: 308, figs. 260, 264.

Crangon clamator. — MacGinitie & MacGinitie 1968: 277, fig. 128.

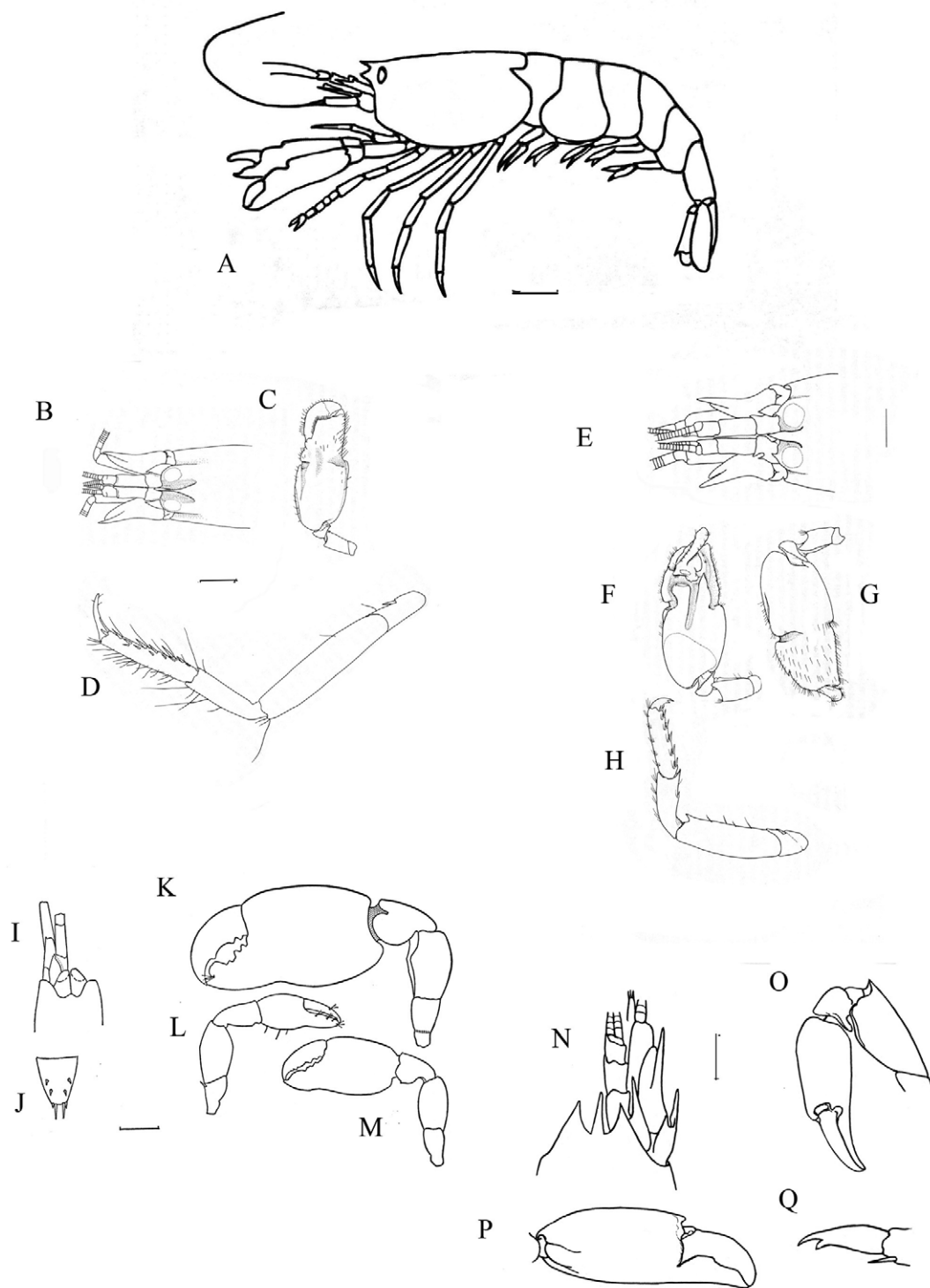


FIGURE 14. Family Alpheidae. A, *Alpheopsis equidactylus* (Lockington, 1877). B–D, *Alpheus californiensis* Holmes, 1900; B, frontal region in dorsal view; C, major chela in lateral view; D, pereopod 3. E–H, *Alpheus clamator* Lockington, 1877; E, pereopod 3; F, major chela, mesial view; G, major chela, lateral view; H, frontal region in dorsal view. I–M, *Automate dolichognatha* de Man, 1888; I, frontal region in dorsal view; J, telson; K, male major cheliped; L, minor cheliped; M, female major cheliped. N–Q, *Synalpheus lockingtoni* Coutière, 1909; N, frontal region in dorsal view; O, major chela in lateral view; P, major chela in mesial view; Q, detail of dactyl of pereopod 3. Scale A = 10 mm; B, E = 4 mm; I–M = 1 mm, N = 3 mm. A, drawn from specimen from LACM (no locality data); B–H from Kim & Abele 1988, I–M from Banner & Banner 1973, N–Q from Coutière 1909.

Diagnosis. Rostrum broadly triangular, reaching to middle of visible part of first segment of antennular peduncle. Sharp tooth on each ocular hood, hoods separated from rostral carina by orbitorostral grooves. Second segment of antennular peduncle the longest, stylocerite not reaching to distal margin of first segment. Scaphocerite with blade shorter than distal tooth, tooth reaching to distal end of antennular peduncle. Basicerite usually with sharp lateral tooth, but may be absent or blunt. Major chela of pereopod 1 with movable finger opening, closing in almost horizontal plane, laterally compressed proximally, bluntly bulbous at apex, palm with superior, palmar, inferior grooves; superior crest distal to transverse groove terminating distally in strong tooth at base of movable finger, entire chela setose. Merus of cheliped without tooth at distal end. Minor chela of pereopod 1 compressed, palm with superior, inferior grooves on outer face, superior transverse depression, tuberculate posterior to superior transverse groove, merus without spine at distal end. Pereopod 2 with 5 carpal articles, article 1 longest. Pereopod 3 stout, with biunguiculate dactylus, propodus bearing 5 pairs movable spines; merus armed with strong tooth near distal end of inferior margin, ischium with one spine. Pereopods 4,5 similar to pereopod 3 but more slender, pereopod 5 lacking meral tooth, spine on ischium. Telson armed with 2 pairs dorsal spines, pair lateral spines on each side of convex margin. Total length to 37 mm.

Color in life. Much of body tan to brown, large chela mottled in red-brown and yellow (Chace & Abbott 1980, fig. 23.2) Rostrum bluish. Anterior margin of carapace pale blue-white. Area posterior to anterior margin dark rusty brown to red band, followed by irregular white band, large area of yellow to rusty brown over posterior half of carapace. Antennae translucent orange, with mottled proximal segments. Large chela with complex pattern of dark brown blotches interspersed with china white patches bearing brown dots, apices of fingers red-orange. Minor chela mostly white with brown dots, with brown patches along superior margin. Posterior pereopods pale olive with brown chromatophores. Abdomen pale olive. Tail fan edged with golden setae. The body of California specimens appears greenish or brownish when seen from distance of more than 0.3 m. The color notes are from shrimp from Monterey Bay, California.

Habitat and depth. Tide pools, kelp holdfasts, worm tubes, rocky reefs, to 10 m.

Range. Dark Gulch, Mendocino County, California to San Bartholome Bay, Baja California. Type locality Santa Barbara I., California.

Remarks. *Alpheus clamator* has a lengthy list of synonyms. The original description was presented without illustrations in 1876, but was not published until the following year. Kingsley (1878a) referred specimens to the species. Holmes (1900) reported the species in a list of crustaceans from California, but Schmitt (1921) incorrectly named Holmes as the author in his account.

Lockington (1878a) described one of Kingsley's specimens as a new species, *Alpheus barbara*. This species supposedly differed from *A. clamator* in lacking teeth on the meri of the third pereopods, having slightly different proportions of the carpal articles of the second pereopod, and lacking a tooth on the basicerite of the antenna. The species was not illustrated. Lockington noted that the specimen was "damaged." The type specimen of *A. barbara* has been lost. Examination of a large series of *A. clamator* suggests that proportions of the carpal articles can be difficult to measure accurately, and that a tooth on the basicerite can be lacking. *Alpheus barbara* is probably a synonym of *A. clamator* (Wicksten 1990a).

The nomenclature of the species was confused while the Californian species was considered to be identical with the European *A. dentipes*. Further examination proved the two to be distinct (Holthuis 1952b). The International Commission on Zoological Nomenclature decided in 1955 to award priority to the generic name *Alpheus* instead of *Crangon*, the generic name now used for the coastal or sand shrimps of the family Crangonidae.

Automate de Man, 1888

***Automate dolichognatha* de Man, 1888**

(Fig. 14I–M)

Automate dolichognatha de Man, 1888: 529, pl. 22, fig. 5. — Banner & Banner 1973: 299, fig. 1 (extensive synonymy). — Wicksten 1981:1104.

Automate haightae Boone, 1931: 184, fig. 22.

Diagnosis. Central part of anterodorsal margin of carapace recessed above eyestalks, leaving them exposed to near base. Rostrum small, rounded, at times triangular, not reaching to level of frontal margin of carapace. Eyestalk exposed, not covered by carapace, corneal area poorly developed. Stylocerite reaching nearly to end of first article of antennular peduncle. Scaphocerite moderately broad, lateral tooth slightly exceeding blade, reaching to or past middle of second segment of antennular peduncle. Chelae of pereopods 1 unequal. Large chela compressed, 2.5 times as long as broad, palm, fingers subequal; with or without teeth on fingers or gape. Smaller pereopod 1 about half as long as larger first pereopod, fingers without gape or teeth. Carpus of pereopod 2 with 5 articles, article 2 slightly longer than article 1, longest of all 5 articles. Pereopod 3 with broad merus, propodus with 5 spinules, dactyl simple. Pereopods 4, 5 similar to 3, but smaller. Telson with 2 pairs dorsolateral spines, 2 pairs terminal spines; inner spines of terminal pair much longer than outer spines. Total length 16 mm.

Color in life. Pale translucent yellow to nearly translucent, fingers of chelae dull white to overall creamy yellow.

Habitat and depth. Usually along shore, under rocks, to 20 m.

Range. Circumtropical except for western Africa. In eastern Pacific, from off Santa Catalina I. to Galapagos Is. Type locality Noordwachter I. (= Pulau Tuguan, Indonesia).

Remarks. Questions remain as to whether this is a single variable species or a complex of similar separate species. Banner & Banner (1973) compared specimens from many geographic regions and of different sizes and sexes, and found no consistency in the variation of the teeth of the chelae or the gape with age, size or habitat. Molecular studies probably would be the best way to resolve taxonomic questions regarding this species. It is easily recognized in California because it is the only alpheid in which the eyestalks are exposed, not covered by the carapace.

***Betaeus* Dana, 1852**

***Betaeus ensenadensis* Glassell, 1938**

(Fig. 15E, F, I, M, N)

Betaeus ensenadensis Glassell, 1938: 416. — Hart 1964: 445, figs. 23–25, 28, 35–36, 43–45. — MacGinitie & MacGinitie 1968: 270. — Word & Charwat 1976: 47. — Chace & Abbott 1980: 569. — Wicksten 1984a: 187.

Diagnosis. Front of carapace slightly curved, depressed anteriorly. Stylocerite reaching to about distal 0.33 of second segment of antennular peduncle. Scaphocerite with narrow blade, lateral tooth exceeding blade, reaching middle of third segment of antennular peduncle. Anterolateral margin of carapace obtuse. Chela of pereopod 1 covered with fine denticles, dactyl shorter than palm, bearing 3 teeth, fingers gaping. Pereopod 2 with 5 carpal articles, article 1 longer than article 5 and about equal to articles 2, 3, 4 together. Pereopods 3, 4 with dilated merus, with movable spines on merus, ischium; acute dactyl. Pereopod 5 with spine on merus only, brush of bristles on propodus. Abdominal pleura 1–4 rounded, pleuron 5 bluntly angled. Telson with 2 pairs spines on dorsal surface, 2 spines at each posterolateral angle, posterior margin slightly curved. Total length about 25 mm.

Color in life. Mostly translucent, with minute red, blue spots; fingers, telson tinted light purple (Glassell 1938).

Habitat and depth. In burrows of *Neotrypaea californiensis* (Callianassidae) or *Upogebia* spp. (Upogebiidae), intertidal zone to 10 m.

Range. Los Angeles Harbor, California to Ensenada, Mexico. Type locality Estero de Punta Banda, Ensenada, Mexico.

***Betaeus gracilis* Hart, 1964**

(Fig. 16 H–J)

Betaeus gracilis Hart, 1964: 453, figs. 50–51, 56, 65–67, 77–78. — Word & Charwat 1976b: 49. — Chace & Abbott 1980: 569. — Wicksten 1984a: 188.

Diagnosis. Front of carapace depressed, deeply indented medially, covering eye with two hoods. Stylocerite reaching nearly to end of second segment of antennular peduncle. Scaphocerite broad, with stout lateral tooth exceeding blade, separated from it for distal third of its length; reaching almost to end of third segment of antennular peduncle. Anterior margin of carapace evenly curved. Chela of pereopod 1 with palm longer than fingers, little gape between fingers. Carpus of pereopod 2 with 5 articles, article 1 longest. Pereopod 3 stout, merus slightly dilated, with movable spine, dactyl narrow, bifid. Pereopods 4, 5 similar to pereopod 3 but smaller. Pleura of abdominal somites 1–3 rounded, those of 4, 5 bluntly square. Telson with 2 pairs dorsal spines, well developed posterolateral spines, posterior margin curved. Total length about 25 mm.

Color in life. Pale olive-green.

Habitat and depth. Kelp holdfasts, intertidal to shallow subtidal areas.

Range. Monterey Bay to Laguna Beach, California. Type locality Laguna Beach.

***Betaeus harfordi* (Kingsley, 1878)**

(Fig. 16A–D, Pl. 4A)

Alpheus harfordi Kingsley, 1878a: 198.

Betaeus harfordi. — Rathbun 1904: 108. — Schmitt 1921: 79, fig. 55. — Johnson & Snook 1927: 310, fig. 261. — Hart 1964: 447, figs. 46–47, 54, 58–61, 73–74. — MacGinitie & MacGinitie 1968: 279. — Ache & Davenport 1972: 94. — Word & Charwat 1976: 51. — Chace & Abbott 1980: 571, fig. 23.3. — Wicksten 1984a: 188. — Campos-Gonzalez 1988: 384. — Kuris *et al.* 2007: 637, PL. 317 D.

Diagnosis. Front of carapace shallowly emarginate, produced over eye. Stylocerite reaching to distal quarter of second segment of antennular peduncle. Scaphocerite narrow, lateral tooth exceeding blade, separated from blade by slit, reaching third segment of antennular peduncle. Anterior margin of carapace shallowly curved. Chela of pereopod 1 flattened laterally, palm, fingers subequal in length; fingers meeting evenly or gaping. Carpus of pereopod 2 with 5 articles, article 1 longest. Pereopod 3 stout, flattened laterally, with spine on merus, stout, bifid dactyl. Pereopod 4 similar but shorter than 3, pereopod 5 shorter than 4. Abdominal pleura 1–4 rounded, pleuron 5 acute. Telson with 2 pairs dorsal spines, posterolateral spines vestigial or missing, posterior margin curved. Total length 24 mm

Color in life. Dark purple, blue-black, deep blue (Hart 1964).

Habitat and depth. In mantle cavity of abalone (*Haliotis* spp.), rarely wavy top, *Astraea undosa* (Woods, 1828); lower intertidal zone to 22 m.

Range. Fort Bragg, California to Magdalena Bay, Baja California, Mexico. Type locality Santa Catalina I., California.

***Betaeus harrimani* Rathbun, 1904**

(Figs. 15A, B, G, K, O–Q)

Betaeus harrimani Rathbun, 1904: 108, fig. 49. — Hart 1964: 435, pl. 1, figs. 1–16, 29–31, 37–39, pl. 1. — Kozloff 1974: 165. — Word & Charwat 1976: 53. — Butler 1980: 151. — Chace & Abbott 1980: 571, fig. 23.4 — Wicksten 1984a: 188. — Jensen 1995: 43, fig. 67. — Kuris *et al.* 2007: 637, pl. 317 B, E, I, M.

Diagnosis. Front of carapace slightly curved, depressed anteriorly. Stylocerite reaching almost to end of second segment of antennular peduncle. Scaphocerite broad, lateral tooth exceeding blade, reaching past middle of last segment of antennular peduncle. Anterior margin of carapace with 2 shallow sinuses. Pereopods 1 with fingers 0.5 times as long as palm, with or without gape. Pereopods 2 slender, with 5 carpal articles; article 1 equal in length to next 3 together. Pereopods 3, 4 slender, somewhat flattened, with thin, curved dactyls. Pereopod 5 similar to 3, 4 but with bands of setae forming brush on distal half of propodus. Pleura of abdominal somites 1–3 rounded, pleura of 4, 5 angled. Telson with 2 pairs spines on dorsal surface, 2 spines at each posteolateral angle, posterior margin deeply curved. Total length 35 mm.

Color in life. Color determined by distribution of blue and red chromatophores: translucent, reddish to purplish, pale green; turning blue at night (Hart 1964).

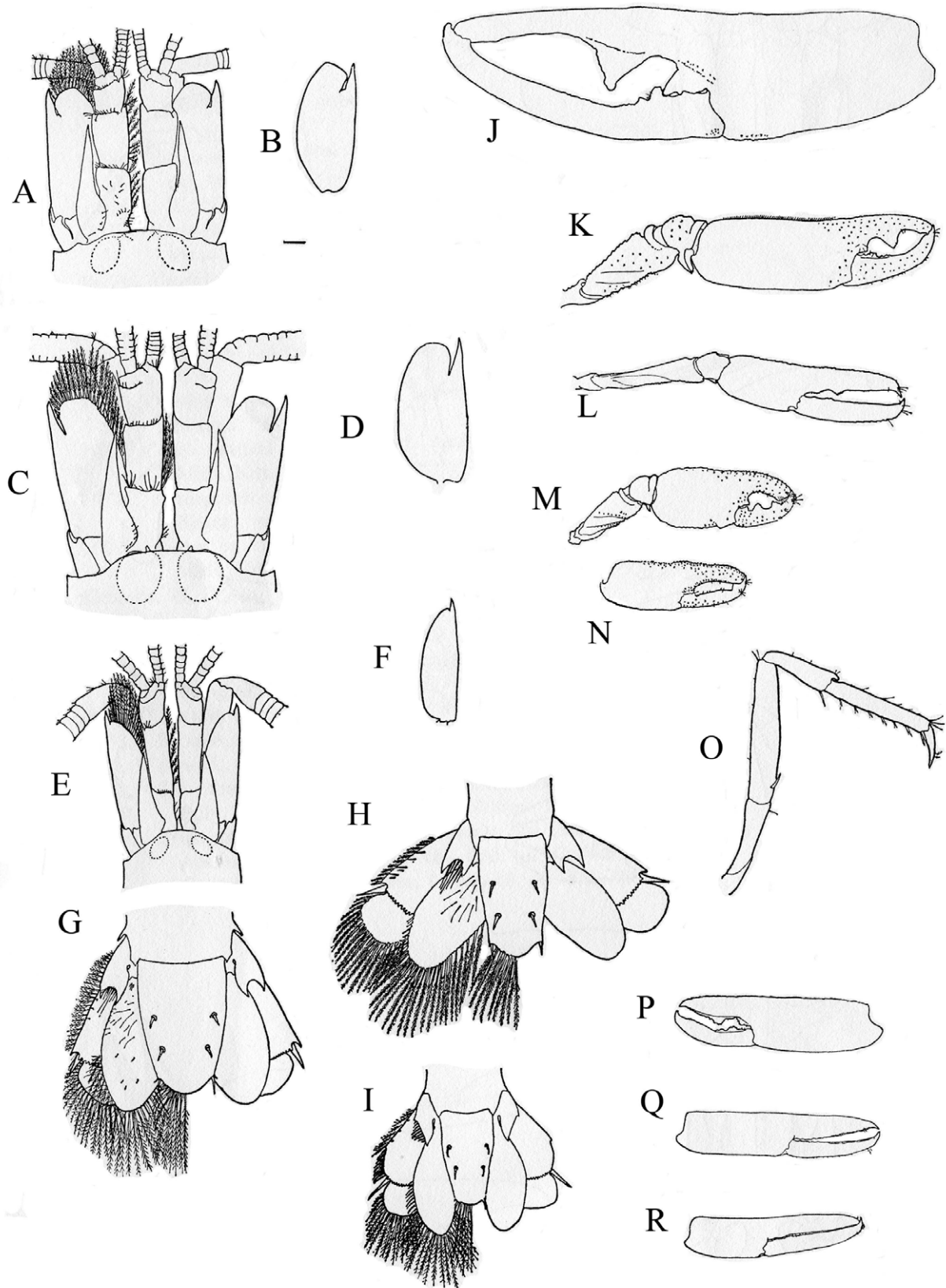


FIGURE 15. Family Alpheidae. A, B, G, K, O, P, Q. *Betaeus harrimani* Rathbun, 1904; A, frontal region in dorsal view; B, scaphocerite; G, tail fan; K, right cheliped of male; O, pereopod 3; P, left chela of female; Q, right chela of female. C, D, H, J, L, R *Betaeus longidactylus* Lockington, 1877; C, frontal region in dorsal view; D, scaphocerite; H, tail fan; J, left chela of male; L, left cheliped of female; R, right chela of female. E, F, I, M, N. *Betaeus ensenadaensis* Glassell, 1938; E, frontal region in dorsal view; F, scaphocerite; I, tail fan; M, right cheliped of mature male; N, right chela of female or immature male. Scale = 1 mm. From Hart 1964.

Habitat and depth. In pools, among oysters, in burrows of *Upogebia pugettensis* and *Neotrypaea californiensis*, intertidal zones.

Range. Sitka, Alaska to Newport Harbor, California. Type locality Sitka, Alaska. This is the northernmost alpheid in the eastern Pacific.

***Betaeus longidactylus* Lockington, 1877**

(Fig. 15 C, D, H, J, L, R, Pl. 3F)

Betaeus longidactylus Lockington, 1877a: 35. — Rathbun 1904: 108. — Schmitt 1921: 80, pl. 12. — Johnson & Snook 1927: 310, fig. 262. — Hart 1964: 441, figs. 20–22, 27, 32–34, 40–42. — MacGinitie & MacGinitie 1968: 279. — Word & Charwat 1976b: 55. — Chace & Abbott 1980: 572, fig. 23.5. — Ricketts *et al.* 1985: 74, fig. 57. — Jensen 1995: 43, fig. 66. — Kuris *et al.* 2007: 637, pl. 317 F, 317 K.

Alpheus (Betaeus) longidactylus. — Holmes 1900: 190.

Diagnosis. Front of carapace straight, slightly swollen over eye. Stylocerite reaching almost to end of second segment of antennular peduncle. Scaphocerite broad, lateral tooth exceeding blade, reaching nearly to end of antennular peduncle. Carapace without teeth. Pereopods 1 usually similar in size, shape, narrow fingers exceeding palm. In small individuals, no large teeth on inner margin of fingers and no gape between fingers when closed; in large shrimp, teeth, obvious gape can be present. Pereopod 2 with 4 carpal articles, article 1 slightly longer than next three together. Pereopod 3 relatively stout, slightly flattened, with simple dactyl. Pereopods 4, 5 similar to pereopod 3 but smaller, more slender. Abdominal pleura 1–3 rounded, 4, 5 slightly angled. Telson with 2 pairs spines on dorsal surface, 2 spines on each posterolateral angle, posterior margin deeply curved. Total length 40 mm.

Color in life. Olive green, olive brown, red-brown, blue green; with light mid-dorsal stripe; legs reddish with white apices, tail fan dark with yellow setae (Hart 1964).

Habitat and depth. Tide pools, among eelgrass, on docks, or in burrows of echiuroid worm *Urechis caupo* Fisher & MacGinitie 1928; or mud shrimps (*Upogebia* spp.), intertidal zones. Often found free-living.

Range. Elkhorn Slough, Monterey County, California; to Tepoca Bay, Gulf of California. Type locality San Diego, California.

Remarks. This tide pool shrimp is common in southern California, and often lives in pairs. It uses its chelipeds to push sediment out of its shallow burrow, and rests under rocks with its chelipeds outstretched in front of it. It is present only on the northern coasts of the Gulf of California. Most records in the Gulf of California come from the vicinity of Puerto Peñasco, Sonora.

***Betaeus macginitieae* Hart, 1964**

(Fig. 16E–G)

Betaeus macginitieae Hart, 1964: 451, figs. 48–49, 55, 62–64, 75–76 (see this reference for previous misidentifications). — Ache & Davenport 1977: 94. — Word & Charwat 1976: 57. — Chace & Abbott 1980: 569. — Wicksten 1984a: 188. — Carvacho & Olson 1984a: 64. — Jensen 1995: 42, fig. 65 — Kuris *et al.* 2007: 637, Pl. 317 G.

Diagnosis. Front of carapace produced to form hood, slightly curved anteriorly but without emargination. Stylocerite reaching to last quarter of second segment of antennular peduncle. Scaphocerite narrow, lateral tooth exceeding blade, reaching middle of third segment of antennular peduncle. Lateral margin of carapace faintly curved. Chela of pereopod 1 elongated, with blunt tooth on proximal part of fixed finger followed by gap before denticulate cutting edge; dactyl with similar proximal tooth. Carpus of pereopod 2 with 5 articles, article 1 longest. Pereopod 3 with stout ischium, slightly dilated merus, spine on proximal part of merus, short dactyl. Pereopods 4, 5 similar but smaller. Pleura of abdominal somites 1–4 rounded, pleuron 5 somewhat acute. Telson with 2 pairs dorsal spines, pair small spines on posterior margin, margin curved. Total length about 25 mm.

Color in life. Dark purple, resembling color of sea urchins; blue to reddish brown (Hart 1964). A specimen from Santa Catalina I. was purple-red, with red appendages.

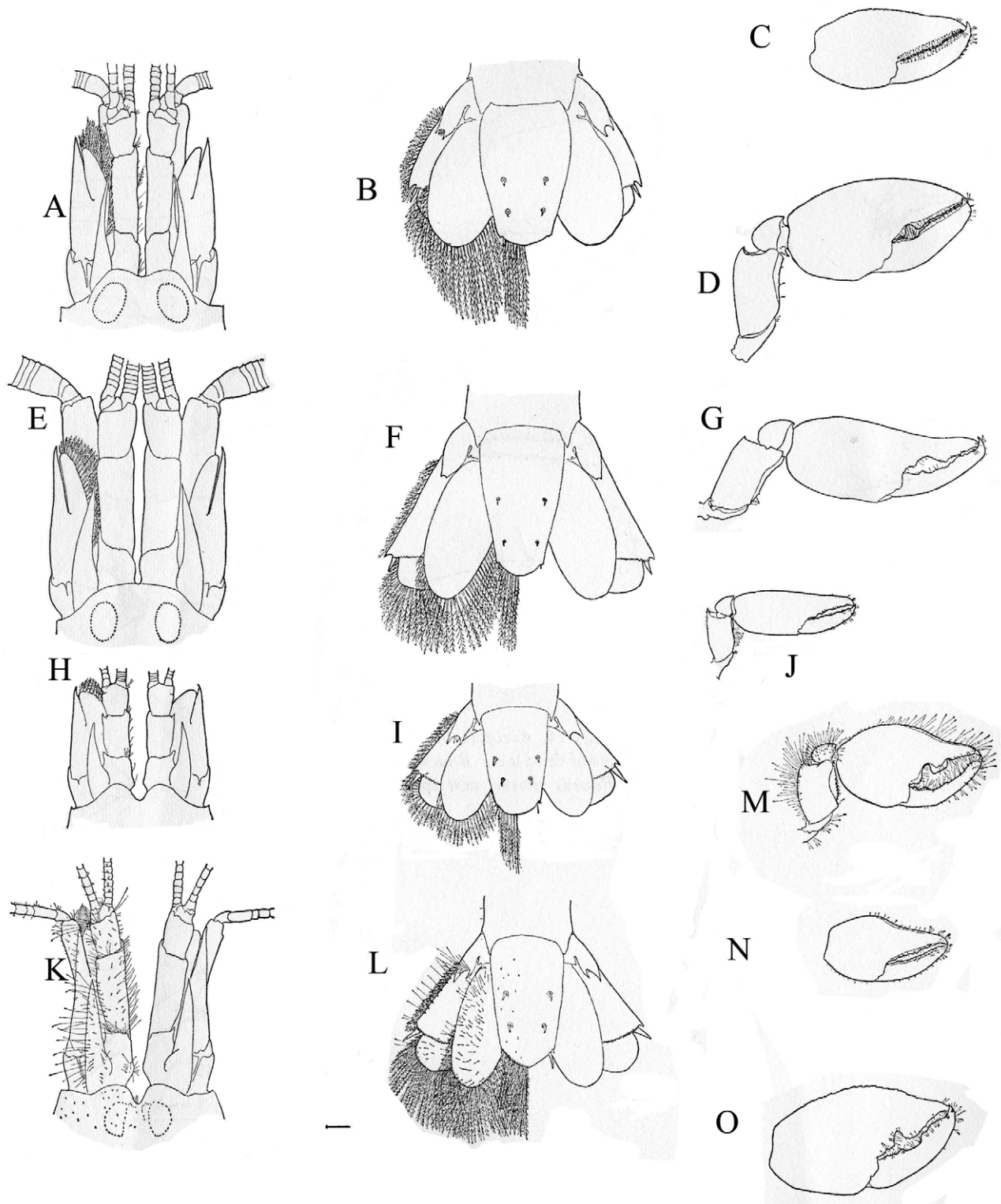


FIGURE 16. Family Alpheidae. A–D, *Betaeus harfordi* (Kingsley, 1878); A, frontal region in dorsal view; B, tail fan; C, right chela of female; D, right cheliped of male. E–G, *Betaeus macginitieae* Hart, 1964; E, frontal region in dorsal view; F, tail fan; G, right cheliped of male. H–J, *Betaeus gracilis* Hart, 1964; H, frontal region in dorsal view; I, tail fan; J, right cheliped of female. K–O, *Betaeus setosus* Hart, 1964; K, frontal region in dorsal view; L, tail fan; M, right cheliped of male; N, O, variations of right chela. Scale=1 mm. From Hart 1964.

Habitat and depth. Tide pools, subtidal rocky areas, in association with sea urchins *Strongylocentrotus purpuratus* (Stimpson, 1857) and *S. franciscanus* (A. Agassiz, 1863); intertidal zones to 10 m.

Range. Monterey, California to Todos Santos Bay, Baja California. Type locality Corona del Mar, Orange County, California.

***Betaeus setosus* Hart, 1964**

(Fig. 16K–O)

Betaeus setosus Hart, 1964: 455, figs. 52–53, 57, 68–72, 79, 80, pl. 2. — Kozloff 1974: 165. — Word & Charwat 1976: 59. — Butler 1980: 153. — Chace & Abbott 1980: 569. — Wicksten 1984a: 188. — Ricketts *et al.* 1985: 408, fig. 312. — Jensen 1986: 180; 1995: 43, fig. 68. — Kuris *et al.* 2007: 637, pl. 317 H, I.

Diagnosis. Front of carapace deeply indented medially, produced laterally over each eye. Stylocerite reaching nearly to end of second segment of antennular peduncle. Scaphocerite slender, lateral tooth longer than blade, separated from it for nearly 0.5 its length, nearly reaching end of third segment of antennular peduncle. Anterior margin of carapace smoothly curved. Chela of pereopod 1 large, much compressed laterally; fixed finger twice as wide at base as dactyl, which is longer than palm. Left chela with large tooth medially on fixed finger, wide gape, smaller proximal teeth; right chela with slight gape but most of teeth intermeshing. Carpus of pereopod 2 with 5 articles, articles 1, 5 about equal in length, longest. Pereopod 3 with inflated merus bearing large proximal spine, dactyl short, broad, bifid. Pereopods 4, 5 similar but smaller. Pleura of abdominal somites 1–3 rounded, pleura of 4, 5 angled. Telson with 2 pairs dorsal spines, 2 spines at posterolateral angle, posterior margin rounded. Much of body setose. Total length to 25 mm.

Color in life. Variable: nearly white, red, brown or green, matching algae; yellow in light but pink or orange in the dark (Hart 1964). Specimens from Pillar Point, San Mateo County, California were straw-colored.

Habitat and depth. Among rocks, kelp holdfasts, tide pools, on pilings, among roots of eelgrass (*Zostera* sp.), intertidal zone to 18 m.

Range. Hecate Strait, British Columbia to Morro Bay, California. Type locality Clayoquot Sound, west coast of Vancouver I., British Columbia.

Remarks. *Betaeus setosus* is invariably associated in Puget Sound with the anomuran crab *Pachycheles rudis* Stimpson, 1860 (Porcellanidae), both of which often are found in dead shells of giant barnacles (*Balanus nubilus* Darwin, 1854) (Jensen 1986). Individuals observed in California were found in quiet tide pools or in marinas, but were not associated with other invertebrates.

***Synalpheus* Bate, 1888**

***Synalpheus lockingtoni* Coutiére, 1909**

(Fig. 14 N–Q)

Synalpheus lockingtoni Coutiére, 1909: 21, fig. 1. — Schmitt 1921: 77, fig. 54. — Word & Charwat 1976: 63. — Chace & Abbott 1980: 569. — Standing 1981: 778. — Wicksten 1983b: 39; 1984a: 187. — Jensen 1995: 44, fig. 71. — Kuris *et al.* 2007: 637.

Diagnosis. Rostrum slightly longer than lateral orbital teeth, reaching end of first segment of antennular peduncle. Stylocerite reaching at least to middle of second segment of antennular peduncle. Scaphocerite with lateral tooth greatly exceeding narrow blade, reaching end of third segment of antennular peduncle or beyond. Chelae of pereopods 1 unequal, large chela with conical tubercle on anterior margin of palm. Carpus of pereopod 2 with 5 articles, article 1 longest, almost equal to combined lengths of other four articles. Pereopod 3 with bifid dactyl, extensor hook of dactyl about twice as long as flexor hook. Telson with posterolateral angles not prolonged into triangular projections, with 2 pairs terminal spines. Total length 30 mm.

Color in life. Major chela green, becoming dark green along distal end, orange apices on cutting edges of fingers. Minor chela, third maxilliped mostly translucent with red dots and green apices. Pereopod 3 translucent. Rest of body (carapace, abdomen and pereopods) translucent blue-green, bearing numerous small red dots. Posterior margins of abdominal somites and tail fan bearing yellow setae. The color is based on fresh specimen from Monterey Bay, California.

Habitat and depth. Among rocks, worm tubes, kelp holdfasts; most specimens taken at depths of 15 m or less.

Range. Cordell Bank, California (CAS unpubl. record) to Marquez Point, Baja California Sur, Mexico. Type locality off San Nicolas I., California.

Remarks. Coutière (1909) proposed the name *S. lockingtoni* to replace the name *Alpheus laeviusculus* Lockington, 1878, which was a homonym of a tropical Pacific species. Lockington's type material (lost, probably burned) came from the Gulf of California, not southern California. The description of Lockington's type seems to match *S. digueti* Coutière, 1909, which does not occur in California (Wicksten 1994). The type locality of San Nicolas I., California is for the material assigned to *S. lockingtoni* Coutière.

Family Hippolytidae Dana, 1852

Following the classification by Christoffersen (1988a), only two species found in the area of coverage now are included in this family. These two species each have one pair of supraorbital teeth and three carpal articles in the second pereopod. Both usually are associated with sea grasses or algae. In life, they are well camouflaged, colored brown, green, splotched, or otherwise like the algae or sea grasses among which they live. At night, they change color to blue. Often, they rest parallel to the long axis of the algae or grass. The shrimps are sexually dimorphic, males usually smaller than females and with a subchelate pereopod 3 and very short rostrum.

Key to species of family Hippolytidae

1. No spines on first segment of antennular peduncle, apex of rostrum trifid. Usually among large brown algae *Hippolyte clarki*
- 1 or 2 spines on first segment of antennular peduncle, apex of rostrum bifid. Usually among sea grasses, *Zostera* sp. *Hippolyte californiensis*

Hippolyte Leach, 1814

Hippolyte californiensis Holmes, 1895

(Fig. 17A–D)

Hippolyte californiensis Holmes, 1895: 576, figs. 21–26; 1900: 193. — Rathbun 1904: 56. — Schmitt 1921: 48, fig. 26. — Johnson & Snook 1927: 304. — Holthuis 1947: 14. — Chace 1951: 35, fig. 1 (part); 1997: 46. — MacGinitie & MacGinitie 1968: 273. — Word & Charwat 1976: 135. — Chace & Abbott 1980: 573, fig. 23.9. — Wicksten 1983b: 23, fig. 3; 1990b: 589. — Ricketts *et al.* 1985: 305. — Jensen 1995: 49, fig. 86. — Wicksten & Hendrickx 2003: 67. — Quirioz-Vázquez *et al.* 2005: 104. — Kuris *et al.* 2007: 638, pl. 318 H1.

Hippolyte mexicana Chace, 1937: 127, fig. 6.

Diagnosis (modified from Chace 1951). Female: length of rostrum exceeding that of antennular peduncle, reaching or slightly exceeding that of scaphocerite, with 3–5 dorsal, 3–5 ventral teeth, apex bifid. Carapace with supraorbital, antennal, branchiostegal teeth. One or 2 spines on first segment of antennular peduncle. Stylocerite not reaching end of first segment of antennular peduncle, peduncle shorter than scaphocerite. Third maxilliped with exopod, no epipod. No epipods on pereopods. Pereopod 1 particularly short, stout. Pereopod 2 with 3 carpal articles, length of article 1 more than twice length of article 2, length of article 2 approximately 0.75 times length of article 3. Pereopods 3–5 with short, spinose dactyls. Merus of pereopod 3 with 3–5 spines, carpus with 1 spine. Propodus with margins more or less straight, dactyl armed with three long, stout spinules, 10–13 long, slender spinules on flexor margin. Merus of pereopod 4, with 3 spines; carpus with 1 spine. Merus, carpus of pereopod 5 with 1 spine each. Propodus, dactyl of pereopods 4, 5 similar to those of pereopod 3. Abdominal somite 3 produced into low, rounded cap over abdominal somite 4, pleuron of somite 5 without point. Abdominal somite 6, 1.75 times as long as length of somite 5, as long as telson in female but shorter in male. Telson with 2 pairs lateral spines, 6–7 terminal spinules. Length of uropods greater than length of telson. Male: rostrum shorter than scaphocerite, more slender than in female, with 3–5 dorsal, 0–5 ventral teeth. Pereopod 3 with propodus expanded in distal half, dactyl armed with numerous spinules on flexor margin. Total length to 40 mm.

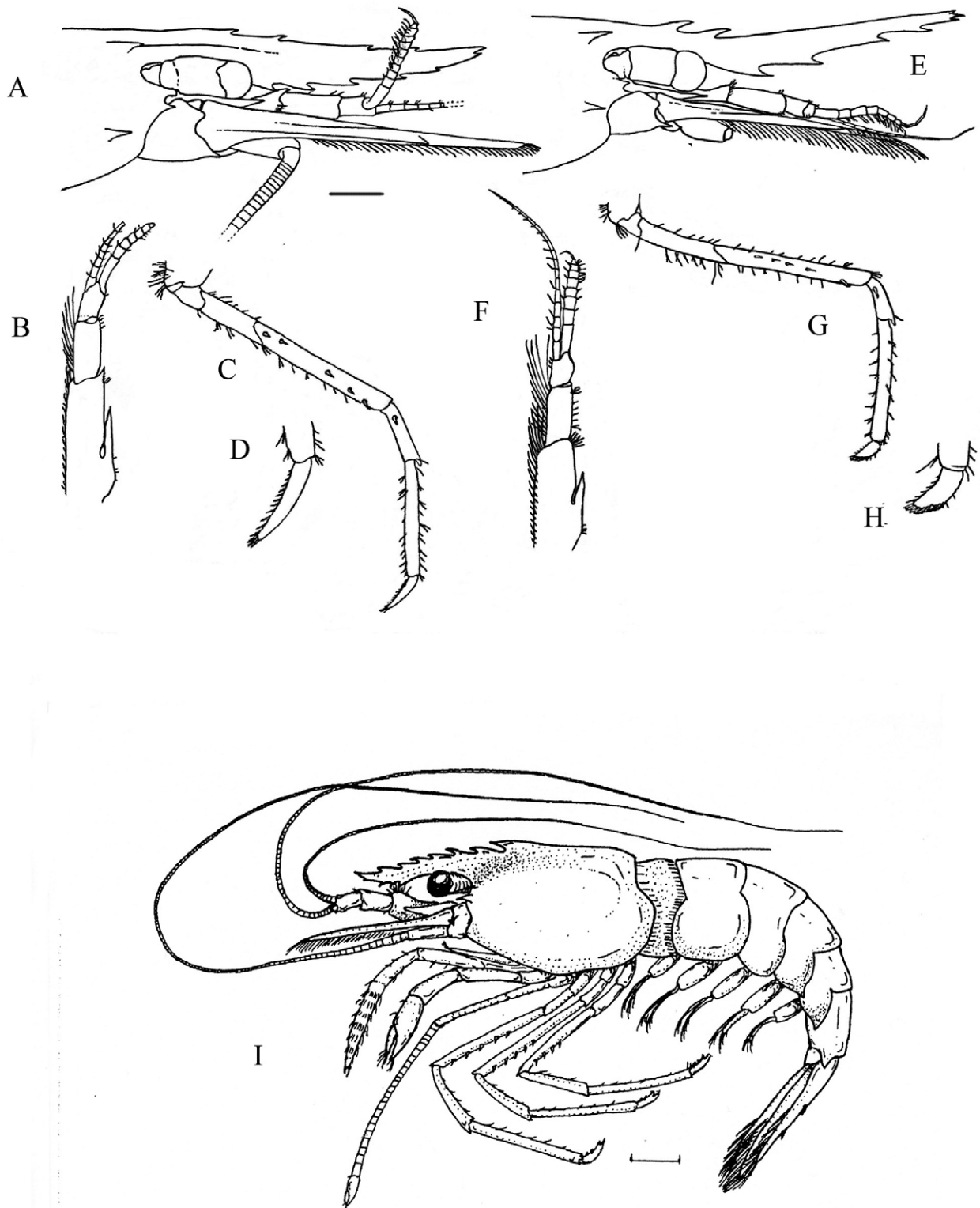


FIGURE 17. Families Hippolytidae, Lysmatidae. A–D, *Hippolyte californiensis* Holmes, 1895. A, frontal region in lateral view; B, antennule; C, pereopod 3, D, dactyl of pereopod 3. E–H, *Hippolyte clarki* Chace, 1951; E, frontal region in lateral view; F, antennule; G, pereopod 3; H, dactyl of pereopod 3. I, *Lysmata californica* (Stimpson, 1866). Scale A, E = 10 mm, I = 3 mm. A–H from Chace 1951; I from Wicksten 2000.

Color in life. Camouflaged like sea grasses: bright green, striped with tan, mottled brown, and similar colors.

Habitat and depth. In shallow areas of sandy bays, usually among sea grasses, *Zostera* sp.

Range. Humboldt Bay, California to Santa Inez Bay, Gulf of California. Type locality Bodega Bay, California.

Remarks. The northern range limit of this species is uncertain. Rathbun (1904) gave the northern range limit of this species as Sitka, Alaska, but the remarks by Schmitt (1921) suggest that she confused *H. californiensis* with *H. clarki*. Butler (1980) and Jensen (1995) reported the northern limit as Sheep Bay, Alaska, but Chace (1951) and Chace & Abbott (1980) gave it as Bodega Bay, California. Chace & Abbott (1980: 574) suggested that *H. clarki* replaces *H. californiensis* "in the Pacific northwest." I have collected this species in Humboldt Bay, California, and so give that bay as the northern range limit. This species might occur in bays in Oregon, where *Zostera* grows.

***Hippolyte clarki* Chace, 1951**

(Fig. 17E–H, Pl. 1 G)

Hippolyte clarki Chace, 1951: 37, fig. 1; 1997: 46. — Kozloff 1974: 165. — Word & Charwat 1976: 137. — Butler 1980: 156, pl. 3A. — Chace & Abbott 1980: 573. — Wicksten 1983b: 25; 1990b: 589. — Ricketts *et al.* 1985: 348. — Jensen 1995: 49, fig. 85. — Kuris *et al.* 2007: 638, pl. 318 G.

Diagnosis (modified from Chace 1951). Female: rostrum exceeding antennular peduncle, scaphocerite, with 2–5 dorsal, 1–5 ventral teeth, apex bifid. No spines on first segment of antennular peduncle, stylocerite not reaching end of first segment, peduncle shorter than scaphocerite. Carapace with supraorbital, antennal, branchiosetegal teeth. Third maxilliped with exopod, no epipod. Pereopods with epipods. Pereopod 1 particularly short, stout. Carpus of pereopod 2 with 3 segments: length of segment 1, 3 times longer than segment 2; segment 2 shorter than segment 3. Pereopods 3–5 with short, spinose dactyls. Merus of pereopod 3 with 2–5 spines, carpus with 1, propodus slender, dactyl curved, armed with 8 long proximal, 6–8 lower distal spinules. Merus of pereopod 4 with as many as 5 spines, merus of pereopod 5 with as many as 4 spines. Pleura of abdominal somites 1–4 rounded, of 5, 6 obliquely pointed. Abdominal somite 3 produced into low, blunt cap over anterior part of somite 4. Length of abdominal somite 6 nearly twice that of somite 5. Telson shorter than abdominal somite, with 2 pairs dorsolateral spines, 6–8 terminal spines. Uropods exceeding length of telson. Male: rostrum similar to that of female but shorter, more slender. Propodi of pereopods 3–5 with dactyl folding against expanded distal portion of propodus. Total length of male to 18 mm, female to 31 mm,.

Color in life. Camouflaged like algae: green, mottled or striped brown with tan, yellow brown.

Habitat and depth. Among kelps: *Macrocystis*, *Eisenia* and *Nereocystis* spp. Usually shallow, near surface in kelp canopy to at least 2 m.

Range. Sheep Bay, Alaska to Cedros I., Baja California, Mexico. Type locality Friday Harbor, Washington.

Remarks. Kuris *et al.* (2007: 651) stated that the habitat of this species is "low intertidal in eelgrass beds." Butler (1980: 157) also reported the species "on eelgrass" but it is far more common in California to find this species among kelps.

Family Lysmatidae Dana, 1852

Species of the Lysmatidae are recognizable by their long antennular flagella and having 17 or more carpal articles in the second pereopods. A molecular study of species of *Lysmata* and related genera by Baeza (2010) supports their designation as a family distinct from the Hippolytidae, as suggested by Christoffersen (1988a). Only one species, *Lysmata californica*, is found in the area of coverage.

Species are usually temperate or tropical in distribution, and live among rocks or corals. They are active at night. Many are colored red or red with white stripes. Many are hermaphrodites.

Some lysmatids are cleaners and remove debris, dead tissue, parasites and mucus from fishes. *Lysmata californica* associates with the green moray eel *Gymnothorax mordax* Ayres, 1859 but also lives freely under rocks and in cracks (Wicksten 2009). Although some species of *Lysmata* form pairs, *L. californica* can occur in swarms of as many as 22 or more individuals.

Lysmata Risso, 1816

Lysmata californica (Stimpson, 1866)

(Fig. 17I, Pl. 2)

Hippolysmata californica Stimpson, 1866: 48. — Holmes 1900: 180, pl. 2, fig. 38. — Rathbun 1904: 56. — Schmitt 1921: 49, fig. 27. — Johnson & Snook 1927: 304, fig. 258. — Holthuis 1947: 19. — MacGinitie & MacGinitie 1968: 274, fig. 125.

Lysmata californica. — Word & Charwat 1976: 145. — Chace & Abbott 1980: 569, fig. 23.8. — Standing 1981: 780. — Wicksten 1983b: 27; 1990b: 596; 2000: 8, fig. 4A; 2009: 1213. — Ricketts *et al.* 1985: 173, fig. 144. — Kerstitch 1989: 81, fig. 198. — Jensen 1995: 51, fig. 90. — Chace 1997: 53. — Wicksten & Hendrickx 2003: 67. — Kuris *et al.* 2007: 63. — Wicksten 2009: 1213. — Baeza 2010: 2.

Diagnosis. Rostrum slender, strongly ridged on sides, bent downward near base, reaching at most end of second segment of antennular peduncle, with 6–7 dorsal, 3 ventral teeth. First segment of antennular peduncle with closely set spinules on distal margin, second, third segments without spines or spinules, stylocerite not reaching end of first segment of peduncle. Flagella of first antenna subequal, longer than body. Flagella of second antenna also longer than body. Carapace with sharp antennal tooth, no branchiostegal tooth, pterygostomial tooth absent or minute. Third maxillipeds with exopod, epipod. Pereopods 1–4 with epipods. Pereopod 2 long, slender; carpus with 26–32 articles. Pereopods 3–5 with stout, spinose dactyls; merus of pereopod, 3, with 6–7 spines, pereopod 4, with 5–6 spines; pereopod 5, with 3 spines. Pleura of abdominal somites 1–4 rounded, of 5, 6, with points. Telson subacute, shorter than uropods, with 2 pairs dorsolateral spines. Total length to 75 mm.

Color in life. Banded with longitudinal red stripes, sometimes with green tinge. Cornea of eye reflecting golden color at night. The color notes are based on shrimp from Point Fermin, Los Angeles County, California.

Habitat and depth. Tide pools, kelp beds, rocky reefs, intertidal zone to 83 m. Adults can cling to drifting kelp and other objects at the surface of the sea.

Range. Usually south of Point Conception, California; rarely as far north as Tomales Bay; along coast of Baja California, Mexico south to Magdalena Bay, and in the northern Gulf of California to Guaymas. Type locality San Diego, California. Reports of this species from southern Mexico to the Galapagos Is. refer to other species of *Lysmata*, usually *L. argentopunctata* Wicksten, 2000. Kuris *et al.* (2007: 651) stated that *L. californica* is "more common in central California and Oregon after El Niños", but there are no records of this species farther north than Tomales Bay.

Family Thoridae Kingsley, 1878

The most diverse and common family of shrimps on the coasts of California and Oregon is the Thoridae. All species have a rostrum, which can vary from a single sharp tooth to an elaborately toothed blade. The eyes are large and not hidden beneath the carapace. The carapace bears two or more supraorbital teeth in *Spirontocaris*, one in *Lebbeus*, and none in other genera found in California and Oregon. Suborbital, antennal, and pterygostomial teeth are often present on the carapace, although the pterygostomial tooth may be small or absent in some species. The carapace does not have a cardiac notch. The third maxilliped is setose and bears small claws at the end of the terminal segment. It bears an exopod in adults of species of *Eualus* and always an additional epipod in species of *Spirontocaris*, *Lebbeus* and *Eualus*. Species of *Heptacarpus* also usually, but not always, have an epipod on the third maxilliped. Pereopod 1 is stout and chelate. Pereopod 2 is slender and chelate, and has a multi-articulate carpus with seven articles. Pereopods 3–5 are ambulatory, and end in curved and simple or stout, spinose dactyls. The pleura of the abdomen can be evenly rounded or bear sharp teeth. The telson bears dorsolateral and terminal spines.

The best-known members of this family are the coastal shrimp, *Heptacarpus* spp., which can be found in tide pools, under docks, in kelp beds or on near-shore sandy bottoms. Coastal shrimps often have camouflaging or disruptive coloration, such as stripes, bands, spots, saddles and other markings of green, brown, black, tan or white. These color patterns are usually seen in adult females, while males often are translucent (Bauer 1981).

In a morphological analysis, Bauer (1984) suggested that *Heptacarpus* spp. with a short, high carapace, a short rostrum, and enlarged first chelae might be considered to be relatively "primitive" compared to more slender species. He considered the number of epipods also to be important in phylogeny, with a higher number indicating a

more ancestral situation, but noted that the number of epipods could vary within a species or even between the sides of a single individual. The more "primitive" species lived in tide pools rather than in deeper water. He considered the potential effects of convergent evolution, and did not attempt to designate species groups. Two of the "species" he considered now are known to be synonyms of *Heptacarpus sitchensis* (Brandt, 1851). This work could be a good starting point for further phylogenetic analysis.

Less is known of the species of the other three genera found in the area. Species of *Lebbeus* range from the lowest intertidal zone to the continental slope. Species of *Eualus* live in kelp beds and in offshore sandy or rocky areas. Species of *Spirontocaris* live subtidally in kelp beds, rocky reefs, and muddy and sandy bottoms of the continental shelf.

Eualus suckleyi (Stimpson, 1864) has been reported once from off Grays Harbor, Washington. It has a rostrum slightly longer than the scaphocerite, with teeth on the dorsal distal half. It usually lacks an epipod on the second pereopod. Butler (1980: 204) provided a diagnosis and an illustration. Word & Charwat (1976b: 148) included *Spirontocaris dalli* Rathbun, 1902 in their guide to shrimps of southern California. Their range map that suggested that it had been collected off Los Angeles, California, but they gave the distribution as "from the Arctic to Sitka, Alaska." I have not seen this specimen and know of no other reports of this species from south of Alaska.

Owen (1839) described three shrimp from Monterey, California. He did not record depth or habitat. All three later were reported by Schmitt (1921, as species of *Spirontocaris*), with previous synonyms. The first of these, *Hippolyte palpator* Owen 1839: 89, pl. 28, fig. 3; now *Heptacarpus palpator*, is recognizable from the original description and still occurs at its type locality (Wicksten 1986). *Hippolyte affinis* Owen, 1839: 56, pl. 27, fig. 4; has not been reported since Owen's original description, as reported by Schmitt (1921: 56). *Hippolyte layi* Owen, 1839: 63, pl. 27, fig. 3; was reported again from Vancouver I. (Bate 1866, in Schmitt 1921: 63). The type material of all three species cannot be located, nor can the specimen mentioned by Bate (1866). Rathbun (1904) transferred all three species to *Spirontocaris*.

It seems reasonable to assign *H. affinis* and *H. layi* to the Thoridae. The illustrated shape of the rostrum of each species is consistent with that of species of *Spirontocaris* or one of the other genera of thorids in the northeastern Pacific, as Rathbun (1904) reported. Holthuis (1947) re-defined the genus *Spirontocaris* s.s. and separated other northeastern thorids into other genera.

Holthuis (1947) discussed both *H. affinis* and *H. layi* in a section on "species incertae." He suggested that *H. affinis* belongs to the genus *Spirontocaris* s. s. Chace & Abbott (1980) reported this species as *S. affinis*, presumably in the strict sense of Holthuis and not in the broad sense of Rathbun (1904) and Schmitt (1921). The illustration clearly shows two supraorbital teeth, a feature characteristic of species of *Spirontocaris*. The rostrum is pictured as ventrally deep, also a character of *Spirontocaris*. The drawing does not show any tapering of the dorsal surface from posterior to anterior, nor does it show the conspicuous ridge that runs the length of the rostrum in species of *Spirontocaris*. The original description states that the "fifth segment of the abdomen" is "laterally unarmed." Although abdominal somite 4 is unarmed in *S. sica* and *S. holmesi* Holthuis, 1947, all of the known species of *Spirontocaris* in the northeastern Pacific have a small tooth on the posterolateral margin of abdominal somite 5.

It is possible that *S. affinis* is a senior synonym of another species of *Spirontocaris* in the area, but others either have a long dagger-like frontal prolongation of the rostrum, as in *S. sica* and *S. holmesi*; a very abrupt rostrum with fewer teeth than illustrated, as in *S. truncata* Rathbun, 1902; or three supraorbital teeth, as in *S. prionota* (Stimpson, 1864). *Spirontocaris snyderi* Rathbun, 1902 can be colored red and occurs in Monterey Bay, but its stylocerite barely reaches the end of the first segment of the antennular peduncle. Its rostrum bears one large dorsal tooth separate from the others. If the original description and illustration are accurate, *S. affinis* must be regarded as a separate species.

Hippolyte layi might belong to either *Heptacarpus* or *Eualus* (Holthuis 1947, Chace & Abbott 1980). The lack of supraorbital teeth indicates that it is not a species of *Spirontocaris*. The shape of the rostrum in the original illustration (Owen 1839, pl. 27, fig. 3) suggests that it might belong to the genus *Heptacarpus*. The illustration shows a vague point, perhaps the stylocerite, which slightly exceeds the first segment of the antennular peduncle. This species might be a senior synonym of another species, perhaps *Heptacarpus paludicola* Holmes, 1900, which has a similar rostral shape and arrangement of teeth. There is no mention of an exopod on the third maxilliped in the description of *H. layi*. Some species of *Eualus*, such as *E. barbatus* (Rathbun, 1899), have an elongate toothed rostrum but it is not curved upward, as shown by Owen in the original illustration of *H. layi*.

MacGinitie & MacGinitie (1968: 273) mentioned that a "new species" of *Spirontocaris* fed on tunicates, *Ciona intestinalis* (Linnaeus, 1767). They used the generic name *Spirontocaris* in the broad sense of Rathbun (1904). Other than that the observation was made "at the laboratory pier", there is no information on where this "new species" was observed. These authors usually studied shallow-water and intertidal species, many of them from the vicinity of Newport Bay and Corona del Mar, California. I have been unable to locate specimens of this unknown species among the specimens that the MacGinities donated to the Allan Hancock Foundation of the University of Southern California (incorporated into the collections of the LACM) or the CAS.

There may be an additional species of *Heptacarpus* similar to *H. palpator* and *H. brevirostris* in southern California. Specimens from San Nicolas I. had a rostrum with 7 dorsal teeth and a shape different from that typical of *H. palpator* and *H. brevirostris*.

Many species of thorids have been described from less than 10 specimens, or without mention of diagnostic features that have been used in more recent descriptions. The degree of polymorphism in species such as *Heptacarpus sitchensis* (Brandt, 1851) has created taxonomic confusion, with the species being described as three species in three genera. Similar confusion as to the correct taxonomic designation may exist in species of *Eualus* and other species of *Heptacarpus*.

Key to Species of Family Thoridae

1. Supraorbital teeth present 2
- Supraorbital teeth absent 12
2. Two or more supraorbital teeth, third maxilliped with exopod 3
- One supraorbital tooth, no exopod on third maxilliped 8
3. Carapace with 3–4 supraorbital teeth 4
- Carapace with 2 supraorbital teeth 5
4. Rostrum deep (protruding ventrally below level of antennular peduncle), with 10–26 dorsal teeth on rostrum proper, ventral margin of pleuron of third abdominal somite acute or pointed *Spirontocaris prionota*
- Rostrum less deep, with 1–3 large dorsal teeth on rostrum proper, ventral margin of pleuron of third abdominal somite broadly rounded *Spirontocaris truncata*
5. Pleura of abdominal somites 1–3 ventrally acute to pointed *Spirontocaris lamellicornis*
- Pleura of abdominal somites 1–3 broadly rounded ventrally 6
6. Rostrum without distinct terminal projection, dactyls of pereopods 3–5 short, stout, apices bifid *Spirontocaris snyderi*
- Rostrum with distinct terminal projection, dactyls of pereopods 3–5 long, slender, simple 7
7. Distal projection of rostrum with 1 ventral tooth, dorsal teeth extending to or past middle of carapace *Spirontocaris holmesi*
- Distal projection of rostrum without ventral tooth, dorsal teeth not extending as far as middle of carapace *Spirontocaris sica*
8. Rostrum reduced to tooth on frontal margin of carapace. 3 teeth on anterior dorsal midline of carapace *Lebbeus lagunae*
- Rostrum prominent, not reduced to tooth. 1–2 teeth on anterior dorsal midline of carapace 9
9. Epipods on only pereopod 1. Living at 950 m and deeper *Lebbeus vicinus montereyensis*
- Epipods on pereopods 1–3. Shallow subtidal to 1808 m 10
10. Antennular peduncle extending nearly to end of scaphocerite. Inhabiting continental slope *Lebbeus washingtonianus*
- Antennular peduncle extending to near middle of scaphocerite. Inhabiting subtidal rocky areas 11
11. Rostrum shorter than eye. Dorsal surface of abdominal somite 2 without furrow, fold *Lebbeus zebra*
- Rostrum longer than eye. Dorsal surface of abdominal somite 2 with furrow, fold *Lebbeus speciosus*
12. Exopod on third maxilliped 13
- No exopod on third maxilliped 19
13. No epipod on any pereopod 14
- Epipod at least on pereopod 1 16
14. Rostrum deep, shorter than carapace, eye large *Eualus macrophthalmus*
- Rostrum slender, as long as or longer than carapace, eye smaller 15
15. Posterior margin of abdominal somites 3–6 each bearing median dorsal tooth *Eualus barbatus*
- Posterior margin of abdominal somites 3–6 unarmed *Eualus biunguis*
16. Rostrum with dorsal margin markedly convex over eye, with 7–14 teeth *Eualus avinus*
- Rostrum nearly straight over eye, with 2–9 teeth 17
17. Pleuron of abdominal somite 4 without ventral tooth. Rostrum with 8–11 dorsal teeth *Eualus berkeleyorum*
- Pleuron of abdominal somite 4 with ventral tooth. Rostrum with 3–6 dorsal teeth 18
18. First segment of antennular peduncle with more than 1 spine. Pereopod 3 with 2 spines on merus. In life, marked with obvious bands *Eualus lineatus*
- First segment of antennular peduncle with only 1 spine. Pereopod 3 with 2–5 spines on merus. In life, translucent or with small brown chromatophores *Eualus subtilus*
19. Ventral margin of fourth pleuron without tooth 20

–	Ventral margin of fourth pleuron with tooth	26
20.	Epipod absent on third maxilliped <i>Heptacarpus tenuissimus</i>	21
–	Epipod present on third maxilliped	21
21.	Epipods present on at least pereopods 1, 2. Dorsal surface of abdominal 3 somite forming conspicuous hump	22
–	Epipods absent from all pereopods. Dorsal surface of abdominal somite 3 evenly rounded, not forming conspicuous hump	23
22.	Epipods present on pereopods 1–3. Rostrum deep, with 3–7 dorsal teeth, 2–6 ventral teeth <i>Heptacarpus carinatus</i>	
–	Epipods present on pereopods 1, 2 only. Rostrum narrow, with 4–5 dorsal teeth, 5–8 ventral teeth <i>Heptacarpus flexus</i>	
23.	Pterygostomian tooth absent	24
–	Pterygostomian tooth present	25
24.	Rostrum shorter than carapace, distal ventral half convex <i>Heptacarpus brachydactylus</i>	
–	Rostrum longer than carapace, distal ventral half not convex or only slightly so <i>Heptacarpus franciscanus</i>	
25.	Scaphocerite shorter than carapace, abdominal somite 6 longer than telson <i>Heptacarpus decorus</i>	
–	Scaphocerite as long as or longer than carapace, abdominal somite 6 shorter than telson <i>Heptacarpus kincaidi</i>	
26.	Rostrum deep. Epipod on pereopod 1 only. Usually on continental shelf, Oregon northward <i>Heptacarpus moseri</i>	
–	Rostrum shallow. Epipods on at least pereopod 1, often pereopod 2. Usually intertidal to subtidal, Alaska to Baja California	27
27.	Epipods on pereopods 1, 2 at most	28
–	Epipods on pereopods 1–3	30
28.	Rostrum barely reaching end of first segment of antennular peduncle. <i>Heptacarpus pugettensis</i>	
–	Rostrum extending beyond end of first segment of antennular peduncle	29
29.	Rostrum reaching to end of antennular peduncle or beyond. Often in sea grass beds <i>Heptacarpus paludicola</i>	
–	Rostrum not reaching end of antennular peduncle. Common in tide pools <i>Heptacarpus sitchensis</i>	
30.	Dactyls of pereopods 3–5 simple, curved; rostrum slightly ascending over eye, with dorsal teeth most thickly set in proximal half. <i>Heptacarpus stimpsoni</i>	
–	Dactyls of pereopods 3–5 bifid, rostrum not slightly ascending over eye, with dorsal teeth more widely spaced	31
31.	Rostrum not reaching as far as cornea of eye, with series of teeth descending from anterior margin of carapace to apex	
–	Rostrum exceeding cornea of eye, rostral teeth more widely spaced, not as clearly descending <i>Heptacarpus taylora</i>	32
32.	Spine on distal ventral flexor margin of merus of pereopod <i>Heptacarpus fuscimaculatus</i>	
–	No spine on distal ventral flexor margin of merus of pereopod 1.	33
33.	Rostrum usually with bifid or trifid apex, exceeding cornea, merus of pereopods 3, 4 with 2 spines <i>Heptacarpus palpator</i>	
–	Rostrum usually with simple apex, not exceeding cornea, merus of pereopods 3, 4 with 1 spine <i>Heptacarpus brevisrostris</i>	

***Eualus* Thallwitz, 1891**

***Eualus avinus* (Rathbun, 1899)**

(Fig. 18A)

Spirontocaris avina Rathbun, 1899: 557; 1904: 103, fig. 47.

Eualus avinus. — Holthuis 1947: 10. — Kozloff 1974: 166. — Butler 1980: 193, color plate 8E. — Wicksten 1990b: 593. — Chace 1997: 42. — Jensen 2004: 468.

Diagnosis. Rostrum short, not reaching end of second antennular segment, arched over eye, with 12–14 dorsal, 1–2 ventral teeth. First, second segments of antennular peduncle each with spine. Carapace with weak pterygostomian tooth. Pereopods 1–3 with epipods. Pereopods 3–5 slender, with long, slender dactyls; each merus of with 5–7 spines. Abdominal somites 1–3 rounded, 4–5 with posterolateral point, somite 6 elongated. Telson with 3 pairs dorsolateral spines. Male total length 29 mm, female 44 mm.

Color in life. Translucent with blotches of orange on body, appendages (Butler 1980 color plate 8E).

Habitat and depth. Muddy, sandy bottoms of continental shelf, 46–642 m.

Range. Pribilof Is., Alaska to off Depoe Bay, Oregon. Type locality north of Unalaska, Aleutian Is.

***Eualus barbatus* (Rathbun, 1899)**

(Fig. 18B, C)

Spirontocaris barbata Rathbun, 1899: 556; 1904: 82, fig. 35.

Eualus barbatus. — Holthuis 1947: 10. — Kozloff 1974: 165. — Butler 1980: 190, pl. 5C. — Wicksten 1984b: 246; 1989b: 312; 1990b: 593. — Chace 1997: 42. — Jensen 2004: 468.

Diagnosis. Rostrum moderately deep, reaching beyond antennular peduncle, with 5–8 dorsal, 3–4 ventral teeth. Stylocerite of antennular peduncle reaching about to end of first segment. Carapace with weak suborbital, strong antennal, pterygostomian teeth. Pereopods lacking epipods. Pereopods 3–5 slender, with spinose dactyls. Merus of pereopod 3, with 3–4 spines; pereopod 4, with 4–5 spines; pereopod 5, with 4–5 spines. Pleura of abdominal somites 3–5 rounded, somites 3–5 each with dorsal carina, tooth; somites 4–5 with ventral point. Telson with 3 pairs dorsolateral spines. Male total length 76 mm, female 95 mm.

Color in life. Body with light orange bands and spots (Butler 1980).

Habitat and depth. Soft mud, 82–507 m.

Range. Pribilof Is., Alaska to Santa Monica Bay, California. Type locality off St. George I., Pribilof Is.

***Eualus berkeleyorum* Butler, 1971**

(Fig. 18D)

Eualus berkeleyorum Butler, 1971: 1616, figs. 1–2; Butler 1980: 199, pl. 5A. — Coyle & Mueller 1981: 17. — Wicksten 1984b: 246; 1990b: 593. — Jensen & Armstrong 1987: 216. — Chace 1997: 42. — Jensen 2004: 468.

Diagnosis. Rostrum short, reaching end of first segment of antennular peduncle, with 8–11 dorsal, 2–5 ventral teeth. Second, third segments of antennular peduncle bearing spines, stylocerite not reaching end of first segment. Carapace with strong suborbital, antennal teeth, weak pterygostomian tooth. Pereopods 1–3 with exopods. Pereopods 3–5 slender, with long, simple dactyls; merus of pereopods 3–5 each with 4–5 spines. Pleura of abdominal somites 1–4 rounded, 5 with point. Telson with 3 pairs dorsolateral spines. Female total length 38 mm, male not reported.

Color in life. White to cream, with red to orange patches on rostrum, body, appendages; saddle-like bands on abdominal somites (Butler 1980 color plate 5A).

Habitat and depth. Soft mud, 46–384 m (Butler 1980).

Range. SE of St. George I., Pribilof Is., Alaska to off Trinidad Harbor, Humboldt County, California. Type locality Strait of Georgia, Alaska.

***Eualus biunguis* (Rathbun, 1902)**

(Fig. 18E)

Spirontocaris biunguis Rathbun, 1902a: 899; 1904: 97, fig. 44.

Eualus biunguis. — Kobyakova 1937: 120. — Holthuis 1947: 10. — Miyake & Hayashi 1967: 248, fig. 1. — Birshtein & Zarenkov 1972: 440. — Kozloff 1974: 165. — Butler 1980: 192, color plate 6C. — Wicksten 1989b: 312; 1990b: 593. — Chace 1997: 42. — Jensen 2004: 468.

Diagnosis. Rostrum long, slender, reaching almost to end of antennular flagella, with 5–7 dorsal, 4–7 ventral teeth, dorsal half of rostrum without teeth. First, second segments of antennular peduncle with dorsal spine each, stylocerite nearly reaching end of first segment. Carapace with weak pterygostomian tooth. Pereopods lacking epipods. Pereopod 1 stout, chelate, other pereopods slender; pereopods 3–5 with long, slender dactyls bearing minute spinules, each merus of pereopods 3–5 with 4–6 spines. Pleura of abdominal somites 1–4 rounded, somite 5 with posterolateral point, somite 6 elongated; none with dorsal carinae. Telson with 5–6 pairs dorsolateral spines. Male total length 49 mm, female to 99 mm.

Color in life. Mostly red with yellow background, white patches on first 3 abdominal pleura pereopods (Butler 1980, color plate 6C).

Habitat and depth. Possibly semi-pelagic, usually lower continental slope, 90–2090 m.

Range. Bering Sea to Oregon, Sea of Japan, Siberian coast. Type locality off Cape St. James, Queen Charlotte Is., British Columbia.

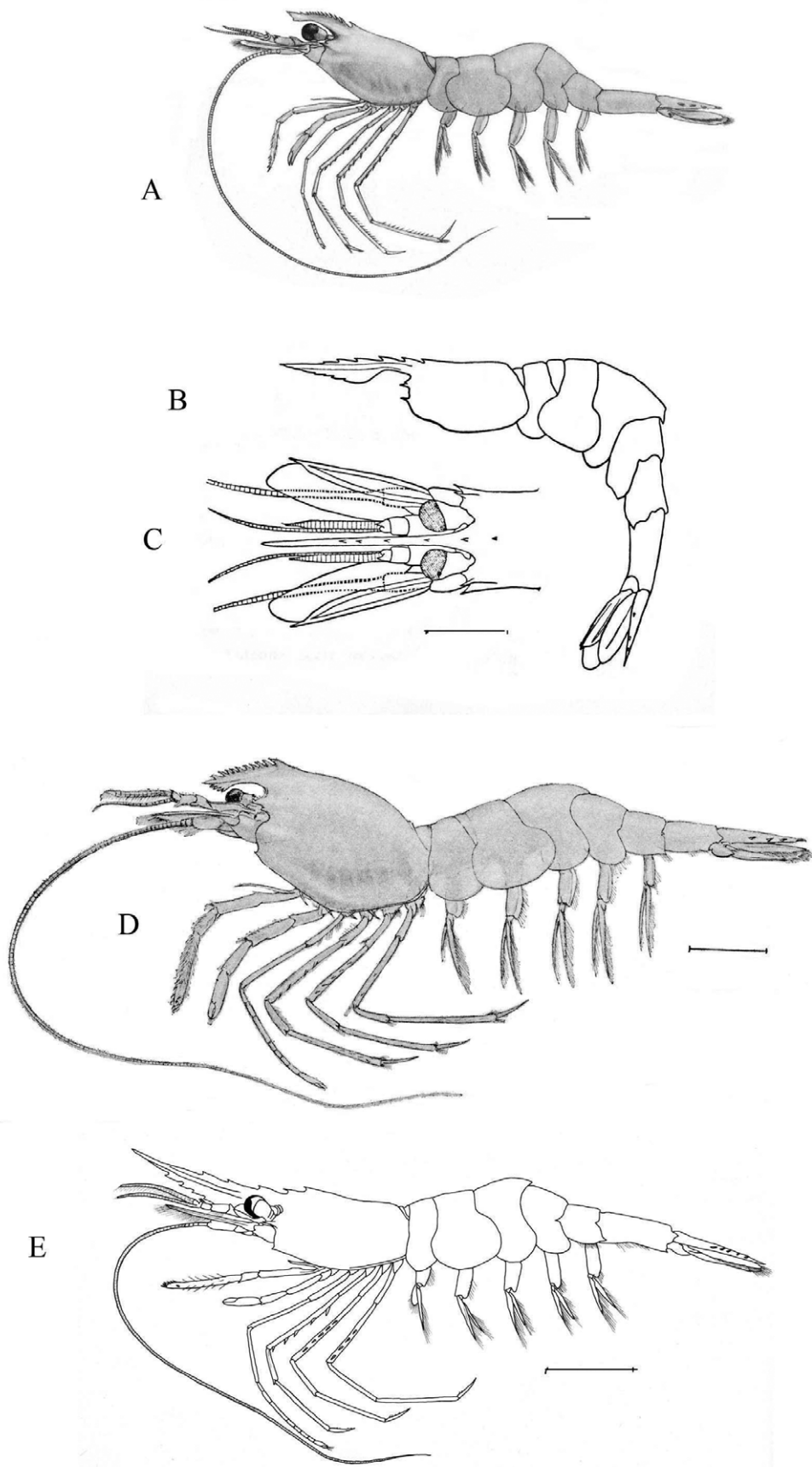


FIGURE 18. Family Thoridae. A, *Eualus avinus* (Rathbun, 1898). B, C, *Eualus barbatus* (Rathbun, 1899); B, carapace and abdomen in lateral view; C, frontal region in dorsal view. D, *Eualus berkeleyorum* Butler, 1971. E, *Eualus biunguis* (Rathbun, 1902). Scales A, B, E = 10 mm, D = 5 mm. A, E from Butler 1980, B, C from Rathbun 1904, D from Butler 1971.

***Eualus lineatus* Wicksten & Butler, 1983**

(Fig. 19A)

Eualus lineatus Wicksten & Butler, 1983: 3, figs. 1–2. — Wicksten 1990b: 593. — Jensen & Johnson 1999: 133. — Chace 1997: 43. — Jensen 2004: 468.

Spirontocaris herdmani Rathbun 1904: 100 [part, not *Spirontocaris herdmani* Walker, 1898].

Eualus herdmani Holthuis 1947: 11 (part). — Kozloff 1974: 166. — Butler 1980: 197, pl. 1C (part).

Diagnosis. Rostrum slender, not reaching end of second segment of antennular peduncle, with 3–6 dorsal, 1–3 ventral teeth. First segment of antennular peduncle with 3 spines, other two segments with 2 spines each, stylocerite reaching or surpassing end of first segment; with curved, dorsal spine near base. Carapace with small suborbital tooth, strong antennal tooth, moderate pterygostomian tooth. Pereopods 1–3 with epipods. Pereopod 1 stout. Pereopods 3–5 slender, with spinose dactyls. Merus of pereopod 3, with 3 spines; pereopod 4, with 2–3 spines; pereopod 5, with 0–1 spine. Pleura of abdominal somites 13 rounded, 4–5 with points. Telson with 3 pairs dorsolateral spines. Male total length 20 mm, female 25 mm.

Color in life. Carapace, abdomen marked with broad orange bands against translucent background (Jensen & Johnson 1999).

Habitat and depth. Rocks, rocky reefs; often among sponges, 12–232 m.

Range. Naha Bay, Alaska to Santa Cruz I., California. Type locality SW of Gull I., off Santa Cruz I., California.

Remarks. This species has been confused with *Heptacarpus herdmani* (Walker, 1898), despite Walker's original description, which stated that the species lacked an exopod on the third maxilliped. *Heptacarpus herdmani* is currently known only from the type specimen from Puget Sound. The species also was confused with *E. subtilis* Carvacho & Owen, 1984; but can be distinguished easily in life by its colorful stripes and larger size than *E. subtilis* (Jensen & Johnson 1999). *Eualus lineatus* seems to be more common in colder water north of Point Conception or in areas of upwelling along the islands of southern California.

***Eualus macrophthalmus* (Rathbun, 1902)**

(Fig. 19B, C)

Spirontocaris macrophthalma Rathbun, 1902a: 900; 1904: 105, fig. 48. — Schmitt 1921: 72, fig. 49.

Eualus macrophthalmus. — Holthuis 1947: 11. — Kozloff 1974: 166. — Word & Charwat 1976: 105. — Butler 1980: 189, pl. 8A. — Wicksten 1989b: 312; 1990b: 593; 2002: 137. — Chace 1997: 43. — Jensen 2004: 468.

Diagnosis. Rostrum deep, reaching beyond antennular peduncle, with 10–14 dorsal, 1–4 ventral teeth, apex acute. Second and third segments of antennular peduncle with terminal spines, stylocerite not reaching end of first segment. Carapace with pterygostomian tooth minute or absent. Pereopod 1 moderately large, pereopod 2 slender. Pereopods 3–5 long, slender, with slender, simple dactyls. Merus of pereopod 3, with 5 or 6 spines; pereopod 4, with 5 or 6 spines; pereopod 5, with 4 spines. Pleura of abdominal somites 1–4 rounded, 5 with ventral point. Telson with 5 or 6 pairs dorsolateral spines. Male total length to 43 mm, female to 71 mm.

Color in life. Pale yellow with red speckling (Butler 1980).

Habitat and depth. The species may be pelagic (Butler 1980), 110–1163 m.

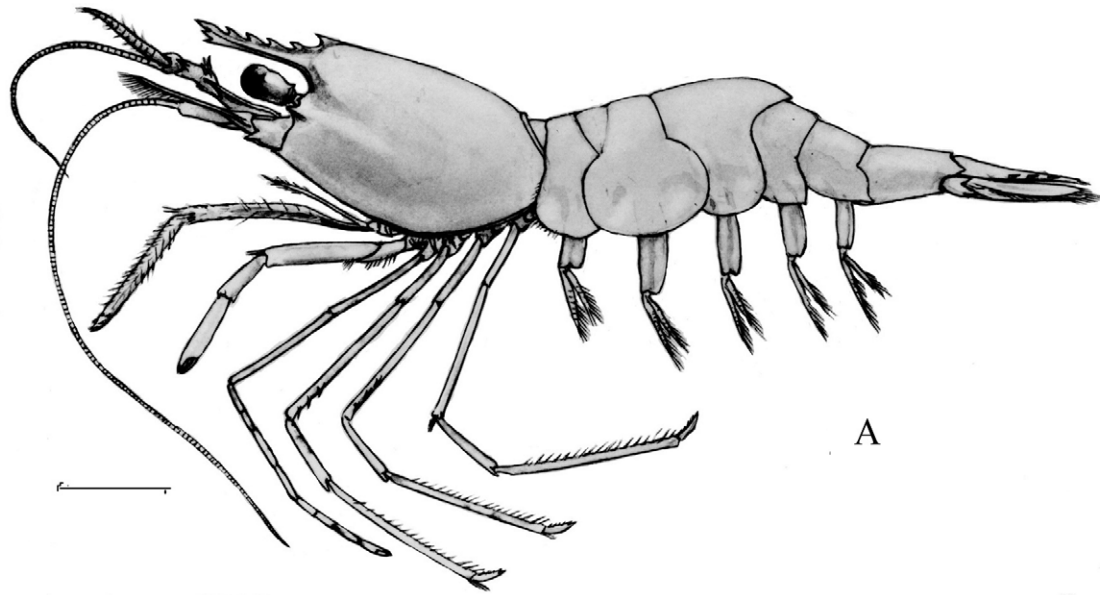
Range. Unalaska to Point Sur, California. Type locality off Tawit Head, Washington. Word & Charwat (1976) erroneously reported it from Tanner Bank. The specimen in question was collected with a "Tanner trawl" off Monterey County, California.

***Eualus subtilis* Carvacho & Olson, 1984**

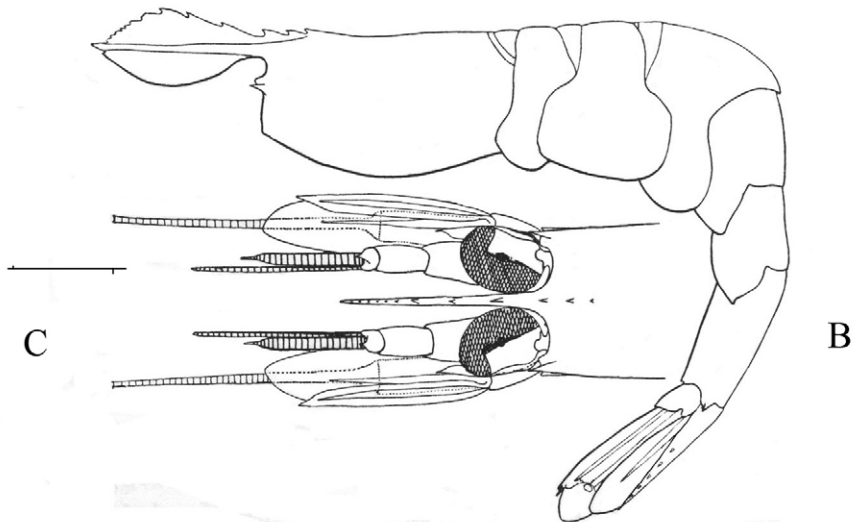
(Fig. 19D)

Eualus subtilis Carvacho & Olson, 1984:59. — Jensen & Johnson 1999: 133. — Chace 1997: 43. — Jensen 2004: 468.

Eualus herdmani. — Word & Charwat 1976: 103. — Butler 1980: 197, pl. 1C (part).

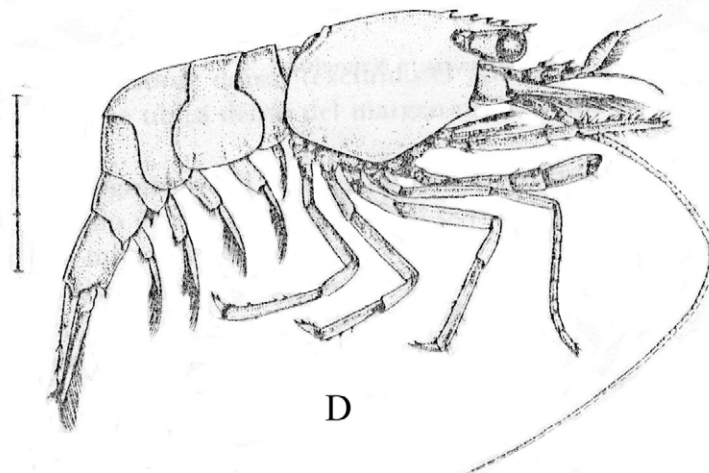


A



C

B



D

FIGURE 19. Family Thoridae. A, *Eualus lineatus* Wicksten & Butler, 1983. B, C, *Eualus macrophthalmus* (Rathbun, 1902); B, carapace and abdomen; C, frontal region in dorsal view. D, *Eualus subtilis* Carvacho & Olson, 1984. Scales: A = 2 mm, B = 4 mm, D = 3mm. A from Wicksten & Butler 1983, B, C from Rathbun 1904, D from Carvacho & Olson 1984.

Diagnosis. Rostrum with 3 or 4 dorsal, 0–2 ventral teeth, reaching cornea of eye. Carapace without supraorbital teeth, no suborbital tooth but strong antennal tooth, small but acute pterygostomial tooth. First segment of antennular peduncle with one small spinule. Stylocerite without curved dorsal tooth near base. Basicerite with one lateral tooth. Third maxilliped with exopod. Pereopods 1, 2 with epipods. Merus of pereopod 3 with 2–5 distal spines, pereopod 4, with 2 or 3 spines; pereopod 5, with 1 spine. Pereopod 3 of male sexually dimorphic: propodus enlarged on flexor margin, dactyl with 8 spines. Abdominal pleura 1–3 rounded, pleura of somites 4, 5 each with posterolateral point. Carapace length of male to 2.1 mm, female to 3.8 mm.

Color in life. Translucent with lines of dark chromatophores.

Habitat and depth. Kelp beds, wrecks, rocky reefs, intertidal zone to 74 m.

Range. Barkley Sound, British Columbia to Punta Banda, Todos Santos Bay, Baja California, Mexico. Type locality Punta Banda.

Remarks. This small shrimp can be common near the surface in kelp beds.

Heptacarpus Holmes, 1900

Heptacarpus brachydactylus (Rathbun, 1902)

(Fig. 20A, B)

Spirontocaris brachydactyla Rathbun, 1902a: 898; 1904: 93, fig. 41. — Schmitt 1921: 72, fig. 48.

Heptacarpus brachydactylus. — Holthuis 1947: 12. — Word & Charwat 1976: 107. — Standing 1981: 779. — Wicksten 1990b: 594. — Chace 1997: 44.

Diagnosis. Rostrum with 6 dorsal, 2 or 3 ventral teeth. First, second segments of antennular peduncle with small spines or knobs, stylocerite exceeding first segment. Carapace with suborbital, antennal teeth. Third maxilliped with epipod. No epipods on pereopods. Pereopods 3–5 slender, with long, bifid dactyls. Merus of pereopods 3, 4 with 2 spines apiece, pereopod 5 with 1 spine. Pleura of abdominal somites 1–4 rounded, 5 with point; sternite of abdominal somite 5 with tooth. Telson with 3 or 4 pairs dorsolateral spines. Female total length 33 mm, male not reported.

Color in life. Not reported.

Habitat and depth. Rocky bottoms, 486–695 m.

Range. Monterey Bay to San Diego, California. Type locality off Santa Cruz I., California.

Remarks. Most records are from off the islands of southern California, but it is not endemic, as shown by Standing (1981).

Heptacarpus brevirostris (Dana, 1852)

(Fig. 21A)

Hippolyte brevirostris Dana, 1852: 566; 1855: pl. 36, fig. 5. — Stimpson 1856: 89.

Heptacarpus brevirostris. — Holmes 1900: 198, pl. 3, figs. 50, 51. — Holthuis 1947: 12. — Kozloff 1974: 167. — Word & Charwat 1976: 109. — Chace & Abbott 1980: 572, fig. 23.6. — Butler 1980: 231. — Ricketts *et al.* 1995: 198. — Wicksten 1986: 54, fig. 5; 1990b: 596. — Jensen 1995: 46, fig. 75. — Chace 1997: 44. — Kuris *et al.* 2007: 640, pl. 318 B. *Spirontocaris brevirostris*. — Rathbun 1904: 99. — Schmitt 1921: 66, fig. 44. — Johnson & Snook 1927: 307, fig. 259c.

Diagnosis. Similar to *H. palpator* except rostrum usually with simple apex, reaching cornea or beyond but not exceeding first segment of antennular peduncle, with 2–6 dorsal, no ventral teeth. First segment of antennular peduncle with 3 or 4 spinules, second, third segments with spine each, stylocerite reaching end of second segment. Third maxilliped long, heavy, especially in male. Pereopods 3–5 with short, spinose dactyls, merus with 1 spine each. Abdominal somite 5 with strong posterolateral point; somite 6, with strong posteroventral point. Telson with 4 pairs dorsolateral spines, acute apex. Uropods exceeding telson. Male total length 49 mm, female 62 mm.

Color in life. Translucent, kelp-brown, opaque pinkish white with green abdomen, red (Butler 1980). Chocolate brown, greenish, mottled with rose pink, or white; well camouflaged among algae. The color notes are from shrimp from northern California and Oregon.

Habitat and depth. Rocky intertidal areas, rocky subtidal areas with algae, 0–128 m.

Range. Attu, Aleutian Is. to Santa Cruz County, California. Type locality Dungeness, Straits of Juan de Fuca.

Remarks. There have been unverified reports from the offshore islands of southern California, but most records come from north of Monterey Bay. This species is the largest common tide pool shrimp from Humboldt County, California northward.

***Heptacarpus carinatus* Holmes, 1900**

(Fig. 20 C)

Heptacarpus carinatus Holmes, 1900: 202, pl. 3, fig. 60. — Holthuis 1947: 12. — Word & Charwat 1976: 111. — Butler 1980: 210. — Chace & Abbott 1980: 569. — Wicksten 1990b: 594. — Jensen 1995: 46, fig. 77. — Chace 1997: 44. — Kuris *et al.* 2007: 639.

Spirontocaris carinata. — Rathbun 1904: 84. — Schmitt 1921: 62, fig. 39. — Johnson & Snook 1927: 305, fig. 259a.

Diagnosis. Rostrum exceeding antennular peduncle, with 3–7 dorsal, 2–6 ventral teeth. Second, third segments of antennular peduncle with spine each, stylocerite not reaching end of first segment. Pereopods 1–3 with epipods. Pereopods 3–5 stout, with spinose dactyls. Merus of pereopod 3, with 1–3 spines; pereopod 4, with 0–2 spines; pereopod 5, with 1 spine. Distal dorsal margin of abdominal somite 3 with pronounced hump. Telson with 2–5 pairs dorsolateral spines. Male total length 38 mm, female 51 mm.

Color in life. Translucent, apple green with red rostrum, stripes on carapace, abdomen; bright green, or red (Butler, 1980).

Habitat and depth. Tide pools, among eelgrass, algae; intertidal zone to 27 m.

Range. Dixon Harbor, Alaska to Point Loma, California. Type locality Monterey Bay, California.

***Heptacarpus decorus* (Rathbun, 1902)**

(Fig. 20D)

Spirontocaris decora Rathbun, 1902a: 896; 1904: 79, fig. 33. — Schmitt 1921: 61, fig. 38.

Heptacarpus decorus. — Holthuis 1947: 12. — Kozloff 1974: 167. — Word & Charwat 1976b: 113. — Butler 1980: 214, pl. 7C. — Standing 1981: 779. — Wicksten 1990b: 594. — Chace 1997: 44.

Diagnosis. Rostrum exceeding antennular peduncle, with 4 or 5 dorsal, 4–8 ventral teeth. Second, third segments of antennular peduncle with spine each, stylocerite reaching at most to end of first segment. Third maxilliped with epipod. Pereopods without epipods. Pereopod 1 with particularly stout chela. Pereopods 3–5 slender, with spinose dactyls. Merus of pereopod 3, with 3–5 spines; pereopod 4, with 4 spines; pereopod 5, with 3 or 4 spines. Pleura of abdominal somites 1–4 rounded, 5 with ventral point. Telson with 4–7 pairs dorsolateral spines. Male total length 33 mm, female 60 mm.

Color in life. Watery pink, with patterns of small red spots on body, appendages (Butler 1980).

Habitat and depth. Benthic, 22–313 m.

Range. Gabriola I., Strait of Georgia, Alaska to San Diego, California. Type locality off Santa Cruz I., California.

***Heptacarpus flexus* (Rathbun, 1899)**

(Fig. 20E)

Spirontocaris camtschatica Rathbun, 1899: 557 [not *Hippolyte camtschatica* Stimpson, 1860].

Spirontocaris flexa Rathbun, 1904: 78, fig. 32. — Schmitt 1921: 58, fig. 36.

Heptacarpus flexus. — Holthuis 1947: 12. — Kozloff 1974: 167. — Word & Charwat 1976b: 115. — Butler 1980: 206. — Wicksten 1989b: 312; 1990b: 594. — Chace 1997: 44. — Komai & Yakovlev 2000: 304.

Diagnosis. Very similar to *H. tenuissimus* except rostrum with 4 or 5 dorsal, 5–8 ventral teeth, anterior-most dorsal tooth near to or behind middle of rostrum. Stylocerite exceeding first segment of antennular peduncle. Third maxilliped, pereopods 1, 2 with epipods. Pereopods 3–5 slender, dactyls slender, weakly bifid. Merus of pereopod 3, with 2 spines; pereopod 4, with 2 spines; pereopod 5, with 1 spine. Pleura of abdominal somites 1–4 rounded, 5 with ventral point. Somite 3 with dorsal hump. Telson with 4 pairs dorsolateral spines. Female total length to 54 mm, male not reported.

Color in life. Not reported.

Habitat and depth. Benthic, 37–172 m.

Range. Sea of Japan, Sea of Okhotsk, Kuril Is. and Kamchatka; Bering Sea to Farallon Is., California. Type locality north of Bird I., Shumagins, Alaska. Word & Charwat (1976) included this species in their guide to the shrimps of southern California, but there are no records of this species south of the Farallon Is.

***Heptacarpus franciscanus* (Schmitt, 1921)**

(Fig. 20F)

Spirontocaris franciscana Schmitt, 1921: 60, pl. 12, figs. 8, 9.

Heptacarpus franciscanus. — Holthuis 1947: 12. — Word & Charwat 1976: 117. — Carvacho & Olson 1984: 59. — Wicksten 1990b: 594. — Chace 1997: 44. — Kuris *et al.* 2007: 639.

Diagnosis. Rostrum exceeding scaphocerite, with 4–6 dorsal teeth reaching at least to end of antennular peduncle, 5–7 ventral teeth including small tooth just distal to apex. First segment of antennular peduncle with distal spine. Carapace with suborbital, antennal teeth, no pterygostomial tooth. Stylocerite not exceeding first segment of antennular peduncle. Third maxilliped with epipod. No epipods on pereopods. Pereopods 3–5 with short dactyls bearing 4 stout spines along each flexor margin. Merus of pereopod 3, with 4 spines; pereopod 4, with 4 spines; pereopod 5, 1 spine. Abdominal somite 3 with posterior margin produced ("geniculate") over anterior margin of abdominal somite 4. Pleura of abdominal somites 1–4 rounded, 5 with posterolateral point. Telson with 4–6 pairs dorsolateral spines. Female total length to 46 mm, male not reported. Diagnosis based on fresh specimen from Santa Monica Bay, California and modified from Schmitt 1921.

Color in life. Pale reddish brown (Schmitt 1921). Red with turquoise dots forming curved line running proximally across the posterior 0.3 of carapace length, turquoise dots on abdominal somites 1, 2. Pereopods 3–5 red near body, fading to translucent distally. The color notes are from a shrimp from Santa Monica Bay, California.

Habitat and depth. On rocks or sand, among red algae, 4–23 m. Although this species is included in the key to intertidal invertebrates of central California (Kuris *et al.*, 2007), all the specimens I have seen were from subtidal areas.

Range. San Francisco Bay, California to Todos Santos Bay, Baja California, Mexico. Type locality off Point Bonita, San Francisco Bay, California (*Albatross* station D5770).

Remarks. Two small and blurred photographs accompanied Schmitt's original description. Schmitt stated that this species differs from the very similar *H. stylus* (Stimpson, 1864), not reported south of Puget Sound, by having teeth extending to the distal half of the dorsal margin of the rostrum, the rostrum only "slightly exceeding" the scaphocerite and the antennal peduncle (carpocerite) reaching about as far forward as the antennular peduncle. He also reported that there was a very small tooth just proximal to the apex of the rostrum, giving the apex a bifid appearance. I have not been able to examine the type material of *H. franciscanus*. According to the description and illustration of *H. stylus* by Butler (1980), the lengths of the rostrum relative to that of the carapace and the carpocerite relative to that of the scaphocerite are almost alike in the two species. The only consistent difference between the two species is the arrangement of dorsal rostral teeth: extending to nearly the midlength of the rostrum in *H. franciscanus* and barely reaching the length of the cornea of the eye in *H. stylus*.

The length of the rostrum clearly exceeds the length of the scaphocerite in the material of *H. franciscanus* examined. The small subapical ventral tooth of the rostrum is absent. The illustrated specimen from Santa Monica Bay has 4, not 5, dorsal teeth on the carapace and rostrum. The specimen drawn by Word & Charwat (1976) had 5 dorsal teeth and 4 ventral teeth on the rostrum.

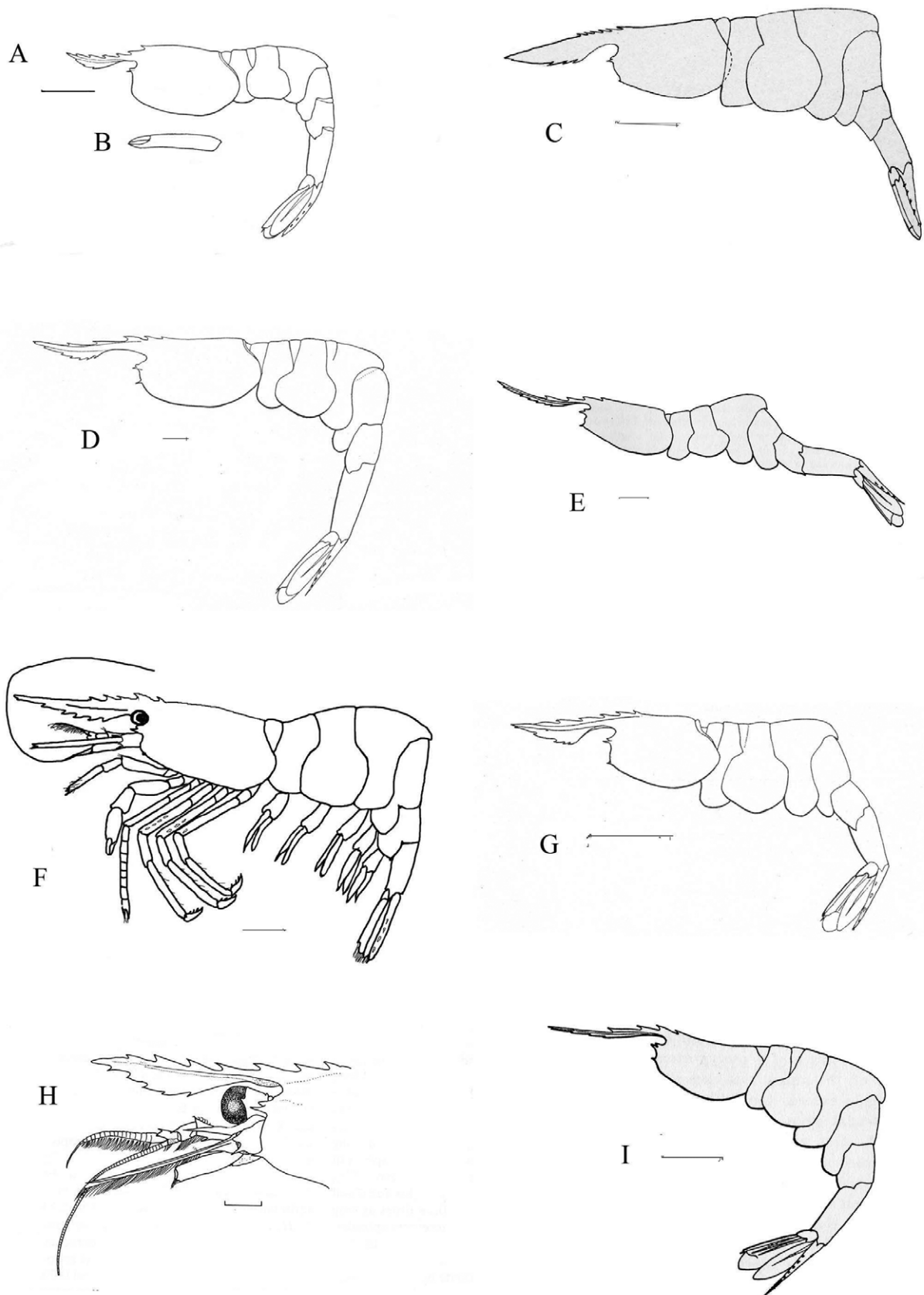


FIGURE 20. Family Thoridae. A, B, *Heptacarpus brachydactylus* (Rathbun, 1902); A, carapace and abdomen in lateral view; B, chela of pereopod 1. C, *Heptacarpus carinatus* Holmes, 1900; carapace and abdomen. D, *Heptacarpus decorus* (Rathbun, 1902). E, *Heptacarpus flexus* (Rathbun, 1899). F, *Heptacarpus franciscanus* (Schmitt, 1921). G, *Heptacarpus kincaidi* (Rathbun, 1902). H, *Heptacarpus moseri* (Rathbun, 1902); frontal region in lateral view. I, *Heptacarpus tenuissimus* Holmes, 1900. Scales: F = 2 mm, A, E, I = 3mm; C, I = 5 mm; C= 10 mm. A, C, D, E, G, I from Schmitt 1921 (I as *Spirontocaris gracilis*); F drawn from specimen from off Redondo Beach; H from Komai 1993.

***Heptacarpus fuscimaculatus* Wicksten, 1986**

(Fig. 21B)

Heptacarpus fuscimaculatus Wicksten, 1986: 47, figs. 1, 2; 1988a: 243; 1990b: 595. — Chace 1997: 44.

Diagnosis. Rostrum short, slightly exceeding first segment of antennular peduncle, with 3–6 dorsal, 0–1 ventral spines. All segments of antennular peduncle with 1 spine each, stylocerite reaching end of first segment. Third maxilliped, pereopods 1–3 with epipods. Merus of first pereopod with spine. Pereopods 3–5 with spinose, bifid dactyls. Merus of pereopod 3 with 2 or 3 spines; pereopod 4, with 1–2 spines; pereopod 5, with 0–1 spine. Pleura of abdominal somites 1–3 rounded, 4, 5 with posterolateral points. Abdominal somite 5 with tooth on ventral midline. Telson with 3–5 pairs dorsolateral spines. Female total length 12 mm, male not reported.

Color in life. Translucent with lines of brown chromatophores to pale green (Wicksten 1986).

Habitat and depth. On floating docks, in kelp holdfasts, sand, gravel, algae, 0–295 m, usually at 50 m or less.

Range. Santa Rosa I., California to off Thurloe Head, Baja California. Type locality Big Fisherman's Cove, Santa Catalina I., California.

***Heptacarpus kincaidi* (Rathbun, 1902)**

(Fig. 20G)

Spirontocaris kincaidi Rathbun, 1902a: 899; 1904: 95, fig. 43. — Schmitt 1921: 63, fig. 40.

Heptacarpus kincaidi. — Holthuis 1947: 12. — Kozloff 1974: 167. — Word & Charwat 1976: 119. — Butler 1980: 218. — Wicksten 1990b: 594. — Jensen 1995: 47, fig. 78. — Chace 1997: 44.

Diagnosis. Rostrum moderately deep, exceeding antennular peduncle, with 5 or 6 dorsal, 5 or 6 ventral teeth; apex usually bifid. Second, third segments of antennular peduncle with 1 spine each, stylocerite reaching end of second segment. Third maxilliped with epipod. No epipods on pereopods. Pereopods 3–5 slender, with spinose dactyls; merus of pereopod 3 with 2–4 spines, pereopod 4, with 2 or 3 spines, pereopod 5, with 2 or 3 spines. Pleura of abdominal somites 1–4 rounded, 5 with sharp ventral point. Dorsal posterior margin of somite 3 forming cap-like lobe. Telson with 4 pairs dorsolateral spines. Female total length 35 mm, male not reported.

Color in life. Mostly transparent, with red spots and bands on body, and appendages (Butler 1980). Rostrum with yellowish stripe, body marked with red and streaked with white and gray-green patches (Jensen 1995).

Habitat and depth. Subtidal rocky areas, in association with sea anemones, *Cribrinopsis fernaldi* Siebert & Spaulding 1976; and *Urticina crassicornis* (O.F. Müller, 1776) (Jensen 1995), 10–183 m.

Range. Discovery Passage, east coast of Vancouver I., British Columbia to San Pedro, California. Type locality Santa Cruz, California.

***Heptacarpus moseri* (Rathbun, 1902)**

(Fig. 20H)

Spirontocaris moseri Rathbun, 1902a: 897; 1904: 91, fig. 39.

Heptacarpus moseri. — Holthuis 1947: 12. — Kozloff 1974: 167. — Butler 1980: 223, color plate 6A. — Wicksten 1989b: 312; 1990b: 595. — Komai 1993: 549, fig. 4. — Chace 1997: 44.

Diagnosis. Rostrum long, exceeding antennular peduncle, with 5–8 dorsal, 1–7 ventral teeth. Each segment of antennular peduncle with spine, stylocerite reaching end of first segment. Third maxilliped, first pereopod with epipods. Pereopods 3–5 slender, with spinose, bifid dactyls. Merus of pereopod 3, with 0–3 spines; pereopod 4, with 3 spines; pereopod 5, with 0–3 spines. Pleura of abdominal somites 1–3 rounded, 4, 5 ending in posterolateral points. Telson with 4–5 pairs lateral spines. Female carapace length 7.3–9.6 mm, male not reported.

Color in life. Translucent, banded, patched with red to red-orange or transparent striped with blue (Butler 1980 color plate 6A).

Habitat and depth. Among algae, to 1100 m. Komai (1993) believed that a previous intertidal record (Hart 1930, cited by Butler 1980) is a misidentification. Material that he examined came from 247–325 m in depth.

Range. Off Hiro, Hokkaido, Japan; Pribilof Is., Alaska to off Columbia River, Oregon. Type locality off Segouam, Aleutian Is.

***Heptacarpus palpator* (Owen, 1839)**

(Fig. 21C, Pl. 3B)

Hippolyte palpator Owen, 1839: 89, pl. 28, fig. 3. — Stimpson 1856: 97.

Heptacarpus palpator. — Holmes 1900: 196, pl. 3, figs. 48, 49. — Holthuis 1947: 12. — Word & Charwat 1976: 121. — Chace & Abbott 1980: 569. — Ricketts *et al.* 1985: 197, fig. 167. — Wicksten 1986: 51, fig. 34; 1990b: 596. — Jensen 1995: 46, fig. 76. — Chace 1997: 44. — Wicksten & Hendrickx 2003: 67. — Kuris *et al.* 2007: 640, Pl. 318 A.

Spirontocaris palpator. — Rathbun 1904: 98. — Schmitt 1921: 65, fig. 43. — Johnson & Snook 1927: 307, fig. 259b.

Diagnosis. Similar to *H. brevirostris* except rostrum reaching at least to end of cornea, often to end of first segment of antennular peduncle or slightly beyond, with 4–7 dorsal, 0–2 ventral teeth. First segment of antennular peduncle with 2 or 3 dorsal spinules, 1 lateral spine. Third maxilliped long, heavy, especially in males. No spine on merus of first pereopod. Pereopods 3–5 with short, spinose dactyls, 1 or 2 meral spines apiece. All abdominal somites with tubercles on ventral midline, somites 1, 2 with 2 tubercles each, other somites with 1 ventral tubercle. Pleura of somites 4, 5 ending in small, sharp points. Abdominal somite 6 longer than somite 5, with 2 sharp lateral points. Telson shorter than uropods, with 4 or 5 pairs dorsolateral spines, apex acute. Total length 46.6 mm.

Color in life. Individuals are well camouflaged among algae. Translucent to dark brown. Anterior part of body translucent with brown mottled bands, with similar markings on appendages, dark brown bands on abdomen, tail fan. The color notes are from shrimp from San Pedro, California.

Habitat and depth. Tide pools, shallow rocky areas and wharf pilings, 0–37 m.

Range. San Francisco Bay, California to Magdalena Bay, Baja California; one record from Epiritu Santo I., Gulf of California. Most common south of Point Conception along the California mainland, rarely north of Monterey Bay. Type locality Monterey, California.

Remarks. The record from San Francisco Bay was by Stimpson (1856). There have been no reports of this shrimp from the bay ever since then.

***Heptacarpus paludicola* Holmes, 1900**

(Fig. 21D)

Heptacarpus paludicola Holmes, 1900: 201, pl. 3, figs. 56–57. — Holthuis 1947: 12. — Kozloff 1974: 167. — Word & Charwat 1976: 123. — Butler 1980: 227. — Chace & Abbott 1980: 569. — Ricketts *et al.* 1985: 85, fig. 66. — Wicksten 1990b: 595. — Chace 1997: 44. — Kuris *et al.* 2007: 639, pl. 318 F.

Spirontocaris paludicola. — Rathbun 1904: 101. — Schmitt 1921: 64, fig. 42. — Johnson & Snook 1927: 306, fig. 259f.

Diagnosis. Rostrum extending beyond antennular peduncle, with 6–8 dorsal, 2–4 ventral teeth. Spine on each of three segments of antennular peduncle, stylocerite not reaching end of first segment. Third maxilliped, pereopods 1, 2 with epipods. Pereopods 3–5 with spinose bifid dactyls. Merus of pereopod 3, with 5 spines; pereopod 4, with 4 spines; pereopod 5, with 2–4 spines. Pleura of abdominal somites 1–3 rounded, fourth with weak point, fifth with well developed point. Telson with 4 or 5 pairs dorsolateral spines. Male total length 20 mm, female 32 mm.

Color in life. Green, with bands, stripes, or speckles; transparent; color dependent on size and substrate. Blue to aquamarine at night (Bauer 1981).

Habitat and depth. Tide pools, eelgrass beds, intertidal zone to 10 m.

Range. Tava I., Alaska to San Diego, California. Type locality Humboldt Bay, California.

***Heptacarpus pugettensis* Jensen, 1983**

(Fig. 21E)

Heptacarpus pugettensis Jensen, 1983: 314, figs. 1–3. 1995: 47, fig. 79. — Wicksten 1988: 242; Wicksten 1990b: 595. —

Jensen 1995: 47, fig. 79. — Chace 1997: 44. — Kuris *et al.* 2007: 640.

Diagnosis. Rostrum rarely overreaching eye, not reaching end of first segment of antennular peduncle, with 3–5 dorsal, 0–2 ventral teeth. First segment of antennular peduncle with ventromedial and dorsolateral spines, second, third segments also with spine each. Stylocerite extending past first segment. Third maxilliped, pereopods 1, 2 with epipods. Pereopods 3–5 strong, with spinose dactyls. Merus of pereopod 3, with 3 spines; pereopod 4, with 2 spines; 5 with 1–0 spines. Pleura of abdominal somites 1–3 rounded, fourth pleuron with weak to moderate point, fifth with acute point. Telson with 3–5 pairs dorsolateral spines. Total length to 21 mm.

Color in life. Carapace with alternating green, red bands; appendages with reddish brown bands, appearing overall dark green with white transverse bands, 3 large yellowish oval markings on abdomen (Jensen 1983).

Habitat and depth. Low intertidal zone, clinging to undersides of large rocks.

Range. Alki Point, Seattle, Washington to Hazard Reef, near Morro Bay, California. Type locality Alki Point, Washington.

***Heptacarpus sitchensis* (Brandt, 1851)**

(Fig. 21F, Pl. 3C)

Hippolyte sitchensis Brandt, 1851: 116, fig. 18.

Hippolyte picta Stimpson, 1871: 125.

Heptacarpus pictus. — Holmes 1900: 200, pl. 3, figs. 54, 55. — Holthuis 1947: 13. — Word & Charwat 1976: 125. — Chace & Abbott 1980: 572, Fig. 23.7. — Ricketts *et al.* 1985: 85. — Wicksten 1990b: 595.

Spirontocaris picta. — Rathbun 1904: 101. — Schmitt 1921: 68, fig. 46. — Johnson & Snook 1927: 308, fig. 259e.

Spirontocaris sitchensis. — Rathbun 1904: 102.

Heptacarpus sitchensis. — Holthuis 1947: 13. — Kozloff 1974: 167. — Butler 1980: 22. — Wicksten 1990b: 595. — Wicksten *et al.* 1996: 71. — Jensen 1995: 47, fig. 80. — Chace 1997: 45. — Stamatious & Jensen 2004: 1. — Kuris *et al.* 2007: 639, pl. 318 E.

Heptacarpus littoralis Butler, 1980: 221. — Jensen & Armstrong 1987: 216.

Diagnosis. Rostrum barely exceeding length of antennular peduncle, with 4–8 dorsal teeth, 0–5 ventral teeth. Each segment of antennular peduncle with sharp spine, stylocerite reaching or exceeding end of first segment. Third maxilliped, pereopods 1, 2 with epipods. Pereopods 3–5 stout, with spinose, bifid dactyls. Merus of pereopod 3, with 0–9 spines; pereopod 4, with 0–5 spines; pereopod 5, with 0–5 spines. Pleura of abdominal somites 1–3 rounded, 4, 5 with posterolateral points. Telson with 4 or 5 pairs dorsolateral spines. Male total length 16 mm, female 28 mm.

Color in life. Variable: translucent, striped with brown, white; longitudinally striped with tan along dorsal midline, entirely green, green with white carapace, or nearly black. Changes to pale blue at night.

Habitat and depth. Tide pools, docks, among algae, rocks; mostly intertidal, rarely to 12 m.

Range. Resurrection Bay, Alaska to Yaquina Bay, Oregon; Duxbury Reef, Marin County, California to Punta Banda, Baja California, Mexico. Type locality Sitka, Alaska.

Remarks. *Heptacarpus sitchensis* and *H. pictus* until recently were considered to be separate species on the basis of the epipods. Unlike the former, *H. pictus* was thought to have epipods on both the first and second pereopods as well as on the third maxillipeds. Some individuals have an epipod only on the left or right first or second pereopod but not on both. Individuals with various arrangements of epipods can be collected in the same tide pool. In the absence of any other distinguishing features, these individuals must be considered to be variants of the same species. Butler (1980) described *H. littoralis* as a separate species based on its more slender body, larger eye, narrower scaphocerite and long curved propodi on pereopod 3–5. Stamatious & Jensen (2004), by rearing larvae, discovered that *H. littoralis* is actually a male of *H. sitchensis*.

Heptacarpus sitchensis, like many other species of carideans, is more active at night.

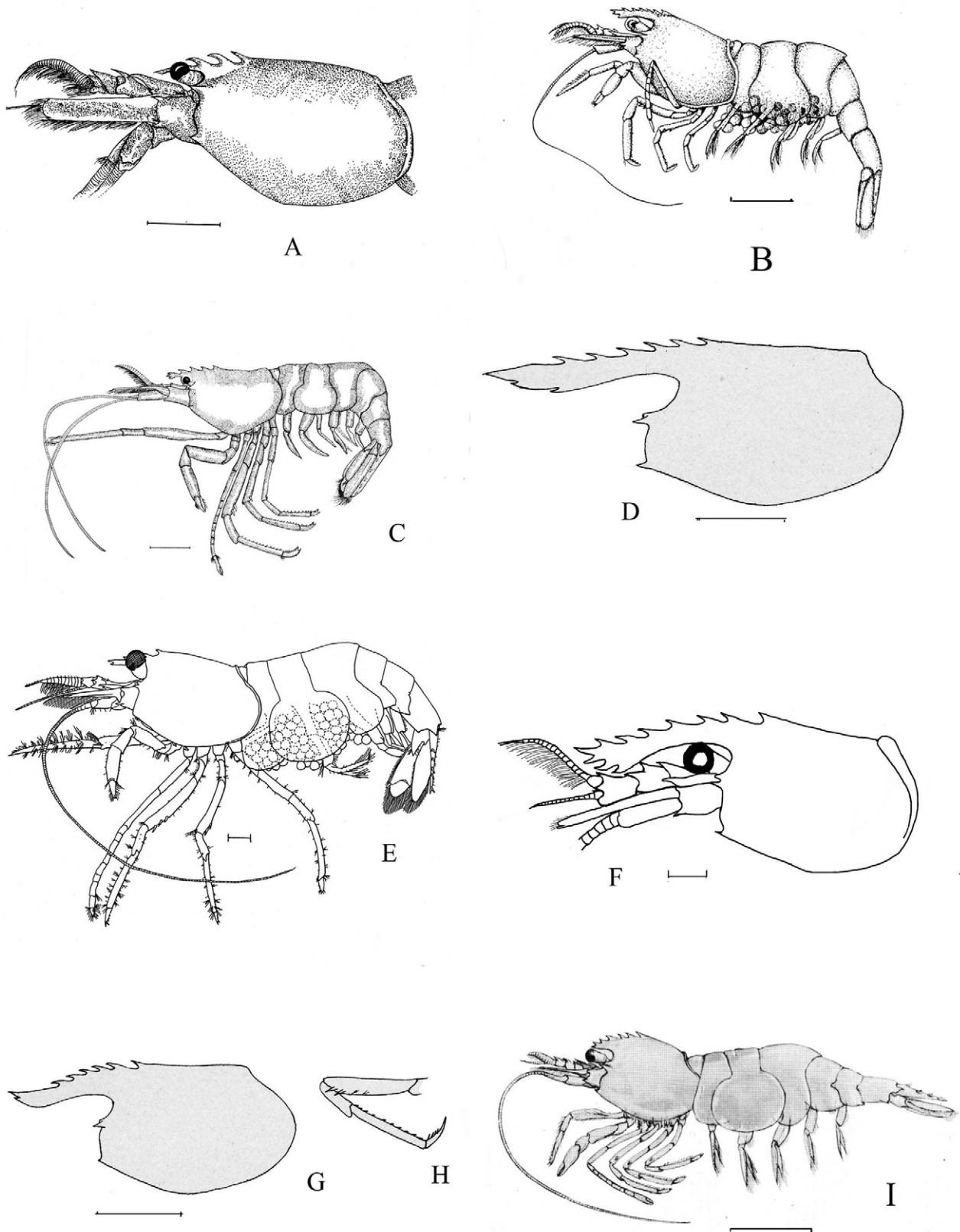


FIGURE 21. Family Thoridae. A, *Heptacarpus brevirostris* (Dana, 1852); carapace and frontal region in lateral view. B, *Heptacarpus fuscimaculatus* Wicksten, 1986. C, *Heptacarpus palpator* (Owen, 1839). D, *Heptacarpus paludicola* Holmes, 1900. E, *Heptacarpus pugettensis* Jensen, 1983. F, *Heptacarpus sitchensis* (Brandt, 1851). G, H, *Heptacarpus stimpsoni* Holthuis, 1947; G, carapace in lateral view; H, pereopod 3. I, *Heptacarpus taylori* (Stimpson, 1857b). Scales: E = 1 mm, D, F, G = 2mm; B = 3 mm, A, I = 5 mm, C = 6 mm, F= 7 mm. A, C from Wicksten 1986, D, G, H from Schmitt 1921, E from Jensen 1983, I from Green & Butler 1988.

***Heptacarpus stimpsoni* Holthuis, 1947**

(Fig. 21G, H)

Hippolyte cristata Stimpson, 1860: 33 [not *Hippolyte cristata* De Haan, 1844, = *Sicyonia cristata*, family Sicyoniidae].

Heptacarpus cristatus. — Holmes 1900: 202, pl. 3, figs. 58, 59.

Spirontocaris cristata. — Rathbun 1904: 102, fig. 45. — Schmitt 1921: 69, fig. 47. — Johnson & Snook 1927: 308, fig. 259g. — Goodwin 1952: 394.

Heptacarpus stimpsoni Holthuis 1947: 13, 44. — Kozloff 1974: 167. — Word & Charwat 1976: 127. — Butler 1980: 229. — Carvacho & Olson 1984: 60. — Ricketts *et al.* 1985. — Wicksten 1988a: 243; 1990b: 595. — Jensen 1995: 48, fig. 81. — Chace 1997: 45. — Kuris *et al.* 2007: 640, pl. 318 C.

Diagnosis. Rostrum not reaching end of antennular peduncle, with 5–8 dorsal teeth away from apex, 1–4 ventral teeth, usually slightly convex dorsally but may be more or less straight. Second, third segments of antennular peduncle with spine each, first segment with dorsal spinules, stylocerite reaching at least to second segment. Third maxilliped, pereopods 1–3 with epipods. Pereopods 3–5 slender, with simple, slender dactyls bearing minute spinules. Merus of pereopod 3, with 4 or 5 spines; pereopod 4, with 4 spines; pereopod 5, with 2–4 spines. Pleura of abdominal somites 1–3 rounded, 4, 5 with posterolateral points. Telson with acute apex, 3 pairs dorsolateral spines. Male total length 23 mm, female 32 mm.

Color in life. Drab brown or gray, with pale bands (Jensen 1995). Banded with dark pigment, giving purple color. The color notes are from shrimp from Redondo Beach, California.

Habitat and depth. On sand, low intertidal zone to 104 m (*Velero III* station 1131-40, LACM) but usually at 10–100 m. May be found among sand dollars, *Dendroaster excentricus* (Eschscholtz, 1831).

Range. Sheep Bay, Alaska to Todos Santos Bay, Point Abrejos, Rosario Bay, Baja California; Melpomene Cove, Guadalupe I., Mexico. Type locality San Francisco, California.

Remarks. The holotype of *Heptacarpus herdmani* bears a strong resemblance to *H. stimpsoni* and may be a malformed individual of this species. The rostrum is of the same length but is not dorsally convex. The dactyls of the posterior pereopods are simple, not bifid and strongly spined. The holotype is broken and shows indications of dehydration.

***Heptacarpus taylori* (Stimpson, 1857)**

(Fig. 21I, Pl. 3E)

Hippolyte taylori Stimpson, 1857b: 500.

Heptacarpus taylori. — Holmes 1900: 199, pl. 3, figs. 52, 53. — Holthuis 1947: 13 — Kozloff 1974: 167. — Word & Charwat 1976: 129. — Chace & Abbott 1980: 569. — Ricketts *et al.* 1985: 198. — Green & Butler 1988: 4, fig. 2. — Wicksten 1988a: 242; 1990b: 595. — Chace 1997: 45. — Kuris *et al.* 2007: 639, pl. 318 D.

Spirontocaris taylori. — Rathbun 1904: 101. — Schmitt 1921: 67, fig. 45. — Johnson & Snook 1927: 307, fig. 259d, 263.

Diagnosis. Rostrum very short, not reaching cornea of eye, with 5 or 6 dorsal, no ventral teeth. Second, third segments of antennular peduncle each with spine, first segment with 3 spinules, stylocerite reaching to end of first segment. Third maxilliped, pereopods 1–3 with epipods. Pereopods 3–5 sturdy, with spinose bifid dactyls. Merus of pereopods 3–5 with 1 spine each. Pleura of abdominal somites 1–3 rounded, 4, 5 with posterolateral points. Telson with rounded apex, 3 pairs dorsolateral spines. Males with heavier third maxillipeds than females. Male total length 25 mm, female 32 mm.

Color in life. Highly variable, including red-brown, greenish with white carapace or mottled colors. mottled brown, with white carapace, reddish brown abdomen, solid green or with mid-dorsal white stripe. The color notes are from shrimp from Pillar Point, San Mateo County, California. Well camouflaged among algae or sea grasses. Johnson & Snook (1927, fig. 263) included a photograph of a shrimp with a saddle-like mark.

Habitat and depth. Among algae, intertidal zone to 13 m.

Range. Queen Charlotte Sound, British Columbia; Dillon Beach, California to Magdalena Bay, Baja California. Type locality Monterey, California.

***Heptacarpus tenuissimus* Holmes, 1900**

(Fig. 20I)

Hippolyte gracilis Stimpson, 1864: 155 [not *Hippolyte gracilis* Lilljeborg, 1850, = *Eualus gaimardii* H. Milne-Edwards, 1837, Arctic species].

Heptacarpus tenuissimus Holmes, 1900: 203. — Holthuis 1947: 13, 43; 1969: 3, fig.1.— Kozloff 1974: 167. — Word & Charwat 1976: 131. — Butler 1980: 208. — Wicksten 1990b: 593. — Jensen 1995: 49, fig. 84. — Chace 1997: 45. — Kuris *et al.* 2007: 651.

Spirontocaris gracilis. — Rathbun 1904: 77, fig. 31. — Schmitt 1921: 59, fig. 37.

Diagnosis. Rostrum exceeding antennular peduncle, with 4 or 5 dorsal, 4–8 ventral teeth, anteriormost dorsal tooth near middle of rostrum. Second, third segments of antennular peduncle with one spine each, stylocerite reaching past first segment. Third maxilliped without epipod. No epipods on pereopods. Pereopods 3–5 slender, with spinose dactyls. Merus of pereopod 3, with 3 or 4 spines; pereopod 4, with 4 spines; pereopod 5, with 2 or 3 spines. Pleura of abdominal somites 1–4 rounded, 5 with strong point. Telson with 4 pairs dorsolateral spines. Male total length 36 mm, female 43 mm.

Color in life. Mostly translucent, with horizontal red line running from scaphocerite to apex of tail fan; appendages marked with red (Jensen 1995, fig. 84).

Habitat and depth. Mixed sand, shell bottoms, among algae or on mud, 2–137 m (Jensen 1995). Off San Francisco, California, taken at 54–74 m on fine dark green sand.

Range. Bird I., Alaska to Santa Catalina I., California. Type locality Puget Sound.

***Lebbeus* White, 1847**

***Lebbeus lagunae* (Schmitt, 1921)**

(Fig. 22B, Pl.1E)

Spirontocaris lagunae Schmitt, 1921: 57, fig. 35, pl. 12, figs. 10–11.

Lebbeus lagunae. — Holthuis 1947: 9. — Word & Charwat 1976: 141. — Wicksten 1978a: 2, figs. 1, 4; 1990b: 592. — Wicksten & Méndez 1982: 117. — Carvacho & Olson 1984: 60. — Jensen 1995: 50. — Chace 1997: 51. — Kuris *et al.* 2007: 636.

Diagnosis. Rostrum reduced to spiniform tooth. Second segment of antennular peduncle with large spine, stylocerite reaching end of first segment. Carapace with 3 large teeth on dorsal margin, large supraorbital tooth. Pereopods 1–3 with epipods. Pereopods 3–5 stout, dactyls spinose, merus of each with spine. Pleura of abdominal somites 1–3 in female rounded, 4 pointed, 5 with acute point; in male, somites narrow, all bluntly to acutely pointed. Telson with 3 pairs dorsolateral spines. Females with more deeply inflated carapace, rounded abdominal pleura than males. Total length 20 mm.

Color in life. Camouflaged like algae: "kelp color", body light, legs darker, red, black on appendages (Schmitt 1921); mottled with white, rose-red, dark rose-red, tan, brick red (Wicksten 1978a), covered with large brown or red blotches (K. Lee, pers. comm.)

Habitat and depth. Rocky reefs, tide pools, kelp beds, intertidal zone to 55m.

Range. Dark Gulch, Mendocino County, California to south of Punta Banda, Baja California. Type locality Laguna Beach, California.

Remarks. Kuris *et al.* (2007: 651) called this a "southern" species, but it ranges into central California. Most observations of this shrimp were made during night dives.

***Lebbeus speciosus* (Urita, 1942)**

(Fig. 22C)

Spirontocaris makarofi speciosa Urita, 1942: 19, fig. 4.

Lebbeus possjeticus Kobyakova, 1967: 235, fig. 4. — Wicksten & Méndez 1982: 118. — Wicksten 1990b: 592.

Lebbeus speciosus. — Hayashi 1992: 132, figs. 13, 14.— Chace 1997: 52.

Diagnosis. Rostrum moderately deep, exceeding apex of antennular peduncle, with 5–7 dorsal teeth, 2 on carapace proper, 3 or 4 ventral teeth. First segment of antennular peduncle with 3 or 4 terminal spines, stylocerite reaching second segment. Carapace with strong supraorbital tooth. Pereopods 1–3 with epipods. Pereopods 3–5 slender, with short, spinose dactyls. Merus of pereopod 3, with 4 spines; pereopod 4, with 3 or 4 spines; pereopod 5, with 1 or 2 spines. Pleura of abdominal somites 1–3 rounded, 4, 5 with small points. Telson with 4 or 5 pairs dorsolateral spines. Total length 32 mm.

Color in life. Carapace, abdomen with dark brown bands, telson dark brown, appendages brown, white (Hayashi 1992).

Habitat and depth. Rocky shores, subtidal areas, 0–57 m.

Range. Hokkaido, Siberia, Bering I., and off San Nicolas I., California. Type locality Sakhalin.

***Lebbeus vicinus montereyensis* Wicksten & Méndez, 1982**

(Fig. 22D)

Lebbeus polaris: Wicksten 1978a: 6, fig. 6 [not *Alpheus polaris* Sabine, 1821].

Lebbeus vicinus montereyensis Wicksten & Méndez, 1982: 114, pl. 6. — Wicksten 1989b: 313; 1990b: 591. — Chace 1997: 52. — Wicksten & Hendrickx 2003: 67

Diagnosis. Rostrum of female long and slender, reaching end of scaphocerite, of male not reaching end of scaphocerite, with 3 or 4 dorsal teeth, 2 or 3 of them on carapace proper, 4 ventral teeth. First segment of antennular peduncle with sharp spine, stylocerite reaching end of first segment. Carapace with supraorbital tooth. Pereopod 1 with epipod. Pereopods 3–5 slender, dactyls with spines. Merus of pereopod 3, with 1 large distolateral, 4–6 smaller lateral spines; pereopod 4, with 4 meral spines; pereopod 5, with 3 lateral meral spines. Pleura of abdominal somites 1–4 rounded, 5 with sharp point. Telson with 2 pairs dorsolateral spines. Total length 50–65 mm.

Color in life. Not reported.

Habitat and depth. Benthic, 954–2086 m.

Range. Monterey Bay, California to Gulf of California, Mexico. Type locality west of Punta Banda, Baja California, Mexico.

***Lebbeus washingtonianus* (Rathbun, 1902)**

(Fig. 22E)

Spirontocaris washingtoniana Rathbun, 1902: 895; 1904: 76, fig. 30. — Schmitt 1921: 55, fig. 33.

Lebbeus washingtonianus. — Holthuis 1947: 10. — Kozloff 1974: 165. — Word & Charwat 1976: 143. — Wicksten 1978: 3, fig. 5; 1980c: 364; 1989b: 313, 1990b: 592. — Butler 1980: 183. — Wicksten & Méndez 1982: 119. — Kikuchi & Ohta 1995: 779, figs. 8–13. — Chace 1997: 52. — Wicksten & Hendrickx 2003: 67. — Martin & Haney 2005: 449.

Diagnosis. Rostrum slender, reaching end of first segment of antennular peduncle, with 4 or 5 dorsal, 2 or 3 ventral teeth. Dorsal spine on each segment of antennular peduncle, stylocerite not reaching end of first segment, flagella each twice length of carapace. Carapace with supraorbital, suborbital, antennal, weak pterygostomian teeth. Pereopods 1–3 with epipods. Pereopods 3–5 long, slender; dactyls slender, spinose. Merus of pereopod 3, with 5 spines; pereopod 4, with 4 spines; pereopod 5, with 1 spine. Pleura of abdominal somites 1–3 rounded, somite 4 with weak ventral teeth, somite 5 with strong tooth. Telson with 4–6 pair dorsolateral spines, acute apex. Male total length 43 mm, female 39 mm.

Color in life. Not reported.

Habitat and depth. Steep slopes, trenches of continental slope, 820–1808 m. Has been found in association with hot vents or cold seeps (Martin & Haney 2005).

Range. Iheya Ridge, Hatoma Knoll and Minami-Ensei Knoll, Okinawa Trough; Anthony I., Queen Charlotte Is., British Columbia to Guaymas Basin, Gulf of California. Type locality off Sea Lion Rock, Washington.

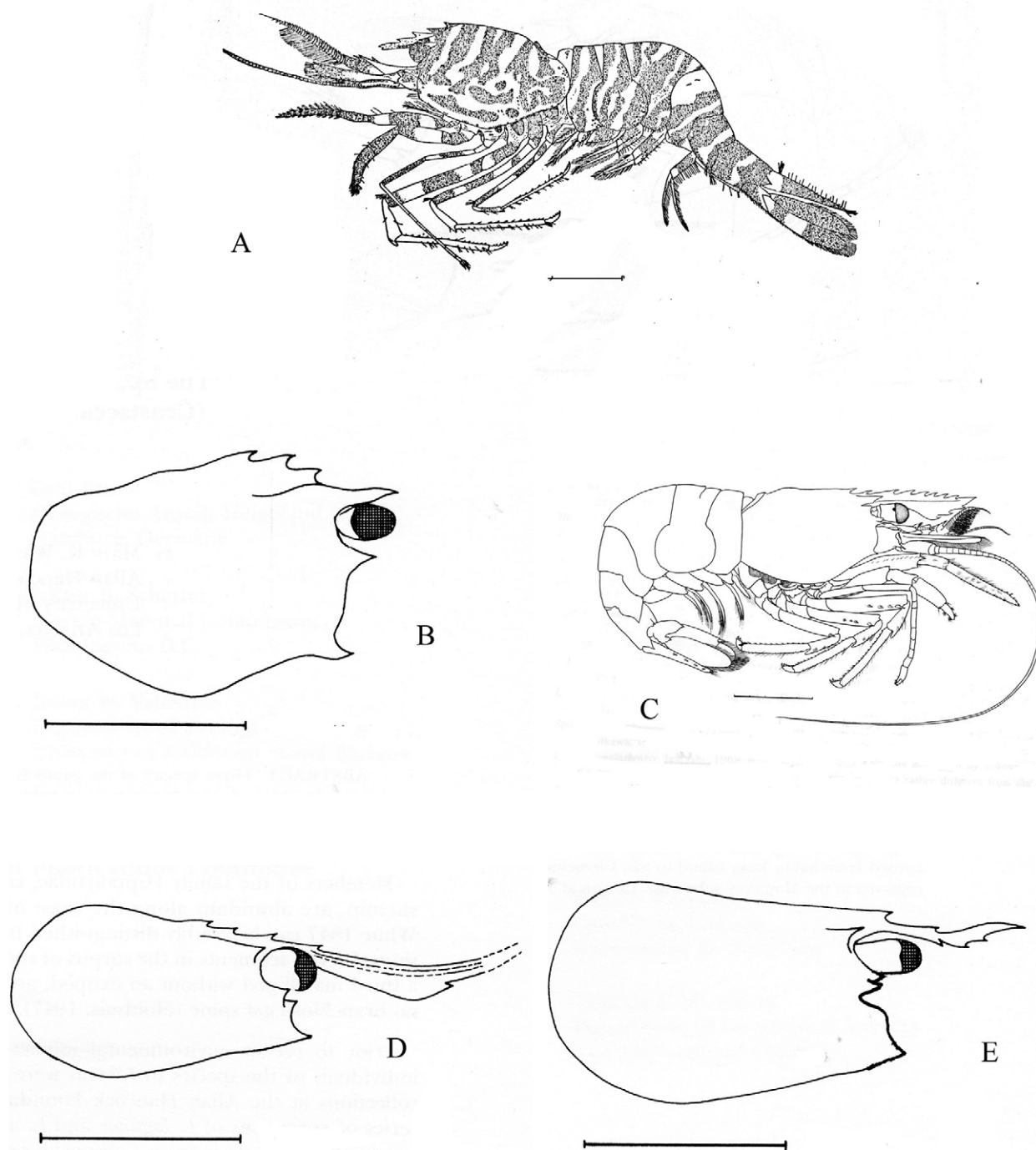


FIGURE 22. Family Thoridae. A, *Lebbeus zebra* (Leim, 1921). B, *Lebbeus lagunae* (Schmitt, 1921); carapace and eye. C, *Lebbeus speciosus* (Urita, 1942). D, *Lebbeus vicinus montereyensis* Wicksten & Méndez, 1982; carapace and eye. E, *Lebbeus washingtonianus* (Rathbun, 1902); carapace and eye. Scales: B, 0.5 mm, A, D, E = 1 mm, C= 5 mm. A from Leim 1921, C from Kobyakova 1967 (as *L. possjeticus*), B, D, E from Wicksten 1978 (D as *L. polaris*).

***Lebbeus zebra* (Leim, 1921)**

(Fig. 22A)

Spirontocaris zebra Leim, 1921: 133, pls. 2–3.

Lebbeus zebra. — Holthuis 1947: 10 (part). — Couture & Trudel 1968: 873, fig. 12.—Butler 1980: 186. — Wicksten & Méndez 1982: 118. — Wicksten 1990b: 592.

Not *Hetairus zebra* Makarov, 1935: 319, fig. 1; =*Hetairus fasciatus* Kobyakova, 1936; western Pacific species.

Diagnosis. Rostrum narrow, reaching at most to end of first segment of antennular peduncle, with 2–5 dorsal teeth, 1–2 on carapace proper, no ventral teeth. First segment of antennular peduncle with 2–4 spines on dorsal margin, appressed mesioventral spine, second and third segments with dorsal spines, stylocerite not reaching end of spine of second article. Carapace with strong supraorbital tooth, suborbital lobe, strong antennal tooth, small pterygostomial tooth. Third maxilliped with epipod but no exopod. Pereopods 1–3 with epipods. Pereopods 3–5 slender, with stout spinose dactyls. Merus of pereopods 3–5 without spines. Pleura of abdominal somites 1–3 rounded, 4, 5 with small points. Telson with 4 or 5 pairs dorsolateral spines, blunt apex. Total length 49 mm.

Color in life. Conspicuously banded with brownish red to orange stripes on body, appendages (Leim 1921).

Habitat and depth. Rocky subtidal areas, 10–140 m.

Range. Gulf of St. Lawrence to Isles of Shoals, Maine; Bering Sea, Vancouver I. to off Santa Rosa I., California. Type locality not specified. Leim's material came from Passamaquoddy Bay, St. Croix River and Campobello I., New Brunswick and St. Mary's Bay, Nova Scotia.

Remarks. Apparently unaware of the name given to the Atlantic species, Makarov (1935) created a homonym when describing the North Pacific species. Kobyakova (1936) re-named the Pacific species, but did not designate any distinctive features that would differentiate it from the Atlantic species. Hayashi (1992: 118, fig. 4) re-described and illustrated *L. fasciatus*. Chace (1997: 45, 51) gave the synonymy of *Hetairus zebra* with *Lebbeus fasciatus* but did not cite the Atlantic *Lebbeus zebra*.

Lebbeus zebra is known from very few Pacific specimens. The Pacific and Atlantic specimens of *L. zebra* are very similar in morphology and habitat. Williams (1984) noted that Atlantic and Pacific specimens differed in the shape of the rostrum, but other species of *Lebbeus* exhibit considerable variation in this feature. It is likely that *L. fasciatus* and *L. zebra* have been confused in the literature. The specimens from Santa Rosa I., California more closely resemble those from St. Mary's Bay, Nova Scotia than those from Vancouver I., British Columbia.

Spirontocaris Bate, 1888

Spirontocaris holmesi Holthuis, 1947

(Fig. 23A)

Spirontocaris bispinosa Holmes, 1900: 207. — Rathbun 1904: 68, fig. 23. — Schmitt 1921: 54, fig. 30. [Not *Hippolyte bispinosa* De Haan, 1841; = *Sicyonia bispinosa* (De Haan, 1849); Sicyoniidae].

Spirontocaris holmesi Holthuis, 1947: 38. — Kozloff 1974: 166. — Word & Charwat 1976b: 149. — Hayashi 1977: 158. — Butler 1980: 165, pl. 6E. — Wicksten 1984b: 135; 1989b: 313; 1990b: 590. — Chace 1997: 56.

Diagnosis. Rostrum moderately deep, with distal styliform process bearing one subapical ventral tooth, 8–16 dorsal, 3–7 ventral teeth, 2 on carapace proper. Each segment of antennular peduncle with dorsal spine, stylocerite reaching second segment. Carapace with 2 supraorbital teeth. Pereopods 1, 2 with epipods. Pereopods 3–5 long, slender; with long, simple dactyls, 0.5–0.6 times length of propodi. Merus of pereopod 3, with 6–7 spines; pereopod 4, with 5–8 spines; pereopod 5, with 4 or 5 spines. Pleura of abdominal somites 1–4 rounded, of 5 with small point. Telson with 3 or 4 pairs dorsolateral spines, apex rounded. Male total length to 44 m, female to 62 mm.

Color in life. Body yellowish, with lines, bars, dots, patches of red (Butler 1980).

Habitat and depth. Mud or sand, 24–485 m. Specimens from California usually taken at 150–300 m.

Range. Yes Bay, Alaska to San Diego, California. Type locality Puget Sound.

Spirontocaris lamellicornis (Dana, 1852)

(Fig. 23B)

Hippolyte lamellicornis Dana, 1852: 24; 1852b: 576, pl. 1, fig. 6.

Spirontocaris lamellicornis. — Holmes 1900: 208. — Rathbun 1904: 62. — Schmitt 1921: 53, fig. 29. — Holthuis 1947: 8. — Zarenkov 1960: 346. — Kozloff 1974: 166. — Standing 1981: 780. — Wicksten 1980: 134; 1990b: 590. — Word 1983: 58. — Jensen 1995: 51, fig. 91. — Chace 1997: 56.

Diagnosis. Rostrum deep, extending beyond antennular peduncle, with midrib extending as strong tooth, 9–23 dorsal, 1–3 ventral teeth including 4 or 5 large teeth on dorsal surface of carapace. Each segment of antennular peduncle with distal spine, stylocerite exceeding length of peduncle. Carapace with 2 supraorbital teeth. Pereopods 1–3 with epipods. Pereopods 3–5 with simple, curved dactyls. Merus of pereopod 3, with 5–7 spines; pereopod 4, with 4 spines; pereopod 5, with 1–2 spines. Pleura of abdominal somites 1–5 usually with sharp points, but becoming rounded in animals larger than 10 mm in carapace length. Telson with 4 pairs dorsolateral spines, acute apex. Male total length to 42 mm, female to 63 mm.

Color in life. Dark brown, pereopods dark red to colorless, tail fan banded; milkish overlaid with fine red mottling interspersed with yellow, brown to black spots; milkish with sixth abdominal somite red to purplish (Butler 1980).

Habitat and depth. Sand or mud bottoms, 3–192 m. Most specimens from California were taken by trawling at 50–70 m.

Range. Commander Is. and Bering Sea to Santa Monica Bay, California. Rarely collected in southern California.

***Spirontocaris prionota* (Stimpson, 1864)**

(Fig. 23C, Pl. 1F)

Hippolyte prionota Stimpson, 1864: 153.

Spirontocaris prionota. — Holmes 1900: 206. — Rathbun 1904: 61. — Schmitt 1921: 52, fig. 28. — Kobayakova 1937: 129. — Holthuis 1947: 8. — Kozloff 1974: 166. — Word & Charwat 1976: 154. — Hayashi 1977: 175, fig. 7. — Butler 1980: 161. — Chace & Abbott 1980: 574, fig. 23.10. — Carvacho & Olson 1984: 64. — Ricketts *et al.* 1985: 197, fig. 109. — Wicksten 1990b: 590. — Jensen 1995: 51, fig. 92. — Chace 1997: 57. — Kuris *et al.* 2007: 638.

Diagnosis. Rostrum deep, extending beyond end of antennular peduncle with 10–15 dorsal, 6 or 7 ventral teeth in male; 12–26 dorsal, 3–8 ventral teeth in female, 3 or 4 large serrate teeth on dorsal midline of carapace proper. Second, third segments of antennular peduncle each bearing spine. Stylocerite reaching third segment of antennular peduncle. Carapace with 3–4 supraorbital teeth. Pereopods 1–3 with epipods. Pereopods 3–5 stout, dactyls spinose, bifid. Merus of pereopod 3 with 1–2 spines, pereopod 4, with 0–2 spines; pereopod 5, 0–1 spine. Pleura of abdominal somites 1–3 rounded, 4–5 pointed to sharp-tipped. Telson with 4 pairs dorsolateral spines, acute apex. Male total length to 19 mm, female to 28 mm.

Color in life. Red-spotted with blue steaks; carapace, uropods olive, rest of body rufous (Butler 1980). Carapace, rostrum china white, rest of body rusty red or green (H. Cheney, Santa Barbara Museum of Natural History, pers. comm., Jensen 1995).

Habitat and depth. Eelgrass beds, lower rocky intertidal zone, rocky subtidal areas, low subtidal areas to 163 m. Specimens from California usually are collected at 30 m or less.

Range. Nunivak I. and Bering I., Bering Sea to Todos Santos Bay, Baja California, Mexico. Type locality Puget Sound.

***Spirontocaris sica* Rathbun, 1902**

(Fig. 23D)

Spirontocaris sica Rathbun, 1902a: 894; 1904: 69, fig. 25. — Schmitt 1921: 55, fig. 32. — Holthuis 1947: 8. — Kozloff 1974: 166. — Word & Charwat 1976: 155. — Hayashi 1977: 158. — Butler 1980: 167. — Wicksten 1980c: 363; 1987: 54; 1989b: 313; 1990b: 590. — Chace 1997: 57.

Diagnosis. Very similar to *S. holmesi* except rostrum with shorter ascending apical styliform region, without subapical ventral tooth; 9–15 dorsal, 3–8 ventral teeth, 2 closely spaced teeth on dorsal surface of carapace proper. Pereopods 3–5 long, slender, with long, simple dactyls, about 0.3–0.4 times length of propodi. Merus of pereopod 3, with 5–9 spines; pereopod 4, with 5–8 spines; pereopod 5, with 3–7 spines. Telson narrow, with 4 pairs dorsolateral spines, acute apex. Male total length 42 mm, female to 65 mm.

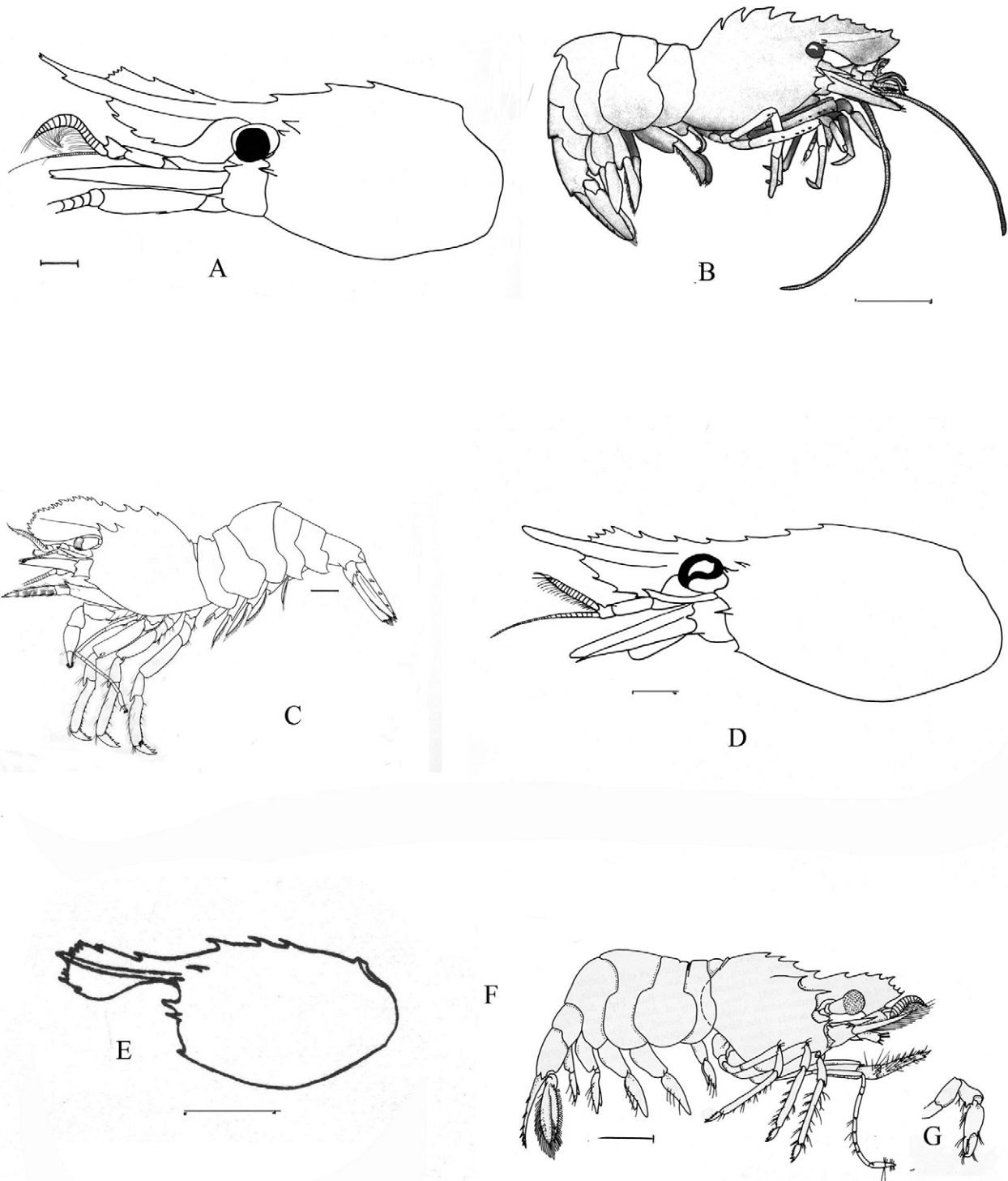


FIGURE 23. Family Thoridae. A, *Spirontocaris holmesi* Holthuis, 1947; carapace and frontal region in lateral view. B, *Spirontocaris lamellicornis* (Dana, 1852a); female. C, *Spirontocaris prionota* (Stimpson, 1864). D, *Spirontocaris sica* Rathbun, 1902; carapace and frontal region in lateral view. E, *Spirontocaris snyderi* Rathbun, 1902; carapace. F, G, *Spirontocaris truncata* Rathbun, 1902; F, lateral view; G, detail of first pereopod. Scales: C = 1 mm, A, D, E = 2 mm, F = 2.5 mm, B = 10 mm. B from photograph by Word 1983, C from Hayashi 1977, E from Schmitt 1921, F from Wicksten 1984.

Color in life. Background milkish to dull yellow, marked by red dots, bands, blotches (Butler 1980).

Habitat and depth. Benthic, 88–849 m (Butler 1980). Most specimens from California were taken on rock, mud or gravel, 150–550 m.

Range. Restoration Bay, Burke Channel, British Columbia to between San Benito Is. and Cedros Is., Baja California, Mexico. Type locality Santa Barbara Channel, California.

Spirontocaris snyderi Rathbun, 1902

(Fig. 23E, Pl. 3A)

Spirontocaris snyderi Rathbun, 1902a: 894; 1904: 69, fig. 24. — Schmitt 1921: 54, fig. 31. — Holthuis 1947: 8. — Kozloff 1974: 166. — Word & Charwat 1976: 157. — Hayashi 1977: 158. — Butler 1980: 171. — Wicksten 1990b: 590. — Jensen 1995: 52, fig. 94. — Chace 1997: 57.

Diagnosis (modified from Butler 1980). Rostrum deep, reaching end of antennular peduncle, with 8–10 dorsal, 3–5 ventral teeth, 3 or 4 dorsal teeth on carapace proper.

Dorsal spine on each of segments of antennular peduncle, stylocerite reaching end of first segment. Carapace with 2 supraorbital teeth. Pereopods 1, 2 with epipods. Pereopods 3–5 slender, merus of each bearing 3–4 spines, dactyls slender, bearing 4–6 spinules. Pleura of abdominal somites 1–3 rounded, 4, 5 with weak point. Telson with 3 or 4 pairs dorsolateral spines, acute apex. Male total length 18 mm, female to 24 mm.

Color in life. Reddish brown, mottled with white, pink, silvery bands, spots (Jensen 1995, fig. 94). Mostly translucent with red bands on third maxillipeds, first pereopods; red lines on anterior carapace, tail fan; pink or red spots on eyestalk, posterior pereopods, abdomen (individual photographed off La Jolla Shores, California, K. Lee, pers. comm.)

Habitat and depth. Usually on sand, or sand mixed with mud, rock; 4–355 m, may live among sand dollars (*Dendraster excentricus*). Most specimens from California were taken at 50–100 m.

Range. Tasu Sound, Queen Charlotte Is., British Columbia to Cedros I., Baja California, Mexico. Type locality Monterey Bay, California.

Spirontocaris truncata Rathbun, 1902

(Figs. 23F, G)

Spirontocaris truncata Rathbun, 1902a: 284; 1904: 67, fig. 22. — Holthuis 1947: 9. — Hayashi 1977: 158. — Butler 1980: 163, pl. 3C. — Wicksten 1984b: 246, fig. 4; 1990b: 590. — Chace 1997: 57.

Diagnosis. Rostrum moderately deep, extending beyond antennular peduncle, with truncate apex, 7–9 dorsal, 3 or 4 ventral teeth. Carapace with 3 supraorbital teeth. Pereopods 1–3 with epipods. Pereopods 3–5 with spinose, bifid dactyls. Merus of pereopod 3, with 2 or 3 spines; pereopod 4, with 2 spines; pereopod 5, with no spines. Pleura of abdominal somites 1–3 broadly rounded, somites 4, 5 sharp-tipped. Telson with 4 or 5 pairs dorsolateral spines, tapering to acute apex. Male total length to 14 mm, female to 20 mm.

Color in life. Carapace yellow-orange, with red-orange to deep red dots, posterior dorsal teeth of carapace dark brown, red dots on appendages, antennae; abdomen milkish with faint red dots on dorsal surface of third segment (Butler 1980: pl. 3C).

Habitat and depth. Rocky reefs, in sponges, 37–92 m.

Range. Gabriola Is., Strait of Georgia, British Columbia to SW of San Carlos Point, Baja California, Mexico. Type locality Hecata Bank, Oregon.

Remarks. All records of this species come from subtidal rocky reefs and banks. One was hand-collected by a SCUBA diver between 37–55 m on a reef off Point Sur, California.

Family Ogyrididae Holthuis, 1955

Although uncommon in California, the longeye shrimps, family Ogyrididae, are unmistakable. Their most outstanding features are the long, slender eyestalks. Like the processids, they have the carpus of the second pereopods subdivided into many articles. The first pereopods are chelate, but about equal in size with the other pereopods. Species of the Ogyrididae are found in sand or mud near shore and on the continental shelf.

Ogyrides Stebbing, 1914

***Ogyrides alphaerostris* (Kingsley, 1880)**

(Fig. 24A)

Ogyris alphaerostris Kingsley, 1880: 420, pl. 14, fig. 7.

Ogyrides alphaerostris. — Williams 1981:144; 1984: 107, fig. 74 (extensive synonymy). — Carvacho & Olson 1984: 66, figs. 3–4. — Hendrickx & Wicksten 1987: 17. — Wicksten & Méndez 1988: 624. — Wicksten & Hendrickx 2003: 68.

Diagnosis. Rostrum short, depressed, triangular, postrostral carina with 8–14 dorsal teeth flanked by row of setae on each side. Carapace with pterygostomial area obtuse. Eystalk exceeding antennular peduncle by up to 2.5 times corneal length. Second segment of antennular peduncle longest, stylocerite with 2 strong terminal teeth, not exceeding first article of antennular peduncle. Scaphocerite rounded, not reaching end of antennular peduncle. Pereopod 1 chelate, fingers gaping when closed. Carpus of pereopod 2 with 4 articles. Pereopods 3–5 slender, single spine on ischium, merus each of pereopod 3. Abdominal pleura rounded to obtuse. Telson with pair lateral spines posterior to lateral prominences. Female total length 16 mm, male not reported.

Color in life. Mostly colorless, small red, yellow spots on appendages, eystalk; red spots on uropods, sixth abdominal somite. The color notes are from a shrimp from Port Aransas, Texas.

Habitat. Mud, fine sand to gravel, but usually in very fine sand mixed with silt or clay; mostly in subtidal areas, to 28 m.

Range. Virginia to Brazil; southern California and western Mexico. Type locality Northampton County, Virginia.

Remarks. Specimens from southern California were taken off Huntington Beach at 26–28 m on sand. Other specimens have been collected off Ventura County. Most specimens from western Mexico were collected in Van Veen grabs, suggesting that the species digs into the substrate. Questions remain as to whether populations in the Atlantic and Pacific are genetically distinct and therefore constitute separate species.

SUPERFAMILY PROCEOIDEA Ortmann, 1896

Family Processidae Ortmann, 1896

Processids, known as night shrimps, resemble the lysmatids in having slender second pereopods with a multi-articulated carpus. Unlike in the lysmatids, the rostrum is short and slender, without teeth or with a bifid apex. The eye is large. At least one of the first pereopods is chelate. Pereopods 3–5 are long and slender. Processids are most common on sandy or muddy bottoms off beaches or in deeper areas, and are active at night.

Schmitt (1921) reported only one species of processid, *Processa canaliculata*, from California. The specimens on which his account was based actually belong to two species: *Ambidexter panamensis* Abele, 1972 and *Processa peruviana* Wicksten, 1983. Only *A. panamensis* seems to maintain a reproducing population in the area.

Key to species of family Processidae

1. Only one of first pair of pereopods chelate, other simple. Pereopod 1 extending beyond scaphocerite. . . . *Processa peruviana*
- Both of first pair of pereopods chelate. Pereopod 1 not extending beyond scaphocerite *Ambidexter panamensis*

***Ambidexter* Manning & Chace, 1971**

***Ambidexter panamensis* Abele, 1972**

(Fig. 24B–E)

Processa canaliculata. — Rathbun 1904: 110 (part). — Schmitt 1921: 81 (part); not pl. 12, fig. 6 (photograph of *P. peruviana*; see Wicksten 1983b: 30). [Not *Processa canaliculata* Leach, 1815; western European species, see Manning & Chace 1971: 15].

Ambidexter panamensis Abele, 1972: 373, figs. 4–5. — Wicksten 1983b: 31. — Wicksten & Hendrickx 2003:68.

Diagnosis. Rostrum with simple apex, not extending to midpoint of eyestalk. Anterior margin of carapace with strong antennal tooth, no other teeth. First segment of antennular peduncle with small tooth on ventral surface, other segments unarmed, stylocerite round and not exceeding first segment. Scaphocerite reaching distal margin of last segment of antennular peduncle, rounded and with strong anterolateral tooth. Pereopods 1 subequal, chelate. Pereopods 2 equal, carpus with 12 or 13 articles. Pereopods 3–5 slender, with simple dactyls. Pleura of abdominal somites 1–4 rounded, pleura of somite 5 rounded to bluntly angled; pleura of somite 6 with acute posterolateral teeth. Telson with two pairs strong dorsal spines, two pair terminal spines flanking sharp point. Male total length 12 mm, female 17 mm.

Color in life. Translucent.

Habitat and depth. Sand, mud or rock, usually shallow, to 65 m

Range. San Diego, California; Gulf of California; Panama, Galapagos Is. Type locality Naos I., Canal Zone, Panama.

Remarks. The only records of this species in California are from San Diego Bay, where it has been collected subtidally on muddy bottoms. It is common from western Mexico southward.

Processa Leach, 1815

Processa peruviana Wicksten, 1983

(Fig. 24G)

Processa canaliculata Rathbun 1904: 110 (part). — Schmitt 1921: 81 (part), pl. 12, fig. 6. [Not *Processa canaliculata* Leach, 1815; western European species].

Processa sp.? — Méndez 1981: 98, fig. 294.

Processa peruviana Wicksten 1983b; 29, figs. 4–6. — Montagne & Cadien 2001: 202. — Wicksten & Hendrickx 2003: 68.

Diagnosis. Rostrum simple, slightly shorter than cornea. Carapace with antennal tooth. First segment of antennular peduncle exceeding setose, setose, without ventral tooth. Stylocerite very short, not reaching half of length of first segment. Scaphocerite elongate, exceeding both antennular, antennal peduncles, with small anterolateral tooth. Third maxilliped with exopod. Right pereopod 1 chelate, left pereopod 1 with simple, hooked dactyl. Left pereopod 2 shorter than right, with 21 to 22 carpal articles. Right pereopod 2 elongate, about equal in length to entire body, with 49–55 carpal articles. Pereopods 3–5 long, slender, with simple dactyls. Male to 23.0 mm, female to 41.7 mm.

Color in life. Not reported.

Habitat and depth. Sand or mud, 31–107 m.

Range. Off Palos Verdes Peninsula, California to north of Mancora, Peru including Galapagos Is. Type locality Manuelita Is., Costa Rica.

Remarks. Manning & Chace (1971) clarified the nomenclature of western Atlantic species of the genus *Processa*, including comparisons of *P. canaliculata* to American species. *Processa peruviana* differs from the European species in the numbers of carpal articles of the right second pereopod and having a tooth on the lobe of abdominal somite 6. Both Rathbun (1904) and Schmitt (1921) included both *A. panamensis* and *P. peruviana* in their accounts as *P. canaliculata*.

Montagne & Cadien (2001: 202) noted that the specimens of *P. peruviana* from California were gravid, but that "no juveniles have yet been taken in the area", suggesting the recruitment has been unsuccessful.

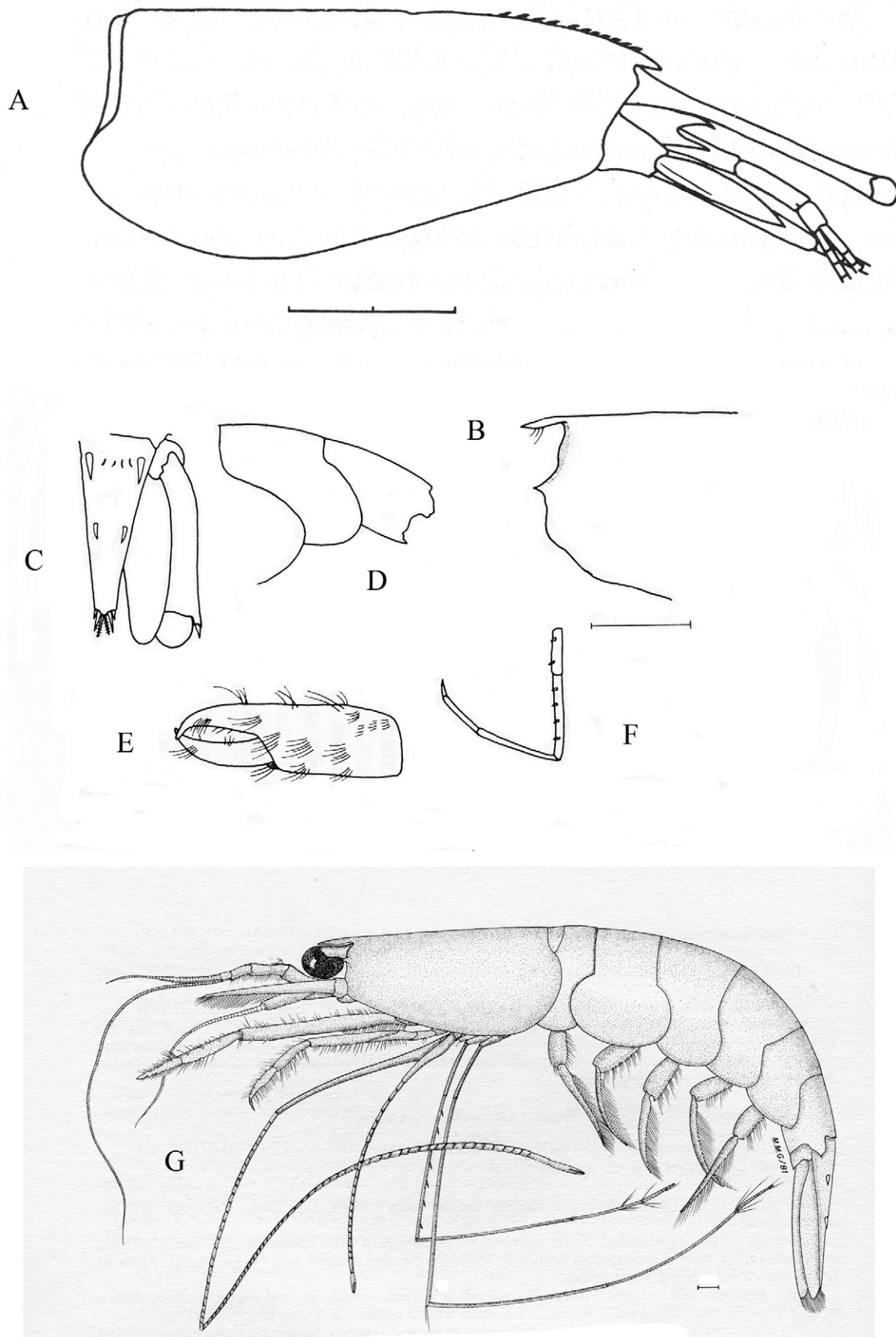


FIGURE 24. Families Ogyrididae and Processidae. A. *Ogyrides alphaerostris* (Kingsley, 1880); carapace and frontal region in lateral view. B–E, *Ambidexter panamensis* Abele, 1972; B, anterior portion of carapace; C, tail fan; D, posterior abdominal somites; E, detail of chela of pereopod 1; F, pereopod 3. G, *Processa peruviana* Wicksten, 1983. Scales: B, G = 1 mm, A = 2 mm. A from Williams 1984, B–F from Abele 1972, G from Wicksten 1983b.

SUPERFAMILY PANDALOIDEA Haworth, 1825

Family Pandalidae Haworth, 1825

Pandalids, known as coon-striped shrimps, spot prawns, or Pacific pink shrimps, are among the largest carideans of California. Many species are common offshore on muddy bottoms, but *Pandalus danae* can occur at the lowest intertidal zone of bays and rocky coasts from Marin County, California northward. Species of *Pandalus* are well represented in the northeastern Pacific, but do not extend south of Magdalena Bay, Baja California (Wicksten 1989b).

Pandalids have a long, slender, laterally compressed rostrum armed with teeth or spines. The first pereopod is slender and simple or microscopically chelate, which distinguishes them from the Thoridae, in which the first pereopod is robustly chelate. As in the Thoridae, the second pereopod is slender and has numerous carpal articles. The outer margin of the outer uropod has two distal spines. Many species are striped or spotted with red and white, or are colored uniformly scarlet. Many species of pandalids are protandrous hermaphrodites, in which the male is smaller and has subchelate third pereopods and a proportionally more slender rostrum than the female.

Pantomus affinis Chace, 1937, usually found from southern Baja California to Peru, has been reported from southern California during El Niño events (Montagne & Cadien 2001). It does not seem to be able to reproduce and establish a resident population in the area. It can be distinguished from all other pandalids in the area by having a hinge at the base of the rostrum. Three additional pandalids, *Plesionika beebei* Chace, 1937, *P. carinirostris* Hendrickx, 1990 and *P. trispinus* Squires & Barragán, 1976, were collected off the Palos Verdes Peninsula and Newport Bay, California during an extreme El Niño period in 1997–1999 but have not been collected since then (Montagne & Cadien 2001).

Key to species of family Pandalidae

1. Antennules twice length of carapace. Merus of third maxillipeds, ischium of first pereopods with laminate expansion fringed with long hairs 2
- Antennules not longer than carapace. Merus of third maxillipeds, ischium of first pereopods without laminate expansion fringed with long hairs 3
2. Rostrum without teeth on distal half of rostrum. Occurs from Washington state south *Pandalopsis ampla*
- Rostrum with teeth on distal half of rostrum. Occurs from Bering Sea to Oregon *Pandalopsis dispar*
3. Third maxilliped with exopod. Known only from south of Point Conception 4
- Third maxilliped without exopod. North or south of Point Conception 5
4. Rostrum with only two small basal dorsal spines, second pereopods equal, with 15–18 carpal articles. Pelagic at 500–4000 m. *Plesionika sanctaecatalinae*
- Rostrum with 4 dorsal teeth and 5–6 dorsal spines, second pereopods very unequal in length, with about 100 left and 20 right carpal articles. Benthic, 55–258 m *Plesionika mexicana*
5. Dorsal spines reaching behind middle of carapace. Intertidal zone to continental shelf 6
- Dorsal spines not reaching behind middle of carapace. Subtidal areas to continental slopes 7
6. Scaphocerite of moderate width. No patch of pubescence on carapace, rostrum usually with trifid apex *Pandalus danae*
- Scaphocerite narrow. Patch of pubescence on carapace, rostrum usually with bifid apex *Pandalus stenolepis*
7. Abdominal somite 6 about 1.5 times as long as wide. Carapace pubescent. With horizontal white stripes on carapace in life *Pandalus platyceros*
- Abdominal somite 6 about 3 times as long as wide. Carapace smooth and shining. Without horizontal white stripes on carapace in life 8
8. Rostrum with spines on distal half of superior margin *Pandalus jordani*
- Rostrum without spines on distal half of superior margin *Pandalus tridens*

Pandalopsis Bate, 1888

Pandalopsis ampla Bate, 1888

(Fig. 25A)

Pandalopsis amplus Bate, 1888: 671, pl. 175, fig. 3.

Pandalopsis ampla. — Faxon 1895: 155. — Rathbun 1904: 51. — Schmitt 1921: 46, pl. 14, fig. 2. — Zarenkov 1960: 345. —

Word & Charwat 1976: 177. — Wicksten 1982b: 245; 1987: 54; 1989b: 313. — Takeda & Hatanaka 1984: 10. — Hendrickx & Wicksten 1989: 82, fig. 10. — Komai 1994: 556.

Pandalus amplus. — Wicksten & Hendrickx 2003: 69.

Diagnosis. Rostrum as long as carapace, curved upward, with 7–14 dorsal spines, teeth between middle of carapace and midpoint of rostrum; 13 ventral teeth, apex with 1–3 small teeth. Eye pigmented. Carapace with antennal, pterygostomial teeth; surface punctate. Antennules twice length of carapace. Scaphocerite with blade nearly as long as carapace, blade broadly rounded and exceeding lateral tooth. Third maxilliped without exopod, with epipod, broad laminate expansion on ischium. Pereopod 1 short, with broad laminate expansion on ischium. Pereopods 2 equal or subequal, carpus with 20–24 articles. Pereopods 3–5 long and slender, with slender spinulose dactyls, 1 or 2 carpal spines, 5 or 6 meral spines. Abdominal somite 3 with posterior dorsal lobe. Abdominal somite 6, 1.5 times as long as wide. Total length to 165 mm.

Color in life. Bright red.

Habitat and depth. Offshore mud and sand, 550–2000 m.

Range. Washington State to Acapulco; Gulf of California, southeastern Atlantic. Type locality off Montevideo, Uruguay.

Remarks. Christoffersen (1989) synonymized *Pandalopsis* with *Pandalus* Leach, 1814; but Komai (1994) rejected this synonymy because it was based on larval features. Because *P. ampla* has been reported in widely separated localities, Komai (1994) suggested that this might actually be a species complex.

***Pandalopsis dispar* Rathbun, 1902**

(Fig. 25B)

Pandalopsis dispar Rathbun, 1902: 902; 1904: 54, pl. 1, fig. 2. — Kozloff 1974: 163. — Butler 1980: 124. — Wicksten 1989b: 313. — Jensen 1995: 53, fig. 97. — Ivanov & Sokolov: 165.

Diagnosis. Rostrum long, arched over eye, with 13–18 dorsal teeth, 2 or 3 spines, 9–15 ventral teeth. Eye large, pigmented. Carapace with strong antennal, moderate pterygostomial teeth. Antennular peduncle short, stylocerite short, flat; outer flagellum longer than body. Scaphocerite much longer than antennular peduncle, blade longer than lateral tooth; length of antennal flagellum 1.5 times as long as body length. Third maxilliped with antepenultimate segment with broad lamella, distal 2 segments slender, epipod present. Pereopods 1–4 with epipods. Pereopod 1 shorter than third maxilliped, ischium with broad lamella, dactyl with rounded apex. Pereopod 2 long, slender, with 26–33 carpal articles, chelate. Pereopods 3–5 slender, with simple dactyls; pereopod 3 with 0–1 spine on ischium, 7–9 outer, 3–5 inner meral spines; 2–3 carpal spines; pereopod 4 with 0–1 spine on ischium, 8–9 outer, 1–3 inner meral spines; 1–3 carpal spines; pereopod 5 without spine on ischium, 8–9 outer, 1–3 inner meral spines; 1–3 carpal spines. Posterior margin of abdominal somite 3 projecting over somite 4, pleura of somites 1–3 rounded, 4–5 with distolateral points, small spinule at midlateral posterior border of somites 4–5, somite 6 with posterolateral point. Telson narrow, 5–7 pairs dorsolateral spines, apex acute. Outer uropod longer than telson. Male total length 182 mm, female 208 mm.

Color in life. Reddish orange, broken white bars on abdominal somites, posterior half of carapace; pereopods 3–5 with red, white bars (Butler 1980 color plate 8D).

Habitat and depth. Continental shelf and upper slope, 46–649 m.

Range. Western Bering Sea, Pribilof Is. to Manhattan Beach, Oregon. Type locality Chernofski Harbor, Unalaska I.

***Pandalus* Leach, 1814**

***Pandalus danae* Stimpson, 1857**

(Fig. 25C–E, Pl. 4 C)

Pandalus danae Stimpson, 1857a: 87. — Holmes 1900: 209, pl. 4, figs. 61–62. — Rathbun 1904: 47, fig. 13. — Schmitt 1921:

44, fig. 25, pl. 13, fig. 3. — Johnson & Snook 1927: 302, fig. 257 a, c. — MacGinitie & MacGinitie 1968: 272. — Kozloff 1974: 163. — Word & Charwat 1976: 179. — Butler 1980: 147, pl. 4A. — Ricketts *et al.* 1985: 352. — Jensen & Armstrong 1987: 216. — Wicksten 1991: 812. — Jensen 1995: 53, fig. 98. — Kuris *et al.* 2007: 637.

Pandalus gurneyi Stimpson, 1871: 128. — Rathbun 1904: 50. — Schmitt 1921: 46, pl. 13, fig. 1. — Johnson & Snook 1927: 303, fig. 257b. — Word & Charwat 1976: 181. — Hendrickx & Wicksten 1989: 83, fig. 8C, D.

Pandalus franciscorum Kingsley, 1878b: 94.

Diagnosis. Rostrum 1.0–1.6 times as long as carapace, nearly straight to sharply upcurved, with 10–15 dorsal teeth, spines; 6–12 ventral teeth, apex trifid. Eye large. Stylocerite of first antennae short, flagella shorter than carapace. Scaphocerite narrow, lateral tooth exceeding blade, flagellum about equal to body length. Carapace with antennal, pterygostomial teeth. Third maxilliped without exopod but with epipod. Pereopods 1–4 with epipods. Pereopod 1 slender, chelate; ischium with slight lamina. Pereopods 2 unequal, left with about 60 carpal articles, right with 18–21 articles, epipods on pereopods 1–4. Pereopods 3–5 slender, margins spinulose, with 6–9 meral spines. Dorsal posterior margin of abdominal somite 3 slightly produced. Pleuron of somite 4 with weak posterolateral point, pleuron of somite 5 with strong posterolateral point. Somite 6 shorter than telson. Telson with 5 or 6 pairs dorsolateral spines, 2 pair terminal spines. Male total length to 123 mm, female to 140 mm.

Color in life. Background translucent, marked with irregular striping, spots of brick red or chocolate brown, with fine brick-red dots between stripes. Fine blue spots on cardiac region of carapace. Antennae and appendages marked with striking bands of white, yellow, red or brown (Butler 1980, color plate 4A; Wicksten 1991).

Habitat and depth. Sea grass beds, rocky reefs, mixed shell, sand; lowest intertidal zone to 185 m.

Range. Black Hills, north side of Alaskan Peninsula, Alaska to San Quintin Bay, Baja California. Type locality Puget Sound.

Remarks. These shrimp often are seen in cracks or near rocks during the day, where they may rest upside down. The long, banded antennae are conspicuous. These shrimp will pick at a diver's equipment or even a gloved hand, but do not show any obvious quivering of the antennae or waving the body, as is seen in tropical cleaner shrimps of the genus *Lysmata* (Wicksten 2009).

Confusion remains as to whether or not *P. danae* and *P. gurneyi* are separate species.

***Pandalus jordani* Rathbun, 1902**

(Fig. 25 F)

Pandalus jordani Rathbun, 1902a: 900; 1904: 40. — Schmitt 1921: 41, pl. 14, fig. 1. — Kozloff 1974: 163. — Word & Charwat 1976: 183. — Butler 1980: 133, pl. 4D. — Wicksten 1989b: 313.

Diagnosis. Body slender, surface smooth. Rostrum as long as carapace, with 4–17 dorsal spines, teeth; 7–10 ventral teeth, apex acute or bifid. Eye large. Stylocerite of first antennae short, both flagella longer than carapace. Length of scaphocerite of second antenna about half length of rostrum length, lateral tooth, blade equal; basicerite with moderate upper lateral, strong lower spines, flagellum longer than body. Third maxilliped with antepenultimate segment having slight lamina, epipod present. Pereopods 1–4 with epipods. Pereopod 1 slender, proximal end of merus with slight lamina. Pereopods 2 unequal, left longer, with 58–62 articles; right shorter, with 19–22 articles. Pereopods 3–5 slender, with slender dactyls bearing 4–7 spinules, propodus with 8–23 spinules, carpus with 2 or 3 spines, merus with 7–11 spines, ischium with 0 or 1 spine, decreasing in number from pereopod 3–5. Abdominal somite 3 with dorsal posterior part compressed, with carina. Posterolateral margin of pleuron 4 with moderate ventral point, pleuron of somite 5 with strong posterolateral point. Somite 6 shorter than telson. Telson with 8–13 pairs dorsolateral spines, 3 pairs distal spines. Male total length to 125 mm, female to 175 mm.

Color in life. Fine red dots on translucent grayish background. Proximal part of antennal flagellum pale pink (Butler 1980).

Habitat and depth. Offshore green mud or mixed sand, 36–457 m.

Range. Iliuliuk Harbor, Unalaska I. to San Nicolas I., California. Type locality off Santa Cruz I., California.

Remarks. *Pandalus jordani* is fished from Vancouver I. to Morro Bay, California, but the highest population density is off central Oregon. Catches are highest at 110–183 m.

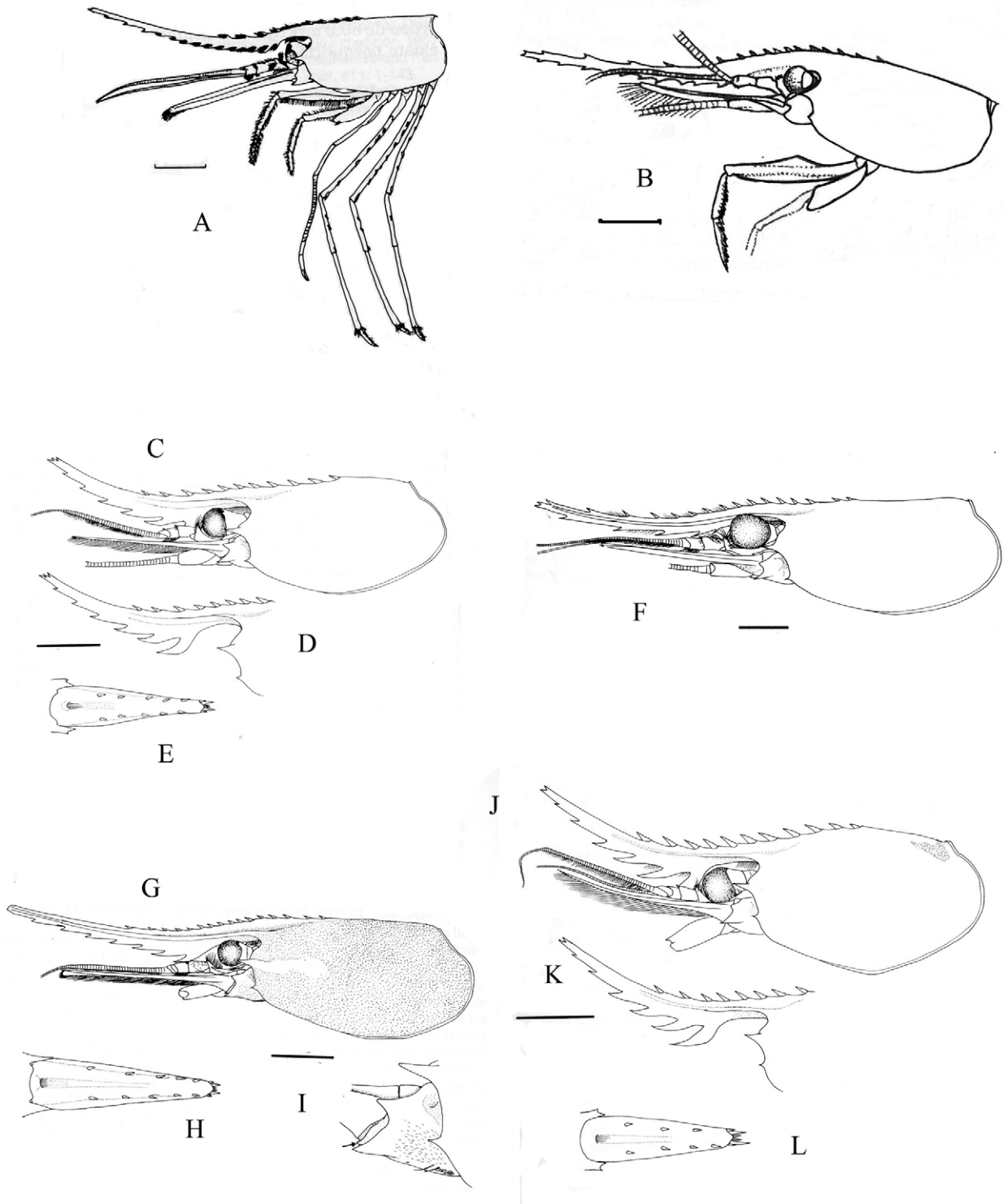


FIGURE 25. Family Pandalidae. A, *Pandalopsis ampla* Bate, 1888; front half of animal in lateral view. B, *Pandalopsis dispar* Rathbun, 1902; carapace, frontal region and frontal appendages in lateral view. C–E, *Pandalus danae* Stimson, 1857; C, carapace and frontal region in lateral view; D, rostrum; E, telson. F, *Pandalus jordani* Rathbun, 1902; carapace and frontal region in lateral view. G–I, *Pandalus platyceros* Brandt, 1851; G, carapace and frontal region in lateral view; H, telson; I, detail of basicerite. J–L, *Pandalus stenolepis* Rathbun, 1902; J, carapace and frontal region in lateral view; K, rostrum; L, telson. Scales: C, D, J, K = 5 mm, A, B, D, F, G = 10 mm. A from Hendrickx & Wicksten 1989, B after Butler 1980, C–L from Komai 1999.

***Pandalus platyceros* Brandt, 1851**

(Fig. 25G–I, Pl. 4D)

Pandalus platyceros Brandt, 1851: 123. — Holmes 1900: 210. — Rathbun 1904: 44. — Schmitt 1921: 43, pl. 14, fig. 3. — Kozloff 1974: 163. — Word & Charwat 1976: 187. — Butler 1980: 139, pl. 2A. — Wicksten 1980c: 364; 1989b: 313. — Jensen 1995: 55, fig. 102.

Pandalus pubescentulus Dana, 1852: 24. — Stimpson 1857b: 501. — Kingsley 1878b: 63.

Diagnosis. Body stout, carapace pubescent. Length of rostrum 1.2–2.0 times carapace length, with 4–17 dorsal spines, teeth; 6–8 ventral rostral teeth, usually one tooth dorsal, proximal to rostral apex. Carapace with antennal, pterygostomian teeth. Eye large. First antenna with short stylocerite, inner flagellum longer than outer, both longer than carapace. Length of scaphocerite slightly longer than 0.5 times rostrum length, spine slightly exceeding blade, basicerite with moderate upper lateral spine, strong lower spine, flagellum equaling or exceeding body length. Third maxilliped stout, antepenultimate segment with slight lamina, epipod present. Pereopods 1–4 with epipods. Pereopod 1 with minute chela, ischium with slight lamella. Pereopods 2 chelate, left longer than right, left with 27–31 articles, right with 8 or 9 articles. Pereopods 3–5 with dactyls having 4–7 spinules, propodus with 8–23 spinules, carpus with 3 spines, merus with 7–11 spines, ischium with one spine. Dorsal posterior margin of abdominal somite 3 slightly produced. Pleuron of abdominal somite 4 with strong ventral point, pleuron of somite 5 with strong posterolateral point. Somite 6 shorter than telson. Telson with 4–6 pairs dorsolateral spines. Male total length to 230 mm, female to 253 mm.

Color in life. Dull red to fawn or tan, with 3 or 4 lateral white stripes on carapace. Pair of conspicuous white spots on dorsolateral surface of abdominal somites 1, 5. Third maxillipeds, pereopods, antennal flagella banded with red, white. Juveniles camouflaged with brown, green or red color similar to algae, eelgrass (Butler 1980).

Habitat and depth. Juveniles usually shallower than adults, among sea grasses or algae, adults usually among rocks or on steep slopes, intertidal zone to 487 m.

Range. Unalaska I. to off San Diego; Sea of Japan north along Asiatic Pacific coast. Type locality Unalaska I.

Remarks. Observations off British Columbia suggest that the shrimp are primarily nocturnal, and may move into shallower waters during the night (Butler 1980). Records from California usually come from deeper subtidal waters, often at the shelf break (about 185 m).

***Pandalus stenolepis* Rathbun, 1902**

(Fig. 25J–L)

Pandalus stenolepis Rathbun, 1902a: 901; 1904: 49, fig. 14. — Johnson & Snook 1927: 303, fig. 257c. — Kozloff 1974: 163. — Butler 1980: 145, pl. 2C. — Wicksten 1989b: 313. — Jensen 1995: 55, fig. 103.

Diagnosis. Body stout. Rostrum with distal 0.66 ascending sharply, 8–12 dorsal teeth, spines; 5–7 ventral teeth, apex bifid. Carapace with strong antennal, moderate to weak pterygostomian teeth, patch of pubescence on cardiac region. Eyes large, cornea almost spherical. Antennular peduncle short, stylocerite short, round. Scaphocerite narrow, lateral tooth exceeding blade, peduncle short. Third maxilliped moderately stout, antepenultimate segment with slight lamina, epipod present. Pereopods 1–4 with epipods. Pereopod 1 slender, ischium with slight lamina. Pereopod 2 chelate, left leg longer, more slender than right, carpus with about 50 articles; carpus of right leg with 10–13 articles. Pereopod 3 moderately stout, with 0 or 1 ischial spines, merus with 5–7 spines, carpus with 1 or 2 spines, propodus with 18–22 spinules, dactyl stout, spinose. Pereopod 4 about as stout as third pereopod, with 1 ischial spine, 5–7 meral spines, carpus with 1–2 spines, propodus with 14–18 spinules, stout dactyl. Pereopod 5 with 0 or 1 meral spine, merus with 3–5 spines, carpus with 2 spines, propodus with 15–23 spinules, stout dactyl. Abdominal somite 2 with distinct transverse dorsal sulcus, somite 3 with dorsal posterior margin moderately produced. Pleuron of somite 4 with weak ventral point, somite 5 with strong posterolateral point, somite 6 with moderate posteroventral point. Telson moderately wide, tapering to blunt apex, with 4–5 pairs dorsolateral spines. Male total length about 76 mm, female 82 mm.

Color in life. Grayish to whitish, with patches of red on carapace, abdomen, appendages; blue dots on abdominal somites.

Habitat and depth. Muddy bottoms, 49–229 m.

Range. Unalaska I. to Hecata Bank, Oregon. Type locality Strait of Juan de Fuca.

***Pandalus tridens* Rathbun, 1902**

(Fig. 26B–D)

Pandalus montagui tridens Rathbun, 1902a: 901; 1904: 41. — Schmitt 1921: 42, pl. 13, fig. 2. — Kozloff 1974: 163. — Word & Charwat 1976: 185.

Pandalus tridens. — Butler 1980: 137, pl. 8B (extensive discussion of nomenclature). — Wicksten 1989b: 313. — Jensen 1995: 55, fig. 104.

Diagnosis. Body moderately stout, shell thin, surface smooth. Length of rostrum 1.3–1.8 times carapace length, distal half slightly ascending, with 9–13 dorsal spines, teeth; 6–8 ventral teeth; no dorsal teeth on distal half, apex bifid or trifid. Carapace with pterygostomian, antennal teeth. Eyes large. First antenna with short stylocerite, length of flagella extending beyond rostrum by about 0.3 times their lengths. Second antenna with scaphocerite reaching middle of rostrum, scaphocerite narrow with lateral tooth slightly exceeding blade, basicerite with weak lower tooth, flagellum longer than body. Third maxilliped with slight lamina on antepenultimate segment, epipod present. Pereopods 1–4 with epipods. Pereopod 1 chelate. Pereopods 2 unequal, left longer with about 74 carpal articles; right shorter with 20–28 articles. Pereopods 3–5 with 5–7 spinules on dactyl, propodus with 15–32 spinules, carpus with 2–4 spines, merus with 4–7 spines, ischium with 0–1 spine, decreasing in number from pereopod 3–5. Posterior margin of abdominal somite 3 with moderate projection. Pleuron of somite 4 with weak ventral point, posterolateral margin of somite 5 with strong point. Somite 6 shorter than telson. Telson with 5 pair dorsolateral spines. Male total length to 83 mm, female to 123 mm.

Color in life. Fine red dots over translucent background. Red blotches, bands on pereopods, yellow blotches on pereopods 3–5, third maxilliped with yellow apex. Antennal flagellum with alternate red, transparent bands, flagella of first antenna with red, white bands (Butler 1980, color plate 8B).

Habitat and depth. Rocky areas, 5–1984 m.

Range. Cape Oyutorsky, Pribilof Is. to San Nicolas I., California, but few records south of Washington state. Type locality off North Head, Akutan I., Alaska.

Remarks. *Pandalus tridens* has been caught commercially off British Columbia. It has been reported southwest of the Colombia River (McCauley 1972, as *P. montagui tridens*) and off Point Arena and San Nicolas I. in California (Schmitt 1921). Most recent records are from Puget Sound northward.

***Plesionika* Bate, 1888**

***Plesionika mexicana* Chace, 1937**

(Fig. 26E, F)

Plesionika mexicana Chace, 1937: 112, fig.1. — Wicksten 1978b: 85; 1983b: 21. — Méndez 1981: 103, figs. 314–315. — Hendrickx & Wicksten 1989: 78, fig. 6. — Wicksten & Hendrickx 2003: 69.

Diagnosis. Rostrum twice as long as carapace, slightly ascending. Five spines at base of rostrum, 4 or 5 teeth on dorsal surface of rostrum proper; apex trifid; 10–14 ventral teeth. Eye large and globular. Stylocerite of first antennae slightly exceeding first segment. Length of flagella of first antennae about 1.5 times length of rostrum. Scaphocerite narrow, exceeded bilateral tooth. Length of antennal flagella about twice body length. Third maxillipeds with exopods. Pereopod 1 microscopically chelate. Pereopods 2 unequal, right shorter, with 20 carpal articles; left longer than rostrum, with about 100 carpal articles. Posterior pereopods long, slender, with simple dactyls and 5 or 6 meral spines. Abdomen smooth, without carina. Pleura of somites rounded except for points on posterolateral angles of somites 4, 5. Length of somite 6, 1.6 times as long as length of somite 5. Telson with 3 pairs dorsolateral, 3 pairs terminal spines. Total length 50–60 mm.

Color in life. Translucent white with short scarlet longitudinal stripes. Antennae, pereopods barred with scarlet, white. Eyes greenish (Chace 1937).

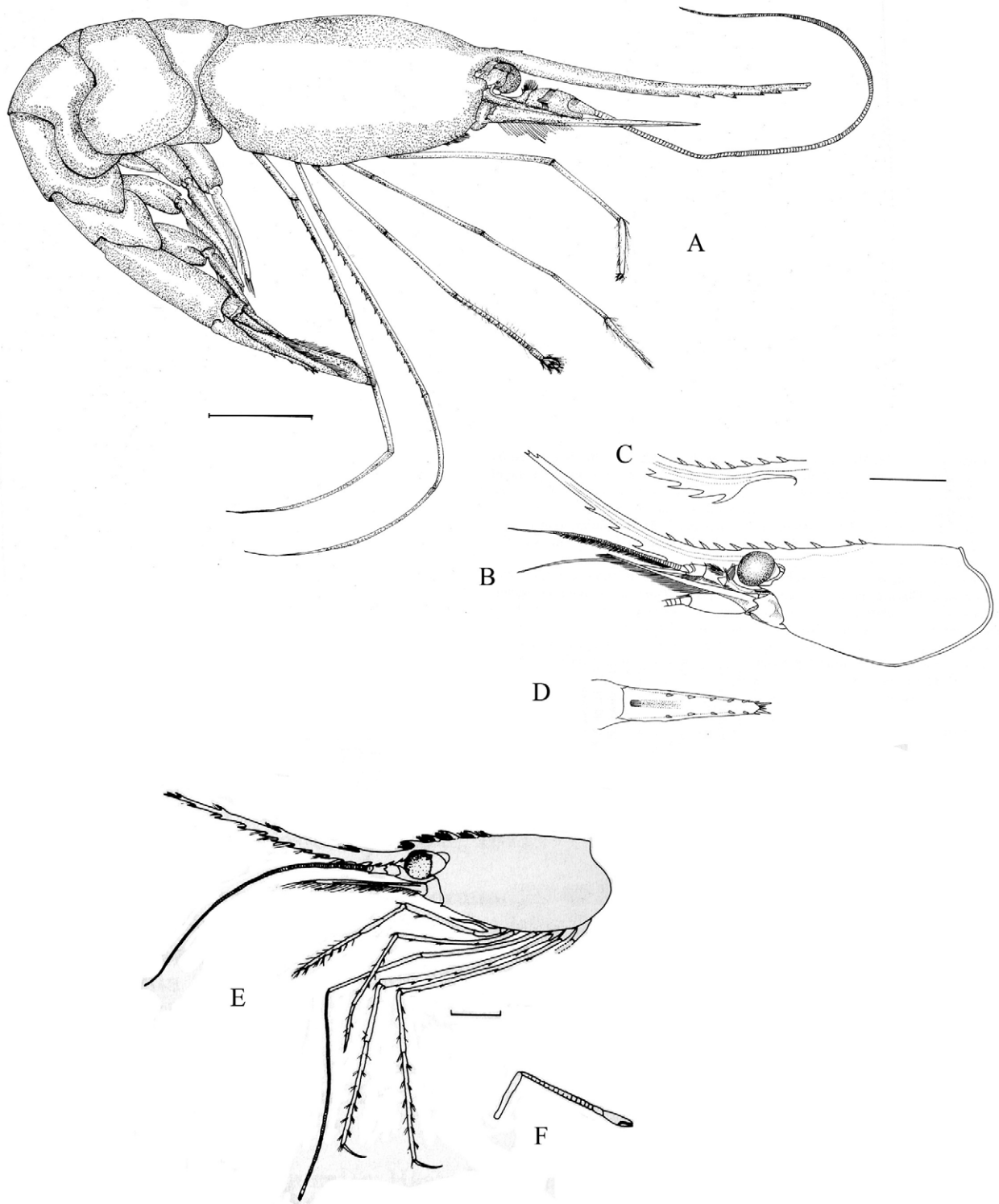


FIGURE 26. Family Pandalidae. A, *Plesionika sanctaecatalinae* Wicksten, 1983. B–D, *Pandalus tridens* Rathbun, 1902; B, carapace and frontal region in lateral view; C, detail of rostrum; D, telson. E, F, *Plesionika mexicana* Chace, 1937; E, anterior half in lateral view; F, pereopod 2. Scales: E = 2 mm. A = 5 mm, C, B = 10 mm. A, E, F from Hendrickx & Wicksten 1989, B–D from Komai 1999.

Habitat and depth. Mud, sand or shell bottoms, 4–258 m but usually at 50–150 m.

Range. Redondo Beach, California to Mancora Bank, Peru, but usually from Gulf of California southward. Type locality Arena Bank, off Baja California, Mexico.

***Plesionika sanctaecatalinae* Wicksten, 1983**

(Fig. 26A)

Plesionika sp.— Ebeling *et al.* 1970: 12.

Plesionika martia semilaevis Wicksten 1978b: 85, fig. 1. — Méndez 1981: 104, pl. 18, figs. 316–317 [not *Plesionika semilaevis* Bate, 1888, Indo-West Pacific species].

Plesionika sanctaecatalinae Wicksten, 1983: 138, figs. 1–3; 2003: 137. — Hendrickx & Wicksten 1989: 80, fig. 7. — Hendrickx & Estrada-Navarrete 1996: 133, fig. 82.

Diagnosis. Rostrum long, thin, exceeding scaphocerite, with 2 minute dorsal spines, 8–12 ventral teeth. One–3 tiny spinules on dorsal midline of carapace posterior to rostrum. Dorsal midline slightly convex posterior to rostrum for about half of carapace length. Carapace with small antennal, branchiostegal teeth and minute punctae. Eyes large, cornea not reaching end of first segment of antennular peduncle. First segment of antennular peduncle longest. Stylocerite longer than cornea of eye. Flagella long, slender. Second antennae with scaphocerite 6.5 times as long as wide, lateral tooth exceeding blade. Basicerite with sharp point on lateral margin, carapocerite reaching first segment of antennular peduncle. Third maxilliped with exopod, epipod. Pereopods 1, 2 with epipods. Pereopod 1 minutely chelate. Pereopods 2 about equal in length, with 15–18 carpal articles. Pereopods 3–5 long, thread-like. Merus of pereopod 3, with 10–14 spines; merus of pereopod 4, with 6–11 spines; merus of pereopod 5, with 4–7 spines. Abdomen lightly punctate. Posterior margin of somite 3 overhanging somite 4. Pleura of somites 1, 2 rounded, pleuron of somite 3 subquadrate, pleura of somites 4, 5 narrowly rounded. Length of somite 6 about twice length of somite 5. Telson shorter than somite 6, with 3 pairs small dorsolateral spines, 2 pairs terminal spines. Total length 70–75 mm.

Color in life. Scarlet.

Habitat and depth. Pelagic, 500–4000 m.

Range. Santa Barbara I., California to Peru. Type locality off Santa Catalina I., California.

SUPERFAMILY CRANGONOIDEA Haworth, 1825

Family Crangonidae Haworth, 1825

Sand shrimps, family Crangonidae, have subchelate first pereopods: the finger of the chela closes obliquely or horizontally across the distal end of the propodus, like the blade of a pocketknife. The rostrum usually is small and without teeth or absent except in *Paracrangon echinata*. The second pereopod, if present, is slender and equal on both sides, with an unsegmented carpus. The body is depressed or squat. Often, ovigerous females have a broader body than males. In species of *Crangon*, teeth may be present on the ventral midline of the abdominal somites. The endopod of the pleopods is short, especially on pleopods 2–5.

The nomenclature of the crangonids has undergone revision in recent years, and specialists still disagree over generic and subgeneric classification (Zarenkov 1965, Christofferson 1988b). Schmitt (1921) used the generic name *Crago* for many species, and applied the name *Crangon* to species of snapping shrimp, now called *Alpheus*. The sand shrimps officially were named *Crangon* by a ruling of the International Commission on Zoological Nomenclature (1955–56). Revisions by Zarenkov (1965), Kuris & Carlton (1977) and Christofferson (1988b) changed additional designations.

The North Pacific is rich in crangonid shrimp. Species of *Mesocrangon* and *Lissocrangon* are confined to the North Pacific. Species of *Argis*, *Crangon*, *Metacrangon* and *Neocrangon* are more common in the North Pacific than anywhere else. Except for *Pontophilus gracilis occidentalis*, a subspecies of a cosmopolitan species, crangonids of the northeastern Pacific belong to genera that occur for the most part in the Pacific, Arctic or North Atlantic.

Species of *Crangon*, *Mesocrangon*, *Lissocrangon*, and *Neocrangon* are mostly benthic and able to dig into sand. Many remain hidden except for the eye, antennae and a respiratory channel. Most are dull-colored or camouflaged by chromatophores. They feed on smaller invertebrates. A parasitic isopod, *Argeia pugettensis* Dana, 1853 forms a bulge in the carapace next to the branchial chamber. Many demersal fishes, crabs, and harbor seals eat sand shrimps.

In using the key, best results will be obtained with fresh specimens. Diagnostic color marks usually fade in alcohol. In older preserved specimens, dorsal faint carinae and ventral sulci often are difficult to see. Pubescence is rubbed off in trawled material. The diagnoses for the most part follow Butler (1980).

Key to species of family Crangonidae

1. Pereopod 2 absent, rostrum elevated, with 4 teeth *Paracrangon echinata*
 – Pereopod 2 present although sometimes very short 2
2. Pereopod 2 much shorter than other pereopods, eye nearly without pigment *Pontophilus gracilis occidentalis*
 – Pereopod 2 subequal in length to other pereopods, eye with obvious pigment 3
3. Dactyls of pereopods 4, 5 flattened, eye partially concealed by dorsal frontal margin of carapace 4
 – Dactyls of pereopods 4, 5 normal, stout to slender; eye not partially concealed by dorsal frontal margin of carapace 5
4. Carapace with 2 median teeth behind anterior margin, abdominal somites 1, 2 not carinated. South of Point Conception, California *Argis californiensis*
 – Carapace with 3–4 median teeth behind anterior margin, abdominal somites 1–4 not carinated. Shelter Cove, California northward *Argis levior*
5. Carapace with 3–4 median dorsal teeth, pleura of abdominal somites 2–5 with posteroventral spines, exoskeleton heavily sculptured *Rhynocrangon alata*
 – Carapace with 0–2 median dorsal teeth, pleura of abdominal somites 5 or 6 only with posteroventral teeth if present, exoskeleton smooth or lightly sculptured 6
6. Carapace with 2 median dorsal teeth 7
 – Carapace with 1 or no median dorsal teeth 15
7. Carapace without submedian teeth 8
 – Carapace with submedian teeth 10
8. Eye very large. Exoskeleton noticeably thin. Usually on lower continental shelf or deeper *Neocrangon abyssorum*
 – Eye of moderate size. Exoskeleton not noticeably thin. Usually on continental shelf 9
9. Abdominal somite 5 with broad dorsal carina *Neocrangon communis*
 – Abdominal somite 5 without broad dorsal carina *Neocrangon resima*
10. Second lateral carina of carapace armed with tooth slightly behind superior lateral tooth. Small, adults 25 mm or less in total length *Mesocrangon munitella*
 – Second lateral carina of carapace not armed with tooth slightly behind superior lateral tooth. Usually larger than 25 mm in total length 11
11. Abdominal somites 1–4 smooth 12
 – Abdominal somites 1–4 carinated 13
12. Anterior median tooth on carapace obliquely erect, larger than posterior, apex of former extending beyond orbital margin *Metacrangon acclivis*
 – Anterior median tooth on carapace not obliquely erect, not larger than posterior, apex of former well behind orbital margin *Metacrangon munita*
13. Abdominal somites 1–3 laterally unarmed *Metacrangon variabilis*
 – Abdominal somites 1–3 laterally armed 14
14. Abdominal pleura 1–3 armed laterally with one tooth each *Metacrangon procax*
 – Abdominal pleura 1–3 armed laterally with two teeth each *Metacrangon spinosissima*
15. Carapace without median dorsal tooth *Lissocrangon stylirostris*
 – Carapace with median dorsal tooth 16
16. Abdominal somite 6 with ventral sulcus 17
 – Abdominal somite 6 without ventral sulcus 21
17. Hand of pereopods 1 very slender, 4 times as long as wide, flexed dactylus almost longitudinal *Crangon franciscorum*
 – Hand of pereopod 1 not as slender, 3.5 times as long as wide or less, flexed dactylus not forming angle less than 45° with propodal margin 18
18. Abdominal somite 5 not carinate. Blade of scaphocerite with anterior margin more advanced at inner than at outer angle. Usually with large circular spot on abdominal somite 6 *Crangon nigromaculata*
 – Abdominal somite 5 carinate. Blade of scaphocerite with anterior margin more advanced at antero-internal angle. No large circular spot on abdominal somite 6 19
19. Scaphocerite broad, short, 0.5 times as long as carapace length or less, abdominal somite 5 with weak dorsal carina *Crangon handi*
 – Scaphocerite longer, more narrow, 0.66 times as long as carapace length or more, abdominal somite 5 with noticeable dorsal carina 20
20. Apex of scaphocerite narrow, lateral tooth long, exceeding blade, finger of hand at about 45° angle to hand *Crangon alaskensis*
 – Apex of scaphocerite broad, lateral tooth generally shorter, barely exceeding blade, finger of hand at about 30° angle to hand *Crangon nigricauda*
21. Hand of pereopod 1 stout, 2.25 times as long as wide, anterior margin more longitudinal than transverse. Antepenultimate seg-

- ment of third maxillipeds greatly dilated *Crangon alba*
- Hand of pereopod 1 elongate, 3 times as long as wide, anterior margin more longitudinal than transverse. Antepenultimate segment of third maxillipeds not dilated *Crangon holmesi*

***Argis* Kröyer, 1842**

***Argis californiensis* (Rathbun, 1902)**

(Fig. 27A)

Nectocrangon californiensis Rathbun 1902a: 24; 1904:140, figs. 80, 81. — Schmitt 1921: 102. — Zarenkov 1965: 1764.
Argis californiensis. — Wicksten 1976: 57; 1977a: 964, fig.1; 1980c: 363;: 313. — Word & Charwat 1976: 71.

Diagnosis. True rostrum absent, but rostral tooth adjacent to frontal margin. Carapace with 2 dorsal teeth posterior to rostral tooth, branchiostegal, pterygostomial teeth, hepatic tooth on each side. Eye small, partly concealed by hood formed by fusion of rostral, postorbital, antennal teeth. Antennular peduncle shorter than scaphocerite, stylocerite short. Scaphocerite with lateral tooth only slightly exceeding blade. Third maxilliped with distal segment flattened, with exopod. Pereopod 1 with dactylus closing obliquely against propodus. Pereopod 2 slender, chelate. Pereopod 3 slender with acute dactylus. Pereopods 4, 5 stout, dactyls flattened. Abdominal somites 1, 2 not carinated, somites 3, 4 feebly carinated, somite 5 strongly carinated, somite 6 with 2 carinae each ending in sharp tooth. Abdominal pleura 1–4 rounded, fifth pleuron pointed. Telson overreaching uropods, with 3 pairs dorsolateral spines, acute apex. Female with more inflated carapace and more elevated eye tubercle than male. Total length to 62 mm.

Color in life. Not reported.

Habitat and depth. Sand, rocks and shell, 20–259 m.

Range. Off Santa Rosa I., California to off Punta Banda, Baja California. Type locality off Santa Catalina I., California.

Remarks. Like other species of *Argis*, *A. californiensis* probably is a burrower that uses its flattened appendages to dig into the sand. These appendages are not "natatorial", as described by Schmitt (1921). The eyes remain above the surface of the sand, as is the case in many crangonids.

Although most records of this species come from the islands off southern California, *A. californiensis* also has been collected off Port Hueneme and San Diego. Its distribution may be governed by the availability of the coarse shelly sand in which it lives. A record of the species (as *Nectocrangon californiensis*) southwest of the Columbia River, Oregon (McCauley 1972) probably is due to a misidentification of another species of *Argis*.

***Argis levior* (Rathbun, 1902)**

(Fig. 27B)

Nectocrangon levior Rathbun, 1902a: 892; 1904: 143, figs. 86, 87. — Zarenkov 1965: 1764.
Argis levior. — Kozloff 1974: 164. — Wicksten 1976: 56, fig. 1.— Butler 1980: 89.

Diagnosis. Rostral tooth short. Carapace with 3 dorsal teeth posterior to rostral tooth, branchiostegal, pterygostomial teeth, hepatic tooth on each side. Eye small, partly concealed by hood. Antennular peduncle not as long as scaphocerite. Lateral tooth of scaphocerite slightly exceeding blade. Distal segment of third maxilliped flattened, with exopod. Pereopod 1 subchelate, dactylus closing obliquely against propodus. Pereopod 2 slender, chelate. Pereopod 3 slender, dactylus slender, acute. Pereopods 4, 5 stout, dactyls flattened. Abdominal somites 1–4 without carinae, somite 5 weakly carinate, somite 6 with 2 dorsal carinae; pleura rounded except for weak posterolateral point on fourth pleuron. Telson about as long as uropods, with 3 pairs dorsolateral spines, acute apex. Female total length 47 mm, male not reported.

Color in life. Not reported.

Habitat and depth. Sand, boulders and shell, 18–77 m.

Range. Aleutian Is. to Shelter Cove, Humboldt County, California. Type locality Admiralty Inlet, Puget Sound.

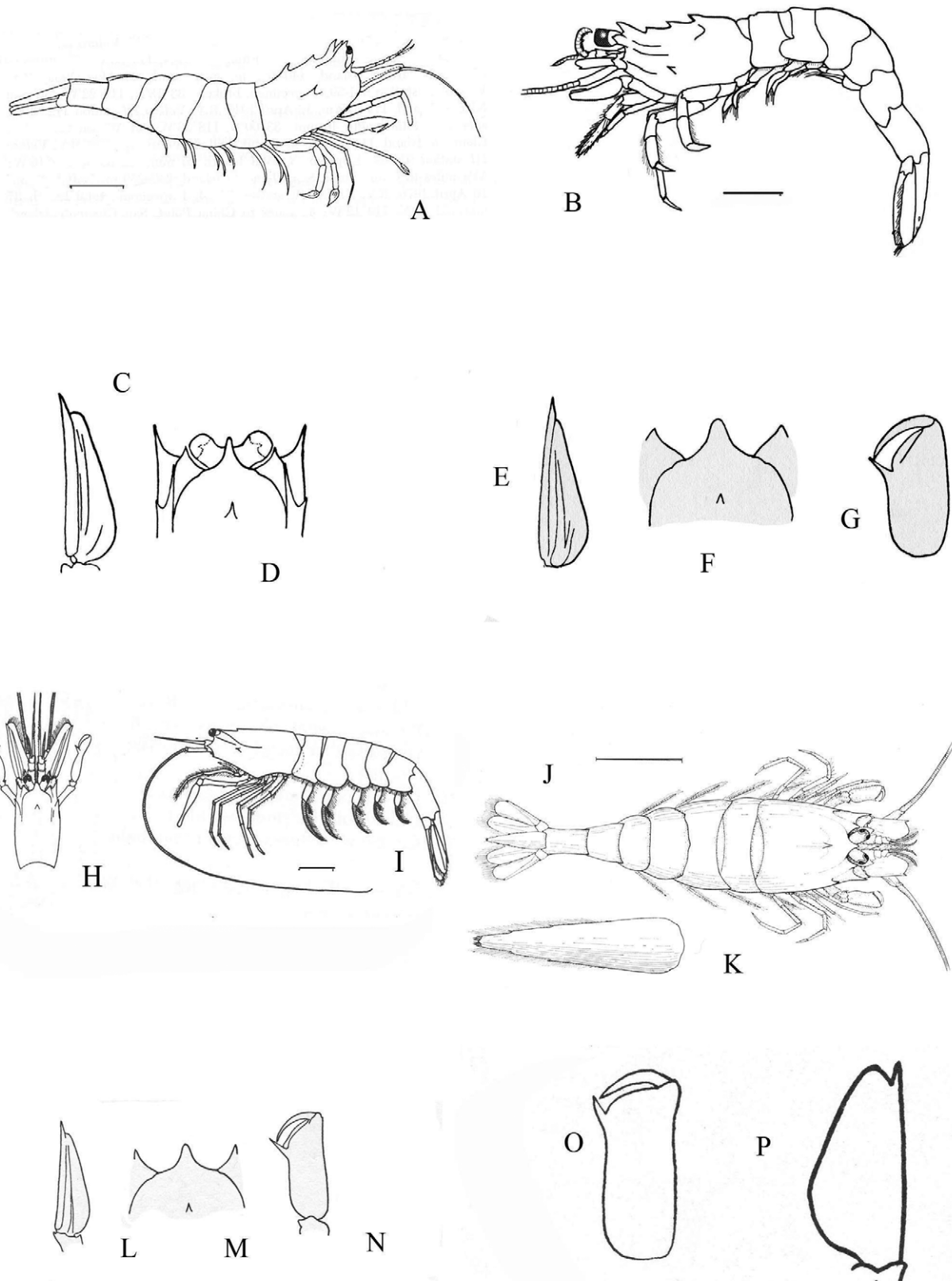


FIGURE 27. Family Crangonidae. A, *Argis californiensis* (Rathbun, 1902). B, *Argis levior* (Rathbun, 1902). C, D, *Crangon alaskensis* Lockington, 1877; C, scaphocerite; D, frontal region in dorsal view. E–G, *Crangon alba* Holmes, 1900; E, scaphocerite; F, front of carapace in dorsal view; G, subchela. H, I, *Crangon franciscorum* Stimpson, 1856; H, carapace, frontal region and first pereopods in dorsal view; I, lateral view. J, K, *Crangon handi* Kuris & Carlton, 1977; J, dorsal view; K, telson. L–N, *Crangon holmesi* Rathbun, 1902; L, scaphocerite; M, front of carapace; N, subchela. O, P, *Crangon nigricauda* Stimpson, 1856; O, subchela; P, scaphocerite. Scales A, B, I, J. = 10 mm. A from Wicksten 1977, B after Wicksten 1976, C–I, L–P from Schmitt 1921, J–K from Kuris & Carlton 1977.

Crangon Fabricius, 1798

***Crangon alaskensis* Lockington, 1877**

(Fig. 27C, D)

Crangon alaskensis Lockington, 1877a: 34. — Zarenkov 1965: 1763. — Kozloff 1974: 164. — Butler 1980: 108. — Carvacho & Olson 1984: 65. — Jensen 1995: 40, fig. 59. — Kuris *et al.* 2007: 636, pl. 319 F.

Crangon alaskensis elongata Rathbun 1902a: 888; 1904: 115, fig. 54.

Crango alaskensis elongata. — Schmitt 1921: 88, fig. 58. — Johnson & Snook 1927: 313. — Word & Charwat 1976: 73. — Wicksten 1980c: 362.

Crango alaskensis. — MacGinitie & MacGinitie 1968: 274.

Diagnosis. Exoskeleton thin and smooth. Rostrum reaching or exceeding cornea of eye, apex rounded. Carapace with 1 median dorsal tooth, also hepatic, branchiostegal teeth, moderate pterygostomian tooth. Eye pigmented. Stylocerite acute, about as long as first segment of antennular peduncle. Scaphocerite narrow, lateral tooth much longer than blade, blade tapering toward distal end. Third maxilliped setose, with exopod. Pereopod 1 with inner spine, strong distal spine on merus, propodus broad, dactyl closing obliquely against propodus. Pereopod 2 slender, chelate. Pereopod 3 slender, with simple dactyl. Pereopods 4, 5 longer and more robust than third, with simple dactyls. Pleura of abdominal somites rounded or blunt. Abdominal somite 6 with posterolateral tooth, ventral groove. Telson with 2 pairs dorsolateral spines, about as long as uropods. Male total length 52 mm, female 65 mm.

Color in life. Grayish brown with scattered black spots.

Habitat and depth. Fine sand, euryhaline, intertidal zone to 275 m but usually subtidal.

Range. Bering Sea to Todos Santos Bay, Baja California. Type locality Mutiny Bay, Alaska.

Remarks. Rathbun (1902) distinguished a southern form, *C. alaskensis elongata*, on the basis of having a longer rostrum and scaphocerite than specimens from Alaska. Considerable overlap has been noted in these characters among shrimps from British Columbia (Butler 1980). I examined 100 specimens from off San Diego, California. In these, shrimps with a carapace length of 7 mm or less often had a broader width/length ratio of the palm of the subchela, about 0.5 instead of 0.3. The rostrum in some of these smaller shrimps from off San Diego was short and broad, not reaching the end of the cornea of the eye. Regardless of the size of the individual, the rostrum usually was more or less level with the plane of the carapace, but in 3 individuals, the rostrum rose at about a 30° angle relative to the carapace. Males had a more slender body than adult females. There was little variation in the relative lengths of the scaphocerite, telson and uropods from that mentioned by Butler (1980); therefore, I concur with his suggestion that designation of the form *C. alaskensis elongata* as a distinct subspecies be dropped from the nomenclature.

Holmes (1900: 170) considered *C. alaskensis* to be a synonym of *C. nigricauda*, but the two species are distinct in morphology and habitat. A narrow scaphocerite with a long, acute lateral tooth is characteristic of the former, which usually occurs in deeper waters than the latter species.

***Crangon alba* Holmes, 1900**

(Fig. 27E–G)

Crangon alba Holmes, 1900: 174. — Rathbun 1904: 117, figs. 56, 57. — Zarenkov 1965: 1763. — Kozloff 1974: 164. — Word & Charwat 1976: 75. — Butler 1980: 104. — Carvacho & Olson 1984: 65.

Crango alba. — Schmitt 1921: 89, fig. 59.

Diagnosis. Exoskeleton thin, smooth. Rostrum short, apex rounded. Carapace with 1 median dorsal tooth, also hepatic, antennal, branchiostegal teeth, weak pterygostomian tooth. Eye pigmented. Stylocerite short. Scaphocerite narrow, lateral tooth greatly exceeding blade. Third maxilliped with basal segment greatly expanded, broad, exopod present. Pereopod 1 with propodus broad, dactyl closing obliquely against propodus. Pereopod 2 slender, chelate. Pereopod 3 slender with simple dactyl. Pereopods 4, 5 longer, more robust than third. Pleura of abdominal somites blunt to rounded. Abdominal somite 6 without ventral groove, with weak posteroventral tooth. Telson with 2 pairs lateral spines, shorter than uropods. Female total length 44 mm, male not reported.

Color in life. White, or white dotted with black.

Habitat and depth. Coarse sand or rocks, 22–88 m.

Range. Queen Charlotte Sound, northeast Vancouver I. to Todos Santos Bay, Baja California. Type locality Monterey Bay, California.

***Crangon franciscorum* Stimpson, 1856**

(Fig. 27 H, I)

Crangon franciscorum Stimpson, 1856: 97. — Rathbun 1904: 120, fig. 61. — Kozloff 1974: 164. — Chace & Abbott 1980: 574. — Jensen 1995: 40, fig. 57. — Kuris *et al.* 2007: 636, pl. 316 F.

Crago franciscorum. — Schmitt 1921: 92, fig. 62. — Johnson & Snook 1927: 313, fig. 267. — MacGinitie & MacGinitie 1968: 275.

Crangon (*Neocrangon*) *franciscorum*. — Zarenkov 1963: 1764.

Crangon franciscorum franciscorum. — Butler 1980: 101.

Diagnosis. Exoskeleton smooth, thin. Rostrum short, not reaching cornea of eye, apex rounded. Carapace with one dorsal median tooth, also hepatic, branchiostegal, moderate pterygostomial teeth. Eye small, pigmented. Stylocerite exceeding first segment of antennular peduncle. First segment of antennular peduncle with distal spine. Scaphocerite with lateral tooth exceeding blade. Third maxilliped setose, with exopod. Pereopod 1 with inner spine on merus; hand of subchela elongate, dactyl closing almost longitudinally against inner tooth. Pereopod 2 slender, chelate. Pereopod 3 slender, with simple dactyl. Pereopods 4, 5 setose, more robust than third, with simple dactyls. Abdominal pleura 1–4 with blunt to rounded pleura, somite 5 with posterolateral tooth, somite 6 with moderate posteroventral tooth. Abdominal somite 6 slender, with ventral groove. Telson narrow, with 2 pairs lateral spines, acute apex, shorter than uropods. Male total length 49 mm, female 68 mm.

Color in life. Mottled gray.

Habitat and depth. Sand, mud, bays, estuaries, intertidal zone to 91 m.

Range. Resurrection Bay, Alaska to San Diego, California. Type locality San Francisco Bay, California.

Remarks. Butler (1980) treated *C. franciscorum* as two separate subspecies, *C. franciscorum franciscorum* and *C. franciscorum angustimana* Rathbun, 1902. The latter, having a more slender subchela than the former (6–8 times as long as wide versus 4–5.5 times as long as wide), was reported from Kachemak Bay, Alaska to Tillamook Rock, Oregon. It seemed to inhabit deeper, cooler, more saline water than the typical form. There has been no subsequent study to determine if these two purported subspecies are valid.

***Crangon handi* Kuris & Carlton, 1977**

(Fig. 27J, K)

Crangon handi Kuris & Carlton 1977: 540, figs. 1, 2. — Standing 1981: 781. — Jensen 1995: 41, fig. 62. — Kuris *et al.* 2007: 636, pl. 319 E.

Diagnosis (after Kuris & Carlton 1977). Rostrum short, not as long as cornea as eye. Carapace with 1 median dorsal tooth, also hepatic, branchiostegal teeth. Stylocerite short, blunt, not as long as first segment of antennular peduncle. Scaphocerite with very broad blade, exceeding lateral tooth. Third maxilliped setose, with exopod. Pereopod 1 stout, merus with 1 spine; hand broad, dactyl closing obliquely against propodus. Pereopod 2 slender, chelate. Pereopod 3 slender, with simple dactyl. Pereopods 4, 5 stouter than third. Pleura of abdominal somites blunt to rounded. Abdominal somite 6 relatively short, with shallow ventral groove. Telson with 2 pairs dorsolateral spines, exceeding uropods. Total length to 50.3 mm.

Color in life. Well camouflaged with bars, patches of white, black, brown or other colors, resembling sand on which it rests (Kuris & Carlton 1977, fig. 2).

Habitat and depth. Coarse sand, intertidal zone to 55 m.

Range. Cape Arago, Oregon to Colnett Bay, Baja California, Mexico. Type locality Horseshoe Cove, Bodega Head, Sonoma County, California.

***Crangon holmesi* Rathbun, 1902**

(Fig. 27L–N)

Crangon holmesi Rathbun, 1902a: 888. — Rathbun 1904: 118, fig. 58. — Zarenkov 1965: 1763. — Word & Charwat 1976: 79. *Crango holmesi*. — Schmitt 1921: 90, fig. 60.

Diagnosis. Exoskeleton thin, smooth. Rostrum short, apex rounded. Carapace with single median tooth, also hepatic, branchiostegal teeth. Eye pigmented. Scaphocerite narrow, lateral tooth greatly exceeding blade. Third maxilliped setose, with exopod. Pereopod 1 with propodus elongate, dactyl closing obliquely against propodus. Pereopod 2 slender, chelate. Pereopod 3 slender, with simple dactyl. Pereopods 4, 5 longer than pereopod 3, with simple dactyls. Pleura of abdominal somites blunt to rounded. Abdominal somite 6 without ventral groove. Telson with 2 pairs dorsolateral spines. Total length to 34.0 mm.

Color in life. Not reported.

Habitat and depth. Sand, mud, 28–107 m.

Range. Wilmington, Los Angeles County to Cedros I., Baja California. Type locality Wilmington, California.

Remarks. The type locality of this species is within Los Angeles Harbor, which has been heavily modified by human activity. Subsequent records have come from coastal waters of California and northern Baja California.

***Crangon nigricauda* Stimpson, 1856**

(Fig. 27O, P, Pl. 4F, G)

Crangon nigricauda Stimpson, 1856: 97. — Holmes 1900: 170, pl. 2, fig. 31. — Rathbun 1904: 112, fig. 50. — Kozloff 1974: 164. — Word & Charwat 1976: 83. — Butler 1980: 106. — Chace & Abbott 1980: 574. — Ricketts *et al.* 1985: 328, fig. 253. — Jensen 1995: 40, fig. 58. — Kuris *et al.* 2007: 636, pl. 319 D.

Crango nigricauda. — Schmitt 1921: 84. — Goodwin 1952: 395.

Crangon (Neocrangon) nigricauda. — Zarenkov 1965: 1763.

Diagnosis. Exoskeleton thin, smooth. Rostrum reaching base of cornea of eye, apex rounded. Carapace with 1 median dorsal tooth, also hepatic, branchiostegal teeth, weak pterygostomial tooth. Eye pigmented. Stylocerite acute, about as long as first segment of antennular peduncle. Scaphocerite broad, blade about equal to lateral tooth. Third maxilliped setose, with exopod. Pereopod 1 with spine on inner surface of merus, propodus broad, dactyl closing nearly transversely across propodus. Pereopod 2 slender, chelate. Pereopod 3 slender, with simple dactyl. Pereopods 4, 5 more robust, longer than third, with simple dactyls. Pleura of abdominal somites blunt to rounded. Somite 6 with median dorsal carina, ventral groove, moderate posteroventral tooth. Telson narrow, with broad median groove, 2 pairs dorsolateral spines. Inner uropod longer than telson. Male total length 32 mm, female 53 mm.

Color in life. Brown (Jensen 1995: fig. 58). Speckled with gray, black, white; tail fan dark brown to black, well camouflaged against sand. The color notes are from shrimp from San Francisco Bay, California.

Habitat and depth. Sand, intertidal zone to 57 m.

Range. Prince William Sound, Alaska to San Geronimo I., Baja California. Type locality Tomales Bay, California.

Remarks. This is one of the most common intertidal shrimps of sandy bays in northern California.

***Crangon nigromaculata* Lockington, 1877**

(Fig. 28A, B, Pl. 4E)

Crangon nigromaculata Lockington, 1877a: 34. — Holmes 1900: 173, pl. 2, fig. 32. — Rathbun 1904: 114, fig. 51. — Word & Charwat 1976: 85. — Chace & Abbott 1980: 574. — Ricketts *et al.* 1985: fig. 153. — Jensen 1995: 41, fig. 60. — Kuris *et al.* 2007: 636, pl. 319 F.

Crango nigromaculata. — Schmitt 1921: 86, fig. 5. — Johnson & Snook 1927: 313.

Crangon (Neocrangon) nigromaculata. — Zarenkov 1963: 1764.

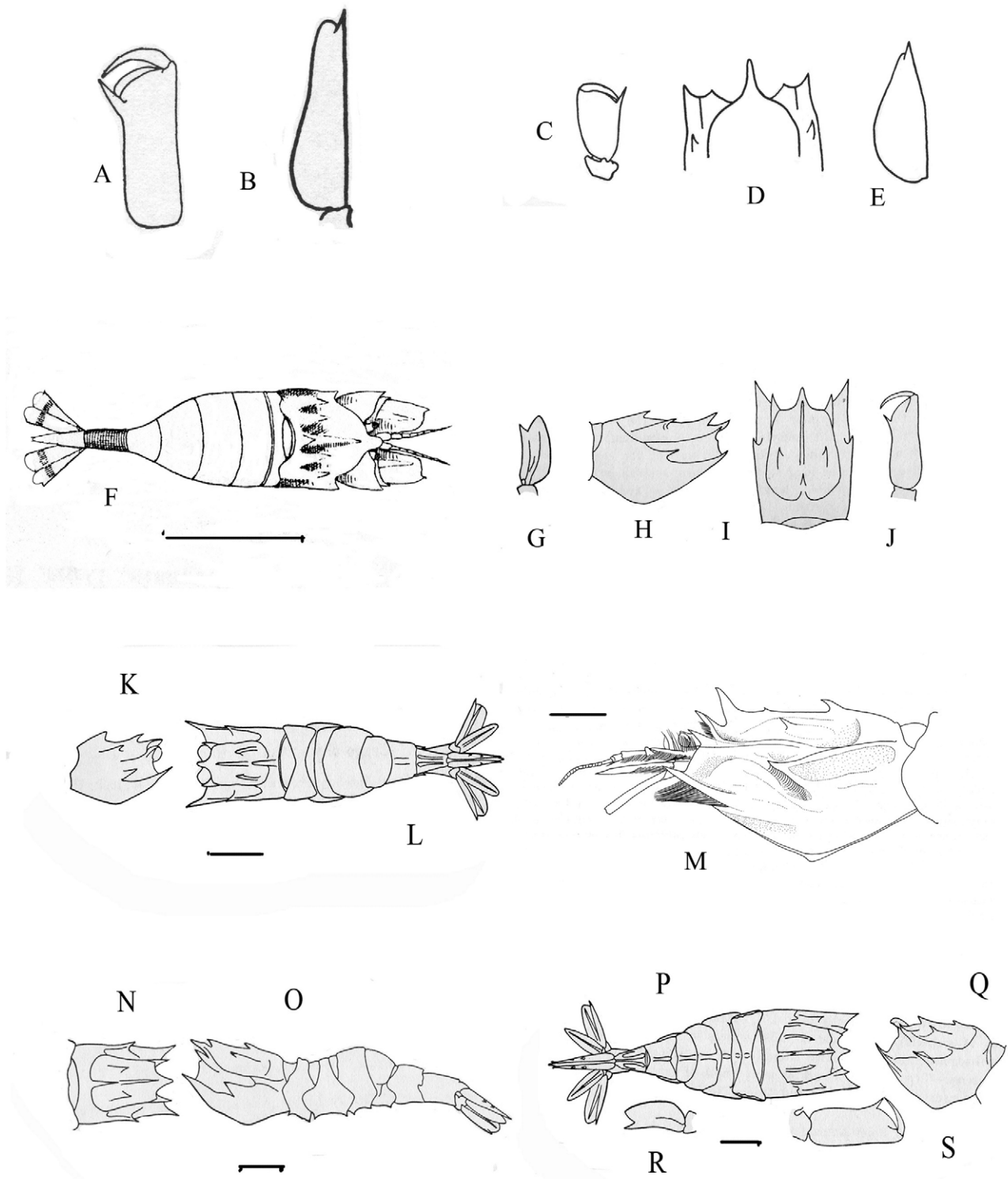


FIGURE 28. Family Crangonidae. A, B, *Crangon nigromaculata* Lockington, 1877; A, subchela; B, scaphocerite. C–E, *Lissocrangon stylirostris* (Holmes, 1900); C, subchela; D, frontal region of carapace; E, scaphocerite. F, *Mesocrangon munitella* (Walker, 1898); G–J, *Metacrangon acclivis* (Rathbun, 1902); G, scaphocerite; H, carapace in lateral view; I, carapace in dorsal view; J, subchela. K, L, *Metacrangon munita* (Dana, 1852); K, carapace in lateral view; L, carapace and abdomen in dorsal view. M, *Metacrangon procax* (Faxon, 1893); carapace and frontal region. N, O, *Metacrangon spinosissima* (Rathbun, 1902); N, carapace in dorsal view; O, carapace and abdomen in lateral view. P–S, *Metacrangon variabilis* (Rathbun, 1902); P, carapace and abdomen in dorsal view; Q, carapace in lateral view; R, scaphocerite; S, subchela. Scales: L, M, O, P = 5 mm; F = 10 mm. A–E, G–L, N–S from Schmitt 1921; F adapted from Walker 1898, M from Komai 1997.

Diagnosis. Exoskeleton thin, smooth. Rostrum short. Carapace with single dorsal median tooth, also hepatic, branchiostegal teeth, weak pterygostomial tooth. Eye small, pigmented. Stylocerite as long as first segment of antennular peduncle. Scaphocerite with lateral tooth exceeding blade, blade sinuous on inner margin, narrow near distal end. Third maxilliped setose, with exopod. Pereopod 1 subchelate, dactyl closing obliquely across propodus. Pereopod 2 slender, chelate. Pereopod 3 slender, with simple dactyl. Pereopods 4, 5 more robust, setose than pereopod 3, with simple dactyls. Pleura of abdominal somites rounded to blunt. Somite 6 with ventral groove, usually also marked with distinctive circular spot on posterolateral surface. Telson about as long as uropods, with 2 pairs dorsolateral spines. Total length to 70 mm.

Color in life. Mottled gray, with obvious spot of purple to blue, surrounding ring of orange to yellow on abdominal somite 6, rarely without spot (Jensen 1995).

Habitat and depth. Sand, mud, 6–61 m.

Range. San Francisco Bay, California to San Cristobal Bay, Baja California, Mexico. Type locality San Diego, California.

Lissocrangon Kuris & Carlton, 1977

Lissocrangon stylirostris (Holmes, 1900)

(Fig. 28C–E)

Crangon stylirostris Holmes, 1900: 174, pl. 2, figs. 33–35. — Rathbun 1904: 118, fig. 59. — Zarenkov 1965: 1763. — Word & Charwat 1976: 91. — Butler 1980: 98. — Chace & Abbott 1980: 574, fig. 23.11. — Carvacho & Olson 1984: 65. — Jensen 1995: 41, fig. 61.

Crango stylirostris. — Schmitt 1921: 90, fig. 61.

Lissocrangon stylirostris. — Kuris & Carlton 1977: 551. — Kuris *et al.* 2007: 636, l. 316 A.

Diagnosis. Exoskeleton thin and smooth. Rostrum short, narrow, reaching end of eye. Carapace without dorsal median tooth, with strong antennal, branchiostegal teeth, hepatic spine with supporting carina. Eye small, pigmented. Antennular peduncle with first segment longest, stylocerite blade-like, about as long as first segment. Scaphocerite with lateral tooth exceeding blade. Third maxilliped stout, first segment broad, with exopod. Pereopod 1 stout, merus with 1 spine, carpus with 2 spines, propodus distally widened, dactyl when flexed obliquely transverse. Pereopod 2 slender, chelate. Pereopod 3 slender, dactyl simple. Pereopods 4, 5 more robust than pereopod 3, with dactyls slightly flattened. Abdominal somites 1, 2, 4 with pleura ventrally concave, pleura of somites 3, 4 rounded, somite 6 with posteroventral tooth, slight ventral groove, no abdominal somites with dorsal carinae. Telson with 2 pairs lateral spines, shorter than uropods. Male total length 43 mm, female 61 mm.

Color in life. Speckled with brown, tail fan brown (Chace & Abbott 1980: fig. 23.11).

Habitat and depth. Sandy bottoms, often in surf zone of semi-protected beaches, intertidal zone to 80 m.

Range. Chirikof I., Alaska to Todos Santos Bay, Baja California. Type locality Trinidad, Humboldt County, California.

Mesocrangon Zarenkov, 1965

Mesocrangon munitella (Walker, 1898)

(Fig. 28F)

Crangon munitellus Walker, 1898: 275, pl. 16. — Holmes 1900: 176. — Kozloff 1974: 164. — Wicksten 1980: 39; 1983b: 51. *Crangon munitella* — Rathbun 1904: 132.

Crango munitella — Schmitt 1921: 101, fig. 70. — Johnson & Snook 1927: 314. — Word & Charwat 1976: 81.

Mesocrangon? munitella — Zarenkov 1965: 1762.

Mesocrangon munitella — Butler 1980: 121. — Carvacho & Olson 1984: 65. — Wicksten & Hendrickx 2003: 69. — Jensen 1995: 39, fig. 56. — Kuris *et al.* 2007: 636.

Diagnosis. Body stout, depressed. Shell thick. Rostrum short, broad, rounded. Carapace with 2 median dorsal

teeth, submedian tooth ahead of mid-carapace, lower submedian tooth, moderate hepatic tooth, each with supporting carina; also moderate antennal, strong branchiostegal, weak pterygostomial teeth. Eye moderately large. Antennular peduncle short. Scaphocerite broad, blade exceeding lateral tooth. Third maxilliped long, with exopod. Pereopod 1 stout, dactylus closing obliquely across propodus. Pereopod 2 long, slender, chelate. Pereopod 3 slender, with simple dactylus. Pereopods 4, 5 stout, with slightly flattened dactyls. Only abdominal somite 6 with flat dorsal median carina; all abdominal pleura rounded. Telson shorter than uropods, with 2 pairs dorsolateral spines, rounded apex. Female total length 23 mm, male not reported.

Color in life. Variable, camouflaged like shell or gravel; mottled brown with white dorsal markings, dark slate, banded with slate, center of body red, banded with slate, red (Jensen 1995).

Habitat and depth. Sand, rock and shell, 2–94 m.

Range. Goose I., Queen Charlotte Sound to off Thurloe Head, Baja California, Mexico; San Francisquito Bay and off Tiburon I., Gulf of California. Type locality Puget Sound.

Metacrangon Zarenkov, 1965

Metacrangon acclivis (Rathbun, 1902)

(Fig. 28G–J)

Crangon acclivis Rathbun, 1902a: 890; 1904: 129, fig. 68. — Kozloff 1974: 164.

Crago acclivis — Schmitt 1921: 98, fig. 67.

Metacrangon acclivis — Zarenkov 1965: 1764. — Butler 1980: 113.

Diagnosis. Rostrum slender, ascending at 45° angle, with rounded apex. Carapace with anterior median tooth obliquely erect, larger than posterior tooth, extending beyond orbital margin; submedial, hepatic teeth with supporting carinae, also antennal, branchiostegal teeth; gastric region depressed. Eye pigmented, cornea with tubercle. Antennules, antennae extremely setose. Scaphocerite with blade exceeding lateral tooth. Third maxilliped setose, with exopod. Pereopod 1 with subchela, dactyl closing obliquely, nearly vertically against propodus. Pereopod 2 slender, chelate. Pereopod 3 slender, simple, pereopods 4, 5 sturdy, setose, with flattened dactyls. Abdominal somites 1–4 without dorsal carinae, with rounded margins. Abdominal somite 5 with pleuron having posterolateral point. Somite 6 with 2 dorsal carinae. Telson with 2 pair dorsolateral spines, nearly same length as uropods. Total length to 27.5 mm.

Color in life. Not reported.

Habitat and depth. Continental shelf to slope, among rocks, pebbles, coarse sand; 118–491 m.

Range. Trinity Is., Alaska to 8 mi. west of Cedros I., Baja California, Mexico (*Velero III* sta. 1253-41, LACM). Type locality off Santa Cruz I., California.

Metacrangon munita (Dana, 1852)

(Fig. 28K, L)

Crangon munitus Dana, 1852: 536; 1855: pl. 33, fig. 5.

Crangon munita. — Rathbun 1904: 127, fig. 67. — Kozloff 1974: 165.

Crago munita. — Schmitt 1921: 98, fig. 66. — Johnson & Snook 1927: 314.

Metacrangon munita. — Zarenkov 1965: 1764. — Butler 1980: 119. — Jensen 1995: 39, fig. 56.

Diagnosis. Body short, exoskeleton thick rugose. Rostrum shorter than eye, apex rounded. Carapace with 2 median teeth, submedial, hepatic teeth strong with supporting carinae; branchiostegal strong, pterygostomial weak; gastric region depressed. Eye short, pigmented. First, second segments of antennular peduncle broad, third very short; stylocerite short. Scaphocerite with blunt blade exceeding lateral tooth, basicerite with 2 lateral teeth. Third maxilliped setose, with exopod. Pereopod 1 stout, subchelate, carpus with distal tooth, dactyl when flexed obliquely transverse. Pereopod 2 long, slender, chelate. Pereopod 3 long and slender, dactyl slender, simple. Pereopods 4, 5 stout, setose, dactyls flattened. Pleura of abdominal somites 1–4 rounded, pleuron of somite 6 with

2 dorsal median carinae, strong posterodorsal tooth, flared posteroventral parts. Telson with median groove, 2 pairs dorsolateral spines, slightly longer than uropods. Male total length 33 mm, female 48 mm.

Color in life. Bases of antennae, most of carapace, anterior half of abdomen china white; rest of carapace, abdomen dark brown. Tail fan ending in mottled white band (Jensen 1995).

Habitat and depth. Continental shelf, on mixed sand and shell, 13–230 m.

Range. Port Etches, Alaska to San Miguel I., California. Type locality Puget Sound.

***Metacrangon procax* (Faxon, 1893)**

(Fig. 28M)

Sclerocrangon procax Faxon, 1893:199; 1895:135, pl. 36.

Crago lomae Schmitt, 1921: 100, pl. 12, figs. 3, 4.

Crangon lomae. — Wicksten 1980a: 39; 1989b: 313.

Metacrangon lomae. — Zarenkov 1965: 1764. — Wicksten 1989: 303, 304, 313.

Metacrangon procax. — Zarenkov 1965: 1764. — Méndez 1981: 122, figs. 357, 358, pl. 7. — Komai 1997: 672, fig. 10. — Wicksten & Hendrickx 2003: 69.

Diagnosis. Rostrum short, apex rounded. Anterior median tooth of carapace acutely pointed, nearly erect, nearly as long as rostrum, small denticle between anterior, posterior median carapace teeth. Carapace with antennal, branchiostegal teeth, hepatic, submedian teeth with supporting carinae. Eye pigmented. First, second segments of antennular peduncle with lateral tooth each. Scaphocerite with lateral tooth much longer than blade, separated from it by deep incision for about distal 0.25 of length. Third maxilliped setose, with exopod. Pereopod 1 subchelate, with dactyl closing obliquely against propodus. Pereopod 2 slender, chelate. Pereopod 3 slender with simple dactyl. Pereopods 4, 5 stout, setose, with flattened dactyls. Abdominal somites 1, 2 with weak dorsal carinae, somites 3–5 with carinae on at least part of dorsal midline, somite 6 with 2 carinae. Ventral surfaces of abdominal somites sexually dimorphic: male with abdominal pleura 1–3 with prominent acute median tooth, somite 4 with blunt tooth, somite 5 with low tubercle, somite 6 ventrally unarmed; female with abdominal somites unarmed except for small tubercle between pleopods of somite 5. Telson with 3–4 pairs dorsolateral spines, apex acute, exceeding inner branch of uropods. Male total length 35 mm, female 44 mm.

Color in life. Light brown (Méndez 1981, pl. 57).

Habitat and depth. Continental slope, 800–1629 m.

Range. San Miguel I., California to off Atico, Peru. Type locality not specified; type specimens came from four stations taken off Malpelo I., off Acapulco, and in Gulf of California.

***Metacrangon spinosissima* (Rathbun, 1902)**

(Fig. 28N, O)

Crangon spinosissima Rathbun, 1902a: 891; 1904: 130, fig. 70. — Word & Charwat 1976: 89.

Crago spinosissima. — Schmitt 1921: 100, fig. 69.

Metacrangon spinosissima. — Zarenkov 1965: 1764. — Butler 1980: 115.

Diagnosis. Exoskeleton thick. Rostrum shorter than eye, with acute or rounded apex. Carapace with anterior median tooth larger than posterior, joined to it by median carina, submedial, subhepatic spines with supporting carinae; strong antennal, branchiostegal teeth, weak pterygostomial spine. Eye small, pigmented. Antennular peduncle with first segment longest, first, second segments with distolateral teeth. Scaphocerite with blade longer than lateral tooth, basicerite with 2 blunt lateral teeth. Third maxilliped setose, with exopod. Pereopod 1 without teeth on merus or carpus, dactyl when flexed obliquely transverse. Pereopod 2 slender, chelate. Pereopod 3 slender, with simple dactyl. Pereopods 4, 5 stout, setose, with flattened dactyls. Abdominal somites 1–5 with 1–2 ventral teeth on pleura, somites 1–5 with median dorsal carina (may be faint), somite 6 with 2 dorsal carinae, posteroventral regions strongly flared. Telson with dorsal median groove, 2 pairs dorsolateral spines; shorter than inner uropod. Male total length 30 mm, female 54 mm.

Color in life. Buff with brownish patches, mottling, bars (Butler 1980: color plate 1B).

Habitat and depth. Continental shelf, 28–220 m.

Range. Nootka Sound, British Columbia to San Martin I., Baja California. Type locality off Point Arena, California.

***Metacrangon variabilis* (Rathbun, 1902)**

(Fig. 28P–S)

Crangon variabilis Rathbun, 1902a: 890; 1904: 129, fig. 69. — Kozloff 1974: 165.

Crago variabilis. — Schmitt 1921: 99, fig. 68.

Metacrangon variabilis. — Zarenkov 1965: 1764. — Birshstein & Zarenkov 1972: 441. — Butler 1980: 117. — Wicksten 1989b: 313.

Diagnosis. Exoskeleton thick. Rostrum short, not exceeding eye, apex rounded. Carapace with 2 median teeth, anterior slightly larger; submedial spine moderate, hepatic strong with supporting carina, branchiostegal tooth strong and with supporting carina, pterygostomial tooth weak, gastric region depressed. Eye large, pigmented. First segment of antennular peduncle long, with distolateral tooth; second shorter, with tooth; third shortest, with tooth. Scaphocerite with lateral tooth equal to or longer than blade. Third maxilliped setose, with exopod. Pereopod 1 stout, merus, carpus each with 2 distal teeth, subchelate, dactyl when flexed obliquely transverse. Pereopod 2 slender, chelate, third slender, with simple dactyl. Pereopod 3 slightly longer than pereopod 2, slightly stouter, dactylus slender. Pereopods 4, 5 stout, setose, with flattened dactyls. Abdominal somites 1–4 with pleura rounded, somites 1–5 with single median dorsal carina; somite 5 with posterolateral tooth, somite 6 with 2 prominent dorsal carinae, posteroventral regions strongly flared. Telson with median dorsal groove, 2 pairs lateral spines, about as long as inner uropod. Female total length 38 mm, male not reported.

Color in life. Transparent with grayish tinge, fine orange-brown, gray-brown chromatophores over body (Butler 1980: color plate 5F).

Habitat and depth. Continental shelf and slope, 92–1271 m.

Range. Commander and Pribilof Is., Bering Sea to San Nicolas I., California. Type locality off North Head, Akutan I., Alaska.

***Neocrangon* Zarenkov, 1965**

***Neocrangon abyssorum* (Rathbun, 1902)**

(Fig. 29A–D)

Crangon abyssorum Rathbun, 1902a: 890; 1904: 125, fig. 66. — Butler 1980: 112. — Krygier & Percy 1981: 89. — Wicksten 1989b: 313.

Crago abyssorum. — Schmitt 1921: 97, fig. 65.

Crangon (*Neocrangon*) *abyssorum*. — Zarenkov 1965: 1762. — Birshstein & Zarenkov 1972: 441.

Neocrangon abyssorum. — Kuris & Carlton 1977: 554.

Diagnosis. Exoskeleton very thin. Rostrum short, ascending, narrow, apex acute. Carapace with 2 median dorsal teeth, anterior one smaller than posterior; strong antennal, branchiostegal and hepatic teeth, weak pterygostomial tooth. Eye large, cornea well developed, both eyes contiguous. Antennular peduncle shorter than 0.5 length of scaphocerite. Scaphocerite slender, lateral tooth exceeding blade. Third maxilliped long, slender, exopod present. Pereopod 1 stout, dactyl closing obliquely across propodus, merus, carpus each with strong distal tooth. Pereopod 2 very slender, chelate. Pereopods 3–5 slender, with simple, slightly flattened dactyls. Abdominal somites 4, 5 smooth, sixth with 2 dorsal carinae, pleura with more or less rounded or obtuse margins. Telson narrow, with median dorsal sulcus, 2 pairs dorsolateral spines, acute apex, exceeding uropods. Male total length 64 mm, female 63 mm.

Color in life. Not reported.

Habitat and depth Benthic, 97–2975 m, but usually deeper than 1200 m off California.

Range. East of Kurile Is., east coast of Japan, Bering Sea to Cortez Bank, California. Type locality Bering Sea, southwest of Pribilof Is.

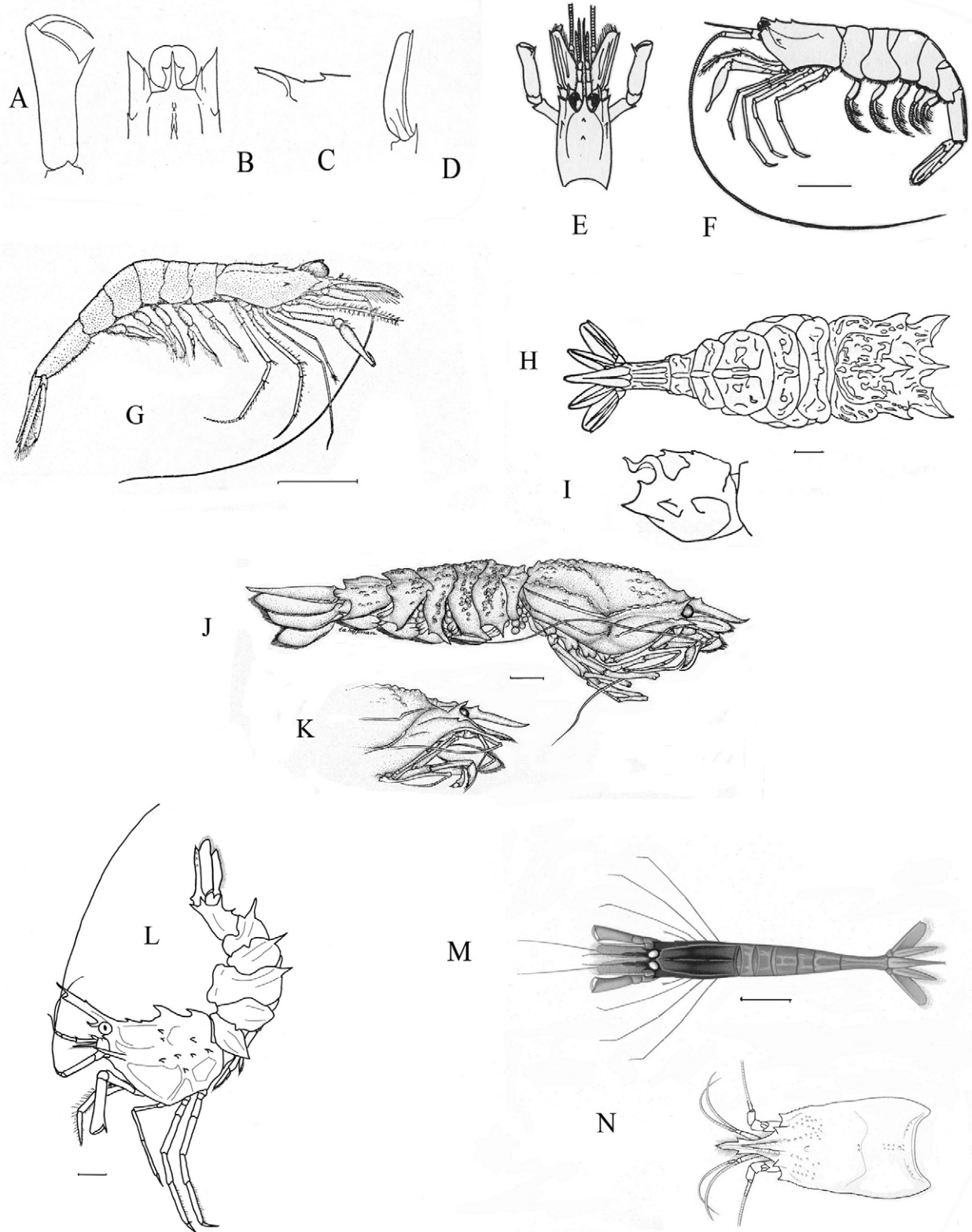


FIGURE 29. Families Crangonidae and Glyphocrangonidae. A–D, *Neocrangon abyssorum* (Rathbun, 1902); A, subchela; B, front of carapace and eye; C, rostrum; D, scaphocerite. E, F, *Neocrangon communis* (Rathbun, 1902); E, carapace, frontal appendages and pereopods 1; F, lateral view. G, *Neocrangon resima* (Rathbun, 1902). H, I, *Rhynocrangon alata* (Rathbun, 1902); H, carapace and abdomen in dorsal view; I, carapace in lateral view. J, K, *Glyphocrangon vicaria* Faxon, 1896; J, lateral view; K, detail of frontal region and pereopods. L, *Paracrangon echinata* Dana, 1852. M, N, *Pontophilus gracilis occidentalis* Faxon, 1893; M, dorsal view; N, carapace and frontal region. Scales: J = 1 mm, H, L = 3 mm; F, G, M = 10 mm. A–F from Schmitt 1921, G from Chace 1937 (as *Crago zaca*); H, I from Rathbun 1904; J, K from Wicksten 1979c; L from photograph by K.G. Hewlett, Vancouver Public Aquarium; M, N from Faxon 1895.

***Neocrangon communis* (Rathbun, 1902)**

(Fig. 29E, F)

Crangon communis Rathbun, 1902a: 889; 1904: 124, fig. 65. — Kozloff 1974: 164. — Word & Charwat 1976: 77. — Butler 1980: 110. — Wicksten 1980c: 362.

Crango communis. — Schmitt 1921: 95, fig. 63.

Sclerocrangon communis. — Kobyakova 1937: 136.

Crangon (*Neocrangon*) *communis*. — Zarenkov 1965: 1762.

Neocrangon communis. — Kuris & Carlton 1977: 554. — Wicksten 1996a: 39, fig. 1 d–f.

Neocrangon resima: Green & Butler 1988: 1, fig. 1 (misidentification).

Diagnosis. Exoskeleton thin, pubescence on anterior part of carapace, in abdominal sulci. Rostrum usually short, rounded, rising at low angle from midline of carapace; rarely rising at sharp angle and having ventral plate. Carapace with 2 median dorsal teeth, moderate antennal, strong branchiostegal, hepatic; weak pterygostomial tooth. Antennular peduncle short, less than 0.5 length of scaphocerite. Scaphocerite narrow, lateral tooth exceeding blade. Third maxilliped long, slender, with exopod. Pereopod 1 with dactylus closing obliquely transverse across propodus, merus with distal tooth, carpus with 2 weak distal teeth. Pereopod 2 shorter than first, slender, chelate. Pereopods 3–5 slender, with simple, slender dactyls. Abdominal somites 1, 2 smooth, somites 3–5 with wide median dorsal carina, somite 6 with 2 median dorsal carinae. Pleura of somites 4, 5 with posteroventral tooth each. Telson slightly exceeding uropods, with median sulcus, 2 pairs dorsolateral spines, rounded apex. Male total length 61 mm, female 80 mm.

Color in life. Medium gray over most of body, uniform brown over branchial region, overlaid with pale yellow spots, fine brown to charcoal dots over rest of carapace, abdomen with brown spots, blotches, light yellow spots, spots and patches of magenta to rust on pereopods and telson (Butler 1980: plate 5D). Specimens from California were dull brick red.

Habitat and depth. Mud bottoms, 16–1537 m.

Range. Sea of Japan, east coast of Honshu I., Chukchi Sea, Bering Sea to San Diego, California, but usually north of Point Conception, California. Type locality off Pribilof Is., Bering Sea.

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

(Fig. 29G)

Crangon resima Rathbun, 1902a: 889; 1904: 124, fig. 65. — Kozloff 1974: 164. — Word & Charwat 1976: 87. — Butler 1980: 97.

Crango resima. — Schmitt 1921: 96, fig. 64. — Goodwin 1952: 394.

Crangon (*Neocrangon*) *resima*. — Zarenkov 1965: 1762.

Neocrangon resima. — Kuris & Carlton 1977: 554. — Wicksten 1996a: 39, fig. 1 a–c. — Wicksten & Hendrickx 2003: 69.

Crango zacae Chace, 1937: 136, fig. 9.

Crangon ? (*Neocrangon*) *zacae*. — Zarenkov 1965: 1764.

Crangon zacae. — Word & Charwat 1976: 93. — Wicksten 1980c: 361.

Neocrangon zacae. — Kuris & Carlton 1977: 554. — Wicksten 1980a: 39.

Diagnosis. Rostrum highly variable: often slightly ascending, narrow, shorter than cornea of eye; in some specimens ascending to sharp apex or having a ventral plate with 0–4 small teeth. Eye of moderate size. Carapace with 2 median dorsal teeth, anterior of these smaller of two, weak antennal, strong branchiostegal, hepatic teeth; no pterygostomial tooth. Antennular peduncle short, less than half length of scaphocerite. Scaphocerite broader near base than at apex of blade, lateral tooth exceeding blade. Third maxillipeds slender, with exopod. Pereopod 1 with 1 strong, 1 weak meral tooth; carpus with 2 weak distal teeth, dactylus closing obliquely across propodus. Pereopod 2 slender, chelate. Pereopods 3–5 long, slender, dactyls simple. Abdominal somites smooth to very weakly carinate except for somite 6, which bears 2 dorsal carinae. Pleura rounded except for those of somites 4, 5, which bear posterolateral teeth. Telson shorter than or about as long as uropods, with 2 pairs dorsolateral spines. Male total length 55 mm, female 20–70 mm.

Color in life. Body semi-translucent, mottled with greenish brown, scarlet on dorsal, lateral surfaces, ventral surface white, antennae banded with scarlet, white (Chace 1937).

Habitat and depth. Muddy, sandy, rocky bottoms, 28–491 m.

Range. Monterey Bay, California to north of Gorgona I., western Colombia. Type locality off San Diego, California.

Remarks. Until recently, it was thought that *N. resima* could be recognized by a distinctive raised rostrum with a ventral plate. The shape of the rostrum and its angle relative to the carapace is highly variable and not a reliable feature for identification. A raised rostrum with the ventral plate seems to occur in less than 10% of the population of *N. resima*. The type material of *N. resima* does not have the ventral plate. Specimens previously identified as *N. zaca* do not differ appreciably from specimens of *N. resima*. Green & Butler (1988) probably misidentified *N. communis* by assuming that only *N. resima* had the raised rostrum. Wicksten (1996: fig. 1) provided illustrations of morphological variation in the rostrum of *N. resima*.

***Paracrangon* Dana, 1852**

***Paracrangon echinata* Dana, 1852**

(Fig. 29L)

Paracrangon echinatus Dana, 1852: 20; 1852b: 538, pl. 33, fig. 6. — Holmes 1900: 176, pl. 2, figs. 36, 37.

Paracrangon echinata. — Faxon 1895: 131. — Rathbun 1904: 103. — Schmitt 1921: 103, fig. 72. — Johnson & Snook 1927: 314. — Kobayakova 1937: 139. — Kozloff 1974: 164. — Butler 1980: 75, pl. 2D; 1995: 39, fig. 54; 2011: 246, fig. 2. — Jensen 2011: 246, fig. 2.

Diagnosis. Rostrum long, equal to carapace length in male, 0.6–0.8 times as long as carapace length in female, with one moderate dorsal tooth near middle; anterior margin with 1 tooth near apex, long curved tooth at base. Carapace with 4 median dorsal teeth on median carina, anterior teeth smaller than posterior; strong antennal tooth, massive, flared branchiostegal tooth, strong pterygostomial tooth; dorsolateral surfaces carinated forming irregular quadrangular teeth at angles of carinae; deep sulcus from base of posterior median tooth across cardiac region. Eyes of moderate size. Peduncle of antennule long, overreaching carapace, stylocerite short, apex rounded. Scaphocerite of second antenna not exceeding second segment of peduncle of antennule, blade exceeding lateral tooth. Third maxilliped long, slender, distal tooth on proximal segment, exopod present. Pereopod 1 about as long as third maxilliped, dactyl of subchela closing obliquely, merus with distal tooth. Pereopod 2 absent. Pereopods 3–5 similar, longer than pereopod 1, slender, dactyls with acute apices. Abdominal somites carinate posterior to somite 2, carina of somite 3 especially high, dorsolateral surfaces of pleura 1–5 each with 2 vertical sulci, pleura 1–5 having strong lateral teeth. Pleura of somite 6 with 2 median dorsal carinae, midlateral tooth, lower lateral, posteroventral, posterodorsal teeth. Pleura of male with lateral sternal teeth; in female, teeth absent. Telson with 2 median dorsal spines, 3 pairs dorsolateral spines. Male total length 44 m, female 65 mm.

Color in life. Light brownish gray, generally overlaid with small brown or black spots (Butler 1980: pl. 2D), mottled brown and translucent or yellowish (K. Lee, pers. comm.).

Habitat and depth. Mixed or rocky bottoms, 7–201 m.

Range. Port Etches, Alaska to La Jolla, California; Sea of Okhotsk, Sea of Japan to Korea Strait, Sagami Bay. Type locality Puget Sound.

Remarks. Live animals often assume the cataleptic position: resting with the pereopods against the bottom and the abdomen flexed upward at a nearly 45° angle. These well-camouflaged shrimp are ambush predators, catching gammarid amphipods, smaller carideans and other small prey. Jensen (2011: fig. 2) photographed their predatory activities.

***Pontophilus* Leach, 1817**

***Pontophilus gracilis occidentalis* Faxon, 1893**

(Fig. 29M, N)

Pontophilus occidentalis Faxon, 1893: 200; 1895: 131, pl. D, figs. 2, 2a–2d. — Wicksten 1977a: 963.

Pontophilus gracilis occidentalis Chace, 1984: 48. — Wicksten 1989b: 31. — Wicksten & Hendrickx 2003: 69.

Diagnosis. Rostrum not reaching end of cornea of eye, with 2 pair lateral teeth. Carapace with dorsal carina, one dorsal tooth past midline, 2 teeth behind rostrum, lateral carina with 1 hepatic tooth at mid-body, antennal and pterygostomial teeth present. Eye large, unpigmented, unafaceted. Length of antennular peduncle about 0.5 as long as length of scaphocerite. Scaphocerite long, narrow; blade about as long as lateral tooth. Pereopod 1 subchelate, about as long as scaphocerite, finger of chela closing nearly horizontally to propodus. Pereopod 2 short, chelate, not reaching end of merus of pereopod 1. Pereopods 3–5 long, slender. Abdominal somites without carinae or teeth on pleura. Telson long, exceeding uropods. Total length 60 mm.

Color in life. Mostly scarlet, carapace brownish (Faxon 1895: pl. D, fig. 2).

Habitat and depth. Deep-sea mud, 1789–4082 m.

Range. 32 km from Castle Rock Light, San Clemente I., California (*Velero IV* sta. 8791, LACM) to off Peru. Type locality off Cocos I., Costa Rica.

Remarks. Chace (1984) considered the eastern Pacific specimens to belong to a subspecies of the cosmopolitan deep-sea shrimp *Pontophilus gracilis* rather than a separate species. Except for a shorter rostrum, the eastern Pacific subspecies is identical to specimens from the Atlantic and Indo-West Pacific.

***Rhynocrangon* Zarenkov, 1965**

***Rhynocrangon alata* (Rathbun, 1902)**

(Fig. 29H, I)

Sclerocrangon alata Rathbun, 1902a: 891. — Rathbun 1904: 134, fig. 72, 73. — Kozloff 1974: 164. — Wicksten 1980: 38.

Rhynocrangon alata. — Zarenkov 1965: 1764. — Butler 1980: 93. — Jensen 1995: 42, fig. 63.

Diagnosis. Body stout, shell thick, knobby. Rostrum short, about 0.5 times carapace length, with broad base, curved concavely from base to apex. Carapace with 2 dorsal teeth arising from median carina, antennal, branchiostegal, weak pterygostomial teeth, hepatic tooth on each side. Eye small, exposed. Antennular peduncle not as long as scaphocerite. Lateral tooth of scaphocerite slightly exceeding blade. Third maxilliped long, stout, with exopod. Pereopod 1 with sharp distal tooth on carpus, dactylus of subchela closing transversely across propodus. Pereopod 2 slender, chelate. Pereopod 3 slender, dactylus slender, acute. Pereopods 4, 5 stout, dactyls slender, acute. Abdominal somites 1, 2 with large median dorsal tubercles, somite 3 with high median carina with posterior projection, somites 4, 5 each with median dorsal carina, projected posteriorly as blunt tooth; pleura rounded or obtuse. Telson shorter than uropods, with 2 pairs minute dorsolateral spines, acute apex. Male total length 44 mm, female 45.

Color in life. Variable, mottled with brown, rose-pink patches (Jensen 1995).

Habitat and depth. On hard rocks or shale 11–167 m.

Range. Peter the Great Bay, Russia; Akutan I., Bering Sea to Santa Barbara Channel, (34° 25' N, 120° 18' W), California. Type locality Admiralty Inlet, Puget Sound.

Family Glyphocrangonidae Smith, 1884

Like the crangonids, the species of the family Glyphocrangonidae have subchelate first pereopods. Their common name, armored shrimps, reflects their firm, sculptured exoskeleton. The rostrum is well developed, dorsoventrally depressed and somewhat concave. The lateral margin of the rostrum bears teeth. The carapace bears grooves, ridges, spines and tubercles. The abdominal somites bear nodules and ventral teeth. The eyes of local species are large and pigmented.

Faxon (1893, 1895, 1896) described eastern Pacific armored shrimps. Holthuis (1971) provided a set of descriptive terms for the various features of the exoskeleton. The descriptions and key in this section use Holthuis' terms.

Little is known of the natural history of armored shrimps. *Glyphocrangon spinicauda* A. Milne-Edwards,

1881 was observed from a submarine off Florida. It spent much of the time with the rostrum embedded in the seabed and the body flexed (Anderson & Bullis 1970). *Glyphocrangon sculpta* (Smith, 1882) of the Atlantic was photographed by a time-lapse camera. It crawled on the bottom at a rate of about 100 cm/hr. Stomach contents of this species included foraminiferans, small bivalve mollusks and small crustaceans (Lampitt & Burnham 1983). Rice (1981) reported that species of *Glyphocrangon* eat small infaunal mollusks. He speculated that the ball and socket joints of the last three abdominal somites and telson could serve as a locking mechanism that would protect the abdomen from attack by predators. Species of *Glyphocrangon* can be parasitized by isopods (*Munidion* sp.)

Key to species of family Glyphocrangonidae

1. Rostrum with 6 or 7 lateral teeth, carapace covered with dense spines *Glyphocrangon spinulosa*
- Rostrum with 2 lateral teeth, carapace with carinae, nodules and anterior spines, but not covered with dense spines
. *Glyphocrangon vicaria*

Glyphocrangon A. Milne-Edwards, 1881

Glyphocrangon spinulosa Faxon, 1893

(Pl. 5F)

Glyphocrangon spinulosa Faxon, 1893: 202; 1895: 138, pl. 38. — Wicksten 1979c: 220, fig. 3A; 1989b: 314. — Wicksten & Hendrickx 2003: 70.

Diagnosis. Entire exoskeleton covered by short spines. Rostrum exceeding antennular peduncle, with 5–7 lateral teeth. Eye large and pigmented. Carapace with large antennal, branchiostegal teeth; cervical, lateral, anterior grooves. Teeth on lateral carinae larger than those on rest of carapace. Antennular peduncle short, stout; exceeding scaphocerite. Scaphocerite broad, apex rounded, with small lateral tooth near base. Third maxilliped short, stout, setose, with exopod. Pereopod 1 subchelate, ischium with anteroventral tooth. Pereopod 2 subchelate right pereopod longer than left, both with multi-articulate carpus. Pereopods 3–5 similar, but third dactylus simple, dactyls 4, 5 more flattened. Abdomen with interrupted median dorsal carina along entire length. Abdominal pleura 1 rounded, pleura of somites 2–5 with two ventral teeth each, pleuron of somite 6 with prominent lateral teeth visible from dorsal aspect. Telson longer than uropods. Total length 110 mm.

Color in life. Red (Faxon 1895).

Habitat and depth. Sand, mud, 1097–1875 m.

Range. Cortez Basin, California, U.S.A. to Costa Rica. Type material was collected at five stations between the southern Gulf of California (*Albatross* sta. 3435, 26° 48' 0" N, 110° 45' 20" W) and off Cape Corrientes, Colombia (*Albatross* sta. 3353, 7° 6' 15" N, 80° 34' 0" W).

Glyphocrangon vicaria Faxon, 1896

(Fig. 29J, K)

Glyphocrangon nobilis?: Faxon 1895: 142.

Glyphocrangon vicaria Faxon, 1896: 159, pl. 1, figs. 5–6. — Wicksten 1979c: 221, Fig. 4A–B; 1989b: 314. — Wicksten & Hendrickx 2003: 70.

Diagnosis. Exoskeleton firm, with scattered nodules but not covered with spines. Rostrum longer than scaphocerite, with 1 pair lateral teeth just beyond cornea of eye, another near base. Carapace with prominent antennal, branchiostegal teeth, each with supporting carina; also cervical, lateral grooves; nodules along submedial carinae, posterior intermediate carina, anterior, posterior antennal carinae. Antennular peduncle stout. Scaphocerite oval, without small tooth. First maxilliped stout, setose, with exopod. Pereopod 1 subchelate. Pereopod 2 slender, subchelate, carpus multi-articulate. Pereopods 3–5 similar, dactylus of third simple, dactyls of 4–5 flattened. Abdominal somite 1 small, pleura rounded. Abdominal pleuron 2 with one ventral tooth, pleura of somites 3–5

with two ventrolateral teeth each. Abdominal pleuron 6 ending in prominent tooth visible from above. Telson exceeding uropods. Total length 157 mm.

Color in life. Brownish-orange.

Habitat and depth. Mud, 938–3880 m.

Range. San Clemente Basin, California, U.S.A. to off Galapagos Is. Type locality north of Galapagos Is. (*Albatross* sta. 3411, 0° 54'N, 91° 9' W).

INFRAORDER ASTACIDEA LATREILLE, 1802

Members of this infraorder commonly are called crayfishes and lobsters. Unlike spiny lobsters, these species have a spiny rostrum, large chelae on the first pereopods and characteristic reproductive structures. Only the freshwater crayfishes (families Cambaridae and Astacidae) are found in California and Oregon, although species of the marine benthic family Nephropidae have been collected on the lower continental shelf and slope off western Mexico (Faxon 1893, Hendrickx 1995b).

In crayfishes, the female bears a depression (the annulus ventralis) between her gonopores on the coxae of the third pereopods. Immature males have stiff gonopods on the first abdominal somite; mature males have characteristic rigid copulatory appendages at this location (Hobbs 1976: figs. 2, 3). The female carries the eggs under the abdomen until they hatch. There are no distinct larval stages.

All species of the Astacidae found in California and Oregon are native to the area. Most live in shallow water (less than 3 m) of rivers and streams, but their depth range often is not reported. These crayfish generally live in cold waters. The male reproductive structures differ only slightly between species.

The family Cambaridae is native to the central and eastern United States, Canada, and Mexico, but has been introduced into at least some freshwater streams and ponds throughout the entire area of coverage. Members of this family inhabit rivers, streams, ponds, lakes, caves, and marshes and even damp meadows. Species of this family often have different color patterns, shape of the chelae and copulatory organs among immatures, non-reproducing males, reproducing males and females. It can be difficult if not impossible to identify members of this family to species without examining the characteristic copulatory structures of mature males. Only two species, *Procambarus clarkii* and *Orconectes virilis*, are commonly found in California and Oregon. *Procambarus clarkii* is widely used for aquaculture, bait or human consumption. *Orconectes neglectus* (Faxon, 1885) has been found lately in the Rogue River drainage of southern Oregon, and *O. rusticus* (Girard, 1852) in the John Day River of Central Oregon (Larson & Olden 2011). Other species of the Cambaridae, such as *Procambarus blandingii* (Harlan, 1830) have been imported and released from time to time (Bonnot 1930).

Crayfishes feed on a wide variety of plants, animals and detrital material. Insects, freshwater mollusks and decaying material rich in protein are favored foods. Many crayfishes can tolerate exposure to air for some time, and may be able to crawl across damp meadows or pastures. Most species are active at night. Species of the Cambaridae may dig burrows in mud. Large fishes, raccoons, egrets and herons feed on crayfishes. Leech-like worms (family Branchiobdellidae) and protozoans may parasitize crayfishes.

There have been few studies on the natural history of native crayfishes of California and Oregon. Hart & Clark (1989) prepared an exhaustive bibliography on many aspects of crayfish biology.

Key to species of Astacidea

1. Ischia of all pereopods lacking hooks 2
- Ischia of third pereopods with hooks 6
2. Rostrum with single pair of marginal tubercles or teeth *Pacifastacus leniusculus*
- Rostrum with at least 3 pairs marginal teeth 3
3. Dorsal surface of palm of chela with 2 conspicuous clusters of setae 4
- Dorsal surface of palm of chela without conspicuous clusters of setae 5
4. Postorbital ridges with 1–2 pairs posterior teeth or tubercles; rostrum lacking median carina *Pacifastacus connectens*
- Postorbital ridges lacking posterior teeth or tubercles; rostrum often with median carina. *Pacifastacus gambelii*
5. Width of palm of chela equal to, or greater than, length of medial margin *Pacifastacus fortis*
- Width of palm of chela less than length of medial margin *Pacifastacus nigrescens*

6. First pleopod terminating in 2 elements *Orconectes virilis*
 – First pleopod terminating in more than 2 elements *Procambarus clarkii*

SUPERFAMILY ASTACOIDEA Latreille, 1802

Family Astacidae Latreille, 1802

Pacifastacus Bott, 1950

Pacifastacus connectens (Faxon, 1914)

(Fig. 30G, H)

Astacus connectens Faxon, 1914: 360, pl. 7, figs 6, 10; pl. 10, fig. 1.

Pacifastacus connectens. — Hobbs 1976: 22, figs. 12d, 14a. — Larson & Olden 2011: 62, p. 61 fig. A.

Diagnosis. Similar to *P. leniusculus* except rostrum with numerous lateral teeth, tubercles. Postorbital ridges with 1–2 pairs posterior teeth or tubercles, rostrum lacking median carina. Dorsal surface of major chela with two conspicuous patches of setae, as well as prominent tubercles in patches. Palm of chela not much wider than fingers, edges more or less straight. Male total length 65 mm, carapace length 34 mm.

Color in life. Brown.

Habitat and depth. Rivers, streams; shallow.

Range. Idaho and Oregon, see map by Larson & Olden (2011: Fig. 1). Type locality Snake River, Idaho.

Pacifastacus fortis (Faxon, 1914)

(Fig. 30C, J)

Astacus nigrescens fortis Faxon, 1914: 360, pl. 7, fig. 5; pl. 9, fig. 2.

Pacifastacus nigrescens. — Riegel 1959: 44, fig. 3D, 9 (in part).

Pacifastacus fortis. — Hobbs 1976: 23, fig. 13c, 14c. — Eng & Daniels 1982: 197, fig. 1a. — Larson & Olsen 2011: 62.

Diagnosis. Similar to *P. leniusculus* except rostrum with numerous sharp teeth. Postorbital ridges with sharp teeth. Major chela with out patches of setae, width of chela equal to or greater than length of mesial margin. Male abdomen narrower, major chelae heavier than those of female. Carapace length to 50 mm.

Color in life. Dark brownish green to dark brown dorsally, bright orange ventrally, occasionally blue-green to bright blue with light salmon color below (Eng & Daniels 1982).

Habitat and depth. Cool, clear, spring-fed lakes, streams; under rocks on clean firm sand or gravel, shallow.

Range. Streams in Fall River, Hat Creek sub-drainages, area of Pit River connecting them, in Shasta County, California. Type localities Fall River Mills and Hat Creek near Cassel, California.

Remarks. Riegel (1959) considered *P. fortis* to be a subspecies of *P. nigrescens*, and included records of *P. fortis* in his account of the range of *P. nigrescens*. His records from Fall River, Fall "City" [*sic*] Mills, (the correct name is Fall River Mills), and Hat Creek at Cassel surely belong to *P. fortis*. Eng & Daniels (1982) prepared an extensive report on the threatened Shasta crayfish.

Pacifastacus gambelii (Girard, 1852)

(Fig. 30A, I, M)

Astacus gambelii Girard, 1852: 90. — Hagen 1870: 90, pl. I, figs. 97–98; pl. III, fig. 170; pl. XI. — Holmes 1900: 164.

Pacifastacus gambeli. — Riegel 1959: 43, fig. 3C, 8.

Pacifastacus gambelii. — Hobbs 1976: 22, figs. 13a, 14b. — Larson & Olden 2011: 63, p. 61 fig. B.

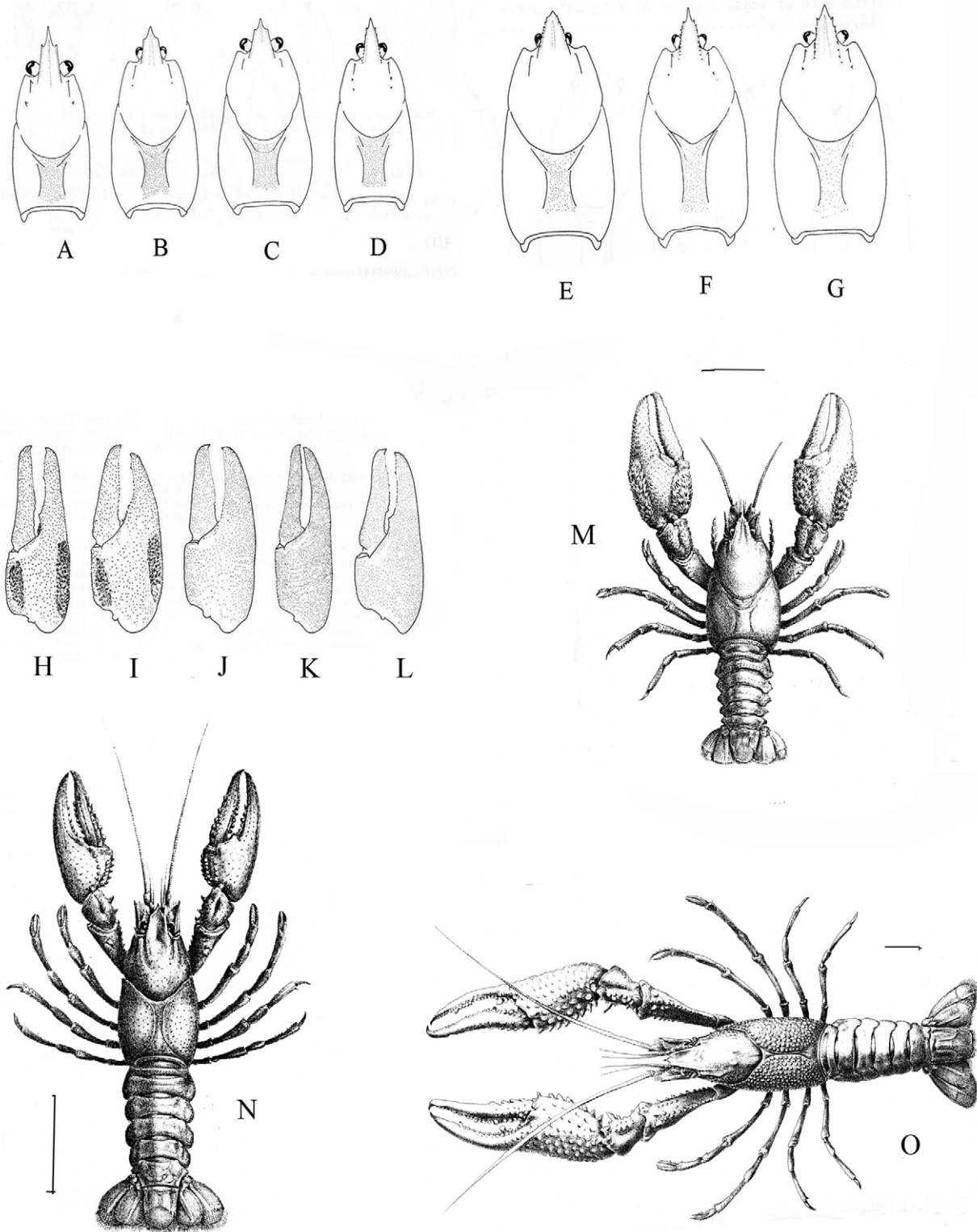


FIGURE 30. Families Astacidae and Cambaridae. Eyes and carapaces: A, *Pacifastacus gambelii* (Girard, 1852); B, *Pacifastacus nigrescens* (Stimpson, 1857); C, *Pacifastacus fortis* (Faxon, 1914); D, *Pacifastacus leniusculus leniusculus* (Dana, 1852); E, *Pacifastacus leniusculus trowbridgii* (Stimpson, 1857); F, *Pacifastacus leniusculus klamathensis* (Stimpson, 1857); G, *Pacifastacus connectens* (Faxon, 1914). Chelae: H, *Pacifastacus connectens*, I, *Pacifastacus gambelii*; J, *Pacifastacus fortis*; K, *Pacifastacus nigrescens*; L, *Pacifastacus leniusculus*. M, *Pacifastacus gambelii*. N, *Orconectes virilis* (Hagen, 1870). O, *Procambarus clarkii* (Girard, 1852); male. Scales: M = 10 mm, N, O = 20 mm. A–L from Hobbs 1976; M–O from Hagen 1870 (as *Astacus gambelii*, *Cambarus virilis* and *Cambarus clarkii*).

Diagnosis. Similar to *P. leniusculus* except rostrum with numerous small teeth, median carina often present. Postorbital ridges lacking posterior teeth or tubercles. Dorsal surface of major chela with two conspicuous patches of setae, as well as minute tubercles. Carapace length to 35 mm.

Color in life. Brown, greenish to blackish.

Habitat and depth. Rivers, streams; shallow.

Range. Snake River and its tributaries in Idaho, Nevada, Utah, and Wyoming; see map by Larson & Olden (2011: Fig. 1). Reported from Oregon, Montana, and Washington, also upper Missouri River and other drainages east of Continental Divide but records may be due to misidentifications. Type locality "California", but there have been no subsequent records from this state (Larson & Olden 2011).

Pacifastacus leniusculus (Dana, 1852)

(Fig. 30D–F, L)

Astacus leniusculus Dana, 1852: 524. — Stimpson 1857b: 493. — Hagen 1870: 94. — Holmes 1900: 166. — Bonnot 1930: 212, figs. 65–67.

Pacifastacus leniusculus. — Riegel 1959: 39, fig. 1F–H, fig. 3A, 6. — Miller & Van Hyning 1970: 77, figs. 1, 2. — Abrahamsson & Goldman 1970: 83. — Hobbs 1976: 21, figs. 5a, 12 a–c, 14e. — Eng & Daniels 1982: 200, fig. 1a. — McGriff 1983: 227. — Kuris *et al.* 2007: 636. — Larson & Olden 2011: 64, p. 61 figs. C, D.

Diagnosis. Rostrum acute, with single pair marginal teeth or tubercles, with or without median carina, with dorsal surface depressed. Postorbital ridges rounded or with pair of teeth or tubercles. Carapace with prominent cardiac grooves, paired branchiocardiac grooves, branchial regions slightly to greatly inflated. First antennae small, peduncle about same length as rostrum. Basicerite of second antenna with sharp lateral tooth. Scaphocerite with acute lateral tooth, as long as or slightly longer than rostrum. Third maxilliped setose, ischium armed with sharp spines on mesial, lateral margins of distal margin (forming "crista dentata"), next segment armed with spinules. Major chelae with smooth to tuberculate surface. Length of fingers about 3 times as long as length of palm, fixed finger with low tooth on cutting edge near proximal end. Outer margin of palm convex, inner convex, flared proximal to dactyl. Inner margin of palm with crest, slight depression parallel to crest on inner, upper, lower surface of palm. Carpus with blunt tooth at distal margin, sharp notch along articulation with chela, 2 teeth on lower margin along distal edge. Merus with large tooth at distal inner end, large tooth, row of teeth along lower edge, 2 teeth parallel, inner to this row. Ischium with tubercles in line with those of merus. Pereopods 2, 3 chelate, sparsely setose. Pereopods 4, 5 with dactyls forming claws. Ischia of all pereopods lacking hooks. Male pleopod 1 simple in structure, slender setose ridge along distal mesial surface. Male pleopod 2 with strong endopod, slender exopod. Female pleopod 1 biramous. Abdomen heavy. Abdominal somites decreasing in size from 1–5, with pleura ending in points curving posteriorly. Pleura of abdominal somite 6 prolonged into hook around base of uropods. Telson with horizontal fissure along dorsal surface near posterior end, 2 lateral teeth in line with this fissure. Outer uropod with fissure across dorsal surface, 2 lateral teeth along fissure, median ridge. Inner uropod with median ridge. Total length to 117 mm.

Color in life. Dark brown to dark greenish. The color notes are from specimens from Lake Tahoe, Nevada.

Habitat and depth. Rivers, streams, lakes, sloughs; less than 1 m to as much as 40 m (Lake Tahoe, Abrahamsson & Goldman 1970).

Range. British Columbia, Washington, Idaho, Oregon, Nevada (Lake Tahoe area) and California, south at least as far as Little Sur River, Monterey County. Introduced into Sweden. Type locality Columbia River, Oregon. Miller & Van Hyning (1970: fig. 3) provided a map of the range of the species in Oregon. Larson & Olden (2011: fig. 1) gave a map of the distribution of the subspecies in Oregon, Washington, southern British Columbia and extreme northwestern California.

Remarks. Three subspecies of *P. leniusculus* have been described: *P. leniusculus leniusculus* (Dana, 1852); *P. leniusculus klamathensis* (Stimpson, 1857) and *P. leniusculus trowbridgii* (Stimpson, 1857). Hobbs (1976) noted that the descriptions do not clearly define these subspecies, and their ranges overlap. Due to human activity, the subspecies have been introduced into new areas and have intermingled.

***Pacifastacus nigrescens* (Stimpson, 1857)**

(Fig. 30B, K)

Astacus nigrescens Stimpson, 1857a: 87; 1857b: 492. — Hagen 1870: 92, pl. III, fig. 168. — Holmes 1900: 166. — Bonnot 1930: 212.

Pacifastacus nigrescens. — Riegel 1959: 44 (part, figures probably are of *P. fortis*). — Hobbs 1976: 23, fig. 13b, 14d. — Kuris *et al.* 2007: 636. — Larson & Olden 2011: 62.

Diagnosis. Similar to *P. leniusculus* except rostrum concave, with prominent, acute apex; 5 or 6 lateral teeth, small spinules on postorbital ridges. Major chelae without clusters of setae, chela narrow, palm barely wider than closed fingers, fingers may be gaping. Abdominal pleura sharply triangular. Total length 78 mm.

Color in life. Blackish.

Habitat and depth. Streams near the coast. Depth not reported.

Range. Unalaska, Alaska; Fort Steilacoom, Washington, Alameda Creek, Alameda County and Coyote Creek, Santa Clara County, California (Holmes 1900). Type locality given as San Francisco, California, but Stimpson said that he purchased his specimens in a market.

Remarks. There have been no reliable records of live *P. nigrescens* since those of Holmes (1900). Subsequent reports by Bonnot (1930) quoted Holmes or considered *P. fortis* to be a subspecies of *P. nigrescens* (Riegel 1959). Holmes' specimens probably were burned in the fire following the San Francisco earthquake in 1906, so it is impossible to double-check the identification of his material from Washington and Alaska.

Family Cambaridae

***Orconectes* Cope, 1872**

***Orconectes virilis* (Hagen, 1870)**

(Fig. 30N)

Cambarus virilis Hagen, 1870: 63, pl. I, figs. 23–28, pl. II, figs. 128–132, pl. III, fig. 155; pl. VIII.

Orconectes virilis. — Hobbs 1976: 91, fig. 72h. — Daniels 1980: 131. — Fetzner 1996: 114, 116, 119. — Johnson & Johnson 2008: 47, photo page 54. — Larsen & Olden 2011: 66, p. 69 fig. C.

Diagnosis. Rostrum with dorsal groove, acute apex well removed from pair lateral teeth. Carapace with sharp cervical spines, prominent antennal angle. Pereopod 1 merus with large tooth near articulation with carpus, smaller teeth on mesial surface, carpus with two large teeth on mesial side. Major chelae with dorsal groove, double row of tubercles on dorsomedial side of palm in adult male; fingers straight, cutting edges lined by blunt teeth, double row of tubercles along mesial side of movable finger; Male with hooks on ischia of pereopod 3. Copulatory structures of male forked, deeply divided, apices of forks well separated, curving posteriorly. Annulus ventralis of female with high, narrow anterior wall divided by fissure, median depression wide, deep. Carapace length to more than 20 mm.

Color in life. Carapace, abdomen greenish-brown; claws, walking legs bluish-green; apices of chelae orange; see Johnson & Johnson (2008: 54) for good color photographs.

Habitat and depth. Lakes, rivers and streams, especially in swiftly moving, turbid water, shore to 20 m.

Range. Native to Canada and northeastern and north-central United States, but widely distributed throughout United States, either originally or through human introduction. Many records in California. Type locality not specified; original material came from Lake Superior, Lake Winnipeg, Saskatchewan, Red River and Toronto, Canada; Quincy, Illinois; Davenport and Burlington, Iowa; Miami River, Dayton, Ohio; Osage River, Missouri; Sugar River, Wisconsin; and San Gabriel River, Texas.

Procambarus Ortmann, 1905

Procambarus clarkii (Girard, 1852)

(Fig. 30O, Pl.5B)

Cambarus clarkii Girard, 1852: 91. — Hagen 1870: 39, pl. I, figs, 7–10, 99,100; pl. II, figs, 133–134; pl. IV.

Procambarus clarkii. — Hobbs 1976: 72, fig. 56d. — Rodriguez-Alvarez & Campos 1994: 729. — Johnson & Johnson 2008: 69, photo pages 70–72. — Kuris *et al.* 2007: 636. — Larson & Olden 2011: 66, p. 69 fig. D.

Diagnosis. Rostrum shorter than scaphocerite or antennular peduncle, with one pair teeth on postorbital ridge. Carapace somewhat granulate. Width of areola very narrow, cervical groove, branchiocardiac grooves delineating small triangular area on dorsal surface. Cervical tooth present. Third maxilliped setose, its ischium with inner distal margin ending in large tooth. Chelipeds narrow. Ischium with teeth in line with those of merus. Merus with teeth, tubercles on upper surface, distal margin, row of teeth on lower margin, smaller row mesial to this row. Carpus with 2 large inner teeth as well as tubercles. Palm of chela tuberculate, with teeth on inner margin; fingers longer than palm. Fixed finger with 2 large, 2 small teeth on cutting edge near proximal end. Dactyl may be concave on outer margin, with 2–3 tubercles on proximal end. Pereopods 2, 3 chelate, smooth. Pereopods 3, 4 with ischial hooks. Pereopods 4, 5 with simple dactyls. Abdominal pleura diminishing in size from 1–5, pleura blunt or with minute terminal tooth curved posteriorly. Pleura of abdominal somite 6 forming hook around base of uropods. Abdominal somites 1, 2 with dorsal sulci running across dorsal surface. Male pleopod 1 with prominent shoulder on cephalic surface. Male pleopod 2 with calcified endopod, soft exopod. Telson with lateral, median sulci, V-shaped fissure with 2 teeth on each side of fissure. Outer uropod with fissure and lateral tooth, also median ridge; inner uropod with lateral spine, median ridge. Male total length 82 mm, female smaller.

Color in life. Juveniles often camouflaged, brown, striped, or mottled; adults bluish to dark green, often with red spots on chelipeds; lower parts orange in breeding adults. Albinos are rare. Johnson & Johnson (2008: 70–72) gave a series of photographs of many color morphs of this species.

Habitat and depth. Ponds, shallow streams, ditches, lakes, shore to at least 6 m. After floods, has been found crossing wet ground and can be washed into estuaries.

Range. Native to southern Illinois to northern Mexico and Escambia County, Florida, but introduced widely elsewhere, including California and northern Mexico. Reported as far south as Ensenada in Baja California Norte and San Juan River in Nuevo Leon, Mexico (Rodriguez-Almaraz & Campos 1994); also introduced into Europe and Japan. Type locality "between San Antonio and El Paso del Norte, Texas." Larson & Olsen (2011: fig. 1) gave a map of the distribution in Oregon, Washington, Idaho and Utah.

Remarks. The red swamp crayfish has been introduced as bait or for use in aquaculture in many areas of the United States and Mexico, and now may well be the most abundant and widely distributed crayfish in North America. Any crayfish found in southern California is likely to be this species or the preceding one.

INFRAORDER PALINURA LATREILLE, 1802

The spiny lobsters are entirely marine. Unlike lobsters of the Astacidea, they have a small rostrum, if any, and do not have heavy pincers. Spiny lobsters have a fragile planktonic larval stage, the phyllosoma. Only one species of one family is native to California and northwestern Mexico. Fitch (1962) reported *Panulirus gracilis* Streets, 1871 from a single specimen taken near the San Diego harbor breakwater, but there have been no subsequent reports of this species from the area.

De Grave *et al.* (2009), following a phylogenetic study by Scholtz & Richter (1995), changed the name of the Infracorder Palinura s.s. to the Achelata. I can see no benefit to changing such a familiar and long-used name. This latest system of classification of spiny lobsters does not include superfamilies.

Family Palinuridae Latreille, 1802

Panulirus White, 1847

***Panulirus interruptus* Randall, 1840**

(Pl. 4D)

Panulirus interruptus Randall, 1840: 137. — Stimpson 1857b: 491. — Rathbun 1904: 148. — Schmitt 1921: 108, fig. 73. — Johnson & Snook 1927: 315, fig. 268, 270. — Ricketts *et al.* 1985: 195, fig. 168. — Williams 1986b: 21, fig. 49, color fig. 79 h, i. — Holthuis 1991: 142, fig. 271. — Jensen 1995: 79, fig. 161. — Hendrickx 1995b: 155.

Diagnosis. Carapace subcylindrical, rostrum absent. Supraorbital teeth strong, eyes not set in orbits. Carapace with numerous teeth, cervical groove. Antennules slender, antennular peduncle slightly longer than antennal peduncle. Antennal flagellum as long as body, armed with spinules; peduncle heavy, spinulose. Pereopods 1–4 with setose, simple dactyls; female pereopod 5 with hooked dactyl, prominent overlapping hook on propodus. Abdominal somites with deep dorsal sulci separated along dorsal midline; abdominal pleura ending in sharp points. Telson rectangular, with tubercles, teeth toward proximal end; uropods as long as telson, similarly armed with tubercles, spinules. Total length to more than 60 cm.

Color in life. Dark green, reddish or brown, with two "eyepots" above base of first antennae; rarely albino. The color notes are from specimens from southern California.

Habitat and depth. Rocky tide pools at extreme low tide, among surf grass (*Phyllospadix* sp.), rocky reefs, breakwaters, and kelp beds; lowest intertidal zone to 70 m.

Range. San Luis Obispo County, California to Magdalena Bay, Baja California; along west coast of Gulf of California from Carmen I. to vicinity of Cape San Lucas, but rare north of Point Conception. Type locality "California."

Remarks. The spiny lobster is primarily nocturnal, hiding in cracks and caves by day and emerging to feed by night. The adults are taken by hand by divers or in traps used by fishermen.

INFRAORDER POLYCHELIDA WOOD-MASON, 1874

Unlike the spiny lobsters, the flatback lobsters are deep-water benthic species with elongated chelae, held folded against the sides of the cephalothorax in life. The animals have eyestalks but are blind. The larval stage (the "eryonicus" larva) has an inflated cephalothorax filled with lipids.

Family Polychelidae Wood-Mason, 1874

***Polycheles* Heller, 1862**

***Polycheles pacificus* Faxon, 1893**

(Fig. 31A)

Polycheles sculptus pacificus Faxon, 1893: 196; 1895: 122, pl. c, fig. 1, 1a.

Eryonicus caecus?: Faxon 1893: 197; 1895: 110, pl. B, fig. 2; pl. 29, figs. 2, 2f (larval stage).

Eryoneicus Agassizi Bouvier, 1915: 2.

Eryonicus agassizi. — Schmitt 1921: 105, pl. 15, figs. 1, 2.

Stereomastis sculpta pacifica. — De Man 1916: 5. — Firth & Pequegnat 1971: 16. — Wicksten 1980b: 914, fig. 1. — Hendrickx 1995b: 156.

Stereomastis pacifica. — Wicksten 2002: 128.

Polycheles pacificus. — Galil 2000: 332, fig. 20.

Diagnosis. Carapace somewhat rectangular, with posterolateral margins converging. Anterior margin slightly concave, with 2 rostral teeth, 1 tooth at each internal orbital angle, blunt tooth on anteromedial edge of each eyestalk; external orbital angles smooth. Ocular notches broad, rounded; edges not parallel with lateral border. Midline teeth arranged as follows: 2 (rostrum), 1–2–1 (cervical groove) 2–2–2; occasionally with 1 tooth instead of 2 at each location. Posterior margin of carapace concave. Four teeth along gastrorbital carinae; 1 more tooth along each side. One tooth each on anterior branches. Superior branchial carinae low, armed with 5–6 teeth on each side.

Abdomen about as long as carapace. Terga of somites 1–5 with anteriorly produced teeth, strongest tooth on fourth tergum. Anterolateral border of first tergum with 3 teeth; edges of first four pleura armed with small tubercles. Abdominal somite 6 with low, double ridge without tubercles or teeth; pleuron almost acute. Base of telson with small blunt tubercle. Two teeth at antero-external edges of antennular peduncle. Ischia of chelipeds unarmed, meri with 1–3 dorsal teeth, carpi with 2 distodorsal, 1 or 2 ventral teeth, inner dorsal edge of propodus with 1 tooth, palms ventrally spinulose, fingers of chela crossing. Female pereopod 5 chelate, male pereopod 5 imperfectly chelate. Total length to 102.5 mm, females growing to larger sizes than males.

Color in life. Brick red, purplish red to scarlet.

Habitat and depth. Muddy areas of lower continental shelf and slope, 750–1875 m.

Range. Off Noyo Canyon, California to off Valparaiso, Chile. Type locality not specified, material came from 7 stations from off Mariato Point and the Gulf of Panama to off the Tres Marias Is., Mexico.

Remarks. The larval stage of this species is the largest decapod larva to be found in the area, reaching 87 mm in total length. The carapace of the larva is filled with fat, giving the animal a blimp-like appearance. Larval stages have been taken in midwater nets at 1846–3692 m (Wicksten 1980b).

INFRAORDER AXIIDEA HUXLEY, 1879

These lobster-like crustaceans formerly included in a single infraorder, the Thalassinidea, have been split into two infraorders based on genetic analyses (Robles *et al.* 2009). De Grave *et al.* (2009) gave an extensive list of references on nomenclature of these decapods.

The rostrum varies from a tiny point to long and triangular or toothed. The eye may or be not pigmented. Pereopods 1, 2 are chelate, but the second are smaller than the first. The first pereopods may be dissimilar in size. The other pereopods end in paddles or simple dactyls. The abdomen is cylindrical, but the exoskeleton may vary from thin and weak to strongly calcified. A telson with flanking uropods is present. These decapods burrow into mud, sand or mixed surfaces.

Classification of the Axiidea has been an ongoing process. Manning & Felder (1991) wrote an extensive revision of the American callianassids, which contains diagnostic drawings and further information on the taxonomy. Poore & Collins (2009) wrote an extensive work on the genera and western Pacific species of the Axiidae. Sakai (2005) presented another system of classification of the Callianassidae and Ctenochelidae. The key presented here will differentiate between axiideans in the area of coverage but does not apply to tropical species. The latest classification of the Axiidea and Gebiidea does not include superfamilies (De Grave *et al.* 2009).

The ghost shrimps (family Callianassidae) are the best studied of the Axiidea. These burrowers range from the intertidal zone to the subtidal continental slope. They are deposit feeders. Their burrows provide shelter for other invertebrates, including shrimps (Alpheidae), crabs (Pinnotheridae), the clam *Cryptomya californica* (Conrad, 1837) and fishes (family Gobiidae).

Little is known of the natural history of species belonging to other species of the Axiidea. In California and Oregon, species of the families Axiidae and Ctenochelidae are found on the continental shelf and slope.

Diagnoses in this section for the most part follow those of Hart (1982) and Williams (1986). MacGinitie & MacGinitie (1968), Haig & Abbott (1980), and Ricketts *et al.* (1985) gave extensive information on the natural history of near-shore species.

Key to species of Axiidea

1. Abdominal pleura large, firm. Rostrum triangular, with lateral teeth, carapace may have median ridge 2
 - Abdominal pleura small or absent. Rostrum broad, with numerous small teeth, setae, or reduced to median tooth or low, rounded margin, carapace without median ridge 6
2. Rostrum slender, carapace with single dorsal ridge. Ridges of telson without teeth 3 (Calocarididae)
 - Rostrum broad, carapace with more than one ridge, teeth or rows of spinules. Ridges of telson with teeth 4
3. Chelipeds with small marginal teeth. Carapace granulate *Lophaxius rathbunae*
 - Chelipeds with prominent marginal teeth. Carapace smooth *Calastacus stilirostris*
4. Carapace inflated. (Living at more than 200 m, among deep-sea sponges) *Eiconaxius acutifrons* (Eiconaxiidae)
 - Carapace not inflated. Not always living at 200 m or more, not associated with deep-sea sponges 5 (Axiidae)

5. Eyes with pigment. Usually living at 200 m or less *Calocarides spinulicauda*
 – Eyes without pigment. Usually living at more than 200 m *Calocarides quinqueseriatus*
 6. Rostrum consisting of median tooth. Eyestalk elongate, unpigmented *Callianopsis goniophthalma* (Ctenochelidae)
 – Rostrum obscure to absent. Eyestalk flattened, pigmented. 7 (Callianassidae)
 7. Eyestalk with tuberculiform apex. Living among rocks or sandy gravel from Santa Barbara County, California south.
 *Neotrypaea biffari*
 – Eyestalk without tuberculiform apex. Living in sand or mud of bays or estuaries, Alaska to Baja California 8
 8. Eyestalk with outer margin slightly concave, extending to 0.33 to 0.66 length of second segment of antennule
 *Neotrypaea gigas*
 – Eyestalk with outer margin slightly convex, barely exceeding distal margin of first segment of antennule
 *Neotrypaea californiensis*

Family Axiidae Huxley, 1879

Calocarides Wollebaek, 1908

Calocarides quinqueseriatus (Rathbun, 1902)

(Fig. 31B)

Calastacus quinqueseriatus Rathbun, 1902a: 887; 1904: 151, fig. 91. — Schmitt 1921: 113, fig. 76. — Wicksten 1980c: 362.
 — Komai 2000: 229.

Calocaris quinqueseriatus. — Hart 1982: 50, fig. 11. — Wicksten 1989b: 312. — Kensley 1996a: 61, figs. 4, 5 (extensive synonymy).

Calocarides quinqueseriatus. — Sakai & de Saint Laurent 1989: 44. — Hendrickx 1995b: 157.

Diagnosis. Rostrum flattened, median carina extending from mid-rostrum posteriorly, armed with 2–6 spines; lateral margins with 3–7 spines, prolonged as ridges on gastric area; these ridges separated by 2 short, spined ridges, forming 5 ridges in all. Carapace smooth, with deep cervical groove. Antennular peduncle short but longer than rostrum. Antennal peduncle with short thorn-like projections on second, third segments. Third maxilliped with teeth on inferior margin of broadest segment. Major chelipeds unequal in size, but similar in shape. Major chela with slight gape between fingers, minor chela without gape. Surfaces of hand granulate, upper margin of palm with teeth, teeth, granules also on carpus and merus. Pereopod 2 chelate, with distinct spines on merus, ischium. Other pereopods slender, with simple, setose dactyls. Abdominal pleura rounded. Telson with median tooth, toothed lateral margins, 2 toothed dorsal ridges, curved posterior margins, Toothed ridge on endopod of uropod. Abdominal somite 1 without pleopods. Other pleopods biramous. Sexes separate. Total length 73 mm.

Color in life. Not reported, but preserved specimens were pale.

Habitat and depth. Mud, 288–2200 m.

Range. Sea of Okhotsk to off San Nicolas I., California; Gulf of California off Angel de la Guardia I. and off Sinaloa, Mexico. Type locality off San Luis Obispo Bay, California. Komai (2000: 229) speculated that the specimens from the Sea of Okhotsk "may represent a distinct species."

Remarks. In California, this species was collected most often on the upper continental slopes along the mainland instead of along the offshore islands (Wicksten 1980).

Calocarides spinulicauda (Rathbun, 1902)

(Fig. 31 D, E)

Axius spinulicauda Rathbun, 1902a: 886. — Rathbun 1904: 149, fig. 90.

Axiopsis spinulicauda. — Schmitt 1921: 111, fig. 74. — Hart 1982: 44, fig. 8, color plate. — Wicksten 1989b: 312.

Acanthaxius spinulicaudus. — Sakai & de Saint Laurent 1989: 66.

Calocarides spinulicauda. — Kensley 1996a: 54.

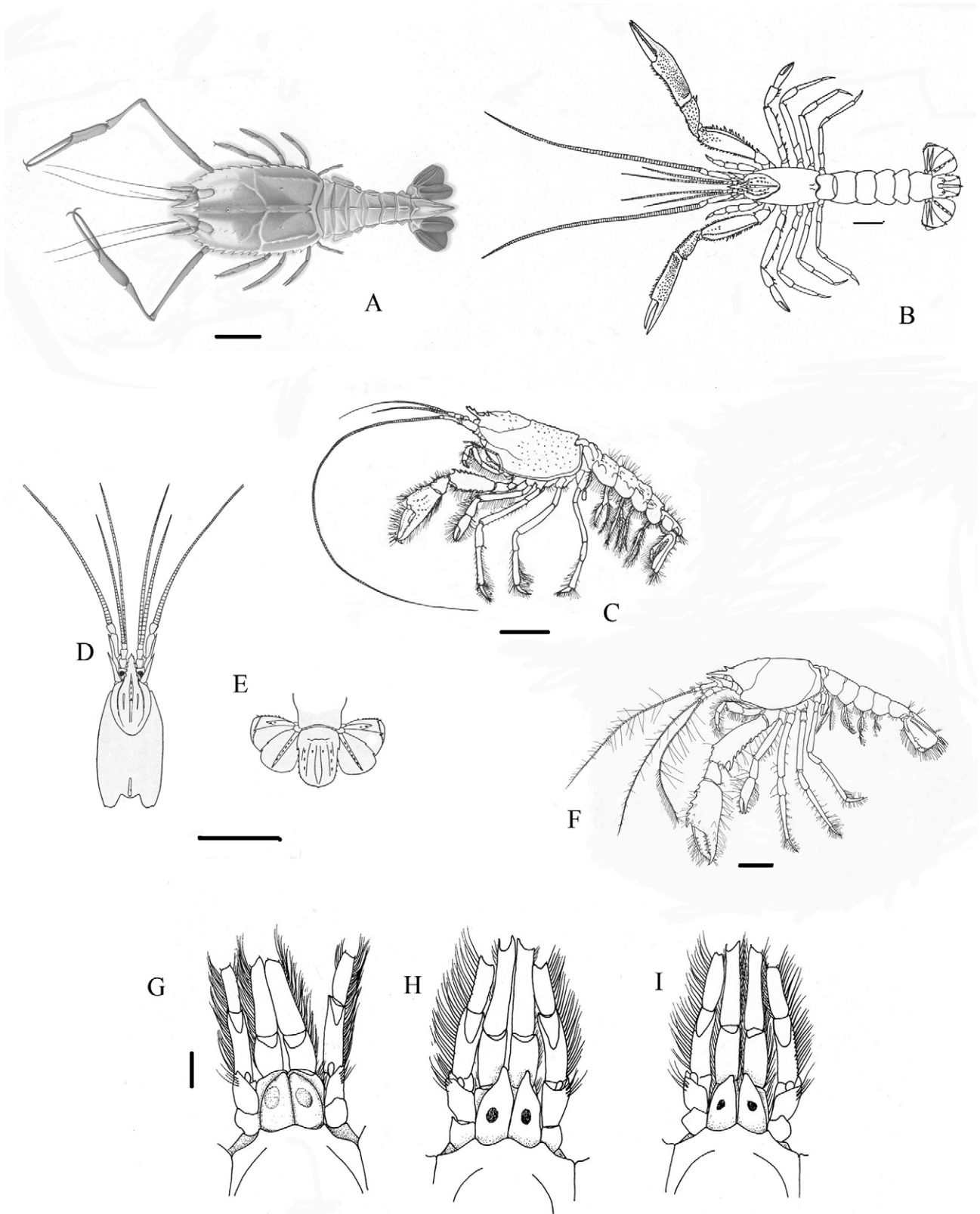


FIGURE 31. Families Polychelidae, Axiidae, Calocarididae and Callianassidae. A, *Polycheles pacificus* Faxon, 1893. B, *Calocarides quinqueseriatus* (Rathbun, 1902). C, *Lophaxius rathbunae* Kesley, 1989. D, E, *Calocarides spinulicauda* (Rathbun, 1902); D, carapace and frontal appendages; E, tail fan. F, *Calastacus stilirostris* Faxon, 1893. G, *Neotrypaea biffari* (Holthuis, 1991); frontal region in dorsal view. H, *Neotrypaea gigas* (Dana, 1852); frontal region in dorsal view. I, *Neotrypaea californiensis* (Dana, 1854); frontal region in dorsal view. Scales: G–I = 1 mm, A–F = 10 mm. A from Faxon 1895, B, D, E from Schmitt 1921 (B as *Calastacus quinqueseriatus*, D, E as *Axiopsis spinulicauda*); C, F from Hart 1982 (C as *Calocaris investigatoris*), G–I from Campos *et al.* 2009.

Diagnosis. Rostrum reaching middle of second segment of antennular peduncle, slightly deflexed, with 5 or 6 lateral teeth on each side. Carapace with 5 anterior longitudinal carinae, none of them reaching cervical groove, median carina reaching base of rostrum, bearing 4 spines; short median dorsal carina near posterior margin of carapace. Eyes pigmented. Long, thorn-like projections near base of antenna, scaphocerite narrow, sharp. Maxillipeds as long as end of antennal peduncle. Major chelipeds unequal in size, sexually dimorphic. Major chela of male subrectangular, with numerous marginal teeth; of female, palm with convex margins, fingers slender. Minor chelae of both sexes with finely toothed, curved margins. Pereopod 2 chelate. Pereopods 3–5 slender, setose, approximately same length, but decreasing in width of segments posteriorly. Abdomen smooth, stout, pleura rounded. Telson with tooth on mid-posterior margin, rows of spines on distal surface. Uropods with outer margins toothed, spines on median dorsal ridges. First pleopods uniramous, others biramous. Male with appendix masculina on second pleopod. Male total length 90 mm, female 89 mm.

Color in life. Mostly pink to coral pink, patches of orange on tail fan.

Habitat. Burrowing in mud, 59–256 m.

Range. Holbert Inlet, British Columbia to off Bodega Head, California. Type locality off Bodega Head. A recent photograph taken off La Jolla, California at 30 m may be this species (K. Lee, pers. comm.)

Family Callianassidae Dana, 1852

Until recently, all eastern Pacific ghost shrimps were considered to belong to the genus *Callianassa*. Manning & Felder (1991) revised the classification of genera in this family, and reassigned the species from California and Oregon to the genus *Neotrypaea*. Sakai (2005) continued to use the generic name *Callianassa* for these species.

There has been little recent work on local callianassids. Campos *et al.* (2009) studied the three species of *Neotrypaea* in northern Baja California and provided a key and an analysis of morphological features useful in identifying the species. Pernet *et al.* (2010) used both molecular and morphological methods to study the callianassids of southern California. These authors disagreed about the utility of using some of the morphological features presented by Campos *et al.* in distinguishing between the species. Although features of the major chela of males proved valuable in identification, these appendages may be lost in sampling and are not present in females or immature animals. The features of the eyestalk (presented in the key) proved most consistent in differentiation of the species. As of this writing, there have been no studies of the callianassids taken in benthic surveys of the continental shelf to determine whether or not they are the same species that occur in shallow and intertidal areas. Specimens from California and Oregon have not been compared with specimens from Mexico.

The alpheid shrimps *Betaeus ensenadensis*, *B. harrimani* and *B. longidactylus*, the crabs *Pinnixa franciscana* Rathbun, 1918; *P. schmitti* Rathbun, 1918; and *Scleroplax granulata* Rathbun, 1893 (Pinnotheridae) and the fishes *Clevalandia ios* (Jordan & Gilbert, 1882) and *Typhlogobius californiensis* Steindacher, 1879 have been reported to live with species of the Callianassidae. Campos *et al.* (2009) listed all the symbiotic or parasitic species found with northeastern Pacific callianassids.

Neotrypaea Manning & Felder, 1991

Neotrypaea biffari (Holthuis, 1991)

(Fig. 31G, Pl. 5C)

Callianassa affinis Holmes, 1900: 162, pl. 2, figs. 29, 30. — Rathbun 1904: 154. — Schmitt 1921: 119, fig. 81. — Johnson & Snook 1927: 330, fig. 277c. — Haig & Abbott 1980: 580, fig. 24.3. — Campos & de Campos 1989: 176. [Not *Callianassa affinis* A. Milne-Edwards, 1861, fossil species].

Neotrypaea affinis. — Manning & Felder 1991: 771. — Jensen 1995: 78, fig. 159.

Callianassa biffari. — Holthuis, 1991: 242, fig. 243. — Sakai 2005: 48, fig. 8.

Neotrypaea biffari. — Campos-Gonzalez *et al.* 2009: 1249, figs. 2g,h; 3a, 4c. — Pernet *et al.* 2010: 324.

Diagnosis. Median tooth of front obscure. Eyestalk with tuberculiform extremity, not divergent, pigmented cornea in front of middle of eyestalk. Carapace smooth, with cervical, lateral grooves. Third maxilliped operculiform.

Pereopods 1 unequal, chelate. Major chela of male with carpus shorter than to equal to palm, fingers crossing, without gape. Merus with large lobe near base. Small cheliped slender. Pereopod 2 chelate, posterior pereopods modified for digging. Abdominal pleura small. Male with vestigial first pleopods, second pleopods absent. Female with uniramous first pleopods, second pleopods biramous. Pleopods 3–5 biramous. Telson subrectangular, uropods about same length as telson. Male total length 61 mm, female not reported.

Color in life. Creamy white. The color note is from shrimp from Point Fermin, Los Angeles County, California; see also Jensen (1995).

Habitat and depth. Tide pools, in sand under rocks, intertidal zone.

Range. Goleta, Santa Barbara County to Tortugas Bay, Baja California, Mexico. Type locality Point Loma, San Diego County, California.

Remarks. This species usually occurs in pairs, often co-habiting its hole with the blind goby, *Typhlogobius californiensis*.

Neotrypaea californiensis (Dana, 1854)

(Fig. 31I, Pl. 5E)

Callianassa californiensis Dana, 1854: 175. — Holmes 1900: 159. — Rathbun 1904: 154. — Schmitt 1921: 117, fig. 78. — Johnson & Snook 1927: 329, figs. 275, 277B. — Haig & Abbott 1980: 579, fig. 24.2. — Hart 1982: 58, fig. 15. — Ricketts *et al.* 1985: 292, fig. 287. — Sakai 2005: 50.

Neotrypaea californiensis. — Manning & Felder 1991: 771, fig. 10. — Jensen 1995: 78, fig. 158. — Kuris *et al.* 2007: 648, pl. 326 G. — Campos-Gonzalez *et al.* 2009: 1249, figs. 2 a–c, 3c, 4a. — Pernet *et al.* 2010: 323, fig. 2.

Diagnosis. Rostrum bluntly rounded. Carapace smooth, with cervical, lateral grooves. Eyestalk without acute and divergent apex, pigmented cornea at middle of eyestalk. Third maxilliped operculiform. First chelipeds unequal, sexually dimorphic. Major cheliped of male with merus having prominent ventral lobe, carpus strongly incurved, subequal in length to hand, fingers gaping, crossing at apices. In female, immature male hand longer than carpus. Smaller cheliped with carpus longer than hand, fingers shorter than palm. Pereopod 2 chelate, flattened. Pereopod 3 with triangular carpus, broad subrectangular propodus, small rounded dactyl. Pereopods 4, 5 slender, last leg chelate. Abdominal pleura narrow. Male with vestigial pleopod 1, pleopod 2 absent, pleopods 3–5 foliaceous. Female with pleopod 1 uniramous, pleopod 2 biramous. Telson subrectangular, with 2 dorsal ribs, tooth on posterior margin. Uropods about same length as telson, exopod with dorsal ribs. Male total length 115 mm, female 120 mm.

Color in life. White to creamy, patches of pink, yellow to orange on appendages, abdomen pink (Jensen 1995).

Habitat and depth. Mud or sand, intertidal zone.

Range. Mutiny Bay, Alaska to Todos Santos Bay, Baja California, Mexico. Type locality "California" (probably San Francisco Bay or Monterey, where Dana obtained specimens).

Neotrypaea gigas (Dana, 1852)

(Fig. 31H)

Callianassa gigas Dana, 1852: 19. — Holmes 1900: 162. — Rathbun 1904: 154. — Schmitt 1921: 119, fig. 80. — Haig & Abbott 1980: 579. — Hart 1982: 56, fig. 14. — Sakai 2005: 57.

Callianassa longimana Stimpson, 1857a: 86. — Rathbun 1904: 154. — Schmitt 1921: 117, fig. 79. — Johnson & Snook 1927: 329, fig. 276. — Wicksten 1980c: 360.

Neotrypaea gigas. — Manning & Felder 1991: 771. — Kuris *et al.* 2007: 648, pl. 326 H. — Campos-Gonzalez *et al.* 2009: 1249, fig. 2 g, h; fig. 3 b, fig. 4 b–d. — Pernet *et al.* 2010: 323, fig. 2.

Diagnosis. Rostrum usually bluntly rounded, rarely acute. Eyestalk with acute, divergent apices, pigmented area behind middle of stalk. Carapace smooth, with cervical, lateral grooves. Third maxillipeds operculiform. First pereopods chelate, unequal, sexually dimorphic. Male major cheliped almost as long as rest of body, merus with large lobe near base, dorsal, ventral margins of carpus, palm relatively straight, chela elongate, usually without gape between propodus, dactyl when closed. Large cheliped of female, immature male with hand longer than

carpus. Small cheliped in both sexes elongate, carpus, hand subequal. Pereopod 2 chelate, palm wide. Pereopods 3–5 flattened, modified for digging, with simple dactyls. Male with vestigial pleopod 1, none on second abdominal somite; pleopods 3–5 well developed. Female with uniramous first pleopods, biramous second pleopods. Telson subrectangular, with pair dorsal ribs. Uropods as long as or longer than telson, exopod with dorsal rib. Male total length 150 mm, female 106 mm.

Color in life. Mostly ivory to cream, abdomen flesh-colored dorsally. Hart (1982) gave a detailed description of the color.

Habitat and depth. Mud or sandy mud, intertidal zone to 50 m.

Range. Digby I., British Columbia to San Quentin Bay, Baja California, Mexico. Type locality Puget Sound.

Family Calocarididae Ortmann, 1891

Calastacus Faxon, 1893

Calastacus stilirostris Faxon, 1893

(Fig. 31F)

Calastacus stilirostris Faxon, 1893: 194; 1895: 106, pl. 27, figs. 1–1f. — de Saint Laurent 1972b: 354. — Hart 1982: 46, fig. 9. — Kensley 1989: 961. — Wicksten 1989b: 312. — Hendrickx 1995b: 157.

Diagnosis. Rostrum long, narrow; reaching second segment of antennular peduncle, with stout teeth at base. Carapace with prominent cervical groove, narrow anterior dorsal ridge. Eyestalk short, cornea without pigment. Antennular peduncle narrow. Antennal peduncle with long, narrow, thorn-like projections on second and third segments. Flagella of both antennae long, setose. Third maxilliped not as long as merus of major chela, with teeth on widest segment. Pereopod 1 with chelipeds subequal, fingers without gape, apices crossing. Palm of chela with prominent dorsal teeth, merus with sharp teeth on both dorsal, ventral sides. Pereopod 2 chelate, posterior pereopods slender, with simple dactyls. Abdomen slender, pleura blunt or rounded. Telson subequal in length to uropods, with 2 unarmed dorsal ridges. Uropods with unarmed ridges, outer margins with teeth. First pleopods modified for copulation, uniramous, others biramous. These crustaceans are hermaphroditic (Hart 1982). Total length 52 mm.

Color in life. Not reported.

Habitat and depth. Brown sand or rock, 700–1208 m.

Range. Southwestern British Columbia to Peru. Type locality southeast of Acapulco, western Mexico (*Albatross* sta. 3418, 16° 33' N, 99° 52' 30"W).

Remarks. At present, there are no records of this species between Washington and northern Baja California.

Lophaxius Kensley, 1989

Lophaxius rathbunae Kensley, 1989

(Fig. 31C)

Calocaris investigatoris. — Rathbun, 1904: 151. — Schmitt 1921: 112. — Pereyra & Alton 1972: 450. — Hart 1982: 48, fig. 10. — Wicksten 1989b: 312. [Not *Calastacus investigatoris* Anderson, 1896: 97, pl. 2; Indo-West Pacific species, as illustrated by Schmitt 1921: fig. 75].

Lophaxius rathbunae Kensley, 1989: 963.

Diagnosis. Rostrum slightly shorter than second segment of antennular peduncle, with sides prolonged into sharp ridges reaching gastric region, bearing 2 teeth each. Carapace granulate, with medial carina ending in tubercle, another tubercle in middle of gastric region on dorsal margin, pronounced cervical, branchial grooves. Eyestalk small, cornea without pigment. Antennular peduncle shorter than antennal peduncle. Second, third segments of antennal peduncle bearing thorn-like projections. Third maxillipeds slender. Major chelipeds unequal in size but

similar in shape. Superior, inferior surfaces of merus with sharp teeth. Fingers long, narrow; with proximal gape; 3 rows granules on outer face of palm, palm with small marginal teeth. Pereopod 2 short, chelate. Other pereopods slender, with simple dactyls. Abdominal somites broad, setose, having grooves, knobs; pleura rounded. Telson longer than uropods, with 2 dorsal rows of fine spines. Uropods with dorsal ridges, few teeth on lateral margins. First pleopods uniramous, modified for copulation; others biramous. These crustaceans are hermaphroditic (Hart 1982). Total length 60 mm.

Color in life. Carapace pale gray to pink, abdomen pinkish orange to light brown, fading to white on sides; appendages pale orange (Hart 1982).

Habitat and depth. Abyssal mud, 549–1733 m.

Range. Eastern Pacific from Aleutian Is. to off San Diego, California. Type localities from off Dannakh I., Alaska (*Albatross* sta. 3210), off Cascade Head, Oregon (*Albatross* sta. 3347) and two stations off San Diego, California (*Albatross* sta. 2928 and 4352).

Remarks. The illustration provided by Schmitt (1921, fig. 75) is not this species but a similar species that lives in the Indian Ocean. Kensley (1989) did not illustrate the eastern Pacific species when he revised the generic designation.

Family Ctenochelidae Manning & Felder, 1991

Manning & Felder (1991) erected the new family Ctenochelidae for ghost shrimps with a cardiac prominence, strong scaphocerite and pediform third maxilliped usually with a distal spine. Only one species has been reported in the area of coverage.

***Callianopsis* de Saint Laurent, 1973**

***Callianopsis goniophthalma* (Rathbun, 1902)**

(Fig. 32A)

Callianassa goniophthalma Rathbun, 1902: 886; 1904: 154, pl. 8. — Schmitt 1921: 121, fig. 82. — Pereyra & Alton 1972: 450. — Wicksten 1980c: 362; 1989b: 312..

Callianopsis goniophthalma. — de Saint Laurent 1973: 515. — Hart 1982: 54, fig. 1. — Manning & Felder 1991: 789, fig. 18. — Hendrickx 1995b: 158. — Sakai 2005: 229.

Diagnosis. Rostrum small, sharp. Carapace smooth, slight elevation on mid-dorsal margin, distinct cervical, lateral groove. Eyestalk long, with small tooth, cornea unpigmented. Both antennae with slender peduncles, long, setose flagella. Third maxillipeds with semicircular dactyls. Larger cheliped with merus with ventral marginal tooth, carpus wide, palm of chela with sharp margins, fingers setose, toothed; gape between fingers in male. Smaller chela slender. Pereopod 2 chelate, Pereopods 3, 4 with simple dactyls, pereopod 5 subchelate. Abdomen with narrow pleura, membranous; sharp tooth on either side of somite 6. Telson subrectangular, uropods longer than telson; all bearing dorsal ribs. Male with first pleopods modified as copulatory appendages, female first pleopods biramous. Total length of male 130 mm, female 100 mm.

Color in life. Not reported, but newly preserved specimens were pale.

Habitat and depth. Continental slopes, mud, clay, 483–1920 m.

Range. Clarence Strait, Alaska to off Palos Verdes Peninsula, California; off Ahome Point, Sinaloa, Mexico. Type locality off Point Conception, California.

Family Eiconaxiidae Sakai & Ohta, 2005

Eiconaxius Bate, 1888

Eiconaxius acutifrons (Bate, 1888)

(Fig. 32B)

Axius acutifrons Bate, 1888: 40, pl. 5, fig. 2. — Faxon 1893: 193; 1895: 103, pl. 28, fig. 2. — de Man 1925: 15, 37, pl. 3, figs. 5–5e. — Wicksten 1982: 246, fig. 1; 1989b: 312.

Eiconaxius acutifrons. — Sakai & de St. Laurent 1989: 15. — Hendrickx 1995b: 157.—Kensley 1996b: 475. — Poore & Collins 2007: 40.

Diagnosis. Rostrum broad, with smooth margins or very small denticles, median rostral carina entire to slightly serrate. Carapace smooth, rounded. Eyes without pigment. Third maxilliped slender. Chelipeds stout, merus with teeth, palm with longitudinal lateral ridge, 4 teeth along dorsal midline, fixed finger of chela with large tooth near proximal end of cutting edge, small teeth beyond it; movable finger with notch into which large tooth inserts. Pereopod 2 chelate. Posterior pereopods with small, sharp dactyls. Abdominal somites smooth, with pointed pleura. Telson with medial row of teeth, row of teeth on dorsal midline of uropod. Female total length 29 mm, male not reported.

Color in life. Creamy white.

Habitat and depth. Sand, mud or rubble bottoms, or among hexactinellid sponges, 595–2310 m. Specimens from California lived inside a sponge.

Range. Off Banda I. and Great Kei I., Indonesia, off Mariato Point, Panama, and south of San Clemente I., California. Type locality off Banda I.

Remarks. Kensley (1996b) described a new species, *Eiconaxius baja*, from off Baja California, Mexico, but did not mention the record of a species of *Eiconaxius* from off California. It would be useful to compare the specimen on which the above record is based with the description of *E. baja*.

INFRAORDER GEBIIDEA DE SAINT LAURENT, 1979

The Gebiidea are distinguished from the Axiidea by having the first pereopod chelate or subchelate and the second much smaller, either without chelae or subchelate. The first pereopods often are equal or nearly equal in size and shape. Like the Axiidea, these lobster-like animals dig or burrow into mud or sandy mud.

Key to species of Gebiidea

1. Pereopod 1 subchelate. Rostrum not flat, densely setose. Southern California southward. . . . *Naushonia macginitiei* (Laomediidae)
– Pereopod 1 chelate. Rostrum flat, densely setose. Washington to Baja California 2 (Upogebiidae)
2. Postocular tooth absent or very tiny. South of Point Conception *Upogebia macginitieorum*
– Postocular tooth robust. May live north of Point Conception 3
3. Merus of pereopod 3 with proximolateral teeth *Upogebia lepta*
– Merus of pereopod 3 without proximolateral teeth 4
4. Short fixed finger of chela with slender, laterally compressed apex. Alaska to Morro Bay, California, intertidal
. *Upogebia pugettensis*
– Short fixed finger of chela with broad apex flattened, corneous on prehensile edge. San Miguel I., California, subtidal
. *Upogebia onychion*

Family Laomediidae Borradaile, 1903b

Only one genus with one species has been reported from the area.

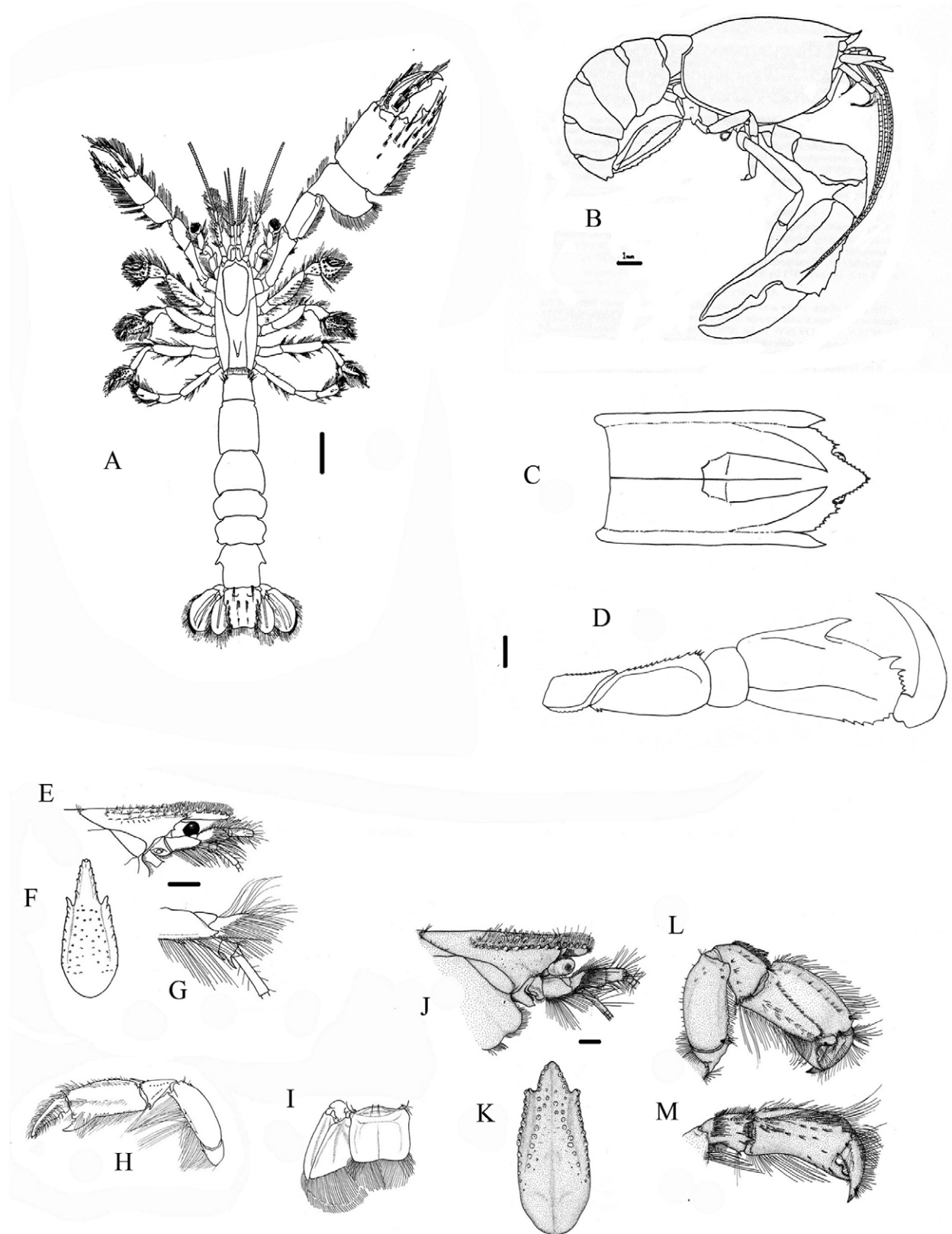


FIGURE 32. Families Ctenochelidae, Eiconaxiidae, Laomediidae, and Upogebiidae. A, *Callianopsis goniophthalma* (Rathbun, 1902). B, *Eiconaxius acutifrons* (Bate, 1888). C, D, *Naushonia macginitiei* (Glassell, 1938); C, carapace in dorsal view, D, pereopod 1. E–I, *Upogebia lepta* Williams, 1986; E, frontal region in lateral view; F, carapace, G, detail of antennular peduncle; H, cheliped; I, telson and uropod. J–M, *Upogebia macginitieorum* Williams, 1986; J, frontal region in lateral view; K, carapace in dorsal view; L, cheliped in lateral view; M, cheliped in mesial view. Scales: B–E, J = 1 mm, A = 10 mm. A from Schmitt 1921 (as *Callianassa goniophthalma*), B from Wicksten 1982b (as *Axius acutifrons*), C, D from Goy & Provenzano 1979, E–M from Williams 1986.

Naushonia Kingsley, 1897

Naushonia macginitei (Glassell, 1938)

(Fig. 32C, D)

Homoriscus macginitei Glassell, 1938: 414, figs. 1–4.

Naushonia macginitei. — Goy & Provenzano 1979: 339, figs. 6b,g; 7c, 8c, f, k, l. — Hendrickx 1995b: 159. — Sirota & Martin 2005: 146, fig. 2.

Diagnosis. Rostrum semi-oval, armed anteriorly with small, sharp teeth; upper surface granulate, slightly concave. Carapace lightly pubescent, with 7 sharp longitudinal ridges. Orbit semicircular, outer orbital angle small, blunt. Antennular peduncle longer than rostrum. Scaphocerite with 7–8 sharp teeth on outer margin, shorter than third segment of antennular peduncle. Ischium of third maxilliped armed on inner side with row of spinules, merus with distal tooth, propodus, dactyl subequal in length, longer than carpus. Pereopod 1 subchelate, propodus broad, upper margin carinate, with large fixed tooth, 3–4 smaller teeth on inner margin. Pereopod 2 short, stout; long setae on merus, simple, setose dactyl. Pereopods 3, 4 more slender, longer than second, with few setae; simple, slender dactyls. Abdominal somites without carinae or teeth. Telson rounded, sides with very fine teeth, 3 pairs lateral spines. Exopod of uropod shorter than endopod, both divided by sutures across posterior half. Carapace length to 7.7 mm, total length 19.2 mm.

Color in life. Bright orange, with appendages speckled with white or beige, dorsal surface of abdomen more uniform beige or cream (Sirota & Martin 2005).

Habitat. Under rocks in pool, among eelgrass (*Zostera* sp.), sand flats; intertidal zone to 11.2 m.

Range. Newport Bay and La Jolla, California; Ensenada de San Francisco, Sonora, Gulf of California, Mexico to Wafer Bay, Cocos I., Costa Rica. Type locality La Jolla, California.

Remarks. This peculiar animal was originally thought to be a sand shrimp (Caridea: Crangonidae). The similarity in the subchelate first pereopods could be confusing. The sutures of the uropod, the unusual rostrum and the ridges of the carapace are characteristic.

Family Upogebiidae Borradaile, 1903b

Only one genus of this family, *Upogebia*, is present in the eastern Pacific Ocean. The key and descriptions presented here follow Williams (1986a), which contains detailed synonymies and descriptions. Williams (1986a: 4) also reported a single finding of the Atlantic species, *U. affinis* (Say, 1818), from San Francisco Bay, California. This may be the record on which Sakai (2006) based his statement that *U. affinis* is distributed in the western Atlantic and “in the eastern Pacific Ocean.” Campos *et al.* (2009) listed parasitic and symbiotic species found with upogebiids.

Upogebia Leach, 1814

Upogebia lepta Williams, 1986

(Fig. 32E–I)

Upogebia lepta Williams, 1986a: 22, fig. 8. — Sakai 2006: 73. — Campos-Gonzalez *et al.* 2009: 1258.

Diagnosis. Rostrum narrowly triangular, straight, longer than eyestalk, with pair small subapical dorsal teeth, 4 lateral teeth on each side, central part of rostrum without teeth. Much of dorsal surface of carapace covered by spiniform tubercles, postocular tooth present. Cervical groove, thalassinidean line conspicuous. Antennular peduncle shorter than antennal peduncle, first, second articles bearing prominent ventral teeth. Third maxilliped with epipod. Major chelipeds nearly equal, slender; ischium with small spine, merus with small spines on superior, inferior sides; carpus with prominent teeth, palm setose, prominent spine at distal end, fixed finger of chela short, with tooth on cutting edge; movable finger slightly curved, with dentate dorsal crest having long proximal tooth.

Pereopod 2 stout, setose; carpus with teeth. Pereopod 3 with slender dactyl, merus with cluster of weak proximoventral spines. Pereopod 4 slender, merus without spines. Pereopod 5 subchelate. Abdomen smooth. Telson rectangular, very slightly lobed posteriorly, with low transverse anterior ridge, low lateral ridges. Uropods with protopod having tiny tooth, exopod with 3 dorsal ridges, endopod with 1 ridge. Male without first pleopods. Male carapace length 6.2 mm., female not reported.

Color in life. Not reported.

Habitat and depth. Benthic, 74–103 m.

Range. Santa Catalina I., California and Coronado Is., Baja California, Mexico. Type locality Coronado Is.

Remarks. Williams (1986a) did not report the substrate, but the areas in which the specimens were collected often have bottoms of shelly sand.

***Upogebia macginitieorum* Williams, 1986**

(Fig. 32J–M)

Upogebia macginitieorum Williams 1986: 30, fig. 11. — Campos & de Campos 1989: 176. — Sakai 2006: 74. — Campos-Gonzalez 2007: 38. — Campos-Gonzalez *et al.* 2009: 1249, fig. 1a,b.

Diagnosis. Rostrum triangular, straight, longer than eyestalk, with pair short subapical teeth followed on each side by 4 small conical teeth; dorsal teeth near midlength continuing with teeth, tubercles over anterior dorsal part of carapace. Two divergent spiny ridges extending from rostrum to posterior half of carapace. Gastric region posteriorly smooth, cervical groove deep, continuous, lateral groove (thalassinidean line) continuing to posterior margin of carapace. Postocular spine obsolescent or absent. Antennular peduncle shorter than antennal peduncle. Third maxilliped with epipod. Chelipeds nearly equal, setose. Ischium with 1 spine, merus with spinules on inferior margin, carpus bearing sharp teeth along posterior margin. Palm of chela broad, fixed finger with 1 large tooth on cutting edge, dactyl curved, overlapping fixed finger. Pereopod 2 very stout, dactyl blunt, not chelate, merus without medioventral tooth. Pereopods 3–5 decreasing in size, setose, with simple dactyls. Abdomen smooth, pleura narrow, pubescent. Telson rectangular, with median indentation, transverse anterior ridge, low lateral ridges. Uropods with tooth on protopod, exopod with 3 dorsal ridges, without transverse suture; endopod with 1 ridge. First pleopod absent in male, biramous in female, other pleopods biramous. Male carapace length 20.7 mm, female carapace length 22.1.

Color in life. Dull grayish to bluish, appendages with whitish to yellow tinge, tail fan with yellow to orange edge.

Habitat and depth. Clay banks, high intertidal zone.

Range. Santa Catalina I. and Newport Bay to Tortugas Bay, Baja California, Mexico. Type locality Tijuana Slough, California.

Remarks. This species has been confused with *U. pugettensis* in older literature.

***Upogebia onychion* Williams, 1986**

(Fig. 33A–E)

Upogebia onychion Williams, 1986a: 33, fig. 12. — Sakai 2006: 74.

Diagnosis. Rostrum broadly triangular, pair of moderate subapical dorsal teeth followed by 2 teeth, central surface bearing tufts of setae, almost without teeth, merging with area of sparse spiniform tubercles and tubercles diminishing over anterodorsal carapace. Gastric region posterior to field of tubercles smooth. Cervical groove moderate, continuous, thalassinidean line continuing to posterior margin of carapace. Postocular margin bearing tooth. Antennular peduncle shorter than antennal peduncle. Second segment of antennal peduncle without subdistal ventral tooth. Scaphocerite moderate. Chelipeds nearly equal, moderately stout. Ischium with 1 small ventral spine, merus with 4 spines on ventral margin, subdistal dorsal spine, carpus with obsolescent teeth, 3–4 tiny teeth on anterodorsal margin, also teeth on distomedial, distoventral margins; palm of chela with rows of setae, dorsal crests low, without teeth; fixed finger stubby, with 1 or 2 teeth on cutting edge; dactyl slightly curved, with 1 low tooth on

cutting edge. Pereopod 2 stout, without chela; merus with dorsal tooth, carpus with dorsal, ventral spines. Pereopods 3–5 smaller, setose, without teeth. Abdomen broad, pleura of first somite narrowly rounded posterolaterally, other pleura broadly rounded. Telson rectangular, with low lateral ridges, median groove obsolescent. Uropods with tiny tooth on protopod, endopod with 2 ribs, exopod with 3. Carapace length 7.2 mm.

Color in life. Not reported.

Habitat and depth. Among sand and rocks, 39 m.

Range. Known only from type locality, east of Cardwell Point, San Miguel I.

***Upogebia pugettensis* (Dana, 1852)**

(Fig. 33F–J)

Gebia pugettensis Dana, 1852: 19.

Upogebia pugettensis. — Holmes 1900: 157. — Rathbun 1904: 153. — Schmitt 1921: 115, fig. 77. — Johnson & Snook 1927: 327, fig. 274 (part). — Haig & Abbott 1980: 579, fig. 24.1 (part). — Hart 1982: 52, fig. 12. — Ricketts *et al.* 1985: 393, fig. 305 (part). — Williams 1986a: 35, fig. 13. — Jensen 1995: 78, fig. 160. — Sakai 2006: 75. — Kuris *et al.* 2007: 648.

Diagnosis. Rostrum broadly triangular, flanked by shorter frontal process at each side; apex obtuse, length shorter than antennular peduncle; lateral borders with 3–5 conical teeth, short subapical pair remote from apex; 0–2 dorsal teeth near midlength on each side. Row of 11 or 12 teeth on ridge lateral to gastric region of carapace, surface mesial to these rows armed with small tubercles or teeth; anterolateral margin with short ocular tooth, extension of epistome in lateral view bearing 1–3 tiny distal teeth. Shoulder of carapace lateral to cervical groove armed with about 20 tiny teeth, thalassinidean line continuing to posterior margin of carapace. First segment of antennular peduncle with sharp tooth at distoventral end of inner border. Second segment of antennal flagellum with small distoventral tooth, scale small, oval. Chelipeds equal. Ischium with small tooth on lower border, merus with upper margin curved, small spine near carpal end, setae, 5 or 6 small teeth on ventrolateral border, 4 spines on ventromedial border; carpus with lateral longitudinal furrow, strong tooth on mediodistal border, 4–10 small teeth nearby, small tooth on distal margin, larger tooth at mediodistal margin, also small tooth at distoventral corner; palm of chela with setose lines, rows of small teeth, setae, mediodistal sharp spine at base of dactyl; fixed finger directed ventromesially, with 1 conical tooth on cutting edge; dactyl slightly curved, upper surface ridged, bearing rows of setae, lateral surface with row of 6 or 7 blunt tubercles, 2 or 3 smaller tubercles near them, 2 low teeth on cutting edge. Pereopod 2 not chelate, merus with tiny tooth on superior margin, carpus with small distal teeth, fringe on setae along lower margins of segments. Pereopods 3–5 setose, decreasing in size, dactyls with spinules on flexor margins. Abdomen rather broad, pleura usually without ventral teeth. Telson widest at anterior end, with low dorsal carina on each side of median furrow. Uropods slightly exceeding telson, bearing dorsal ribs, minute marginal spines, protopod bearing small tooth. Total lengths 75–112 mm, males smaller than females.

Color in life. Deep olive, brown, deep blue to dirty bluish white. The color may depend on the feeding habits of the individual.

Habitat and depth. Burrows in muddy beaches, mud flats, sloughs or estuaries, intertidal to shallow subtidal zones near shore.

Range. Sawmill Bay, Alaska to Morro Bay, California. Type locality Puget Sound.

INFRAORDER ANOMURA MACLEAY, 1838

The most recent attempt to analyze the systematics of the families of the Anomura and organize them into superfamilies was that of McLaughlin *et al.* (2007). This system, using a combination of morphological and cladistic analysis, is followed in the current work. Many problems in distinguishing relationships between the various anomurans remain unsolved because of different conclusions based on molecular versus morphological data, examination of only a few specimens in a taxon or over-generalization of the significance of particular features during development. Older works combined the old infraorder Thalassinidea (now the Axiidea and Gebiidea) with the Anomura, but sufficient molecular and morphological evidence supports their removal from the Anomura.

Most anomurans in the northeastern Pacific and adjacent waters are crab-like. The carapace is not fused to the epistome (the area above the mouth). In many species, the second antennae are elongated instead of short, and are not retractable into sockets. Often, one pair of antennae lies mesial to the eyestalks and the other lateral to them. In the hermit crabs, king crabs and galatheoids, the third maxillipeds do not form a plate-like covering of the mouth (an operculum). Pereopod 1 is chelate in all local species but *Emerita analoga*. Pereopod 5 often is modified for digging, gripping a shell or cleaning the body. The abdomen may be soft, twisted to one side or partially membranous, but not among the mole crabs. Pleopods often are reduced or present on only one side of the abdomen. The telson may be reduced or absent, or form part of a tail fan. Unlike true crabs (Brachyura), anomurans may be able to swim by flapping the abdomen.

In anomurans and brachyurans, the term "spine" refers to any sharply pointed process and a "tooth" is either flattened or rounded.

Key to families of Anomura

1. Abdomen soft, elongate. Inhabiting shells or tubes 2
 - Abdomen usually not soft, if so, rounded, not elongate. Not inhabiting shells or tubes 4
2. Outer maxillipeds close together at base, chelipeds subequal Diogenidae
 - Outer maxillipeds separated by the width of one maxilliped at least at base, chelipeds not equal in size, shape 3
3. Toothed ridge of outer maxilliped with 1 or more accessory teeth, female with gonopore on both third pereopods. Intertidal or deeper Paguridae
 - Toothed ridge of outer maxilliped without accessory teeth, female with gonopore on left third pereopod only. Continental shelf, slope Parapaguridae
4. Body somewhat egg-shaped to rectangular, highly modified for digging 5
 - Body not egg-shaped to rectangular, not modified for digging 7
5. Pereopods 1 without chelae, telson elongate, spearhead-shaped Hippidae
 - Pereopods 1 with chelae, telson small, somewhat circular to ovate 6
6. Eyestalks elongate ovoid, with pigmented corneae Blepharipodidae
 - Eyestalks squarish, corneae without pigment Albuneidae
7. Abdomen tightly flexed beneath abdomen, soft to calcified but incapable of being used in swimming, not lobster-like; uropods absent 8
 - Abdomen loosely flexed beneath abdomen, lightly calcified, capable of being used in swimming, may be lobster-like; uropods present 9
8. Abdomen soft, uncalcified. Intertidal to shallow subtidal zones, not found at depths of more than 165 m ... Hapalogasteridae
 - Abdomen at least partially calcified but may have membranous sutures. Intertidal zone to continental slopes at greater than 165 m Lithodidae
9. Abdomen not lobster-like, folded against cephalothorax, pereopods 1 heavy, not elongate Porcellanidae
 - Abdomen lobster-like but short, not folded against cephalothorax, pereopods 1 slender, elongate 10
10. Third maxilliped without epipod. Telson folded beneath preceding abdominal somites. Continental slopes, usually living on colonial anthozoans Chirostylidae
 - Third maxilliped with epipod. Telson not folded beneath preceding abdominal somites. Surface waters to abyssal plains, various substrata 11
11. Front broad, triangular Galatheidae
 - Front not broad or triangular, composed of slender rostrum flanked by supraorbital spines 12
12. First maxilliped without flagellum or flagellum strongly reduced. Cornea of eye without pigment. Usually found at 200 m or deeper Munidopsidae
 - First maxilliped with well-developed flagellum. Cornea of eye pigmented. Usually at surface to 200 m Munididae

SUPERFAMILY GALATHEOIDEA Samouelle, 1819

Squat lobsters, langostinos or craylets of the families Chirostylidae, Galatheidae, Munididae, and Munidopsidae; generally are found on the continental shelf and deeper in the northeastern Pacific. Ah Yong *et al.* (2010), in a recent revision, divided the old family Galatheidae into the Galatheidae s.s. and the families Munididae and Munidopsidae. Most of these species are epibenthic on the continental shelf and in deeper areas. Only *Pleuroncodes planipes* at times is cast ashore or enters near shore waters. Baba *et al.* (2009) listed all of the families, genera and species worldwide.

Ranges of deep benthic galatheoids of the eastern Pacific remain uncertain, as does some classification to species. It is not known yet whether populations of species thought to be pan-Pacific or cosmopolitan are actually separate species. Macpherson *et al.* (2010), in a biogeographical study, noted the isolation of the eastern Pacific galatheoid fauna. Two genera, *Janetogalatea* and *Pleuroncodes*, are endemic to the eastern Pacific.

Family Chirostylidae Ortmann, 1892

The Chirostylidae are deep-water crabs that superficially resemble the Galatheidae. All chirostylids have elongate chelipeds ending in slender, gaping fingers. They immediately can be distinguished from galatheids by the form of the telson. Baba & Haig (1990) gave a key to the five members of the genus *Gastroptychus* that occur in the eastern Pacific. Janet Haig provided the previously unpublished information and key given here.

Rice & Miller (1991) discussed several examples of commensalism between chirostylids and cnidarians and echinoderms. Both species of *Gastroptychus* from the northeastern Pacific associate with colonial cnidarians..

Key to species of family Chirostylidae

1. Lateral carapace margins strongly convex in posterior 0.66; tergum of abdominal segment 5 unarmed. . . *Gastroptychus iaspis*
- Lateral carapace margins nearly straight posteriorly; tergum of abdominal segment 5 spiny *Gastroptychus perarmatus*

Gastroptychus Caullery, 1896

Gastroptychus iaspis Baba & Haig, 1990

(Fig. 33K, L)

Chirostylus sp: Hart 1982: 166, fig. 65. — Wicksten 1982: 245; 1989b: 315.

Gastroptychus iaspis Baba & Haig 1990: 854, figs. 1, 2.

Diagnosis. Rostrum short, triangular, terminating in narrow spine directed upward. Carapace slightly longer than greatest width. Lateral margins strongly convex in posterior 0.66 of carapace length; well developed anterolateral spine, row of inconspicuous lateral spines. Gastric region bearing 6 prominent spines arranged in hexagon, few additional, widely set spines. Mid-cervical groove located about halfway along carapace. One or 2 pronounced spines on anterior branchial region; cardiac region with pair prominent spines; posterior branchial region with short, widely set spines. Tergum of abdominal somite 1 with transverse row of 5–11 spines. Tergum of somite 2 with transverse row of tubercles, pleura with 1–5 small dorsal spines along anterolateral margin. Tergum of somites 3, 4 unarmed; pleura with 1–4 small posterior marginal spines or none. Tergum of somite 5 unarmed; pleura bearing 1–7 small spines on posterolateral margin, occasionally 1 or 2 small spines on pleural surface. Tergum of somite 6 with 3 prominent posterior marginal spines, 6 (occasionally more) dorsal spines; pleura usually unarmed, rarely with spines on lateral margin. barely reaching end of rostral spine; cornea dilated. Length of chelipeds about 5 times length of carapace excluding rostrum. Merus, carpus, palm with several regular longitudinal rows of spines. Pereopods 2–4 slender, merus and carpus with 6 rows spines, propodus with dorsal, mesial, dorsolateral spines in longitudinal rows, ventral margin with row of closely set movable spinules; length of dactyl less than 0.33 times length of propodus, with ventral spinules, terminating in acute corneous claw. Carapace length excluding rostrum: male 30.0 mm, ovigerous female 25.5.

Color in life. Anterior carapace bluish pink, laterally pale pink, white; spines orange. Antennules, antennae, eyestalk orange; cornea black. Chelipeds orange with white spines, fingers; pereopods 2–4 orange becoming paler on dactyls (Hart 1982). A specimen from southern California was dark carrot-orange.

Habitat and depth. On abyssal muddy sand in northern part of range (Hart 1982); hard bottom on Jasper Seamount (Baba & Haig 1990); 600–1189 m.

Range. Southeastern Vancouver I., British Columbia, 48°13'N (Hart 1982) to Jasper Seamount off Baja California, 30°25'N. Type locality Jasper Seamount, from 30° 25.6' N, 122°43.7' W to 30° 25.5' N, 122° 44.3' W.

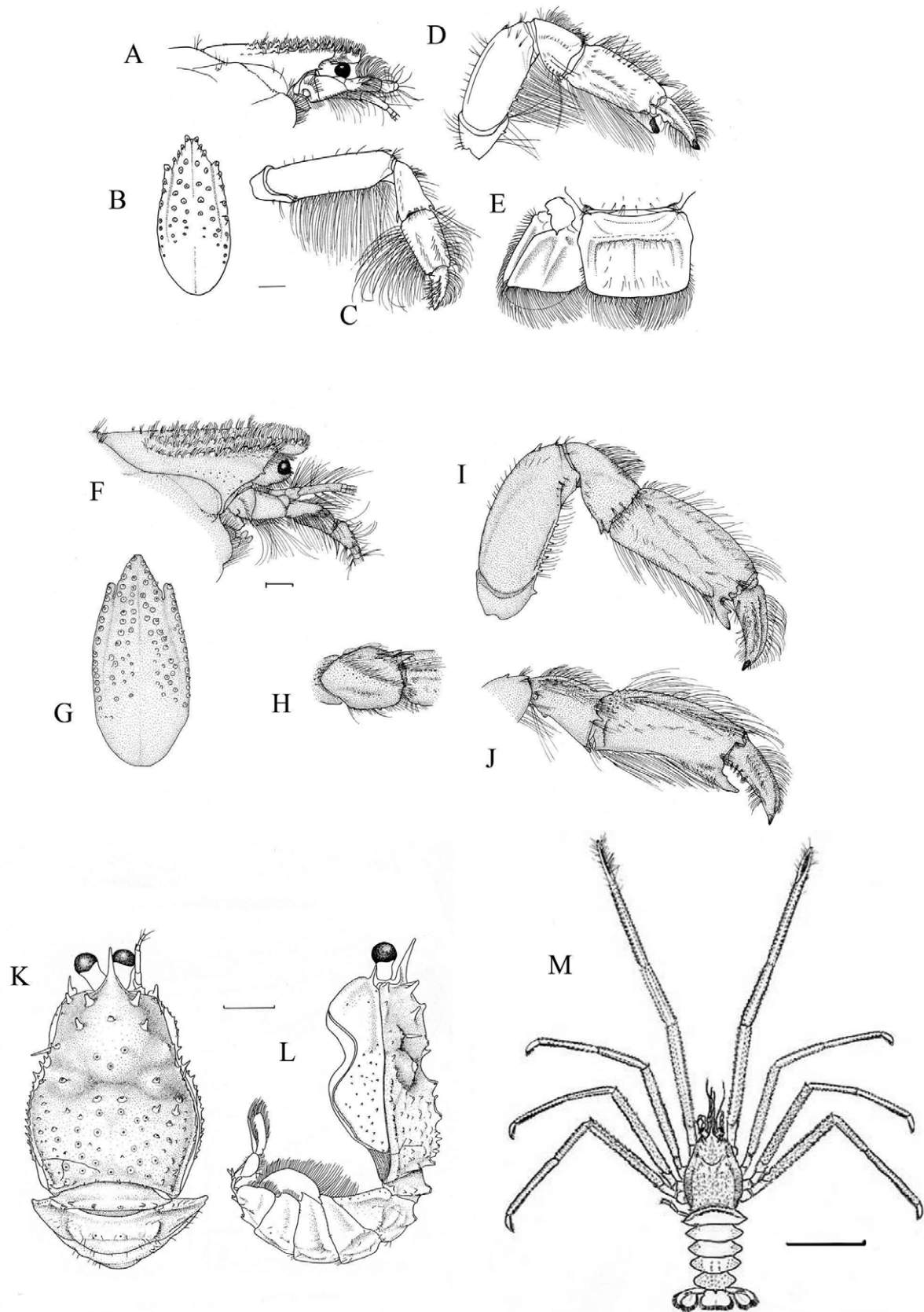


FIGURE 33. Families Upogebiidae and Chirostylidae. A–E, *Upogebia onychion* Williams, 1986; A, frontal region in lateral view; B, carapace in dorsal view; C, pereopod 2; D, cheliped; E, telson and uropod. F–J, *Upogebia pugettensis* (Dana, 1852); F, frontal region in lateral view; G, carapace; H, detail of carpus of cheliped; I, cheliped in lateral view; J, cheliped in mesial view. K, L, *Chirostylus iaspis* Baba & Haig, 1990; K, carapace and abdomen in dorsal view; L, carapace and abdomen in lateral view. M, *Chirostylus perarmatus* (Haig, 1968). Scales: A, F = 1 mm, K, L = 5 mm, M = 20 mm. A–J from Williams 1986, K, L from Baba & Haig 1990, M from Haig 1968 (as *Gastroptychus perarmatus*).

Remarks. This species is an important member of the Jasper Seamount community at the 600–1100 m depth interval, where it was usually seen on gorgonians and antipatharians (A. Genin, California Department of Fish and Game, pers. comm.) These crabs have been caught in baited fish traps off southern California, which suggests that they are scavengers (Wicksten 1982b).

***Gastroptychus perarmatus* (Haig, 1968)**

(Fig. 33M)

Chirostylus perarmatus Haig, 1968: 272, figs. 1–3. — Wicksten 1989b: 315.

Gastroptychus perarmatus. — Baba & Haig 1990: 859.

Diagnosis. Rostrum as in *G. iaspis*. Carapace excluding rostrum 1.5–1.6 times as long as greatest width. Lateral margins nearly straight posteriorly; strong anterolateral spine and row of small lateral spines. Gastric region with numerous small spines and spinules interspersed with larger spines, most prominent an epigastric pair. Mid-cervical groove distinctly anterior to halfway point of carapace. Anterior branchial region with several large, small spines; cardiac region with pair prominent spines, few smaller ones; regions posterior to cervical groove with numerous, closely set large, small spines in irregular longitudinal rows. Tergum of abdominal somite 1 with transverse row of 12–18 spines. Tergum of somite 2 with transverse row of small spines, pointed granules, and pointed tubercles at junction with pleura; pleura with small spines on anterolateral margin, dorsal surface. Tergum of somites 3, 4 unarmed except for 1–3 spines on surface. Tergum of somite 5 with 4 longitudinal rows of spines, each outer row at junction with pleuron; pleura with small spines on surface. Tergum of somite 6 bearing numerous large, small spines; pleura with few spines on surface. Eyestalk barely reaching end of rostral spine; cornea dilated. Length of chelipeds about 6 times length of carapace excluding rostrum. Merus, carpus, palm with regular longitudinal rows of spines. Pereopods 2–4 slender, merus, carpus with 6 rows of spines; propodus with dorsal, mesial, dorsolateral rows of spines, ventral margin with row of closely set movable spinules; length of dactyl less than 0.33 times length of propodus, with ventral spinules, terminating in acute corneous claw. Carapace length excluding rostrum: male 20.5 mm, female 16.0 mm.

Color in life. Not reported. Bright pink after a few weeks of preservation in alcohol, soon fading to white (Haig 1968).

Habitat and depth. Green mud bottom or on antipatharians; from 229–366 m.

Range. From north of Anacapa I. to Coronado Bank, California. Type locality north of Anacapa I., from 34° 05.8' N, 119° 23.3' W to 34° 6.0' N, 119° 24.3' W.

Remarks. Two specimens collected off Coronado Bank in 366 m were clinging to a branch of black coral, order Antipatharia.

Family Galatheidae Samouelle, 1819

As revised by Ahyong *et al.* (2010), only one species lives in the area of coverage.

***Janetogalthea* Baba & Wicksten, 1997**

***Janetogalthea californiensis* (Benedict, 1902)**

(Fig. 34A, Pl. 7A)

Galathea californiensis Benedict, 1902: 247, fig. 1. — Schmitt 1921: 164, fig. 104. — Wicksten 1982: 245. — Wicksten 1987: 55; 1989b: 315.

Janetogalthea californiensis. — Baba & Wicksten 1997: 38, figs. 1–3. — Hendrickx & Harvey 1999: 375. — Macpherson *et al.* 2010: 234. — Hendrickx *et al.* 2011: 89, figs. 1, 2.

Diagnosis. Rostrum more than twice as long as eye, broad, flattened dorsoventrally, armed with one pair lateral spines, one pair basal spines. Carapace with 6 lateral spines, most anterior of these largest; dorsal surface with

transverse ridges, pair of well developed epigastric spines. Chelipeds with thorn-like spines; fingers of chela with rows of small teeth along cutting edges. Pereopods 2–4 with spines on merus, carpus, dactyls short, stout. Abdomen without spines. Carapace length to 31.3 mm.

Color in life. Reddish on much of surface, carapace with white transverse stripes along main transverse ridges, white background on pereopods. The color notes are from a specimen from Monterey Bay, California.

Habitat and depth. Among rocks and sponges, 87–376 m. Hendrickx *et al.* (2011) could find no verified report of the species at 3990 m, the maximum depth given for this species previously (Schmitt 1921).

Range. Monterey Bay, California to off Guadalupe I., Mexico; central Gulf of California. Type locality off Santa Cruz I., California (*Albatross* sta. 2946).

Remarks. This craylet has been taken in baited traps.

Family Munididae Ahyong, Baba, Macpherson & Poore, 2010

In the northeastern Pacific, most members of the Munididae live on the continental shelf or deeper. Some of these craylets are epibenthic, while others dig burrows. Feeding is by scavenging or using the setose third maxillipeds to rake the sediment for edible material. Munidids can swim for some distance by flapping the abdomen and spreading the legs. Pereopod 5 is slender and modified into a cleaning brush. Craylets use this appendage to clean the dorsal surface of the appendages and carapace. They can open the carapace to clean the surfaces of the gills.

Key to species of family Munididae

1. Latero-inferior regions of carapace greatly swollen. Pereopods flattened, fringed with setae *Pleuroncodes planipes*
– Latero-inferior regions of carapace not greatly swollen. Pereopods rounded, not fringed with setae 2
2. Branchial regions laterally inflated. Carapace dorsally depressed, orbital margin almost straight *Munida macrobrachia*
– Branchial regions not laterally inflated. Carapace not dorsally depressed, orbital margin angled 3
3. Abdomen, posterior margin of carapace unarmed *Munida quadrispina*
– Second, third, fourth abdominal somites armed with spines *Munida hispida*

Munida Leach, 1820

Munida hispida Benedict, 1902

(Fig. 34C, D; Pl.7 D)

Munida hispida Benedict, 1902: 260, fig. 6. — Schmitt 1921: 166, fig. 106. — Wicksten 1982b: 245; 1987: 55; 1989b: 315. — Hendrickx & Harvey 1999: 375. — Hendrickx 2003a: 124.

Diagnosis. Rostrum spine-like, more than twice as long as supraocular spines. Supraocular spines slightly exceeding corneas of eye. Carapace with ridges, 7–10 lateral spines posterior to larger anterolateral spines; pair gastric spines, also 5 or 6 spines in line along gastric region; smaller spinules on posterior dorsal surface of carapace, posterior border of carapace with 10–18 low spines. Chelipeds with numerous spinules. Fingers of chelae slender, gaping in adult male. Pereopods 2–4 with spines on merus, fewer spinules on carpus, propodus, dactyl slender. Abdomen with spinules on second to fourth abdominal somites. Carapace length to 20 mm.

Color in life. Mostly reddish. Carapace with white grooves. spines on chelipeds dark red.

Habitat and depth. Rocky or muddy areas, 165–500 m.

Range. Monterey Bay, California to Galapagos Is. Type locality off Galapagos Is., *Albatross* station 2817.

Munida macrobrachia Hendrickx, 2003

(Fig. 35A–D)

Munida macrobrachia Hendrickx, 2003a: 121, figs. 4, 5C, D.

Diagnosis (after Hendrickx 2003). Rostrum spiniform, sharp, slightly serrate dorsally and laterally. Eye small. Supraocular spines sharp, almost parallel. Carapace slightly convex anteriorly and latero-posteriorly, almost flat in central part, all main striae strongly elevated. Frontal margin of carapace almost transversal. Gastric region slightly elevated, with 2 pairs epigastric spines; one small hepatic spine, one parahepatic, one anterior branchial spine on each side. Cervical groove deep. Strong anterolateral spine. Lateral margin almost straight in anterior 0.66 of length, slightly convex in posterior third, with 3 spines on anterior branchial margin, 4–6 posterior spines. Abdominal tergites unarmed. Chelipeds of adult male subequal, squamous, with rows of irregularly set mostly blunt spines, tubercles. Length of left cheliped almost 3 times as long as length of carapace. Pereopods 2–4 slender, flattened, outer face, part of inner face covered with flattened tubercles, some tipped with blunt spines. Dactyls with about 25 movable spinules along flexor margins. Carapace length 13.7–30.5 mm without rostrum.

Color in life. Not reported.

Habitat and depth. Continental shelf, 540–612 m. All of the areas in which this species was taken have a steeply sloping bottom.

Range. Off Point Vicente, Santa Catalina I. and San Clemente I., southern California. Type locality 10.4 miles offshore of Point Vicente, Los Angeles County, California (*Velero IV* sta. 24480).

***Munida quadrispina* Benedict, 1902**

(Fig. 34E, F; Pl.7 B)

Munida quadrispina Benedict, 1902: 269, fig. 17. — Rathbun 1904: 166. — Schmitt 1921: 165, fig. 10. — Goodwin 1952: 395. — Pereyra & Alton 1972: 450. — Wicksten 1980c: 363; 1982: 245; 1989: 315. — Hart 1982: 168, fig. 66. — Burd & Brinkhurst 1984: 1, figs. 2, 8. — Jensen 1995: 73, fig. 145. — Hendrickx 2003a: 126, figs. 5A, B; 7–9.

Diagnosis. Rostrum long, spine-like; flanked by pair of supraocular spines reaching to cornea of eye. Carapace with ridges, 8–10 lateral spines, 6 gastric spines. Chelipeds with numerous spines, slender fingers of chela. Pereopods 2–4 armed with short spines. Abdomen without spines except for few spinules on tail fan. Carapace length to 67 mm, usually smaller.

Color in life. Reddish brown, ridges red with grooves white, blue spots in cervical groove. Apices of fingers of chelae white. Pereopods 2–4 with irregular red bands.

Habitat and depth. Among rocks, gravel, mud, and sponge beds, 12–1463 m. Tolerates areas of low oxygen concentration.

Range. Sitka, Alaska to Los Coronados Is., Mexico. Type locality off Cape Beale, Vancouver I. (*Albatross* sta. 2878).

Remarks. This craylet has been observed feeding on zooplankton. Burd & Brinkhurst (1984) observed that crabs occurred in higher densities with less within-species aggressive behavior in areas of low oxygen concentration. The craylet can swim by flapping the abdomen.

Pleuroncodes Stimpson, 1860

***Pleuroncodes planipes* Stimpson, 1860**

(Fig. 34B, Pl.7 B)

Pleuroncodes planipes Stimpson, 1860: 245. — Holmes 1900: 112. — Schmitt 1921: 163, pl. 31, fig. 2. — Haig *et al.* 1970: 22. — Blackburn 1977: 178. — Jensen 1995: 74, fig. 146. — Hendrickx & Harvey 1998: 377. — Kuris *et al.* 2007: 647. — Macpherson *et al.* 2010: 234.

Diagnosis. Rostrum long, slender, flanked by two spine-like supraorbital teeth. Eye large, globular, pigmented. Carapace transversely rugose, with latero-inferior regions swollen; spine at anterolateral angle with few spines on lateral margin. Abdomen dorsally unarmed. Chelipeds, pereopods 2–4 flattened, edged with setae. Carapace length to 50 mm.

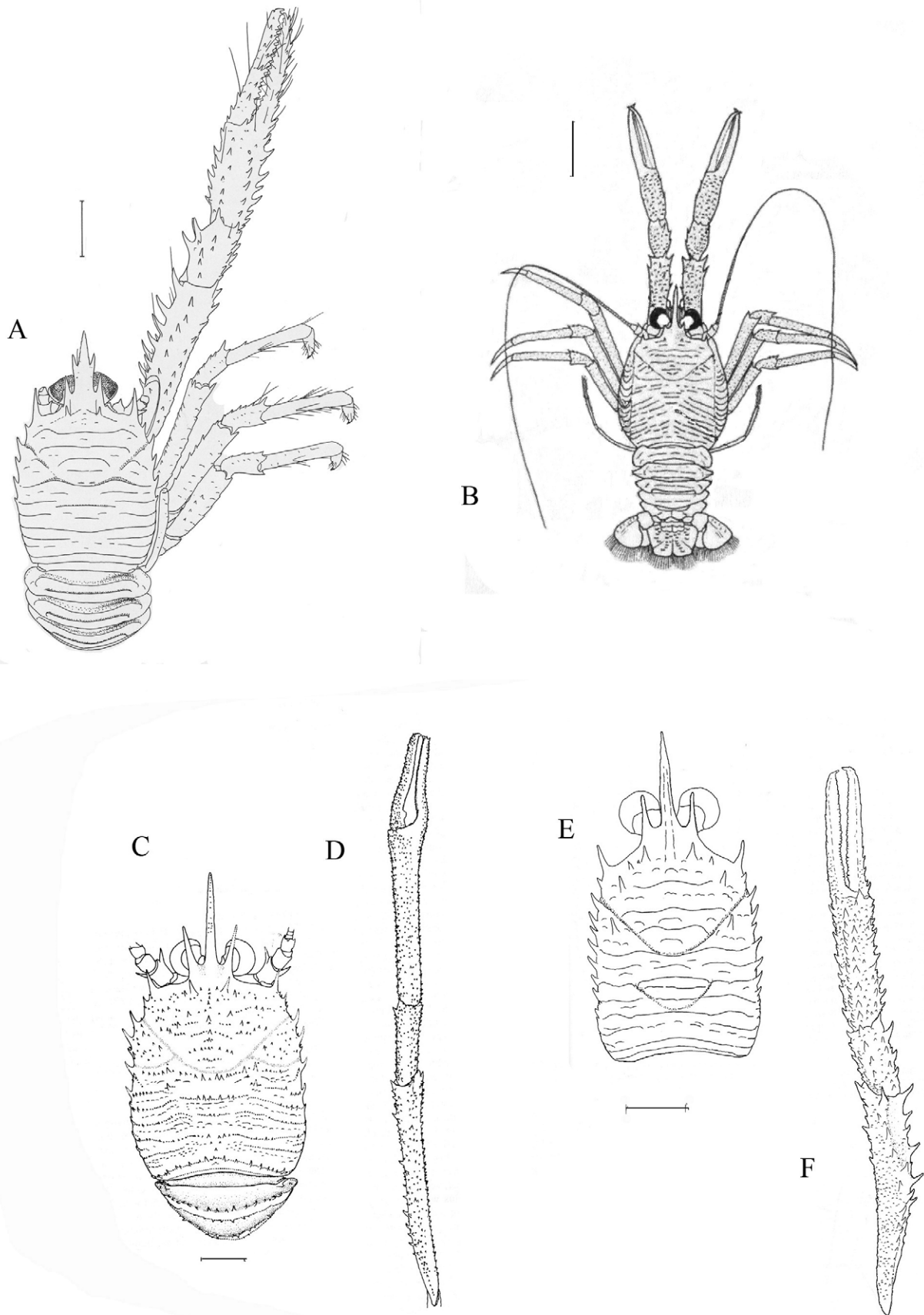


FIGURE 34. Families Galatheidae and Munidae. A, *Janetogalatea californiensis* (Benedict, 1902). B, *Pleuroncodes planipes* Stimpson, 1860. C, D, *Munida hispida* Benedict, 1902; C, carapace and eye; D, cheliped. E, F, *Munida quadrispina* Benedict, 1902; E, carapace and eye; F, cheliped. Scales: A = 5 mm, B, C, E = 10 mm. A from Baba & Wicksten 1997, B adapted from Hendrickx 1995a; C, D from Hendrickx 2000, E, F from Hendrickx 2003.

Color in life. Red, setae golden. The color notes are from craylets from Santa Catalina I.

Habitat and depth. Existing as both a swimming and benthic phase, surface to 90 m.

Range. San Francisco, California to the Gulf of California and Central America. Southern range limit not defined; has been taken in Costa Rica (J. Haig, pers. comm.) Type localities "Pacific Ocean, 24°N, 130°W and Monterey, California."

Remarks. Fishermen call this species the "pelagic red crab" or "tuna crab." Usually, it occurs off the coast of Baja California, Mexico but can be carried northward during years of warm currents. The crabs may be stranded in tide pools and on the beach. Numerous pelagic fishes, dolphins and the humpback whale eat these crabs. Hendrickx & Harvey (1998) provided an extensive list of references.

Family Munidopsidae Ortmann, 1898

Key to species of family Munidopsidae

1. Abdomen unarmed2
– Abdomen with spines or tubercles4
2. Dorsal surface of carapace covered by spiny-pointed tubercles *Munidopsis scabra*
– Dorsal surface without spiny-pointed tubercles3
3. Chelipeds with epipods. Pereopods not conspicuously setose. Eyes ovate *Munidopsis lignaria*
– Chelipeds without epipods. Pereopods conspicuously setose. Eyes globular. *Munidopsis verrilli*
4. Rostrum with lateral spines5
– Rostrum without lateral spines6
5. Eyestalk spined on dorsal surface. Dorsal armature of abdomen not confined to median line *Munidopsis hystrix*
– Eyestalk not spined on dorsal surface. Dorsal armature of abdomen confined to median line *Munidopsis depressa*
6. Carapace with one very large median dorsal spine, two smaller ones. Anterolateral spine of carapace large. *Munidopsis diomedae*
– Carapace without one very large median dorsal spine, any median dorsal spines small. Anterolateral spine of carapace small, if present7
7. Anterior margin of carapace with small, serrated lobe on either side of base of rostrum behind ocular peduncle, lateral margins arcuate *Munidopsis aspera*
– Anterior margin of carapace straight, at right angles to lateral margin; lateral margins straight *Munidopsis quadrata*

Munidopsis Whiteaves, 1784

Munidopsis aspera (Henderson, 1885)

(Fig. 35E)

Elasmonotus asper Henderson, 1885: 416.

Munidopsis aspera. — Rathbun 1904: 167. — Schmitt 1921: 171, pl. 31, fig.1. — Wicksten 1989b: 315. — Hendrickx & Harvey 1999: 376.

Diagnosis. Rostrum elongate, triangular, length variable: from same as eyestalk to twice its length. Carapace with small lobe on orbital border, dorsal surface with tubercles, 2 large tubercles on cardiac area. Chelipeds elongate, setose, with scattered spines. Pereopods 2–4 with elongate dactyls. Abdominal somites 2, 3 with tubercles. Total length 28 mm.

Color in life. Not reported.

Habitat and depth. Continental shelf and slope, 104–2748 m.

Range. Santa Catalina I., California to Straits of Magellan; off Brazil and Patagonia. Type localities off coast of Brazil and off Patagonia.

Remarks. There are no accurate and detailed drawings of this species.

***Munidopsis depressa* Faxon, 1893**

(Fig. 35F)

Munidopsis depressa Faxon 1893:189; 1895: 96, pl. 22, figs. 2, 2a, 2b. — Haig 1956: 79. — Wicksten 1980c: 362; 1989b: 315. — Hendrickx & Harvey 1999: 376. — Hendrickx 2003b: 23.

Diagnosis. Rostrum elongate, triangular, with 2 small lateral teeth near apex, smaller posterior ones, denticles along median groove. Carapace wider near posterior margin than in front half, with sharp anterolateral spines, rows of sharp spinules along lateral surfaces, 3 medial dorsal spines, small spines and tubercles elsewhere on dorsal surface; posterior margin with large median spine, row of teeth on either side. Chelipeds with thorn-like spines. Pereopods 2–4 with spines on merus, carpus, proximal surface of propodus, dactyls elongate. Abdominal somites 1–4 with spines or tubercles. Carapace length 20.3 mm.

Color in life. Not reported.

Habitat and depth. Continental slope, on green mud and sand, 185–1255 m.

Range. Santa Catalina I., California to off Cape Corrientes, Mexico, including Gulf of California. Type locality off Cape Corrientes (*Albatross* sta. 3425, 21° 19' N, 106° 24' W).

***Munidopsis diomedae* (Faxon, 1893)**

(Fig. 35G)

Galacantha diomedae Faxon, 1893: 180; 1895: 79, pl. 25.

Munidopsis diomedae. — Haig & Wicksten 1975: 101. — Wicksten 1980c: 364; 1989b: 315. — Hendrickx & Harvey 1999: 376. — Hendrickx 2003b: 24.

Diagnosis. Rostrum without lateral spines, distal part angled upward. Carapace with one very large, 2 smaller median dorsal spines, large anterolateral spine followed by smaller one on each side, anterior part of carapace with tubercles, posterior half with tuberculate ridges. Pereopods tuberculate. Carpus of cheliped with 2 distal spines. Pereopods 2–4 with one spine each at end of carpus, merus. Abdominal somites 1–3 with small median spines. Carapace length to 28 mm.

Color in life. Red.

Habitat and depth. Lower continental slope, on mud and *Globigerina* ooze, 768–3790 m.

Range. San Clemente I., California to Chile. Type locality not designated; type material came from 15 stations between the Gulf of Panama and the Gulf of California.

Remarks. Faxon (1895) noted that this craylet was parasitized by rhizocephalan cirripeds and epicaridean isopods.

***Munidopsis hystrix* Faxon, 1893**

(Fig. 35H)

Munidopsis hystrix Faxon, 1893: 183; 1895: 89, pl. 19, figs. 1, 1a. — Rathbun 1904: 166. — Schmitt 1921: 168, fig. 10. — Garth & Haig 1971: 6.6. — Wicksten 1989b: 315. — Hendrickx & Harvey 1999: 376. — Hendrickx 2003 b: 25.

Diagnosis. Rostrum long, armed with 2–5 spines on each side. Carapace setose, covered with small spinous tubercles, one at external angle of each orbit, 3 prominent spines on gastric region, one on cardiac area, one on each branchial area, row of spines on each lateral margin. Chelipeds with thorn-like spines on merus, carpus, propodus. Pereopods 2–4 each with sharp tooth at distal end of carpus. Abdomen with spines on second, third somites. Carapace length 26 mm.

Color in life. Not reported.

Habitat and depth. Continental slope, on green mud or *Globigerina* ooze, 552–1243 m.

Range. Anacapa I., California to Peru. Type localities off Cape Corrientes, Mexico (*Albatross* sta. 3424, 21° 15' N, 106° 23' W and sta. 3425, 21° 19' N, 106° 24' W) and off Acapulco, Mexico (*Albatross* sta. 3417, 16° 32' N, 99° 48' W).

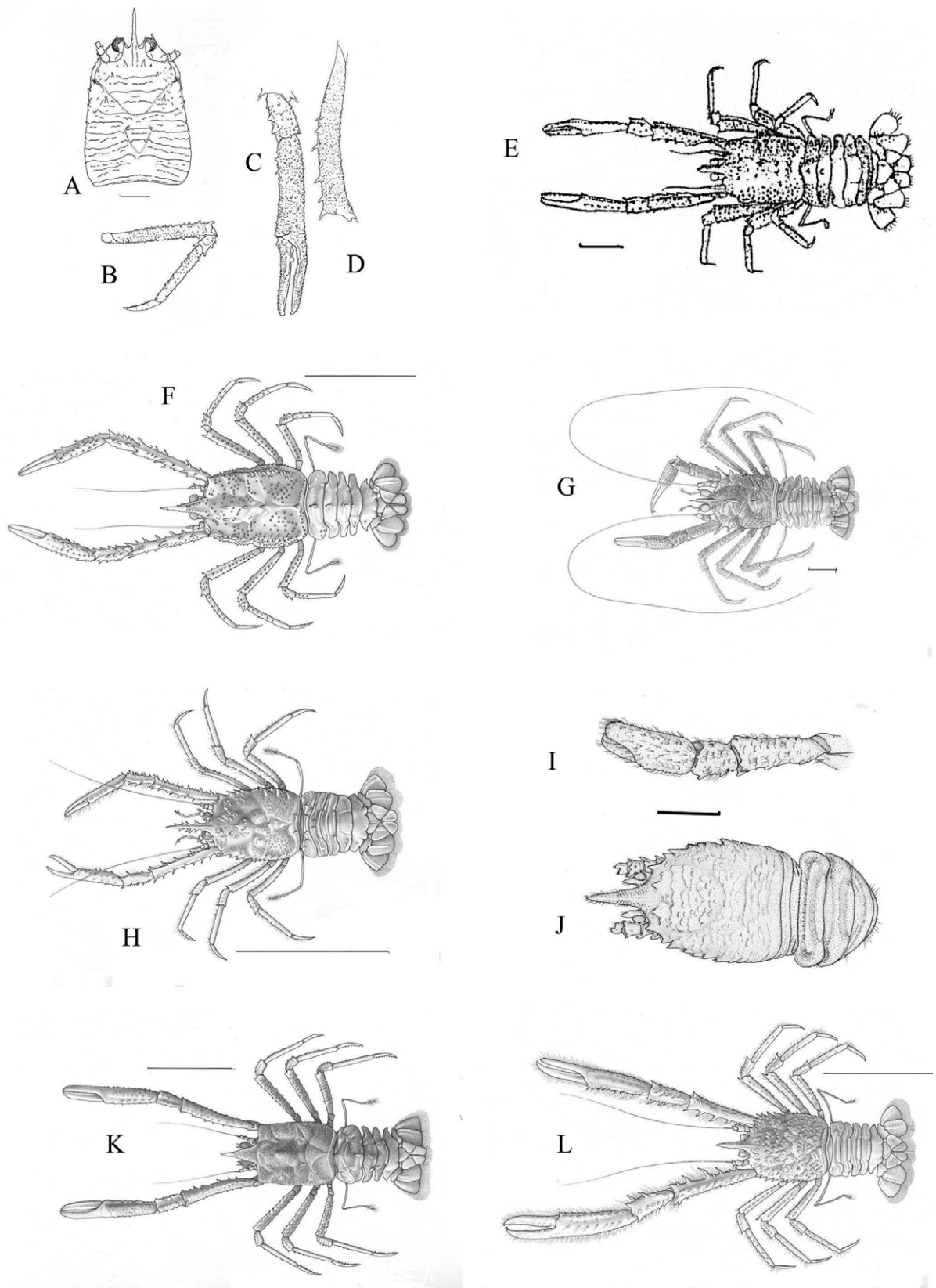


FIGURE 35. Families Munidae and Munidopsidae. A–D, *Munida macrobrachia* Hendrickx, 2003; A, carapace and eye; B, pereopod 2; C, left cheliped, distal segments; D, left cheliped, merus. E, *Munidopsis aspera* (Henderson, 1885). F, *Munidopsis depressa* Faxon, 1893. G, *Munidopsis diomedea* (Faxon, 1893). H, *Munidopsis hystrix* Faxon, 1893. I, J, *Munidopsis lignaria* Williams & Baba, 1989; I, cheliped; J, carapace and abdomen in dorsal view. K, *Munidopsis quadrata* Faxon 1893. L, *Munidopsis scabra* Faxon, 1893. Scales: I, J = 3 mm; E–H, K, L = 10 mm. A–D from Hendrickx 2003, E from Bate 1888, F, G, H, K, L from Faxon 1895 (G as *Galacantha diomedea*); I, J from Williams & Baba 1989.

Remarks. In the Gulf of California, Hendrickx (2000b) reported collecting this crab at oxygen levels oxygen levels of 0.15–0.22 ml O₂/l, the lowest overall oxygen levels at which species of *Munidopsis* were collected in the area.

***Munidopsis lignaria* Williams & Baba, 1989**

(Fig. 35I, J)

Munidopsis ciliata: Ambler 1980: 19, fig. 4. [Not *M. ciliata* Wood-Mason, 1891, Indo-West Pacific species].

Munidopsis lignaria Williams & Baba, 1989: 904, figs. 2f, 4.

Diagnosis (after Williams & Baba 1989). Rostrum narrowly triangular, exceeding eyestalk by its own or slightly greater length, without lateral spines. Eyes with ovate corneae. Front of carapace with slightly hooked antennal spine lateral to eyestalk followed by concavity ending in small, acute anterolateral angle. Gastric region bearing short setose rugosities behind strong gastric spine at either side of midline, secondary spine lateral to each large spine. Anterior branchial region with less prominent rugosities, lateral margin with strong anterior tooth followed by 4 spines successively smaller in size. Posterior branchial region with moderately developed spine at anterolateral corner, with distinct, transverse rugae. Posterior margin shallowly concave preceded by raised submarginal rim. Abdomen without spines but somites 2, 3 with bold transverse ridges. Chelipeds stout, subequal, with variable rugosities tending to be arranged in longitudinal tracts, ischium with short lateral spine, merus with 3 principal mesial spine, 1 distodorsal spine, distoventral spine, carpus with row of 3 mesiodorsal spines, palm nearly spooned, fingers spooned at apices. Pereopods 2–4 rather long, each merus with crest on dorsal margin ending in distal spine. Carpi with longitudinal spiny dorsal, tuberculate dorsolateral crests, each ending in spine; each propodus slender, with dorsal crest with 2 remote proximal spines, dactyls slender, with row of 10–12 movable spines on flexor margin. Carapace length 6.5–11.6 mm (excluding rostrum).

Color in life. Not reported.

Habitat and depth. In association with sunken wood, deep sea basins, 2020–2875 m.

Range. Cascadia Basin off Oregon, 44° 39.8' N, 12° 36.4' W (type locality) to East Pacific Rise off south central Mexico, 11° 52' N, 103° 51' W.

Remarks. The craylet can have wood fragments in its stomach contents.

***Munidopsis quadrata* Faxon, 1893**

(Fig. 35K)

Munidopsis quadrata Faxon, 1893: 188; 1895: 97, pl. 23, fig. 1. — Rathbun 1904: 167. — Schmitt 1921: 170, fig. 109. — Pereyra & Alton 1972: 450. — Hart 1982: 170, fig. 67. — Wicksten 1989b: 315. — Hendrickx & Harvey 1999: 376. — Hendrickx 2003b: 25.

Diagnosis (modified from Hart 1982). Rostrum more or less flat, triangular. Carapace rectangular, without prominent spines but covered with granules. Chelipeds setose, armed with thorn-like spines. Pereopods 2–4 with small spines on merus, carpus; dactyls with spinules along flexor margin. Abdominal somites 2–4 with median teeth. Carapace length to 15.5 mm.

Color in life. Carapace pinkish tan. Rostrum pink, white. Chelipeds mostly white, basis orange, ischium pink. Pereopods 2–4 white, pale tan. Abdomen pinkish with white (Hart 1982).

Habitat and depth. Mud and sand, 86–1572 m. Most records are from deeper than 900 m.

Range. Queen Charlotte Is., British Columbia to off Cape Corrientes, Mexico. Type localities off Cape Corrientes (*Albatross* sta. 3424, 21° 15' N, 106° 23' W and sta. 3425, 21° 19' N 106° 24' W).

***Munidopsis scabra* Faxon, 1893**

(Fig. 35L)

Munidopsis scabra Faxon, 1893: 186; 1895: 93, pl. XXI, figs. 1, 1a. — Garth & Haig 1971: 6.6. — Pereyra & Alton 1972:450. — Haig & Wicksten 1975:10. — Wicksten 1989b: 315.

Diagnosis. Rostrum without lateral spines, slightly turned upward. Carapace covered with spiny-pointed tubercles; with 9 or 10 lateral spinules, row of 8 spinules on posterior margin. Chelipeds with thorn-like spines except on fingers. Pereopods 2–4 with rows of small, sharp spines. Abdomen without spines. Carapace length 40 mm.

Color in life. Not reported.

Habitat and depth. Continental slope, among sand, mud and rubble, 567–1243 m.

Range. Oregon to Peru. Type localities off Cape Corrientes, Mexico (*Albatross* sta. 3424, 21° 15' N, 106° 23' W; and sta. 3425, 21° 19' N, 106° 24' W).

***Munidopsis verrilli* Benedict, 1902**

(Fig. 36A)

Munidopsis verrilli Benedict, 1902: 291, fig. 34. — Schmitt 1921: 169, fig. 108. — Goodwin 1952: 395. — Wicksten 1989b: 316.

Diagnosis. Rostrum slender, triangular, without lateral spines. Front of carapace angled 45° from base of rostrum to anterolateral margin, with sharp spine just posterolateral to eye, lateral margin with 4 spines, surface rough, with low tubercles, two spines on gastric region. Chelipeds relatively short, with sharp thorn-like spines on merus, carpus, two spines on palm of chela, fingers relatively short, stout. Pereopods 2–4 with sharp spines on merus, carpus; propodus unarmed, dactyls slender. Abdomen without spines. Carapace length 17 mm.

Color in life. Carapace iridescent.

Habitat and depth. Continental slope, 1253–1986 m.

Range. Oregon to off Cedros I., Baja California, Mexico. Type locality off San Diego (*Albatross* station 2923).

Family Porcellanidae Haworth, 1825

Porcelain crabs are flattened dorso-ventrally and able to slip under rocks, into cracks and other tight spaces. The third maxillipeds are fringed with long setae, which are extended into the water and employed to capture plankton. The crabs also can graze on filamentous algae and scrape detritus from the sea floor by use of the third maxillipeds. They usually do not tear and scavenge food. Pereopod 5 is modified into a cleaning brush. In *Petrolisthes cincitipes* and *P. cabrilla*, the crabs maintain an individual distance of the length of a second antenna from the nearest neighbor. Individuals of *Petrolisthes cincitipes* use the large chelipeds to raise themselves off the substrate or to "elbow" intruding neighbors. The crabs can swim short distances by flapping the abdomen. Wicksten (1973) and Gonor & Gonor (1973) studied feeding and swimming in porcellanids.

Haig (1960) gave a comprehensive account of porcellanid synonymies, morphological variation and sites where they have been collected. Haig & Abbott (1980) provided additional information on feeding, ecology and larval stages.

Key to species of family Porcellanidae

- 1. Chelipeds markedly unequal in size, shape; thick and more or less roughened2
- Chelipeds more or less equal in size, shape; flattened4
- 2. Carapace with tuft of plumose hairs on front. Chelipeds covered by velvet-like pubescence *Pachycheles holosericus*
- Carapace without tuft of plumose hairs on front. Chelipeds either with few, coarse hairs or with short pubescence interspersed with tufts of longer hairs3
- 3. Chelipeds tuberculate above, without short pubescence, few if any setae in gape of fingers *Pachycheles rudis*

- Chelipeds granulated, with short pubescence, dense pubescence in gape of fingers *Pachycheles pubescens*
- 4. Carapace markedly wider than long, chelipeds with dense fringe of setae on outer surface *Polyonyx quadriungulatus*
- Carapace about as wide as long, chelipeds without dense fringe of setae on outer surface 5
- 5. Carpus of cheliped elongated, more than twice as long as wide 6
- Carpus of cheliped short, less than twice as long as wide 7
- 6. Carapace with short transverse striations, flattened tubercles *Petrolisthes rathbunae*
- Carapace anteriorly with granules, without striations, posteriorly smooth *Petrolisthes manimaculis*
- 7. Carpus of cheliped without lobe on anterior margin, anterior and posterior margins subparallel *Petrolisthes eriomerus*
- Carpus of cheliped lobed on anterior margin 8
- 8. Carpal lobe occupying proximal 0.25 of anterior margin, anterior, posterior margins otherwise subparallel; merus of pereopod 4 not inflated. (Rarely found north of Point Conception, California) *Petrolisthes cabrilloi*
- Carpal lobe not confined to proximal 0.25 of anterior margin of chelipeds, anterior, posterior margins converging distally; merus of pereopod 4 inflated. (Usually found north of Point Conception, California) *Petrolisthes cinctipes*

Pachycheles Stimpson, 1860

Pachycheles holosericus Schmitt, 1921

(Fig. 36B)

Pachycheles holosericus Schmitt, 1921: 177, pl. 33, fig. 3. — Haig 1960: 173, pl. 34, fig. 2. — Haig *et al.* 1970: 23. — Haig & Abbott 1980: 589, fig. 24.21.

Diagnosis. Front narrow, trilobate in frontal view, with tuft of plumose setae. Carapace about as long as broad, strongly convex from front to back, plicate on posterolateral regions. Chelipeds unequal. Merus rugose, granular, anterior margin with strongly projecting granular lobe. Carpus with broad lobe on anterior margin, edged with large granules, rest of surface covered by small granules largely concealed by thick setae. Chelae with large coarse granules, upper surface covered with short plumose setae; fingers gaping in major cheliped; gape in major cheliped with tuft of plumose setae. All segments of pereopods 2–4 with long plumose setae. Telson of abdomen with 5 plates. Carapace length to 18mm.

Color in life. Body dull brown (Haig & Abbott 1980).

Habitat and depth. Under rocks, on pier pilings and in sheltered places such as kelp holdfasts and in cavities in sponges, intertidal zone to 18 m.

Range. Santa Barbara, California to Magdalena Bay, Baja California, Mexico. Type locality Venice, California. There have been no reports of the crab from its type locality since its original description.

Remarks. Haig & Abbott (1980) reported that these crabs are typically are found in pairs.

Pachycheles pubescens Holmes, 1900

(Fig. 36C, Pl. 7F)

Pachycheles pubescens Holmes, 1900: 110. — Rathbun 1904: 168. — Schmitt 1921: 117, pl. 33, fig. 4; fig. 112. — Johnson & Snook 1927: 350. — Haig 1960: 162, pl. 34, fig. 3. — Haig *et al.* 1970: 23. — Gonor & Gonor 1973: 225, figs. 2–5. — Haig & Abbott 1980: 589, fig. 24.19. — Hart 1982: 102, fig. 35. — Ricketts *et al.* 1985: fig. 31 (larval stages). — Jensen 1995: 74, fig. 148. — Kuris *et al.* 2007: 648, pl. 326 C.

Diagnosis. Front trilobate in frontal view, with small tuft of setae. Carapace slightly broader than long, strongly convex from front to back, plicate on posterolateral regions, punctate elsewhere. Chelipeds unequal. Merus of chelipeds with flattened granules, anterior margin with strongly projecting subtriangular lobe. Carpus with broad lobe on anterior margin, cut into 3 or 4 uneven, serrate teeth, lobe, remainder of carpus covered with granules. Entire surface of chelipeds thickly covered with short plumose setae. Fingers slightly gaping in major cheliped; gape thickly covered with short setae. Pereopods 2–4 with fringes of plumose setae. Telson with seven plates. Carapace length to 18 mm.

Color in life. Carapace white, dappled with brown, gray, purple; may have blue, tan comma-shaped mark on each branchial region. Chelipeds covered by mud-colored setae. Pereopods 2–4 with merus blue, brown, propodus and dactyl with distal white bands (Hart 1982).

Habitat and depth. Rocky coasts, usually intertidal but as deep as 55 m.

Range. Queen Charlotte Is., British Columbia to Thurloe Head, Baja California, Mexico. Type localities Drake's Bay, Farallon Is. and Humboldt County, California.

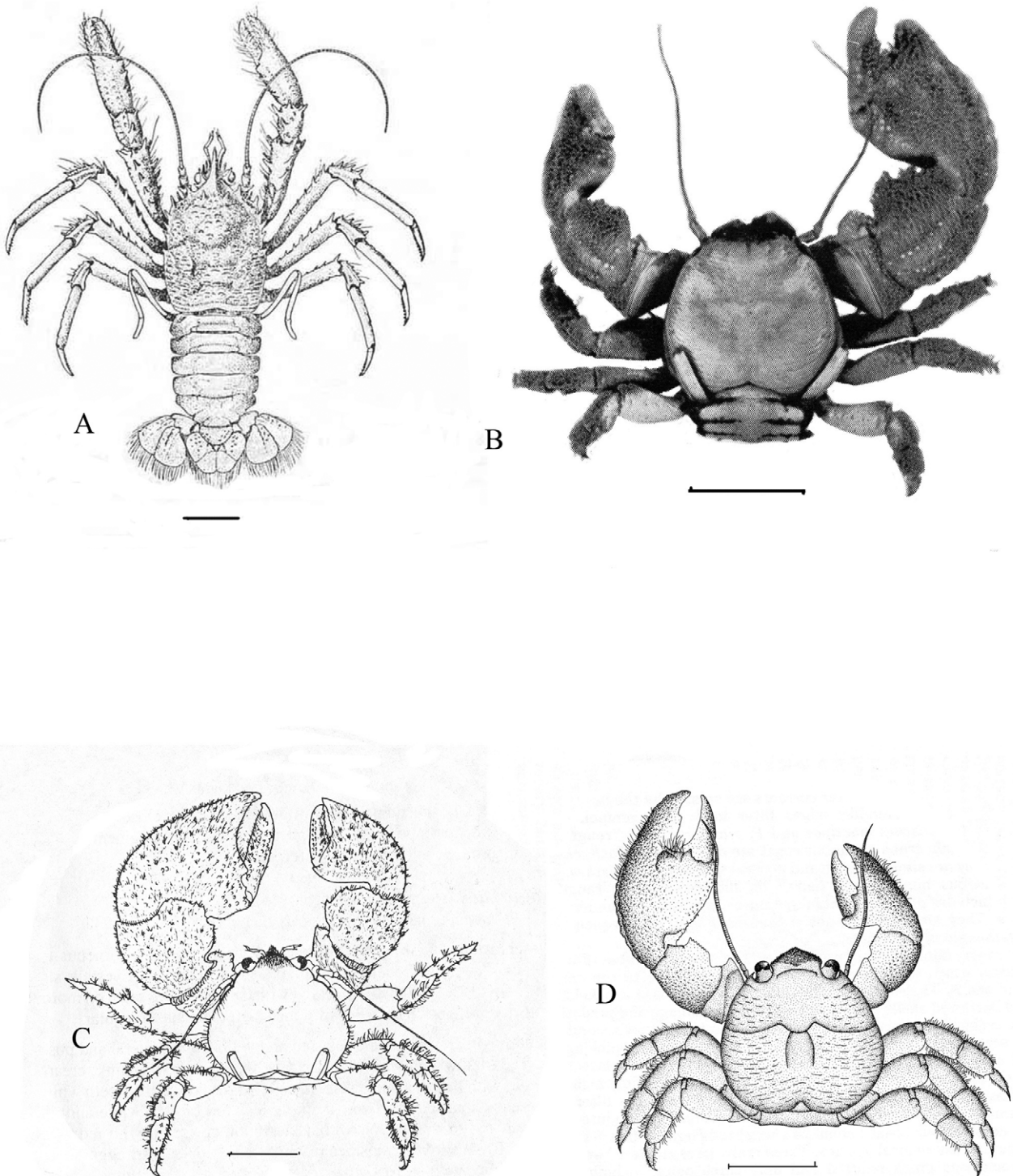


FIGURE 36. Families Munidopsidae and Porcellanidae. A, *Munidopsis verrilli* Benedict, 1902. B, *Pachycheles holosericus* Schmitt, 1921. C, *Pachycheles pubescens* Holmes, 1900. D, *Pachycheles rudis* Stimpson, 1859. Scales = 10 mm. A from Benedict 1902, B from Haig 1960, C from Hart 1982, D from Brusca & Brusca 1978.

***Pachycheles rudis* Stimpson, 1859**

(Fig. 36D, Pl. 7E)

Pachycheles rudis Stimpson, 1859: 76, pl. 1, fig. 5. — Holmes 1900: 109. — Rathbun 1904: 168, fig. 6. — Schmitt 1921: 176, pl. 32, fig. 2; fig. 11. — Johnson & Snook 1927: 350, fig. 298. — Haig 1960: 170, pl. 34, fig. 1. — Haig *et al.* 1970: 26. — Gonor & Gonor 1973: 25. — Haig & Abbott 1980: 589, fig. 24.20. — Hart 1982: 100, fig. 101. — Ricketts *et al.* 1985: 402, fig. 308. — Jensen 1986: 180; 1995: 74, fig. 147. — Kuris *et al.* 2007: 648, pl. 326 B1.

Diagnosis. Front narrow, trilobate in frontal view, with dense short setae. Carapace about as broad as long, strongly convex from front to back, mostly punctate or with flattened granules. Chelipeds unequal. Merus rugose, granular, anterior margin with strongly projecting lobe. Carpus with broad subtriangular lobe on anterior margin, dorsal surface covered with long setae, large coarse granules. Chelipeds with large coarse granules; large protuberance at base of dactyl, surface covered with setae which do not extend beyond most proximal part of dactyl. Pereopods 2–4 with thick fringe of plumose setae along anterior margins. Telson with 5 plates. Carapace length to 17.4 mm.

Color in life. Carapace mottled, with gray, brown, white stripes; in smaller animals, may be almost completely white except for one or two brown patches. Chelipeds greenish brown with gray and bluish granules. Pereopods 2–4 mottled with brown, gray, or white. The color notes are based on crabs from Pillar Point, San Mateo County, California.

Habitat and depth. Under stones, in holdfasts or in well-protected crevices, usually intertidal, to 29 m.

Range. Kodiak, Alaska to Magdalena Bay, Baja California, Mexico. Type locality Monterey, California.

Remarks. This crab may live in pairs, sometimes in association with the shrimp *Betaeus setosus* (Jensen 1986).

***Petrolisthes* Stimpson, 1860**

***Petrolisthes cabrilloi* Glassell, 1945**

(Fig. 37A, Pl. 8B)

Petrolisthes cabrilloi Glassell, 1945: 225, fig. 4. — Kropp 1981: 307.

Petrolisthes cabrilloi. — Haig 1960: 88, pl. 26, fig. 3. — Haig *et al.* 1970: 26. — Haig & Abbott 1980: 588, fig. 24.17. — Jensen 1995: 76, fig. 153. — Kuris *et al.* 2007: 648. — Sloan *et al.* 2010: 159.

Diagnosis. Front triangular, with deep median sulcus. Carapace about as long as broad, usually covered with plications, fine granules; but sometimes nearly smooth. Chelipeds finely granular. Merus with strongly projecting lobe on anterior margin. Carpus setose, about twice as long as wide, with small lobe occupying about 0.25 of proximal end, granules along outer margin enlarged, forming crest ending distally in sharp tooth. Chela smooth to lightly pubescent, gape with thick pubescence. Pereopods 2–4 rugose, merus of pereopod 3 unarmed, not inflated; all segments with tufts of setae. Carapace length to 16 mm.

Color in life. Carapace brown to tan, with striations, numerous spots of pale greenish white. Chelipeds brown, chela may have greenish tinge, red spot at base of dactyl. Pereopods 2–4 dull brown, with bands of tan, darker brown on propodus. Outer segments of maxillipeds red (Haig 1960).

Habitat and depth. Among rubble, on pilings or among mussels, intertidal zone.

Range. Morro Bay, California to Magdalena Bay, Baja California, Mexico, including Santa Cruz and Santa Catalina Is., California. Type locality Anaheim Landing, California.

Remarks. This porcelain crab seems to replace *P. cinctipes* south of Point Conception, California. It is extremely common. As many as 22 individuals were found under a single rock with area of about 0.9 m² among rocky rubble near Point Fermin, Los Angeles County, California. Sloan *et al.* (2010) reported that it is parasitized by the rhizocephalan *Lernaeodiscus porcellanae*. They also noted that the sizes of the largest individuals in a population varied geographically even among sites separated by only a few kilometers, perhaps in response to food.

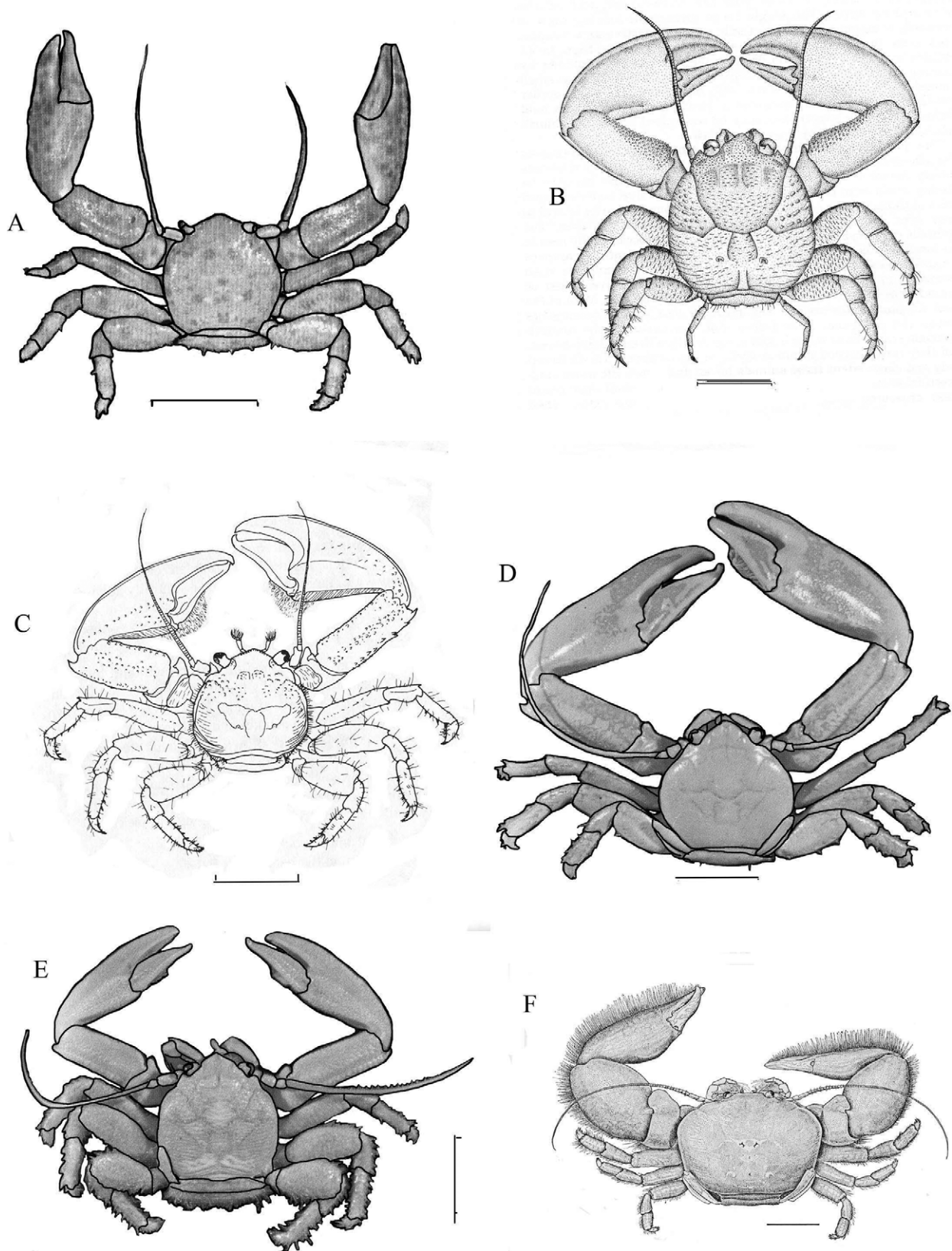


FIGURE 37. Family Porcellanidae. A, *Petrolisthes cabrilloi* Glassell, 1945. B, *Petrolisthes cincipes* (Randall, 1839). C, *Petrolisthes eriomerus* Stimpson, 1871. D, *Petrolisthes manimaculis* Glassell, 1945. E, *Petrolisthes rathbunae* Schmitt, 1921. F, *Polyonyx quadriungulatus* Glassell, 1935. Scales = 10 mm. A, D, E adapted from Haig & Abbott 1980; B from Brusca & Brusca 1978, C from Hart 1982, F from Glassell 1935.

***Petrolisthes cinctipes* (Randall, 1840)**

(Fig. 37B, Pl. 8A)

Porcellana cinctipes Randall, 1840: 136.

Petrolisthes cinctipes. — Holmes 1900: 107 (part). — Rathbun 1904: 168. — Schmitt 1921: 179, fig. 113, pl. 32, fig. 1. — Johnson & Snook 1927: 351. — Haig 1960: 90, pl. 28, fig. 3 (extensive synonymy). — Wicksten 1973: 161. — Gonor & Gonor 1973: 225. — Haig & Abbott 1980: 588, fig. 24.18. — Hart 1982: 98, fig. 3. — Ricketts *et al.* 1985: 45, fig. 30. — Jensen 1995: 75, fig. 149. — Kuris *et al.* 2007: 648, pl. 326 A.

Diagnosis. Front strongly deflexed, triangular, with deep median groove. Carapace about as long as wide, covered with fine granules. Chelipeds covered with fine granules, without setae. Merus with strongly projecting lobe on anterior margin. Carpus 1.5–2 times as long as wide, strong lobe occupying more than 0.25 of proximal anterior margin, anterior, posterior margins converging distally, posterior margin with row of tubercles forming ridge, ending distally in strong tooth. Chela smooth, gape with tuft of setae. Pereopods 2–4 rugose, merus unarmed, usually naked, that of third leg inflated; carpus nearly devoid of setae; propodus, dactyl with setae. Carapace length to 24 mm.

Color in life. Light to dark brown, granules bluish, with blue, white comma-like mark on either side of cardiac area. Chelipeds with red spot at base of dactyl. Pereopods 2–4 with yellow median band on propodus, dactyl yellow with narrow brown band. Outer segments of maxillipeds red. Individuals ready to molt may be blue (Hart 1982).

Habitat and depth. Under rocks or among mussel beds, midlittoral zone, rarely as deep as 64 m.

Range. Porcher I., British Columbia to Santa Barbara, California. Type locality incorrectly given as "Sandwich Islands" (Hawaiian Is.). Some of Randall's specimens were collected at or near Monterey, California, which may be the actual type locality.

Remarks. This is another very common intertidal crab, often found under rocks in rubble beds in the midlittoral zone. In life, pereopods 5 are folded alongside the carapace. Records of *P. cinctipes* from south of Point Conception prior to 1945 are likely to be misidentifications of *P. cabrilloi*.

***Petrolisthes eriomerus* Stimpson, 1871**

(Fig. 37C, Pl. 8C)

Petrolisthes eriomerus Stimpson, 1871: 119. — Lockington 1878: 395. — Holmes 1900: 108, pl. 1, fig. 15. — Rathbun 1904: 168. — Schmitt 1921: 180 (in part), pl. 23, fig. 2, fig. 114. — Johnson & Snook 1927: 351, fig. 299. — Haig 1960: 74, pl. 26, fig. 4. — Gonor & Gonor 1973: 225. — Haig & Abbott 1980: 587, fig. 24.15. — Hart 1982: 96, fig. 32. — Ricketts *et al.* 1985: 306. — Jensen 1995: 75, fig. 150. — Kuris *et al.* 2007: 648.

Diagnosis. Front broad, triangular, with deep median groove. Carapace about as long as wide, anterior part covered with rough granules, posterolateral areas plicate. Chelipeds covered with large granules. Merus with strongly projecting lobe on anterior margin. Carpus twice as long as wide, margins subparallel; outer margin serrate, ending in distal tooth. Chela naked, gape filled with thick pubescence. Pereopods 2–4 granular, merus not inflated, all segments with setae. Carapace length to 19 mm.

Color in life. Granules on carapace red-brown or white with blue tinges in grooves, blue, white comma-like mark on either side of cardiac region. Chelipeds with dark, light red granules; orange areas, blue-white patches at junctions of segments; blue spot at base of dactyl. Pereopods 2–4 brown with 2 patches of yellow on merus; red, yellow band proximally, yellow distally on propodus; dactyl brown, yellow. Outer maxillipeds with both surfaces of last two articles bright blue (Hart 1982). Individuals ready to molt may be bluish.

Habitat and depth. Under rocks in lowest intertidal zone, rarely to 86 m.

Range. Chicagof I., Alaska to La Jolla, California. Type locality Mendocino, California.

***Petrolisthes manimaculis* Glassell, 1945**

(Fig. 37D)

Petrolisthes manimaculis Glassell, 1945: 223, text fig. 1. — Haig 1960: 77, pl. 27, fig. 1; see this reference for previous misidentifications. — Haig & Abbott 1980: 587, fig. 24.16. — Jensen 1995: 75, fig. 151. — Wasson *et al.* 2002: 482. — Kuris *et al.* 2007: 648.

Diagnosis. Front triangular, with deep median groove. Carapace slightly longer than wide, somewhat granular. Chelipeds finely to roughly granular. Merus with strongly projecting lobe on anterior margin. Carpus 2.5–3 times as long as wide, margins subparallel. Chela naked, fingers long, slender; gape with thick pubescence. Pereopods 2–4 smooth to granular; merus not inflated; all segments covered with scattered tufts of setae. Carapace length to 20 mm.

Color in life. Ground color chocolate brown, row of blue dots on median longitudinal ridge of palm of chela, red spot at base of dactyl of chela (Haig 1960).

Habitat and depth. Among rocks and in piles of rocky rubble, lowest intertidal zone to at least 2 m.

Range. Baker Beach and Indian Beach, Humboldt County, California to Punta Eugenia, Baja California, Mexico. Type locality Morro Bay, California.

Remarks. This species is common in shallow subtidal rock piles along Santa Catalina I., California. It has been confused with *P. gracilis* Stimpson, 1860; which occurs in the Gulf of California.

***Petrolisthes rathbunae* Schmitt, 1921**

(Fig. 37E)

Petrolisthes rathbunae Schmitt, 1921: 181, pl. 32, fig. 3. — Haig 1960: 72, pl. 26, fig. 2. — Haig & Abbott 1980: 587, fig. 24.14. — Campos & de Campos 1989: 174. — Jensen 1995: 76, fig. 152. — Kuris *et al.* 2007: 648.

Diagnosis. Front triangular, with deep median sulcus. Carapace about as long as wide, with short, transverse striations. Chelipeds equal, lightly pubescent. Merus rugose, with strongly projecting lobe on anterior margin. Carpus about 2.5 times as long as wide, margins subparallel, covered with flattened granules. Chela granular, inner margin with large flattened granules; dactyl with longitudinal median crest composed of tubercles; gape with thick pubescence. Pereopods 2–4 with short rugae, long setae. Carapace length to 17 mm.

Color in life. Carapace with dotted stripes of dark purple on ground of greenish dark olive. Chelae brown, becoming lighter distally. Merus of pereopods 2–4 buff dotted with maroon. Carpus, propodus dark brown banded with orange red. Dactyls scarlet. Ventral side mostly red orange (Haig 1960).

Habitat and depth. Under stones or in rock piles, lower intertidal to subtidal zones.

Range. Monterey, California to Tortugas Bay, Mexico. Type locality San Clemente I., California. Most specimens have been taken south of Point Conception, California.

Remarks. There are few records of this porcelain crab. It is difficult to collect because of the speed with which it retreats into cracks between rocks in rubble piles.

***Polyonyx* Stimpson, 1858**

***Polyonyx quadriungulatus* Glassell, 1935**

(Fig. 37F)

Polyonyx quadriungulatus Glassell, 1935: 93, pl. 9. — Haig 1956: 80; 1960: 236, pl. 41, fig. 2; text fig. 12 (1). — Haig *et al.* 1970: 26. — Kudenov & Haig 1974: 105. — Jensen 1995: 76, fig. 154.

Diagnosis. Front convex or concave in dorsal view, with short fringe of setae. Carapace subovate, 1.2–1.4 times as broad as long. Chelipeds unequal. Merus with broad, rounded lobe on anterior margin; posterior margin fringed with fine setae. Carpus with anterior margin bearing high lamellar crest, anterior, posterior margins fringed with

setae. Chela slender, dorsal surface swollen, without crest in major cheliped; outer margin with sharp crest lined with row of granules, thick fringe of setae extending nearly to apex of dactyl, gape of fingers with scattered short setae. In major chela, dactyl crosses over fixed finger at apex of chela. Pereopods 2–4 smooth, all segments with fringe of fine setae. Merus with fringe of fine setae. Propodus with pair of movable spinules at distal end of posterior margin, single movable spine posterior to them, one on middle or proximal third of posterior margin. Dactyl with 4 fixed spines, distal three large, proximal one small. Telson with 7 plates. Carapace length to 13.5 mm.

Color in life. Carapace, chelipeds dark brown, mottled with green, red; pereopods 2–4 lighter, banded (Glassell 1935).

Habitat and depth. Strictly symbiotic, living in pairs within tubes of polychaete *Chaetopterus variopedatus* (Renier, 1804), intertidal zone to 46 m.

Range. Santa Rosa I., California to Punta San Eugenio, Baja California, Mexico, Gulf of California at Puerto Peñasco, Loreto, and El Mogote. Type locality Estero de Punta Banda, Baja California, Mexico.

SUPERFAMILY HIPPOIDEA Latreille, 1825

The egg-like shape and flat legs of these crabs are specializations for digging into sand. The pereopods are flattened, fold against the body, and bear fringes of setae that keep sand away from the body proper. The eye shape ranges from elongate to very flat. The antennae are long and setose, providing a channel for respiration while the animal is buried. The abdomen can flap, aiding in quick backward motion. Mole crabs generally feed on small particles strained from the water or caught in the setae of the antennae during the backwash of wave action.

The three families of the mole crabs are easily distinguished by looking at the edge of the carapace and the eyestalk. Boyko (2002) monographed species assigned to the family Albuneidae and divided it into two families: the Albuneidae in s.s. and the Blepharipodidae. This work contains further synonyms, keys and illustrations.

Key to species of Hippoidea

1. Carapace without lateral teeth *Emerita analoga* (Hippidae)
- Carapace with lateral teeth 2
2. Eyes flat, square *Lepidopa californica* (Albuneidae)
- Eyes cylindrical. 3 (Blepharipodidae)
3. Carapace with 4 lateral spines *Blepharipoda occidentalis*
- Carapace with 3 lateral spines *Lophomastix diomedae*

Family Albuneidae Stimpson, 1860

Lepidopa Stimpson, 1860

Lepidopa californica Efford, 1971

(Fig. 38C, D)

Lepidopa myops: Holmes 1900: 172. — Schmitt 1921: 172, pl. 31, fig. 4. — Johnson & Snook 1927: 349, figs. 296, 297. — MacGinitie & MacGinitie 1968: 305 fig. 149. — Haig *et al.* 1970: 25. — Haig & Abbott 1980: 583. — Ricketts *et al.* 1985: 336, fig. 216. — Jensen 1995: 77, fig. 157. [Not *Lepidopa myops* Stimpson, 1860: 241 (now *Paraleucolepidopa myops*, from western Mexico, see Boyko 2002)].

Lepidopa californica Efford, 1971: 59.—Boyko 2002: 140, figs. 46, 47 (extensive synonymy).— Kuris *et al.* 2007: 648.

Diagnosis. Carapace somewhat square, marked with transverse grooves, median projection of front rounded, anterolateral margin with only one tooth, median ridge unarmed. Both antennae long and setose, first antennae twice as long as carapace. Eyestalk flat. First pereopods chelate. Pereopods 2–4 flattened, with semicircular dactyls. Abdominal somites well separated laterally, telson triangular. Carapace length to 20 mm.

Color in life. Gray, white or bluish, with iridescent sheen (Jensen 1995).

Habitat and depth. Protected or open coast sandy beaches, lower intertidal zone, rarely as deep as 128 m.

Range. Rarely as far north as Monterey Bay, California; usually from San Pedro, California to the Gulf of California. Type locality Long Beach, California.

Remarks. This crab burrows deeply. The long antennules form a passageway for respiration while buried.

Family Blepharipodidae Boyko, 2002

Blepharipoda Randall, 1840

Blepharipoda occidentalis Randall, 1840

(Fig. 38A, B)

Blepharipoda occidentalis Randall, 1840: 131, pl. 6. — Holmes 1900: 104. — Rathbun 1904: 167. — Schmitt 1921: 172, pl. 31, fig. 6. — Johnson & Snook 1927: 347, fig. 295. — MacGinitie & MacGinitie 1968: 304. — Haig & Abbott 1980: 582, fig. 24.5. — Ricketts *et al.* 1985: 254, fig. 205. — Jensen 1995: 77, fig. 156. — Boyko 2002: 27, figs. 9–11. — Kuris *et al.* 2007: 648.

Diagnosis. Carapace oblong, with 4 sharp spines on each side, somewhat scaly in front, smooth posteriorly; median projection spiniform, longitudinal median ridge with spine at anterior end. Both pairs of antennae long, setose. Eyestalk cylindrical, exceeding length of median projection of carapace. First pereopods with strong, spiny chelipeds. Pereopods 2–4 flattened, with semicircular dactyls. Abdominal somites well separated laterally. Telson rounded. Carapace length to 60 mm.

Color in life. Carapace dark gray, legs cream-colored. The color notes are based on crabs from San Francisco, California.

Habitat and depth. Sandy beaches, lower intertidal zone to 9 m.

Range. Stinson Beach, California to Santa Rosalia Bay, Baja California, Mexico. Type locality San Diego, California.

Remarks. Adults of this species are scavengers, whereas juveniles filter plankton from the water. The crabs usually are buried out of sight in sand. Molts commonly are cast ashore.

Lophomastix Benedict, 1904

Lophomastix diomedae Benedict, 1904

(Fig. 38E, F)

Lophomastix diomedae Benedict, 1904: 621, fig. 1. — Haig & Wicksten 1975: 100. — Boyko 2002: 20, figs. 7, 8.

Diagnosis. Carapace with only 3 large lateral spines, numerous minute spinules along rostrum, frontal margin of carapace. First antennae with feathery setae, second sparsely setose. Eyestalk slender, cylindrical. First pereopods chelate, pereopods 2–4 with sickle-shaped dactyls. Abdominal somites widely separated laterally, telson rounded. Carapace length to 21 mm.

Color in life. Not reported.

Habitat and depth. Sand and shell, 29–68 m.

Range. Santa Cruz I., California to Cortez Bank, Baja California, Mexico. Type locality off Cortez Bank.

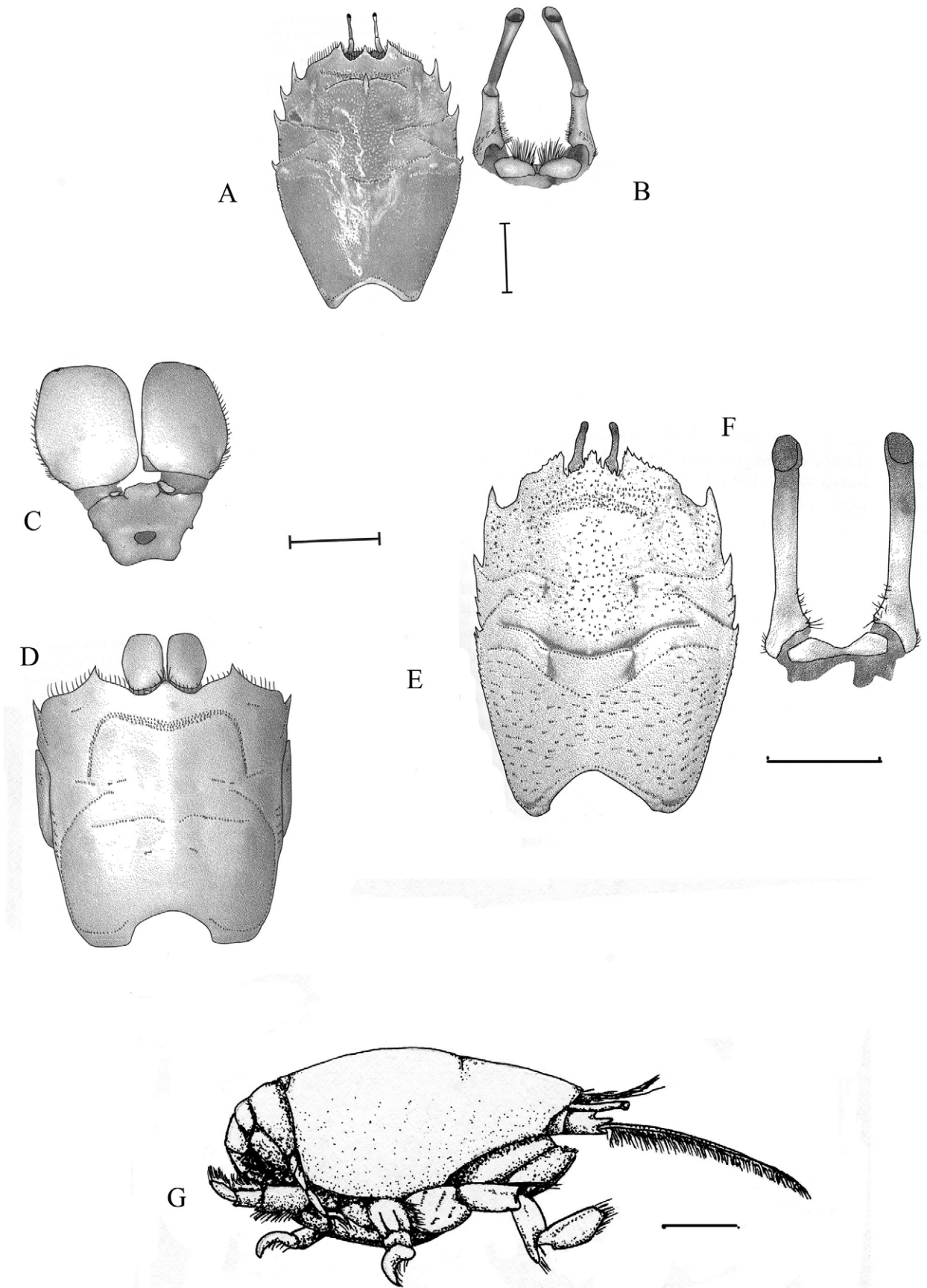


FIGURE 38. Families Blepharipodidae, Albuneidae and Hippidae. A, B, *Blepharipoda occidentalis* Randall, 1839; A, carapace; B, eyestalks. C, D *Lepidopa californica* Efford, 1971; C, eyestalks; D, carapace. E, F, *Lophomastix diomedea* Benedict, 1904; E, carapace; F, eyestalks. G, *Emerita analoga* (Stimpson, 1857). Scales: D = 4.4 mm, F = 5.8 mm, G = 10 mm, A = 17.2 mm. A–F from Boyko 2002.

Family Hippidae Latreille, 1825

Emerita Scopoli, 1777

Emerita analoga (Stimpson, 1857)

(Fig. 38 G, Pl. 5 D)

Hippa analoga, 1857a: 85. — Holmes 1900: 103.

Emerita analoga. — Rathbun 1904: 168. — Schmitt 1921: 173 (extensive synonymy). — Johnson & Snook 1927: 341, figs. 289–290. — MacGinitie & MacGinitie 1968: 301, figs. 145–148. — Haig *et al.* 1970: 25. — Haig & Abbott 1980: 581, fig. 24.4. — Hart 1982: 164, fig. 64. — Ricketts *et al.* 1985: 252, fig. 204. — Jensen 1995: 77, fig. 155. — Kuris *et al.* 2007: 648, pl. 326 D.

Diagnosis. Body egg-shaped. Carapace with fine transverse striations on anterior half, front with 3 broad teeth, lateral margins without teeth. Eyestalk long, slender; cornea pigmented. Both pairs antennae setose, antennal flagella long, with double rows of setae, capable of being folded beneath mouth parts. First pereopods flattened, not chelate. Pereopods 2–4 flattened, dactyls curved. Abdominal somites decreasing in size, ending in arrowhead-shaped telson. Uropods well developed. Carapace length to 35 mm.

Color in life. Carapace greenish to gray with fine stripes of light color anteriorly, with two white dots posteriorly on light colored mid-dorsal area, lateral areas pink. First pereopods pink, white, other pereopods mostly pink. Abdomen gray, telson white, with two pink stripes.

Habitat and depth. Surf-swept sandy beaches, mostly in intertidal zone.

Range. Usually from Oregon to Mexico, rarely as far north as Karluk, Kodiak I., Alaska. Records from Peru, Chile and Argentina probably belong to another species (J. Haig, pers. comm.). Type locality "California." (Many of Stimpson's specimens came from the area of San Francisco to Monterey, California).

Remarks. This small crab is an important prey item for nearshore fishes and shorebirds, as well as a much-used item of bait. Haig & Abbott (1980) gave extensive references on this crab.

SUPERFAMILY LITHOIDEA Samouelle, 1819

McLaughlin *et al.* (2007), in a comprehensive morphological and cladistic revision of the Anomura, firmly supported the designation of the king crabs (Lithodidae) and their relatives as a separate superfamily within the Anomura. De Grave *et al.* (2009), in their comprehensive list of the decapods, also followed this system of classification. Although certain aspects of the developmental biology of the pagurids and lithodids suggested that the lithodoids might be derived by carcinization from pagurids (the "hermit to king" hypothesis), McLaughlin *et al.* (2007) found no convincing evidence for this idea. They also supported the division of the Hapalogastridae and Lithodidae s. s. into separate families.

Family Hapalogasteridae Brandt, 1850

Hapalogasterids are confined to the North Pacific, rarely occurring as far south as Point Conception, California.

Key to species of family Hapalogasteridae

1. Carapace distinctly flattened, covered with numerous subequal spines. Legs spiny *Acantholithodes hispidus*
- Carapace flattened to moderately convex, without spines; legs sparsely setose to extremely setose but without spines 2
2. Carapace and legs flattened, pubescent. Carapace not granular on upper surface *Hapalogaster cavicauda*
- Carapace, legs not flattened or pubescent. Carapace granular on upper surface *Oedignathus inermis*

Acantholithodes Holmes, 1895

Acantholithodes hispidus (Stimpson, 1860)

(Pl. 6C)

Dermaturus hispidus Stimpson, 1860: 242. — Bouvier 1895: 174, pl. 11, figs. 3, 16; pl. 12, figs. 2, 16, 31.

Acantholithodes hispidus. — Holmes 1895: 575; 1900: 120. — Schmitt 1921: 152, pl. 19, fig. 2; fig. 98. — Hart 1982: 70, fig. 19. — Wicksten 1982: 246. — Dawson 1989: 319. — Jensen 1995: 69, fig. 132.

Diagnosis. Rostrum prominent, ending in strong spines. Carapace flattened, with numerous short setose spines; broadly pear-shaped, widest just past midlength; branchial regions with slight depressed area, sharp narrow cleft between cardiac, gastric regions. Abdomen short, broad, soft. Chelipeds, pereopods 2–4 armed with numerous spines. Carapace length to 62 mm.

Color in life. Body yellowish to tan, spines darker, sometimes with faint bands of red on legs; hands of chelipeds with tinge of red, fingers bright red with white teeth, black apices (Hart 1982).

Habitat and depth. Usually on vertical rock walls, zone to 165 m but usually subtidal in southern parts of its range.

Range. Off Moorovskoy Bay, Alaska to San Nicolas I., California. Type locality Monterey Bay, California.

Hapalogaster Brandt, 1850

Hapalogaster cavicauda Stimpson, 1859

(Pl. 6G)

Hapalogaster cavicauda Stimpson, 1859: 81, pl. 1, fig. 7. — Bouvier 1895: 166, pl. 12, fig. 29. — Holmes 1900: 113. — Schmitt 1921: 149, pl. 29, fig. 1; fig. 9. — Johnson & Snook 1927: 337, fig. 286. — MacGinitie & MacGinitie 1968: 299. — Haig & Abbott 1980: 582, fig. 24.6. — Ricketts *et al.* 1985: 171, fig. 140. — Dawson 1989: 319. — Jensen 1995: 69, fig. 134. — Hendrickx & Harvey 1999: 374. — Kuris *et al.* 2007: 648.

Diagnosis. Body and legs very flat, covered with dense, short setae. Carapace with front bearing medial tooth, lateral teeth, prominent cervical groove, widest behind midlength. Chelipeds unequal in size, hand of larger chela with 1 or 2 small tubercles on inner surface. Pereopods 2–4 with deep incisions on anterior margins; these hidden by setae. Abdomen bulbous, visible in dorsal view. Carapace length 18.3 mm.

Color in life. Yellowish brown. The color note is based on crabs from Mendocino, Mendocino County, California.

Habitat and depth. Under rocks in low intertidal zone, intertidal zone to 15 m.

Range. Washington; Cape Mendocino, California to San Jeronimo I., Baja California but uncommon south of Monterey Bay, California. Type locality Monterey, California.

Remarks. Schmitt (1921) cited *H. grebnitzkii* Schalfeev, 1892 from "Humboldt Bay, California." There are no other reports of the species from California. Hart (1982) gave the southern geographic limit of this species as Puget Sound, Washington. The record by Schmitt may have come from Humboldt Bay, Alaska instead of California (J. Haig, pers. comm.)

Hendrickx & Harvey (1999) reported *H. cavicauda* from Guaymas, Sonora, Gulf of California. This record surely is in error. This may be a misidentification of *Petrolisthes hirtipes* Lockington, 1878 (Porcellanidae).

Oedignathus Benedict, 1895

Oedignathus inermis (Stimpson, 1860)

(Fig. 39A)

Hapalogaster inermis Stimpson, 1860: 243.

Oedignathus inermis. — Holmes 1900: 119. — Rathbun 1904: 163. — Schmitt 1921: 151, pl. 19, fig. 1; fig. 97 (early synonymy). — Johnson & Snook 1927: 337. — Makarov 1962: 231, fig. 80. — MacGinitie & MacGinitie 1968: 301. — Haig & Abbott 1980:

583, fig. 24.7. — Hart 1982: 68, fig. 18, color plate. — Ricketts *et al.* 1985: 171. — Dawson 1989: 319. — Jensen 1995: 70, fig. 136. — Kuris *et al.* 2007: 648.

Diagnosis. Carapace widest behind midlength, with abrupt angle at anterior edge of widest point; covered with scale-like plates; rostrum triangular, with frontolateral teeth, small teeth just mesial to them. Chelipeds unequal, covered by wart-like granules; hand of larger cheliped large and swollen, fingers with gape at base. Pereopods 2–4 with tubercles, stiff setae on dactyls. Female abdomen somewhat hardened on left side. Carapace length to 30 mm.

Color in life. Brown, with dark tubercles; tubercles on major cheliped of adult blue (Hart 1982).

Habitat and depth. Rocky subtidal zones, especially in areas with strong currents; rarely lowest intertidal zone, to 15 m. In California, it has been collected in the last 20 years at the Farallon Is. off San Francisco.

Range. Korea, Japan; Dutch Harbor, Alaska to Pacific Grove, California. Type locality Puget Sound.

Family Lithodidae Samouelle, 1819

The Lithodidae, including the king crabs, are primarily a cold-water family with the greatest species diversity and diversity in body form in the North Pacific. Few studies have been conducted on their natural history. Most seem to be scavengers or predators on sea other invertebrates, including mollusks. Dawson (1989) gave a comprehensive bibliography of lithodids.

From photographs, it may be difficult to distinguish species of *Paralithodes* from brachyuran crabs of the superfamily Majoidea. In lithodids, the longer second antennae lie lateral to the eye; while in brachyurans, both pairs of antennae are short and have their origins mesial to the eye. Lithodids have at most three pairs of locomotory appendages posterior to the chelipeds, while brachyurans usually have four pairs. The abdomen of a lithodid generally is asymmetrical and contains membranous areas, while the abdomen of a brachyuran generally is symmetrical and well calcified.

Dawson (1989: 318) reported *Neolithodes diomedea* Benedict, 1895 from "Eastern Pacific, Southern California, Mexico to Scotia Sea; deep water." There are specimens identified as this species in the Benthic Invertebrate Collection of Scripps Institution of Oceanography (Luke 1977). It would be wise to re-examine these specimens and confirm the identification.

Key to Species of family Lithodidae

1. Carapace broadly oval, convex and smooth, completely concealing pereopods from dorsal view 2
- Carapace not broadly oval, usually rough, not completely concealing pereopods from dorsal view 3
2. Chelae tuberculate. Rostrum narrowing distally, end rounded *Cryptolithodes typicus*
- Chelae smooth. Rostrum widened toward transverse distal end *Cryptolithodes sitchensis*
3. Carapace with two deep pits within triangular excavated area, surrounded by rounded papillated tubercles. Abdominal plates with central membranous area. *Phyllolithodes papillosus*
- Carapace without deep pits, papillated tubercles. Abdominal plates without central membranous area 4
4. Carapace with outline of an equilateral triangle, with deep fossa separating cardiac region from other regions of carapace *Rhinolithodes wosnessenskii*
- Carapace with outline more rounded, without deep fossa separating cardiac region from other regions of carapace 5
5. Pereopods 2–4 shorter than greatest width of carapace. Outline of carapace roughly pentagonal or hexagonal, convex, with short tubercles 6
- Pereopods 2–4 longer than greatest width of carapace. Outline of carapace broadly pear-shaped 8
6. Without wart-like prominence on each side of median gastric area. Pereopods 2–4 spinose. Not found north of Los Angeles County, California *Glypholithodes cristatipes*
- With wart-like prominence on each side of median gastric area. Pereopods 2–4 tuberculate. Usually found north of Los Angeles County, California 7
7. Tubercles of chelipeds, pereopods 2–4 spiniform, carpus of chelipeds with outer edge excavated, forming deep rounded sinus *Lopholithodes foraminatus*
- Tubercles of chelipeds, pereopods 2–4 rounded, blunt; carpus of chelipeds without deep, rounded sinus on outer edge. *Lopholithodes mandti*
8. Abdomen mostly leathery. Carapace with tubercles or short spines 9
- Abdomen well calcified. Carapace often with long spines 10
9. Carapace spiny. Pereopods 2–4 legs angular *Paralomis multispina*

- Carapace with tubercles. Pereopods 2–4 much compressed *Paralomis verrilli*
- 10. Plates of second abdominal segment more or less fused *Lithodes couesi*
- Plates of second abdominal segment distinct 11
- 11. Rostrum bifid, anterior lateral spines of rostrum reaching to apex of bifurcation of rostrum *Paralithodes rathbuni*
- Rostrum simply bifid or split, anterior lateral spines of rostrum not reaching half way to bases of terminal spines
..... *Paralithodes californiensis*

***Cryptolithodes* Brandt, 1848**

***Cryptolithodes sitchensis* Brandt, 1853**

(Fig. 40B, Pl. 6B)

Cryptolithodes sitchensis Brandt, 1853: 254. — Holmes 1900: 125, pl. 2, figs. 21–25. — Schmitt 1921: 155, pl. 20, figs. 3, 4, fig. 100. — Johnson & Snook 1927: 339, fig. 287. — Makarov 1962: 268, figs. 108, 109. — Haig & Abbott 1980: 583, figs. 24.8 a–g. — Hart 1982: 76, fig. 22. — Ricketts *et al.* 1985: 171, fig. 139. — Odenweller 1972: 240, figs. 1, 2. — Dawson 1989: 317. — Jensen 1995: 71, fig. 138. — Kuris *et al.* 2007: 648.

Diagnosis. Carapace covering most of body, pereopods, about 1.3 times as wide and long, with lateral extensions almost as long as rostrum, with dorsal tubercles, low teeth along lateral margins. Rostrum widened distally, usually ending in distinct anterolateral angles, sometimes with small median tooth. Chelipeds smooth, unequal. Pereopods 2–4 smooth, flat. Abdomen flat, triangular. Carapace length to 68 mm.

Color in life. Orange, mottled, ivory, red, pink with red spots; see color photographs by Haig & Abbott (1980: figs. 24.8 a–g).

Habitat and depth. Rocky reefs and tide pools, lowest intertidal zone to 17 m.

Range. Sitka, Alaska to Point Loma, California. Type locality Sitka, Alaska. This crab is uncommon south of Point Conception.

Remarks. These little crabs sometimes bear injuries around the rim of the carapace. At times, two or more of these crabs will grip each other by the rim of the carapace. Whether this activity constitutes mating behavior or aggression is unknown.

***Cryptolithodes typicus* Brandt, 1853**

(Fig. 39C, D)

Cryptolithodes typicus Brandt, 1853: 654. — Holmes 1900: 124. — Rathbun 1904: 16. — Schmitt 1921: 154, pl. 20, figs. 1, 2. — Johnson & Snook 1927: 339. — Makarov 1962: 270, figs. 110, 111. — Haig & Wicksten 1975: 102. — Hart 1982: 78, fig. 23.—Dawson 1989: 317. — Jensen 1995: 71, fig. 139.

Diagnosis. Carapace about twice as wide as long, with lateral expansions not reaching midlength of rostrum, with dorsal tubercles, broad teeth along lateral margins. Rostrum narrowing distally, end rounded. Chelipeds tuberculate, unequal in size. Pereopods 2–4 flattened. Abdomen flat, triangular. Carapace length to 49 mm.

Color in life. Highly variable: red, ivory, gray, orange, or spotted (Hart 1982).

Habitat and depth. Often in shell rubble by rocky reefs, low intertidal zone to 45 m.

Range. Amchitka I., Alaska to Santa Rosa I., California. Type locality "northern California."

Remarks. Brandt received specimens that came from the coast of California near Fort Ross, which may be the actual type locality of this crab.

***Glyptolithodes* Faxon, 1893**

***Glyptolithodes cristatipes* (Faxon, 1893)**

(Fig. 39E, F)

Rhinolithodes cristatipes Faxon, 1893:163.

Glyptolithodes cristatipes. — Faxon 1895: 43, pl. 7, fig. 2, 2a–2c. — Haig 1974: 161, fig. 5. — Baez & Andrade 1979: 222, pl. 1, fig. 2. — Wicksten 1982: 247. — Wicksten 1989b: 314. — Dawson 1989: 317. — Martin *et al.* 1997: 83, figs. 2, 3 (extensive synonymy). — Hendrickx & Harvey 1999: 374.

Diagnosis (after Haig 1974 and Martin *et al.* 1997). Carapace subtriangular, tuberculate; gastric area raised into conical prominence, crescent-shaped ridge on each branchial region, cardiac area enclosed in deep fossa. Ridges, prominences more marked in juvenile than adult. Rostrum straight, triangular. Anterolateral margin of carapace with 5 teeth. Chelipeds unequal, right one larger; coxa granulated, lower margin of ischium, merus with 3–4 blunt teeth, upper surface of merus toothed. Pereopods 2–4 with crest along anterior margin. Abdomen tuberculate. Juveniles with more spines than adults, carapace more angular, appendages more stout, short. Carapace length to 71.4 mm.

Color in life. Not reported.

Habitat and depth. Continental shelf and slope, 183–800 m.

Range. Palos Verdes Peninsula, California to off Valparaiso, Chile. Type locality Gulf of Panama (*Albatross* sta. 3354, 7° 9' 45" N, 80° 50' 0" W). Hendrickx & Harvey (1999) mistakenly reported the species from "Palo Alto, California", but the record in fact came from off the Palos Verdes Peninsula, Los Angeles County, California.

Lithodes Latreille, 1806

Lithodes couesi Benedict, 1895

(Pl. 6A)

Lithodes couesi Benedict, 1895: 481. — Schmitt 1921: 162, pl. 28, pl. 29 figs. 3–5. — Makarov 1962: 255, fig. 101. — Pereyra & Alton 1972: 450. — Somerton 1981: 259, figs. 7, 8. — Hart 1982: 94, fig. 31. — Wicksten 1982: 245; 1989b: 314. — Dawson 1989: 317. — Komai & Anaoka 1989: 287. — Martin *et al.* 1997: 79, fig. 1 (extensive synonymy). — Macpherson & Wehrtmann 2010: 148.

Diagnosis. Carapace longer than wide, with spines on dorsal surface and larger ones along margins. Rostrum with bifid apex, pair lateral spines. Chelipeds much shorter than walking legs, with spines; fingers with gape. Pereopods 2–4 with spines on upper surface, margins. Abdomen without spines. Spines relatively larger and rostrum relatively longer in relation to carapace in juveniles than in adults. Individuals varying in shape, length of rostrum; also lateral spines of carapace. Carapace length to 105 mm.

Color in life. Carapace rosy pink, spines red. Chelipeds, other pereopods crimson with white joints. Juveniles scarlet (Hart 1982).

Habitat and depth. Among mud or boulders, 258–1829 m.

Range. Okhotsk Sea off Japan; Bering Sea to south of Tortugas Bay, Baja California, Mexico. Type locality north of Unalaska.

Remarks. *Lithodes couesi* has three adaptations to survival in areas of low oxygen concentration: inflated branchial chambers, large exhalent openings and large scaphognathites. Photographs show the crab walking on tiptoe atop soft muddy sediments (Somerton 1981). Martin *et al.* (1997) reported that the crab can be heavily infested by the rhizocephalan *Briarosaccus callosus* Boschma, 1930.

Lopholithodes Brandt, 1848

Lopholithodes foraminatus (Stimpson, 1859)

(Pl. 6D)

Echinocerus foraminatus Stimpson, 1859: 79.

Lopholithodes foraminatus. — Holmes 1900: 130. — Schmitt 1921: 157, pl. 21, fig. 2; fig. 102. — Johnson & Snook 1927: 340, figs. 288, 294. — Goodwin 1952: 176. — MacGinitie & MacGinitie 1968: 300. — Pereyra & Alton 1972: 450. — Wicksten 1980: 363. — Hart 1982: 80, fig. 24. — Wicksten 1980c: 363; 1982b: 245; 1989b: 314. — Dawson 1989: 318. — Jensen 1995: 72, fig. 143. — Martin & Haney 2005: 450. — Kuris *et al.* 2007: 648.

Diagnosis. Carapace tuberculate, depressed; gastric region elevated, margins with low, wide spines. Rostrum short, with median spine, spiny tubercles above base. Chelipeds tuberculate, equal; with broad sinus on carpus forming, with similar sinus on pereopods 2, large respiratory opening. Pereopods 2–4 tuberculate, capable of being drawn tightly against cephalothorax. Abdomen asymmetrical, tuberculate. Carapace length to 165 mm.

Color in life. Drab reddish-brown or tan. The color notes are based on crabs trawled off southern California.

Habitat and depth. Sandy subtidal areas, rarely low intertidal zone to 547 m.

Range. Kodiak, Alaska to San Diego, California. Type locality "near San Francisco, California." The crab often is trawled north of San Francisco.

Remarks. MacGinitie & MacGinitie (1968) gave a good account of the natural history of this burrowing crab. Martin & Haney (2005) reported this species from extinct vent sites in the Oregon Subduction Zone.

***Lopholithodes mandtii* Brandt, 1848**

(Fig. 39G)

Lopholithodes mandtii Brandt, 1848: 174. — Holmes 1900: 128. — Schmitt 1921: 156, pl. 21, fig. 1; fig. 101. — Johnson & Snook 1927: 340. — Makarov 1962: 266, figs. 106, 107. — Pereyra & Alton 1972: 450. — Hart 1982: 82, fig. 25. — Dawson 1989: 318. — Jensen 1995: 73, fig. 144. — Kuris *et al.* 2007: 648.

Diagnosis. Carapace strongly convex; gastric, cardiac, branchial regions each with prominent subconical tubercle, anterolateral margin with large, small spines; large prominence at each posterolateral angle; all raised areas more prominent in juveniles than in adults. Rostrum short, consisting of subconical tubercle, knob with two lateral tubercles with posterior notch. Chelipeds unequal. Chelipeds, pereopods 2–4 with tubercles. Abdomen asymmetrical, with tubercles. Carapace length to 177.8 mm.

Color in life. Scarlet, red or orange, with bright purple markings on ventral part of body, legs (Hart 1982).

Habitat and depth. Usually subtidal rocky areas, rarely lowest intertidal zone, to 200 m.

Range. Sitka, Alaska to Monterey, California but few reports south of Washington. Type locality Sitka, Alaska.

***Paralithodes* Brandt, 1848**

***Paralithodes californiensis* (Benedict, 1895)**

(Fig. 39H, Pl. 6F)

Lithodes californiensis Benedict, 1895: 483. — Holmes 1900: 131.

Paralithodes californiensis. — Bouvier 1896: 23. — Schmitt 1921: 161, pl. 25, pl. 30, figs. 1, 2. — Goodwin 1952: 178, fig. 10. — MacGinitie & MacGinitie 1968: 300. — Anderson & Cailliet 1974: 29. — Wicksten 1982: 245; 1989b: 314. — Dawson 1989: 318.

Diagnosis. Carapace longer than wide, with long spines on dorsal regions, margins of carapace; one large spine each above origins of pereopods 3, 4. Spines more pronounced in juveniles than in adults. Rostrum bifid, with two subrostral spines extending to end of cornea of eye. Chelipeds slender, spinous. Pereopods 2–4 elongate, spinous. Abdomen with membranous medial area. Carapace length 95 mm.

Color in life. Orange with bluish-white spines. The color notes are from a crab taken off southern California.

Habitat and depth. Mud or rocks, 145–300 m.

Range. Off Pismo Beach to off San Diego, California. Type locality off Santa Cruz I., California.

Remarks. This lithodid crab serves as host or substrate for other species. The gammarid amphipod *Commensipleustes commensalis* (Shoemaker, 1952) has been found on the carapace. Eggs of a snailfish, *Careproctus* sp., have been found in the gill chambers of this crab (Anderson & Cailliet 1974). Some larger crabs had cocoons of marine leeches on the carapace. The crab may be parasitized by rhizocephalan cirripeds.

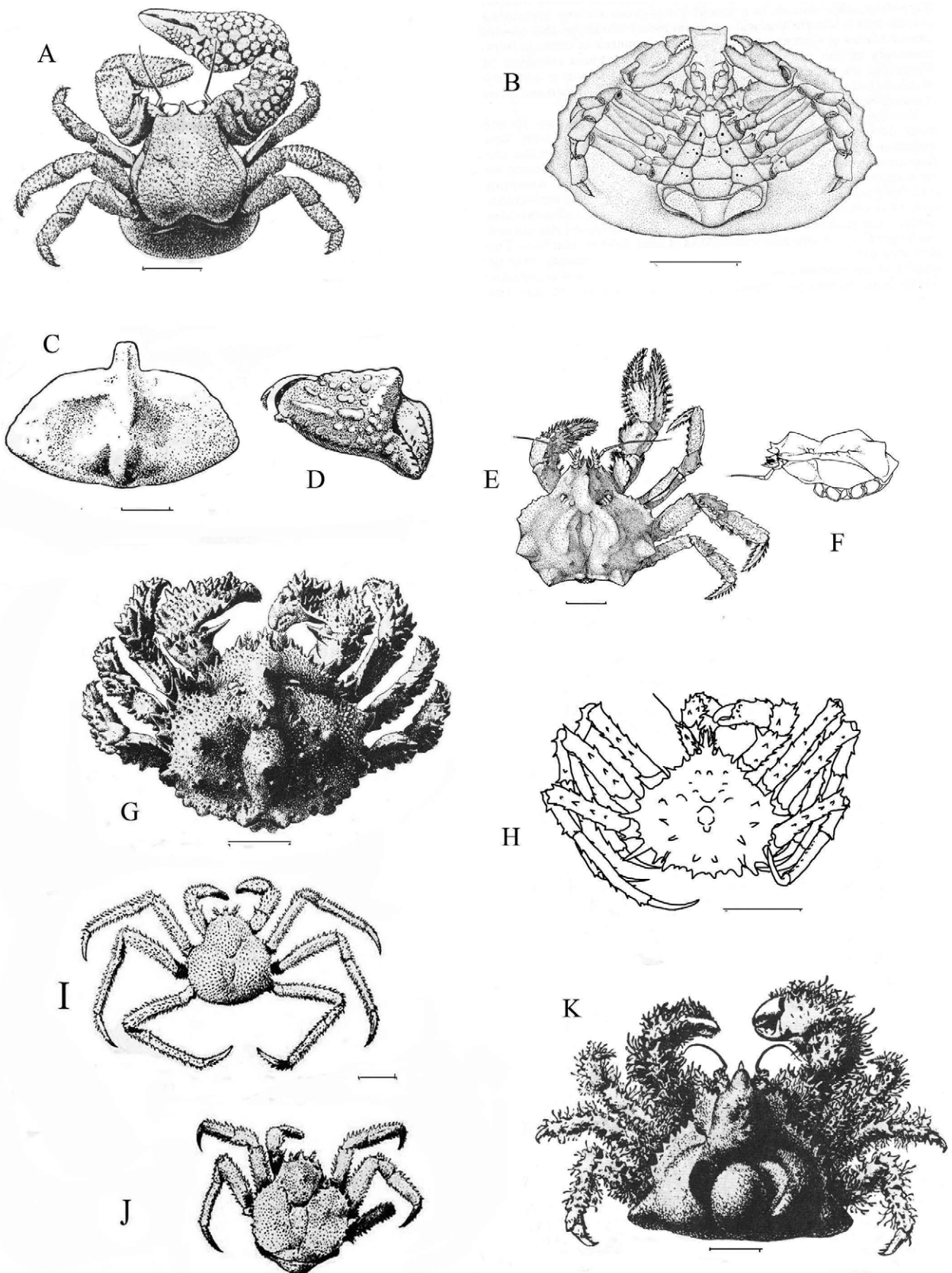


FIGURE 39. Families Hapalogastridae and Lithodidae. A, *Oedignathus inermis* (Stimpson, 1860). B, *Cryptolithodes sitchensis* Brandt, 1853; ventral view. C, D, *Cryptolithodes typicus* Brandt, 1849; C, dorsal view; D, chela. E, F, *Glyptolithodes cristatipes* Faxon, 1893; E, dorsal view; F, carapace in lateral view. G, *Lopholithodes mandtii* Brandt, 1849. H, *Paralithodes californiensis* (Benedict, 1895). I, *Paralomis multispina* (Benedict, 1895). J, *Paralomis verrilli* (Benedict, 1895). K, *Rhinolithodes wosnessenskii* Brandt, 1849. Scales: I, J = 5 mm; A, B, C, K = 10 mm; E, H = 30 mm; G = 50 mm. A–D, G, I–K from Makarov 1962, E, F from Haig 1974, H drawn from photograph by Goodwin 1952.

***Paralithodes rathbuni* (Benedict, 1895)**

(Pl. 6F)

Lithodes rathbuni Benedict, 1895: 482. — Holmes 1900: 131,

Paralithodes rathbuni. — Bouvier 1896: 23. — Schmitt 1921: 160, pl. 26, pl. 27, figs. 6, 7; pl. 30, figs. 3, 4. — Goodwin 1952: 177, fig. 9. — Wicksten 1982: 245; 1987: 55; 1989b: 314. — Dawson 1989: 318.

Diagnosis. Carapace slightly wider than long, with long spines on dorsal regions, margins of carapace; more pronounced in juveniles than in adults. Rostrum directed upward, with 2 lateral spines, pair of spines flanking terminal point. Chelipeds slender, armed with strong spines; shorter than walking legs. Pereopods 2–4 slender, spiny. Abdomen with membranous medial area. Carapace length 65 mm.

Color in life. Pale orange. The color note is from a crab taken in Monterey Bay, California.

Habitat and depth. Sand, mud or rock; 92–380 m.

Range. Cordell Bank, California to south of San Benito Is., Baja California. Type locality off San Simeon Bay, California.

***Paralomis* White, 1856**

***Paralomis multispina* (Benedict, 1895)**

(Fig. 39I, Pl. 6A)

Leptolithodes multispinus Benedict, 1895: 484. — Rathbun 1904: 165.

Paralomis multispina. — Bouvier 1896: 25. — Schmitt 1921: 159, pl. 23, pl. 30, figs. 7, 8. — Goodwin 1952: 176, fig. 8. — Makarov 1962: 257, fig. 102. — Pereyra & Alton 1972: 450. — Wicksten 1980c: 364; 1982: 245; 1989b: 314. — Hart 1982: 88, fig. 28. — Dawson 1989: 318. — Hendrickx & Harvey 1999: 374. — Martin & Haney 2005: 450. — Hall & Thatje 2010: 504, fig. 7.

Diagnosis. Carapace about as long as wide, dorsal surface, lateral margins with numerous spines: stout, sharp-tipped, conical in adult, short, blunt in juvenile with carapace width of 30 mm or less. Rostrum with simple median spine, two basal spines. Chelipeds unequal, slender, with prominent spines on carpus. Pereopods 2–4 elongate, cylindrical, thickly set with spines. Female abdomen twisted to right. Carapace length 80 mm.

Color in life. Body red to pale pink, spines dark red. The color notes are from a crab taken in a trap off southern California.

Habitat and depth. Muddy continental slope, 1100–1577 m. The crab has been found near cold seeps off Japan.

Range. Sagami Bay, Japan; Shumagin Bank, Alaska to off Guadalupe I., Baja California; off Carmen I., Gulf of California. Type locality off Queen Charlotte Is.

Remarks. This large crab has been fished commercially by trapping. The caprellid amphipod *Caprella ungulina* Mayer, 1903; clings to the legs of this crab (Wicksten 1982). Hall & Thatje (2010) demonstrated ontogenetic changes in the morphology of crabs of the genus *Paralomis*, including this species. Juveniles have much shorter dorsal carapace spines than do adults.

***Paralomis verrilli* (Benedict, 1895)**

(Fig. 39J)

Pristopus verrilli Benedict 1895: 486. — Rathbun 1904: 165.

Paralomis verrilli. — Schmitt 1921: 159, pl. 24, pl. 30, figs. 5, 6. — Makarov 1962: 258, fig. 103. — Pereyra & Alton 1972: 450. — Hart 1982: 86, fig. 2. — Wicksten 1989b: 315. — Dawson 1989: 318. — Komai & Amaoka 1989: 288. — Hendrickx & Harvey 1999: 374.

Diagnosis. Carapace slightly longer than wide, with spines, granules; large spines on margins, elevated areas. Rostrum bifid with subrostral spine. Chelipeds shorter than walking legs, spinous; right larger than left. Pereopods

2–4 somewhat flattened, with large teeth on margins, smaller teeth on dorsal surface. Abdomen with small spines, nodules. Carapace length 112 mm.

Color in life. Carapace pale reddish brown, thoracic appendages deep red. Distal half of cutting edges of chelae black or deep brown (Komai & Amaoka 1989).

Habitat and depth. Continental slope, 450–2379 m.

Range. Sea of Okhotsk to off San Benito I., Baja California; and Gulf of California. Type locality off Pribilof Is.

***Phyllolithodes* Brandt, 1848**

***Phyllolithodes papillosus* Brandt, 1848**

(Pl. 6E)

Phyllolithodes papillosus Brandt, 1848: 175. — Bouvier 1895: 174, pl. 11, fig. 12; pl. 12, figs. 14; 25; pl. 13, fig. 1. — Holmes 1900: 122. — Rathbun 1904: 164. — Schmitt 1921: 153, pl. 22, fig. 2. — Johnson & Snook 1927: 339. — Makarov 1962: 238, fig. 82. — Hart 1982: 72, fig. 20. — Dawson 1989: 319. — Jensen 1995: 72, fig. 142.

Diagnosis. Carapace triangular, with deep pits within heart-shaped area on dorsal surface; lateral margins with strong spines, posterior margin with large nodes. Rostrum ending in two horns, with subacute median spine. Chelipeds unequal, chelipeds, pereopods 2–4 with long spines. Carapace length to 90 mm.

Color in life. Carapace grayish, reddish or brown; walking legs often with cream-colored band above dactyl. Hart (1982) gave a more extensive description of the living color.

Habitat and depth. Rocky subtidal areas, lowest intertidal zone to 183 m.

Range. Dutch Harbor, Alaska to San Miguel I., California. Type locality Kodiak I., Alaska. Uncommon south of Monterey County, California.

***Rhinolithodes* Brandt, 1848**

***Rhinolithodes wosnessenskii* Brandt, 1848**

(Fig. 39K)

Rhinolithodes wosnessenskii Brandt, 1848: 174. — Schmitt 1921: 158, pl. 22, fig. 1, fig. 103. — Makarov 1962: 260, fig. 104. — Hart 1982: 74, fig. 21. — Dawson 1989: 319. — Jensen 1995: 72, fig. 141.

Diagnosis. Carapace tuberculate, somewhat triangular, with deep semicircular fossa separating cardiac region from other parts of carapace. Rostrum blunt at base, tapering abruptly to median spine. Chelipeds unequal, armed with short spines. Pereopods 2–4 also with short spines. Abdomen with small tubercles. Carapace length to 59 mm.

Color in life. Mostly yellowish to grayish brown, markings of orange, cream in carapace depression; see Hart (1982) for a detailed color description.

Habitat and depth. Rock or gravel bottoms, often in crevices, 6–73 m.

Range. Kodiak, Alaska to Crescent City, California. Type localities Sitka and Kodiak, Alaska.

SUPERFAMILY PAGUROIDEA Latreille, 1802

The most familiar of all anomurans are the hermit crabs. These crabs usually inhabit shells or tubes but may live inside hollows in sponges, bits of crab exoskeleton, twigs or even bones. Species occur from the upper tide pools to the abyssal plains.

In hermit crabs, the abdomen is soft and ends in a small telson and uropods. The pleopods usually are reduced at least along one side of the abdomen. The carapace, although present, usually is lightly calcified. The eye are stalked and well developed, with pigmented corneae. The antennules are well equipped with sensory setae, the

aesthetascs. In life, the antennae flick, aiding the crab in tracking chemosensory cues. The second antennae are long and whip-like in most species, but setose and used in gathering particles in some species of the Diogenidae. The rostrum varies from long and pointed to almost absent. The third maxillipeds are leg-like and setose. The first pereopods bear chelae, one often larger than the other. In some species, the major cheliped ends in an enlarged chela that can block the aperture of the shell. The size and shape of the chelae can be sexually dimorphic. Pereopods 2, 3 are ambulatory. The last pairs of pereopods are short and grip the shell.

Older books classified all hermit crabs in a single family, the Paguridae. Today, three families are recognized as occurring in California and Oregon. The Paguridae, most often observed and studied, range from the continental slopes to the intertidal zone. Species of the Diogenidae usually are subtidal, and may be able to bury themselves in sand. The Parapaguridae are found on the continental shelf and deeper areas. The work by McLaughlin (1974) provides keys, illustrations and further information on hermit crabs occurring north of Point Conception, California. Lemaitre & Castaño (2004) presented a list of all the species of *Pagurus* of the eastern Pacific with species group assignments, but noted that, as of their writing, many species had yet to be assigned.

The key to the Paguroidea presented here is modified from a manuscript key by Janet Haig, and includes one as yet undescribed subtidal species from southern California. I have included another artificial key based on color patterns to aid in the identification of living or photographed hermit crabs. Both of these keys originally were presented to a meeting of the Southern California Coastal Water Research Project in February 1977, but never were formally published.

Key to species of Paguroidea

1. Outer maxillipeds approximated at their bases; chelipeds equal or subequal in size 2 (Diogenidae)
 - Outer maxillipeds widely separated at their bases; right cheliped larger than left 7
2. Pereopod 4 subchelate, no paired pleopods in either sex. Often buried in sand *Isocheles pilosus*
 - Pereopod 4 simple, paired pleopods in both sexes. Living in sand or among rocks, usually not buried 3
3. Dorsal surface of palms of chelae coarsely granulated, and bearing fluffy clusters of short plumose setae . . . *Paguristes parvus*
 - Dorsal surface of palms of chelae with large conical tubercles, each tipped with dark corneous spine; chelae bearing many long stiff simple setae 4
4. Rostrum about as long as lateral frontal projections of carapace; antennal flagellum with short, wide-set hairs on lower surface 5
 - Rostrum longer than lateral frontal projections of carapace; antennal flagellum with long, close-set hairs on lower surface. . . 6
5. Chelae very broad, their dorsomesial margin strongly convex *Paguristes bakeri*
 - Chelae relatively narrow, dorsomesial margin not strongly convex *Paguristes turgidus*
6. Rostrum broad at base, reaching about to base of eyecales; propodus, dactyl pereopods 2, 3 with small, dark corneous spines on inner surface *Paguristes ulreyi*
 - Rostrum slender, narrow at base, apex reaching beyond base of eyecales; propodus, dactyl of pereopods 2, 3 unarmed on inner surface ... *Paguristes* undescribed species
7. Crista dentata of outer maxillipeds with 1 or more accessory teeth, first maxilliped exopod with flagellum, female with gonopore on coxa of both third pereopods. (Intertidal zone to continental slopes, common) 8 (Paguridae)
 - Crista dentata of outer maxillipeds lacking accessory tooth, first maxilliped exopod without flagellum, female with gonopore on coxa of left third pereopod only. (Continental shelf to abyssal plains) 38 (Parapaguridae)
8. Telson with posterior margin entire, lacking lobes, median cleft 9
 - Telson divided into lobes posteriorly 10
9. Telson unarmed terminally, uropods asymmetrical *Enallopaguroopsis guatemoci*
 - Telson with terminal spines; uropods symmetrical *Discorsopagurus schmitti*
10. Propodial rasp of pereopod 4 a single row 11
 - Propodial rasp of pereopod 4 with multiple scale rows 13
11. Abdomen straight; uropods symmetrical *Pylopagurus holmesi*
 - Abdomen coiled; uropods asymmetrical. 12
12. Major chela discoid, dorsal surface of palm convex, bearing many low boss-like tubercles; dactyl with raised ridge on dorsal face; pereopod 4 with preungual process *Phimochirus californiensis*
 - Major chela subquadrate, dorsal surface of palm slightly concave, with raised margins, scattered slender tubercles; dactyl without facial ridge, but bearing proximal tubercle row on dorsal face; pereopod 4 lacking preungual process . . . *Haigia diegensis*
13. Abdomen straight, uropods symmetrical. Often inhabiting tubes or tubular shells *Orthopagurus minimus*
 - Abdomen coiled, uropods asymmetrical 14
14. Male with short sexual tube on coxa of pereopod 5 15
 - Male without sexual tube on coxa of pereopod 5 except *Pagurus aleuticus* male 18
15. Dactyls of pereopods with pronounced lateral sulcus *Pagurus aleuticus* female

–	Dactyls of pereopods lacking lateral sulcus	16
16.	Dorsal surface of palm of major chela unarmed proximally; scattered small spinules or spinulose tubercles distally, on fixed finger	<i>Parapagurodes makarovi</i>
–	Dorsal surface of palm of major chela armed proximally with one or more irregular rows of widely spaced strong spines, these not extending onto fixed finger	17
17.	Dactyls of chelae without row of spines in dorsal midline. In life, without bright color marks on chelipeds, other pereopods	<i>Parapagurodes laurentae</i>
–	Dactyls of chelae with row of spines in dorsal midline. In life, with bright color marks on chelipeds, other pereopods	<i>Parapagurodes hartae</i>
18.	Minor chela with dorsal surface of palm flattened, propodus of pereopod 3 with row of spines on upper margin	19
–	Minor chela with dorsal surface of palm elevated, propodus of pereopods usually unarmed on upper margin	22
19.	Dorsomesial margin of minor chela strongly convex, posterior lobes of telson armed on both terminal, lateral margins	<i>Pagurus spilocarpus</i>
–	Dorsomesial margin of minor chela nearly straight, posterior lobes of telson armed on terminal margins only	20
20.	Dactyls of pereopods 2, 3 with prominent longitudinal sulcus on dorsal surface	<i>Pagurus aleuticus</i>
–	Dactyls of pereopods 2, 3 with 3 longitudinal rows of small spines or spinulous tubercles on dorsal surface, separated proximally by 2 shallow longitudinal sulci	21
21.	Chelae with moderately short, bluntly conical spines or tubercles on dorsal surface	<i>Pagurus ochotensis</i>
–	Chelae with acute spines on dorsal surface	<i>Pagurus armatus</i>
22.	Minor chela with dorsolateral surface concave, midline elevated into prominent ridge; palm of right chela raised into prominent, triangular plateau	23
–	Minor chela with dorsolateral surface convex, midline often elevated, but not into prominent ridge	25
23.	Dorsal margins of propodi of pereopods 2, 3 serrate, dactyls not flattened	<i>Pagurus tanneri</i>
–	Dorsal margins of propodi of pereopods 2, 3 not serrate, dactyls flattened	24
24.	Large hand with apex of raised triangular area horn-shaped in profile	<i>Pagurus cornutus</i>
–	Large hand with apex of raised triangular area rounded in profile	<i>Pagurus confragosus</i>
25.	Merus of major cheliped with 1 or 2 prominent tubercles on ventral surface	26
–	Merus of major cheliped without prominent tubercles on ventral surface	34
26.	Dorsal surface of palm smooth, paved with tiny, close-set granules. Major chela with sharp lateral angles, enlarged, operculum-like	<i>Pagurus retrorsimanus</i>
–	Dorsal surface of palm of chela roughened, with prominent granules. Major chela with rounded margins, not operculum-like	27
27.	Rostrum only slightly produced	28
–	Rostrum distinct, produced well beyond lateral frontal lobes of carapace	31
28.	Merus of major chela with 1 prominent tubercle ventrally	<i>Pagurus caurinus</i>
–	Merus of major chela with 2 or more prominent tubercles ventrally	29
29.	Merus of right cheliped without row of spinules along disto-dorsal margin. Ocular scales tipped with up to 3 spinules	<i>Pagurus quaylei</i>
–	Merus of right cheliped with distinct row of spinules along distodorsal margin. Ocular scales tipped with only 1 spinule	30
30.	Major chela more or less evenly, finely granulated dorsally, palm of minor chela granulated on lower surface	<i>Pagurus granosimanus</i>
–	Major chela more or less coarsely, irregularly granulated dorsally, palm of minor chela smooth on lower surface	<i>Pagurus beringanus</i>
31.	Carpus of major chela deeper than wide, shield shiny, smooth; entire crab almost hairless	<i>Pagurus hemphilli</i>
–	Carpus of major chela wider than deep; shield, legs setose	32
32.	Merus of major cheliped with 2 prominent tubercles ventrally, carapace shield distinctly longer than wide	<i>Pagurus samuelis</i>
–	Merus of major chela with 1 prominent tubercle ventrally; carapace shield wider than long	33
33.	Carapace shield distinctly wider than long. North of Point Conception, California	<i>Pagurus hirsutiusculus</i>
–	Carapace shield slightly longer than wide. Usually south of Point Conception, California	<i>Pagurus venturensis</i>
34.	Eyescales obliquely truncate, oblique margin with 4–5 spinules	<i>Pagurus redondoensis</i>
–	Eyescales subovate, usually terminating in single spine	35
35.	Major chela with spines, granules, setae short, inconspicuous	<i>Pagurus dalli</i>
–	Major chela with spines but not granules, setae longer, easily seen	36
36.	Dactyls of pereopods 2, 3 with row of small corneous spinules on lower margins	<i>Pagurus capillatus</i>
–	Dactyls of pereopods 2, 3 with row of strong corneous spines on lower margins	<i>Pagurus setosus</i>
38.	Dorsal surface of palm of major chela evenly granulate; male with 2 pairs of pleopods	<i>Parapagurus benedicti</i>
–	Dorsal surface of palm of major chela with few longitudinal rows of small pointed granules or tubercles; no paired pleopods in male	<i>Oncopagurus haigae</i>

Artificial key to species of common intertidal and shallow subtidal hermit crabs

1.	Chelae equal in size, shape	2
–	Chelae not equal in size, shape	6

2.	Anterior surfaces of chelae not heavily setose, outer surface at least partially visible through coating of setae	3
–	Anterior surfaces of chelae heavily setose, outer surface not easily visible through dense covering of setae	5
3.	Antennae pale blue, heavily setose. Inhabiting sandy beaches of subtidal sand	<i>Isocheles pilosus</i>
–	Antennae banded with brown, translucent areas, with few setae. Inhabiting subtidal rocky areas	<i>Paguristes parvus</i>
4.	Antennae sparsely setose. Usually deeper than 30 m in California	<i>Paguristes turgidus</i>
–	Antennae heavily setose, moth-like. Often found at less than 30 m	5
5.	Chelae broad, about 0.5 times longer than wide	<i>Paguristes bakeri</i>
–	Chelae not as broad, about 0.3 times longer than wide	<i>Paguristes ulreyi</i>
6.	Right chela more than 2 times wider than left chela, modified to form operculum	7
–	Right chela 2 times or less wider than left chela, not modified to form operculum	8
7.	Pereopods 2–4 dark red, without stripes. Right chela without lateral expansion	<i>Haigia diegensis</i>
–	Pereopods 2–4 reddish brown with cream stripes. Right chela with lateral expansion	<i>Phimochirus californiensis</i>
8.	Antennae bright red	9
–	Antennae brown, golden, orange or banded	12
9.	Pereopods 2–4 brown or greenish, with or without bands	10
–	Pereopods 2–4 red, or red with yellow dactyls	11
10.	Pereopods 2–4 with bands of white, blue or both colors	<i>Pagurus samuelis</i>
–	Pereopods 2–4 without bands, but with bluish or buffy granules	<i>Pagurus granosimanus</i>
11.	Pereopods 2–4 dark red, with yellow dactyls. Major chela not twisted under body.	<i>Pagurus hemphilli</i>
–	Pereopods 2–4 light red, with many minute red dots. Major chela twisted under body	<i>Pagurus retrorsimanus</i>
12.	Chelae with large, distinct spines. Eye with large, round black, green or golden cornea	13
–	Chelae with small spines or spines absent. Eye narrow, cornea not enlarged	15
13.	Dorsomesial margin of minor chela strongly convex. Carpus of chelipeds with bright blue or purple mark. Southern California	<i>Pagurus spilocarpus</i>
–	Dorsomesial margin of minor chela almost straight. Carpus of chelipeds without such mark. Northern California northward	14
14.	Pereopods 2–4 opalescent with golden sheen. Mendocino County, California northward	<i>Pagurus ochotensis</i>
–	Pereopods 2–4 prominently banded with white, red or orange. Usually from Monterey, California northward	<i>Pagurus armatus</i>
15.	Pereopods 2–4 with longitudinal white or bluish stripes on dactyls	16
–	Pereopods 2–4 without longitudinal white or bluish stripes on dactyls	18
16.	Chelae of adults with gape between fingers. Color brown to grayish.	<i>Pagurus quaylei</i>
–	Chelae of adults without gape between fingers. Color black, dirty brown or olive green	17
17.	Dactyls of pereopods 2–4 with distinct stripes of red, white. Usually in southern California, inhabiting shells of <i>Callianax</i> sp.	<i>Pagurus venturensis</i>
–	Dactyls of pereopods 2–4 with stripes of red, pale brown or blue. Usually north of Point Conception, inhabiting shells of <i>Nucella</i> spp. or other gastropods	<i>Pagurus hirsutiussculus</i>
18.	Pereopods 2–4 with prominent white or cream-colored bands.	19
–	Pereopods 2–4 without prominent white or cream-colored bands	20
19.	Antennae banded. Merus of cheliped with white band bordered by black band	<i>Pagurus redondoensis</i>
–	Antennae orange, not banded. Cream-colored band without black band on merus of cheliped	<i>Pagurus caurinus</i>
20.	Inhabiting tubes of worms, twigs, or tubular shells.	<i>Orthopagurus minimus</i>
–	Inhabiting coiled shells.	21
21.	Pereopods 2–4 with red bands separating bluish-gray, greenish or cream-colored areas. Usually found from Mendocino County, California northward	<i>Pagurus beringanus</i>
–	Pereopods 2–4 reddish to purple, without red bands. Can be found south of Mendocino County	<i>Parapagurodes hartae</i>

Family Diogenidae Ortmann, 1892

The "even-clawed" hermit crabs are widely distributed, especially in tropical regions. Ayón-Parente & Hendrickx (2010), in a study of species richness in the eastern Pacific, called attention to the paucity of genera and species in the northern temperate provinces. At most, only seven species in three genera occurred in the Californian and Oregonian provinces while 55 species in 11 genera occurred in tropical provinces. In their analysis, *Clibanarius digueti* Bouvier, 1898 and *Dardanus magdalensis* Ayón-Parente & Hendrickx, 2009; neither of which has been recorded farther north than Magdalena Bay, Baja California, were included as northern temperate species.

In California and Oregon, diogenids are primarily subtidal, although *Isocheles pilosus* may be exposed at very low tide. Except for *Paguristes parvus*, the crabs often have setose second antennae. These antennae can be used to capture particles, which are swept off by the third maxillipeds and then eaten (Wicksten 1979a, 1988b). The crabs also can graze and scavenge, feed on smaller invertebrates, or use the third maxillipeds to brush edible debris off the bottom.

Species of the Diogenidae include some of the largest hermit crabs of the area. The shells may contain small polychaetes or slipper shells (*Crepidula* and *Crepipatella* spp.) Bryozoans, algae, or barnacles often heavily encrust shells inhabited by epibenthic species. Although these hermit crabs often seen by divers, there have been few studies or observations on their natural history.

Schmitt (1921: 126, pl. 17, figs. 3, 4) described an additional species, *Dardanus jordani*, from San Francisco Bay, California. The species, based on a single specimen, has not been reported since then. The locality of the collection may have been error, or the specimen might have been of a species native to some other part of the world.

***Isocheles* Stimpson, 1860**

***Isocheles pilosus* (Holmes, 1900)**

(Fig. 40A–C, Pl. 8D)

Holopagurus pilosus Holmes, 1900: 154. — Schmitt 1921: 127, pl. 17, fig. 2. — Provenzano 1959: 377.

Isocheles pilosus. — Forest 1964: 294. — Haig *et al.* 1970: 17. — Haig & Wicksten 1975: 102. — Wicksten 1979c: 100; 1988b: 321. — Haig & Abbott 1980: 584, fig. 24.9. — Ricketts *et al.* 1985: 336, fig. 262. — Jensen 1995: 67, fig. 127. — Kuris *et al.* 2007: 648.

Diagnosis (based on one specimen each from Newport Bay and Cabrillo Beach, Los Angeles County, California). Rostrum blunt, rounded, reaching about as far forward as lateral projections of carapace. Carapace bluntly triangular, as long as or slightly longer than wide. Second antennae setose. Eystalks set close together, not dilated, exceeding antennal peduncle but not reaching distal end of antennular peduncle, cornea not dilated. Ocular acicle broad at base, extending into distal portion set at almost a 90° angle to basal area; distal portion with 3 strong claw-like spines, 3 strong setae. Antennae densely setose. Antennal acicle reaching close to 0.5 times length of eystalk, set with small spines, setae. Chelipeds densely setose, similar in size, shape in smaller individuals but left chela wider in large adults. Carpus with with strong dorsal ridge bearing spines, 7–9 larger mesiolateral spines, two rows of larger dorsal spines, scattered rows of smaller spines along lateral margin. Hands horizontally flattened, set with prominent scattered spines, palms gently convex but with transverse depression anterior to base of fingers. Fingers with 3 or 4 rows of prominent spines, ending in sharp apices, without gape. Left cheliped widest across base of fingers, relatively narrower than larger, with inner, outer faces parallel. Pereopods 2, 3 with merus having tubercles, long setae, carpus with 2 rows of dorsal tubercles, mesial margin tuberculate, set with long setae; propodus with strong dorsal spinulose ridge, with rows of long, simple setae; dactyls long, gently curved, with lateral groove, flattened toward apex. Pereopod 4 ischium bearing two large ventral prominences, tuft of lateral setae; merus with lateral, dorsal tufts of elongate setae, carpus with tuberculate dorsal margin, dorsal, lateral tufts of elongate setae; propodus with lateral tuft of setae, well-developed granulate bean-shaped propodial rasp fringed dorsally by stiff setae; dactyl with 5 strong darkly pigmented teeth, fringe of elongate setae. Pereopod 5 chelate. Telson nearly as long as wide, slightly asymmetrical, left lobe slightly longer than right, lateral margins set with acute stiff setae, distal margin with 16 minute teeth, simple setae. Carapace length of larger examined specimen 7.8 mm.

Color in life. Carapace and antennae mottled with bluish, gray tints. Chelipeds cream to orange with bluish tinge on upper surface, line of brick red along chela. Pereopods 2, 3 tan to whitish, marked with brick red stripes. The color notes are from specimens from Cabrillo Beach, San Pedro, California.

Habitat and depth. Medium-grained sand of beaches, low intertidal zone to 55 m.

Range. Bodega Bay, California to Estero de Punta Banda, Baja California, Mexico. Type locality off San Diego, California.

Remarks. Holmes (1900) and Schmitt (1921) provided only a short diagnosis and poor illustrations of this species. Schmitt (1921) reported that the carapace length "of the single Bay specimen" was 28 mm. This length is far greater than that of any specimen I have examined.

This hermit crab can be very abundant on sandy beaches. It inhabits shells of *Polinices* spp., *Callianax biplicata* (G.B. Sowerby, 1825); *Caesea fossatus* (Gould, 1850); and other sand-dwelling gastropods. The crab can scurry on top of the sand or dig into the sand, leaving only the oral region, eystalks and antennae exposed. It can feed in three ways: raking the surface of the sand with the third maxillipeds, capturing particles filtered by the antennae, or using the chelae to pick up food (Wicksten 1988b).

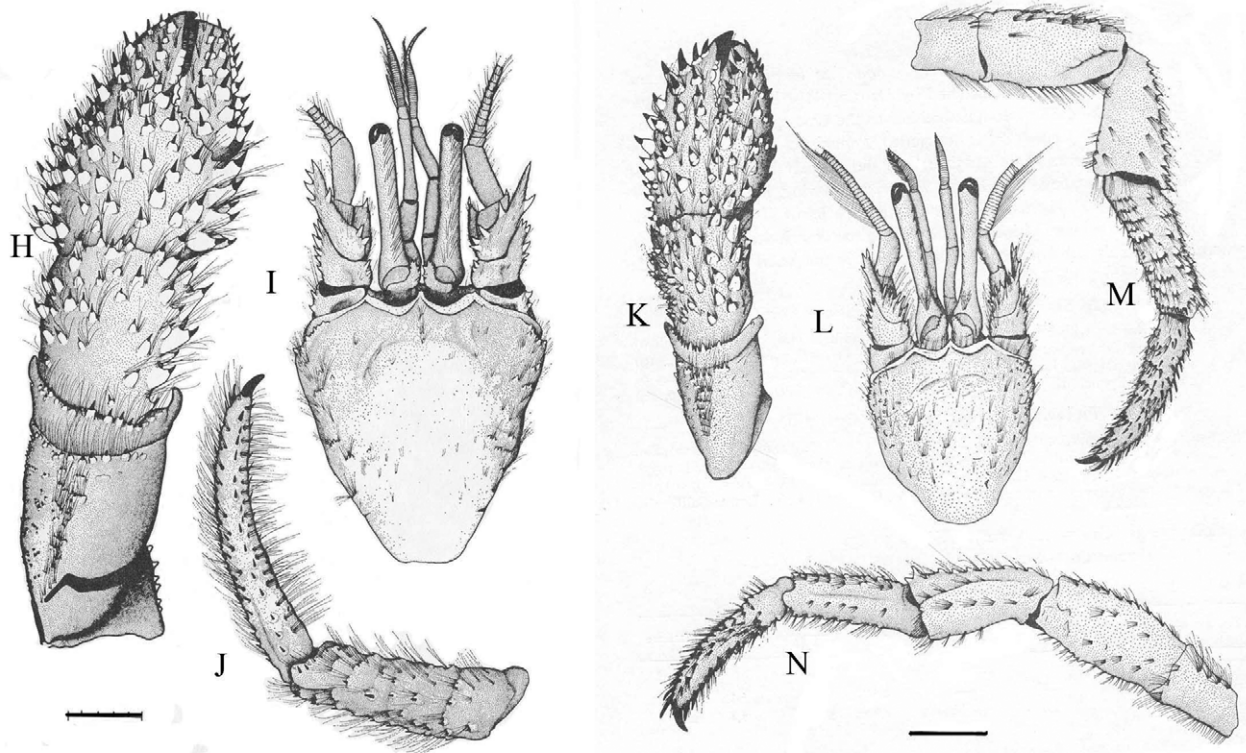
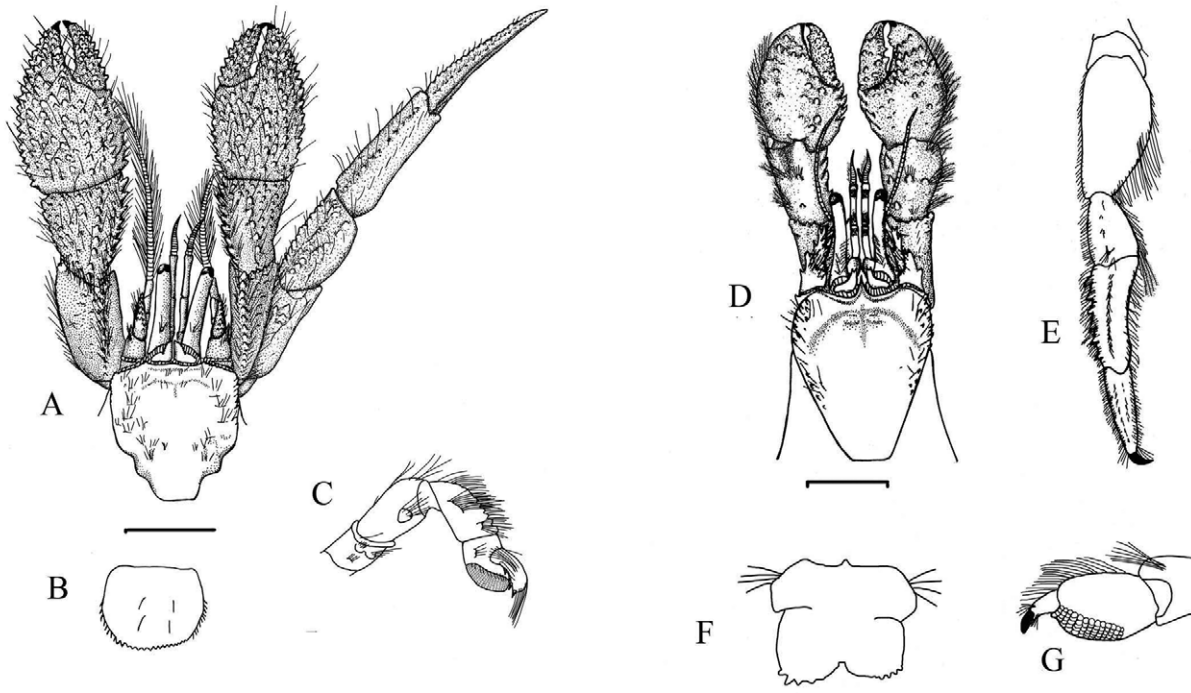


FIGURE 40. Family Diogenidae. A–C, *Isocheles pilosus* (Holmes, 1900); A, carapace and frontal region in dorsal view; B, telson; C, pereopod 4. D–G, *Paguristes parvus* Holmes, 1900; D, carapace and frontal part of crab in dorsal view; E, pereopod 2; F, telson; G, propodial rasp of pereopod 4. H–J, *Paguristes turgidus* (Stimpson, 1857); H, major cheliped; I, carapace and frontal region in dorsal view; J, pereopod 2. K–N, *Paguristes ulreyi* Schmitt, 1921; K, major cheliped; L, carapace and frontal region in dorsal view; M, pereopod 2 in mesial view; N, pereopod 2 in lateral view. Scales: D = 3mm, A, H–N = 5 mm. A–C drawn from crab from Cabrillo Beach, Los Angeles County, California; D–G based on crab from Santa Catalina I., modified from drawings of related species by Provenzano 1959; H–N from McLaughlin 1974.

The southern range limit of this species is uncertain. Specimens identified as *Isocheles pilosus* have been collected at Ballenas Bay, Boca de San Domingo, Hughes Point and San Juanico Bay (Haig *et al.* 1970) and Magdalena Bay, Baja California (Wicksten 2006), but the identification is uncertain.

Provenzano (1959, as *Holopagurus pilosus*) mentioned that this species is very similar to the western Atlantic species *Isocheles wurdemanni*. Stimpson, 1860. He noted that *I. wurdemanni* had chelipeds that could have hands equal in size or the left larger than the right. In specimens that I have examined, these two species differ in three major features: *I. pilosus* is much more setose than *I. wurdemanni*; the dactyl of pereopod 4 bears teeth in *I. pilosus* and not in *I. wurdemanni*, and the telson bears numerous small teeth in *I. pilosus* but only as many as three on each side in *I. wurdemanni*. A fine illustration of *I. wurdemanni* by Provenzano (1959) is marred by an incorrect placement of the chelipeds relative to the eyestalks and antennae.

***Paguristes* Dana, 1851**

***Paguristes bakeri* Holmes, 1900**

(Pl. 8E)

Paguristes bakeri Holmes, 1900: 152. — Schmitt 1921: 124, pl. 18, figs. 2, 6. — Johnson & Snook 1927: 333, fig. 282. — Haig *et al.* 1970: 17. — Wicksten 1988a: 321; 1988b: 321. — Jensen 1995: 68, fig. 130. — Hendrickx *et al.* 2006: 33. — Kuris *et al.* 2007: 648.

Diagnosis. Rostrum about as long as lateral projections of carapace. Second antennae sparsely setose. Length of eyestalk about 0.75 times as long as width of anterior portion of carapace. Hands of chelae broad, about 1.2 times wider than long, outer margin strongly convex; immovable finger about 2 times as wide at base as movable finger; upper surface of hands strongly spined. Appendages covered by shaggy setae. Carapace length to 35 mm.

Color in life. Dark reddish to brown; sometimes with blue shade on pereopods 2, 3.

Habitat and depth. Often in silty sand, usually subtidal; lowest intertidal zone to 212 m. According to Hendrickx *et al.* (2006), a report of the species at 232 m probably is in error. Most records are from less than 100 m.

Range. Bodega Bay, California to Gulf of California, Mexico. Type locality San Diego, California.

Remarks. This large hermit crab usually inhabits shells of moon snails (*Polinices* spp.) It can dig into the sediment, and can use both its antennae and third maxillipeds to capture particles of food. Hendrickx *et al.* (2006) provide detailed accounts of the sediments and temperature regimes in which this hermit crab is found in the Gulf of California and southwestern Baja California.

***Paguristes parvus* Holmes, 1900**

(Fig. 40D–G, Pl. 8F)

Paguristes parvus Holmes, 1900: 151, pl. 2, fig. 26. — Schmitt 1921: 124, fig. 83. — Haig *et al.* 1970: 18. — Haig & Wicksten 1975: 102. — Jensen 1995: 68, fig. 131.

Diagnosis (modified from Schmitt 1921, based on specimen from Big Fisherman's Cove, Santa Catalina I., California). Rostrum long, prominent; reaching to or close to end of ocular acicles. Ocular acicles ending in two blunt teeth. Eyestalk about 0.66 times width of anterior portion of carapace, overreaching distal margin of merus of cheliped, distal half of eyestalk about as wide as cornea, proximal half abruptly enlarged. First antennae longer than eyestalk. Peduncle of second antennae with three sharp teeth on lateral, mesio-lateral surfaces. Antennal acicle almost obscured with dense pinnate setae, with one strong lateral tooth, one mesial tooth, bifid apex. Flagellum of second antenna with few sparse setae. Merus of cheliped bearing 3 small teeth on upper distal margin. Carpus with row of 3 large teeth along mesial margin, 2 large teeth on upper surface, smaller tubercle along dorsolateral surface, dense tuft of pinnate setae on disto-lateral margin. Upper surfaces of hands of chelae coarsely granulate, armed with 3 short, stout spines on inner margin proximal to dactyl, row of prominent tubercles dorsal to them, dactyls with small teeth along inner margins, apices dark colored. Pereopods 2, 3 with setose margins, line of lateral setae on carpus, propodus, dactyl; tufts of elongate simple setae proximal to apex of dactyl, dactyl with hooked dark

apex. Pereopod 4 bearing propodal rasp consisting of 13 lines of bead-like tubercles, dactyl curved, dark-tipped. Pereopod 5 ending in short rasp of beaded rows. Telson with left side longer than right, divided into two lobes on each side, without any distal teeth but rows of simple setae on proximal lobes. Carapace length to 7.8 mm.

Color in life. Chelae creamy to light gray, pereopods 2, 3 creamy, banded with dark brown, red-brown; antennae banded with brown. The color notes are based on crabs from Santa Catalina I.

Habitat and depth. Subtidal rocky areas, lowest intertidal zone to 20 m.

Range. Off Point Conception, California to Sacramento Reef, Baja California, Mexico. Type locality White's Point, Los Angeles County, California.

Remarks. Holmes (1900) and Schmitt (1921) provided only a short diagnosis of this hermit crab without adequate illustrations. This is the only species of *Paguristes* in the area of coverage that does not have setose antennae. Its dense covering of pinnate setae also is characteristic. It is the smallest of the species of *Paguristes* in the area. *Paguristes parvus* is one of the most common subtidal hermit crabs of southern California, especially along the shores of the offshore islands.

Paguristes turgidus (Stimpson, 1857)

(Fig. 40H–J)

Eupagurus turgidus Stimpson, 1857b: 484, pl. 21, fig. 1.

Paguristes turgidus. — Holmes 1900: 151. — Schmitt 1921: 123, pl. 18, figs. 1, 8. — Johnson & Snook 1927: 332. — Pereyra & Alton 1972: 450. — McLaughlin 1974: 28, figs. 10–12. — Wicksten 1980c: 363; 1989b: 314. — Hart 1982: 104, fig. 36. — Jensen 1995: 68, fig. 129.

Diagnosis. Rostrum about as long as lateral projections of carapace. Second antennae sparsely setose. Length of eyestalk about 0.75 times width of anterior portion of carapace. Hands about 1.33 times longer than wide, outer margin slightly convex; immovable finger at base subequal to movable finger; upper surface of hands strongly spined with numerous dark-tipped spines. Appendages densely setose. Dactyls of pereopods 2, 3 longer than propodi. Propodus, merus of pereopod 2 with strong marginal spines. Telson strongly asymmetrical, left side more elongated than right; with deep lateral notches, teeth along posterior margin. Posterior margin deeply concave. Carapace length to 32 mm.

Color in life. Yellowish to orange-brown, eyestalk with longitudinal crimson stripe.

Habitat and depth. Rocks and muddy sand, 5–465 m.

Range. Chuckchi Sea to San Diego, California. Type locality Puget Sound.

Remarks. In the northern part of its range, the species often inhabits the shells of *Fusitriton oregonensis* (Redfield, 1846). Crabs from California inhabited shells of species of the cold-water whelks, family Neptunidae.

Paguristes ulreyi Schmitt, 1921

(Fig. 40K–N, Pl. 8G)

Paguristes ulreyi Schmitt, 1921: 125, pl. 18, figs. 3, 4, 5, 7. — Johnson & Snook 1927: 333. — Haig *et al.* 1970: 18. — McLaughlin 1974: 19, figs. 7–9. — Hart 1982: 106, fig. 37. — Wicksten 1988b: 321. — Jensen 1995: 67, fig. 128. — Kuris *et al.* 2007: 648.

Diagnosis. Rostrum triangular, acute, reaching to base of eye scales, exceeding lateral projections of carapace. Eyestalk long, slender; as long as or longer than anterior carapace width. Ocular scales each with 4–5 spiniform teeth. Second antennae with thick setae on lower surface, shorter setae above. Chelipeds equal, densely setose; merus with spines on anterior edge, inner border of lower face, carpus with 5 stout spines on upper inner edge; upper surface of hand with dark-tipped spines, inner edge of palm proximal to dactyl with 3 prominent spines. Hands about 0.33–0.5 times longer than wide. Pereopods 2, 3 very setose, their dactyls slightly shorter than the propodi. Pereopod 2 with spines along margin of dactyl, propodus, carpus, pereopod 3 with less prominent spines. Telson asymmetrical, deeply notched along lateral margins, posterior end; posterior margin, posterolateral edge with teeth. Carapace length to 32.3 mm.

Color in life. Orange to dark brown, covered by dense golden setae, often with white spots on maxillipeds. The color notes are based on crabs from Monterey Bay and Redondo Beach, California.

Habitat and depth. Sandy or rocky subtidal areas, rarely cast ashore after storms; 0–157 m.

Range. Frederick I., British Columbia to Pacific coast of Baja California and Punta Gorda, Gulf of California, Mexico. Type locality off Point Loma, San Diego, California, *Albatross* sta. 4303.

Remarks. This is one of the largest hermit crabs of California and Oregon. It is common in kelp beds and rocky subtidal areas. The crab can use its third maxillipeds and setose antennae to capture particles used as food. It also may scavenge on remains left by other predators. I observed an aggregation of more than 20 of these hermit crabs next to a feeding sea star, *Pisaster giganteus* (Stimpson, 1857).

The crabs inhabit a great variety of shells, but especially those of *Astraea* spp. and *Kelletia kelletii* (Forbes, 1852) in southern California. Often, algae, polychaete worms and even small corals encrust the shells. Slipper shells (*Crepidatella* spp.) often live inside the aperture of the shells.

Family Paguridae Latreille, 1802

The "unequal-clawed" hermit crabs are abundant worldwide, and range from the uppermost tide pools to the continental slopes. South of Point Conception, California, one finds members of the genera *Enallopaguropsis*, *Pylopagurus*, *Phimochirus* or *Haigia*, in which the major chela is broad and seals the aperture of the shell. These are primarily tropical genera, formerly all considered belonging to the genus *Pylopagurus*. They usually occur on subtidal rocky bottoms. McLaughlin (1981) performed a taxonomic revision of these genera.

Among species in this family, the posterior pereopods and parts of the uropods may bear roughened areas containing tiny scales or spinules. These areas, called rasps, aid the crab in gripping its covering. The telson and uropods can be asymmetrical.

Species of the Paguridae have been studied extensively. Their characteristic behavior of testing, turning and quickly moving from shell to shell has been subjected to numerous experiments. Elwood & Neil (1992) produced an extensive, illustrated review of hermit crab behavior. The hermit crabs are scavengers, grazers and predators on smaller invertebrates. None of the species of California and Oregon have setose antennae that can be used to capture particles.

Discorsopagurus McLaughlin, 1974

Discorsopagurus schmitti (Stevens, 1925)

(Fig. 41C, D)

Pylopagurus schmitti Stevens, 1925: 298, figs. 17–22.

Orthopagurus schmitti. — Stevens 1927: 249, figs. 2–4.

Discorsopagurus schmitti. — McLaughlin 1974: 354, figs. 96, 97. — Hart 1982: 118, fig. 41. — Gherardi & McLaughlin 1995: 258, figs. 1–10. — Jensen 1995: 62, fig. 111.

Diagnosis. Rostrum triangular, longer than lateral projections of carapace. Eyestalk relatively long, stout; cornea slightly dilated. Major cheliped setose, with scattered spines, granules on carpus and hand; inner margin of palm serrate with large, sharp teeth, outer margin with row of spines. Minor cheliped more slender; carpus, hand with spines, sharp granules. Pereopods 2, 3 slender, setose; dactyl shorter than propodus. Abdomen straight, with pleopods on left side only. Telson with lateral margins rounded, with 4 short teeth on each side of distolateral margin. Uropods developed on both sides, upper uropod longer, with prominent rasp. Carapace length to 6 mm.

Color in life. Chelipeds creamy, mottled with red-brown, apice of fingers red-brown; pereopods 2, 3 banded with cream; red-brown; antennae and eyestalk marked with red-brown. Hart (1982) gave an extensive description of the living color.

Habitat and depth. Usually subtidal; low intertidal zone to 220 m, inhabiting worm tubes (families Sabellidae and Serpulidae).

Range. Japan, Sitka Sound, Alaska to near Albion, Mendocino County, California. Type locality off Point Caution, Washington.

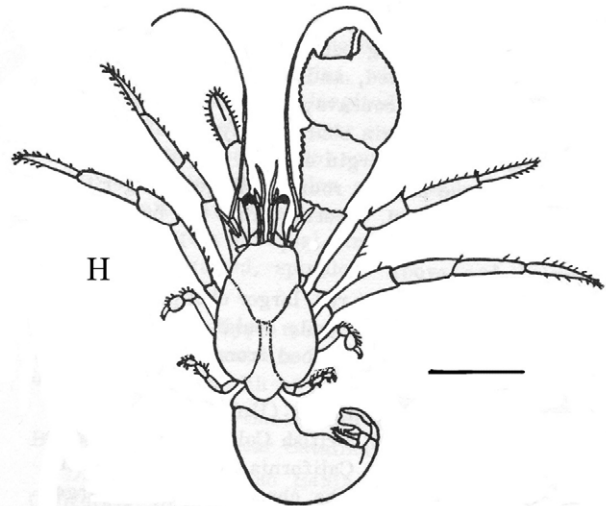
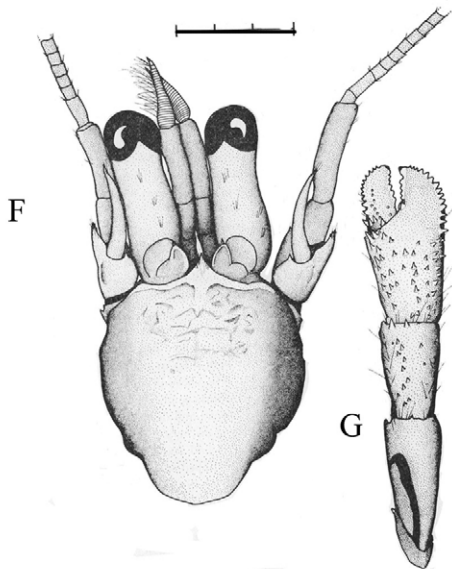
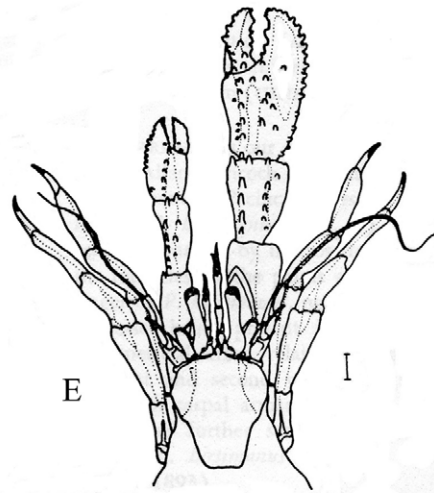
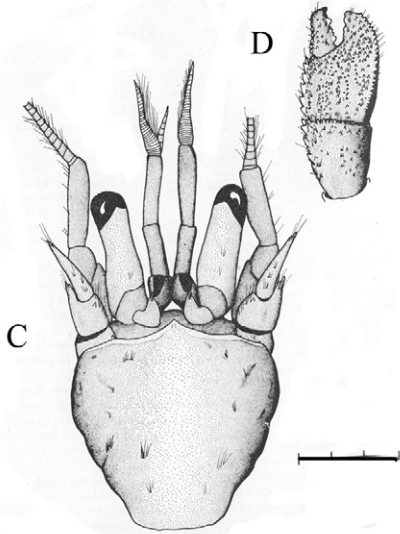
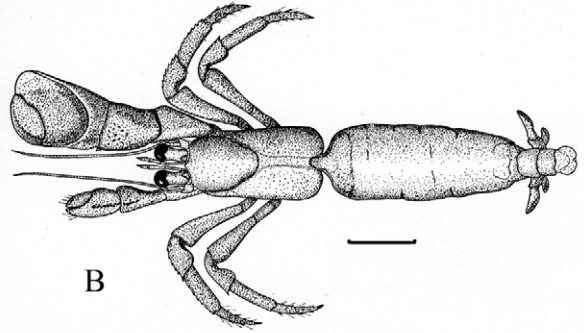
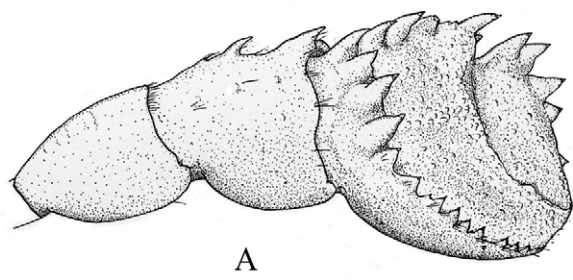


FIGURE 41. Family Paguridae. A, *Enallopaguopsis guatemoci* (Glassell, 1937); major cheliped. B, *Pylopagurus holmesi* Schmitt, 1921. C, D, *Discorsopagurus schmitti* (Stevens, 1925); C, carapace and frontal region; D, major cheliped. E, *Haigia diegensis* (Scanland & Hopkins, 1969). F, G, *Orthopagurus minimus* (Holmes, 1900); F, carapace and frontal region in dorsal view; G, major cheliped. H, *Phimochirus californiensis* (Benedict, 1892). Scales: C, F = 1 mm; I = 2 mm, B, H = 5mm. A, B from Walton 1954; C, D, F, G from McLaughlin 1973; E from Scanland & Hopkins 1969, H from Faxon 1895.

***Enallopaguropsis* McLaughlin, 1981**

***Enallopaguropsis guatemoci* (Glassell, 1937)**

(Fig. 41A)

Pylopagurus guatemoci Glassell, 1937: 254. — Walton 1954: 146, pl. 43B. — Wicksten 1980c: 361.

Enallopaguropsis guatemoci. — McLaughlin 1981: 7; 1982: 849, figs. 9a, 10 a–c.

Diagnosis. Rostrum broad, triangular, carapace with lateral projections rounded but tipped with minute subterminal spinule. Eyestalk cylindrical, cornea slightly dilated. Ocular scale bluntly rounded with acute subterminal spines. Major cheliped with merus smooth, trigonal in shape, with narrow indentation at margin of ischium; carpus greatly widened distally, with 2 prominent, forward-curving spines; hand discoidal, almost completely surrounded by toothed margin, proximal margin with teeth irregular in size, tipped with spines, some teeth double; teeth on fingers diminishing in size; face of hand set with rounded granules bearing slender spines. Small cheliped with row of spines on dorsolateral margin of carpus; hand depressed, with outer margin of row of spines, small median row of spines on palm, medial margin unarmed, slightly setose. Pereopods 2, 3 with dactyls shorter than propodi, having spinulose margins. Telson symmetrical, semi-oval, margins entire. Uropods developed on both sides, upper distal face with rasp, posterior blade reduced, rasp covering almost all upper surface. Carapace length 3 mm.

Color in life. Mostly salmon-colored. Second antennae translucent gold and white. Major cheliped with red dots along outer margin of chela, minor chela with red dots along outer margin of chela, base of movable finger. Pereopods 2, 3 banded with salmon, red-brown, white. The color notes are from a crab taken off Blue Cavern Point, Santa Catalina I., California.

Habitat and depth. Sand, rocks, shell, or mud, 20–275 m.

Range. Point Hueneme, California to Cedros I., Baja California and Angel de la Guardia I., Gulf of California, Mexico. Type locality 5 miles west of San Jose Point, Pacific coast of Baja California, Mexico.

***Haigia* McLaughlin, 1981**

***Haigia diegensis* (Scanland & Hopkins, 1969)**

(Fig. 41E, Pl. 8E)

Pylopagurus diegensis Scanland & Hopkins 1969: 257, fig. 1. — Haig *et al.* 1970: 21. — Haig & Wicksten 1975: 102.

Haigia diegensis. — McLaughlin 1981: 5. — Jensen 1995: 61, fig. 109. — McLaughlin & Lemaitre 2001: 477, figs. 14a, 14b, 17.

Diagnosis. Rostrum prominent, about 0.5 times length of ocular scale. Lateral projections of carapace very low. Eyestalk swollen at base, ocular scale with 1 blunt spine. Major cheliped with merus essentially smooth, carpus with 3 prominent spines along distal margin, 2 rows of longitudinal spines. Palm of chela with 9–12 tubercles forming oblique ridge from articulation of movable finger to carpus; outer, inner margins lined with tubercles, small tubercle in depression extending from fixed finger toward carpus; 4 minute tubercles in row on inner side beneath inner dorsal margin; entire upper margin lined with setae. Movable finger with 2 or 3 tubercles in row; outer edge with row of tubercles. Minor cheliped thinner; merus with 6–8 spines on lower, outer distal margin; carpus with 2 close-set subparallel rows of spines; palm with median longitudinal row of tubercles, single outer proximal marginal tooth, row of 9–11 outer, distal marginal teeth. Movable finger with 1 or 2 minute tubercles in proximal half; lateral teeth obscure. Pereopods 2, 3 with short dactyls having 8 spines in longitudinal row. Telson symmetrical, with transverse suture, terminal margins armed with series of small teeth. Uropods asymmetrical. Carapace length 13.8 mm.

Color in life. Chelipeds, pereopods 2, 3 dark pink to brick red. Pereopods 2, 3 banded with cream. Third maxillipeds and first antennae bright blue. The color notes are from crabs from Santa Catalina I., California.

Habitat and depth. Among rocks, boulders and rubble piles; 3–18 m.

Range. Santa Catalina I., California to Guadalupe I., Mexico. Type locality La Jolla Cove, San Diego County, California.

Orthopagurus Stevens, 1927

Orthopagurus minimus (Holmes, 1900)

(Fig. 41F, G)

Pagurus minimus Holmes, 1900: 145.

Pylopagurus minimus. — Schmitt 1921: 114, pl. 16, figs. 1a–1c.

Orthopagurus minimus. — Stevens 1927: 247, fig. 1. — Makarov 1962: 215, pl. 2, fig. 1. — McLaughlin 1974: 363, figs. 98, 99. — Wicksten 1980c: 361. — Hart 1982: 116, fig. 40; color plate. — Jensen 1995: 62, fig. 112.

Diagnosis. Rostrum long, triangular; reaching at least half length of ocular scale. Eyestalk long, stout; cornea slightly dilated, ocular scale rounded. Major cheliped sparsely setose; merus with few or no spines, carpus with dorsal row of spines, scattered spinules; hand widening distally, with spines on palm, fingers; fingers wide, flat; with spines along margins. Minor cheliped small, slender, setose; with few spinules; hand convex, without spines on margins but with rows of spines dorsally, extending to fixed finger. Dactyls, propodi of pereopods 2, 3 equal in length, slender, with marginal setae. Abdomen straight. Telson symmetrical, with deep lateral, terminal notch flanked with 4 or more strong teeth. Uropods symmetrical. Carapace length 5.6 m.

Color in life. Major cheliped with dark red ischium, merus, carpus light golden but covered with dark red spots on spines, teeth; chela dark red with whitish apices to fingers. Minor cheliped light golden but covered with small red dots, pereopods 2, 3 similar but merus of each dark red. Eyestalk, first antennae dark red with irregular white bands. Antennae dark red near base, golden distally. Hart (1982) gave an extensive description of the living color.

Habitat and depth. Rocks or broken shell and gravel, 11–64 m, rarely cast ashore after storms.

Range. Tartar Strait and East Sakhalin; Skidegate, Queen Charlotte Sound, British Columbia to San Diego, California. Type locality off San Diego.

Remarks. This hermit crab often inhabits tubes of polychaetes or the tube mollusk *Serpulorbis squamigerus* (Carpenter, 1857), or shells of *Dentalium* spp. On rare occasions, one will inhabit a coiled shell, but the crab moves awkwardly and will vacate such a shell quickly if offered a suitable tube.

Pagurus Fabricius, 1775

Pagurus aleuticus (Benedict, 1892)

(Fig. 42A)

Eupagurus aleuticus Benedict, 1892a: 3.

Pagurus ochotensis aleuticus. — Makarov 1962: 192, pl. 2, fig. 3.

Pagurus aleuticus. — Pereyra & Alton 1972: 45. — McLaughlin 1974: 72, figs. 17–19 (extensive synonymy). — Haig & Wicksten 1975: 101. — Hart 1982: 131, fig. 47. — Wicksten 1989b: 314. — Lemaitre & Castaño 2004: 77.

Diagnosis. Rostrum triangular, about as long as lateral projections of carapace. Eyestalk short, stout; cornea dilated, ocular scale pointed. Major cheliped shorter than pereopods 2, 3; with numerous spines, granules over dorsal, lateral, mesial surfaces; lateral margins serrate. Minor cheliped exceeding carpus of major cheliped, with spines on dorsal surface, particularly long spines on carpus, margins of chela serrate. Pereopods 2, 3 long, slender; with serrate margins, dorsal spines; dactyl curved, with longitudinal groove, longer than propodus. Telson slightly asymmetrical, with lateral, terminal notches; terminal margin with small spinules. Uropods asymmetrical. Carapace length 28.1 mm.

Color in life. Appendages mostly pink. Chelipeds with red spines, sometimes also iridescence. Pereopods 2, 3 iridescent pink with maroon streaks, dark spines, dactyl orange with red stripe, dorsal groove dark red. Eyestalk white, tan; antennal flagellum orange or tan (Hart 1982).

Habitat and depth. Mud or sand, 15–435 m.

Range. Bering Sea to Eureka, California. Type locality Aleutian Is.

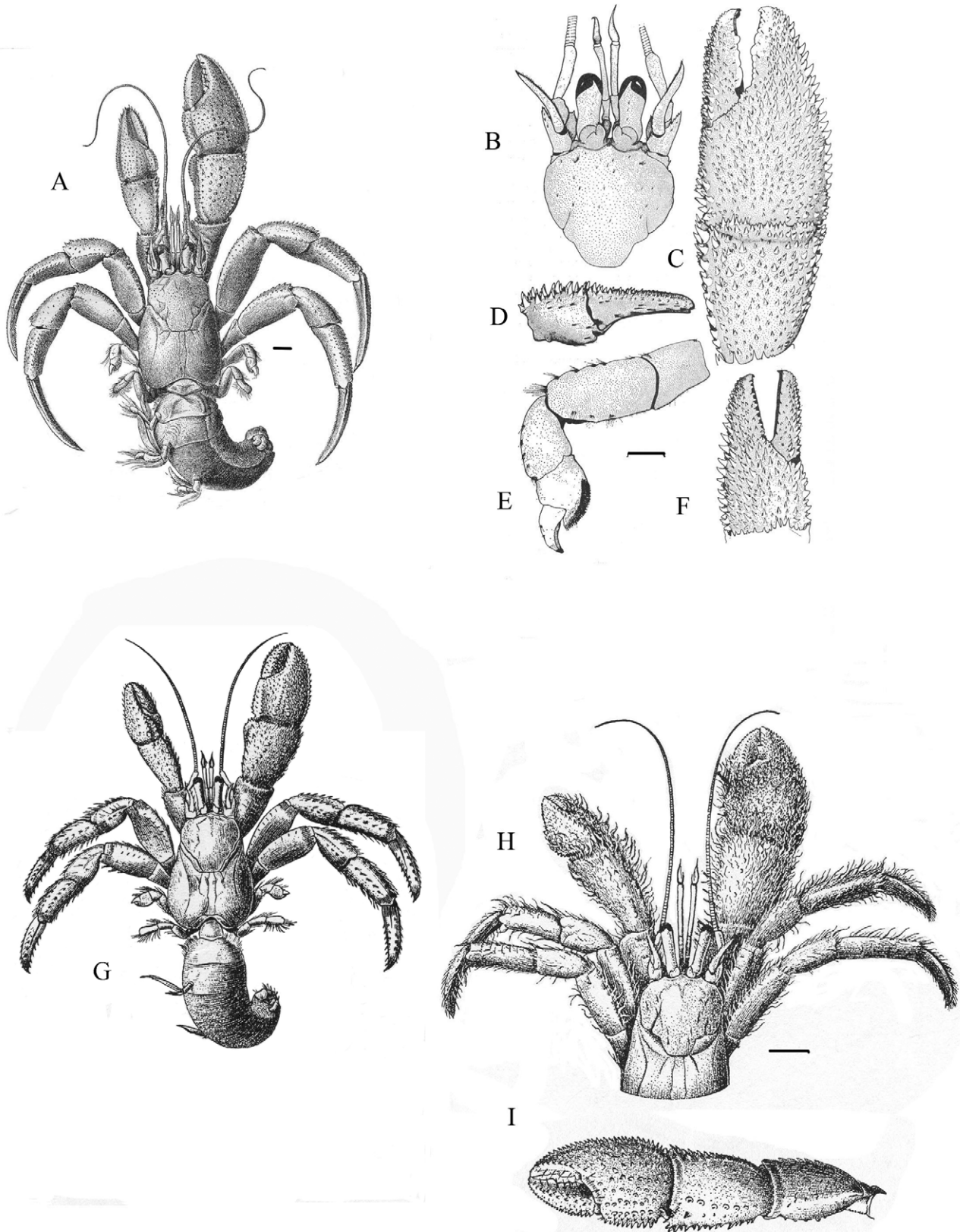


FIGURE 42. Family Paguridae. A, *Pagurus aleuticus* (Benedict, 1892). B–F, *Pagurus armatus* Dana, 1852; B, carapace and frontal region in dorsal view; C, major (right) chela, dorsal view; D, left chela, mesial view; E, pereopod 4; F, left chela in dorsal view. G, *Pagurus beringanus* (Benedict, 1892). H, I, *Pagurus capillatus* (Benedict, 1892); H, front of body in dorsal view; I, denuded major chela. Scales = 5 mm. A from Benedict 1901, B–F from McLaughlin 1974, G–I from Schmitt 1921.

***Pagurus armatus* (Dana, 1855)**

(Fig. 42B–F, Pl. 9C)

Pagurus armatus Dana, 1855: 27. — Makarov 1962: 202, pl 2, fig. 4. — McLaughlin 1974: 48, figs. 13,14. — Wicksten 1984c: 132. — McLaughlin & Gore 1992: 448, figs. 2–7. — Jensen 1995: 64, fig. 117. — Lemaitre & Castaño 2004: 77. — Kuris *et al.* 2007: 649.

Pagurus ochotensis: Schmitt 1921: 130, fig. 84. [Not *Pagurus ochotensis* Brandt, 1851, see McLaughlin 1974].

Diagnosis. Rostrum triangular, longer than lateral projections of carapace. stout, cornea dilated, ocular scale leaf-shaped, ending in stout spine. Major cheliped densely covered by triangular spines, not set into particular rows, setae; spines particularly strong along mesial margin of carpus. Minor cheliped similar, reaching about 0.5 times as long as length of fingers of major cheliped. Pereopods 2, 3 long, with spines along dorsal margins of carpus, propodus, dactyl longer than propodus, curved, with groove, small spinules along dorsal margin. Telson asymmetrical, with lateral notches, concave terminal margin lined by teeth. Uropods asymmetrical. Carapace length to 43 mm.

Color in life. Mostly reddish-orange. Carpus of chelipeds, pereopods 2, 3 with white bands flanked by dark red bands. White marks on maxillipeds. Eyestalk marked with yellowish and dark red, cornea black. Antennal flagella orange. Color of chelipeds may be obscured by silt on setae in life. The color notes are from crabs from Monterey Bay, California.

Habitat and depth. On sand, lowest intertidal zone to 146 m.

Range. Dutch Harbor, Alaska to San Diego, California. Type locality Puget Sound, Washington.

Remarks. This crab runs across sandy bottoms. The shell often is covered by pink hydroids (*Hydractinia* sp.) The crab often inhabits moon shells (family Naticidae). In northern California, the species is very common at depths of 35–75 m (Wicksten 1984c).

***Pagurus beringanus* (Benedict, 1892)**

(Fig. 42G)

Eupagurus beringanus Benedict, 1892a: 17.

Pagurus beringanus. — Rathbun 1904: 159, pl. 5, fig. 5. — Schmitt 1921: 135, fig. 8. — Makarov 1962: 176, pl. 5, fig. 4. — McLaughlin 1974: 139, figs. 35, 36. — Haig & Abbott 1980: 586. — Hart 1982: 140, fig. 52. — Ricketts *et al.* 1985: 289. — Jensen 1995: 65, fig. 122. — Lemaitre & Castaño 2004: 7. — Kuris *et al.* 2007: 649.

Diagnosis. Rostrum triangular but blunt, slightly longer than lateral projections of carapace. Eyestalks moderately stout, cornea not dilated, ocular scale pointed. Major cheliped stout, shorter than pereopods 2, 3; merus with upper surface convex, with large marginal teeth, 2 large ventral knobs, carpus convex, with rows of granules, spines; hand convex, with many granules, spines, serrate margins, fingers short. Minor cheliped smaller, merus laterally compressed, with spinules and granules. Pereopods 2, 3 stout, setose; merus laterally compressed, carpi with serrate margins, propodus of first leg serrate, dactyls about as long as propodi and stout. Telson asymmetrical, with lateral notches, deep terminal notch, terminal margin with teeth. Uropods asymmetrical. Carapace length to 26 mm.

Color in life. Chelipeds reddish, carpus with bright band at distal end. Pereopods 2, 3 gray to white, with red distal bands on propodus, dactyl; spines reddish. Cornea of eye black with gold or silver semicircle. Antennal flagellum translucent with red lateral mark. Hart (1982: 140) gave a more extensive description of the living color.

Habitat and depth. Protected intertidal areas to rocky subtidal zones, lowest intertidal zone to 364 m. Usually in subtidal areas in California.

Range. Bering Sea and Aleutian Is. to Monterey, California but rarely found south of Point Arena, California. Type locality Bristol Bay, Alaska.

Remarks. This hermit crab often inhabits shells of *Nucella lamellosa* (Gmelin, 1791); *Ceratostoma foliatum* (Gmelin, 1791); and *Fusitriton oregonensis*.

***Pagurus capillatus* (Benedict, 1892a)**

(Fig. 42H, I)

Eupagurus capillatus Benedict, 1892a: 8.

Pagurus capillatus. — Holmes 1900: 138. — Rathbun 1904: 157, pl. 4, fig. 3. — Schmitt 1921: 132, fig. 85. — Makarov 1962: 208, pl. 3, fig. 2. — McLaughlin 1974: 93, figs. 22, 23. — Hart 1982: 154, fig. 59. — Wicksten 1989b: 314. — Lemaitre & Castaño 2004: 77.

Diagnosis. Rostrum low, about as long as lateral projections of carapace. Eyestalk long, slender; cornea slightly dilated, ocular s pointed. Major cheliped setose, dorsal surface with spines, mesial margin with serrate margin, outer margin with low teeth, fingers slender. Minor cheliped setose; carpus with proximal row of dorsal spines, scattered larger distal spines; hand with rows of spinules, row of small spines on dactyl, fingers slender. Pereopods 2, 3 slender, setose; carpi of first legs serrate on dorsal margins; dactyls longer than propodi, with ventral spines. Telson asymmetrical, with lateral notches, terminal concavity, terminal teeth. Uropods asymmetrical. Carapace length to 26 mm.

Color in life. Ground color whitish. Chelipeds with merus having bands of rose, brown; carpus with apricot spines and mottling of brown, red; hand light brown, fingers with apricot apices. Pereopods 2, 3 with ischium splotched with pink, red and yellow; merus banded in red and brown, carpus and propodus each with 2 bands, dactyl greenish yellow. Eyestalk with outer rose stripe, inner brown stripe, cornea black with gold flecks. Antennal flagellum translucent. In life, color often obscured by silt on setae (Hart 1982).

Habitat and depth. Muddy subtidal areas, 4–439 m.

Range. Northwestern Pacific, Chukchi Sea; Bering Sea to off Santa Cruz, California. Type locality Norton Sound, Alaska.

***Pagurus caurinus* Hart, 1971**

(Fig. 43A–D)

Pagurus caurinus Hart, 1971: 1528, figs. 1–7. — McLaughlin 1974: 132, figs. 33, 34. — Haig & Wicksten 1975: 101. — Hart 1982: 152, fig. 58. — Bidle & McLaughlin 1992: 224, figs. 2–8. — Jensen 1995: 66, fig. 123. — Lemaitre & Castaño 2004: 78. — Kuris *et al.* 2007: 650.

Diagnosis. Rostrum obtuse, lateral projections of carapace nearly obsolete. Eyestalk long, slender; slightly constricted medially, cornea slightly dilated, ocular scale with blunt apex, sharp submarginal tooth. Major cheliped stout, with numerous setae; with 1–2 large knobs medio-ventrally, carpus with dorsolateral row of sharp teeth, smaller spinules, palm with numerous spines, distolateral margin with spines, smaller spines along mesial margin. Minor cheliped slender, setose, with 2 rows of spines on dorsal surface of carpus, 2–3 rows of spines on hand, fixed finger, smaller spines on movable finger. Pereopods 2, 3 stout, carpus of anterior leg with serrate dorsal margin, dactyls more or less straight, with setae, small spines on ventral margin. Telson more or less symmetrical, with notch on lateral margin, terminal margin with notch, sharp teeth. Carapace length to 10 mm.

Color in life. Chelipeds with carpus, chela greenish gray to green, with orange-tipped tubercles, merus red-brown with cream-colored band at distal end. Pereopods 2, 3 banded with reddish brown and cream. Setae of appendages golden-brown. Eyestalk translucent with brown bands. Antennal flagellum orange. Hart (1982) gave a detailed description of the living color.

Habitat and depth. Rocks or sand, lowest intertidal zone to 126 m. Usually found in subtidal areas.

Range. Port Gravina, Alaska to San Pedro, California but rarely reported in California. Type locality Frank I., Tofino, British Columbia.

***Pagurus confragosus* (Benedict, 1892)**

(Fig. 43E–G)

Eupagurus confragosus Benedict, 1892a: 11.

Pagurus confragosus. — Pereyra & Alton 1972: 45. — McLaughlin 1974: 203, figs. 51–54. — Hart 1982: 146, fig. 55. —

Diagnosis. Rostrum acute, triangular, much longer than lateral projections of carapace. Eyestalk short, stout; cornea dilated, ocular scale short, acute. Major cheliped stout, setose, shorter than pereopods 2, 3; merus setose, carpus with small dorsal spines, serrate margins; hand spinose, with raised triangular ridge extending past base of fixed finger. Minor cheliped slender, with rows of spines on carpus, hand, palm greatly inflated on outer side of convex ridge, with row of large spines on right side, small ones on left, extending nearly to middle of fingers. Pereopods 2, 3 stout, carpus serrate on margin of pereopod 2; dactyls longer than propodi, flattened, with longitudinal groove, with stiff dorsal setae, ventral movable spines. Telson nearly symmetrical, with lateral notches, terminal notch, teeth. Carapace length to 20.2 mm.

Color in life. Chelipeds red, white blotched proximally; carpus white with red blotches, spines; hand pink, fingers with white cutting edges. Pereopods 2, 3 with ischium pink, red, white; merus, carpus red, white, tan; propodus with red proximal bands, lighter color between them; dactyl red with lateral stripe, orange distally, pink medially. Eyestalk pink with white stripe, red patches; cornea black with gold flecks (Hart 1982).

Habitat and depth. Continental shelf, slope, on rocks, mud, sand or gravel, 55–435 m.

Range. Bristol Bay, Alaska to Columbia River mouth, Oregon. Type locality Portlock Bank, Alaska.

***Pagurus cornutus* (Benedict, 1892)**

(Pl. 9A)

Eupagurus cornutus Benedict, 1892a:12.

Pagurus cornutus. — Makarov 1962: 181, pl. 5, fig. 1. — Pereyra & Alton 1972: 45. — McLaughlin 1974: 225, fig. 57, 58. — Hart 1982: 144, fig. 54. — Wicksten 1989b: 314. — Lemaitre & Castaño 2004: 78.

Diagnosis. Rostrum acute, longer than lateral projections of carapace. Eyestalk short, stout; corneae dilated, ocular scale with subterminal spine. Major cheliped stout, shorter than pereopods 2, 3; with setae; merus with distal toothed margin; carpus with serrate margins and few dorsal spines, large, triangular horn-shaped ridge on palm, apex past base of fixed finger. Minor cheliped stout, hand swollen on left side, with spinous ridge running from middle of base of palm to middle of fixed finger; fixed finger with curved apex. Pereopods 2, 3 setose, carpus of pereopod 2 serrate, also carpus of right pereopod 3; dactyls with stiff dorsal setae, movable ventral spines, dactyls longer than propodi, flattened, with longitudinal groove. Telson asymmetrical, with lateral notch, terminal margin with medial notch, teeth. Carapace length to 18.7 mm.

Color in life. Mostly red to orange. Ischium and merus of each chela with cream stripes, spines, white marginal teeth, carpus with yellow spine; palm pink with yellow spines along margins. Pereopods 2, 3 deep or pale red; merus with distal pink band, dactyl pale. Eyestalk orange with light spots, ocular scale orange, cornea black with silver flecks. Antennal flagellum pale orange (Hart 1982).

Habitat and depth. Continental shelf and slope, on mud or sand, 160–830 m.

Range. Northwestern Pacific and Bering Sea to west of Columbia River mouth, Oregon. Type locality Clarence Strait, Alaska.

***Pagurus dalli* (Benedict, 1892)**

(Fig. 43H–K)

Eupagurus (Trigonocheirus) dalli Benedict, 1892: 9.

Pagurus (Trigonocheirus) Dalli. — Holmes 1900: 139.

Pagurus dalli. — Rathbun 1904: 158, pl. 4, fig. 1. — McLaughlin 1974: 280, figs. 72, 73 (extensive synonymy). — Hart 1982: 160, fig. 62. — Ricketts *et al.* 1985: 300.

Diagnosis (after McLaughlin 1974). Rostrum usually slightly longer than lateral projections of carapace, triangular, ending in small acute spine, usually with terminal tuft of short setae. Eyestalk moderately short, stout; reaching middle of third segment of antennular peduncle. Ocular scale subovate. Major cheliped elongate,

ventromesial margin of merus without strong spinose protuberance; dorsal, lateral surfaces set with sharp teeth. Minor cheliped much smaller than major cheliped, with dorsal surface convex, midline elevated, bearing single row of strong spines. Pereopods 2, 3 nearly equal in size, their segments flat, dactyl equal in size to or slightly exceeding length of propodus. Telson asymmetrical, lateral margins rounded, terminal margins strongly spinose. Carapace length to 11.9 mm.

Color in life. Overall brown with opaque white bands on distal part of the meri of pereopods 1–3. Hart (1982) gave a detailed description of the color pattern.

Habitat and depth. Gravel, sand or mud, intertidal zone to 276 m (Hart 1982).

Range. Bering Sea to Oregon. Type locality Bristol Bay, Alaska (*Albatross* sta. 3233).

Remarks. Ricketts *et al.* (1985) noted that this hermit crab often lives within holes in the sponge *Suberites ficus* (Johnston, 1842).

***Pagurus granosimanus* (Stimpson, 1860)**

(Fig. 43K–N, Pl. 9E)

Eupagurus granosimanus Stimpson, 1860: 90.

Pagurus granosimanus. — Holmes 1900: 146. — Rathbun 1904: 160, pl. 5, fig. 8. — Schmitt 1921: 141, fig. 91. — Johnson & Snook 1927: 336, figs. 278, 284. — McLaughlin 1974: 158, figs. 39, 40. — Haig & Abbott 1980: 586, fig. 24.13. — Hart 1982: 136, fig. 50. — Ricketts *et al.* 1985: 273. — Jensen 1995: 65, fig. 121. — Lemaitre & Castaño 2004: 78. — Kuris *et al.* 2007: 649, pl. 326 E.

Diagnosis. Rostrum short, blunt, barely longer than lateral projections of carapace. Eyestalk long, corneae slightly dilated, ocular scale rounded. Major cheliped stout, covered with small spinules, granules, fingers very short. Minor cheliped similar to major but with most granules on palm, fingers, fewer on proximal parts. Pereopods 2, 3 stout, with rows of spinules, serrate margins of propodi and carpi, dactyls about as long as propodi, broad. Telson slightly asymmetrical, lateral margins notched, terminal margin with median notch, spinules. Uropods asymmetrical. Carapace length to 19 mm.

Color in life. Reddish to olive green with white or blue granules, pereopods 2, 3 without prominent bands. Eyestalk with faint yellow stripes. Flagellum of antenna bright red.

Habitat and depth. Usually mid-littoral zone of rocky areas, bays and tide pools, intertidal zone to 36 m.

Range. Unalaska, Alaska to Ensenada, Baja California. Type locality Monterey, California.

Remarks. This common intertidal hermit crab usually inhabits shells of *Tegula* spp.

***Pagurus hemphilli* (Benedict, 1892a)**

(Fig. 43O, Pl. 9F)

Eupagurus hemphilli Benedict, 1892a: 16.

Pagurus hemphilli. — Holmes 1900: 147. — Rathbun 1904: 160, pl. 5, fig. 9. — Schmitt 1921: 142, fig. 92. — Johnson & Snook 1927: 336. — McLaughlin 1974: 149, figs. 37, 38. — Haig & Wicksten 1975: 102. — Haig & Abbott 1980: 586, fig. 24.12. — Hart 1982: 134, fig. 49. — Ricketts *et al.* 1985: 58, fig. 2. — Jensen 1995: 63, fig. 114. — Lemaitre & Castaño 2004: 78. — Kuris *et al.* 2007: 649.

Diagnosis. Rostrum wide, triangular, longer than lateral projections of carapace. Eyestalk slender, cornea slightly dilated, ocular scale pointed. Major cheliped much larger than minor cheliped, finely granulate, with few setae, some teeth on distal margins of merus, carpus; carpus laterally compressed, inflated ventrally, triangular in lateral view; fingers of chela very short, broad. Minor cheliped very short, granulate, laterally compressed. Pereopods 2, 3 stout, dorsal margins of propodus, carpus serrate, dactyls broad, stout, as long as or shorter than propodi. Telson asymmetrical, with notches on lateral, terminal margins; terminal margin with teeth. Uropods asymmetrical. Carapace length to 15 mm.

Color in life. Rich maroon with blue granules; ends of dactyls yellow. Cornea with gold ring. Flagellum of antenna red. Juveniles may have white bands on pereopods 2, 3. The color notes are from crabs from Monterey Bay, California.

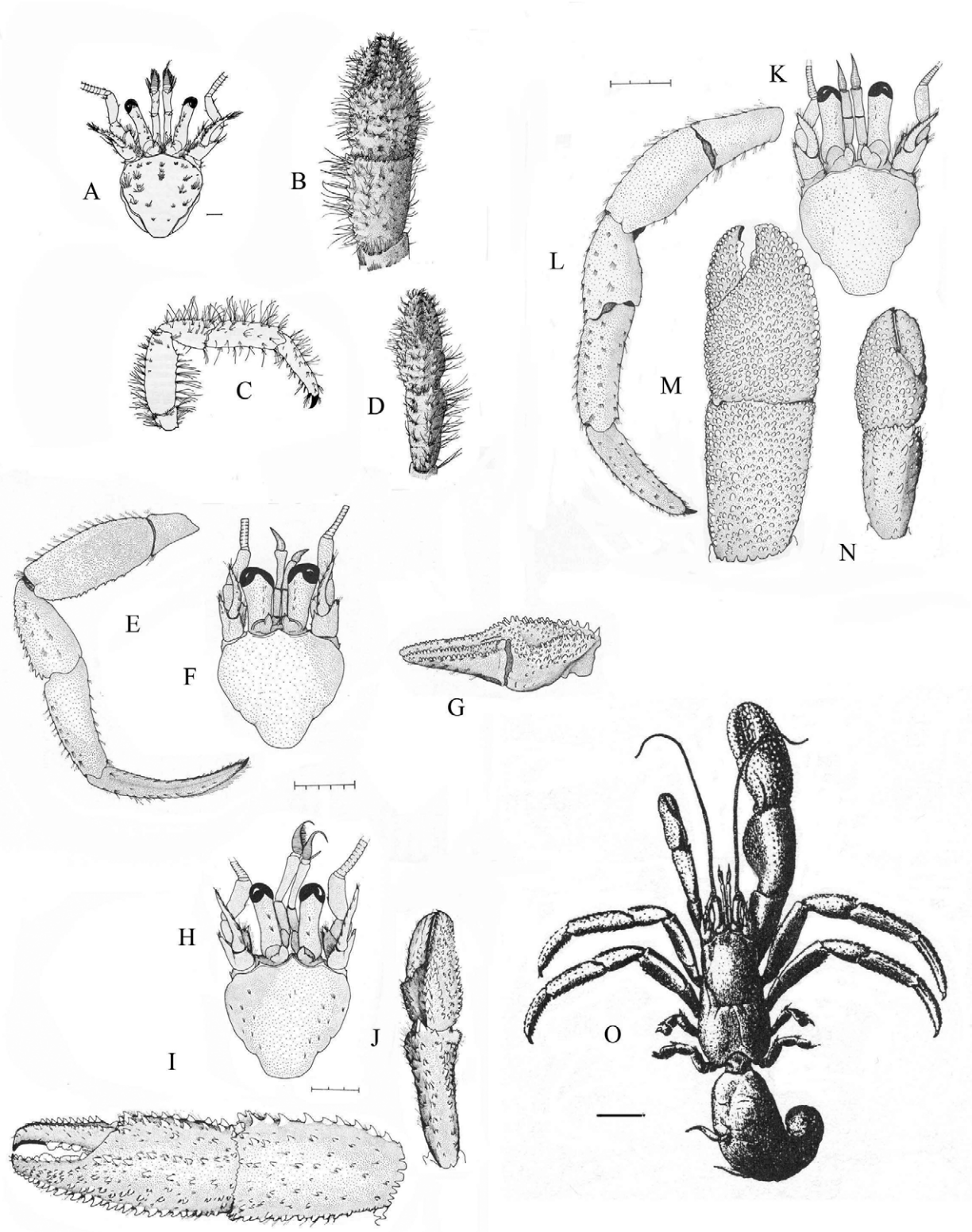


FIGURE 43. Family Paguridae. A–D, *Pagurus caurinus* Hart, 1971; A, carapace and frontal region in dorsal view; B, major chela; C, pereopod 2; D, minor chela. E–G, *Pagurus confragosus* (Benedict, 1892); E, pereopod 2; F, carapace and frontal region in dorsal view; G, major chela in lateral view. H–K, *Pagurus dalli* (Benedict, 1892); H, carapace and frontal region in dorsal view; I, major cheliped; J, minor cheliped. K–N, *Pagurus granosimanus* (Stimpson, 1859); K, carapace and frontal region in dorsal view; L, pereopod 2; M, major cheliped; N, minor cheliped. O, *Pagurus hemphilli* (Benedict, 1892). Scales: A = 1 mm; H, K = 3 mm, F, O = 5 mm. A–D from Hart 1971, E–N from McLaughlin 1974, O from Schmitt 1921.

Habitat and depth. Rocky areas and kelp beds on open coasts; lowest intertidal zone but usually subtidal, to 50 m.

Range. Klokachef I., Alaska to San Miguel I., California. Particularly common in central California from Mendocino to San Luis Obispo counties. Type locality Monterey, California.

Remarks. This hermit crab usually inhabits shells of *Tegula* and *Astraea* spp. Often, the shells are encrusted with red algae. The slipper shell *Garnotia adunca* (G.B. Sowerby, 1825); and the white limpet *Acmaea mitra* Rathke, 1833 may live atop the shells.

***Pagurus hirsutiusculus* (Dana, 1851)**

(Fig. 44A, B; Pl. 10B)

Bernhardus hirsutiusculus Dana, 1851: 70; 1852: 443, pl. I; 1855: pl. 27, fig. 3.

Pagurus hirsutiusculus.—Holmes 1900: 143 (part). — Rathbun 1904: 159 (part). — Schmitt 1921: 137, fig. 89 (part). — Johnson & Snook 1927: 334, figs. 279, 280 (part). — Makarov 1962: 171, pl. 3, fig. 4. — Wicksten 1977c: 541. — Hart 1982: 138, fig. 51 (part). — Ricketts *et al.* 1985: 278 (part). — Jensen 1995: 66, fig. 125. — Komai & Yakovlev 2000: 305. — Lemaitre & Castaño 2004: 78. — Kuris *et al.* 2007: 650.

Pagurus hirsutiusculus hirsutiusculus. — McLaughlin 1974: 175, figs. 43a–c, 44a–h. — Haig & Abbott 1980: 585, fig. 24.11. — McLaughlin *et al.* 1988: 430. — Mesce 1993: 95.

Diagnosis. Rostrum triangular, pointed, reaching to middle of ocular scale or beyond; much longer than lateral projections of carapace. Eyestalk stout, cornea not dilated, ocular scale pointed. Major cheliped stout, shorter than pereopods 2, 3; merus, carpus setose, with granules, spines, ridges; hand slightly convex, with many granules. Major cheliped elongated, fingers gaping in adult male. Minor cheliped setose, with granules. Pereopods 2, 3 setose, dactyls slender, about as long as propodi. Telson asymmetrical, lateral margins with notches, terminal margin with notch, teeth. Uropods asymmetrical. Carapace length to 19 mm.

Color in life. Almost black to greenish brown. Apices of minor chela tan or orange. Pereopods 2, 3 with white band on propodus, often also blue dot; dactyl whitish, striped with blue, red. Antennal flagellum banded with translucent and brown. The color notes are from crabs from Coyote Point, San Francisco Bay, California.

Habitat and depth. Often in protected areas with silt or in bays or harbors. Usually upper and middle intertidal zone, to 110 m.

Range. Eastern Hokkaido, Kuril Is., Kamchatka; Pribilof Is. to Monterey, California. Type locality Puget Sound. Records from southern California refer to *Pagurus venturensis* Coffin, 1957.

Remarks. This is a common intertidal hermit crab. It usually lives in areas more protected from strong surf than *P. samuelis*, although both species can co-occur. It often inhabits shells of *Nucella* spp. In San Francisco Bay, it uses shells of gastropod species introduced from the Atlantic. Slipper shells (*Crepidula* spp.) may live inside the aperture of the shell. Mesce (1993) determined that setae on the minor chela of *P. hirsutiusculus* act as mechanoreceptors and chemoreceptors during examination of gastropod shells.

***Pagurus ochotensis* Brandt, 1851**

(Fig. 44C–G)

Pagurus ochotensis Brandt, 1851: 108. — Johnson & Snook 1927: 333 (part). — Makarov 1962: 188, pl. 2, fig. 2. — McLaughlin 1974: 57, figs. 15, 16 (extensive synonymy). — Haig & Wicksten 1975: 101. — Hart 1982: 128, fig. 46. — McLaughlin *et al.* 1992: 507, figs. 1–12. — Jensen 1995: 64, fig. 118. — Lemaitre & Castaño 2004: 78. — Kuris *et al.* 2007: 649.

Not *Pagurus ochotensis* of Schmitt, 1921: 130, fig. 84; =*Pagurus armatus* (Dana).

Diagnosis. Rostrum triangular, about as long as or slightly longer than lateral projections of carapace. Eyestalk short, stout; cornea dilated, ocular scale pointed. Major cheliped stout, shorter than walking legs; carpus with 2 rows dorsal spines, strong spines along lateral, mesial borders; hand with 3 rows small spines not continuing to fixed finger but also with numerous spinules on dorsal surface, fingers; row of low spines on lateral margin. Minor cheliped with spines similar to major cheliped. Pereopods 2, 3 long, with spines along margins of carpus, propodus; dactyls longer than propodi, curved, with serrate dorsal margins, 2 shallow grooves, close-set ventral spines. Telson asymmetrical, left lobe longer than right, with notches on lateral margins, terminal margin concave, with teeth. Uropods asymmetrical. Carapace length to 27.7 mm.

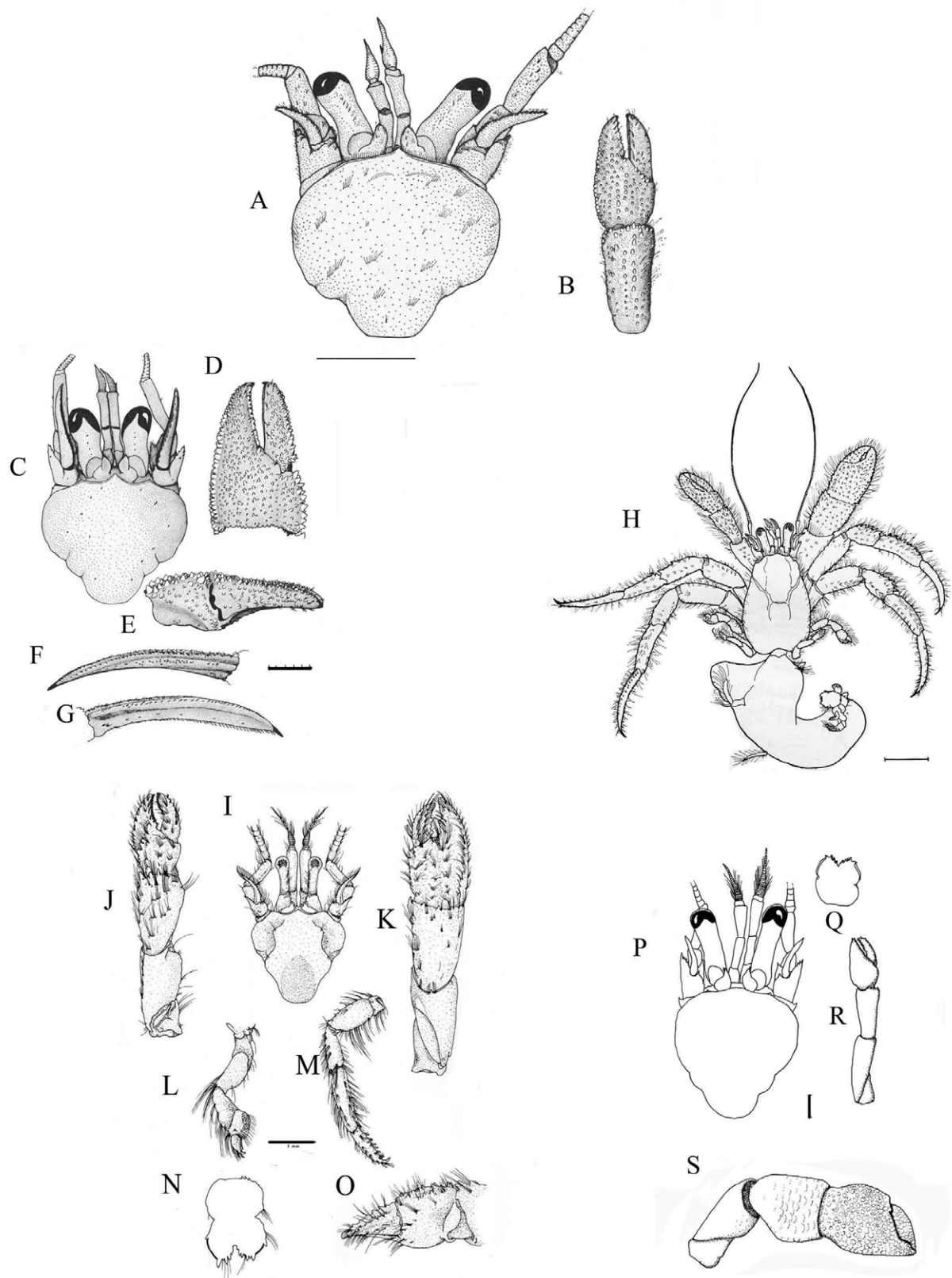


FIGURE 44. Family Paguridae. A, B, *Pagurus hirsutiussculus* (Dana, 1851); A, carapace and frontal region in dorsal view; B, major chela. C–G, *Pagurus ochotensis* Brandt, 1851; C, carapace and frontal region in dorsal view; D, left chela in dorsal view; E, left chela in mesial view; F, dactyl of left pereopod 3, dorsolateral view; G, dactyl of left pereopod 3, mesial view. H, *Pagurus quaylei* Hart, 1971. I–O, *Pagurus redondoensis* Wicksten, 1982; I, carapace and frontal region in dorsal view; H, minor cheliped; K, major cheliped; L, pereopod 4; M, pereopod 2; N, telson; O, pereopod 2. P–S, *Pagurus retrorsimanus* Wicksten & McLaughlin, 1998; P, carapace and frontal region in dorsal view; Q, telson; R, minor cheliped; S, major cheliped. Scales: I, P = 1 mm; A, C = 5 mm. A–G from McLaughlin 1974, I–O from Wicksten 1982d, P–S from Wicksten & McLaughlin 1998.

Color in life. Right cheliped with ischium, merus white, merus with pearly iridescence, streaks, bands of maroon; carpus gray to brown with gray spines, green, pink or bronze iridescence; hand white or pinkish covered by gray or brown spines, granules; maroon streak along fixed finger. Left cheliped similar but no prominent maroon streak on hand. Pereopods 2, 3 with ischium yellowish, merus light brown with maroon, blue areas, green iridescence, carpus, propodus similar but also with 2 maroon stripes, dactyl with marks of maroon, blue stripes. Eyestalk white with red spots, greenish yellow band; cornea distinctively greenish yellow. Antennae pinkish brown (McLaughlin 1974). The color of the cornea and the iridescence of the appendages are distinctive.

Habitat and depth. Sand or mud, usually subtidal, lowest intertidal zone to 388m.

Range. Pribilof Is., Alaska to Point Arena, California. Type locality "Okhotsk Sea."

Remarks. This species often inhabits the shells of large moon snails (Naticidae). Divers have seen it running across sandy areas.

***Pagurus quaylei* Hart, 1971**

(Fig. 44H)

Pagurus quaylei Hart, 1971: 1532, figs. 8–16. — McLaughlin 1974: 85, figs. 20, 21. — Hart 1982: 158, fig. 61. — Lemaitre & Castaño 2004: 79.

Diagnosis. Rostrum triangular, low; barely longer than lateral projections of carapace. Eyestalk elongate, cornea slightly longer than stalk, ocular scale oval, with 1 or more marginal teeth. Major cheliped stout, shorter than pereopod 2, setose; merus with 1 or more large ventral knobs, carpus with small dorsal spines, larger spines on inner margin; hand convex with numerous sharp spines in irregular rows, finger short. Minor cheliped long, slender, setose, spinulose; row of prominent spines on dorsomedial surface of carpus; fingers gaping. Pereopods 2, 3 long, slender, with tufts of setae; pereopods 2 with serrate margins of carpi, propodi; pereopods 3 with few spines on carpus, dactyls longer than propodi, slightly curved. Dactyl of left pereopod 3 may be armed with numerous spines, tubercles. Telson asymmetrical, lateral margins with notches, terminal margin with deep notch, spinules. Uropods asymmetrical. Carapace length 4.3 mm.

Color in life. Mostly brown or gray. Major cheliped with merus dark brown with light spots, pale distal band; carpus mottled gray to brown with gray spots, spines; palm greenish-brown with gray, white spines; fingers white. Minor cheliped similar but distal part of carpus white, distal part of hand gray-blue. Pereopods 2, 3 with band of red-brown, gray, whitish on merus, carpus gray to white with red-brown stripes; propodus gray with 4 red-brown stripes, dactyl with dark gray patch proximally, short red-brown stripes dorsally, laterally. Eyestalk pale brown with red, brown, white dots; cornea with 2 circular bands. Antennal flagellum irregularly banded with dark brown (Hart 1982).

Habitat and depth. Sand or gravel, lowest intertidal zone to 97 m.

Range. San Fernando I., Alaska to San Quentin Bay, Baja California, Mexico. Type locality off Frederick I., British Columbia.

Remarks. Along the Palos Verdes Peninsula, California, this small hermit crab is very common on sandy sea floors and among tubes of sand-dwelling polychaete worms.

***Pagurus redondoensis* Wicksten, 1982**

(Fig. 44I–O)

Pagurus redondoensis Wicksten, 1982d: 605, figs. 1–3. — Harvey & McLaughlin 1991: 20. — Haig & Harvey 1991: 10. — Jensen 1995: 62, fig. 113. — Lemaitre & Castaño 2004: 79.

Diagnosis. Rostrum short, rounded to triangular, about as long as lateral projections of carapace. Eyestalk long, slender, cornea dilated; ocular scale ending in 4–5 spinules. Major cheliped with setae on carpus, chela; carpus with teeth along mesial, distal margins; palm with 2 rows of dorsal spines, teeth along mesial margin; gap between fingers in adult males. Minor cheliped with prominent distal spines on carpus, low spines or teeth along mesial margin of merus, carpus, chela; 2 rows of large spines on palm. Pereopods 2, 3 setose, dactyls shorter than propodi,

with ventral spines. Telson asymmetrical, lateral margins with cleft, terminal margin with deep u-shaped cleft and teeth. Uropods asymmetrical. Carapace length to 6 mm.

Color in life. Greenish brown to reddish, but color often obscured by silt on setae. Chelipeds with prominent white band, narrow dark band at distal end of merus. Pereopods 2, 3 with white band at distal end of merus. Eystalk with gray tinge, lightly banded with darker shades. Antennal flagellum dark brown with white bands. The color notes are from crabs from Catalina Harbor, Santa Catalina I.

Habitat and depth. Usually in protected bays or harbors, often among tube mollusks (*Serpulorbis squamigerus*), lowest intertidal zone to 50 m.

Range. Redondo Beach, to La Jolla, California. Type locality Redondo Beach.

Remarks. This is a very common hermit crab in the appropriate habitat and depth in southern California.

***Pagurus retrorsimanus* Wicksten & McLaughlin, 1998**

(Fig. 44P–S, Pl. 9D)

Pagurus species 2: Jensen 1995: 67.

Pagurus retrorsimanus Wicksten & McLaughlin, 1998: 153, figs. 1, 2. — Lemaitre & Castaño 2005: 79.

Diagnosis. Rostrum triangular to obsolete, much shorter than lateral projections of carapace. Eystalk short, cornea slightly dilated, ocular scale triangular to subovate, with submarginal spine. Major cheliped stout, slightly longer than walking legs; merus relatively smooth, carpus with lateral surface strongly produced ventrally, all surfaces covered with flattened tubercles; hand covered by flattened, plate-like tubercles, palm very broad, dorsoventrally compressed; movable finger with 1 broad tooth, 3 smaller distal teeth, fixed finger with broad tooth, few smaller distal teeth. Major chela carried with chela twisted back toward body in life. Minor cheliped reaching only to proximal half of palm of major cheliped; fingers longer than palm, with few tufts of stiff setae, small teeth; carpus subtriangular. Pereopods 2, 3 stout, with spinules on propodus, ending in short claw-like dactyl. Telson with distinct transverse suture; posterior lobes separated by median cleft, terminal margins oblique, armed with 3–5 strong teeth, smaller teeth. Shield length to 6.2 mm.

Color in life. Ocular peduncles, antennules dark, translucent blue. Antennal flagellum reddish. Third maxilliped orange-red. Major chela proper usually white, rarely red. Pereopods 2, 3, minor cheliped and major cheliped except for chela proper covered with dark red specks, giving crab reddish color when seen from distance. The color notes are from a crab from Long Point, Palos Verdes Peninsula, Los Angeles County, California.

Habitat and depth. Rocks, sand, gravel, kelp beds, 11–50 m.

Range. Monterey, California to Los Coronados Is., Mexico. Type locality off Redondo Beach, California.

***Pagurus samuelis* (Stimpson, 1857)**

(Fig. 45C–G, Pl. 10A)

Eupagurus samuelis Stimpson, 1857a: 86. — Stimpson 1860: 90, pl. 1, fig. 8.

Pagurus samuelis. — Holmes 1900:144. — Rathbun 1904: 160, pl. 5, fig. 7. — Schmitt 1921: 139, pl. 16, figs. 2, 3. — Johnson & Snook 1927: 334, figs. 281, 284a. — McLaughlin 1974: 166, figs. 41, 42; 1976: 24. — Haig & Abbott 1980: 584, fig. 24.10. — Hart 1982: 132, fig. 48. — Ricketts *et al.* 1985: 37, fig. 22. — Jensen 1995: 65, fig. 120. — Lemaitre & Castaño 2004: 79. — Kuris *et al.* 2007: 649, pl. 326 F.

Diagnosis. Rostrum triangular and low, longer than lateral projections of carapace. Eystalk stout, cornea not dilated; ocular scale pointed. Major cheliped shorter than pereopods 2, 3; carpus, hand with granules, lateral margins beaded; fingers broad. Minor cheliped barely longer than carpus of major cheliped, ventral margin of merus with strong teeth; carpus, chela with granules. Pereopods 2, 3 stout, dorsal margins with stiff setae, dactyls stout, curved; propodus, dactyl of left pereopod 3 with spines, granules ventrally. Telson asymmetrical proximal to left lateral groove, terminal margin with very shallow concavity, teeth. Uropods asymmetrical. Carapace length to 19 mm.

Color in life. Greenish brown to olive with red granules. Fingers of chelae with orange apices. Pereopods 2, 3 with prominent blue band in adult, bands of blue and white in juvenile. Antennal flagellum red, carapace with

white stripes. Crabs close to molting may be colored blue. Hart (1982) gave a more detailed description of the living color.

Habitat and depth. Rocks, tide pools and jetties, high intertidal zone.

Range. Nootka Sound, British Columbia to Point Eugenia, Baja California, Mexico. Type locality Tomales Bay, California. Reports from Japan and Russia should be referred to a sibling species, *Pagurus geminus* McLaughlin, 1976.

Remarks. This is the best-known intertidal hermit crab of California and Oregon. It is abundant along the outer coastline and just inside the mouths of larger bays and harbors, such as San Francisco Bay and Los Angeles Harbor. It usually inhabits shells of *Tegula* spp. Slipper shells (Calyptraeidae) may live inside the aperture of the shell or on top of it.

***Pagurus setosus* (Benedict, 1892)**

(Fig. 45H)

Eupagurus setosus Benedict, 1892a: 19.

Pagurus setosus. — Rathbun 1904: 159, pl. 5, fig. 1. — Schmitt 1921: 136, fig. 58. — McLaughlin 1974: 110, figs. 27–29. — Lemaitre & Castaño 2004: 79.

Diagnosis. Rostrum rounded, slightly longer than lateral projections of carapace. Eyestalk elongate, cornea not dilated, ocular scale pointed. Major cheliped with carpus, chela proper sharply spinose, chela proper setose, bearing 7 longitudinal rows of spines. Minor cheliped setose, carpus, chela also bearing spines. Pereopods 2, 3 with elongate dactyls, series of spines on carpus of anterior pair only, both pairs with scattered setae. Telson with left lobe slightly larger than right, with V-shaped median cleft; right terminal margin with 4–8 small teeth, 1 stronger laterodistal tooth; left with 4–9 small teeth, one larger laterodistal tooth. Carapace length to 21 mm.

Color in life. Not reported. Rathbun (1904) noted that pereopods 2, 3 were banded.

Habitat and depth. Mud or sand, 9–476 m.

Range. Kodiak, Alaska to off Santa Cruz I., California. Type locality Sitka, Alaska.

Remarks. A small and common hermit crab of the continental shelf off southern California has been identified as *P. setosus* (Wicksten 1980c: 361). This identification needs confirmation.

***Pagurus spilocarpus* Haig, 1977**

(Fig. 44I–M, Pl. 9B)

Pagurus spilocarpus Haig, 1977: 646, figs. 1, 2. — Jensen 1995: 64, fig. 117. — Lemaitre & Castaño 2004: 79.

Diagnosis (after Haig 1977). Rostrum shorter than or equal to lateral projections of carapace, obtusely triangular or rounded. Eyestalk long, moderately stout, somewhat inflated basally, cornea dilated, ocular scales with prominent subterminal spine. Major cheliped stout, with fine setae, strong spines dorsally. Lateral, mesial margins with prominent spines. Minor cheliped with strong dorsal, lateral spines, also mesial spines except on carpus. Pereopods 2, 3 elongate, propodus, carpus serrate, dactyl slender, longer than propodus. Telson asymmetrical, left lobe larger than right, with lateral notches, terminal margin with median cleft, close-set teeth. Uropods asymmetrical. Carapace length to 43 mm.

Color in life. Appendages mostly tan. Chelipeds with spines white at base, purple at apices. Fingers with row of blue tubercles next to cutting edge; longitudinal bluish line outside of tubercles. Carpus with large dark purple spot on dorsal surface. Merus with triangular reddish-brown area dorsodistally; band of reddish-brown on lateral face. Pereopods 2, 3 with reddish-brown blotch on lateral surface of carpus, merus with broad reddish-brown band at distal end. Eyestalk white with reddish brown areas (Haig 1977). In life, setae often covered by silt, color somewhat obscured.

Habitat and depth. Sand, low intertidal zone to 60 m, usually subtidal.

Range. Zuma Beach, California to Point Abrejos, Baja California. Type locality off Belmont Pier, Orange County, California.

Remarks. This hermit crab commonly lives on sand bottoms along the mainland coast of southern California.

***Pagurus tanneri* (Benedict, 1892)**

(Fig. 45N)

Eupagurus tanneri Benedict, 1892: 10.

Pagurus tanneri. — Holmes 1900: 140. — Rathbun 1904: 158, pl. 4, fig. 7. — Schmitt 1921: 133, fig. 8. — Makarov 1962: 184, pl. 5, fig. 5. — Pereyra & Alton 1972: 450. — McLaughlin 1974: 216, figs. 55, 56. — Hart 1982: 142, fig. 53. — Wicksten 1988a: 243; 1989b: 314. — Lemaitre & Castaño 2004: 79.

Diagnosis. Rostrum triangular, longer than lateral projections of carapace. Eyestalk short and stout, cornea dilated, ocular scale with sharp points. Major cheliped stout, slightly shorter than pereopods 2, 3; merus setose, carpus with small dorsal spines, serrate margins; hand spiny, with raised triangular ridge, small spines on fingers, margin setose. Minor cheliped smaller, slender, hand slightly swollen on left side, with curved raised ridge edged with 2 rows of spines on palm; fingers elongate. Pereopods 2, 3 slender, carpus, merus with dorsal serrate edges, dactyls slightly longer than propodi, curved; with dorsal setae, small ventral spines. Telson asymmetrical, with lateral notches, terminal margin with median notch, teeth. Uropods asymmetrical. Carapace length 18.1 mm.

Color in life. Mostly orange to scarlet. Chelipeds with white spines and granules; palm yellowish. orange with white apex, cornea black, antennal flagellum scarlet. Hart (1982) gave a more detailed description of the living color.

Habitat and depth. Boulders of lower continental shelf and slope, 91–1372 m; usually deeper than 390 m in California.

Range. Bering Sea and Unalaska to off Point Loma, San Diego County, California. Type locality Clarence Strait, Alaska.

Remarks. This species often lives in shells of *Neptunea* sp. or *Bathybembix bairdi* (Dall, 1889). Stalked barnacles, family Scalpellidae, may attach to the shell.

***Pagurus venturensis* Coffin, 1957**

(Fig. 45A, B, Pl. 10C)

Pagurus hirsutiussculus venturensis Coffin, 1957: 1, fig. 2. — McLaughlin 1974: 185, figs. 43d, 44. — Haig & Abbott 1980: 585. — McLaughlin *et al.* 1988: 431.

Pagurus venturensis. — Crain & McLaughlin 1993: 985, figs. 1–11 (extensive synonymy). — Lemaitre & Castaño 2004: 79.

Diagnosis. Rostrum triangular, reaching beyond base of ocular scale, exceeding lateral projections of carapace. Eyestalk stout, cornea weakly dilated, ocular scale subacute, with subterminal spine. Major cheliped tuberculate, carpus with dorsal setae; fingers very short, stout; gap between fingers. Minor cheliped with 2 rows of sharp dorsal spines on carpus, palm tuberculate. Pereopods 2, 3 stout, setose; dactyls subequal to propodi, dactyls with row of ventral spines, carpi with 2–3 rows of spines. Telson asymmetrical, with cleft on lateral margin, concavity in terminal margin; terminal margin with teeth. Uropods asymmetrical. Carapace length to 4.6 mm.

Color in life. Olive brown to light gray. Apices of chelae white. Pereopods 2, 3 with white bands at distal ends of merus, carpus, propodus. Carpus with white stripe. Dactyl pale blue, with longitudinal reddish stripes. Eyestalk light golden brown. Antennal flagella translucent brown. The color notes are from crabs from Cabrillo Beach, Los Angeles County, California.

Habitat and depth. Sheltered bays, tide pools with mixed rocks and sand; low intertidal zone.

Range. Monterey Peninsula to San Diego, California. Type locality 12 miles north of Ventura, California.

Remarks. In life, *P. venturensis* usually is lighter in color than *P. hirsutiussculus*. It does not grow to as large a size as its northern counterpart. *Pagurus venturensis* often inhabits the shells of *Callianax biplicata* and *Acanthina* spp. in Los Angeles Harbor.

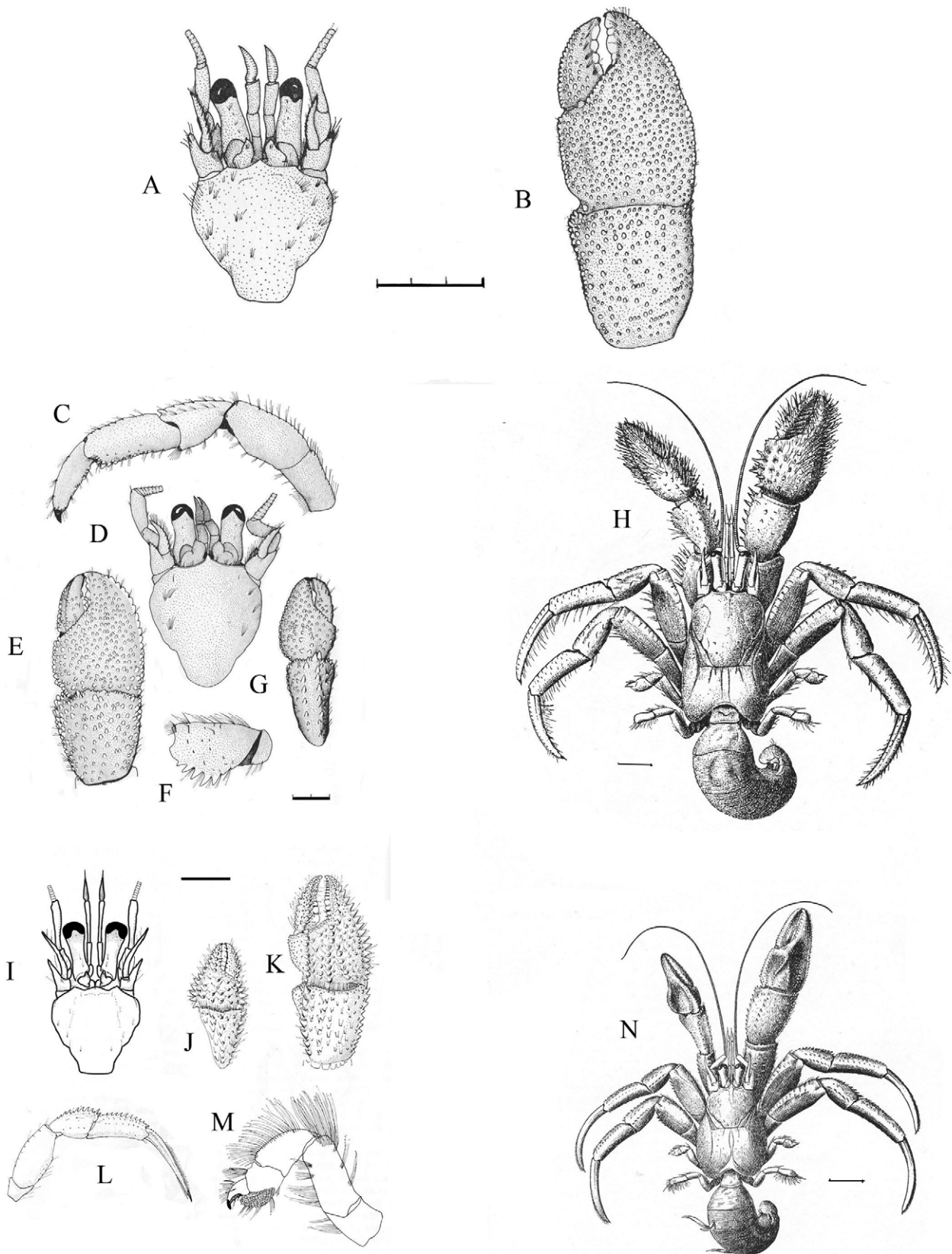


FIGURE 45. Family Paguridae. A, B, *Pagurus venturensis* Coffin, 1957; A, carapace and frontal region in dorsal view; B, major chela. C–G, *Pagurus samuelis* (Stimpson, 1857); C, pereopod 2; D, carapace and frontal region in dorsal view; E, major chela; F, detail of merus of minor cheliped; G, minor chela. H, *Pagurus setosus* (Benedict, 1892). I–M, *Pagurus spilocarpus* Haig, 1977; I, carapace and frontal region in dorsal view; J, minor chela; K, major chela; L, pereopod 2; M, pereopod 4. N, *Pagurus tanneri* (Benedict, 1892). Scales: C–E, G = 1 mm; A, B = 3 mm; H–L, N = 10 mm. A–G from McLaughlin 1974, H, N from Schmitt 1921, I–M from Haig 1977.

***Parapagurodes* McLaughlin & Haig, 1973**

***Parapagurodes hartae* McLaughlin & Jensen, 1996**

(Fig. 46A–F)

Pagurus sp: Hart 1982: 148, fig. 56.

Pagurus sp. 1: Jensen 1995: 66, fig. 124.

Parapagurodes hartae McLaughlin & Jensen, 1996: 841, figs. 1–4.

Diagnosis. Rostrum triangular, greatly exceeding lateral projections of carapace and reaching beyond base of ocular scale, subacute or with small tooth. Eyestalk moderately stout, with cornea slightly dilated. Major cheliped longer than pereopods 2, 3 in adult male. Mesial margins lined with strong spines, especially on carpus, rows of spines along dorsal surface of carpus, palm; row of spines continuing on each finger, lateral margin of palm; fingers with row of spines. Minor cheliped with long setae on dorsal margin of merus, carpus with 2 rows of strong dorsal spines, rows of spinules on palm, fixed finger; raised ridge near center of palm, few spinules on movable finger. Pereopods 2, 3 slender, dactyls slightly shorter to slightly longer than propodi, with row of 7–13 spines. Telson more or less symmetrical, lateral margins notched, terminal margin with median cleft, row of teeth. Uropods asymmetrical. Carapace length to 2.9 mm.

Color in life. Appendages covered by large patches of deep violet bordered by crimson. Chelipeds with orange palms, fingers; meri, carpi also orange; pereopods 2, 3 with patches of pale blue to ivory. Eyestalk translucent with bands, stripes of red, first antennae banded with red, white, and/or blue, antennal flagellum transparent (McLaughlin & Jensen 1996).

Habitat and depth. Among rocks, boulders, sand, gravel and shell; 6–635 m.

Range. Queen Charlotte Is., British Columbia to south of Pyramid Cove, San Clemente I., California. Type locality Chatham Sound, British Columbia. The crab has not been reported from Washington, Oregon or most of northern California except Carmel Bay, Monterey County.

***Parapagurodes laurentae* McLaughlin & Haig, 1973**

(Fig. 46G–J)

Parapagurodes laurentae McLaughlin & Haig, 1973: 129, figs. 4b, 9–11.

Diagnosis. Rostrum triangular, acute, often with small spine, longer than lateral projections of carapace and reaching less than half length of ocular scale. Eyestalk robust, short, with cornea dilated; ocular scale subtriangular and ending subacutely. Major cheliped long and slender. Merus with tufts of setae, carpus, palm, fingers with rows of spines, very long, sharp spines along mesial margins. Minor cheliped similar but more elongate, fingers especially long. Pereopods 2, 3 long, dactyls at least as long as propodi with row of strong spines on ventral margins. Telson generally symmetrical; lateral margin notched; with posterior cleft, flanked with teeth, spinules. Uropods asymmetrical. Carapace length to 3.5 mm.

Color in life. Not reported.

Habitat and depth. Mud and gray sand, upper continental slope, 16–475 m.

Range. Off Santa Cruz I., California to Pacific coast of Baja California and off San Pedro Nolasco I., Gulf of California, Mexico. Type locality off Seal Rocks, Santa Catalina I., California.

***Parapagurodes makarovi* McLaughlin & Haig, 1973**

(Fig. 46K–N)

Eupagurus mertensii. — Benedict, 1892a: 2. [Not *Pagurus Mertensii* Brandt, 1851, northwestern Pacific species].

Parapagurus Mertensii. — Holmes 1900: 155.

Parapagurus mertensii. — Rathbun 1904: 162, pl. 5, fig. 6. — Schmitt 1921: 146, pl. 16, fig. 5.

Parapagurodes makarovi McLaughlin & Haig, 1973: 119, figs. 4a, 5–8.

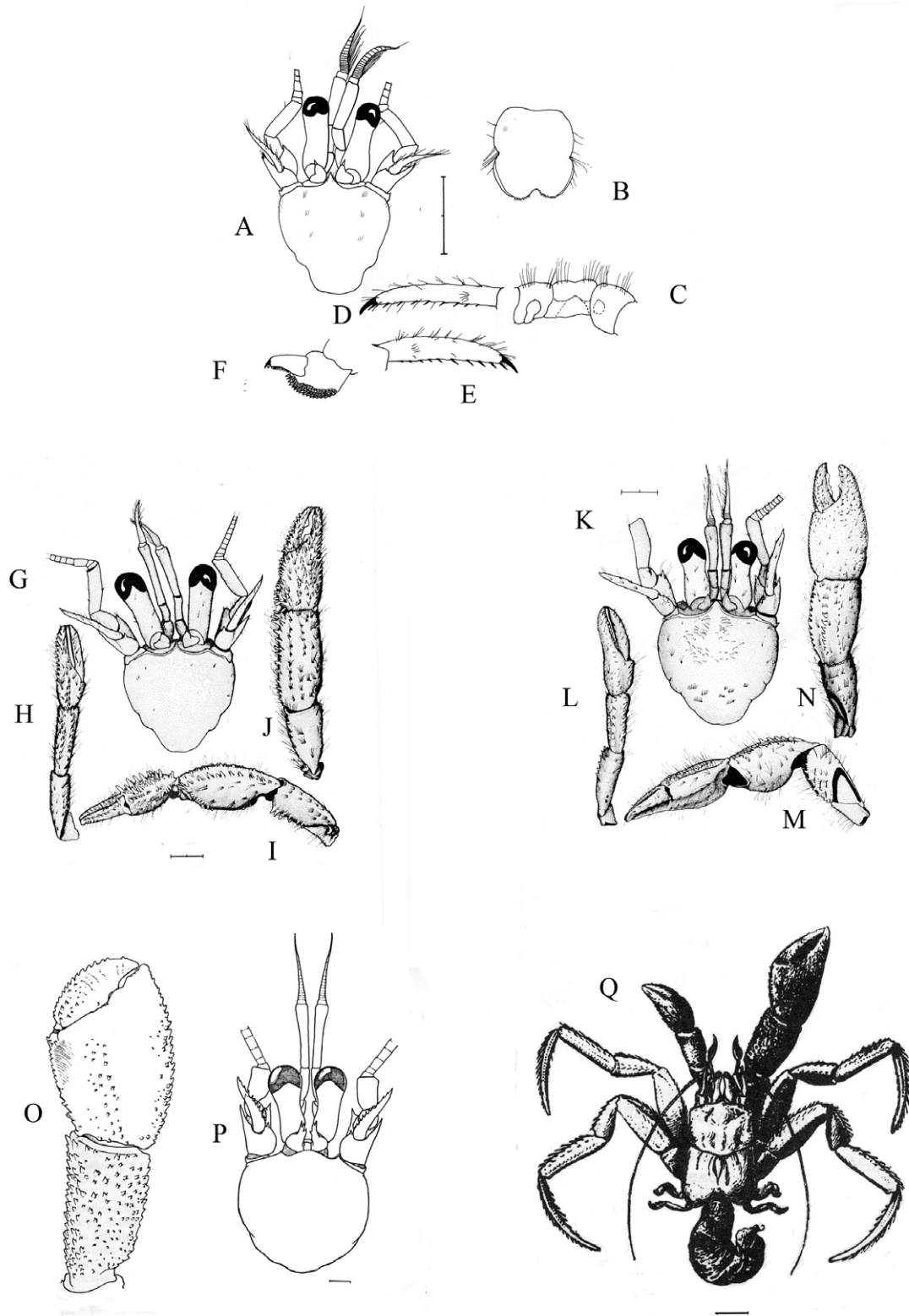


FIGURE 46. Families Paguridae and Parapaguridae. A–F, *Parapagurodes hartae* McLaughlin & Jensen 1995; A, carapace and frontal region in dorsal view; B, telson; C, sternite and coxa of pereopod 5; D, dactyl of right pereopod 2; E, dactyl of left pereopod 3; F, dactyl and propodus of left pereopod 4. G–J, *Parapagurodes laurentae* McLaughlin & Haig, 1973; G, carapace and frontal region in dorsal view; H, minor cheliped; I, major cheliped in lateral view; J, major cheliped in dorsal view. K–N, *Parapagurodes makarovi* McLaughlin & Haig, 1973; K, carapace and frontal region in dorsal view; L, minor cheliped; M, major cheliped in lateral view; N, major cheliped in dorsal view. O, P, *Oncopagurus haigae* (de Saint Laurent, 1972); O, major cheliped; P, carapace and frontal region in dorsal view. Q, *Parapagurus benedicti* de Saint Laurent, 1972. Scales: G–P = 1 mm; A = 2 mm, Q = 10 mm. A from McLaughlin & Jensen 1996, G–N from McLaughlin & Haig 1973, O, P from de Saint Laurent 1972 (as *Parapagurus haigae*), Q from Makarov 1962 (as *Parapagurus pilosimanus*).

Diagnosis. Rostrum elongate, considerably exceeding lateral projections of carapace, triangular, terminating in small spinule. Eyestalks short, stout, cornea dilated; ocular scale triangular, with strong submarginal spine, with acute or subacute apex. Major cheliped elongate, moderately slender; merus with tufts of setae, few spinules; carpus with dorsal row of strong spines, few spinules, sharp mesial teeth; palm with few spinules, especially along lateral margin, fingers with few spinules. Minor cheliped elongate, merus with mesial spines, carpus with dorsolateral row of strong spines, also smaller spines; palm, fingers with few low spinules. Pereopods 2, 3 elongate, dactyls slender, laterally compressed, shorter than propodi; with small spines. Telson symmetrical, with shallow median cleft; terminal margin with small teeth, small median slit. Uropods asymmetrical. Carapace length to 4.6 mm.

Color in life. Not reported.

Habitat and depth. Gray sand, rock and mud of continental shelf, 75–574 m.

Range. South of Santa Cruz, Monterey Bay, California to off Cedros I., Baja California, Mexico. Type locality off Anacapa I., California.

***Phimochirus* McLaughlin, 1981**

***Phimochirus californiensis* (Benedict, 1892)**

(Fig. 41H, Pl. 9G)

Eupagurus californiensis Benedict, 1892: 21. — Faxon 1895: 55, pl. 11, fig. 2–2e.

Pagurus californiensis. — Holmes 1900: 149. — Rathbun 1904: 161. — Schmitt 1921: 143, fig. 93.

Pylopagurus californiensis. — Haig *et al.* 1970: 20. — McLaughlin 1981: 5.

Phimochirus californiensis. — McLaughlin 1981: 5. — Jensen 1995: 61, fig. 110.

Diagnosis. Rostrum short, triangular, about as long as lateral projections of carapace. Eyestalk moderately long, slender, not dilated; ocular scale pointed. Major chela with row of spinules on distal margin of merus; carpus with spinules along inner margin; chela suborbicular, feebly granulated, with row of spinules along inner margin. Minor chela very small, slender, its width less than 0.3 times width of palm of larger chela. Dactyls of pereopods 2, 3 thin, setose, with spinules; longer than propodi. Telson with transverse suture, terminal margins oblique, each with series of moderately strong teeth. Uropods asymmetrical. Carapace length 26 mm.

Color in life. Reddish-brown, with whitish spots, bands. Major chela mostly white except for small blue dots; carpus reddish with whitish border on inner surface. Pereopods 2, 3 banded with cream or tan, with faint darker brown stripes. Eyestalk mostly orange, with whitish band at base. The color notes are from a crab from Blue Cavern Point, Santa Catalina I. California).

Habitat and depth. Rocks, kelp beds and sand near rocks, 10–106 m.

Range. Santa Catalina I., California to Galapagos Is. Type locality Catalina Harbor, Santa Catalina I., California.

Remarks. This is a very common species along the offshore islands of southern California. The large major chela tightly seals the opening of the shell when the hermit crab withdraws into it. The shell may be heavily encrusted by bryozoans.

***Pylopagurus* Milne-Edwards & Bouvier, 1893**

***Pylopagurus holmesi* Schmitt, 1921**

(Fig. 41 B)

Pylopagurus holmesi Schmitt, 1921: 144, fig. 94. — Walton 1954: 141, pl. 39. — McLaughlin 1981: 3. — McLaughlin & Lemaitre 2001: 459, figs. 7–9.

Pylopagurus longicarpus Walton, 1954: 144, pl. 40. — McLaughlin 1981: 3.

Diagnosis. Rostrum narrow, triangular, acute, reaching beyond middle of ocular scale, much longer than lateral projections of carapace. Eyestalk compressed, of equal length throughout. Chelipeds with scant setae. Major chela with granulate carpus; upper surface of hand discoidal, widest at base of fingers, with raised, denticulate margins; fingers flat, wide. Minor cheliped with hand narrow, rounded, fingers slightly gaping. Pereopods 2, 3 with dactyls slightly longer than propodus, strongly compressed, spinulose. Telson symmetrical, with notch in terminal margin; strong, curving flattened tooth at each end of notch. Anterior blades of uropods 2 twice size of posterior pair, both setose. Carapace length 7.5 mm.

Color in life. Not reported.

Habitat and depth. Usually among sand or sand and shell, rarely among rocks, 18–55 m.

Range. San Miguel I., California to Pacific coast of Baja California; Gulf of California from Lobos Point to Inner Gorda Banks. Type locality near Catalina Harbor, Santa Catalina I., California.

Remarks. This species usually inhabits shells of *Dentalium* spp. or tubes formed by the colonial bryozoan *Antropora tinctoria* (Hastings, 1930).

Family Parapaguridae Smith, 1882

As in species of the Paguridae, the species of the Parapaguridae have the third maxillipeds widely separated at the base. The chelipeds are dissimilar and unequal. In this family, only the male bears abdominal appendages other than the uropods. The female has only one oviduct, which opens on the coxa of left pereopod 3. Species of this family are found from the continental shelf down to the abyssal plains. Typically, the dactyls of the pereopods are elongated. Parapagurids may carry sea anemones or zoanthids on their shells.

Oncopagurus Lemaitre, 1996

Oncopagurus haigae (de Saint Laurent, 1972)

(Fig. 46O, P)

Parapagurus haigae de Saint Laurent, 1972a: 115, figs. 9, 17. — Wicksten 1980: 362; 1987: 55; 1989b: 314.

Sympagurus haigae. — Lemaitre 1989: 37.

Oncopagurus haigae. — Lemaitre 1996: 194. — Hendrickx & Harvey 1999: 373.

Diagnosis. Rostrum a low rounded prominence, barely surpassing low lateral projections of carapace. Ocular scales ending in single point. Eyestalk short, robust, not as long as first segment of antennular peduncle, cornea wider than proximal part of eyestalk. Major cheliped robust, carpus with numerous spinules; chela proper oval-shaped, hand with row of small dorsal spinules, movable finger semicircular along lateral margin. Pereopods 2, 3 with dactyls curved. Carapace length not reported.

Color in life. Not reported. Preserved specimens were pale.

Habitat and depth. Rocks, sand or mud; continental shelf, slope, 185–224 m.

Range. Off San Miguel I., California to Gulf of Panama including Gulf of California. Type locality off Santa Cruz I., California (*Velero III* sta. 993-39). The type locality given in the original description, "Golfe de Californie", is incorrect, although the species has been collected near Cape San Lucas.

Parapagurus Smith, 1879

Parapagurus benedicti de Saint Laurent, 1972

(Fig. 46Q)

Parapagurus pilosimanus benedicti de Saint Laurent, 1972a: 103, pl. 1, fig. 6. — McLaughlin 1974: 372, figs. 100, 101 (extensive synonymy). — Wicksten 1980c: 364; 1982: 245; 1989b: 314. — Hart 1982: 108, fig. 38.

Parapagurus pilosimanus. — Haig 1955: 1. — Makarov 1962: 212, fig. 747. — Pereyra & Alton 1972: 450.

Parapagurus benedicti. — Lemaitre 1989b: 11. — Hendrickx & Harvey 1999: 373.

Diagnosis. Rostrum rounded, slightly longer than lateral projections of carapace. Ocular scale usually bifid but sometimes with 1–3 points. Eyestalk slender, elongate, cornea slightly wider than eyestalk. Major cheliped elongate, much longer than minor cheliped, set with small tubercles but without spines; palm of chela broad, with short fingers having irregular teeth; chela in adults can be covered by thick golden setae. Minor cheliped more slender, fingers more elongate in proportion to chela than in major chela. Pereopods 2, 3 slender, dactyls almost as long as propodus, carpus combined. Telson with convex posterior margin, often with very slight median sinus; with 6–12 teeth on lateral margins. Carapace length to 16 mm.

Color in life. Bright red; setae of major chela golden. The color notes are from a crab collected off southern California.

Habitat and depth. Muddy sea floor of continental slope, 750–1902 m.

Range. Alaska to Chile. Type locality off Point Sur Light, Monterey County, California.

INFRAORDER BRACHYURA LATREILLE, 1802

A straight, symmetrical abdomen, not used in swimming, characterizes brachyuran crabs. In most brachyurans (and in all of those in California and Oregon), the abdomen is closely bent under the thorax instead of extending posteriorly. The abdomen usually is symmetrical and calcified. The uropods (if present) are not biramous. The cephalothorax is fused with the epistome laterally. The third maxillipeds are broad and often form a cover over the oral field. Pereopod 1 forms a strong cheliped, often with distinctive teeth. The antennae are relatively short in most species. Pereopod 5 is not developed into cleaning brushes or shell-holding appendages as in the Anomura. Consult Garth & Abbott (1980) for good accounts of the natural history of many near-shore and intertidal species.

Recent comparative genetic studies and examination of the genital apparatus in brachyurans have led to different interpretations of the higher classification of brachyurans into sections, tribes or superfamilies. Guinot (1977, 1978) conducted a major reconsideration of the sections, incorporating the location of the genital openings into classification and stressing the importance of the male copulatory structures. She and most other authors have considered the brachyurans to constitute a monophyletic group. Spears *et al.* (1992), based on a molecular analysis, and Rice (1980) suggested that features of the larval development tended to link some of the "primitive" brachyurans, such as the dromiids, with the Anomura. Ng *et al.* (2008) summarized new evidence for the Brachyura as a monophyletic group and provided an extensive new description of the group. They also provided morphological and genetic evidence for the arrangement of families into superfamilies and attempted to place them in a sound phylogenetic order. These major works contain further information regarding classification to superfamilies and families.

The key to the families is artificial and based on characters readily visible in species that occur in the area. Family names follow Ng *et al.* (2008). For the sake of uniformity with other sections of the text, I have omitted the names of sections, tribes or subfamilies.

Benedict (1892b: 224) reported a specimen of *Telmessus cheiragonus* (Tilesius, 1815: 347, pl. 7, fig. 1) (Atelecyclidae), from "Port Townsend, Oregon", but Port Townsend actually is in the state of Washington. Kuris *et al.* (2007: 653) reported *Telmessus cheiragonus* as being "northern, subtidal, rarely low intertidal" in California and Oregon but did not document the source of this information. Schmitt (1921: 235) reported this species from "California", but he quoted a report by Holmes (1900: 70) of the crab from "upper California." Holmes mentioned that there was a specimen of this species at the museum of the University of California. (This specimen has been lost). He noted that the label said that it came from the "Gulf of California", but "possibly this is wrong as this species appears to be a northern one." Rathbun (1930: 152) quoted Stimpson (1857b) in saying that the species was collected "off northern California."

Stimpson (1857b: 465) (as *Cheirogonus hippocarcinoides*) said of the species that it "was found on the coast of Upper California by Dr. Le Conte." John Le Conte was a noted naturalist who studied some of the beetles collected during the United States Exploring Expedition (Watson 1985). In 1841, that expedition made collections in Puget Sound south to the mouth of the Columbia River, and visited San Francisco Bay. John Le Conte was not a member of the expedition, nor did he collect on the west coast of North America, but he may have sent specimens to Stimpson. Stimpson and others complained that specimens from the Expedition had no labels and their catalog records were lost or in error. The boundary between "Oregon Territory" and "Upper California" was poorly defined

in 1841. It is possible that both the collector and the location of Stimpson's specimen from "California" (presumably lost in the Chicago Fire of 1871) were in error.

Key to families of Brachyura

1. Fifth pereopods conspicuously smaller than anterior legs, subdorsal, dactyls with hooks or spines, capable of gripping objects. Male, female genital openings coxal. 2
 - Fifth pereopods usually nearly as long as anterior legs, but if smaller, usually lateral; dactyls usually without hooks or spines, not capable of gripping objects. Female genital opening sternal, male opening coxal or sternal. 4
2. Carapace with pair longitudinal suture lines. Eye not retractile into orbits. Third maxilliped slender, not rectangular or triangular, not forming cover over oral field Homolidae
 - Carapace without pair longitudinal suture lines. Eye at least partially retractile into orbits. Third maxilliped rectangular or triangular, forming cover over oral fields 3
3. Oral field square. Carapace inflated. In life, carrying piece of shell, sponge or ascidian over dorsal surface of body, usually concealing entire animal when seen in dorsal view Dromiidae
 - Oral field triangular. Carapace flat. In life, carrying piece of shell or sponge over dorsal surface of body but often partially visible when seen in dorsal view Cyclodorippidae
4. Oral field triangular. Outgoing branchial channels opening at middle of endostome. Often into living on or buried in sandy substrates 5
 - Oral field square to oval. Outgoing branchial channels opening laterally. Living on various substrates 6
5. Chelipeds folding flat against body, dactyl or chelipeds at right angle to palm Calappidae
 - Chelipeds not folding flat against body, dactyl of chelipeds extending horizontally from palm Leucosiidae
6. Front of carapace narrow, often with rostrum carapace triangular to rounded, branchial region inflated 7
 - Front of carapace broad, usually without rostrum, carapace oval to square, branchial region not inflated 12
7. Chelipeds projecting laterally, fingers deflexed. Carapace, posterior pereopods without hooked setae. Carapace triangular Parthenopidae
 - Chelipeds not projecting laterally, fingers not deflexed. Carapace, posterior pereopods with hooked setae, at least in juveniles. Carapace pear-shaped, squarish to rounded but not triangular 8
8. Eye without orbits; ocular peduncles long, either non-retractile or retractile against sides of carapace or against acute postorbital spine. Basal antennal article extremely long, slender 9
 - Eye with incomplete or commencing orbits. Basal antennal article not extremely long 10
9. Lateral edges of carapace set in groove of gill chamber walls, with external part visible as pleural plates. First pleonite joined to carapace. Carapace pubescent, especially in small individuals Inachoididae
 - Lateral edges of carapace not set in groove of gill chamber walls, without external part visible as pleural plates. First pleonite not joined to carapace. Carapace not pubescent Inachidae
10. Male abdomen terminally broadened, seventh segment subquadrate, inserted deeply into sixth segment. Inhabiting continental shelf, slope or subtidal north of Monterey Bay, California Oregoniidae
 - Male abdomen not terminally broadened, seventh segment subtriangular, not inserted deeply into sixth segment. Intertidal or deeper, with ranges extending south of Monterey Bay, California 11
11. Eyestalk either concealed by supraocular spine or sunk in sides of rostrum. Usually found among algae Epialtidae
 - Eyestalk with commencing orbits having, in addition to supraocular spine, large cupped postocular process into which eye retracts. Usually found among rocks, sponges or mixed habitats Pisidae
12. Front of carapace with 3 teeth, one of these medial; antennules folding longitudinally. Carapace broadly oval, with 9–11 lateral teeth Cancridae
 - Front of carapace with or without teeth, but if present, never with median tooth; antennules folding obliquely or transversely. Carapace oval-square, with or without lateral teeth 13
13. Fifth pereopods ending in flattened dactyls, usually forming swimming paddles; carapace with 5 or more sharp lateral teeth Portunidae
 - Fifth pereopods not ending in flattened dactyls, not forming swimming paddles; carapace with or without lateral teeth. 14
14. Ocular peduncles elongate, folding horizontally against front of cephalothorax. Carapace rectangular, front narrow Ocypodidae
 - Ocular peduncles short, folding into sockets. Carapace rectangular or not, front usually wide. 15
15. Last pair of walking legs short, at most slightly longer than merus of preceding leg; often subdorsal 16
 - Last pair of walking legs only slightly shorter than entire length of anterior leg, always lateral 17
16. Eyes very large. Carapace broadly transverse, anterolateral margins dentate. Not symbiotic, well calcified Palicidae
 - Eyes small. Carapace round to subcylindrical, anterolateral margins without teeth. Usually symbiotic with larger invertebrates, sometimes poorly calcified Pinnotheridae
17. Carpus of third maxilliped not articulating at or near anterointernal angle of merus, lateral margins of mouth frame parallel to extremely convergent. Carapace square to trapezoidal, intertidal zone or living on floating debris or sea turtles. 18
 - Carpus of third maxilliped not articulating at or near antero-internal angle of merus, lateral margins of oral frame parallel to divergent. Carapace square to oval, intertidal to subtidal zones 19
18. Lower margin of orbit oriented downward toward buccal cavity, not distantly supplemented by suborbital crest. Intertidal or pelagic on sea turtles or floating debris Grapsidae
 - Lower margin of orbit not oriented downward toward buccal cavity, distantly supplemented by suborbital crest. Intertidal to

- shallow subtidal, not pelagic Varunidae
19. Carapace, appendages set with coarse setae Pilumnidae
 – Carapace, appendages not set with coarse setae 20
20. Male first gonopod apex having numerous complex folds. Carapace more or less squarish to pentagonal, usually with no more than 3 lateral teeth; if 5 teeth, posterior ones smaller than anterior 3 teeth Panopeidae
 – Male first gonopod with simple apex. Carapace usually more or less oval, usually with 4–9 lateral teeth Xanthidae

SUPERFAMILY HOMOLOIDEA De Haan, 1839

Family Homolidae de Haan, 1839

Homolid crabs, sometimes called carrier crabs, range from the lower subtidal zone down into abyssal depths. Their characteristic subdorsal legs are used to carry objects over the posterior part of the carapace. Only one species lives off California and northern Mexico.

Moloha Barnard, 1947

Moloha faxoni (Schmitt, 1921)

(Fig. 47A)

Homola faxoni Schmitt, 1921: 184, pl. 31, fig. 7.

Paromola faxoni. — Rathbun 1937: 68, pl. 18, pl. 19, fig. 1. — Guinot & Richer de Forges 1981: 536. — Wicksten 1985: 476.

— Kuck & Martin 1994: 177, figs. 1–4.

Mohola faxoni.—Guinot & Richer de Forges 1995: 383, fig. 33 c, d, g, h. — Hendrickx 1997: 33, fig. 41.

Diagnosis (after Kuck & Martin 1994). Carapace some what square, longer than broad, with short pubescence; short spiniform rostrum present, stout supraorbital spines with small hooked spines on upper surfaces, smaller spines posterior to supraorbital spines in line with their base, spines on hepatic, gastric, branchial regions; tubercles on much of carapace. Distinct pair of suture lines (linea homolica) on carapace. Antennal flagellum relatively long. Eye exposed, without orbit. Third maxillipeds slender, not covering oral field. Chelipeds long, slender, setose; fingers with dark apices. Pereopods 2–4 slender, with sharp spine on dorsal margin of merus, dactyl long, slender. Pereopod 5 subdorsal, shorter than preceding pereopods, with curved dactyl folding against spiny propodus. Basal segments of abdomen armed with sharp median tubercle apiece. Female genital openings coxal. Male carapace length to 83.3 mm, female to 59.3 mm.

Color in life. Brown, golden brown or brick red. The color notes are from crabs collected off southern California.

Habitat and depth. Continental shelf, 18–460 m.

Range. Tajiguas, Santa Barbara County, California to Cedros I., Baja California; San Jose I., Gulf of California. Type locality off Point Loma, California.

Remarks. The crab may carry a piece of gorgonian or sponge in its fifth pereopods (Wicksten 1985).

SUPERFAMILY DROMIOIDEA De Haan, 1833

Family Dromiidae de Haan, 1833

The sponge crabs use their subdorsal posterior pereopods to carry pieces of sponges, ascidians or shells, concealing their entire bodies. The crabs cut pieces of sponge or ascidian, and then tumble over to fit the body against the interior of the "cap." Only one species has been reported from California. Many species are nocturnal.

***Cryptodromiopsis* Borradaile, 1903**

***Cryptodromiopsis sarraburei* (Rathbun, 1910)**

(Fig. 47B)

Dromidia larraburei Rathbun, 1910: 553, pl. 48, fig. 4. — Schmitt 1921: 183, pl. 33, fig. 1. — Rathbun 1937: 35, text fig. 13, pl. 7, figs. 4, 5. — Kerstich 1989: 244.

Dromidia segnipes Weymouth, 1910: 15, pl. 1, figs. 1, 2.

Cryptodromiopsis larraburei. — McLay 1993: 187. — Hendrickx 1997: 17, fig. 33.

Cryptodromiopsis sarraburei. — Boyko 1998: 234.

Diagnosis. Carapace setose, rounded, inflated, longer than wide. Front narrow, with 3 teeth, lateral margins with 4–6 small teeth. Flagellum of antenna long; eye, antennules retractile into common orbito-antennary pits. Third maxilliped more or less square to rectangular, covering oral field. Chelipeds short, stout; fingers gaping at base. Pereopods 2, 3 with curved dactyls; pereopod 4 narrow, subdorsal, with curved dactyl; pereopod 5 short, subdorsal, with spiny dactyl folding against spine of propodus. Female genital openings coxal. Abdominal somite 6 with uropods plates. Male carapace width 15 mm, female 28 mm.

Color in life. Pale brown to gray, apices of chelae red (color photo by Kerstich 1989).

Habitat and depth. Rocks or sand, low intertidal zone to 82 m.

Range. Monterey Bay, California to Sechura Bay, Peru, but rarely collected north of Baja California, Mexico. Type locality Sechura Bay, Peru.

Remarks. In life, the crab carries a sponge or colonial ascidian over its dorsal surface.

SUPERFAMILY CYCLODORIPPOIDEA Ortmann, 1892b

Family Cyclodorippidae Ortmann, 1892b

These small crabs occur on shell hash bottoms along the coast of California. The last pereopods are held subdorsally. Both local species belong to the genus *Deilocerus*.

Key to species of family Cyclodorippidae

1. Frontal lobes ending in pronounced cylindrical blunt spines, carapace distinctly granulate *Deilocerus decorus*
- Frontal lobes ending in blunt teeth, carapace minutely granulate to smooth *Deilocerus planus*

***Deilocerus* Tavares, 1993**

***Deilocerus decorus* (Rathbun, 1933)**

(Fig. 47C, D)

Clythrocerus decorus Rathbun, 1933: 185. — Rathbun 1937: 118, text fig. 30, pl. 34, figs. 3, 4. — Wicksten 1988: 242.

Deilocerus decorus. — Tavares 1993: 140. — Hendrickx 1997: 37, fig. 43.

Diagnosis. Carapace rounded, about as long as wide, granulate; frontal lobes ending in cylindrical blunt spines separated by triangular sinus, orbit with triangular notch above, outer subacute spine. Lateral margin with two prominent teeth. Flagellum of antenna short, peduncle with tubercle. Eye short, without true orbit. Third maxillipeds elongate. Chelipeds stout, excurrent branchial openings near their bases; carpus with two lobes on outer margin, one at inner angle; large tooth at proximal outer margin of propodus, another at articulation with dactyl. Pereopods 2, 3 long and slender; merus, carpus spinulose on margins; dactyls long, simple. Pereopods 4, 5 short, subdorsal, with dactyl closing against propodus. Basal segments of abdomen visible in dorsal view, female abdomen particularly wide and cupped, male abdomen narrow. Male, female genital openings coxal. Carapace length 6 mm.

Color in life. Not reported.

Habitat and depth. Among broken shells, 70–185 m.

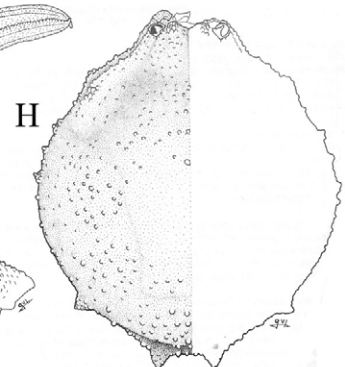
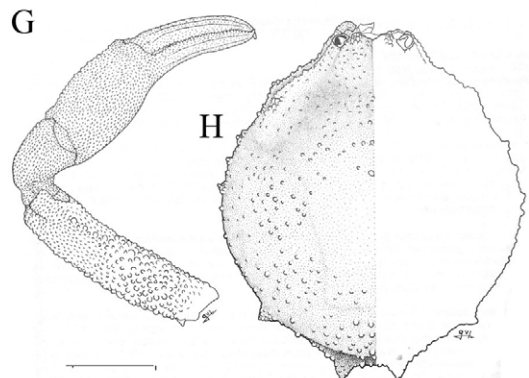
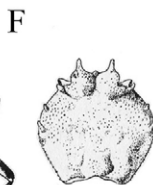
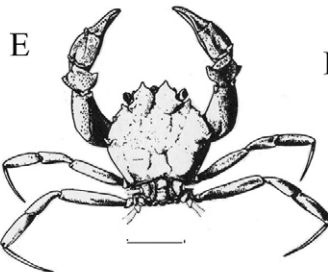
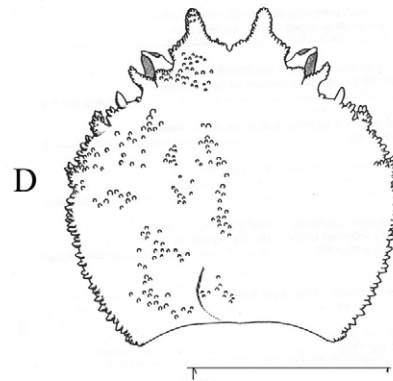
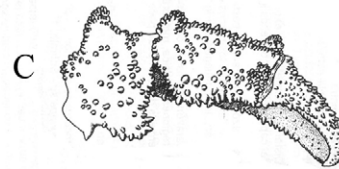
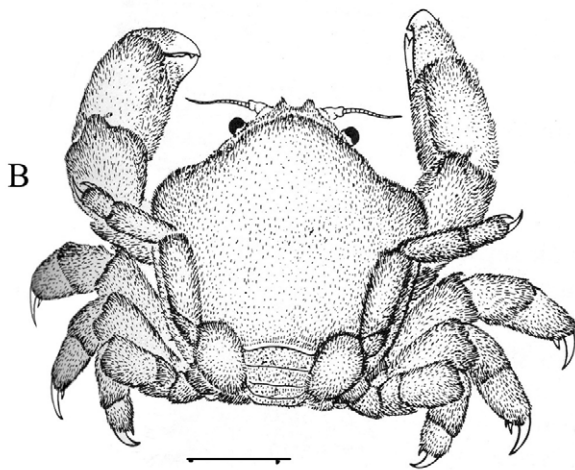


FIGURE 47. Families Homolidae, Dromiidae, Cyclodorippidae and Leucosiidae. A, *Moloha faxoni* (Schmitt, 1921). B, *Cryptodromiopsis sarraburei* (Rathbun, 1910). C, D, *Deilocerus decorus* (Rathbun, 1933); C, cheliped; D, carapace; E, F, *Deilocerus planus* (Rathbun, 1900); E, dorsal view (pereopods 4, 5 missing); F, carapace. G, H, *Randallia ornata* (Randall, 1839); G, cheliped; H, carapace. Scales: E, F = 2 mm; C, D = 4 mm; B, G, H = 10 mm; A in cm. A from Kuck & Martin 1994, as *Paromola faxoni*, B from Brusca 1980, C, D from Rathbun 1937 (as *Clythrocerus decorus*); E, F from Schmitt 1921 (as *Clythrocerus planus*); G, H from Hendrickx 1997.

Range. Off Soberanes Point, Monterey County, California to off Point Loma, California; north of Angel de la Guardia I. and south of Tiburon I., Gulf of California, Mexico. Type locality off Brockway Point, Santa Rosa I., California.

Remarks. One was observed to carry a sponge in its hind legs (Wicksten 1988).

***Deilocerus planus* (Rathbun, 1900)**

(Fig. 47E, F)

Cyclodorippe plana Rathbun, 1900: 519. — Schmitt 1921: 186, fig. 115.

Clythrocerus planus. — Rathbun 1904: 168, pl. 9, fig. 4; 1937: 114, text fig. 29, pl. 34, figs. 1–2. — Wicksten 1980c: 361; 1982: 306.

Deilocerus planus. — Tavares 1993: 140. — Hendrickx 1997: 43, fig. 47.

Diagnosis. Similar to *D. decorus* except frontal lobes ending in blunt teeth, carapace minutely granulate to smooth. Male carapace length 3.4 mm, female 2.8 mm.

Color in life. Pale-dark gray to whitish. The color notes are from crabs from Catalina I.

Habitat and depth. Among broken shells, 20–60 m.

Range. Santa Catalina I., California to Gulf of California. Type locality "southern California at Catalina Harbor (probably)" [*sic*] (Rathbun 1937).

Remarks. These small crabs carry pieces of shell, pebbles, sticks, or algae over their carapaces by means of the specialized hind legs (Wicksten 1982). They are abundant on "shell hash" bottoms along the offshore islands of California, rarely occurring along the mainland coast except in areas of steep rocky bottoms.

SUPERFAMILY CALAPPOIDEA De Haan, 1833

Family Calappidae H. Milne-Edwards, 1837

Although the Calappidae and related families are well represented in tropical seas, only one species occurs in the Californian and Oregonian provinces. These crabs use their powerful chelae to crush the mollusks that they eat. They can burrow into sand or mud, using the space between the chelipeds and the body as a respiratory opening.

***Platymera* H. Milne-Edwards, 1837**

***Platymera gaudichaudii* H. Milne-Edwards, 1837**

(Pl. 10D)

Platymera gaudichaudii H. Milne-Edwards, 1837: 108. — Holmes 1900: 99. — Rathbun 1904: 170. — Galil 1993: 371. — Hendrickx 1997: 101, fig. 77 (extensive synonymy). — Kuris *et al.* 2007: 640, pl. 319, fig. K.

Mursia gaudichaudii. — Weymouth 1910: 19. — Schmitt 1921: 190. — Rathbun 1937: 220, pl. 66, figs. 1–3. — Garth 1957: 16. — Haig & Wicksten 1975: 102. — Hart 1982: 173, fig. 68.

Diagnosis. Carapace convex, front narrow, lateral margins edged by about 15 small teeth, very large lateral spine. Eye not completely retractile into orbit. Third maxillipeds not completely covering mouth field. Chelipeds strong, chelae proper armed with teeth, ridges bearing tubercles, fingers at right angle to palm, bearing teeth; cheliped folding flat against frontal part of cephalothorax. Pereopods 2–5 lateral, similar, decreasing in size from anterior to posterior, with sharp dactyls. Abdomen concealed under cephalothorax. Male genital openings coxal, female sternal. Male carapace width 162.5 mm, female 71.8 mm.

Color in life. Carapace with light olive gray background, covered with orange to red to overall brick red with cream tubercles. Chelae dull gray with red shading to brick red, lower surface pale yellow to whitish. Pereopods 2–5 pale olive gray with purple spots to overall reddish, lower parts, apices of dactyls whitish to cream. The color notes are from crabs taken off Newport Beach, California.

Habitat and depth. Sand or mud, 48–402 m, rarely cast ashore.

Range. Off Englefield Bay, Queen Charlotte Is. and SW of La Pérouse Bank, British Columbia, to Talcahuano, Chile. Type locality "coast of Chile."

SUPERFAMILY LEUCOSIOIDEA Samouelle, 1819

Family Leucosiidae Samouelle, 1819

The purse crabs burrow in sand, leaving only the front of the carapace, eye, antennae and a respiratory channel exposed. Members of the superfamily are diverse in tropical and warm-temperate waters elsewhere in the world, but only one species occurs in California.

***Randallia* Stimpson, 1857**

***Randallia ornata* (Randall, 1840)**

(Fig. 47G, H, Pl. 10G)

Ilia ornata Randall, 1840: 129.

Randallia ornata. — Stimpson 1857b: 471, pl. 19, fig. 3. — Holmes 1900: 100. — Rathbun 1904: 170; 1937: 172, pl. 49, figs. 1, 2. — Weymouth 1910: 18, pl. 1, fig. 3. — Schmitt 1921: 188, fig. 11. — Johnson & Snook 1927: 363, fig. 314 — Ricketts *et al.* 1985: 321, fig. 247. — Jensen 1995: 34, fig. 52. — Hendrickx 1997: 163, fig. 114 (extensive synonymy). — Kuris *et al.* 2007: 640, pl. 319, fig. J.

Randallia angelica Garth, 1940: 54, pl. 11, figs. 1, 2.

Diagnosis. Carapace of adult nearly smooth, with few scattered granules and minute spinules on lateral margin, juveniles with numerous rough tubercles, posterior margin with two prominent tubercles. Front short, narrow; with concave anterior margin, eye set into margin. Third maxillipeds triangular, long. Cheliped long and subcylindrical; hand, fingers narrow, fingers acute. Pereopods 2–5 similar, with simple dactyls. Male, female genital openings sternal. Male carapace width 53.2 mm, female 34.9 mm.

Color in life. Carapace cream marked with reddish to purple spots, patches; chelipeds, legs cream; chelipeds with red-purple bars, blotches; legs with prominent red to purple bands on merus. The color notes are from crabs taken at San Pedro, California.

Habitat and depth. Sand, lowest intertidal zone to 94 m. The crab often buries itself leaving only the front exposed.

Range. Mendocino County, California to Magdalena Bay, Baja California; northern Gulf of California between Isla Angel de la Guardia, Point Willard, Tiburon I. and Cape Tepoca, Sonora. Type locality "California" (perhaps Monterey, where some of Randall's specimens were collected).

Remarks. Weymouth (1910), Schmitt (1921), and Rathbun (1937) reported *Randallia bulligera* Rathbun, 1898 from San Diego, California. There have been no subsequent reports of this crab from California. This crab has a tuberculate carapace. Schmitt speculated that this crab might actually be the juvenile of another species, but Hendrickx (1997: 160) treated it as a distinct species, usually ranging from Baja California, Mexico to Peru.

SUPERFAMILY MAJOIDEA Samouelle, 1819

Until recently, all of the spider crabs were included in one family, the Majidae. Garth (1958) placed the genera that occur in the entire eastern Pacific Ocean into seven subfamilies, three of which do not occur in the area of coverage. Drach & Guinot (1983) and Hendrickx (1995c, 1999) elevated the existing eastern Pacific subfamilies (as presented by Garth) to family status, and added another family, the Inachoididae. I have followed this family arrangement in the text that follows. Martin & Davis (2001) listed seven families under the superfamily Majoidea, but did not elevate Garth's subfamily Oregoniinae to family status. Ng *et al.* (2008) and Ng *et al.* (2009) considered the family Pisidae to be poorly defined but included it as a subfamily, the Pisinae, of the Epiplatidae. In a molecular analysis, Hultgren & Stachowitz (2008) found good support for the family Oregoniidae and Inachidae but a "close

phylogenetic association" between the Epialtidae and Pisidae. However, their analysis was limited to only 36 species, mostly common and shallow water inhabitants of the north Pacific. The species of the epialtoids and pisids in the Californian-Oregonian region are distinct in morphology and habitat, and therefore are considered here to be separate families.

The spider crabs are common in California and Oregon, and range from the intertidal zone to the continental slopes. As the common name implies, the body is spider-like in that pereopods 2–5 usually are relatively long in comparison with the body. A rostrum usually is present. The second article of the antennae is well developed, but usually fused with the epistome and often with the front. The orbits usually are incomplete. The chelipeds are slender and agile at least in smaller individuals, and can be used in delicate picking and twisting maneuvers as well as in crushing.

Most species possess hooked setae on the dorsal surface of the body and walking legs at least during part of their life cycle, and can attach food or camouflaging materials to these setae. Well-camouflaged species commonly are called decorator crabs (regardless of their generic classification). The crabs usually attach materials that are flexible and common in their habitat. Attachment is mechanical. The crabs do not secrete bioadhesive materials to the material. Some species store uneaten food on their hooked setae; others usually camouflage themselves with inedible materials (Wicksten 1993).

Spider crabs usually feed on algae, smaller invertebrates, detritus and dead animals. Species of *Loxorhynchus* prey on echinoderms as well. The crabs in turn fall prey to the sea otter *Enhydra lutris* (Linnaeus, 1758); large fishes including *Anarrichthys ocellatus* Ayres, 1855; and *Scorpaenichthys marmoratus* (Ayres, 1854); large cancrivora crabs and octopuses.

Adult spider crabs reach sexual maturity after a terminal molt, and do not molt or regenerate lost or damaged appendages after reaching maturity. Adult males usually are larger than females. The males' chelipeds often are longer than those of females, and the chelae often are heavier, broader and brightly colored on the interior surface. Adult females have slender chelipeds and rounded bodies. The decorating habit often is lost in adult males.

The definitive work on spider crabs of the eastern Pacific is that of Garth (1958). Extensive synonymies and detailed information on anatomy and distribution can be found in this work.

Family Epialtidae MacLeay, 1838

Commonly called kelp crabs, these crabs generally are found among algae.

Key to species of family Epialtidae

1. Five free abdominal segments in both sexes. Rostrum with shallow apical notch. Carapace nearly smooth, with broad hepatic, branchial lobes *Epialtoides hiltoni*
- Seven free abdominal segments in both sexes. Rostrum bifid. Carapace smooth or with tubercles, with or without lobes 2
2. Antennae not visible at sides of rostrum in dorsal view. Carapace broadly oval, smooth *Taliepus nuttallii*
- Antennae visible at sides of rostrum in dorsal view. Carapace varying in shape, smooth or with tubercles 3
3. Carapace with broad lateral expansions, leaf-like branchial expansion overlapping hepatic region dorsally *Mimulus foliatus*
- Carapace without broad lateral expansions, expansions inwardly separated 4
4. With smaller secondary spine between postorbital, hepatic spines at slightly lower level. South of Point Conception to northern Mexico *Pugettia venetiae*
- Without smaller secondary spine between postorbital, hepatic spines at slightly lower level. May range north of Point Conception 5
5. Hepatic projection a transverse spine not joined with postorbital spine by lateral expansion of carapace. Postorbital projection consisting of ovate lobe directed forward *Pugettia dalli*
- Hepatic projection a triangular tooth, joined completely or incompletely with postorbital spine by lateral expansion of carapace. No such ovate lobe 6
6. Carapace smooth, sides subparallel. No constriction between hepatic, branchial tooth *Pugettia producta*
- Carapace tuberculate, sides not subparallel. Constriction between hepatic, branchial tooth 7
7. Tubercles of carapace uneven in size. Hepatic tooth broadly joined to postorbital, its outer margin trending toward longitudinal *Pugettia gracilis*
- Tubercles of carapace even in size. Hepatic tooth deeply separated from postorbital, its outer margin trending toward transverse *Pugettia richii*

Epialtoides Garth, 1958

Epialtoides hiltoni (Rathbun, 1923)

(Fig. 49A, B)

Epialtus bituberculatus Rathbun, 1894: 67 (part). — Schmitt 1921: 203 (not text fig. 126). [Not *Epialtus bituberculatus* Milne-Edwards, 1834, western Atlantic species].

Epialtus hiltoni Rathbun, 1923: 72; 1925: 156, pl. 46, figs. 1 2; text figs. 53 m, n.

Epialtoides hiltoni. — Garth 1958: 234, pl. O, fig. 7; pl. 26, fig. 33. — Garth & Abbott 1980: 597, fig. 25.2. — Jensen 1995: 25, fig. 25.—Hendrickx 1999: 93, fig. 53.

Diagnosis. Rostrum oblong, apex bilobed; deeply emarginate in young animals. Carapace high in median region, lateral wings broad, ascending, anterior lobe larger, intervening sinus deep. Posterior margin of hepatic lobe convex. Preorbital tooth outstanding, postorbital tooth inconspicuous. Male chelipeds of moderate size, merus bluntly angled, carpus, manus with subacute outer carina, tubercle on upper surface of carpus, outer margin of fingers with carina, large tooth on dactyl within narrow gape. Female with less massive cheliped, merus, manus foreshortened. Pereopods 2–5 rather stout, 2 tubercles on lower margin of merus of first leg, dactyls with spinules. Male, female with 5 free abdominal segments. Male carapace length 17.3 mm, width 15.7 mm; female 10.7 mm, width 9.6 mm.

Color in life. Camouflaged like brown algae; brown, olive, mottled with dark brown or cream. The color notes are from crabs from Santa Catalina I.

Habitat and depth. Among low-growing algae, in kelp holdfasts of among surf grasses (*Phyllospadix* spp.), intertidal zone to 5 m.

Range. Santa Catalina I., California to Magdalena Bay, Baja California. Type locality Laguna Beach, California.

Remarks. *Epialtoides hiltoni* may attach bits of algae to its rostrum. This crab may be abundant, but its small size and cryptic coloration render it inconspicuous.

Mimulus Stimpson, 1860

Mimulus foliatus Stimpson, 1860

(Fig. 49C, Pl. 12A)

Mimulus foliatus Stimpson, 1860: 200, pl. 5. — Holmes 1900: 23. — Rathbun 1904: 173; 1925: 182, pl. 60, text figs. 70 71 — Weymouth 1910:30, pl. 4, figs. 12, 13. — Schmitt 1921: 204, fig. 127a,b. — Johnson & Snook 1927: 368, fig. 320. — Garth 1958: 183, pl. L, fig. 1; pl. 25, fig. 3. — Garth & Abbott 1980: 600, fig. 25.8. — Hart 1982: 182, fig. 72. — Ricketts *et al.* 1985: 170, fig. 138. — Jensen 1995: 26, fig. 29. — Kuris *et al.* 2007: 641, pl. 319, fig. H.— Hultgren & Stachowitz 2008: 994.

Diagnosis. Rostral horns flattened, notch between them triangular, rows of hooked setae on rostrum. Carapace flattened, median region with 2 small tubercles; lateral margin bearing broad, leaf-like expansions divided by narrow fissure. Hooked setae present on median region of small crabs. Preorbital tooth large, triangular, acute; postorbital tooth small, pointing obliquely downward. Peduncle of antennae reaching to or near rostrum apex. Male cheliped large, merus rough, carpus with ridge on inner margin, hand with fingers bent downward, curved inward, gaping near base but distally with small teeth. Female cheliped smaller, without prominent ridge on merus, fingers not gaping, dentate along entire margin. Pereopod 2 longer than following pereopods. Propodus of pereopods 2–5 with setose tooth near middle of inferior margin. Male, female abdomens with seven free segments. Male carapace length 23.4 mm, width 39 mm; female carapace length 19.3 mm, width 32.4 mm.

Color in life. Carapace highly variable: reddish, rose-red, purple, tan and marked with stripes, white with brick-red rostrum, red-brown with white "V" mark or orange. Male cheliped reddish or white with red fingers. Pereopods 2–5 reddish with white bands. The color notes are from crabs from Monterey Bay, California.

Habitat and depth. Among rocks and algae, shore to 129 m but usually at 30 m or less.

Range. Unalaska, Alaska to San Diego, but uncommon south of Point Conception, California. Type locality off Monterey, California.

Remarks. *Mimulus foliatus* may attach bits of algae to its carapace. Large individuals may have encrusting sponges or bryozoans on the carapace. This crab often is found among coralline algae and kelp holdfasts.

Hultgren & Stachowitz (2008), in a molecular analysis, noted that *M. foliatus* nested in a clade with *Pugettia* spp. and is morphologically and ecologically similar to other *Pugettia* species. They noted that Rathbun (1894) also suggested that there was not good reason for placing *Mimulus* in a genus distinct from *Pugettia*. They suggested that *M. foliatus* be reclassified as a member of the genus *Pugettia* but did not formally change the designation of this crab.

***Pugettia* Dana, 1851**

***Pugettia dalli* Rathbun, 1894**

(Fig. 48C)

Pugettia dalli Rathbun, 1894: 232; 1904: 173, pl. 2, figs. 1, 1a; 1925: 178, pl. 59, figs. 1–4, text fig. 67. — Holmes 1900: 26. — Johnson & Snook 1927: 369, fig. 322. — Garth 1958: 199, pl. L, fig. 6, pl. 21, fig. 1. — Jensen 1995: 22, fig. 18. — Hendrickx 1999: 107, fig. 62.

Diagnosis. Rostral horns slender, divergent. Carapace subtriangular, more rounded in females than males; with hooked setae, covered with small prominences. Large tubercle on cardiac region, intestinal region, each protogastric lobe; female with swollen gastric region. Lateral carapace margin with slender hepatic spine; stout, upturned branchial spine. Preorbital tooth sharply pointed. Postorbital tooth thin, obtuse, upper surface flattened into smooth oval lobe. Antennae exceeding rostrum; large lobe on outer margin of basal article. Male cheliped strong, merus with thin, irregular ridge on margins, carpus with strong ridge above, on inner margin, hand large, compressed, margins thin, fingers gaping, tooth near base of dactyl. Female cheliped similar but with slender chela, fingers in contact. Pereopods 2–5 slender, pereopods 2 as long as or longer than chelipeds, remaining legs shorter, margins fringed with coarse setae. Male carapace length 18.0 mm, width 13.8 mm; female 14.6 mm, width 10.3 mm.

Color in life. Reddish to brown, similar to algae. The color notes are from crabs from Redondo Beach, California.

Habitat and depth. Among algae, sea grasses; open coasts and harbors, intertidal zone to 118 m but usually at less than 50 m.

Range. San Miguel I., California to Thurloe Bay, Baja California. Type locality "Southern California" (possibly Catalina Harbor, Santa Catalina I., based on records of specimens examined by Rathbun).

Remarks. *Pugettia dalli* is common, but small and cryptic. It can be collected in abundance among low-growing algae and holdfasts. These crabs decorate themselves life-long with pieces of algae, bryozoans and hydroids.

***Pugettia gracilis* Dana, 1851**

(Fig. 48A)

Pugettia gracilis Dana, 1851. — Holmes 1900: 25. — Rathbun 1904: 173; 1925: 172, pl. 58, text figs. 64,65. — Weymouth 1910: 29, pl. 4, fig. 10. — Schmitt 1921: 206, pl. 33, fig. 7, text figs. 128a, b. — Johnson & Snook 1927: 368, fig. 322. — Garth 1958: 196, pl. L, fig. 4, pl. 20, fig. 2. — Garth & Abbott 1980: 598, fig. 25.5. — Hart 1982: 186, fig. 74. — Ricketts *et al.* 1985: 298. — Jensen 1995: 23, fig. 15. — Kuris *et al.* 2007: 641.

Diagnosis. Rostrum deeply notched, outer margins of rostral horns subparallel. Carapace oval, with 2 gastric, one cardiac, one intestinal tubercles; tuft of setae preceding each tubercle, hooked setae on rostrum, sides of carapace. Lateral projections of carapace broad, anterior one large, wing-like; posterior projection smaller with anterior end lobiform, posterior end spiniform. Hepatic tooth broad, completely joined to postorbital tooth. Basal article of antennae bearing tooth at anteroexternal angle, flagellum not reaching end of rostrum. Chelipeds large, strong; merus triangular, with superior crest bearing 3 or more teeth; carpus with 2 longitudinal crests, propodus with

superior crest, inferior margin with prominent posterior lobe; male chela with fingers widely gaping, large tooth near base of dactylus; female fingers not gaping. Pereopods 2–5 stout, with small tubercles, dactyls with sharp apices. Male carapace length 35.5 mm, width 26.5 mm; female carapace length 33.5 mm, width 25.0 mm.

Color in life. Greenish brown, yellow or reddish, ventral side lighter (Garth 1958).

Habitat and depth. Docks, pilings, among rocks, algae, eel grass beds; intertidal zone to 140 m.

Range. Attu I., Aleutian Is. to Monterey Bay, California, but usually north of San Francisco. Type locality Puget Sound, Washington.

Remarks. *Pugettia gracilis* usually has little material attached to its dorsal surface.

***Pugettia producta* (Randall, 1840)**

(Fig. 48D, Pl. 12B, C)

Epialtus productus Randall, 1840: 110. — Holmes 1900: 22. — Rathbun 1904: 17. — Weymouth 1910: 28, fig. 93. — Schmitt 1921: 201, text fig. 124. — Johnson & Snook 1927: 367, fig. 318.

Pugettia producta. — Rathbun 1925: 167, pls. 56–57, text figs. 62, 633. — Garth 1958: 188, pl. L, fig. 2, pl. 19. — Garth & Abbott 1980: 598, fig. 25.4. — Mastro 1981: 64. — Hart 1982: 184, fig. 73. — Wicksten & Bostick 1983: 364. — Ricketts *et al.* 1985: 134, fig. 106. — Jensen 1995: 22, fig. 16. — Hendrickx 1999: 110, pl. 2B. — Kuris *et al.* 2007: 641.

Diagnosis. Rostrum deeply notched, with hooked setae on horns. Carapace smooth, sides subparallel, with large hepatic tooth broadly but distantly joined with postorbital; large tooth midway between anterolateral tooth, posterior margin; posterior margin with strong convexity in middle. Newly-settled crabs bearing tufts coarse setae on lateral margins of carapace. Small preorbital, postorbital tooth. Male chelipeds stout, shorter than pereopods 2, carpus with outer ridge, hand long, narrow but inflated in largest individuals; fingers slender, bent downward, curved inward; inner margins dentate, gaping in largest males; female cheliped more slender. Pereopods 2–5 decreasing in length posteriorly, dactyls slender, with spinules. Male carapace length 71 mm, width 62 mm; female 69 mm, width 59 mm.

Color in life. Camouflaged like algae; light olive-green to almost black. Ventral surface yellowish in juveniles, females; brilliant red in mature males. Color may depend on age, nearness to next molt and uptake of pigments from algal food. The color notes are from crabs from Pillar Point, San Mateo County, California.

Habitat and depth. Wharves, docks, pilings, kelp beds, tide pools, eel grass flats, and beds of brown algae (especially *Egregia* spp.); intertidal zone to 74 m, but usually shallow and near shore.

Range. Prince of Wales I., Alaska to Point Asuncion, Baja California. Type locality "Upper California."

Remarks. *Pugettia producta* is the largest and most easily observed of the kelp crabs. The crab may store bits of algae on the rostrum, and later remove and eat the algae (Mastro 1981). Kelp crabs may move from place to place during the year to feed on algae or mate.

***Pugettia richii* Dana, 1851**

(Fig. 48B)

Pugettia richii Dana 1851: 268. — Holmes 1900: 24. — Rathbun 1904: 173; 1925: 176, text fig. 66. — Weymouth 1910: 30, pl. 4, fig. 11. — Schmitt 1921: 207, pl. 33, fig. 6, text fig. 129. — Johnson & Snook 1927: figs. 322, 324. — Garth & Abbott 1980: 599, fig. 25.6. — Hart 1982: 188, fig. 75. — Jensen 1995: 22, fig. 17. — Hendrickx 1999: 111, pl. 2C. — Kuris *et al.* 2007: 641.

Pugettia richi.—Garth 1958: 193, pl. L, fig. 3, pl. 20, fig. 1.

Diagnosis. Rostrum with long horns, deep notch, hooked setae. Carapace ovate, tuberculate, constricted at base of hepatic tooth, broader in female than in male. Median region of carapace with three anterior tubercles in row, one somewhat anterior to them; rows of hooked setae near lateral tubercles, cardiac, intestinal regions with tubercle each, 2 tubercles on branchial region, posterior margin of carapace markedly convex. Supraorbital tooth acute, directed forward; postorbital tooth acute, triangular; large, slender tooth posterior to postorbital tooth, prominent pointed tubercle on posterolateral margin of carapace, spine on subbranchial region, pterygostomian region with 3–6 small teeth. Flagella of antennae visible near rostrum. Male chelipeds larger, more robust than those of female;

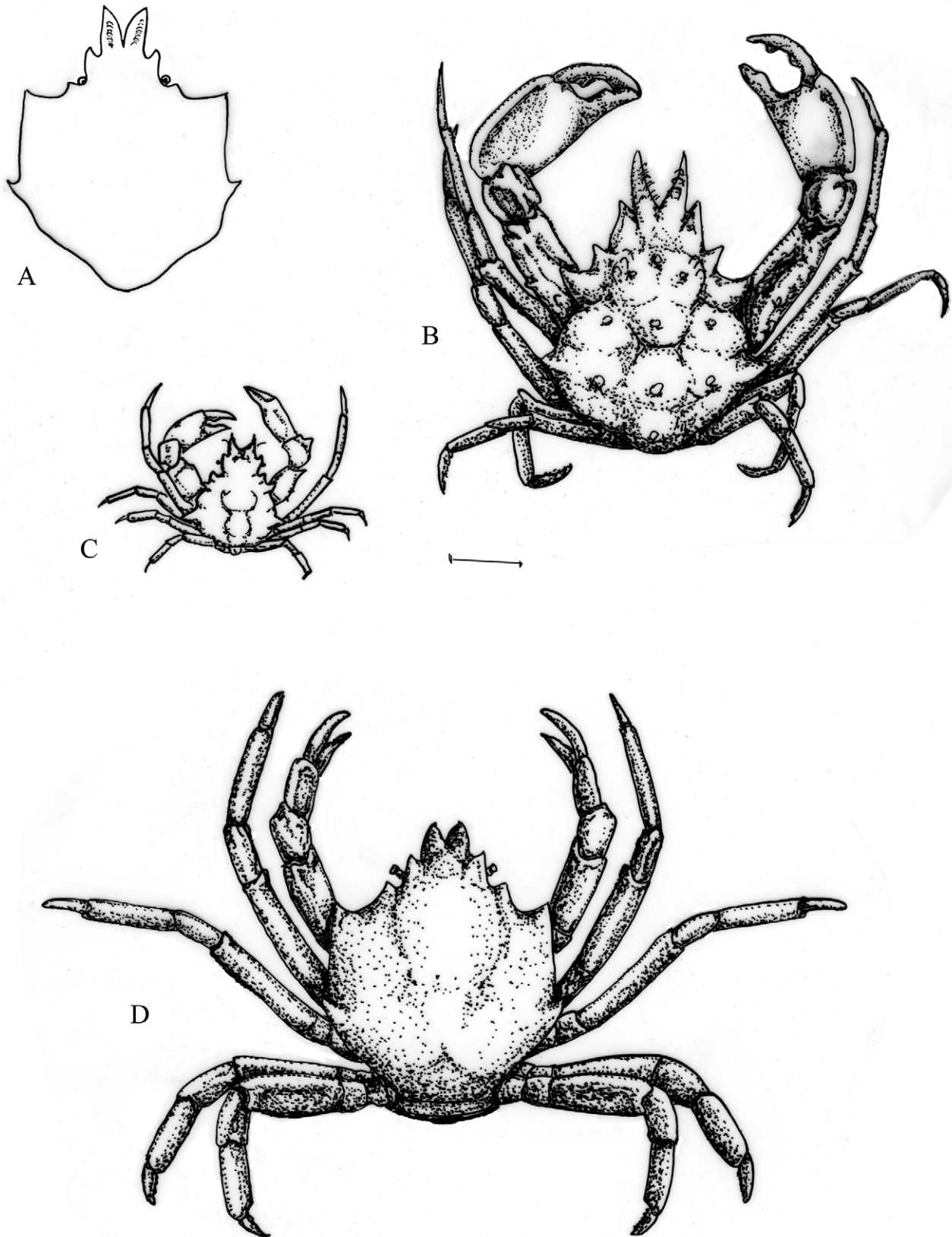


FIGURE 48. Family Epialtidae. A, *Pugettia gracilis* Dana, 1851; carapace. B, *Pugettia richii* Dana, 1851; adult male. C, *Pugettia dalli* Rathbun, 1893. D, *Pugettia producta* (Randall, 1839); juvenile. Scale =10 mm. A, after Garth, 1958; B, drawn from crab from Monterey Bay; C, drawn from crab from Santa Catalina I.; D, drawn from crab from Princeton, San Mateo County.

merus with tubercles, ridge along inner side in adult; carpus with 2 or 3 ridges, especially in adult, hands compressed, fingers gaping in adult. Female chelipeds more slender, fingers not gaping. Pereopods 2–5 subcylindrical, dactyls sharp. Male carapace length 44 mm, width 36 mm; female 33 mm, width 26.5 mm.

Color in life. Bright to dark red, matching red algae. Pereopods 2–5 banded with dark red, tan. The color notes are from crabs from Monterey Bay, California.

Habitat and depth. Tide pools, docks, pilings, among algae or sea grasses; intertidal zone to 98 m but usually in shallow areas near shore.

Range. Prince of Wales I., Alaska to San Geronimo I. and Asuncion Bay, Baja California. Type locality "California", possibly San Diego or San Francisco, from which Dana received specimens.

Remarks. *Pugettia richii* decorates heavily throughout its lifespan. The crab may be covered by pieces of algae, hydroids or bryozoans, often with long "streamers" of material projecting forward from the rostrum.

***Pugettia venetiae* Rathbun, 1924**

(Fig. 49D, E)

Pugettia venetiae Rathbun, 1924: 2; 1925: 180, pl. 59, figs. 57, text figs. 68, 69. — Garth 1958: 204, pl. L, fig. 5, pl. 21, fig. 2. — Hendrickx 1999: 113, fig. 66.

Diagnosis. Rostral horns long, acute, divergent. Carapace tuberculate, spinous; with 4 gastric, 2 lateral, one cardiac, 3 intestinal, 4 or 5 branchial tubercles, one branchial, 2 hepatic lateral spines. Postorbital spine slender. Supraocular eave less expanded over eye than in related species. Preorbital spine large, directed forward, antennal spine visible in front of it. Basal antennal article having antero-external spine, 2 smaller spines. Male chelipeds about as long as carapace, ischium with spine on inner margin, merus with spines on inner, upper, outer margins; carpus with 2 spines on inner margin, 4 on outer margins, palm with spinules on upper surface, fingers narrow, deflexed, toothed, narrow gape at base. Female cheliped shorter, similar, fingers not gaping. Pereopods 2–5 subcylindrical, dactyls with two rows sharp spinules. Much of dorsal surface of both sexes setose. Male carapace length 16.2 mm, width 10.7 mm; female length 23.9 mm, width 17.3 mm.

Color in life. Rostrum, frontal region, chelae dull orange. Carapace gray-tawny brown with white, lavender marks. Fingers of chela purple-brown at base, becoming orange-red, fading to white at apices. Pereopods 2–5 brownish orange, banded. Ventral surface dull lilac on abdomen, orange on front (Garth 1958).

Habitat and depth. Sand, shell, rock, 9–120 m, usually at 90 m or less.

Range. San Miguel I., California to Magdalena Bay, Baja California. Type locality off Newport Beach, California.

Remarks. Specimens of *P. venetiae* are unusual for spider crabs in being relatively clean of attached material.

***Taliepus* A. Milne-Edwards, 1878**

***Taliepus nuttallii* (Randall, 1840)**

(Fig. 49 F, Pl. 10 F)

Epiplatys nuttallii Randall, 1840: 109. — Holmes 1900: 23. — Rathbun 1904: 173. — Schmitt 1921: 202, text fig. 125. — Johnson & Snook 1927: 367, fig. 319.

Taliepus nuttallii. — Rathbun 1925: 162, pls. 50, 51; text fig. 61. — Garth & Abbott 1980: 597, fig. 25.3. — Ricketts *et al.* 1985: 136. — Jensen 1995: 24, fig. 24.

Taliepus nuttallii. — Garth 1958: 208, pl. L, fig. 8; pl. 22. — Hendrickx 1999: 117, pl. 2D, 3A, B.

Diagnosis. Rostrum with convergent sides, inclined downward, with triangular notch at apex. Carapace ovate, convex, smooth. No preorbital tooth, postorbital tooth small. Antennae not reaching end of rostrum. Male cheliped stout, unarmed, fingers gaping, margins of fingers with row of low teeth; female cheliped more slender, fingers not gaping. Pereopods 2–5 stout, subcylindrical, dactyls strongly curved, with 2 rows of spinules on dactyls. Seven free abdominal segments in both sexes. Male carapace length 106 mm, carapace width 92 mm; female approximately half this size.

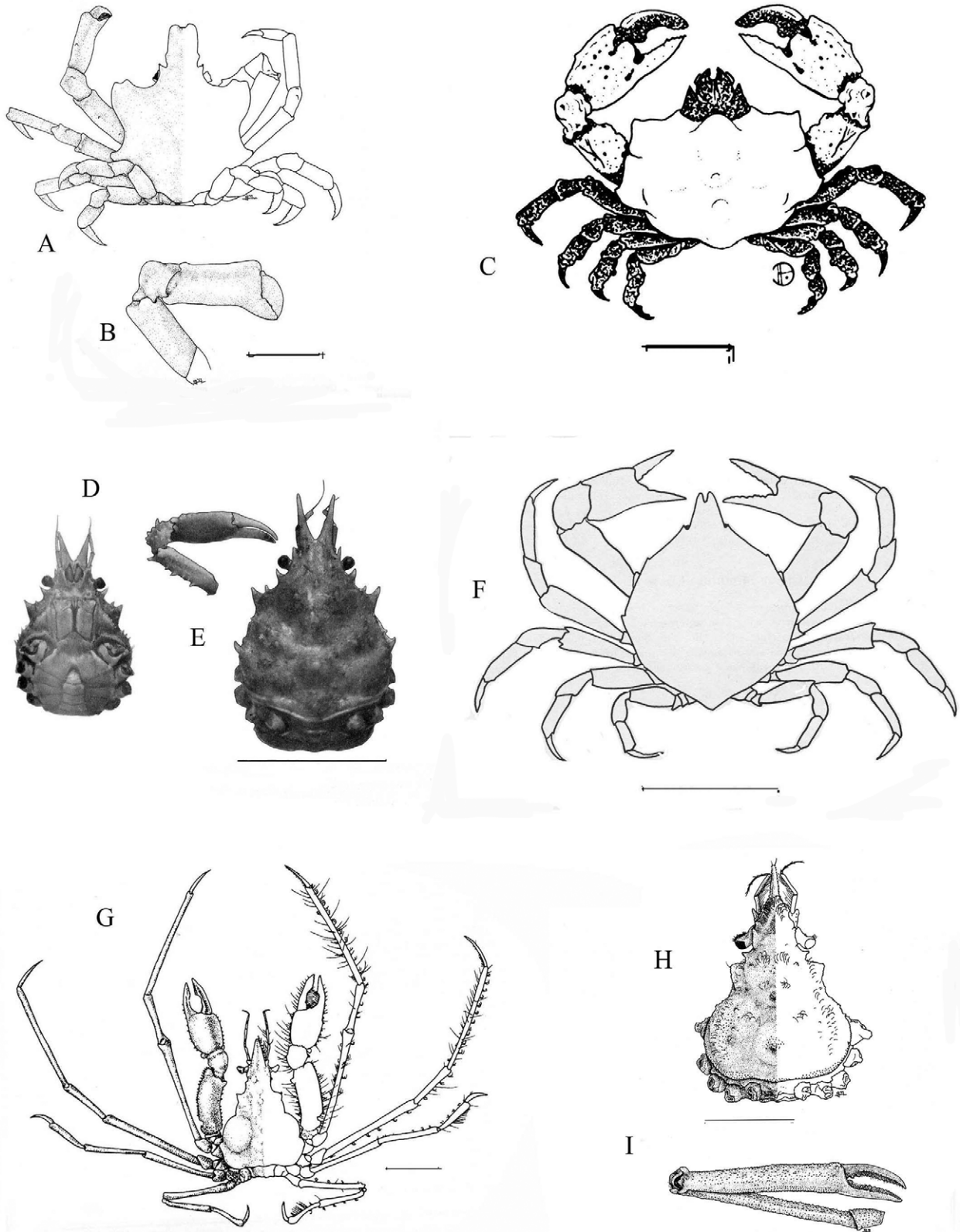


FIGURE 49. Families Epialtidae and Inachidae. A, B, *Epialtoides hiltoni* (Rathbun, 1923); A, dorsal view; B, cheliped. C, *Mimulus foliatus* Stimpson, 1860; adult male. D, E, *Pugettia venetiae* Rathbun, 1924; D, ventral view; E, dorsal view of cephalothorax with detached cheliped. F, *Taliepus nuttalli* (Randall, 1839). G, *Ericerodes hemphillii* (Lockington, 1877); adult male. H, I, *Erileptus spinosus* Rathbun, 1893; H, dorsal view of cephalothorax; I, cheliped. Scales: A = 5mm; C–E, G–I = 10 mm. F = 60 mm. A, B, H, I from Hendrickx 1999; C from Wicksten 1983c, D, E from Rathbun 1925, F, G from Schmitt 1921.

Color in life. Juvenile camouflaged like algae, olive-green to reddish; adults red-brown to dark purple. The color notes are from crabs from Point Fermin, Los Angeles County, California.

Habitat and depth. Rocky shores, kelp beds, especially among brown algae, intertidal to 92 m, but usually less than 50 m.

Range. Santa Barbara, California to Magdalena Bay, Baja California. Type locality "Upper California."

Family Inachidae MacLeay, 1838

Only three species of these, the most spider-like of the spider crabs, are regularly reported from the area. Coelho (2006) revised species of the genus *Podochela* and changed the generic classification of one local species. The Panamic arrow crab, *Stenorhynchus debilis* (Smith, 1871), was reported from Huntington Beach and Santa Catalina I. in 1998, during an El Niño period and might be expected to return again during periods of unusually warm waters (Montagne & Cadien 2001).

Key to species of family Inachidae

1. Merus of outer maxilliped as broad as ischium, palp of moderate size. Carapace with supraocular spine, surface spinous. Leg span rarely more than 30 mm, found on shell hash, gravel or coarse sand. *Erileptus spinosus*
- Merus of outer maxilliped narrower than ischium, palp large. Carapace without supraocular spine, surface with tubercles. Leg span often more than 30 mm, usually found on pilings, among algae or on rocks 2
2. Only one tubercle on first abdominal segment. No strap-shaped hepatic spine *Ericerodes hemphilli*
- Two tubercles on first abdominal segment. Strap-shaped hepatic spine. *Podochela lobifrons*

Ericerodes Rathbun, 1897

Ericerodes hemphilli (Lockington, 1877)

(Fig. 49G, Pl.11)

Microrhynchus hemphillii Lockington, 1877a: 30.

Podochela hemphillii. — Holmes, 1900: 17. — Rathbun 1904: 1717, pl. 10, fig. 2; 1925:

49, pl. 18, pl. 209, fig. 2. — Weymouth 1910: 26, pl. 2, fig. 6. — Schmitt 1921: 195, text fig. 120.

Podochela hemphilli. — Garth 1958: 104, pl. H, fig. 6, pl. 7. — Ricketts *et al.* 1985: 420. — Jensen 1995: 25, fig. 26. —

Hendrickx 1999: 28, fig. 15. — Kuris *et al.* 2007: 641.

Ericerodes hemphilli. — Coelho 2006: 7.

Diagnosis. Rostrum broad to acutely triangular, variable in length, ending in spine, with hooked setae. Carapace pyriform; gastric region prominent, rounded, bearing hooked setae; hepatic regions bearing 2 pointed tubercles; cardiac region separated by shallow grooves from branchial, bearing prominent elevation; branchial regions flattened or raised. No supraorbital tooth or spine, no tooth at posterior margin of orbit but sometimes small one short distance behind orbit. Eyestalk constricted at middle. Basal antennal article with longitudinal ridge on posterior 0.5–0.66 with groove on either side. Male with robust chelipeds, merus incurved, having outer spiny ridge; carpus with posterior spine on upper side, hand oblong, palm inflated, fingers gaping at base. Female chelipeds smaller, slender, fingers nearly straight. Pereopods 2–5 long, slender, furnished with hooked setae, dactyls slender, curved. Abdomen of male six-segmented, narrow; female abdomen with five segments, rounded; female sternum, ventral surface of abdomen concave. Male carapace length 34 mm, width 22.4 mm; 18.5 mm, width 11.5 mm.

Color in life. Dorsal surface of carapace pale olive buff with band of carmine along each side, two patches of carmine on cardiac region, two smaller patches on intestinal region. Chelipeds yellowish cream. Pereopods 2–5 marked with carmine. Lower body surface creamy white (Garth 1958).

Habitat and depth. Docks, pilings, among low-growing algae on rocks, sand; shore to 166 m but usually at 100 m or less.

Range. Monterey Bay, California to Magdalena Bay, Baja California; Angel de la Guardia I., Gulf of California to Cape Corrientes, Colombia. Rarely reported north of San Miguel I., California. Type locality San Diego Bay, California.

Remarks. *Ericerodes hemphilli* frequently is covered by algae, hydroids or bryozoans which may be attached perpendicular to the axis of pereopods 2–5. The crab may store edible material among the hooked setae and then remove and eat it later.

***Erileptus* Rathbun, 1893**

***Erileptus spinosus* Rathbun, 1893**

(Fig. 49 H, I)

Erileptus spinosus Rathbun, 1893: 227. — Holmes 1900: 21. — Rathbun 1904: 171, pl. 10, fig. 1; 1925: 68, pls. 212, 213, text fig. 18. — Weymouth 1919: 27, pl. 3, fig. 7. — Garth 1958: 91, pl. E, fig. 8, pl. 5, fig. 2. — Wicksten 1980c: 361. — Jensen 1995: 26, fig. 28. — Hendrickx 1999: 12, fig. 5.

Anasimus spinosus.—Schmitt 1921: 196, text figs. 121a, b.

Diagnosis. Rostrum strongly sexually dimorphic. Male with slender, spinulose rostrum, about 0.5 times length of postfrontal portion of carapace. Carapace spinulose: 2 spines on median line, one long spine on branchial region with small spine in front of it, 2 on margin; spine on margin of hepatic region, 2 very small ones arranged transversely on gastric region; slender spine on orbital arch. Prominent supraorbital spine, postorbital spine small, distant from eye. Abdomen with spine on segment 1. Chelipeds nearly 3 times as long as carapace, granulate; merus with one spine at anterior margin, hand slender, slightly flattened vertically, fingers gaping. Pereopods 2–5 slender, decreasing regularly in length from anterior to posterior. Female with slender, upcurved, spinulose rostrum. Carapace with 2 median spines, 2 spines on each branchial region, spine on each protogastric region, lateral margins spinulose, surface pubescent. Prominent supraorbital spine. Abdomen with spine on segment 1, smaller spine on segment 2. Chelipeds weak, margins of merus spinulose, slender spine near carpus, hand slender, granulate, fingers in contact. Pereopods 2–5 slender, pubescent, decreasing in length from anterior to posterior. Dactyls of pereopods 2–5 slender, spinulose in both sexes. Male carapace length 11 mm, female 5.7 mm

Color in life. Dull brown to grayish. The color notes are from crabs taken at Santa Catalina I.

Habitat and depth. Usually shelly sand, often in steeply sloping areas, 4–554 m.

Range. San Miguel I., California to Magdalena Bay, Baja California; Gulf of California from Rocky Point, Sonora south to Cardones I., Panama. Type locality off San Diego, California.

Remarks. This small crab is especially common on "shell hash" bottoms along the islands of southern California.

***Podochela* Stimpson, 1860**

***Podochela lobifrons* Rathbun, 1893**

(Fig. 50A, B)

Podochela (Coryrhynchus) lobifrons Rathbun, 1893: 226.

Podochela lobifrons. — Garth 1958: 116, pl. H, fig. 1; pl. 8, fig. 1. — Hendrickx 1999: 34, fig. 19.

Podochela barbarensis Rathbun, 1924: 1; 1925: 54, pl. 20, figs. 3, 4, text fig. 13.

Diagnosis. Rostrum long, slender, 0.5–0.6 postrostral carapace length. Carapace setose, cardiac region with large conical elevation, 2 median gastric tubercles, prominent strap-shaped spine on hepatic region, small, similar one on pterygostomial ridge, small postorbital spine, orbital arch finely spinulose. Antenna overreaching rostrum, movable articles of peduncle slender, basal article with spinulose outer margin. Two blunt median tubercles on abdominal segment 1. Chelipeds spinulose, spine at outer distal margin of merus, knob on outer surface of carpus, chela widest behind middle of palm, one tooth on finger of cheliped at middle of gape. Pereopod 2 as much as 3 times carapace length, very slender, with slender dactyl. Pereopods 3–5 with curved dactyls. Male carapace length 21.5 mm, female 18.3 mm.

Color in life. Brown, chelipeds banded with red, fingers of the chelae mostly cream with patches of red. The color is based on a crab photographed in the La Jolla Submarine Canyon, San Diego County, California.

Habitat and depth. Sand, rocks, among alge, 2–230 m.

Range. Point Mugu, California to San Cristobal Bay, Baja California; Angel de la Guardia I. to outer Gorda Bank, Gulf of California. Type locality off Abrejos Point, Baja California.

Remarks. In southern California, *P. lobifrons* usually occurs deeper than *E. hemphilli*. Freshly caught crabs often are coated with mud, foraminiferans and debris.

According to the revision of the species of *Podochela* by Coelho (2006), it seems that this species should be transferred to the genus *Coryrhynchus* Kingsley, 1879, but the species is not mentioned in this work. Rathbun (1893) used *Coryrhynchus* as a subgenus without explanation. Specimens should be examined to determine if a change in the generic designation is warranted.

Family Inachoididae Dana, 1851

Members of the family Inachoididae live on sand, mud or pilings in harbors. Although proposed as a distinct family by Dana (1851), the group had been considered as part of the family Majidae until a revision by Drach & Guinot (1983) provided evidence to support their differentiation from other majoid families. Inachoidids have the lateral edges of the carapace set in a groove of the pleural (gill chamber) walls, with the external part visible as pleural plates. The first pleonite (abdominal segment 1) is jointed to the carapace. The pereopods are relatively long and slender. There are nine genera of this family along both coasts of the Americas, but only one species is reported from Oregon to northern Baja California.

Pyromaia Stimpson, 1871

Pyromaia tuberculata tuberculata (Lockington, 1877)

(Fig. 50C, D)

Inachus tuberculatus Lockington, 1877: 30.

Dasygius tuberculatus. — Holmes 1900: 27. — Rathbun 1904: 172, pl. 10, figs. 3, 3a, text fig. 92. — Weymouth 1910: 27, pl. 3, fig. 8.

Inachoides tuberculatus. — Schmitt 1921: 199, text figs. 123a. — Johnson & Snook 1927: 365, fig. 317.

Pyromaia tuberculata. — Rathbun 1925: 133, pl. 40, fig. 3; pl. 218, figs. 1–4. — Garth 1958: 85, pl. E, fig. 7, pl. 6, figs. 1, 2. — Ricketts *et al.* 1985: 334. — Jensen 1995: 25, fig. 27. — Hendrickx 1999: 75, fig. 42 (extensive synonymy). — Lemaitre *et al.* 2001: 771. — Kuris *et al.* 2007: 641.

Pyromaia tuberculata tuberculata. — Garth & Abbott 1980: 597, fig. 25.1.

Diagnosis. Rostrum acute, apices of postorbital spines pointing anteriorly, upper margin of orbit prominent but without supraocular spine. Basal antennal article with outer margin prolonged into slightly incurved spine. Carapace broadly triangular, pear-shaped, convex; surface granulate, tuberculate, with fine pubescence, especially in small individuals. Male chelipeds short, stout, granulate; chela inflated, fingers nearly as long as palm, gaping at base; female chelipeds more slender, margins of hand parallel, fingers slightly gaping. Pereopods 2–5 slender, similar, diminishing in length from anterior to posterior, dactyls moderately curved, almost smooth. Male carapace length 15.7 mm, carapace width 12.3 mm, female not reported.

Color in life. Dull green-brown, ventral surface dirty white. The color notes are from a crab from Princeton Harbor, San Mateo County, California.

Habitat and depth. Pilings, sandy bottoms, sand, shell, among seaweeds, extreme low intertidal zone to 415 m.

Range. Tomales Bay, California to Cape Corrientes, western Colombia. Introduced into Japan, New Zealand, and Australia (Lemaitre *et al.* 2001). Type locality mouth of San Diego Bay, California.

Remarks. *Pyromaia tuberculata* may be found almost devoid of a covering or may be densely covered by small bits of algae. The crab can move with great agility on sand. Small ones may associate with the sea star *Pisaster brevispinus* (Stimpson, 1857). Garth (1958) recognized two subspecies, *P. tuberculata mexicana* and *P. tuberculata tuberculata*. The typical subspecies is the one present in the area of coverage. Hendrickx (1990: 79) considered that this division was unjustified.

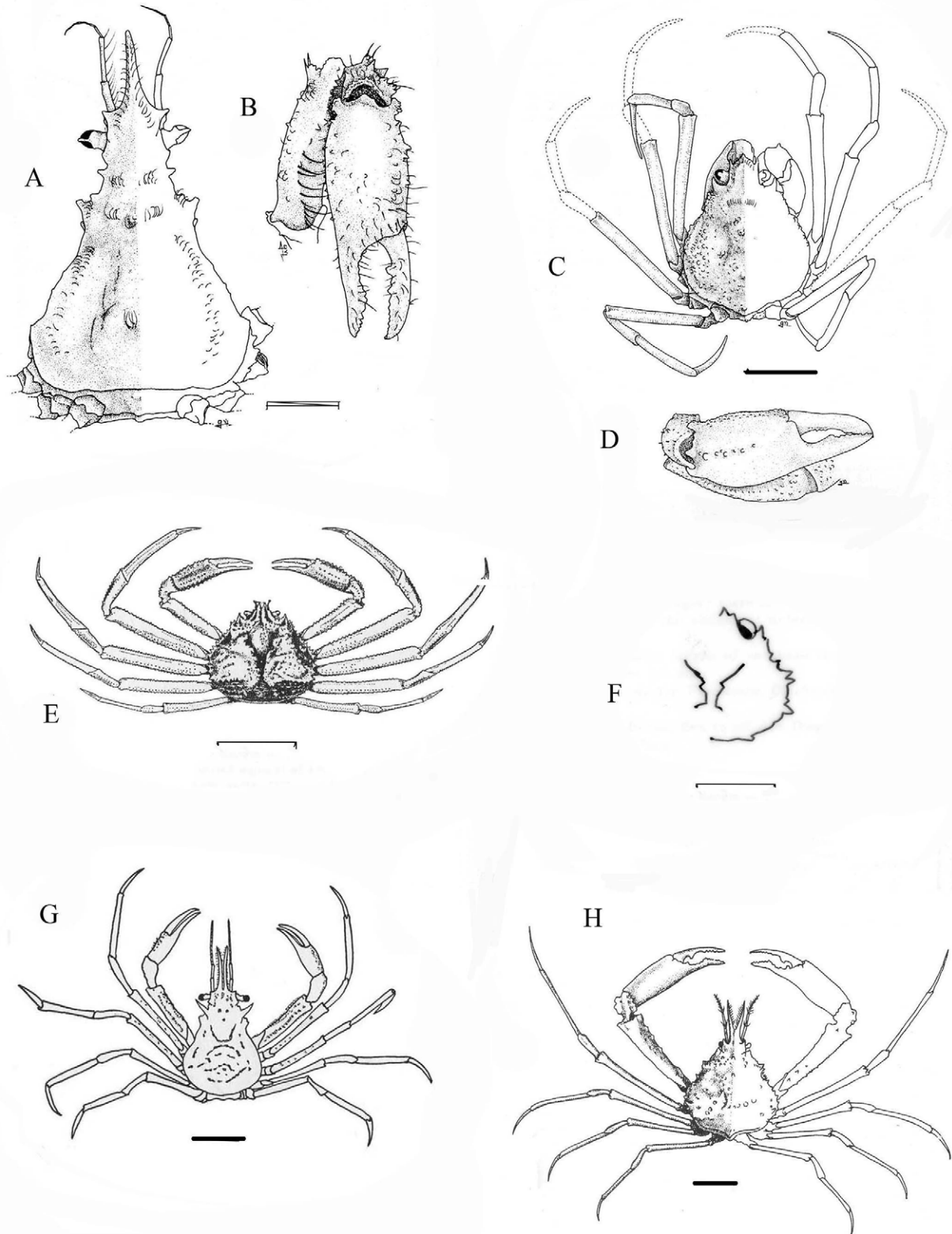


FIGURE 50. Families Inachidae, Inachoididae, Oregoniidae and Pisidae. A, B, *Podochela lobifrons* Rathbun, 1893; A, cephalothorax in ventral view; B, cheliped. C, D, *Pyromaia tuberculata* (Lockington, 1877); C, dorsal view, D, cheliped. E, *Chionoecetes tanneri* Rathbun, 1893. F, *Chionoecetes angulatus* Rathbun, 1893; dorsal view of right side of carapace. G, *Oregonia gracilis* Dana, 1851; H, *Chorilia longipes* Dana, 1851. Scales: A, B = 5 mm, C, D, G=10 mm, H =20 mm, E, F = 37 mm. A-D from Hendrickx 1999, E, G, H from from Schmitt 1921; F after Garth 1958.

Family Oregoniidae Garth, 1958

Confined to the northern hemisphere, oregoniids inhabit cold temperate, boreal and deep-sea environments. Barry *et al.* (1996: 1746) reported *Chionoecetes bairdi* Rathbun, 1924 from the Monterey Submarine Canyon. This species has not been reported previously from anywhere south of Washington. If this identification is correct, this record constitutes a significant southern range extension for the species. Garth (1958: pl. 15) and Jensen (1995: fig. 11) illustrated this species.

Key to species of family Oregoniidae

1. Carapace longer than broad, rostrum elongate *Oregonia gracilis*
- Carapace either broader than long, or very little longer than broad; rostrum short 2
2. Interspace between branchial regions of carapace deep. Two small subequal spines at curve made by intersection of two dorsal branchial ridges *Chionoecetes tanneri*
- Interspace between branchial regions of carapace shallow. Large spine at angle made by intersection of two dorsal branchial ridges *Chionoecetes angulatus*

Chionoecetes Kröyer, 1838

Chionoecetes angulatus Rathbun, 1924

(Fig. 50F)

Chionoecetes angulatus Rathbun, 1894: 76 (part). — Rathbun 1925: 247, pls. 90, 91. — Garth 1958: 159, pl. I, fig. 7; pl. 16, fig. 1.

Chionoecetes tanneri. — Rathbun 1894: 76 (part).

Diagnosis. Rostrum small, teeth wide and inclined upward. Carapace broad, spinulose, pubescent, lateral margins partially concealed by expanded branchial regions; space between branchial regions shallow. Dorsal ridges of branchial region converging in straight lines, meeting in acute angle marked by large spine. Male cheliped longer than that of female; palm inflated, fingers narrow, curved. Pereopods 2–5 flattened, meri little dilated; dactyls long and slender. Male carapace length 24.6 mm, width 23.3 mm; female 26.4 mm, width 24.8 mm.

Color in life. Not reported.

Habitat and depth. Green mud, fine black sand; 90–3000 m but usually on continental slope, depth greater than 200 m.

Range. Bering Sea off Pribilof Is., Alaska to northwest of Cape Blanco, Oregon. Type locality south of Pribilof Is.

Chionoecetes tanneri Rathbun, 1894

(Fig. 50E, Pl. 10E)

Chionoecetes tanneri Rathbun, 1894: 76, pl. 4, figs. 1–4 (part); 1904: 174; 1925: 243, pls. 88, 89, 234. — Holmes 1900: 40. — Weymouth 1910: 35, pl. 7, fig. 19. — Schmitt 1921: 210, text fig. 131. — Garth 1958: 156, pl. I, fig. 8; pl. 16, fig. 2. — Hart 1982: 196, fig. 79. — Hendrickx 1999: 49, pl. 1A, C.

Diagnosis. Rostrum short, wide space between horns, horns slightly upturned, hooked setae present in newly-settled juvenile only. Carapace broad, swollen at branchial regions, spinous; space between branchial regions deep. Outer spine of branchial row as large as outer spine of transverse row, directly in front of it, another row of spines forming lateral supramarginal border of branchial region; spines continuing of pterygostomial region, branchial region; irregular row of small spines crossing gastric region. Orbits, outer margin of postorbital teeth, inferolateral, posterior margins of carapace armed with spinules. All spinules may be blunt in very large crabs. Male cheliped much longer than that of mature female, palm swollen, fingers long, curved. Pereopods 2–5 flattened, armed with spines, dactyls long, flat. Male carapace length 31 mm, width 29 mm; female 31 mm, width 29.1 mm.

Color in life. Bright scarlet, apices of appendages yellow. The color notes are from a crab trapped off San Clemente I., California.

Habitat and depth. Green mud, fine gray sand, 54–1960 m but usually between 200–500 m on continental slopes; may migrate vertically along bottom during year.

Range. Bering Sea to off Coronado Is., Baja California. Type locality Gulf of Farallones, California.

Remarks. The Tanner crab is edible and is the object of a fishery off Oregon. Species of *Chionoecetes* have a relatively thin and flexible exoskeleton in relation to their musculature, which allows easier extraction of their meat than in other spider crabs.

***Oregonia* Dana, 1851**

***Oregonia gracilis* Dana, 1851**

(Fig. 50G)

Oregonia gracilis Dana, 1851: 270. — Holmes 1900: 19. — Rathbun 1904: 171; 1925: 71, pls. 24, 25, text figs. 19, 20. — Schmitt 1921: 198, text figs. 122a, b. — Johnson & Snook 1927: 365, fig. 315. — Garth 1958: 136, pl. I, fig. 2, pl. 10, pl. 11, fig. 1. — Hart 1982: 176, fig. 69. — Ricketts *et al.* 1985: 298, 334. — Jensen 1995: 20. — Komai & Yakovlev 2000: 309, fig. 2 (extensive synonymy). — Kuris *et al.* 2007: 641.

Diagnosis. Rostrum with two long, slender contiguous spines, length, shape of rostral spines variable; and rows of hooked setae. Carapace subtriangular, setose, covered by prominences, broader in female than male. Prominence on anterior side of eye peduncle. Postorbital spine remote from eye, acute, directed outward. Septum between first antennae produced into spine. Chelipeds of male robust, those of female more slender, exceeding length of pereopods 2–5, merus subcylindrical, tuberculate; carpus rounded, hand long, slender; fingers slender, smooth, incurved. Pereopods 2–5 cylindrical, decreasing in length posteriorly, dactyls long, tipped by claws. Male carapace length 65.7 mm, width 39 mm; female 27.5–44.6 mm, width 165 mm.

Color in life. Tan or gray, red mark on chela (Garth 1958).

Habitat and depth. Among algae, eel grass and pilings, intertidal zone to 390 m but usually subtidal in California and Oregon.

Range. Off Choshi, Chiba Prefecture, Japan to Comander Is.; Bristol Bay, Bering Sea to Monterey Bay, California; rarely found south of Point Arena, California. Type locality Puget Sound, Washington.

Remarks. *Oregonia gracilis* decorates heavily with bits of algae, hydroids, bryozoans, sponges and wood chips. Komai & Yakovlev (2000) noted that there are two morphs of this species, one with long chelipeds and pereopods 2–5 and the other with short chelipeds and pereopods 2–5 but with longitudinal rows of long stiff setae on the propodi of those pereopods. The two morphs occur sympatrically and thus are considered to belong to the same species. These authors also note that there is considerable sexual dimorphism in the species. Females have relatively shorter rostral spines and more dense setae on the dorsal surface of the carapace than do the males, as well as differing in the shape of the abdomen and the chelipeds.

Family Pisidae Dana, 1851

Pisids generally are found on rocky sea floors but *Loxorhynchus* spp. may cross open sand or areas with worm tubes, especially at night. The group includes some of the most heavily decorated of the spider crabs and *Loxorhynchus grandis*, the largest crab in the area. Ng *et al.* (2008: 102) and De Grave *et al.* (2009) considered this group to be a subfamily of the Epialtidae. They noted that either the pisids and epialtids have poorly developed or no orbits, yet commented that "the need to separate obviously related genera...does seem logical." The pisids, if one includes "unusual genera" (Ng *et al.* 2008: 98), seem to be a heterogeneous group. Garth (1958: 249) noted that the shape of the male first pleopod, a diagnostic feature of many brachyuran families, is highly diverse in the pisids. The shape of the first maxilliped, broad basal segment of the antenna and bifurcate rostrum seem to be consistent within the group in the northeastern Pacific (Hendrickx & Cervantes, 2003).

Northeastern Pacific pisids generally are setose, at least as juveniles. Many species possess club-shaped setae on the carapace and pereopods. The carapace has lateral spines and raised knobs, bosses or prominences. Their pereopods are relatively more heavily calcified than those of the inachids.

Key to species of family Pisidae

1. Body, pereopods flattened, legs with small lateral spines. Spine present on orbital margin between supraocular eave and postocular cup *Herbstia parvifrons*
- Body, pereopods not flattened, legs with or without spines. No spine on orbital margin between supraocular eave and postocular cup 2
2. Rostrum bifid for not more than half its length. Pereopods 2–5 with broad, flat segments *Pelia tumida*
- Rostrum bifid for more than half its length. Pereopods 2–5 with rounded segments 3
3. Rostrum with slender horns. Continental shelf and slope *Chorilia longipes*
- Rostrum with broad horns. Intertidal to continental shelf. 4
4. Rostrum flat, horizontal; horns shaped like feathers of arrow *Scyra acutifrons*
- Rostrum deflexed; horns not shaped like feathers of arrow 5
5. Carapace with many small spines; 2 spines on hepatic region. Front strongly deflexed. Adult male, female with few setae and without camouflaging material *Loxorhynchus grandis*
- Carapace with large tubercles or raised areas; one spine on hepatic region. Front less strongly deflexed. Adult male, female setose, adult male usually with camouflaging material on rostrum only, female covered by material *Loxorhynchus crispatus*

Chorilia Dana, 1851

Chorilia longipes Dana, 1851

(Fig. 50H, Pl. 12D)

Chorilia longipes Dana, 1851: 269. — Rathbun 1904: 174; 1925: 203, pl. 224, figs. 1–3. — Weymouth 1910: 33, pl. 6, fig. 16. — Schmitt 1921: 209, text fig. 130. — Garth 1958: 263, pl. P, figs 45; pl. 30. — Hart 1982: 180, fig. 71. — Jensen 1995: 2, fig. 19.

Hyastenus (Chorilia) longipes. — Holmes 1900: 33.

Chorilia longipes turgida Rathbun, 1924: 3. — Garth 1958: 263. — Wicksten 1980c: 363. — Hendrickx 1999: 120, fig. 69, pl. 6A.

Diagnosis. Rostrum almost half as long as remainder of carapace, horns tapering. Carapace covered by numerous tubercles and spines; largest spine at widest part of carapace at margin of branchial region; 2 median gastric spines, ridge or tubercle on hepatic region. Slender preorbital spine. Basal antennal segment with 2 spines on outer margin, followed posteriorly by triangular tooth. Chelipeds massive; merus rough and with spines and tubercles; carpus also rough, hand compressed, upper edge thin, finger narrow, gaping in male; dactyl with sub-basal tooth, distal ends of fingers meeting. Pereopods 2 about as long as chelipeds, pereopods 3–5 shorter; merus of each with short sharp point; dactyls slender, curved. Male carapace length 50.4 mm, width 30.2 mm; female 54 mm, width 40 mm.

Color in life. White to reddish or dirty brown. The color notes are from crabs from Monterey Bay, California.

Habitat and depth. Among boulders or on mud, 33–1200 m, usually found at greater depths toward southern end of range.

Range. Off Shumagin Bank, Alaska to Cortez Bank, California; northern Peru. Type locality "Oregon territory."

Remarks. Three subspecies are recognized. Of these, *C. longipes japonica* (Miers, 1879) is reported from temperate waters of the western Pacific, in Japan from Tohoku province south to Sagami Bay and the Korean Channel (Sakai 1965). *Chorilia longipes longipes* Dana has a blunt ridge on the hepatic region; *C. longipes turgida* Rathbun has a spine on the hepatic region. *Chorilia longipes longipes* occurs from Alaska to off Santa Catalina I., California; *C. longipes turgida* had been found from Monterey Bay to off San Diego. The distribution of the typical form seems to be related to colder water temperatures, for the occurrence of this form toward the south is related to zones of upwelling (Garth 1958). Water temperatures either were not reported at all or were reported at the surface when most of these crab specimens were collected. It would be useful to perform a more rigorous correlation analysis between the shape of the hepatic protrusion and the water temperature and geographical location of collection. The geographical distribution of the two supposed subspecies overlaps, so they may in fact be ecophenotypes instead of reproductively isolated populations.

***Herbstia* H. Milne-Edwards, 1834**

***Herbstia parvifrons* Randall, 1840**

(Fig. 52A, Pl. 12F)

Herbstia parvifrons Randall, 1840: 107. — Holmes 1900: 38. — Schmitt 1921: 215, text fig. 135. — Rathbun 1925: 296, pl. 106, text fig. 99. — Garth 1958: 316, pl. 8, fig. 5; pl. 34, fig. 2. — Garth & Abbott 1980: 602, fig. 25.13. — Jensen 1995: 21, fig. 14. — Hendrickx 1999: 124, pl. 4B, D. — Kuris *et al.* 2007: 641.

Rhodia parvifrons. — Rathbun 1904: 175. — Weymouth 1910: 34, pl. 7, fig. 18.

Diagnosis. Rostral horns short, notch shallow. Carapace ovate, tuberculate, flattened, setose, gastric region with 4 inconspicuous tubercles in transverse row, median tubercle on posterior portion; 3–4 small tubercles on cardiac region, 5 on each branchial region; 2 tubercles in transverse line on intestinal area, intestinal area projecting slightly beyond posterior marginal level. Preorbital spine present, acute; 2 small spines at margin of orbit between preorbital, postorbital spines; anterolateral margin of carapace provided with postorbital spine, 5 other spines, several smaller spines above these on posterior margin. Three subhepatic spines, row of 5–6 pterygostomian spinules. First movable segment of antenna short, not reaching rostrum apex. Male cheliped more robust than pereopods 2–5, exceeding length of pereopod 2; female cheliped more slender. Merus with 5 larger spines on superior inner margin, numerous smaller external spines; carpus with 10–11 spinules; hand with 5–6 blunt spines on superoproximal border, male dactyl with ridge in gape, female chela without gape. Pereopods 2–5 elongate, setose; meri with 7–9 spinules on anterior margins; no more than 3 on posterior margins; carpi with single distal spinule; propodi long, unarmed; dactyls spinulose. Male carapace length 33.0 mm, width 30.0; female length 19.5 mm, width 17.1 mm.

Color in life. Tan mottled with dark brown to reddish, legs barred with reddish brown. The color notes are from crabs from Santa Catalina I.

Habitat and depth. Almost always among rocks or rocky rubble, intertidal to 74 m.

Range. Monterey Bay, California to Magdalena Bay, Baja California. Type locality "western America."

Remarks. In its natural habitat, *H. parvifrons* slips into narrow spaces between and under rocks. The crab frequently is covered with small calcareous sponges. Kuris *et al.* (2007) gave the northern range of this species as "Monterey and north" without any records or exact locations. I know of no records of this species from north of Monterey. It is common in rock falls off the islands of southern California.

Holmes (1900) reported *Herbstia camptacantha* (Stimpson, 1871) from San Pedro, San Clemente I. and Santa Catalina I., California, but Garth (1958: 318) determined that these records belong to *H. parvifrons*.

***Loxorhynchus* Stimpson, 1857**

***Loxorhynchus crispatus* Stimpson, 1857**

(Fig. 51A, Pl. 13B, D)

Loxorhynchus crispatus Stimpson, 1857b: 453, pl. 22, figs. 2–4. — Holmes 1900: 30. — Rathbun 1904: 175. — Weymouth 1910: 32, pl. 5, fig. 15. — Schmitt 1921: 213, text figs. 133a b. — Rathbun 1925: 200, pls. 66, 67. — Johnson & Snook 1927: 374, fig. 328. — Garth 1958: 260, pl. P, fig. 3, pl. 27, fig. 2; pl. 28, fig. 1. — Wicksten 1975: 35; 1977b: 122; 1978c: 217; 1979b: 37. — Garth & Abbott 1980: 601, fig. 25.11. — Ricketts *et al.* 1985: 168, fig. 136. — Jensen 1995: 24, fig. 22. — Hendrickx 1999: 140, pl. 5C. — Kuris *et al.* 2007: 641, pl. 320 E.

Diagnosis. Rostrum with more divergent horns than in *L. grandis*, not as deflexed, separated for more than 0.5 length of rostrum, with rows of hooked setae. Carapace somewhat triangular, more rounded in females than males, with few large tubercles: prominent tubercle on cardiac region connected by prominent ridge with tubercle on intestinal region; two tubercles on branchial regions, large tubercle, dome-like prominence on hepatic region; tubercle on anterior, posterior portion of median region; tubercle on either side of anterior median tubercle; row of small blunt tubercles on each median region extending to each rostral horn; in most individuals, all tubercles, with surrounding pile, standing out as discrete masses. Carapace densely covered with pile, with patches of hooked setae in all but oldest mature males. Preorbital spine prominent, subconical. Cheliped of adult male longer than in

female, chela much more massive. In both sexes, cheliped with 3–4 upper tubercles on merus; carpus with small tubercles; fingers of chela curved. Pereopods 2–5 rather short, with hooked setae; pereopod 2 shorter than chelipeds of adult male but longer in female, merus grooved above, dactyls of all legs short, stout. Male carapace length to 196 mm, width to 140; female 105 mm, width 68 mm. (Largest male exceptionally big for this species).

Color in life. Light brown, freshly-molted individuals with dark bands on legs, fingers of chelae white, with red marks in adult male. The color notes are from crabs from Monterey Bay and San Pedro, California.

Habitat and depth. Rocks, jetties, pilings, kelp beds, rocky reefs, worm tube beds; extreme low tidal zone to 200 m.

Range. Orford Reef, Oregon to Natividad I., Baja California, but rarely found north of San Francisco, California. Type locality San Miguel I., California.

Remarks. The moss crab *Loxorhynchus crispatus* is the most heavily decorated crab of California or Oregon. Juveniles camouflage themselves with pieces of algae, bryozoans, sponges, ascidians, hydroids, or whatever is flexible and available (in one instance in Carmel Bay, with leaves from a tree). The decorating behavior remains in adult females but is lost in mature males, which at most decorate the rostrum. Large adults of both sexes also may bear barnacles, tunicates, tubeworms and other organisms that settle on them in situ.

Loxorhynchus grandis Stimpson, 1857

(Fig. 51B, Pl. 13C)

Loxorhynchus grandis Stimpson, 1857a: 85. — Holmes 1900: 29. — Rathbun 1904: 175. — Weymouth 1910: 31, pl. 5, fig. 14. — Schmitt 1921: text figs. 132a, b. — Rathbun 1925: 198, pls. 64, 65, text fig. 80. — Johnson & Snook 1927: 372, fig. 328. — Garth 1958: 257, pl. P, fig. 2; pl. 29. — Wicksten 1979b: 37. — Garth & Abbott 1980: 600, fig. 25.10. — Jensen 1995: 24, fig. 23. — Hendrickx 1999: 141, pl. 5D. — Hobday & Rumsey 1991: 1. — Kuris *et al.* 2007: 641.

Diagnosis. Rostrum slightly longer than broad, much deflexed, horns convex above, below and separated for more than half their length, with rows of hooked setae except in mature adults. Carapace rounded, inflated, covered with small, conical tubercles which may be worn in mature adults; juveniles with abundant hooked setae. Stout spine on margin of hepatic region, another just below margin. Preorbital spine large, often double pointed; postorbital spine subconical, acute. Basal antennal segment with anteroexternal spine, tubercle on outer margin; another on anterior margin at insertion of next segment. Chelipeds of adult male large, tuberculate; hand with palm inflated; female with shorter chelipeds, palm not inflated; chela slender, with narrow fingers in juveniles. Pereopods 2–5 subcylindrical, with few tubercles, propodi with grooves above, dactyls short, stout. Male carapace length 190 mm, width 145 mm; female length 114 mm, width 86 mm.

Color in life. Brown, becoming bluish-gray to chalky white in aging adults; ventral surface white. The color notes are from crabs from San Pedro and Santa Catalina I., California. Stimpson's color notes as given by Garth (1958: 259) surely were of a dead or preserved crab.

Habitat and depth. Rocks, pilings, subtidal sand flats, sand dollar beds; lowest intertidal zone to 125 m.

Range. Cordell Bank, California to Thurloe Head, Baja California. Type locality near San Francisco, California.

Remarks. Juvenile *L. grandis* usually are almost impossible to detect in their natural habitat. A dense coat of bryozoans, sponges, algae, hydroids, and pieces of gorgonians or other materials covers their bodies. As the animals grow and mature, the hooked setae are lost or worn off. Mature males and females do not decorate at all.

Divers have seen adult *L. grandis* congregating into mating "pods" in subtidal areas near the Redondo Submarine Canyon and La Jolla. There is a fishery for them in southern California. *Loxorhynchus grandis* is the largest and heaviest crab found in California.

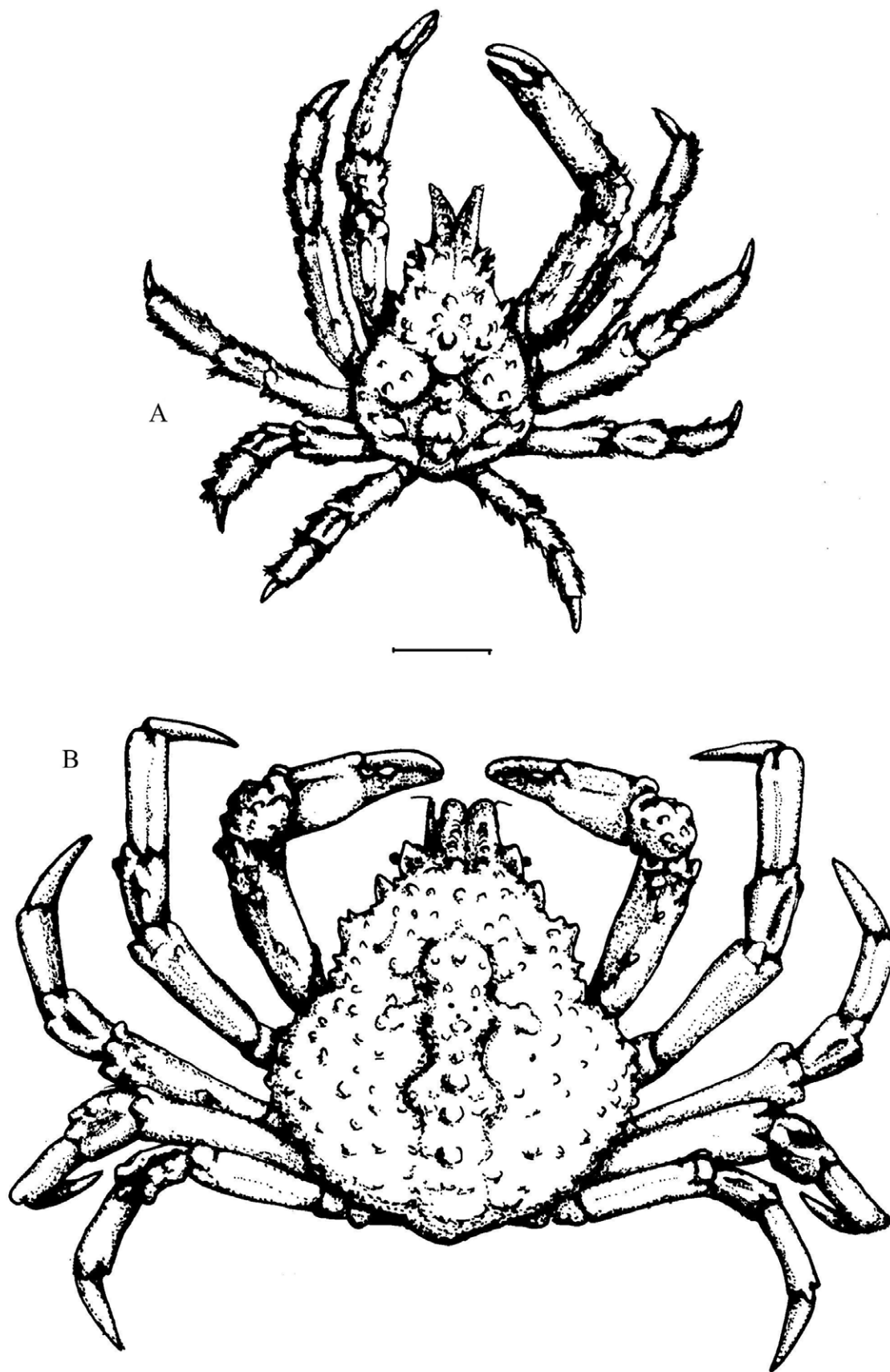


FIGURE 51. Family Pisidae. A, *Loxorhynchus crispatus* subadult. B, *Loxorhynchus grandis* adult female. Scale = 26 mm. A, drawn from crab from Monterey Bay; B, drawn from crab from Santa Catalina I.

***Pelia* Bell, 1835**

***Pelia tumida* (Lockington, 1877)**

(Fig. 52 B,C; Pl. 12E)

Pisoides ? tumidus Lockington, 1877: 30.

Pelia tumida. — Holmes, 1900: 35. — Rathbun 1904: 174. — Schmitt 1921: 211, pl. 34, figs. 5, 6. — Rathbun 1925: 281, pl. 99, figs. 23. — Johnson & Snook 1927: 369, figs. 321, 323. — Garth 1958: 271, pl. Q, fig. 1; pl. 31, fig. 2. — Garth & Abbott 1980: 601, fig. 25.12. — Jensen 1995: 23, fig. 21. — Hendrickx 1999: 150, fig. 86, pl. 6C. — Kuris *et al.* 2007: 641.

Pelia clausa Rathbun, 1907: 72. — Schmitt 1921: 211, pl. 34, figs. 1–4.

Diagnosis. Rostrum with shallow notch, rostral horns nearly parallel. Carapace pyriform, pubescent, without spines. Gastric region rounded, elevated, with small rounded tubercle; branchial regions inflated, cardiac region with rounded elevation. Anterolateral margin entire. Basal antennal segment longer than wide, with tooth at anteroexternal angle, flagella longer than rostrum. Chelipeds unarmed, hand inflated, male with fingers widely gaping, tubercle on margin of dactyl near base. Pereopods 2–5 flattened, pubescent, dactyls with sharp, curved apices. Male carapace length 21.2 mm, width 14.5 mm; female 20.5 mm, width 13.0 mm.

Color in life. Carapace buff, tan or orange, chelae white, mottled with brown, chela of adult male bright red, pereopods 2–5 with marks of orange, brown. The color notes are from crabs from San Pedro, California.

Habitat and depth. Rocks, rocky reefs, intertidal to 129 m, but usually at 50 m or less.

Range. Monterey Bay to Petatlan Bay, Mexico including Gulf of California. Type locality near San Diego. Uncommon north of Point Conception, California.

Remarks. *Pelia tumida* always has an unidentified yellow sponge attached to its dorsal surface. The crab attaches pieces to itself soon after molting. The sponge regenerates and grows to cover the entire dorsal surface of the crab.

The early confusion in the nomenclature of this species reflects the marked sexual dimorphism seen in adults. Immature males, like females, do not have as expanded chelae as mature males, nor is there a gape between the fingers.

***Scyra* Dana, 1851**

***Scyra acutifrons* Dana, 1851**

(Fig. 52D, E; Pl. 13A)

Scyra acutifrons Dana, 1851: 269. — Holmes 1900: 41. — Rathbun 1904: 175; 1925: 195, pl. 79; pl. 224, figs. 4 5; text fig. 79. — Weymouth 1910: 33, pl. 6, fig. 17. — Schmitt 1921: 214, text figs. 134a, b. — Johnson & Snook 1927: 374, fig. 329. — Garth 1958: 252, pl. P, fig. 1; pl. 27, fig. 1. — Garth & Abbott 1980: 600, fig. 25.9. — Hart 1982: 190, fig. 76. — Ricketts *et al.* 1985: 169. — Jensen 1995: 21, fig. 13. — Hendrickx 1999: 156, fig. 90, pl. 6D, E. — Kuris *et al.* 2007: 641.

Diagnosis. Rostrum flattened, short, horns shaped like feathers or arrow; rows hooked setae on horns. Carapace pyriform; median region separated from cardiac, branchial regions by conspicuous depression; acute tubercle near center of median region, larger tubercle behind it. Branchial region with felt-like setae, bearing large, projecting tubercle; elevated prominence proximal to tubercle, usually bearing several small tubercles; large tubercle on cardiac region, smaller tubercle on intestinal region. Considerable variation among individuals, between sexes in width of carapace, degree of prominence, elevation of tubercles and regions of carapace. Preorbital spine acute. Pterygostomian regions with several rounded teeth. Two spines on outer margin of basal antennal segment, lobe on its outer margin, flagellum long. Male cheliped considerably more robust than those of female, merus subcylindrical, somewhat flattened below, bearing pustules; carpus pustulate, ridges on outer side; hand long, narrow, compressed, palm often with inflated ridge; fingers deflexed, in older male, gaping, with tooth near base of dactyl. Pereopods 2–5 subcylindrical, pubescent, propodi bearing groove on either side; dactyls short, rounded at apex. Male carapace length 46.5 mm, width 33.7 mm; female 23.9 mm, width 15.9 mm.

Color in life. Dull tan to gray with red marks on chelipeds, walking legs.

Habitat and depth. Rocks, rocky reefs, pilings; intertidal zone to 114 m but usually less than 50 m. As noted by Kuris *et al.* (2007), the species is rare in the intertidal zone.

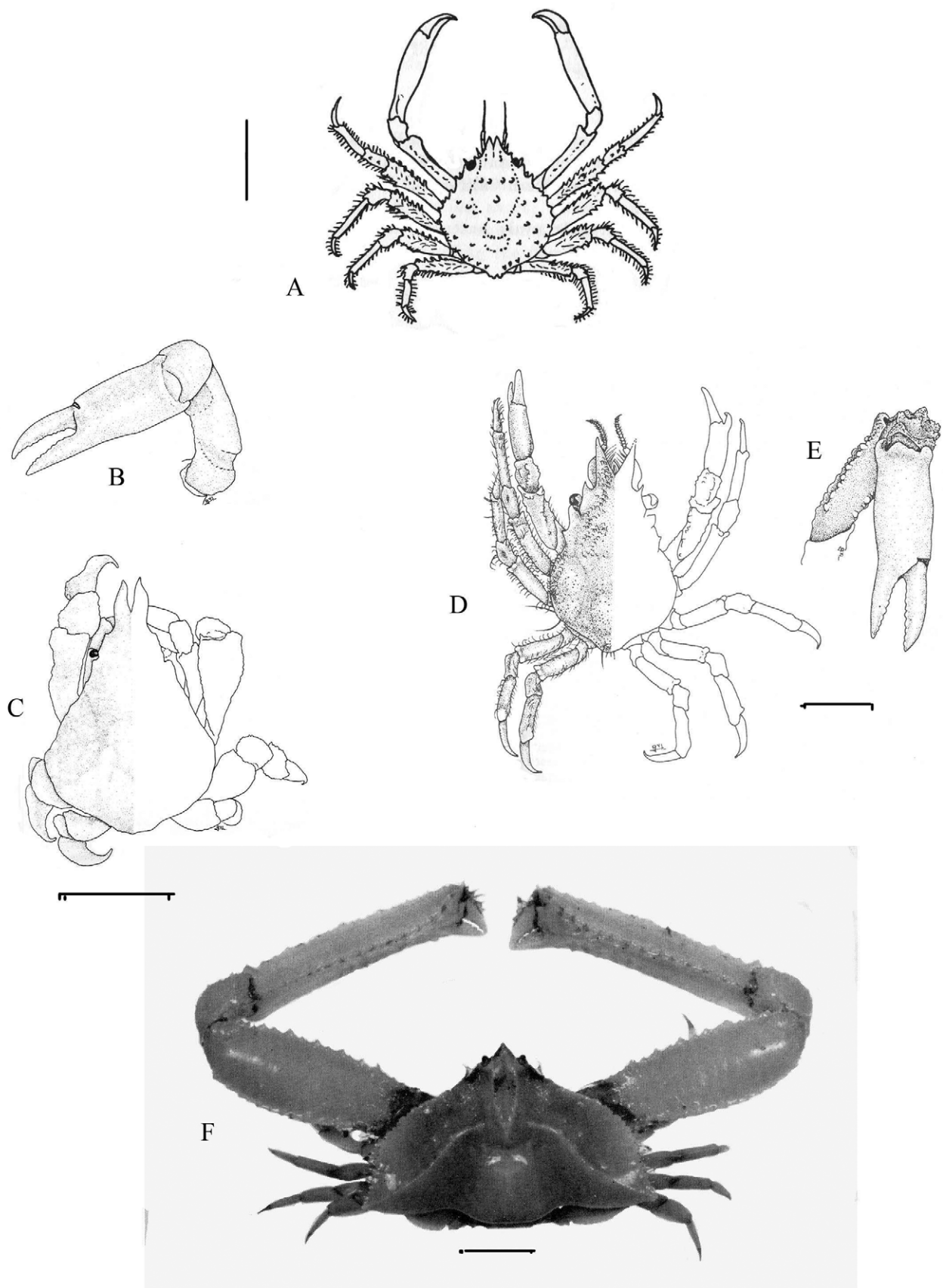


FIGURE 52. Families Pisidae and Parthenopidae. A, *Herbstia parvifrons* Randall, 1839. B, C, *Pelia tumida* (Lockington, 1877); B, cheliped; C, crab in dorsal view. D, E, *Scyra acutifrons* Dana, 1851; D, crab in dorsal view, showing setae of left side; E, cheliped. F, *Latolambrus occidentalis* (Dana, 1854). Scales: F = 5mm, A, C, D = 10 mm. A from Schmitt 1921; B–E from Hendrickx 1999; F from Garth 1958.

Range. Kachemak Bay, Cook Inlet, Alaska to Point San Carlos, Baja California. Type locality "Oregon."

Remarks. *Scyra acutifrons* usually does not decorate, but instead is encrusted by sponges, barnacles, bryozoans or tunicates. Garth & Abbott (1980) reported that they rest with the anterior region aimed downward, but I have not observed any consistent posture in these crabs.

Garth (1958) noticed that there were two distinct types of this crab. The "northern form" has a raised carapace with the gastric region deeply separated from the cardiac and branchial regions, and a broad rostrum. The "southern form" has a more rounded carapace and a narrow rostrum.

It is easy to confuse this species with similar subtidal spider crabs. Juvenile *Loxorhynchus* spp. are much more setose than *S. acutifrons*, decorate themselves, and possess a down-curved rostrum. The rostrum of *Oregonia gracilis* is much more elongate than that of *S. acutifrons*.

Ricketts *et al.* (1985) claimed that *S. acutifrons* was "uncommon below Pacific Grove", but this is not so. The crab is common on subtidal rocks and jetties along the mainland coast of Los Angeles County, California, but rarely is found on the islands of southern California.

SUPERFAMILY PARTHENOPOIDEA Macleay, 1838

Family Parthenopidae MacLeay, 1838

Members of the family Parthenopidae commonly are called elbow crabs. The elongate chelipeds, folded across the front, suggest the name. These sand-dwelling crabs, mostly tropical in distribution, are represented in California by only one species.

Parthenopid crabs have retractile eyes with small and well-defined orbits. The basal antennal segment is small and deeply imbedded between the inner angle of the orbit and the pits at the bases of the first antennae. The first antennae fold somewhat obliquely, not vertically. The distinctive chelipeds have fingers bent at an angle. Pereopods 2–5 are short, flattened and have broad segments.

Elbow crabs can dig into sand and remain motionless with only the eye, apex of the rostrum and a respiratory passage exposed. Their cryptic coloration renders them further difficult to detect.

Latolambrus Tan & Ng, 2007

Latolambrus occidentalis (Dana, 1854)

(Fig. 52F)

Cryptopodia occidentalis Dana, 1854: 430.

Heterocrypta occidentalis. — Holmes 1900: 44. — Rathbun 1904: 170; 1925: 559, pls. 204, 205. — Weymouth 1910: 21, pl. 2, figs. 4, 5. — Schmitt 1921: 192, 119. — Johnson & Snook 1927: 363, fig. 316. — Garth 1958: 476, pl. Z, figs. 14, 14a; pl. 55, fig. 2. — Ricketts *et al.* 1985: 321, fig. 246. — Jensen 1995: 34, fig. 53. — Hendrickx 1999: 251, pl. 8C. — Kuris *et al.* 2007: 641, pl. 319 I.

Latulambrus occidentalis. — Tan & Ng 2007: 106.

Latcrypta occidentalis. — Tan & Ng 2007: 106, fig. 8. (Error, Corrigenda in Tan & Ng 2007).

Diagnosis. Rostrum subtriangular, subacute, short. Carapace broadly triangular; median region narrow, flattened upper surface bounded by 2 granulated ridges, converging to triangular point posteriorly. Cardiac region with 3-sided elevation, edges usually granulated. Posterolateral regions large, with S-shaped, granulated crest, pair minute tubercles in front of anterior bend of crest. Anterolateral margins straight to slightly concave in front, convex near middle, posterior portion extending outwards, backwards, arching over legs; teeth on anterior part small, irregular, but becoming larger posteriorly, there furnished with secondary denticles. Posterolateral margins transverse; posterior margin not produced over abdominal segments. Chelipeds long, triangular in cross-section; sides of merus convex, edge sharply granulate to toothed; carpus with 3–4 granulate lines; hand about as long as merus, angles prominent, dentate; sides convex; dactyl short but longer than fixed finger, when closed, outer margin at right angle to long axis of palm. Chelipeds folding against long triangular concave area of body, this area fringed by setae. Pereopods 2–5 compressed, strongly ridged above; dactyls narrow, curved. Male carapace length 21.0 mm, width 34.0 mm; female length 17.3 mm, width 26.8 mm.

Color in life. Grayish or brownish, sometimes with minute spots of white, purple; camouflaged like sand. Lower surface light yellow.

Habitat and depth. Sand, sand mixed with shell, rock, or mud; intertidal zone to 175 m, but usually at less than 100 m.

Range. Drake's Bay, Marin County, California to Dewey Channel, Baja California; also Gorda Bank, Gulf of California and Boca de Piedras, Sinaloa, Mexico. Type locality Monterey, California.

Remarks. The drawing by Dana (1854), copied by Schmitt (1921: fig. 119), is inaccurate. The inner crest of the cheliped and its dentate margin extends to the large teeth just distal to the margin of the dactyl. The dentate margins of the chelipeds are suggested vaguely. Hendrickx (1999: fig. 138H) provided a sketch of the carapace.

SUPERFAMILY CANCROIDEA Latreille, 1802

Family Cancridae Latreille, 1802

The rock crabs, among the largest species of crabs in California or Oregon, have broad, oval carapaces and strong chelae. The front has several teeth, including a median tooth. The antennules fold back longitudinally. The antennal flagella are short and bear setae, especially in small animals. The third maxillipeds overlap the endostome. In many species, the ventrolateral parts of the body bear dense setae.

Species of cancrids inhabit both rocky and sandy bottoms, or areas of rocks lying among sand. *Metacarcinus magister* (Rathbun, 1897) and *M. gracilis* (Dana, 1852), which usually live on open sand, have especially flattened appendages with long dactyls. Other species tend to have more rounded appendages with shorter dactyls, which often bear stiff setae or spines. *Metacarcinus magister* is the object of a commercial fishery, primarily from San Francisco, California northward. Natural predators of cancrids include octopuses, large fishes and the sea otter. See Garth & Abbott (1980) for a lengthy account of the natural history of these crabs.

Until recently, the most comprehensive recent work on species of cancrids was that of Nations (1975). New morphological and molecular work by Schweitzer & Feldmann (2000) elevated the subgenera used by Nations to distinct generic status.

The key follows those of Schmitt (1921) and Rathbun (1930), but incorporates the recent changes in generic nomenclature. A carapace is said to be areolated if it displays prominent elevated areas. The guide by Phillips (1939) is useful for identification of larger species.

Key to species of family Cancridae

1. Front markedly projecting beyond outer orbital angles, with 5 subequal teeth. Carapace with 5 broad anterolateral teeth
..... *Cancer productus*
- Front not markedly projecting beyond outer orbital angles, with 5 or more unequal teeth. Carapace with 5 or more curved, acute or widely separated anterolateral teeth 2
2. Adults small, carapace length not more than 40 mm. Carapace with sharply elevated regions bearing coarse, rounded granules. Chelipeds with granulated tubercles or spines on upper part of manus, carpus 3
- Adults large, carapace length more than 40 mm. Carapace smooth or with small granules concentrated on moderately raised areas. Chelipeds smooth or with sharp spines or granules 4
3. Carapace widest at seventh or eighth tooth, with conspicuous raised, granulate areas, 12 or 13 anterolateral teeth, anterolateral margin not meeting posterolateral margin at distinct angle. Small, rarely south of Point Arena, California
..... *Glebocarcinus oregonensis*
- Carapace widest at ninth anterolateral tooth, with raised, granulate areas but not as prominent as in preceding species, 9 or 10 anterolateral teeth, anterolateral margin meeting posterolateral margin at distinct angle. Larger, generally found south of Point Conception *Glebocarcinus amphioetus*
4. Carapace with anterolateral teeth not strongly produced or forward curving, front slightly produced (if at all), with triangular medial tooth, chelipeds smooth to spiny 5
- Carapace with anterolateral teeth strongly produced, curving forward, front moderately produced, with acute medial tooth; chelipeds with sharp spines or granules along carinae of outer, upper surfaces of manus, carpus (may be blunt in very old animals) 7
5. Carapace widest at tenth anterolateral tooth; no eleventh tooth. Usually found north of Point Conception on sand, carapace width to 230 mm *Metacarcinus magister*
- Carapace widest at ninth anterolateral tooth; with tenth, sometimes eleventh tooth. Found north or south of Point Conception on sand or among rocks, carapace width to 91 mm 6
6. Pereopods 2–5 flattened. Fingers of chelipeds without dark color, chela without orange blotch on inner surface of palm. Merus of third maxilliped rounded anteriorly *Metacarcinus gracilis*

- Pereopods 2–5 rounded in cross section. Fingers of chelipeds ending in dark color, chela with orange blotch on inner surface of palm. Merus of third maxilliped not rounded anteriorly *Metacarcinus anthonyi*
- 7. Carpus of cheliped with single spine at distal end, hand smooth or granulated. Inner surface of cheliped with red spots
 *Romaleon antennarius*
- Carpus of cheliped with two spines at distal end, hand roughened, armed with two spines (may be inconspicuous). Inner surface of cheliped without red spots 8
- 8. Tenth anterolateral tooth conspicuous, eleventh present; dactyl of cheliped spiny. Carapace with prominently raised areas
 *Romaleon branneri*
- Tenth anterolateral tooth inconspicuous, eleventh not present; dactyl of cheliped not spiny. Carapace with slightly raised areas
 *Romaleon jordani*

Cancer Linnaeus, 1758

***Cancer productus* Randall, 1840**

(Fig. 54G, H; Pl. 13E)

Cancer productus Randall, 1840: 116. — Rathbun 1904: 175, 1930: 203, text fig. 32. — Weymouth 1910: 40, pl. 8, figs. 20–24. — Schmitt 1921: 220, text fig. 136. — Johnson & Snook 1927: 378, figs. 306, 307, 330. — Phillips 1939: 27, fig. 19. — Nations 1975: 40, figs. 13A, 13B, 14A, 14B, 39-1, 39-2. — Word & Charwat 1975: 53.—Garth & Abbott 1980: 607, fig. 25.22. — Hart 1982: 206, fig. 84. — Ricketts *et al.* 1985: 134, fig. 105. — Jensen 1995: 27, fig. 32. — Schweitzer & Feldmann 228. — Kuris *et al.* 2007: 641, pl. 320, fig. D.

Diagnosis. Front markedly produced beyond outer orbital angles, with 5 subequal teeth, fronto-orbital width about 0.2 times width of carapace. Carapace very broad, widest at anterolateral tooth 9 tooth 10 present. Surface of carapace somewhat convex, smooth to minutely granulate. Carpus of cheliped with large tooth at antero-internal angle, smaller one at upper hinge joint, palm with ridge along dorsal surface, granulate ridges on palm. Carapace length to 66.4 mm.

Color in life. Juveniles highly variable: carapace red, orange, striped with white, red; mottled, gray or gray with median stripe of red; legs striped or red; see color photographs by Garth & Abbott (1980: figs. 25.22a–25.22h) and Jensen (1995: fig. 32). Adult dark red above, white to yellowish below. Chelae with dark apices.

Habitat and depth. Tide pools, rocks in sand, rocky reefs, breakwaters; intertidal zone to 79 m.

Range. Kodiak I., Alaska to San Diego, California. Older reports from Magdalena Bay, Baja California are unconfirmed. Type locality "western America."

Remarks. The red rock crab can have a carapace width of up to 173.5 mm. The exoskeleton is heavily calcified. The crab is one of the largest intertidal crabs in California and Oregon, as well as one of the heaviest. It is edible but not sufficiently common to support a commercial fishery.

***Glebocarcinus* Nations, 1975**

***Glebocarcinus amphioetus* (Rathbun, 1898)**

(Fig. 53B, C)

Cancer amphioetus Rathbun, 1898a: 582. — Rathbun 1904: 175, pl. 6, fig. 3; 1930: 205, pl. 91. — Schmitt 1921: 223, pl. 36, figs. 1, 2. — Johnson & Snook 1927: 378. — Sakai 1965: 105, pl. 48, fig. 1. — Nations 1975: 30, figs. 15AB, 16AB, 30-7, 30-8. — Word & Charwat 1975: 41.—Garth & Abbott 1980: 604. — Jensen 1995: 29.

Glebocarcinus amphioetus.—Schweitzer & Feldmann 200: 235.

Diagnosis. Carapace smooth, strongly areolated, front with 5 median teeth, median tooth small; anterolateral margins with 9 flat, broadly triangular teeth, tiny tooth 10. Third maxilliped with merus truncated anteriorly. Body not setose. Carpus of cheliped with 2 teeth, one at distal end, second below it on inner angle; hand of cheliped with 1–2 spines on upper margin, 3 longitudinal ridges on outer surface. Pereopods 2–5 stout. Male carapace length 22.2 mm, female 27.5 mm.

Color in life. Reddish brown, lighter beneath; fingers of chelae dark, with color reaching more than half of length of outer margin.

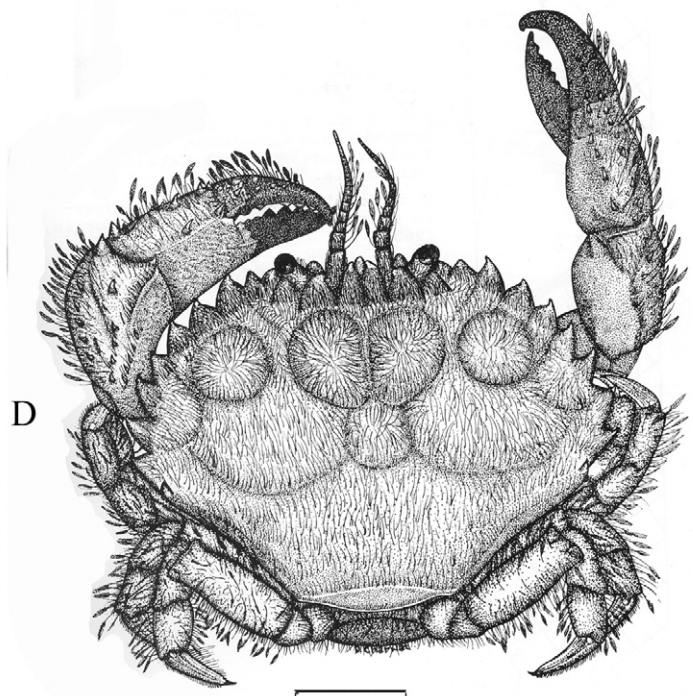
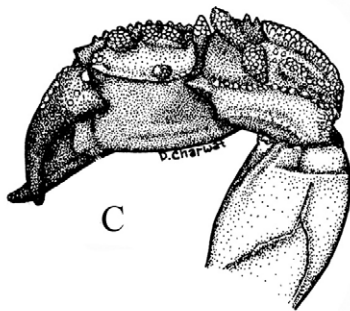
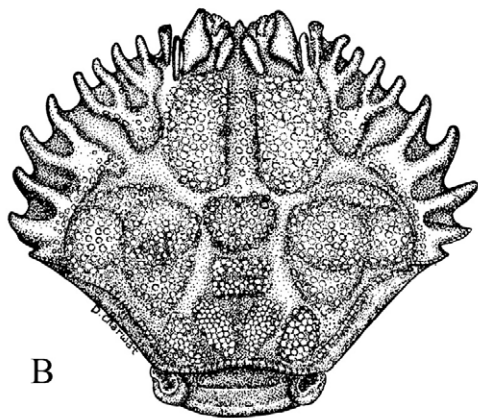
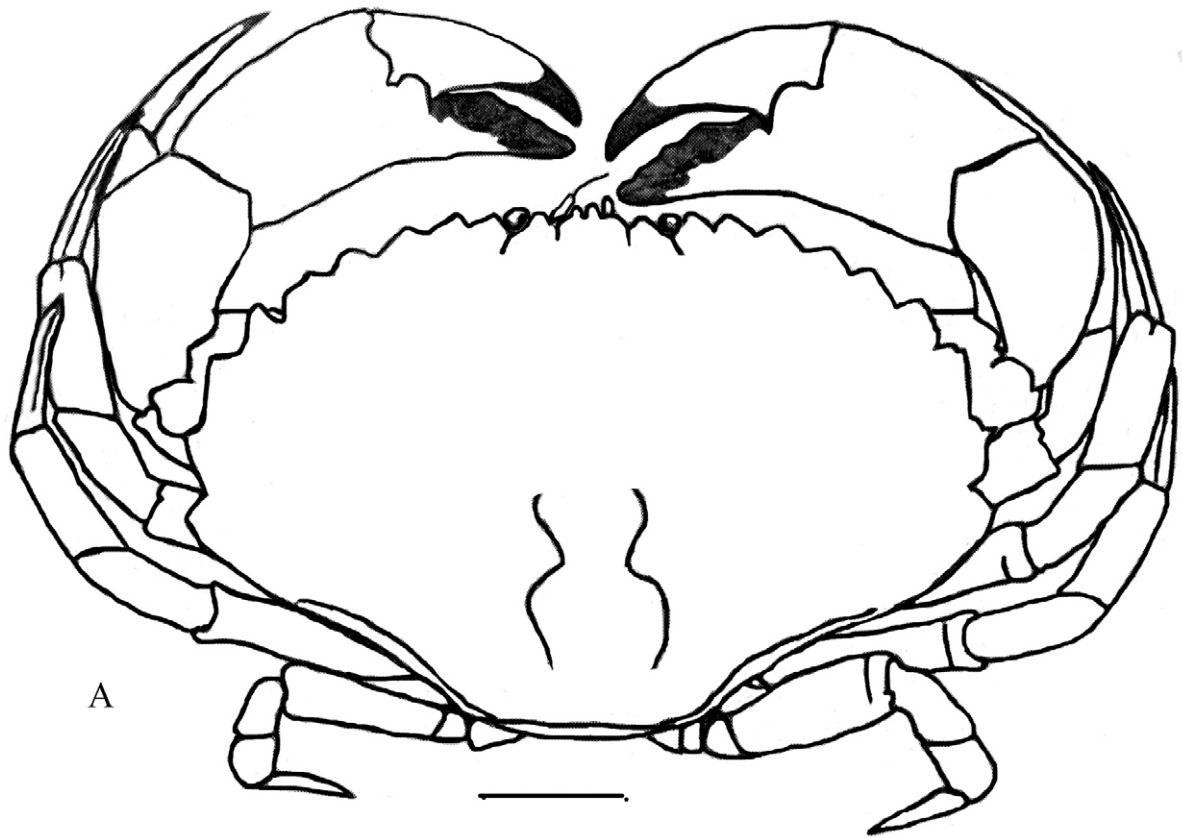


FIGURE 53. Family Cancridae. A, *Metacarcinus anthonyi* (Rathbun, 1897). B, C, *Glebocarcinus amphioetus* (Rathbun, 1898); B, carapace; C, right chela. D, *Glebocarcinus oregonensis* (Dana, 1852). Scales: B, C, D = 10 mm; A = 20 mm. A after photo by Phillips 1939, B–D from Word & Charwat 1975.

Habitat and depth. On rocks, sand, shells, mud, intertidal to 148 m, usually subtidal.

Range. El Segundo, California to Magdalena Bay, Baja California; Gulf of California, Japan, Korea, and northern China. Type locality "off the Korean coast."

***Glebocarcinus oregonensis* (Dana, 1852)**

(Fig. 53D)

Trichocera oregonensis Dana, 1852: 86.

Trichocarcinus oregonensis. — Holmes, 1900: 54.

Cancer oregonensis. — Rathbun 1904: 178, pl. 7, fig. 1; 1930: 226, pl. 96. — Weymouth 1910: 49, pl. 11, fig. 34. — Schmitt 1921: 234, pl. 36, figs. 3, 4. — Johnson & Snook 1927: 383, fig. 337. — Nations 1975: 38, figs. 17E, F, 18E, F, 30-1, 30-2. — Word & Charwat 1975: 51. — Wicksten 1979d: 1181. — Garth & Abbott 1980: 607, fig. 25.21. — Hart 1982: 210, fig. 86. — Ricketts *et al.* 1985: 305, fig. 237. — Jensen 1995: 29, fig. 36. — Kuris *et al.* 2007: 641.

Glebocarcinus oregonensis. — Schweitzer & Feldmann 2000: 234.

Diagnosis. Carapace rounded, anterolateral, posterolateral margins not meeting at distinct angle, widest at tooth 7 or 8, 12–13 anterolateral teeth. Ornamentation of dorsal surface of carapace variable; from moderately raised areas to pronounced tuberculate patches. Merus of third maxilliped with antero-external angle produced. Carpus of cheliped with spine at antero-internal angle with tooth below it; hand thick, high; upper edge of palm with 2 rows small tubercles; outer surface with 5 granulated lines. Carapace length to 36.5 mm.

Color in life. Usually dark red-brown above, lighter below; pereopods 2–5 may have bands of light color. In some individuals, carapace entirely gray or with red spots or bands of orange or yellow. Chelipeds with dark apices. The color notes are from crabs from Trinidad, Humboldt County, California; see also color photograph by Jensen (1995).

Habitat and depth. Among rocks, tide pools, in barnacle shells, among mussels on pilings, intertidal zone to 435 m.

Range. St. George I., Pribilof Is. to off Palos Verdes Peninsula, California, but rarely found south of Point Arena, Mendocino County, California. Common in tide pools from Humboldt County, California northward. Type locality Puget Sound.

***Metacarcinus* A. Milne-Edwards, 1862**

***Metacarcinus anthonyi* (Rathbun, 1897)**

(Fig. 53A, Pl. 13F)

Cancer anthonyi Rathbun, 1897: 111. — Rathbun 1904: 176, pl. 6, fig. 2; 1930: 218, pl. 94, fig. 3. — Weymouth 1910: 49, pl. 11, fig. 33. — Schmitt 1921: 227, pl. 35, fig. 1. — Johnson & Snook 1927: 379, fig. 334. — Phillips 1939: 29, fig. 20. — Nations 1975: 32, figs. 13E, F, 14E, F, 35-5, 35-6. — Word & Charwat 1975: 44. — Garth & Abbott 1980: 604, fig. 25.17. — Wicksten 1980c: 360. — Jensen 1995: 28, fig. 33. — Kuris *et al.* 2007: 642.

Metacarcinus anthonyi. — Schweitzer & Feldmann 2000: 235.

Diagnosis. Front narrow, not produced, with 3 teeth. Carapace granulate, convex, widest at anterolateral tooth 9, anterolateral teeth broad, last 3 teeth with sharp apices; anterolateral tooth 10 indistinct. Merus of third maxillipeds oblong, anterior margins slightly oblique. Carpus of chelipeds with single distal spine; hand smooth or granulated, without spines. Pereopods 2–5 sparsely setose to smooth. Male carapace length 52.1 mm.

Color in life. Brownish-red to yellowish-orange, lighter beneath, without spots; blotch of orange on inner surface of palm of chela, fingers of chela black. Juveniles may have mottled carapace with markings of white, brown or tan. The color notes are from crabs from Cabrillo Beach, Los Angeles County, California.

Habitat and depth. Tide pools, among rocks in bays, estuaries, intertidal zone to 132 m.

Range. Humboldt Bay, California to Magdalena Bay, Baja California, but uncommon north of Los Angeles County, California. Type locality Long Beach, California.

Remarks. The yellow crab is a large, heavily calcified intertidal crab. It seems to prefer slightly warmer waters than *C. productus* and *Romaleon antennarius* (Stimpson, 1856); the other similar large crabs that live in rocky habitats. Records north of San Pedro usually come from bays and harbors rather than the open coast.

***Metacarcinus gracilis* (Dana, 1852)**

(Fig. 54E, F; Pl. 13G)

Cancer gracilis Dana, 1852: 73. — Holmes 1900: 52. — Rathbun 1904: 177; 1930: 219, pl. 95, text fig. 34. — Weymouth 1910: 42, pl. 9, figs. 26–28. — Schmitt 1921: 232, pl. 35, fig. 2. — Johnson & Snook 1927: 381, fig. 336. — Phillips 1939: 23, fig. 17. — Nations 1975: 34, figs. 17C, D, 18C, D, 36-1, 36-2. — Word & Charwat 1975: 48.—Garth & Abbott 1980: 604, fig. 25.18. — Wicksten 1980c: 360. —Hart 1982: 214, fig. 88. — Ricketts *et al.* 1985: 543. — Jensen 1995: 28, fig. 34. — Kuris *et al.* 2007: 642.

Metacarcinus gracilis. — Schweitzer & Feldmann 2000: 235.

Diagnosis. Carapace strongly convex, front not produced, with 3 median teeth. Anterolateral teeth of carapace low, not pointed, carapace granulated, widest at tooth 9; small anterolateral tooth 10. Merus of third maxillipeds elongated, rounded anteriorly. Carpus of cheliped with 2 teeth, one above at distal angle, second below it. Palm with rows of minute spinules, movable finger roughened dorsally but without large teeth. Pereopods 2–5 slender, dactyls elongated. Carapace length 27.3 mm.

Color in life. Carapace brownish to gray, lower surface, much of legs yellowish; purple marks on pereopods 2, 3. Apices of chelae white. The color notes are from crabs from Cabrillo Beach, Los Angeles County; and Princeton Harbor, San Mateo County; California.

Habitat and depth. Mud flats, sandy beaches and offshore areas, eel grass beds, intertidal zone to 174 m.

Range. Prince William Sound, Alaska to Playa Maria Bay, Baja California, Mexico. Type locality San Francisco, California.

Remarks. Megalops larvae and juveniles of this crab have been found on large medusae.

***Metacarcinus magister* (Dana, 1852)**

(Fig. 54C, Pl. 14A)

Cancer magister Dana, 1852 : 73. — Holmes 1900: 50. — Rathbun 1904: 177; 1930: 222, text figs. 35, 36. —Weymouth 1910: 42, pl. 9, fig. 25. — Schmitt 1921: 229, text fig. 138. — Johnson & Snook 1927: 379, fig. 335. — Phillips 1939: 21, fig. 15. — Nations 1975: 37, figs. 17AB, 18AB, 23, 34-1, 34-2. — Garth & Abbott 1980: 605, Fig. 25.20. — Hart 1982: 212, fig. 87. — Ricketts *et al.* 1985: 199, fig. 170. — Jensen & Armstrong 1987: 216. — Jensen 1995: 27, fig. 31. — Kuris *et al.* 2007: 641.

Metacarcinus magister. — Schweitzer & Feldmann 2000: 235.

Diagnosis. Front of carapace not produced, with 3 small median teeth. Carapace granulate, widest at anterolateral tooth 10, no eleventh tooth, anterolateral teeth serrate anteriorly. Carpus of cheliped with single distal tooth, palm with dorsal serrate ridge having conspicuous teeth, ridges on sides; movable finger with dorsal teeth, lateral ridges. Merus of third maxilliped widened distally, its anterior margin forming obtuse angle with outer margin. Pereopods 2–5 broad, flat. Carapace length 120.7 mm.

Color in life. Carapace brown to gray, lower surface, appendages creamy white to yellowish. Fingers of chelipeds light-colored. The color notes are from crabs from Princeton Harbor, San Mateo County; and Coyote Point, San Francisco Bay, California.

Habitat and depth. Bays, harbors, sandy beaches, eelgrass flats, sandy areas of continental shelf, low intertidal zone to 230 m.

Range. North and east of St. George I., Pribilof Is. to Pismo Beach, California. Old records from Santa Barbara, California and Magdalena Bay, Baja California are unconfirmed. Type locality San Francisco Bay.

Remarks. The Dungeness crab is the most important commercial crab of the Pacific coast of the United States. Adult crabs usually are trapped off shore, but juveniles often can be found in bays and harbors at low tide. Very small juveniles and megalops larvae sometimes ride on medusae and the by-the-wind sailor *Veleva* sp. (Wickham 1979).

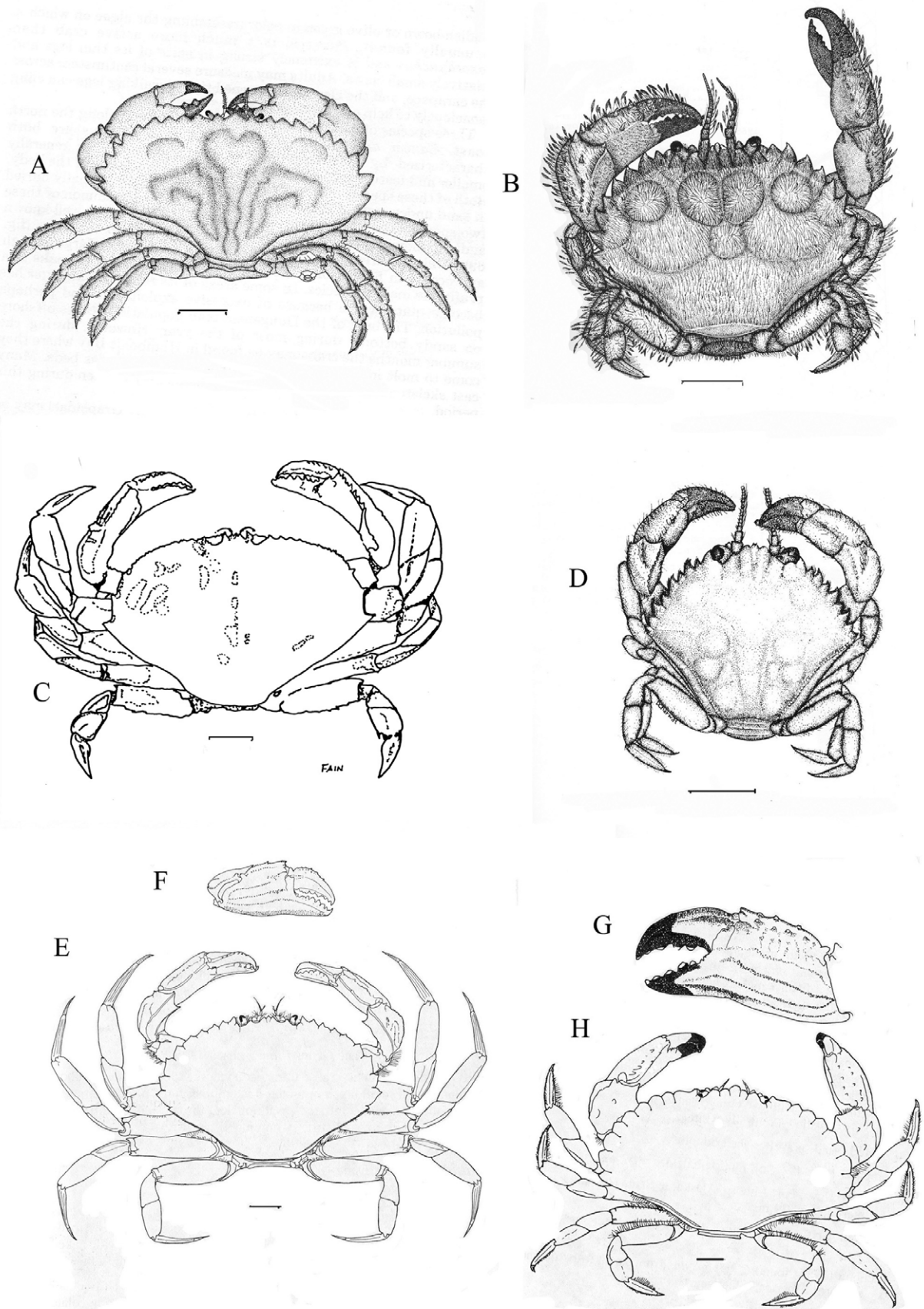


FIGURE 54. Family Cancridae. A, *Romaleon antennarius* (Stimpson, 1856). B, *Romaleon branneri* (Rathbun, 1926). C, *Metacarcinus magister* (Dana, 1852). D, *Romaleon jordani* (Rathbun, 1900); juvenile. E, F *Metacarcinus gracilis* (Dana, 1852); E, dorsal view; F, chela. G, H *Cancer productus* Randall, 1840; G, chela; H, dorsal view. Scales: B, D, E, H = 10 mm; A = 20mm, C = 30 mm. A from Brusca & Brusca 1978, B, D from Word & Charwat 1975; C by G.F. Hubbard, E–H from Hart 1982.

Romaleon Gistl, 1848

***Romaleon antennarius* (Stimpson, 1856)**

(Fig. 54A, Pl. 13H)

Cancer antennarius Stimpson, 1856: 96. — Holmes 1900: 49. — Rathbun 1904: 176; 1930: 210, pl. 92, pl. 93, fig. 2; text fig. 33. — Weymouth 1910: 47, pl. 10, fig. 31. — Schmitt 1921: 224, pl. 35, fig. 3; pl. 36, fig. 8; text fig. 137. — Johnson & Snook 1927: 378, figs. 331, 332. — Nations 1975: 31, figs. 13C, D, 14C, D, 32-5, 32-6. — Garth & Abbott 1980: 602, fig. 25.16. — Word & Charwat 1975: 42.—Ricketts *et al.* 1985: 133, fig. 104. — Breen & Wicksten 1990: 10. — Jensen 1995: 28, fig. 35. — Kuris *et al.* 2007: 642, pl. 320, fig. H.

Romaleon antennarius. — Schweitzer & Feldmann 2000: 243.

Diagnosis. Carapace smooth, front not produced, with 3 median teeth. Carapace widest at anterolateral tooth 8, 11 anterolateral teeth present. Merus of third maxillipeds with distal margin nearly transverse, angles rounded. Chelipeds may be slightly unequal in size. Carpus of cheliped with single spine above, carpus, palm bearing faint ridges, movable finger smooth. Pereopods 2–5 stout, usually setose. Juveniles may be more setose than adults. Male carapace length 61.7 mm, female to 54.1 mm.

Color in life. Dark reddish above, yellowish with red spots below. Fingers of chelae dark. The color notes are from crabs from Moss Beach, San Mateo County, California.

Habitat and depth. Under rocks set in sand, tide pools, among sea grasses, breakwaters, rocky reefs; intertidal zone to 40 m.

Range. Coos Bay, Oregon to Todos Santos Is., Baja California. Reports from British Columbia are unconfirmed. Type locality San Francisco Bay.

Remarks. The rock crab is one of the most common larger crabs in California and Oregon. It is taken by sport fishermen as well as predatory fishes, octopuses and sea otters.

***Romaleon branneri* (Rathbun, 1926)**

(Fig. 54B)

Cancer branneri Rathbun, 1926: 63; 1930: 211, pl. 93, fig. 1 (extensive synonymy). — Nations 1975: 33, figs. 15E, F, 16E, F, 31-1, 31-2. — Word & Charwat 1975: 46.—Garth & Abbott 1980: 605. — Hart 1982: 208, fig. 85. — Jensen 1995: 29, fig. 37. — Kuris *et al.* 2007: 641.

Cancer gibbosulus. — Rathbun 1904: 176. — Weymouth 1910: 43, pl. 10, fig. 29. — Schmitt 1921, pl. 36, fig. 7. — Johnson & Snook 1927: 378. [Not *Cancer gibbosulus* (De Hann, 1835); east Asian species].

Romaleon branneri. — Schweitzer & Feldmann 2000: 243.

Diagnosis. Carapace markedly areolated, sparsely setose with coarse setae. Front with 5 acute teeth, anterolateral margin with 9 forward-curving teeth, all but first 2 teeth tipped with spines; tenth, eleventh teeth present. Merus of third maxillipeds abruptly truncated. Chelipeds setose, carpus with 2 teeth, one above at distal end, second below it at inner angle; upper surface of hand with 2 rows of 3–5 spines; outer surface of hand with 5 ridges marked with setae, small spines; upper margin of movable finger spinous. Pereopods 2–5 setose; dactyls somewhat long, straight, tipped with spines. Male carapace length to 35.5 mm.

Color in life. Variable: carapace whitish with irregular reddish blotches to dark reddish brown, fingers of chelae dark, pereopods 2–5 light-colored, banded with red. The color notes are from crabs from Redondo Beach, California.

Habitat and depth. On sandy mud, coarse sand or shells, intertidal zone to 80 m.

Range. Port Althorp, Alaska to Cedros I., Baja California, Mexico. Type locality San Francisco, California.

Remarks. This small crab is very abundant at Redondo Beach, California.

***Romaleon jordani* (Rathbun, 1900)**

(Fig. 54D)

Cancer jordani Rathbun, 1900: 133; 1904: 176, pl. 6, fig. 4; 1930: 215, pl. 94, figs. 1, 2. — Weymouth 1910: 45, pl. 10, fig. 30. — Schmitt 1921: 228, pl. 36, figs. 5, 6. — Johnson & Snook 1927: 379, fig. 333. — Nations 1975: 36, fig. 15C, D, 16C, D, 31-3, 31-4. — Word & Charwat 1975: 50. — Garth & Abbott 1980: 605, fig. 25.19. — Jensen & Armstrong 1987: 216. — Jensen 1995: 29, fig. 38. — Kuris *et al.* 2007: 642.

Romaleon jordani. — Schweitzer & Feldmann 2000 : 243.

Diagnosis. Carapace slightly areolated, setose. Front with 5 teeth, almost hidden by setae, median tooth very small; anterolateral carapace margin with 9 prominent teeth, often alternating in size; tooth 10 present in older specimens. Merus of third maxilliped obliquely truncated. Carpus of cheliped with 2 spines, palm of cheliped with 2 superior, 5 external ridges, fringed with setae, several spines on upper ridges, movable finger without spines. Male carapace length 25.4 mm, female 15.5.

Color in life. Mottled with light brown, tan, lower surface yellowish, setae brownish to golden, fingers of chelae dark; see color photograph by Jensen (1995).

Habitat and depth. On sand or among kelp holdfasts, lowest intertidal zone to 104 m. Juveniles often cling to large medusae.

Range. Between Sekiu and Neah Bay, Washington to Cape Thurloe, Baja California. Type locality Monterey Bay, California.

Remarks. The illustration shows a juvenile, which has a more narrow carapace than an adult, and omits some of the dense setae usually seen in this species.

SUPERFAMILY PORTUNOIDEA Rafinesque, 1815

Family Portunidae Rafinesque, 1815

The swimming crabs are most abundant in warm temperate to tropical seas. Three native species, only one of them common, may be found in California. The Atlantic green crab *Carcinus maenas* has been introduced into bays. Individuals or parts of the exoskeleton of *Callinectes sapidus* Rathbun, 1896; the Atlantic blue crab, have been reported in San Francisco and Half Moon Bays, California, and rarely elsewhere. This crab has been shipped to fish markets alive from the eastern coast and Gulf of Mexico of the U.S.A. There is no evidence that this estuarine species is established anywhere on the west coast of North America. Kuris *et al.* (2007, pl. 319 M) provided an illustration. There are two old records of *Callinectes bellicosus* (Stimpson, 1859) from San Diego and Point Loma (Garth & Stephenson 1966: 47), but this crab generally is found from San Quintin Bay, Baja California south to the southern Gulf of California, Mexico.

Swimming crabs usually have a carapace that is wider than long. There is no rostrum. The carapace bears lateral teeth, the posterior of which may be considerably larger than the anterior teeth. The orbit is complete. The first antennae fold obliquely or transversely. The chelae are toothed; the cheliped bears spines. As the common name suggests, most swimming crabs can swim strongly by means of paddle-like dactyls of the fifth pereopods. Common near shore species can dig rapidly into sand.

Except for *Carcinus maenas*, species of the Portunidae of the eastern Pacific have been discussed in detail in the work by Garth & Stephenson (1966). The descriptions and key given here are in large part derived from the 1966 work, which contains further information on anatomy, ranges and classification.

Key to species of family Portunidae

1. Eyestalk extremely long, 0.3 or more of carapace breadth *Euphyllax dovii*
- Eyestalk not as long, much less than 0.3 of carapace breadth 2
2. Carapace narrow, 5 anterolateral teeth; pereopods 5 without flattened swimming paddles *Carcinus maenas*
- Carapace broad, 9 anterolateral teeth, pereopods 5 with flattened swimming paddles 3
3. Male abdomen triangular; anteroexternal angle of merus of third maxilliped not strongly produced laterally
- Male abdomen shaped like inverted T; anterolateral angle of merus of third maxilliped strongly produced laterally
- *Portunus xantusii*
- *Callinectes arcuatus*

***Callinectes* Stimpson, 1860**

***Callinectes arcuatus* Ordway, 1863**

(Fig. 55A)

Callinectes arcuatus Ordway, 1863: 578. — Rathbun 1930: 121, pl. 52, text figs. 15h, 16h, 17f, 18g. — Garth & Stephenson 1966: 43, pl. V, fig. A; pl. VIII, fig. A; pl. X, fig. A; pl. XII, fig. D. — Garth & Abbott 1980: 603, fig. 25.15. — Jensen 1995: 32, fig. 47.

Diagnosis. Carapace with surface moderately finely granulate, regions well marked. Front with 4 triangular teeth, orbital region with inner supraorbital lobes square-cut, inner supraorbital fissure closed, suborbital tooth prominent. Anterolateral teeth stout, first 4 blunt; 5–7 sharp, tooth 8 very sharp, tooth 9 moderately long. Cheliped with carina of hand granular. Pereopod 5 with swimming paddle. Male carapace length to 51.3 mm, female to 43.3 mm.

Color in life. Carapace olive gray-green, chelipeds olive green dorsally, whitish ventrally, apices yellow-brown; legs turquoise with olive stain, setae golden; fifth legs olive green with turquoise tints, paddles with black stain (Garth & Stephenson 1966).

Habitat and depth. Bays and estuaries, sand, mud or shell bottoms, intertidal zone to 28 m.

Range. Los Angeles Harbor, California to off Puerto Pizarro, Peru. Type locality Cape San Lucas.

Remarks. In California, scattered populations have been reported in recent years at Anaheim Slough and in San Diego County.

***Carcinus* Leach, 1814**

***Carcinus maenas* (Linnaeus, 1758)**

(Fig. 55B)

Cancer maenas Linnaeus, 1758: 627.

Carcinides maenas. — Rathbun 1930: 15, fig. 4.

Carcinus maenas. — Ingle 1980: 100, figs. 44, 44a, pl. 12b (extensive synonymy).—Williams 1984: 356, fig. 289. — Ricketts *et al.* 1985: 296, fig. 231. — Jensen 1995: 33, fig. 49. — Kuris *et al.* 2007: 642.

Diagnosis. Carapace about 0.75 times as long as broad. Front with 3 broad teeth, anterolateral margin with 5 strong teeth. Third maxilliped with anteroexternal angle not produced. Chelipeds slightly unequal, nearly smooth except for 2 ridges on upper surface of hand; merus short, carpus with broad internal tooth or angle. Pereopods 2–5 smooth, unarmed, dactyl of pereopod 5 lance-shaped, not forming swimming paddle. Male, female carapace length to 60 mm.

Color in life. Carapace dark green, bluish to reddish, sometimes China white; legs varying to yellowish white to tile white or violet; juveniles often more colorful, polymorphic in pigmentation than adults. Williams (1984: 356) gave a lengthy description of the cold patterns.

Habitat and depth. Bays, tide pools; among rocks, oysters, gravel or shells, intertidal to 200 m, but usually shallow. Tolerant of low salinity.

Range. Northumberland Strait to Virginia in North America; Kvaenangen, Norway, Baltic Sea and North Sea to Mauritania. Introduced into San Francisco Bay, California and Willapa Bay, Washington; also Australia, Burma, Red Sea, Madagascar, India, and Ceylon. Type locality Marstrand north of Goteborg, west coast of Sweden.

Remarks. Hardy and a prolific breeder, the green crab easily can be spread by human activity. It is a predator on clams and oysters, and thus is considered a pest by fishermen. The range of this species is spreading rapidly.

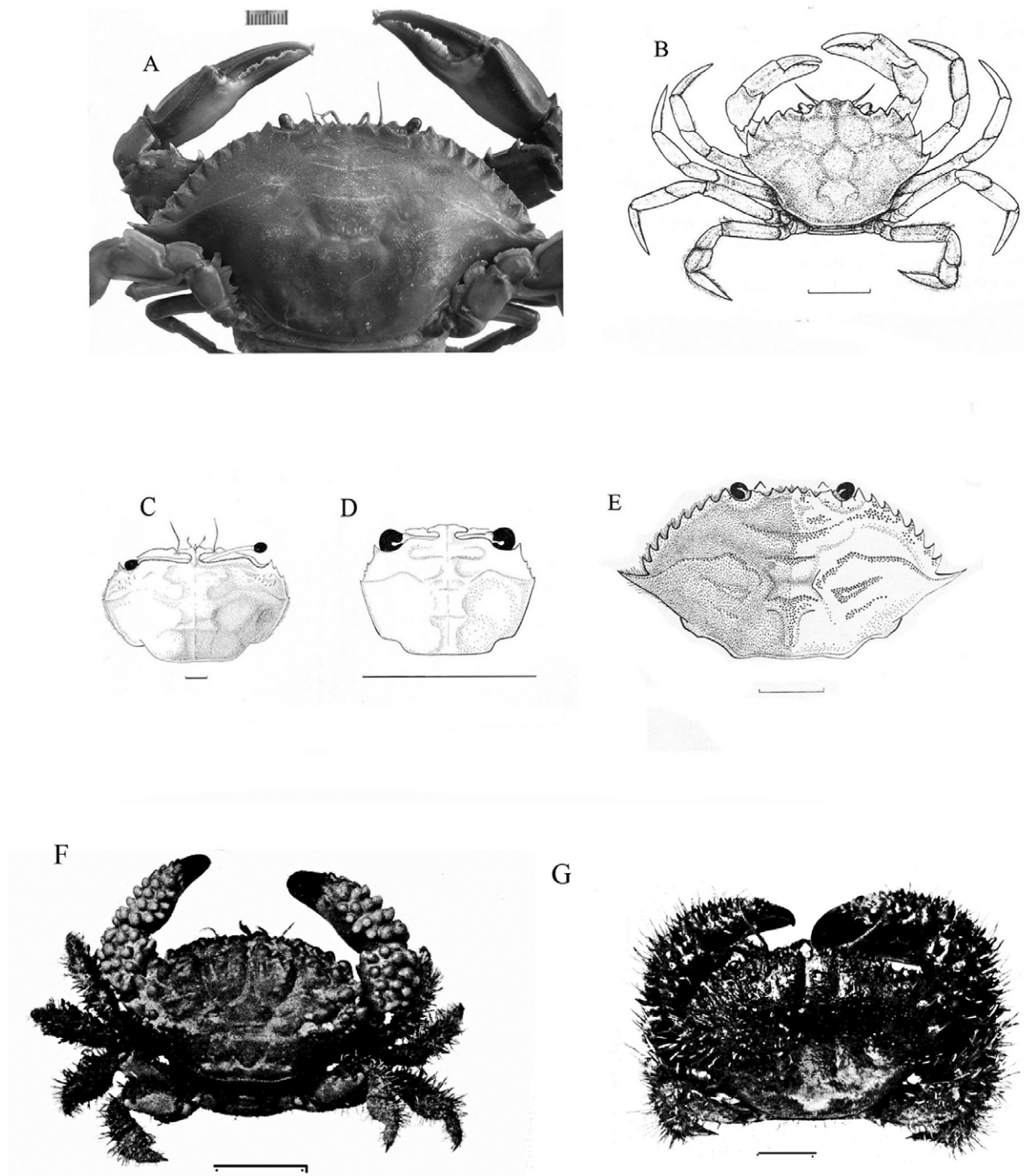


FIGURE 55. Families Portunidae, Xanthidae and Pilumnidae. A. *Callinectes arcuatus* Ordway, 1863. B, *Carcinus maenas* (Linnaeus, 1758). C, D *Euphylax dovii* Stimpson, 1860; C, adult; D, juvenile. E, *Portunus xantusii xantusii* (Stimpson, 1860); carapace. F, *Paraxanthias taylori* (Stimpson, 1860). G, *Pilumnus spinohirsutus* (Lockington, 1877). Scales: A, C, D, E, F, G = 10 mm, B = 20 mm. A photo by Camm Swift, B from Williams 1983, C–E from Garth & Stephenson 1966, F, G from Rathbun 1917.

***Euphylax* Stimpson, 1860**

***Euphylax dovii* Stimpson, 1860**

(Fig. 55C, D)

Euphylax dovii Stimpson, 1860: 226, pl. 5, figs. 5, 5a. — Rathbun 1930: 147, pl. 65. — Garth & Stephenson 1966: 64, pl. VI, figs. A, B; pl. VIII, fig. F, pl. X, figs. F, G; pl. XII, fig. G, text fig. 3a. — Word 1976: 161, fig. 1. — Chivers 1979: 276.

Diagnosis. Carapace relatively long, roughly ovoid; widest near middle, cardiac, branchial regions swollen. Front narrow, T-shaped, with median notch. Orbital region broad, length of eyestalk over 0.66 times carapace breadth. Four-five anterolateral teeth or lobes; first most stout, last most protruding. Third maxilliped with anteroexternal angle laterally produced. Chelipeds long, hands compressed. Fingers with well spaced large teeth, movable finger with dorsal carina. Pereopods 2–4 elongate; dactyls broad, flat. Merus of pereopod 5 with subterminal spine on posterior margin, dactyl forming swimming paddle. Male carapace length to 52.8 mm, female to 25.9 mm.

Color in life. Carapace and merus of all legs deep purple, rest of appendages wine red; undersides blue, sternum white, abdomen brownish (Garth & Stephenson 1966).

Habitat and depth. Mud or sand, intertidal zone to 65 m but often taken well offshore; capable of swimming long distances.

Range. Monterey Bay, California to Gulf of Guayaquil, Peru. Type locality "western coast of Central America." This crab rarely occurs in California.

***Portunus* Weber, 1795**

***Portunus xantusii xantusii* (Stimpson, 1860)**

(Fig. 55E, Pl. 14G)

Achelous xantusii Stimpson, 1860: 222.

Portunus xantusii. — Holmes 1900 : 71. — Rathbun 1904: 179; 1930: 50, pl. 18. — Weymouth 1910: 49, pl 12, fig. 35. — Schmitt 1921: 237, text fig. 141. — Johnson & Snook 1927: 384, fig. 339. — Ricketts *et al.* 1985: 322, fig. 248. — Jensen 1995: 32, fig. 46.

Portunus xantusii xantusii. — Garth & Stephenson, 1966: 32, pl. IV, fig. A; pl. VII, fig. B; pl. IX, fig. B; pl. XI, fig. B. — Garth & Abbott 1980: 602, fig. 25.14.

Diagnosis. Carapace broad, pilose, posterolateral corner rounded. Front advanced, with 4 lobes. Orbital region with inner supraorbital angle partially subdivided, supraorbital fissures open to closed. Supraorbital tooth acute to blunt, suborbital fissure open. Anterolateral tooth 1 blunt, tooth 5 stouter than teeth 4 or 6, tooth 9 long. Third maxilliped with anteroexternal angle of merus not produced laterally. Chelipeds moderately long, robust, with 4–6 spines on anterior border. Carpus with inner, outer spines moderately well developed, fingers of chela short and stout. Pereopod 5 with posterodistal border of merus having spinules. Male carapace length to 70.7 mm, female to 55.9 mm.

Color in life. Speckled with gray, black or white, pereopods 2–5 with white, brown bands; apices of chelae, other legs pinkish (Garth & Stephenson 1966). Camouflaged like sand.

Habitat and depth. Usually on sand, intertidal to 181 m but usually shallow, capable of swimming to surface.

Range. South of Santa Cruz I. and SE of Santa Barbara Point, California to Marquis Point, Baja California; and from San Ignacio Bay to near Piaxtla Point, Sinaloa, Mexico. Type locality Cape San Lucas. Other subspecies range into the Gulf of California and south to Colombia

SUPERFAMILY XANTHOIDEA MacLeay, 1838

Xanthoid crabs demonstrate enormous species diversity in tropical and subtropical regions. Until recently, all of them were considered to belong to only one family, the Xanthidae. Guinot (1971, 1978) and Ng (1998) divided the old family Xanthidae into new families and subfamilies. The work largely was based on morphology of the male gonopods, used in this work to separate the Panopeidae from the Xanthidae in the new sense. *Pilumnus spinohirsutus* (Lockington, 1877) now is placed in the superfamily Pilumnoidea, family Pilumnidae. See Ng (1998) for illustrations of the gonopods, a key to the families and a more recent systematic treatment of xanthoid crabs worldwide.

The tremendous diversity in size, body shape, habitat, commensal associations, and pereopod morphology has created confusion in trying to assemble the xanthoids into natural assemblages. There has been no recent comprehensive systematic work on the xanthoid crabs of the eastern Pacific. The keys to species presented here are artificial. Following Ng (1998), *Malacoplax californiensis* (Lockington, 1877); formerly considered to belong the

family Goneplacidae, now is included in the Panopeidae. The key to the species of *Lophopanopeus* is modified from that of Menzies (1948). Subspecies are treated in the sections on the species.

Xanthoids commonly are called mud, pebble or rubble crabs, appropriate for the many species that hide among shells, under rocks, in kelp holdfasts or among worm tubes. They are most diverse and abundant from Point Conception southward, but *Lophopanopeus bellus* (Stimpson, 1862) ranges as far north as Alaska.

Like species of the family Cancridae, with which they can be confused, xanthoids can be common in intertidal areas, especially in southern California. Among xanthoids, the antennules fold obliquely or transversely, not lengthwise. The flagellum of the antenna is smooth, not setose. The anterolateral teeth of the carapace often are fewer in number or are more blunt than those of cancrids. The chelipeds may differ greatly in size. The fingers may bear a large crushing tooth. Only *Cycloxanthops novemdentatus* (Lockington, 1877) grows to the size of an edible cancrid in this area. Xanthoids rarely inhabit sandy shores or sandy areas of the continental shelf, and do not have flattened appendages, as do some common cancrids.

Schmitt (1921: 248) reported the crab *Heteractaea lunata* (Milne-Edwards & Lucas, 1847) (family Xanthidae) as occurring in San Diego, California. Garth (1957) noted that this is primarily a species of the tropical eastern Pacific, and is associated with corals of the genus *Pocillopora*. These corals do not live in California. There are no new records of this species in California. See Hendrickx (1995c) for the recorded geographic range of this crab in the eastern tropical Pacific. The original locality record may have been in error.

Stimpson (1871) described *Micropanope latimanus* briefly and without illustrations. Rathbun (1930) mentioned that the type was not extant, nor was the material mentioned by Lockington (1877a). The species is included here in the family Xanthidae, to which other species of *Micropanope* have been assigned. This crab may not be correctly assigned to genus. There have been no reports of this crab in California since Rathbun (1930) quoted even earlier reports.

Martin & Velarde (1997:105) reported yet another xanthoid-like crab, *Pilumnoides rotundus* Garth, 1940 off San Diego at 695 m. Other records of this crab come mostly from the Gulf of California with a single record from Cedros I., western Baja California. Garth (1940: pl. 23) gave a description and illustration. Originally placed in the family Xanthidae, this crab now is considered to belong to a separate family, the Pilumnoididae, in the superfamily Pseudozioidea (Ng *et al.* 2008: 179).

Family Panopeidae

Key to species of family Panopeidae

1. Eyestalk elongate. Carapace squarish, chelipeds with hands wide, compressed, with ridges on fingers. Living in muddy bays from Santa Barbara area southward *Malacoplax californiensis*
- Eyestalk not elongate. Carapace oval to pentagonal, chelipeds without hands wide, compressed; without ridges on fingers. Living in bays or among rocks, tide pools, may be found north of Santa Barbara 2
2. Fingers of chelae with white apices or white throughout their length. Carpal joints of walking legs not bilobed 3
- Fingers of chelae with black or brown apices. Carpal joints of walking legs slightly to strongly bilobed 4
3. Dactyl of major chela strongly curved. Fingers of chelae light-colored throughout their length. Introduced into bays
- Dactyl of major chela angled downward. Fingers of chelae with proximal dark blotches. Subtidal off Anacapa I., California *Rhithropanopeus harrisi*
- Dactyl of major chela angled downward. Fingers of chelae with proximal dark blotches. Subtidal off Anacapa I., California *Eurypanopeus hyperconvexus*
4. No enlarged tooth present at proximal end of cutting edge of dactyl of major cheliped *Lophopanopeus frontalis*
- Enlarged tooth present at proximal end of cutting edge of dactyl of major cheliped 5
5. Pereopods 2–5 with carpal, meral segments not pubescent. Carapace smooth. Carpus of chelipeds smooth or pitted, never covered with bumps *Lophopanopeus leucomanus*
- Pereopods 2–5 with carpal, meral segments pubescent. Carapace pubescent. Carpus of chelipeds smooth or covered with irregular raised bumps *Lophopanopeus bellus*

Eurypanopeus A. Milne-Edwards, 1880

Eurypanopeus hyperconvexus Garth, 1986

(Fig. 56B)

Eurypanopeus hyperconvexus Garth, 1986: 11, fig. 6 A–F.

Diagnosis. Carapace convex, with rough lines forming ridges on carapace of female. Front with shallow notch, closed fissure. Anterolateral teeth 1, 2 fused, low; teeth 3, 4 subequal, tooth 5 short, triangular. Merus of third maxilliped subrectangular. Chelipeds similar. Carpus with inner tooth blunt. Palm somewhat swollen, upper margins with faint double crest. Finger of major chela without large basal tooth, fingers of minor chela longer, more slender than those of major, neither chela with gape. Pereopods 2–5 slender, carpi without lobes, dactyls long. Male carapace length 10.5 mm, female carapace length 9.6.

Color in life. Body not reported. Fingers of chelae with brown bases, color of immovable finger extending short distance on palm, apices white (Garth 1986).

Habitat and depth. Subtidal on rock and sand, 68–79 m.

Range. Known only from type locality, 0.8–1.6 km NW of Anacapa I. Light, California.

Lophopanopeus Rathbun, 1898

Lophopanopeus bellus (Stimpson, 1860)

(Fig. 56G, Pl. 14C)

Xantho bella Stimpson, 1860: 204, pl. 5, fig. 2.

Lophopanopeus bellus. — Rathbun 1898b: 272; 1904: 180; 1930: 320, pls. 150, 151. — Weymouth 1910: 51, pl. 12, fig. 37. — Schmitt 1921: 241, p. 37, fig. 4, text fig. 143. — Johnson & Snook 1927: 387, fig. 343. — Ricketts *et al.* 1985: 305.—Jensen 1995: 19, fig. 7. — Kuris *et al.* 2007: 643.

Lophopanopeus diegensis Rathbun, 1900: 137; 1904: 184, pl. 9, fig. 3; 1930: 327, pl. 153, figs. 6,7, 10; text fig. 49. — Weymouth 1910: 52, pl. 12, fig. 39. — Schmitt 1921: 245, pl. 37, fig. 5, text fig. 146.

Lophopanopeus bellus bellus. — Menzies 1948: 4, pl. 1, figs. 1–5; pl. 5, fig. 38 (extensive synonymy). — Garth & Abbott 1980: 609, fig. 25.2. — Hart 1982: 202, fig. 82.—Campos & de Campos 1989: 175.

Lophopanopeus bellus diegensis. — Menzies 1948: 7, pl. 1, figs. 6–8. — Garth & Abbott 1980: 609. — Hart 1982: 200, fig. 81. — Campos & de Campos 1989: 175.

Diagnosis. Carapace with few granules on anterior regions, front with tiny notch, 3 developed anterolateral teeth, pubescent. Carpus of chelipeds with tubercles or roughened, tubercles continued on palm or not; major chela with enlarged tooth on movable finger. Carpus of pereopods 2–5 slightly to prominently bilobed, carpus, merus pubescent. Male carapace length to 13.7 mm.

Color in life. Bluish, red, yellowish, mottled with red, brown or gray; carapace, appendages may be of contrasting colors. Dark color on fingers of chelae does not extend to palm. The color notes are from crabs from Moss Beach and Pillar Point, San Mateo County, California; see also Garth & Abbott 1980: figs. 25.24a–25.24d.

Habitat and depth. Rocks, under rocks in sand, tide pools, kelp holdfasts, bases of sea grasses, intertidal zone to 73 m.

Range. Resurrection Bay, Alaska to Tortugas Bay, Baja California. Type locality Monterey, California.

Remarks. There are two subspecies of this species. *Lophopanopeus bellus bellus* is the northern form, ranging from Alaska to Tortugas Bay, Baja California. It is most abundant north of Point Conception, California. In this subspecies, the carpus of the chelipeds may be smooth to roughened, but does not bear irregular raised bumps or tubercles. The carpus of pereopods 2–5 is not markedly bilobed and does not have bumps. *Lophopanopeus bellus diegensis* ranges from Monterey Bay to off Cape Tortola, Baja California, but usually is found south of Point Conception. The carpus of the chelipeds bears irregular raised bumps. The carpus of pereopods 2–5 is markedly bilobed and has bumps.

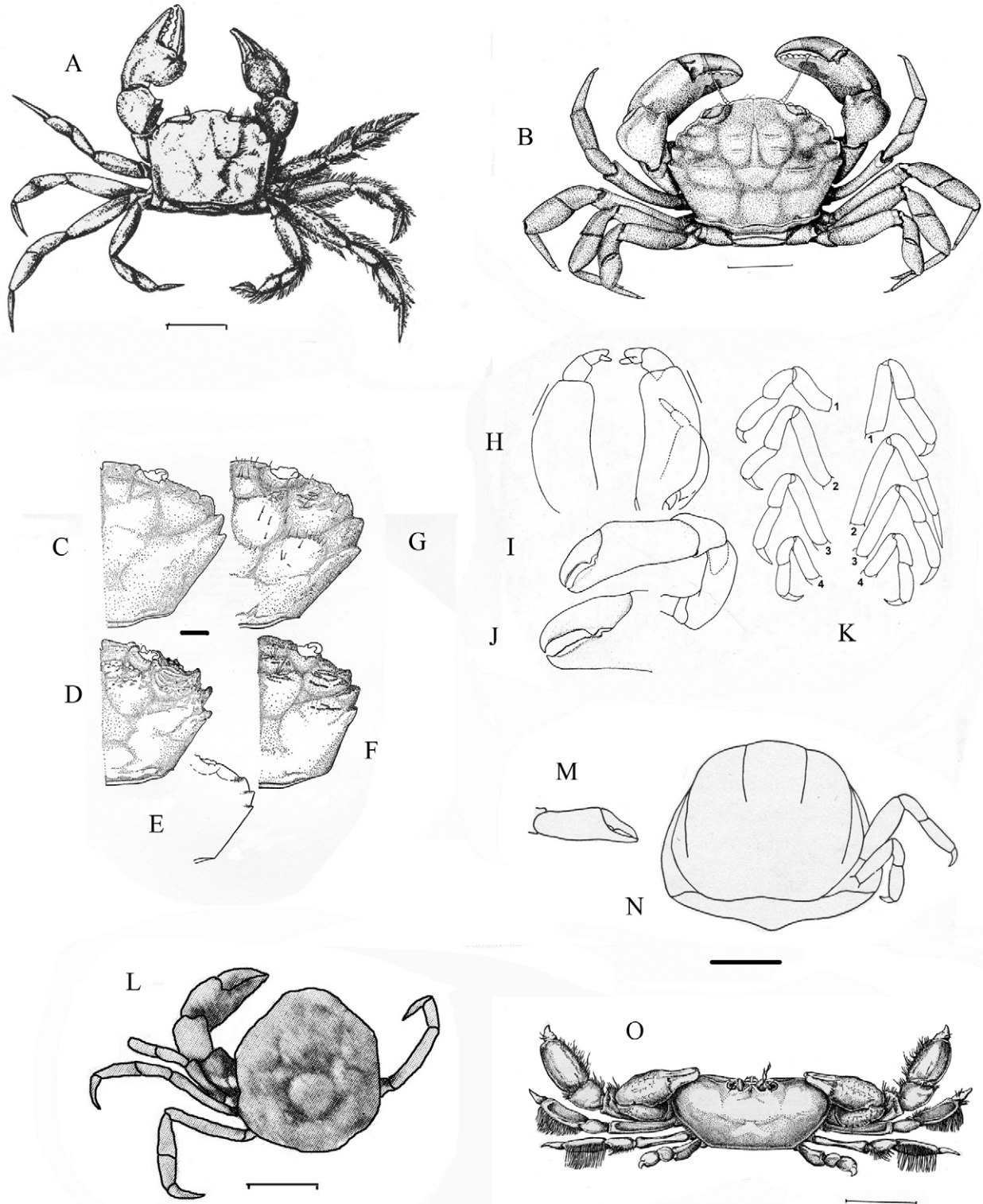


FIGURE 56. Families Panopeidae and Pinnotheridae. A, *Malacoplax californiensis* (Lockington, 1877). B, *Eurypanopeus hyperconvexus* Garth, 1986. C, *Lophopanopeus leucomanus heathii* Menzies, 1948; right side of carapace. D, *Lophopanopeus leucomanus leucomanus* (Lockington, 1877); right side of carapace. E, F, *Lophopanopeus frontalis* (Rathbun, 1893); E, right side of carapace of female; F, right side of carapace of male. G, *Lophopanopeus bellus bellus* (Stimpson, 1860); right side of carapace. H–K, *Enigmatheres canfieldi* (Rathbun, 1918); H, third maxillipeds; I cheliped; J, detail of chela; K, pereopods. L, *Fabia concharum* (Rathbun, 1893); female. M, N, *Fabia subquadrata* Dana, 1851; M, chela; N, adult female in dorsal view. O, *Parapinnixa affinis* Holmes, 1900. Scales: H = 0.57 mm, L = 1 mm, C–G, O = 2 mm, B = 5 mm, A, N = 10 mm. A, L–N from Schmitt 1921, B from Garth 1986, C–G from Menzies 1948, H–K from Campos 2002, O from Glassell 1933.

***Lophopanopeus frontalis* (Rathbun, 1894)**

(Fig. 56E, F)

Lophozozymus frontalis Rathbun, 1894: 236.

Lophoxanthus frontalis. — Holmes 1900: 64, pl. 1, figs. 5, 6.

Lophopanopeus frontalis. — Rathbun 1904: 181, pl. 7, fig. 8; 1930: 323, pl. 152. — Schmitt 1921: 242, pl. 37, fig. 3; text fig. 144. — Johnson & Snook 1927: 387. — Menzies 1948: 16, pl. 3, figs. 17–29, pl. 4, figs. 30–32, pl. 5, figs. 36, 37. — Garth & Abbott 1980: 610, fig. 25.26. — Ricketts *et al.* 1985: 296. — Jensen 1995: 19, fig. 8.

Diagnosis. Carapace almost smooth, somewhat broader than long. Front prominent, with median notch; with 3 developed anterolateral teeth. Chelipeds with carpus, hand smooth, hand with large lobe on upper margin, dactyl without enlarged tooth. Pereopods 2–5 with carpus slightly bilobed, propodus with convex anterior margin. Male carapace length 17.2 mm.

Color in life. Yellowish-brown, fingers of chela black, dark color extending to palm (Menzies 1948, Garth & Abbott 1980: fig. 25.26).

Habitat and depth. Among rocks and among mussels on pilings, intertidal zone to 37 m.

Range. Santa Monica Bay, California to Magdalena Bay, Baja California. Type locality San Diego.

***Lophopanopeus leucomanus* (Lockington, 1877)**

(Fig. 56 C, D)

Xanthodes leucomanus Lockington, 1877a: 32.

Lophopanopeus heathii Rathbun, 1900: 137; 1904: 182, pl. 7, fig. 9. — Weymouth 1910: 51, pl. 12, fig. 38. — Schmitt 1921: 243, pl. 37, fig. 1. — Johnson & Snook 1927: 387, fig. 342.

Lophopanopeus leucomanus. — Rathbun 1904: 182; 1930: 324, pl. 153, figs. 5, 9; pl. 154, fig. 4. — Schmitt 1921: 243, pl. 37, fig. 6, text fig. 145. — Johnson & Snook 1927: 386, fig. 341. — Jensen 1995: 20, fig. 10. — Kuris *et al.* 2007: 643.

Lophopanopeus leucomanus heathii. — Menzies 1948: 13, pl. 2, figs. 15, 16; pl. 5, fig. 34. — Garth & Abbott 1980: 610. — Ricketts *et al.* 1985: 169, fig. 137.

Lophopanopeus leucomanus leucomanus. — Menzies 1948: 10, pl. 2, figs. 9–14; pl. 5, fig. 35 (extensive synonymy). — Campos & de Campos 1989: 175.

Diagnosis. Carapace with anterior half irregularly roughened; granulated patch on hepatic region, front with shallow notch, 3 developed anterolateral teeth. Carpus of chelipeds smooth to pitted. Movable finger of major chela with strong basal tooth. Carpus of pereopods 2–5 slightly to strongly bilobed, without pubescence, propodus broad. Male carapace length to 12.2 mm.

Color in life. White, dark red, brown, gray or mottled; pereopods may have different color than carapace; fingers of chelae with dark color not extending back on palm. See Garth & Abbott 1980: figs. 25.25b–25.25f.

Habitat and depth. Among rocks, tide pools, among tube mollusks, intertidal zone to 200 m.

Range. Moss Beach, San Mateo County, California to Cedros I., Baja California, Mexico. Type locality Monterey, California.

Remarks. There are two subspecies of this species. The typical form, *L. leucomanus leucomanus*, ranges from Carmel to Cedros I. The carpus of the cheliped bears a network of lines ("reticulating ridges"), which extend to the palm of the chela. The carpus of pereopods 2–5 is bilobed. *Lophopanopeus leucomanus heathii* ranges from Moss Beach to La Jolla, California. It does not have the reticulating ridges on the carpus, and the carpus of the walking legs is barely bilobed.

***Malacoplax* Guinot, 1969**

***Malacoplax californiensis* (Lockington, 1877)**

(Fig. 56A)

Eucrate ? californiensis Lockington, 1877a: 33.

Speocarcinus californiensis. — Holmes 1900: 77. — Rathbun 1904: 190, pl. 9, fig. 1; 1917: 42, text fig. 16, pl. 10, figs. 2–3. —

Schmitt 1921: 249, fig. 148, pl. 34, fig. 7. — Johnson & Snook 1927: 389, fig. 346.
Malacoplax californiensis. — Guinot 1969: 259, fig. 27. — Garth & Abbott 1980: 612, fig. 25.30. — Ricketts *et al.* 1985: 357, fig. 274. — Hubbard & Dugan 1989: 55. — Jensen 1995: 33, fig. 50.

Diagnosis. Carapace nearly smooth, width of front over 0.25 times width of carapace, front notched in center; anterolateral carapace margins strongly curved, furnished with 3 teeth apiece. Third maxillipeds diverging anteriorly. Chelipeds unequal; carpus with spine on antero-internal angle, ridge at distal end of outer surface; hands wide, compressed; upper edge acute, sharply granulated, fingers ridged, nearly straight. Pereopod 5 upturned, relatively short. Carapace length 20.8 mm.

Color in life. Brownish to white, chelae with apices of fingers black (Jensen (1995)). The photograph by Garth & Abbott (1980) appears to be that of a preserved specimen.

Habitat and depth. Usually middle to low intertidal zones of mud flats, intertidal zone to 33 m.

Range. Morro Bay, California to Magdalena Bay, Baja California; but usually south of Point Conception. Type locality San Diego, California.

Remarks. *Malacoplax californiensis*, the California burrowing crab, is uncommon and may be endangered by habitat destruction.

***Rhithropanopeus* Rathbun, 1898**

***Rhithropanopeus harrisii* (Gould, 1841)**

(Pl. 14B)

Pilumnus harrisii Gould, 1841: 326.

Rhithropanopeus harrisii. — Rathbun 1898b: 273; 1930: 456, pl. 183, figs. 7, 8. — Garth & Abbott 1980: 610, fig. 25.27. — Williams 1984: 401, figs. 316-317. — Ricketts *et al.* 1985: 296. — Jensen 1995: 18, fig. 5. — Kuris *et al.* 2007: 642.

Diagnosis (after Williams 1984). Carapace subquadrate, about as long as wide, sparsely pubescent toward anterolateral angles, lines of granules across carapace. Front almost straight, slightly notched. First anterolateral tooth fused with postorbital angle, followed by 2–3 other anterolateral teeth. Chelipeds unequal. Carpus with moderately developed internal tooth. Major chela with short fixed finger, strongly curved dactyl. Minor chela with proportionately longer fixed finger, long straight dactyl. Pereopods 2–5 long, slender, compressed, somewhat setose. Male carapace length 15.6 mm, female carapace length 12.4 mm.

Color in life. Brown to pale gray or yellowish above, pale below; fingers of chelae light-colored throughout their length. The color notes are from crabs from various locations in Texas.

Habitat and depth. Rocks, oyster shells, or debris, often in estuarine areas, intertidal zone to 36.6 m, but usually shallow.

Range. Native to southwestern Gulf of St. Lawrence, Canada to Veracruz, Mexico; introduced into parts of Europe and San Francisco and Coos Bays on west coast of U.S.A. Type locality Cambridge Marshes and Charles River, Massachusetts.

Family Xanthidae

Key to Species of family Xanthidae

1. Carapace, chelipeds with prominent rounded tubercles *Paraxanthiastaylori*
- Carapace, chelipeds without prominent rounded tubercles. 2
2. Width of fronto-orbital border less than half of greatest width of carapace. Anterolateral margin of carapace with 8–10 teeth. Carapace broadly oval *Cycloxanthops novemdentatus*
- Width of fronto-orbital border half or more of greatest width of carapace. Anterolateral margin of carapace with fewer than 8 teeth. Carapace not broadly oval *Micropanope latimanus*

Cycloxanthops Rathbun, 1897

Cycloxanthops novemdentatus (Lockington, 1877)

(Pl. 14C)

Xanthodes ? *novem-dentatus* Lockington, 1877a: 32.

Cycloxanthops rugosa Holmes, 1900: 59.

Cycloxanthops rugosus. — Rathbun 1904: 180. — Schmitt 1921: 240.

Cycloxanthops novemdentatus. — Holmes 1900: 56, pl. 1, fig. 2. — Rathbun 1904: 180, pl. 7, fig. 10; 1930: 292, pl. 134, fig. 1; pl. 135, figs. 2, 3, text fig. 46 (extensive synonymy). — Weymouth 1910: 50, pl. 12, fig. 36. — Schmitt 1921: 239, pl. 37, fig. 7, text fig. 142. — Johnson & Snook 1927: 386, fig. 340. — Garth & Abbott 1980: 608, fig. 25.23. — Ricketts *et al.* 1985: 172, fig. 141. — Jensen 1995: 18, fig. 6. — Kuris *et al.* 2007: 642.

Diagnosis. Carapace broad, slightly convex, somewhat roughened toward anterior; front with deep, closed median notch (more evident in smaller individuals), anterolateral margin with 8–9 teeth besides postorbital tooth. Merus of third maxillipeds obliquely truncate at anterior end. Carpus of chelipeds roughened, with 2 blunt teeth at antero-internal angle; hand roughened above, upper, lower margins nearly parallel; fingers long, grooved; not gaping. Pereopods 2–5 with setose margins, dactyls longer than propodi. Carapace length 23.9 mm.

Color in life. Brown, purple or red, rarely white; fingers of chelipeds black, teeth along inner chela margins white (Jensen 1995).

Habitat and depth. Tide pools, rocks, among sea grasses or tube mollusks, low intertidal zone to 73 m.

Range. Monterey Bay, California to Magdalena Bay, Baja California. Type locality San Diego, California.

Remarks. This is the largest xanthoid crab of California, and the most likely to be confused with a species of the Cancridae.

Micropanope Stimpson, 1871

Micropanope latimanus Stimpson, 1871

Micropanope latimana Stimpson, 1871: 107.

Xanthodes latimanus. — Lockington, 1877a: 31.

Xanthias latimanus. — Holmes 1900: 66. — Rathbun 1904: 185. — Schmitt 1921: 247.

Micropanope latimanus. — Rathbun 1930: 433 (extensive synonymy).

Diagnosis (after Rathbun 1930). Carapace moderately convex, smooth except for granules along anterior, anterolateral margins. Front broad. Chelipeds unequal, minor chela with fingers more deflexed than those of major chela; angular. Palms broader than long, smooth, polished; strongly protuberant at postero-inferior angle. Fingers black, as long as palm, deflexed. Pereopods 2–5 with slender dactyls, with sparse setae. Carapace length 7.1 mm. There is no information on the number of lateral teeth of the carapace.

Color in life. "Marbled" (Lockington 1877).

Habitat and depth. Not reported.

Range. San Diego, California, Cape San Lucas, Baja California; and in Gulf of California from Mulege Bay, Port Escondido and San Jose I. Type locality Cape San Lucas.

Remarks. All of the specimens of this species seem to have been lost or destroyed. Stimpson's material, Lockington's types and any other early specimens of the California Academy of Sciences probably were burned. There are no illustrations at all of this species. The few records seem to indicate that the species should occur more frequently in Baja California Sur than in California, U.S.A. Garth (1986) noted that the genus *Micropanope* probably needs revision.

A. Milne-Edwards (1880, quoted by Rathbun 1917) suggested that *M. latimanus* might be a junior synonym of *Glyptoplax pugnax* Smith, 1870 (family Panopeidae), a species reported from Costa Rica and Panama. A different species, *Glyptoplax consagae* Hendrickx 1989, has been collected in the northern Gulf of California. There are no verified reports of either species of *Glyptoplax* in the southern Gulf of California, the Pacific coast of Baja California or California, U.S.A.

***Paraxanthias* Odhner, 1925**

***Paraxanthias taylori* (Stimpson, 1860)**

(Fig. 55F, Pl. 14E)

Xanthodes taylori Stimpson, 1860: 208, pl. 3, fig. 3.

Xanthias taylori.—Holmes 1900: 65. — Rathbun 1904: 185. — Weymouth 1910: 52, pl. 13, fig. 40. — Schmitt 1921: 246, fig. 147. — Johnson & Snook 1927: 389, fig. 344.

Paraxanthias taylori. — Rathbun 1930: 466, pl. 188, pl. 189, fig. 1. — Garth & Abbott 1980: 611, fig. 25.28. — Ricketts *et al.* 1985: 172, fig. 142. — Jensen 1995: 19, fig. 9. — Kuris *et al.* 2007: 642, pl. 320B.

Diagnosis. Carapace nearly flat posteriorly, front divided by wide, rounded notch, with 4 or 5 anterolateral teeth, anterior half of carapace bearing bumps or tubercles. Chelipeds often unequal, carpus covered with rounded tubercles, hand with tubercles in 7–8 longitudinal rows; fingers stout, black; gaping in major chela. Pereopods 2–5 covered with stiff setae. Carapace length 24.6 mm.

Color in life. Dark red, lighter below, fingers black. See color photograph by Jensen (1995) and pl. 14E.

Habitat and depth. Among rocks, kelp holdfasts or among tube mollusks, intertidal zone to 100 m.

Range. Monterey, California to Magdalena Bay, Baja California. Type locality Monterey.

Remarks. The lumpy rubble crab is most common from Santa Monica Bay southward into Baja California.

SUPERFAMILY PILUMNOIDEA Samouelle, 1819

Family Pilumnidae Samouelle, 1819

Pilumnids can be distinguished easily from xanthoids by their coarse setae. Like xanthoids, they are most abundant in warm temperate and tropical areas, and generally live among rocks, corals or shells. Ng *et al.* (2008: 135) gave additional taxonomic references on these crabs.

***Pilumnus* Leach, 1815**

***Pilumnus spinohirsutus* (Lockington, 1877)**

(Fig. 55G, Pl. 14F)

Acanthus spino-hirsutus Lockington, 1877a: 32.

Pilumnus spino-hirsutus. — Holmes 1900: 67.

Pilumnus spinohirsutus. — Rathbun 1904: 185, pl. 7, fig. 2; 1930: 503, pl. 203. — Schmitt 1921: 247, pl. 37, fig. 10.—Johnson & Snook 1927: 389, fig. 345. — Garth & Abbott 1980: 611, fig. 25.29. — Ricketts *et al.* 1985: 172, fig. 143. — Jensen 1995: 18, fig. 4.

Diagnosis. Carapace strongly convex, covered with stiff setae; median frontal lobes truncated, separated by prominent notch; each frontal lobe armed with 4 or 5 spines; orbits armed with strong spines; 5 anterolateral spines. Chelipeds unequal, setose, carpus with spines, hand with several series of spines, fingers dark colored. Carapace length 25.4 mm.

Color in life. Pale brown, red, golden brown. Transverse ridge in front of mouth area with bright red tint. The color notes are from crabs from Redondo Beach and San Pedro, Los Angeles County, California.

Habitat and depth. Among rocks or tube mollusks, tide pools, breakwaters, harbors; intertidal zone to 25 m.

Range. Venice, Los Angeles County, California to Magdalena Bay, Baja California. Type locality San Diego, California.

Remarks. This crab usually is well hidden under rocks or in holes. It seems to prefer warmer waters. It is common near outlets of a power plant in King Harbor at Redondo Beach, California.

SUPERFAMILY PINNOTHEROIDEA de Haan, 1833

Family Pinnotheridae de Haan, 1833

The pea crabs generally are commensals of larger invertebrates, including polychaete and echiuroid worms, pelecypods, large chitons, keyhole limpets, sea urchins, sea cucumbers, and ascidians. The species generally associate with only one general type of host: those that live with polychaetes usually do not associate with mollusks and vice versa, for example. The associations do not seem to be species-specific.

Pinnotherids have a rounded to rectangular carapace, often wider than long. Usually, the carapace is soft. Most pinnotherids are colored whitish to yellowish, but some, such as *Opisthopus transversus* Rathbun, 1893; may have a spotted carapace and banded legs. The front, eye and orbits may be reduced. The antennules fold transversely.

Sexual dimorphism is pronounced in certain pinnotherids, with males being smaller and having a less inflated body than the females. In others, the chelae of the male are sturdier than those of the female. Pereopods 2–5 may differ in size and shape from anterior to posterior. The dactyls of pereopods 2–5 may be modified for crawling, grasping, or gripping the surface of a host.

Members of the family Pinnotheridae lately have undergone taxonomic revision. The generic placement of tropical species has been revised; males and females of sexually dimorphic groups have been matched so that some names applied only to one sex have been put into synonymy. For references prior to 1970, the account by Schmitt *et al.* (1973) remains valuable. The key given here follows the work of Davidson (1968) and Zmarzly (1992). Zmarzly's study of species of *Pinnixa* should be consulted for additional anatomical details and illustrations. A key by Campos-Gonzalez (2007) to the intertidal pinnotherids of central California to Oregon includes new drawings and valuable information. That key includes several species, such as *Parapinnixa affinis* Holmes, 1900; that have not been reported north of Point Conception.

Pinnotheres holmesi Rathbun, 1918 and *Pinnotheres nudus* Holmes, 1895 (part) seem to be synonyms of the Atlantic oyster crab *Zaops geddesi* (Miers, 1880). This crab may have been introduced with the oyster *Crassostrea virginica* in the early twentieth century but has not been reported in the area since then. *Pinnotheres nudus* as originally described, however, may be a synonym of *Opisthopus transversus*.

Key to species of family Pinnotheridae

1. Ischium of third maxillipeds rudimentary or indistinguishably fused with merus; palp not more than 0.5 times as large as merus-ischium. Carapace rounded, subquadrate or broadly transverse 2
 - Ischium of third maxillipeds usually distinct from merus, although smaller, sometimes imperfectly joined with it; palp of larger size, usually about as large as merus-ischium. Carapace broadly transverse 6
2. Carapace much broader than long, anterior margin nearly straight. Pereopods 2–5 diminishing in length from anterior to posterior, pereopod 5 very small *Parapinnixa affinis*
 - Carapace suborbicular or subquadrate, not strikingly wider than long. Pereopods 2–5 not successively diminishing in length from anterior to posterior 3
3. Carapace without 2 longitudinal, impressed lines leading posteriorly from middle of upper margin of orbit. Symbiotic with ascidians *Pinnotheres pugettensis*
 - Carapace with 2 longitudinal, impressed lines leading posteriorly from middle of upper margin of orbit. Usually symbiotic with pelecypods, occasionally echinoderms, rarely ascidians 4
4. Female: pereopods 3 unlike, right longer than left. Commensal in keyhole limpet, *Megathura crenulata*
..... *Enigmatheres canfieldi*
 - Female: pereopods 3 alike. Symbiotic with pelecypods, echinoderms, rarely ascidians 5
5. Female: Front sharply deflexed with transverse sulcus across vertical front between orbits; hand of cheliped widening distally, bearing two rows of setae along lower margin. Male: terminal abdominal segment semi-circular, immovable finger of chela bearing large serrate lobe on upper margin. Alaska to La Jolla, California *Fabia subquadrata*
 - Female: Front sharply deflexed but lacking transverse sulcus across vertical front between orbits; hand of cheliped not widening distally, bearing one row of setae along lower margin. Male: terminal abdominal segment widening distally with distal margin slightly deflexed, immovable finger of chela bearing 2 small teeth or lobes on upper margin. San Pedro, California to Magdalena Bay *Fabia concharum*
6. Carapace about as wide as long, suborbicular. Pereopods 2–5 more or less subequal, pereopod 3 longest. Carapace spotted red to purple *Opisthopus transversus*
 - Carapace much wider than long. Pereopod 4 longest. Carapace whitish to brown, not spotted 7
7. Pereopod 4 not markedly longer than others, legs more or less subequal. Carapace hard, granulate anteriorly; lower anterolateral margin curving gradually into posterolateral margin *Scleroplax granulata*
 - Pereopod 4 markedly longer, larger than others. Carapace usually soft, if hard, not granulate; lower anterolateral margin forming angle with posterolateral margin 8
8. Carapace strongly convex, hard, 1.5 times as wide as long. Often symbiotic with holothurians *Pinnixa barnharti*

- Carapace flat or slightly convex, more than 1.5 times as wide as long. Not symbiotic with holothurians9
- 9. Dactyl of pereopod 5 shorter than propodus 10
- Dactyl of pereopod 5 equal to or longer than propodus 14
- 10. Apex of dactyl of pereopod 5 falling short of or just reaching distal end of merus of pereopod 4 when both legs extended .. 11
- Apex of dactyl of pereopod 5 reaching beyond distal end of merus of pereopod 4 when both are extended. 12
- 11. Posteroventral margin of ischium of pereopod 5 with 2–3 large tubercles; margins of pereopod 5 with long fringe of setae ...
..... *Pinnixa longipes*
- Posteroventral margin of ischium of pereopod 5 without tubercles; pereopod 5 without long fringe of setae ..*Pinnixa tubicola*
- 12. Ventral margin of propodus of pereopod 4 with 2 ridges, ridges granulate or serrate; dactyl of pereopod 4 spinous, slightly curved *Pinnixa tomentosa*
- Ventral margin of propodus of pereopod 4 without ridges; dactyl of pereopod 4 smooth, strongly curved. 13
- 13. Male: fixed finger of chela slightly deflexed relative to palm; inner margin of dactyl of chela toothless. Female: fixed finger slightly deflexed; slight gape visible between opposing margins of fingers of chela when fingers tightly closed
..... *Pinnixa littoralis*
- Male: fixed finger of chela straight relative to palm; inner margin of dactyl of chela with single blunt triangular tooth. Female: fixed finger nearly straight; opposing margins of fingers of chela meeting tightly, no gape *Pinnixa faba*
- 14. Anterolateral aspect of carapace with granulate or serrate ridge 15
- Anterolateral aspect of carapace smooth, round; without granulate or serrate ridge 19
- 15. Fixed finger of chela angled obliquely downward relative to palm 16
- Fixed finger of chela straight or curving upward; not deflexed 17
- 16. Length of propodus of pereopod 4, 1.5–2 times its width *Pinnixa occidentalis*
- Length of propodus of pereopod 4, at least 2.5 times its width *Pinnixa scamit*
- 17. Anterior face of chela entirely smooth, without granules or with line of coarse granules just above ventral margin of propodus, scattered granules over rest of propodus *Pinnixa schmitti*
- Anterior face of chela with line of tubercles or granules above ventral margin, rest of palm smooth or granulate 18
- 18. Anterior face of chela with line of tubercles just above ventral margin, largely confined to region where fixed finger meets palm; rest of palm smooth *Pinnixa hiatus*
- Anterior face of chela with prominent line of densely packed granules forming ridge above ventral margin, running most of length of propodus; dorsal margin of propodus granulate *Pinnixa franciscana*
- 19. Inner margin of dactyl of chela with single small triangular tooth at midpoint *Pinnixa weymouthi*
- Inner margin of dactyl of chela toothless 20
- 20. Fingers of chela long, about twice as long as length of palm; apex of dactyl of pereopod 5 falling short of distal end of carpus of pereopod 4 when both legs extended *Pinnixa forficulimanus*
- Fingers of chela short, about as long as length of palm; apex of dactyl of pereopod 5 exceeding distal end of carpus of pereopod 4 when both legs extended *Pinnixa minuscula*

***Enigmatheres* Campos-Gonzalez, 2002**

***Enigmatheres canfieldi* (Rathbun, 1917)**

(Fig. 56H–K)

Fabia canfieldi Rathbun, 1917: 106, text fig. 57, pl. 24, figs. 5, 7. — Schmitt 1921: 254, pl. 39, figs. 5, 6. — Schmitt *et al.* 1973: 22.

Enigmatheres canfieldi. — Campos-Gonzalez 2002: 31, fig. 1.

Diagnosis. Female: Carapace broad, soft. Front without setae, with short, longitudinal median depression. Second segment of palp of third maxilliped small, shorter, narrower than first segment, terminal segment attached at middle. Palm of chela increasing in width to distal end, fingers long, inclined downward, lower margin of propodus sinuous, fingers not gaping, setose on upper surface, prehensile tooth at middle of dactyl, smaller one at base of fixed finger. Pereopods 2–5 slender, subcylindrical. Pereopod 2 stouter than others, propodi slightly curved, dactyls short, slender. Length of pereopod 3 on right side about 0.3 times longer than length of pereopod 3 on left. Dactyls with hooked apices except on right pereopod 3, with dactyl long, straight. Carapace length about 5 mm. Male has not been described.

Color in life. Not reported.

Habitat and depth. In mantle cavity of keyhole limpet, *Megathura crenulata* (G.B. Sowerby, 1825). Depth not reported but probably low intertidal or subtidal zone, where the limpet lives.

Range. Known only from type locality, Monterey, California.

Remarks. Except for the peculiarly elongated legs and their asymmetry, this crab closely resembles the

polymorphic crab *Fabia subquadrata* Dana, 1851. That species usually associates with pelecypods. More study is needed to determine whether or not this is truly a distinct species.

***Fabia* Dana, 1851**

***Fabia concharum* (Rathbun, 1893)**

(Fig. 56L)

Cryptophrys concharum Rathbun, 1893: 250 (part).—Rathbun 1904: 188, pl. 7.—Weymouth 1910: 60.

Raphonotus lowei Rathbun, 1900c: 590; 1904: 186, text fig. 93.

Fabia lowei Rathbun 1917: 104, pl. 24, figs. 2, 4, text fig. 55. — Schmitt 1921: 254, pl. 39, figs. 3, 4, text fig. 151. — Johnson & Snook 1927: 391.

Pinnotheres concharum. — Rathbun 1917: 86, pl. 20, figs. 3–6, text fig. 42 (part). — Schmitt 1921: 252, pl. 38, figs. 1–4.

Fabia concharum. — Davidson 1968: 87, fig. 1B, 1C, 1E, 1F (extensive synonymy). — Schmitt *et al.* 1973: 23. — Garth & Abbott 1980: 613, fig. 25.32.

Diagnosis. Carapace subpentagonal, slightly longer than broad, smooth, rigid, with ridge of coarse setae along anterior, anterolateral margins. Female front sharply deflexed, lacking transverse sulcus across vertical front between orbits. Orbits circular, antennules large, nearly transverse. Palp of third maxilliped very small, merus produced on distomedial margin. Hand of cheliped not widened distally, bearing one row of setae along lower margin. Pereopods 2–4 subequal, pereopod 5 shortest, dactyls about as long as propodi, ending in curved hooks. Male abdomen with terminal segment widening distally, sixth segment hairless with margins subparallel, abdomen considerably wider near proximal end than at distal end. Male carapace length 3.0 mm, female 10.0 mm.

Color in life. Pale brown (Garth & Abbott 1980: fig. 25.32).

Habitat and depth. Commensal in mantle cavities of pelecypods, intertidal to subtidal. zones. Males may move between hosts.

Range. San Pedro, California to Turtle Bay, Baja California. Type locality San Diego Bay, California.

Remarks. Davidson (1968) explained the confusion between this species and *Fabia subquadrata*.

***Fabia subquadrata* Dana, 1851**

(Fig. 56M, N)

Fabia subquadrata Dana, 1851: 253. — Holmes 1900: 87 (part). — Rathbun 1917: 102, pl. 24, figs. 1, 3; text fig. 53 (part) — Schmitt 1921: 253, pl. 39, figs. 1, 2; text fig. 150. — Johnson & Snook 1927: 391, fig. 347. — Davidson 1968: 85, fig. 1A.

1D, 1G, 1H. — Schmitt *et al.* 1973: 24. — Garth & Abbott 1980: 612, fig. 25.31. — Hart 1982: 226, fig. 93. — Ricketts *et al.* 1985: 221, fig. 179. — Campos 1986: 238. — Jensen 1995: 30, fig. 39. — Campos-Gonzalez 2007: 644, pl. 321 B3.

Raphonotus subquadratus. — Rathbun 1904: 186. — Weymouth 1910: 55, fig. 2.

Diagnosis. Carapace smooth, membranous, subquadrate; soft in adult female, hard in male. Female front sharply deflexed with transverse sulcus across vertical front between orbits. Anterolateral margin rounded, marked by round cluster of pits, male with dense pubescence along margin. Antennules in very wide grooves. Male with large orbits. Palp of third maxilliped about as long as adjacent segment, merus with small point on distomedial margin. Palm of chela widened distally, bearing 2 rows of setae along lower margin. Immobile finger with large serrate lobe on upper margin; dactyl with 1 large tooth on lower margin, upper margin with tuft of dense setae. Pereopods 2–5 with segments flattened, margins densely pubescent, dactyls large, subequal, curved. Male abdomen with terminal segment semi-circular, lateral margins of penultimate segment distally depressed, broader at proximal end than distal but not markedly so. Male carapace length to 7.3 mm, female to 16.2 mm.

Color in life. Translucent whitish to yellowish, at times with dark areas on carapace (Jensen 1995).

Habitat and depth. Usually commensal in pelecypods, especially mussels, *Mytilus* spp., and soft-shell clams, *Mya arenaria* Linnaeus, 1758. Also reported from other pelecypods, rarely sea urchins, ascidians; intertidal zone to 220 m. Garth & Abbott (1980) gave a list of hosts.

Range. Akutan Pass, Aleutian Is. to Todos Santos Bay, Baja California, Mexico. Type locality Puget Sound.

Remarks. The grooved mussel crab perhaps is the largest and best known of the pinnotherids of the western coast of North America. Its change of size, shape and habitat during its life cycle can cause confusion with other species. Smaller individuals are more setose and can swim. The first host usually is a clam. The crabs produce hard shells prior to molting, accomplished while the crabs swarm into the plankton. Ovigerous females develop a large, soft exoskeleton later when they move to a larger host, often a mussel. Males remain hard-shelled. Garth & Abbott (1980) gave additional information and references on the life cycle.

***Opisthopus* Rathbun, 1893**

***Opisthopus transversus* Rathbun, 1893**

(Fig. 57A, Pl. 15B)

Opisthopus transversus Rathbun, 1893: 252; 1904: 188, text fig. 95; 1917: 173, pl. 37, figs. 4, 5; text fig. 110. — Holmes 1900: 97. — Weymouth 1910: 61, text fig. 9. — Schmitt 1921: 268, pl. 44, figs. 4, 5, text fig. 158. — Johnson & Snook 1927: 394, fig. 350. — Schmitt *et al.* 1973: 131. — Garth & Abbott 1980: 618, fig. 25.42. — Ricketts *et al.* 1985: 105, fig. 80. — Campos-Gonzalez *et al.* 1992: 754. — Jensen 1995: 31, fig. 44. — Campos-Gonzalez & Manning 2000: 799. — Campos-Gonzalez 2007: 644, fig. 321 C1.

Pinnotheres nudus Holmes 1895: 563, figs. 1–5. — Rathbun 1917: 83, fig. 40. — Schmitt 1921: 252, fig. 149. — Johnson & Snook 1927: 391. — Schmitt *et al.* 1973: 60.

Not *Pinnotheres nudus* Weymouth, 1910: 53, fig. 1; =*Zaops geddesi* (Miers, 1880); Atlantic species; see Campos & Manning 2000: 803.

Diagnosis. Carapace somewhat rounded, convex, moderately hard. Front deflexed, almost straight, with slight median groove. Antennules well developed, set in deep notches. Third maxilliped with ischium well developed, merus broad, palp 3-jointed, last joint articulated on inner side of preceding joint. Chelae short, stout. Pereopods 2–5 similar to each other, segments rather broad, dactyls curved, small. Abdomen of male narrow at base, tapering from third segment to end; abdomen of female wide, long. Male carapace length to 10 mm, female to 17 mm.

Color in life. Carapace mottled with vermilion to deep red, legs banded with red to purple, background white to cream. The color notes are from crabs from Cabrillo Beach, Los Angeles County, California.

Habitat and depth. Commensal in mantle cavities of pelecypods, gastropods (including large opisthobranchs), and giant chiton *Cryptochiton stelleri* (von Middendorff, 1847); in cloacae of sea cucumbers, and with polychaete *Chaetopterus variopedatus*; intertidal to subtidal zones.

Range. Monterey, California to San Ignacio Lagoon, Baja California; San Felipe, Baja California (Gulf of California). Type locality Monterey.

Remarks. Evidence suggests that the color of the crab is dependent on the habitat and host. Crabs that inhabit suspension-feeding pelecypods tend to have less color than those that live in deposit-feeding or grazing hosts. Garth & Abbott (1980) gave further information and references.

After storms, the mottled pea crab may be cast ashore alive and away from a host. The crabs can crawl easily. It is not known if they move from host to host under normal conditions.

***Parapinnixa* Holmes, 1895**

***Parapinnixa affinis* Holmes, 1900**

(Fig. 56O)

Parapinnixa affinis Holmes, 1900: 95. — Rathbun 1917: 111. — Schmitt 1921: 255. — Glassell 1933: 321, pls. 20, 21. — Schmitt *et al.* 1973: 31. — Garth & Abbott 1980: 614, fig. 25.33. — Campos-Gonzalez *et al.* 1992: 756. — Campos-Gonzalez 2007: 644.

Diagnosis (after Glassell, 1933). Carapace smooth, shining; transversely oval, anterolateral corner dilated, making straight line at anterior margin. Front broad, triangular, with short median groove. Orbit oval, inner hiatus wide, partly filled by basal segment of small, short antenna. Antennule folding obliquely. Buccal area small, broadly triangular. Ischium of third maxilliped rudimentary, merus large, triangular, with 3-segmented palp. Cheliped stout, smooth, hand dilated, dactyl hooked at apex, armed with small tooth near middle of inner margin, upper side

smooth; fixed finger with 2 distal teeth, large triangular tooth extending from apex to proximal side of center. Single row setae extending longitudinally from margin of carpus to fixed finger, gape of dactyl with fringe short setae. Pereopod 2 larger than others; dactyl short, stout. Pereopods 3, 4 comparatively slender, with slightly longer dactyls. Pereopod 5 small, reaching about to apex of merus of preceding pair, dactyls short, stout, slightly hooked. Merus of pereopods 3–5 compressed, broad. Abdomen with 7 segments, widest at segment 3, segment 7 nearly twice as long as broad. Carapace length to 3.6 mm long.

Color in life. Carapace light amber with mottling of dark ochre, protogastric, cardiac regions light orange; rarely white. Legs pale ochre with greenish tinge, dactyl yellow with white apex. Setae on pereopods 3, 4 reddish brown (Glassell 1933).

Habitat and depth. Bays and harbors, low intertidal zone among mud, sand, shells, algae; living in tube with polychaetes *Amphitrite* sp., *Neoleprea californica* Moore, 1904; and *Loimia* sp.

Range. San Pedro to San Diego, California; La Bajada, Tortugas Bay, Baja California, Mexico. Most reports are from Newport Bay, Orange County, California. Reports from Sakhalin and the Kurile Is. may refer to *Parapinnixa yokoyai* Glassell, 1933. Type locality Deadmans I., San Pedro, California.

Remarks. Although Glassell (1933) was able to study "hundreds" of this crab, the California bay pea crab has rarely been reported since then. The type locality, Deadmans I., was destroyed during development inside Los Angeles Harbor. Other protected bays of southern California have undergone various types of habitat destruction which probably adversely affected this and other crabs.

Pinnixa White, 1846

Pinnixa barnharti Rathbun, 1917

(Fig. 57E)

Pinnixa barnharti Rathbun, 1917: 149, fig. 91, pl. 32, text fig. 91. — Schmitt 1921: 261, pl. 41 — Schmitt *et al.* 1973: 103. — Garth & Abbott 1980: 614, fig. 25.34. — Ricketts *et al.* 1985: 338. — Zmarzly 1992: 679, figs. 2, 3. — Jensen 1995: 31. — Campos-Gonzalez 2007: 644, pl. 322 A.

Diagnosis. Carapace hexagonal, calcified, convex, anterolateral margin with line of fine granules, surface coarsely pubescent towards sides, furrow behind gastric region shallow, 3 deep pits on each side anteriorly, posterior margin concave. Lobes of front prominent, arcuate. Orbits broadly oval. Length of antenna as long as width of front, one orbit. Chelipeds large, merus setose above, chelae dilated toward fingers, sinus in lower margin near base of subhorizontal fixed finger, apex obliquely truncate, lower corner armed with short, sharp tooth, dactyl oblique, making gape with fixed finger, strong tooth in middle of dactyl, fringe of setae above, patch of setae in gape. Pereopods 2–5 thick, merus setose, propodus tapering, dactyl short, relatively straight. Pereopod 2 nearly as long as pereopod 3, pereopod 4 longest, propodus of pereopods 4, 5 setose below, carpus, propodus of pereopod 5 setose above. Carapace length to 10.7 mm.

Color in life. Creamy to brownish with brown mottling. The color notes are from a crab from Abalone Cove, Palos Verdes Peninsula, Los Angeles County, California.

Habitat and depth. Bays, sandy areas, living in cloacae of holothuroids, especially *Caudina* spp., low intertidal to subtidal zones.

Range. Puget Sound; Venice, California to Ballenas Bay, Baja California; Zihuatanejo, Guerrero, Mexico. Type locality Venice, California. Most recent records come from southern California.

Pinnixa faba (Dana, 1851)

(Fig. 57F, G)

Pinnotheres faba Dana, 1851: 253.

Pinnixa faba. — Holmes 1900: 93. — Rathbun 1904: 188; 1917: 142, pl. 31, figs. 1–4, text figs. 27, 88. — Weymouth 1910: 59, text fig. 7 (part). — Schmitt 1921: pl. 40, figs. 1–4, text fig. 154. — Johnson & Snook 1927: 393. — Zullo & Chivers 1969: 72, fig. 2. — Schmitt *et al.* 1973: 108. — Garth & Abbott 1980: 615, fig. 25.3. — Hart 1982: 234, fig. 97. — Ricketts

et al. 1985: 377. — Zmarzly 1992: 682, fig. 4. — Schneider 1993: 842.—Jensen 1995: 30, fig. 41. — Campos-Gonzalez 2007: 645, pl. 323 A3.

Diagnosis. Carapace 1.5–1.9 times as long as wide, strongly convex, truncated at sides, no transverse ridge behind gastric area, anterolateral margins marked by low ridge. Orbits oval. Female more rotund than male, with bilobed frontal region. Hands of chelipeds flattened, pubescent on inner side between fingers; fingers of female short, straight, those of male curved, gaping. Male chela more robust than that of female. Pereopods 2–5 robust, carpus, propodus about equal in length; dactyl shorter than propodus, somewhat curved. Pereopod 4 longest. Dactyl of pereopod 5 reaching middle of carpus of pereopod 4. Female carapace length 11.7 mm, male smaller.

Color in life. Brown to brownish red, dirty white, yellowish to pure white; see color photograph by Jensen (1995).

Habitat and depth. Usually symbiotic in mantle cavity of pelecypods, rarely gastropods, holothuroids, ascidians; in sheltered intertidal areas. A late Pleistocene fossil of this species was found in the shell of *Tresus capax* (Zullo & Chivers 1968).

Range. Prince of Wales I., Alaska to Camalu Point, Baja California, Mexico. Type locality Puget Sound, Washington.

Remarks. The mantle pea crab is a common pinnotherid of intertidal habitats. It can be confused with *P. littoralis*. Males of *P. faba* have characteristic chelae in which the fixed fingers are straight and tapering to a conical apex. In *P. littoralis*, the fixed fingers are slightly deflexed and have excavated apices. Females of *P. faba* have fingers of the chelae without gapes; in *P. littoralis*, the fingers gape slightly when closed. Zmarzly (1992) gave further details on differentiation of *P. faba* from *P. littoralis*.

***Pinnixa forficulimanus* Zmarzly, 1992**

(Fig. 57H–J)

Pinnixa forficulimanus Zmarzly, 1992: 685, fig. 6.

Diagnosis. Carapace 1.8–2.2 times as wide as long, flattened, shiny, dorsal surface with shallow pits, anterolateral region smooth, lacking ridge. Slight depression in gastric region. Frontal margin straight; median groove not well developed. Chela small, scissors-like, with long, thin fingers. Length of fingers about twice length of palm, apices crossing when closed. Palm of chela sparsely setose, dorsal margin of dactyl also setose. Pereopods 2–5 similar in form and flattened, with smooth margins, dactyls slender, straight to slightly curved. Pereopod 4 more robust than others. Apex of dactyl of pereopod 5 reaching middle of carpus of pereopod 4. Carapace length about 2 mm.

Color in life. Carapace translucent, organs visible within, with brown coloration (Zmarzly 1992).

Habitat and depth. Sandy areas, 12–46 m. Symbiotic associations unknown.

Range. Santa Cruz to San Diego, California. Type locality Santa Cruz, California.

***Pinnixa franciscana* Rathbun, 1917**

(Fig. 57K, L)

Pinnixa franciscana Rathbun, 1917: 161, pl. 35, figs. 1–4, text fig. 100. — Schmitt 1921: 263, pl. 42, figs. 1–4. — Schmitt *et al.* 1973: 110. — Garth & Abbott 1980: 671, fig. 25.38. — Ricketts *et al.* 1985: 307, fig. 238. — Zmarzly 1992: 687, fig. 7. — Campos-Gonzalez 2007: 646, pl. 325 A3.

Diagnosis. Carapace about twice as wide as long, pitted, with blunt, straight cardiac ridge; granulate ridge running from orbit to branchial region. Palm of chela densely granulate, with ridge just above lower edge continued to end of fixed finger, finger fringed with setae, line of granules through middle. Fingers wide, slightly gaping, apices crossing, dactyl with large triangular tooth, fixed finger also with tooth. Dactyls of pereopods 2–5 slender. Pereopod 2 reaching middle of dactyl of pereopod 3. Pereopod 4 much larger than others, with dorsal margin of merus, carpus, propodus serrate; ventral margin of merus also serrate. Pereopod 5 setose, reaching middle of carpus of pereopod 4. Female carapace length 5.7 mm.

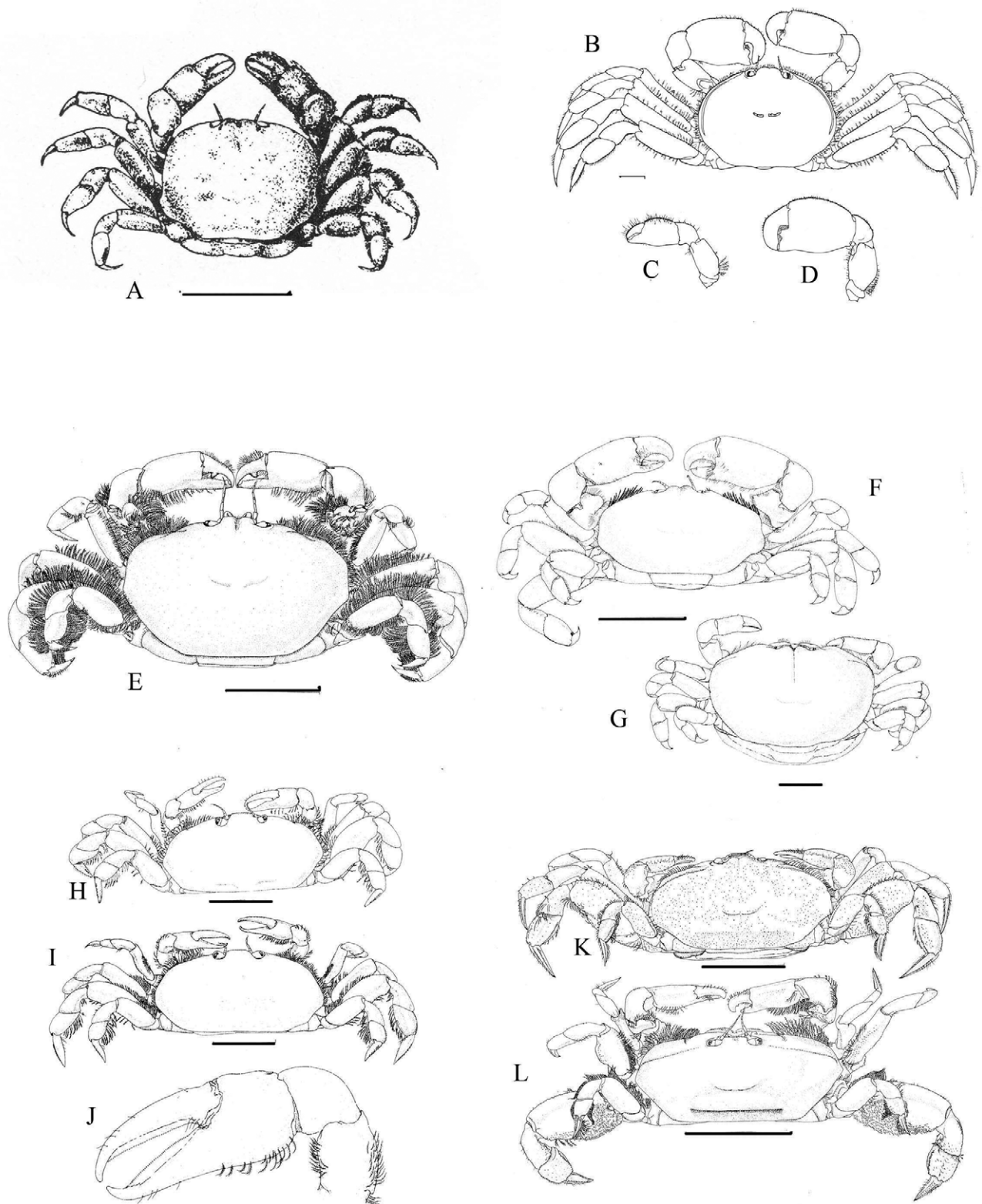


FIGURE 57. Family Pinnotheridae. A, *Opisthopus transversus* Rathbun, 1893; B–D, *Scleroplax granulata* Rathbun, 1893; B, dorsal view; C, right cheliped of female; D, right cheliped of mature male. E, *Pinnixa barnharti* Rathbun, 1918. F, G *Pinnixa faba* (Dana, 1851); F, male; G, female. H–J, *Pinnixa forficulimanus* Zmarzly, 1992; H, male; I, female; J, cheliped. K, L, *Pinnixa franciscana* Rathbun, 1918; K, female; L, male. Scales: B, H, I = 2 mm; C, G, K, L = 5 mm; A, F = 7 mm. A from Schmitt 1921, B–D from Hart 1982, E–L from Zmarzly 1992.

Color in life. Dirty brown to golden brown. The color notes are from crabs from Princeton Harbor, San Mateo County, California.

Habitat and depth. Sandy mud, symbiotic with echiurans, polychaetes, callianassid shrimp; intertidal zone to 47 m.

Range. San Francisco Bay, California to Turtle Bay, Baja California. Type locality east of Point San Quentin, San Francisco Bay (*Albatross* sta. D5709).

***Pinnixa hiatus* Rathbun, 1917**

(Fig. 58A, B)

Pinnixa hiatus Rathbun, 1917: 164, pl. 36, figs. 1–4, text fig. 102. — Schmitt 1921: 265, pl. 43, figs. 1–4. — Schmitt *et al.* 1973: 111. — Zmarzly 1992: 690, fig. 8.

Diagnosis. Carapace about twice as wide as long, anterolateral margin without definite angle, marked by raised and granulate ridge up to hepatic region; posterior margin long, straight; front advanced, widely emarginate. Surface smooth, sparingly punctate, groove behind gastric region. Subhepatic region prominent. Chelae robust. Palm suboblong, upper margin convex, lower margin of palm, fixed finger with granulate ridge on distal half just above lower edge. Dactyl curved, with ridge and tooth near middle. Fixed finger shorter than dactyl, curving up toward it, having large tooth; in male, finger deeply excavate at distal apex, forming notch into which apex of dactylus can insert. Fingers gaping when closed. Anterior edge of merus, posterior of propodus of pereopods 2–5 finely serrate, posterior edge of merus coarsely granulate, dactyls elongate, slender. Pereopod 2 most slender. Posterior margin of pereopod 3, both margins of pereopod 5 fringed with setae. Female carapace length 3.6 mm.

Color in life. Not reported.

Habitat and depth. In green sand or mud, 27–100 m. Symbiotic associations unknown.

Range. Goleta, Santa Barbara County to San Diego and offshore islands, California. Type locality off Santa Catalina I., California.

***Pinnixa littoralis* Holmes, 1894**

(Fig. 58D, E)

Pinnixa littoralis Holmes, 1894: 571, pl. 20, figs. 14–16. — Rathbun 1904: 188; 1917: 145, pl. 31, figs. 5–8, text fig. 89, 90. — Weymouth 1910: 58 (part). — Schmitt 1921: 260, pl. 40, figs. 5–8, text fig. 155. — Johnson & Snook 1927: 393, figs. 349, 356. — Garth & Abbott 1980: 616, fig. 25.36 — Hart 1982: 236, fig. 98. — Ricketts *et al.* 1985: 377. — Campos-Gonzalez 1986: 238. — Zmarzly 1992: 693, fig. 9. — Jensen 1995: 31, fig. 42.

Diagnosis. Carapace about twice as long as wide, pointed at sides, flattened above, with transverse depression behind median region. Orbits pointed at outer angle. Hands of chelipeds compressed, fingers gaping, especially in adult male, dactyl strongly curved, fingers usually without teeth. Pereopods 2–5 slender, pereopod 4 thickest. Propodus of pereopods 2–5 elongate, dactyl strongly curved, shorter than propodus. Merus of pereopod 4 broad. Dactyl of pereopod 5 slightly exceeding end of merus of pereopod 4 when extended. Carapace length 4.5 mm.

Color in life. Grayish white, pereopods 2–5 often with brownish-tipped (Schmitt 1921).

Habitat and depth. Usually living in mantle cavity of pelecypods, rarely with tube anemones (order Ceriantharia); intertidal to 91 m.

Range. Sitka, Alaska to Santa Maria, Baja California, Mexico. Type locality Bodega Bay, California.

Remarks. Juveniles of *P. littoralis* and *P. faba* may be nearly impossible to differentiate (Zmarzly 1992).

***Pinnixa longipes* (Lockington, 1877)**

(Fig. 58C)

Tubicola longipes Lockington, 1877c: 55.

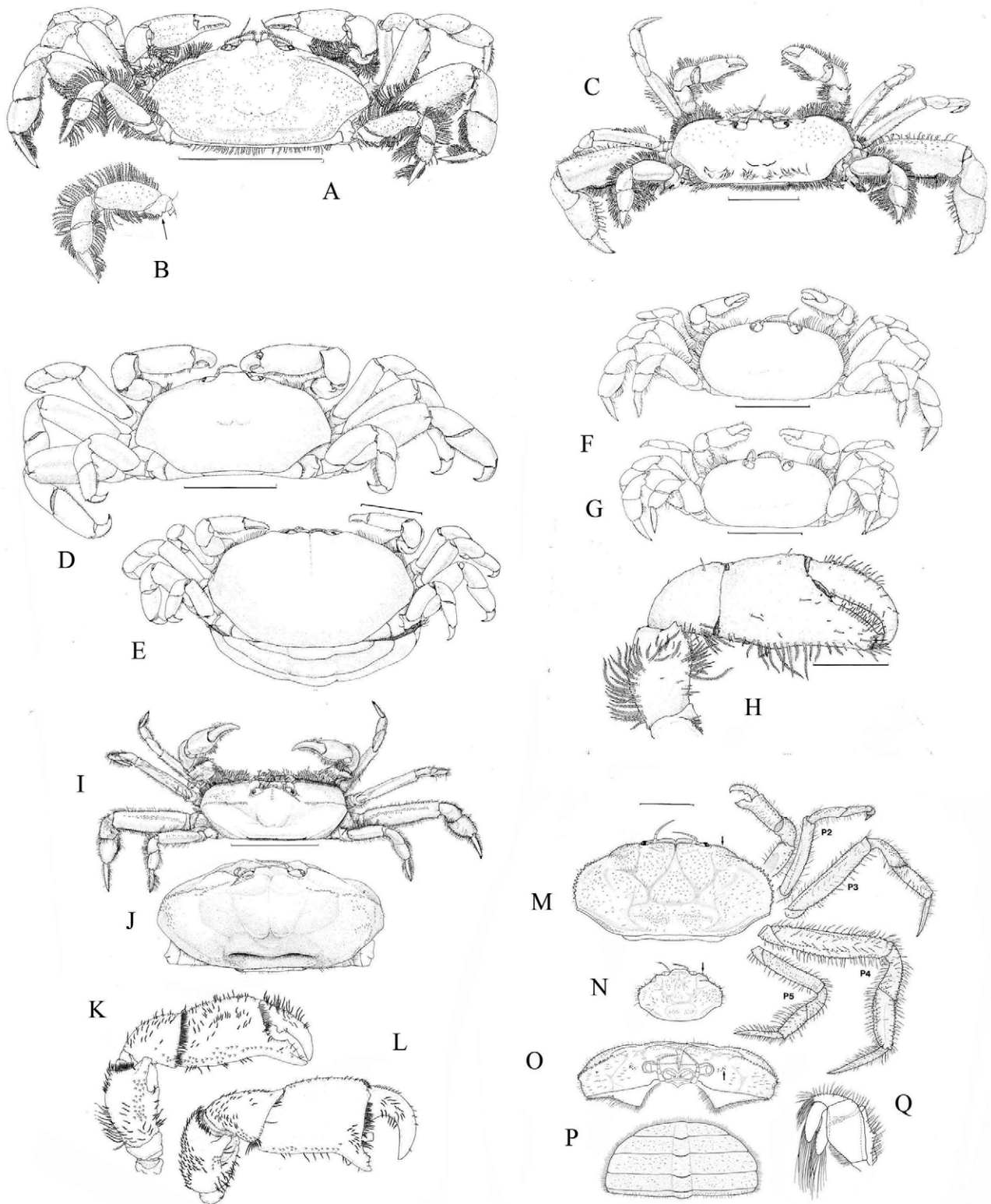


FIGURE 58. Family Pinnotheridae. A, B, *Pinnixa hiatus* Rathbun, 1918; A, entire crab; B, detail of pereopod 5. C, *Pinnixa longipes* (Lockington, 1877). D, E, *Pinnixa littoralis* Holmes, 1894; D, male; E, female. F–H, *Pinnixa minuscula* Zmarzly, 1992; F, female; G, male; H, male cheliped. I–L, *Pinnixa occidentalis* Rathbun, 1893; I, male; J, carapace of juvenile male; K, female cheliped; L, male cheliped. M–Q, *Pinnixa scamit* Martin & Zmarzly, 1994; M, female carapace and appendages; N, carapace of immature crab; O, carapace in frontal view; P, female abdomen; Q, third maxilliped. Scales: F, G, M = 2 mm; C = 2.5 mm, A, I 4 mm; D = 4 mm, E = 5 mm. A–L from Zmarzly 1992, M–Q from Martin & Zmarzly 1994.

Pinnixa longipes. — Holmes 1900: 92. — Rathbun 1904: 188; 1917: 137, figs. 80, 81. — Weymouth 1910: 58, text fig. 6. — Schmitt 1921: 257, text fig. 152. — Johnson & Snook 1927: 392, fig. 348. — Schmitt *et al.* 1973: 113. — Garth & Abbott 1980: 617, fig. 25.38. — Ricketts *et al.* 1985: 307, fig. 238. — Zmarzly 1992: 695, fig. 10. — Campos-Gonzalez 2007: 645, pl. 322 B1.

Diagnosis. Carapace more than twice as long as wide, with acute lateral angle, somewhat flattened, with transverse depression behind gastric area. Frontal area concave, dissected by deep longitudinal groove. Anterolateral region smooth, rarely with weakly granulate ridge. Body entirely surrounded by fringe of long plumose setae. Chelipeds small, short, setose; chelae stout, those of mature male more robust than female. Inner margin of dactyl with single triangular tooth; inner margin of fixed finger irregularly serrated. Gape present when fingers closed. Anterior face of propodus with tubercles just above ventral margin. Pereopods 2, 3 slender, similar; with long, slender, nearly straight dactyls nearly equal to length of propodi. Pereopod 4 enormously developed relative to other legs. Posteroventral margin of ischium tuberculate. Dorsal margin of merus smooth to serrate, posteroventral margin of merus denticulate, produced as shelf. Ventral margin of propodus granulate. Dactyl short, thick. Pereopod 5 short, not reaching end of merus of pereopod 4, slender, more stout than pereopods 2, 3; dactyl short, stout. Carapace length 3.2 mm.

Color in life. Pale brownish to yellowish white; see color photograph by Garth & Abbott (1980: fig. 25.37).

Habitat and depth. Sandy sediments, living with polychaete worms *Axiiothella rubrocincta*, *Pectinaria californiensis* Hartman, 1941; *P. granulata* (Linnaeus, 1757); and *Pista elongata* Moore, 1909; rarely echiurans; intertidal zone to 128 m. In southern California, common at 45 m.

Range. Bodega Bay, California to Ensenada, Baja California, Mexico. Type locality Tomales Bay, California.

***Pinnixa minuscula* Zmarzly, 1992**

(Fig. 58F–H)

Pinnixa minuscula Zmarzly, 1992: 697, fig. 11.

Diagnosis. Carapace oval, 1.7–2.0 times as wide as long, surface smooth, flat; anterolateral region smooth, without ridge, slight depression in gastric region. Ventrally directed edge of anterolateral region granulate, sometimes with long plumose setae. Chelae sexually dimorphic. Female, immature male with fingers about equal in length to palm, apices of fingers curving inward, apex of dactyl closing into toothed pocket on fixed finger. Dorsal margin of dactyl with 6–10 tubercles, sparsely setose. Inner margin of dactyl concave, with small serrations. Fixed finger robust, with small serrations. No gape when closed. Mature male with more robust chela, palm wider than in female, fingers relatively shorter. Pereopods 2–5 flattened, with long slender dactyls. Pereopod 4 most robust, its propodus with 4–6 sharp spines on ventral margin. Dactyl of pereopod 5 reaching distal end of carpus of pereopod 4. Carapace length about 2 mm.

Color in life. Carapace somewhat translucent, internal organs visible within, otherwise orange brown (Zmarzly 1992).

Habitat and depth. Sandy substrates, 27–50 m. Symbiotic associations unknown.

Range. Goleta, Santa Barbara County to San Diego, California. Type locality San Diego.

***Pinnixa occidentalis* Rathbun, 1893**

(Fig. 58I–L)

Pinnixa occidentalis Rathbun, 1893: 248; 1904: 187, pl. 7, fig. 4, pl. 9, figs. 6, 6a (part); 1917: pl. 34, fig. 1, text fig. 96. — Holmes 1900: 8. — Weymouth 1910: text fig. 3. — Schmitt 1921: 262, pl. 42, figs. 5, 6; text fig. 156. — Schmitt *et al.* 1973: 115. — Hart 1982: 242, fig. 101. — Zmarzly 1992: 700, fig. 12. — Campos-Gonzalez 2007: 646.

Pinnixa californiensis Rathbun, 1893: 249; 1904: 187, pl. 7, fig. 3. — Holmes 1900: 90. — Weymouth 1910: 56 (part).

Diagnosis. Carapace about twice as long as wide, dorsal surface pitted, irregular. Carapace with cardiac crest, crest bilobed in males; anterolateral margin with granulated ridge running from orbit diagonally outward, backward; crossing hepatic region. Chelipeds stout, setose, immovable finger short, markedly deflexed, with stout tooth in

middle, small tooth near apex; dactyl much curved, with or without tooth at middle. Male chela more robust than that of female, with proportionally shorter fixed finger having stout, flat tooth proximally. Pereopods 2–5 setose, dactyls slender. Pereopod 2 shorter than chelipeds, pereopod 3 longer stronger than pereopod 2; pereopod 4 longest, pereopod 5 with dactyl as long as propodus, reaching carpus of pereopod 4. Male carapace length 9.5 mm, female 10.5 mm.

Color in life. Dirty white. The color note is based on specimens taken in box cores off Santa Barbara County, California.

Habitat and depth. In green sand or mud, free-living or symbiotic with echiuroid worms (*Echiurus alaskanus* Fisher, 1948; *Listriolobus pelodes* Fisher, 1946), shallow subtidal zone to 439 m. Very common along continental shelf of southern California.

Range. Unalaska to Magdalena Bay, Baja California. Unverified report from "Gulf of California." Type locality south of Unimak I., Alaska.

Remarks. Hart (1982) suggested that *P. occidentalis* might in fact represent a species complex.

***Pinnixa scamit* Martin & Zmarzly, 1994**

(Fig. 58M–Q)

Pinnixa scamit Martin & Zmarzly, 1994: 354, figs. 1, 2. — Campos-Gonzalez *et al.* 1998: 378, fig. 5. — Campos-Gonzalez 2007: 646.

Diagnosis. Carapace twice as wide as long, highly sculptured, with anterolateral ridge bearing pronounced, slightly anteriorly-curved teeth; frontal margin with deep median cleft; cardiac ridge present and granular. Chelipeds slightly dimorphic, left larger. Fixed finger slightly deflexed, its length nearly half of length of palm. Dactyl, fixed finger each with pronounced tooth at approximately midlength, row small transparent teeth merging distally into sharp ridge along cutting edges. Palm with scattered short setae, granules on outer surface, serrate ridge on dorsal border. Carpus, merus with acute teeth on dorsolateral, dorsodistal surfaces. Pereopods 2–5 long, slender. Each pereopod with row of well developed teeth on dorsal, ventral borders of merus, carpus, propodus. Dactyls more or less straight. Pereopod 4 longest, its propodus with ventral margin bearing two ridges. Carapace width 7.4 mm.

Color in life. Not reported.

Habitat and depth. Slime-clay bottom, 27–48 m, 311 m. Commensal associations unknown, but specimens from Todos Santos Bay taken in samples with numerous polychaetes (Campos-Gonzalez *et al.* 1998).

Range. Western Santa Barbara Channel, SSW of Point Arguello, California (type locality) and Todos Santos Bay, Baja California, Mexico.

Remarks. This species is included in the key to intertidal pinnotherids of central California and Oregon by Campos (2007), but there are no records of the crab north of Point Arguello.

***Pinnixa schmitti* Rathbun, 1918**

(Fig. 59A)

Pinnixa schmitti Rathbun, 1918: 162, pl. 35, figs. 6, 7, 9; text fig. 101. — Schmitt 1921: pl. 42, figs. 7–9, text fig. 157. — Schmitt *et al.* 1973: 120. — Garth & Abbott 1980: 617. — Wicksten 1980c: 360. — Hart 1982: 244, fig. 102. — Ricketts *et al.* 1985: 387. — Zmarzly 1992: 702, figs. 13, 14. — Campos-Gonzalez 2007: 646, pl. 325 B3.

Diagnosis. Carapace 1.8–2.2 times wider than long, laterally truncate; with prominent ridge of small, tightly packed granules curving along dorsal surface ending at hepatic region. Numerous scattered granules along frontolateral parts of carapace. Perimeter of dorsal carapace pitted. Gastric region with transverse depression. Palm of chela swollen, upper, lower surfaces sinuous to slightly convex; outer, upper surfaces granulate in female, shiny, smooth in mature male. Apices of fingers of chela curving inward, without gape in female, with small gape in male. Inner margin of dactyl with small proximal tooth, fixed finger with several small teeth toward proximal end. Carpus of female cheliped scalloped. Pereopods 2–5 setose, with relatively long, slender dactyls. Rows of granules on merus of pereopods 2–5, also on carpus, propodus of pereopods 4, 5. Pereopod 4 longest, pereopod 5 reaching carpus of pereopod 4. Carapace length 5 mm.

Color in life. Not reported.

Habitat and depth. In sand, common in bays, symbiotic with echiuroids, holothuroids, polychaetes, callianassids, rarely ophiuroids; intertidal zone to 146 m

Range. Port Levasheff, Unalaska, Alaska to San Diego, California. Type locality San Francisco Bay, California.

***Pinnixa tomentosa* Lockington, 1877**

(Fig. 59B, C)

Pinnixa tomentosa Lockington, 1877d: 156. — Rathbun 1917: 141, pl. 30, fig. 8, text figs. 85, 86. — Schmitt 1921: 258, text fig. 153. — Schmitt *et al.* 1973: 121. — Scanland & Hopkins 1978: 636, figs. 1A–C, 2A–C. — Garth & Abbott 1980: 617. — Zmarzly 1992: 706, fig. 15. — Campos-Gonzalez 2007: 645.

Diagnosis. Carapace 1.7–2.5 times as long as wide, rounded, sloping toward margins; shallow depression behind gastric region, cardiac region swollen. Transverse depression behind margin of front; anterolateral margin with granulated line on branchial region. Carapace, pereopods setose. Hand of chela oblong, margins convex. Fingers with hooked apices, each with small tooth near midpoint, not gaping when closed. Pereopod 2 slender, short; pereopod 3 nearly as long as pereopod 4 but less stout, dactyls of pereopods 2, 3 slender, slightly curved. Dactyls of pereopods 4, 5 stout, short, not hooked. Pereopod 4 broad, propodus nearly square, pereopod 5 similar to pereopod 4 but much smaller, reaching to end of merus of pereopod 4. Female carapace length 7.5 mm, male smaller.

Color in life. Carapace mottled brown and cream, appendages light tan (Scanland & Hopkins 1978).

Habitat and depth. Symbiotic with polychaetes, especially *Chaetopterus variopedatus*; intertidal to 21 m.

Range. Monterey, California to Cape San Lucas, Baja California; in Gulf of California at San Felipe, Point Cholla, and Angeles Bay. Type locality Angeles Bay, Gulf of California. Most records are from southern California.

***Pinnixa tubicola* Holmes, 1894**

(Fig. 59F, G; Pl. 15C)

Pinnixa tubicola Holmes, 1894: 569, pl. 20, figs. 17, 18; 1900: 91. — Rathbun 1904: 187; 1917: 165, fig. 103, pl. 36, figs. 5–8. — Weymouth 1910: 57, text fig. 4. — Schmitt 1921: 265, pl. 43, figs. 5–8. — Johnson & Snook 1927: 394. — Schmitt *et al.* 1973: 122. — Scanland & Hopkins 1978: 636, figs. 1D–F, 2D–F. — Garth & Abbott 1980: 617, fig. 25.39. — Hart 1982: 238, fig. 99. — Ricketts *et al.* 1985: 82. — Zmarzly 1992: 709, fig. 16. — Jensen 1995: 31, fig. 43. — Campos-Gonzalez 2007: 645, pl. 322 C1.

Diagnosis. Carapace subcylindrical, 2.5 times wide as long in female to twice as wide as long in male, transverse depression behind gastric region, from which carapace curves sharply downward; outer portion of anterolateral margin defined by ridge. Chelipeds small, hand oblong, fingers hooked at apices, inner margins meeting when closed, immovable finger curved upward distally; lower margin of palm convex. Pereopod 2 slender with slender dactyls equal in length to propodi. Pereopod 3 longer, stouter than pereopod 2, with relatively stouter dactyls. Pereopod 4 stout, little longer than pereopod 3, with short, stout dactyls. Pereopod 5 similar to but shorter than third, not exceeding end of merus of pereopod 4. Propodi of pereopods 3, 4 inflated, only slightly longer than wide. Length of carapace 4 mm.

Color in life. Golden brown with spots of bluish gray or white on dorsal surface, lighter, uniform in color on ventral surface (Schmitt 1921).

Habitat and depth. Sand or mud, symbiotic with polychaetes, often living in male-female pairs; intertidal zone to 57 m.

Range. Prince Rupert, British Columbia to Blanca Bay, Baja California; unverified reports from "Alaska." Type locality not specified; type material from Trinidad (Humboldt County), Cape Mendocino, and Bodega Bay, California.

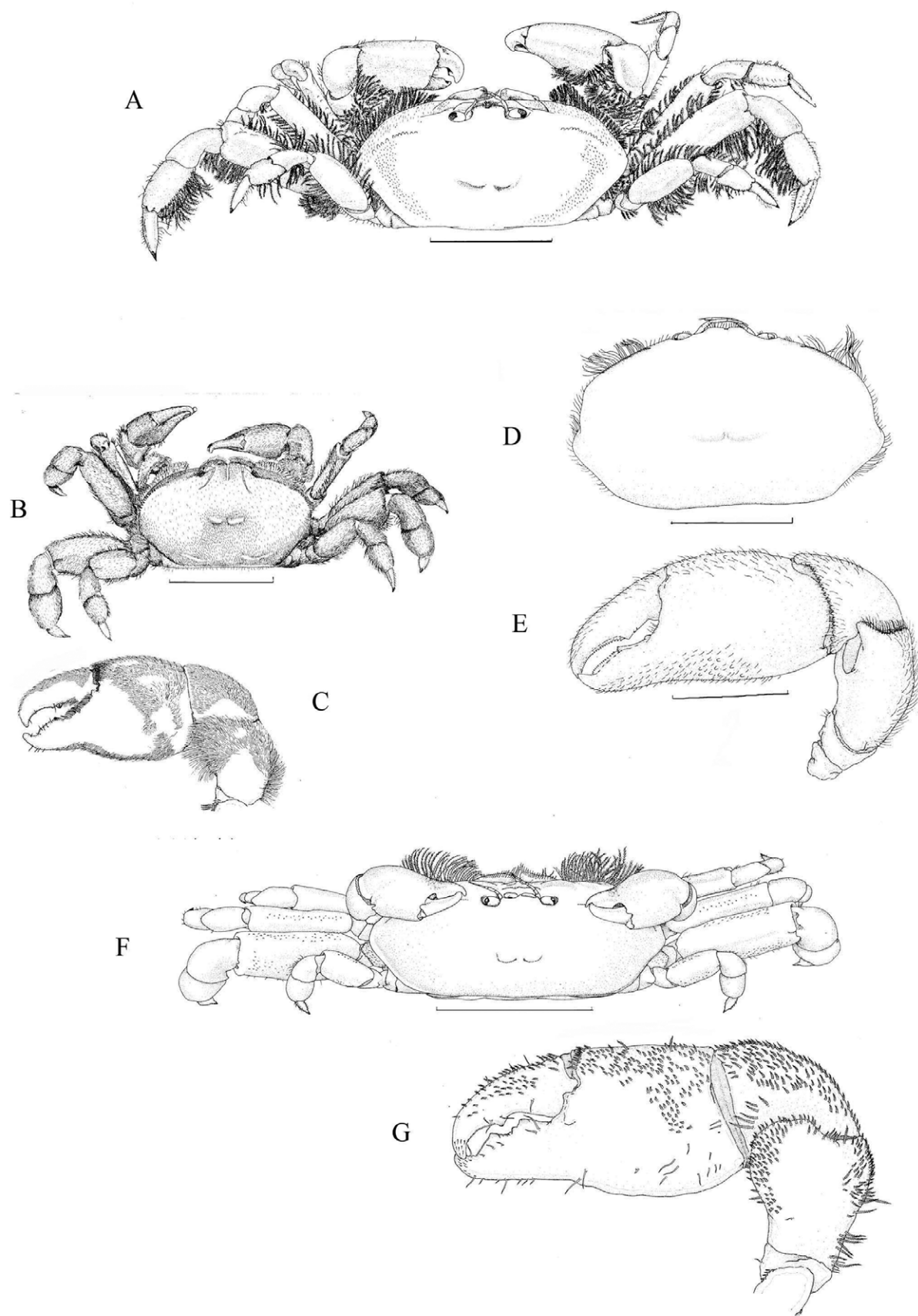


FIGURE 59. Family Pinnotheridae. A, *Pinnixa schmitti* Rathbun, 1918. B, C, *Pinnixa tomentosa* Lockington, 1877; B, dorsal view; C, male cheliped. D, E, *Pinnixa weymouthi* Rathbun, 1918; D, carapace, E, cheliped. F, G, *Pinnixa tubicola*. F, entire crab; G, cheliped. Scales: D = 2 mm, A = 3 mm, B, F = 5 mm. From Zmarzly 1991.

***Pinnixa weymouthi* Rathbun, 1910**

(Fig. 59D, E)

Pinnixa californiensis Weymouth, 1910: 56 (part, see Rathbun 1917).

Pinnixa weymouthi Rathbun, 1917: 166, pl. 36, figs. 9, 10, text fig. 104. — Schmitt 1921: 266, pl. 43, figs. 9, 10. — Schmitt *et al.* 1973: 124. — Garth & Abbott 1980: 618, fig. 25.40. — Zmarzly 1992: 710, fig. 17. — Campos-Gonzalez 2007: 646, pl. 323 C.

Diagnosis. Carapace smooth, sides subtruncate, anterolateral angles prominent; front advanced but deflexed, weakly bilobed; transverse depression in gastric region. Palm of chela with short coarse setae, scattered granules. Dactyl setose dorsally, longer than fixed finger, with small triangular tooth toward proximal end, row of small teeth near apex of dactyl. Fixed finger with triangular tooth at middle, small teeth opposite those of dactyl. Fingers with small gape proximally when closed. Pereopods 2–5 fringed with setae, with nearly straight dactyls. Ventral margin of propodus of pereopod 3 with 6 spines, that of pereopod 4, 5 with 4 spines. Pereopod 4 longest, thickest. Dactyl of pereopod 5 extending to carpus of third leg. Male carapace length 3.3 mm, female not reported.

Color in life. Yellowish white; see color photograph by Garth & Abbott (1980: fig. 25.40).

Habitat and depth. In polychaete tubes, low intertidal zone to 10 m.

Range. Monterey and Pacific Grove, California. Type locality Monterey Bay, California.

Remarks. Weymouth (1910) did not seem to know that Rathbun (19893) had used the name *Pinnixa californiensis*. That name now is considered to be a junior synonym of *Pinnixa occidentalis*. Garth & Abbott (1980) gave the only figure of this species that was based on a specimen other than the type material.

***Pinnotheres* Bosc, 1802**

***Pinnotheres pugettensis* Holmes, 1900**

(Fig. 60A, B)

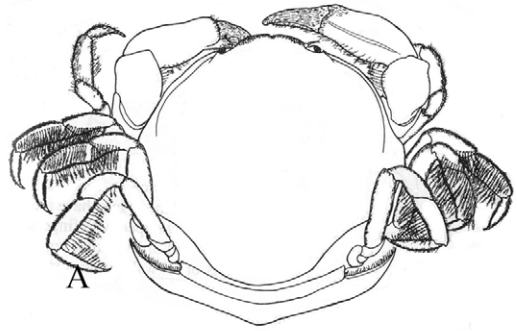
Pinnotheres pugettensis Holmes, 1900: 86. — Rathbun 1904: 185; 1917: 63, pl. 17, figs. 7, 8; pl. 18, fig. 1, text fig. 39. — Johnson & Snook 1927: 390. — Schmitt *et al.* 1973: 82. — Garth & Abbott 1980: 613. — Hart 1982: 232, fig. 96. — Jensen 1995: 32, fig. 45.

Diagnosis. Female: carapace soft, smooth, subpentagonal. Front triangular, curved downwards. Orbits nearly circular. Antennae short. Third maxillipeds oblique, strongly pubescent; merus narrow with outer margin convex; penultimate joint broad, subquadrate, distally truncated; dactyl inserted at lower proximal edge. Cheliped smooth, merus short, upper margin with setae, hand narrow, elongate, smooth; dactyl, inner side of palm short, pubescent; fingers nearly straight with hooked apices, dactyl with low tooth near base of inner margin. Pereopods 2–5 increasing in length posteriorly, propodi setose, dactyls narrow, compressed, apex forming short, curved claw. Dactyl of pereopod 5 longer than propodus, longer than that of pereopod 4. Carapace length 10 mm. Male: Smaller than female, entire body usually covered by dense brown pile. Carapace slightly longer than wide to about as long as wide, front produced, with medial sulcus, faint grooves along gastric, cardiac regions. Orbits, antennae small. Third maxilliped similar to that of female, last two segments slightly shorter. Abdomen with 7 segments, tapering from proximal end to obtusely pointed apex. Chelipeds robust, chela with groove on inner surface from articulation of dactyl to proximal dorsal edge. Fingers of chelae with acute apices, crossing; fixed finger with row of sharp teeth on cutting edge. Pereopods 2–5 decreasing gradually in length from anterior to posterior, robust, pilose. Pereopods 2–4 with long setae on propodus or propodus, carpus. Dactyls acute, long, subequal in size. Carapace length to 5.8 mm, width to 6.4 mm.

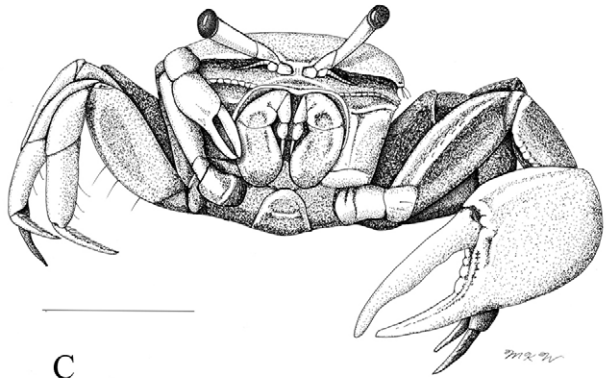
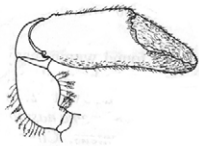
Color in life. Female very pale, almost translucent white to yellowish, outer surface of palm of chela with light-colored net-like pattern. Male light brown (Hart 1982).

Habitat and depth. Symbiotic with large solitary ascidians, sponge *Tethya californiana* (de Laubenfels, 1932); and rock scallop *Crassadomas gigantea* (Gray, 1838); 6–64 m.

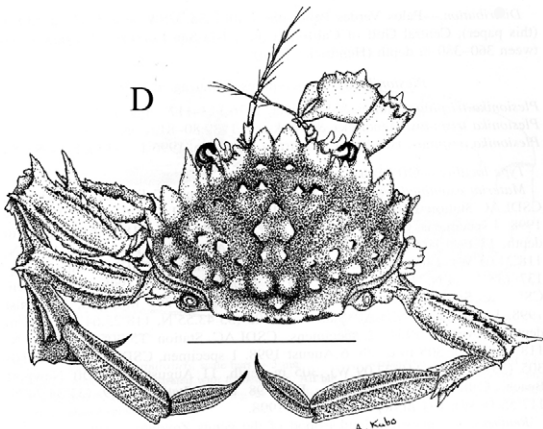
Range. Spider Anchorage, British Columbia; Puget Sound, Monterey Bay and King Harbor, Los Angeles County, California. Type locality Puget Sound.



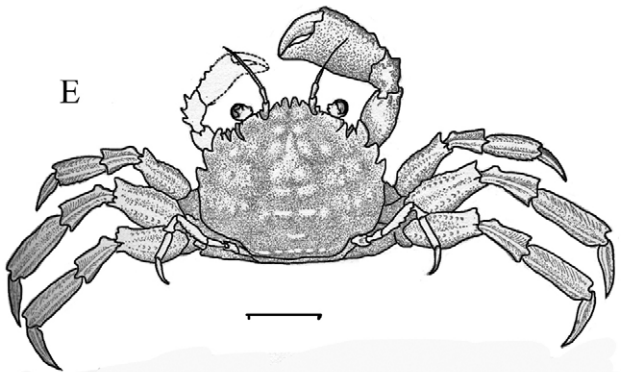
B



C

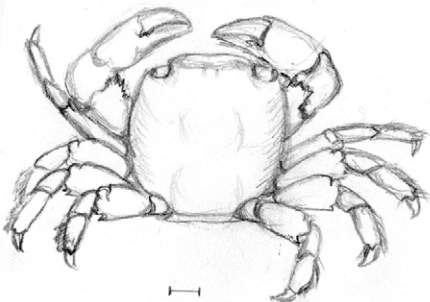


D



E

F



G



H

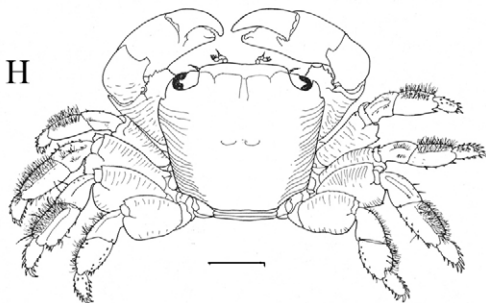


FIGURE 60. Families Pinnotheridae, Ocypodidae, Palicidae, Grapsidae. A, B, *Pinnotheres pugettensis* Holmes, 1900; A, entire crab; B, chela. C, *Uca crenulata crenulata* (Lockington, 1877). D, *Palicus cortezi* (Crane, 1937). E, *Palicus lucasii* Rathbun, 1898. F, *Planes major* (MacLeay, 1838). G, H, *Planes marinus* Rathbun, 1915; G, chela; H, crab in dorsal view. Scales: A, C = 5 mm, D–F, H = 10 m. A, B, G, H from Hart 1982, C drawn from crab from Santa Catalina I., D from Montagne & Cadien 2001, E after Rathbun 1917, F drawn from crab from western Panama.

***Scleroplax* Rathbun, 1893**

***Scleroplax granulata* Rathbun, 1893**

(Fig. 57B–D, Pl. 15A)

Scleroplax granulata Rathbun, 1893: 251; 1904: 188, pl. 7, fig. 5; 1917: 171, pl. 37, figs. 1–3, text fig. 109. — Weymouth 1910: 59, text fig. 85. — Schmitt 1921: 267, pl. 44, figs. 1–3. — Johnson & Snook 1921: 394. — Schmitt *et al.* 1973: 96. — Garth & Abbott 1980: 618, fig. 25.41. — Hart 1982: 228, fig. 94. — Ricketts *et al.* 1985: 384, fig. 300. — Jensen 1995: 30, fig. 40. — Campos-Gonzalez 2006: 33, fig. 1 A–C; 2007: 644, pl. 322 D2.

Diagnosis. Carapace subpentagonal, hard, granulate anteriorly near margins; punctate elsewhere; front narrow, produced, slightly convex. Orbits nearly circular, eyestalk short, thick. Antennules almost transverse. Chela of male swollen, heavy; those of female not as large. Dactyl curved, fixed finger with large tooth, fingers gaping. Pereopods 2–5 slender, granulate. Pereopod 4 longest, its segments narrow, flattened; dactyls slender, almost straight, nearly as long as dactyls. Male abdomen narrow, tapering gradually to broad terminal segment, female abdomen fringed with setae. Male carapace length about 3 mm, female to 6 mm.

Color in life. Grayish white, brownish, yellowish mottled with red-brown (Hart 1982).

Habitat and depth. Bays and harbors, symbiotic with echiuroid worm *Urechis caupo*, ghost shrimps *Neotrypaea californiensis*, *N. gigas*, *Upogebia pugettensis*, and *U. macginitieorum*; intertidal zone to 13 m.

Range. Roller Bay, Vancouver I. to El Coyote Estuary, Abreojos Point, Baja California; off Mazatlán, Sinaloa, Mexico. Type locality Ensenada, Baja California.

SUPERFAMILY OCYPODOIDEA Rafinesque, 1815

Family Ocypodidae Rafinesque, 1815

The ghost crabs and fiddler crabs are common in sandy areas, marshes and mangroves swamps of tropical areas. Only one species lives in southern California. Schmitt (1921:278, fig. 163) reported *Ocypode gaudichaudii* (H. Milne Edwards & Lucas, 1843) from "Lower California", perhaps not recognizing that this geographic area usually refers to Baja California, Mexico. Hendrickx (1995c: 142) reported *O. occidentalis* Stimpson, 1860 from Todos Santos Bay, west coast of Baja California. There are no other reports of this species from north of Magdalena Bay, Baja California. Schmitt (1921: 280, fig. 165) reported *Uca musica* Rathbun, 1914 from California, U.S.A. and Vancouver I., British Columbia. These reports probably are based on incorrect locality records. This species is not known from north of Magdalena Bay, Baja California (Crane 1975: 317). Holmes (1900: 76, as *Uca rectilata*) quoted Lockington (1877) in reporting *Gelasimus rectilatus* Lockington, 1877, as from the "west coast of Lower California." According to Crane (1975: 325), the type material of this species was destroyed and the drawings and description are inadequate to identify the species. Holmes (1900: 77) also mentioned that *Uca stenodactyla* (now *U. stenodactylus* (H. Milne-Edwards & Lucas, 1843) "is reported from San Diego by Ortmann." This record may be due to an error in the collection locality or a misidentification. Crane (1975: 284) reported that *U. stenodactylus* ranges from El Salvador to northern Peru.

These active crabs possess elongated stalked eyes that fold into long transverse orbits. The third maxillipeds almost cover the rounded oral field. The carapace is more or less rectangular and without lateral teeth. Members of the family almost entirely inhabit the intertidal zone. Some may construct deep and elaborate burrows. Crane (1975) gave an exhaustive treatment of the species of *Uca* worldwide.

***Uca* Leach, 1814**

***Uca crenulata crenulata* (Lockington, 1877)**

(Fig. 60C, Pl. 15G)

Gelasimus crenulatus Lockington, 1877: 149.

Uca crenulata. — Holmes 1900: 75, pl. 1, figs. 7–9. — Rathbun 1904: 190; 1917: 409, pl. 146. — Schmitt 1921: 279, fig. 164.

— Johnson & Snook 1927: 399, figs. 357, 358. — Ricketts *et al.* 1985: 354, fig. 273. — Hubbard & Dugan 1989: 55. — Jensen 1995: 34, fig. 51.

Uca crenulata crenulata. — Crane, 1975: 232, pl. 30 E-I, figs. 70D, G, 101. — Garth & Abbott 1980: 622, fig. 25.46. — Bonfil *et al.* 1992: 50, fig. 5B.

Diagnosis (modified from Crane 1975). Frontal region narrow, its width less than 0.3 times width of carapace. Orbits nearly straight, suborbital margins with rounded tubercles. Carapace smooth, moderately convex; lateral margins nearly parallel behind acute anterolateral angles, then converging. Male major cheliped with outer surface finely granulated; inner surface with oblique tuberculate ridge running vertically down from dorsal surface, then bending obliquely to run somewhat parallel to gape; two rows of denticles at base of fixed finger. Fingers of old male cheliped longer than those of younger male. Smaller chela of both sexes with fingers equal, gape narrow. Pereopods 2–5 with pile, merus transversely granulate. Abdomen of male with 7 segments. Carapace length to 13 mm in either sex.

Color in life. Carapace grayish white to pale brown. Major chela of male with merus bright red on exterior surface, inner surface of merus, fingers of chela bright white. Palm, inner part of chela yellowish to white. Minor chela pinkish. Merus of pereopod 2 crimson red; otherwise cream-colored; other pereopods marked with cream. Female chelae brownish to cream-colored. See Crane (1975) for a more detailed color description.

Habitat and depth. Upper parts of mud flats and salt marshes, intertidal zone.

Range. Discontinuous, from Goleta, California to Turtle Bay, Baja California, including Santa Catalina I., California; and San Felipe to La Paz and Guaymas to Tenacatita Bay, western Mexico. Type locality Todos Santos Bay, Baja California. A distinct subspecies, *U. crenulata coloradensis* (Rathbun, 1893), lives at the head of the Gulf of California.

Remarks. Fiddler crabs dig burrows in the upper reaches of mud flats and salt marshes. They manipulate balls of sediment in their mouthparts as they extract detritus and other food material. The burrows, mud balls and tracks are good indication of their presence even if the crabs themselves are not visible. Fiddler crabs today live in California mostly in wildlife refuges and other areas protected from human habitat destruction.

SUPERFAMILY PALICOIDEA Bouvier, 1898

Family Palicidae Bouvier, 1898

Two species of this family have been reported from California, both from specimens collected during an El Niño period of warmer waters. Older works refer to this family as the Cympolidae, but the generic name *Cympolia* has been found to be a homonym. Holthuis & Gottlieb (1958) and Ng *et al.* (2008: 127) gave further information on the nomenclature of this family. Martin & Davis (2001: 56) included this family among the superfamily Ocypodoidea but noted differing opinions on its superfamilial relationships. I follow Ng *et al.* (2008) in placing the family into a separate superfamily based on the location of the genital openings.

Key to species of family Palicidae

1. Carapace with 4 slender frontal teeth *Palicus lucasii*
- Carapace with 2 large triangular frontal teeth *Palicus cortezi*

Palicus Philippi, 1838

Palicus cortezi (Crane, 1937)

(Fig. 60D)

Cympolia cortezi Crane, 1937: 75, pl. 8, fig. 25. — Garth 1946: 499, pl. 85, fig. 2.

Palicus cortezi. — Montagne & Cadien 2001: 206, fig. 3.

Diagnosis. Carapace wider than long, with 2 large triangular teeth mesial to large eye, 2 sharp anterolateral teeth,

dorsal surface strongly tuberculate. Right cheliped with dactyl deflexed, propodus with large tubercles along margin, carpus also with strong teeth. Pereopods 2–4 wide, with acute ridges on merus, carpus, propodus, dactyl. Sharp dorsal teeth at distal dorsal, ventral margins of merus. Dactyl ovate tapering to acute apex. Pereopod 5 shorter than other pereopods. Male carapace length 6.2 mm (juvenile specimen), female not reported.

Color in life. Not reported.

Habitat and depth. Rock sand, crushed shell and coral, 61–275 m.

Range. Off Palos Verdes Peninsula, Los Angeles County, California to Wenman I., Galapagos Is. Type locality Santa Inez Bay, Gulf of California, Mexico.

***Palicus lucasii* Rathbun, 1898**

(Fig. 60E)

Palicus lucasii Rathbun, 1898a: 600, pl. 43, fig. 2. — Montagne & Cadien 2001: 207.

Cympolia lucasii. — Rathbun 1917: 193, pl. 44, figs. 1, 2, text fig. 119. — Garth 1946: 500, pl. 87, fig. 1.

Diagnosis. Eyes large. Carapace slightly wider than long, with 4 frontal lobes, anterolateral margin with 2 acute teeth beyond exorbital; supraorbital teeth sharp; dorsal surface of carapace tuberculate. In adult male, right chela heavier than left. Chelipeds of male unequal, right larger than left, both shorter than length of pereopod 2. Pereopods 2–5 wide, merus of pereopods 2, 3 with sharp tooth at distal end; merus of pereopod 4 with rounded lobe. In adult male, pereopods 2 with shaggy setae. Dactyls of pereopods 3, 4 with sinuous margins. Pereopod 5 short, slightly longer than merus of leg 3. Male carapace length to 13.5 mm, female not reported.

Color in life. Carapace with solid median band of blood red extending from front to posterior border. Most of carapace white; anterolateral and preorbital teeth blood red, orbital tooth white. Pereopods 2–4 banded with red, white; apex of dactyl white; reduced leg entirely white (Garth 1946).

Habitat and depth. Muddy and sandy bottoms, 9–111 m.

Range. Off Malaga Cove, Palos Verdes Peninsula, California to Galapagos Is. Type locality off Cape San Lucas, Baja California, Mexico.

SUPERFAMILY GRAPSOIDEA MacLeay, 1838

The shore crabs (families Grapsidae and Varunidae) inhabit intertidal regions or floating objects. Recent molecular studies (Schubart *et al.* 2002) tend to validate the elevation of what were considered to be subfamilies by Rathbun (1917) to the level of full families. Fast moving and hardy, they are conspicuous inhabitants of temperate and tropical regions worldwide. Their eyestalks are not as long as those of the Ocypodidae, but their vision apparently is keen. They usually are scavengers and grazers on algae instead of deposit feeders. They do not construct long burrows, as do the Ocypodidae. The crabs often are sexually dimorphic, with the male being larger and more brightly colored than the female.

Except for the smallest crabs, which tend to be translucent to drab, the grapsoid crabs of California and Oregon have characteristic color patterns. A rare color form, in which the carapace is either entirely china white to yellowish or patched with these colors, and pereopods 2–5 are banded, occurs in both species of *Hemigrapsus*.

Three species of grapsoids are common in intertidal areas of California and Oregon. Another two species rarely occur on floating objects, and may be cast ashore after severe storms. Holmes (1900: 84) described yet another grapsoid, *Grapsodius eximius*, from San Diego, California. This crab resembled a species of *Pachygrapsus*, but had the posterior surface of the orbits "bulging outwards." The species was not illustrated, and the type material seems to have been lost. The crab has not been reported since its description. It may have been an aberrant specimen of a species of *Pachygrapsus*. A record of *Pachygrapsus transversus* (Gibbes, 1850) from California (Schmitt 1921: 271, fig. 160) probably is in error. The species ranges from the southern Gulf of California south to Peru.

Family Grapsidae MacLeay, 1838

Key to species of family Grapsidae

1. Carapace broader than long, somewhat trapezoidal, marked with grooves. Anterior edges of pereopods 2–5 without thick fringe of setae. Intertidal *Pachygrapsus crassipes*
- Carapace as long as or longer than broad, subcircular, smooth. Anterior edges of pereopods 2–5 with thick fringe of setae. Pelagic, usually found among floating debris or on sea turtle 2
2. Lateral margins of carapace convex, front with slight median depression. Upper margin of cheliped rounded . . . *Planes major*
- Lateral margins of carapace straight, front straight. Upper margin of cheliped angled *Planes marinus*

Pachygrapsus Randall, 1840

Pachygrapsus crassipes Randall, 1840

(Fig. 61A, Pl. 15E)

Pachygrapsus crassipes Randall, 1840: 125, pl. 5, fig. 4. — Holmes 1900: 79. — Rathbun 1904: 189; 1917: 241, pl. 59. — Weymouth 1910: 61, pl. 13, fig. 41. — Schmitt 1921: 270, text fig. 159, pl. 45. — Johnson & Snook 1927: 395, figs. 354, 355. — Garth & Abbott 1980: 619, fig. 25.43. — Ricketts *et al.* 1985: 42, fig. 27. — Jensen 1995: 17, fig. 3. — Kuris *et al.* 2007: 641.

Diagnosis. Carapace nearly square, lateral margins broadest behind orbit, entirely upper surface except cardiac, intestinal regions transversely grooved, sides with single tooth posterior to prominent postorbital tooth. Third maxillipeds with merus lobate at antero-internal angle. Chela of adult male broad, heavy; raised line present on upper side of propodus, smaller line on lower portion of outer surface, apice of fingers spooned. Female chela not as broad as in male. Merus of pereopods 2–5 broad, with tooth on posterodistal angle except on pereopod 5; propodus, dactyl of each leg spinulose. Male carapace length 41 mm, female smaller.

Color in life. Carapace dark green with faint whitish stripes, inner surface of chela white, adult male chela bright red above, white below. The color notes are from crabs from Moss Beach, San Mateo County, California.

Habitat and depth. Upper intertidal rocks, sometimes on docks, pilings or mud flats.

Range. Japan, Korea; Charleston, Oregon to Santa Margarita I. and Alijos Rocks, Pacific coast of Baja California; sporadic in Gulf of California. Type locality "Sandwich Islands", but probably in error. Most of Randall's specimens came from California, especially near Monterey, Los Angeles, and San Diego.

Remarks. *Pachygrapsus crassipes* is one of the most common crabs of California and Oregon. The megalops larvae can ride on drifting seaweed or wood, giving the species great capacity for dispersal. The population in Asia may have been introduced in ballast water from ships.

Planes Bowdich, 1825

Planes major (MacLeay, 1838)

(Fig. 60F)

Nautilograpsus major MacLeay, 1838: 66.

Planes cyaneus Dana, 1851: 250. — Chace 1951: 65; 1966: 646. — Hart 1963: 127; 1982: 216, fig. 89. — Manning & Holthuis 1981: 235.

Planes minutus: Rathbun 1904: 189; 1917: 253, pl. 63 (part). — Weymouth 1910: 63. Pl. 14. — Schmitt 1921: 272, pl. 46. — Johnson & Snook 1927: 397, fig. 353. — Garth 1946: 510.

Not *Planes minutus* (Linnaeus, 1758).

Planes major. — Ng & Ahyong 2001: 97, figs. 6 A, B (extensive synonymy).

Diagnosis. Carapace as long as broad, subcircular, almost smooth but for few faint lines on anterior, lateral regions, single blunt tooth behind postorbital angle, front sinuous. Chela broad, fingers somewhat deflexed, with several oblique lines on dorsal, ventral surfaces; somewhat obscure longitudinal line on lower portion of propodus; one tooth on inner margin of lower finger, 2–3 on dactyl. Pereopods 2–5 broad, somewhat flat, especially propodus,

dactyl; anterior margins with dense fringe of setae, 1–3 spinules on lower distal margin of merus. Carapace length 15 mm.

Color in life. Very variable, mottled with yellowish brown or dark brown, white; or blue (Schmitt 1921).

Habitat and depth. Pelagic among floating debris and barnacles (*Lepas* spp.) or on sea turtles, often near tail of sea turtle.

Range. Widespread between 41° N and 35° S in Pacific; eastern Pacific from off British Columbia to Peru; Indian Ocean, South Atlantic Ocean; rare in North Atlantic and Gulf of Mexico. Type locality Pacific Ocean at 28°N, 174° E (west of Midway I.).

Remarks. Specimens of *P. major* from off the Pacific coast of Panama were encrusted by the naked barnacle *Conchoderma virgatum* (Spengler, 1790). Johnson & Snook (1927, as *P. minutus*) reported that these crabs can swim by sweeping pereopods 2–5 like oars, backward and forward in unison.

Ng & Ah Yong (2001) re-examined of the type material of *Nautilograpsus major* and found that its generic designation is a junior synonym of *Planes*, but the species name takes precedence over *P. cyaneus*. See this paper for further discussion of the confused nomenclature of this crab.

***Planes marinus* Rathbun, 1915**

(Fig. 60G, H)

Planes marinus Rathbun, 1915: 120, pl. 3; 1917: 258, pl. 64. — Chace 1966: 646. — Hart 1982: 218, fig. 90.

Pachygrapsus marinus. — Chace 1951: 65. — Edmondson 1959: 169, fig. 8b. — Hart 1963: 127.

Diagnosis. Carapace somewhat broader than long, lateral margins nearly straight, converging posteriorly, one blunt tooth behind postorbital tooth; front more or less straight; surface of carapace marked by grooves. Chelipeds heavy, merus marked by short lines, anterodistal border expanded, dentate; carpus with blunt tooth at inner angle, palm swollen, fingers curved, with teeth. Pereopods 2–5 short, flat, merus broad, anterior border of propodus with dense setae, dactyl short, bearing spines, setae. Male carapace length 9 mm, female carapace length to 15 mm.

Color in life. Variable, carapace bright red-brown with dark striations, chocolate brown or light gray, cheliped gray with pink on merus, carpus; pereopods 2–5 banded with light, dark gray or shades of brown (Hart 1982).

Habitat and depth. On floating objects, usually away from shore.

Range. British Columbia to Baja California, off Oahu, Hawaiian Is.; New Zealand, off St. Helena I. in southern Atlantic. Type locality west of "Lower California."

Remarks. There are fewer reports of this species than of *Planes major* in California and Oregon. It has been taken at sea off British Columbia and been cast ashore in Oregon. *Planes major* and *P. marinus* may co-occur on the same drifting log.

Family Varunidae Milne-Edwards, 1853

Key to species of family Varunidae

1. Carapace about as long as wide, frontal margin toothed, outer margin of chelipeds setose. Introduced into San Francisco Bay area *Eriocheir sinensis*
- Carapace considerably more broad than long, frontal margin without teeth, outer margin of chelipeds not setose. Widespread, native 2
2. Pereopods 2–5 setose. Front with deep median sinus. Chelae not spotted with red or purple *Hemigrapsus oregonensis*
- Pereopods 2–5 not setose. Front somewhat sinuous. Chelae spotted with red or purple *Hemigrapsus nudus*

***Eriocheir* De Haan, 1835**

***Eriocheir sinensis* H. Milne-Edwards, 1853**

(Fig. 61B)

Eriocheir sinensis H. Milne-Edwards, 1853: 177; 1854: 146, pl. IX, fig. 1. — Ingle 1980:123, fig. 76, pl. 24b (extensive

synonymy). — Cohen & Carlton 1995: 95; 1997: 1. — Debelius 1999: 96. — Clark 2006: 17 (Discussion of the correct date of publication of the original species description). — Gollasch 2006: 1, figs. 1–3. — Kuris *et al.* 2007: 641.

Diagnosis (after Ingle 1980). Carapace slightly broader than long. Frontal region with pair prominently bifid, acute, submedian lobes, pair tuberculate dorsal carinae. Anterolateral margin of carapace with 3 well-developed teeth, posterolateral margin with single small tooth, lateral margins slightly convex, divergent distally. Chelipeds robust, dorsal surface tuberculate, outer face of chela with dense setae extending onto proximal part of dactylus, carpus with long spine. Pereopods 2–5 moderately stout, margins of carpus to dactylus setose. Female with chelipeds slightly smaller than those of male. Carapace length to 62 mm.

Color in life. Dorsal surface of carapace grayish-green, pereopods lighter (Ingle 1980).

Habitat and depth. Estuarine, ranging into freshwater at mouths of rivers, shallow.

Range. Native range eastern Asia from Vladivostok to South China, especially China Sea. Introduced into Great Britain, almost all of the Baltic Sea and North Sea, northeastern Atlantic to Mediterranean Sea, Netherlands, Rhine and Seine River drainages in Europe (Ingle 1980, Noel 1992, Gollasch 2006); San Francisco Bay drainage. Sporadic reports from Volga River, Russia; Great Lakes region, U.S.A. Chesapeake Bay, Hudson River, Mississippi River Delta (Gollasch 2006). Type locality "coast of China."

Remarks. This crab is a nuisance, damaging riverbanks and levees by burrowing, competing with native species and serving as an intermediate host of the human liver fluke. Consult on-line databases of introduced marine species for the latest area in which this crab has been reported.

***Hemigrapsus* Dana, 1851**

***Hemigrapsus nudus* (Dana, 1851)**

(Fig. 61C, Pl. 15D)

Pseudograpsus nudus Dana, 1851: 249; 1852: 335; 1855: pl. 20, fig. 7.

Brachynotus nudus. — Holmes 1900: 81.

Hemigrapsus nudus. — Rathbun 1904: 189; 1917: 267, pl. 68. — Weymouth 1910: 62, pl. 14, fig. 42. — Schmitt 1921: 273, text fig. 161, pl. 47. — Johnson & Snook 1927: 395, fig. 351. — Garth & Abbott 1980: 621, fig. 25.44. — Hart 1982: 222, fig. 92. 320 A. — Jensen 1995: 17, fig. 1,

Diagnosis. Carapace more or less square, posteriorly flat, front somewhat sinuous, with two lateral spines posterior to postorbital spines. Chelipeds smooth, fingers curved, with teeth on margins, spooned; larger in male than in female; male chela with patch of pile on inner surface of propodus. Pereopods 2–5 without setae, dactyls short. Length of male carapace to 45 mm, female smaller.

Color in life. Carapace dark red to purple, upper parts of pereopods 2–5 same color as carapace, lower parts yellowish to white; chelae with conspicuous spots of red to purple (Hart 1982).

Habitat and depth. Tide pools, boulder, cobble fields, upper to middle intertidal zone.

Range. Yakobi I., Alaska to Turtle Bay, Baja California, but uncommon south of Point Conception, California. Type locality Puget Sound. Records of this species from the Gulf of California are in error.

Remarks. This is a very common intertidal crab, usually found in areas that are less silty than where one finds *H. oregonensis*.

***Hemigrapsus oregonensis* (Dana, 1851)**

(Fig. 61D, Pl. 15F)

Pseudograpsus oregonensis Dana, 1851: 248; 1852: 334; 1855: pl. 20, fig. 6.

Brachynotus oregonensis. — Holmes 1900: 82.

Hemigrapsus oregonensis. — Rathbun 1904: 189; 1917: 270, pl. 70. — Weymouth 1910: 63, pl. 14, fig. 43. — Schmitt 1921: 274, text fig. 162, pl. 48. — Johnson & Snook 1927: 396, fig. 352. — Garth & Abbott 1980: 621, fig. 25.45. — Hart 1982: 220, fig. 91. — Ricketts *et al.* 1985: 358, fig. 275. — Campos & de Campos 1989: 174. — Bonfil *et al.* 1992: 39, fig. 1B. — Jensen 1995: 17, fig. 2. — Kuris *et al.* 2007: 641.

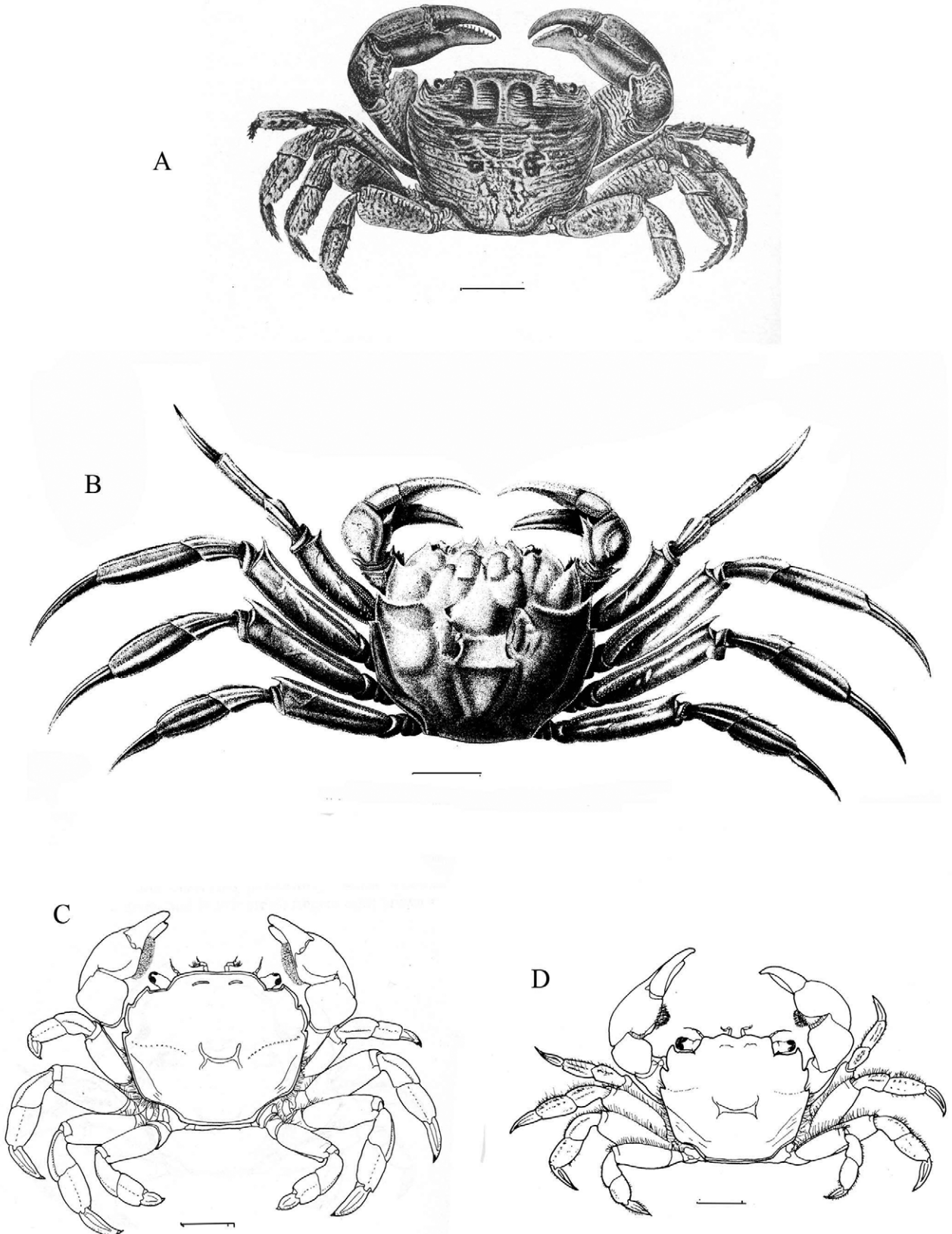


FIGURE 61. Families Grapsidae, Varunidae. A, *Pachygrapsus crassipes* Randall, 1839. B, *Eriocheir sinensis* H. Milne-Edwards, 1853. C, *Hemigrapsus nudus* (Dana, 1851). D, *Hemigrapsus oregonensis* (Dana, 1851). Scales = 10 mm. A from Schmitt 1921, B from H. Milne-Edwards 1853, C, D from Hart 1982.

Diagnosis. Carapace more or less square, smooth, with 2 lateral teeth posterior to postorbital tooth. Front with deep median sinus. Chelipeds smooth, adult male with rounded lobe on antero-internal angle of merus, patch of setae on inner surface of propodus; fingers of cheliped curved, with teeth, spooned. Pereopods 2–5 with coarse, sparse setae, dactyls narrow. Male carapace length to 29 mm, female smaller.

Color in life. Greenish to muddy gray, sometimes with minute black dots; fingers of chela white, without red-purple spots (Hart, 1982).

Habitat and depth. Salt marshes, mud flats; quiet, protected tide pools, gravel flats, intertidal zone.

Range. Resurrection Bay, Alaska to Tortugas Bay, Baja California, Mexico. Type locality Puget Sound.

Remarks. In bays and harbors, *H. oregonensis* can occur by the hundreds.

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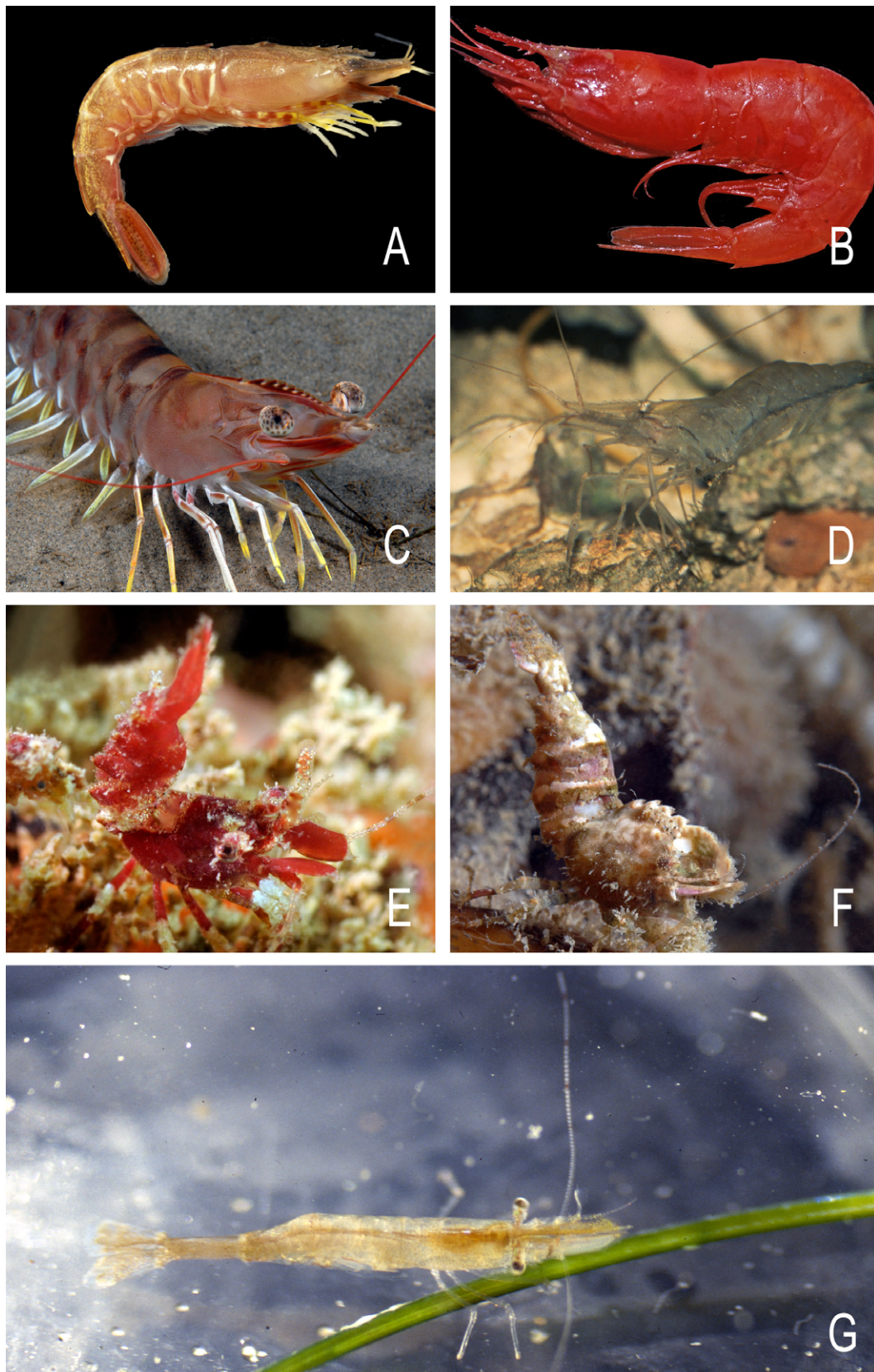


PLATE 1. A, *Sicyonia ingentis*, (Burkenroad, 1938); off Newport Bay; B, *AcanthePHYra eximia* Smith, 1884; northern Gulf of Mexico; C, *Farfantepenaeus californiensis*, (Holmes, 1900); Redondo Submarine Canyon; D, *Palaemon macrodactylus* (Rathbun, 1902); aquarium, San Francisco Bay; E, *Lebbeus lagunae* (Schmitt, 1921); Palos Verdes Peninsula; F, *Spirontocaris prionota* (Stimpson, 1864); La Jolla Shores, San Diego County; G, *Hippolyte clarki* Chace, 1951; Santa Catalina I. Photo credits: C, E, F, by Kevin Lee.



PLATE 2. *Lysmata californica* (Stimpson, 1866); with California moray, *Gymnothorax mordax*, Laguna Beach. Photo credit: Kevin Lee.

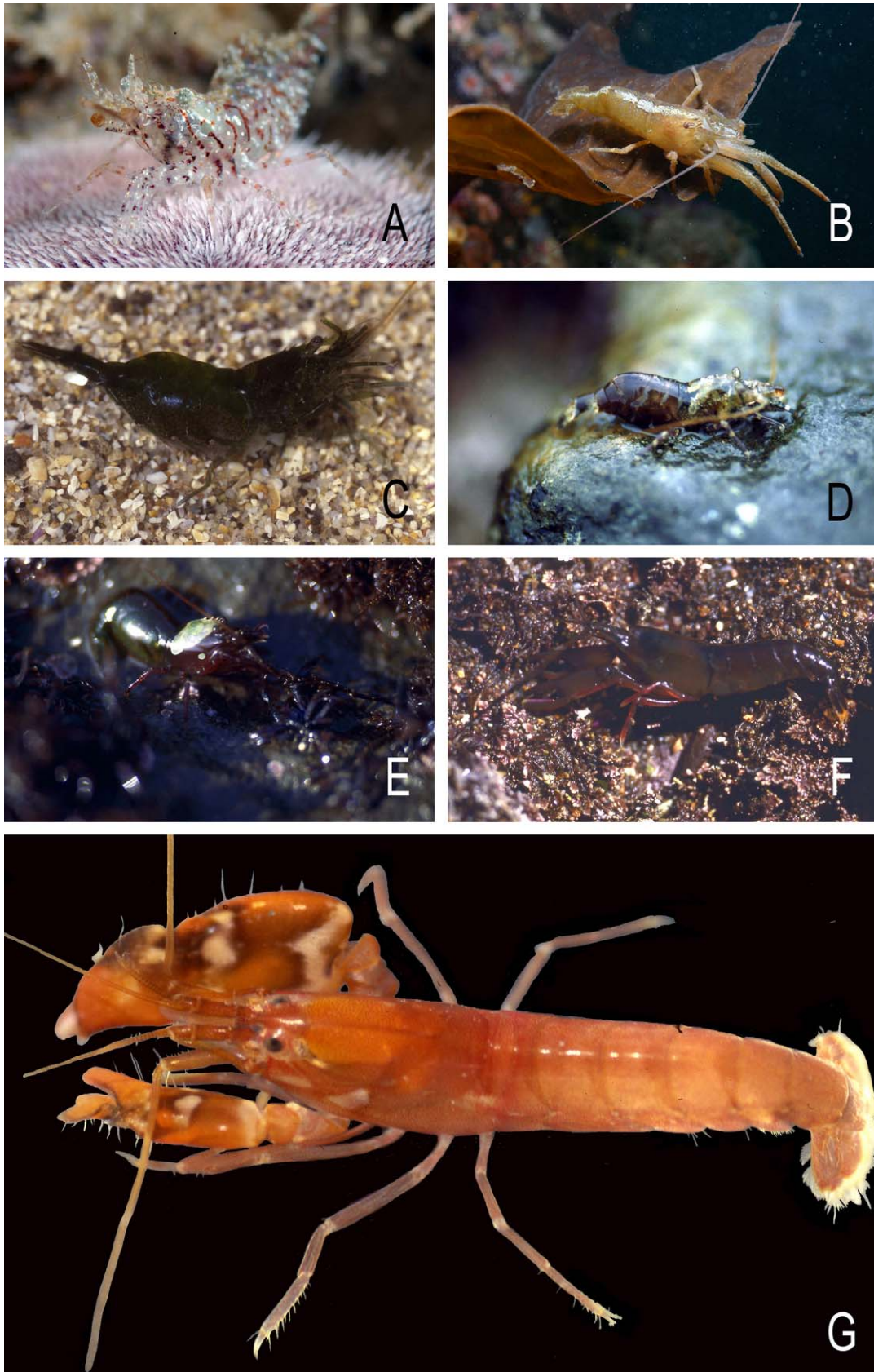


PLATE 3. A, *Spirontocaris snyderi* Rathbun, 1902; La Jolla Shores, San Diego County; B, *Heptacarpus palpator* (Owen, 1839): Monterey Bay; C, *Heptacarpus sitchensis* (Brandt, 1851); Pillar Point, San Mateo County; D, *Heptacarpus brevirostris* (Dana, 1852); Pillar Point; E, *Heptacarpus taylora* (Stimpson, 1857); Pillar Point; F, *Betaeus longidactylus* Lockington, 1877; Point Fermin, Los Angeles County; G, *Alpheus bellimanus* Lockington, 1877; off Newport Bay. Photo credits: A, Kevin Lee; B, Steve Lonhart.

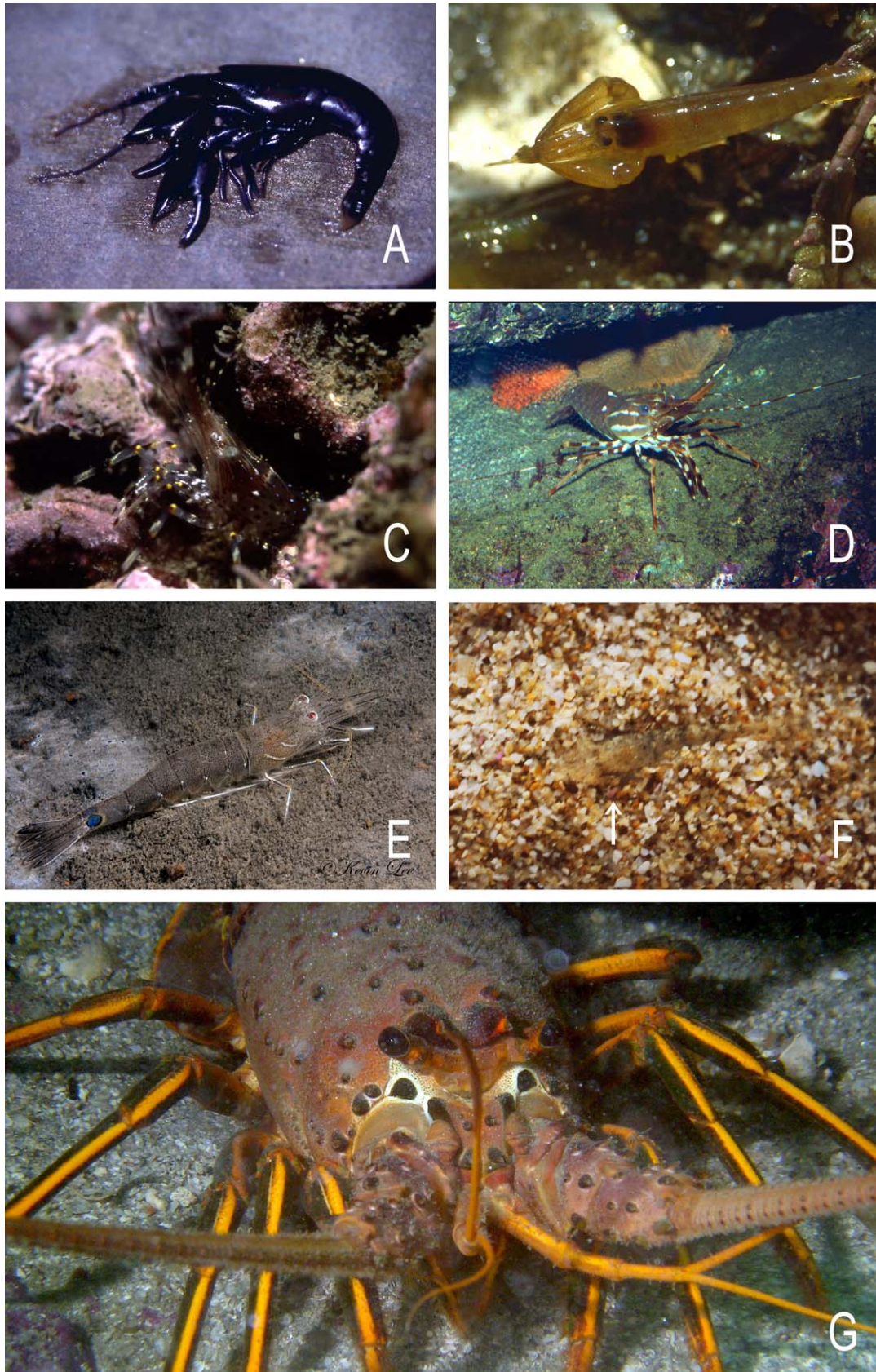


PLATE 4. A, *Betaeus harfordi* (Kingsley, 1878); Santa Catalina I.; B, *Betaeus setosus* Hart, 1964; Pillar Point, San Mateo County; C, *Pandalus danae* Stimson, 1857; Palos Verdes Peninsula; D, *Pandalus platyceros* Brandt, 1851; aquarium, Monterey Bay; E, *Crangon nigromaculata* Lockington, 1877; Redondo Submarine Canyon; F, *Crangon nigricauda* buried in sand, Coyote Point, San Francisco Bay; G, *Panulirus interruptus* Randall, 1839, Santa Catalina I. Photo credits: C, Dick Turner; E, Kevin Lee; G, Stuart Berryhill.



PLATE 5. A, *Crangon nigricauda*, dorsal view, Coyote Point, San Francisco Bay; B, *Procambarus clarkii* (Girard, 1852); Bryan, Texas; C, *Neotrypaea biffari* (Holthuis, 1991); Point Fermin, Los Angeles County; D, *Emerita analoga* (Stimpson, 1857); Princeton, San Mateo County; E, *Neotrypaea californiensis* (Dana, 1854); Coyote Point; F, *Glyphocrangon spinulosa* Faxon, 1893; off Costa Rica.

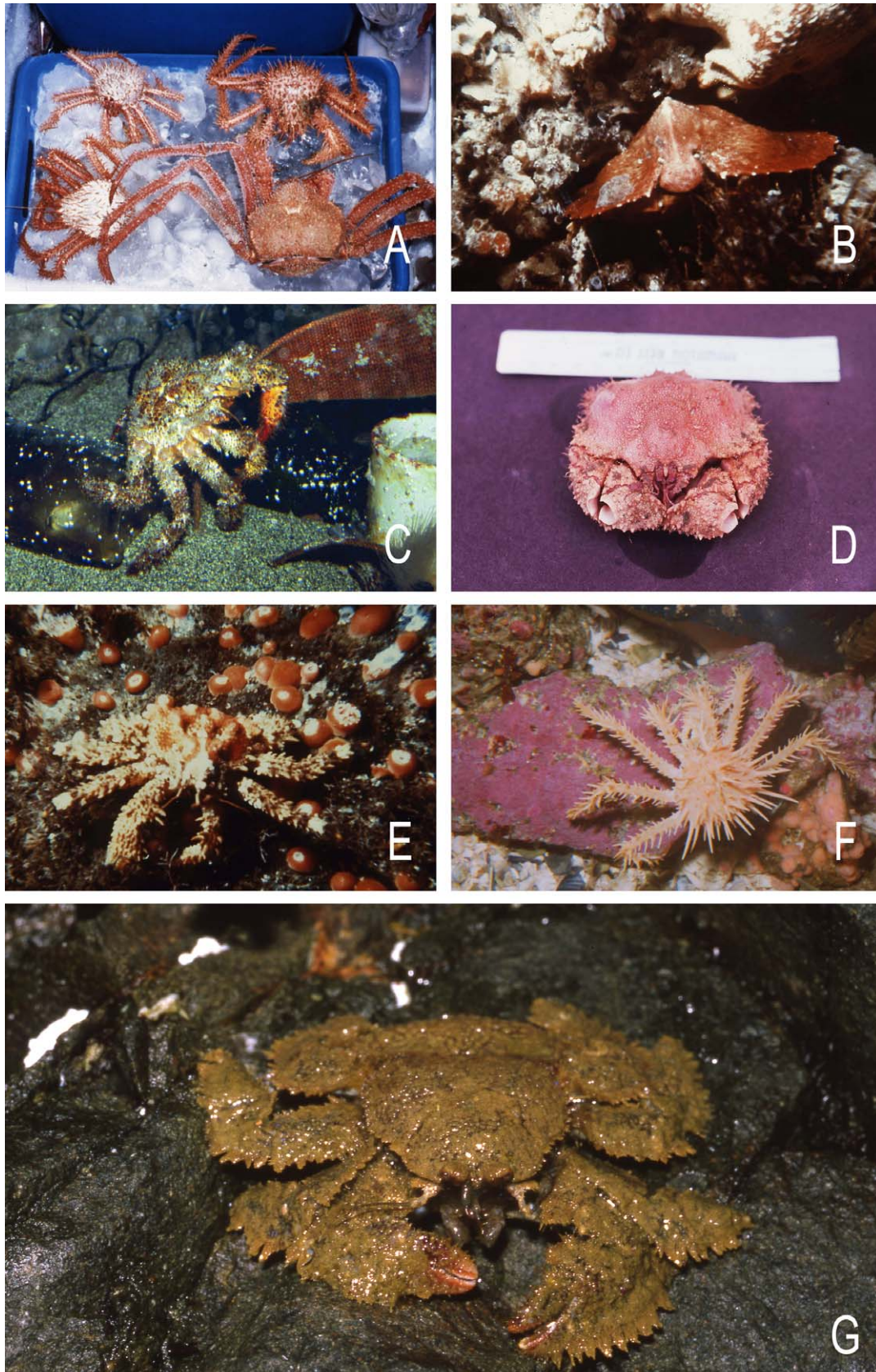


PLATE 6. A, *Paralomis multispina* (Benedict, 1895) and *Lithodes couesi* Benedict, 1895 (large crab on lower right); commercial catch from off Farallon Is.; B, *Cryptolithodes sitchensis* Brandt, 1853; Carmel Bay; C, *Acantholithodes hispidus* (Stimpson, 1860); aquarium, Monterey Bay; D, *Lopholithodes foraminatus* (Stimpson, 1859); off Santa Cruz I.; E, *Phyllolithodes papillosus* Brandt, 1849; Carmel Bay; F, *Paralithodes rathbuni* (Benedict, 1895); juvenile, aquarium, Monterey Bay; G, *Hapalogaster cavicauda* Stimpson, 1859; Mendocino, Mendocino County. Photo credit: A, California Academy of Sciences.

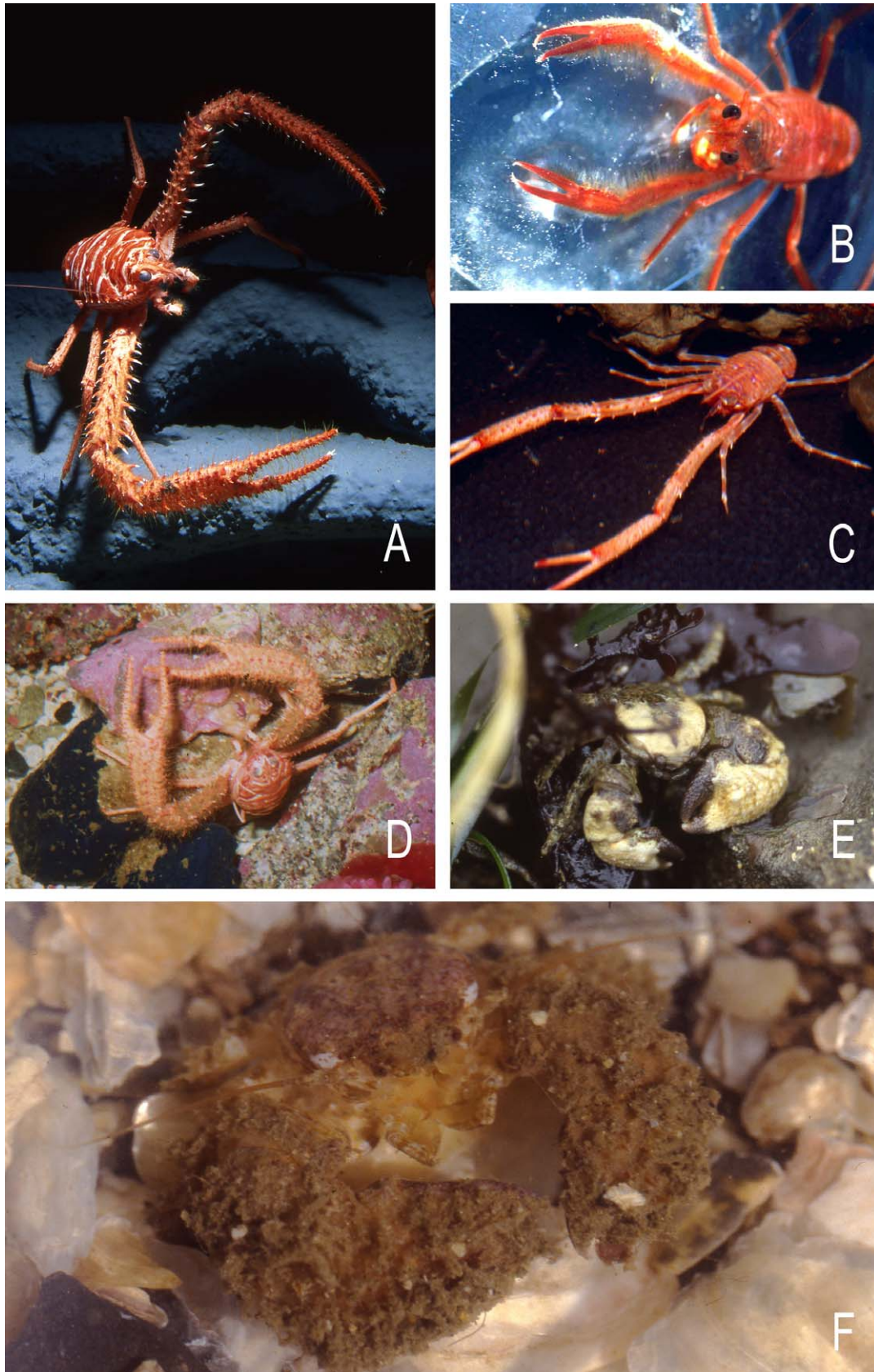


PLATE 7. A, *Janetogalthea californiensis* (Benedict, 1902); aquarium, Monterey Bay; B, *Pleuroncodes planipes* Stimpson, 1860; aquarium, Santa Catalina I.; C, *Munida quadrispina* Benedict, 1902; aquarium, Monterey Bay; D, *Munida hispida* Benedict, 1902; aquarium, Monterey Bay; E, *Pachycheles rudis* Stimpson, 1859; Pillar Point, San Mateo County; F, *Pachycheles pubescens* Holmes, 1900; Pillar Point. Photo credit: A, Karen Light.

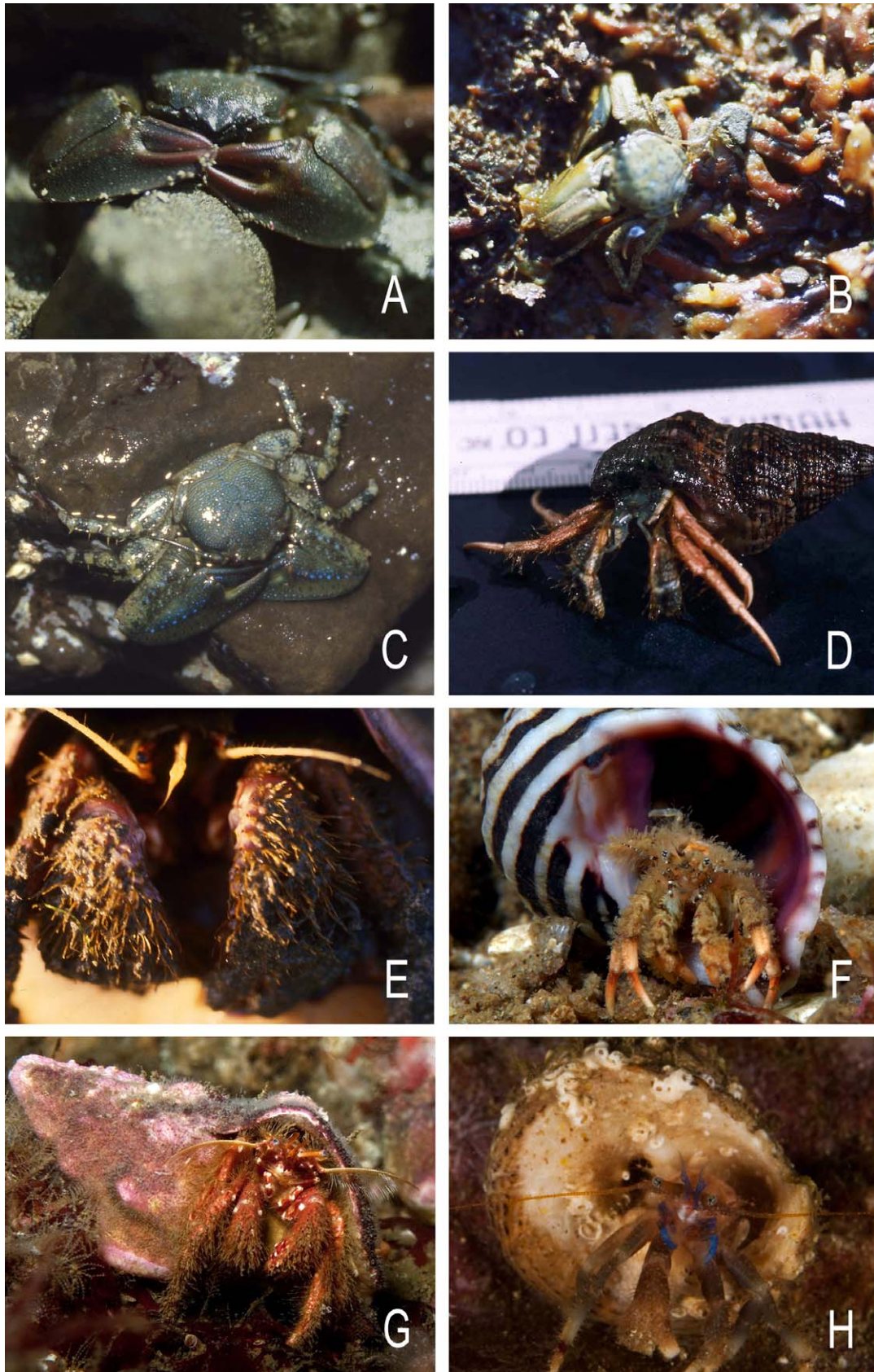


PLATE 8. A, *Petrolisthes cinctipes* (Randall, 1839); Princeton, San Mateo County; B, *Petrolisthes cabrilloi* Glassell, 1945; Point Fermin, Los Angeles County; C, *Petrolisthes eriomereus* Stimpson, 1871; Pillar Point, San Mateo County; D, *Isocheles pilosus* (Holmes, 1900); Cabrillo Beach, Los Angeles County; E, *Paguristes bakeri* Holmes, 1900; Doran Beach, Sonoma County; F, *Paguristes parvus* Holmes, 1900; Laguna Beach; G, *Paguristes ulreyi* Schmitt, 1921; off Redondo Beach; H, *Haigia diegenesis* (Scanland & Hopkins, 1969); Santa Catalina I. Photo credits: F, Kevin Lee; G, Phil Garner; H, Scott Webb.

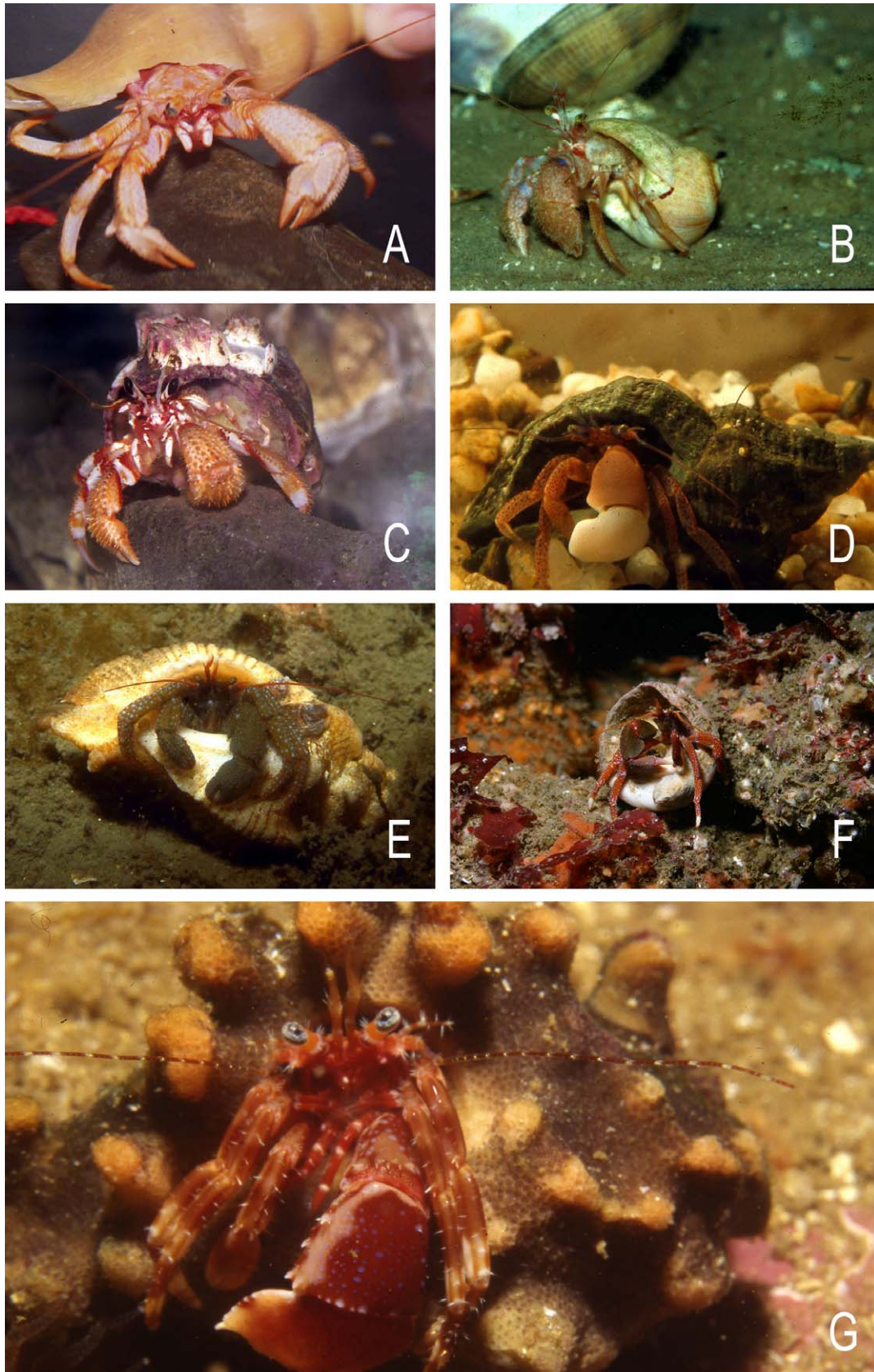


PLATE 9. A, *Pagurus cornutus* (Benedict, 1892); aquarium, Monterey Bay; B, *Pagurus spilocarpus* Haig, 1977; Newport Beach; C, *Pagurus armatus* (Dana, 1855); Monterey Bay; D, *Pagurus retrorsimanus* Wicksten & McLaughlin, 1998; aquarium, Palos Verdes Peninsula; E, *Pagurus granosimanus* (Stimpson, 1859); Los Angeles Harbor; F, *Pagurus hemphilli* (Benedict, 1892); Monterey Bay; G, *Phimochirus californiensis* (Benedict, 1892); Santa Catalina I. Photo credit: F, Steve Lonhart.

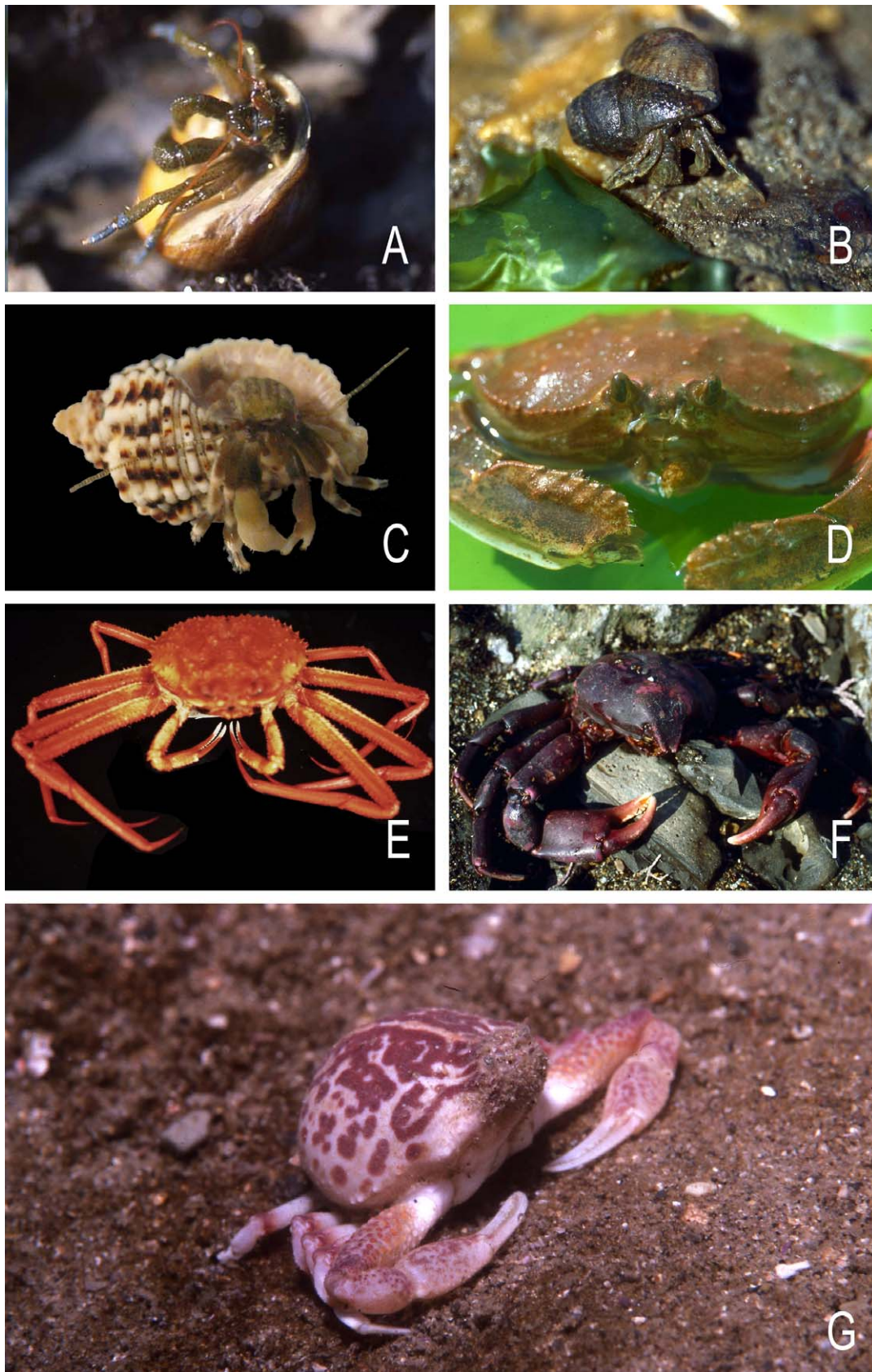


PLATE 10. A, *Pagurus samuelis* (Stimpson, 1857); Moss Beach, San Mateo County; B, *Pagurus hirsutiusculus* (Dana, 1851): Coyote Point, San Francisco Bay; C, *Pagurus venturensis* Coffin, 1957; Point Fermin, Los Angeles County; D, *Platymera gaudichaudii* H. Milne-Edwards, 1837; off Los Angeles Harbor; E, *Chionoecetes tanneri* Rathbun, 1893; off San Clemente I.; F, *Taliepus nuttallii* (Randall, 1839); Point Fermin; G, *Randallia ornata* (Randall, 1839); off Palos Verdes Peninsula. Photo credits: C, Jennifer Cross; G, Dick Turner.



PLATE 11. *Ericerodes hemphillii* (Lockington, 1877); La Jolla Shores, San Diego County. Photo credit: Allison Vitsky.

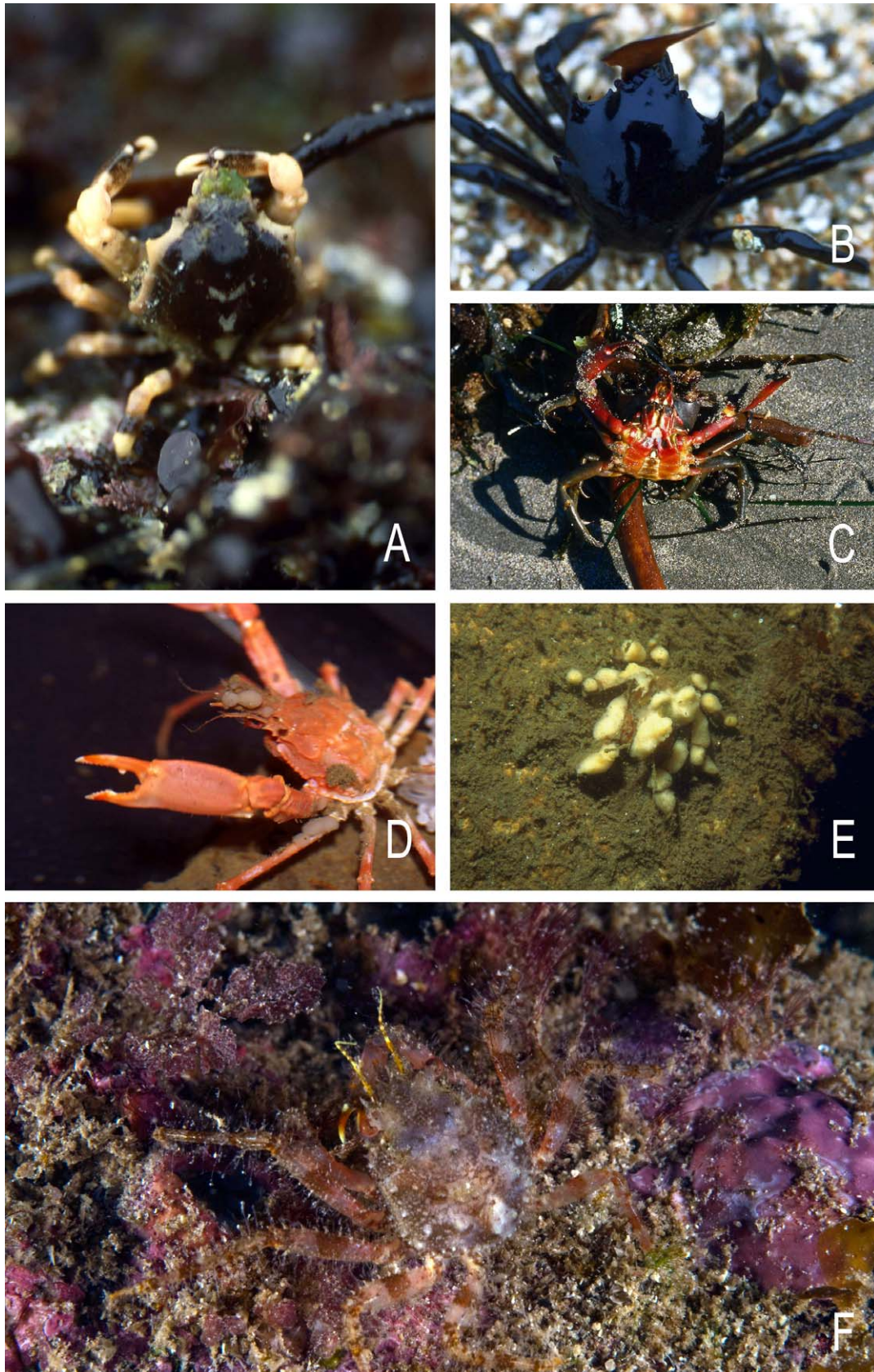


PLATE 12. A, *Mimulus foliatus* Stimpson, 1860; Monterey Bay; B, C, *Pugettia producta* (Randall, 1839); B, juvenile; C, adult male, Pillar Point, San Mateo County; D, *Chorilia longipes* Dana, 1851; aquarium, Monterey Bay; E, *Pelia tumida* (Lockington, 1877); Los Angeles Harbor Breakwater; F, *Herbstia parvifrons* Randall, 1839; Santa Catalina I. Photo credit: F, Scott Webb.

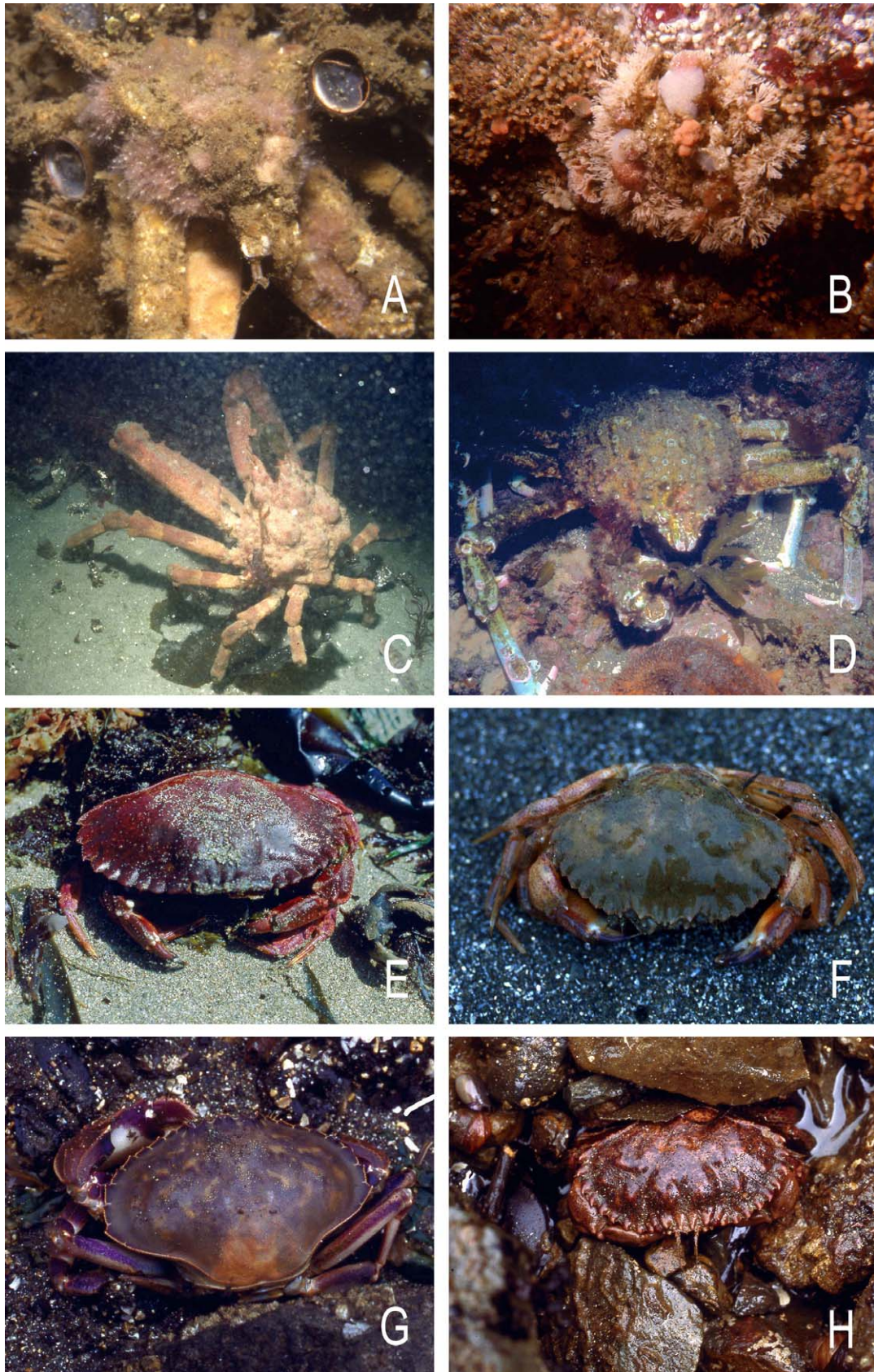


PLATE 13. A, *Scyra acutifrons* Dana, 1851; Los Angeles Harbor Breakwater; B, C, *Loxorhynchus crispatus* Stimpson, 1857; B, juvenile, C, adult male, Monterey Bay; D, *Loxorhynchus grandis* Stimpson, 1857; Anacapa I.; E, *Cancer productus* Randall, 1839; Pillar Point, San Mateo County; F, *Metacarcinus anthonyi* (Rathbun, 1897); Cabrillo Beach, Los Angeles County; G, *Metacarcinus gracilis* (Dana, 1852); Princeton, San Mateo County; H, *Rhomaleon antennarius* (Stimpson, 1856); Moss Beach, San Mateo County.

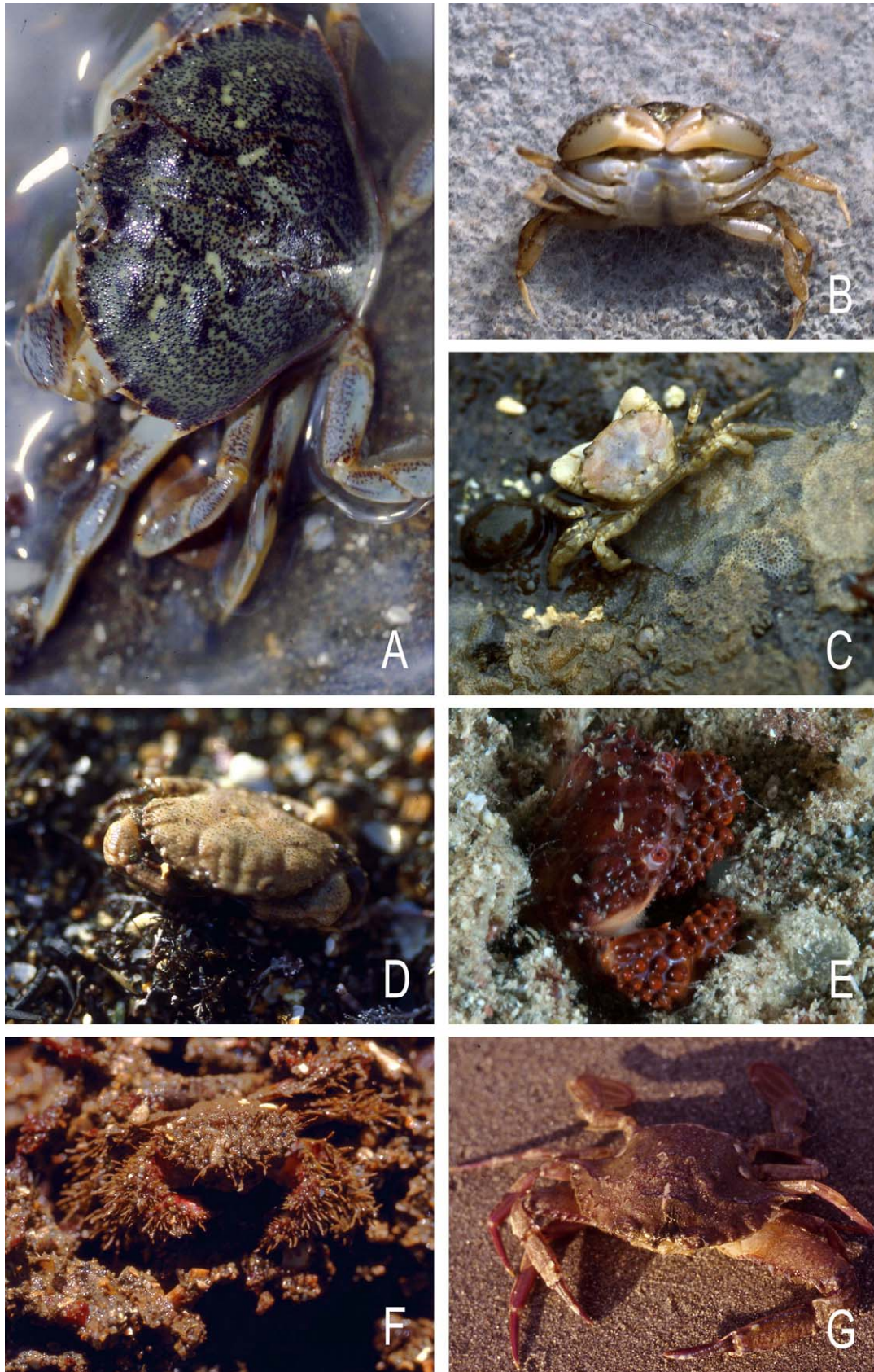


PLATE 14. A, *Metacarcinus magister* (Dana, 1852); Princeton, San Mateo County; B, *Rhithropaneopeus harrisii* (Gould, 1841); Port Aransas, Texas; C, *Lophopaneopeus bellus* (Stimpson, 1860); Moss Beach, San Mateo County; D, *Cycloxanthops novemdentatus* (Lockington, 1877); Point Fermin, Los Angeles County; E, *Paraxanthias taylora* (Stimpson, 1860); Santa Catalina I.; F, *Pilumnus spinohirsutus* (Lockington, 1877); Point Fermin; G, *Portunus xantusii xantusii* (Stimpson, 1860); Cabrillo Beach, Los Angeles County. Photo credit: E, Scott Webb.

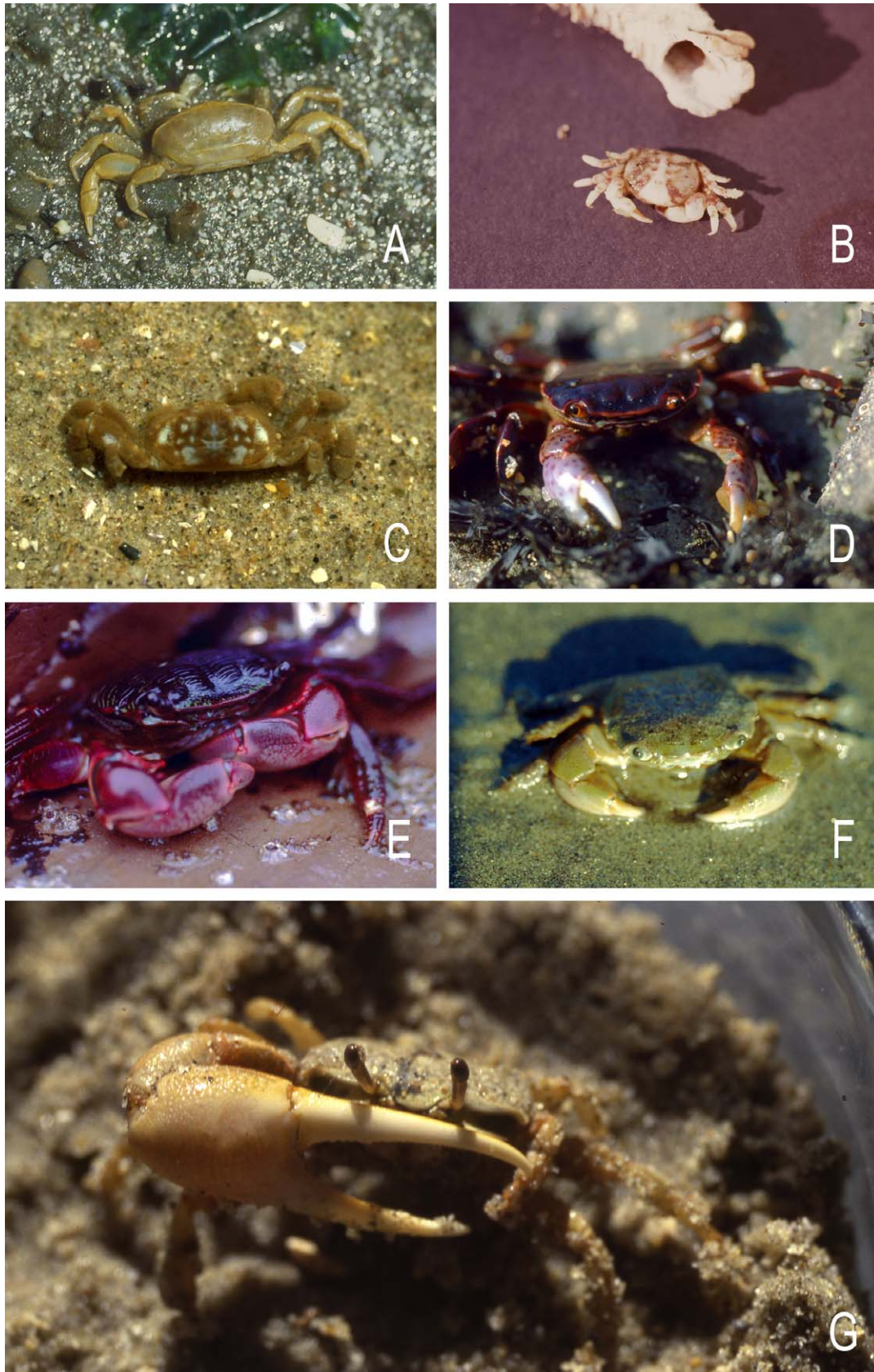


PLATE 15. A, *Scleroplax granulata* Rathbun, 1893; Princeton, San Mateo County; B, *Opisthopus transversus* Rathbun, 1893; Cabrillo Beach, Los Angeles County; C, *Pinnixa tubicola* Holmes, 1894; Newport Beach; D, *Hemigrapsus nudus* (Dana, 1851); Moss Beach, San Mateo County; E, *Pachygrapsus crassipes* Randall, 1839; Moss Beach; F, *Hemigrapsus oregonensis* (Dana, 1851); Coyote Point, San Francisco Bay; G, *Uca crenulata crenulata* (Lockington, 1876); male, Santa Catalina I.