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Amphipoda

(Plate 254)

The Amphipoda have been divided into the suborders Gammaridea, Caprellidea, Cyamidea, Hyperiidea and Ingolfiellidea (Schram 1986, Crustacea. Oxford University Press, New York). However, Myers and Lowry (2003) regard the caprellids, or skeleton shrimps, and the cyamids, or whale lice, as families Caprellidae and Cyamidae. These distinctive groups are covered in separate sections in this manual, for ease of recognition and identification.

The Caprellidae (plate 254A) occur on solid surfaces and are strictly marine or estuarine. The Cyamidae are ectoparasites of cetaceans and are occasionally found on beached whales and dolphins (plate 254B). The Hyperiidea (plate 254C) are parasites and commensals of marine macrozooplankton and are exclusively pelagic. Hyperiids are occasionally discovered free swimming intertidally or in shallow-water plankton tows, or are found attached beneath or embedded in the bells of stranded medusae or salps. The Gammaridea (scuds, landhoppers, and beachhoppers) (plate 254E) are the most abundant and familiar amphipods. They occur in pelagic and benthic habitats of fresh, brackish, and marine waters, the supralittoral fringe of the seashore, and in a few damp terrestrial habitats and are difficult to overlook. The wormlike, 2-mm-long interstitial Ingofiellidea (plate 254D) has not been reported from the eastern Pacific, but they may slip through standard sieves and their interstitial habitats are poorly sampled.

Key to Amphipoda

1. Gills not exceeding three pairs, female oöstegites not exceeding two pairs; pleon and urosome (abdomen) vestigial and pereonite 1 fused to head 2
— Gills and oöstegites exceeding three pairs, abdomen and abdominal appendages well developed; head and pereonite 1 separate 3
2. Body segments tubular, legs with moderate hooks, free living (plate 254A) . . . . Caprellidae
— Body segments loosely separated, legs powerful with sharp hooks, parasites of cetaceans (plate 254B) . . . . . Cyamidae
3. Urosome with only two segments; palps of maxillipeds absent; eyes usually cover most of head but can be tiny; entirely pelagic (plate 254C) . . . . Hyperiidea
— Urosome with three segments; palps of maxillipeds present 4
4. Pleopods leaflike, vestigial, or absent; movable compound claw of gnathopods formed of articles 6 and 7 together; body vermiform; without coxal and epimeral plates; entirely interstitial (unreported from the northeast Pacific) (plate 254D) . . . . Ingolfiellidea
— Pleopods well developed, with few exceptions; dactyls of gnathopods formed by article 7 alone (plate 254E). . . . . Gammaridea

Gammaridea

JOHN W. CHAPMAN

(Plates 255–304)

The ubiquitous and abundant gammaridean amphipods are critically important in marine and estuarine shallow-water ecosystems of the northeast Pacific and warrant reliable, workable guides to the species. The numerical abundances and species and life-history diversities of the Gammaridea exceed all other eucaridan or peracaridan orders. Gammaridean amphipods are one of the most common aquatic taxa. The taxonomy and systematics of marine eastern Pacific species have greatly advanced since 1975, but many undescribed species occur in the region and little more than the names of most described species are known. The lack of research is disproportionate to these species' importance in ecosystems that are of great interest to humans.

Gammaridean amphipods are critical food sources of whales, fish, and birds, (Moore et al. 2003, McCurdy et al. 2005, Schneider and Harrington 1981) and are highly sensitive to environmental alterations (Conlan 1994, Zajac et al. 2003). All amphipods care for their offspring for extended periods (Jones 1971, Shillaker and Moore 1987). Some change sex (Lowry and Stoddart 1986); others attract, hold, and defend mates (Borowsky1983, 1984, 1985; Conlan 1989, 1995a) and

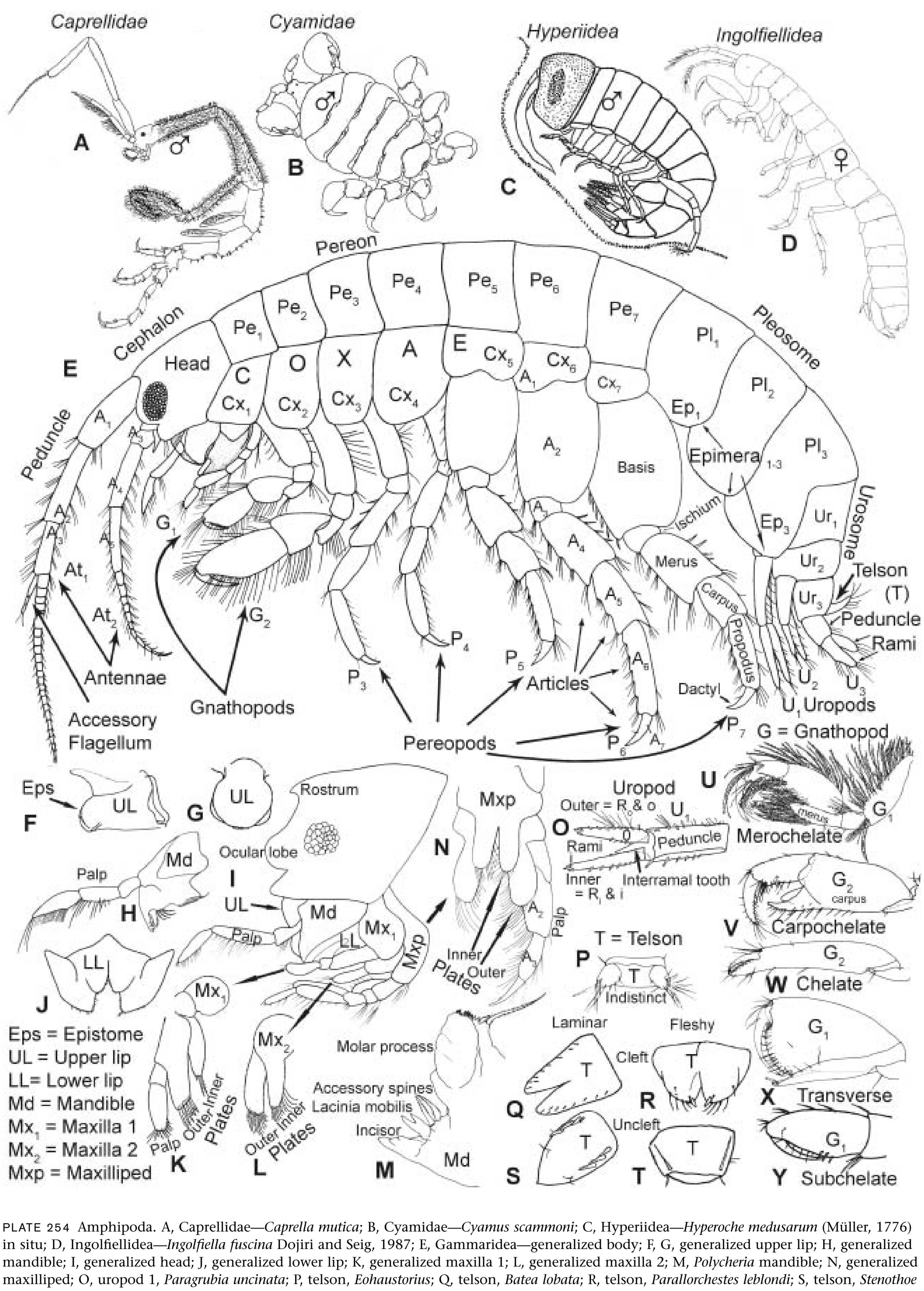

PLATE 254 Amphipoda. A, Caprellidae—*Caprella mutica*; B, Cyamidae—*Cyamus scammoni*; C, Hyperiidea—*Hyperoche medusarum* (Müller, 1776) in situ; D, Ingolfiellidea—*Ingolfiella fuscina* Dojiri and Seig, 1987; E, Gammaridea—generalized body; F, G, generalized upper lip; H, generalized mandible; I, generalized head; J, generalized lower lip; K, generalized maxilla 1; L, generalized maxilla 2; M, *Polycheria* mandible; N, generalized maxilliped; O, uropod 1, *Paragrubia uncinata*; P, telson, *Eohaustorius*; Q, telson, *Batea lobata*; R, telson, *Parallorchestes leblondi*; S, telson, *Stenothoe estacola*; T, telson, *Paracorophium* sp.; U, gnathopod 1, *Aoroides secundus*; V, gnathopod 2, *Ericthonius brasiliensis*; W, gnathopod 1, *Americhelidium shoemakeri*; X, gnathopod 2, *Americhelidium rectipalmum*; Y, gnathopod 1, *Stenothoe valida* (figures modified from: Barnard 1953,1962c, 1965, 1975; Barnard and Karaman 1991a, 1991b; Bousfield 1973; Bousfield and Chevrier 1996; Bousfield and Hendrycks 2002; Bousfield and Kendall 1994; Doiji and Sieg 1987, Flores and Brusca 1975; Gurjanova 1938; Margolis et al. 2000; Todd Miller, personal communication; and Platovoet et al. 1995).

territories (Connell 1963). Some use chemicals for defense (Hay et al. 1987, Hay et al. 1990) or are repelled by defensive chemicals (Hay et al. 1988, 1990; Cronin and Hay 1996a, 1996b). Some species undergo risky long-distance migrations (Chess 1979, Mills 1967, Watkin 1941), and others exploit, imitate, parasitize, eat (Crane 1969, Cartwright and Behrens 1980, Goddard, Skogsberg, and Vansell 1928), displace, or attack other invertebrates and fish (Bousfield 1987, Wilhelm and Schindler 1999); burrow in wood (Barnard 1955c) or macroalgae (Conlan and Chess 1992); or alter sediment dynamics in estuaries (Olafsson and Persson 1986). Lysianassid amphipods are adapted for engorgement and are among the most important carrion feeders in the sea (Dahl 1979, Thurston 1990). Some amphipods die of unknown diseases (Pelletier and Chapman 1996), which they may introduce with them by humans to new areas (Slothouber Galbreath et al. 2004).

Genus-level variation within most families occurs in geographical patterns that correspond with the Cretaceous continental divisions. However, these evolutionary patterns have been and continue to be obscured by human introductions of shallow-water amphipods among continents. One in 10 of the eastern Pacific shallow-water species treated herein are likely introductions.

Morphologies for stridulation (to make harsh sounds) occur among Isaeidae, Melitidae, and perhaps Phoxocephalidae and are likely adaptations for attracting mates. Their sounds have not been recorded and their adaptive values have not been resolved. Most amphipod species are beautiful (flamboyant) in color and form, but color pictures of live amphipods are seldom published and only a few are posted on the internet.

All coastal marine and estuarine gammaridean amphipod families, genera, and species from the Columbia River to Point Conception reported from $<$10 m depths are included in the keys or listed. A few species known only from depths $>$10 m or slightly north or south of the region are listed and indicated by asterisks. These latter species are recognized from limited taxonomical or geographical information and thus, although not clearly within the geographical region, cannot be reliably discounted. Few of these latter species are included in the keys.

The first edition of *Light's Manual* (Light 1941) covered 47 gammaridean species; the second edition Barnard (1954d) covered approximately 61, and the third edition (Barnard 1975) included 141 species. This section includes 351 species. The exponential increase in species (including nearly half of the species discovered or resolved since the 1970s) is due largely to the contributions of Bousfield, Conlan, Hendrycks, and coworkers at the Canadian Museum of Nature. The many species and additional character variations and types of taxonomic characters that Bousfield and his colleagues discovered reveal the paramount importance of distinguishing interspecific and intraspecific variation. The taxonomic outlines for this section rely extensively on their contributions. General treatments of gammaridean amphipod taxonomy and systematics also include Barnard and Barnard (1983a, b), Barnard and Karaman (1991a, b), Bellan-Santini (1999), Bousfield (2001), Myers and Lowry (2003), Serejo (2004) and Staude (1997).

Additional guides to amphipod taxonomic literature of the eastern Pacific include bibliographies (SCAMIT 2001) and Internet postings, such as the "Amphipod Newsletter."

Although intended to be comprehensive within the region, these keys are not reliable outside of their specified geographic, bathymetric, or ecological boundaries. Barnard's (1975) emphasis on durable and external morphology is followed with "natural" dichotomies sacrificed when artificial distinctions are more apparent, where family, genus, or species relationships remain poorly resolved, where difficult dissections or magnifications of greater than 40x can be avoided, or where characters are fragile or difficult to observe or to define. Occasional notes in the species lists are to assist with identifications, indicate pitfalls, or provoke interest.

The Gammaridea (plate 254E, center) (legged order) have a clearly defined **CEPHALON (HEAD)**, a thorax or **PEREON** of seven freely articulated segments, (**PEREONITES** = **PE**$_{1-7}$), a six-segmented **ABDOMEN** (**PLEON**) of three (**PLEONITES** = **PL**$_{1-3}$) **(PLEOSOME)** and three (**UROSOMITES** = **UR**$_{1-3}$) (**UROSOME**) and a **TELSON (=T)**. The **TELSON** is a flap over the anus attached to pleonite 6 (urosomite 3). Most gammarideans are laterally flattened. Each pleonite has a pair of **PLEOPODS** (swimmerets). The pleopods are complex and seldom illustrated. The lower lateral edges of the pleonites that extend below the body are **EPIMERA** (=**EP**$_{1-3}$). The urosomites of the **UROSOME** each bear rigid, lateral, posterior projecting **UROPODS** (=**U**$_{1-3}$). The uropods usually consist of a basal **PEDUNCLE** and one or two distal **RAMI**.

The appendages of the head (plate 254E, 254I center left) are, in order from anterior to posterior: **ANTENNA 1**, **ANTENNA 2** (=**AT**$_{1-2}$) (plate 254E, center left), **UPPER LIP** (**UL**) (plate 254F, 254G, bottom left), **MANDIBLE** (**MD**) (plate 254H, 254M), **LOWER LIP** (**LL**) (plate 254J), **MAXILLA 1** (**MX**$_1$) (plate 254K), **MAXILLA 2** (**MX**$_2$) (plate 254L), and the **MAXILLIPED** (**MXP**) (plate 254N).

ANTENNA 1 (plate 254E, center left) is composed of a three-article peduncle and a **FLAGELLUM** of variable article numbers. An **ACCESSORY FLAGELLUM** extends from the distal medial surface of the third peduncle article and is prominent on many species and families but is also minute (requiring high magnification to observe) or absent in other species and families.

ANTENNA 2 (plate 254E, center left) consists of five peduncular articles and a flagellum of variable article numbers. The morphologies of the peduncle articles and the flagellum and the distributions and morphologies of their spines and sensory organs (calceoli) are important taxonomic characters (Steele and Steele 1993, Bousfield 2001). Count peduncle articles from the fifth backward because articles 1–3 are usually more difficult to distinguish than the difference between peduncle and flagellum.

The **EPISTOME (EPS)** (plate 254F, bottom left) is a cephalic sclerite attached to of the anterior upper lip and usually fused to the upper lip when it is large. The epistome is taxonomically important mainly in Phoxocephalidae and Lysianassidae. However, the epistome varies greatly in other families and perhaps the most spectacular is the noselike extension of *Proboscinotus loquax* (plate 256B) for which this species is named.

The **UPPER LIP** (plate 254F, 254G, bottom left) is variable among species and families but seldom used for taxonomic purposes unless it has a well-developed epistome. Najnidae and Pleustidae have asymmetrical upper lips.

The **MANDIBLE** (plate 254H, 254M) has a **MOLAR** (plate 254M), which can be large and triturative, reduced, or vestigial and without a grinding surface. The molar often bears a large pinnate seta (illustrated in plate 254M). The apex of the mandible is the **INCISOR** (plate 254M), which usually projects as a series of teeth. Above the incisor is the **LACINIA MOBILIS** (plate 254M), a spinelike movable appendage of the medial mandibular edge that consists of variable numbers of individual or fused articulated spines (see E. Dahl and R. T. Hessler, 1982, Zool. J. Linnean Soc. 74: 133–146 on origin, function and phylogeny). The lacinia mobilis (plate 254M) varies laterally in Phoxocephalidae and Pleustidae and is used for species distinctions among pleustids (Bousfield and Hendrycks 1994a, 1994b; Hendrycks and Bousfield 2004). A row of accessory spines usually occur above the lacinia mobilis (plate 254M). The mandible also usually bears a triarticulate **PALP** (plate 254H, 254I). The mandibular palp is sometimes only one or two articles and is lacking in Dogielinotidae, Eophliantidae, Hyalidae, Hyalellidae, Najnidae, Phliantidae and Talitridae and variably present in Dexaminidae and Synopiidae.

The **LOWER LIP** (plate 254J) lies behind the mandibles and in front of the first pair of maxillae. The lower lip can be difficult to remove without damage. (see instructions for dissection below) but is a particularly important character for distinguishing ampithoid and pleustid species and genera and for distinguishing eusirids from pleustids.

The **MAXILLA 1** (plate 254K) have an inner and an outer plate and a palp of two or more articles. The inner plate is not closely contiguous with the outer plate and can be overlooked or lost during dissection when it remains partially attached to the lower lip. The outer plate bears heavy distal spines. The palp is occasionally reduced to one article or is absent.

The **MAXILLA 2** (plate 254L) are two simple, setose plates and lack a palp.

The **MAXILLIPED** (plate 254N) usually covers the other mouth parts from below and is therefore usually removed first in mouth part dissections. The maxillipeds are fused at the base and appear as a single branched appendage. Each branch has an inner and an outer plate and a palp that is usually composed of four articles. The palp is occasionally reduced to three articles (absent in hyperiids), and the plates are often severely reduced in size. The distal palp article is usually pointed and referred to as a dactyl.

The amphipod **ROSTRUM** (plate 254I) is variable and can extend over or between the first antennae, or it can be greatly reduced or absent. Some amphipods are blind. Most have lateral eyes of one to hundreds of ommatidia. The ocular lobe (plate 254I) of many Gammaroidea, including Hadzioidea, Eusiroidea, and Corophioidea, extends over the second antenna and usually forms a ventral antennal sinus notch. Oedicerotidae and Synopiidae ommatidia merge dorsally into a single eye. Argissidae eyes each consist of four lenticular facets and Ampeliscidae eyes consist of two corneal lenses.

Most uropods ($=\mathbf{U}_{1-3}$) (plate 254E, right; 254O) are composed of a **PEDUNCLE** and one or two **RAMI** (plate 254O). The inner and outer rami are labelled in illustrations as $\mathbf{R_i}$ and $\mathbf{R_o}$ respectively, or simply "$_i$" and "$_o$." The rami vary from bare or spinose stubs, to short ornamented appendages with fine teeth and denticles, to tubular, to long and spinose, lanceolate (spear-shaped), and to foliose (leaf-shaped). Many species have a large peduncular tooth extending between the rami (plate 254O) of the first or second uropods or other large spines that are important taxonomic characters. Most rami are of a single article, but on uropod 3, outer rami of two articles are characteristic of Lysianassidae, Liljeborgiidae, Gammaridae, Hadzioidea, Melitidae, and Stenothoidae.

General **TELSON** ($=\mathbf{T}$) morphologies (plate 254P–254T, bottom center) are, respectively: **INDISTINCT** (plate 254P), **LAMINAR CLEFT** (plate 254Q), **FLESHY CLEFT** (plate 254R), **LAMINAR UNCLEFT** (plate 254S), and **FLESHY UNCLEFT** (plate 254T). Fleshy and laminar telsons range greatly in form between **CLEFT** (split into two lobes) and **UNCLEFT** (fused into a single piece). **LAMINAR** telsons are dorsoventrally thin (flattened). Some laminar telsons (Pleustidae) have a ventral keel that creates a thickened appearance from a lateral view even though the edges and apex are laminar. Fleshy telsons are at least one-third as thick as they are wide or long. The tonguelike telsons of some Stenothoidae (plate 254S) seem to fall in between, but they are mostly longer and wider than thick. Haustoriidae telsons (plate 254P) are referred to as indistinct because the widely separated lobes are not clearly fleshy or laminar.

"Amphipod" means "double feet." The amphipod thorax (**PEREON**) (plate 254E, center) bears seven pairs of walking legs (**PEREOPODS** $= \mathbf{P}_{1-7}$). Naming systems for amphipod legs (pereopods) vary. The first two pereopods are adapted primarily for feeding, defense, cleaning, and reproductive activities. Evolution of gnathopod morphology for feeding, mating, and defense is unlikely to have occurred in response to the same selection processes as pereopods 3–7, which are used for attachment, mobility, and nest or tube construction. The reference to pereopods 1 and 2 as **GNATHOPODS** ($=\mathbf{G}_{1-2}$) and continuing the sequence with **PEREOPODS** 3–7 ($=\mathbf{P}_{3-7}$) is used here (plate 254E, center; plate 254U–254Y). However, reference to all walking legs as pereopods 1–7 is also correct. Beware of amphipod descriptions previous to the 1980s that commonly refer to gnathopods 1 and 2 and then to pereopods 2–7 as pereopods 1, 2, 3, 4, and 5.

Each pereopod has seven **ARTICLES** ($=\mathbf{A}_{1-7}$) (plate 254E, center) ("joint" is an inappropriate term). These seven articles are, respectively, the **COXA**, **BASIS**, **ISCHIUM**, **MERUS**, **CARPUS**, **PROPODUS**, and **DACTYL** (plate 254E, center). The **COXAE** ($=\mathbf{CX}_{1-7}$) (plate 254E, center) is pereopod article 1 and often expands from its attachment point on the body downward to cover remaining parts of the pereopod. The coxae are normally the most conspicuous articles of the pereopods. Reference to the coxae and dactyls and then to article numbers 2–6, rather than **MERUS–PROPODUS**, is common usage, but exceptions are numerous in this key and elsewhere when descriptions require fine details or distinctions.

Details of the prehensile gnathopod morphology are critical in amphipod taxonomy. **MEROCHELATE** (plate 254U, lower right) refers to the condition in which articles 5 (carpus), 6 (propodus), and 7 (dactyl), respectively, fold around the merus (article 4) to become prehensile. **CARPOCHELATE** (plate 254V) refers to the condition in which articles 6 (propodus) and 7 (dactyl) fold around the carpus (article 5) to become prehensile. The posterior edge of gnathopod article 6 that is overlapped by the dactyl is commonly referred to as a **HAND** or **PALM**. **CHELATE** (plate 254W) refers to the dactyl (article 7) closing onto an extended finger of the palm at $>90°$. **TRANSVERSE** (plate 254X) applies to pereopods and gnathopods on which the dactyl closes against a palm at a 90° angle. **SUBCHELATE** (plate 254Y) is the condition where the dactyl closes against the palm at less than a 90° angle. **SIMPLE** refers to the condition in which the dactyl does not fold onto article 6 and is thus not prehensile. Thus, most pereopods ($\mathbf{P}_{3-7}$) (plate 254E, center) are simple.

Sexual differences are distinct in many species, with males bearing enlarged, heavily prehensile gnathopods; extra large, long, and densely setose antennae; large and densely setose uropod 3; powerful pleopods; and, occasionally, large eyes. However, many species have few external sexual differences. Mature males have a minute pair of **PENIAL PROCESSES** (penes) that hang ventrally from the pereonite 7 between the coxae. Penes often bear tiny spines that are difficult to see and, after the seventh pereopods are removed, can be confused with broken ends of tendons. The penes can also be confused with gills (plate 255MM), which are attached to the coxae and vary greatly in shape and size among amphipod families. Among appendages of the pereopods, if they break off easily, they are probably gills.

Breeding females bear up to six laminate brood plates (**OÖSTEGITES**) (plate 255MM, 255NN) in the space between the bases of coxae 2 and 5. The oöstegites form a pericardium (marsupium or brood chamber) that encases the eggs and for which peracaridans are named. The oöstegites are attached to the coxae medially and can be confused with the gills but are clearly distinguished by their long, interleaving, pinnate setae on mature females.

COLLECTION AND DISSECTION

The great diversity and superficially similar morphologies of gammaridean amphipods could make their taxonomy appear difficult, but they don't. Sharp forceps, sometimes probes tipped with insect pins or fine sewing needles, a stereomicroscope with magnifications ranging between 6x and 40x, patience, and interest to learn the simple anatomy, follow instructions, and learn from mistakes are all that is needed to identify amphipods.

Dissections of mouth parts under high magnification can appear daunting, but preparation is more important than skill. The top half of 50-mm petri dishes are good containers for dissections. Glass is preferable. Detach the base of transmitting stereoscopes that do not have hand rests or otherwise provide a platform level with the specimens that will allow palms to rest on a surface and stabilize both hands for the fine manipulations that are needed. Replace or cover clear glass microscope stages with black or dark blue covers to prevent transmitted light and maximize reflected light. Adjust the light source to maximize unobstructed illumination of the specimen without reflection from overlying liquid surface.

A compound microscope with 100x–1,000X magnifications (and transmitted light) is necessary to observe tiny appendages or fine anatomical characters. Prepare mounts of these characters under the stereoscope using the equipment above. Tiny parts are easy to lose. A slide placed off center on the petri dish with a centered drop of glycerin will allow continuous observation of the transfer of dissected parts directly from the dissecting dish into the glycerin drop.

Begin with numerous large, mature, unbroken specimens of a single species bearing both pairs of antennae, all three pairs of uropods, a telson, both pairs of gnathopods, and at least the first three articles of all other legs. Previously identified species, if available, limit the need for guessing at the conditions of difficult-to-find or -observe characters. Readily identifiable gammaridean amphipods that are easy to find include beach hoppers (Talitridae) of open coastal beaches; the large green Ampithoidae of docks and floats in bays and estuaries, and Corophiidae and Aoridae of estuary mudflats and fouling communities are usually large enough for observations of basic morphology and anatomy under low magnification.

Amphipods occur nearly everywhere that permanent water occurs, and they are easy to find by washing aquatic sediments or plants on a 0.5 mm or 1.0 mm mesh sieve or in a section of plastic window screening or by sweeping with a dip net. Spread the washed material in a shallow pan and sort out the animals using light forceps or plastic eyedropper (pipette). Freezing kills painlessly and does not ruin amphipods for later use if they are preserved in 70% alcohol within a few hours. Suitable preservation for morphological analyses includes fixing the animals in 10% formalin for a few days before permanent storage in 70% alcohol. Preserve the specimens directly in alcohol if they are to be used for molecular genetics analyses.

For dissection, immerse a specimen in 70% alcohol that is sufficiently deep for manipulations using forceps without distorting the liquid surface directly over the specimen. The best light is usually by reflection from the sides of the specimen rather than transmitted from beneath. Two lamps from different angles are better than one. Cool fiber optics lamps are better than direct, hot light from tungsten lamps.

Examine coxa 1 to determine whether it is significantly smaller than or hidden by coxa 2, or nearly as large as coxa 2 and freely visible. Tilt and rotate the amphipod and adjust the light(s) to provide maximum lateral illumination and contrast of plate and segment edges for these observations. Count the coxae to ensure that all seven are being observed.

Manipulate the telson to determine its fleshy or laminar condition. A laminar telson is freely articulate at its base. Remove the urosome and mount it dorsal side up on a depression slide filled with glycerin overlain with a coverslip. Note whether the urosome consists of three separate segments or has one or two fused segments. The rami of uropod 3 are often lost during preservation. Check the mounted urosome and count the rami of the uropods (usually three pairs). Damaged uropods are especially common among Iphimediidae, Megaluropidae, Oedicerotidae, Pleustidae, Eusiroidea, and a few genera of the Podoceridae. Some Gammaridae and Hyalidae have extremely short or inconspicuous inner rami. Remove uropod 3 if necessary and mount it on slide for observation under 100x magnification or more. A sclerotic socket usually remains to mark the presence of a ramus that has been lost.

SPINES and **SETAE** are the ends of a range of homologous structures. Setae are highly flexible and can be bent in the middle without breaking. Spines are thickened setae that are less flexible and can break when bent. Subtle differences in the placement and arrangement of spines and setae are becoming critical characteristics for distinguishing species in many families. Whether the distal spines of uropod 1 are apicomedial (between the rami) or apicolateral (lateral to the rami), for example, are critical taxonomic characters for distinguishing genera of Phoxocephalidae.

Examine antenna 1 for the presence of an accessory flagellum on the distal medial corner of peduncle article 3 and its condition, if it is present. If an accessory flagellum is not obvious, tiny accessory flagella are readily observed by mounting antenna 1 in glycerin on a slide with a bit of clay or a few grains of sand under a thin coverslip. The sand or clay on the slide allow movement of the coverslip, which can be used to roll appendages to suitable angles for observation. The glycerin slide mounts also work for other small appendages requiring high magnification observations.

Make a slide for each appendage. Hold the body with a dissecting pin or forceps and remove pereopod 5, including the coxa, by grasping deeply into the basal musculature with forceps. Place the pereopod on a drop of glycerin with the outside up. Add the coverslip. Repeat this process for pereopods 4 and 3 and for gnathopods 2 and 1 in order. Remove and mount the urosome. Label the slides as they are produced using a grease pencil or tape labels.

Study the slide of the urosome (telson and urosomites 1–3) and note whether the urosomites are fused, the proportionate lengths of the urosomites, the numbers of uropods, the number of rami on the uropods, the relative lengths of the uropods, and the lengths of the rami relative to the peduncles of the uropods.

Examine the general condition of gnathopods 1 and 2. Proceed in the key as far as is possible with these observations. Make additional slides as needed, or fully dissect the amphipod into its component parts. (About 20 slides are required to mount each major character of a specimen.) Observations on the head and **EPIMERA** (the ventral, lateral, posterior sides of the pleonites) can be difficult using a stereomicroscope. Remove the pleopods for a clearer view of the epimera. Closely observe the head, noting the general outline, the shape of the ocular lobe and any anterior or ventral incisions before removing the antennae or any mouth parts.

Test the amphipod for shrinkage in glycerin before mounting parts in critical dissections. Use a slow-drip method for an hour to replace the alcohol preservative with glycerin if the amphipod develops significant "frost," or air bubbles. Hyalidae are especially sensitive to glycerin.

Spear the head with a needle or clutch it dorsally with forceps in a dish of alcohol to remove mouth parts. Right-handers should hold the left side down with the left forceps or needle and point the mouth parts toward 12 o'clock. Mouth parts are easy to dissect from back to front. Grab the maxilliped across its base with the right forceps to pull it off. Mount it in a drop of glycerin with the curved posterior side upward and without separating the lobes or palps. Follow this procedure to remove and mount maxilla 1 and 2.

The mandibles are heavily scleroticized, solidly attached, or somewhat twisted, can be difficult to remove. If possible, note the presence or absence of the mandibular palps before dissecting the mandibles because they are easily lost during dissection. Use extreme care not to grab the mandible near the molar, incisor, or palp because these characters are readily shattered or broken away. Rotate the mandible outward with slight pressure of the forceps to identify the medial molar before grasping heavily. Remove the mandible by grabbing deeply into and tearing out the fleshy and flexible tissue immediately *behind* it and place it in a puddle of glycerin on a slide. This mass will often include the right and left maxilla 1 and lower lip attached together. Tease away the lower lip, leaving the inner plates of the maxillae attached to their outer plates. Separate and mount the maxillae 1 in glycerin under a coverslip. Mount each mandible in glycerin with sand grains under a coverslip. The sand will allow the mandibles to be rolled over and properly oriented for observation. Label the left and right mandibles.

A clear view of the epistome is possible from the lateral front of the head. Pull the first and second antennae forward and up. The epistome reaches forward beyond the mouth part bundle and can be extended into a significant tooth, spike, or cusp. Care is needed not to confuse the **EPISTOMAL SPIKE** with the **MANDIBULAR PALPS**; the latter are flexible and setose whereas the epistomal spike is solid, smooth, and fixed. An epistomal spike may also be confused with the lateral **EXCRETORY SPOUTS** or **ENSIFORM PROCESSES** projecting from the ventral side of the second antennae peduncle article 2 of phoxocephalids.

AIDS TO IDENTIFICATION

Characters referred to in the keys are usually illustrated in the introduction, family key, or keys to species. Families are clustered in the illustrated keys into similar groups where whole body pictures of each genus are attempted. "Flipping" can be a good way to quickly search among taxa, and the plates are ordered, in part, for this purpose. Use keys forward and backward from known species to test or "verify" identifications (and the key). Read the ecology, natural history, and identification notes in the species lists for more hints on their identities. Most anatomical characters referred to in the keys are clustered in the illustrations of plate 254 to allow quick access to explanations of morphologies referred to in the keys. Mark or copy plate 254 for continuous reference to anatomical notes.

First identifications should begin with large mature specimens in good condition, free of debris or damaged appendages. Return to a mature specimen of the opposite sex or the sex appropriate for the particular key to check critical characters. Test identifications further by reference to any additional relevant literature. Keys interpret nature from incomplete knowledge. Even the best keys can be wrong, incomplete, or unclear. Many northeast Pacific amphipod species remain to be identified or fully described. New species continue to be introduced. Identifications of species using a single key can provide only a first level of confidence.

Specific identifications are increasingly reliable as they are based on increasing numbers of characters and include more biogeographic, ecological, and natural history information. Comparisons with original taxonomic descriptions or with type specimens provide increasingly confident identifications. Character distinctions should also account for variations due to size, reproductive development, and age.

Specific differences are nearly all based on adult morphologies and often on only one sex. The opposite sex often is too poorly described for specific distinctions. Groups emphasizing males usually provide a lower proportion of specimens suitable for identifications. Species are keyed out twice in some cases when sexual characters are critical in the taxonomy and where sexual dimorphism is known.

TABULAR KEY TO FAMILIES

In addition to flaws in the keys, damaged specimens (from gut contents in particular) often lack critical anatomical features, preventing progress directly through dichotomous keys. The gammaridean families and suborders are therefore distinguished additionally in a tabular key and followed by notes on distinctive external and readily observed internal characters. The auxiliary information on the shapes of heads, gnathopods, telsons, and third uropods (and quick-to-observe internal characters) are useful for identifying families "at a glance," or to test questionable endpoints. Gammaridean families and suborders are arranged in Table 5 by telson shape and condition, then by the number and shapes of the rami of uropod 3, and then by external similarity. Use the tabular key and notes to check the dichotomous keys (and vice versa) and broaden searches for family placements of specimens missing critical morphological characters. The following notes, in order of family or suborder, include salient characters that would not readily fit in the tabular key.

TAXONOMIC NOTES BY FAMILY AND SUPERFAMILY

AMPELISCIDAE tiny eyes when present, two separated dorsal frontal lenses when present, massive head, pleated gills, build pocket-shaped silt tubes.

TABLE 5

Tabular Key for Gammaridea

		Telson		U3	Rami			Gnathopods			Pereopods			Mandible	
								Type			P6 & P7				
Family/Suborder	*Plates*	Shape	Cleft	No.	Shape	*Urosomites*	*Oöst. setae*	G1	G2	Largest size	Smlrty	Largest	Acc. flag.	Molar	Palp
Talitridae	303–304	Flesh	UnCl	1	Stubby	CmprUr2&3	Curl	Smpl–Tnsv	SbC	G2	S	P7	0	+	−
Phliantidae	258	Flesh	UnCl	0	—	CmprUr2&3	Curl	Smpl	Smpl	=	D	P7	0	−	−
Eophliantidae	258	Fused	—	0	—	FsdUr2&3	Curl?	Smpl	Smpl	=	S	=	0	−	−
Hyalidae	273	Flesh	Cleft	1	Stubby	CmprUr2&3	Curl	Tnsv–Chlt	SbC	G2	~S	P7	0	−	−
Hyalellidae	272	Flesh	UnCl	1–2	Stubby	CmprUr2&3	Curl	Tnsv–Chlt	SbC	G2	~S	P7	0	−	−
Najnidae	271	Flesh	UnCl	1	Stubby	CmprUr2&3	Curl	SbC–Tnsv	SbC–Tnsv	=	S	P7	0	−	−
Dogielinotidae	271	Flesh	UnCl	1	Stubby	CmprUr2&3	Curl	SbC	SbC	G2	D	P7	0	−	−
Podoceridae	259	Flesh	UnCl	0	—	LongUr1	Stra	Smpl–SbC	SbC	G2	S	=,P6	0−~1	+	+
Cheluridae	260	Flesh	UnCl	2	Leaf	Sep	Stra	Tnsv	Tnsv–Chlt	G2	S	~P7	0	+	+
Corophiidae	269–270	Flesh	UnCl	1–2	Stubby	Sep, Fsd	Stra	SbC	Mero	G2	D	P7	0	+	+
Aoridae	262	Flesh	UnCl	1–2	Stubby	Sep	Stra	SbC–Mero	SbC	G1	S	P7	1	+	+
Isaeidae	263–264	Flesh	UnCl	1–2	Stubby	Sep, FUr2&3	Stra	Smpl–SbC	SbC–Tnsv	G2	=–D	P7	1–3+	+	+
Ischyroceridae	267–268	Flesh	UnCl	1–2	ShMd	Sep	Stra	SbC	SbC–Carp	G2	S	P7	0	+	+
Ampithoidae	265–266	Flesh	UnCl	2	ShMd	Sep	Stra	Tnsv–Chlt	SbC	G2	S	P7	0–3+	+	+
Lysianassoidea	286–287	Lmnr	UnCl–Cleft	0–2	NrSpn–Lnc	Sep	Stra	Smpl–Chlt	Chlt	G1	=−D	=–P6	0–3+	−−+	+
Stenothoidae	275	Lmnr	UnCl	1	Tblr	Sep	Stra	Smpl–SbC	SbC	G2	=−D	P6	0	−−+	−−+
Leucothoidae	282	Lmnr	UnCl	2	NrSpn	Sep	Stra	Carp	SbC	G2	S	P7	0	−−.5	+
Amphilochidae	274	Lmnr	UnCl	2	NrSpn	Sep	Stra	Smpl–Tnsv	Smpl–Tnsv	G2	S	=	0	−−+	+
Stegocephaloidea	283	Lmnr	UnCl	2	NrSpn	Sep	Stra	Chlt	Smpl, Tnsv	G2	S	=	0	−−+	+
Dexaminidae	279	Lmnr	Cleft	2	NrSpn	FsdUr2&3	Stra	SbC	Tnsv	=	=−D	P6	0	+	−,+
Ampeliscidae	276–278	Lmnr	Cleft	2	Lnc	FsdUr2&3	Stra	Smpl	Smpl	=	D	P6	0	+	+
Argissidae	284	Lmnr	Cleft	2	Lnc	Sep	Stra	Smpl	Smpl	=	~S	P7	2~2	+	+
Megaluropidae	285	Lmnr	Cleft	2	Leaf	Sep	Stra	Smpl	Smpl	G2	D	P7	2~2	+	+
Oedicerotidae	280	Lmnr	UnCl	2	NrSpn	Sep	Stra	SbC–Tnsv	SbC–Chlt	G1	D	P7	0	+	+
Synopiidae	281	Lmnr	Cleft	2	Lnc	Sep	Stra	Smpl	Smpl	=	~S	~P6	3+	+	−−+
Phoxocephalidae	289–292	Lmnr	Cleft	2	Lnc	Sep	Stra	SbC– ~Chlt	SbC– ~Chlt	G2	D	P6	3+	−−+	+
Urothoidae	288	Lmnr	Cleft	2	Lnc	Sep	Stra	SbC	SbC	=	S	P6	3+	+	+
Haustoriidae	261	Sep	Sep	2	Lnc	Sep	Stra	Smpl	Chlt	G2	D	P6	3+	+	+
Pontoporeidae	293	Lmnr	Cleft	2	Lnc	Sep	Stra	SbC	Tnsv	G1	D	P6	3+	+	+
Liljeborgiidae	298	Lmnr	Cleft	2	Lnc	Sep	Stra	SbC	SbC	G2	S	P7	2–3+	−−.5	+
Pleustidae	294–295	Lmnr	UnCl	2	NrSpn	Sep	Stra	SbC	SbC	G2	S	=	0–1	−−+	+
Eusiriodea	296–297	Lmnr	UnCl–Cleft	2	NrSpn	Sep	Stra	Red, SbC	SbC	=−G2	S	~P7	0–1	+	+
Hadzioidea	300–301	Lmnr	Cleft	2	Lnc	Sep	Stra	SbC	SbC–Chlt	G2	~S	=	3+	+	+
Gammaroidea	299	Lmnr	Cleft	2	Lnc	Sep	Stra	SbC	SbC	~=	S	=	3+	+	+
Crangonyctidae	302	Lmnr	Cleft	2	Lnc	Sep	Stra	SbC	SbC	G2	S	P6	3+	+	+

NOTE: Family-Superfamily Key including; Plate number(s); Telson "Shape" (Lmnr, Flesh, Fused and Sep respectively: laminar, fleshy, fused to urosome, and separate) and "Cleft" (Cleft and Uncl respectively: cleft and uncleft); Uropod 3 "(U3)" rami number (0, 1, and 2) and "Rami Shape" (Stubby, ShMd, NrSpn, Lnc and Leaf, respectively: stubby, short and modified [bearing denticles, teeth or hooks], narrow with dorsal spine rows, lance shaped with lateral spines, and leaf shaped); Urosomite (CmprU2&3, LongU1, FsdUr2&3, Sep, Fsd indicate respectively: compressed or shortened urosomites 2 and 3, long urosomite 1, fused urosomites 2 and 3, separate urosomites, and all urosomites fused); "oöstegite setae" (Curled and Stra respectively: curled and straight); "Gnathopods" "G1" and "G2", "Type" (Smpl, SbC, Tnsv, Chlt, Red), G1 and G2 are respectively: simple, subchelate, transverse, chelate, reduced) and "Largest" size (G1 or G2 and =); "pereopods" 6 and 7 "P6 & P7" similarity "Smlrty" (S, D, ~S respectively: closely similar, different, nearly similar) and "Largest" pereopod 6 or 7 (respectively: P6, P7, =); "Acc. flag." accessory flagellum article numbers (0, 1, 2 and, 3+ are respectively: absent, a tiny difficult to observe article, one or two prominent articles, and multiple prominent articles) and; "Mandible" "molar" and "palp" (+, − and, .5 indicate respectively: present, absent and greatly reduced). Character qualifications are: dash "–" indicates a range of conditions between two states, comma "," indicates exclusive condition states, tilde "~" indicates poor resolution of the condition and an empty underline "__" indicates irrelevance of the character.

AMPHILOCHIDAE coxa 1 obscured, gnathopods 1 and 2 and article 5 extending along article 6, telson distally acute, uropod 2 not extending as far as uropods 1 and 3.

AMPITHOIDAE uropod 3 outer ramus with large hooks, lower lip with distinctive prominent inner lobes.

AORIDAE gnathopod 1 basket-shaped and merochelate or carpochelate and larger than gnathopod 2, uropod 3 biramous except for uniramous *Grandidierella*.

ARGISSIDAE coxa 1–4 ventrally rounded, coxa 3 shorter than coxa 2 and 4, eyes consist of 4 elements or are absent, male urosomite 2 bearing a dorsal tooth.

CHELURIDAE urosomite 1 bearing a giant dorsal tooth, uropods 1–3 rami grossly different, lives in wood chambers.

COROPHIIDAE basket-shaped gnathopod 2, suspension feeders, sediment tube builders.

CRANGONYCTIDAE lacks ventral antenna sinus or notch, uropod 3 inner ramus short, freshwater or low salinity estuary.

DEXAMINIDAE pereopods 3–7 dactyls short, pleated gills.

DOGIELINOTIDAE fossorial, uropods 1 and 2 peduncles lined dorsally with long spines, pereopods 5 and 6 lined with straight stout digging spines, pereopod 6 and 7 dactyls straight.

EOPHLIANTIDAE head blunt, body antlike, mature specimens unknown.

EUSIROIDEA rostrum pointed or minute, rostrum inserted between antenna 1 peduncle first articles, ventral antenna sinus notched (except *Batea*), dorsal urosome spineless.

GAMMAROIDEA urosomites 1–3 dorsally spinose, gnathopods 1 and 2 palm lined with thick short spines, uropod outer ramus minutely biarticulate, ventral antenna sinus notch lacking.

HADZIOIDEA male gnathopod 2 larger than gnathopod 1, ventral antenna sinus notched (except *Maera, Netamelita,* and *Quadrimaera*), urosome dorsally spineless (although teeth or setae may occur), uropod 3 rami short or long, uniarticulate or biarticulate.

HAUSTORIIDAE fossorial, blind, rostrum lacking, antenna 2 peduncle article 4 laterally expanded, gnathopod and pereopod dactyls minute or absent.

HYALELLIDAE maxilla 1 palp lacking or consisting of a single inconspicuous article.

HYALIDAE maxilla 1 palp of 2 articles, male gnathopod 1 dactyl modified for clasping female.

ISAEIDAE gnathopod 2 larger than 1, uropod 3 usually with 2 short rami and accessory flagellum usually present.

ISCHYROCERIDAE uropod 3 outer ramus with denticles or teeth, telsons diverse.

LEUCOTHOIDAE gnathopod 2 article 5 extending along article 6, telson distally acute. Liljeborgiidae: mandibular molar reduced, telson lobes distally notched, commensal with polychaetes and echiuroids.

LILJEBORGIIDAE mandibular molar reduced, telson lobes distally notched; commensal with polychaetes and echiurans.

LYSIANASSOIDEA antenna 1 article 1 swollen, gnathopod 2 hand mitten-shaped and article 3 longer than wide.

MEGALUROPIDAE coxae 1–4 ventrally rounded, coxa 3 shorter than coxa 2 and 4, eyes large.

NAJNIDAE down-turned antennae, rounded forehead, kelp burrower.

OEDICEROTIDAE eyes dorsal, rostrum helmet-shaped, gnathopods 1 and 2 article 5 variously extended along article 6, pereopod 7 is 50% longer than pereopod 6 and with long straight dactyl.

PHLIANTIDAE rostrum spatulate, body isopodlike and dorsoventrally flattened.

PHOXOCEPHALIDAE fossorial, rostrum shieldlike, antenna 2 spinose, antenna 2 article 4 narrow or expanded.

PLEUSTIDAE rostrum massive to minute, lacking a ventral antenna sinus, telson notch ventrally keeled.

PODOCERIDAE telson spinose, pleopods powerful, eyes bulge laterally.

PONTOPOREIIDAE fossorial, rostrum lacking, head lacking ventral antenna sinus notch, sternal gills, fresh to brackish waters.

STEGOCEPHALOIDEA epimeron 3 ornate, coxa 1 ventrally acute, rostrum large decurved (*Iphimediidae* gnathopod 2 with long lysianassoid article 3).

STENOTHOIDAE coxa 3 and 4 massive, coxa 1 small, obscured, distal telson bluntly acute, tongue-like.

SYNOPIIDAE rostrum helmet-shaped, eyes fused dorsally, tiny accessory lateral eyes in species of the region, telson large, urosomites 1 and 2 with dorsal tooth.

TALITRIDAE terrestrial, antenna 1 tiny.

UROTHOIDAE fossorial, head with extended ventral anterior edge, rostrum lacking, antenna 2 peduncle article 4 narrow.

KEY TO FAMILIES AND SUPERFAMILIES

Families of the region occurring only in deep water, offshore, or only to the north or south of the region, and thus not included, are Lafystiidae, Melphidippidae, Parampithoidae, Pardaliscidae, and Stilipedidae.

1. Telson fleshy, thick, short, or minute not readily articulated at base, uncleft or cleft (plate 255A–255F); telson lobes broadly separate (plate 255G) or telson indistinct (plate 255H); rami of uropod 3 (if present) shorter than peduncle (with numerous exceptions) 2
— Telson flat, laminar, and moveable, uncleft or deeply cleft, always distinct, never both uncleft and fleshy (plate 255I–255N); rami of uropod 3 always present and usually longer than the peduncle 18
2. Antenna 1 much shorter than antenna 2, and no longer than the head (plate 255O); telson with 10 or more irregularly distributed stout spines (plate 255A) and pereopods particularly heavy, terrestrial or semiterrestrial . . . . Talitridae (plates 303–304)
— Antenna 1 of similar size or larger than antenna 2 or significantly longer than the head (plate 255P); telson with six or less irregularly spaced stout spines (not counting long spines or setae) entirely aquatic or intertidal 3
3. Uropod 3 indistinct or absent 6 (plate 255F, 255H, 255Q) 4
— Uropod 3 large and readily visible (plate 255R–255V) . . 6
4. Telson fused to urosome and urosomites 2 and 3 fused (plate 255H), body tubular, ant- or tanaidaceanlike, burrows into kelp . . . . Eophliantidae (plate 258)
— Telson separate from urosome, not ant- or tanaidaceanlike (plate 255F, 255Q–255V), body laterally or dorsoventrally flattened. 5
5. Urosome less than twice as long as deep (plate 255Q); rostrum spatulate (plate 255W). . . . . Phliantidae (plate 258)
— Urosome more than twice as long as deep (plate 255F2); body laterally compressed; rostrum an evenly rounded bulge, small or absent. . . . . Podoceridae (plate 259)
6. Pleonite 3 with immense posteriorly projecting dorsal tooth, uropod 2 peduncle greatly expanded, uropods 2 and 3 enormous and urosomites 1–3 fused (plate 255P) . . . . Cheluridae (plate 260)

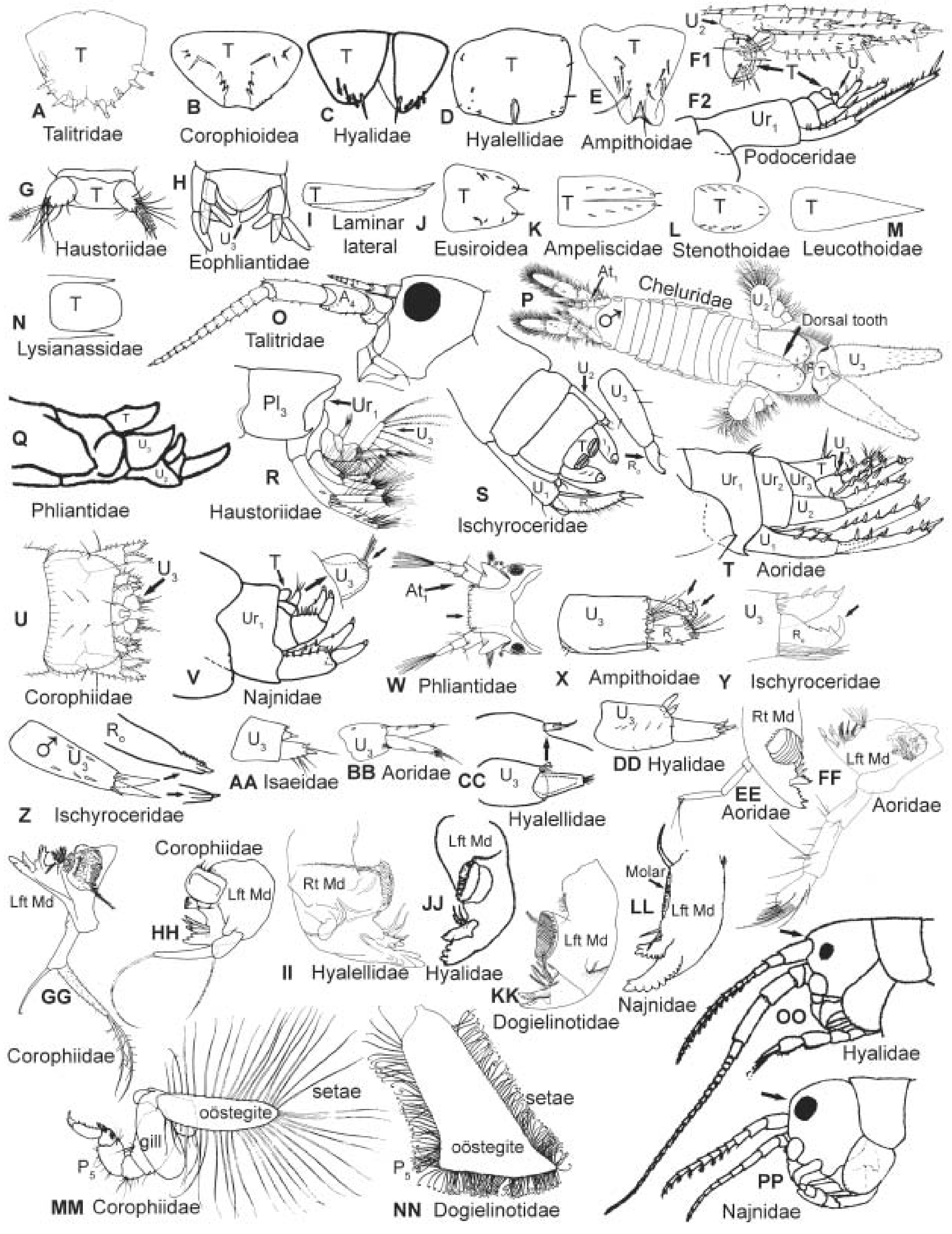

PLATE 255 Family Key. A, Telson, *Orchestia gammarellus*; B, telson, *Americorophium brevis*; C, telson, *Apohyale anceps*; D, telson, *Allorchestes bellabella*; E, telson, *Ampithoe aptos*; F, urosome, *Podocerus cristatus*; G, telson, *Eohaustorius*; H, urosome, *Lignophliantis pyrifera*; I, telson, generalized; J, telson, *Oligochinus lighti*; K, telson, *Ampelisca*; L, telson, stenothoid; M, telson, *Leucothoe*; N, telson, *Lysianassa*; O, head, *Orchestia georgiana*; P, body, *Chelura terebrans*; Q, urosome with uropod 1 removed, *Pariphinotus seclusus*; R, urosome, *Eohaustorius washingtonianus*; S, urosome, *Cerapus tubularis*; T, urosome, *Bemlos concavus*; U, urosome, *Laticorophium baconi*; V, urosome, *Carinonajna kitamati*; W, head and rostrum dorsal, *Pariphinotus escabrosus*; X, uropod 3, *Ampithoe plumulosa*; Y, uropod 3, *Jassa falcata*; Z, uropod 3, *Ischyrocerus pelagops*; AA, uropod 3, *Cheiriphotis megacheles*; BB, uropod 3, *Columbaora cyclocoxa*; CC, uropod 3, *Parallorchestes bellabella*; DD, uropod 3, *Prohyale frequens*; EE, mandible, *Aoroides exilis*; FF, mandible, *Grandidierella japonica*; GG, mandible, *Corophium alienense*; HH, mandible, *Americorophium spinicorne*; II, mandible, *Allorchestes angusta*; JJ, mandible, *Parallorchestes americana*; KK, mandible, *Proboscinotus loquax*; LL, mandible, *Carinonajna bicarinata*; MM, oöstegite, pereopod 5, *Americorophium salmonis*; NN, oöstegite, pereopod 5, *Proboscinotus loquax*; OO, head, *Ptilohyale longipalpa*; PP, head, *Carinonajna bicarinata*. (figures modified from Barnard 1950, 1954a, 1962a, 1962c, 1965, 1967a, 1969a, 1972c, 1975, 1979a; Bousfield 1958a, 1961a, 1973; Bousfield and Conlan 1982; Bousfield and Hendrycks 2002; Bousfield and Hoover 1995, 1997; Bousfield and Marcoux 2004; Chapman 1988; Chapman and Dorman 1975 ; Conlan 1990; Conlan and Bousfield 1982a, 1982b; and Shoemaker 1933, 1934).

— Pleonite 3 without posteriorly projecting dorsal tooth; uropod 2 without greatly expanded peduncle (plate 255F2, 255Q–255V) 7
7. Uropod 3 with 2 prominent short or long rami that may not be equal (plate 255X–255BB) 8
— Uropod 3 with 1 ramus only or with inner ramus minute, scalelike or otherwise indistinct and difficult to observe (plate 255S, 255U–255V, 255CC, 255DD) 12
8. Urosome decurved, nearly ventral to pleonite 3 (plate 255R); telson lobes widely separated (plate 255G) . . . . Haustoriidae (plate 261)
— Urosome normally aligned with (not ventral to) pleonite 3 (plate 255S–255V); telson lobes adjacent or fused (plate 255B–255E) 9
9. Uropod 3 rami structurally similar and the outer ramus with setae or with short, straight spines but not hooks or denticles (plate 255AA, 255BB) 10
— Uropod 3 rami different in structure and the outer ramus bearing conspicuous hooks or denticles (plate 255X–255Z) 11
10. Male gnathopod 1 larger than gnathopod 2 . . . . Aoridae (plate 262)
— Male gnathopod 1 smaller than gnathopod 2 . . . . Isaeidae (plates 263–264)
11. Outer ramus of uropod 3 stout, with two heavy, hooked spines and inner ramus flat and apically setose (plate 255X) . . . . Ampithoidae (plates 265–266)
— Outer ramus of uropod 3 apically stout, bearing a single large hook (plate 255Y) or relatively slender, outer ramus either denticulate (plate 255Z) or unornamented (an exception is *Cerapus* [plate 255S], which lacks an inner ramus) . . . . Ischyroceridae (plates 267–268)
12. Combined lengths of urosomites 2 and 3 greater than one-half of urosomite 1 (plate 255T) or urosomites 1–3 fused (plate 255U); mandibular palp present (plate 255EE–255HH); oöstegites lined with evenly curved or straight setae (plate 255MM) 13
— Urosomites 2 and 3 combined lengths less than one half of urosomite 1 (plate 255V); mandibular palp absent (plate 255II–255LL); oöstegites lined with distally curled setae (plate 255NN) 15
13. Male gnathopod 1 or gnathopod 2 carpochelate (plate 254V) 14
— Male and female gnathopod 2 basket-shaped, merochelate, or simple, ventrally lined with long pinnate setae (plate 254U) and larger than gnathopod 1 . . . . Corophiidae (plates 269–270)
14. Gnathopod 1 carpochelate (*Grandidierella japonica*) . . . . Aoridae (with Corophiidae) (plate 262)
— Gnathopod 2 carpochelate (*Cerapus*) . . . . Ischyroceridae (plates 267–268)
15. Head anteriorly square and antenna 1 insertion dorsal to the eye (plate 255OO); molar prominent (plate 255JJ–255KK); uropod 3 ramus short but readily apparent (plate 255CC, 255DD) 16
— Head anteriorly decurved, insertions of antenna 1 ventral to the eye (plate 255PP); mandibular molar an indistinct flat plate (plate 255LL); uropod 3 ramus tiny (plate 255V) . . . . Najnidae (plate 271)
16. Pereopods 2–7 fossorial, pereopod 6 articles 4–6 densely lined with long, straight setae and with straight dactyl (plate 256A); epistome of upper lip proboscoid (noselike) (plate 256B); uropod 1 peduncle lined with long spines and rami without spines (plate 256C) . . . . Dogielinotidae (plate 271)
— Pereopods 2–7, articles 4–7 with sparse, short setae and with curved dactyls (plate 256D); uropod 1 rami and lateral peduncle with short stout spines (plate 256E); epistome reduced (plate 256F) 17
17. Telson uncleft or cleft less than one-third of total length (plate 255D); maxilla 1 palp extremely reduced or absent, not extending to distal plate end (plate 256G) . . . . Hyalellidae (plate 272)
— Telson cleft more than one half of the entire length into subtriangular lobes (plate 255C); maxilla 1 palp extending to distal end of outer plate (plate 256H, 256I) . . . . Hyalidae (plate 273)
18. Coxa 1 tiny and obscured by coxa 2 and coxa 2–4 enlarged or immense (arrows, plate 256J, 256K) 19
— Coxa 1 at least half as large as coxa 2 and coxa 2–4 not greatly enlarged or immense (plate 256L, 256M) 22
19. Rostrum inserted between first antennae (plate 256N); telson laminar and deeply cleft (plate 254Q); gnathopod 1 vestigial . . . . Eusiroidea (Bateidae) (plate 296)
— Rostrum vestigial (plate 256K) or extended over first antenna (plate 256M) but not inserted between the antennae; telson uncleft (plate 256L–256M) 20
20. Gnathopod 1 carpochelate (plate 256O, 256P) . . . . Leucothoidae (plate 282)
— Gnathopod 1 simple, transverse or subchelate but not carpochelate 21
21. Uropod 3 biramous, rami of a single article, uropod 2 not reaching distal end of uropod 3 and telson acute (plate 256Q); gnathopods 1 and 2 article 5 extending to the posterior palm edge of article 6 (plates 254X, 256R) . . . . Amphilochidae (plate 274)
— Uropod 3 with a single biarticulate ramus (plate 256T); gnathopod 2 article 5 not extending along posterior edge of the palm of article 6 (plate 256S); telson evenly rounded or bluntly acute posteriorly (plate 255L) and uropod 2 extending as far as distal uropods 1 and 4 . . . . Stenothoidae (plate 275)
22. Urosomites 2 and 3 fused together (plate 256L, 256U) 23
— Urosomites separate (plate 256J, 256K, 256M) 24
23. Head as long as combined lengths of pereonites 1–3, pereopod 3 and 4 dactyls longer than combined articles 5 and 6; pereopods 6 and 7 dissimilar, eyes tiny, consisting of one dorsal lateral and one anteroventral cuticular lens (plate 256L) . . . . Ampeliscidae (plates 276–278)
— Head shorter than the combined lengths of pereonites 1 and 3; pereopods 2 and 3 dactyls shorter than combined articles 5 and 6; pereopods 6 and 7 similar; eyes with numerous ommatidia (plate 256V) . . . . Dexaminidae (plate 279)
24. Eyes coalesced into a single dorsal anterior mass on a strongly decurved, usually helmet shaped, rostrum (plate 256W, 256X) 25
— Eyes lateral, rostrum present or absent (plate 256M, 256N, 256Y–256AA) 26
25. Telson emarginated (plate 256BB) or evenly rounded; urosome dorsally unarmed and telson not extending beyond peduncle of uropod 3 (plate 256CC); gnathopod 1 article 6 stout (plate 254X); accessory eyes lacking (plate 256W) . . . . Oedicerotidae (plate 280)
— Telson deeply cleft (plate 256DD); telson extending beyond peduncle of uropod 3 and urosomites 1 and 2 dorsally toothed (plate 256EE); gnathopod 1 article 6 weak (plate 256FF); accessory flagellum prominent and multiarticulated (plate 256GG) . . . . Synopiidae (plate 281)

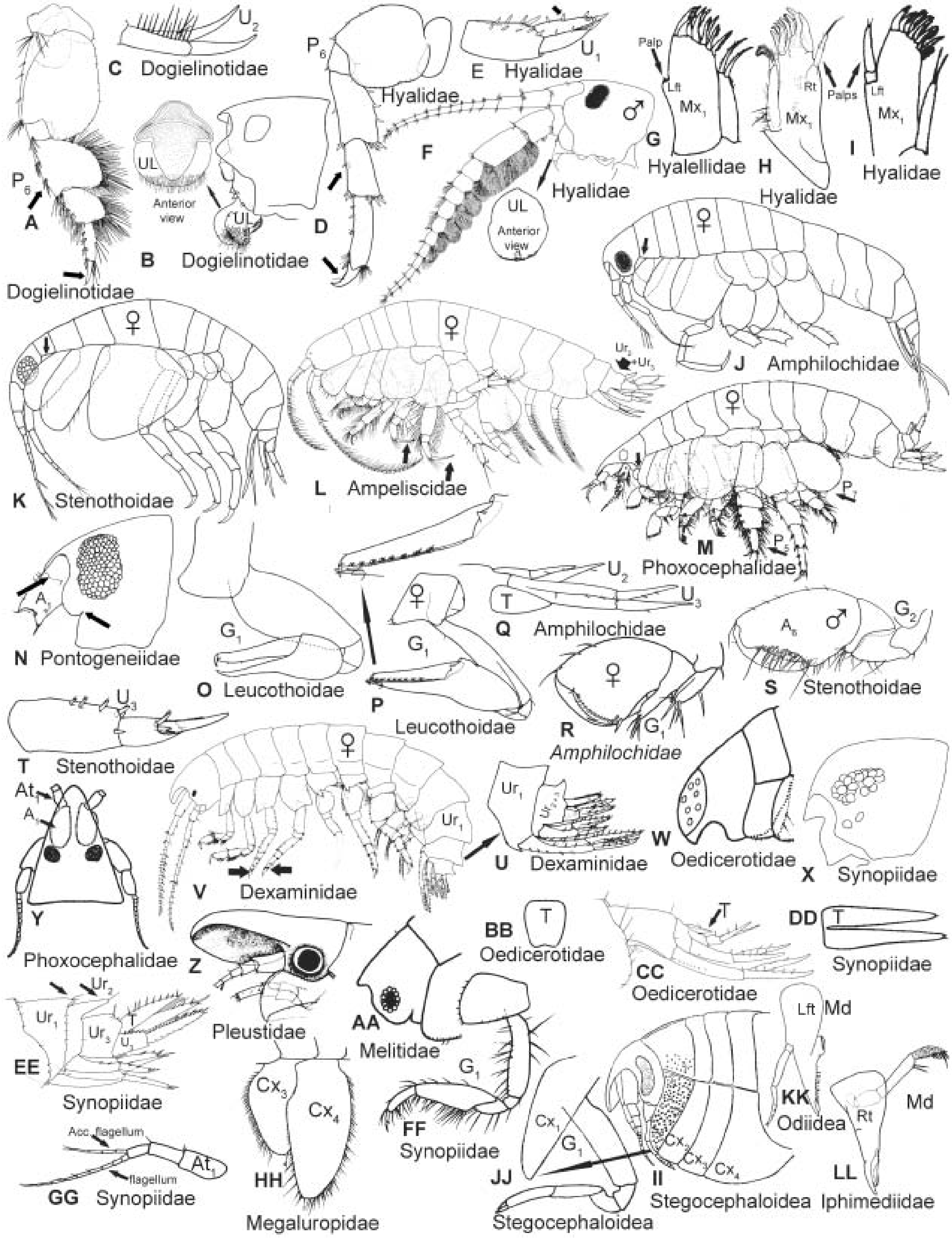

PLATE 256 Family Key. A, pereopod 6, B, head and upper lip, C, uropod 1, *Proboscinotus loquax*; D, pereopod 6, *Apohyale anceps*; E, uropod 1, *Apohyale anceps*; F, head and upper lip (UL = *Apohyale pugettensis*), *Ptilohyale littoralis*; G, maxilla 1, *Allorchestes rickeri*; H, maxilla 1, *Apohyale anceps*; I, maxilla 1, *Parallorchestes cowani*; J, body, *Gitana calitemplado*; K, body, *Stenula modosa*; L, body, *Ampelisca milleri*; M, body, *Eobrolgus chumashi*; N, head, *Pontogeneia rostrata*; O, gnathopod 1, *Leucothoe alata*; P, gnathopod 1, *Leucothoides pacifica*; Q, telson and uropods 1 and 2, *Apolochus littoralis*; R, gnathopod 1, *Apolochus barnardi*; S, gnathopod 2, *Stenothoe estacola*; T, uropod 3, *Stenula incola*; U, urosome, V, body, *Atylus levidensus*; W, head, *Americhelidium shoemakeri*; X, head, *Metatiron tropakis;* Y, head, *Foxiphalus obtusidens*; Z, rostrum, *Thorlaksonius grandirostris*; AA, head, *Elasmopus antennatus*; BB, telson, *Monoculodes emarginatus*; CC, urosome, *Americhelidium micropleon*; DD, telson, *Tiron biocellata*; EE, urosome, *Metatiron tropakis*; FF, gnathopod 1, *Tiron biocellata*; GG, antenna 1, *Tiron biocellata*; HH, coxae 3 and 4, *Gibberosus myersi*; II, head and 3 pereonites, *Cryptodius kelleri*; JJ, gnathopod 1, *Cryptodius kelleri*; KK, left mandible, *Cryptodius kelleri*; LL, right mandible, *Coboldus hedgpethi* (figures modified from: Barnard 1960a, 1962a, 1962b, 1962c, 1962e, 1967a, 1969a, 1972b, 1972c, 1977, 1979a; Bousfield and Chevrier 1996; Bousfield and Kendall 1994; Bousfield and Hendrycks 1994a, 2002; Dickinson 1982; Gurjanova 1951; Hendrycks and Bousfield 2001; Jarrett and Bousfield 1994b; Moore 1992; and Nagata 1965a).

26. Gnathopod 1 carpochelate (plate 256O, 256P) . . . . Leucothoidae (plate 282)
— Gnathopod 1 not carpochelate. 27
27. Coxa 4 is 50% longer than coxa 3 or more and ventrally rounded (plate 256HH) 29
— Coxae 3 and 4 within 30% of the same length and ventrally square or acute, not rounded (plate 256II) 28
28. Coxa 1 ventrally acute (plate 256JJ); mandibles needlelike with molars weak or lacking (plate 256KK, 256LL) . . . . Stegocephaloidea (plate 283)
— Coxa 1 ventrally square or rounded (plate 257A); mandible not as above 30
29. Eye round and of four distinctive ommatidia (plate 257B); uropod 3 rami posteriorly acute (plate 257C); mandibular palp slight with article 3 longest (plate 257D). . . . . Argissidae (plate 284)
— Eye variously shaped, multifaceted (plate 257E); uropod 3 rami foliate (plate 257F) (this appendage is often lost); mandible palp stout and article 2 is longest (plate 257G); mandible with triturative molar (plate 257H) . . . . Megaluropidae (plate 285)
30. Antenna 1 article 1 depth usually half or more of the length (plate 257I, 257J); gnathopod 2 article 3 at least 1.5 times longer than wide and article 6 mitten-shaped with dactyl minutely transverse (plate 257K); body usually white, compact, shiny and densely calcified . . . . Lysianassoidea (plates 286–287)
— Antenna 1 article 1 longer than deep (plates 256M, 256N, 257N, 257Q); gnathopod 2 article 3 less than 1.2 times longer than wide, article 6 not mitten–shaped and dactyl prominent (plate 257L, 257M) 31
31. Fossorial—dense long stout lateral spines lining antennae 2 (plates 256M 257N, 257O) and lining pereopod 5 articles 4–6 (plates 256M, 257N, 257P). 33
— Nonfossorial—antennae 2 and pereopod 5 articles 4–6 not lined with long dense stout lateral spines (plate 257Q, 257R) 32
32. Accessory flagellum two articles or more and apparent at magnifications of 40x or less (plate 257Q, 257R); all telsons cleft and with prominent distal setae or spines (plate 257S, 257T) 37
— Accessory flagellum absent or a tiny article apparent only at magnifications >40x (plate 257U–257W); telsons deeply cleft or evenly rounded and with few or no prominent distal setae or spines (plate 257X, 257Y) 35
33. Pereopods 6 and 7 similar in length and form, ventral cephalic margin extended (see arrow; plate 257N) entirely marine . . . . Urothoidae (plate 288)
— Pereopod 7 different in form and at least 40% shorter than pereopod 6 (plate 256M); ventral cephalic margin reduced (see arrows; plates 256M, 257Z) 34
34. Rostrum extended and visorlike (plate 256M, 256Y) entirely marine or high-salinity estuary. . . . . Phoxocephalidae (plates 289–292)
— Rostrum minute; entirely freshwater or low-salinity estuary (plate 257Z) . . . . Pontoporeiidae (plate 293)
35. Telson evenly rounded (plate 257X) or emarginate (plate 255J). 36
— Telson deeply cleft (plate 257Y) . . . . Eusiroidea (Pontogeneiidae) (plates 296–297)
36. Ventral antennal sinus without a notch (plate 257W); upper lip ventrally bilobed (plate 257AA, 257BB); lower lip with inwardly tilting pillow shaped inner and outer lobes (except for *Anomalosymtes coxalis*) (plate 257CC) and with short mandibular extensions (arrows, plate 257DD, 257EE) . . . . Pleustidae (plates 294–295)
— Ventral antennal sinus with a notch (plate 256N); lower lip ventrally convex (plate 257FF); inner and outer lobes of lower lip not pillow shaped and bearing large extensions of the outer lobes (plate 257GG, 257HH). . . . . . Eusiroidea (Calliopidae) (plates 296–297)
37. Pereopods 5–7 dactyls small and straight (plate 257Q); uropod 3 rami sharply pointed distally, nearly equal in length and lined with single thick spines (plate 257II, 257JJ); molar reduced (plate 257KK) . . . . Liljeborgiidae (plate 298)
— Pereopods 5–7 dactyls stout and slightly curved (plate 257R); uropod 3 rami with thick spines in clusters or inner ramus greatly reduced (plate 257LL–257NN); molar prominent (plate 257OO, 257PP). 38
38. Urosome with dorsal clusters of large stout spines or setae (plate 257QQ) . . . . Gammaroidea (plate 299)
— Urosome dorsum bare (plate 257P) or variously toothed (plate 257RR) but without clusters of spines 39
39. Head with an inferior antennal sinus (plate 257R, 257SS, 257TT); accessory flagellum of three or more segments (plate 257R) . . . . Hadzioidea (plates 300–301)
— Head lacking inferior antennal sinus and accessory flagellum of two segments (plate 257UU). . . . . Crangonyctidae (plate 302)

LISTS OF GAMMARIDEA SPECIES BY FAMILY

Species lists include author, notes, species lengths and depth ranges. Species lengths are a crude index of size based on the distance from the distal end of the head to the posterior edge of the telson and are usually of the largest specimens reported. Species preceded by an asterisk are not in the key or are out of the range of the region.

EOPHILANTIDAE

Eophliantidae are kelp burrowers of the eastern Pacific and southern hemisphere. This rare, antlike species is the only member of the family with a fused telson. Urosomites 2 and 3 are also fused. Reproductive individuals are unknown. The name *Lignophliantis* indicates an eophliantid with lignin in its gut (Barnard 1969a: 104).

KEY TO EOPHILIANTIDAE

1. Tiny tubular body, lacking accessory flagellum, with sparse body setae and spines and pereonites lacking a ventral flange (plate 258A); mandible lacking palp or molar (plate 258B); uropod 3 consisting of a peduncle only (plate 255H) . . . . *Lignophliantis pyrifera*

LIST OF SPECIES

Lignophliantis pyrifera Barnard, 1969a. Bores into haptera of the kelp *Macrocystis pyrifera*. A lack of records is likely due to low probability of retention on standard 0.5 mm mesh collecting sieves normally used and the difficulty of recognizing such a small, unusual amphipod in nearshore algae samples; 1.4 mm; intertidal—3 m.

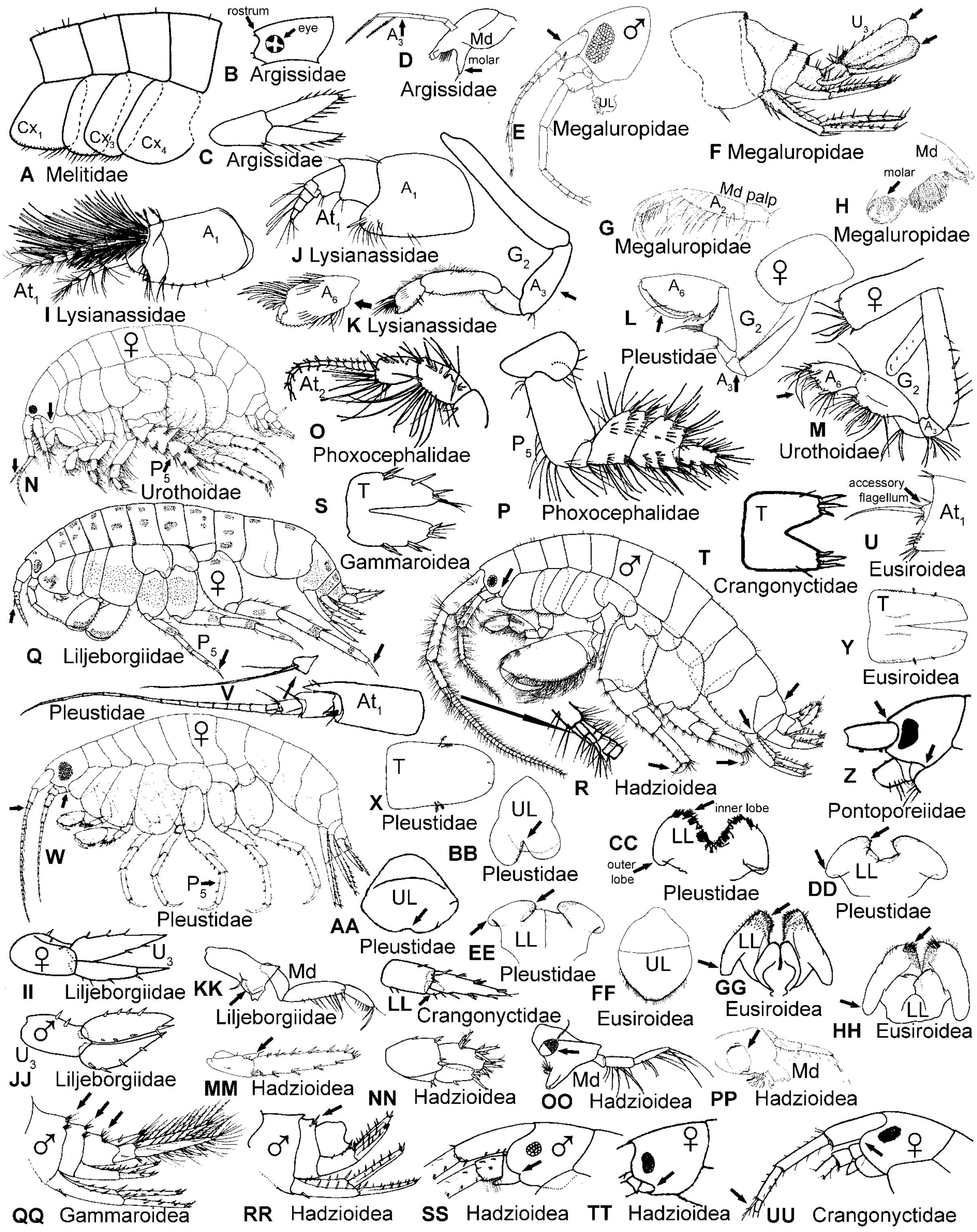

PLATE 257 Family Key. A, coxae 1-4, *Elasmopus antennatus*; B, head, C, telson, D, mandible, *Argissa hamatipes*; E, head, F, urosome, G, mandibular palp, H, molar, *Gibberosus myersi*; I, antenna 1, *Macronassa pariter*; J, antenna 1, *Ocosingo borlus*; K, gnathopod 2, *Macronassa macromer*; L, gnathopod 2, *Pleusirus secorrus*; M, gnathopod 2, *Urothoe varvarini*; N, body, *Urothoe marina*; O, antenna 2, *Grandifoxus grandis*; P, pereopod 5, *Grandifoxus grandis*; Q, body, *Listriella diffusa*; R, body, *Elasmopus antennatus*; S, telson, *Anisogammarus pugettensis*; T, telson, *Crangonyx pseudogracilis*; U, accessory flagellum, *Oligochinus lighti*; V, antenna 1 and accessory flagellum, *Anomalosymtes coxalis*; W, body, *Kamptopleustes coquillus*; X, telson, *Chromopleustes lineatus*; Y, telson, *Pontogeneia rostrata*; Z, head, *Monoporeia affinis*; AA, upper lip, *Anomalosymtes coxalis*; BB, upper lip, *Chromopleustes lineatus*; CC, lower lip, *Anomalosymtes coxalis*; DD, upper lip, *Holopleustes aequipes*; EE, lower lip, *Chromopleustes lineatus*; FF, upper lip, *Oligochinus lighti*; GG, lower lip, *Accedomoera vagor*; HH, lower lip, *Paracalliopiella pratti*; II, female uropod 3, *Listriella diffusa*; JJ, male uropod 3, *Listriella diffusa*; KK, mandible, *Listriella melanica*; LL, uropod 3, *Crangonyx pseudogracilis*; MM, uropod 3, *Melita nitida*; NN, uropod 3, *Elasmopus antennatus*; OO, mandible, *Maera similis*; PP, mandible, *Megamoera dentata*; QQ, urosome, *Gammarus daiberi*; RR, urosome, *Desdimelita microdentata*; SS, head, *Melita nitida*; TT, head, *Maera jerrica*; UU, head, *Crangonyx pseudogracilis* (figures modified from: Barnard 1954a, 1959a, 1959b,1960a, 1962b, 1969a, 1969b, 1979a; Bousfield 1958b, 1973; Bousfield and Hendrycks 1995b; Gurjanova 1953; Hendrycks and Bousfield 2004; Jarrett and Bousfield 1996; Krapp-Schickel and Jarrett 2000; Lincoln 1979; McKinney 1980; Segerstråle 1937; and Thomas and Barnard 1986).

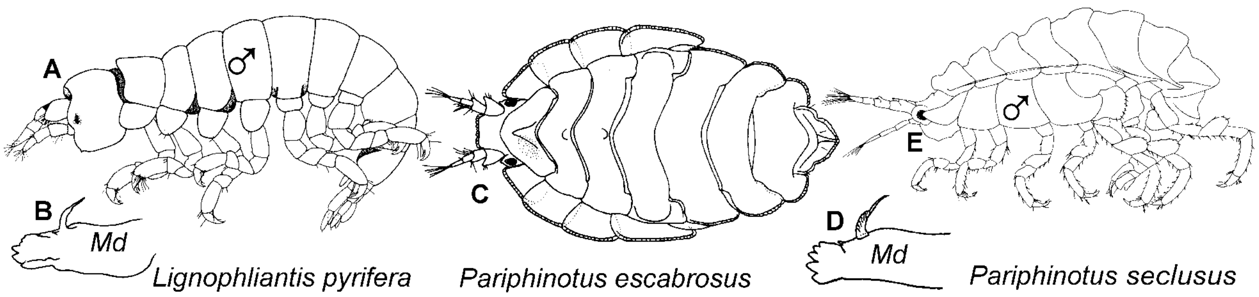

PLATE 258 Eophliantidae and Phliantidae. A, B, *Lignophliantis pyrifera*; C, E, *Pariphinotus escabrosus;* D, *Pariphinotus seclusus* (figures modified from: *Pariphinotus escabrosus, Pariphinotus seclusus* of: Barnard 1969a, 1979a, and Shoemaker 1933).

PHLIANTIDAE

Phliantidae look more like isopods than amphipods, with their simple or barely subchelate gnathopods, square rostrum, dorsoventrally flattened calcified body, short antennae, splayed coxae, and the lack of a third uropod.

KEY TO PHLIANTIDAE

1. Body broad, dorsoventrally flattened (plate 258C, sex not known); mandibule lacking palp and molar (plate 258D); coxae splayed (plate 258C, 258E); rostrum square and distally annulated (plate 255W) . . . . . *Pariphinotus escabrosus*

LIST OF SPECIES

Pariphinotus escabrosus (Barnard, 1962b) (=*Heterophlias*). Moderately abundant under rock substrata, in kelp *Macrocystis* holdfasts, rare in surfgrass *Phyllospadix*. *P. escabrosus* was initially misidentified as *Pariphinotus seclusus* Shoemaker, 1933, from the Dry Tortugas, Florida, which does not occur in the Pacific; 3.8 mm; intertidal—16 m.

PODOCERIDAE

Podoceridae have an extended urosomite 1, minute or absent uropod 3, and fleshy, entire telsons. The delicate antennae, pereopods, and pleopods of preserved specimens are usually missing. Some species are brilliantly pigmented and occur in highly visible locations (Goddard 1984). An unidentified *Podocerus* of Oregon (probably in the *P.* "*cristatus*" group) appears to be a Batesian mimic of *Flabellina trilineata* (Goddard 1984, Shells and Sea Life 16: 220–222). The particularly long urosomite 1 of males may be an adaptation for their powerful pleopods, which are used for pelagic swimming in search of mates (Conlan 1991, Hydrobiologia 223: 255–282). The broad geographic ranges of many podocerids are likely due to human introductions or to poorly resolved species definitions.

KEY TO PODOCERIDAE

1. Urosomites 1–3 separate and antenna 1 shorter than antenna 2 (plate 259A, 259B); uropod 3 minute (plate 259B) 2
— Urosomites 2 and 3 fused (plate 259C); antenna 1 as long or longer than antenna 2, uropod 3 absent (plate 259D). 4
2. Pleonites with raised carina (plate 259E) . . . . *Podocerus "cristatus"*
— Pleonites without raised carina (plate 259B) 3
3. Male gnathopod 2 article 4 extended forward (plate 259F) . . . . *Podocerus spongicolus*
— Male gnathopod 2 article 4 not greatly extended forward (plate 259G) . . . . *Podocerus brasiliensis*
4. Pereopods 3 and 4 article 2 expanded and pereopods 5–7 lengths <1.5 times length of pereopods 3–4 (plate 259H) 6
— Pereopods 3 and 4 article 2 narrow and pereopods 5–7 greater than two times lengths of pereopods 3–4 (plate 259D) 5
5. Pereopod 7 article 5 shorter than article 6 (plate 259D); gnathopod 2 dactyls denticulate, uropods 1 and 2 lateral edges with spines (plate 259B) . . . . *Dulichia rhabdoplastis*
— Pereopod 7 article 5 longer than article 6, gnathopod 2 palm without teeth, uropods 1 and two lateral edges without spines (not illustrated). . . . . *Dulichia* sp.
6. Male and female coxa 1 with anteriorly directed spine (plate 259H, 259I), eyes small and within lateral cephalic bulge, accessory flagellum of one article . . . . *Dyopedos arcticus*
— Female coxa 1 with out anteriorly directed spine (plate 259J), eyes large, usually with light outer ring, accessory flagellum with three articles . . . . . . *Dyopedos monacanthus*

LIST OF SPECIES

Dulichia rhabdoplastis McClosky, 1970. Commensal on sea urchin *Strongylocentrotus franciscanus*; 25 mm; intertidal—25 m.

Dulichia sp. Soft benthos in San Francisco Bay (Presidio Yacht Club, Sausalito, collected 2003). Possibly an introduced undescribed species, not commensal on echinoderms; 6 mm; shallow subtidal—3 m.

Dyopedos arcticus (Murdoch 1885). Pan Arctic; in Pacific from Pt. Barrow to southern California; to 20 mm; 3 m–410 m.

Dyopedos monacanthus (Metzger, 1875). Pan Arctic; in Pacific in Northern California, often clinging to algae, hydroids, and bryozoans, on sand-gravel, to silt clay; 8 mm; 12 m–217 m.

Podocerus brasiliensis (Dana, 1853). Cosmopolitan in tropical and warm temperate seas and likely an introduction in California harbors; 8 mm; intertidal—12 m.

Podocerus "cristatus" (Thompson, 1879). A likely species complex reported widely from warm temperate waters; on our coast from southern California to Magdalena Bay among Sertulariidae, *Boltenia,* and seaweeds, on mud and gravel, on corals and

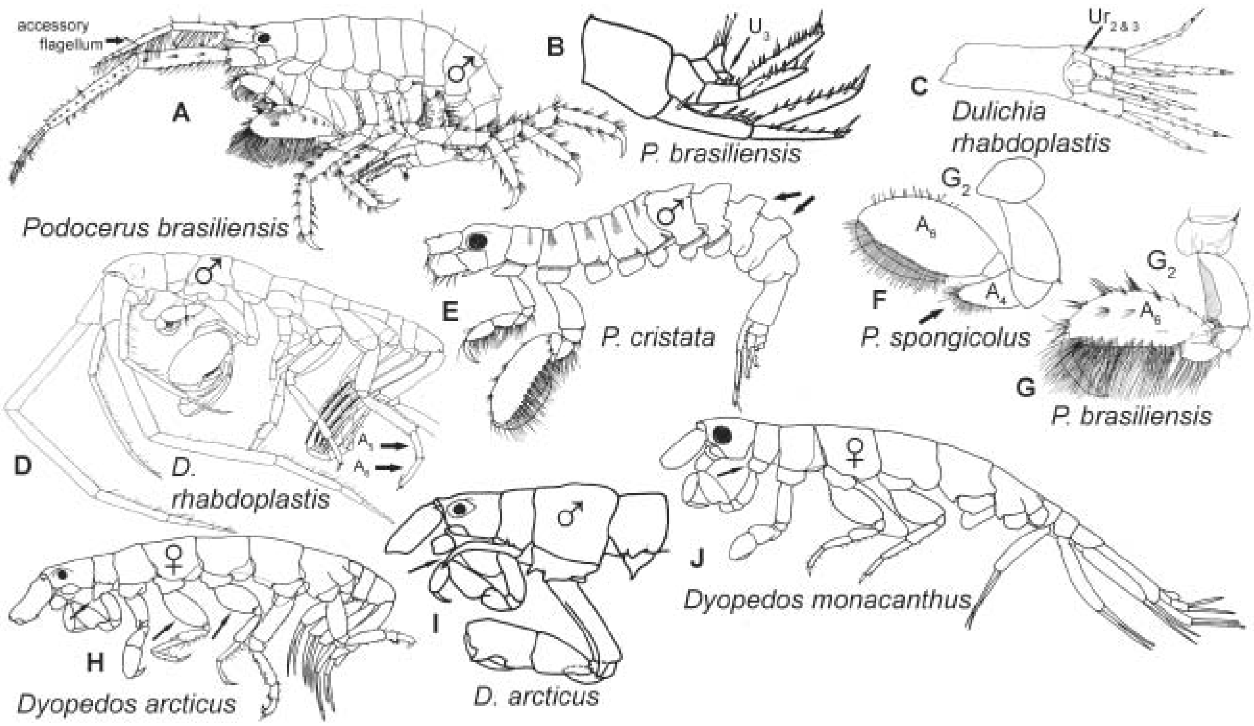

PLATE 259 Podoceridae. C, D, *Dulichia rhabdoplastis*; H, I, *Dyopedos arcticus*; J, *Dyopedos monacanthus*; A, B, G, *Podocerus brasiliensis*; E, *Podocerus cristata*; F, *Podocerus spongicolus* (figures modified from Alderman 1936; Barnard 1962a, 1970; Laubitz 1977; and McClosky 1970).

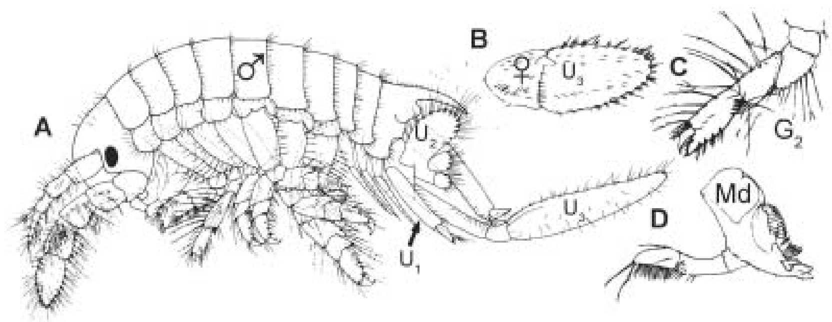

PLATE 260 Cheluridae. A-D, *Chelura terebrans* (figures modified from Barnard 1950, and Bousfield 1973).

among anemones; some species or populations are possible Batesian mimics; 6 mm; 7 m–100 m.

Podocerus spongicolus Alderman, 1936. In sponges; poorly known; 6 mm; intertidal—4m.

CHELURIDAE

Cheluridae invade holes that the isopod *Limnoria* make in wood; the chelurids then enlarge the holes into galleries by scraping furrows in the soft grains (Barnard 1955, Essays in the Natural Sciences in Honor of Captain Allan Hancock, pp. 87–98, Los Angeles: Univ. So. Calif.). *Chelura terebrans* is the only chelurid in this region and is distinguished from all other species by its completely fused urosome, enormous uropods, and dorsally spiked pleonite 3.

KEY TO CHELURIDAE

1. Body dorsally depressed and cylindrical (plates 255P, 260A); sexual dimorphism in the third uropod (plate 260A, 260B); gnathopods weak and chelate (plate 260C); mandible with large palp and molar (plate 260D) . . . . *Chelura terebrans*

LIST OF SPECIES

Chelura terebrans (Philippi, 1839). An introduced cosmopolitan mid-latitude wood-boring species that was not reported from the eastern Pacific until the 1950s (Barnard, 1950, 1952). Warm, high salinity protected areas of bays and estuaries; 6 mm; shallow subtidal and intertidal.

HAUSTORIIDAE

Haustoriidae are blind, unpigmented, and fossorial and are most abundant in clean, fine marine, or estuarine sands where they swim and burrow upside down. Haustoriid burrows result in distinctive, punctate indents and shiny marks on wet sand surfaces of swash zones and high intertidal sand pools.

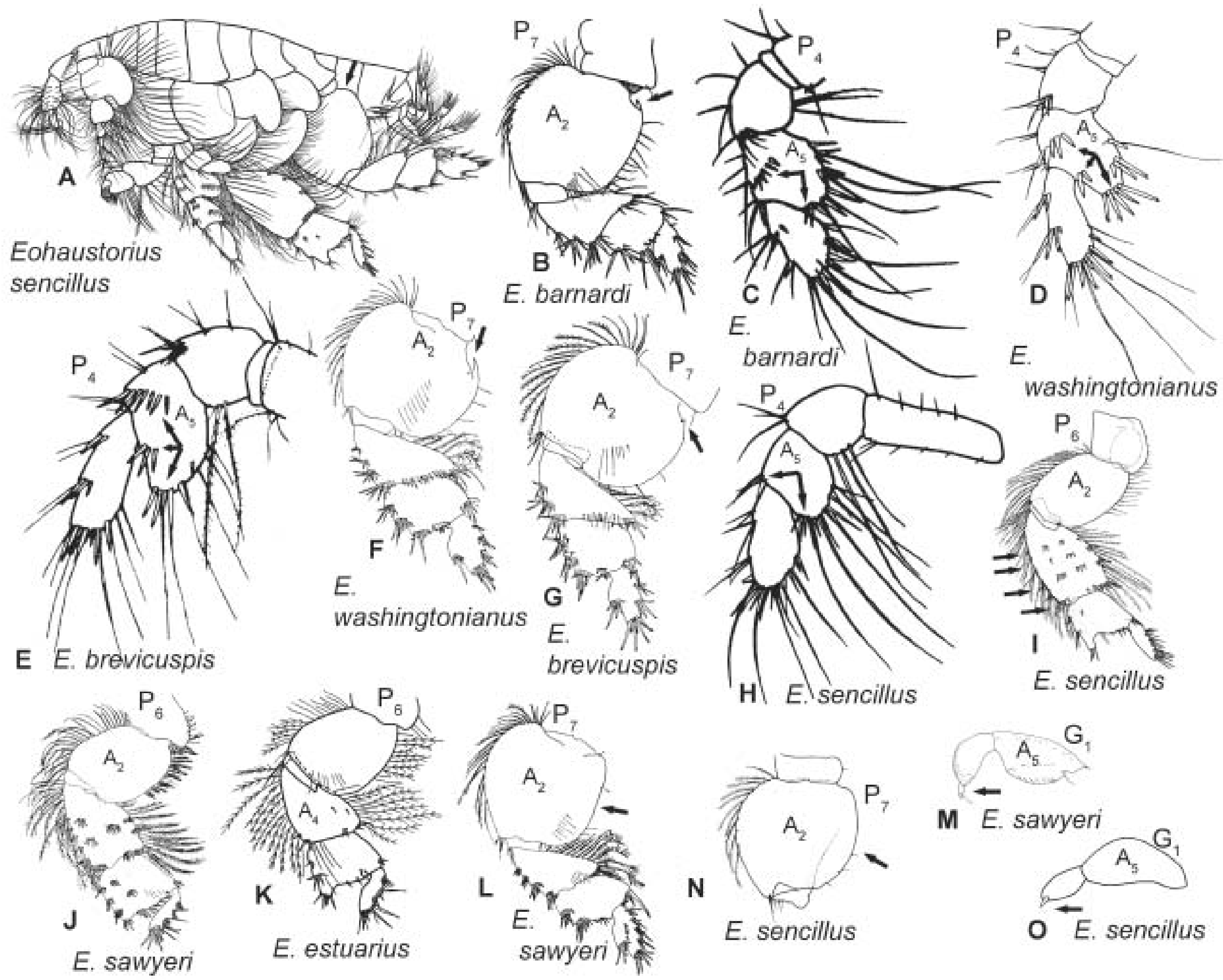

PLATE 261 Haustoriidae. B, C, *Eohaustorius barnardi*; E, G, *Eohaustorius brevicuspis*; K, *Eohaustorius estuarius*; A, H, I, N, O, *Eohaustorius sencillus*; J, L, M, *Eohaustorius sawyeri*; D, F, *Eohaustorius washingtonianus* (figures modified from Barnard 1957a, 1962e; Bousfield and Hoover 1995; Bosworth 1973; and Thorsteinson 1941).

See Jones 1977, Wasmann J. Biol. 21: 114–149 (seasonal occurrence).

KEY TO HAUSTORIIDAE

1. Pereopod 7 article 2 lacking posterior dorsal cusp (plate 261A) 4
— Pereopod 7 article 2 with sharp posterior dorsal cusp (plate 261B) 2
2. Pereopod 4 article 5 width and length nearly equal, bearing only two ventral spine fascicles and extending only slightly posteriorly (plate 261C) . . . . *Eohaustorius barnardi*
— Pereopod 4 article 5 width nearly twice the length, bearing three ventral spine fascicles, and greatly extending posteriorly (plate 261D) 3
3. Pereopod 7 posterior dorsal cusp height twice its base (plate 261F) . . . . *Eohaustorius washingtonianus*
— Pereopod 7 posterior dorsal cusp short, height equal to its base (plate 261G) . . . . *Eohaustorius brevicuspis*
4. Pereopod 4 article 5 width equal to length (not extending posteriorly) and with two ventral spine fascicles (plate 261H) 5
— Pereopod 4 article 5 width nearly twice length, with three ventral spine fascicles and extending posteriorly (plate 261E) . . . . *Eohaustorius brevicuspis*
5. Pereopod 6 article 4 long, nearly as wide at mid-length as at distal end and with three or more sets of spine fascicle rows (plate 261I, 261J) 6
— Pereopod 6 article 4 narrower at mid-length and with less than three sets of spine fascicle rows (plate 261K) . . . . *Eohaustorius estuarius*
6. Pereopod 7 article 2 posterior edge nearly straight (plate 261L), dactyl of gnathopod 1 small (plate 261M) . . . . *Eohaustorius sawyeri*
— Pereopod 7 article 2 posterior edge evenly rounded (plate 261N), dactyl of gnathopod 1 missing or fused with article 6 (plate 261O) . . . . *Eohaustorius sencillus*

LIST OF SPECIES

Eohaustorius barnardi (Barnard 1957). Fine sand marine beaches; 5 mm; 5 m–20 m.

Eohaustorius brevicuspis Bosworth, 1973. *E. brevicuspis* and *E. washingtonianus* are distinguished only by the variable posterior

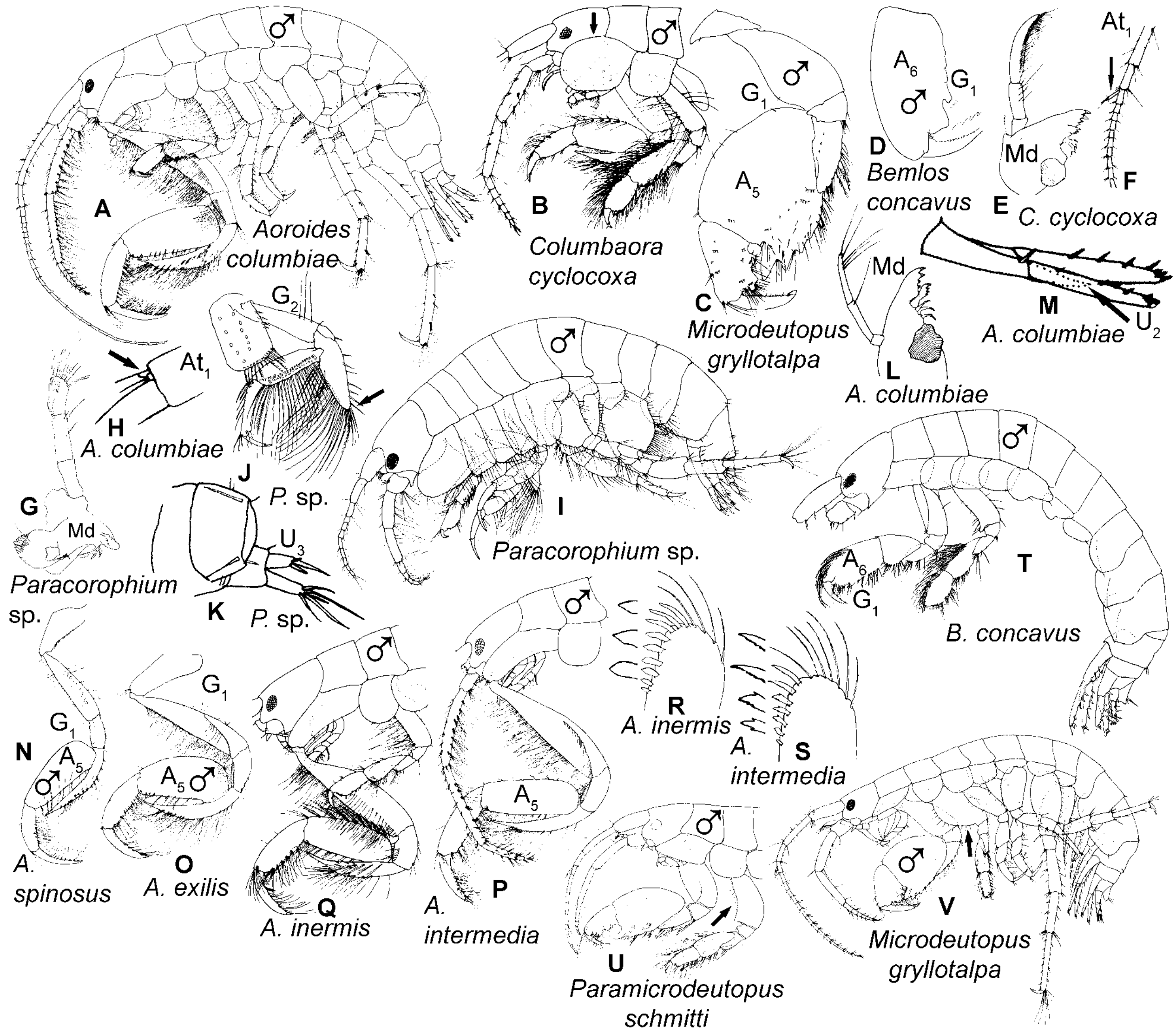

PLATE 262 Aoridae. A, H, L, M, *Aoroides columbiae*; O, *Aoroides exilis*; P, R, *Aoroides inermis*; Q, S, *Aoroides intermedia*; N, *Aoroides spinosus*; D, T, *Bemlos concavus*; B, E, F, *Columbaora cyclocoxa*; C, V, *Microdeutopus gryllotalpa*; U, *Paramicrodeutopus schmitti*; G, I, J, K, *Paracorophium* sp. (figures modified from Bousfield 1973; Chapman and Dorman 1975; Chapman, personal observation; Conlan and Bousfield 1982b; Miller, personal observation; and Shoemaker 1942).

cusp of pereopod 7 and therefore are not clearly distinct species; 5 mm; intertidal—1 m.

Eohaustorius estuarius Bosworth, 1973. Estuarine sands; an important species for toxicity tests (Hecht and Boese, 2002, Envir. Toxicol. and Chem. 21: 816–819); 1 mm–5 mm; intertidal—7 m.

Eohaustorius sawyeri Bosworth, 1973. Fine sands; not clearly distinct from *E. sencillus*; 4 mm; intertidal—1 m.

Eohaustorius sencillus Barnard, 1962. Fine sand beaches and sandy mud benthos; 4 mm; intertidal—30 m.

Eohaustorius washingtonianus (Thorsteinson 1941). Sandy and muddy sand sediments; 6 mm; intertidal—18 m.

AORIDAE

Aoridae, including the corophiid *Paracorophium* keyed here, are tube-building suspension feeders and occur over a wide range of depths in marine and estuarine rocky, fouling, and soft benthic communities. Urosome articles are separate and uropod 3 is usually biramous. Rostrum short or absent, eyes small or large, ocular lobe large and rounded. Antenna 1 usually long but often lost in preservation. Male gnathopod 1 larger than gnathopod 2 in most genera. Telson entire and fleshy. Pereopod 7 long, extending further than pereopod 6. Aorid taxonomy is not reliable for females. At least four nonnative aorids occur within this region. More arrivals and new discoveries are expected in busy international ports and oystering bays.

KEY TO AORIDAE

1. Male gnathopod 1 merochelate (plate 262A, 262B) 2
— Male gnathopod 1 carpochelate (plate 262C) or subchelate (plate 262D) 9
2. Male coxa 1 greatly inflated (plate 262B); mandibular palp article 3 falcate and densely setose (plate 262E); antenna 1 accessory flagellum conspicuous but only as long as first

article of flagellum (plate 262F) . . . . *Columbaora cyclocoxa*
— Male coxa 1 not inflated (plate 262A); mandibular palp article 3 not falcate or densely setose (plate 262G, 262L); antenna 1 accessory flagellum minute (plate 262H) or absent (view under 100×) 3
3. Coxae 2–4 deeper than wide (plate 262I); article 4 of gnathopod 2 distally blunt (plate 262J); uropod 3 short (plate 262K); mandibular palp stout (plate 262G) . . . . *Paracorophium* sp.
— Coxae 2–4 not deeper than wide (plate 262A); distal end of gnathopod 1 article 4 sharply pointed (plate 262A, 262B); uropod 3 long (plate 262A); mandibular palp slender, article 3 longer than article 2 (plate 262L) 4
4. Uropod 2, peduncle lacking ventral interramal spine. . . . . *Aoroides secundus*
— Uropod 2, peduncle with prominent ventral interramal spine (plate 262M) 5
5. Male gnathopod 1, article 5 without anterior setae bundles, and width >1.4 times width of article 2 (plate 262A, 262N, 262O) 6
— Male gnathopod 1 article 5 with anterior setae bundles and article 5 and article 2 widths nearly equal (plate 262P, 262Q) 8
6. Gnathopod 1, anterior and lateral edges of article 2 densely setose and hind margin of article 2 bare (plate 262A) . . . . *Aoroides columbiae*
— Gnathopod 1, anterior and lateral edges of article 2 sparsely setose and posterior edge of article 2 with setae (plate 262N, 262O) 7
7. Gnathopod 1, anterior edge of article 3 with sparse setae (plate 262N) . . . . *Aoroides spinosus*
— Gnathopod 1, anterior edge of article 3 with dense setae (plate 262O). . . . . *Aoroides exilis*
8. Gnathopod 1, article 5 anterior margin densely setose (plate 262Q), thick spines of inner edge of inner plate of maxilliped nearly smooth (plate 262R) . . . . *Aoroides inermis*
— Gnathopod 1, article 5 anterior margin sparsely setose (plate 262P), thick spines of inner edge of inner plate of maxilliped serrate (plate 262S) . . . . *Aoroides intermedia*
9. Male gnathopod 1 subchelate (plate 262D, 262T). . . . . *Bemlos concavus*
— Male gnathopod 1 carpochelate (plate 262C) 10
10. Article 2 of male gnathopods 1 and 2 not expanded (plate 262U). *Paramicrodeutopus schmitti*
— Article 2 of male gnathopods 1 and 2 both expanded (plate 262C, 262V) . . . . *Microdeutopus gryllotalpa*

LIST OF SPECIES

Aoroides columbiae Walker, 1898. Abundant in subtidal fouling communities of rocks, pilings and floats; 6 mm; intertidal—>100 m.

Aoroides exilis Conlan and Bousfield, 1982b. Among algae and sponges under stones and on sand and gravel beaches of open coasts and protected waters; 6 mm; intertidal—50 m.

Aoroides inermis Conlan and Bousfield, 1982b. High-salinity sand and rock surfaces of exposed and protected waters; 6.5 mm; intertidal—148 m.

Aoroides intermedia Conlan and Bousfield, 1982b. 6 mm; intertidal—63 m.

Aoroides secundus Gurjanova, 1938. An Asian species introduced probably by ships to the Pacific coast where it occurs on floats and docks of central San Francisco Bay and southern California harbors; 3.5 mm; intertidal—2 m.

Aoroides spinosus Conlan and Bousfield, 1982b. Low intertidal and subtidal; on various substrata, but especially with algae and among debris; not known south of Coos Bay; 7 mm; intertidal—45 m.

Bemlos concavus (Stout, 1913). Stony bottoms, surf exposed bedrock, *Phyllospadix*, kelp, *Corallina*; 6 mm; intertidal—3 m.

Columbaora cyclocoxa Conlan and Bousfield, 1982b. Under boulders and among *Laminaria* on exposed algal-covered rocky beaches; 7 mm; intertidal—10 m.

Microdeutopus gryllotalpa Costa, 1853. Introduced, a well-known western Atlantic and Mediterranean species of shallow estuaries found on the intertidal mud flats of Humboldt Bay since the 1980s (Boyd et al. 2002); 10 mm; to 150 m in Atlantic.

Paramicrodeutopus schmitti (Shoemaker, 1942). Rocky surf-washed beaches among *Phyllospadix* and red algae; 5 mm; intertidal—43 m.

LIST OF SPECIES

Paracorophium sp. An introduced intertidal mudflat species of northern Humboldt Bay, possibly from South America, included here because of its biramous uropod 3, collected and illustrated by Todd Miller; 4 mm; intertidal—2 m.

ISAEIDAE

Isaeidae are entirely marine suspension feeders that build tubes or occupy empty shells and occur at a wide depth range. Male gnathopod 1 is smaller than gnathopod 2. *Photis* males bear conspicuous stridulation ridges on the lateral face of gnathopod article 2 and medial ventral edge of coxa 2. Rostrum short or absent, eyes small or large, ocular lobe prominent and pointed. Pereopod 7 longer than pereopod 6. The common loss of pereopods and antennae in preservation can greatly complicate identifications. Urosome articles are separate except for *Chevalia*. Uropod 3 is biramous and the telson is entire. The taxonomy is reliable for males only.

KEY TO ISAEIDAE

1. Uropod 3 inner ramus less than half as long as outer ramus and scale- or platelike (plate 263A, 263B) 2
— Uropod 3 inner ramus more than half as long as outer ramus (plate 263C). 5
2. Gnathopod 2 article 5 of males less than one-third as large as article 6 (plate 263D) 3
— Gnathopod 2 article 5 of males more than half as large as article 6 (plate 263E) 4
3. Antenna 1, accessory flagellum a tiny nub (plate 263F) (view at 100×); coxa 3 deeper than pereonite 3 (plate 263G) 8
— Antenna 1, accessory flagellum multiarticulated, and coxa 3 shallower than pereonite 3 (plate 263D); large teeth on palm of male gnathopod 2 vary from three to five (adults lose inner ramus of uropod 3). . . . . *Cheiriphotis megacheles*
4. Gnathopod 2 article 5 broader than article 6 (plate 263E); gnathopods 1 and 2 palms transverse and greatly overlapped by dactyls (plate 263H, 263I) . . . . *Cheirimedeia zotea*
— Gnathopod 2 article 5 and 6 approximately equal in width (plate 263J); gnathopods 1 and 2 palms oblique and not

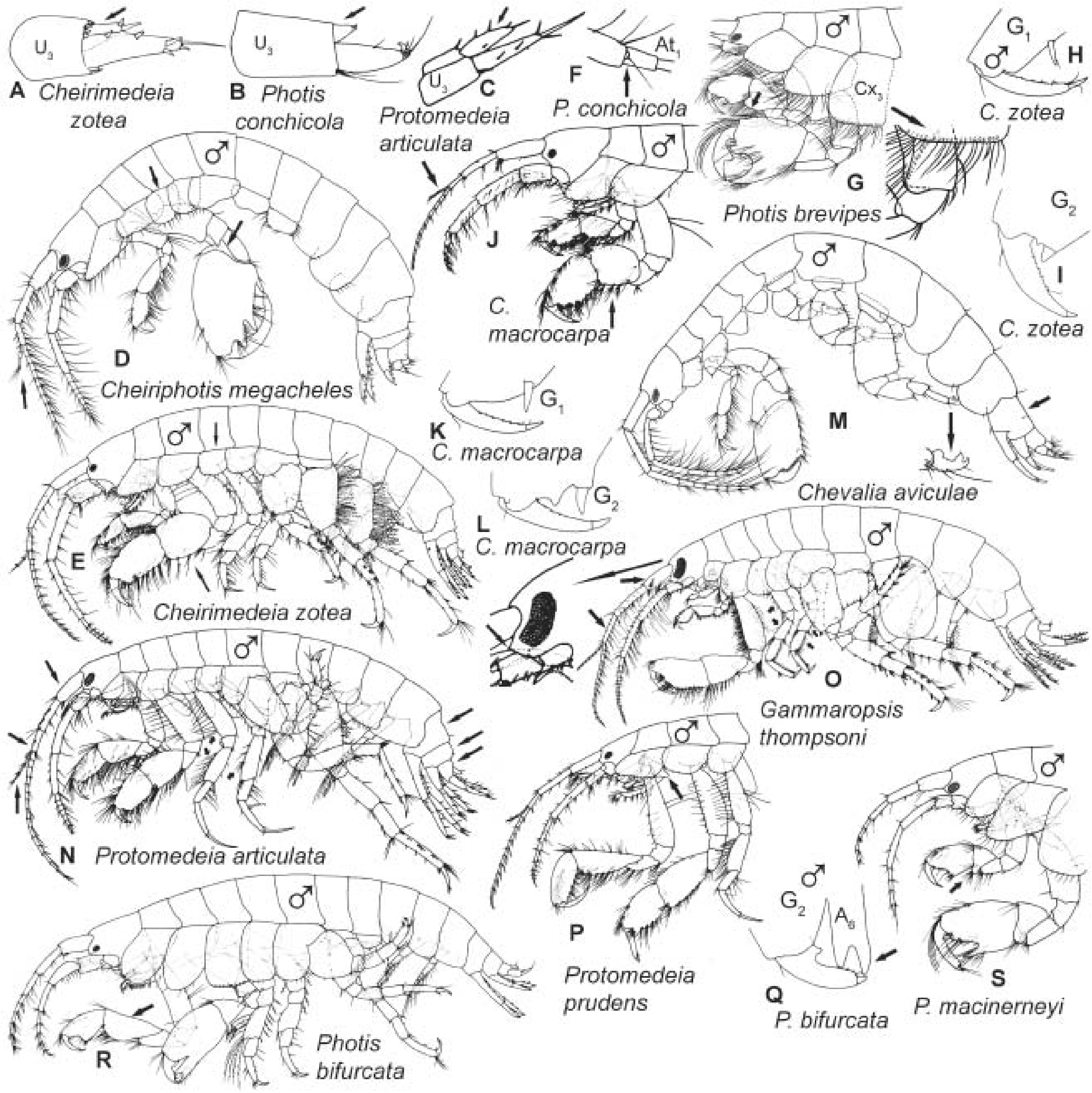

PLATE 263 Isaeidae. J, K, L, *Cheirimedeia macrocarpa*; A, E, H, I, *Cheirimedeia zotea*; D, *Cheiriphotis megacheles*; M, *Chevalia aviculae*; O, *Gammaropsis thompsoni*; Q, R, *Photis bifurcata*; G, *Photis brevipes*; B, F, *Photis conchicola*; S, *Photis macinerneyi*; C, N, *Protomedeia articulata*; P, *Protomedeia prudens* (figures modified from Barnard 1962a; and Conlan 1983).

greatly overlapped by dactyls (plate 263K, 263L) . . . . *Cheirimedeia macrocarpa*

5. Urosomites 1 and 2 coalesced and pereopod 5–7 with heavy gripping dactyl (plate 263M) . . . . *Chevalia aviculae*

— Urosomites 1 and 2 separate, accessory flagellum of two or more articles, usually conspicuous (plate 263N) 6

6. Antenna 1 article 3 shorter than article 1, pereopods 3 and 4 anterior margins of articles 2 and 4 strongly setose, male ocular lobes distally rounded (plate 263N) 7

— Antenna 1 article 3 as long as article 1 or longer, pereopods 3 and 4 anterior margins of articles 2 and 4 weakly setose, ocular lobes distally pointed (plate 263O) 13

7. Gnathopods 1 and 2 palms more than half as long as dactyls and coxa 1 without a posterior tooth (plate 263N) . . . . *Protomedeia articulata*

— Gnathopods 1 and 2 palms less than half as long as dactyls and coxa 1 with a posterior tooth (plate 263P) . . . . *Protomedeia prudens*

8. Gnathopod 2 with two teeth defining the palm process of article 6 (plate 263Q); gnathopod 1 article 5 nearly three times as long as wide (plate 263R) . . . . *Photis bifurcata*

— Gnathopod 2 with a single tooth defining the palmer process of article 6 and gnathopod 1 article 5 less than twice as long as wide (plate 263S) 9

9. Gnathopod 1 article 5 posterior margin short, less than one-third the length of the anterior margin (plate 263S) . . . . *Photis macinerneyi*

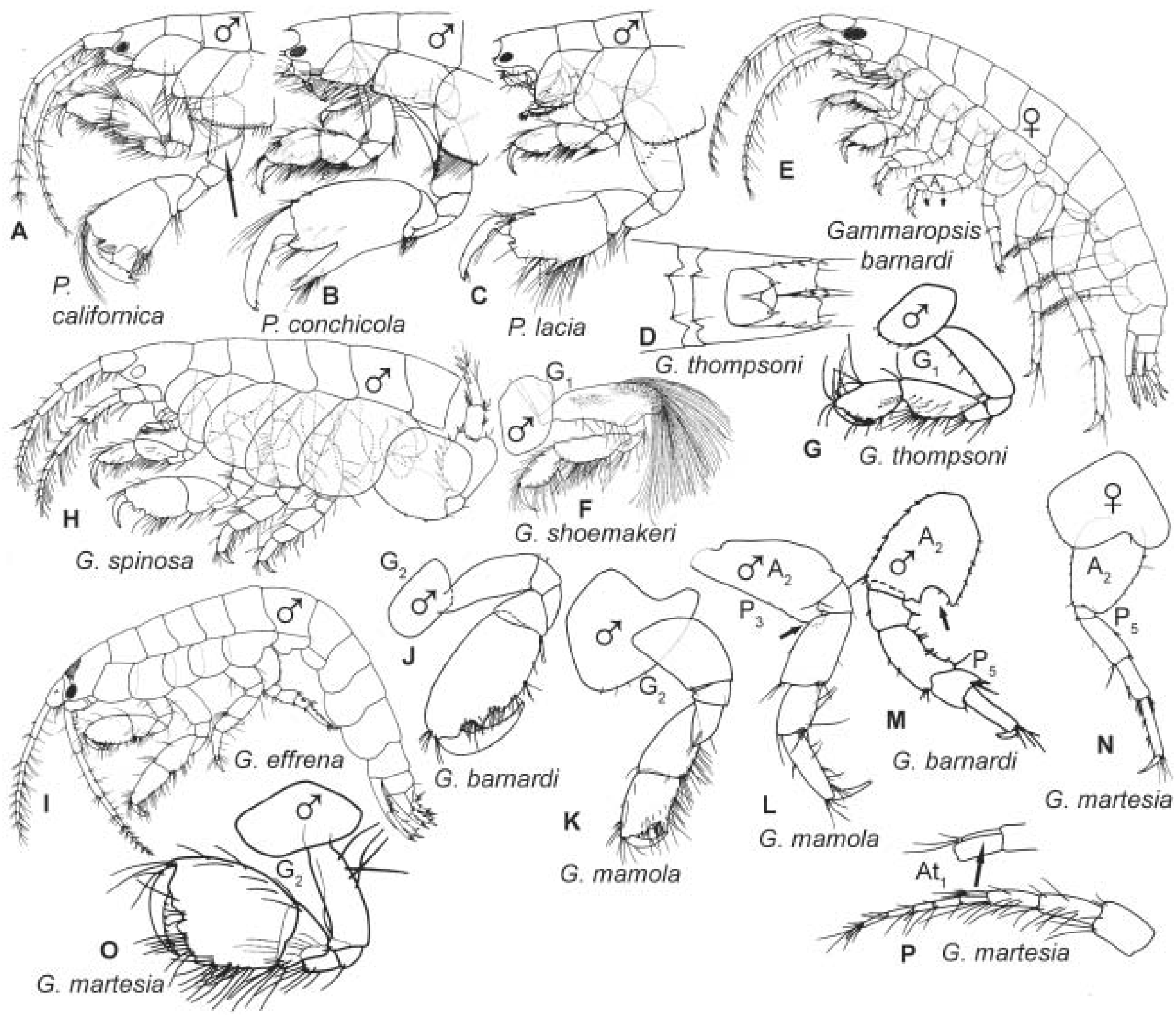

PLATE 264 Isaeidae. E, J, M, *Gammaropsis barnardi*; I, *Gammaropsis effrena*; K, L, *Gammaropsis mamola*; N–P, *Gammaropsis martesia*; F, *Gammaropsis shoemakeri*; H, *Gammaropsis spinosa*; D, G, *Gammaropsis thompsoni*; A, *Photis californica*; B, *Photis conchicola*; C, *Photis lacia* (figures modified from Barnard 1959b, 1962a, 1969a; Conlan 1983; Kudrajaskov and Tzvetkova 1975; and Shoemaker 1942).

— Gnathopod 1 article 5 posterior margin extended, more than one-third the length of the anterior margin (plate 263G) 10

10. Palmar excavation deeply rounded (plates 263G, 264A) 11

— Palmar excavation sharply incised (plate 264B) 12

11. Inner margin of gnathopod 2 dactyl without a large protrusion (plate 264A) . . . . *Photis californica*

— Inner margin of gnathopod 2 dactyl with a large protrusion (plate 263G) . . . . *Photis brevipes*

12. Dactyl of gnathopod 2 extending past the defining palmar tooth of article 6 (plate 264B); lives in small snail shells attached by mucus to algae on rocky coasts . . . . *Photis conchicola*

— Dactyl of gnathopod 2 not extending past the defining palmar tooth of article 6 (plate 264C) . . . . *Photis lacia*

13. Urosome of males dorsally cusped (plate 264D); coxa 7 greatly expanded posteriorly, pereopods 3 and 4 articles 4 and 5 subequal (plate 263O). 14

— Urosome of both sexes dorsally smooth, pereopod 7 coxa short, pereopods 3 and 4 articles 5 half to three-quarters the length of article 4 (plate 264E). 15

14. Male gnathopod 1 posterior distal corner of article 2 expanded and densely covered with setae (plate 264F) . . . . *Gammaropsis shoemakeri*

— Gnathopod 1 posterior distal corner of article 2 unexpanded and without dense cover of setae (plate 264G) . . . . *Gammaropsis thompsoni*

15. Gnathopod 2 (both sexes) posterior margin of gnathopod 2 article 5 more than one-third the length of article 6 (plate 264H, 264I) 16

— Gnathopod 2 (both sexes) posterior margin of gnathopod 2 article 5 less than one-fifth the length of article 6 (plate 264E, 264J) 18

16. Male coxa 2 posteriorly straight or only slightly concave (plate 264H, 264I); pereopod 3 anteriodistal article 2 not expanded 17

— Male coxa 2 posteriorly lobed (plate 264K); pereopod 3 anteriodistal article 2 expanded (plate 264L). . . . . *Gammaropsis mamola*

17. Antenna 1 article 1 twice as thick as article 2, accessory flagellum tiny and of two articles, articles 2 and 4 of pereopod 5 normal, head pigmented, ocular lobes rounded (plate 264I) . . . . *Gammaropsis effrena*
— Antenna 1 article 1 only slightly thicker than article 2, accessory flagellum prominent and of three articles, pereopod 5 articles 2 and 4 of thick, article 4 posterior lined with spines, head unpigmented, ocular lobes pointed (plate 264H) . . . . *Gammaropsis spinosa*
18. Male pereopod 5 article 2 posterior ventral edge deeply notched (plate 264M); gnathopod 2 article 6 half as wide as long (plate 264J); accessory flagellum a microscopic button (not shown) (plate 264E) . . . . . *Gammaropsis barnardi*
— Male pereopod 5 article 2 posterior ventral edge evenly rounded (plate 264N); gnathopod 2 article 6 two-thirds as wide as long (plate 264O); accessory flagellum as long as the first article of the flagellum (plate 264P) . . . . *Gammaropsis martesia*

LIST OF SPECIES

Cheirimedeia macrocarpa Bulytscheva, 1952. In brackish to full marine waters on semiprotected sand flats; possibly introduced; 5 mm; intertidal.

Cheirimedeia zotea (Barnard, 1962) (=*Protomedeia zotea*). In mixed mud and sand sediments; 5 mm; intertidal—113 m.

Cheiriphotis megacheles (Giles, 1885). Abundant among *Phyllospadix* and *Silvetia* and under rocks in California; also reported widely from the warmer Pacific and Indian Oceans. Cryptogenic, possible species complex; 3 mm; intertidal—16 m.

Chevalia aviculae (Walker, 1898). Reported also in the Indian Ocean, South Africa, and the Caribbean Sea; cryptogenic; soft benthos; 4 mm; intertidal—35 m.

Gammaropsis barnardi (Kudriaschov and Tzvetkova, 1975) (=*Podoceropsis barnardi*). In mixed rock sediments and sand; 5 mm; intertidal—17 m.

Gammaropsis effrena (Barnard, 1964). Among *Phyllospadix*, algae, and polychaete tubes in rocky areas; 3.7 mm; intertidal.

Gammaropsis mamola (Barnard, 1962). Among algae holdfasts and on hard surfaces including submerged logs. 4 mm; 3 m–25 m.

Gammaropsis martesia (Barnard, 1964a). Among *Phyllospadix*, tunicates, and sponges; 3 mm; intertidal—84 m.

Gammaropsis shoemakeri Conlan, 1983. Among kelp and hydroids; 5.5 mm; intertidal—27 m.

Gammaropsis spinosa (Shoemaker, 1942). Among algae, sponges, and polychaete tubes; 3.5 mm; intertidal—27 m.

Gammaropsis thompsoni (Walker, 1898). Among encrusting animals and in algal holdfasts; 11.5 mm; intertidal—27 m.

Photis bifurcata Barnard, 1962. Usually on soft sediments; 4 mm; low water—109 m.

Photis brevipes Shoemaker, 1942. In various sediments but especially sand; 7 mm; low water—289 m.

Photis californica Stout, 1913. Among *Phyllospadix* and on open coast rocky shores; 6 mm; low intertidal—147 m.

Photis conchicola Alderman, 1936. On rocky beaches with algae and surfgrass, often paguridlike, living in empty gastropod shell; 5.5 mm; intertidal—42 m.

Photis lacia Barnard, 1962a. In sandy sediments of exposed coasts; 3.3 mm; low intertidal—40 m.

Photis macinerneyi Conlan, 1983. Sandy substrates of exposed and protected marine coasts; 4.3 mm; low intertidal—40 m.

Protomedeia articulata Barnard, 1962. In soft sediments; 8 mm; low intertidal to deep subtidal

Protomedeia prudens Barnard, 1966. In soft sediments; 7.5 mm; intertidal—400 m.

AMPITHOIDAE

Ampithoidae are herbivores that build nests of algae or burrow into kelp stipes and commonly attain the same color as the algae they inhabit. The third uropods and rami are short, with two (occasionally one) distinctive stout hook spines on the outer ramus. Taxonomy emphasizes males.

KEY TO AMPITHOIDAE

1. Pereopods 3 and 4 article 2 strongly inflated, width more than three-fourths of the width of the coxa (plate 265A); gnathopod 1 palm transverse (plate 265B) 9
— Pereopods 3 and 4 article 2 width less than one-half of the width of the coxa (plate 265C); gnathopod 1 palm subchelate (plate 265D) 2
2. Antenna 1 accessory flagellum multiarticulated (plate 265C); uropods 1 and 2 with distal ventral spinose process projecting below the rami (plate 265E) . . . . *Paragrubia uncinata*
— Antenna 1 accessory flagellum vestigial or absent (plate 265F); uropods 1 and 2 with distal ventral spinose process small or absent (plate 265G). 3
3. Gnathopod 1 posterior lobe of article 5 long, more than 40% of the length of the entire article (plate 265F, 265H). 4
— Gnathopod 1 posterior lobe of article 5 short, <40% of the length of the entire article (plate 265I) 6
4. Antenna 2 peduncle 5 and flagellum with dense plumose setae (plate 265H); male gnathopod 1 article 5 shorter than article 6 (plate 265H); male gnathopod 2 palm slightly oblique (plate 265J); epimeron 3 hind margin evenly rounded (plate 265K). . . . . *Ampithoe plumulosa*
— Antenna 2 lacking dense plumose setae, gnathopod 1 article 5 as long or longer than article 6, male gnathopod 2 palm transverse or produced forward (plate 265F); epimeron 3 posterior ventral corner with intersecting ridge and angular or slightly notched (plate 265F) 5
5. Male gnathopod 2 palm produced forward (plate 265F); epimeron 3 posterior ventral corner with small notch at the end of the intersecting ridge (plate 265F); lower lip lobes widely separated (plate 265L). . . . . *Ampithoe lacertosa*
— Male gnathopod 2 palm transverse and bearing square tooth (plate 265M); epimeron 3 posterior ventral corner without a notch at the end of the intersecting ridge (plate 265N); lower lip lobes separated by narrow gap (plate 265O) . . . . *Ampithoe valida*
6. Apex of telson with two enlarged, lobed "rabbit ear" folds (plate 265P); pereopod 5 article 5 less than half as long as article 6 (plate 265S) . . . . *Ampithoe aptos*
— Apex of telson with two minute lateral knobs (plate 265R); pereopod 5 article 5 more than half as long as article 6 (plate 265Q). 7
7. Male gnathopod 2 palm sharply incised to form a large pointed tooth (plate 266A); antenna 2 slightly shorter than antenna 1 (plate 266A); antenna 2 setose and with flagellum shorter than combined articles 4 and 5 (plate 266A) . . . . *Ampithoe sectimanus*
— Male gnathopod 2 palm roundly incised to form short, blunt tooth (plate 266B); antenna 2 longer than antenna 1 (plate 266B), antenna 2 weakly setose and with flagellum

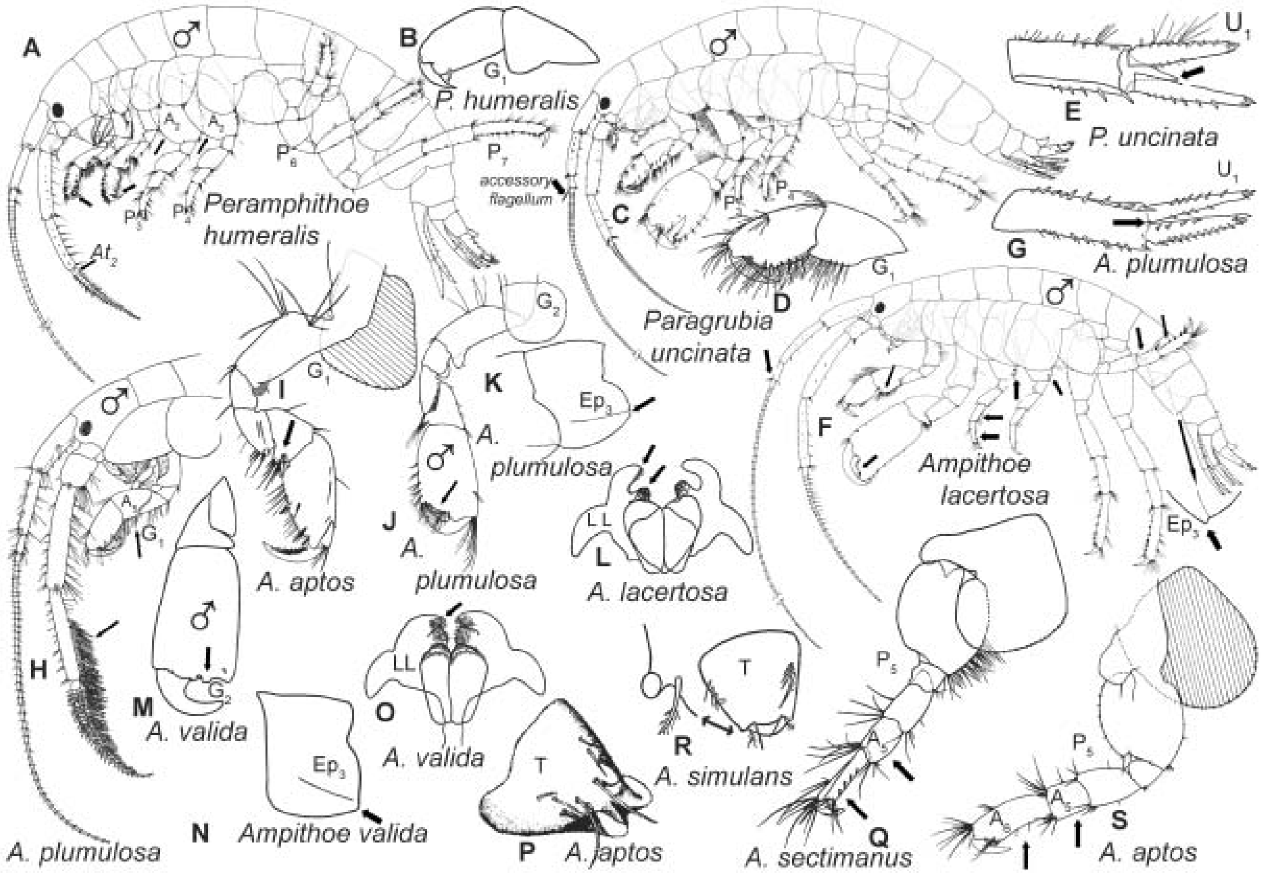

PLATE 265 Ampithoidae. I, P, S, *Ampithoe aptos*; F, L, *Ampithoe lacertosa*; G, H, J, K, *Ampithoe plumulosa*; Q, *Ampithoe sectimanus*; R, *Ampithoe simulans*; M–O, *Ampithoe valida*; C–E, *Paragrubia uncinata*; A, B, *Peramphithoe humeralis* (figures modified from Barnard 1952b, 1965, 1969a; Conlan and Bousfield 1982a; and Shoemaker 1938a).

as long as peduncular articles 4 and 5 (plate 266B). 8

8. Male gnathopod 1 articles 2 anterior edge lined with plumose setae (plate 266B); mandibular palp article 3 distal seta row marked by angle at inner proximal margin (plate 266C); epimeron 3 posterior ventral corner evenly rounded (plate 266D) . . . . *Ampithoe dalli*

— Male gnathopod 1 article 2 anterior edge bare (plate 266E); mandibular palp article 3 distal seta row rounding evenly into inner proximal margin (plate 266F); epimeron 3 posterior ventral corner notched (plate 266G) . . . . *Ampithoe simulans*

9. Male gnathopod 2 article 6 less than twice as thick as gnathopod 1 article 6 (plates 265A, 266H, 266I) 10

— Male gnathopod 2 article 6 more than twice as thick as gnathopod 1 article 6 (plate 266J–266L) 12

10. Antenna 2 flagellum proximal articles fused into one article longer than wide (plate 266I) . . . . *Peramphithoe stypotrupetes*

— Antenna 2 flagellum proximal articles separate and not longer than wide (plate 265A) 11

11. Pereopod 7 more than 1.5 times as long as pereopod 6 (plate 265A); gnathopod 2 (both sexes) palm transverse; and article 5 equal to or longer than article 6 (plate 266M) . . . . *Peramphithoe humeralis*

— Pereopod 7 less than 1.2 times length of pereopod 6; and gnathopod 2 (both sexes) palm oblique with article 5 length less than article 6 (plate 266H) . . . . *Peramphithoe mea*

12. Male gnathopod 2 palm well defined, extending about half the length of posterior edge of article 6 (plate 266K); antenna 2 article 5 shorter than article 4 (plate 266N) . . . . *Peramphithoe lindbergi*

— Male gnathopod 2 palm poorly defined and extending more than half length of article 6; antenna 2 article 4 length approximately equal to article 5 (plate 266L). 13

13. Lower lip lateral and medial lobes projecting equally (plate 266O); antenna 2 flagellum article 1 nearly 2 times longer than more distal articles (plate 266L). . . . . *Peramphithoe plea*

— Lower lip lateral lobes projecting further than medial lobes (plate 266P); antenna 2 flagellum article 1 less than two times wider than more distal articles (plate 266Q) . . . . *Peramphithoe tea*

LIST OF SPECIES

Ampithoe aptos (Barnard, 1969) (=*Pleonexes aptos*). Algal covered bottoms where it is scarce; 7 mm; intertidal.

**Ampithoe corallina* Stout, 1913. Southern California; possible *nomen nudum*.

Ampithoe dalli Shoemaker, 1938. Boreal, south to Cape Arago on exposed and protected beaches, in tide pools, under rocks and log fouling organisms, in 10–34‰ salinity. Females ovigerous March to August; 20 mm; intertidal—10 m.

* = Not in key.

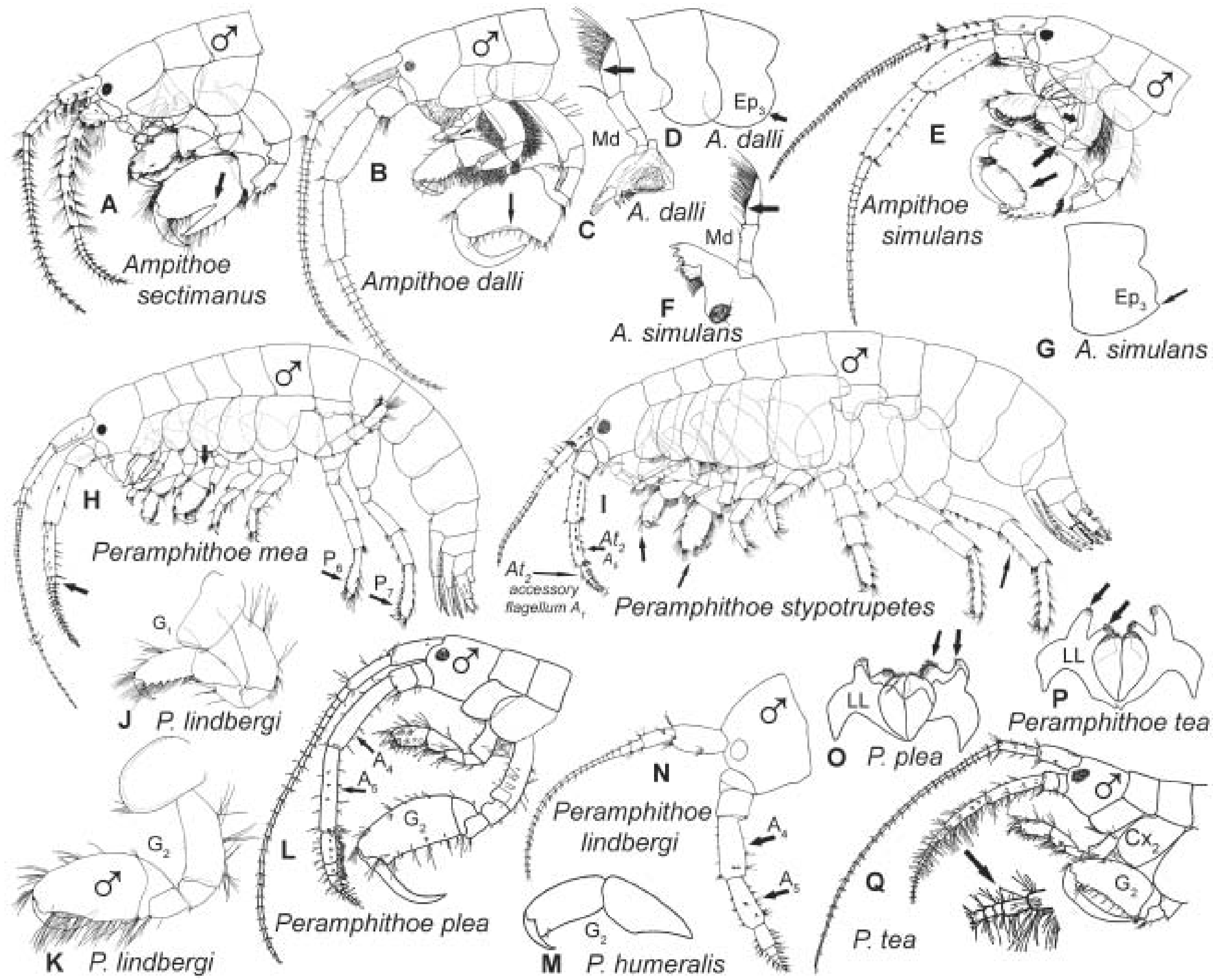

PLATE 266 Ampithoidae. B, C, D, *Ampithoe dalli*; A, *Ampithoe sectimanus*; E–G, *Ampithoe simulans*; M, *Peramphithoe humeralis*; J, K, N, *Peramphithoe lindbergi*; H, *Peramphithoe mea*; L, O, *Peramphithoe plea*; I, *Peramphithoe stypotrupetes*; P, Q, *Peramphithoe tea* (figures modified from Barnard 1952b, 1965; Conlan and Bousfield 1982a; Conlan and Chess 1992; and Shoemaker 1938a).

Ampithoe lacertosa (Bate, 1858). Among algae, gravel, or woody debris and on pilings and floats of estuaries; also protected open coasts; heavily speckled with diffuse spots. See Heller 1968, MSc thesis, Univ. Washington 132 pp. (biology and development); 24 mm; intertidal—11 m.

**Ampithoe longimana* (Smith, 1873). North Atlantic, introduced to southern California, may receive protection from predators by accumulating toxins from algae it ingests (Hay et al. 1990, Ecology 71: 733–743); 10 mm; intertidal—10 m.

Ampithoe plumulosa Shoemaker, 1938. Eastern Pacific and western Atlantic; common on algae and *Mytilus* beds; origins unclear, a likely introduction or misidentified elsewhere in the world; 16 mm; intertidal—15 m.

**Ampithoe pollex* Kunkel, 1910. Northeast Pacific records unclear due to poor description of type populations; possibly introduced to southern California; 5.5 mm; intertidal.

**Ampithoe ramondi* Audoin, 1828. Cosmopolitan at latitudes <45°; not reported north of Point Conception but may appear to the north with climate warming; in diverse algae; 12 mm; intertidal—32 m.

Ampithoe sectimanus Conlan and Bousfield, 1982. High salinity exposed rocky coasts among algae, females ovigerous May to August; 12.5 mm; intertidal.

Ampithoe simulans (Alderman, 1936). Among algae and *Phyllospadix* of open and semiprotected coasts, occasionally in brackish water; 30 mm; intertidal—4 m.

Ampithoe valida Smith, 1873. Abundant among green algae and in fouling communities of pilings floats, docks, and on mudflats of estuaries in Europe, eastern and western United States, Japan, Argentina; a likely Atlantic species introduced to the Pacific coast. See Alonso et al. 1995, Oebalia 21: 77–91 (seasonal population changes); Pardali et al. 2000, Mar. Ecol. Prog. Ser. 196: 207–219 (biology, ecology in Portugal); Borowsky 1983, Mar. Biol. 77:257–263 (tube building and reproductive ecology); 12.5 mm; intertidal—30 m.

Paragrubia uncinata (Stout, 1912) (=*Cymadusa uncinata*). Rolls blades of kelp *Macrocystis pyrifera* into cigar-shaped tubes, occurs also among *Phyllospadix*; 35 mm; 4 m–27 m.

**Peramphithoe eoa* (Bruggen, 1907). Sea of Japan, northeast Pacific records of this species and its distinction from *P. mea* are unclear; 10 mm; intertidal—90 m.

Peramphithoe humeralis (Stimpson, 1864). This very large amphipod (like *Paragrubia*) makes nests in *Alaria* or *Macrocystis* by curling the fronds into a tube in which the young

* = Not in key.

may remain in a colony for several instars after emerging from the female oötangium. The upper walls of the tube are consumed by adults and their juveniles. Reproduction June to August. See Jones 1971, pp. 343–367, in W. North, ed., The biology of giant kelp beds (*Macrocystis*) in California. Nova Hedwigia 32 (general biology). Conlan and Bousfield (1982a) consider the South African *Peramphithoe humeralis* (see Griffiths 1979) to be a different species, although it may live in *Macrocystis* there also; up to 53 mm; low intertidal—18 m.

Peramphithoe lindbergi (Gurjanova, 1938). Boreal south to Corona del Mar, among eelgrass and algal holdfasts, ovigerous June to September; 12.5 mm; intertidal—18 m.

Peramphithoe mea (Gurjanova, 1938). Boreal, south possibly to Coos Bay, Oregon, or southern California; southern populations of eastern Pacific *P. mea, P. plea,* and *P. tea* are not clearly distinguished; among eelgrass; 22 mm; rarely intertidal—60 m.

Peramphithoe plea (Barnard, 1965). Among kelp holdfasts on exposed coasts; 12.5 mm; intertidal—17 m.

Peramphithoe stypotrupetes Conlan and Chess, 1992. Burrows into *Eisenia* and *Laminaria* stipes, cohorts remain and graze on the stipe's interior; 21 mm; shallow subtidal—10 m.

Peramphithoe tea (Barnard, 1965). Among algae of exposed and semiprotected high salinity areas, distinction from *P. plea* unclear, ovigerous May to August; 12 mm; intertidal—67 m.

ISCHYROCERIDAE

Ischyroceridae construct tubes on hard surfaces in areas of high water velocity and include many of the most common amphipods of fouling communities. *Jassa* males and probably males of all other genera use gnathopod 2 for mate guarding, combat, and display, while "sneaker" males obtain mates as paedomorphs (Kurdzie and Knowles 2002, Roy. Soc. 269: 1749–1754). Male gnathopod 2 larger than gnathopod 1. Intraspecific variation in male secondary sex characters among mating systems (Conlan 1989, 1991, 1995a, 1995b) and the adaptive variations in mating systems with environmental conditions complicate the taxonomy of Ischyroceridae based on male secondary sex characters. Uropod 3 bearing short rami, the outer ramus bearing single large hook spines in *Jassa* and *Microjassa* and comblike fused spines among *Ischyrocerus*. Uropod 3 of *Ericthonius* and *Cerapus* bearing a single ramus.

KEY TO ISCHROCERIDAE

1. Male gnathopod 2 carpochelate, coxa 4 longer than deep (plate 267A, 267B); telson extremely short and covered with dorsally directed spines (plate 267C, 267D); uropod 3 uniramous (plate 267C, 267E) 2
— Male gnathopod 2 subchelate, coxa 4 as deep or deeper than long (plate 267F); telson without dense dorsally directed spines (plate 267G–267I); uropod 3 biramous (plate 267J) 4
2. Rostrum acute, antenna 1 article 1 swollen (plate 267A); uropod 2 reduced, bearing single vestigial ramus (plate 267C) . . . . *Cerapus* spp.
— Rostrum absent, antenna 1 article 1 only slightly thicker than article 2 and uropod 2 with two normal rami (plate 267B) 3
3. Male gnathopod 1 article 2 with dorsal posterior protrusion (plate 267K); male gnathopod 2 article 5 apically bifid and coxa 2 bearing stridulating ridges (plate 267L) . . . . *Ericthonius brasiliensis*
— Male gnathopod 2 article 5 with a simple apical tooth; male gnathopod 1 article 2 without dorsal posterior protrusion (plate 267B) and coxa 2 without stridulating ridges . . . . *Ericthonius rubricornis*
4. Peduncle of uropod 1 with lateral row of plumose setae (plate 267F, 267M) . . . . *Ruffojassa angularis*
— Peduncle of uropod 1 bearing only short, stout spines, without lateral plumose setae (plate 267N) 5
5. Coxa 5 anterior and posterior lobes approximately equal (plate 267N). 6
— Coxa 5 anterior at least three times larger than the posterior lobe (plate 267O) 7
6. Male gnathopod 2 article 6 with swollen dorsoanterior margin (plate 267N) . . . . *Microjassa litotes*
— Male gnathopod 2 article 6 with evenly rounded dorsoanterior margin (plate 267P) . . . . *Microjassa barnardi*
7. Uropod 3 rami blunt, outer ramus bearing irregular teeth proximal to a single heavy distal hooked spine rami (plate 267Q) 9
— Uropod 3 rami pointed, outer ramus bearing small straight distal spine or no spine, usually lined with microscopic denticles (plate 267R) (confirm at 100–400x) 8
8. Eye diameter less than one-fifth of the depth of head (plate 267S); male gnathopod 2 palm concave (plate 267T). . . . . *Ischyrocerus anguipes*
— Eye diameter more than one-fourth of head, male gnathopod 2 palm straight (plate 267O) . . . . *Ischyrocerus pelagops*
9. Gnathopod 2 anterolateral margin of article 2 with a row of setae (plates 267U, 268A) 11
— Gnathopod 2 article 2 without anteriolateral setae (plate 268B) 10
10. Uropod 1, posterioventral interramal spine less than one-eighth length of outer ramus (plate 268C). . . . . *Jassa shawi*
— Uropod 1, posterioventral interramal spine more than one-third length of outer ramus (plate 268D) (*J. shawi* and *J. falcata* are poorly distinguished species). . . . . *Jassa falcata*
11. Male gnathopod 1 article 5 without anteriodistal seta at the junction of article 6 (plate 268E) . . . . *Jassa staudei*
— Male gnathopod 1 article 5 with one or more anteriodistal seta at the junction of article 6 (plate 268F–268H) 12
12. Anteriodistal seta of gnathopod 1 tiny and slightly lateral (plate 268F) . . . . *Jassa marmorata*
— Anterior distal seta of gnathopod 1 article 5 long, slightly medial or dorsal (plate 268G, 268H) 13
13. Uropod 1 ventral distal peduncle spine more than one-fourth of the length of the shortest ramus (plate 268D). 14
— Uropod 1 ventral distal peduncle spine less than one-eighth of the length of the shortest ramus (plate 268C); antenna 2 anterior article 5 distal half densely setose, gnathopod 2 article 2 anterior setae dense and article 6 thumb small (plate 268I); female gnathopod 2 palm concave (plate 268J) . . . . *Jassa borowskyae*
14. Tip of telson bearing apical setae as well as lateral setae (plate 268K) and gnathopod 2 of large-thumbed male with defining spines on a ledge (plate 268L). . . . . *Jassa morinoi*
— Tip of telson without apical setae (plate 268M); gnathopod 2 of large-thumbed male with defining spines absent (plate 268A) or not in a deep ledge (plate 268N). 15
15. Male gnathopod 2 thumb tip angled and bearing defining spines (plate 268N); female gnathopod 1 palm (not illustrated) and male evenly convex (plate 268G) . . . .

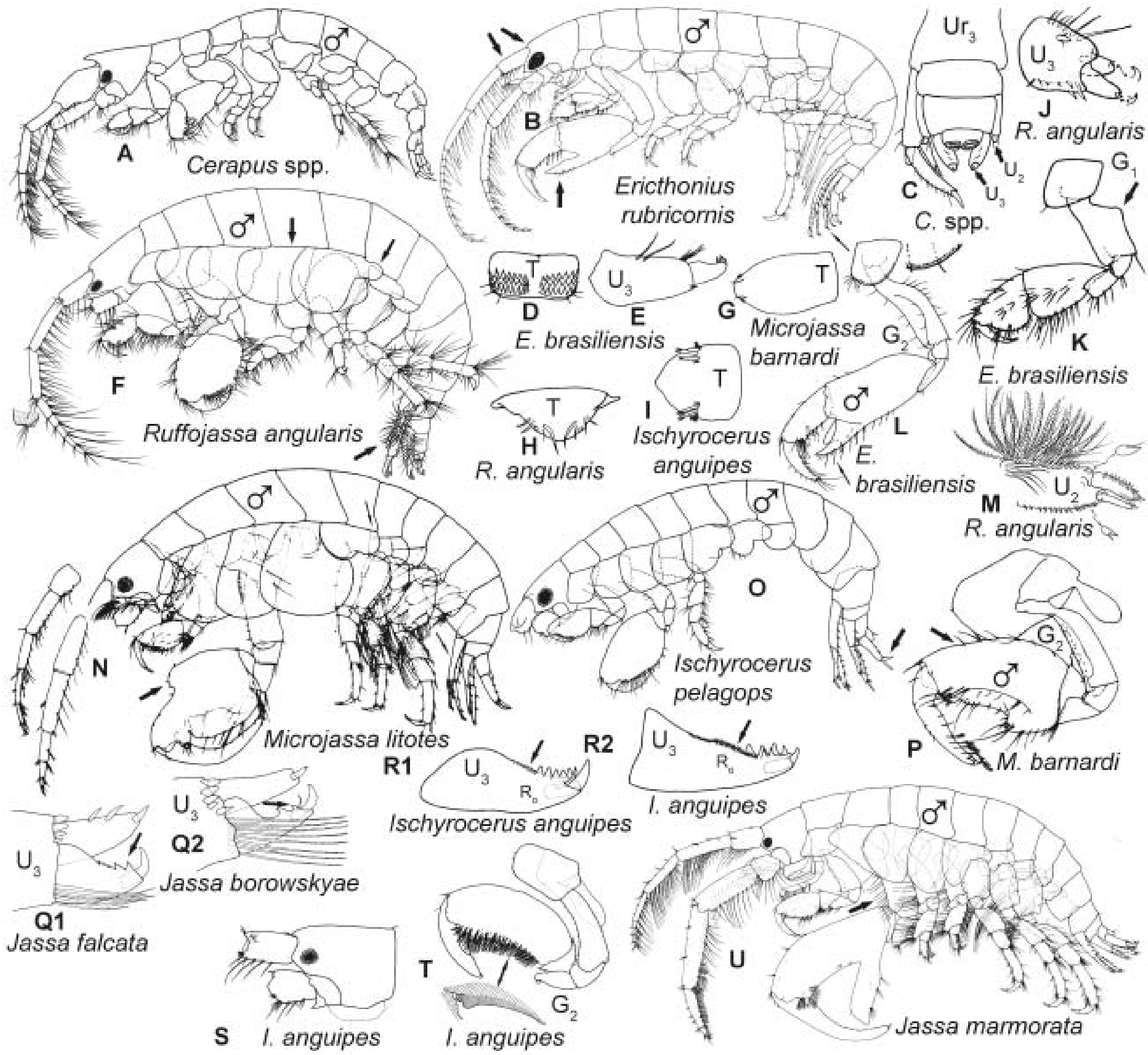

PLATE 267 Ischyroceridae. A, C, *Cerapus* spp.; B, *Ericthonius rubricornis*; D, E, K, L, *Ericthonius brasiliensis*; I, R–T, *Ischyrocerus anguipes*; O, *Ischyrocerus pelagops*; Q2, *Jassa borowskyae*; Q1, *Jassa falcata*; U, *Jassa marmorata*; G, P, *Microjassa barnardi*; N, *Microjassa litotes*; F, H, J, M, *Ruffojassa angularis* (figures modified from Bousfield 1973; Barnard 1962a, 1969a ; and Conlan 1990, 1995b).

. . . . *Jassa carltoni*

— Gnathopod 2 thumb tip straight, defining spines absent (plate 268A) and gnathopod 1 palm female (not illustrated) and male straight or concave (plate 268O) . . . . *Jassa slatteryi*

LIST OF SPECIES

Cerapus spp. Referred to previously in the eastern Pacific as the Atlantic species *Cerapus tubularis* Say, 1817, but Pacific taxa likely represent one or more undescribed native species; build thick, pliable, striped, cylindrical tubes open at both ends; 3.2 mm; intertidal and shallow subtidal.

Ericthonius brasiliensis (Dana, 1853). Taxonomy poorly resolved: open coast populations (in habitats such as *Phyllospadix*) and harbor populations (likely introduced) probably represent different species; exhibits territorial behavior (Connell 1964, Res. Pop. Ecol. 87: 87–101); 6.5 mm; intertidal—300 m.

Ericthonius rubricornis (Stimpson, 1853) (=*Ericthonius hunteri*). Amphiboreal, forming mats of muddy tubes on diverse substrata; shallow water populations may be introduced; possibly a hypermale of *E. brasiliensis* (Myers and McGrath 1984, J. Mar. Biol. Assoc. UK 64: 379–400) or part of a species complex; 9 mm; intertidal—235 m.

Ischyrocerus anguipes (Kroyer, 1838). Boreal-temperate North Atlantic and eastern Pacific, tube-building on various substrata, a likely species complex with origin of shallow water harbor species uncertain; 12 mm; intertidal—326 m.

**Ischyrocerus parvus* Stout, 1913. Possibly *I. anguipes*; 3 mm; rocky intertidal.

Ischyrocerus pelagops Barnard, 1962. Fine gray sands; 4.5 mm; intertidal—24 m.

* = Not in key.

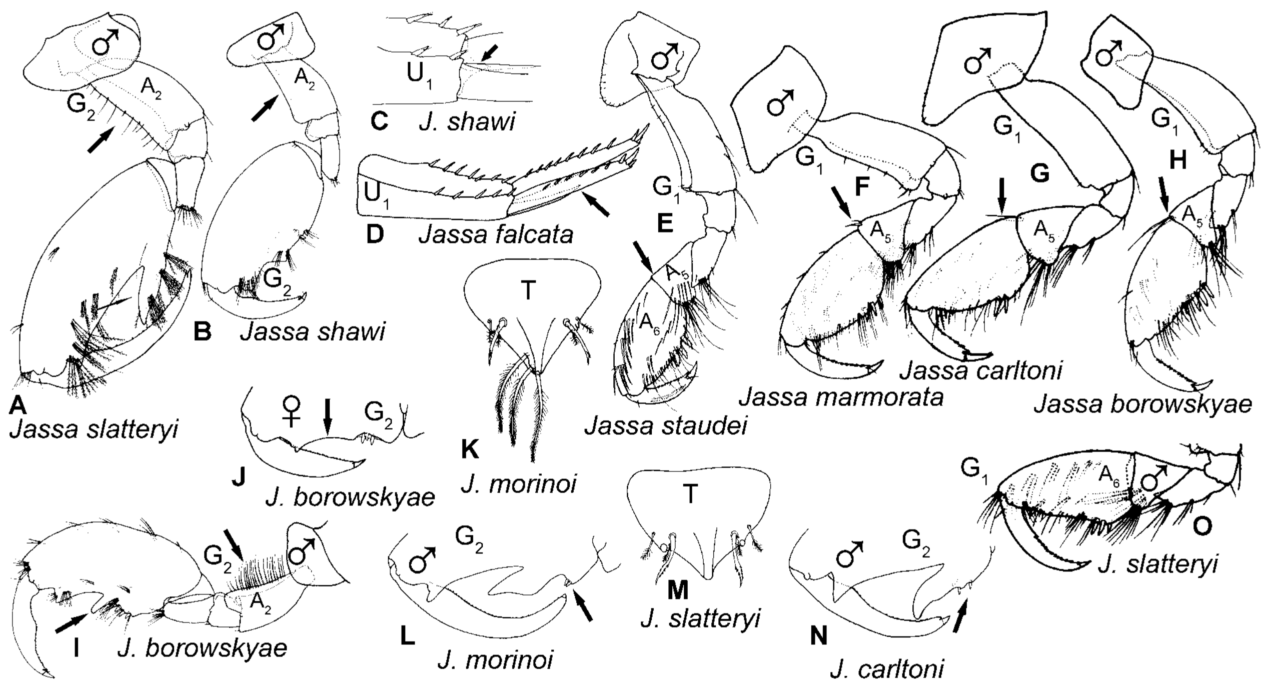

PLATE 268 Ischyroceridae. H, I, J, *Jassa borowskyae*; G, N, *Jassa carltoni*; D, *Jassa falcata*; F, *Jassa marmorata;* K, L, *Jassa morinoi*; B, C, *Jassa shawi*; A, M, O, *Jassa slatteryi*; *E, Jassa staudei* (figures modified from Barnard 1962a, 1969a; and Conlan 1990).

**Ischyrocerus* sp. A Barnard, 1969. Possibly *I. pelagops*; 3.8 mm; rocky intertidal.

**Ischyrocerus* sp. B Barnard, 1969. Possibly *I. anguipes*; 3.4 mm; intertidal.

Jassa borowskyae Conlan, 1990. California, Siberia, Sea of Japan, exposed rocky shores on algae and surfgrass; 7.7 mm; low intertidal—20 m.

Jassa carltoni Conlan, 1990. Southern California in *Phyllospadix*, named in honor of James T. Carlton (of Light and Smith's Manual); difficult to distinguish from *J. morinoi* or *J. slatteryi*; 3.5 mm; intertidal.

**Jassa falcata* (Montagu, 1808). Most shallow water mid-latitude marine *Jassa* of the world were referred to as *J. falcata* prior to the work of Conlan (1990); presently recognized only in European harbors, but not clearly absent elsewhere; 7 mm; low intertidal—40 m.

Jassa marmorata Holmes, 1903. Introduced cosmopolitan marine and estuarine species, found in fouling communities on floats and pilings in harbors of Asia, Europe, New England, and the northeast Pacific; 7 mm; low intertidal—30 m.

Jassa morinoi Conlan, 1990. North Pacific, Atlantic, and Mediterranean; a likely introduced species, on rocks and algae; 6 mm; low intertidal—7 m.

Jassa shawi Conlan, 1990. On hard substrata and sponges; 7 mm; low intertidal.

Jassa slatteryi Conlan, 1990. On algae and hydroids; Ecology (Jeong et al. 2007, J. Crust. Biol. 27[1]:65–70); 5.5 mm; low intertidal.

Jassa staudei Conlan, 1990. On rocks and algae; 11.4 mm; low intertidal—82 m.

Microjassa barnardi Conlan, 1995b. On algal holdfasts and rocks; 2.5 mm; intertidal—52 m.

Microjassa litotes Barnard, 1954. On algal holdfasts; 3.5 mm; intertidal—157 m.

* = Not in key.

Ruffojassa angularis Shoemaker, 1942b. A southern species and a likely introduction that occurs as far north as Carmel; also reported from Madagascar, Hawaiian Islands; 3.5 mm; shallow subtidal—30 m.

COROPHIIDAE

Corophiidae build U-shaped tubes in soft sediments or on hard surfaces. Morphological variations in the male rostrums and massive peduncle of the second antennae of most species allow field identifications. Most females can be reliably identified to species. Telson fleshy and entire, outer lobes of lower lip entire, article 5 of pereopods 3–6 short and reniform, urosomites 1–3 fused or separate and similar in length, uropod 3 with one ramus which can bear multiple articulate setae or spines, gnathopod 2 article 5 of most corophiids is fused over a broad suture to article 4 and lined posteriorly with long, pinnate setae that form a basket used for suspension feeding. Also keyed here is the aorid *Grandidierella japonica* because of its similarity to the corophiids.

KEY TO COROPHIIDAE

1. Male gnathopod 1 massive and carpochelate (plate 269A); male and female uropod 3 ramus spinose, more than three times longer than wide and round in cross-section (plate 269B); pereopod 7 only slightly longer than pereopod 6 (plate 269C) (Aoridae) . . . . *Grandidierella japonica*
— Male gnathopod 1 relatively small; pereopod 6 half as long as pereopod 7 (plate 269D); uropod 3 ramus oval and dorsoventrally flattened (plate 269E–269G) (Corophiidae) 2
2. Urosomites separate (plate 269D–269G) 3
— Urosomites fused (plate 269F–269G) (gently clean dorsal urosome with fine needle or brush if unclear). 13

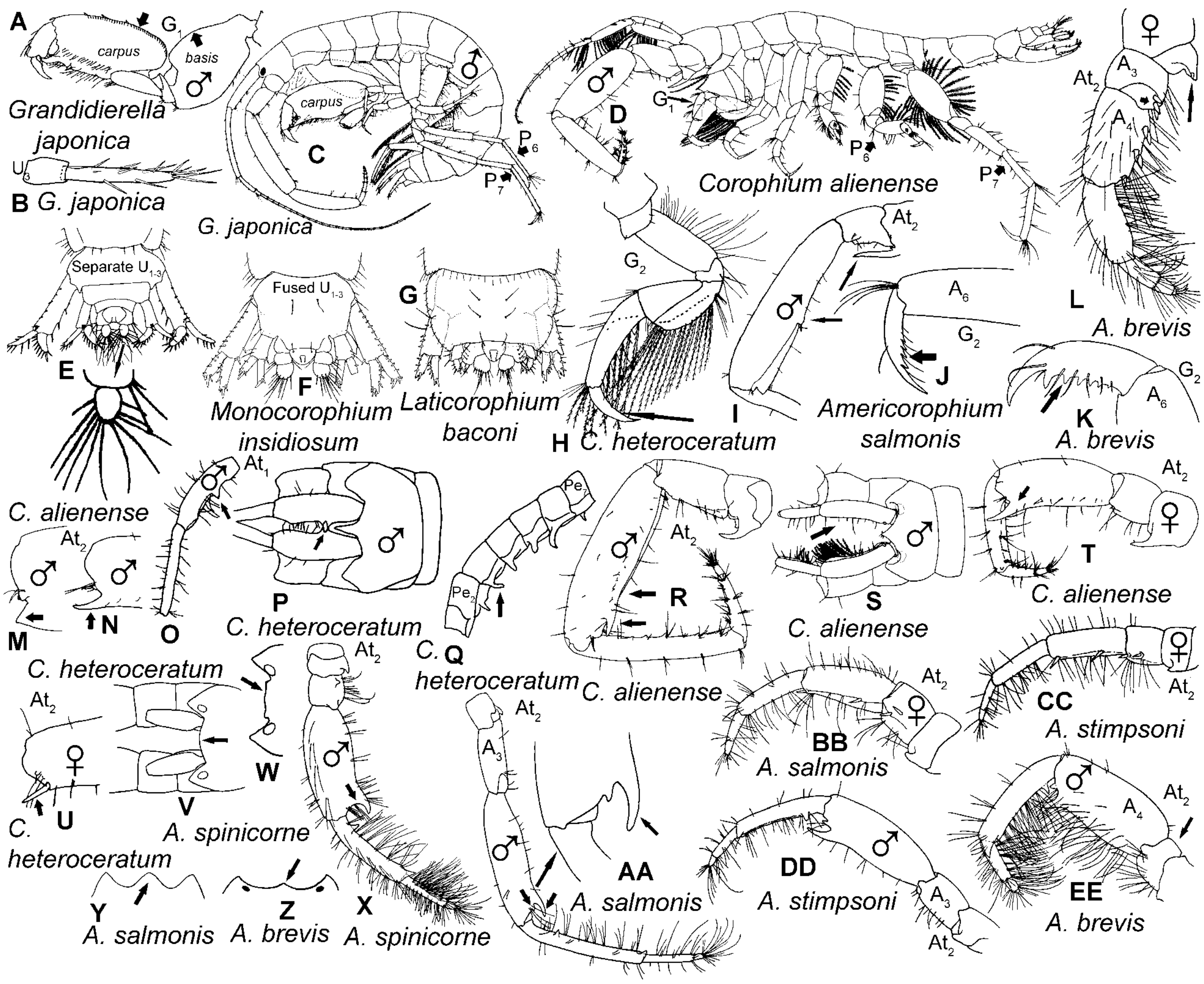

PLATE 269 Corophiidae. K, L, Z, EE, *Americorophium brevis*; J, Y, AA, BB, *Americorophium salmonis*; V–X, *Americorophium spinicorne*; CC, DD, *Americorophium stimpsoni*; D, E, R–T, *Corophium alienense*; H, I, M–Q, U, *Corophium heteroceratum*; A–C, *Grandidierella japonica*; G, *Laticorophium baconi*; F, *Monocorophium insidiosum* (figures modified from Barnard 1954a; Faith Cole, personal communication; Chapman and Dorman 1975; Hiryama 1984; Nagata 1965b; Chapman 1988; and Shoemaker 1934, 1947, 1949).

3. Gnathopod 2 dactyl posterior edge smooth (plate 269H) (apparent at 40×–50×); antenna 2 article 2 excretory spout more than half as long as article 1 (plate 269I) 4
— Gnathopod 2 dactyl posterior edge toothed (plate 269J, 269K); antenna 2 article 2 excretory spout less than half as long as article 1 (plate 269L) 7
4. Male (lacking brood lamellae) 5
— Female (bearing brood lamellae) 6
5. Antenna 2 article 4 with a single denticle on medial edge (plate 269I) and variably pointed or truncated distal tooth (plate 269M, 269N) ; antenna 1 article 1 inner edge with 1 (sometimes 2), medial tooth (plate 269O, 269P); pereonites 2–7 with ventral projections (plate 269Q) . . . . *Corophium heteroceratum*
— Antenna 2 with multiple denticles lining ventral medial edges of articles 4 and 5 and bearing a pointed distal tooth on article 4 (plate 269R); antenna 1 inner edge of article 1 without tooth (plate 269S); pereonites 2–7 without ventral projections . . . . *Corophium alienense*
6. Antenna 2 article 4 with stout distal medial tooth (plate 269T) . . . . *Corophium alienense*
— Antenna 2 article 4 with a stout distal medial spine and no tooth (plate 269U) . . . . *Corophium heteroceratum*
7. Rostrum broadly rounded (plate 269V) or flat (plate 269W); antenna 2 with a single prominent distal tooth on article 4 (plate 269X) . . . . *Corophium spinicorne*
— Rostrum narrowly rounded (plate 269Y) or pointed (plate 269Z); antenna 2 article 4 of males with one prominent and one accessory distal ventral tooth (plate 269AA) and female antenna 2 article 4 with single distal spine and without distal teeth (plate 269BB, 269CC) 8
8. Male (lacking brood lamellae) 9
— Female (bearing brood lamellae) 11
9. Antenna 2 with few setae, article 3 longer than wide (plate 269AA, 269DD) 10
— Antenna 2 setose, article 3 half as long as wide (plate 269EE). . . . . *Americorophium brevis*
10. Antenna 1 article 1 dorsally more than twice as long as wide (plate 270A) and with a ventral tooth (plate 270B) . . . . *Americorophium stimpsoni*
— Antenna 1 article 1 broadly expanded laterally (plate 270C) and without a ventral tooth (plate 270D) . . . . *Americorophium salmonis*

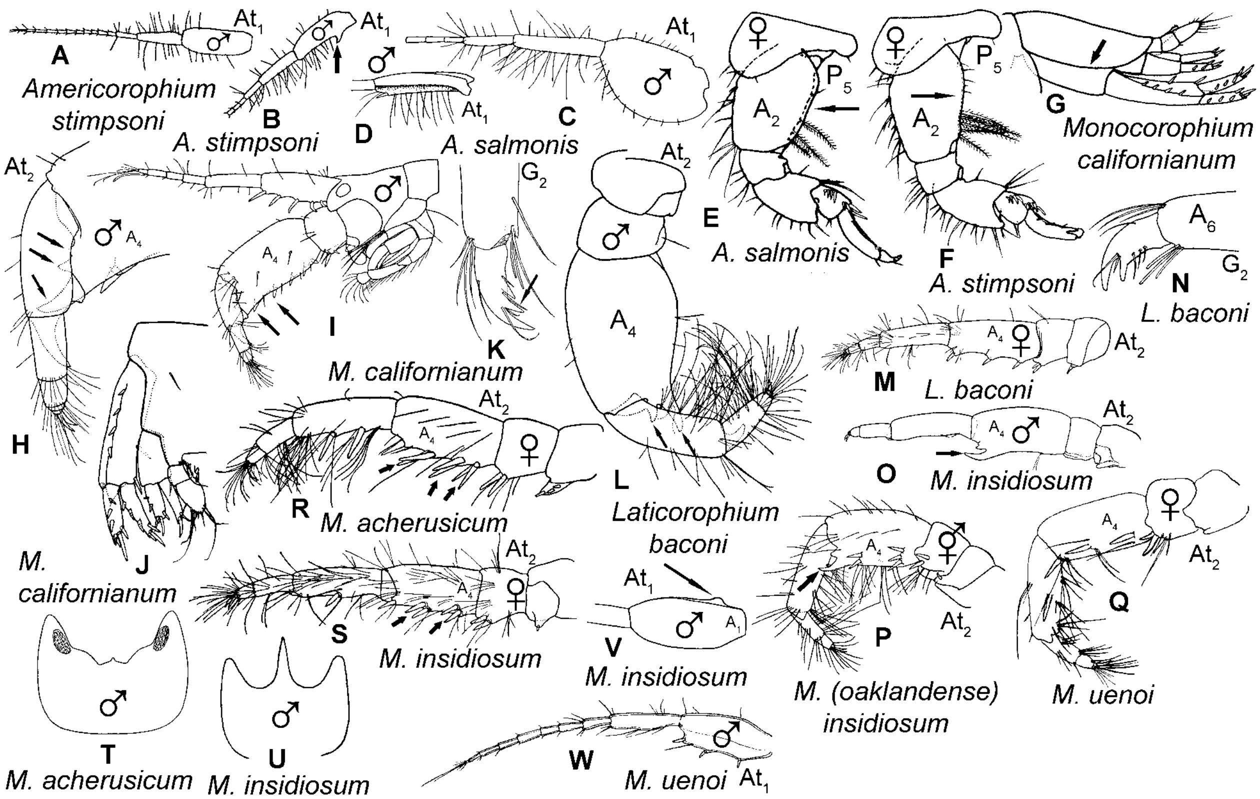

PLATE 270 Corophiidae. C–E, *Americorophium salmonis*; A, B, F, *Americorophium stimpsoni*; L, M, *Laticorophium baconi*; R, T, *Monocorophium acherusicum*; G–K, *Monocorophium californianum*; O, S–U, V, *Monocorophium insidiosum*; P, *Monocorophium (oaklandense) insidiosum*; Q, W, *Monocorophium uenoi* (figures modified from Bousfield and Hoover 1997; Shoemaker 1934, 1947, 1949; and Stephensen 1932).

11. Antenna 2, setose, peduncle article 3 with three ventral spines and article 4 with two pairs of ventral spines (plate 269L) . . . . *Americorophium brevis*
— Antenna 2 not setose, articles 3 and 4 each with two ventral spines (plate 269BB, 269CC) (female *A. salmonis* and *A. stimpsoni* may be indistinguishable) 12
12. Female pereopod 5 article 2 posterior edge faintly concave and with sharp lateral edge (plate 270E) . . . . *Americorophium salmonis*
— Female pereopod 5 article 2 straight or slightly convex posteriorly and with rounded posterolateral edge (plate 270F) . . . . *Americorophium stimpsoni*
13. Uropod 1 inserted ventral to dorsolateral ridge of urosome (plates 269G, 270G) 14
— Uropod 1 inserted laterally and urosome without dorsolateral ridge (plate 269F) 15
14. Antenna 2 article 4 with one large and two small distal medial teeth (plate 270H) and lined on ventral medial edge with four to five stout spines (plate 270I); uropod 2 length 1.5 times uropod 3 (plate 270J); gnathopod 2 dactyl with three teeth (plate 270K). . . . . *Monocorophium californianum*
— Antenna 2 article 4 with two large distal medial teeth and two or less ventromedial spines (plate 270L); female antenna 2 article 5 without spines on medial ventral edge or a distal medial tooth on article 4 (plate 270M); gnathopod 2 dactyl with two teeth (plate 270N); uropods 2 and 3 lengths equal (plate 269G) . . . . *Laticorophium baconi*
15. Antenna 2 article 4 with large distal medial tooth (plate 270O, 270P). 18
— Antenna 2 article 4 without a distal medial tooth (plate 270Q–270S) 16
16. Antenna 2 article 4 lined ventrally with single stout spines in tandem and article 5 with single ventral spine (plate 270Q) . . . . *Monocorophium uenoi*
— Antenna 2 article 4 lined ventrally with pairs of stout spines (plate 270R, 270S) 17
17. Antenna 2 article 4 with three ventral pairs of stout spines and article 5 with two single spines (plate 270R) . . . . *Monocorophium acherusicum*
— Antenna 2 article 4 with two ventral pairs of stout spines and article 5 with a single spine (plate 270S) . . . . *Monocorophium insidiosum*
18. Antenna 2 article 4 lined with ventral triads or pairs of spines and with a distal medial tooth (plate 270P) . . . . *Monocorophium* (*oaklandense*) *insidiosum*
— Antenna 2 article 4 without ventral spines (plate 270O) 19
19. Rostrum short, not extending past ocular lobes (plate 270T) . . . . *Monocorophium acherusicum*
— Rostrum long, extending past ocular lobes (plate 270U) 20
20. Antenna 1 article 1 with medial protrusion (plate 270V) . . . . *Monocorophium insidiosum*
— Antenna 1 article 1 without medial protrusion (plate 270W) . . . . *Monocorophium uenoi*

LIST OF SPECIES

Americorophium brevis (Shoemaker, 1949) (=*Corophium brevis*). Previously ranging from Prince William Sound to San Francisco Bay (extinct in San Francisco Bay, its type locality; next nearest population is Humboldt Bay); predominantly in marine fouling communities, but also soft benthos of estuaries; 6 mm; intertidal—35 m.

Americorophium salmonis (Stimpson, 1857) (=*Corophium salmonis*). Southern Alaska to Humboldt Bay, high salinity estuary to freshwater on muddy bottoms; probably introduced far up Columbia River; critical prey of juvenile salmon (Bottom and Jones 1990, Prog. Oceanogr. 25: 243–270); 7 mm; intertidal—10 m.

Americorophium spinicorne (Stimpson, 1857) (=*Corophium spinicorne*). Vancouver Island to San Louis Obispo, estuarine and freshwater. Introduced to upper Putah Creek, California, and upper Columbia River (Lester and Clark 2002, West. N. American Nat. 62: 230–233). Status and taxonomy of southern populations unclear. Tubes almost exclusively attached to hard surfaces. The long article 3 of male *A. salmonis* and *A. stimpsoni* antenna 2 allow distinctions of these species from *A. spinicorne* in the field, which has a nearly square article 3; 7 mm; intertidal—20 m. See Aldrich 1961, Proc. Acad. Natl. Sci. Phil. 113: 21–28 (ecology); Eriksen 1968, Crustaceana 14: 1–12 (ecology).

Americorophium stimpsoni (Shoemaker, 1941) (=*Corophium stimpsoni*). Historically from Mendocino County south to Santa Cruz Island, estuarine and freshwater, exclusively in soft benthos. A potentially threatened species not found in recent decades outside of the San Francisco Bay Delta east of Carquinez Strait; 6 mm; intertidal—10 m.

Corophium alienense Chapman 1988. San Francisco Bay, Tomales Bay, Los Angeles Harbor, introduced from Asia during the Vietnam War, also in China (Ren, 1995, Studia Marina Sinica 10: 267–271, as *Corophium dentalium*), occasionally in high pools reaching temperatures of 30°C; 6.5 mm; intertidal—3 m.

Corophium heteroceratum Yu, 1938. San Francisco Bay and Los Angeles Harbor, morphologically plastic, introduced, probably from the Yellow Sea, estuarine and marine; 9 mm; shallow subtidal—10 m.

**Crassicorophium bonellii* (Milne Edwards 1830) (=*Corophium bonellii*). A "bipolar" (Bousfield 1973) cold water marine parthenogenic morphotype transferred around the world by humans; Arctic, North Atlantic, Falkland Islands, Chile. Not formally reported from the northeast Pacific, but the proposed differences between *C. bonellii, M. acherusicum,* and *M. insidiosum* are gnathopod 2 dactyl teeth numbers and antenna spine patterns that are too variable for species distinctions. *Crassicorophium bonellii* is possibly a parthenogenic form of one or both species, but see Myers et al. 1989, J. Mar. Biol. Assoc. U.K., 69: 319–321 (a presumed male); 6 mm; intertidal—18 m.

Laticorophium baconi (Shoemaker, 1934) (=*Corophium baconi*). On benthos off coastal shelf in California and among marine float fouling communities; 4 mm; intertidal—55 m.

Monocorophium acherusicum (Costa 1857) (=*Corophium acherusicum*). Cosmopolitan marine, introduced from North Atlantic by shipping and other means to all protected marine coasts between 50° north and 50° south latitude; abundant in float fouling communities and estuary soft benthos. *Crassicorophium bonellii* is indistinguishable from *M. acherusicum*; 4.5 mm; intertidal—10 m.

Monocorophium californianum (Shoemaker, 1934) (=*Corophium californianum*). Marine rocky and sandy bottoms; 3.5 mm; intertidal—100 m. Extremely rare.

**Monocorophium carlottensis* Bousfield and Hoover, 1997. Marine fouling communities, northern species (Prince William Sound to Puget Sound); 4.2 mm; low intertidal—10 m.

Monocorophium insidiosum (Crawford, 1937) (=*Corophium insidiosum*). Cosmopolitan marine and estuarine, introduced from North Atlantic; high frequencies of an undescribed nicothoid copepod egg predator occur among summer Puget Sound populations; 4.5 mm; intertidal—10 m.

Monocorophium oaklandense (Shoemaker, 1949) (=*Corophium oaklandense*). The occasional appearance of this morphotype in pure lab cultures of *M. insidiosum* suggests that *M. oaklandense* is a triploid intersex and thus a synonym of *M. insidiosum*; 5 mm; intertidal—2 m.

Monocorophium uenoi (Stephensen, 1932) (=*Corophium uenoi*). Sea of Japan, South China Sea, introduced to California; 5 mm; intertidal to 24 m.

* = Not in key.

AORIDAE

Grandidierella japonica Stephensen 1938. Keyed here with corophiids due to the uniramous uropod 3. The distinctive gnathopod, green eggs, and black head permit recognition of females and wandering males in the field. Preserved specimens are readily confused with *Microdeutopus gryllotalpa,* which has a biramous uropod 3. The mature male gnathopod 1 (plate 269A) basis is expanded forward and bears onto anterior ridges of the carpus (see arrows in figure) in an apparent adaptation for stridulation. This Japanese species ranges from the Fraser River to Bahia de San Quintin and also occurs in Hawaii, England, and Australia in fine muds of estuarine flats. *G. japonica* feeds on epiphytes, suspended partiles, and detritus and is a facultative cannibal and amphipod predator. See Bay et al. 1989, Environ. Toxicol. Chem. 8: 1191–1200 (toxicology); Greenstein and Tiefenthaler 1997, Bull. So. Calif. Acad. Sci. 96: 34–41 (reproduction and population dynamics in Newport Bay); 13 mm; high intertidal—10 m.

NAJNIDAE

Najnidae are algivores that burrow into and form galls in the stipes and holdfasts of intertidal and shallow subtidal macrophytes including *Alaria, Egregia, Macrocystis,* and *Lessoniopsis*. The najnid molar is a uniquely thickened surface on the mandible and the palp is reduced or absent (plate 255LL), and the sharply produced posterior coxa 4 (plate 271A) is characteristic of the family. Sexual dimorphism is weak. All *Carinonajna* were previously recognized as *Najna consiliorum* Derzhaven 1937, occurring on both Asian and western North American coasts (Barnard 1962c). Barnard (1979a) distinguished the North American populations (as *Najna kitamati*) from the Asian *N. conciliorum* by their rounded rather than square third epimeron, their longer maxilliped palp dactyl, and their minute ramus of uropod 3. Bousfield (1981) and Bousfield and Marcoux (2004) erected the North American *Carinonajna* based on the above distinctions and the occurrence of a lateral carina on the urosome and pleonite 1 of the North American forms. Bousfield and Marcoux (2004) added 10 species to *Carinonajna*. However, the morphological variations proposed to distinguish these *Carinonajna* species (eye size, lacinia mobilis tooth numbers, gnathopod palm spine numbers and sizes, the spine numbers on uropod 1 and 2 rami, and dorsal urosomal carination) are unclear in illustrations and the descriptions and do not fully reveal species differences.

KEY TO NAJNIDAE

1. Gnathopods 1 and 2 article 6 posteriodistal corner with one large and one tiny medial spine (plate 271B, 271C); epimeron

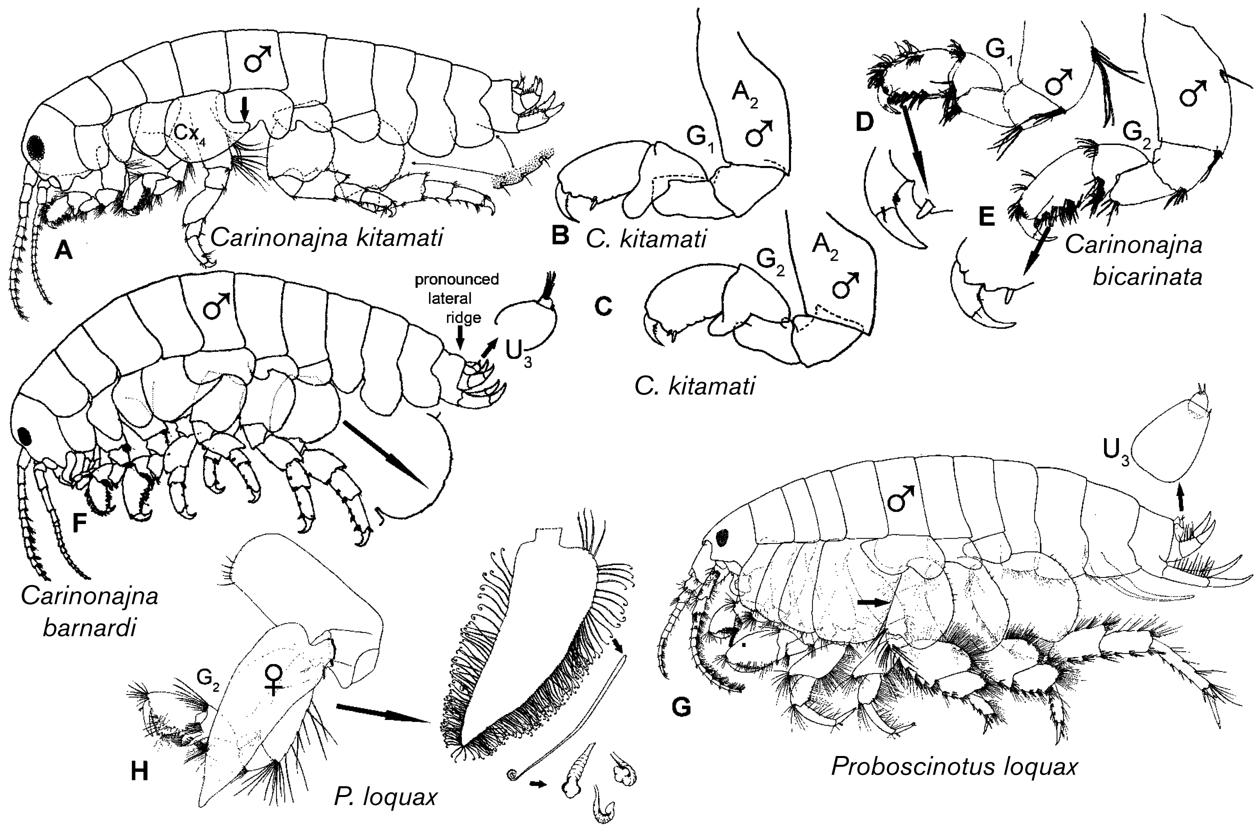

PLATE 271 Najnidae and Dogielinotidae. A–C, *Carinonajna kitamati*; D, E, *Carinonajna bicarinata*; F, *Carinonajna barnardi*; G, H, *Proboscinotus loquax* (figures modified from Barnard 1962c, 1967a; and Bousfield and Marcoux 2004).

3, pereopod 7 posterior pereopod 7 basis and epimeron 3 strongly crenulate (plate 271A) (*C. kitamati* subgroup). . . . . *Carinonajna kitamati, C. lessoniophila, C. bispinosus*

— Posteriodistal corner of gnathopod 2 article 6 bearing a single stout spine (plate 271D, 271E); posterior edge of epimeron 3 and pereopod 7 basis weakly crenulate (plate 271F) (*C. bicarinata* subgroup) . . . . *Carinonajna barnardi, C. longimana, C. carli,* and *C. bicarinata*

LIST OF SPECIES

Carinonajna barnardi (Bousfield 1981). 9.5 mm; intertidal—10 m.

Carinonajna bicarinata (Bousfield, 1981). In *Phyllospadix* and *Laminaria* holdfasts; 8.5 mm; intertidal—10 m.

Carinonajna bispinosa Bousfield and Marcoux, 2004. 7.5 mm; intertidal—10 m.

Carinonajna carli Bousfield and Marcoux, 2004. *Phyllospadix,* boulders and gravel, *Hedophyllum*; 8.2 mm; intertidal—10 m.

Carinonajna kitamati (Barnard, 1979) (=*Najna ?consiliorum*). Among *Egregia* and rarely *Postelsia* and *Macrocystis*; 8 mm; intertidal—17 m.

Carinonajna lessoniophila (Bousfield, 1981). From galls in stipes of *Lessoniopsis littoralis*; 9.2 mm; intertidal—10 m.

Carinonajna longimana (Bousfield, 1981). On *Hedophyllum, Laminaria,* and in *Phyllospadix* root mass communities on semi-protected beaches; 5.5 mm; intertidal—1 m.

DOGIELINOTIDAE

Dogielinotidae superficially resemble other fossorial families of the region (Phoxocephalidae, Urothoidae, and Pontoporeiidae); however, the reduced urosomites 2 and 3, reduced mandibular palp (plate 255KK), single, reduced ramus of uropod 3 (plate 271G), lack of an accessory flagellum and remarkable distally curled setae of the oöstegites (plate 271H) indicate their talitrid origins along with the Najnidae, Hyalellidae, and Hyalidae.

KEY TO DOGIELINOTIDAE

1. Surf-zone sand burrowing (fossorial) lacking accessory flagellum (plate 271G); posterior coxa 4 not produced, uropods 1 and 2 rami bare and uropod 3 with minute ramus (plate 271G); oöstegites lined with distally curled setae (plates 255NN, 271H); epistome proboscoid shaped (plate 256B) . . . . *Proboscinotus loquax*

LIST OF SPECIES

Proboscinotus loquax (Barnard, 1967d). The talking nose amphipod—from the root meaning of *proboscis* "nose" (due to the noselike epistome) (plate 256B) and the root meaning of *loquax* "talk." Open coast fine and coarse sand beaches. The restricted range, Washington coast of the Juan de Fuca Straits to Clam Beach, Eureka, in northern California of this abundant, distinctive species is unusual among native species. Its

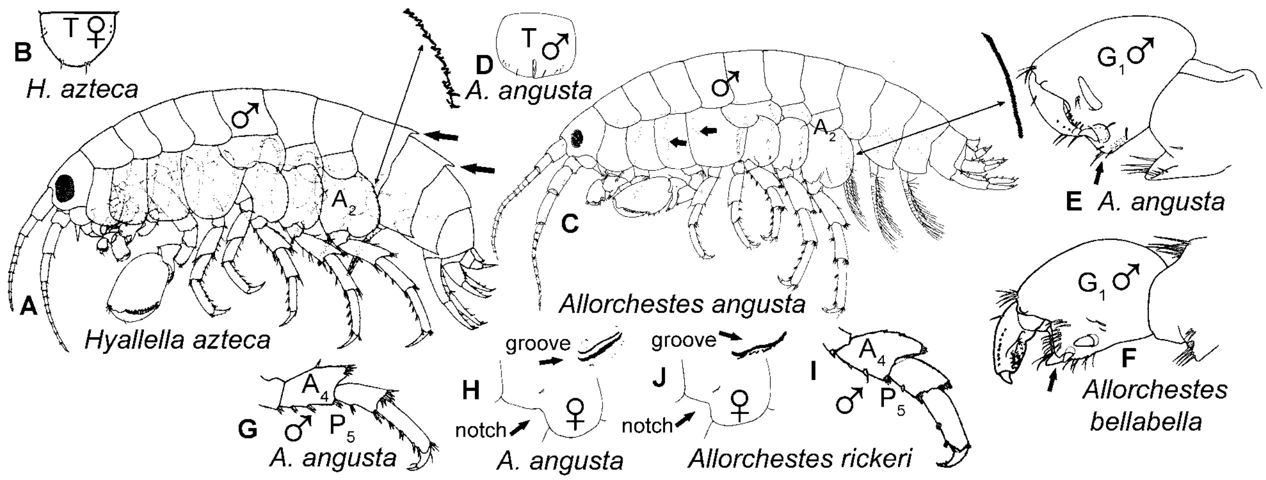

PLATE 272 Hyalellidae. A, B, *Hyalella azteca*; C–E, G, H, *Allorchestes angusta*; F, *Allorchestes bellabella*; I, J, *Allorchestes rickeri* (figures modified from Barnard 1979a and Hendrycks and Bousfield 2001).

endemic status in North America should be examined. An important prey of shorebirds in the region. See Hughes 1982, Mar. Biol. 71: 167–175 for population biology. Open sandy beaches; 8 mm; intertidal.

HYALELLIDAE

Hyalellidae are herbivorous talitroideans closely related to Hyalidae and Najnidae that live in coarse sand and rock-cobble areas and among aquatic plants. The hyalellids are relatively helpless out of water, while the allorchestids hop and otherwise move quickly when exposed. The first male gnathopods are modified for clasping to the highly modified female ventral pereonite 2 and dorsal coxa 2 (Hendrycks and Bousfield 2001) (plate 272H, 272J).

KEY TO HYALELLIDAE

1. Primarily freshwater, pereopod 7 article 2 posterior edge serrate (plate 272A); telson uncleft (plate 272B) . . . . *Hyalella azteca*
— Marine and estuarine, pereopod 7 article 2 posterior edge smooth or slightly crenulate but not serrate (plate 272C), telson slightly cleft (plate 272D) 2
2. Male gnathopod 1 dactyl not inflated, 5 times longer than wide, palm nearly straight, and broadly square posteriorly (plate 272E) 3
— Male gnathopod 1 dactyl inflated, half as wide as long, palm deeply incised and sharply angular posteriorly (plate 272F) . . . . *Allorchestes bellabella*
3. Pereopod 5, article 4 width one-half of the length (plate 272G); female coxa 2 anteriodistal preamplexing notch broadly obtuse (plate 272H) . . . . *Allorchestes angusta*
— Pereopod 5, article 4 width two-thirds of the length (plate 272I); preamplexing notch nearly at right angle (plate 272J) . . . . *Allorchestes rickeri*

LIST OF SPECIES

Allorchestes angusta Dana, 1856. Japanese records refer to *A. malleola* (Stebbing 1899); 10 mm; intertidal—1 m.

Allorchestes bellabella Barnard, 1974. Marine to estuarine, sometimes planktonic; 13 mm; intertidal—7 m.

Allorchestes rickeri Hendrycks and Bousfield, 2001. Open coast and semiprotected sand and rock beaches; 6 mm; intertidal.

Hyalella azteca (Saussure, 1858). A mostly freshwater species with low-salinity populations in upper estuaries, coastal lakes, rivers, and barrier beach lagoons to the tree line; likely species complex (Hogg et al. 1998), but also with many likely introduced populations. The illustration of *H. azteca* from San Francisco Bay in Toft et al. (2002) is of *Hyalella montezuma* Cole and Watkins, 1977, from Montezuma Well, Arizona, and not of San Francisco Bay material; 5 mm; intertidal—20 m.

HYALIDAE

Hyalidae are intertidal marine and estuarine herbivores with entirely cleft fleshy telsons and greatly reduced urosomite 2. Hyalids hop and otherwise move quickly when exposed. The first male gnathopods are modified for clasping to the highly modified female ventral pereonite 2 and dorsal coxa 2 (Bousfield and Hendrycks 2002) (plate 273T).

KEY TO HYALIDAE

1. Uropod 3 with scalelike inner ramus (plate 273A); maxilla 1 palp consisting of two articles (plate 273B) 2
— Uropod 3 with single ramus (plate 273C); maxilla 1 palp consisting of a single article (plate 273D) 4
2. Antenna 2 peduncle length less than length from anterior head to posterior pereonite 1 and faint dorsal carination on pereonites 1–6 (plate 273E) . . . . *Parallorchestes americana*
— Antenna 2 peduncle length greater than length from anterior head to posterior pereonite 1 and faint dorsal carination on pereonites 1–5 only or absent entirely (plate 273H) 3
3. Peduncle of antenna 2 length equal to distance from anterior of head to pereonite 2 and carinations on pereonites absent (plate 273G) . . . . *Parallorchestes cowani*
— Peduncle of antenna 2 length greater than distance from anterior head to pereonite 2, faint carination on pereonites

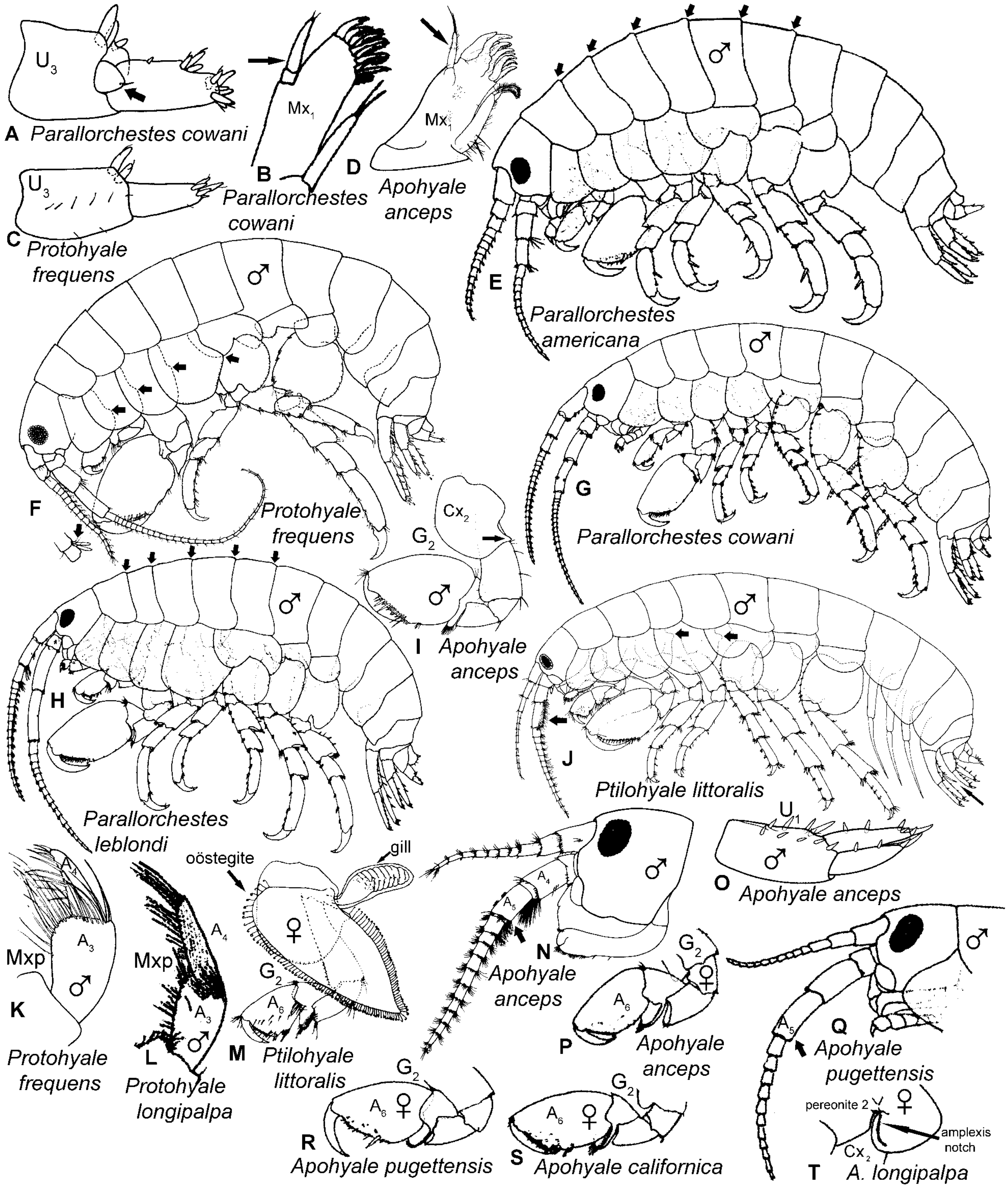

PLATE 273 Hyalidae. D, I, N–P, *Apohyale anceps*; S, *Apohyale californica*; Q, R, *Apohyale pugettensis*; E, *Parallorchestes americana*; A, B, G, *Parallorchestes cowani*; H, *Parallorchestes leblondi*; C, F, K, *Protohyale frequens*; L, *Protohyale longipalpa* (T, amplexis notch); J, M, *Ptilohyale littoralis* (figures modified from Barnard 1952b, 1962c, 1969a; Bousfield 1973; and Bousfield and Hendrycks 2002).

1–5 (plate 273H) . . . . *Parallorchestes leblondi*

4. Posterior edge of coxae 1–4 without pointed cusps (plate 273F) 5

— Posterior edge of coxae 1–4 with pointed cusps (plate 273I, 273J). 6

5. Maxilliped palp article 4 equal to or shorter than article 3 (plate 273K) . . . . *Protohyale frequens*

— Maxilliped palp article 4 longer than article 3 (plate 273L) . . . . *Protohyale longipalpa*

6. Antenna 2, peduncle article 5 plumose along entire ventral surface (plates 256F, 273J); uropod 1 with a prominent distal medial spine (plate 273J); female gnathopod 2 article 6 expanding distally (plate 273M) . . . . *Ptilohyale littoralis*

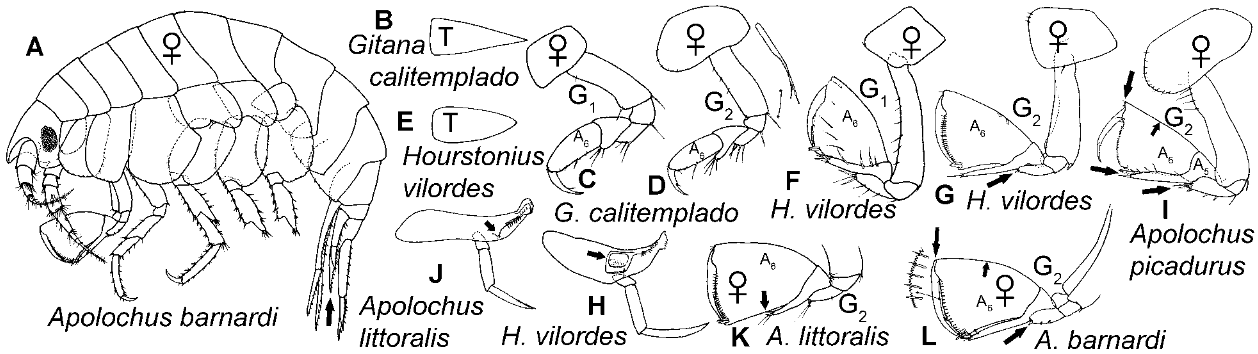

PLATE 274 Amphilochidae. A, L, *Apolochus barnardi*; J, K, *Aplolochus litoralis*; I, *Apolochus picadurus*; B–D, *Gitana calitemplado*; E–H, *Hourstonius vilordes* (figures modified from Barnard 1962c and Hoover and Bousfield 2001).

— Antenna 2, peduncle article 5 lacking distal setae (plate 273N); uropod 1 lacking prominent distal spine (plate 273O); female gnathopod 2 article 6 with parallel anterior and posterior edges (plate 273P). 7

7. Antenna 2 peduncle article 5 with proximal ventral setae (plate 273N) . . . . *Apohyale anceps*

— Antenna 2 peduncle article 5 without ventral setae (plate 273Q) 8

8. Female gnathopod 2 palm longer than posterior edge (plate 273R) . . . . *Apohyale pugettensis*

— Female gnathopod 2 palm shorter than posterior edge (plate 273S). . . . . *Apohyale californica*

LIST OF SPECIES

Apohyale anceps (Barnard, 1969a) (=*Hyale anceps*). Abundant on wave-dashed turf platforms and under cobbles and in *Silvetia* of the rocky open coast; 12–18 mm; intertidal.

Apohyale californica (Barnard, 1969a) (=*Hyale grandicornis californica*). Abundant on wave-dashed turf platforms and under cobbles and in *Silvetia* of the rocky open coast. Whether *A. californica* and *A. pugettensis* are different species or size-related morphologies of a single species is unclear; 6 mm–12 mm; intertidal.

Apohyale pugettensis (Dana, 1853) (=*Hyale pugettensis*). Frequent in nearly freshwater open coast spray pools and above high-water level along bedrock shores; 18 mm; intertidal.

*****Hyale seminuda* (Stimpson 1856). Stimpson noted that this species occurred "on seaweed and among barnacles on piles, stones, etc. at half tide in San Francisco Harbor." The identity of *H. seminuda* is unclear; no additional records have appeared since the original report; 13 mm; intertidal.

Parallorchestes americana Bousfield and Hendrycks, 2002. Specific distinctions in carination among *Parallorchestes* of the northeast Pacific are unclear and awaiting analyses of sexual, allometric, and meristic variation. Commonly free swimming in intertidal areas of surf-exposed costs; 7.5 mm; intertidal.

Parallorchestes cowani Bousfield and Hendrycks, 2002 (=*Allorchestes ochotensis* in part). Free swimming or associated with brown algae and *Phyllospadix* at low water on exposed and semiprotected rocky coasts; 13 mm; intertidal.

Parallorchestes leblondi Bousfield and Hendrycks, 2002. Exposed sandy and rocky beaches at low water level; 11 mm; intertidal.

Prohyale frequens (Stout, 1913) (=*Hyale frequens*). Characters distinguishing all other *Prohyale* of the region (*P. jarrettae, P. oclairi,* and *P. setucornis*) from *P. frequens* (Bousfield and Hendrycks 2002) are indistinct when adjusted for size. One of the most abundant intertidal amphipods and particularly abundant among *Phyllospadix* roots and coralline algae of open and semiprotected coasts; 8 mm; intertidal—6 m.

Protohyale longipalpa Bousfield and Hendrycks 2002. Among algae in semiprotected areas; 8.5 mm; intertidal—1 m.

Ptilohyale littoralis (Stimpson, 1853) (=*Hyale plumulosa, Ptilohyale plumulosa, Hyale crassicorne, Ptilohyale litoralis*). Male head shown in plate 256F. A probable solid ballast introduction between the northwest Atlantic and northwest Pacific and Australia. Protected shores in salt marshes among *Spartina* and fucoids, stones, or high-tide, low-salinity pools; 8 mm; intertidal.

* = Not in key.

AMPHILOCHIDAE

Seldom observed alive, Amphilochidae are small colorful leucothoideanlike amphipods commensal with sea fans, hydroids, and other sessile marine invertebrates. They are distinguished by prominent, decurved rostrums, projecting article 5 of gnathopod 2 along the posterior edge of article 6, round or oval eyes with darkly pigmented centers surrounded by pale ommatidia, laminate uncleft acute telsons and second uropods that do not extend as far as uropods 1 and 3 (plates 256J, 274A).

KEY TO AMPHILOCHIDAE

1. Telson 2.3 times as long as wide, lateral edges straight and distally acute (plate 274B); gnathopods 1 and 2 weak, palm of article 6 indistinct (plate 274C, 274D). . . . . *Gitana calitemplado*

— Telson only twice as long as wide, distally blunt and lateral edges convex (plate 274E); gnathopods 1 and 2 article 6 with distinct palm separated from the posterior edge by a corner (plate 274F, 274G). 2

2. Gnathopod 2 article 4 with single large spine at apex (plate 274G); mandibular molar triturative (plate 274H) . . . . *Hourstonius vilordes*

— Gnathopod 2 article 4 with multiple spines at apex and posterior edge (plate 274I); mandibular molar vestigial (plate 274J, arrow). 3

3. Gnathopod 2 article 5 not projecting half way along posterior edge of article 6 (plate 274K) . . . . *Apolochus littoralis*

— Gnathopod 2 article 5 projecting more than halfway along posterior edge of article 6 (plate 274I) 4

4. Gnathopod 2 anterior margin nearly straight and projecting over the dactyl hinge; distal margin of article 4 bearing one spine and one seta (plate 274I) . . . . *Apolochus picadurus*
— Gnathopod 2 anterior margin curved outward and not projecting over dactyl hinge; distal margin of article 4 bearing one spine only (plate 274L) . . . . *Apolochus barnardi*

LIST OF SPECIES

Apolochus barnardi Hoover and Bousfield, 2001 (=*Amphilochus neapolitanus*). In *Phyllospadix* and *Egregia* root masses and among coralline algae; 2.5 mm; intertidal—6 m.

Apolochus littoralis (Stout, 1912) (=*Amphilochus littoralis*). Low intertidal rocks and shell and among coralline algae; 2.3 mm; intertidal—2 m.

Apolochus picadurus (Barnard, 1962c) (=*Amphilochus picadurus*). Mud and rock bottoms; 2.7 mm; 2 m–6 m.

Gitana calitemplado Barnard, 1962c. A rare shallow water species of bays and protected coasts. Whole body illustration plate 256J; 2.0 mm; 9 m–27 m.

Hourstonius vilordes (Barnard, 1962c) (=*Gitanopsis vilordes*). From rocks and *Egregia*; 3.0 mm; intertidal—4 m.

STENOTHOIDAE

Stenothoidae are commensals and probable parasites or micropredators on hydroids. Some species, including *Stenothoe valida,* are beautifully pigmented. "Steno" and "tho" mean narrow and quick, but stenothoids are fat and are not remarkably quick. Their massive coxae 2–4 cover all appendages (plate 275A), allowing rapid identification of the family. Undescribed species may occur in this region but are obscured by the poor taxonomic resolution of existing species. Concepts of stenothoid genera are based on the degree of fusion and reduction of mouth parts, which are delicate and easily broken or lost in dissections. Fusion or separation of articles can be difficult to determine (Barnard 1962c) and intraspecific variation in mouth part morphology is unknown. External morphology is emphasized here, but mouth part morphology may be more reliable.

KEY TO STENOTHOIDAE

1. Article 2 of pereopod 6 linear, thin (plate 275A, 275B) 2
— Article 2 of pereopod 6 expanded (plate 275C, 275D) 4
2. Mandibular palp 1 articulate or absent (no published illustrations) . . . . *Stenothoides burbanki*
— Mandibular palp 2–3 articulate (plate 275E, 275F) 3
3. Article 5 of gnathopod 1 twice as long as article 6 (plate 275G); mandibular palp large and 3 articulate (plate 275E) . . . . *Mesometopa esmarki*
— Articles 5 and 6 of gnathopod 1 equal in length (plate 275H); mandibular palp minute and 2 articulate (plate 275F) . . . . *Mesometopa sinuata*
4. Gnathopod palm shallowly concave, with distal notch and large tooth, densely setose and lacking a proximal defining tooth (plate 275I); maxilla 1 palp of two articles (plate 275J); mandible lacking palp (plate 275K) . . . . *Stenothoe valida*
— Gnathopod 2 palm with relatively few setae, a proximal defining tooth and a small distal hinge tooth (plate 275L–275N); mandible with palp (plate 275O, 275P); maxilla 1 palp of one article (plate 275Q, 275R) (difficult, requiring dissection and mounting on a slide for 100x magnification observation) 5
5. Telson with four stout spines (plate 275S); mandibular palp of two articles (plate 275O) . . . . *Metopa cistella*
— Telson lacking stout spines (plate 275T, 275U); mandibular palp of one article (plate 275P) 6
6. Gnathopod 1 article 5 longer than article 6 (plate 275V); pereopod 7 article 4 extending less than half of the length of article 5 (plate 275W) . . . . *Stenula modosa*
— Gnathopod 1 article 5 length equal to article 6 (plate 275Y); pereopod 7 article 4 extending the length of article 5 (plate 275X) . . . . *Stenula incola*

LIST OF SPECIES

Mesometopa esmarki (Boeck, 1872). Boeck's description and the only record of this species are based upon a specimen from central California, perhaps from San Francisco Bay. Only the incomplete illustrations reproduced herein were published. The long article 5 of gnathopod 1 (plate 275G) was reported to be of a male but is characteristic of females among stenothoids; 5 mm; intertidal.

Mesometopa sinuata Shoemaker, 1964. Coos Bay to Monterey Bay (holotype collected from a boat bottom in Monterey Bay); the description is based on a male. Whether a female could be distinguished from *M. esmarki* is unclear; 4 mm; intertidal.

Metopa cistella Barnard, 1969. Commensal with anemones, hydroids and sea pens; 2.3 mm; low intertidal to deep subtidal.

**Stenothoe estacola* Barnard, 1962c. Pt. Conception and south, associated with the worm *Phragmatopoma*. Expanded posterior basis of pereopod 6, six stout spines on dorsal telson, but lacking extended setose palm of *S. valida*; 3.0 mm; intertidal.

Stenothoe valida (Dana, 1852). Cosmopolitan in marine bays and harbors of temperate latitudes; transported by human activity. Hydroid predator or commensal; 5 mm; shallow subtidal—10 m.

Stenothoides burbanki Barnard, 1969a. Among tunicates and sponges, algal turf, *Egregia* and *Laminaria* holdfasts; scarce. Except for lacking a mandibular palp, not distinguished from *Mesometopa sinuata*; 3 mm; intertidal—3 m.

Stenula incola Barnard, 1969a. Not clearly distinguished from *S. modosa* morphologically. Sex-based variation in *Metopa cistella* gnathopod morphology (Barnard 1969) closely matches the differences between *S. incola,* described entirely from a male specimen, and *S. modosa,* described from a female specimen. Occurring in algal turf; 3 mm; intertidal.

Stenula modosa Barnard, 1962c. Mud bottoms. Body shown in plate 256K. Distinguished from *S. incola* primarily by ecological differences; 2 mm; subtidal—92 m.

AMPELISCIDAE

Ampeliscidae build pocket-shaped tubes with a single opening in fine sand or mud bottoms and feed by sweeping in suspended particulates using their antennae. Urosomites 2–3 are fused; the head is longer than deep and lacks a rostrum. The eyes, when present, consist of dorsal frontal lenses with anterior pairs of ommatidia. *Byblis* and *Haploops* are predominantly deep-sea species. Pelagic phase males have long antennae, larger pleosomes, broad setose uropod 3 rami, and larger dorsal carina on urosomites 1. The taxonomy is based on female morphology.

* = Not in key.

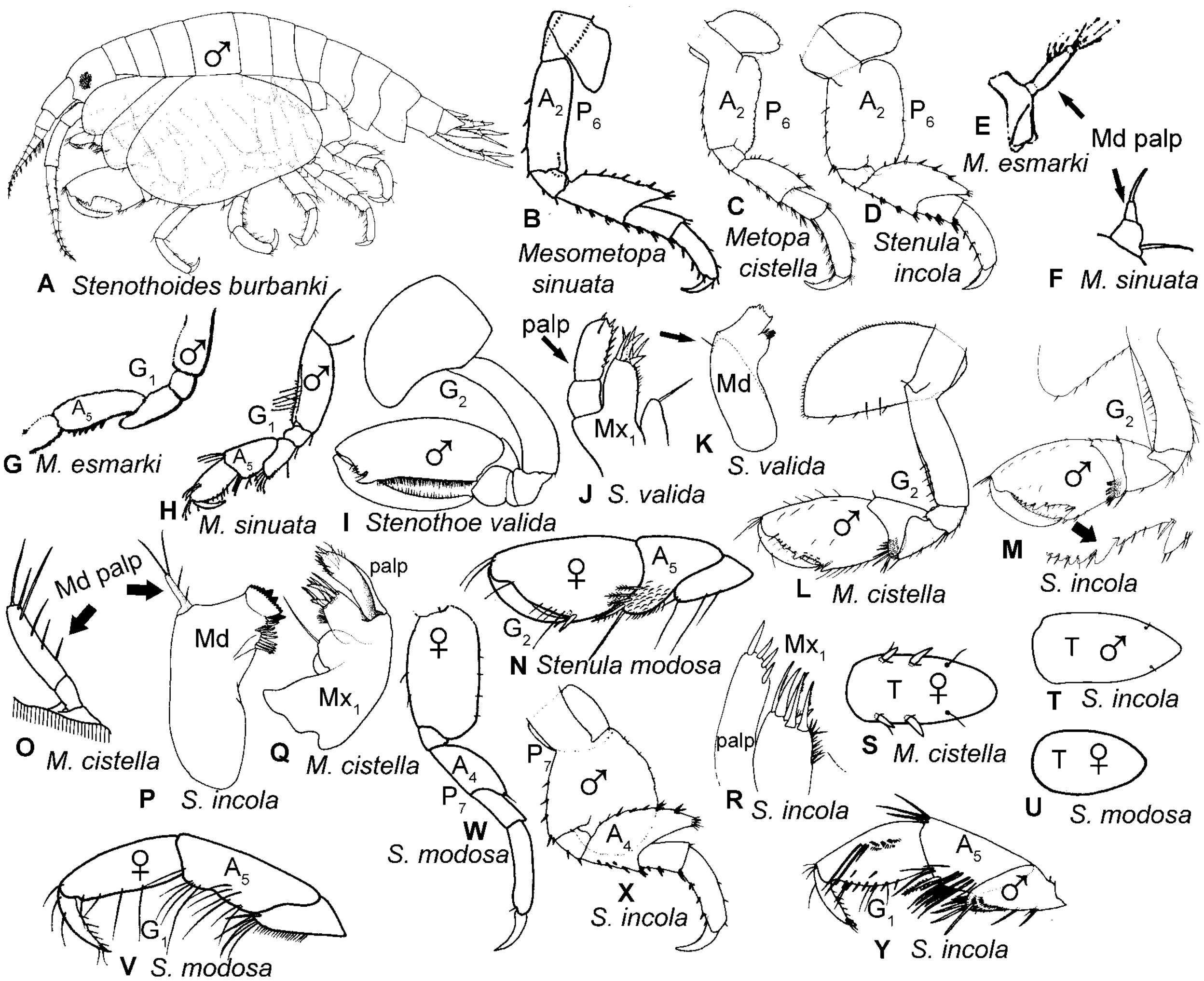

PLATE 275 Stenothoidae. E, G, *Mesometopa esmarki*; B, F, H, *Mesometopa sinuata*; C, L, O, Q, S, *Metopa cistella*; I–K, *Stenothoe valida*; A, *Stenothoides burbanki*; D, M, P, R, T, X, Y, *Stenula incola*; N, U–W, *Stenula modosa* (figures modified from Barnard 1953, 1962c, 1969a; Boeck 1872; and Shoemaker 1964).

KEY TO AMPELISCIDAE

1. Pereopod 7 article 2 with roundly expanded posterior edge and more than twice as wide as article 3 (plate 276A) 2
— Pereopod 7 article 2 with anterior and posterior edges nearly parallel and less than twice as wide as article 3 (plate 276B) . . . . *Haploops*
2. Pereopod 7 article 2 anterior edge of posterioventral lobe without setae at junction with article 3 and lobe extending ventrally (plate 276C); uropod 3 rami facing edges smooth or evenly serrate (plate 276D) 3
— Pereopod 7 article 2 anterior ventral edge bearing setae at junction with article 3 and lobe extending obliquely (plate 276E1); uropod 3 facing edges of rami unevenly serrate (plate 276E2) 20
3. Pleonite 3 posteriodistal corner produced into large or small acute tooth (plate 276A) 4
— Pleonite 3 posteriodistal corner square or rounded but not produced (plate 276F) 12
4. Pereopod 7 article 5 anterior margin notched and article 4 posterior lobe broad, extending more than two-thirds the length of segment 5 (plate 276G); uropod 1 not reaching beyond midpoint of uropod 2 ramus (plate 276A); telson dorsal surface with long spines (plate 276H) 5
— Pereopod 7 article 5 without anterior notch and article 4 posterior lobe acute, extending less than two-thirds the length of article 5 (plate 276I); uropod 1 reaching beyond midpoint of uropod 2 ramus (plate 276J); telson dorsal surface with short spines (plate 276K) 6
5. Epimeron 3 posterior ventral tooth minute (plate 276L); head ventral edge slightly concave (plate 276M), uropod 1 rami extending to middle of uropod 2 rami (plate 276L). . . . . *Ampelisca indentata*
— Epimeron 3 posterior ventral tooth distinct (plate 276A); head ventral edge straight or convex (plate 276N), uropod 1 rami not extending to the middle of uropod 2 rami (plate 276A) . . . . *Ampelisca pugetica*
6. Uropod 2 outer ramus lacking subapical spine and pleonite 3 posterior margin evenly concave (plate 276J) . . . . *Ampelisca hancocki*
— Uropod 2 outer ramus with long subapical spine and pleonite 3 posterior margin sinuate (plate 276O) 7
7. Head lower front margin deeply concave and parallel with upper margin (plate 276P) 8
— Head lower front margin convex or only slightly concave

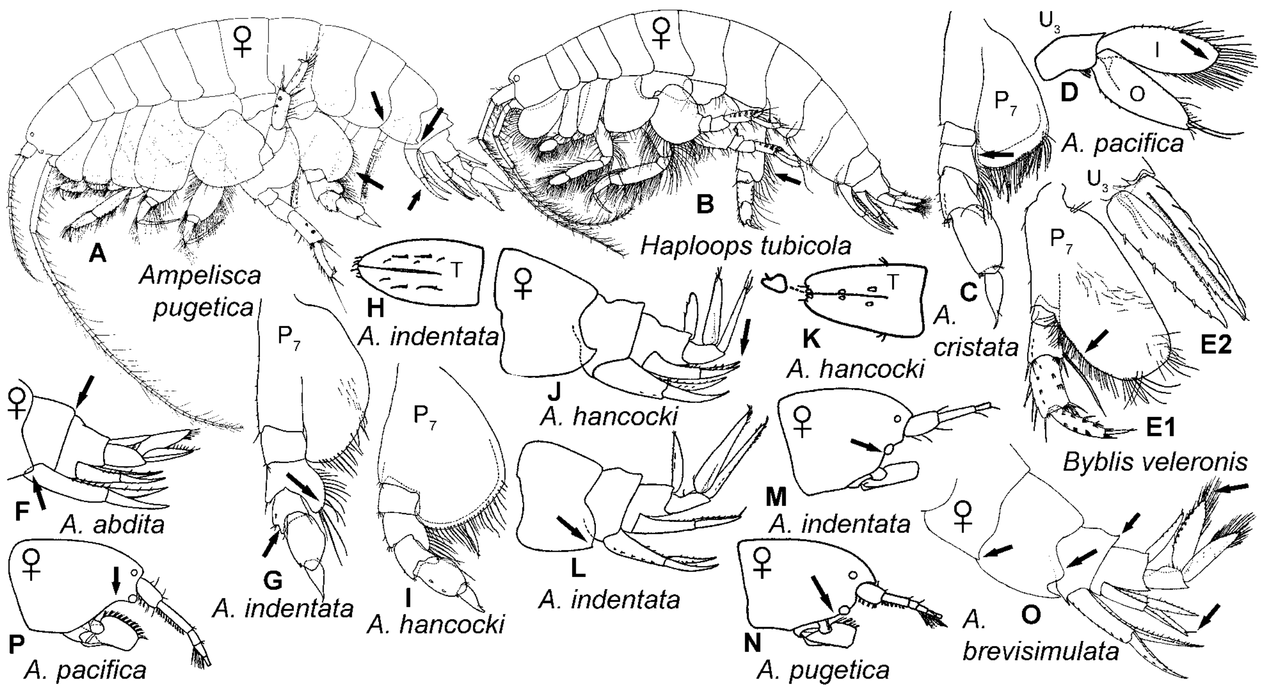

PLATE 276 Ampeliscidae. F, *Ampelisca abdita*; O, *Ampelisca brevisimulata*; C, *Ampelisca cristata*; I–K, *Ampelisca hancocki*; G, H, L, M, *Ampelisca indentata*; D, P, *Ampelisca pacifica*; A, N, *Ampelisca pugetica*; E1, E2, *Byblis veleronis*; B, *Haploops tubicola* (figures modified from Barnard 1954b, 1966a; Dickinson 1982; and Mills 1964).

but never parallel with upper margin (plate 277Q). . . . 10

8. Uropod 3 inner ramus distally rounded (plate 276D); pleonite 2 posterioventral corner without a tooth . . . . *Ampelisca pacifica*

— Uropod 3 inner ramus distally pointed and pleonite 2 posterioventral corner with a tooth (plate 276O) 9

9. Pleonite 3 posterior produced into a large rounded process extending posteriorly to or beyond the ventral tooth; uropod 1 peduncle dorsolateral edge evenly curved without expansion; urosomal carina massive and not laminar (plate 276O); telson apex lobes narrow and lacking a notch (plate 277B) . . . . *Ampelisca brevisimulata*

— Pleonite 3 posterior edge weakly convex, not extending posteriorly beyond the ventral tooth; uropod 1 peduncle proximolateral edge expanded dorsally and urosomal carina laminar (plate 277C); telson apex lobes with a notch (plate 277D). . . . . *Ampelisca cristata*

10. Telson dorsal surface with short, blunt spines aligned in a median row (plate 277E) (this species may not occur in this region: see *A. careyi* and *A. unsocalae*) . . . . *Ampelisca macrocephala*

— Telson dorsal surface with long slender spines irregularly positioned over the lobes (plate 277F) 11

11. Antenna 1 insertion below dorsal head margin, forming a forehead, head lower anterior slightly concave, antenna 1 reaching end of peduncle of antenna 2 (plate 277A); telson lobes with apical notch laterally facing (plate 277F) (distinctions between *A. caryei* and *A. unsocalae* questioned by Watling 1997: 140) . . . . *Ampelisca careyi*

— Antenna 1 insertion at dorsal head margin precluding a forehead, head lower anterior straight, without a concavity, antenna 1 not reaching end of peduncle of antenna 2 (plate 277G) telson lobes with apical notch facing slightly medial (plate 277H). . . . . *Ampelisca unsocalae*

12. Pereopod 7 article 3 equal to or longer than article 4 and article 2 basal lobe not extending past article 3 (plate 277I); mandibular palp article 2 with inflated edges curved (plate 277J). 13

— Pereopod 7 article 3 shorter than article 4 and article 2 basal lobe extending past article 3 (plate 276C, 276I); mandibular palp article 2 straight, parallel sided (plate 277K) 14

13. Pereopod 5 article 2 posterioventral lobe enlarged (plate 277L); pereopod 7 article 2 posterior edge expanded (plate 277M) . . . . *Ampelisca abdita*

— Pereopod 5 article 2 posterioventral lobe straight and indistinct (plate 277N); pereopod 7 article 2 posterior edge almost evenly rounded, not expanded (plates 256L, 277I) . . . . *Ampelisca milleri*

14. Uropod 2 outer ramus bearing subapical spine (plate 277O); telson lobes middle dorsal surface bearing one or two diagonal rows of five to nine setae (plate 277P); head ventral margin concave (plate 277Q). . . . . *Ampelisca venetiensis*

— Uropod 2 outer ramus not bearing subapical spine (plate 277R); telson lobes middle dorsal surface bearing various arrangements of single setae (plate 277S); head ventral margin faintly incised or convex (plate 277T). 15

15. Urosomite 1 produced dorsally into a prominent carina or bump (plate 277C, 277R); female uropod 3 inner ramus inner edge smooth or only faintly serrate (plate 277U) 16

— Urosomite 1 evenly rounded not produced into prominent carina or bump (plate 277V); female uropod 3 inner ramus inner edge serrate (plate 277W) 18

16. Uropod 1 rami similar in length and longer or equal in length to the peduncle (plate 277R, 277X), telson lobes without a medial projection (plate 277Y) 17

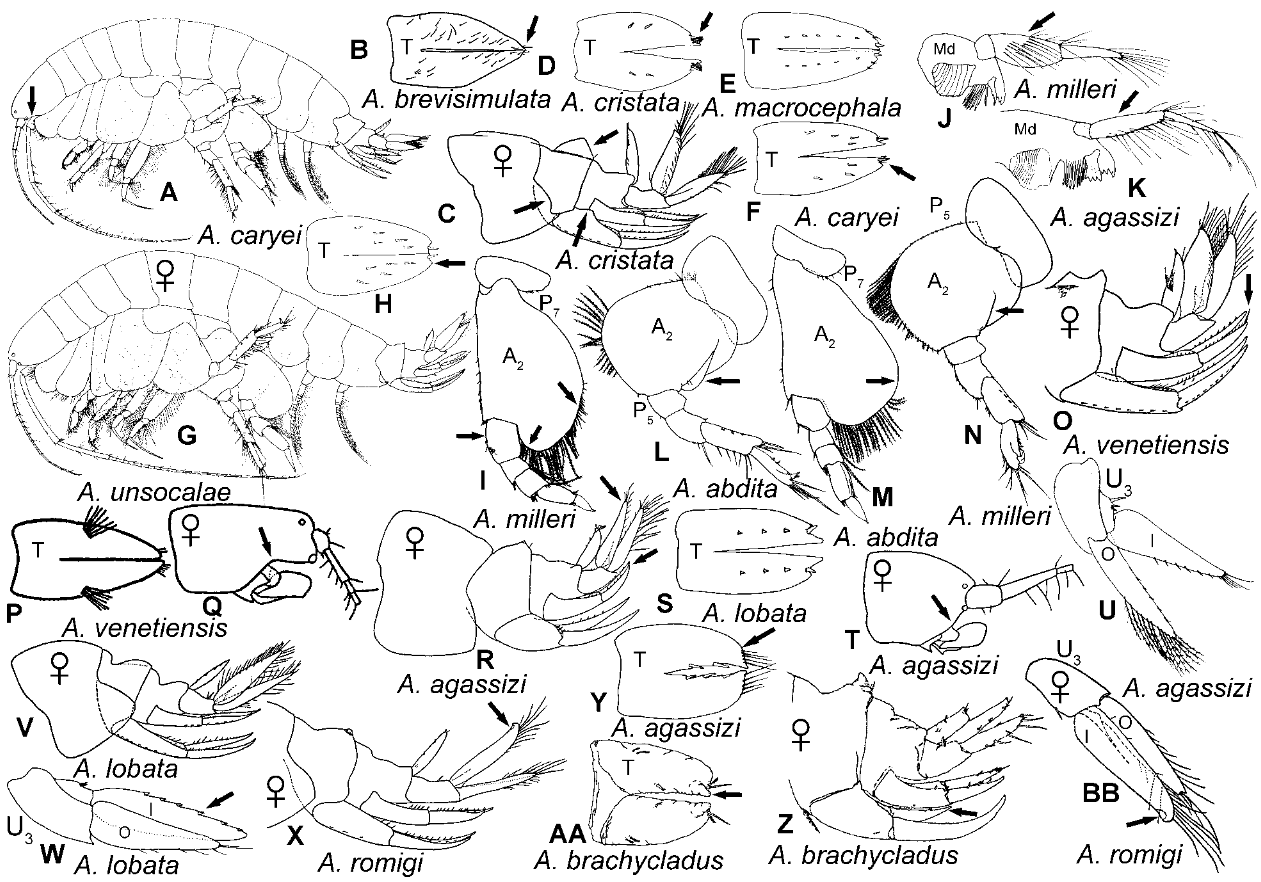

PLATE 277 Ampeliscidae. L, M, *Ampelisca abdita*; K, R, T, U, Y, *Ampelisca agassizi*; B, *Ampelisca brevisimulata*; Z, AA, *Ampelisca brachycladus*; A, F, *Ampelisca careyi*; C, D, *Ampelisca cristata*; S, V, W, *Ampelisca lobata*; E, *Ampelisca macrocephala*; I, J, N, *Ampelisca milleri*; X, BB, *Ampelisca romigi*; G, H, *Ampelisca unsocalae*; O–Q, *Ampelisca venetiensis* (figures modified from: Barnard 1954b, 1960b; Chapman 1988; Dickinson 1982; and Roney 1990).

— Uropod 1 inner ramus less than one-half as long as the outer ramus and shorter than the peduncle (plate 277Z); telson lobes with a medial projection (plate 277AA). . . . . *Ampelisca brachycladus*

17. Uropod 1 rami and peduncle equal in length (plate 277X); telson lobes bare on medial edge; antenna 1 reaching distal end of antenna 2 peduncle, uropod 3 inner ramus uncinate (plate 277BB). . . . . *Ampelisca romigi*

— Uropod 1 rami longer than peduncle (plate 277R) and uropod 3 inner ramus sharply lanceolate (plate 277U); telson lobes with four to five medial spines (plate 277Y); antenna 1 not reaching distal end of antenna 2 peduncle . . . . *Ampelisca agassizi*

18. Pereopod 7 article 5 lacking spine bearing notch on anterior margin (plate 278A); uropod 1 inner margin of outer ramus with spines (plate 278B); uropod 3 inner edge of inner ramus lined with evenly spaced serrations bearing inserted spines (plate 277W) . . . . *Ampelisca lobata*

— Pereopod 7 article 5 with spine bearing notch on anterior margin (plate 278C); uropod 1 inner margin outer ramus without spines (plate 278D); uropod 3 inner edge of inner ramus lined with smaller, unevenly spaced serrations that are without inserted spines (plate 278E, 278F) 19

19. Uropod 3 inner and outer rami lengths equal and with tiny serrations on inner edge of inner ramus (plate 278E, note arrow); coxa 1 expanding only slightly distally (plate 278G) . . . . *Ampelisca fageri*

— Female uropod 3 inner ramus longer than outer ramus and inner edge of inner ramus with medium-size serrations (plate 278F); coxa 1 expanding distally (plate 278H) (Pacific records are probably *A. fageri* variants). . . . . *Ampelisca schellenbergi*

20. Distal peduncle of uropod 1 reaching distal end of uropod 2 peduncle, coxae 2–3 posterodistal corner evenly truncated with posterior edge as long as anterior edge and coxa 1 with straight anterior edge and about equal in length to coxa 2 (plate 278I). . . . . *Byblis millsi*

— Distal peduncle of uropod 1 reaching less than two-thirds of the length of uropod 2 peduncle (not shown); coxae 2–3 posterodistal corners obliquely truncated with anterior edges longer than posterior edges and coxa 1 with concave anterior edge and longer than coxa 2 (plate 278J) . . . . *Byblis veleronis*

LIST OF SPECIES

Ampelisca abdita Mills, 1967 (=*A. milleri* of earlier San Francisco Bay literature, not of Barnard, 1954b). An estuarine species native to and characteristic of the North American Atlantic coast, and introduced to central California (San Francisco and Tomales Bays); see Mills 1967, J. Fish. Res. Bd. Can. 24: 305–355 (biology, ecology); Chapman 1988, J. Crust. Biol. 8: 364–382 (introduced status). Whole body illustration shown in plate 256L; 8 mm; intertidal to 15 m.

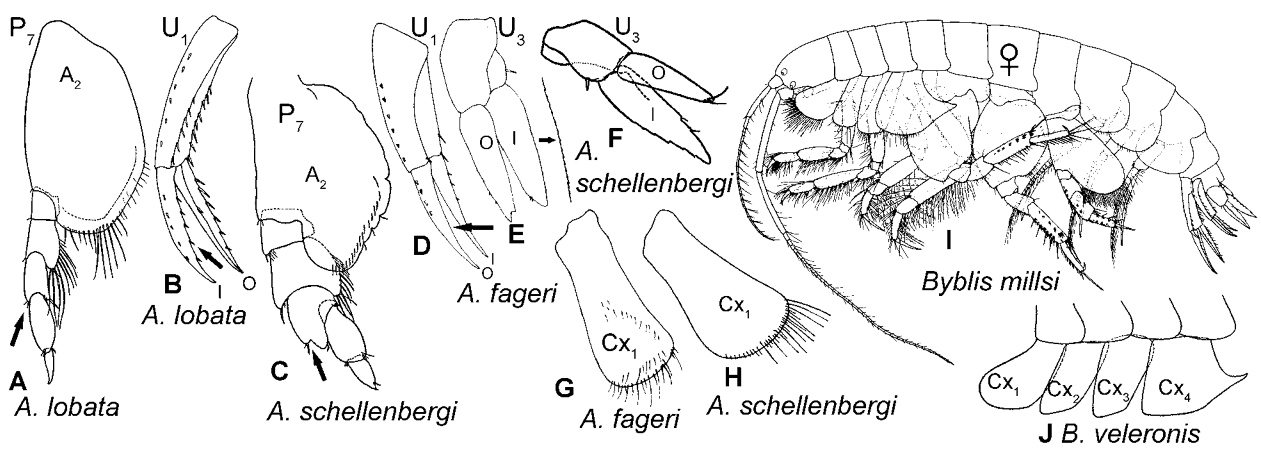

PLATE 278 Ampeliscidae. D, E, G, *Ampelisca fageri*; A, B, *Ampelisca lobata*; C, F, H, *Ampelisca schellenbergi*; I, *Byblis millsi*; J, *Byblis veleronis* (figures modified from Barnard 1954b, 1967b; and Dickinson 1982, 1983).

Ampelisca agassizi (Judd, 1896). Western Atlantic and Eastern Pacific, cold temperate to tropical, and probably more than one species; 7.5 mm; 5 m–450 m.

**Ampelisca brachycladus* Roney, 1990. Southern, not reported in the region of this book, but likely to be confused with *A. agassizi*; 10 m–50 m.

Ampelisca brevisimulata Barnard, 1954b. 9 mm; 4 m–456 m.

Ampelisca careyi Dickinson 1982. A possible variant of *A. unsocala*e; 12 mm; intertidal—200 m.

Ampelisca cristata Holmes, 1908. In coarse sand; 14 mm; intertidal—152 m.

Ampelisca fageri Dickinson, 1982. Mixed bottom areas of sand and boulders; 8 mm; intertidal—40 m.

Ampelisca hancocki Barnard, 1954b. Fine sand and silt; 6.5 mm; 9 m–200 m.

**Ampelisca indentata* Barnard, 1954b. Point Conception and south; not clearly within the region but could be confused with small *A. pugetica*; 5 mm; 33 m–98 m.

Ampelisca lobata Holmes, 1908, 7 mm, shallow subtidal to 591 m.

**Ampelisca macrocephala* (Liljeborg 1852). Boreal; 9 mm; 10 m–280 m.

Ampelisca milleri Barnard 1954b. Central California (Gulf of the Farallones) to Ecuador, and the Galapagos Islands, a native marine species earlier confused with the estuarine *A. abdita* in San Francisco Bay; 6 mm; intertidal—187 m.

Ampelisca pacifica Holmes, 1908. Monterey Bay and south; 12 mm; 5 m–1,821 m.

Ampelisca pugetica Stimpson, 1864. 8.5 mm; intertidal—255 m.

Ampelisca romigi Barnard, 1954b. Monterey Bay and south; 10 mm; 3 m–508 m in coarse sand and gravel.

**Ampelisca schellenbergi* Shoemaker, 1933. A species recorded by this name from tropical and boreal seas. Records in our region are probably *A. fageri* variants; 7.6 mm; intertidal—46 m.

Ampelisca unsocalae Barnard, 1960b. 9 mm; 50 m–1,700 m.

**Ampelisca venetiensis*, Shoemaker, 1916. Venice, California and south, but distribution poorly resolved; 18 mm; intertidal—84 m.

Byblis millsi Dickinson, 1983. 10 mm; intertidal—100 m.

Byblis veleronis Barnard, 1954b. 14 mm; 5 m–422 m.

Haploops spp. Key to species in Dickinson 1983. A deep-water genus with two confirmed species in the region (*H. lodo* and *H. tubicola,* 18 mm).

* = Not in key.

DEXAMINIDAE

Dexaminidae have fused urosomites 2 and 3 biramous uropod 3 and variable length rostrums. The inferior antennal sinus is small or lacking, the gnathopods weak or simple, the telson is laminar and deeply cleft, and coxae 1–4 are deep or shallow and, in common with Ampeliscidae, have deeply pleated gills. *Guernea*, *Paradexamine,* and *Polycheria* lack mandibular palps.

KEY TO DEXAMINIDAE

1. Pereopods 3–7 fully prehensile, pereopods 5–7 article 2 narrow, coxae 1–4 longer than deep and rostrum indistinct (plate 279A); feeds upside down from inside tunicate *Amaroucium* colonies (plate 279B) . . . . . *Polycheria osborni*
— Pereopods 3–7 simple (not prehensile), pereopods 5–7 article 2 expanded, coxae 1–4 deeper than long and rostrum distinct (plate 279C) 2
2. Pleonites 1–3 bearing lateral carina in addition to dorsal medial carina (plate 279C) . . . . *Paradexamine* sp.
— Pleonites 1–3 lacking lateral carina, dorsal carina present or absent (plate 279D). 3
3. Dorsal anteriorly directed tooth of urosomite 1 and deeply beveled, (possibly adapted for interlocking urosomites 2 and 3 with urosomite 1) and coxa 5 larger than coxa 4 (plate 279D) . . . . *Guernea reduncans*
— Dorsal tooth of urosomite 1 absent or posteriorly directed, pereopod 5 coxa smaller than coxa 4 (plate 279E, 279F) 4
4. Coxa 4 posteriorly expanded, urosomite 1 and fused urosomites 2 and 3 with a sharp mid dorsal tooth preceded by a deep notch (plate 279E) . . . . *Atylus tridens*
— Coxa 4 lacking posterior expansion and urosomites with rounded mid dorsal teeth that lack an anterior notch (plate 279F) 5
5. Telson wider than long (plate 279G); eye longer than the rostrum (plate 279F). . . . . *Atylus georgianus*
— Telson longer than wide (plate 279H); eye shorter than the rostrum (plate 279I) . . . . *Atylus levidensus*

LIST OF SPECIES

Atylus species were previously in Atylidae.

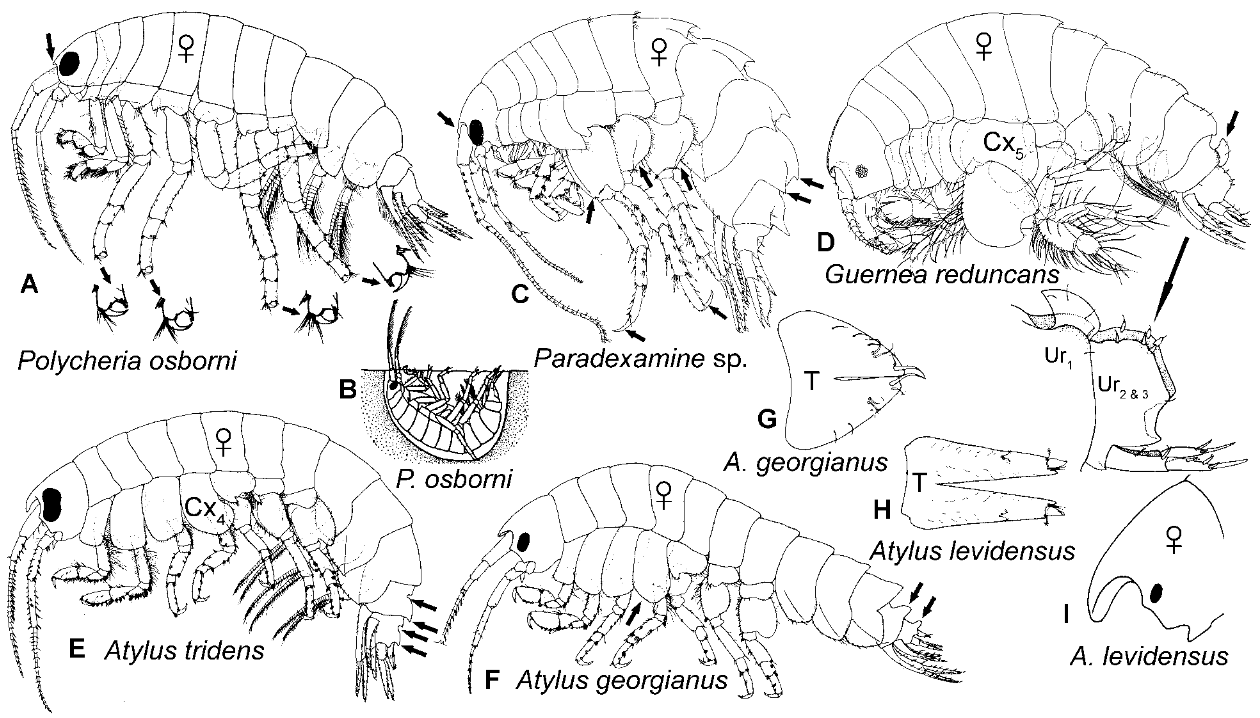

PLATE 279 Dexaminidae. F, G, *Atylus georgianus*; H, I, *Atylus levidensus*; E, *Atylus tridens*; D, *Guernea reduncans*; C, *Paradexamine* sp.; A, B, *Polycheria osborni* (figures modified from Barnard 1972a; Barnard and Karaman 1991a; Bousfield and Kendall 1994; and Skogsberg and Vansell 1928).

Atylus georgianus Bousfield and Kendall, 1994. Subtidal sand and eelgrass; 8 mm; intertidal—3 m.

Atylus levidensus Barnard, 1956. Various sediments but especially in sand; 12 mm; intertidal—3 m.

Atylus tridens (Alderman, 1936). Sand, eelgrass, and rocky bottoms, occasionally pelagic; 10 mm; intertidal—6 m.

Guernea reduncans (Barnard, 1957b) (=*Dexamonica reduncans*). In fine sand and green mud; 2.5 mm; subtidal—180 m.

Paradexamine sp. Introduced, occurs in high-salinity fouling communities of Los Angeles, Long Beach Harbor and San Francisco Bay; 5 mm, intertidal—3 m. The illustration of the Australian *P. frinsdorfi* Sheard, 1938 is provided as an example of the genus.

Polycheria osborni (Calman, 1898). *Polycheria* makes pits in compound tunicate tests (especially *Aplidium californicum*); they live upside down in the pits (which they can open and close), with their legs extended and pleopods propelling water forward along the body, while feeding on suspended particles. Broods up to 80 young in early summer. Intertidal rocky shores; 5.8 mm.

OEDICEROTIDAE

Oedicerotidae have weakly fossorial pereopods and burrow into fine sand or mud where most species are probably predators on meiofauna. The eyes are dorsally coalesced into a single mass on the decurved rostrum. The telson is laminar and entire, and pereopod 7 is more than half again as long as pereopod 6. Oedicerotidae lack an accessory flagellum. Mandibular palps are present and molars are prominent or reduced. The taxonomy is based on females.

KEY TO OEDICEROTIDAE

1. Gnathopod 2 chelate (plate 280A); mandibular molar reduced (plate 280B) 2
— Gnathopod 2 subchelate (plate 280C); mandibular molar prominent (plate 280D) 6
2. Pereopod 5, article 5 approximately half as long as article 6 (plate 280E) . . . . *Eochelidium* cf. *miraculum*
— Pereopod 5 article 5 equal to or longer than article 6 (plate 280F) 3
3. Uropod 3 half as long as uropod 1 (plate 280F) . . . . *Americhelidium micropleon*
— Uropod 3 more than two-thirds as long as uropod 1 (plate 280G) 4
4. Gnathopod 1 palm of article 6 transverse (plate 280H), gnathopod 2 dactyl nearly one-third of the length of article 6 (plate 280I) . . . . *Americhelidium rectipalmum*
— Gnathopod 1 palm of article 6 is slightly oblique, verging toward subchelate (plate 280J); gnathopod 2 dactyl less than one-fourth of the length of article 6 (plate 280K) 5
5. Epimeron 2 posterior ventral corner produced (plate 280L) . . . . *Americhelidium shoemakeri*
— Epimeron 2 posterior ventral corner square (plate 280M) . . . . *Americhelidium pectinatum*
6. Gnathopod 2 article 5 not extending over the posterior edge of article 6 (plate 280C); head as long as first four pereonites combined (plate 280N) . . . . *Westwoodilla tone*
— Gnathopod 2 article 5 extending over more than half of the posterior edge of article 6 (plate 280O); head shorter than first four pereonites combined (plate 280P) 7
7. Pereopod 4 article 4 anteriorly expanded (plate 280Q) pereopod 7 article 2 posterior ventral corner expanded (plate 280R); pleonite 2 posterior ventral corner strongly produced and rostrum anterior curved to less than 60° angle of the head dorsum (plate 280R) . . . . *Pacifoculodes spinipes*
— Pereopod 4 article 4 parallel sided (plate 280P, 280S); pleonite 2 posterior ventral corner square or rounded (plate

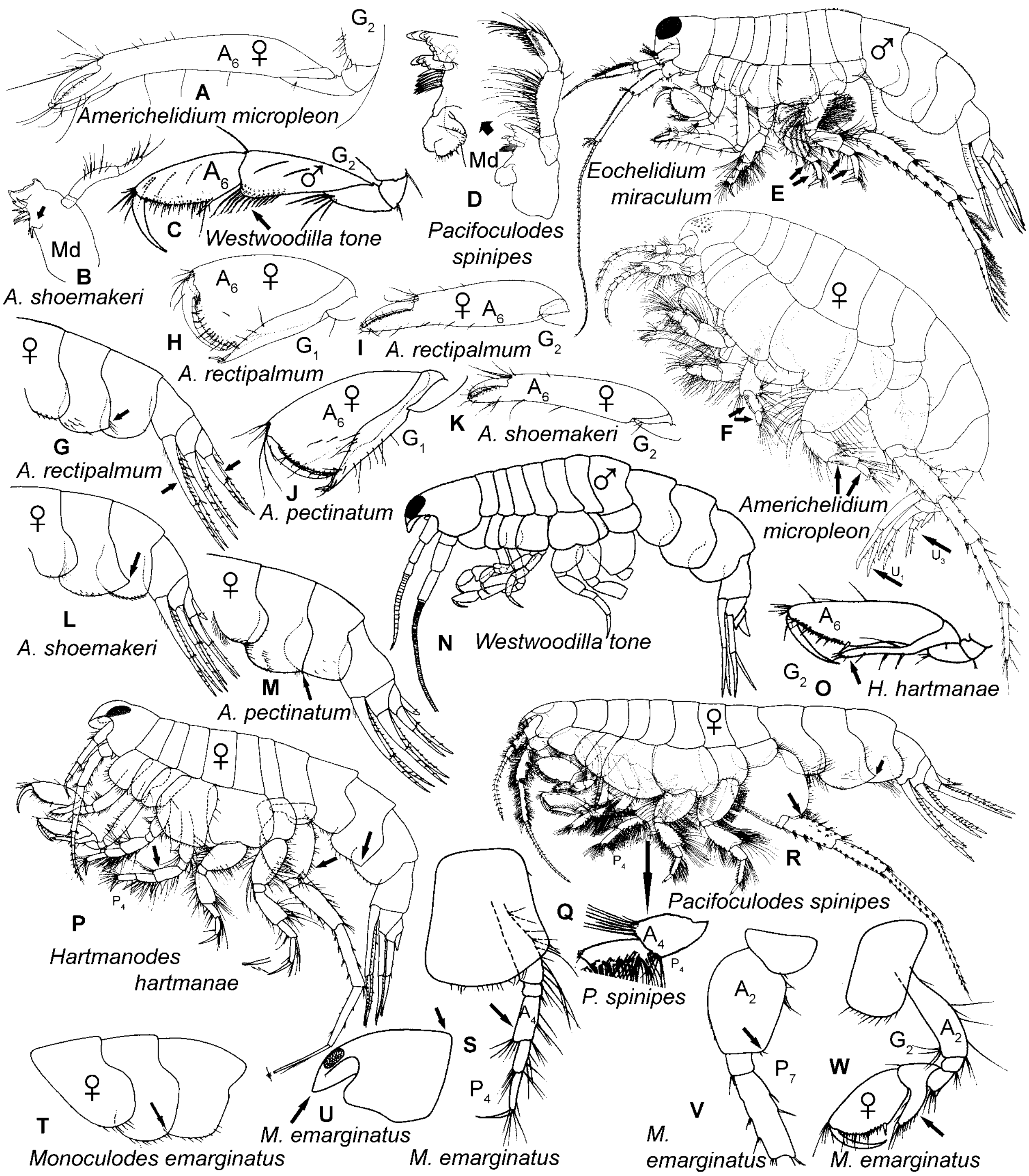

PLATE 280 Oedicerotidae. A, F, *Americhelidium micropleon*; J, M, *Americhelidium pectinatum*; G–I, *Americhelidium rectipalmum*; B, K, L, *Americhelidium shoemakeri*; E, *Eochelidium* sp. cf. *E. miraculum*; O, P, *Hartmanodes hartmanae*; S–W, *Monoculodes emarginatus*; D, Q, R, *Pacifoculodes spinipes*; C, N, *Westwoodilla tone* (figures modified from Barnard 1962d, 1977; Bousfield and Chevrier 1996; Imbach 1967; Jansen 2002; and Mills 1962).

280P, 280T); rostrum anterior curved to 80° or greater angle with the head dorsum (plate 280U); pereopod 7, posterior ventral corner of article 2 not expanded ventrally (plate 280P, 280V) 8

8. Gnathopod 2 extension of article 5 less than 60% total length of article 6 (plate 280W); pleonite 2 posterior ventral corner rounded (plate 280T) . . . . *Monoculodes emarginatus*

— Gnathopod 2 extension of article 5 more than 60% length of article 6 (plate 280O); pleonite 2 posterior ventral corner square (plate 280P) . . . . *Hartmanodes hartmanae*

LIST OF SPECIES

Americhelidium micropleon (Barnard, 1977) (=*Synchelidium micropleon*). On open fine sand beaches, not reported north of Dillon Beach; 3.5 mm; intertidal.

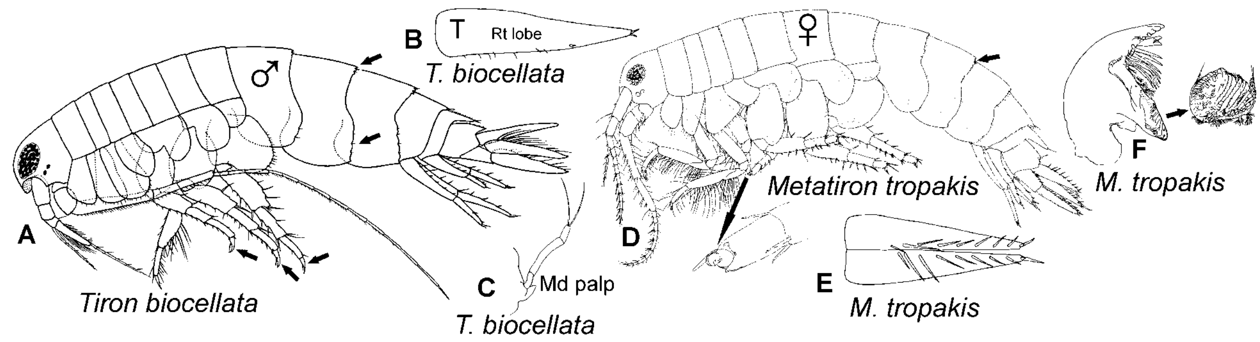

PLATE 281 Synopiidae. D–F, *Metatiron tropakis*; A–C, *Tiron biocellata* (figures modified from Barnard 1962b, 1972b).

Americhelidium pectinatum Bousfield and Chevrier, 1996. Shallow sandy sediments; 4 mm; intertidal—50 m.

Americhelidium rectipalmum (Mills, 1962) (=*Synchelidium rectipalmum*). Clean sand bottoms; 6 mm; intertidal—90 m.

Americhelidium shoemakeri (Mills, 1962) (=*Synchelidium shoemakeri*). Clean sand bottoms; 4.5 mm; intertidal—180 m.

Eochelidium sp. *cf. E. miraculum* (Imbach, 1967). The identity of this species is unclear. In fine silty sediments of warm, high-salinity harbor areas (Puget Sound, San Francisco Bay, and Los Angeles Harbor); a likely ballast water introduction from Asia; 5 mm; intertidal—10 m.

Hartmanodes hartmanae (Barnard, 1962d) (=*Monoculodes hartmanae*). Common in rocky intertidal and shallow water communities and scarce below 37 m; 5 mm; intertidal—146 m.

**Monoculodes emarginatus* Barnard, 1962d. Fine mud and sand, may not be a shallow water species, difficult to distinguish from *M. perditus* Barnard 1966; 4.5 mm; 10 m–200 m.

Pacifoculodes spinipes Mills, 1962 (=*Monoculodes spinipes*). Surf zone of open sandy beaches; 11 mm; intertidal—98 m.

Westwoodilla tone Jansen, 2002. Fine mud and sand, usually offshore; broad-bodied species; previously confused with the North Atlantic *W. caecula* (Bate, 1857) (see: Jansen 2002, Steenstrupia 27(1): 83–136); 8 mm; shallow subtidal—500 m.

SYNOPIIDAE

Synopiidae (Tironidae) have helmet or plough-shaped heads, prominent and multiarticulate accessory flagella, similar length pereopods 6 and 7 (relative to Oedicerotidae), and strong sexual dimorphism. Collected in both benthic grabs and vertical plankton hauls, and some species having peculiar grasping dactyls (see *Metatiron*). Synopiidae may be commensals of benthic or epibenthic invertebrates. The family remains poorly studied in the region. Gnathopods of *Tiron* and *Metatiron* are weakly subchelate or simple, and they bear two accessory eyes near the base of antenna 2. *Garosyrrhoe* and *Syrrhoe,* occurring near our region, have transverse gnathopods and lack accessory eyes.

KEY TO SYNOPIIDAE

1. Pleonites 1–3 crenulate dorsally and on medioposterior edges and dactyls normal and strong (plate 281A); telson lacking dorsal spines (plates 256DD, 281B); mandibular palp present (plate 281C) (condition of the molar has not been reported) .... *Tiron biocellata*
— Pleonites crenulate only on dorsal third, dactyls stubby and twisted (plate 281D); telson lobes lined with large medial spines (plate 281E); mandibular palp absent and molar large (plate 281F) .... *Metatiron tropakis*

LIST OF SPECIES

**Garosyrrhoe bigarra* (Barnard 1962b). Southern California; 4.5 mm; sublittoral.

Metatiron tropakis (Barnard, 1972b). In sand, both coasts of North America and the Caribbean; a species complex; 6 mm; 3 m–357 m.

**Syrrhoe crenulata* Göes, 1866. 10 mm; off of Oregon in deeper water (40 m–200 m).

**Syrrhoe longifrons* Shoemaker, 1964. Vancouver Island; 10 mm, "shallow waters."

Tiron biocellata Barnard 1962b. Rock bottoms associated with the worms *Diopatra* and *Nothria*. Caribbean records are probably of another species; 4.6 mm; shallow subtidal—180 m.

LEUCOTHOIDAE

Leucothoidae are commensals of tunicates identifiable to family by their carpochelate gnathopods. Previously recognized Anamixidae appear to be nonfeeding super-male leucothoid morphs referred to as "anamorph" stages with mandibles and maxillae replaced by a ventral keel (Thomas and Barnard 1983) and "anamixid" females were previously recognized as *Leucothoides*. The Leucothoidae are thus likely to be sequential hermaphrodites. Distinctions among families, genera, species, and morphs (and the biogeography) in this group are difficult to resolve without greater knowledge of their life histories and development patterns. See Thomas 1997 Rec. Australian Mus. 49: 35–98.

KEY TO LEUCOTHOIDAE

1. Gnathopod 2 dactyl reaching distal process of article 5 (plate 282A) 2
— Gnathopod 2 dactyl not reaching extended process of article 5 (plate 282D, 282E); mandible (plate 282B) and maxilliped (plate 282C) fully formed .... *Leucothoides pacifica*
2. Mandibles and maxilliped replaced by a ventral keel (males only) (plate 282F) ....

* = Not in key.

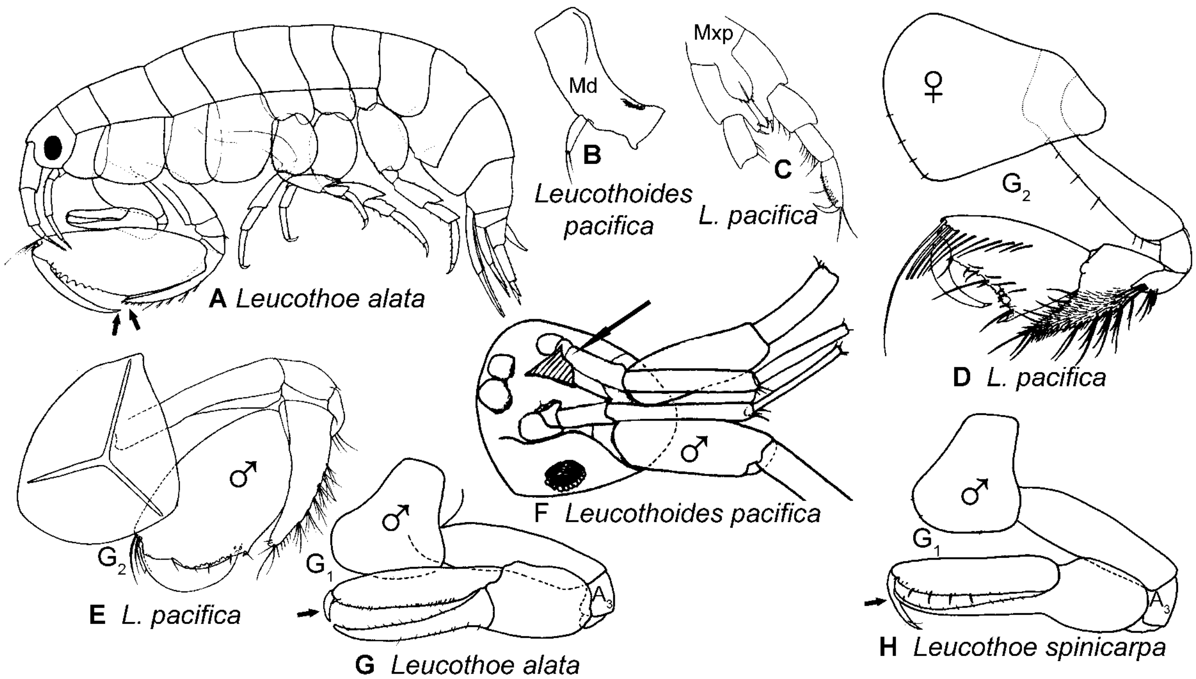

PLATE 282 Leucothoidae. A, G, *Leucothoe alata* (male?); H, *Leucothoe spinicarpa*; B–F, *Leucothoides pacifica* (figures modified from Barnard 1955b, 1962c, 1969a and Nagata 1965a).

. . . . . . *Leucothoides pacifica* (previously *Anamixis lindsleyi*)
— Mandible and maxilliped fully formed (plate 282B, 282C) 3
3. Male gnathopod 1 dactyl shorter than article 3 (plate 282G) . . . . *Leucothoe alata*
— Male gnathopod 1 dactyl 1.5 times longer than article 3 (plate 282H) . . . . *Leucothoe spinicarpa*

LIST OF SPECIES

Leucothoides pacifica (Barnard 1955b) (=*A. lindsleyi*, *Anamixis pacifica*). In sponges and tunicates, especially on pilings. *Leucothoides* could be a morph of *Leucothoe*; 2.8 mm; intertidal—8 m.

Leucothoe alata Barnard, 1959b (=*Anamixis pacifica*). Introduced parasite and commensal of tunicates in San Francisco Bay, and recorded in "open-sea" algal bottoms (Barnard 1962C); Japan; sex (plate 282A) not given; to 12.3 mm; intertidal—18 m.

Leucothoe spinicarpa (Abildgaard, 1789). Introduced cosmopolitan marine parasite and commensal of tunicates "widely distributed from subarctic waters to south temperate regions; perhaps universally distributed" (Barnard 1962C) and thus likely to consist of multiple species; 3 mm; intertidal—10 m.

STEGOCEPHALOIDEA

Stegocephaloidea (Iphimediidae and Odiidae) are distinguished primarily by mouth part morphology because the body sculpturing and ornamentations are often similar among genera. The cone-shaped mouth bundle, needle-shaped mandibles, and weak molars (plate 256KK–256LL) are probable adaptations for predation on coelenterates, sponges, and bryozoans (Coleman and Barnard 1991, Moore and Rainbow 1992). Most species appear to be protandrous hermaphrodites or parthenogenic (Moore 1992).

KEY TO STEGOCEPHALOIDEA

1. Pleonites 1–3 dorsal and lateral teeth reduced except for a single rounded dorsal tooth on pleonite 3 (plate 283A); telson with convergent lateral edges and bluntly acute (plate 283B); gnathopod 2 article 6 expanding distally (plate 283C). . . . . *Cryptodius kelleri*
— Pleonites 1–3 with pairs of teeth at the posterior margins and dorsally (plate 283D, 283E); gnathopod 2 article 6 distally narrow (plate 283F); telson with nearly parallel lateral edges and broad posterior excavation (plate 283G, 283H) 2
2. Telson posterior excavation deep (plate 283G); maxilla 1 palp of two articles (plate 283I) . . . . *Iphimedia rickettsi*
— Telson posterior excavation shallow (plate 283H); maxilla 1 palp of one article (plate 283J) . . . . . *Coboldus hedgpethi*

LIST OF SPECIES

IPHIMEDIIDAE

Coboldus hedgpethi (Barnard, 1969a) (=*Panoploea* in Iphimediidae, previously Acanthonotozomatidae). In mixed sediments (especially cobbles) among algae and on harbor pilings; 4.5 mm; 1 m–82 m.

Iphimedia rickettsi (Shoemaker, 1931) (=*Panoploea ricketsi*). Rocky substrata, especially in holdfasts of kelps and coralline algae, possibly commensal; 8 mm; low intertidal—60 m.

LIST OF SPECIES

Cryptodius kelleri (Bruggen, 1907) (=*Odius kelleri*). Boreal northern Pacific, rocky substrata, especially among algae; 5 mm; intertidal—90 m.

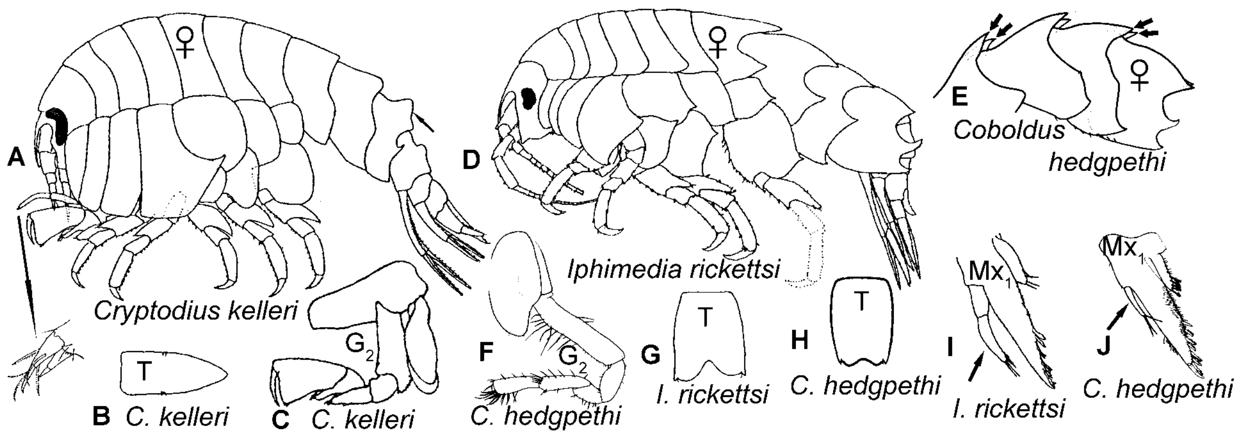

PLATE 283 Stegocephaloidea. E, F, H, J, *Coboldus hedgpethi*; A–C, *Cryptodius kelleri*; D, G, I, *Iphimedia rickettsi* (figures modified from: Barnard 1969a and Moore 1992).

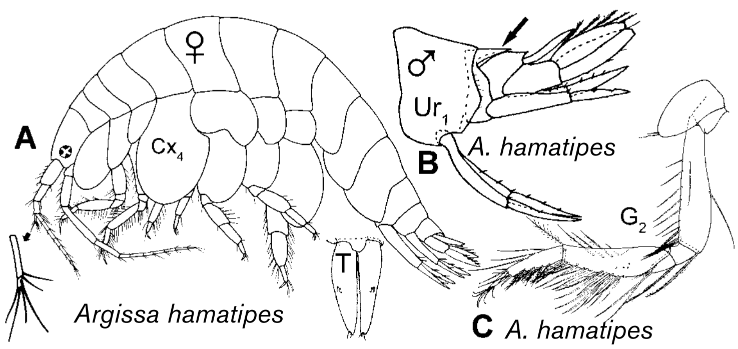

PLATE 284 Argissidae. A–C, *Argissa hamatipes* (figures modified from Barnard 1969b and Hirayama 1983).

ARGISSIDAE

Argissidae of this region include a single cosmopolitan species distinguished by the combination of long coxae 1 and 4, feeble gnathopods, telson deeply cleft and posteriorly expanded pereopod 7 article 2. Eyes (when present) consist of four visual elements. The Pacific species is unlikely to be the same as *A. hamatipes* of the North Atlantic. The unusual coxa of Argissidae may allow upside-down burrowing and feeding similar to Megaluropidae, which Argissidae resemble.

KEY TO ARGISSIDAE

1. Eye of four visual elements, coxa 4 longer than coxa 3, female urosomite 1 evenly rounded (plate 284A); male urosomite 1 with a large tooth (plate 284B); gnathopod 2 simple (plate 284C) . . . . *Argissa hamatipes*

LIST OF SPECIES

Argissa hamatipes (Norman, 1869). Cosmopolitan in mud, sand and rock benthos. A likely complex of species of which there are shallow and deep-water members. Males of eastern Pacific populations have carina on dorsal urosomites 1–3 (no illustrations published); 4.5 mm; 4 m–1,096 m.

MEGALUROPIDAE

Megaluropidae feed upside down at the sand episurface. Their unusual coxae allow dorsal extension of pereopods 3–4 from the upside down position; the long, flexible pereopods 5–7 can quickly dig into well-sorted sediments leaving only a hole at the sand surface that is maintained by the legs and leaf like uropods (Barnard et al., 1988, Crustaceana Suppl. 13: 234–244). Terminal pelagic males have large eyes and antenna 2 with long flagellum and setal tufts on the peduncle, a "distinctive" gnathopod 2 and large pleon.

KEY TO MEGALUROPIDAE

1. Gnathopod 2 article 4 distally produced (plate 285A, 285B); male rostrum short and ocular lobe of head bearing a sharp angle (plate 285C); accessory flagellum of two articles (plate 285D) 2
— Gnathopod 2 article 4 not distally produced (plate 285E); male rostrum long, ocular lobe lacking sharp angle, accessory flagellum of one article (plate 285F) . . . . . . *Resupinus*
2. Epimeron 3 posteriorly serrate (plate 285A, 285G) . . . . *Gibberosus myersi*
— Epimeron 3 posteriorly smooth (plate 285H) . . . . *Gibberosus devaneyi*

LIST OF SPECIES

**Resupinus* sp. Shallow-water tropical genus (Thomas and Barnard 1986) included for reference due to complex geography and taxonomy of *Gibberosus*.

Gibberosus myersi (McKinney, 1980) (=*Megaluropus longimerus* Barnard 1962b). Cryptogenic: in Atlantic from Caribbean to

* = Not in key.

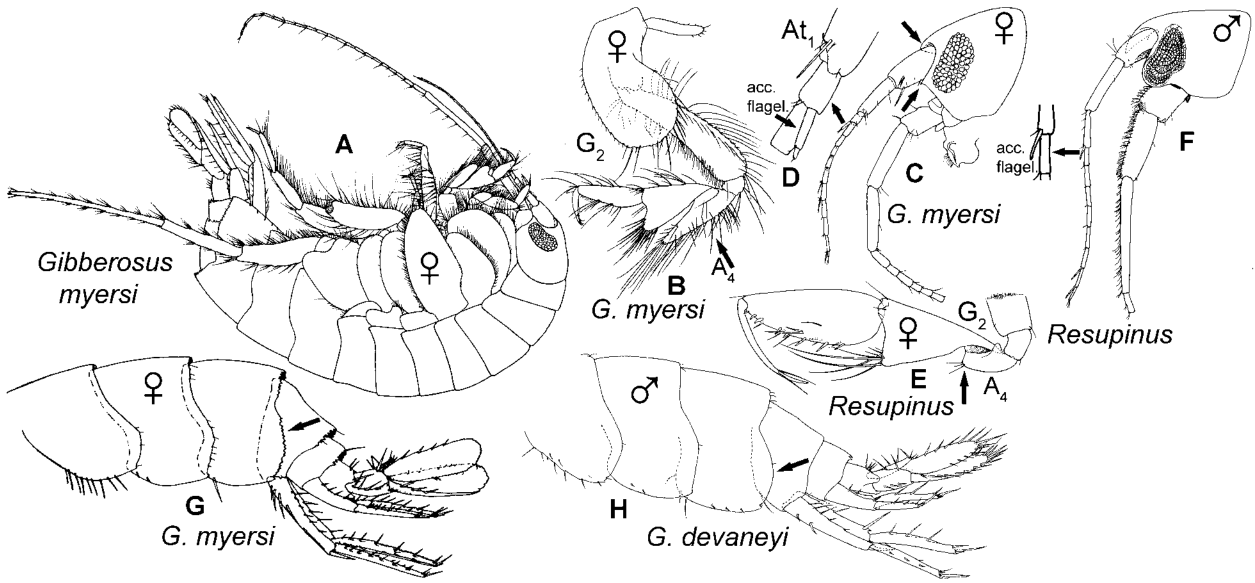

PLATE 285 Megaluropidae. H, *Gibberosus devaneyi*; A–D, G, *Gibberosus myersi*; E, F, *Resupinus* (figures modified from Barnard 1962b; McKinney 1980; Thomas and Barnard 1986).

North Carolina and in the eastern Pacific from Peru to British Columbia; not likely to be a single species; eastern Pacific forms on sand bottoms, among *Phyllospadix* and *Silvetia,* and occasionally among *Anthopleura elegantissima*; 4 mm; intertidal—27 m.

**Gibberosus devaneyi* Thomas and Barnard 1986. La Jolla and south but may occur in the southern end of our region; 2–3 mm; intertidal sand beaches.

LYSIANASSOIDEA

Lysianassoidea (Aristidae, Lysianassidae, Opisidae, Uristidae) are predators, scavengers, commensals, and parasites (Dahl, 1979; Conlan 1994). The mitten-shaped article 6 and long article 3 of gnathopod 2 and stubby article 1 of antenna 2 are distinctive characteristics of the infraorder. Telsons of lysianassids range from flat and deeply cleft to entire and stubby.

KEY TO LYSIANASSOIDEA

1. Uropod 3 consisting of peduncle only (plate 286A); pereopod 7 article 2 greatly expanded (plate 286B); body may be covered with scales and fuzz; one to three pleonites plus the first urosomite forming erect peaks (plate 286B); or body smooth, with only the third pleonite forming peaks (plate 286C) (secondary phase male) . . . . . *Ocosingo borlus*
— Uropod 3 with two rami (plate 286D); body not as above 2
2. Gnathopod 1 chelate (plate 286E) 3
— Gnathopod 1 simple (plate 286F), or subchelate, or parachelate (plate 286G), maximum extension of thumb not beyond dactyl hinge 4
3. Gnathopod 1 inner margins of dactyl and palm nearly parallel (plate 286E, 286H); telson entire (plate 286I); eye usually present . . . . *Prachynella lodo*
— Dactyl and palm of gnathopod 1 outlining a circular gap with the dactyl and thumb touching only at the tips (plate 286J); telson deeply cleft (plate 286K), eyes always present . . . . *Opisa tridentata*
4. Telson entire (plate 286L) 5
— Telson cleft (plate 286M) 10
5. Telson distally concave (plate 286L). 6
— Telson distally convex (plate 286N) 8
6. Female antenna 1 article 3 half as long as wide and epistome not extending past upper lip (plate 286O); outer ramus of uropod 3 of two prominent articles (plate 286P) . . . . *Dissiminassa dissimilis*
— Female antenna 1 article 3 less than one-third as long as wide (plate 286Q); and epistome extending past upper lip (plate 286R); outer ramus of uropod 3 with a minute distal article (plate 286S) 7
7. Female third pleonal epimeron a quadrate plate (plate 286T) . . . . *Aruga holmesi*
— Female third pleonal epimeron posteriorly concave (plate 286U) . . . . *Aruga oculata*
8. Posterior edge of telson with two stout spines (plate 286N); outer ramus of uropod 3 of two articles (plate 286V); gnathopod 1 palm transverse 7 (plate 286G). . . . . *Orchomenella recondita*
— Posterior edge of telson without stout spines (plate 286W, 286X); uropod 3 outer ramus of a single article (plate 286Y); gnathopod 1 simple (plate 286Z) 9
9. Uropod 3 inner ramus over half as large as outer ramus (plate 286Y); anterior cephalic lobe and posterior margins of pereopod 7 crenulate (plate 286AA); mandibular molar large (plate 286BB) . . . . *Macronassa macromera*
— Uropod 3 inner ramus <30% as large as outer ramus (plate 286CC); anterior cephalic lobe and posterior margins of pereopod 7 smooth (plate 286DD, 286EE); mandibular molar small and fuzzy (plate 286FF) . . . . *Macronassa pariter*
10. Ventral posterior of pleonal epimeron 3 faintly or strongly hooked (plate 287A, 287B); mandibular palp even with molar (plate 287C) 14

* = Not in key.

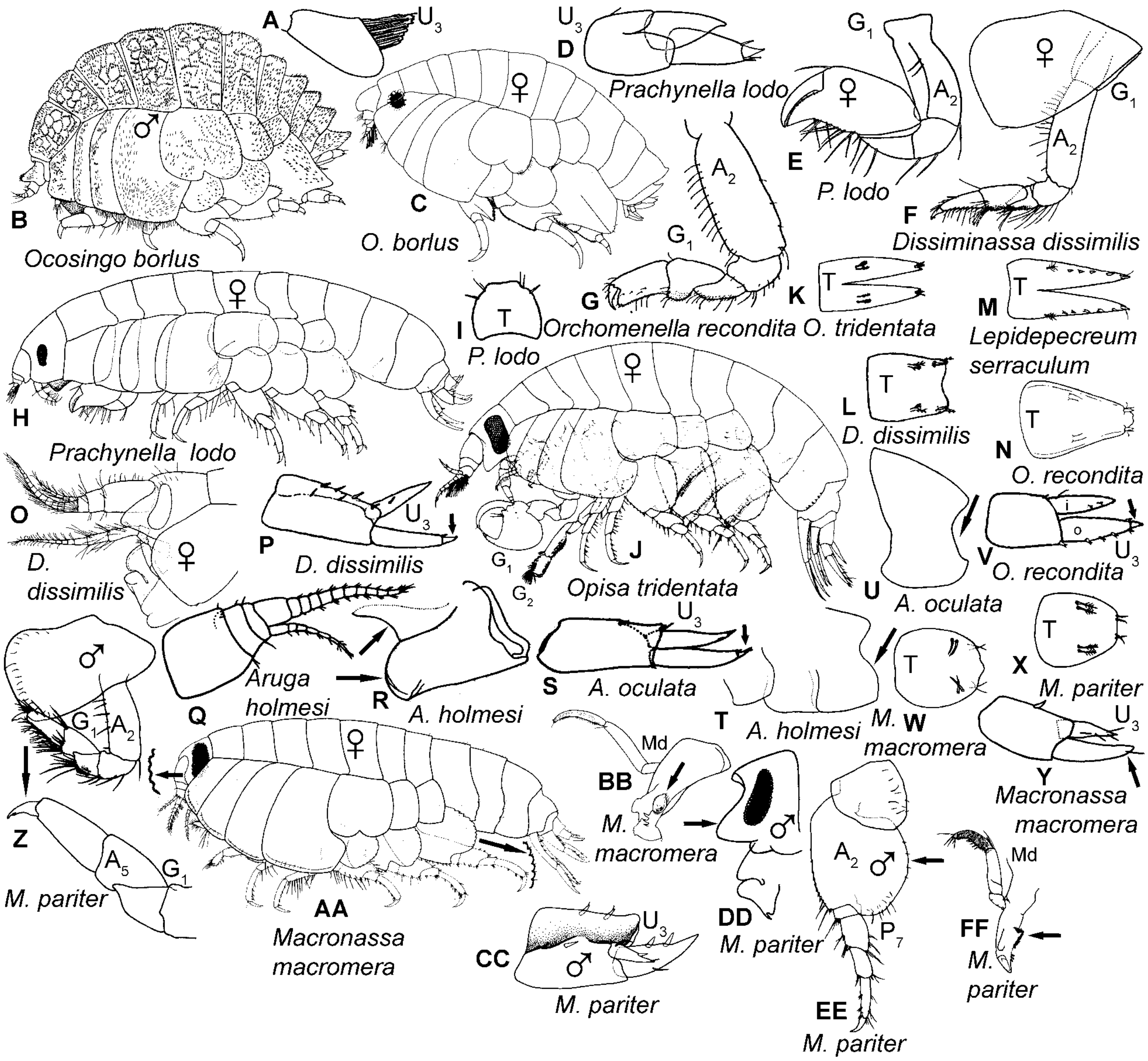

PLATE 286 Lysianassoidea. Q, R, T, *Aruga holmesi*; S, U, *Aruga oculata*; F, L, O, P, *Dissiminassa dissimilis*; M, *Lepidepecreum serraculum*; W, Y, AA, BB, *Macronassa macromera*; X, Z, CC–FF, *Macronassa pariter*; G, N, V, *Orchomenella recondita*; A–C, *Ocosingo borlus*; J, K, *Opisa tridentata*; D, E, H, I, *Prachynella lodo* (figures modified from Barnard 1955a, 1964b, 1967c, 1969a; Bousfield 1987; Dalkey 1998; Shoemaker 1942; and Stasek 1958).

— Ventral posterior of third pleonal epimeron square, rounded, not hooked (plate 287D); mandibular palp proximal to molar (plates 286BB, 286FF, 287E). 11

11. Urosomite 1 dorsally carinate, overlapping urosomite 2 (plate 287D). 12

— Urosomite 1 rounded, not overlapping urosomite 2 (plate 287F) . . . . *Orchomene minutus*

12. Dorsal pereonites and pleonites rounded (plate 287D); anterior extension of antenna 1 article 1 over article 2 slight (plate 287G). 13

— Dorsal pereonites and pleonites carinate or sharply extending posteriorly (plate 287H); large projection on dorsal antenna 1, article 1 (plate 287I). . . . *Lepidepecreum gurjanovae*

13. Third pleonal epimeron extension acuminate (plate 287J) . . . . *Orchomene pacifica*

— Third pleonal epimeron square (plate 287D). . . . . *Lepidepecreum serraculum*

14. Coxa 1 tapering distally, smaller and partially hidden by coxa 2 (plate 287K); uropod 3 outer ramus article 2 narrower than article 1 (plate 287L). . . . . *Aristias veleronis*

— Coxa 1 not tapering distally, of similar size and not obscured by coxa 2 and uropod 3 outer ramus article 2 expanding evenly to width of 1 (plate 287A) 15

15. Coxa 1 anterior concave (plate 287A); and upper lip greatly extending beyond the epistome (not shown) 16

— Coxa 1 anterior convex (plate 287M); upper lip not extending to or extending only slightly beyond the epistome (plate 287N). 17

16. Epimeron 2 ventral posterior corner square (plate 287O); uropod 2 weakly constricted (not shown), outer ramus with enlarged spines (plate 287P); possibly a new species . . . . *Anonyx* cf. *lilljeborgi*

— Epimeron 2 ventral posterior corner produced into a sharp tooth (plate 287Q); uropod 2 distal rami with small spines (plate 287R) . . . . *Anonyx* cf. *nugax*

17. Pereopod 7 longer than pereopod 6 (plate 287M). . . . . *Psammonyx longimerus*

— Pereopod 7 shorter than pereopod 6 (plate 287S) 18

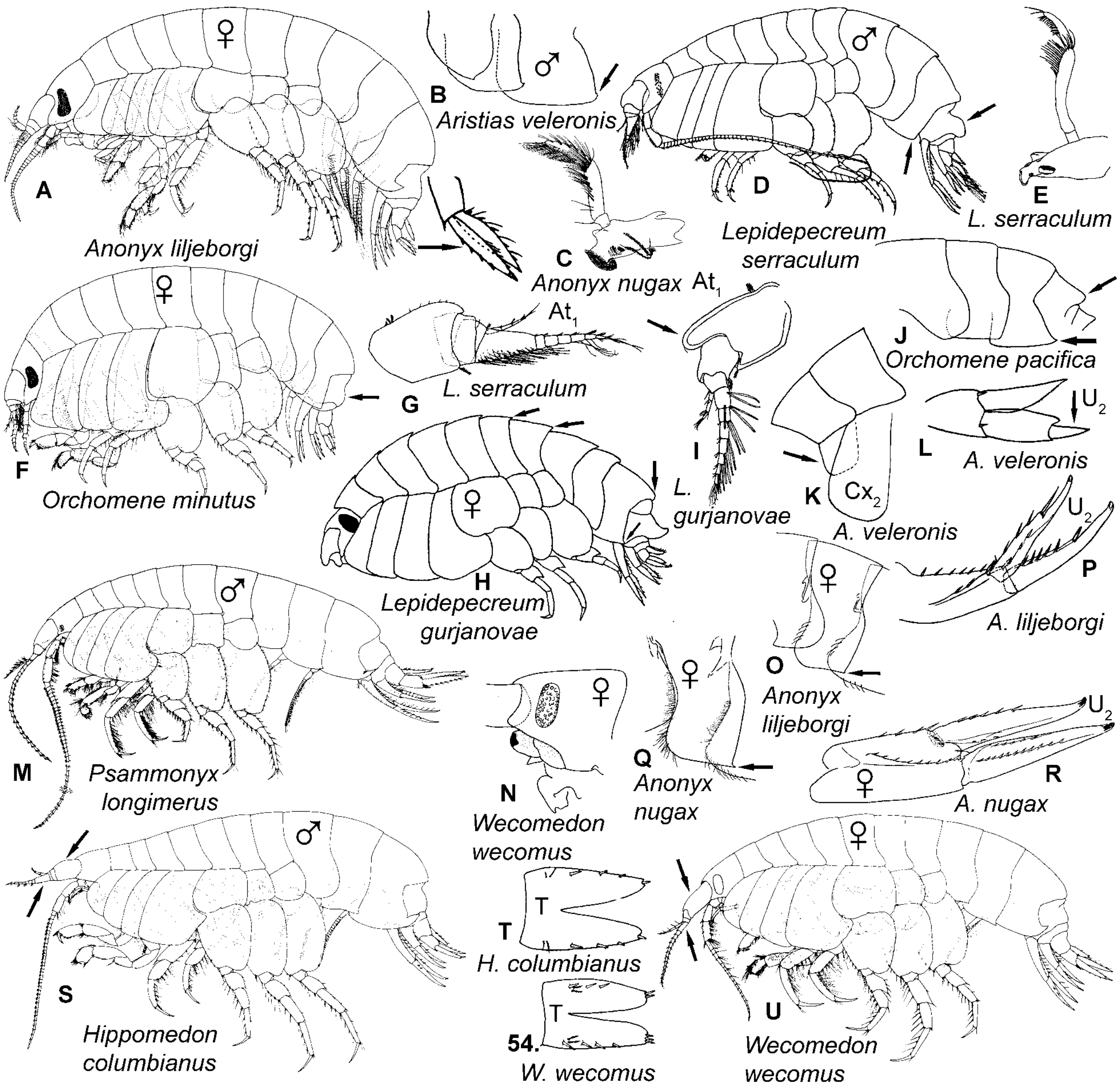

PLATE 287 Lysianassoidea. A, O, P, *Anonyx lilljeborgi*; C, Q, R, *Anonyx nugax*; B, K, L, *Aristias veleronis*; S, T, *Hippomedon columbianus*; H, I, *Lepidepecreum gurjanovae*; D, E, G, *Lepidepecreum serraculum*; F, *Orchomene minutus*; J, *Orchomene pacifica*; M, *Psammonyx longimerus*; N, U, V, *Wecomedon wecomus* (figures modified from Barnard 1964c, 1971; Bousfield 1973; Dalkey 1998; Hurley 1963; Jarrett and Bousfield 1982; Lincoln 1979; and Steel and Brunel 1968).

18. Antenna 1 flagellum article 1 more than half as long as peduncle article 1 (plate 287S); tips of telson pointed and bearing one to two spines (plate 287T) .... *Hippomedon columbianus*

— Antenna 1 flagellum article 1 less than half as long as article 1 (plate 287U); tips of telson blunt and bearing two or more spines (plate 287V)........ *Wecomedon wecomus*

LIST OF SPECIES

ARISTIDAE

Aristias veleronis Hurley, 1963. A likely commensal with brachiopods, sponges, and ascidians. Possible synonym of *A. pacificus* Schellenberg, 1936; *Aristias* sp. A (1985, SCAMIT Newsletter 3[10]) in the sponge *Staurocalyptus* may also be this species; 6 mm; intertidal—18 m.

LYSIANASSIDAE

Aruga holmesi Barnard, 1955a. Soft sediment; Washington, California, Gulf of Mexico, Western Florida; perhaps two species, one in each ocean; 11.5 mm; intertidal—183 m.

Aruga oculata Holmes, 1908. Most common in shallow soft benthos of California; 15 mm; 1 m–457 m.

Dissiminassa dissimilis (Stout, 1913) (=*Lysianassa dissimilis*). Tomales Bay and south among *Macrocystis* holdfasts, *Aplidium* sp., loose rocks, *Phyllospadix* and coralline algae; 6 mm; intertidal—73 m.

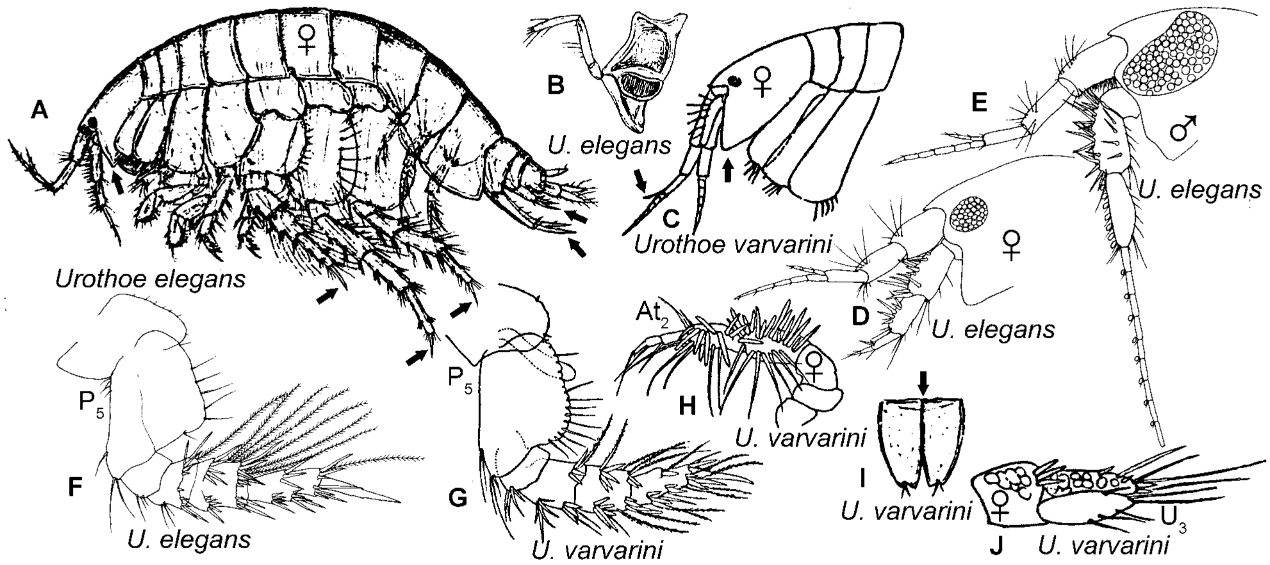

PLATE 288 Urothoidae. A, B, D–F, *Urothoe elegans*; C, G–J, *Urothoe varvarini* (figures modified from Gurjanova 1953; Lincoln 1979; and Sars 1895).

Hippomedon columbianus Jarrett and Bousfield, 1982. Soft benthos, epimeral notch not apparent in specimens <3 mm; 4.8 mm; 4 m–320 m.

Lepidepecreum gurjanovae Hurley, 1963. Sex of illlustrated specimen not given. Three forms occur (1) in Carmel and Goleta, 0 m–3 m, (2) in southern California shelf, 15 m–135 m, and (3) from southern California to British Columbia, being the typical 3-mm form described by Hurley, 1963 (see Barnard 1969a: 175); intertidal–1,720 m; tiny (to 3 mm).

Lepidepecreum serraculum Dalkey, 1998. A shallow-water species of the *L. gurjanovae*—complex, fine sandy silt to coarse red sand off open coasts; also in harbors; 3 mm at Mexico-United States border ranging to 6 mm in Canada; intertidal—150 m.

Macronassa macromera (Shoemaker, 1916) (=*Lysianassa macromera*). Abundant in high-energy intertidal environments among *Egregia* holdfasts and *Anthopleura elegantissima*; 5 mm.

Macronassa pariter (Barnard, 1969a) (=*Lysianassa pariter*). Among sponges and tunicates, Cayucos and south; 5.7 mm; intertidal.

Ocosingo borlus Barnard, 1964c (=*Fresnillo fimbriatus* [Barnard, 1969]). A sequential hermaphrodite; the secondary phase male was renamed *F. fimbriatus* (see Lowry and Stoddart 1983, 1986); 2 mm; intertidal—180 m.

Orchomene minutus (Kroyer, 1846). A boreal species found south to Oregon and south to the Gulf of St. Lawrence in the Atlantic; 11 mm; intertidal—547 m.

Orchomene pacifica (Gurjanova, 1938). Japan Sea, coastal shelf of southern California; 5 mm; 3 m–421 m.

Orchomenella recondita (Stasek, 1958) (=*Allogaussia recondita;* =*Orchomene recondita*). Commensal in the gut of the sea anemone *Anthopleura elegantissima,* Oregon to Santa Cruz Island; intertidal; with global warming, should be watched for north of Oregon; 4 mm. See De Broyer and Vader 1990; Beaufortia 41: 31–38 (biology).

Prachynella lodo Barnard, 1964b. A southern species found as far north as Monterey Bay; also reported from Sea of Japan; 5.8 mm; 10 m–439 m.

Psammonyx longimerus Jarrett and Bousfield, 1982. Sandy sediments; 14 mm; intertidal—200 m.

Wecomedon wecomus (Barnard, 1971). Soft sandy sediments; 13 mm; intertidal—100 m.

OPISIDAE

Opisa tridentata Hurley, 1963. Fish gill parasite; 8 mm; 17 m–183 m.

URISTIDAE

Anonyx cf. *lilljeborgi* Boeck, 1871b. Soft sediments; another boreal species assumed to occur from the Gulf of Alaska to Mexico on our coast (southern populations should be reexamined), and from Nova Scotia to Delaware in the Atlantic, but perhaps representing a species complex; 11 mm; intertidal—1,015 m.

Anonyx cf. *nugax* (Phipps, 1774). Panboreal, south to California, perhaps representing a species complex but also perhaps misreported; up to 42 mm; 4 m–1,184 m.

UROTHOIDAE

Urothoidae of our region are probably undescribed but have been variously assigned to *Urothoe varvarini* and *U. elegans*. Urothoids live in fine subtidal sediments over a large depth range and are likely meiofaunal predators. Although reported mostly from deep water, this obscure, low-density group could be overlooked in shallow marine benthic habitats. The description and illustrations here are composites from previous reports in which specimens from the region were compared with Sars' (1895) and Lincoln's (1979) illustrations of *U. elegans* and with Gurjanova's (1953) illustrations of *U. varvarini*.

KEY TO UROTHOIDAE

1. Large dactyls on pereopods 5–7; pereopod 7 article 2 oval (plate 288A); prominent mandibular palp and molar (plate 288B); weak rostrum, broad ventral extensions of the head and prominent accessory flagellum (plate 288A, 288C–D); small subchelate gnathopods (plate 257L); spinose fossorial pereopods 5 (plate 288F, 288G) and

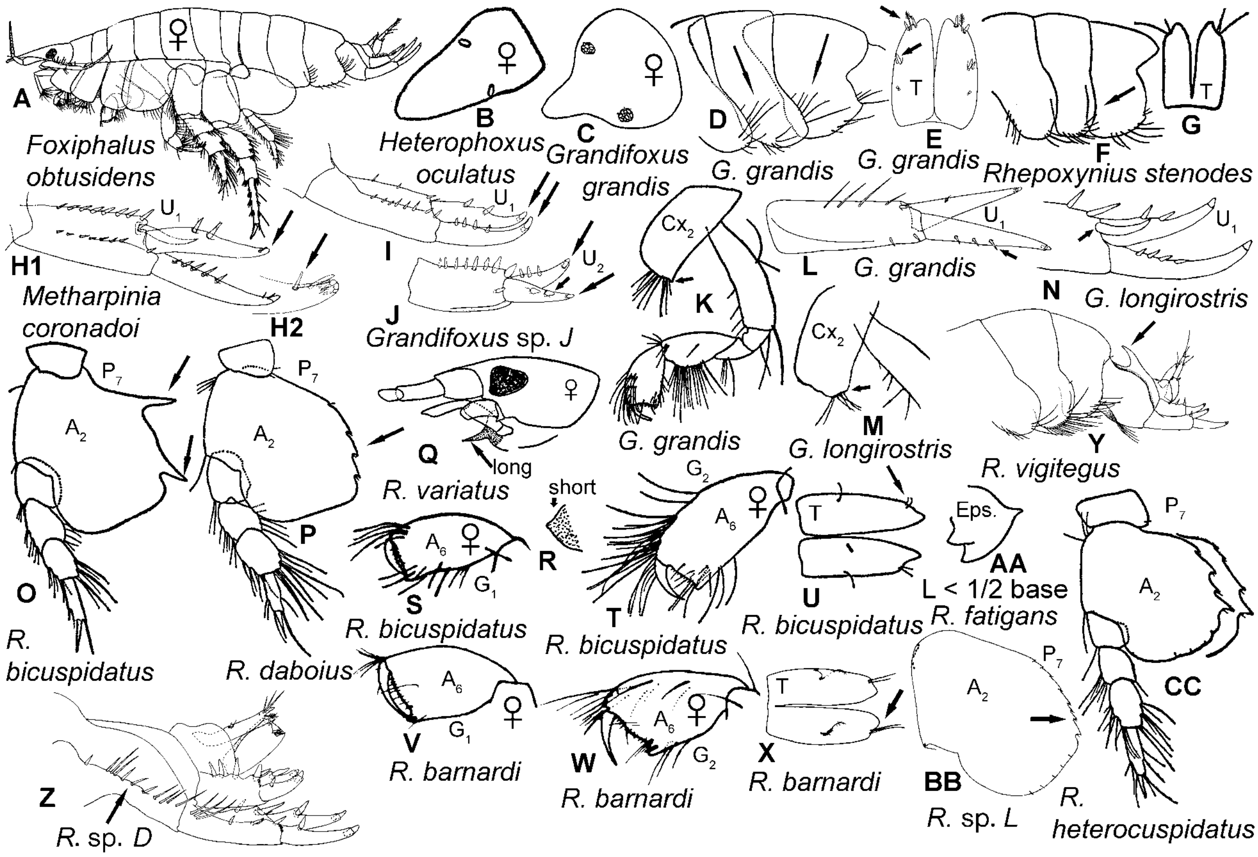

PLATE 289 Phoxocephalidae. A, *Foxiphalus obtusidens*; C–E, K, L, *Grandifoxus grandis*; M, N, *Grandifoxus longirostris*; I, J, *Grandifoxus* sp.; B, *Heterophoxus oculatus*; H, *Metharpinia coronodoi* (expanded tip of outer ramus); AA, *Rhepoxynius fatigans*; V–X, *Rhepoxynius barnardi*; O, R–U, *Rhepoxynius bicuspidatus*; P, *Rhepoxynius daboius*; CC, *Rhepoxynius heterocuspidatus*; Z, *Rhepoxynius* sp. D; BB, *Rhepoxynius* sp. *L*; F, G, *Rhepoxynius stenodes*; Q, *Rhepoxynius variatus*; Y, *Rhepoxynius vigitegus* (figures modified from Barnard 1960a, 1971, 1980a, 1980b; Barnard and Barnard 1982a;, Coyle 1982; Gurjanova 1938; and Jarrett and Bousfield 1994a).

antenna 2 (plate 288H); straight rami of uropods 1 and 2 (plate 288A); laminar telson cleft to the base (plate 288I), and biramous uropod 3 (plate 288J) . . . . *Urothoe* sp.

LIST OF SPECIES

**Urothoe elegans* Bate 1857. Cited in the eastern Pacific but not clearly present; mud benthos; 6 mm; shallow subtidal—shelf depths.

**Urothoe varvarini* Gurjanova 1953. Rare in mud benthic samples; 5 mm; 5 m–1,292 m.

PHOXOCEPHALIDAE

Phoxocephalidae, "spiny heads," are the most diverse and abundant sand- and mud-burrowing marine crustaceans of the 1 mm–10 mm range in coastal soft bottoms after ostracodes (Barnard 1960a). Phoxocephalidae variously resemble Dogielonotidae, Haustoriidae, Urothoidae, Gammaridae, and Pontoporeiidae, but are distinguished readily from these taxa by their shieldlike pointed rostrums. Sexual dimorphism occurs in eye development, uropod 3, gnathopods, and antennae. Phoxocephalid taxonomy is reliable only for females and rests on untested assumptions of the invariance of characters. Phoxocephalidae are predators of meiofauna and invertebrate larvae (Oliver et al. 1982, Mar. Ecol. Prog. Ser. 7: 179–184; Oakden 1984, J. Crust. Biol. 4: 233–247). They live a year or more (Kemp et al., 1985, J. Crust. Biol. 5: 449–464) and are used extensively in aquatic toxicology due to their great sensitivity to pollutants (Robinson et al. 1988, Environ. Tox. Chem. 7: 953–959).

* = Not in key.

KEY TO PHOXOCEPALIDAE

1. Rostrum unconstricted, lateral edges straight or slightly convex (plate 289A, 289B) 22
   Rostrum constricted, lateral edges concave (plate 289C) 2
2. Epimera 1 and 2 posterior edges with numerous long setae (plate 289D); telson with distal and medial dorsal spines (plate 289E) 3
   — Epimera 1 and 2 without posterior setae (plate 289F); telson with only distal spines (plate 289G) 6
3. Uropods 1 and 2 with tiny, subapical supernumerary spines on one or more rami and with subapical spines poorly developed (plate 289H); examine this character under a minimum of 50x magnification . . . . *Metharpinia* spp.
   — Uropods 1 and 2 without tiny, subapical supernumerary spines on any rami and subapical ramal spines well developed (plate 289I, 289J) 4

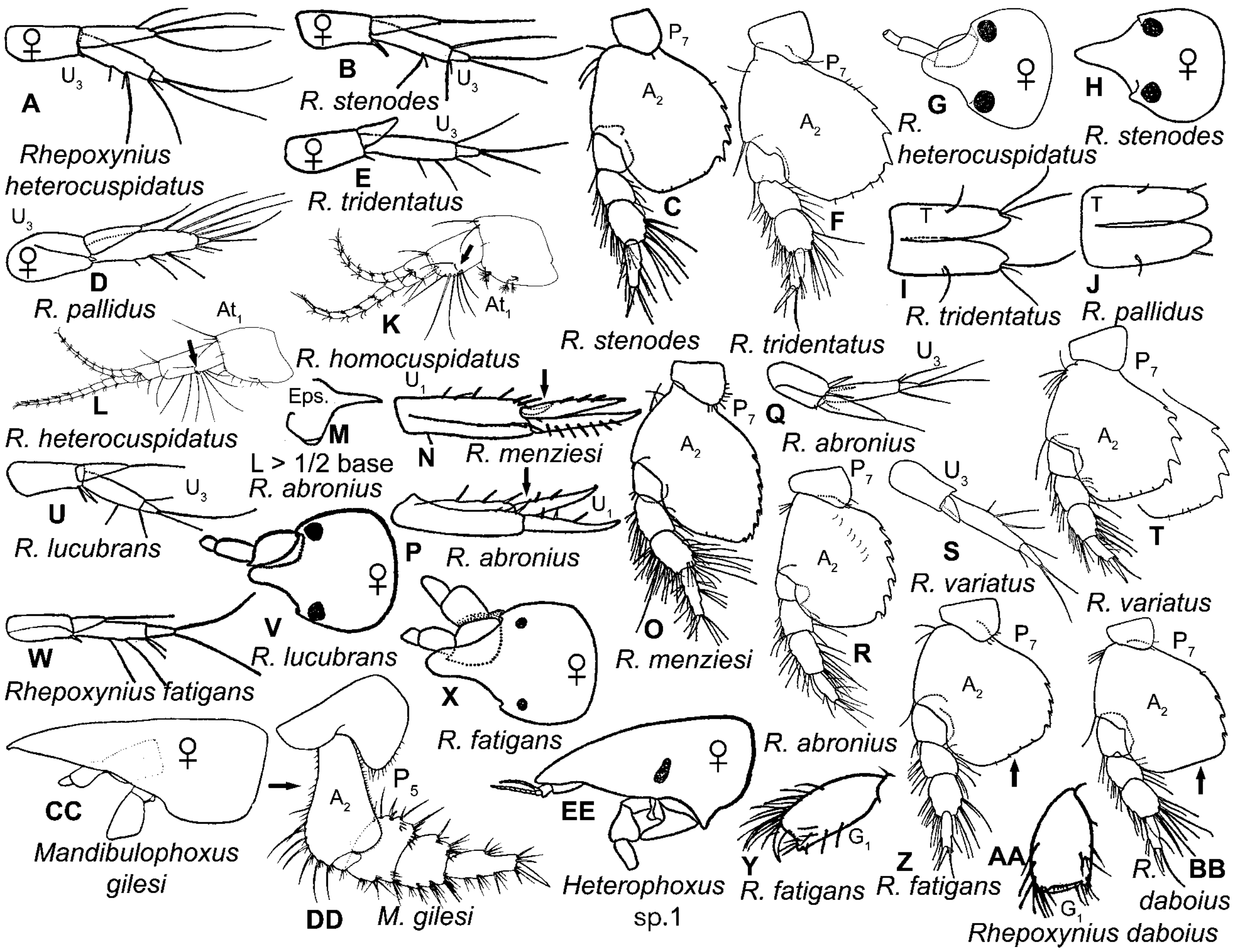

PLATE 290 Phoxocephalidae. EE, *Heterophoxus* sp. 1; CC, DD, *Mandibulophoxus gilesi*; M, P, R, *Rhepoxynius abronius*; AA, BB, *Rhepoxynius daboius*; W–Z, *Rhepoxynius fatigans*; A, G, L, *Rhepoxynius heterocuspidatus*; K, *Rhepoxynius homocuspidatus*; U, V, *Rhepoxynius lucubrans*; N, M, *Rhepoxynius menziesi*; D, J, *Rhepoxynius pallidus*; B, C, H, *Rhepoxynius stenodes*; E, F, I, *Rhepoxynius tridentatus*; S, T, *Rhepoxynius variatus* (figures modified from Barnard 1954a, 1957c, 1960a; and Barnard and Barnard 1982a).

4. Coxae 1–3 with distinct posterioventral tooth (plate 289K); uropod 1 inner distal peduncle lacking large displaced spine (plate 289L) 5
— Coxae 1–3 posteriorly rounded (plate 289M); uropod 3 with large distal medial spine (plate 289N) . . . . *Grandifoxus longirostris*
5. Uropods 1 and 2 outer ramus spines small (plate 289L) . . . . *Grandifoxus grandis*
— Uropods 1 and 2 (U_2 not illustrated) outer ramus spines thick, rhomboid (plate 289J); coxae 1 setae narrowly spread (not illustrated) . . . . *Grandifoxus* sp. J
6. Pereopod 7 article 2 posterior edge with two prominent spurs (plate 289O) 7
— Pereopod 7 article 2 posterior edge with three or more large spurs (plate 289P) 9
7. Epistome prominent and pointed (plate 289Q) (*R.* sp. A not illustrated but similar to *R. variatus*). . . . . *Rhepoxynius* sp. A
— Epistome blunt, inconspicuous (plate 289R) 8
8. Female gnathopods 1 and 2 article 6 anterior and posterior edges parallel at distal end (plate 289S, 289T); telson with short distal setae (plate 289U) . . . . *Rhepoxynius bicuspidatus*
— Female gnathopods 1 and 2 article 6 expanding at distal ends (plate 289V, 289W); telson with long distal setae (plate 289X) . . . . *Rhepoxynius barnardi*
9. Urosome dorsal surface smooth, without a tooth (plate 289A) 10
— Urosome dorsal surface bearing conspicuous anteriorly reverting tooth (plate 289Y) . . . . *Rhepoxynius vigitegus*
10. Urosome with lateral spine row (plate 289Z). . . . . *Rhepoxynius* sp. D
— Urosome bare, without lateral spine row (plate 289A). 11
11. Epistome rounded, lacking anterior cusp. 12
— Epistome anterior cusp pointed (long or short) (plate 289AA) 17
12. Pereopod 7, article 2 posterior edge with six or more small teeth (plate 289BB) 16
— Pereopod 7, article 2 posterior with five or less prominent teeth (plate 289CC). 13
13. Female uropod 3 inner ramus more than two-thirds length of outer ramus (plate 290A, 290B); pereopod 7 article 2 posterior edge with more than three teeth (plates 289CC, 290C) 14
— Female uropod 3 inner ramus length one-half or less of outer ramus (plate 290D, 290E); pereopod 7 article 2 with three large posterior teeth (plate 290F) 15

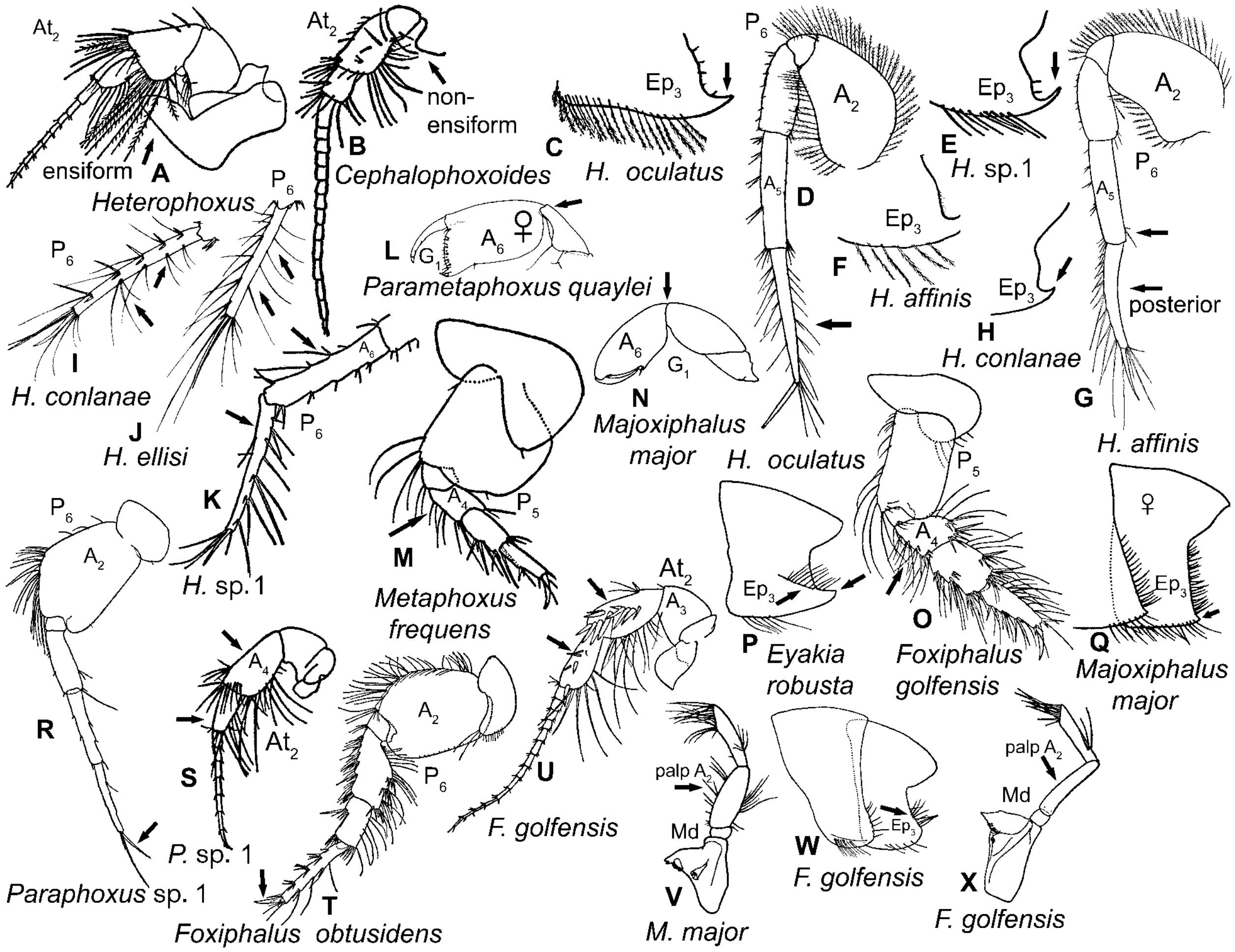

PLATE 291 Phoxocephalidae. B, *Cephalophoxoides homilis*; P, *Eyakia robusta*; O, U, W, X, *Foxiphalus golfensis*; T, *Foxiphalus obtusidens*; A, *Heterophoxus*; F, G, *Heterophoxus affinis*; H, I, *Heterophoxus conlanae*; J, *Heterophoxus ellisi*; C, D, *Heterophoxus oculatus* (original drawing incomplete); E, K, *Heterophoxus* sp. 1; N, Q, V, *Majoxiphalus major*; M, *Metaphoxus frequens*; L, *Parametaphoxus quaylei*; R, S, *Paraphoxus* sp. 1 (figures modified from Barnard 1960a; Holmes 1908; and Jarrett and Bousfield 1994b).

14. Pereopod 7 article 2 with four to five asymmetrical posterior serrations on article 2 (plate 289CC); female rostrum broad, with base greater than one-half of the head width (plate 290G) . . . . *Rhepoxynius heterocuspidatus*
— Pereopod 7 article 2 with four symmetrical posterior teeth (plate 290C); rostrum narrow, with base less than one-third of the head width (plate 290H) . . . . . *Rhepoxynius stenodes*
15. Female uropod 3 inner ramus length one-third of outer ramus (plate 290E); male telson medial setae long (plate 290I) . . . . *Rhepoxynius tridentatus*
— Female uropod 3 inner ramus length one-half of outer ramus (plate 290D); male telson medial setae short (plate 290J) . . . . *Rhepoxynius pallidus*
16. Antenna 1, article 2 lateral marginal setae extending to apex (plate 290K) . . . . *Rhepoxynius homocuspidatus*
— Antenna 1, article 2 lateral marginal setae extending less than one-third of the distance to the apex (plate 290L) (illustrations of *R.* sp. L not published; *R. heterocuspidatus* is a similar example) . . . . *Rhepoxynius* sp. L
17. Epistome cusp long, extending >1.5 times the width of its base (plate 290M) 18
— Epistome cusp short, extending approximately equal to width of its base (plate 289AA). 20
18. Female uropod 1 peduncle with large displaced dorsomedial spine (plate 290N); pereopod 7 article 2 with eight small posterior teeth (plate 290O) . . . . *Rhepoxynius menziesi*
— Female uropod 1 peduncle without large displaced dorsomedial spine (plate 290P); pereopod 7 article 2 with less than eight posterior teeth. 19
19. Female uropod 3 inner ramus length greater than one-half of the outer ramus (plate 290Q); pereopod 7 article 2 with five to six posterior teeth (plate 290R) . . . . *Rhepoxynius abronius*
— Female uropod 3 inner ramus length less than one-half of the outer ramus (plate 290S); pereopod 7 article 2 with three to five (usually four) variably sized teeth lining posterior edge (plate 290T) . . . . *Rhepoxynius variatus*
20. Female uropod 3 inner ramus length about one-half of the outer ramus length (plate 290U); eyes large (plate 290V) . . . . *Rhepoxynius lucubrans*
— Female uropod 3 inner ramus length less than one-third of the outer ramus (plate 290W); eyes small (plate 290X). 21
21. Gnathopod 1 article 6 narrow (plate 290Y); pereopod 7 article 2 ventral edge slightly beveled, not straight (plate 290Z) . . . . *Rhepoxynius fatigans*

— Gnathopod 1 article 6 broad (plate 290AA); pereopod 7 article 2 ventral edge straight (plate 290BB) . . . . *Rhepoxynius daboius*

22. Pigmented eyes absent (plate 290CC) (check also *Heterophoxus oculatus* if antenna 2 ensiform process is longer than wide); pereopod 5 article 2 slightly concave and expanding distally (plate 290DD) . . . . *Mandibulophoxus gilesi*

— Pigmented eyes present (plate 290EE); pereopod 5 article 2 convex and parallel-sided or slightly narrowing distally 23

23. Antenna 2 with ensiform process longer than wide (plate 291A) 24

— Antenna 2 ensiform process absent or wider than long (plate 291B) 28

24. Epimeron 3 tooth weakly upturned or straight (plate 291C); pereopod 6, article 6 with posterior setae (plate 291D) 25

— Epimeron 3 tooth strongly upturned (plate 291E, 291F); pereopod 6, article 6 without posterior setae (plate 291G) 27

25. Pleonite 3 with more than 14 ventral, plumose setae and posterioventral tooth as thick at the base as length (plate 291C) . . . . *Heterophoxus oculatus*

— Pleonite 3 with less than 14 ventral, plumose setae and with posterioventral tooth longer than thick (plate 291H) 26

26. Pereopod 6 article 6 posterior edge lined with doubly or triply inserted setae (plate 291I); female pereopod 7 with small coxal gill . . . . *Heterophoxus conlanae*

— Pereopod 6 article 6 posterior edge lined with singly inserted setae (plate 291J); female pereopod 7 lacking coxal gill . . . . *Heterophoxus ellisi*

27. Pereopod 6 article 5 posterior margin with three setae pairs plus a single seta and article 6 with one mid-posterior seta (plate 291K) . . . . *Heterophoxus* sp. 1

— Pereopod 6 articles 5 and 6 with posterior setae only on extreme distal ends (plate 291G) . . . . . . *Heterophoxus affinis*

28. Female gnathopod 1 article 5 attachment to article 6 constricted (plate 291L); pereopod 5, article 4 deeper than wide (plate 291M) 40

— Female gnathopod 1 article 5 attachment to article 6 normal, unconstricted (plate 291N); pereopod 5, article 4 wider than deep (plate 291O) 29

29. Epimeron 3 with large posterioventral tooth and an oblique row of facial setae (plate 291P) . . . . *Eyakia robusta*

— Epimeron 3 posterioventrally square or rounded and without an oblique row of facial setae (plate 291Q) 30

30. Pereopod 6 dactyl long and thin (plate 291R); antenna 2, articles 4 and 5 without facial spine clusters (plate 291S) . . . . *Paraphoxus* sp. 1

— Pereopod 6 dactyl shorter and relatively stout (plate 291T); antenna 2, articles 4 and 5 with facial spine clusters (plate 291U) 31

31. Epimeron 3 posterior edge lined with 20 or more setae (plate 291Q); mandibular palp second article swollen (plate 291V) . . . . *Majoxiphalus major*

— Epimeron 3 posterior edge lined with 15 or less setae (plate 291W); mandibular palp article 2 linear with parallel sides (plate 291X) 32

32. Uropod 1 peduncle with large displaced lateral or medial distal spine (plate 292A) (variable in *Eobrolgus*, plate 292L) 34

— Uropod 1 peduncle without large displaced lateral or medial distal spine (plate 292B) (variable in *Eobrolgus*, plate 292L) 33

33. Pereopod 7 article 2 ventral edge slightly crenulated and lined with long setae (plate 292C) . . . . *Foxiphalus golfensis*

— Pereopod 7 article 2 ventral edge smooth and without long setae (plate 292D) . . . . *Foxiphalus falciformis*

34. Epistome produced (plate 292E) 35

— Epistome unproduced (plate 292F, 292G) 36

35. Epistome cusp longer than width of base (plate 292H, 292I) . . . . *Foxiphalus similis*

— Epistome length no greater than width of base (plate 292E) . . . . *Foxiphalus cognatus*

36. Telson lobes with dorsolateral spines (plate 292J) 37

— Telson lobes without dorsolateral spines (plate 292K) 38

37. Uropod 1 inner ramus apical nail flexible, articulate (flex the inner distal nail with a fine needle to make this observation) (plate 292A, right arrow) . . . . *Foxiphalus obtusidens*

— Uropod 1 inner ramus apical nail immersed, rigid (plate 292M) . . . . *Foxiphalus xiximeus*

38. Female rostrum lateral edges straight or slightly concave (plate 292N); two stout distal spines on the inner maxilliped palp (plate 292O) . . . . *Foxiphalus aleuti*

— Female rostrum lateral edges slightly convex (plate 292P); one stout distal spine on the inner maxilliped palp (plate 292Q) 39

39. Epimeron 3 bearing one to two ventral setae (plate 292R); outer plate of maxilla 1 with 11 spines (incompletely illustrated) (plate 292S) . . . . *Eobrolgus chumashi*

— Epimeron 3 bearing a single ventral seta (plate 292T); outer plate of maxilla 1 with nine spines (not illustrated) . . . . *Eobrolgus spinosus*

40. Gnathopods 1 and 2 sixth articles similar in shape and length (plate 292U, 292V); mandibular molar triturative (plate 292W) . . . . *Cephalophoxoides homilis*

— Gnathopod 1 article 6 longer than gnathopod 2 article 6 (plate 292X, 292Y); mandibular molar weak, nontriturative (plate 292Z) 41

41. Gnathopod 1 palm not extending beyond anterior distal corner and posterior article 5 of gnathopods 1 and 2 overlapped by articles 6 and 4 (plate 292X, 292Y) . . . . *Metaphoxus frequens*

— Gnathopod 2 weakly chelate, palm extending beyond anterior distal corner, and posterior lobe of article 5 of gnathopod 1 free of articles 6 and 4 (plate 292AA, 292BB) 42

42. Pereopod 5 coxa extending less than 40% of article 2 length (plate 292CC); pereopod 6 article 2 ventral posterior corner extended and rounded (plate 292CC) . . . . *Parametaphoxus quaylei*

— Pereopod 5 coxa extending more than 50% of article 2 length(plate 292DD); pereopod 6 article 2 posterior ventral corner square (plate 292EE) . . . . *Parametaphoxus* sp.

LIST OF SPECIES

Cephalophoxoides homilis (Barnard 1960a) (=*Phoxocephalus homilis*). Intertidal eelgrass beds (Dean and Jewitt 2001, Ecol. Appl. 11: 1456–1471) and soft benthos; 4.3 mm; intertidal—250 m.

Eobrolgus chumashi Barnard and Barnard, 1981. Marine, estuary, muddy sands; body (plate 256M). *Eobrolgus* are not

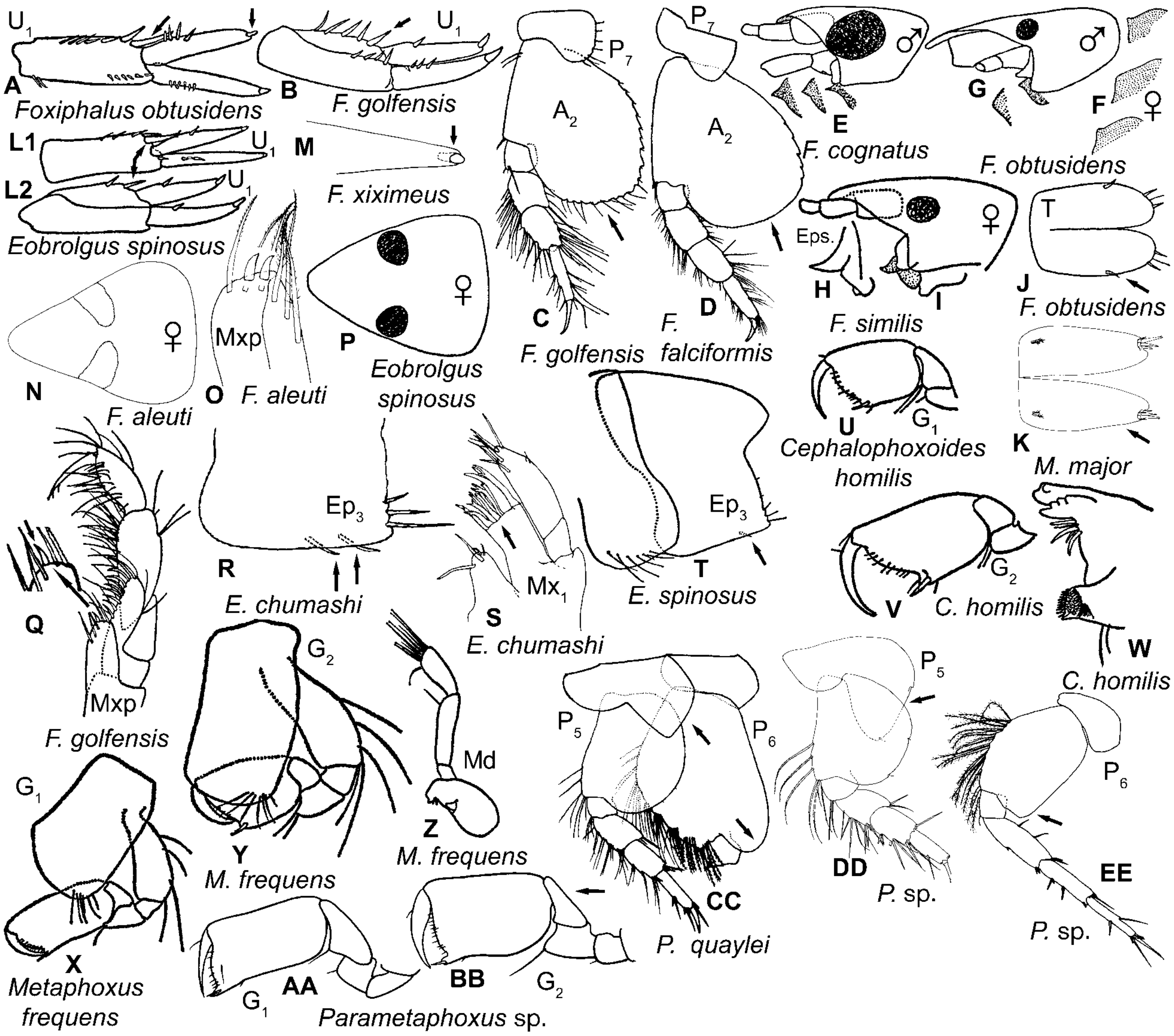

PLATE 292 Phoxocephalidae. U–W, *Cephalophoxoides homilis*; R, S, *Eobrolgus chumashi*; L, P, T, *Eobrolgus spinosus*; N, O, *Foxiphalus aleuti*; E, *Foxiphalus cognatus* (epistomes); D, *Foxiphalus falciformis*; B, C, Q, *Foxiphalus golfensis* (distal inner plate); E, F, G (epistomes); A, F, G, J, *Foxiphalus obtusidens*; H, I, *Foxiphalus similis*; M, *Foxiphalus xiximeus*; K, *Majoxiphalus major*; X–Z, *Metaphoxus frequens*; CC, *Parametaphoxus quaylei*; AA, BB, DD, EE, *Parametaphoxus* sp. (figures modified from Alderman 1936; Barnard 1960a, 1964a; Barnard and Barnard 1982a, 1982b; Chapman, personal communication; and Jarrett and Bousfield 1994a, 1994b).

distinguished morphologically from *Foxiphalus falciformis*; 4.5 mm; intertidal—11 m.

Eobrolgus spinosus (Holmes, 1903). A possible introduction from the Northwest Atlantic; "study on hybridization [with *E. chumashi*] is warranted" (Barnard and Barnard, 1981). Displaced uropod 1 spine on uropod 1 variably present. Estuarine, muddy sand; 4 mm; intertidal.

Eyakia robusta. (Homes, 1908). Associated with brittle stars, occasional surface swimmer of neritic zone; Alaska population is possibly a different species (Jarrett and Bousfield 1994a Amphipacifica 1: 89); 6.5 mm–15 mm; intertidal—320 m.

Foxiphalus aleuti Barnard and Barnard, 1982b. In sand; 9 mm; subtidal—110 m.

Foxiphalus cognatus (Barnard, 1960). In coarse shell and sand; 5 mm; intertidal—324 m.

Foxiphalus falciformis Jarrett and Bousfield, 1994a. Fine marine sands; doubtfully distinguished from *Eobrolgus* and *F. golfensis* by pereopod 7 and minute differences in mandibles; 8 mm; intertidal.

Foxiphalus golfensis Barnard and Barnard, 1982b. Oregon and south; 9.1 mm; intertidal—91 m.

Foxiphalus obtusidens (Alderman, 1936). Common in sand tide pools; 5.5 mm–15 mm; intertidal—210 m.

Foxiphalus similis (Barnard, 1960a). Surf-protected fine sands; 5 mm; sublittoral—324 m.

Foxiphalus xiximeus Barnard and Barnard, 1982. May not be distinct from *F. obtusidens*; medium surf-exposed beaches in sand; 8 mm; low intertidal—20 m.

Grandifoxus grandis (Stimpson, 1856) (=*Paraphoxus milleri*). Often in reduced salinities; 9.5 mm–14 mm; intertidal.

Grandifoxus longirostris (Gurjanova, 1938). In sand, largely subtidal; 8 mm; 10 m–90 m.

Grandifoxus sp. Barnard 1980a. Pacific Grove, from a "senile" incompletely described 14.6 mm male, may not be distinct from *G. grandis*; intertidal sands.

Heterophoxus affinis (Holmes, 1908). In fine sand to mud, the deep-water populations may include *Heterophoxus* sp. 1

of Jarrett and Bousfield 1994b; 9 mm; shallow subtidal to 600+ m.

Heterophoxus conlanae Jarrett and Bousfield, 1994b. Not clearly distinguished from *H. oculatus*; 8 mm; intertidal—40 m.

Heterophoxus ellisi Jarrett and Bousfield 1994b. Fine sands and mud; 7 mm; intertidal—155 m.

Heterophoxus oculatus (Holmes, 1908). In fine sands, eye loss occurs in deeper populations and is not accompanied by other character differences (Cadien 2002, SCAMIT 21[2]: 7); 9 mm; 10 m–120 m.

Heterophoxus sp. 1 Jarrett and Bousfield 1994b. Southern California, not clearly distinguished from *H. affinis*; fine sediments; 7 mm; 90 m–360 m.

Majoxiphalus major (Barnard, 1960a). *Majoxiphalus* is poorly distinguished from *Foxiphalus*; differences may be size- or age-related; 6.5 mm–17.5 mm; intertidal—91 m.

Mandibulophoxus gilesi Barnard, 1957c. Fine sands; 6 mm; shallow subtidal—14 m.

Metaphoxus frequens Barnard, 1960a. Fine sands and muddy sand; 3.5 mm; intertidal—496 m.

**Metharpinia coronadoi* Barnard, 1980a. Southern California, posterioventral corner of pleonite 3 produced into a large hook, muddy sand; 7 mm; 18 m–43 m.

**Metharpinia jonesi* (Barnard, 1963). Southern, pleonite 3 without posterioventral hook; 3.8 mm; intertidal—18 m.

**Parametaphoxus* sp. Chapman (undescribed). Southern California and south; 3.5 mm; intertidal—170 m.

**Parametaphoxus quaylei* Jarrett and Bousfield 1994b. Fine sand and mud, Washington and north; 2.8 mm; 25 m–100 m. *Parametaphoxus* sp. Chapman and *P. quaylei* may occur in our region.

**Paraphoxus* spp. Barnard 1960a. Shallow water *Paraphoxus* reported north and south of the region in mixed sediments and mud but not confirmed in the region (Barnard 1979b); 3 mm–5 mm; shallow subtidal to 2,800 m.

Rhepoxynius abronius (Barnard, 1960a). Abundant inshore and subtidally at the high salinity mouths of estuaries, mostly in surf-protected localities, in sand to below 50 m. An important species for toxicity bioassays (Ambrose 1984, J. Exp. Mar. Biol. Ecol. 80: 67–75 (behavior); DeWitt et al. 1988, Mar. Envir. Res. 25: 99–124 (sediment features, toxicity); Swartz 1986, Mar. Envir. Res. 18: 133–153 (toxicity); 5.5 mm; shallow subtidal—90 m.

**Rhepoxynius barnardi* Jarrett and Bousfield 1994a. Sand habitats, a possible synonym of *R. bicuspidatus*; 4 mm; intertidal—59 m.

Rhepoxynius bicuspidatus (Barnard, 1960a). Fine sand and sandy mud, a low proportion of specimens of this species has three spurs on article 2 of one or both seventh pereopods; 4.5 mm; 8 m–475 m.

**Rhepoxynius boreovariatus* Jarrett and Bousfield 1994a. Northern; 4.5 mm; intertidal—40 m.

Rhepoxynius daboius (Barnard, 1960a). Sandy mud, a probable synonym of *R. fatigans*; 4 mm; intertidal—813 m.

Rhepoxynius fatigans (Barnard, 1960a). Sandy mud; 4 mm; intertidal—330 m.

**Rhepoxynius heterocuspidatus* (Barnard, 1960a). 4.8 mm, intertidal—146 m. This species, *Rhrepoxynius* sp. C, *R. stenodes* and the following three species occur south of this region.

**Rhepoxynius homocuspidatus* (Barnard and Barnard, 1982a). 3.5 mm; intertidal—64 m.

**Rhepoxynius lucubrans* (Barnard, 1960a). 5.3 mm; intertidal—91 m.

**Rhepoxynius menziesi* (Barnard and Barnard, 1982a). 7 mm; intertidal—22 m.

**Rhepoxynius pallidus* (Barnard, 1960). British Columbia and Washington; possible synonym of *R. tridentatus* ; 6 mm; intertidal—40 m.

Rhepoxynius sp. A SCAMIT, 1987. Sand benthos; length not known; <20 m.

**Rhepoxynius* sp. C Barnard and Barnard 1982a. Sand; 4.3 mm; intertidal—15 m.

**Rhepoxynius* sp. D Barnard and Barnard 1982a. Southern California, a possible morph of *R. menziesi*; 8 mm; intertidal—27 m.

Rhepoxynius sp. *L* Barnard and Barnard 1982a. Dillon Beach, fine sand; epistome is assumed to be rounded since it combines "characters of both *R. heterocuspidatus* and *R. homocuspidatus*" (Barnard and Barnard 1982a); a lack of illustrations of the epistome and antenna 1 leave the placement of this species uncertain; 5.7 mm; intertidal—2 m.

**Rhepoxynius stenodes* (Barnard, 1960a). Muddy sand; 3.5 mm; 2 m–374 m.

Rhepoxynius tridentatus (Barnard, 1954a). Mud and sand; 5 mm, intertidal—89 m.

Rhepoxynius variatus (Barnard, 1960a). Muddy sands; number and relative sizes of teeth on posterior pereopod 7 are variable; 5 mm; intertidal—89 m.

Rhepoxynius vigitegus (Barnard,1971). Sandy mud; 4.5 mm; shallow subtidal to 30 m.

PONTOPOREIIDAE

Pontoporeiidae are represented in the eastern Pacific by *Diporeia erythrophthalma* and *Monoporeia* sp. (see species list below). The figures are of *Monoporeia affinis* for identifying the genus. American pontoporeiids were long assumed to be "glacial marine relicts" dispersed over North America and Eurasia during the Pleistocene deglaciation by marine inundations of coastal regions that trapped brackish water species in freshening ponds and then forced them inland (e.g., Segerstråle 1976, Dadswell 1974). However molecular (Väinölä and Varvio 1989) and morphological data (Bousfield 1989) indicate that speciation among these "relicts" has occurred, a pattern expected from long isolation among distant populations rather than recent arrivals. Pontoporeiidae mate pelagically (Bousfield 1989), and male antennae can be twice as long as their bodies. Pontoporeiidae differ from Gammaridae by lacking pereopod 7 coxal gills, from Phoxocephalidae by lacking a rostrum, and from Urothoidae by dissimilar pereopods 6 and 7.

KEY TO PONTOPOREIIDAE

1. Urosome evenly rounded, lateral head lobe slightly acute, eyes dark, prominent accessory flagellum (plate 293A); gnathopod 1 article 5 posterior edge length greater than half the anterior article length (plate 293B); gnathopod 2 article 6 narrowest distally and with pinnate distal setae (plate 293C); coxa 5 lobes ventral projection equal (plate 293D); sternal gills on pereonites 2–5 (arrows) (plate 293A, 293E); telson as wide as long cleft two-thirds of its length (plate 293F) and; uropod 3 outer ramus with a tiny distal nail (plate 293G) . . . . *Monoporeia* sp.

* = Not in key.

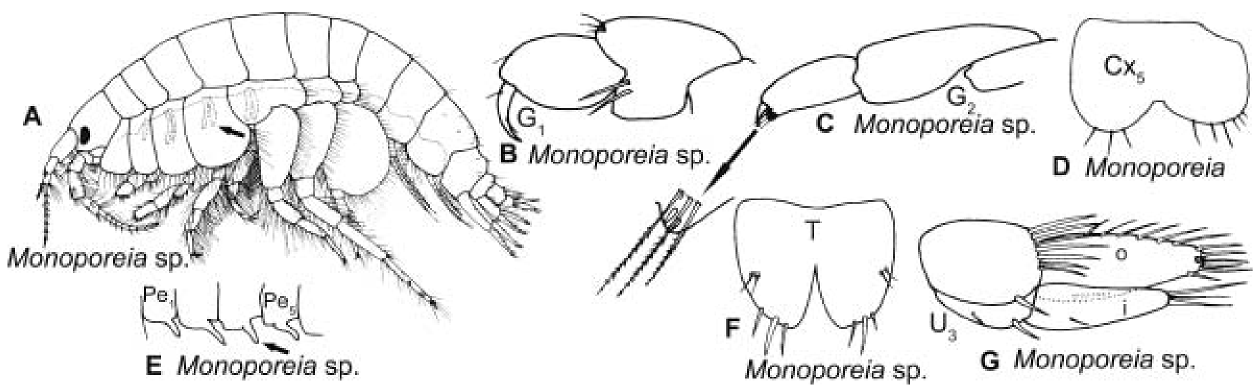

PLATE 293 Pontoporeiidae. A–G, *Monoporeia* sp. (figures modified from Bousfield 1989).

LIST OF SPECIES

**Diporeia erythrophthalma* (Waldron 1953). Named for its red eyes, known only from freshwater Lake Washington and the only other pontoporeiid of the eastern Pacific; 5 mm; 0 m–50 m.

Monoporeia sp. Restricted to the low-salinity benthos of the lower Columbia River where it is common, and from a single male collected in August 2004 from low-salinity benthos of Yaquina Bay, Oregon. Cryptogenic (historical occurrence in the region unclear, but unknown elsewhere); 8 mm; intertidal—20 m.

PLEUSTIDAE

Pleustidae are commensals, egg predators, and microparasites of other invertebrates and are common in fouling communities. The left mandible morphology is used for taxonomy because the right lacinia mobilis is greatly reduced or missing in many species. *Thorlaksonius* may be Batesian mimics of snails, while the bright colors of *Chromopleustes* may be for warning or Mullerian mimicry. Males have relatively larger gnathopods and smaller, narrower bodies, but sexual dimorphism is weak. The distinctive and beautiful pigmentation of pleustids is lost in preservation. The loss of pigment and the emphasis placed on the left mandible morphology to define species increases the difficulty of distinguishing pleustids of the region. Genera and species erected without complete notes on the presence or absence of the mandibular molar are doubtful; in particular, all characters proposed to distinguish *Gnathopleustes*, *Incisocalliope,* and *Trachypleustes* vary uniformly among the taxa or with size and thus do not yet reveal significant differences.

KEY TO PLEUSTIDAE

1. Gnathopods 1 and 2 article 5 distally truncate and broadly attached to article 6 (plate 294A, 294B); pereopods 3 and 4 dactyls more than one-third of the length of article 6 and simple (plate 294A) or short and notched (plate 294C) . . . 2
— Gnathopods 1 and 2 article 5 distally produced and narrowly attached to article 6, eusiridlike and pereopod 3 and 4 dactyls less than one-third of the length of article 6 and simple (plate 294D) . . . . *Pleusirus secorrus*
2. Mandibular molar reduced, nontriturative (plate 294E), antenna 1 article 1 without anterior projections (plate 294A) 3
— Mandibular molar fully developed, triturative (plate 294F); and antenna 1 article 1 with anterior ventral or dorsal projections (except for *Heteropleustes setosus*) (plate 294G). 18
3. Rostrum massive, extending beyond antenna 1 peduncle article 1, dorsal pleonites1–3 weakly or strongly carinate (plate 294A) 4
— Rostrum moderate or indistinct, extending less than length of antenna 1 peduncle article 1 and dorsal pereonites 1–4 smooth, not carinate or ridged (plate 294D) 8
4. Rostrum apex strongly deflexed (80°–90°) with nearly straight lower margin (plate 294A). 5
— Rostrum apex at <80° angle to dorsum, lower margin convex (plate 294H) 7
5. Coxa 7 not laterally ridged or sharply pointed posteriorly (plate 294A) . . . . *Thorlaksonius brevirostris*
— Coxa 7 laterally ridged or sharply pointed posteriorly (plate 294I). 6
6. Coxa 7 posteriorly pointed but not laterally ridged (plate 294I) . . . . *Thorlaksonius depressus*
— Coxa 7 posteriorly pointed bluntly and laterally ridged (plate 294J) . . . . *Thorlaksonius subcarinatus*
7. Coxa 5 with large lateral ridge and pointed behind (plate 294H). . . . . *Thorlaksonius borealis*
— Coxa 5 with reduced lateral ridge and obtuse behind (plate 294K) . . . . *Thorlaksonius grandirostris*
8. Antenna 1 and 2 length less than one-third of the total body length; gnathopods 1 and 2 article 6 palms shorter than posterior margin (plate 294L) 9
— Antennae 1 and 2 and more than one-third of the total body length (not shown); gnathopods 1 and 2 palms equal to or longer than article 6 posterior margin (plate 294M) 11
9. Pereopods 3–7 dactyls less than one-third the length of article 6 (plate 294N) and distally notched (plate 294C), coxa 1 smaller than coxa 2 (plate 294N) . . . . *Dactylopleustes echinoides*
— Pereopods 3–7 dactyls more than one-third of the length of article 6 and unnotched; coxa 1 approximately equal to coxa 2 (plate 294L) 10
10. Gnathopods 1 and 2 article 6 width about equal to of posterior margin length (plate 294L). . . . . *Micropleustes nautilus*
— Gnathopods 1 and 2 article 6 width about 60% of posterior margin length (plate 294O) . . . . . . *Micropleustes nautiloides*
11. Pereopod 4 article 6 swollen and lined posteriorly with large stout spines (plate 294P) . . . . *Commensipleustes commensalis*

* = Not in key.

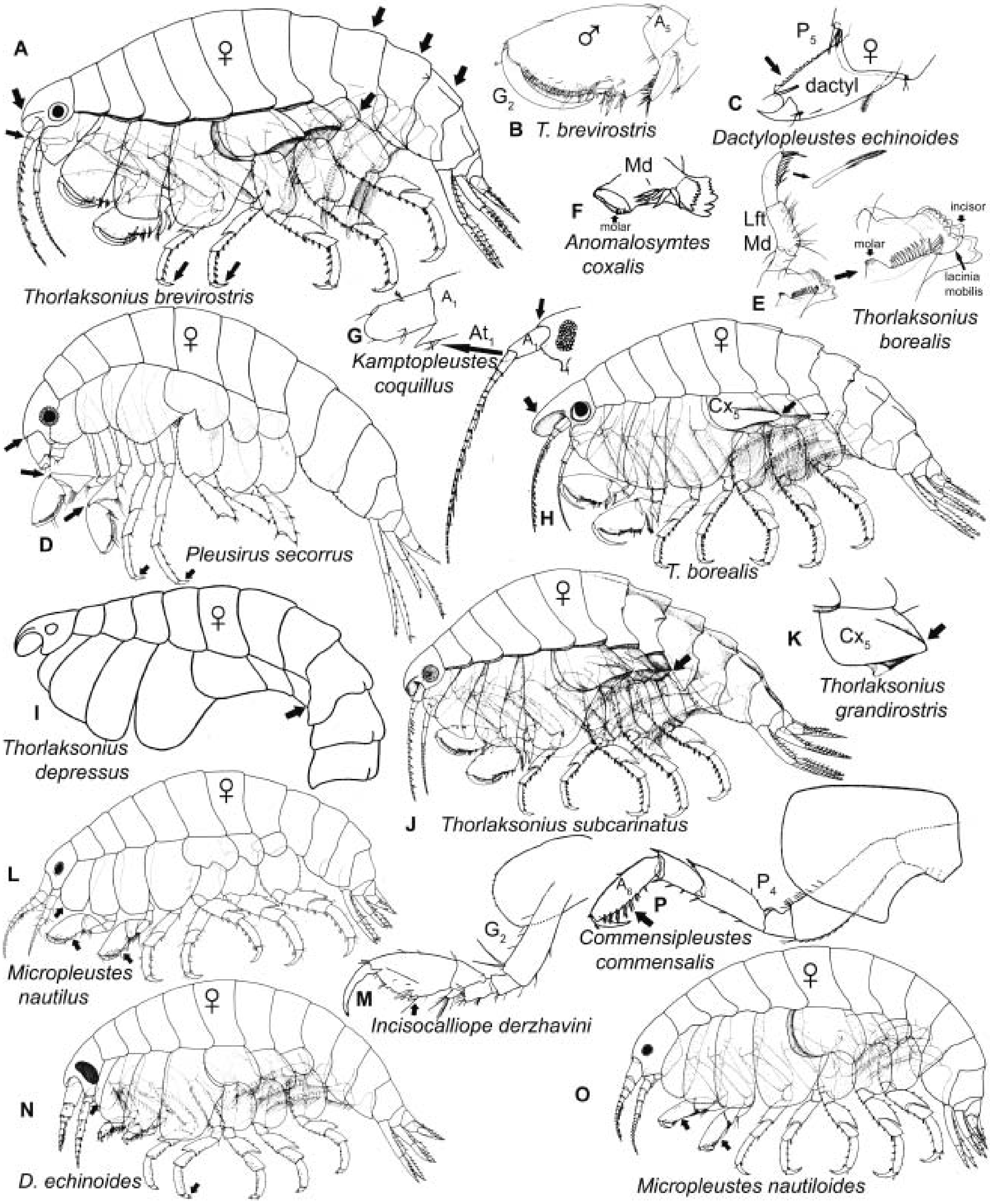

PLATE 294 Pleustidae. F, *Anomalosymtes coxalis*; P, *Commensipleustes commensalis*; C, N, *Dactylopleustes echinoides*; M, *Incisocalliope derzhavini*; G, *Kamptopleustes coquillus*; O, *Micropleustes nautiloides*; L, *Micropleustes nautilus*; D, *Pleusirus secorrus*; E, H, *Thorlaksonius borealis*; A, B, *Thorlaksonius brevirostris*; I, *Thorlaksonius depressus*; K, *Thorlaksonius grandirostris*; J, *Thorlaksonius subcarinatus* (figures modified from Alderman 1936; Barnard 1969a; Bousfield and Hendrycks 1994b, 1995b; Hendrycks and Bousfield 2004; and Shoemaker 1952).

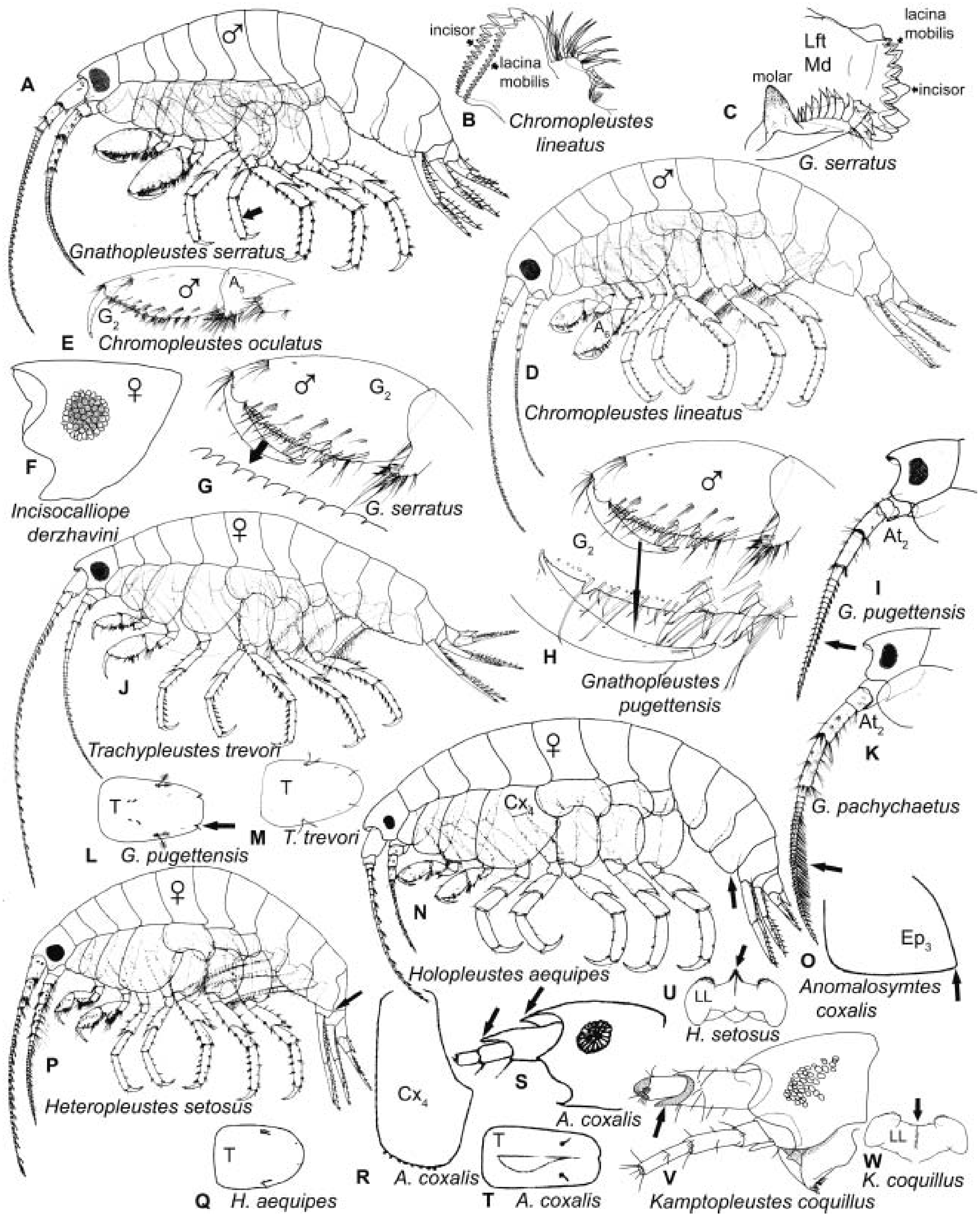

PLATE 295 Pleustidae. O, R–T, *Anomalosymtes coxalis*; B, D, *Chromopleustes lineatus*; E, *Chromopleustes oculatus*; K, *Gnathopleustes pachychaetus*; H, I, L, *Gnathopleustes pugettensis*; A, C, G, *Gnathopleustes serratus*; P, U, *Heteropleustes setosus*; N, Q, *Holopleustes aequipes*; F, *Incisocalliope derzhavini*; V, W, *Kamptopleustes coquillus*; J, M, *Trachypleustes trevori* (figures modified from Barnard 1971; Chapman 1988; Bousfield and Hendrycks 1995b; and Hendrycks and Bousfield 2004).

— Pereopod 4 article 6 of uniform width and lined posteriorly with long setae or short spines but not stout large stout spines (plate 295A). 12
12. Lacinia mobilis of left mandible with 17–50 teeth (plate 295B), live specimens brilliantly pigmented 13
— Lacinia mobilis of left mandible with 10 or less teeth (plate 295C), live pigmentation unknown 14
13. Male gnathopod 2 article 5 less than half the length of article 6 (plate 295D). . . . . *Chromopleustes lineatus*
— Male and female gnathopod 2 article 5 more than half as long as article 6 (plate 295E) . . . . *Chromopleustes oculatus*
14. Anterior edge of eye convex (oval), protected bays and estuaries (plate 295F) . . . . *Incisocalliope derzhavini*
— Anterior edge of eye concave or flat (bean-shaped), marine (plate 295A) 15
15. Gnathopod dactyls serrate (plate 295G). . . . . *Gnathopleustes serratus*
— Gnathopod dactyls smooth (plate 295H). 16
16. Antenna 2 flagellum sparsely setose (plate 295I, 295J) 17
— Antenna 2 flagellum densely setose (plate 295K) . . . . *Gnathopleustes pachychaetus*
17. Telson posterior edge truncate and with lateral setae set into tiny notches (plate 295L) . . . . *Gnathopleustes pugettensis*
— Telson posterior evenly rounded and without distal notches (plate 295M) . . . . *Trachypleustes trevori*
18. Pleon epimera 3 posterior ventral corner blunt or rounded, not produced (plate 295N, 295O) 19
— Epimera 3 posterior ventral corner sharply acute (plate 295P) 20
19. Coxa 4 nearly as wide as long, ocular lobe rounded or obtuse, and anterior of antenna 1 article 1 blunt or bluntly produced (plate 295N); telson distally rounded (plate 295Q) . . . . *Holopleustes aequipes*
— Coxa 4 nearly twice as deep as long (plate 295R), antenna 1 peduncle dorsal anterior article 1 and ocular lobe both sharply produced (plate 295S); telson distally blunt or notched (plate 295T) (note ventral keel) . . . . *Anomalosymtes coxalis*
20. Antenna 1 article 1 bearing an acute dorsal projection and ocular lobe evenly rounded (plate 295P); lower lip with acute medial process (plate 295U) . . . . *Heteropleustes setosus*
— Antenna 1 article 1 bearing an acute ventral projection (plate 295V); ocular lobes acute (plate 257W, 295V); medial junction of lower lip flat (plate 295W) . . . . *Kamptopleustes coquillus*

LIST OF SPECIES

Anomalosymtes coxalis Hendrycks and Bousfield 2004. Natural history and ecology unknown. Lack of a ventral antenna 2 sinus in common with Pleustidae, but the lower lip lacks pillow-shaped inner lobes and resembles Eusiroidea. Mandibular palp present and molar triturative; 3 mm; shallow subtidal—25 m.

Chromopleustes (=*Parapleustes*) *lineatus* (Bousfield, 1985). A commensal and possible egg predator of echinoderms in rocky habitats. Four to five bright yellow and brown longitudinal body stripes (Bousfield, 1985, Rotunda 18: 30–36); 9 mm; shallow subtidal—17 m.

Chromopleustes (=*Parapleustes*) *oculatus* (Holmes, 1908) (=*Parapleustes oculatus*). Predator of the sea cucumber *Cucumaria miniata* (Chen and Norton, 2005, Abstracts, Estuarine Research Federation Annual Meeting, Norfolk, VA), and also associated with the brittle star *Amphiodia urtica* (Barnard and Given, 1960, Pac. Nat. 1: 46). Not clearly distinguished from *Heteropleustes setosus* or *Pleusymptes pacifica*; 11 mm; intertidal—2 m or more.

Commensipleustes (=*Parapleustes*) *commensalis* (Shoemaker, 1952). Commensal and possible lobster egg predator. Bousfield and Hendrycks (1995a) give northern records on sponges, indicating plasticity in the species or taxonomic complications; 5.5 mm; intertidal—50 m.

Dactylopleustes echinoides Bousfield and Hendrycks 1995b. Commensal or egg predator of sea urchins; 3.3 mm; intertidal—2 m.

Gnathopleustes pachychaetus Bousfield and Hendrycks, 1995b. Rocky intertidal (to 2 m) among algae; 7 mm.

Gnathopleustes pugettensis (Dana, 1853) (=*Parapleustes pugettensis*). Rocky and soft benthos. See also *Trachypleustes trevori*; 6 mm; intertidal—140 m.

Gnathopleustes serratus Bousfield and Hendrycks 1995b. Under intertidal boulders, associated with sessile invertebrates; 10 mm.

Heteropleustes setosus Hendrycks and Bousfield 2004. Associated with sponges; 6.7 mm; intertidal.

Holopleustes aequipes Hendrycks and Bousfield 2004. Open-coast sand and algae; 3.3 mm; intertidal—2 m.

**Incisocalliope bairdi* Hendrycks and Bousfield 2004 (=*Parapleustes bairdi* of Barnard, 1956). Soft benthos, probably associated with hydroids or bryozoans; could be misidentified *Gnathopleustes*; 5.5 mm; intertidal—140 m.

Incisocalliope derzhavini (Gurjanova, 1938) (=*Parapleustes derzhavini*). Introduced Asian species in protected bays, harbors and estuaries; may include *I. newportensis*; 4 mm; shallow subtidal—2 m.

**Incisocalliope newportensis* Barnard 1959c (=*Parapleustes newportensis*). Bays and estuaries among fouling organisms of floats and pilings and of doubtful distinction from *I. derzhavini*; 5 mm; intertidal—2 m.

Kamptopleustes coquillus (Barnard, 1971) (=*Pleusymptes coquillus*). Whole body illustration plate 257W; on mud and sandy mud; 3.8 mm; 3 m–200 m.

Micropleustes nautiloides Bousfield and Hendrycks, 1995b (=*Parapleustes nautiloides*). In coralline algae and *Phyllospadix* mats; 2.9 mm; intertidal.

Micropleustes nautilus (Barnard, 1969a) (=*Parapleustes nautilus*). In exposed rocky shore algal mats, sponges and among *Phyllospadix*; 3.4 mm; intertidal—3 m.

Pleusirus secorrus Barnard, 1969a. Low intertidal and subtidal cobbles; 3.8 mm; intertidal—25 m.

**Pleusymptes subglaber* Barnard and Given 1960 (=*Sympleustes subglaber*). Recorded from San Clemente sublittoral, but the unknown condition of the *P. subglaber* mandibular molar and distal ventral extension of antenna 1 article prevent confidence in its distinction from species of either *Chromopleustes* or other *Pleusymptes*; 4 mm; 9 m or less to 110 m.

Thorlaksonius borealis Bousfield and Hendrycks, 1994b. Occurring in offshore fouling communities of hard substrate; 11 mm; intertidal—10 m.

Thorlaksonius brevirostris Bousfield and Hendrycks, 1994b. Among algae on rocks; 7 mm; intertidal—35 m.

Thorlaksonius depressus (Alderman, 1936) (=*Pleustes depressus*). Among algae on rocks and among *Phyllospadix*. Mimics snails (Carter and Behrens, 1980, Veliger 22: 376–377); 8.5 mm; intertidal—4 m.

* = Not in key.

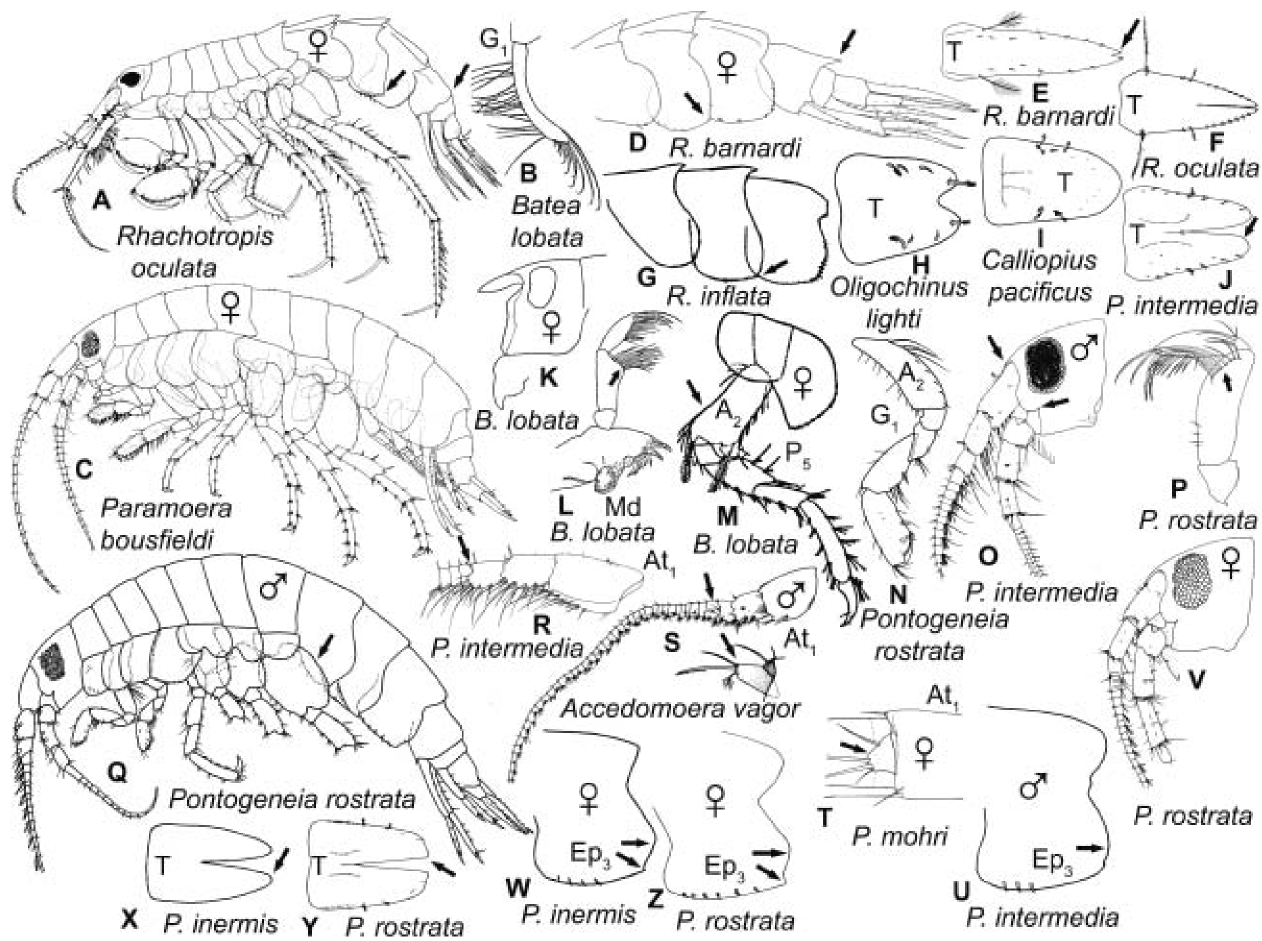

PLATE 296 Eusiroidea. S, *Accedomoera vagor*; B, K, L, M, *Batea lobata*; I, *Calliopius pacificus*; H, *Oligochinus lighti*; C, *Paramoera bousfieldi*; W, X, *Pontogeneia inermis*; T, *Paramoera mohri*; J, O, R, *Pontogeneia intermedia*; N, P, Q, V, Y, Z, *Pontogeneia rostrata*; D, E, *Rhachotropis barnardi*; G, *Rhachotropis inflata*; A, F, *Rhachotropis oculata* (figures modified from Barnard 1952b, 1964c, 1969a, 1971, 1979; Bousfield 1973; Bousfield and Hendrycks 1995a, 1997; Sars 1895; Shoemaker 1926; and Staude 1995).

Thorlaksonius grandirostris Bousfield and Hendrycks, 1994b. On rocks with seagrass, probably mimics a snail; 6 mm; intertidal—2 m.

**Thorlaksonius platypus* (Barnard and Given, 1960) (=*Pleustes platypa*). Pt. Conception and south; but not clearly distinct from the more northern *T. grandirostris*. On various macrophytes. Imitates a snail (Crane 1969, Veliger 12: 200; Field 1974. Pacific Science 28: 439–447); 8.5 mm; 3 m–100 m.

Thorlaksonius subcarinatus Bousfield and Hendrycks, 1994b. On rocks and algae; 9.5 mm; intertidal—25 m.

Trachypleustes trevori Bousfield and Hendrycks, 1995b. Associated with sponges and tunicates under rocks of exposed coasts. Distinction from *Gnathopleustes pugettensis* is mainly the smaller gnathopods which are described largely from males; 5 mm; intertidal.

EUSIROIDEA

Eusiroidea (Bateidae, Calliopiidae, Eusiridae, Pontogeneiidae) include a broad range of morphological diversity (which is particularly apparent in the shapes of telsons—laminar cleft or entire—and in the absolute and relative sizes of first and second gnathopods), which makes this group difficult to distinguish from other families. The Bateidae, with vestigial gnathopod 1 and coxa 1 obscured by coxa 2, are among the most extreme of gnathopod morphotypes. Accessory flagellum either a tiny button or absent. Rostrum variable, urosomites separate, third uropod biramous. Eusiroidea are free living, with well-developed molars and mandibular palps. *Pontogeneia* and *Paramoera* occasionally swarm in intertidal pools and eusirids are extremely abundant in hard bottom nearshore marine communities.

* = Not in key.

KEY TO EUSIROIDEA

1. Gnathopods powerful and subchelate with dactyls reaching more than two-thirds of the length of article 6, dorsal urosomites 1 and 2 and posterior ventral epimeron 3 toothed, dactyls of pereopods 10–20 times as long as broad (plate 296A) 2
— Gnathopod 1 vestigial, (plate 296B), or normally subchelate (plate 296C); if dactyl present, not reaching one-half of the length of article 6 (plate 296C) 4
2. Urosomite 1 dorsally toothed, epimeron 2 nearly square (plate 296D); distal notch of telson small (plate 296E). . . . . *Rhachotropis barnardi*
— Urosomite 1 not dorsally toothed (plate 296A); epimeron 2 produced or rounded; telson cleft more than one-third of its length (plate 296F). 3

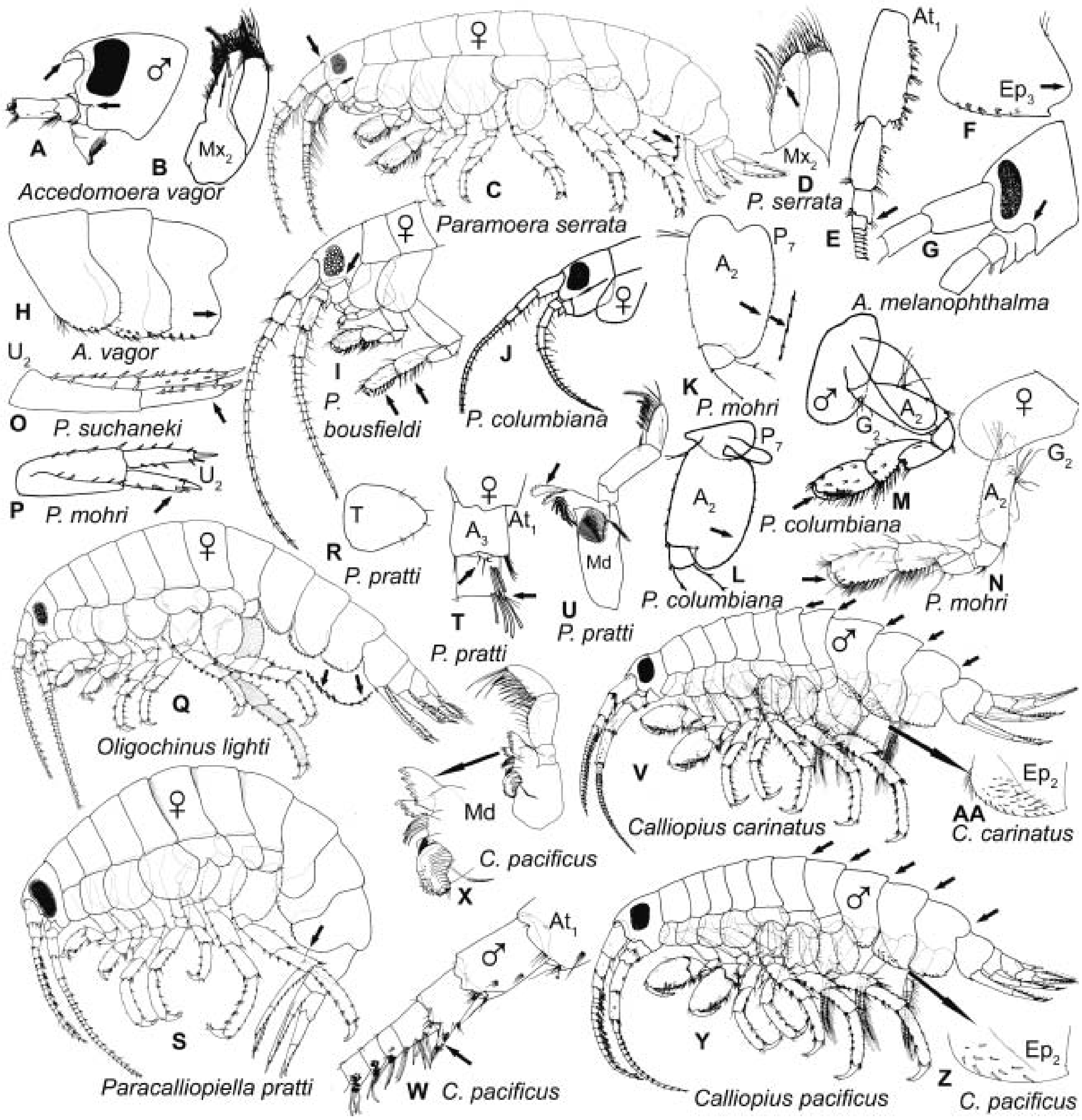

PLATE 297 Eusiroidea. E–G, *Accedomoera melanophthalma*; A, B, H, *Accedomoera vagor*; V, AA, *Calliopius carinatus*; W–Z, *Calliopius pacificus*; Q, *Oligochinus lighti*; R–U, *Paracalliopiella pratti*; I, *Paramoera bousfieldi*; J, L, M, *Paramoera columbiana*; K, N, P, *Paramoera mohri*; C, D, *Paramoera serrata*; O, *Paramoera suchaneki* (figures modified from Barnard 1952b, 1969a; Bousfield 1958a; Bousfield and Hendrycks 1997; Gurjanova 1938; and Staude 1995).

3. Posterior ventral epimeron 2 acute (plate 296A) . . . . *Rhachotropis oculata*
— Posterior ventral epimeron 2 rounded (plate 296G) . . . . *Rhachotropis inflata*
4. Telson entire, distally concave (plate 296H); or convex (plate 296I) but not cleft. 15
— Telson deeply cleft (plate 296J). 5
5. Gnathopod 1 reduced to two articles (plate 296B); head without a ventral antenna 2 sinus (plate 296K); mandibular palp article 2 with distal expansion for dense distal setae group (plate 296L); pereopod 5 article 2 parallel sided and distally expanded (plate 296M) . . . . *Batea lobata*
— Gnathopod 1 of 7 normal articles (plate 296N); head with ventral antennal sinus (plate 296O); mandibular palp article 2 without distal expansion for dense distal group of long setae (plate 296P); pereopod 5 article 2 expanded and thickest in the middle (plate 296Q) 6
6. Antenna 1 without an accessory flagellum (plate 296R) (examine this character under more than 50x) 7
— Antenna 1 with a tiny uniarticulate accessory flagellum (plate 296S, 296T) (examine character under more than 50x) 9
7. Rostrum reaching no more than one-fourth of the length of antenna 1 article 1 (plate 296O); posterior extension of

epimeron 3 slight (plate 296U). . . . . *Pontogeneia intermedia*
— Rostrum reaching more than one-third of the length of antenna 1 article 1 (plate 296V); posterior extension of epimeron 3 prominent (plate 296W) 8
8. Apices of telson rounded (plate 296X); posterior margin of epimeron 3 strongly convex and with obtuse ventral corner (plate 296W). . . . . *Pontogeneia inermis*
— Apices of telson angled (plate 296Y); posterior margins of epimeron 3 with moderate convex posterior edge and weak ventral tooth (plate 296Z) . . . . *Pontogeneia rostrata*
9. Rostrum prominent (plate 297A); inner plate of maxilla 2 with one medial spine (plate 297B) 10
— Rostrum indistinct or absent (plate 297C); inner plate of maxilla 2 with multiple medial spines (plate 297D) 11
10. Antenna 1, peduncular article 3 with ventral distal tooth (plate 297E); epimeron 3 posterior edge greatly expanded beyond ventral corner (plate 297F); ventral antennal sinus evenly rounded (plate 297G) . . . . *Accedomoera melanophthalma*
— Antenna 1, peduncular article 3 without a ventral distal tooth (plate 296S); epimeron 3 posterior edge only slightly expanded beyond ventral corner (plate 297H); ventral antennal lobe notched (plate 297A) . . . . . *Accedomoera vagor*
11. Deep cleft separating ocular lobe and second antenna sinus and female gnathopod 2 article 5 shorter than or equal to article 6 (plate 297C) 12
— Shallow cleft separating ocular lobe and antenna 2 sinus and female gnathopod 2 article 5 as long as article 6 (plate 297I). . . . . *Paramoera bousfieldi*
12. Anterioventral region of head below the antennal notch extending nearly even with the ocular lobe and posterior edges of pereopod 7 article 2 strongly serrate (plate 297C) . . . . *Paramoera serrata*
— Anterioventral region of head posterior to ocular lobe (plate 297J); posterior edges of pereopod 7 article 2 weakly serrate (plate 297K) or smooth (plate 297L) 13
13. Male gnathopod 2 palm one-half of the length of article 6 and subchelate (plate 297M) . . . . . . *Paramoera columbiana*
— Male gnathopod 2 palm less than one-third of the length of article 6 and oblique (plate 297N) 14
14. Female uropod 2 outer ramus equal to or longer than inner ramus (plate 297O). . . . . *Paramoera suchaneki*
— Female uropod 2 outer ramus shorter than inner ramus (plate 297P) . . . . *Paramoera mohri*
15. Telson, posteriorly concave (plate 296H); pleonal epimeron 3, posteriorly serrate and with ventral spines (plate 297Q) . . . . *Oligochinus lighti*
— Telson, posteriorly convex and evenly rounded (plates 296I, 297R); epimeron 3, without serrations (plate 297S) 16
16. Pleonite 3 posteriorly rounded (plate 297S); antenna 1 article 3 without ventromedial extension (plate 297T); lacinia mobilis of mandible greatly extended (plate 297U) . . . . *Paracalliopiella pratti*
— Pleonite 3 posterior ventrally square and with a minute tooth (plate 297V); antenna 1 article 3 ventromedially extended (plate 297W); lacinia mobilis of mandible normal (plate 297X). 17
17. Dorsal pereonites 5–7 and pleonites 1 and 2 not carinate (plate 297Y); pleon plate 2 with facial setae in two to three submarginal rows (plate 297Z) . . . . *Calliopius pacificus*
— Dorsal pereonites 5–7 and pleonites 1 and 2 carinate (plate 297V); pleon plate 2 with facial setae in five to seven submarginal rows (plate 297AA) . . . . *Calliopius carinatus*

LIST OF SPECIES

BATEIDAE

Batea lobata Shoemaker, 1926. Inshore sand and mud bottoms and pier pilings; 6 mm; intertidal—8 m.

CALLIOPIIDAE

Calliopius carinatus Bousfield and Hendrycks, 1997. Common in surf-swash zone, mainly along rocky shores, marine to mesohaline inshore waters; 9 mm; intertidal.

Calliopius pacificus Bousfield and Hendrycks, 1997. Dominant in inshore waters of bays and estuaries, apparently moderately euryhaline, among submerged plants and algae and on floats; 15 mm; intertidal to shallow depths.

Oligochinus lighti Barnard, 1969a. In the cobble–*Silvetia*–*Phyllospadix* zone; among the most abundant amphipods in *Mastocarpus papillatus* and *Endocladia muricata* of high and middle intertidal where they feed on epiphytic algae; see Johnson 1975, pp. 559–587 in Gates and Schmerl, eds., Perspectives of biophysical ecology, Springer Verlag (ecology); named in honor of the founder of this book, Sol Felty Light, 1886–1947; 11.5 mm.

Paracalliopiella pratti (Barnard 1954a). Low intertidal and subtidal on algae, mixed sediment, and seagrass. Known only from Alaska, Puget Sound, and Fossil Point in Coos Bay, Oregon, the latter collected from the introduced Japanese seaweed *Sargassum muticum*; 5 mm; intertidal—2 m.

EUSIRIDAE

Rhachotropis barnardi Bousfield and Hendrycks 1995a. Deep subtidal on fine sediment and probably also pelagic; abundance in shallow waters unclear; 4 mm; 17 m–350 m.

Rhachotropis inflata (Sars, G. O., 1883). On fine sediments and pelagic, circum-Arctic; occurrence in shallow waters possible; 8 mm; 10 m–154 m.

Rhachotropis oculata (Hansen,1888). Pan-arctic, swimming, planktivorous; south to southern California; occurrence in shallow waters unclear; 10 mm; 18 m–274 m.

PONTOGENEIIDAE

Accedomoera melanophthalma (Gurjanova, 1938). On mixed algae and sediments of boreal western Pacific to California, but Eastern Pacific occurrences poorly documented; 8 mm; intertidal—80 m.

Accedomoera vagor Barnard, 1969a. On algae in exposed rocky areas; 7.5 mm, intertidal—2 m.

Paramoera bousfieldi Staude, 1986. Gravel of brackish, stream mouths or intertidal freshwater seeps; 4.5 mm.

Paramoera columbiana Bousfield, 1958. Estuary, in gravel and other mixed sediments; 11 mm; intertidal.

Paramoera mohri Barnard, 1952b. Marine rocky open coasts; 6.5 mm, intertidal—10 m.

Paramoera serrata Staude, 1995. Marine, sand, and mixed sediments; 6 mm; low intertidal.

Paramoera suchaneki Staude, 1986. Marine, gravel, cobble and mussel beds; 13 mm; intertidal.

Pontogeneia inermis (Kroyer, 1838). Pan boreal in northern hemisphere, eastern Pacific identification uncertain; mixed sediments, possible echinoderm and coelenterate commensal

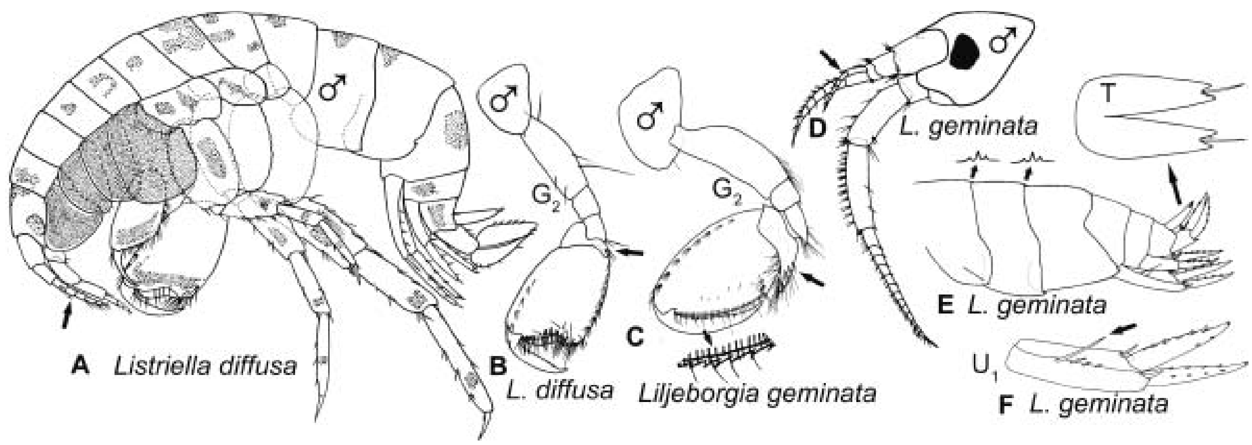

PLATE 298 Liljeborgiidae. C–F, *Liljeborgia geminata*; A–B, *Listriella diffusa* (figures modified from Barnard 1959a, 1969a).

and also common in nocturnal plankton samples; 4.5 mm; intertidal—220 m.

Pontogeneia intermedia Gurjanova, 1938. Intertidal and shallow subtidal on algae and various rocky sediments occurring also Japan and eastern Russia; 7.5 mm; intertidal.

Pontogeneia rostrata Gurjanova, 1938. On algae and mixed sediments; 6.5 mm; shallow subtidal and low intertidal.

**Pontogeneia* sp. A shallow subtidal undescribed purple species that occurs among *Strongylocentrotus purpuratus* spines (Harty 1979, p. 198, concerning observations at Cape Arago, Oregon, in: Bull. So. Calif. Acad. Sci. 78: 196–199); 7 mm; shallow subtidal.

LILJEBORGIIDAE

Liljeborgiidae have tiny rostrums, short antenna 2 relative to antenna 1, prominent accessory flagellum, poorly developed mandibular molars (plate 257KK), large gnathopods, and distally notched, laminar telsons that are cleft to the base. Pigmentation of many *Listriella* remains partially intact in preservation. Liljeborgiidae are likely commensals in tubes and burrows of large subtidal invertebrates, including polychaetes and echiuroids.

KEY TO LILJEBORGIIDAE

1. Gnathopods and often body pigmented urosome smooth and accessory flagellum of two articles (plates 257Q, 298A); gnathopod 2 article 5 posterior lobe not extending behind article 6 and dactyl posterior edges minutely serrate or smooth (plate 298B). . . . . *Listriella diffusa*

— Gnathopods and body not pigmented, gnathopod 2 article 5 posterior lobe extending behind article 6 and dactyls deeply serrate (plate 298C); accessory flagellum multiarticulate (plate 298D); pleonites 1 and 2 minutely toothed dorsally (plate 298E); uropod 1 peduncle with long lateral spines (plate 298F). . . . . *Liljeborgia* ? *geminata*

LIST OF SPECIES

**Liljeborgia geminata* Barnard 1969a. Of a poorly distinguished species complex (Barnard 1969a) occurring in the Atlantic and Pacific Oceans; on floats and pilings of southern California harbors and shallow coastal waters in rhizomes of *Macrocystis pyrifera*. Multiple long spines on peduncles of uropods 1 and 2 (plate 298F) are characteristic of this species; 8.7 mm; 1 m–70 m.

**Listriella albina* Barnard 1959a. Oregon to Baja California, a shallow warm-water species in its southern range and found at great depths in its northern range (Barnard 1971); 7.5 mm; 16 m–721 m.

Listriella diffusa Barnard 1959a. Shallow subtidal to 23 m in sandy sediments, possibly a commensal with large tube building polychaetes. Additional species of *Listriella* reported from southern California (Barnard 1959a) are expected in our region. Whole female body illustration plate 257Q. The toothlike structures on the inner lobes of the lower lip (functions unknown) occur also in Melitidae; 3.5 mm; 3 m–172 m.

**Listriella goleta* Barnard 1959a. Oregon to Baja California, a shallow warm-water species in its southern range found at great depths in its northern range; 3.5 mm, 16 m–721 m.

GAMMAROIDEA

Gammaroidea (Anisogammaridae and Gammaridae) are free-living, benthic, and epibenthic omnivores and zooplankton predators that range widely in shallow marine shores, estuaries, tidal creeks, and low-elevation rivers and lakes. Sexual dimorphism is weak. Whether native Gammaridae occur in the region is unclear.

KEY TO GAMMAROIDEA

1. Male gnathopod palms nearly transverse, lined with thick peg spines and gnathopod dactyls thick (plate 299A–299C); gills with accessory lobes (plate 299D). 2

— Gnathopod palms oblique, lined with simple spines and dactyls slender (plate 299E); gills normal, without accessory lobes (plate 299F) 6

2. Urosomite 2 with prominent median tooth (plate 299G); uropod 3 inner ramus >60% length of outer ramus (plate 299H). . . . . *Anisogammarus pugettensis*

— Urosomite 2 without prominent median tooth (plate 299A, 299I); uropod 3 inner ramus less than 30% length of outer ramus (plate 299J) 3

3. Pleon segments dorsum bare (plate 299A) or with a few tiny setae (plate 299I) . . . . *Eogammarus confervicolus*

* = Not in key.

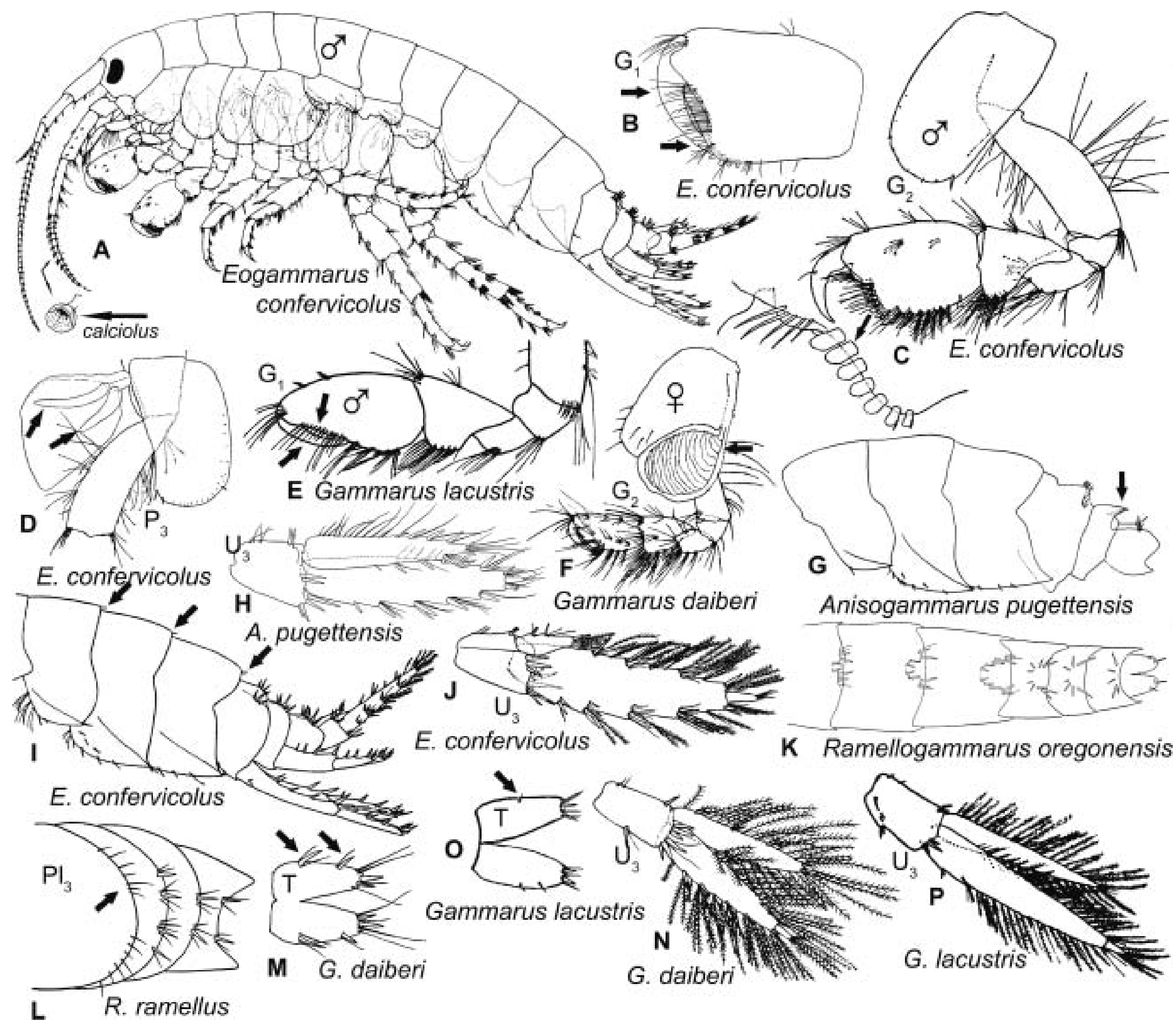

PLATE 299 Gammaroidea. G, H, *Anisogammarus pugettensis*; A–D, I, J, *Eogammarus confervicolus*; F, M, N, *Gammarus daiberi*; E, O, P, *Gammarus lacustris*; K, *Ramellogammarus oregonensis*; L, *Ramellogammarus ramellus* (figures modified from Barnard 1954a; Bousfield 1958b, 1973, 1979; Shoemaker 1944, 1964; and Weckel 1907).

— Pleon segments (one or more) with numerous, conspicuous, dorsal spines or setae (plate 299K, 299L) 4
4. Pleonite 3 with few or no setae and numerous stout spines (plate 299K) 5
— Pleonite 3 with numerous long setae and few stout spines (plate 299L) . . . . *Ramellogammarus ramellus*
5. Pleonites 1–3 with few setae and stout spines anterior to posterior pleonite margins (plate 299K). . . . . *Ramellogammarus oregonensis*
— Pleonites 1–3 with few setae and stout spines only on posterior edges . . . . *Ramellogammarus* spp.
6. Telson with two lateral bundles of prominent spines and seta (plate 299M); inner ramus extending to distal end of the first article of the outer ramus article 1 (plate 299N) . . . . *Gammarus daiberi*
— Telson with one or no lateral spine bundles and few seta (plate 299O); inner ramus not reaching distal end of the first article of the outer ramus article 1 (plate 299P) . . . . *Gammarus lacustris*

LIST OF SPECIES

ANISOGAMMARIDAE

Anisogammarus pugettensis (Dana, 1853). Marshes and low-salinity estuaries; high tolerance of low oxygen (Waldichuck and Bousfield 1962, J. Fish. Res. Bd. Canada 19: 1163–1165); 17 mm; subtidal to intertidal.

Eogammarus confervicolus (Stimpson, 1856) (=*E. oclairi* Bousfield, 1979). Estuarine, intertidal, and subtidal; various substrata but especially associated with sedges, eelgrass, algae, and wood chips; calceoli (plate 299A) are chemosensory organs of ecological and taxonomic interest (Stanhope et al. 1992, J. Chem. Ecol.18: 1871–1887); 19 mm; subtidal to intertidal. The major character separating *E. oclairi* and *E. confervicolus* (two distal telson lobe spines instead of one) is size dependent: *E. oclairi* are large (19 mm) *E. confervicolus*, and are thus synonyms.

**Eogammarus oclairi* Bousfield 1979. See *E. confervicolus*.

* = Not in key.

**Ramellogammarus columbianus* Bousfield and Morino, 1992. Freshwater, occurring in pebble and stone bottoms in moss or woody detritus often at the mouths of medium-size streams flowing into protected bays; 13 mm; intertidal.

**Ramellogammarus littoralis* Bousfield and Morino, 1992. Freshwater, occurring in pebble and stone bottoms in moss or woody detritus often at the mouths of medium-size streams flowing into protected bays; 9.5 mm; intertidal.

Ramellogammarus oregonensis (Shoemaker 1944) (=*Anisogammarus oregonensis*, *Eogammarus oregonensis*). Known only from extreme low salinities and freshwater of Big Creek and mouth of D River, Lincoln County, Oregon, and Siltcoos River, Lane County, Oregon; 10 mm; subtidal to intertidal.

Ramellogammarus ramellus (Weckel, 1907) (=*Gammarus ramellus*, *Anisogammarus ramellus* and *Eogammarus ramellus*). Low-salinity and freshwater marshes and stream mouths among coarse sand, stones, and wood debris, a morphologically variable, poorly described species or species complex; 13 mm; subtidal to intertidal.

Ramellogammarus spp. Several freshwater species from aquatic plants, coarse gravel and benthos of the lower Columbia River and coastal river mouths in up to 2% salinities (Bousfield and Morino 1992, Cont. Nat. Sci. 17: 1–22)

GAMMARIDAE

Gammarus daiberi Bousfield 1969. Ballast water introduction from eastern North America to 0–15% salinity areas of San Francisco Bay and Delta, benthic and semipelagic; 12.5 mm; subtidal to intertidal.

**Gammarus tigrinus* Sexton 1939. A benthic and pelagic species, introduced to the North Sea from eastern North America with ballast water, a likely invader of the intertidal Pacific coast and estuaries; referred to in Europe as a "scourge" due to its likely replacement of native gammaroid species (see Dielman and Pinkster 1977, Bull. Zool. Mus. Univ. Amsterdam 6: 21–29; Pinkster et al. 1977, Crustaceana Suppl. 4: 91–105); morphology and ecology are similar to *G. daiberi*, 1–25% salinity; 14 mm; low intertidal to shallow subtidal.

**Gammarus lacustris* (Sars, 1863). Filamentous algae in weed and rush margins of hard-water lakes and ponds of American Pacific coastal alpine, rare in tidal waters of rivers, West Coast distribution and taxonomy unclear and may be present along the Pacific coast south of 45° N (Barnard and Barnard 1983: 81); important zooplankton predator in lakes (Wilhelm and Schindler 1999, Can. J. Fish. Aquat. Sci. 56: 1401–1408); 15 mm; intertidal river mouths, low elevation lakes and streams.

HADZIOIDEA

Hadzioidea (Hadziidae and Melitidae) occur in marine and estuarine benthic fouling communities. The Hadzioidea have large accessory flagella, short antenna 2 relative to antenna 1, waxy cuticles and greater lateral body compression than most Gammaridea. The only Hadziidae of the region is marine. Estuarine Melitidae may overlap with Crangonyctidae in low-salinity environments. The diversity of secondary sex characters in Melitidae, ranging from the enormous male gnathopods of *Dulichia*, probably adapted for competition for females, to the stridulating anatomy in *Melita* perhaps to attract males, indicate broad variation in mating behaviors in the family.

* = Not in key.

KEY TO HADZIOIDEA

1. Uropod 3 inner ramus less than a fifth as long as the outer ramus (plate 300A) 2
— Rami of uropod 3 similar in length (plate 300B) 12
2. Male and female gnathopod 2 article 6 equal to or smaller than article 5 and coxa 2–3 longer than deep (plate 300C) . . . . *Netamelita cortada*
— Male and female gnathopod 2 article 6 larger than article 5 and coxa 2–3 deeper than long (plate 300D) 3
3. Pleosome segments 1–3 with a central dorsal tooth plus accessory lateral teeth (plate 300E) 4
— Pleosome segments 1–3 without dorsal teeth (plate 300D) or with only dorsal lateral teeth (plate 300F) 6
4. Male gnathopod 2 article 6 immense and chelate (plate 300G) . . . . *Dulichiella spinosa*
— Male gnathopod 2 large but subchelate and not immense (plate 300H). 5
5. Gnathopod 2 dactyl distally blunt and without dense anterior setae (plate 300H); dorsal pleonite 1 with multiple lateral teeth (plate 300I) . . . . *Megamoera subtener*
— Gnathopod 2 dactyl distally pointed and covered anteriorly with setae (plate 300J); pleonite 1 with single lateral teeth (plate 300E) . . . . *Megamoera dentata*
6. Male gnathopod 1 article 6 and dactyl highly modified (plate 300K); distinct from simple female dactyl (plate 300L) 7
— Male gnathopod 1 article 6 and dactyl normally subchelate, not modified or distinct from simple dactyl of female (plate 300M) 10
7. Urosomite 1 posterior edge with a distinct dorsal medial tooth (plate 300D); condition of female coxa 5 not reported . . . . *Melita sulca*
— Urosomite 1 posterior edge without a medial tooth (plate 300F, 300N); female coxa 5 ventrally extended (plate 300O) 8
8. Urosomite 3 dorsally bare and pleonal epimeron 3 of both sexes weakly toothed or square (plate 300N). . . . . *Melita nitida*
— Urosomite 2 with dorsal lateral teeth (plate 300F, 300P); posterior edge of pleonal epimeron 3 of both sexes sharply toothed (plate 300Q, 300R) 9
9. Urosomite 2 with widely separate pairs of dorsal lateral teeth (plate 300P); male gnathopod 1 dactyl overlapped by article 6 less than half its length (plate 300S) . . . . *Melita oregonensis*
— Urosomite 2 with only two closely spaced dorsolateral teeth (plate 300F); male gnathopod 1 dactyl overlapped more than half by article 6 (plate 300K) . . . . *Melita rylovae*
10. Urosomite 1 with 3–5 dorsal lateral teeth (plate 301A) . . . . *Desdimelita californica*
— Urosomite 1 with a single dorsal tooth (plate 301C). 11
11. Pereopods 5–7 dactyl lengths greater than 4 times width (plate 301C). . . . . *Desdimelita desdichada*
— Pereopods 5–7 dactyls lengths <3 times width (plate 301D) . . . . *Desdimelita microdentata*
12. Pleon epimeron 3 with multiple irregular posterior teeth (plate 300T); mandibular palp article 3 less than one third of the length of article 2 (plate 300V) . . . . *Ceradocus spinicauda*
— Pleon epimeron 3 rounded (plate 300U) or with one ventral posterior tooth (plate 301O); mandibular palp article 3 greater than two thirds of the length of article 2 (plate 301F). 13

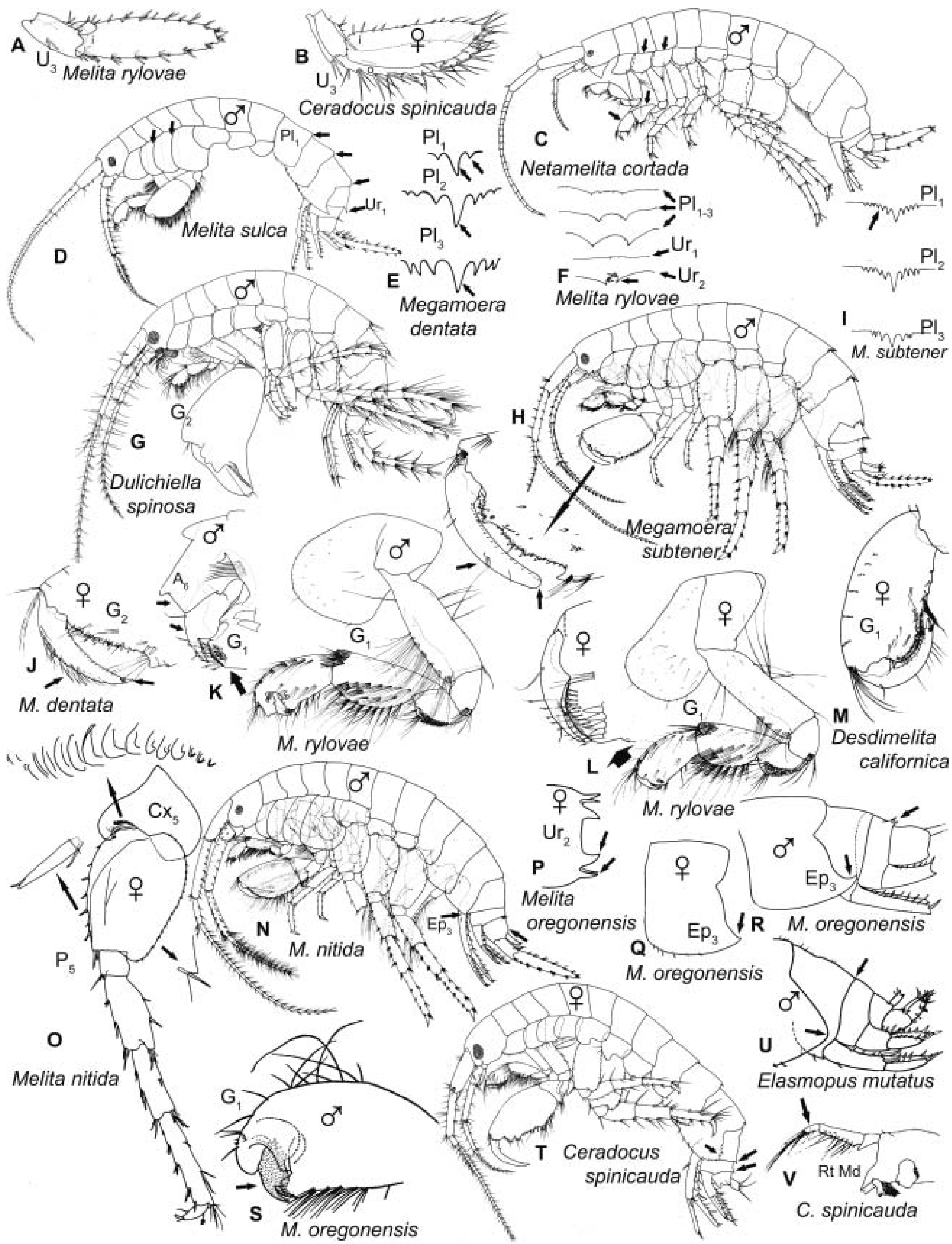

PLATE 300 Hadzioidea. B, T, V, *Ceradocus spinicauda*; M, *Desdimelita californica*; G, *Dulichiella spinosa*; U, *Elasmopus mutatus*; E, J, *Megamoera dentata*; H, I, *Megamoera subtener*; N, O, *Melita nitida*; P–S, *Melita oregonensis*; A, F, K, L, *Melita rylovae*; D, *Melita sulca*; C, *Netamelita cortada* (figures modified from Barnard 1954a, 1962b, 1969a, 1970; Chapman 1988; Jarrett and Bousfield 1996; Krapp-Schickel and Jarrett 2000; and Yamato 1987, 1988).

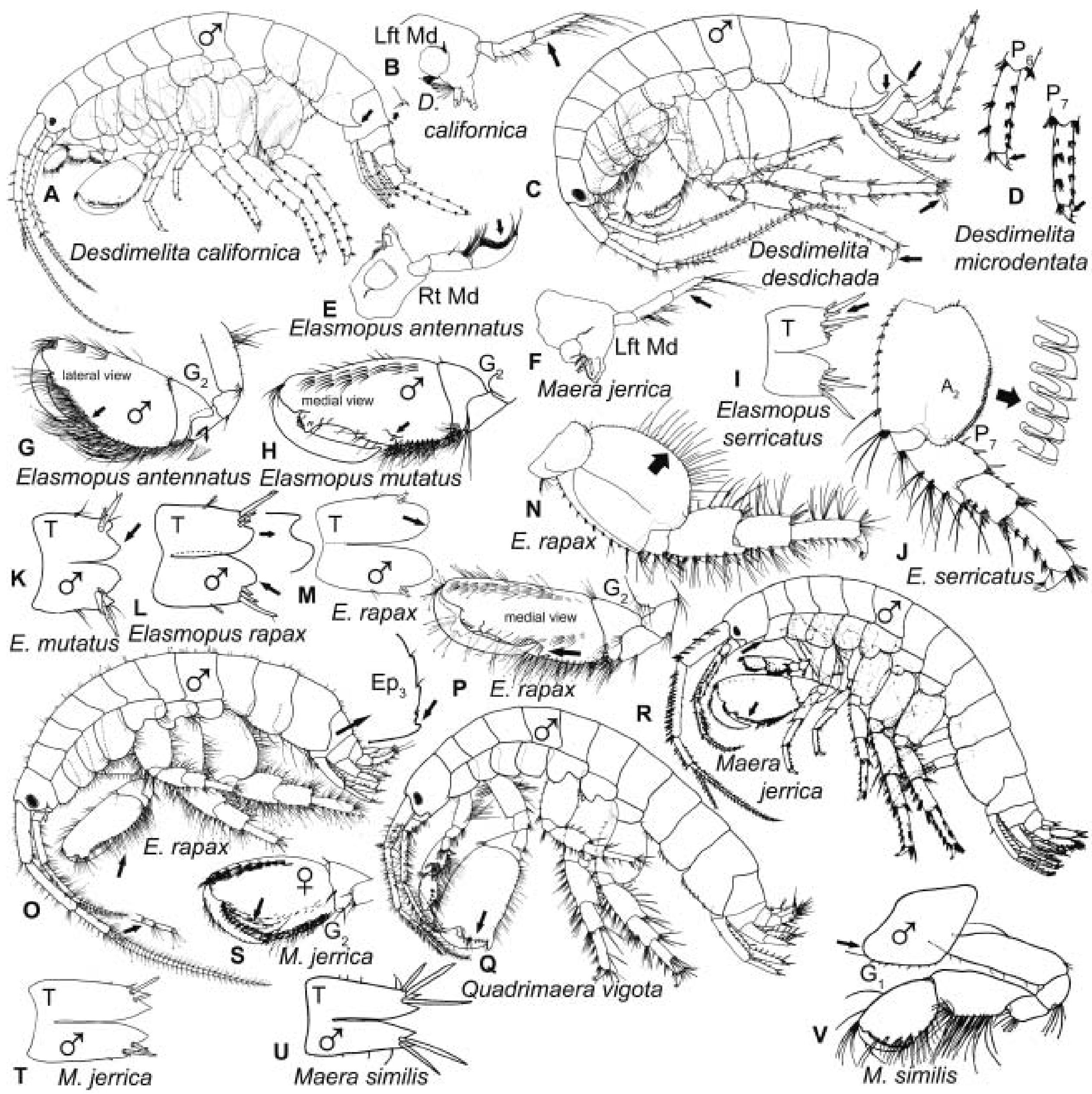

PLATE 301 Hadzioidea. A, B, *Desdimelita californica*; C, *Desdimelita desdichada*; D, *Desdimelita microdentata*; E, G, *Elasmopus antennatus*; H, K, *Elasmopus mutatus*; L–P, *Elasmopus rapax*; I, J, *Elasmopus serricatus*; F, R–T, *Maera jerrica*; U, V, *Maera similis*; Q, *Quadrimaera vigota* (figures modified from Barnard 1954a, 1959b, 1962b, 1969b, 1979a and Krapp-Schickel and Jarrett 2000).

13. Mandibular palp article 3 falcate and with dense comblike setae (plate 301E) 14
— Mandibular palp ordinary and sparsely setose (plate 301F) 17
14. Male gnathopod palm without defining proximal processes (plate 301G) (examine from lateral and medial. These processes are nearly transparent and can be obscured by dense setae) . . . . *Elasmopus antennatus*
— Male gnathopod palm with defining proximal processes (plate 301H). 15
15. Telson distally truncate and spinose (plate 301I); posterior pereopod 5 deeply serrated (plate 301J) . . . . *Elasmopus serricatus*
— Telson less spinose, distally incised and with medial extensions of the lobes (plate 301K–301M); posterior pereopod 5 weakly serrate (plate 301N) 16
16. Third pleonal epimera posterior ventrally rounded (plate 300U); male gnathopod 2 article 6 proximal palmar tooth reduced and palm bearing few setae (plate 301H); medial lobe of telson bluntly acute (plate 301K). . . . . *Elasmopus mutatus*
— Third pleonal epimera posterior ventrally square or with a small tooth (plate 301O); male gnathopod 2 with a defining hinge process at the proximal medial corner of article 6; palm (plate 301P) with dense setae (plate 301O, 301P) . . . . *Elasmopus rapax*

17. Male gnathopod 2 nearly transverse, 80–90° angle of article 6 distal posterior corner (plate 301Q) . . . . *Quadrimaera vigota*
— Male and female gnathopod 2 subchelate, with palm angle >100° (plate 301R, 301S) 18
18. Telson distal spines less than one-third of the telson length (plate 301T); coxa 1 anterior acute (plate 301R) . . . . *Maera jerrica*
— Telson distal spines greater than one-half of the telson length (plate 301U); coxa 1 anterior rounded (plate 301V) . . . . . . *Maera similis*

LIST OF SPECIES

HADZIIDAE

Netamelita cortada Barnard, 1962b. Tunicate colonies at base of *Phyllospadix* beds; 3.5 mm; intertidal—20 m.

MELITIDAE

Ceradocus spinicauda (Holmes, 1908). Intertidal algae among cobbles; 12 mm; 3 m–218 m.

Desdimelita californica (Alderman, 1936). Among cobbles to fine sediments; 10 mm; intertidal—10 m.

Desdimelita desdichada (Barnard, 1962b) (=*Melita desdichada*). Soft sediments; 9 mm; 10 m–108 m.

Desdimelita microdentata Jarrett and Bousfield, 1996. 11 mm; 1 m–35 m.

Dulichiella spinosa Stout, 1912 (=*Melita appendiculata*). A rocky intertidal semitropical species reported north of Pt. Conception only once (Bousfield and Jarrett 1996, Amphipacifica 2[2]: 13); not clearly distinct from tropicopolitan *Dulichiella appendiculata* (Say, 1818); 4.5 mm; intertidal—3 m.

Elasmopus antennatus (Stout, 1913). Distinguished from *E. mutatus* by its acute rather than round posterior epimeron 3 (plate 257R); among *Phyllospadix* and algae bottoms; 10.5 mm; intertidal—18 m.

Elasmopus mutatus Barnard, 1962b. Open rocky coast among algae turf. Allometric distinctions between *E. mutatus* and the larger *E. rapax* are unclear; 7.5 mm; intertidal.

Elasmopus rapax Costa, 1853. Cosmopolitan in latitudes below 45° and restricted to enclosed bays. Introduced in California. Variation in telson morphology with size is apparent in male telsons of 7.5 mm *E. mutatus* (plate 301K) and 8 mm and 11 mm *E. rapax* (plate 301L, 301M); to 11 mm; intertidal—100 m.

Elasmopus serricatus Barnard, 1969b. Among *Egregia*, *Phyllospadix* and coralline algae. Poorly distinguished from southern Californian *Elasmopus holgurus* Barnard, 1962b. 8 mm; intertidal.

**Maera grossimana* (Montagu, 1808). The northeast Pacific record of this North Atlantic species (Bousfield 2001) is uncertain; 10 mm.

Maera jerrica Krapp-Schickel and Jarrett, 2000 (=*Maera inaequipes* Barnard, 1954a). Among intertidal algae and in soft offshore sediments; 14 mm; intertidal—135 m.

Maera similis Stout, 1913. Soft benthos of estuaries and coastal waters. 9 mm, intertidal—221 m.

Megamoera dentata (Kroyer, 1842). Cosmopolitan in Arctic to cold temperate northern hemisphere oceans, on rocky and sedimentary bottoms; to 28 mm; intertidal—672 m.

* = Not in key.

Megamoera subtener (Stimpson, 1864) In coarse gravel and shell, under stones and kelp; 12 mm; intertidal—10 m.

Melita nitida Smith, 1874. Estuarine, abundant among algae and hydroids. Introduced probably from the northwest Atlantic, but also indistinguishable from the Asian *Melita setiflagellata* Yamato 1987 and therefore may be introduced to or from Asia. See Borowsky et al. 1997, J. Exp. Mar. Biol. Ecol. 214: 85–95 (reproductive morphology and physiology in polluted estuarine sediments); 12 mm; intertidal—10 m.

Melita oregonensis Barnard, 1954a. Rocky shores; 12 mm, intertidal.

Melita sulca (Stout, 1913). Condition of female coxa 5 not described. Harbors and among cobbles and algae holdfasts of open coasts; 12 mm; intertidal—101 m.

Melita rylovae Bulycheva, 1955. Introduced to San Francisco Bay from Asia and also found in ballast water samples collected in Australia where it is also introduced (Williams et al. 1996, Est. Coastal Shelf Sci. 26: 409–420); in fouling communities of docks and floats; 7.5 mm; 1 m–10 m.

Quadrimaera vigota (Barnard, 1969a) (=*Maera vigota*). Abundant under cobbles, on sponges and tunicates and rarely on algal holdfasts; dark pink; 8.5 mm; intertidal.

CRANGONYCTIDAE

Crangonyctidae have two segment accessory flagella (plate 257UU) with small terminal articles, dorsally smooth urosomes and lack a ventral antenna sinus. They are distinguished from the Hadzioidea also by having pereopod 6 longer than pereopod 7. Sexual dimorphism is reduced. As crangonyctids, *Crangonyx pseudogracilis* and *C. floridanus* share a biramous uropod 3 with reduced inner ramus (plate 302A) singly inserted spine rows on lateral article 6 of gnathopods 1 and 2 (plate 302B, 302C), eyes, and above ground occurrence; but morphological distinctions between the two species are not clear, with pleon tooth development and ventral comb setae of the male uropod 2 outer ramus being variable and of uncertain significance. The low-salinity occurrences of *Crangonyx pseudogracilis* and *C. floridanus* are unique among the almost exclusively freshwater Crangonyctidae.

KEY TO CRANGONYCTIDAE

1. Pleon epimera teeth reduced (plate 302D); male uropod 2 outer ramus slightly decurved and lined ventrally with tiny comb spines (plate 302E) . . . . *Crangonyx pseudogracilis*
— Pleon epimera teeth large (plate 302F); male uropod 2 outer ramus straight and lined ventrally with large comb spines (plate 302G). . . . . *Crangonyx floridanus*

LIST OF SPECIES

Crangonyx floridanus Bousfield, 1963. Endemic to sloughs, swamps, caves, and ponds along the U.S. Gulf Coast and possibly introduced to San Francisco Bay. The specific identity of *C. floridanus* in the San Francisco Bay Delta (Toft et al. 2002) is unclear since the associated illustration in the report is of a previously published figure of *Crangonyx forbesi* (Hubricht and Mackin 1940); 6 mm; intertidal—10 m.

Crangonyx pseudogracilis Bousfield, 1958. Occurring in aquatic vegetation in still or slow flowing, organically polluted, low salinity waters. Introduced to western North America and Japan (Zhang 1997) and Europe, where it spread secondarily from Great Britain to Ireland possibly in aquarium

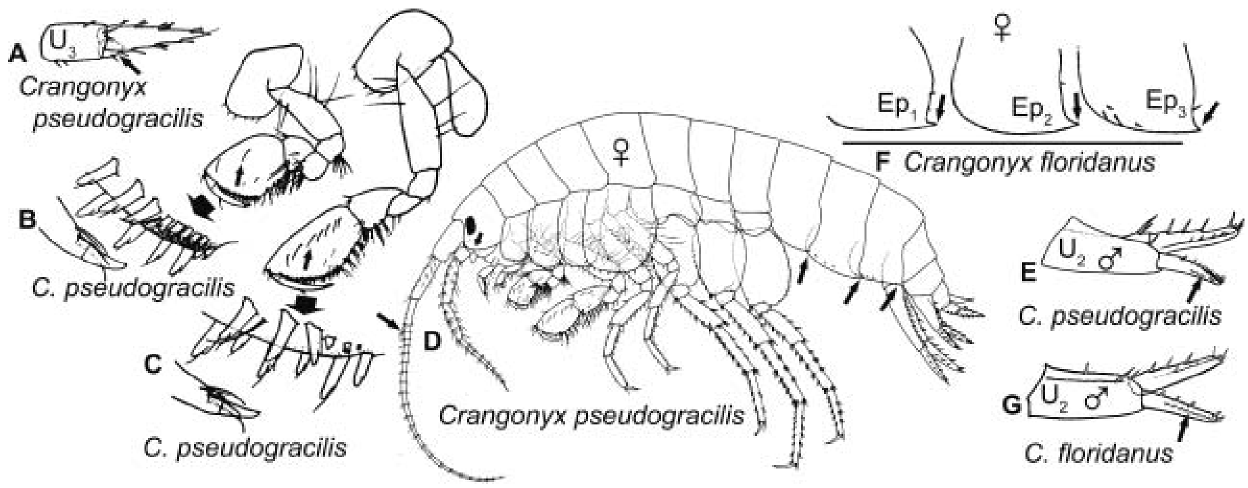

PLATE 302 Crangonyctidae. F, G, *Crangonyx floridanus*; A–E, *Crangonyx pseudogracilis* (figures modified from Bousfield 1958b, 1963, 1973).

plants (Costello 1993, Crustaceana 65: 287–299). Whether *C. floridanus* or *C. pseudogracilis* occur in San Francisco Bay should be more than an academic concern. *Crangonyx pseudogracilis* is declining in some areas of its native central and eastern North American range in the presence of invading introduced species (Beckett et al. 1997). In contrast, native European amphipod populations decline in the presence of the invading *C. pseudogracilis* which are largely unaffected by native parasites (MacNeil et al. 2003). However, the microsporidian parasite *Fibrillanosema crangonycis* of *C. pseudogracilis* appears to be transmitted with the host in invasion events and then vertically transmitted to native European amphipod hosts (Slothouber Galbeath et al. 2004). Vertical transmission combined with host sex ratio distortion may enhance host invasion success through increased rates of population growth and declines of potential native competitors (MacNeil et al. 2003). *C. pseudogracilis* also occurs in Oregon (Bousfield 1961b) and southern California (Bottoroff et al. 2003); 5 mm; intertidal—10 m.

TALITRIDAE

EDWARD L. BOUSFIELD

Talitrids comprise mainly beach hoppers, common at night on damp sand beaches, where they feed upon seaweeds cast up by the tide. Fresh beach wrack may contain purely aquatic amphipods, but their death is rapid in the air, whereas beach hoppers survive well out of water. Because the patterns and colors by which they may be identified in life are lost in preservatives, a morphological key to the Talitridae precedes a key to *Megalorchestia* based largely on color (Bowers 1963).

Although entirely terrestrial talitrids (land hoppers) are not native to our area, the student and professional zoologist will encounter southern hemisphere species introduced in urban and agriculture environments in California. Abundant, for example, under *Eucalyptus* and other leaf litter in Golden Gate Park (and other parks) in the City of San Francisco is the introduced Australian leafhopper *Arcitalitrus sylvaticus* (Haswell, 1880).

KEY TO TALITRIDAE GENERA

From Bousfield 1982.

1. Male gnathopod 1 simple, article 6 more than twice as long as wide (plate 303A1, 303C3, 303F1, 303H1); pereopods and uropods stout, with large spines; pleopod peduncles laterally spinose (plate 303A2); burrowers. . . . . *Megalorchestia*
— Male gnathopod 1 transverse, article 6 less than twice as long as wide (plate 303B1, 303E1); appendages slender, with small spines; pleopod peduncles with few or no lateral spines (plate 303B2); under debris or rocks 2
2. Male antenna 2 thick (plate 303E6) and sexual dimorphism is strong; male gnathopod 2 dactyl sinuate (plate 303E2) . . . . *Transorchestia*
— Male antenna 2 slender (plate 303B1, 303G1) and sexual dimorphism is weak; male gnathopod 2 dactyl evenly curved (plate 303B1) 3
3. Uropod 1 with distolateral spine (plate 303G2); telson longer than broad, with single dorsolateral spines (plate 303G3); female gnathopod 1 articles 5 and 6 posteriorly swollen, dactyl not exceeding palm (303G4); brood plate setae simple (i.e., plate 255MM) . . . . *Paciforchestia*
— Uropod 1 lacking distolateral spine (plate 303B1, 303E4); telson broader than long, with groups of dorsal and marginal spines (plate 303B3); female gnathopod 1 segments 5 and 6 not swollen posteriorly and dactyl slightly exceeding palm (plate 303B4); brood plate setae hook-tipped (i.e., plate 255NN) . . . . *Traskorchestia*

KEY TO TALITRIDAE

1. Male gnathopod 1 transverse, dactyl not or barely overlapping palm (plate 303B1, 303E1, 303G4); pereopod 7 longer than 6 (plate 303B1); uropod 3, ramus narrowing distally and shorter than peduncle (plate 303E3) 2
— Male and female gnathopod 1 simple (both sexes), dactyl strong, heavy (fossorial) (plate 303A1, 303C3, 303D1, 303F1, 303H1); pereopod 6 longer than 7 (plate 303A1); uropod 3 ramus distally broad and as long as peduncle (plate 303C1) 4
2. Pereopods 3 and 4 slender, article 5 about equal to article 6 length and width (plate 303E5); male gnathopod 2 palm slightly concave and dactyl sinuate (plate 303E2); male antenna 2 peduncle thick (plate 303E6) . . . . *Transorchestia enigmatica*
— Pereopods 3 and 4 article 5 shorter and thicker than segment 6 (303B1); male gnathopod 2 palm evenly convex,

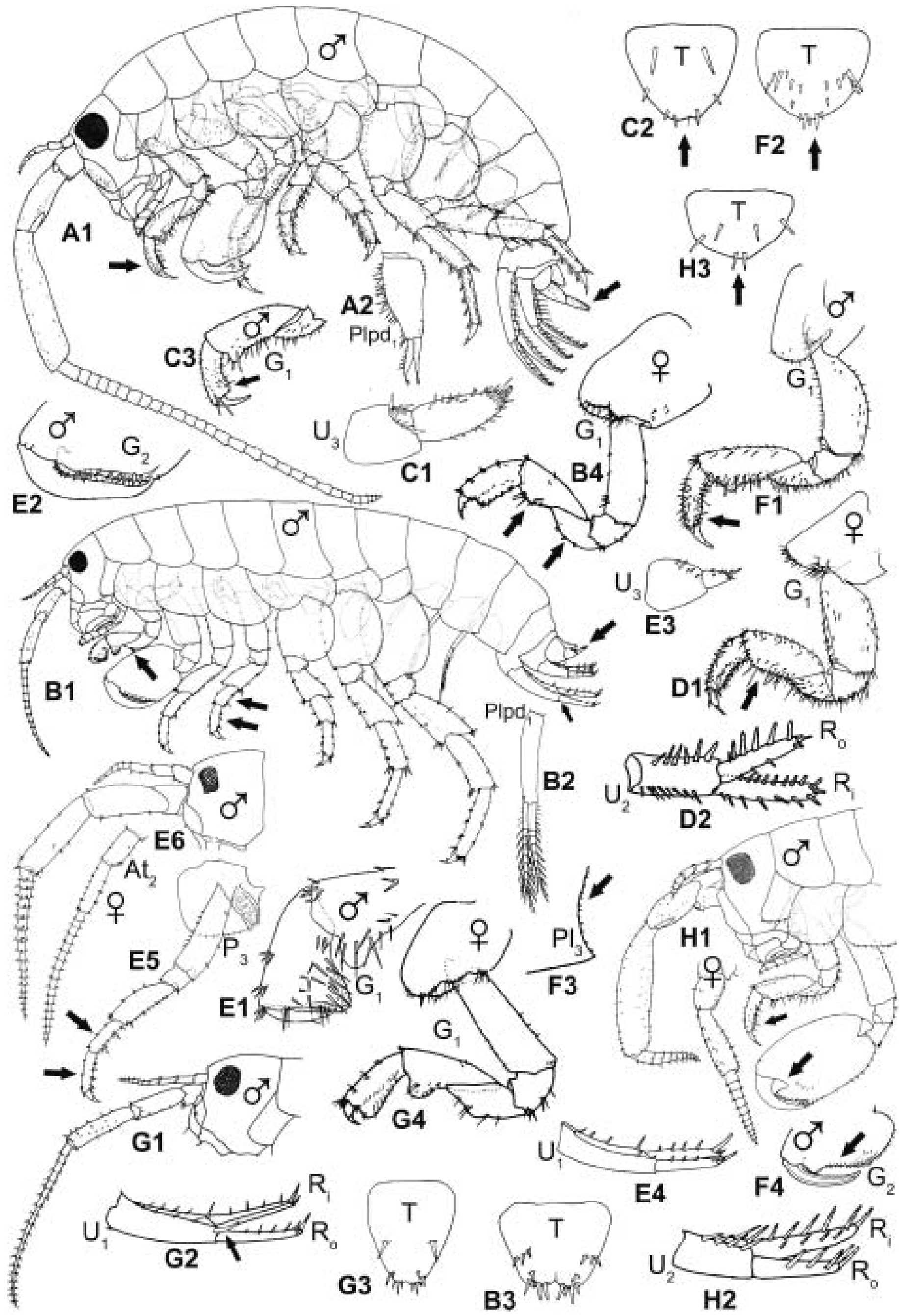

PLATE 303 Talitridae. H, *Megalorchestia benedicti*; A, *Megalorchestia californiana*; D, *Megalorchestia pugettensis*; F, *Megalorchestia corniculata*; C, *Megalorchestia californiana*; G, *Paciforchestia klawei*; E, *Transorchestia enigmatica*; B, *Traskorchestia traskiana* (figures modified from: Bousfield 1961a; Bousfield 1982, Nat. Mus. Canada, Publ. Biol. Oceangr. 11, 73 p.; Bousfield and Carlton 1967. Bull. Sth. Calif. Acad. Sci. 66: 277–283).

dactyl evenly curved and male antenna 2 peduncle relatively short and thin (plate 303B1) 3

3. Pleopods weak, rami 4–6 segmented; male gnathopod 1 article 4 lacking posterior translucent process ("blister") . . . . *Traskorchestia georgiana*
— Pleopods strong, rami 7–10 segmented (plate 303B2); male gnathopod 1 article 4 with small, posterior, translucent process (plate 303B1, arrow) . . . . *Traskorchestia traskiana*
4. Uropod 2, inner and outer margins of outer ramus bearing spines (plate 303D2); flagellum of male antenna 2 as long or longer than peduncle (plate 303A1) 5
— Uropod 2, only outer margin of outer ramus bearing spines (plate 303H2); flagellum of antenna 2 shorter than peduncle (plate 303H1). 6
5. Posterior margins of pleonites with numerous small spines (plate 303F3); female gnathopod 1 article 5 with posterior translucent process ("blister"); pleopod rami less than one half of the peduncle length . . . . *Megalorchestia californiana*
— Posterior margins of pleonites without spines; female gnathopod 1 without translucent process on article 5 (plate 303D1, arrow); pleopod rami half to three fourths as long as peduncles. . . . . *Megalorchestia columbiana*
6. Telson with shallow distal notch (plate 303C2); anteroventral margin of pleonite 1 with 1–7 spines; male gnathopod 1 article 6 with posterior distal expansion (plate 303C3, arrow) . . . . *Megalorchestia pugettensis*

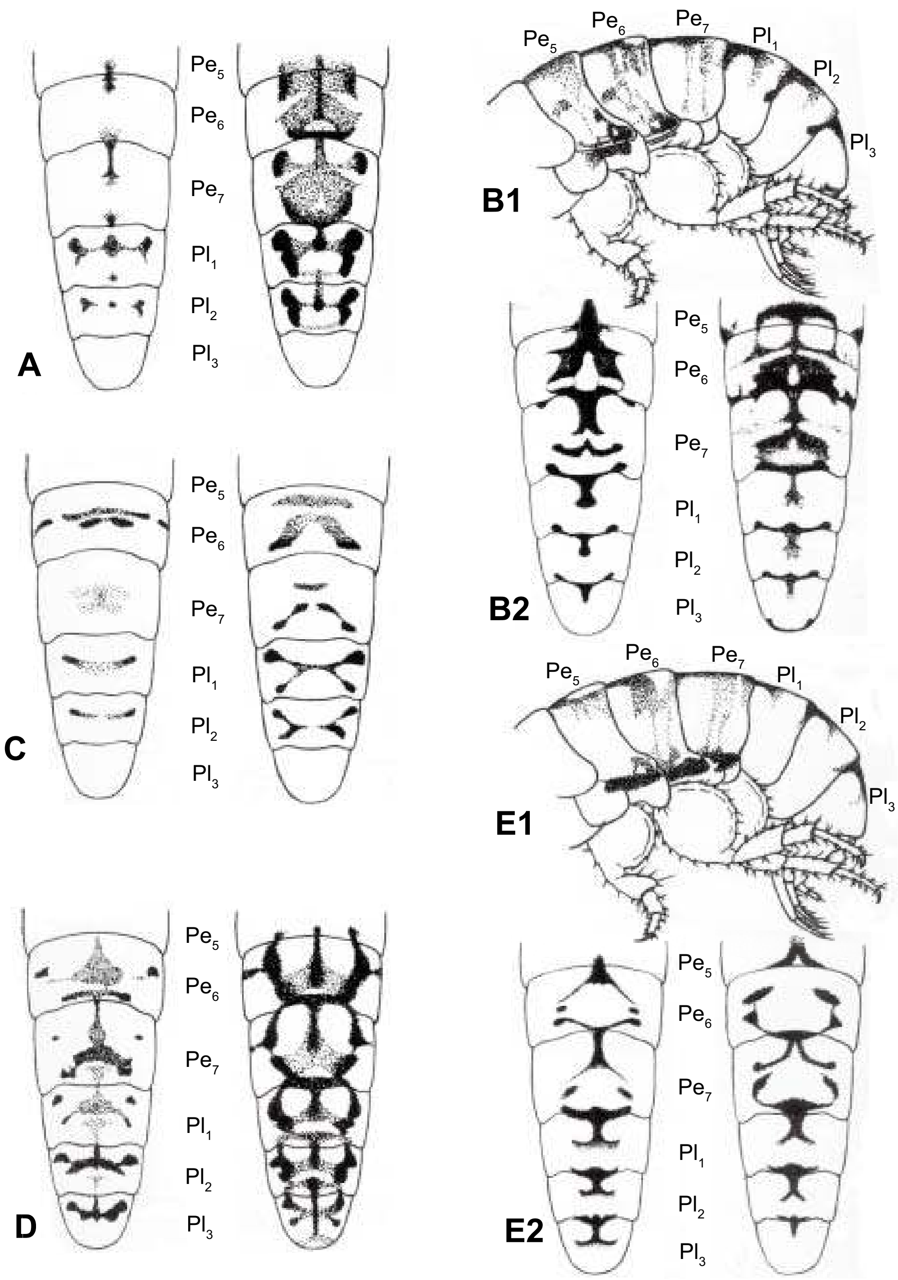

PLATE 304 Talitridae. Color patterns of *Megalorchestia*: dorsal and lateral views; paired figures show extent of pattern variation. A, *M. californiana*; B, *M. corniculata*; C, *M. columbiana*; D, *M. benedicti*; E, *M. pugettensis* (figures after Bowers 1963, Pac. Sci. 17:315–320).

— Telson without distal notch (entire) (plate 303F2, 303H3); anteroventral margin of pleonite 1 without spines; male gnathopod 1 article 6 without posterior distal expansion (plate 303F1, 303H1, arrows) 7

7. Posterior pleonite edges with 10 or more small spines (plate 303F2); male gnathopod 2 shallowly concave (plate 303F4) . . . . *Megalorchestia corniculata*

— Posterior pleonite edges with five or less spines; male gnathopod 2 deeply incised (plate 303H1, arrow). . . . . *Megalorchestia benedicti*

A FIELD (COLOR-PATTERN) KEY TO *MEGALORCHESTIA*

DARL E. BOWERS

(Plate 304)

1. Mature *Megalorchestia* 2

— *Megalorchestia* immature or not distinguished in couplets 2a through 4a below 5

2. Antenna 2 when folded reaching back to or past middle of body; flagellum longer than peduncle 3

— Antenna 2 when folded not reaching middle of body; flagellum shorter than peduncle 4

3. Color of antennae 2 rosy red . . . . *Megalorchestia californiana*

— Color of antennae 2 bluish white. . . . . *Megalorchestia columbiana*

4. Color of antennae 2 usually salmon pink . . . . *Megalorchestia corniculata*

— Color of antennae 2 otherwise 5

5. Dorsal pigment pattern containing "butterfly" design 6

— Dorsal pigment pattern containing T-shaped figures; the lower limb of the T may be faint or missing 8

6. Mid-dorsal line absent; "butterfly" spots are flattened. . . . . *Megalorchestia columbiana*

— Mid-dorsal line present 7

7. No markings on third pleonite; sides of body relatively free of pigment marks . . . . *Megalorchestia californiana*
— Markings on third pleonite; sides of body blotched in checkerboard pattern . . . . *Megalorchestia benedicti*
8. Two diffuse spots on lateral pereonites 5–7 . . . . *Megalorchestia corniculata*
— Three discrete spots on lateral pereonites 5–7 . . . . *Megalorchestia pugettensis*

LIST OF SPECIES

EDWARD L. BOUSFIELD

Species of *Megalorchestia* were formerly *Orchestoidea,* and species of *Paciforchestia, Transorchestia,* and *Traskorchestia* were formerly in *Orchestia*.

Megalorchestia benedicti (Shoemaker, 1930). Common on fine-sand beaches with *M. californiana*; 8 mm.

Megalorchestia californiana (Brand, 1851). Large and common, high up on wide, exposed beaches of fine sand; digs burrows of elliptical cross-section. May have parasitic mites (see note under *M. corniculata*); 23 mm.

Megalorchestia columbiana (Bousfield, 1958). On coarse-sand beaches with little seaweed. See Bowers 1964, Ecology 45: 677–696 (ecology); 22 mm.

Megalorchestia corniculata (Stout, 1913). Large and common, on steep, protected beaches with coarse sand and considerable seaweed; burrow nearly circular in cross-section. May be infested on their ventral surface with parasitic mites. See Craig 1971, Anim. Behav. 19: 368–374 and 1973, Anim. Behav. 21: 699–706 (lunar orientation); Craig 1973, Mar. Biol. 23: 101–109 (ecology). See Bowers 1964, Ecology 45: 677–696 (ecology); 21 mm.

**Megalorchestia minor* (Bousfield, 1957). A southern species occurring north to San Simeon, just north of Point Conception, on surf-exposed flat sand beaches; see Bousfield, 1982; 15 mm.

Megalorchestia pugettensis (Dana, 1853). Under debris on coarse-sand beaches with little seaweed; 17 mm.

**Paciforchestia klawei* (Bousfield, 1961). Known from British Columbia and from southern and Baja California; to be expected within our range. Under debris on protected coarse-sand and pebble beaches; 14.5 mm.

Transorchestia enigmatica Bousfield and Carlton, 1967. Described as a new species from the estuarine Lake Merritt, in Oakland, in San Francisco Bay, this amphipod is a member of the *T. chiliensis* species group, known from Chile and New Zealand (although the *enigmatica* clade remains unknown from either region). It was introduced in solid ballast from the southern hemisphere, perhaps by sailing ships carrying lumber from California to Valparaiso or Iquique, and returning in ballast, which was known to then be dumped into the Oakland Estuary near Lake Merritt. Under debris on sandy beaches; 15 mm.

Traskorchestia georgiana (Bousfield, 1958). In the drift line of protected stony and pebbly beaches, on sand with windrows of *Zostera* and *Sargassum* and usually co-occurring with *T. traskiana*. Possibly sexually dimorphic uropod 1; 13.5 mm.

Traskorchestia traskiana (Stimpson, 1857). On rocky beaches, occasionally on sandy beaches with algae; under debris and boards in salt marshes. See Page, 1979, Crustaceana 37: 247–252 (antennal growth); Busath, 1980, pp. 395–401 in Power ed, The California Islands Santa Barbara Mus. Natl. Hist. (genetics); Koch 1980, Crustaceana 57: 295–303 (behavior); Koch 1990, Crustaceana 59: 35–52 (population biology); 17 mm.

* = Not in key.

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CAPRELLIDAE

LES WATLING AND JAMES T. CARLTON

(Plates 305–311)

Caprellids, or "skeleton shrimp," are remarkable crustaceans in which one can easily invest many hours of profitable observation, watching their feeding behavior, inter- or intraspecific interactions, and sheer gymnastics, as they cling and climb, often perfectly camouflaged, on hydroids, bryozoans, or other substrates. Much remains to be learned about their biology, ecology, and distribution along the Pacific coast, and some relatively common intertidal species remain known from hardly more than their original descriptions. Especially overlooked—or mistaken for juveniles—are those species that are only a few millimeters in length as adults. The patient student working with living substrates, a comfortable chair, and a good microscope will be richly rewarded.