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Decapod Crustacea of the Californian and Oregonian Zoogeographic Provinces

MARY K. WICKSTEN
Department of Biology, Texas A&M University, College Station TX 77843-3258 U.S.A.
E-mail: *Wicksten@bio.tamu.edu*

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MARY K. WICKSTEN
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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 ben 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 *Janetogalathea* (Galatheidae), *Acantholithodes*, *Phyllolithodes*, and *Rhinolithodes* (Lithodidae); and the brachyurans *Mimulus* (Epialtidae), *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 Epialtidae, 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.

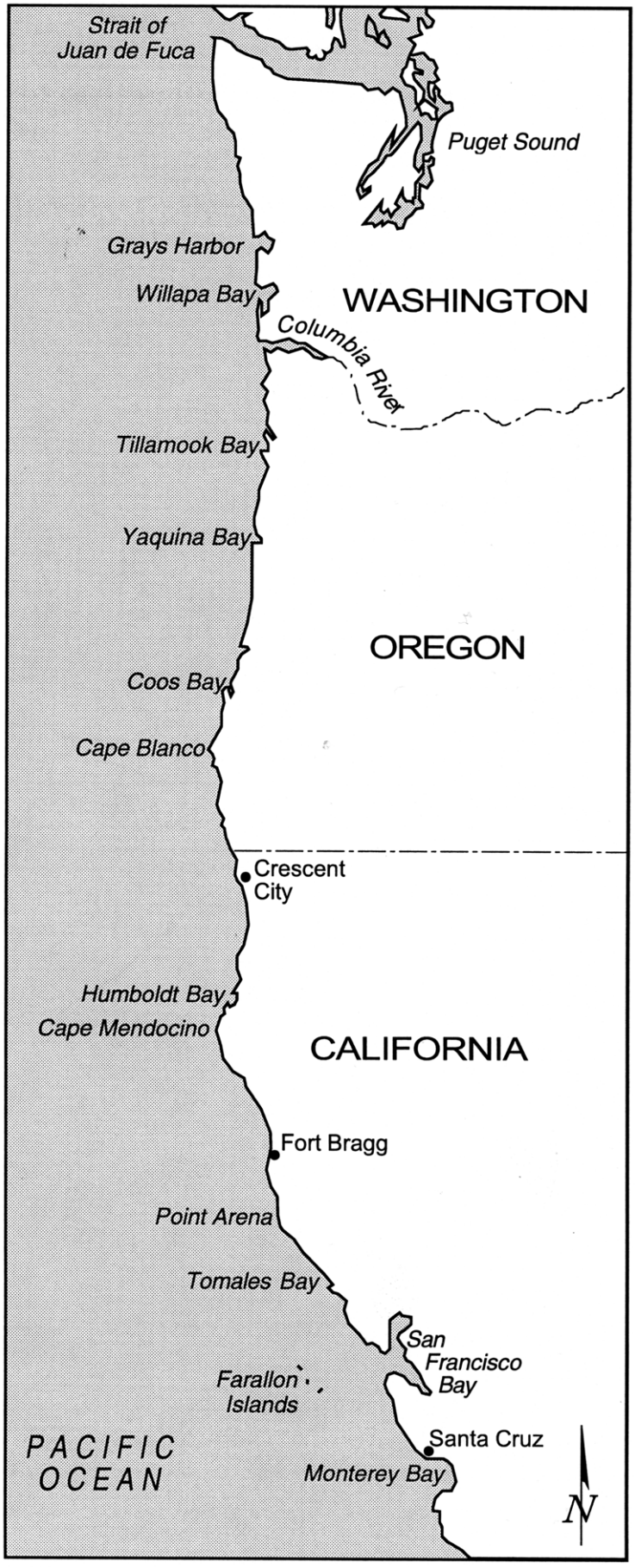

FIGURE 1. Northern area of coverage.

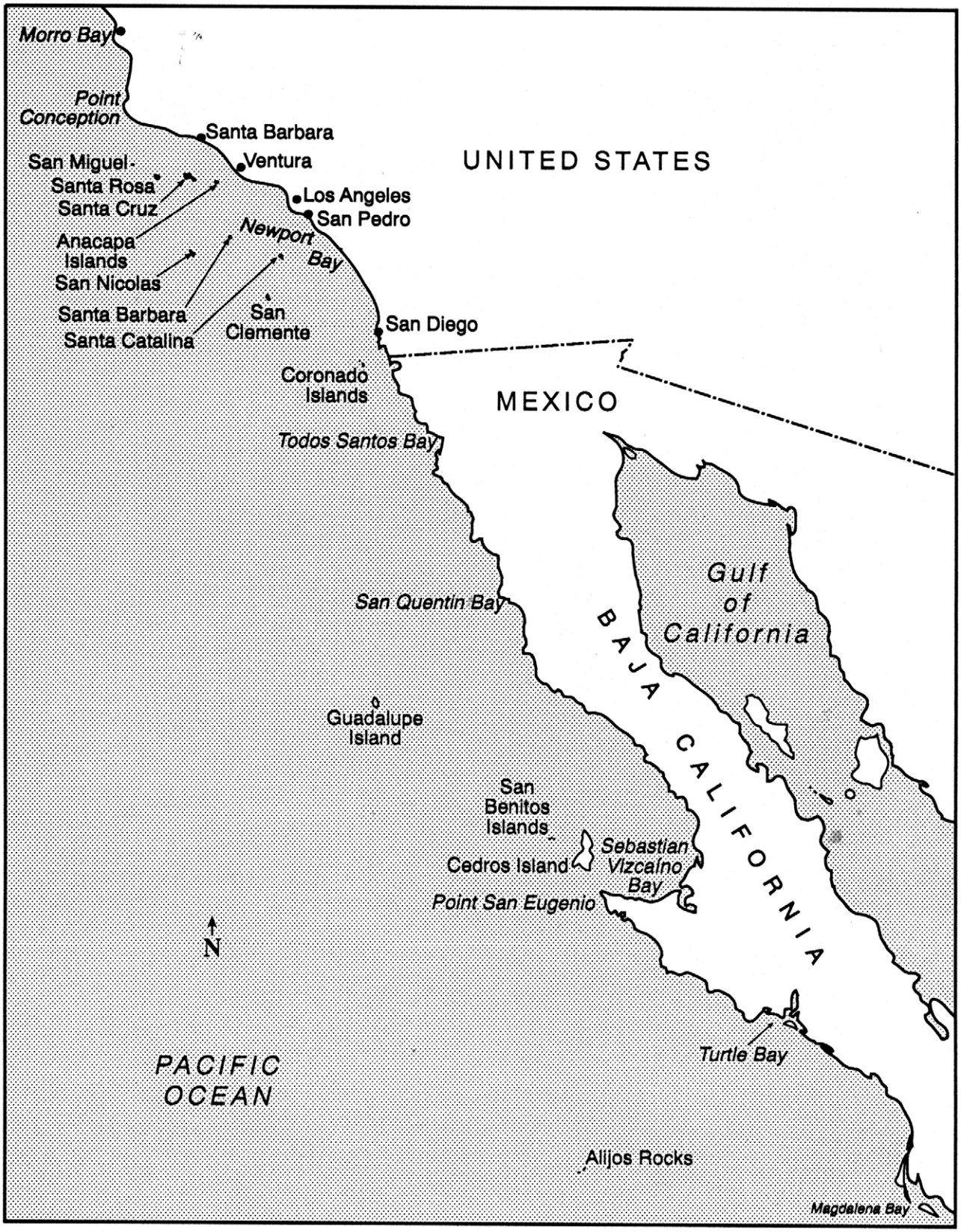

FIGURE 2. Southern area of coverage.

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 is 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: *Syncaris* (2, California)

Thoridae: *Heptacarpus* (35).

Crangonidae: *Lissocrangon stylirostris* (monotypic genus, eastern Pacific), *Mesocrangon munitella* (monotypic genus, eastern Pacific), *Rhynocrangon* (2)

Galatheidae: *Janetogalathea californiensis* (monotypic genus, eastern Pacific)

Hapalogasteridae: family endemic to region (5 genera, 8 species)

Lithodidae: *Cryptolithodes* (2), *Phyllolithodes papillosus* (monotypic genus), *Rhinolithodes wosnessenskii* (monotypic genus)

Epialtidae: *Mimulus foliatus* (monotypic genus, eastern Pacific), *Pugettia* (19)

Oregoniidae: *Oregonia* (2)

Pisidae: *Chorilia* (2), *Loxorhynchus* (3, eastern Pacific), *Scyra* (3)

Cancridae: *Glebocarcinus* (2)

Panopeidae: *Malacoplax californiensis* (monotypic genus, eastern Pacific)

Pinnotheridae: *Enigmatheres canfeldi* (monotypic genus, eastern Pacific), *Opisthopus transversus* (monotypic genus, eastern Pacific), *Scleroplax granulata* (monotypic genus, eastern Pacific)

Extending from North Pacific into Arctic Ocean and/or North Atlantic:

Thoridae: *Spirontocaris* (24, only 2 Atlantic)

Pandalidae: *Pandalus* (20, only 1 Atlantic)

Crangonidae: *Argis* (12, one of which extends into North Atlantic), *Sclerocrangon* (6 species, 1 circumboreal), *Crangon* (15–20 species but some taxonomic confusion, 3 in Atlantic)

Oregoniidae: *Chionoecetes* (7, 1 circumboreal), *Hyas* (5, 1 circumboreal, 1 Atlantic)

Extending from North Pacific to Pacific coasts of Central or South America:

Alpheidae: *Betaeus* (11, 2 South Pacific)

Crangonidae: *Paracrangon* (2, 1 North Pacific, 1 South Pacific), *Neocrangon* (3, 1 extending to South Pacific)

Munidae: *Pleuroncodes* (2,1 North Pacific, 1 South Pacific)

Lithodidae: *Glyptolithodes cristatipes* (monotypic genus), *Lopholithodes* (4, 3 North Pacific, 1South Pacific)

Epialtidae: *Taliepus* (3, 1 North Pacific, 2 South Pacific)

Families widespread in cold or deep water but most diverse in North Pacific:

Thoridae: *Eualus* (27, 18 North Pacific, 4 circumboreal, 2 Europe-Mediterranean, 3 southern hemisphere, some taxonomic confusion)

Cancridae: *Metacarcinus* (5, 3 North Pacific, 1 South America, 1 New Zealand), *Romaleon* (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, Pilumnidae, 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 Benthesicymidae, 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 *Benthesicymus tanneri* Faxon, 1893 (Benthesicymidae), 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 hirsutiusculus* (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 californiensi*s (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 Benthesicymidae, Oplophoridae, 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 (Oplophoridae) were considered bathypelagic (500–800 m). Pearcy & Forss (1966), Wasmer (1972b), and Krygier & Pearcy (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* (Epialtidae), *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* (Epialtidae), *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: *Janetogalathea 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 hirsutiusculus* 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 Benthesicymidae 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 *Benthesicymus* 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 Benthesicymidae

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 . . . . . *Benthesicymus 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 . . . . . *Benthesicymus tanneri*
– Median carina of abdominal somites 5, 6 not terminating in teeth; sixth somite ending in upturned transverse ridge . . . . . *Benthesicymus 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 Maldive 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).
Gennadas 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 Kaui, 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 200: 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 pterygostomian 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

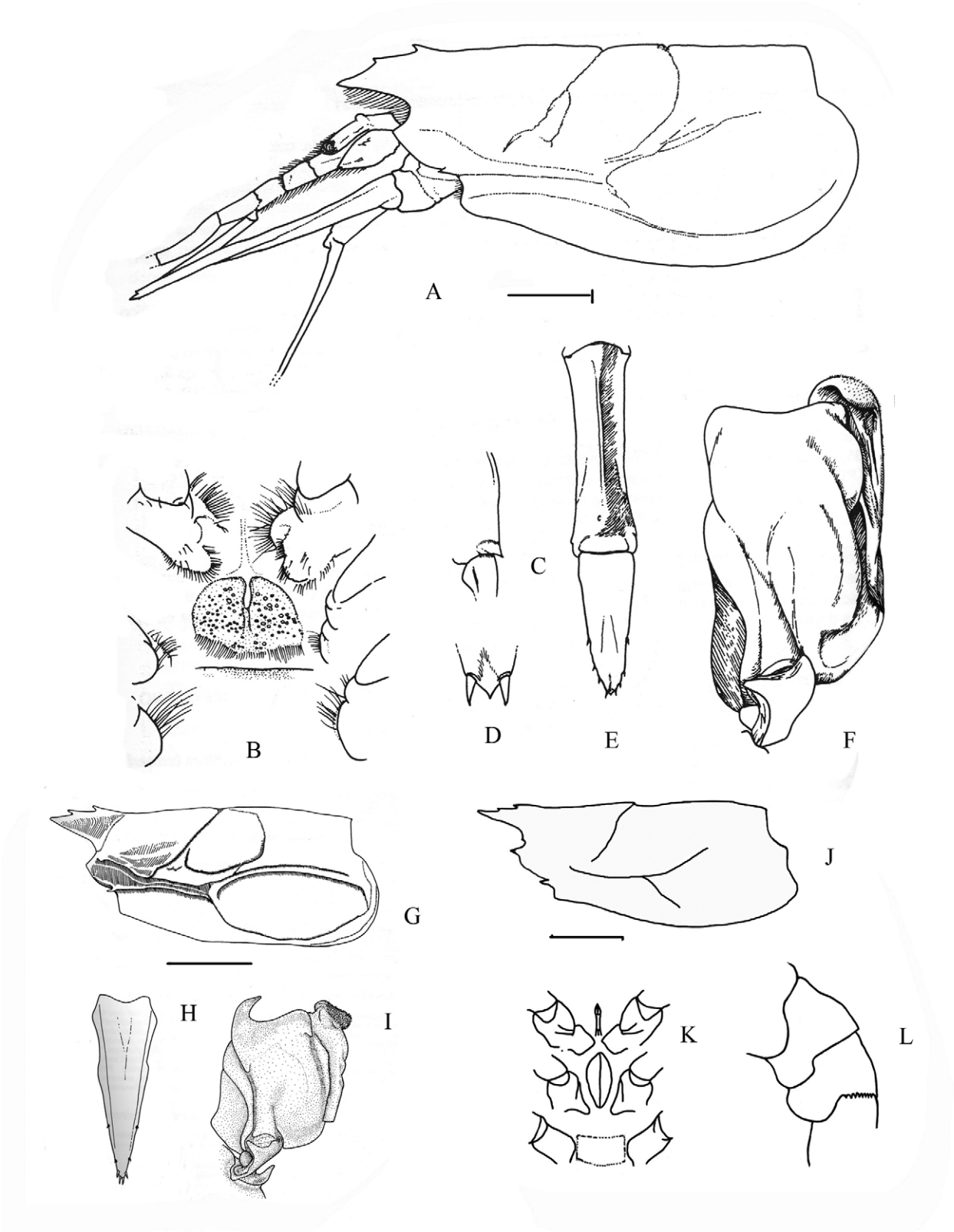

FIGURE 3. Family Benthesicymidae. A–F, *Benthesicymus altus* Bate, 1881; A, carapace and frontal region in lateral view; B, thelycum; C, distal point of abdominal somite 6; D, apex of telson; E, abdominal somite 6 and telson; F, petasma. G–I, *Benthesicymus tanneri* Faxon, 1893; G, carapace in lateral view; H, telson; I, petasma. J–L, *Benthesicymus 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. — Kobyakova 1937: 141, fig. 9. — Goodwin 1952: 393. — Kozloff 1974: 162.

Bentheogennema borealis. — Anderson & Lindner 1943: 295. — Pearcy & Forss 1966: 1137. — Butler 1980: 41. — Krygier & Pearcy 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, pterygostomian 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 & Pearcy 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).

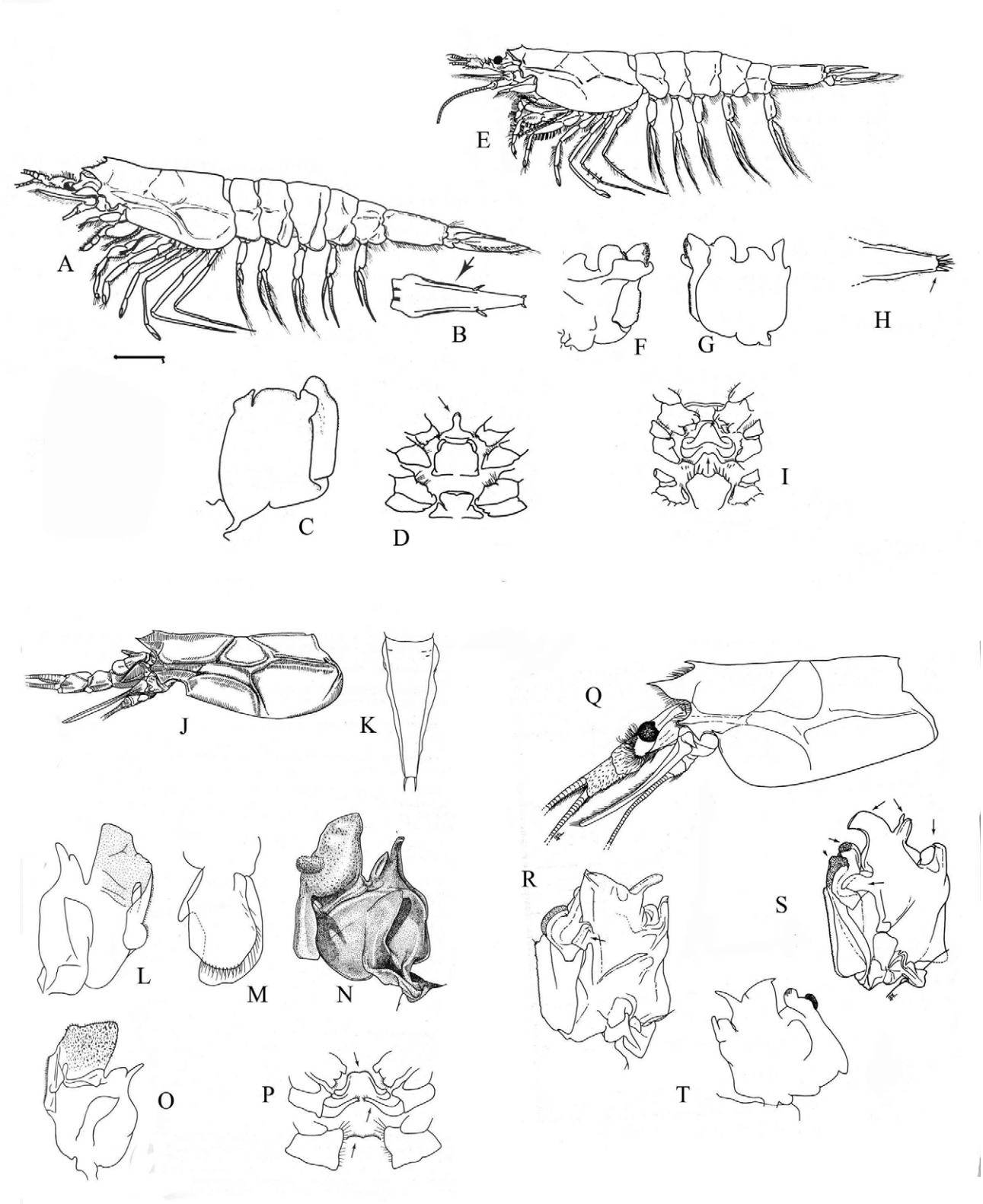

FIGURE 4. Family Benthesicymidae. A–D, *Bentheogennema borealis* (Rathbun, 1902); A, entire animal in lateral view; B, dorsal view of telson; C, petasma; D, thelycum. E–I, *Bentheogennema burkenroadi* Krygier & Wasmer, 1975; E, entire animal in lateral view; F, petasma in anterior view; G, petasma in posterior view; H, detail of telson; I, thelycum. J–P, *Bentheogennema 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. — Pearcy & Forss 1966: 1137. — Ebeling *et al*. 1969: 12. — Kensley 1972: 12, 14, figs. 4i, 5j. — Crosnier 1978: 37, figs. 15b, 19a. — Krygier & Pearcy 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. — Pearcy & Forss 1966: 1137. — Ebeling *et al.* 1969: 12. — Crosnier 1978: 38, figs. 16b, 18d,e.—Krygier & Pearcy 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.

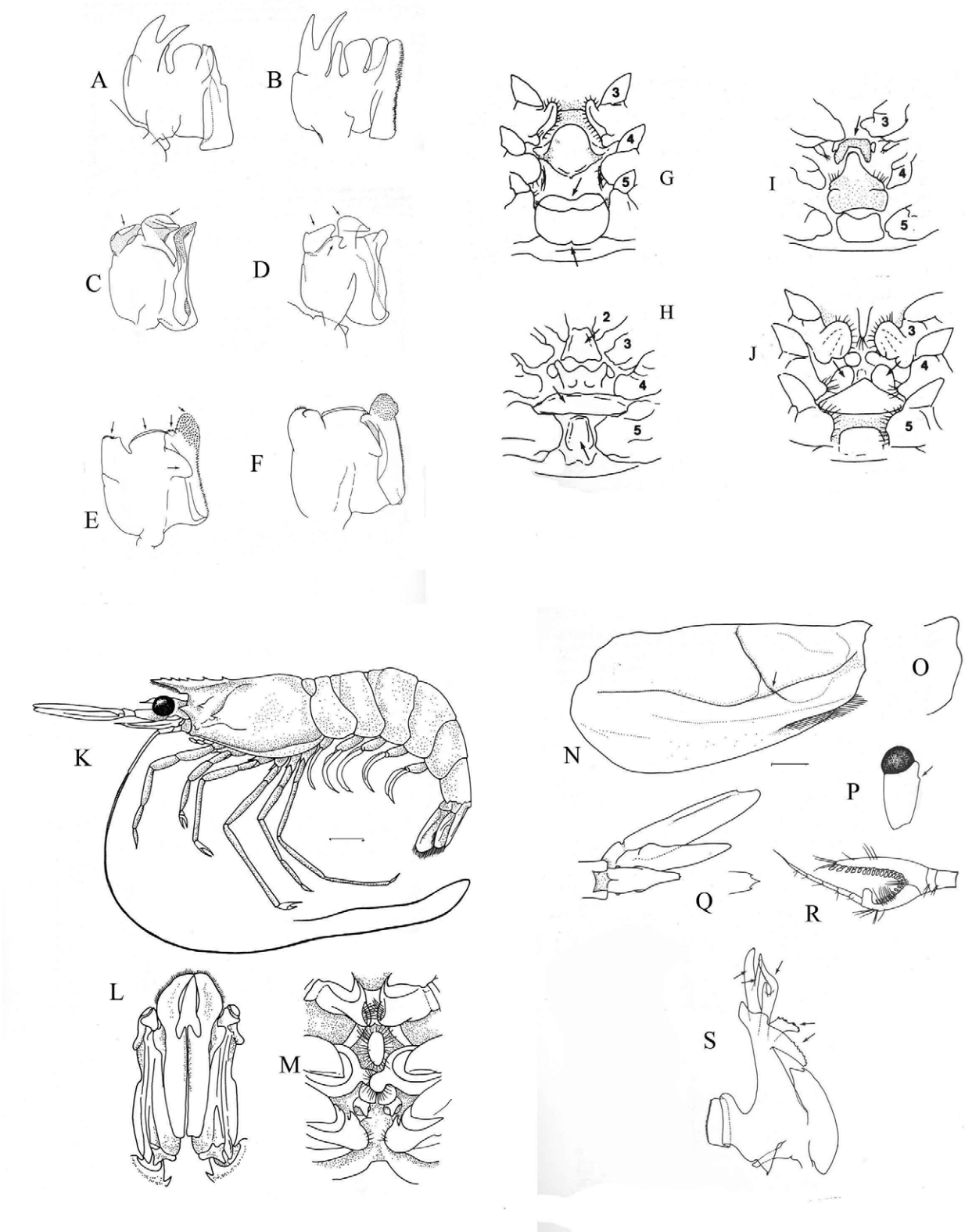

FIGURE 5. Families Benthesciymidae and Sergestidae. A, B, G, *Gennadas incertus* (Balss, 1927); A, B, petasma; F, G, thelycum. C, D, I, *Gennadas sordidus* Kemp, 1910; C, D, petasma; I, thelycum. E, F, J, *Gennadas tinayrei* Bouvier, 1906; E, petasma; J, thelycum. H, *Gennadas propinquus* Rathbun, 1906; thelycum. K–M, *Solenocera mutator* Burkenroad, 1938; K, shrimp in lateral view; L, petasma; M, thelycum. N–S, *Petalidium suspiriosum* 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 & Pearcy 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, pterygostomian 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. Arthrobranchs of up to 13 rami, lamellae relatively large and independent in appearance; petasma with processus ventralis forked . . . . . *Petalidium suspiriosum*
– Arthrobranchs 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 pestafer*
– 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 pestafer (Burkenroad, 1937)

(Fig. 6A–E)

Sergestes pestafer 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 pestafer. — 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. — Pearcy & Forss 1969: 755. —Word & Charwat 1976: 29. — Butler 1980: 47. — Krygier & Pearcy 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 Butler1980). 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.

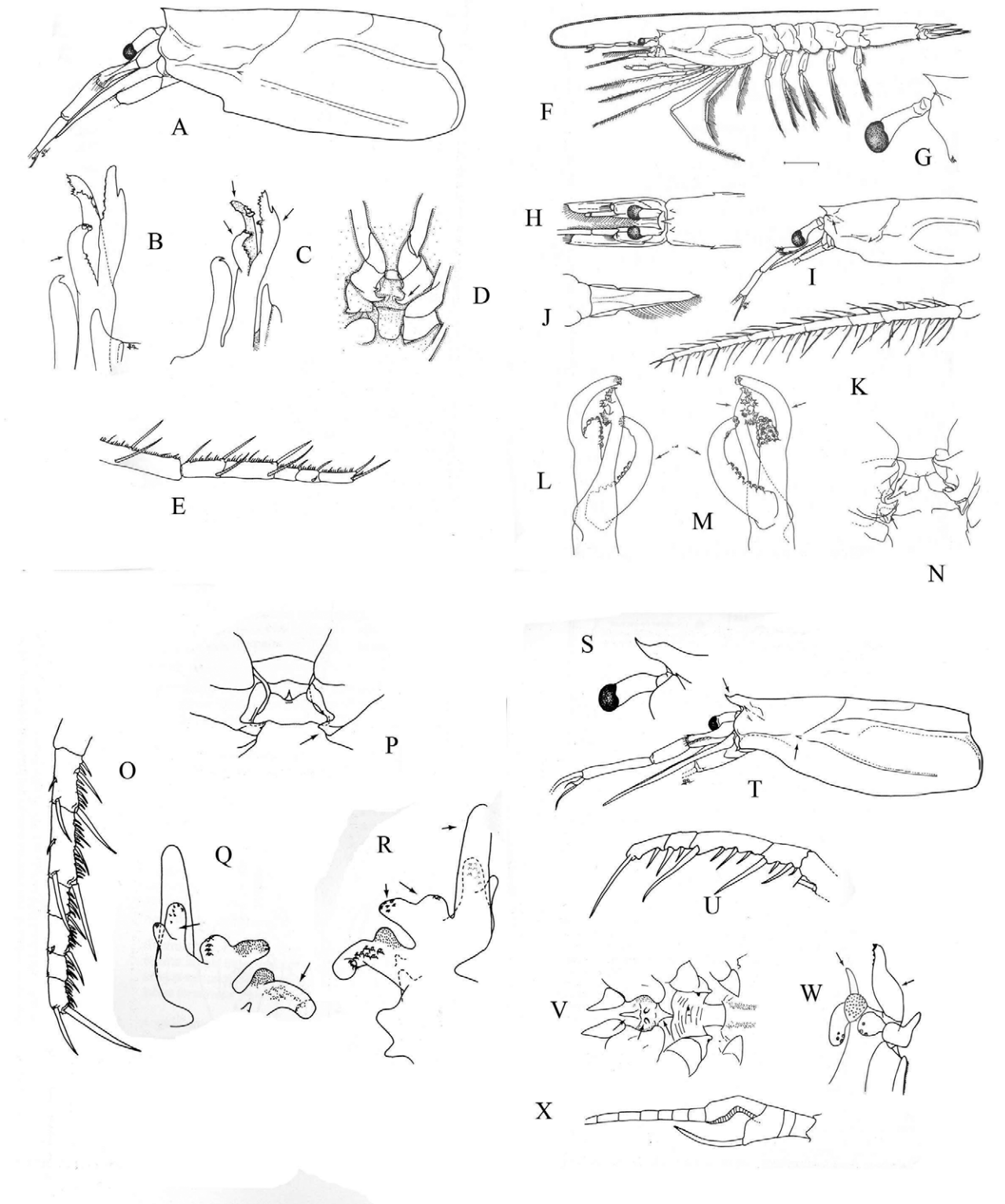

FIGURE 6. Family Sergestidae. A–E, *Allosergestes pestafer* Burkenroad, 1937; A, carapace, eye and antennae in lateral view; B, C, petasma; D, thelycum; E, dactyl of third maxilliped. F–N, *Eusergestes similis* (Hansen, 1903); F, entire shrimp in lateral view; G, ocular peduncle; H, frontal region in 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 & Pearcy 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, pterygostomian 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 & Pearcy 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* exept 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. — Pearcy & Forss 1966: 1137. — Walters 1976: 823. — Butler 1980: 49. — Krygier & Pearcy 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.

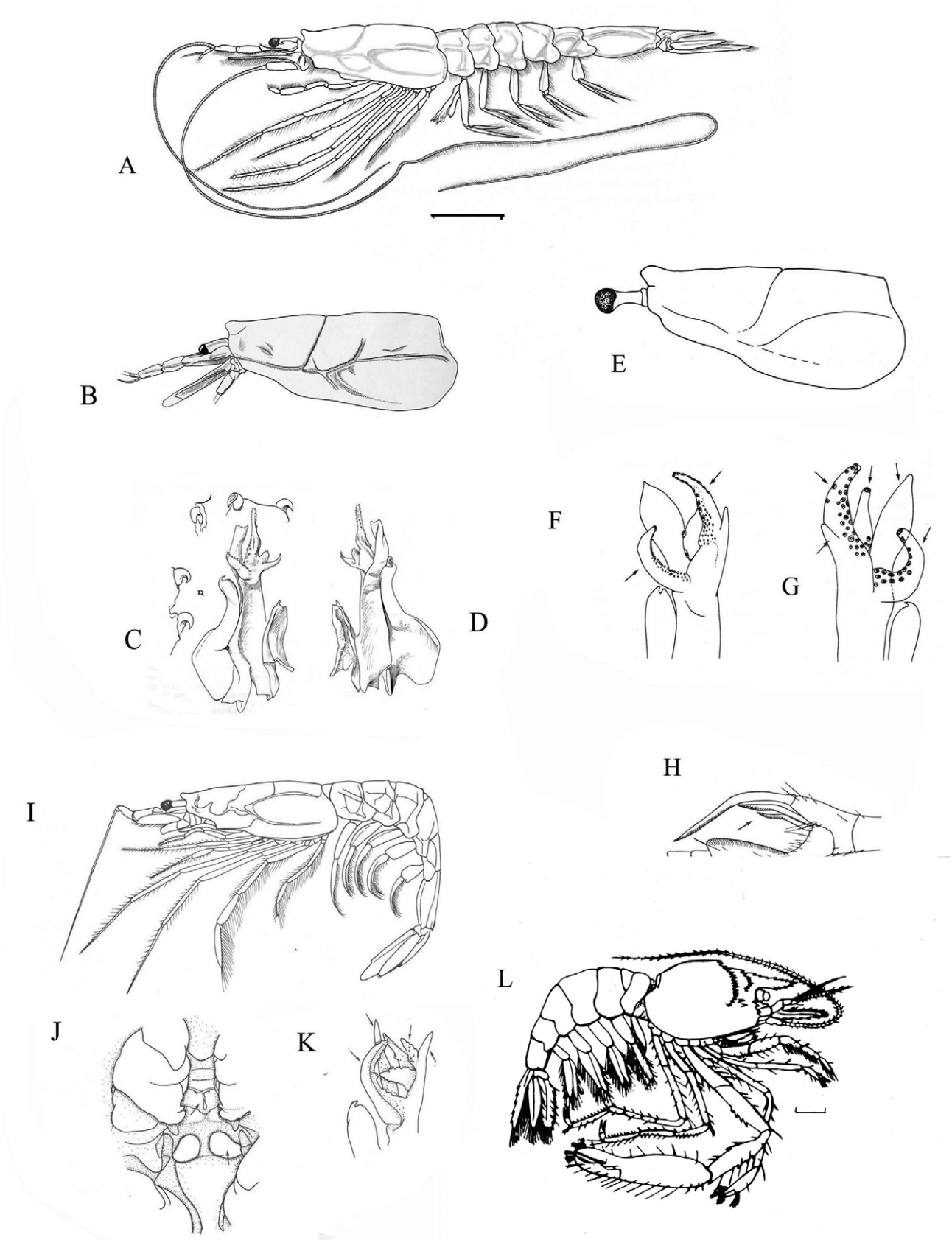

FIGURE 7. Families Sergestidae and Stenopodidae. A, *Sergia tenuiremis* (Kröyer, 1855); B–D, *Sergia japonica* (Bate, 1881); B, carapace, eye and antennae; C, D, petasma and details. E–H, *Sergia laminata* (Burkenroad, 1940); E, carapace and eye; F–G, petasma; H, lower antennular flagellum. I–K, *Sergia 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 & Pearcy 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 & Pearcy 1981).

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

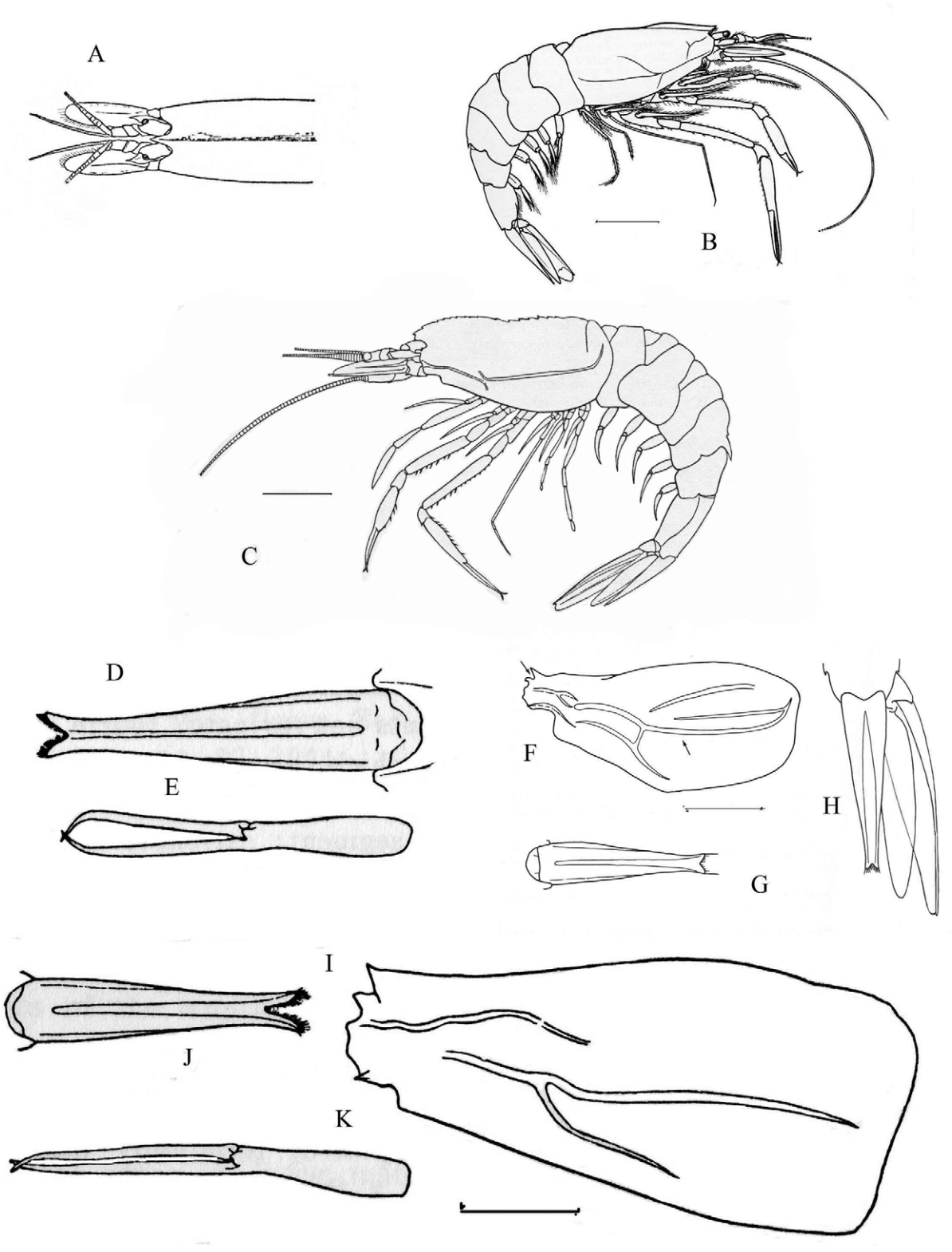

FIGURE 8. Family Pasiphaeidae. A, *Parapasiphae cristata* Smith, 1884; dorsal view of carapace and frontal region. B, *Parapasiphae sulcatifrons* Smith,1884. C, *Eupasiphae serrata* (Rathbun, 1902). D, E, *Pasiphaea affinis* Rathbun, 1902; D, telson; E, major chela. F–H, *Pasiphaea emarginata* Rathbun, 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 & Pearcy 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 & Pearcy 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 suprabranchial carina; anterior margin produced dorsally into blunt, convex lobe, sinuous ventrally, branchioestegal tooth prominent. Eye well developed, pigmented. Antennular peduncle with narrow stylocerite. Basicerite 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 & Pearcy 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 & Pearcy 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 & Pearcy 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 & Pearcy 1981).

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

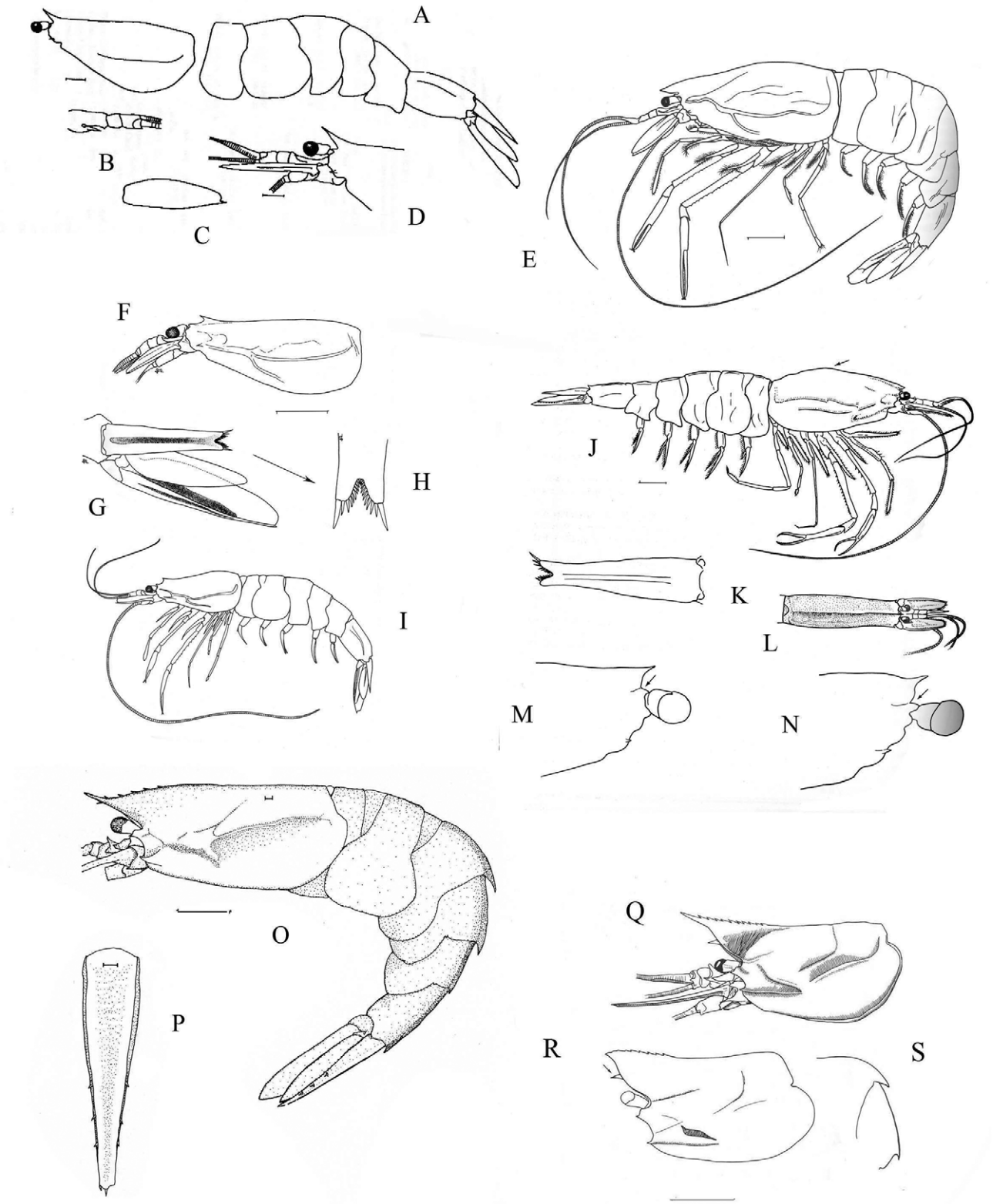

FIGURE 9. Families Pasiphaeidae and Oplophoridae. A–D, *Pasiphaea chacei* Yaldwyn, 1962; A, carapace and abdominal regions in lateral view; B, antennule; C, scaphocerite; D, anterior carapace, eye and antennae. E, *Pasiphaea magna* Faxon, 1893. F–I, *Pasiphaea pacifica* Rathbun, 1902; F, carapace and 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 & Pearcy 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 & Pearcy 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 & Pearcy 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 pterygostomian 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 & Pearcy 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 & Pearcy 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 localitity off New Jersey to Maryland; 40° 26' 40" N, 67°05' 15" W–37°12' 20" N, 69°36' 00" W.

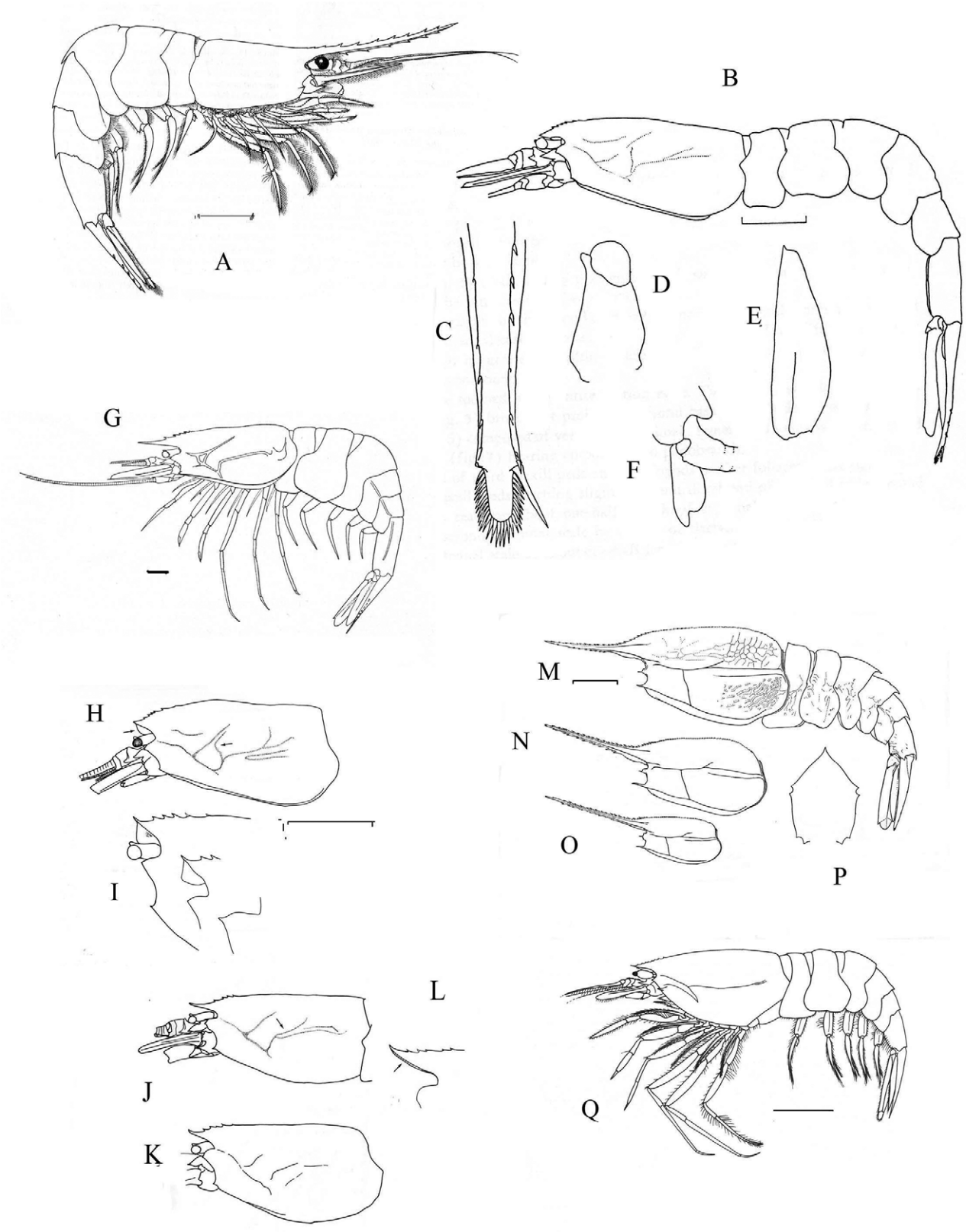

FIGURE 10. Family Oplophoridae. A, *Acanthephyra quadrispinosa* Kemp, 1939. B–F, *Hymenodora acanthitelsonis* Wasmer, 1972; B, carapace, frontal region and abdomen in lateral view; C, telson; D, ocular peduncle; E, scaphocerite; F, endopod of pleopod 1. G, *Hymenodora frontalis* Rathbun, 1902. H, I, *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-Naverrete 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 & Pearcy 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 & Pearcy 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 & Pearcy 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 & Pearcy (1981) based their identification of *N. exilis* on the features given by Crosnier & Forest (1973) for differentiating *N. exilis* from *N. ensife*r (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.

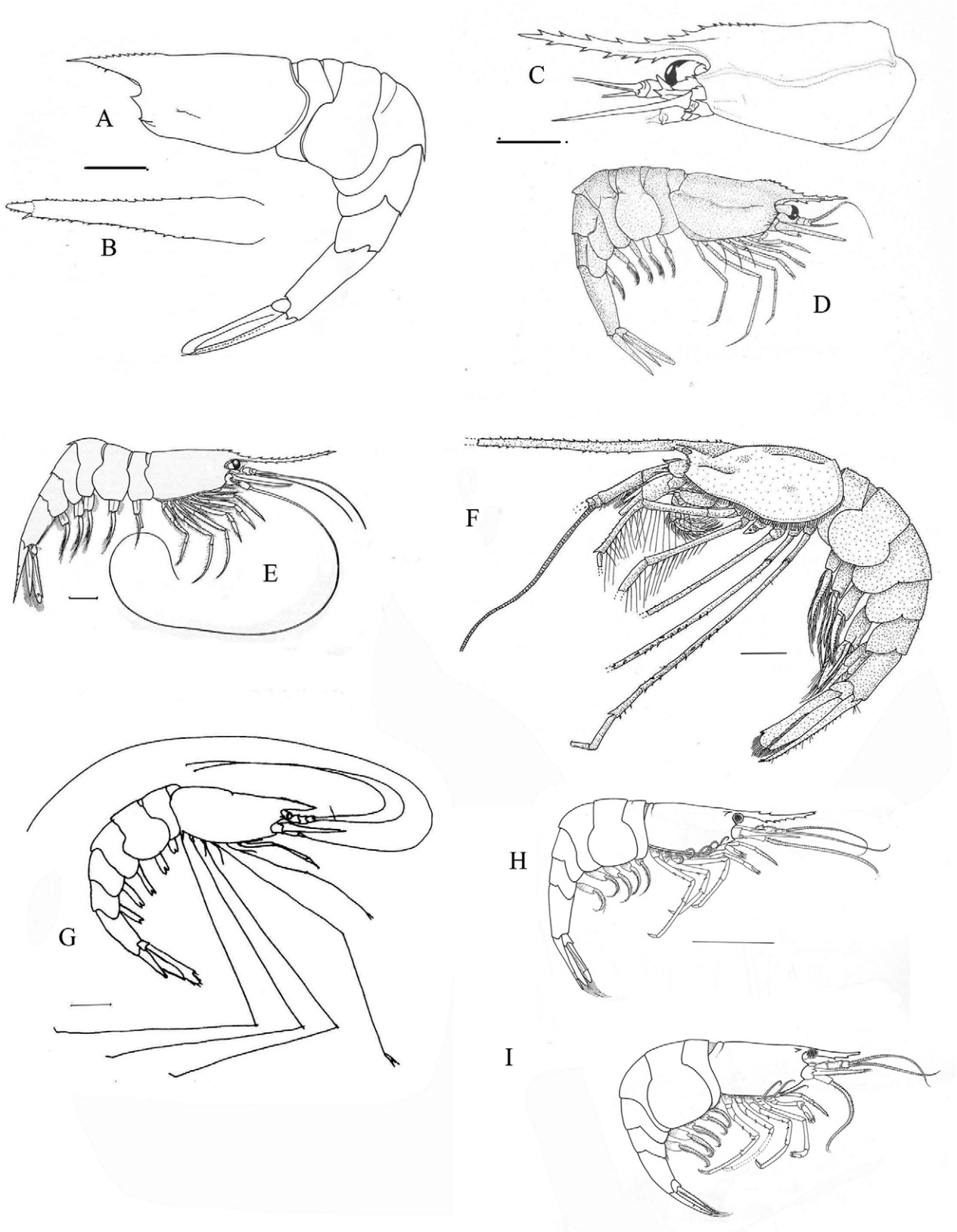

FIGURE 11. Families Oplophoridae, Nematocarcinidae, Stylodactylidae and Atyidae. A, B, *Systellaspis braueri paucispinosa* Crosnier, 1987; A, carapace and adomen; B, telson. C, D, *Systellaspis cristata* (Faxon, 1893); C, carapace and abdomen in lateral view; D, entire shrimp. E, *Systellaspis debilis* (A. Milne-Edwards, 1881). F, *Bathystylodactylus echinus* Wicksten & Martin, 2004. G, *Nematocarcinus exilis* (Bate, 1888). H, S*yncaris 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. 11I)

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	*Palaemon ritteri*
–	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	*Palaemon macrodactylus*
–	Rostrum without subapical tooth, mandible without palp. Total length reaching 25 mm	*Palaemonetes hiltoni*
4.	Rostrum without dorsal teeth	5
–	Rostrum with dorsal teeth	6
5.	Body stout, major chelipeds heavy, lobster-like. Symbiotic with ascidians	*Ascidonia californiensis*
–	Body, major chelipeds slender. Not symbiotic with ascidians	*Pseudocoutierea elegans*
6.	Rostrum arched over eye, carapace without supraorbital teeth	*Periclimenes infraspinis*
–	Rostrum not arched over eye, carapace with supraorbital teeth	*Palaemonella holmesi*

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).

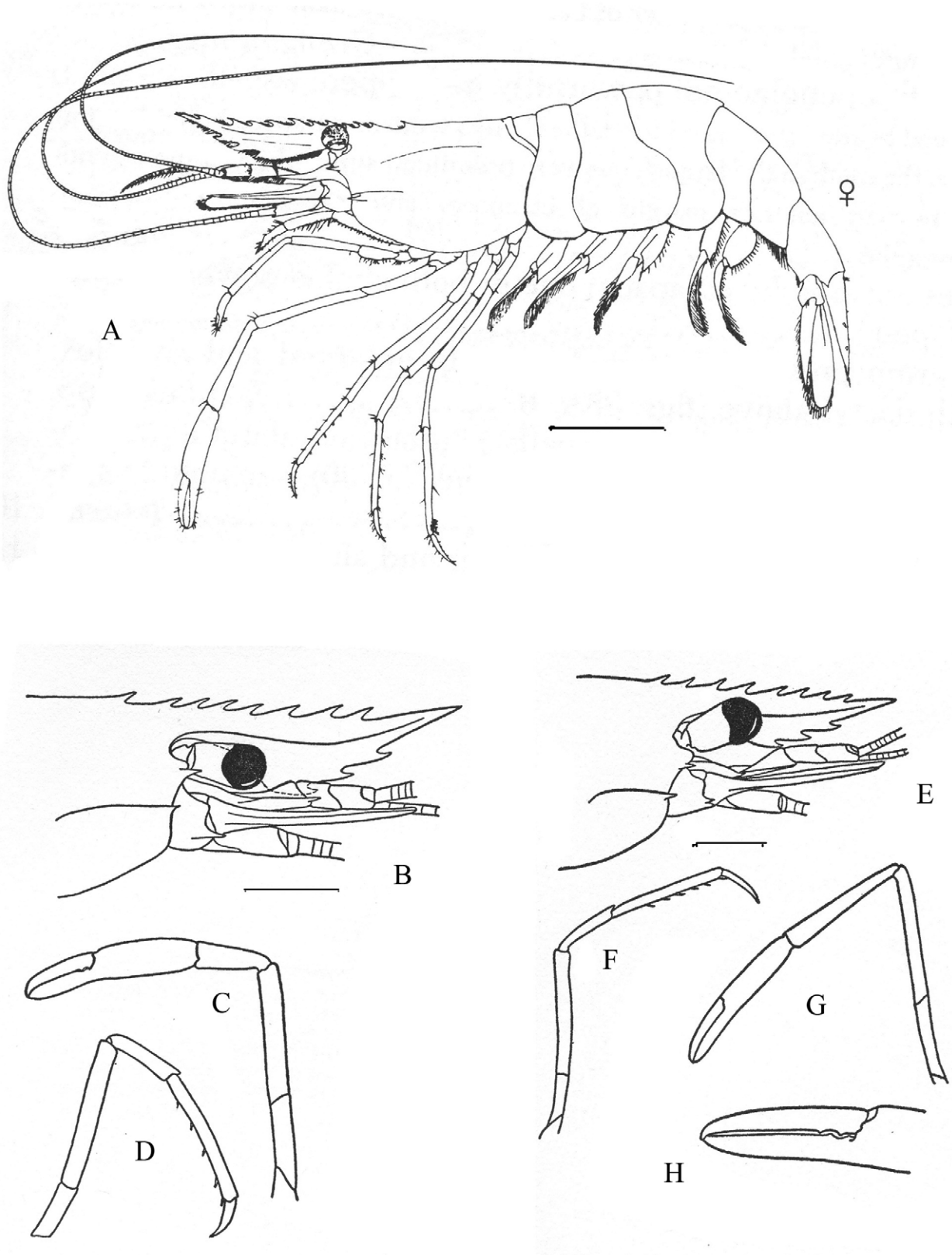

FIGURE 12. Family Palaemonidae. A, *Palaemon macrodactylus* (Rathbun, 1902). B–D, *Palaemon ritteri* Holmes, 1895; B, frontal region in lateral view; C, pereopod 2; D, pereopod 3. E–H, *Palaemonetes hiltoni* Schmitt, 1921; E, frontal region in lateral view; F, pereopod 3; G, pereopod 2; H, detail of 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.

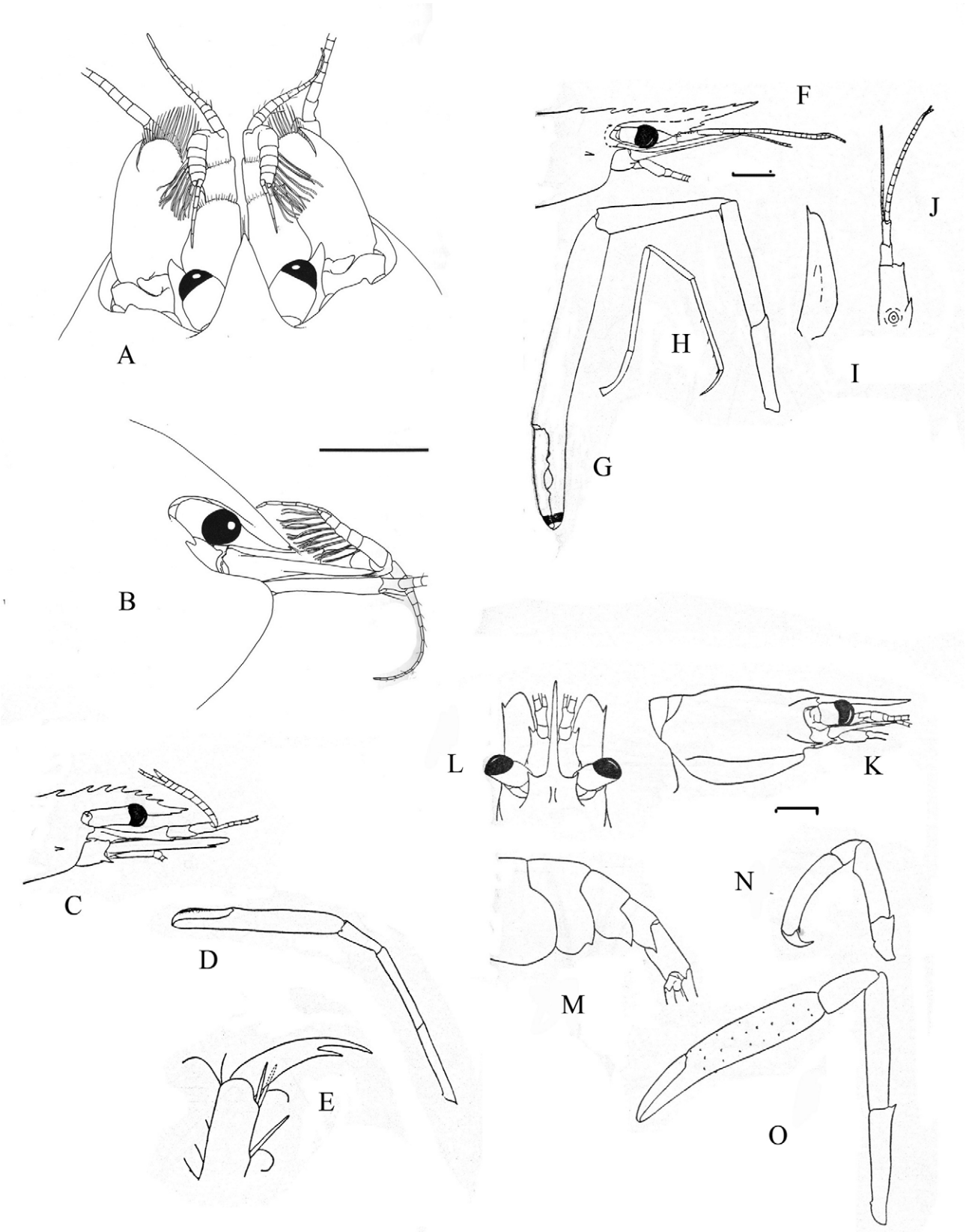

FIGURE 13. Family Palaemonidae. A, B, *Ascidonia californiensis* (Rathbun, 1902); A, anterior appendages, dorsal view; B, anterior appendages, lateral view. C–E, *Periclimenes infraspinis* (Rathbun,1902); C, frontal region in lateral view; D, pereopod 2; E, dactyl of pereopod 3. F–J, *Palaemonella holmesi* (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* Coutiére, 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 Coutiére, 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.

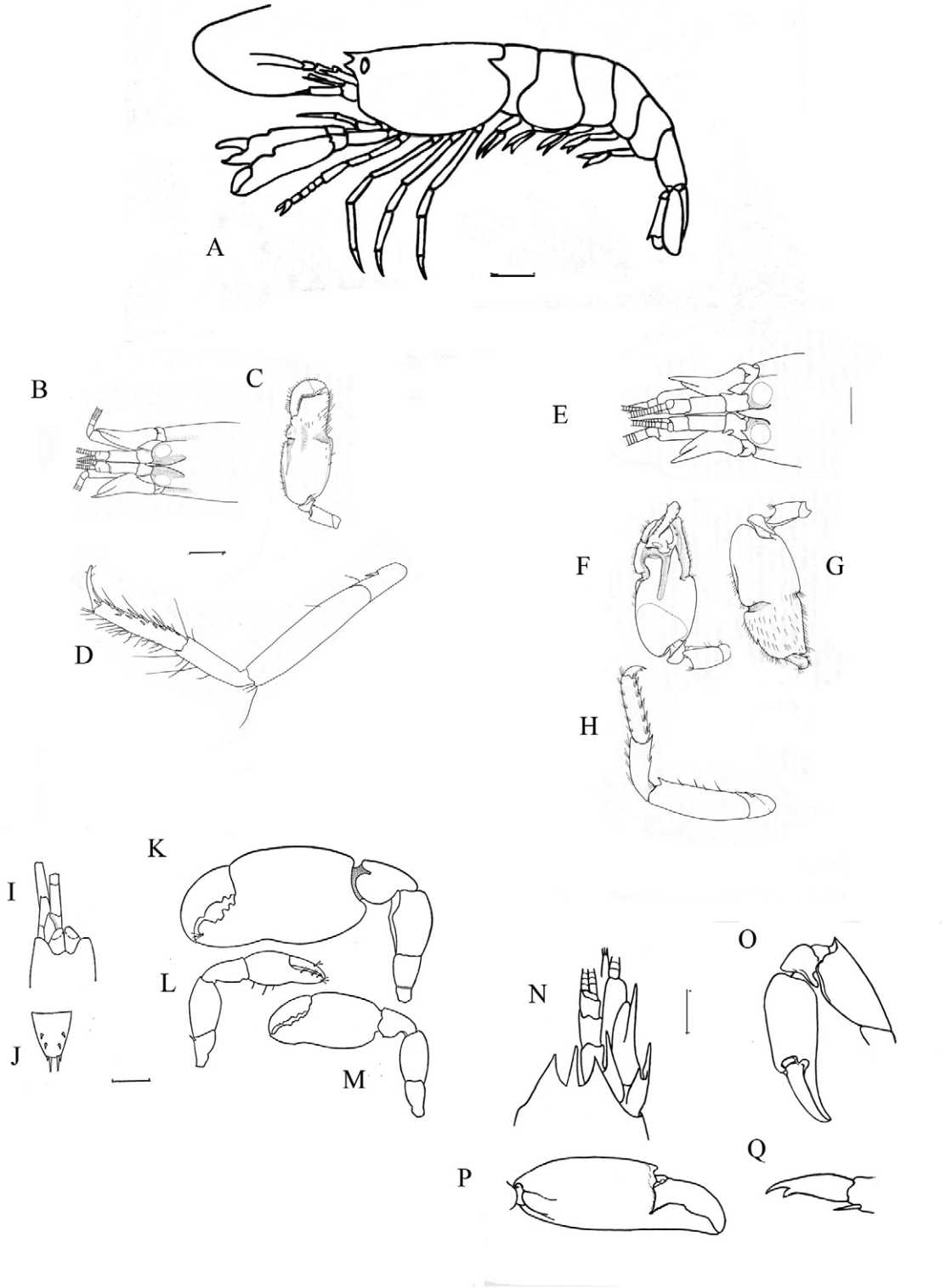

FIGURE 14. Family Alpheidae. A, *Alpheopsis equidactylus* (Lockington, 1877). B–D, *Alpheus californiensis* Holmes, 1900; B, frontal region in dorsal view; C, major chela in lateral view; D, pereopod 3. E–H, *Alpheus clamator* Lockington, 1877; E, pereopod 3; F, major chela, mesial view; G, major chela, 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 980: 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, l, 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).

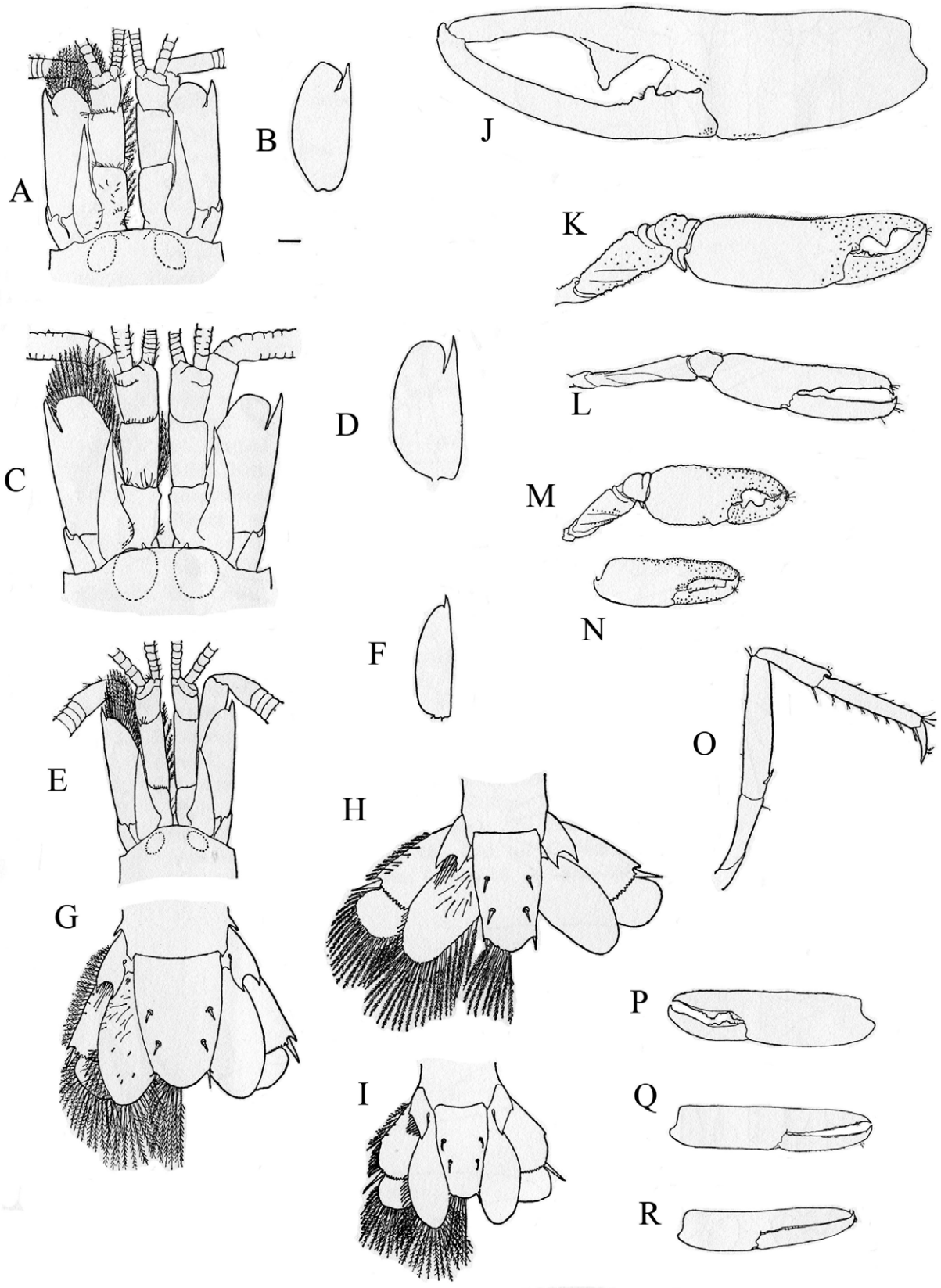

FIGURE 15. Family Alpheidae. A, B, G, K, O, P, Q. *Betaeus harrimani* Rathbun, 1904; A, frontal region in dorsal view; B, scaphocerite; G, tail fan; K, right cheliped of male; O, pereopod 3; P, left chela of female; Q, right chela of female. C, D, H, J, L, R *Betaeus longidactylus* Lockington, 1877; 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.

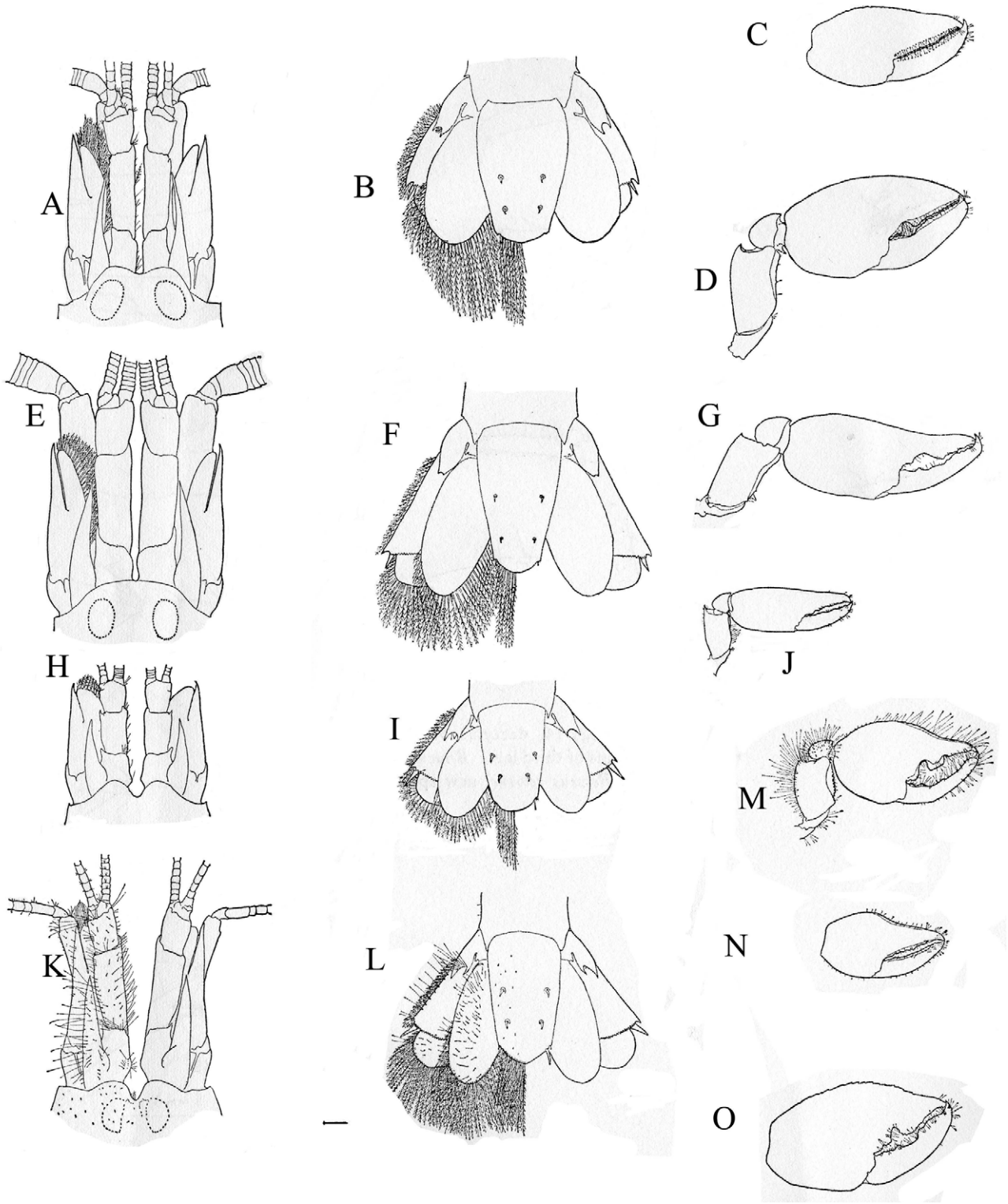

FIGURE 16. Family Alpheidae. A–D, *Betaeus harfordi* (Kingsley, 1878); A, frontal region in dorsal view; B, tail fan; C, right chela of female; D, right cheliped of male. E–G, *Betaeus macginitieae* Hart, 1964; E, frontal region in dorsal view; F, tail fan; G, right cheliped of male. H–J, *Betaeus gracilis* 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 nubilis* 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. Coutiére (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* Coutiére, 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* Coutiére.

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. — Qurioz-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.

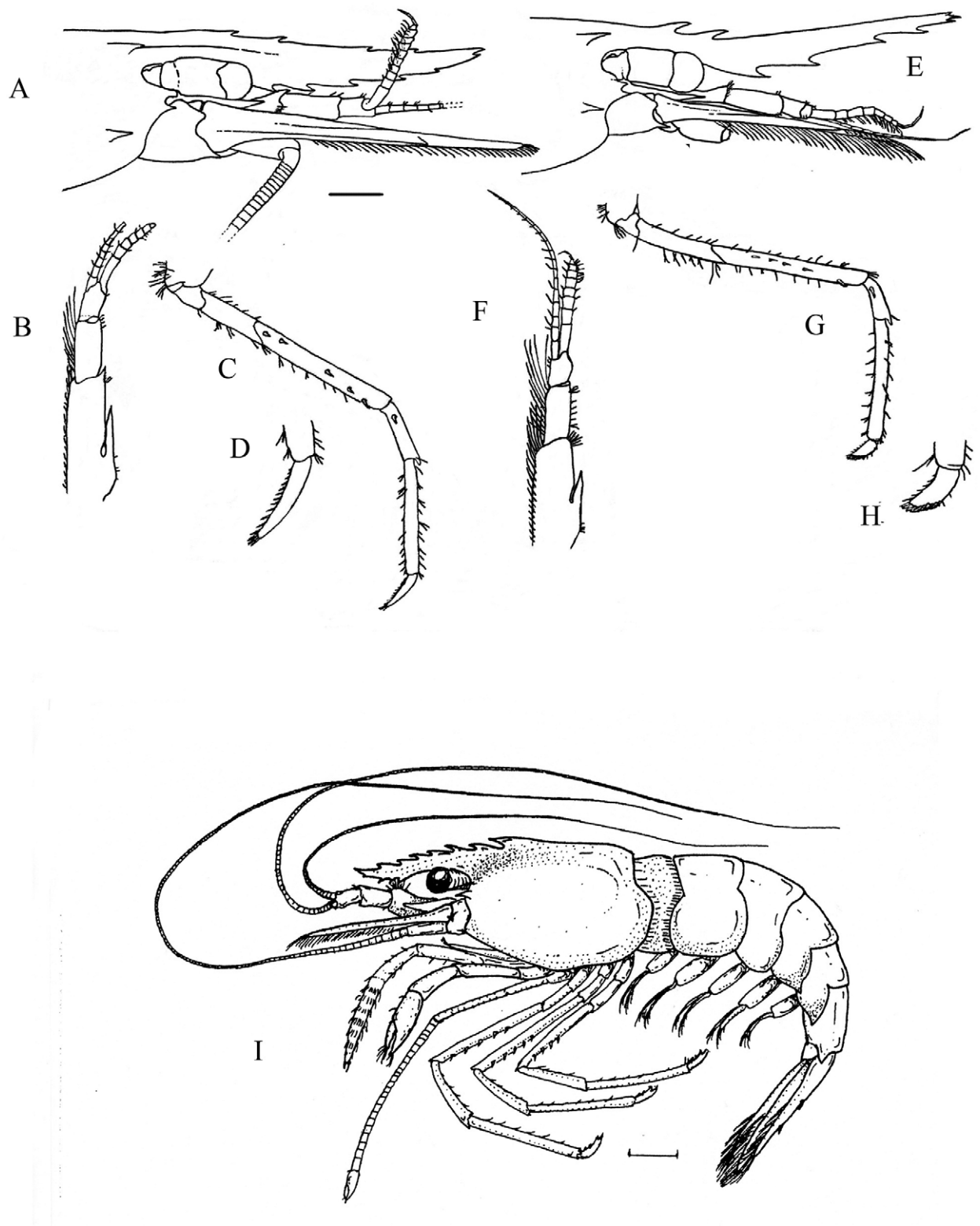

FIGURE 17. Families Hippolytidae, Lysmatidae. A–D, *Hippolyte californiensis* Holmes, 1895. A, frontal region in lateral view; B, antennule; C, pereopod 3, D, dactyl of pereopod 3. E–H, *Hippolyte clarki* Chace, 1951; E, frontal region in lateral view; F, antennule; G, pereopod 3; H, dactyl of pereopod 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 *Lysmat*a 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, pterygostomian 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 pterygostomian teeth are often present on the carapace, although the pterygostomian 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 Ratbhun (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 segement 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 . . . . . *Heptacarpus tenuissimus*
– 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 . . . . . *Heptacarpus carinatus*
– Epipods present on pereopods 1, 2 only. Rostrum narrow, with 4–5 dorsal teeth, 5–8 ventral teeth . . . . . *Heptacarpus flexus*
23. Pterygostomian tooth absent 24
– Pterygostomian tooth present 25
24. Rostrum shorter than carapace, distal ventral half convex . . . . . *Heptacarpus brachydactylus*
– Rostrum longer than carapace, distal ventral half not convex or only slightly so . . . . . *Heptacarpus franciscanus*
25. Scaphocerite shorter than carapace, abdominal somite 6 longer than telson . . . . . *Heptacarpus decorus*
– Scaphocerite as long as or longer than carapace, abdominal somite 6 shorter than telson . . . . . *Heptacarpus kincaidi*
26. Rostrum deep. Epipod on pereopod 1 only. Usually on continental shelf, Oregon northward . . . . . *Heptacarpus moseri*
– 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. . . . . *Heptacarpus pugettensis*
– 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 . . . . . *Heptacarpus paludicola*
– Rostrum not reaching end of antennular peduncle. Common in tide pools . . . . . *Heptacarpus sitchensis*
30. Dactyls of pereopods 3–5 simple, curved; rostrum slightly ascending over eye, with dorsal teeth most thickly set in proximal half. . . . . *Heptacarpus stimpsoni*
– 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 . . . . . *Heptacarpus taylori*
– Rostrum exceeding cornea of eye, rostral teeth more widely spaced, not as clearly descending 32
32. Spine on distal ventral flexor margin of merus of pereopod . . . . . *Heptacarpus fuscimaculatus*
– No spine on distal ventral flexor margin of merus of pereopod 1. 3
33. Rostrum usually with bifid or trifid apex, exceeding cornea, merus of pereopods 3, 4 with 2 spines . . . . *Heptacarpus palpator*
– Rostrum usually with simple apex, not exceeding cornea, merus of pereopods 3, 4 with 1 spine . . . . *Heptacarpus brevirostris*

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.

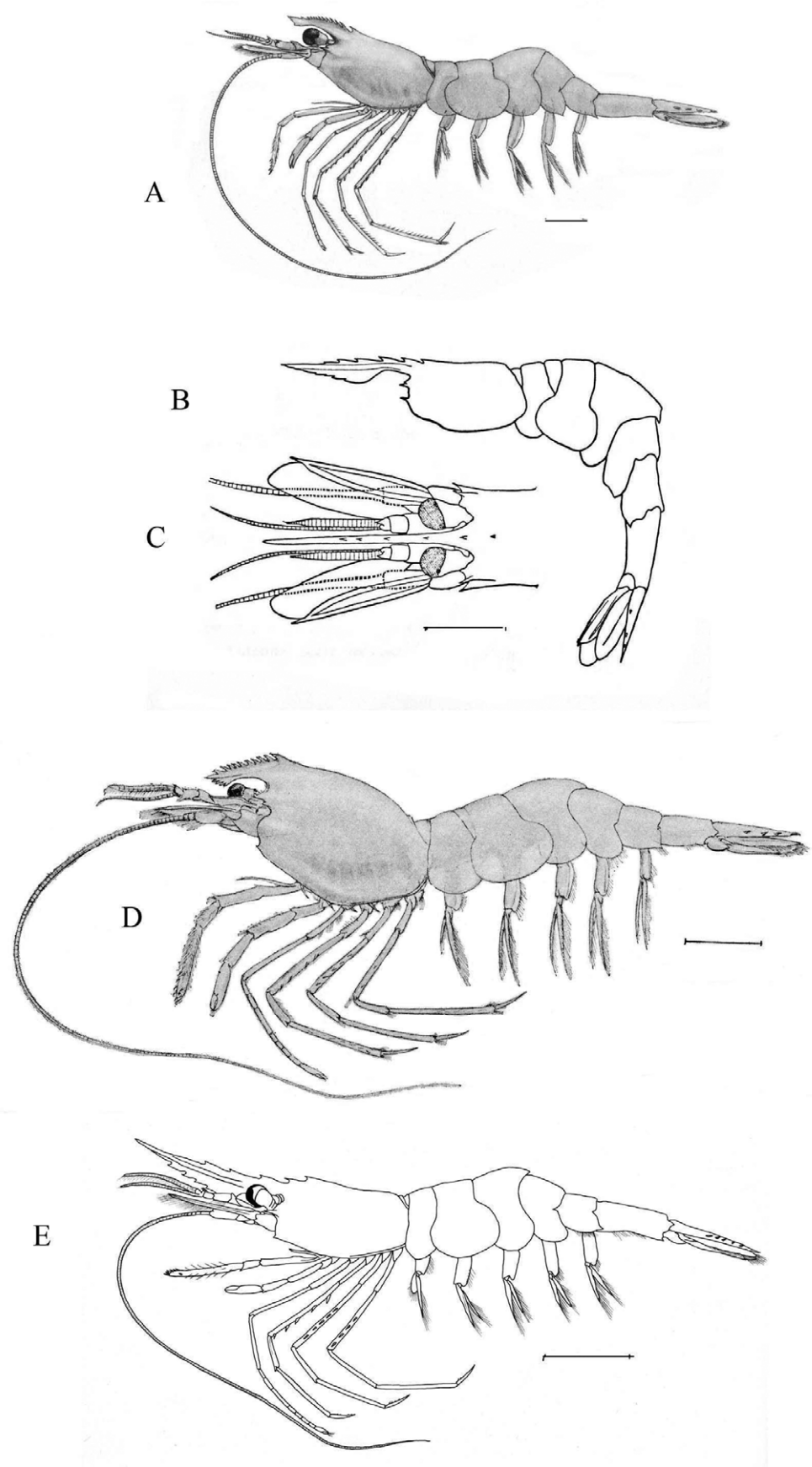

FIGURE 18. Family Thoridae. A, *Eualus avinus* (Rathbun, 1898). B, C, *Eualus barbatus* (Rathbun, 1899); B, carapace and abdomen in lateral view; C, frontal region in dorsal view. D, *Eualus berkeleyorum* Butler, 1971. E, *Eualus biunguis* (Rathbun, 1902). Scales A, B, E = 10 mm, D = 5 mm. A, E from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

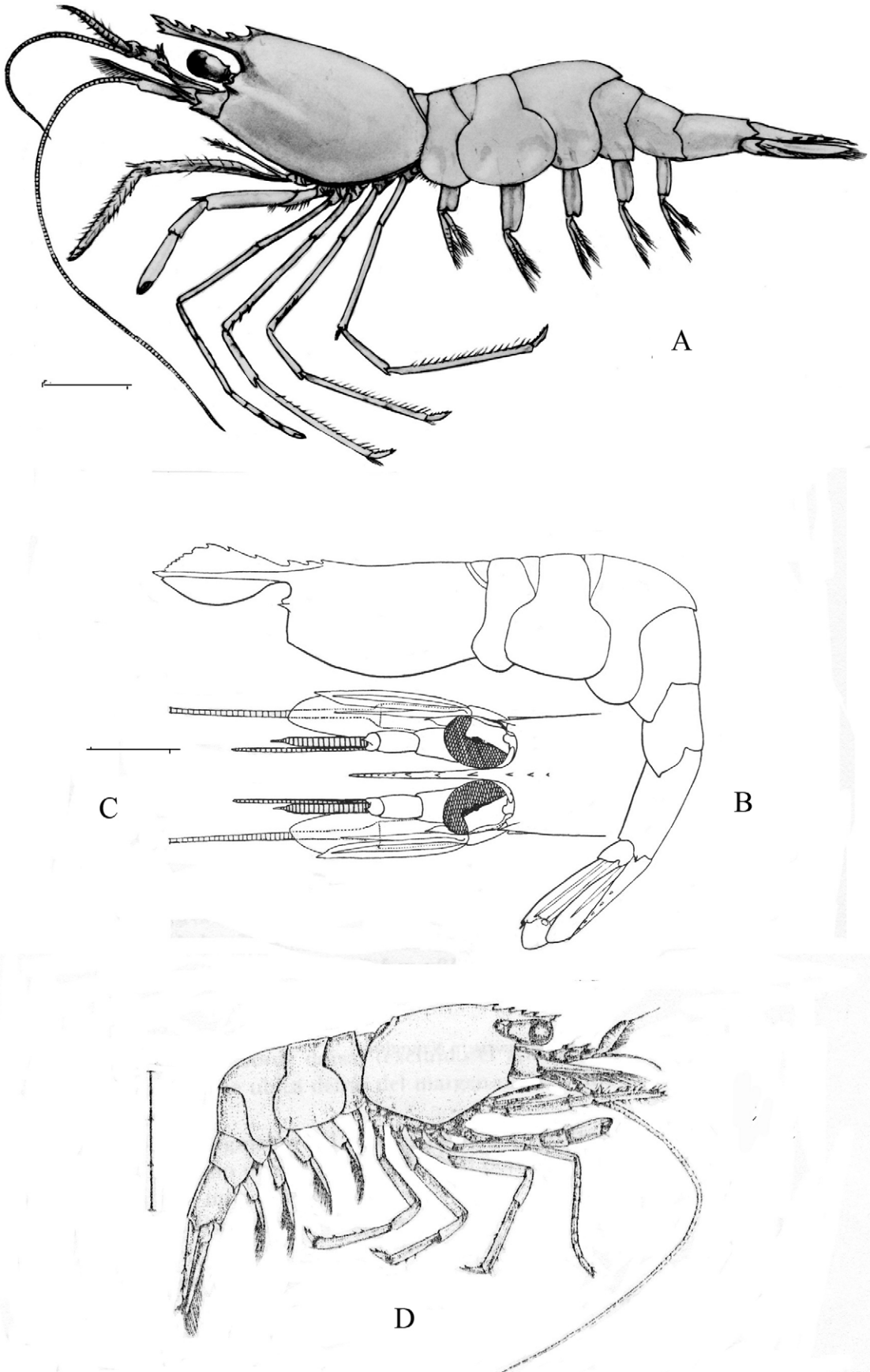

FIGURE 19. Family Thoridae. A, *Eualus lineatus* Wicksten & Butler, 1983. B, C, *Eualus macrophthalmus* (Rathbun, 1902); B, carapace and abdomen; C, frontal region in dorsal view. D, *Eualus subtilis* Carvacho & Olson, 1984. Scales: A = 2 mm, B = 4 mm, D = 3mm. A from Wicksten & Butler 1983, B, C from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

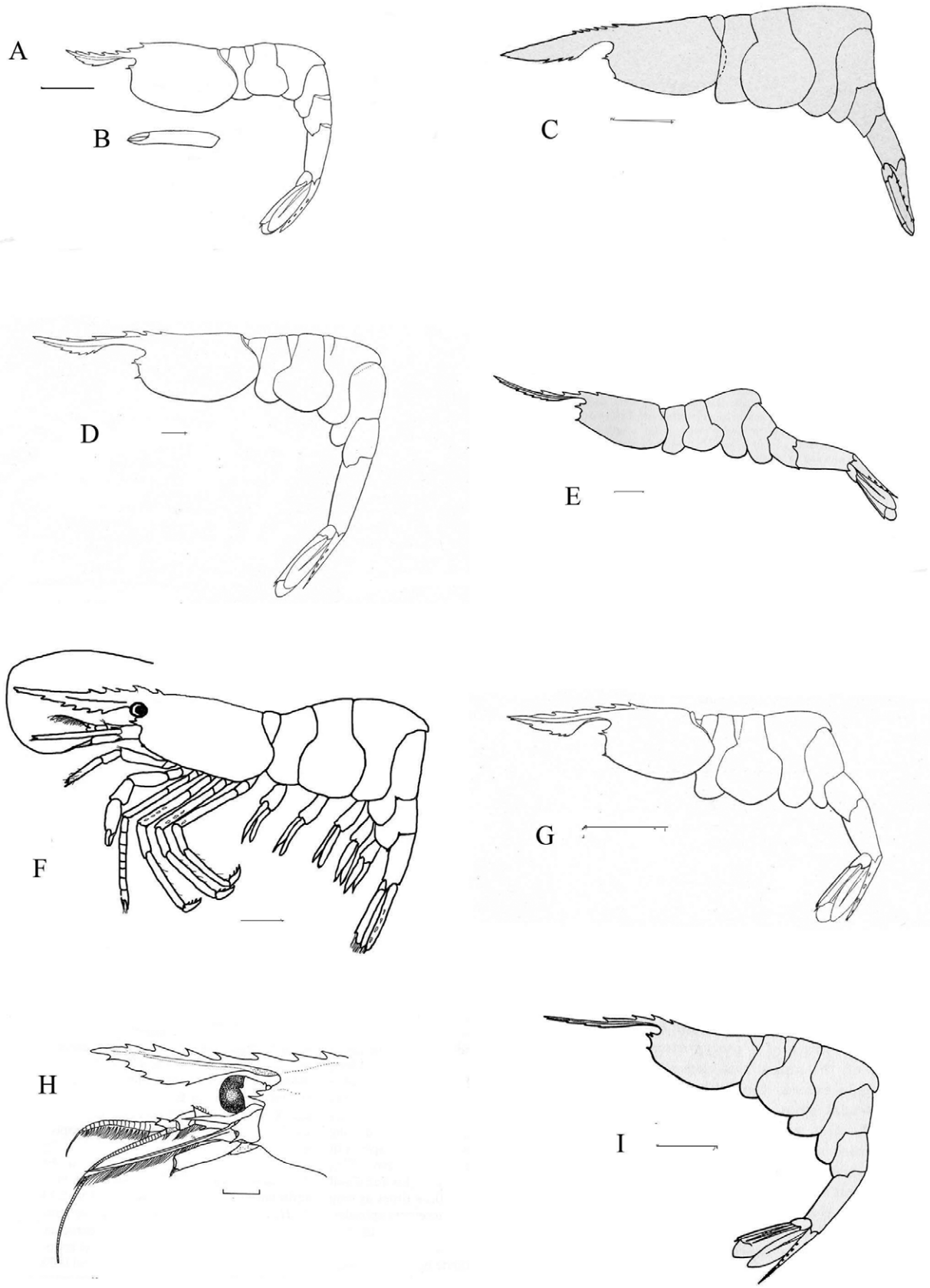

FIGURE 20. Family Thoridae. A, B, *Heptacarpus brachydactylus* (Rathbun, 1902); A, carapace and abdomen in lateral view; B, chela of pereopod 1. C, *Heptacarpus carinatus* Holmes, 1900; carapace and abdomen. D, *Heptacarpus decorus* (Rathbun, 1902). E, *Heptacarpus flexus* (Rathbun, 1899). F, *Heptacarpus 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 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 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 aong 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 1888: 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.

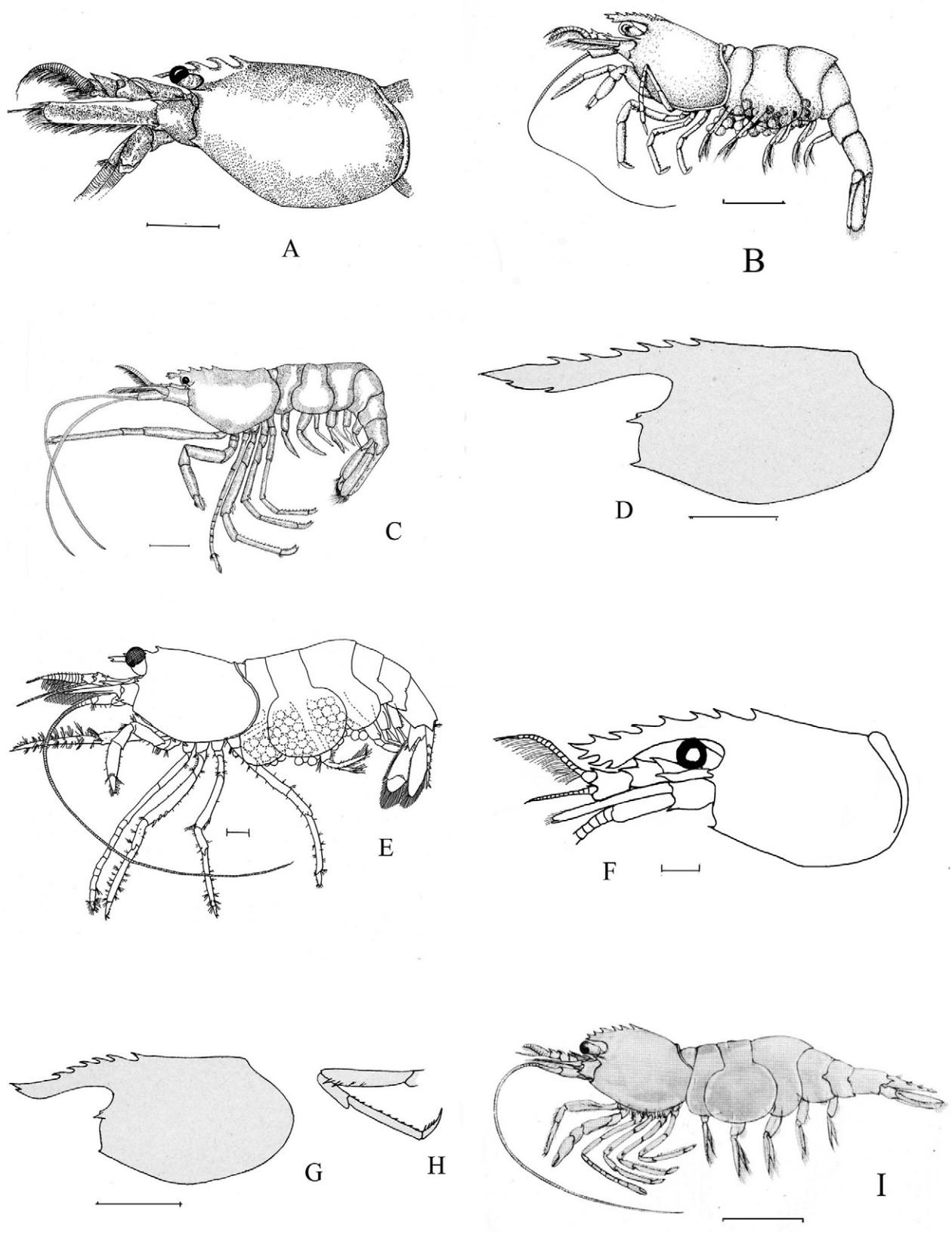

FIGURE 21. Family Thoridae. A, *Heptacarpus brevirostris* (Dana, 1852); carapace and frontal region in lateral view. B, *Heptacarpus fuscimaculatus* Wicksten, 1986. C, *Heptacarpus palpator* (Owen, 1839). D, *Heptacarpus paludicola* Holmes, 1900. E, *Heptacarpus pugettensis* Jensen, 1983. F, *Heptacarpus 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, *Dendraster excentricus* (Eschscholtz, 1831).

Range. Sheep Bay, Alaska to Todos Santos Bay, Point Abreojos, 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.

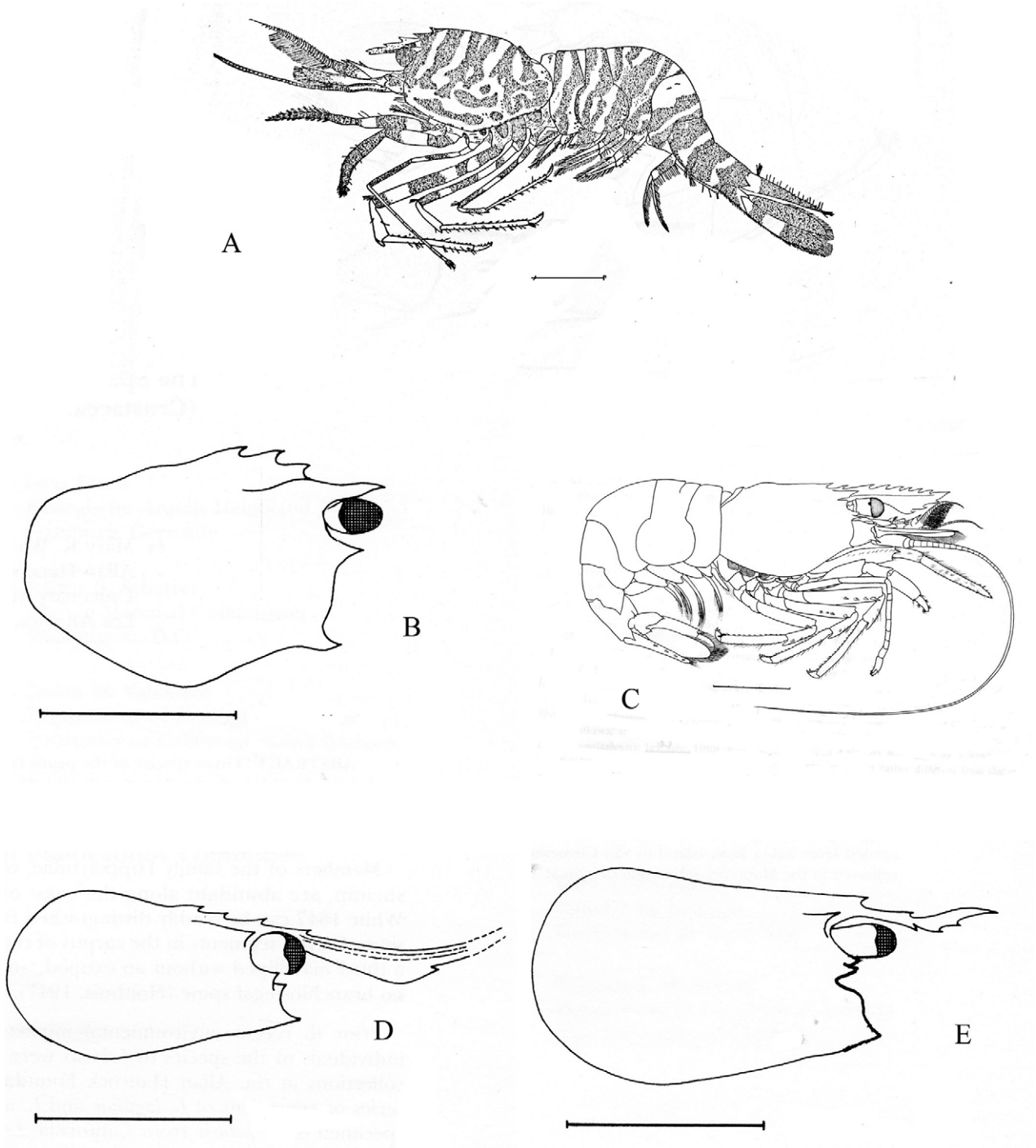

FIGURE 22. Family Thoridae. A, *Lebbeus zebra* (Leim, 1921). B, *Lebbeus lagunae* (Schmitt, 1921); carapace and eye. C, *Lebbeus speciosus* (Urita, 1942). D, *Lebbeus vicinus montereyensis* Wicksten & Méndez, 1982; carapace and eye. E, *Lebbeus washingtonianus* (Rathbun, 1902); carapace and eye. Scales: 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 pterygostomian 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. Koyakova (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. — Kobyakova 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.

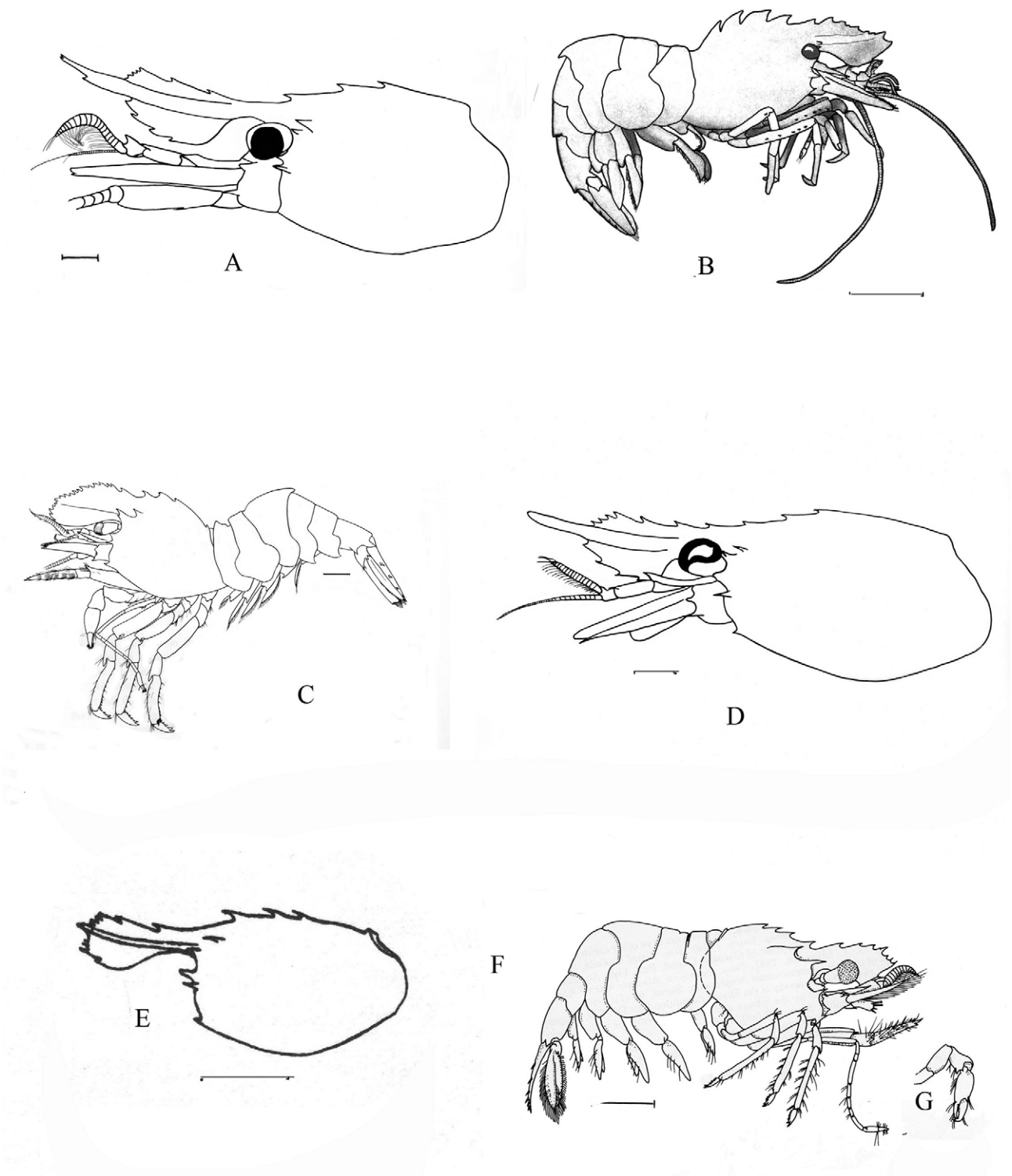

FIGURE 23. Family Thoridae. A, *Spirontocaris holmesi* Holthuis, 1947; carapace and frontal region in lateral view. B, *Spirontocaris lamellicornis* (Dana, 1852a); female. C, *Spirontocaris prionota* (Stimpson, 1864). D, *Spirontocaris sica* Rathbun, 1902; carapace and frontal region in lateral view. 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 pterygostomian area obtuse. Eyestalk 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, eyestalk; 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 PROCESSOIDEA 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.

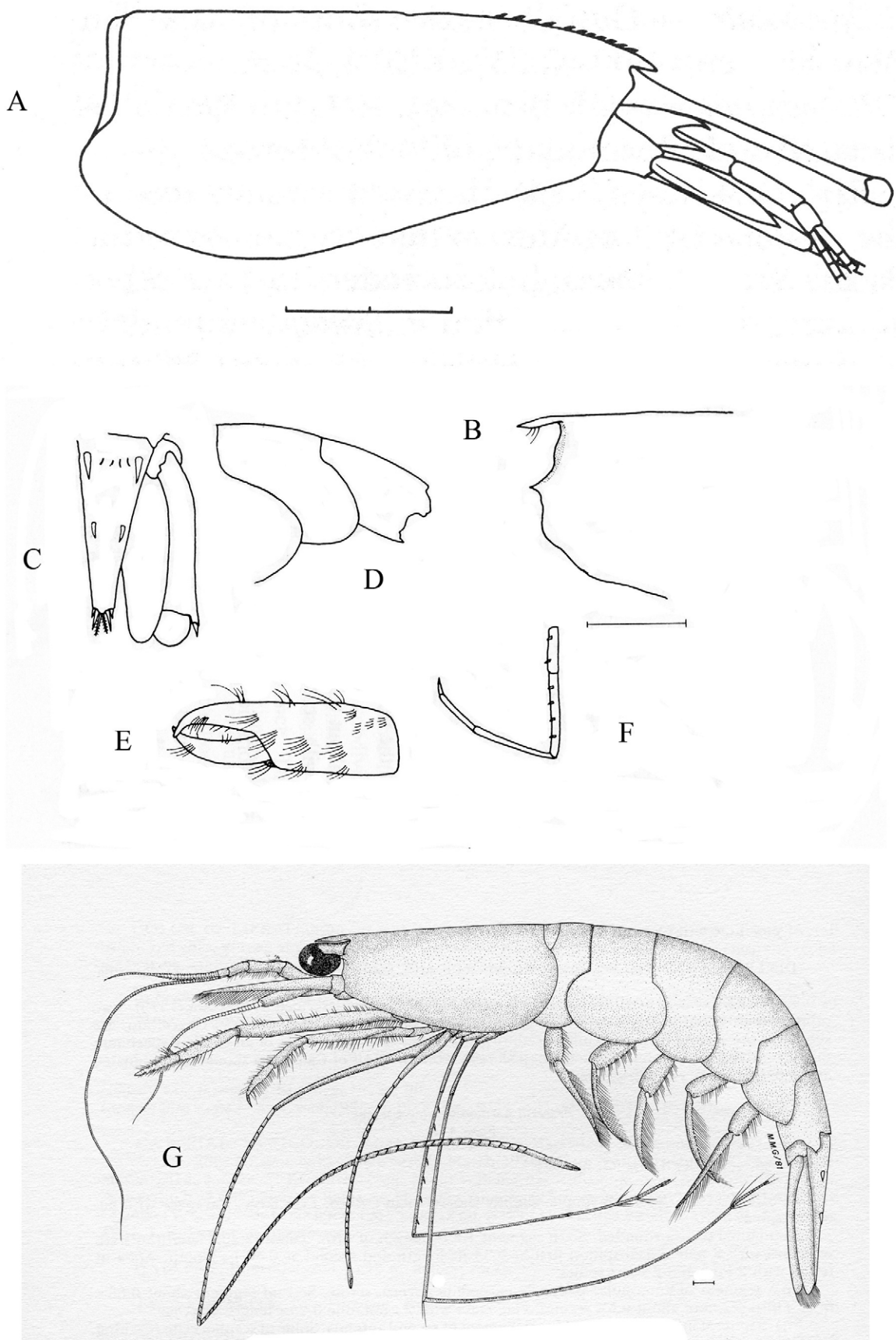

FIGURE 24. Families Ogyrididae and Processidae. A. *Ogyrides alphaerostris* (Kingsley, 1880); carapace and frontal region in lateral view. B–E, *Ambidexter panamensis* Abele, 1972; B, anterior portion of carapace; C, tail fan; D, posterior abdominal somites; E, detail of chela of pereopod 1; F, pereopod 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 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, pterygostomian 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 pterygostomian 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, pterygostomian 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.

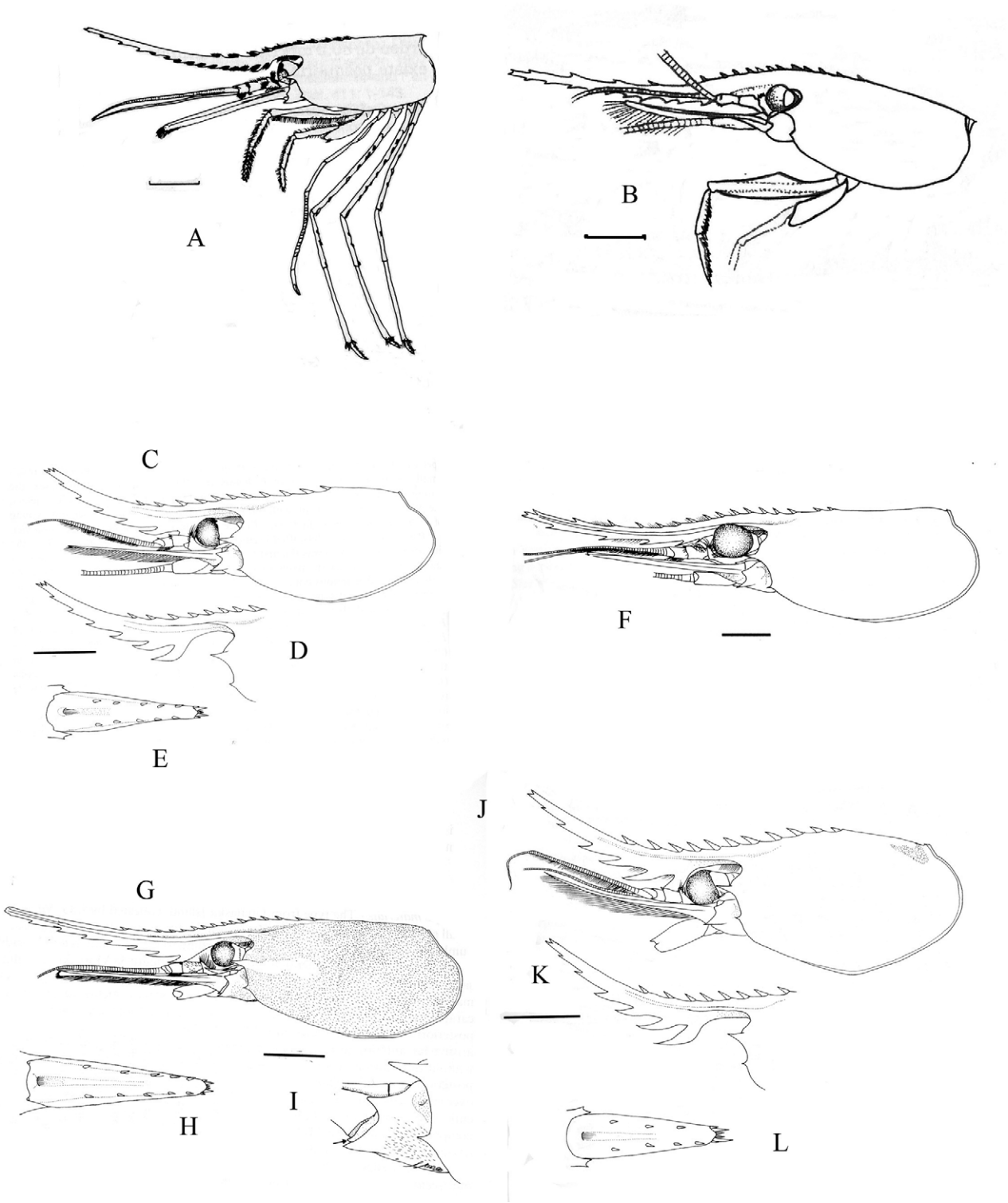

FIGURE 25. Family Pandalidae. A, *Pandalopsis ampla* Bate, 1888; front half of animal in lateral view. B, *Pandalopsis dispar* Rathbun, 1902; carapace, frontal region and frontal appendages in lateral view. C–E, *Pandalus danae* Stimspon, 1857; C, carapace and frontal region in lateral view; D, rostrum; 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 l980: 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 l0–13 articles. Pereopod 3 moderately stout, with 0 or l ischial spines, merus with 5–7 spines, carpus with 1 or 2 spines, propodus with l8–22 spinules, dactyl stout, spinose. Pereopod 4 about as stout as third pereopod, with 1 ischial spine, 5–7 meral spines, carpus with l–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 backgroun. 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).

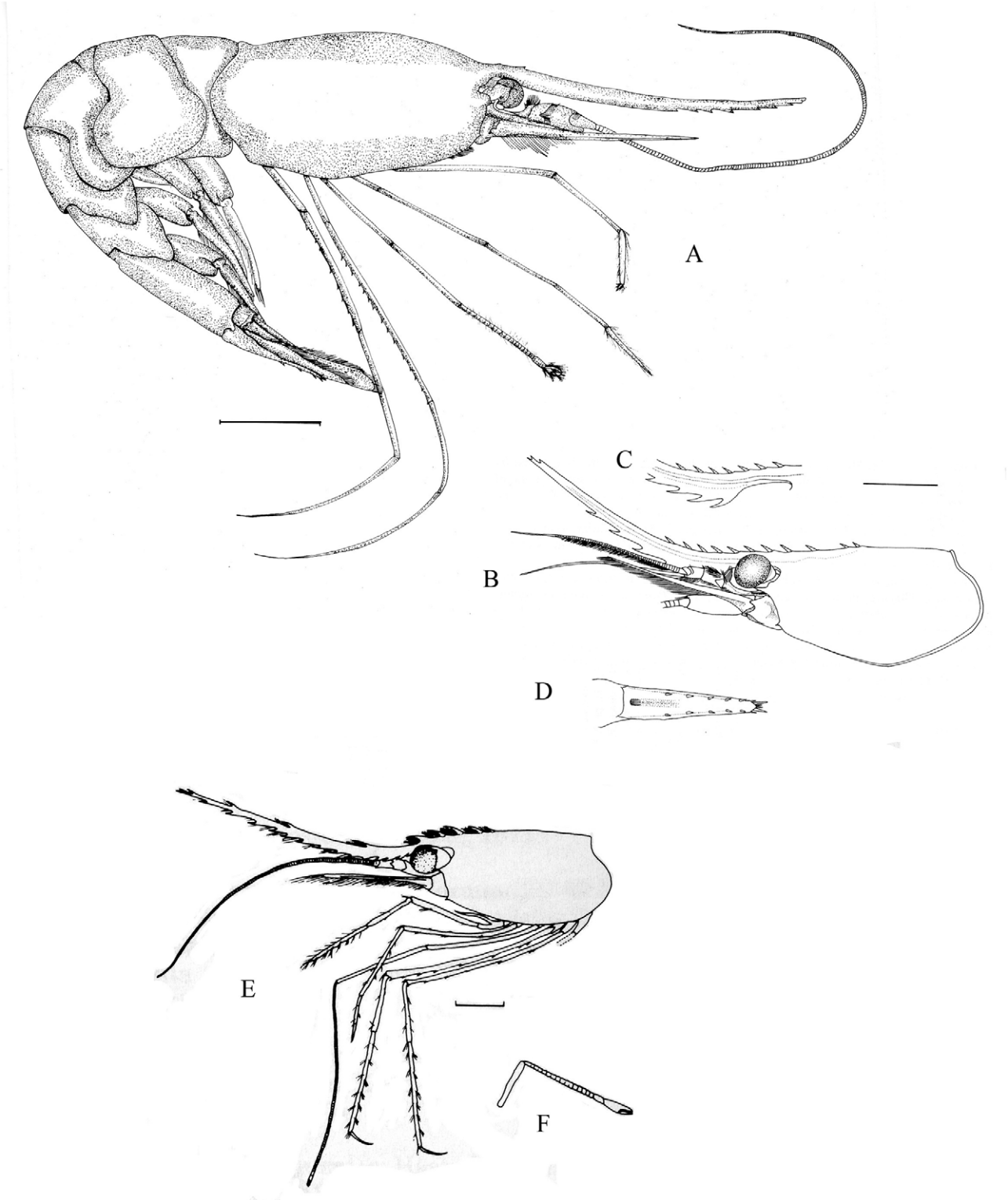

FIGURE 26. Family Pandalidae. A, *Plesionika sanctaecatalinae* Wicksten, 1983. B–D, *Pandalus tridens* Rathbun, 1902; B, carapace and frontal region in lateral view; C, detail of rostrum; D, telson. E, F, *Plesionika mexicana* Chace, 1937; E, anterior half in lateral view; F, pereopod 2. Scales: E = 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, carpocerite 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 1stout, 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, pterygostomian 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 (McCauley1972) 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, pterygostomian 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.

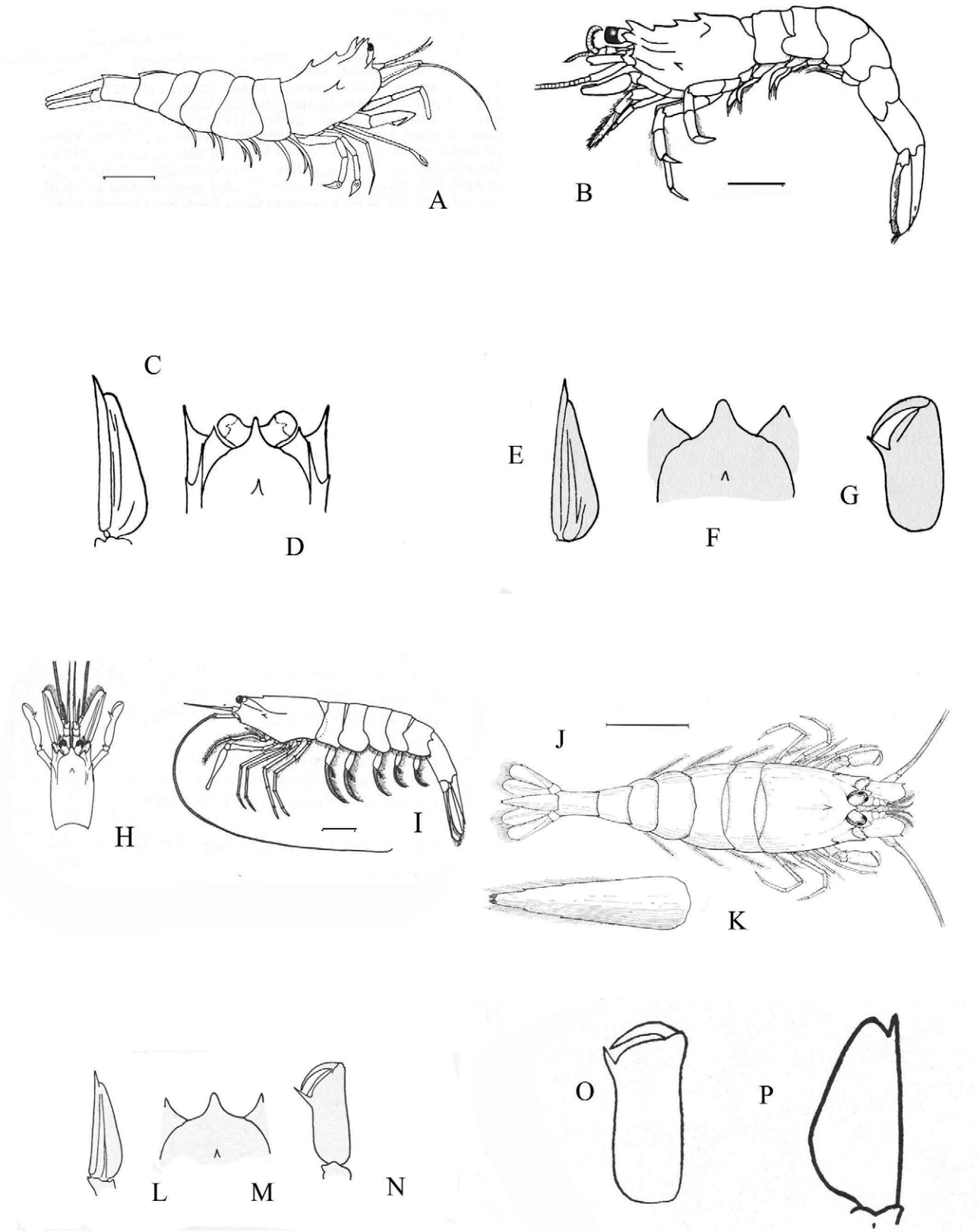

FIGURE 27. Family Crangonidae. A, *Argis californiensis* (Rathbun, 1902). B, *Argis levior* (Rathbun, 1902). C, D, *Crangon alaskensis* Lockington, 1877; C, scaphocerite; D, frontal region in dorsal view. E–G, *Crangon alba* Holmes, 1900; E, scaphocerite; F, front of carapace in dorsal view; G, subchela. 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.
Crago alaskensis elongata. — Schmitt 1921: 88, fig. 58. — Johnson & Snook 1927: 313. — Word & Charwat 1976: 73. — Wicksten 1980c: 362.
Crago 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.
Crago 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 pterygostomian 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.
Crago 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.
Crago 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 pterygostomian 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. PrinceWilliam 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.
Crago nigromaculata. — Schmitt 1921: 86, fig. 5. — Johnson & Snook 1927: 313.
Crangon (*Neocrangon*) *nigromaculata*. — Zarenkov 1963: 1764.

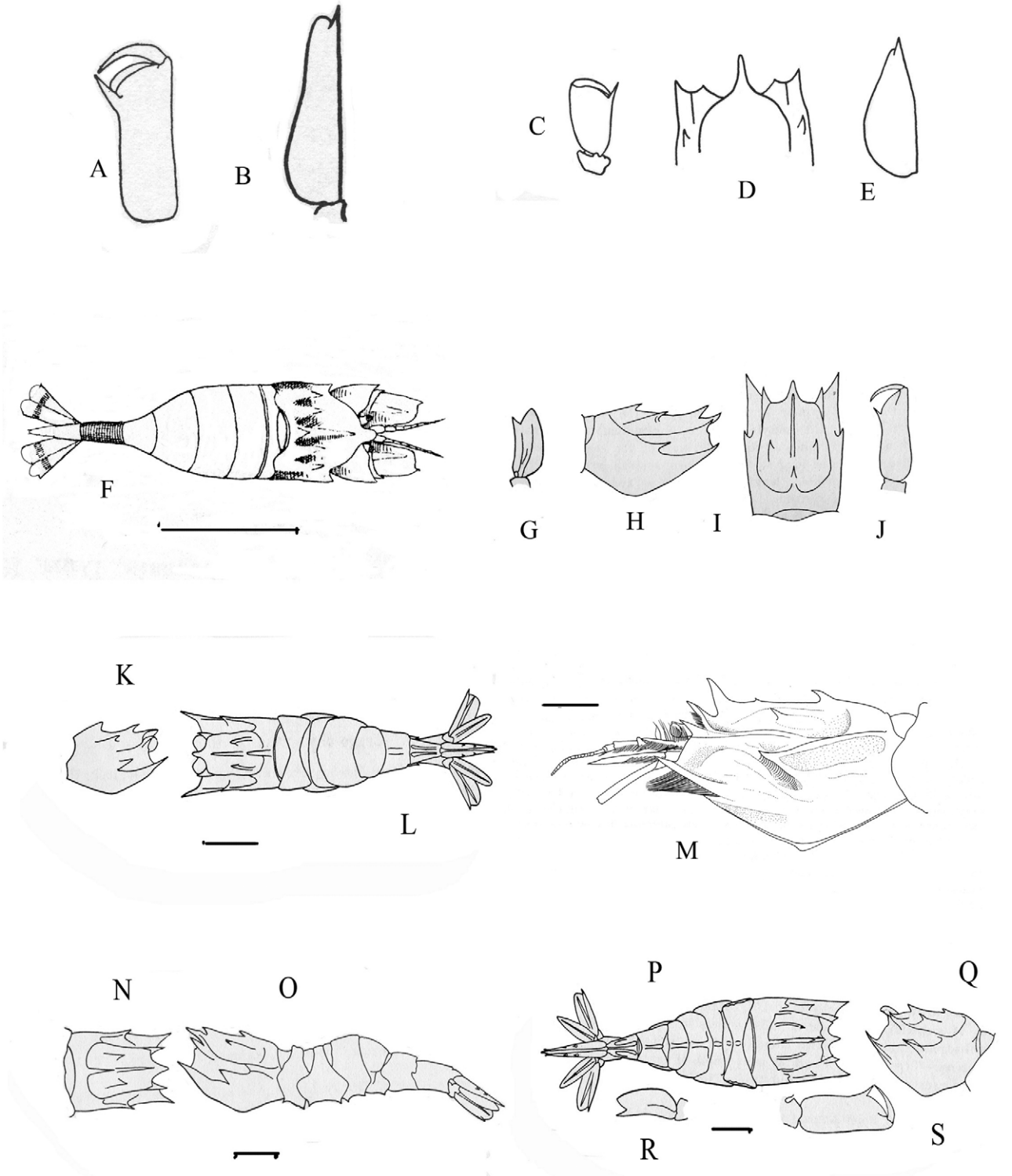

FIGURE 28. Family Crangonidae. A, B, *Crangon nigromaculata* Lockington, 1877; A, subchela; B, scaphocerite. C–E, *Lissocrangon stylirostris* (Holmes, 1900); C, subchela; D, frontal region of carapace; E, scaphocerite. F, *Mesocrangon munitella* (Walker, 1898); G–J, *Metacrangon acclivis* (Rathbun, 1902); 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 pterygostomian 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.
Crago 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.
Crago 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 pterygostomian 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, pterygostomian 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 pterygostomian 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. — Birshtein & 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, pterygostomian 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 & Pearcy 1981: 89. — Wicksten 1989b: 313.
Crago abyssorum. — Schmitt 1921: 97, fig. 65.
Crangon (*Neocrangon*) *abyssorum*. — Zarenkov 1965: 1762. — Birshtein & 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 pterygostomian 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.

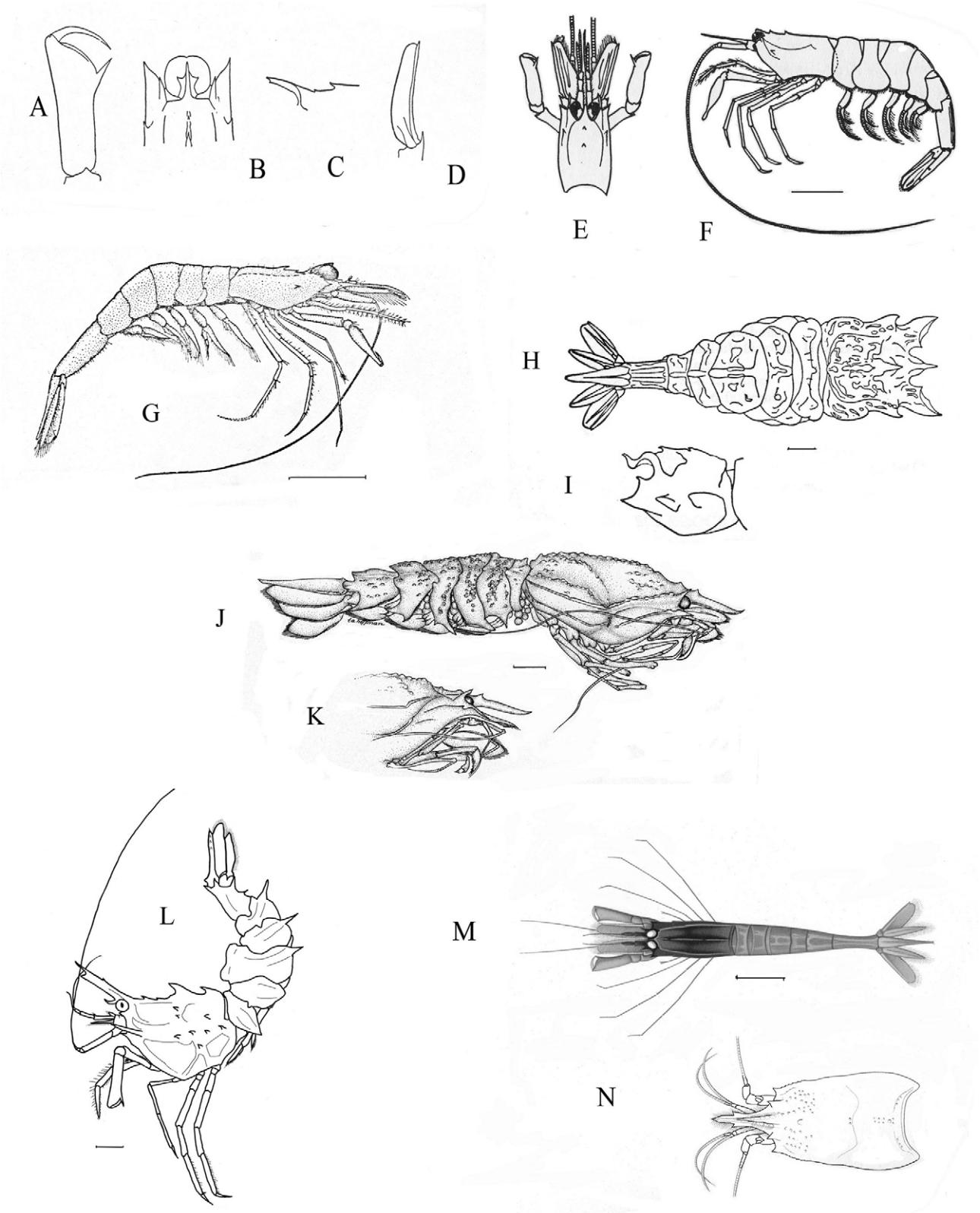

FIGURE 29. Families Crangonidae and Glyphocrangonidae. A–D, *Neocrangon abyssorum* (Rathbun, 1902); A, subchela; B, front of carapace and eye; C, rostrum; D, scaphocerite. E, F, *Neocrangon communis* (Rathbun, 1902); E, carapace, frontal appendages and pereopods 1; F, lateral view. G, *Neocrangon resima* (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 zacae*); 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.
Crago 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 pterygostomian 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.
Crago 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.
Crago 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 pterygostomian 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. zacae* 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. — Kobyakova 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 pterygostomian 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 carpocerite, 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 pterygostomian teeth present. Eye large, unpigmented, unfaceted. 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 pterygostomian 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,

1881was 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 annulis 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.