. . . . *Lamprops triserratus*

9. Uropod exopod equal in length to proximal two articles of endopod (plate 228D) . . . . *Lamprops obfuscatus*

— Uropod exopod extends beyond end of second article of endopod (plate 228E) . . . . *Lamprops tomalesi*

Key to Species with No Free Telson

1. Uropod endopod composed of two distinct articles 2

— Uropod endopod uniarticulate 3

2. First antenna with conspicuous "elbow"; carapace with large tooth at anteroventral corner; first pereonite very narrow (plate 230A) . . . . *Eudorella pacifica*

— First antenna without elbow; carapace anteroventral corner rounded; first pereonite wide enough to be easily seen in lateral view (plate 229A) . . . . *Nippoleucon hinumensis*

3. Carapace extended posteriorly, overhanging first few pereonites so that pereonites 1 and 2 are much narrower than pereonites 3–5 4

— Carapace not overhanging pereon, pereonites 1 and 2 same length as pereonites 3–5 (plate 229B) . . . . . *Cumella vulgaris*

4. Carapace smooth, female with a small groove extending posteriorly from anterior margin (plate 229C) . . . . *Campylaspis canaliculata*

— Carapace with bumps or large ridges 5

5. Carapace with series of large ridges, no bumps or tubercles (plates 229D, 230C) . . . . *Campylaspis hartae*

— Carapace with series of tubercles, some organized into shallow ridges; carapace, legs and uropods with many pigment spots (plates 229E, 230B) . . . . . *Campylaspis rubromaculata*

List of Species

LAMPROPIDAE

Hemilamprops californicus Zimmer, 1936.

Lamprops tomalesi Gladfelter, 1975.

Lamprops obfuscatus (Gladfelter, 1975) (=*Diastylis obfuscata*). This species and *L. triserratus* were assigned by Gladfelter to the genus *Diastylis*, which belongs to a different family.

Lamprops quadriplicata Smith, 1879.

Lamprops triserratus (Gladfelter, 1975) (=*Diastylis triserrata*).

Mesolamprops dillonensis Gladfelter, 1975. This species may be the same as *Hemilamprops californicus*.

DIASTYLIDAE

Anchicolurus occidentalis (Calman, 1912).

Diastylopsis dawsoni Smith, 1880. One of the most common shallow-water species.

Diastylis abbotti Gladfelter, 1975.

Diastylis santamariensis Watling and McCann, 1997.

Diastylis pellucida Hart, 1930.

LEUCONIDAE

Eudorella pacifica Hart, 1930.

Nippoleucon hinumensis (Gamô, 1967) (=*Hemileucon hinumensis*). This species was introduced from Japan in ballast water and occurs along much of the coast in estuaries and bays; it is particularly common, for example, in San Francisco Bay and Coos Bay.

NANNASTACIDAE

Campylaspis canaliculata Zimmer, 1936.

Campylaspis rubromaculata Lie, 1971 (=*C. nodulosa* Lie, 1969).

Campylaspis hartae Lie, 1969.

Cumella vulgaris Hart, 1930.

References

Calman, W. T. 1912. The Crustacea of the Order Cumacea in the collection of the United States National Museum. Proceedings of the U.S. National Museum 41: 603–676.

Gladfelter, W. B. 1975. Quantitative distribution of shallow-water cumaceans from the vicinity of Dillon Beach, California, with descriptions of five new species. Crustaceana 29: 241–251.

Hart, J. F. L. 1930. Some Cumacea of the Vancouver Island region. Contributions to Canadian Biology and Fisheries 6: 1–8.

Lie, U. 1969. Cumacea from Puget Sound and off the Northwestern coast of Washington, with descriptions of two new species. Crustaceana 17: 19–30.

Lie, U. 1971. Additional Cumacea from Washington, U.S.A., with description of a new species. Crustaceana 21: 33–36.

Sars, G. O. 1899–1900. Cumacea. An Account of the Crustacea of Norway. Volume 3. Christiania, Bergen, Norway.

Watling, L. 1979. Marine fauna and flora of the Northeastern United States: Cumacea. National Marine Fisheries Service, Circular 423, 22 pp.

Watling, L., and L. D. McCann. 1997. Cumacea, pp. 121–180. In Taxonomic atlas of the benthic fauna of the Santa Maria Basin and western Santa Barbara Channel. Volume 11: The Crustacea Part 2—The Isopoda, Cumacea and Tanaidacea. J. A. Blake and P. H. Scott, eds. Santa Barbara: Santa Barbara Museum of Natural History, Santa Barbara, California, 278 pp.

Isopoda

RICHARD C. BRUSCA, VÂNIA R. COELHO, AND STEFANO TAITI

(Plates 231–252)

Isopods are often common and important members of many marine habitats. They can be distinguished from other peracarids, and other crustaceans in general, by the following combination of characteristics:

1. Body usually flattened (except in Anthuridea and Phreatoicidea).
2. Head (cephalon) compact, with unstalked compound eyes, two pairs of antennae (first pair minute in Oniscidea), and mouthparts comprising a pair of mandibles, two pairs of maxillae (maxillules and maxillae), and one pair of maxillipeds.
3. A long thorax of eight thoracomeres, the first (and also the second in Gnathiidea) fused with the head and bearing the maxillipeds, the remaining seven (called pereonites) being free and collectively comprising a body division called the pereon.
4. Seven pairs of uniramous legs (pereopods), all more or less alike (hence, "iso-pod"), except Gnathiidea, which have only five pairs of walking legs.
5. Appendages never chelate (i.e., the subterminal article, or propodus, is not modified into "hand" that works with the terminal article, or dactyl, as a true claw).

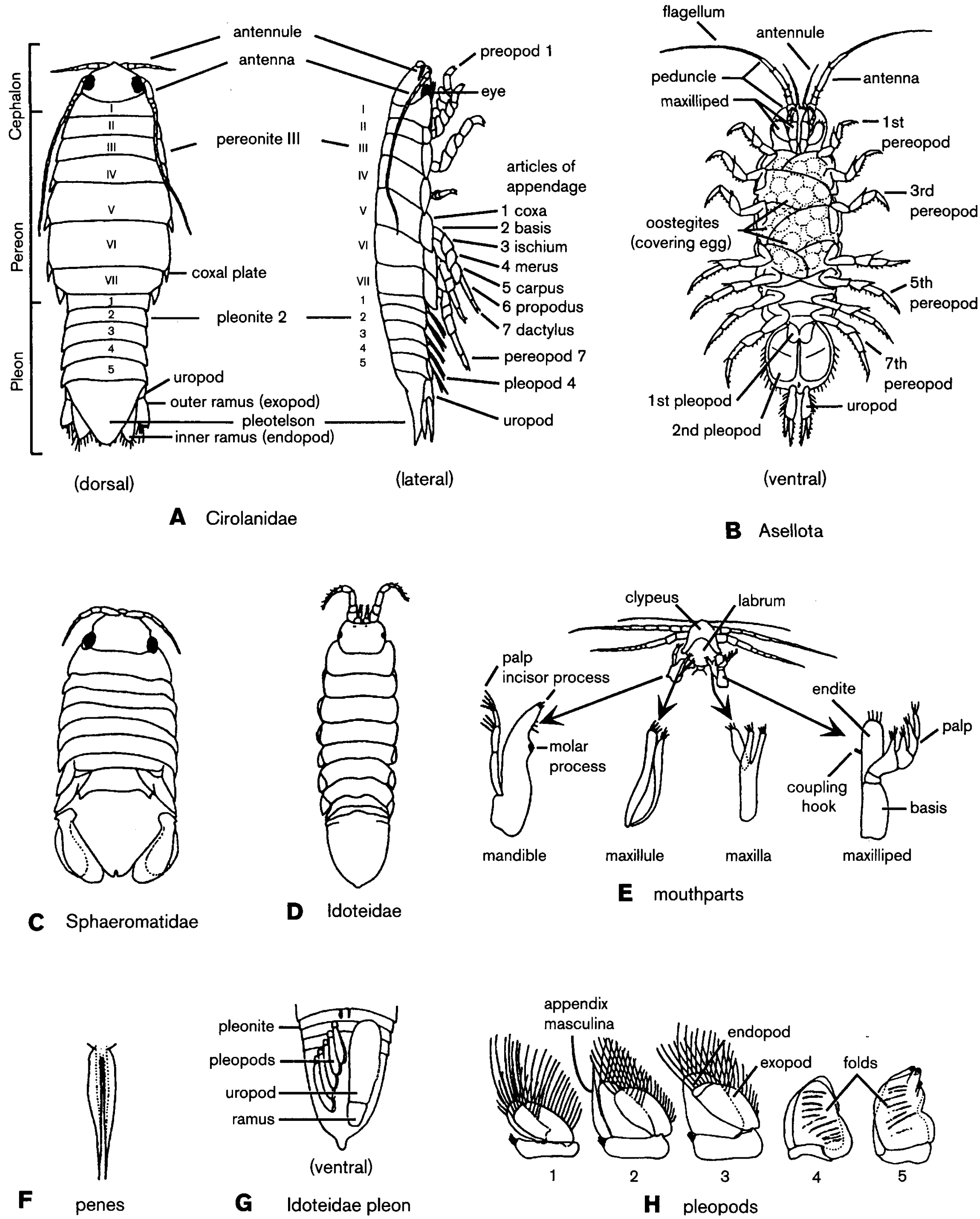

PLATE 231 Isopoda. Isopod anatomy in representative groups: A, Cirolanidae; B, Asellota; C, Sphaeromatidae; D, Idoteidae; E, generalized mouthparts; F, penes; G, pleon of Valvifera (ventral view); H, Generalized pleopods (after Van Name 1936; Menzies and Frankenberg 1966; Menzies and Glynn 1968).

6. A relatively short abdomen (pleon) composed of six somites (pleonites), at least one of which is always fused to the terminal anal plate (telson) to form a pleotelson.
7. Six pairs of biramous pleonal appendages, including five pairs of platelike respiratory/natatory pleopods and a single pair of fanlike or sticklike, uniarticulate (unjointed) uropods.
8. Heart located primarily in the pleon.
9. Biphasic molting (i.e., posterior half of body molts before anterior half).

For general isopod morphology, see plate 231.

All isopods possess one of two fundamental morphologies, being "short-tailed" or "long-tailed" (Brusca and Wilson 1991). In the more primitive, short-tailed isopods, the telsonic region is very small, positioning the anus and uropods terminally or subterminally on the pleotelson (Phreatoicidea, Asellota, Microcerberidea, Oniscidea, Calabozoidea). The more highly derived long-tailed isopods have the telsonic region greatly elongated, thus shifting the anus and uropods to a subterminal position on the pleotelson (Flabellifera, Anthuridea, Gnathiidea, Epicaridea, Valvifera).

Isopods can be sexed in several ways. If oöstegites, or a marsupium, are present, one is obviously examining a female. The openings of the oviducts in females (near the base of the legs on the fifth pereonite) are difficult to observe. If oöstegites are absent, males can be distinguished by the presence of paired penes on the sternum of pereonite 7 (or pleonite 1) or appendices masculinae (sing. appendix masculina) on the endopods of the second pleopods. Absence of penes, appendices masculinae, and oöstegites indicates the specimen is either a nongravid female or a juvenile that has not yet developed secondary sexual features.

Isopods are a large, diverse order with 10 named suborders, all but two (Phreatoicidea and Calabozoidea) of which occur in California and Oregon. They are found in all seas and at all depths, in fresh and brackish waters and on land (the Oniscidea). The approximately 10,000 species are more or less equally split between marine and terrestrial/freshwater environments.

Several general guides to marine isopods of Pacific North and Middle America have been published. These include: Richardson (1905) (still a valuable reference, although obviously out of date), Schultz (1969), Brusca (1980) and Brusca et al. (2004, keys to common Gulf of California species), Brusca and Iverson (1985, the only summary treatment available for the tropical eastern Pacific region), and Wetzer et al. (1997). Kensley and Schotte (1989) is also a useful reference, especially for keys to higher taxa. Key citations to the original literature are provided in this section, and the history of Pacific isopodology (with a complete bibliography) can be found in Wetzer et al. (1997).

The California marine isopod fauna (native and introduced) numbers approximately 200 named species in eight suborders. The keys treat species occurring primarily in the intertidal and supralittoral zones for all of the California and Oregon coasts, plus the commonly encountered fish parasites of the family Cymothoidae.

In the sea, isopods compare in ecological importance to the related Amphipoda and Tanaidacea, notably as intermediate links in food chains. They typically predominate (numerically), along with tanaids, bivalves, and polychaetes, in soft bottom sediment samples from continental shelves. On some tropical coasts, isopods may constitute the majority of prey items consumed by rocky-shore fishes. In the Arctic region, they are one of the primary food items of gray whales. Intertidal isopods are predominantly benthic and cryptic, living under rocks, in crevices, empty shells and worm tubes, and among sessile and sedentary organisms, such as algae, sponges, hydroids, ectoprocts, mussels, urchins, barnacles, and ascidians.

Some isopods burrow in natural substrates including mud, sand, soft rocks, and driftwood, and some burrowers, such as *Limnoria* (the gribbles) and *Sphaeroma,* do extensive damage to pilings and wooden boats. In the tropics, some species of *Sphaeroma* burrow into mangroves, weakening the prop roots and causing them to break more easily, which typically stimulates the growth of multiple new rootlets, leading to the classic stairstep structure of red mangrove prop roots (Perry and Brusca 1989). Several species are important scavengers on shore wrack or dead animals (e.g., *Ligia, Tylos*). Cirolanids, corallanids, and tridentellids are voracious carnivores, functioning both as predators and scavengers. Epicarideans are all parasites on other crustaceans, cymothoids are all parasites on fishes, and aegids are "temporary parasites" (or "micropredators") on fishes. Some invertebrate parasites, notably acanthocephalans, use isopods as intermediate hosts.

Identification of isopods often requires dissection and microscopic examination of appendages and other structures using fine-pointed "jewelers" forceps under a binocular dissecting microscope. Dissected parts may be mounted on microscope slides in glycerin or a more permanent medium for observation under a compound microscope.

Key to the Suborders of Isopoda

1. With five pairs of pereopods (thoracomere 2 entirely fused to cephalon, with its appendages modified as pylopods and functioning as a second pair of maxillipeds; thoracomere 8 reduced, without legs); adult males with mandibles grossly enlarged, forcepslike, projecting in front of head; adult females without mandibles . . . . Gnathiidea
— With seven pairs of pereopods (thoracomere 2 not fused with cephalon, with one pair of maxillipeds and seven pairs of pereopods); males without projecting, forcepslike mandibles; females with mandibles 2
2. Adults obligate parasites on other crustaceans; bilateral symmetry reduced or lost in females; male a small bilaterally symmetrical symbiont living on the body of the female; antennae (antennae 2) vestigial; antennules (antennae 1) reduced to three or fewer articles; without maxillules (maxillae 1) . . . . Epicaridea
— Not obligate parasites on other crustaceans; bilateral symmetry retained in both sexes; male not as above; antennae never vestigial; antennules variable; usually with maxillules 3
3. Body cylindrical or tubular in cross-section, but often appearing laterally compressed (amphipodlike) due to ventrally elongated abdominal pleura; with distinct row of filter setae along medial margin of maxilla (maxilla 2); penes located on coxae of male pereopod 7; apex of pleotelson curves dorsally; pleonite 5 elongate, markedly longer than any other pleonites (known only from the southern hemisphere and India) . . . . Phreatoicidea
— Body variable, but not appearing laterally compressed as above; without row of filter setae along medial margin of maxilla; penes on sternum of male pereonite 7 (or on sternum of pleonite 1); apex of pleotelson does not curve dorsally; pleonite 5 rarely elongate (markedly longer than other pleonites only in Limnoriidae) 4
4. Terrestrial; antennules vestigial, minute; pleon always of five free pleonites, plus the pleotelson . . . . Oniscidea
— Aquatic; antennules normal, or if reduced not minute; pleon variable, with or without fused pleonites 5
5. Anus and articulating base of uropods positioned terminally (or subterminally) on pleotelson; uropods styliform 6
— Anus and articulating base of uropods positioned at base of pleotelson; uropods flattened 8
6. With lateral coxal plates; antenna peduncle 5-articulate; maxillipeds without coupling setae; penes of male arise from articulation between pereonite 7 and pleonite 1; mandible without palp; pleopodal exopods broad and opercular to the thick tumescent endopods; female pleopod 1 present . . . . Calabozoidea
— Without lateral coxal plates (pereopodal coxae small); antenna peduncle 6-articulate; maxillipeds with or without coupling setae; penes of male arise on sternum of pereonite 7; mandible with palp; pleopods not as above; female pleopod 1 absent 7
7. Minute, usually <3 mm long; long and slender, length about six times width; antenna peduncle without a scale;

antennule reduced, peduncle indistinguishable from flagellum; maxilliped without coupling setae on endite; female pleopod 2 biramous; male pleopod 2 endopod not geniculate; interstitial . . . . Microcerberidea
— Rarely minute, usually >4 mm long; body not elongate (length less than six times width); antenna peduncle usually with a scale; antennule rarely reduced, peduncle and flagellum distinct; maxilliped almost always with coupling setae on endite; female pleopod 2 uniramous; male pleopod 2 endopod large and geniculate; rarely interstitial . . . . Asellota
8. Body elongate, length usually more than six times width; uropodal exopod curving dorsally over pleotelson; coxae of maxillipeds fused to head (i.e., not freely articulating); mandible with lamina dentata in lieu of spine row and lacinia mobilis (lamina dentata, spine row and lacinia mobilis lacking in Paranthuridae); maxillule an elongate stylet with apical hooks or serrate margin; maxilla vestigial and fused with paragnath (or absent) . . . . Anthuridea
— Body not markedly elongate, length usually less than four times width; uropodal exopod not curving over pleotelson; coxae of maxillipeds not fused to head; mandible without lamina dentata; maxillule variable; maxilla well developed, never fused with paragnath 9
9. Uropods modified as a pair of ventral opercula covering the entire pleopodal chamber; males with penes arising on sternum of pleonite 1, or on articulation between pereonite 7 and pleonite 1; mandibular molar process a stout, flattened grinding structure . . . . Valvifera
— Uropods not modified as ventral opercula covering pleopods, but positioned laterally; males with penes arising on sternum of pereonite 7; mandibular molar process usually a thin, bladelike, cutting structure, or absent (flattened only in Sphaeromatidae). . . . . Flabellifera

ANTHURIDEA

Key general references: Menzies 1951; Menzies and Barnard 1959; Negoescu and Wägele 1984; Poore 1984; Kensley and Schotte 1989; Cadien and Brusca 1993; Wetzer and Brusca 1997.

Anthurideans are long, slender, subcylindrical isopods, with a length usually six to 15 times the width. The pereonites are mostly longer than wide (in contrast to most isopods, in which the reverse is true), and the dorsum often bears distinctive ridges, grooves, or chromatophore patterns. Distinct coxal plates are rarely evident. The pleonites are often fused in various combinations, and pleonite 6 usually has its line of fusion with the telson demarcated by a deep dorsal groove. The first antennae are short (except in males of some species), as are the second antennae. The mandibles lack a distinct lacinia mobilis or spine row, instead usually having a dentate lobe or plate (the "lamina dentata"). The outer ramus of the maxillule is a slender stylet with terminal spines; the maxillae are rudimentary. The maxillipeds are more or less fused to the head and lack coupling setae on the endites.

Anthurideans are thought to be primarily carnivores, feeding on small invertebrates. Most inhabit littoral or shallow shelf environments, although some deep benthic (and some freshwater) species are also known. Many are known to be protogynous sequential hermaphrodites, and males have not yet been reported for several species. Fewer than 600 species of anthurideans have been named, but many remain undescribed. Four families of Anthuridea are currently recognized, distinguished primarily by characters of the mouthparts and pleon: Hyssuridae, Antheluridae, Anthuridae, Paranthuridae—the latter two occur in California waters.

1. Mouthparts styletlike, adapted for piercing and sucking, forming a conelike structure; mandible usually with smooth incisor, no molar process or lamina dentate; pleonites 1–6 usually with distinct sutures . . . . Paranthuridae 2
— Mouthparts adapted for cutting and chewing; mandible usually with molar process, lamina dentate and toothed incisor; all or most pleonites usually fused . . . . Anthuridae 4
2. Seven pairs of pereopods; pereonite seven not minute (plate 232D) . . . . *Paranthura elegans*

Note: *Paranthura japonica* (plate 252E) is a recently introduced species found in fouling communities in bays and estuaries; see species list.

— Six pairs of pereopods; pereonite seven minute, <20% length of pereonite 6 3
3. Pleon slightly longer than pereonites 6+7 (plate 232B) . . . . *Colanthura bruscai*
— Pleon slightly shorter than pereonites 6+7 . . . . *Califanthura squamosissima*
4. Maxilliped of four articles (at least three free); no pigmentation pattern on pereonites (plate 232A) . . . . *Cyathura munda*
— Maxilliped of five articles; pereonites 1–6 each with a rectangular outline of pigment, characteristically discontinuous on each segment, and segment 7 with posterior transverse pigmentation (plate 232C) . . . . *Mesanthura occidentalis*

ASELLOTA

Key general references: Richardson 1905; Menzies 1951, 1952; Menzies and Barnard 1959; Kussakin 1988; George and Strömberg 1968; Wilson 1994, 1997; Wilson and Wägele 1994.

Asellotans are easily recognized by the following combination of features: uropods terminal and styliform; pleonites 4–5, and often pleonite 3, fused to pleotelson, creating an enlarged terminal piece; pleonite 1, 2, or 3 forming an operculum over the more posterior pleopods; male pleopods 2 with specialized copulatory apparatus consisting of an enlarged protopod, a geniculate (kneelike) endopod, and typically a well-muscled exopod; pereonites without coxal plates.

The Asellota are one of the most diverse groups of isopods, comprising about 25% of all marine species. They are most successful and diverse in the deep sea. Thirty-eight species of Asellota, in nine families, are known from California waters; 18 (in four families) occur in California's intertidal region.

1. Eyes on lateral, peduncle-like projections; terminal article (dactylus) of pereopods 2–7 with two claws 2
— Eyes (if present) dorsolateral on head, not pedunculate; dactylus of pereopods 2–7 with two or three claws 3
2. Pleotelson somewhat pear-shaped; uropods greatly reduced, barely visible dorsally . . . . Munnidae 4
— Pleotelson broad, shieldlike; uropods short but clearly visible in dorsal view . . . . Santiidae

Note: Only one species of this family, *Santia hirsuta* (plate 235A) is known from California.

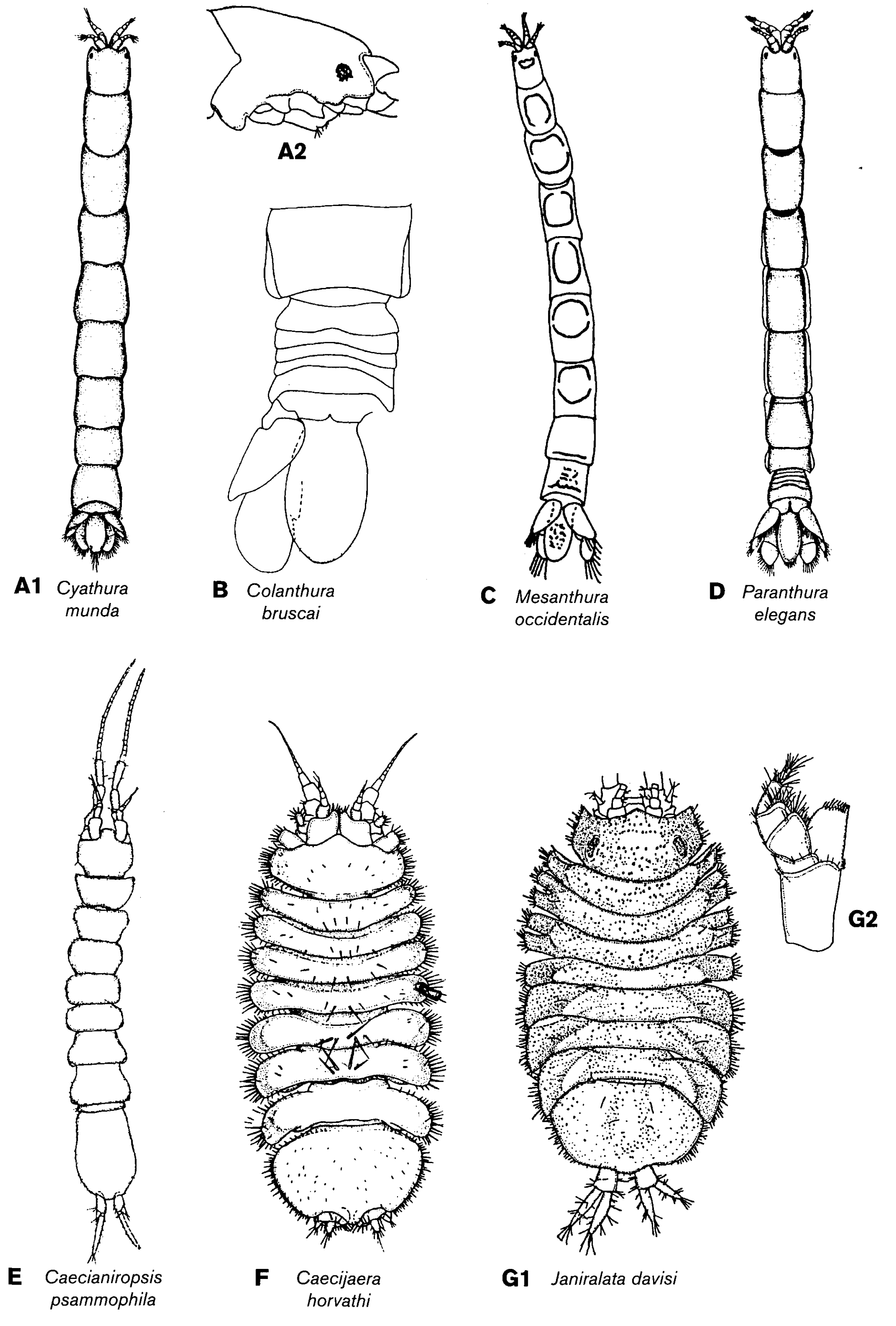

PLATE 232 Isopoda. Anthuridea: A, *Cyathura munda*, A1, whole animal, A2, detail of the head in lateral view; B, *Colanthura bruscai*, pleon; C, *Mesanthura occidentalis*; D, *Paranthura elegans*; E–G, Asellota: E, *Caecianiropsis psammophila*; F, *Caecijaera horvathi*; G, *Janiralata davisi*, G1, whole animal, G2, maxilliped (after Menzies 1951A; Menzies and Petit 1956; Menzies and Barnard 1959; Poore 1984; Wetzer and Brusca 1997).

3. Both pairs of antennae small, flagella lacking or rudimentary; antenna articles of peduncle dilated; uropods short, inserted in subterminal excavations of pleotelson, not extending much beyond its posterior margin, if at all . . . . Joeropsididae 7
— Antennae long with multiarticulate flagella (caution: often broken off); antenna articles of peduncle not dilated; uropods well developed. . . . . Janiridae 8

Note: *Iais californica* (plate 252A), a tiny commensal species that lives on the underside of its host isopod *Sphaeroma quoianum,* is often common and may become disassociated from its host in samples.

4. Uropods minute, without serrate distal margin; male first pleopods with apices tapering to tip (plate 235E) . . . . *Uromunna ubiquita*
— Uropods not minute, with serrate distal margin; male first pleopods with apices laterally expanded 5
5. Uropods without large acute spinelike protuberances on distal margin; dentate suburopodal shelf visible in dorsal view (plate 235C). . . . . *Munna halei*
— Uropods with large acute spinelike protuberances on distal margin; no dentate suburopodal shelf visible in dorsal view. 6
6. Pleotelson broad (length about 0.8 times width); body stout (length about 1.7 times width) (plate 235D) . . . . *Munna stephenseni*
— Pleotelson narrow (length about 1.6 times width); body relatively elongate (length about 2.6 times width) (plate 235B) . . . . *Munna chromatocephala*
7. Pleotelson with five to seven spines on each lateral border (plate 234D) . . . . *Joeropsis dubia dubia*
— Pleotelson with three spines on each lateral border (plate 234E). . . . . *Joeropsis dubia paucispinis*
8. Eyes lacking 9
— Eyes present. 10
9. Body not elongate, length less than three times width; not a minute interstitial species (plate 232F) . . . . *Caecijaera horvathi*
— Body elongate, length about six times width; minute (<2 mm long) interstitial species (plate 232E). . . . . *Caecianiropsis psammophila*
10. Propodus (next to last article) of first pereopod with conspicuous serrated margin on proximal third of ventral margin; basal three articles of maxillipedal palp as wide as endite. . . . . *Janiralata* 11
— Propodus of first pereopod with proximal third of inferior border smooth; maxillipedal palp with second and third articles much wider than endite . . . . *Ianiropsis* 12
11. Pleotelson with distinct, medially curved, spinelike posterolateral angles (plate 233A) . . . . . *Janiralata occidentalis*
— Pleotelson with posterolateral angles evenly curved, lacking distinct angles or spinelike processes (plate 232G) . . . . *Janiralata davisi*
12. Lateral borders of pleotelson with spinelike serrations. 13
— Lateral borders of pleotelson spineless (fine setae may be present) 15
13. Pleotelson with four to seven spinelike serrations on each side; lateral apices of first male pleopod not directed abruptly posteriorly (plate 233B) . . . . . . *Ianiropsis analoga*
— Pleotelson with two to three spinelike serrations on each side; lateral apices of first male pleopod directed abruptly posteriorly 14
14. Pleotelson with two spinelike serrations on each side (plate 233D). . . . . *Ianiropsis epilittoralis*
— Pleotelson with three spinelike serrations on each side (plate 234C). . . . . *Ianiropsis tridens*
15. Uropods half or less length of pleotelson. 16
— Uropods considerably exceeding half pleotelson length 17
16. Pleotelson with distinct posterolateral angles lateral to uropod insertions (plate 233C) . . . . *Ianiropsis derjugini*
— Pleotelson lacking posterolateral angles lateral to uropod insertions (plate 234A) . . . . *Ianiropsis minuta*
17. Uropods exceeding length of pleotelson; lateral apices of first male pleopod bifurcate (plate 234B) . . . . *Ianiropsis montereyensis*
— Uropods not exceeding pleotelson length; lateral apices of first male pleopod not bifurcate (plate 233E) . . . . *Ianiropsis kincaidi*

EPICARIDEA

Key general references: Richardson 1905; Shiino 1964; Markham 1974, 1977.

Epicarideans are ectoparasites of other crustaceans (malacostracans, ostracodes, copepods, and cirripeds). Females are usually greatly distorted, being little more than an egg sac in some species. Males are symmetrical but minute and live on the body of the female. Eyes are usually present in males, but reduced or absent in females. The antennules (first antennae) are very reduced, usually of only two or three articles; a 3-articulate peduncle is generally apparent only in juvenile stages. The antennae (second antennae) are vestigial in adults. The mouthparts are reduced, forming a suctorial cone with a pair of piercing stylets formed from the mandibles; a mandibular palp is absent. The maxillules and maxillae are reduced or absent.

There are no good references for the Epicaridea as a whole, although Strömberg (1971) reviews the embryology (including that of several California species), and Jay (1989) cites several other papers containing general information. The California fauna is poorly known, both taxonomically and biologically. About 700 species of epicarideans have been described worldwide in 11 families. Three of these families are represented in California waters by 16 species, six of which occur in the intertidal region and are included in the key.

Species in the family Bopyridae retain complete, or nearly complete, body segmentation, and usually have six or seven pereopods on one side but far fewer on the other. The sides of the pleonites are often produced as large lateral plates (epimeres) that resemble pleopods. Adult bopyrids are parasites either on the abdomen or in the branchial chamber of decapod crustaceans. In branchial parasites, the female attaches ventrally to the host's branchiostegite, inducing a bulge in the host's carapace. Males are much smaller and usually found on the ventral side of the pleon of the female isopod. Females brood many small eggs in an oöstegial brood pouch that hatch as a free-swimming epicaridium stage. The epicaridium attaches to an intermediate host, a calanoid copepod. Once on the copepod, the isopod molts into a microniscus stage and then into the cryptoniscus stage. The cryptoniscus detaches from the copepod, is free-swimming, and eventually attaches to the definitive host. All species are probably sequential hermaphrodites. About 500 species have been described worldwide.

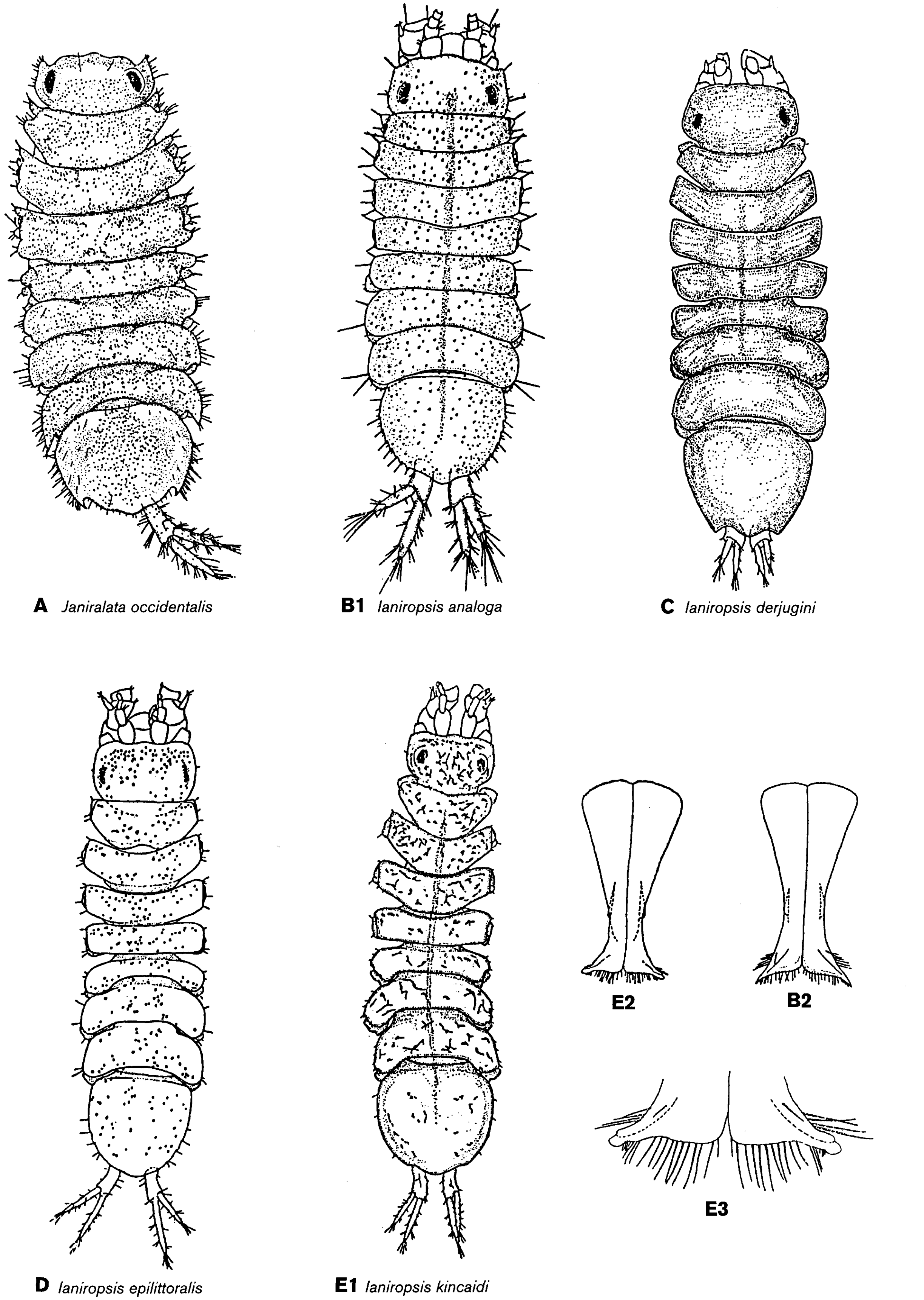

PLATE 233 Isopoda. Asellota: A, *Janiralata occidentalis*; B, *Ianiropsis analoga*, B1, whole animal, B2, male first pleopods; C, *Ianiropsis derjugini*; D, *Ianiropsis epilittoralis*; E, *Ianiropsis kincaidi*, E1, whole animal, E2, male first pleopods, E3, detail of the distal part of the male first pleopods (after Menzies 1951A, 1952).

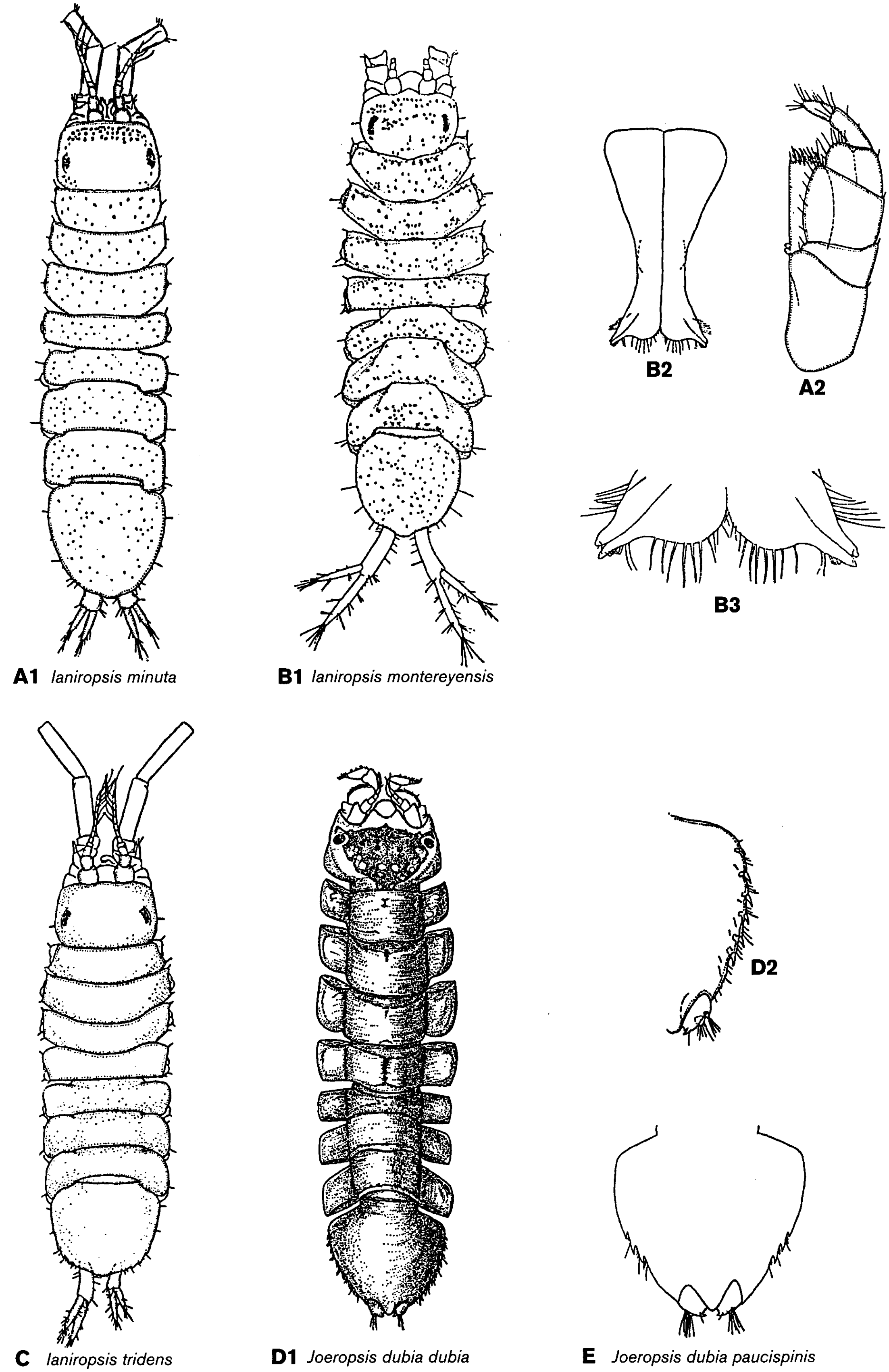

PLATE 234 Isopoda. Asellota: A, *Ianiropsis minuta*, A1, whole animal, A2, maxilliped; B, *Ianiropsis montereyensis*, B1, whole animal, B2, male first pleopods, B3, detail of the distal part of the male first pleopods; C, *Ianiropsis tridens*; D, *Joeropsis dubia dubia*, D1, whole animal, D2, detail of the lateral margin of the pleotelson; E, *Joeropsis dubia paucispinis*, detail of pleotelson (after Menzies 1951A, 1952).

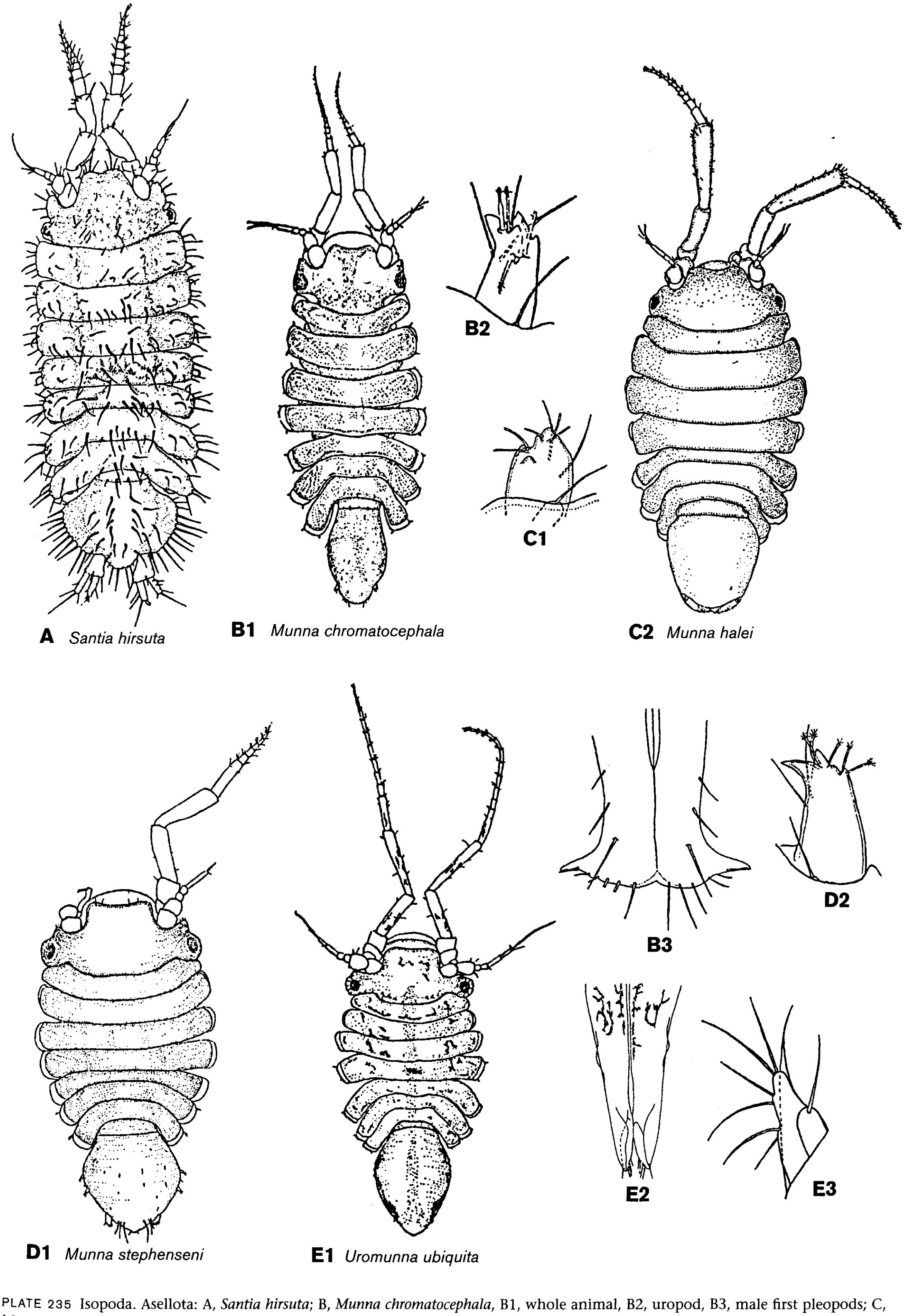

PLATE 235 Isopoda. Asellota: A, *Santia hirsuta*; B, *Munna chromatocephala*, B1, whole animal, B2, uropod, B3, male first pleopods; C, *Munna halei*, C1, uropod, C2, whole animal; D, *Munna stephenseni*, D1, whole animal, D2, uropod; E, *Uromunna ubiquita*, E1, whole animal, E2, male first pleopods, E3, uropod (after Menzies 1951A, 1952).

Species in the family Entoniscidae are internal parasites of crabs and shrimps. Females are usually modified beyond recognition, with the marsupium grossly inflated and in some cases extending dorsally over the head. Males and mancas, however, are less distorted with a flattened body, complete segmentation, and pereopods. Mature females are surrounded by a host response sheath, with an external communication to the environment via a small hole or furrow in the carapace of the hosts. Most are parasitic castrators, and in some cases entoniscids can feminize male hosts. Good references on the biology of this family include: Giard (1887), Giard and Bonnier (1887), Veillet (1945), and Reinhard (1956). The following key is based mainly on adult females.

1. Female without segmentation, simply an egg sac; antennae and mouthparts absent. . . . . Hemioniscidae

   Note: One California species, *Hemioniscus balani*, parasitic in barnacles of the genera *Balanus* and *Chthamalus*.

— Female with distinct or weak segmentation; not simply an egg sac; antennae and mouthparts present, although may be greatly reduced 2

2. Body of female without indication of rigid exoskeleton, seemingly undifferentiated, but body divisions and segmentation present; pereonites expanded laterally into thin plates; maxillipeds are the only recognizable mouthparts; pereopods stubby or absent; endoparasites in body cavity of decapod crustaceans . . . . Entoniscidae

   Note: One California species, *Portunion conformis*, plate 237A, in body cavity of the crab *Hemigrapsus* spp.

— Female distinctly segmented; pereonites not expanded laterally into thin plates; mouthparts rudimentary; pereopods prehensile, seven present on one side, but all except first may be absent on the other side; parasites of branchial cavity or on pleopods of decapod crustaceans . . . . Bopyridae 3

3. Pleon with lateral plates (epimeres or pleural lamellae) elongate, those of female fringed with long, branched processes, those of male without such digitations; in branchial cavity of ghost shrimps of the genus *Neotrypaea* (plate 236B) . . . . *Ione cornuta*

— Pleon in both sexes with pleural lamellae rudimentary or absent (caution: do not confuse lateral biramous pleopods with pleural lamellae) 4

4. Female pleopods not prominent, relatively short, not noticeable in dorsal view; in branchial chamber of the snapping shrimp *Synalpheus lockingtoni* and *Alpheopsis equidactylus* (plate 236A) . . . . *Bopyriscus calmani*

— Female pleopods prominent, long, visible in dorsal view 5

5. Pleopods biramous, with narrow branches arising from a peduncle or stem, extending laterally from narrow pleon; among pleopods of the mud shrimp *Upogebia pugettensis* (plate 236D) . . . . *Phyllodurus abdominalis*

   Note: Compare to the recently recognized *Orthione griffensis* (plate 252B), now abundant along the coast in the mud shrimp *Upogebia* (see species list).

— Pleopods biramous, lanceolate, not arising from a peduncle, extending posteriorly from pleon; in branchial chamber of the pelagic galatheid crab *Pleuroncodes planipes* (plate 236C) . . . . *Munidion pleuroncodis*

FLABELLIFERA

Key general references: Stimpson 1857; Richardson 1899, 1905, 1909; Holmes and Gay 1909; Hatch 1947; Menzies 1962; Menzies and Barnard 1959; Schultz 1969; Brusca 1981, 1989; Bruce et al. 1982; Bruce 1986, 1990, 1993; Harrison and Ellis 1991; Brusca and Wilson 1991; Brusca et al. 1995; Wetzer and Brusca 1997.

Flabellifera comprise a large paraphyletic assemblage of families defined more by the absence of certain features than by any unique attributes. The eyes are usually large and well-developed but are reduced or absent in cave and deep-sea species. The mouthparts are usually robust, adapted for cutting and grinding, or occasionally for piercing. Both the maxillules and maxillae are biramous. The pereopods are usually subsimilar, but in Serolidae, and some Cirolanidae and Sphaeromatidae, the anterior pairs may be subchelate/prehensile. The pleon comprises one to five free segments, plus the pleotelson. The uropods arise laterally, usually forming a distinct tailfan with the pleotelson.

With more than 3,000 described species, the Flabellifera is the second largest isopod suborder, represented in California by seven families, three of which (Anuropidae, Excorallanidae, Serolidae) have not been reported north of Point Conception. Because of the great diversity of this suborder, it is more convenient to key the families first, and then the species in each family.

Key to Families

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

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

2. Pleon composed of three or fewer dorsally visible free pleonites, plus the pleotelson 3

— Pleon composed of four or five dorsally visible free pleonites, plus the pleotelson 4

3. Pleon composed of three dorsally visible free (complete) pleonites, plus pleotelson; cephalon fused medially with first pereonite; body strongly depressed and expanded laterally; pereonite 7 tergite incomplete or absent; antennae set very close together; frontal lamina reduced to a small triangular plate visible only by pushing aside antennal bases; pleopods 1–3 small and natatory, basis elongated; pleopods 4–5 large, broadly ovate, suboperculiform . . . . . . Serolidae

— Pleon composed of one or two dorsally visible free (complete) pleonites plus pleotelson; cephalon not fused with first pereonite (except in *Ancinus* and *Bathycopea*); body convex dorsally, not strongly depressed; pereonite 7 tergite complete; antennae not set close together; frontal lamina large and distinct; pleopods subequal, of modest size, basis not elongated; pleopods 4–5 ovate but not operculiform . . . . Sphaeromatidae

4. All pereopods prehensile (dactyli longer than propodi); antennae reduced, without clear distinction between peduncle and flagellum; maxillipedal palp two-articulate. . . . . Cymothoidae

— At least pereopods 4–7 ambulatory (dactyli not longer than propodi); antennae not as above, with clear distinction between peduncle and flagellum; maxillipedal palp of two to five articles. 5

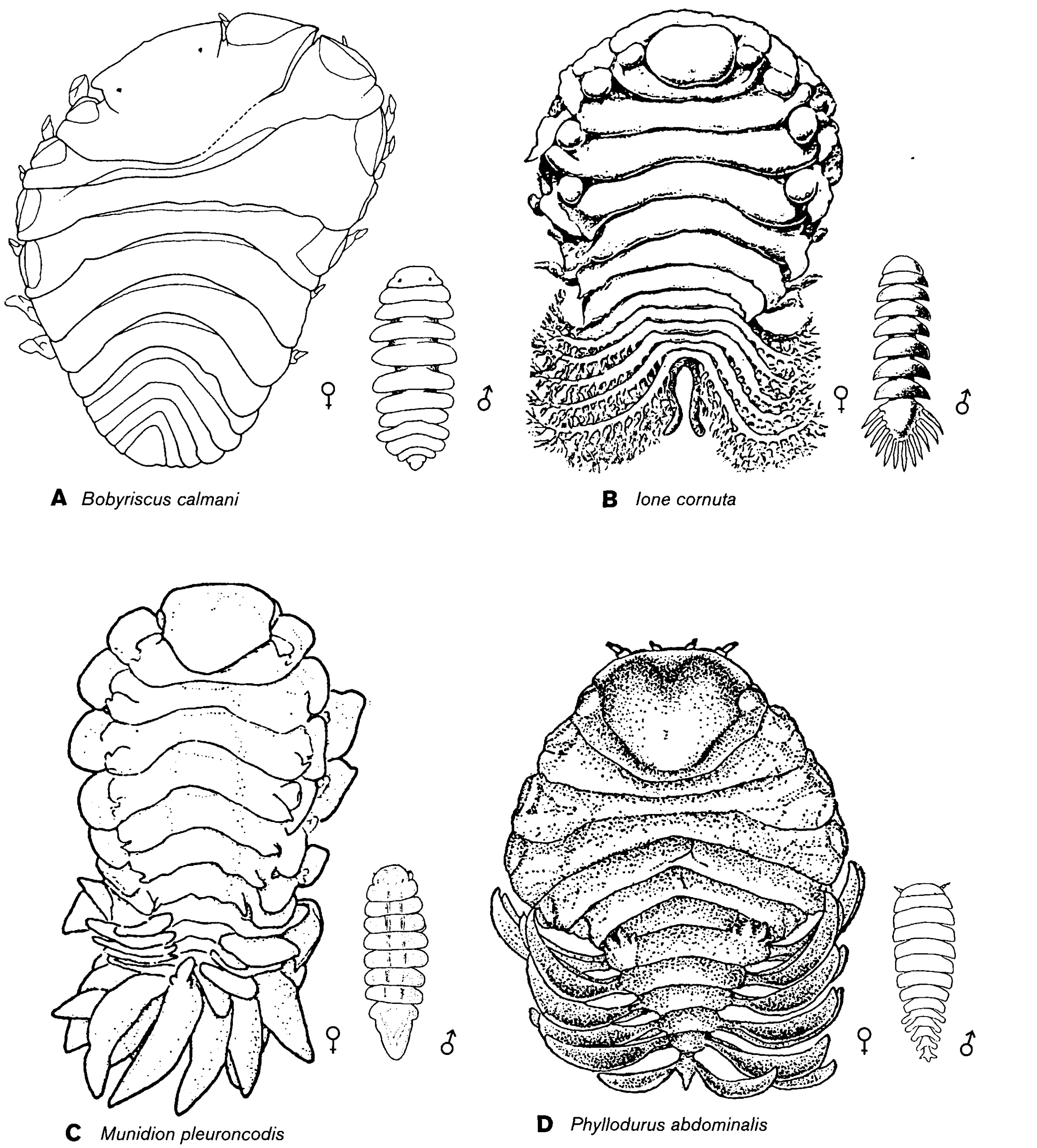

PLATE 236 Isopoda. Epicaridea: A, *Bopyriscus calmani*; B, *Ione cornuta*; C, *Munidion pleuroncodis*; D, *Phyllodurus abdominalis* (after Richardson 1905; Markham 1975; Sassaman et al. 1984).

5. Pereopods 1–3 strongly prehensile (dactyli longer than propodi); maxillipeds and maxillules and maxillae with stout, curved, apical setae; lacinia and molar process of mandible reduced or absent; maxilla reduced to a single slender stylet . . . . Aegidae
— Pereopods 1–3 weakly prehensile at best; maxillipeds without stout, curved setae; mandible with or without lacinia and molar process; maxilla not a slender stylet. 6
6. Mandible with distinct lacinia and large bladelike molar process; mandibular incisor generally broad, three-dentate; maxillule lateral (outer) lobe often with several (10–14) stout spines, never styletlike or falcate; maxilla well-developed; pereopods 1–3 not prehensile (dactyli not longer than propodi) . . . . Cirolanidae
— Mandible with lacinia and molar process greatly reduced, vestigial, or absent; mandibular incisor narrow; maxillule lateral (outer) lobe simple and falcate; maxilla reduced; pereopods 1–3 weakly prehensile or ambulatory. . . . . Corallanidae

AEGIDAE

Aegids are cirolanidlike, with the smooth dorsal surface either vaulted or flattened. The maxillipedal palp is of two, three, or five articles, the terminal ones with stout acute setae ("spines"). The mandible is elongate, with a narrow incisor and reduced or vestigial molar process. Coxal plates of pereonites 2–6 are large and distinct. Pereopods 1–3 are prehensile (i.e., the dactyli are as long or longer than the propodi and strongly curved); pereopods 4–7 are ambulatory. The family Aegidae comprises six genera. All are temporary parasites on marine fishes. Adults engorge themselves with food (presumably blood) from their hosts, then dislodge and sit on the bottom to digest their meal. Nine species, in two genera, have been reported from Pacific North America, six of which inhabit California waters. However, only a single species occurs in the intertidal zone, *Rocinela signata* (plate 237B).

CIROLANIDAE

Cirolanids have sleek symmetrical bodies, two to 6.5 times longer than wide, with well-developed coxal plates on pereonites 2–7. The mandible has a broad tridentate incisor and a spinose bladelike molar process. The maxillipedal palp typically is five-articulate, and the articles never have hooked or curved setae or spines. All pereopods are ambulatory, although legs 1–3 tend towards a grasping form, with well-developed dactyli. The uropods form a tail fan with the pleotelson.

Cirolanids are all carnivores, either predatory or scavenging. A number of species are known to attack sick or weakened fish, or fish trapped in fishing nets, and some are capable of stripping a fish to the bones in a matter of hours. Stepien and Brusca (1985, cited in the species list at *Cirolana diminuta*) review this phenomenon and describe the behavior from Catalina Island. This large family includes 55 genera. Eight species (in six genera) are known from California waters, six of which occur intertidally.

1. Antennule peduncle article 1 longer than articles 2 or 3; antennule article 2 arising at right angle to article 1; maxilliped endite barely reaching (or extending barely beyond) first palp article; maxilliped endite without coupling setae; antennae long, extending beyond pereonite 7; lateral margins of pleonite 5 not encompassed by pleonite 4 .... *Eurydice*

   Note: One species in California: E. caudata, plate 238B.

— Antennule peduncle article 2 or 3 longest; antennule article 2 not arising at right angle to article 1; maxilliped endite extending well beyond first palp article, usually to distal margin of second palp article; maxilliped endite with coupling setae; antennae length variable; lateral margins of pleonite 5 variable 2

2. Antennule peduncle article 2 or 3 longest; clypeus projecting ventrally 3

— Antennule peduncle article 3 always longer than 1 or 2; clypeus short, broad, flat, and sessile, not projecting ventrally .... *Cirolana* 4

3. Prominent rostral process, apically spatulate, separating antennules .... *Excirolana* 5

— Without prominent rostral process............ *Eurylana*

   Note: One species, E. *arcuata*, plate 238A.

4. Uropodal rami without apical notch; rostrum meets but does not overlap frontal lamina; antennule peduncle articles 1 and 2 not fused (plate 237D)........... *Cirolana harfordi*

— Both uropodal rami with apical notch; rostrum overlaps frontal lamina; antennule peduncle articles 1 and 2 fused (plate 237C)....................... *Cirolana diminuta*

5. Pleotelson broadly rounded and crenulate posteriorly; antennule peduncle with articles 2 and 3 subequal in length (plate 238C) .... *Excirolana linguifrons*

— Pleotelson obtusely rounded and acuminate posteriorly; antennule peduncle with article 3 longer than article 2 (plate 238D) .... *Excirolana chiltoni*

CORALLANIDAE

Corallanids resemble cirolanids but are even more highly modified as predators. Characteristic features of the family include very large eyes, absence of an endite on the maxilliped, large falcate apical setae on the lateral lobes of the maxillules (often tended by subapical accessory setae), vestigial uniramous maxillae, and frequently a heavily ornamented dorsum beset with setae, spines, tubercles or carinae (especially in males). There are always five free pleonites. The first three pairs of pereopods are often grasping (dactylus as long or longer than the propodus).

Corallanidae is a small group, with six genera and about 70 species. The family is largely confined to tropical and subtropical shallow-water marine habitats, although some brackish and freshwater species are known. Many species are common on coral reefs (hence the name). Because they are often found attached to large prey, such as fishes, rays, turtles, or shrimps, they are sometimes called parasites, but they are actually predators. Two species in the large New World genus *Excorallana* occur in our intertidal region. Both can be collected using night lights over rocky bottoms. *E. tricornis occidentalis,* at least in Costa Rican waters, has nocturnal mass-migrations into the water column, perhaps preying on other microcrustaceans (Guzman et al. 1988, Bull. Mar. Sci. 43: 77–87). Two species belonging to the closely related family Tridentellidae are easily mistaken for corallanids; *Tridentella glutacantha* and *T. quinicornis* both occur in shallow subtidal rocky regions of California's offshore islands (see Delaney and Brusca 1985, J. Crust. Biol. 5: 728–742; Wetzer and Brusca 1997).

1. Head of male ornamented with three tubercles; pereonites 4–7 with row of tubercles on posterior margin; pleotelson not densely covered by setae (plate 238E) .... *Excorallana tricornis occidentalis*

— Head of male not ornamented with tubercles; pereonites 4–7 without row of tubercles on posterior margin; pleotelson densely covered by setae (plate 238F) .... *Excorallana truncata*

CYMOTHOIDAE

Cymothoids resemble cirolanids and corallanids but are modified for a parasitic lifestyle—all are fish parasites. The definitive features of the family are that all seven pairs of pereopods are prehensile (with long, strongly recurved dactyli as long as or longer than the propodi) and the maxillipedal endite lacks coupling setae. Overall, the mouth appendages are highly modified for the parasitic lifestyle. The maxillipeds are reduced to small palps of two or three articles, the maxillules are modified as slender uniarticulate stylets lying adjacent to one another to facilitate transfer the host's blood to the mouth, and the maxillae are reduced to small bilobed appendages. All of these mouth appendages bear stout, curved, terminal, or subterminal spinelike setae that serve to hold the buccal region strongly affixed to the flesh of the host fish. All cymothoid species are probably

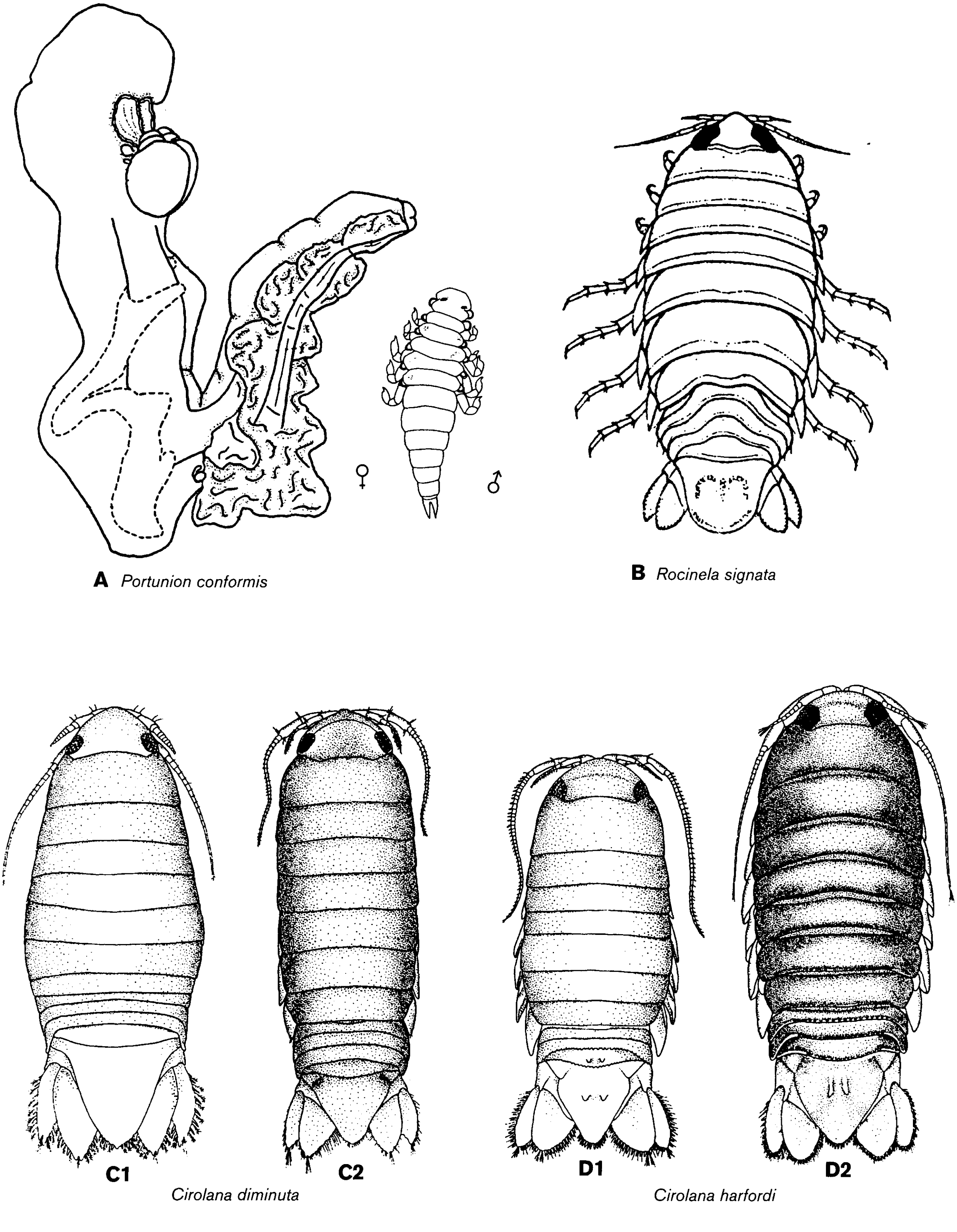

PLATE 237 Isopoda. Epicaridea: A, *Portunion conformis*; B-D, Flabellifera: B, *Rocinela signata*; C, *Cirolana diminuta*, C1, postmanca, C2, adult male; D, *Cirolana harfordi*, D1, male, D2, a different male morphotype (after Richardson 1905; after Schiödte and Meinert; Muscatine 1956; Brusca et al. 1995).

protandric hermaphrodites, first maturing into males and later transforming into females (unless retained in the male stage by the presence of a female already in place on the host fish).

Cymothoids are parasites on marine or freshwater fishes, and they are commonly found on sport and commercial fishes, such as mullet, jacks, groupers, flounder, perch, anchovies, and many others. Although they are not intertidal species, they are often seen by sport fishers and researchers, Most species attach either epidermally, in the gill chamber, or in the buccal region. However, species in some genera actually burrow beneath the skin where they live in a pocket or capsule formed within the musculature of the host (e.g., *Artystone, Riggia, Ichthyoxenus,*

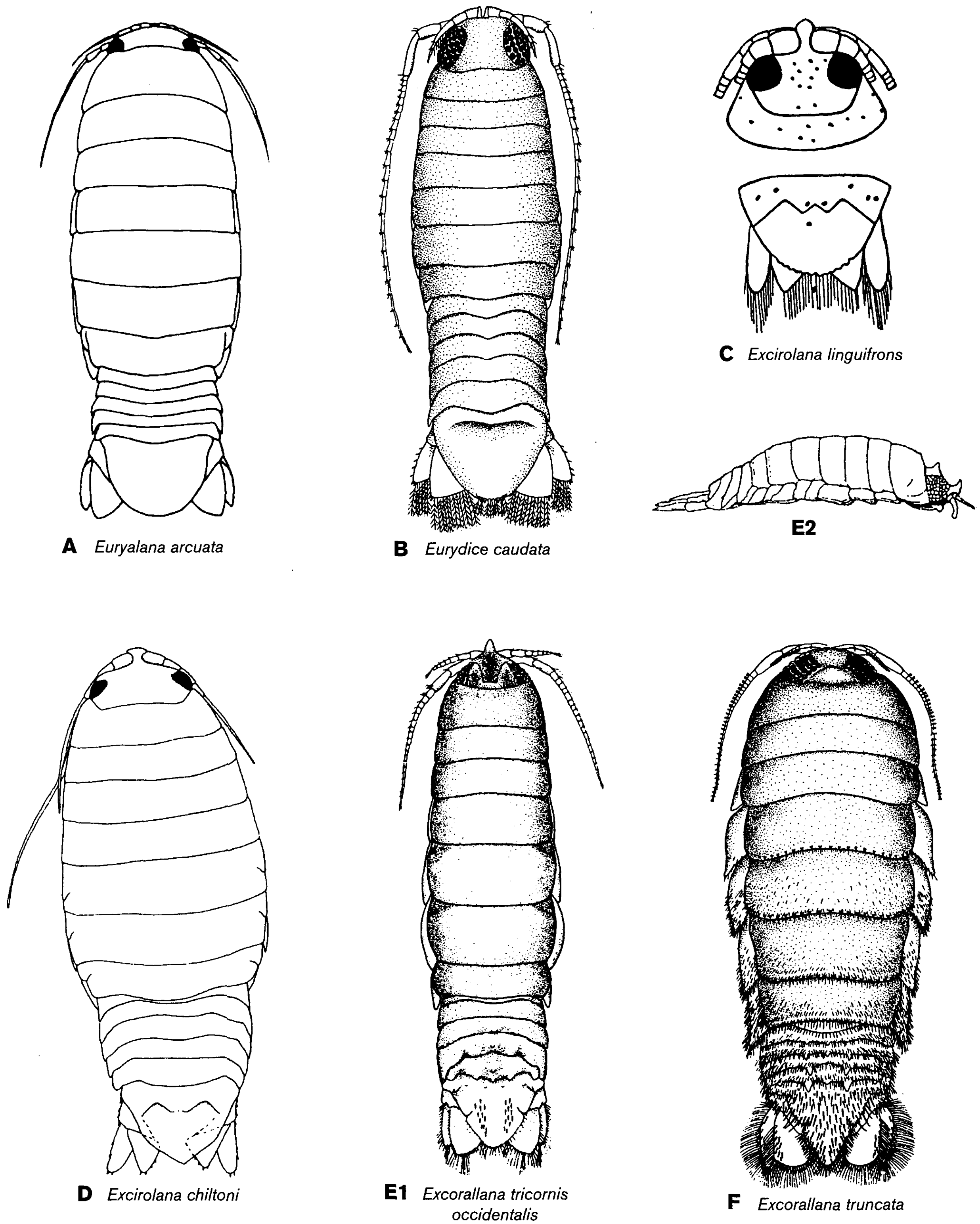

PLATE 238 Isopoda. Flabellifera: A, *Eurylana arcuata*; B, *Eurydice caudata*; C, *Excirolana linguifrons*, cephalon, pleotelson; D, *Excirolana chiltoni*; E, *Excorallana tricornis occidentalis*, E1, whole animal in dorsal view, E2, whole animal in lateral view; F, *Excorallana truncata* (after Richardson 1899, 1905, after Hansen; Bruce and Jones 1981; Jansen 1981; Delaney 1982, 1984; Brusca et al. 1995).

Ourozeuktes). Aside from some localized damage, in most cases cymothoids do not appear to create a great hardship for their hosts. Host-parasite specificity varies between genera, being high in some (e.g., *Cymothoa, Idusa, Mothocya*) and low in others (e.g., *Anilocra, Nerocila, Livoneca, Elthusa*). The only known case of a parasite functionally replacing a host organ occurs in *Cymothoa exigua,* a species that sucks so much blood from its host fish's tongue that the tongue atrophies and is destroyed, but the isopod remains attached to the remaining tongue stub where the host uses it as a replacement tongue for food manipulation (Brusca and Gilligan 1983). An extensive radiation of cymothoid genera and species has taken place in the freshwater rivers of the Amazon Basin, and to a lesser extent central Africa and southeast Asia. Forty-three nominate genera and more than 400 species of cymothoids exist, but the taxonomy of this family is very poorly understood. Seven species, in five genera, are known from California waters.

1. Posterior margin of cephalon trisinuate; pleon not immersed in pereon 2
— Posterior margin of cephalon not trisinuate; pleon partially immersed in pereon 3
2. Cephalon not immersed in pereonite 1; uropods generally extend beyond posterior border of pleotelson, and clearly visible in dorsal view . . . . *Nerocila*

Note: One species in California, *N. acuminata*, plate 240C.

— Cephalon somewhat immersed in pereonite 1; uropods barely or not extending beyond posterior border of pleotelson and typically held concealed under the pleotelson (not visible in dorsal view) . . . . *Enispa*

Note: One species in California, *E. convexa*, plate 239C.

3. Basal articles of antennules not expanded and touching 4
— Basal articles of antennules expanded and touching or nearly touching . . . . *Ceratothoa* 5
4. Antennule longer than antenna . . . . *Mothocya*

Note: One species in California, *M. rosea* (plate 239D).

— Antennule shorter than antenna . . . . *Elthusa* 6
5. Pereopods 4–7 not carinate; posterior margin of pleonite 5 smooth, not trisinuate; labrum with free margin wavy, with wide medial notch (plate 239B). . . . . *Ceratothoa gilberti*
— Pereopods 4–7 carinate; posterior margin of pleonite 5 trisinuate (except in occasional males); labrum with free margin broadly excavate, without medial notch (plate 239A) . . . . *Ceratothoa gaudichaudii*
6. Pleotelson in adult female nearly twice as broad as long; eyes medium-size and widely separated; anterior border of head broadly rounded or truncate; antenna of 10–11 articles; juveniles with diffuse dark pigmentation on uropodal exopod and anterolateral areas of pleotelson (plate 240B) . . . . *Elthusa vulgaris*
— Pleotelson in adult female about as broad as long; eyes large, close-set medially; anterior border of head strongly produced, apically blunt; antenna of eight to nine articles; juveniles with pigment granules concentrated in melanophores, lacking distinct color pattern (plate 240A) . . . . *Elthusa californica*

LIMNORIIDAE

Limnoriids are a cosmopolitan family of wood and algae-boring isopods (the marine gribbles), distinguished by their minute size (4 mm or less in length), wood/algae boring habits, and several unique anatomical features: the head is set off from the pereon and freely rotates, the mandible incisor process lacks teeth and instead forms a projecting rasp-and-file device used to work wood, the mandibular molar process is absent, the basis of the maxillipeds is elongated and waisted, and the uropods are greatly reduced, with a minute often clawlike exopod.

More than 70 species, in three genera (*Limnoria, Lynseia, Paralimnoria*), have been described. Four species are known from California waters, one of which is an algal borer (*L. algarum*) and can be most easily found in the holdfasts of large brown algae such as *Macrocystis, Egregia, Laminaria, Postelsia*, and *Nereocystis*. The others infest marine woods, such as pier pilings, docks, boats, driftwood, etc.

1. Incisor process of mandibles simple, lacking rasp or file; algal holdfast borers (plate 240D) . . . . *Limnoria algarum*
— Incisor of right mandible with filelike ridges, that of left with rasplike sclerotized plates; wood borers. 2
2. Dorsal surface of pleotelson with a median Y-shaped keel at base; lateral and posterior borders of pleotelson smooth (plate 241B). . . . . *Limnoria lignorum*
— Dorsal surface of pleotelson with symmetrically arranged tubercles anteriorly; lateral and posterior borders of pleotelson smooth or tuberculate 3
3. Four anterior tubercles on pleotelson; posterior and lateral margins of pleotelson not tuberculate (plate 241A) . . . . *Limnoria quadripunctata*
— Three anterior tubercles on pleotelson; posterior and lateral borders of pleotelson tuberculate (plate 241C). . . . . *Limnoria tripunctata*

SEROLIDAE

Serolids are quickly recognized by their broadly ovate, very thin, flattened bodies with broadly expanded coxal plates. The head is deeply immersed in the pereon. Some species are quite large (to 80 mm). The mandible lacks a molar process, and the maxilliped lacks coupling setae on the endite. Pereonite 1 is fused dorsally with the cephalon and encompasses it laterally. Pereopod 1 of both sexes and pereopod 2 of most adult males are subchelate, with the dactylus folding back upon an inflated propodus.

Serolidae is a cold-water family, primarily distributed in the southern hemisphere. Deep-sea species often have reduced eyes or are blind. They are carnivores, scavengers, or omnivores. *Heteroserolis carinata,* which ranges form southern California to the Gulf of California, is the only California species (plate 241D). It burrows just under the sediment surface, from the low intertidal zone to about 100 m depth.

SPHAEROMATIDAE

Sphaeromatid isopods can be recognized by their compact, convex bodies, usually capable of rolling into a ball (conglobation); by their pleon which is consolidated into two or three divisions; and by their lateral uropods in which the endopod is rigidly fused to the basal article and the exopod (if present) is movable. In their ability to conglobate, sphaeromatids resemble certain terrestrial isopods called "pillbugs"—a striking example of parallel evolution. Identification of genera and species is often difficult because of marked sexual dimorphism. Hence it is advisable, when making determinations, to have a representative sample including adults of both sexes. Twenty-five species of sphaeromatids, in 10 genera, have been described from California waters, 12 of which occur intertidally and are included in the following key. Some workers place *Ancinus, Bathycopea,* and *Tecticeps* in separate families, while others recognize various subfamilies. However, the relationships of the sphaeromatid genera have yet to be analyzed phylogenetically and such taxonomic opinions are based largely on intuition.

Sphaeromatids are primitive flabelliferans with herbivorous habits. The molar process of the mandible is a broad, ovate

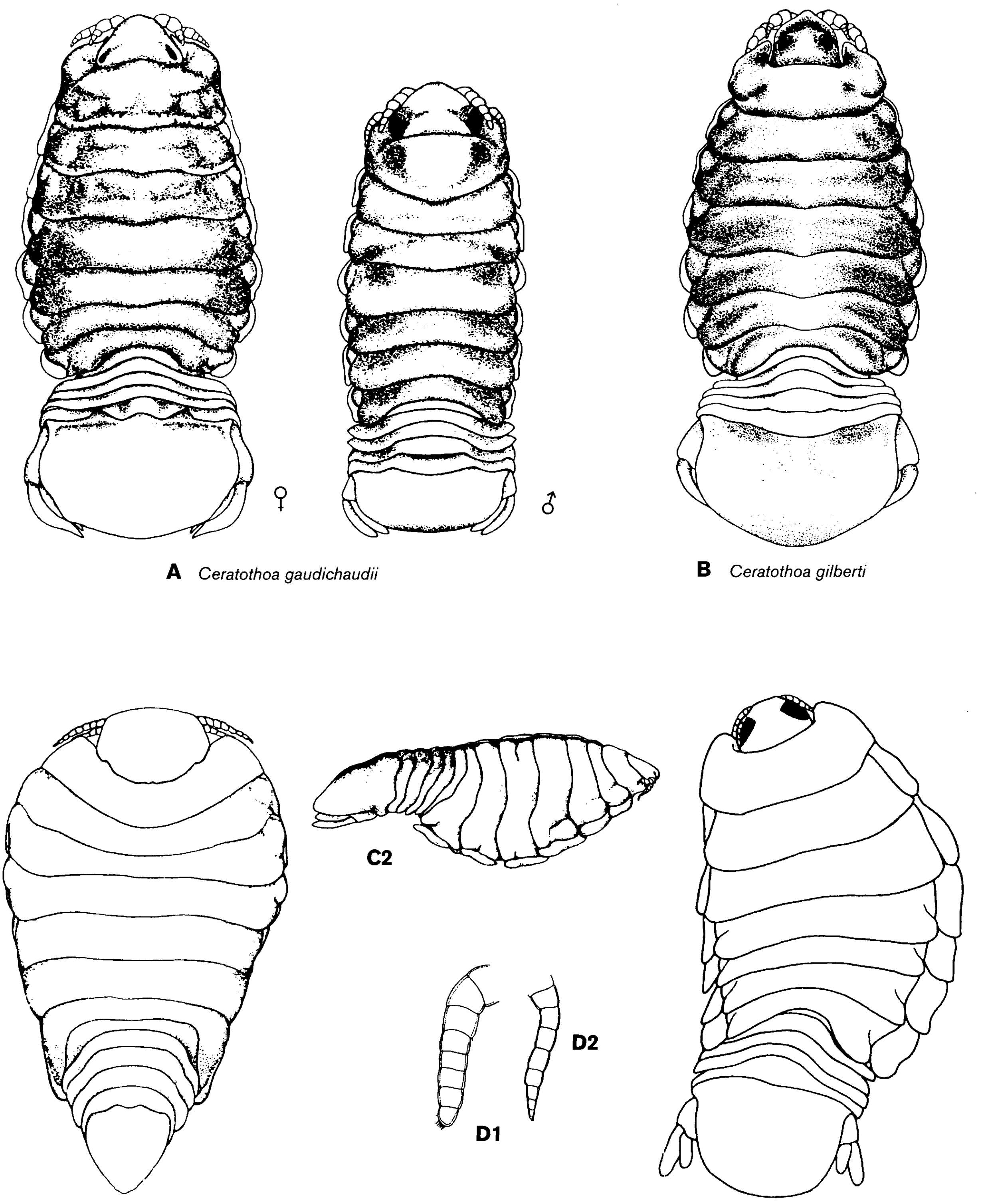

PLATE 239 Isopoda. Flabellifera: A, *Ceratothoa gaudichaudii*; B, *Ceratothoa gilberti*; C, *Enispa convexa*, C1, whole animal in dorsal view, C2, whole animal in lateral view; D, *Mothocya rosea*, D1, antenna 1, D2, antenna 2, D3, whole animal (after Brusca 1981; Bruce 1986).

grinding structure used to chew algae or other plant material. Smaller species probably feed by scraping diatoms and detritus off sand grains. *Paracerceis sculpta,* a subtropical species that finds its way north to southern California, is unique in that it is possesses three distinct male morphs (designated alpha, beta, and gamma males). Alpha males are large, with a distinct morphology typical of other members of the genus; beta males mimic females; gamma males mimic juveniles. The advantage of the beta and gamma males is thought to be in allowing them to sneak into the harem, protected by a single alpha male, to inseminate females (see Shuster et al. citations under *Paracerceis* in species list). In the Sea of Cortez, harems most

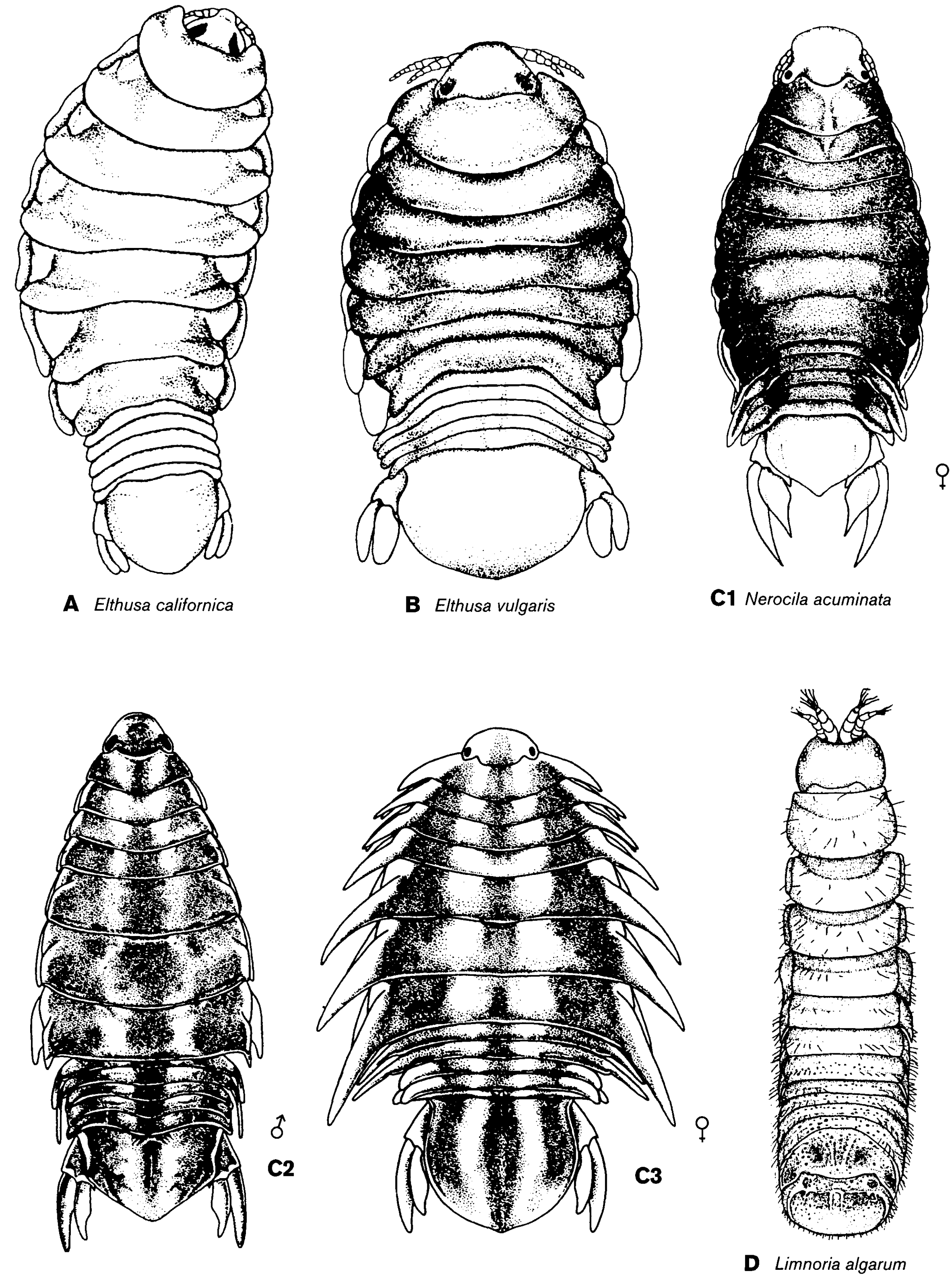

PLATE 240 Isopoda. Flabellifera: A, *Elthusa californica*; B, *Elthusa vulgaris*; C, *Nerocila acuminata*, C1, acuminata form, female, C2, acuminata form, male, C3, aster form, female; D, *Limnoria algarum* (after Menzies 1957; Brusca 1981).

commonly form in calcareous sponges; the natural history of California populations of *P. sculpta* has not been studied.

Note: A sometimes common sandy beach and surf zone isopod is the distinctive *Tecticeps convexus,* with a broad oval, flattened body, about 15 mm long. Morris, Abbott, and Haderlie (1980, *Intertidal Invertebrates of California*) present a color photo. See further notes in species list.

1. Pereopod 1 prehensile; uropod lacking exopod (plate 241E) . . . . *Ancinus*

Note: One species in California, *A. granulatus*.

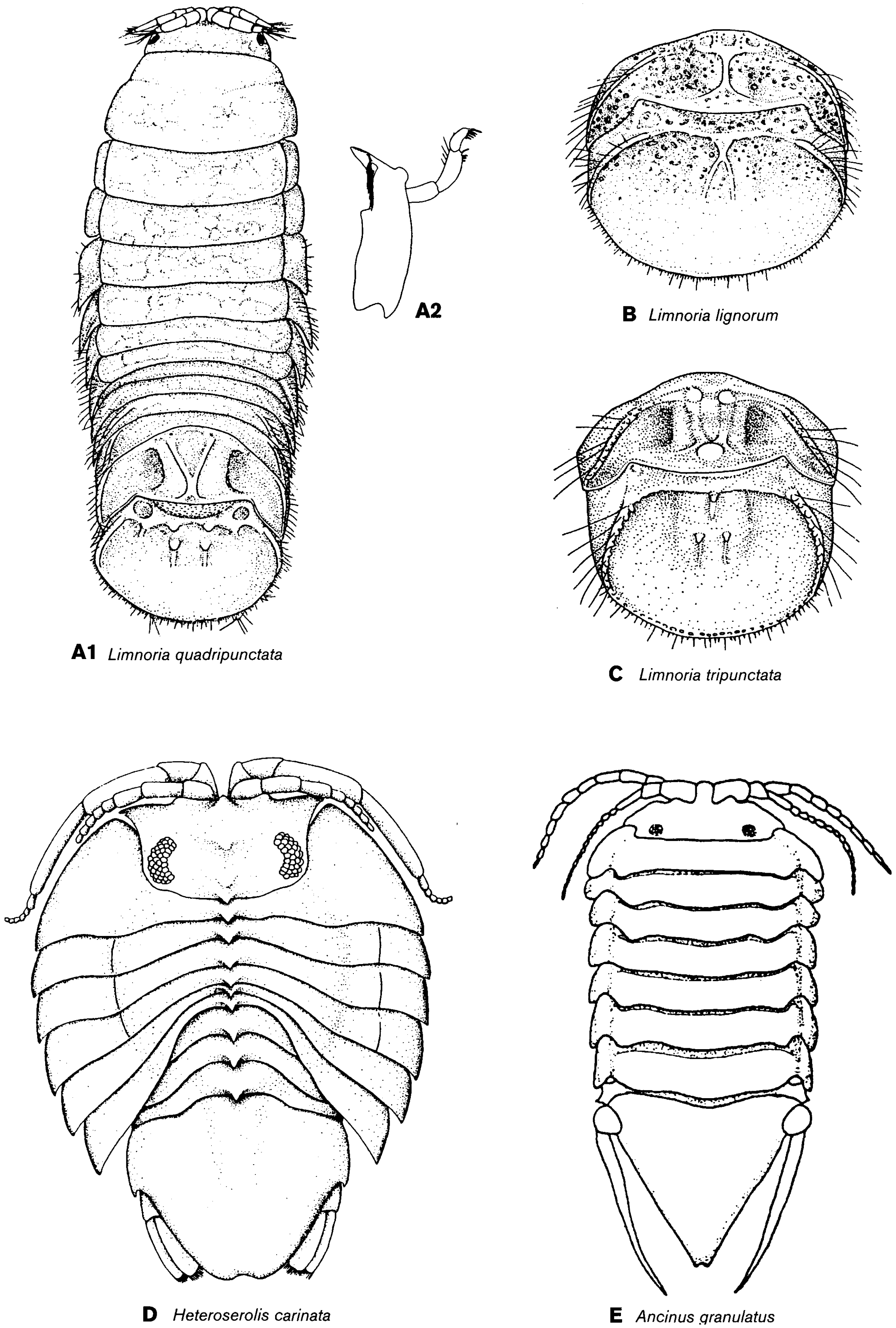

PLATE 241 Isopoda. Flabellifera: A, *Limnoria quadripunctata*, A1, whole animal, A2, mandible; B, *Limnoria lignorum*, pleotelson; C, *Limnoria tripunctata*, pleotelson; D, *Heteroserolis carinata*; E, *Ancinus granulatus* (after Menzies 1957; Trask 1970; Wetzer and Brusca 1997).

— Pereopod 1 ambulatory; uropod with exopod 2
2. Pleopods 4 and 5 lacking pleats. . . . . *Gnorimosphaeroma* 3
— Pleopods 4 and 5 with pleats on endopods 4
3. First article of peduncles of right and left antennae touching each other (plate 243B) . . . . *Gnorimosphaeroma noblei*
— First article of peduncles of right and left antennae not touching each other (plate 243C). . . . . *Gnorimosphaeroma oregonense*

Note: Two additional species of *Gnorimosphaeroma* occur in our region: *G. insulare,* common intertidally in some areas, such as estuarine reaches of San Francisco Bay, and *G. rayi,* intertidal in Tomales Bay. In *G. insulare* (plate 252C1), only the first two pleonites of second (first visible) pleonal division form its lateral margin; in *G. oregonense* (plate 243C), all three pleonites comprising the second (first visible) pleonal division reach and form its lateral margin. In *G. rayi* (plate 252C2), the basis (first free joint) of pereopod 1 has a tuft of seven to nine setae, and the sternal crest of the ischium (second free joint) has two to three setae; in *G. oregonense* (plate 252C3) the basis of pereopod 1 has only 1 seta, and the ischium has rows of long setae.

4. Pleopod 4 and 5 with branchial pleats on both rami. 5
— Pleopod 4 and 5 with branchial pleats on endopods only 6
5. Uropods lamellar in females, endopod reduced and exopod elongate-cylindrical in males; ovigerous females with four pairs of oöstegites . . . . *Paracerceis* 7
— Uropods lamellar in both sexes; ovigerous females lacking oöstegites 8
6. Uropodal exopod with serrate outer margin . . . . *Sphaeroma* 12
— Uropodal exopod with smooth or lightly crenulate outer margin . . . . *Exosphaeroma* 13
7. Male uropods with spines; female pleotelson stout, with four tubercles (plate 242F) . . . . *Paracerceis cordata*
— Male uropods without spines; female pleotelson elongate, with three tubercles (plate 243A) . . . . . . *Paracerceis sculpta*
8. Frontal margin of head produced as a quadrangular process; first two articles of antennules dilated (plate 242E) . . . . *Dynamenella dilatata*
— Frontal margin of head not produced; articles of antennules not dilated 9
9. Uropod rami with crenulate margin (at least in males) (plate 242A) . . . . *Paradella dianae*
— Uropod rami without crenulate margin. 10
10. Pleotelson with many tubercles (plate 242B). . . . . *Dynamenella sheareri*
— Pleotelson without tubercles. 11
11. Pleotelson with many ridges; uropod rami of similar length (plate 242C) . . . . *Dynamenella benedicti*
— Pleotelson smooth; uropod with exopod (outer ramus) longer than endopod (inner ramus) (plate 242D) . . . . *Dynamenella glabra*
12. Pleotelson with many rows of tubercles, posterior extremity without prominent transverse elevation (plate 244B). . . . . *Sphaeroma walkeri*
— Pleotelson with two rows of tubercules, posterior extremity with prominent transverse elevation (plate 244C). . . . . *Sphaeroma quoianum*

Note: *Pseudosphaeroma campbellenis* is a recently introduced, small New Zealand sphaeromatid that may be confused with *S. walkeri* and *S. quoianum.* Often light green in color, *P. campbellensis* has a narrow, upturned granulated pleotelson; there are two tubercles on pleonite 5, and four tubercles on the anterior portion of the pleotelson; the uropods are smooth and rounded (A. Cohen, J. T. Carlton, and J. Chapman, personal communication).

13. Pleotelson and uropods relatively small; posterior margin of pleotelson rounded (plate 244A) . . . . *Exosphaeroma inornata*
— Pleotelson and uropods very large; posterior margin of pleotelson acuminate (plate 243D) . . . . *Exosphaeroma amplicauda*

GNATHIIDEA

Key general references: Monod 1926; Menzies and Barnard 1959; Menzies 1962; Schultz 1966; Brusca 1989; Cohen and Poore 1994; Wetzer and Brusca 1997.

Gnathiids are quickly recognized by the presence of only six free pereonites and five pairs of pereopods, the first pereonite being fused to the cephalon (with its appendages functioning as a second pair of maxillipeds, or pylopods) and the seventh pereonite being greatly reduced and without legs. The pleon is abruptly narrower than the pereon, always with five free pleonites (plus the pleotelson). Adult males have broad flattened heads with grossly enlarged mandibles that project in the front. Females have small narrow heads and no mandibles at all. In both sexes the eyes are well developed and frequently on short processes (ocular lobes). The embryos are incubated internally, distending the entire body cavity and displacing the internal organs.

Gnathiids occur from the littoral zone to the deep sea, and they are often numerous in shallow soft-bottom benthic samples. Adults probably do not feed and are often found in association with sponges. Adults are benthic, but the juvenile stage, called "praniza," is a temporary parasite on marine fishes. Praniza are good swimmers, whereas adults have only limited swimming capabilities. Females and juveniles cannot be identified, and the taxonomy of this suborder is based entirely on males. About 10 genera and 125 species, in a single family (Gnathiidae), have been described worldwide. Eight species have been found in California waters, all but *G. steveni* (plate 244D) being subtidal. Only two species have been reported from north of Point Conception, *Gnathia tridens* and *Caecognathia crenulatifrons,* the latter in subtidal waters in Monterey Bay. For a key to all known California species see Wetzer and Brusca (1997).

MICROCERBERIDEA

Key general reference: Wägele et al. 1995.

Being tiny (<2 mm in length) and cryptic, members of this suborder are overlooked by most collectors. Microcerberids resemble anthurid isopods in having an elongate body and subchelate first pereopods. However, they are most closely related to the Asellota, with which they share the terminal styliform uropods and many other features. An asellote species, *Caecianiropsis psammophila*, also lives interstitially in intertidal sands of central California and shows the same adaptations to this habitat as microcerberids—i.e., elongation, small size, and loss of eyes and pigmentation. Only one species of microcerberid has been reported from California waters, *Coxicerberus abbotti*, known from the interstitial environment in the Monterey Bay area (plate 244E).

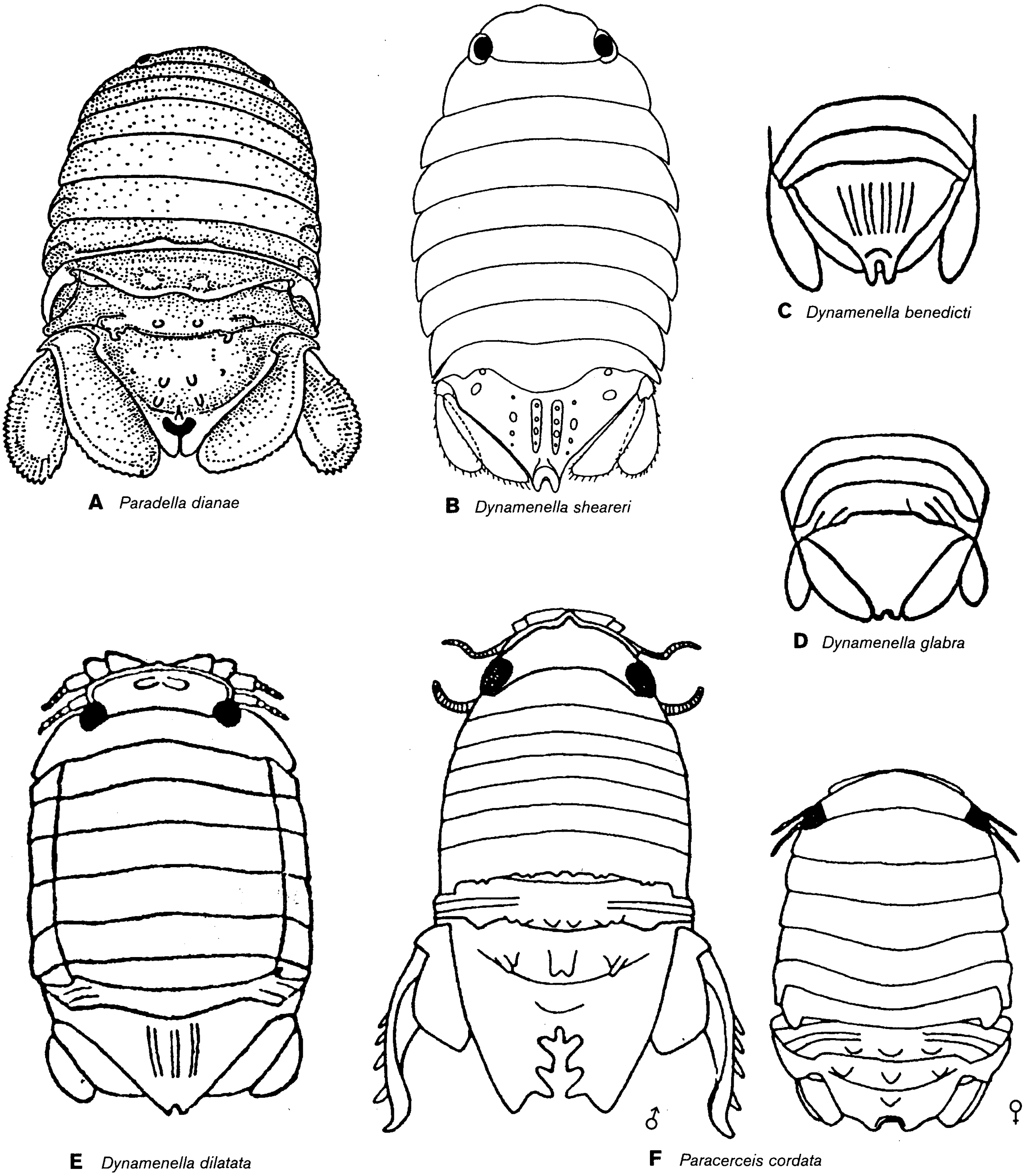

PLATE 242 Isopoda. Flabellifera: A, *Paradella dianae*; B, *Dynamenella sheareri*; C, *Dynamenella benedicti*, pleotelson; D, *Dynamenella glabra*, pleotelson; E, *Dynamenella dilatata*; F, *Paracerceis cordata* (after Richardson 1899; Menzies 1962; George and Strömberg 1968; Schultz 1969).

VALVIFERA

Key general references: Stimpson 1857; Richardson 1905.

Valviferans are distinguished by the unique opercular uropods that form hinged doors ("valves") covering the pleopods. Additional features that aid in recognition are the well-developed coxal plates, often partly fused pleonites, absence of mandibular palps (except in the southern hemisphere family Holognathidae), and the penes of males arising from pleonite 1, or on the articulation of pleonite 1 and pereonite 7 (rather than on the thorax, as in all other marine isopods).

Three families and 34 species are represented in our waters. *Mesidotea entomon,* an offshore circum-Arctic species, is reported to occur as far south as Pacific Grove and is the only representative of the Chaetiliidae in California. Twenty-one species in the families Arcturidae and Idoteidae occur in our intertidal region.

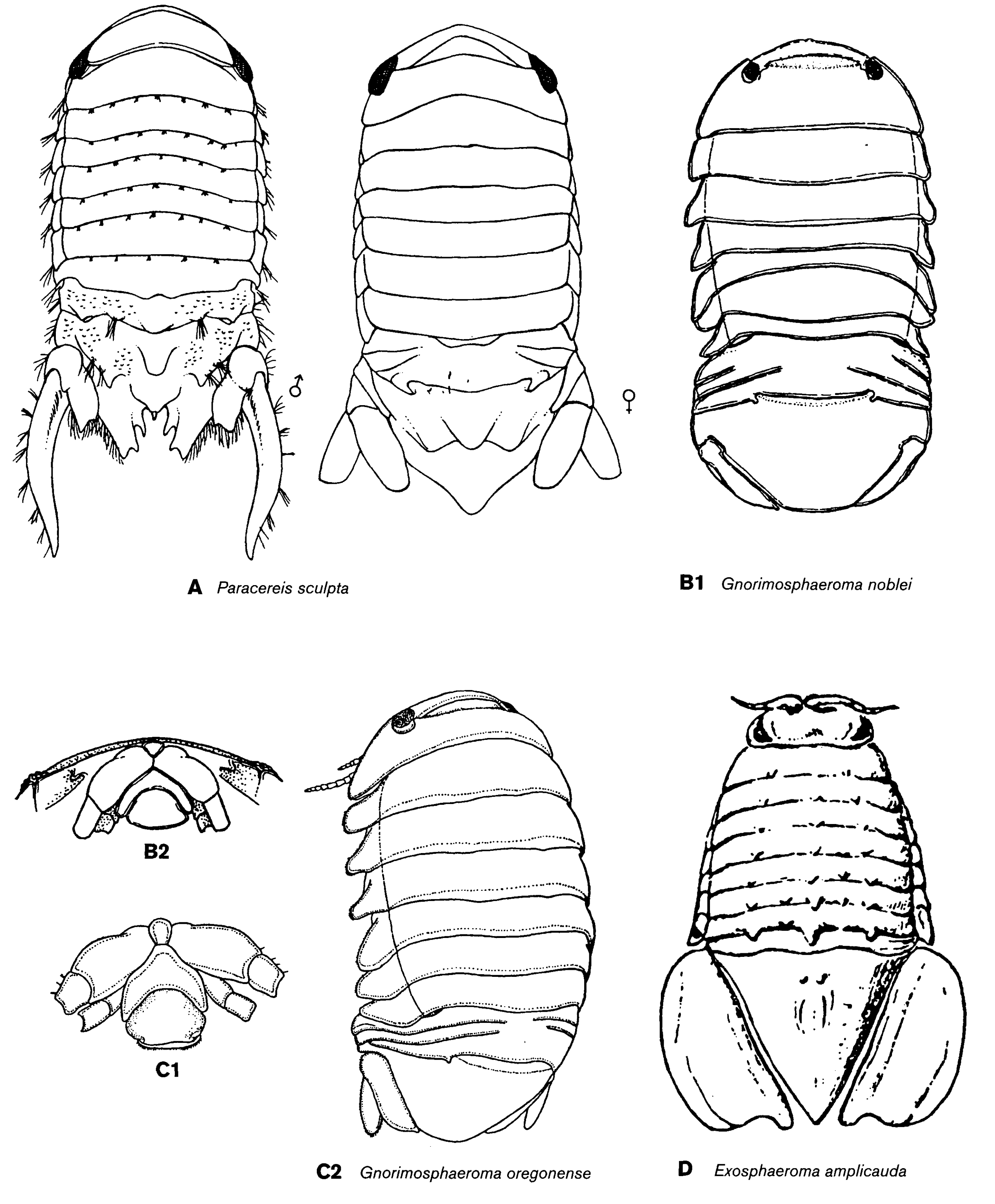

PLATE 243 Isopoda. Flabellifera: A, *Paracerceis sculpta*; B, *Gnorimosphaeroma noblei*, B1, whole animal, B2, frontal view of cephalon; C, *Gnorimosphaeroma oregonense*, C1, frontal view of cephalon, C2, whole animal; D, *Exosphaeroma amplicauda* (after Stimpson 1857; Menzies 1954A; Brusca 1980).

1. Body narrow, subcylindrical; anterior four pereopods unlike posterior three, being smaller, setose, and nonambulatory; head fused with first pereonite, leaving six free pereonites .... Arcturidae: *Idarcturus*

Note: One intertidal species in California and Oregon, *I. hedgpethi*, plate 244F.

— Body dorsoventrally depressed; pereopods subsimilar and ambulatory; seven free pereonites .... Idoteidae 2

2. Pleon composed of three complete pleonites and one incomplete pleonite (represented by a pair of lateral suture lines), plus pleotelson.................... *Cleantioides*

Note: One species in California and Oregon, *C. occidentalis*, plate 244G.

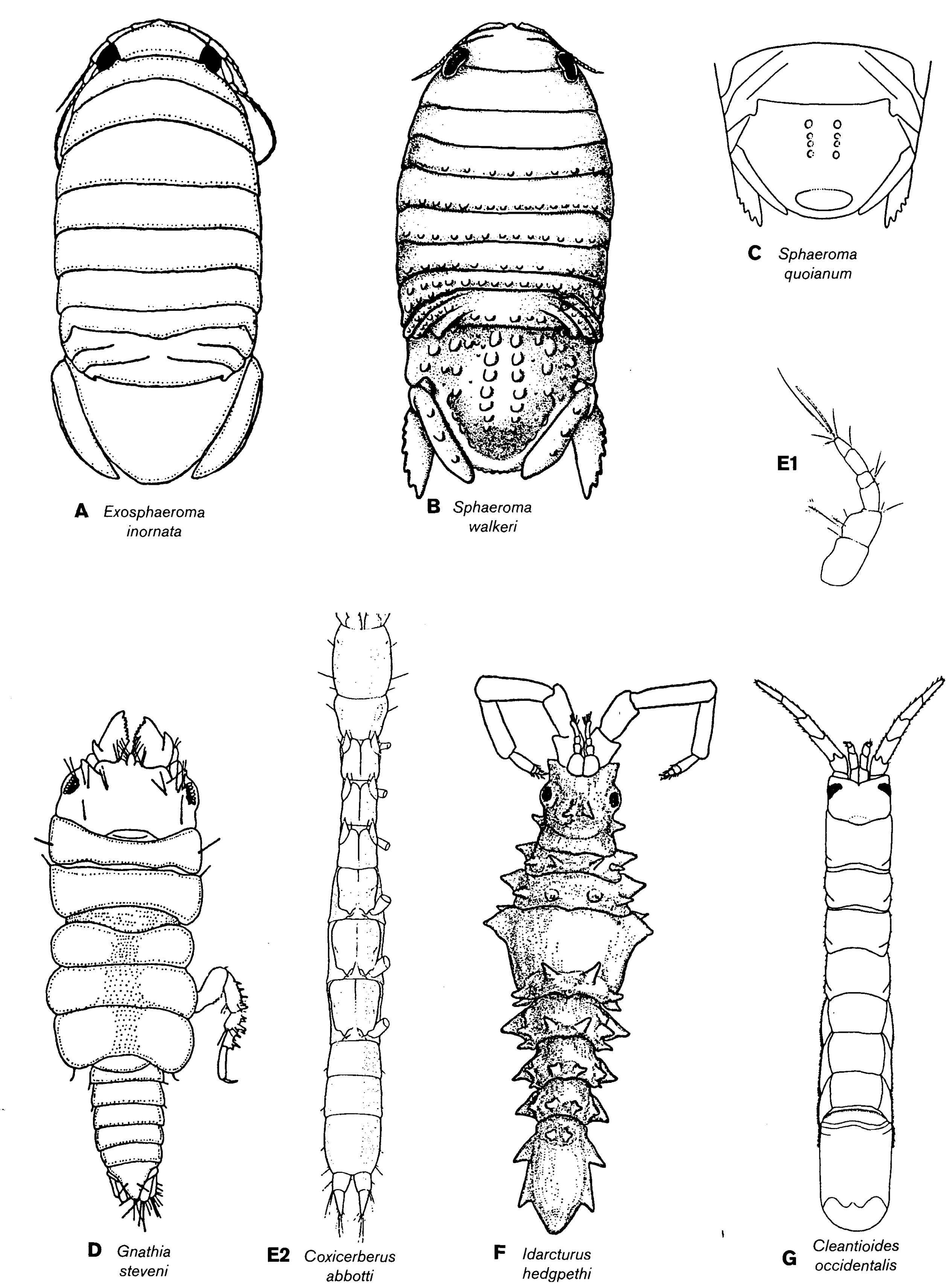

PLATE 244 Isopoda. Flabellifera: A, *Exosphaeroma inornata*; B, *Sphaeroma walkeri*; C, *Sphaeroma quoianum*, pleotelson; D, Gnathiidea: D, *Gnathia steveni*; E, Microcerberidea: E, *Coxicerberus abbotti*, E1, antenna 1, E2, whole animal; F–G, Valvifera: F, *Idarcturus hedgpethi*; G, *Cleantioides occidentalis* (after Richardson 1905; Menzies 1951A, 1962; Dow 1958; Lang 1960; Brusca and Wallerstein 1979; Kensley and Schotte 1989).

— Pleon with less than three complete pleonites 3
3. Pleon composed of a single segment, with or without incomplete suture lines 4
— Pleon composed of two complete pleonites and one incomplete pleonite . . . . *Idotea* 6
4. Antenna with multiarticulate flagellum; pleon with one pair of incomplete suture lines 5
— Antenna with single clavate flagellar article; pleon usually without suture lines . . . . *Erichsonella* 15
5. Maxillipedal palp of four articles . . . . *Colidotea* 16
— Maxillipedal palp of three articles . . . . *Synidotea* 17
6. Maxillipedal palp of four articles 7
— Maxillipedal palp of five articles 9
7. Pleotelson posterior margin concave (plate 246D) . . . . *Idotea rufescens*
— Pleotelson posterior margin not concave 8
8. Pleotelson posterior margin with strong median process, triangular in shape and with rounded apex (plate 246B) . . . . *Idotea ochotensis*
— Pleotelson posterior margin without strong median process (plate 247B) . . . . *Idotea urotoma*
9. Eyes transversely (dorsoventrally) elongate; maxilliped with one, two or three coupling setae (plate 246F) . . . . *Idotea stenops*
— Eyes not transversely elongate; maxilliped with one coupling seta 10
10. Posterior border of pleotelson strongly concave (plate 246C) . . . . *Idotea resecata*
— Posterior border of pleotelson not concave 11
11. Pleonite 1 with acute lateral borders 12
— Pleonite 1 without acute lateral borders 13
12. Eyes reniform; anterior margin of pereonite 1 encompassing cephalon (plate 247A) . . . . *Idotea wosnesenskii*
— Eyes rectangular; anterior margin of pereonite 1 not encompassing cephalon (plate 246E) . . . . *Idotea schmitti*
13. Pleotelson with median posterior projection 14
— Pleotelson without median posterior projection (plate 245F) . . . . *Idotea kirchanskii*
14. Eyes circular; pleotelson median posterior projection long (plate 245E) . . . . *Idotea aculeata*
— Eyes with straight anterior and convex posterior border; pleotelson median posterior projection short (plate 246A) . . . . *I. montereyensis*
15. Body not elongated (length about 3 times width) (plate 245D) . . . . *Erichsonella pseudoculata*
— Body elongate (length about 7.4 times width) (plate 245C) . . . . *Erichsonella crenulata*
16. Posterior margin of pleotelson rounded; body relatively stout (length about 2.6 times width); antenna not, or barely, reaching pereonite 2; body dark purple or dark red (fading to bluish-gray in alcohol); commensal on sea urchins (plate 245A) (*Strongylocentrotus*) . . . . *Colidotea rostrata*
— Posterior margin of pleotelson triangular-shaped; body elongate (length about 5.5 times width); antenna reaching pereonite 3 or 4; body brown to brownish-green; not commensal on sea urchins (usually in brown algae) (plate 245B) . . . . *Colidotea findleyi*
17. Body smooth; head without preocular horns or other projections (plate 247E) . . . . *Synidotea harfordi*

Note: *Synidotea laticauda* (plate 252D) is a very abundant isopod in fouling communities of San Francisco Bay, living on hydroids on floats, buoys, and pilings. The frontal margin of the head is transverse or slightly concave with a slight median excavation; in *S. harfordi*, the frontal margin of the head is transverse or slightly convex, with no median excavation. In *S. laticauda*, the pleon is less than one-third longer (in midline) than the greatest width; in *S. harfordi*, the pleon is at least one-third longer than broad.

— Body with tuberculations, carinae or bumps; head with preocular horns or other processes 18
18. Pereon lacking tubercles (plate 247D) . . . . *Synidotea consolidata*
— Pereon with tubercles 19
19. Preocular horns project forward (plate 247G) . . . . *Synidotea ritteri*
— Preocular horns project laterally 20
20. Lateral borders of first four pereonites acute; each pereonite with a transverse row of three pointed tubercles (plate 247F) . . . . *Synidotea pettiboneae*
— Lateral borders of second, third and fourth pereonites blunt; pereonites with many small tubercles (plate 247C) . . . . *Synidotea berolzheimeri*

ONISCIDEA (TERRESTRIAL, MARITIME ISOPODS)

Key general references: Van Name 1936 and 1940, 1942 supplements; Mulaik and Mulaik 1942; Garthwaite et al. 1985, 1992; Garthwaite 1992; Leistikow and Wägele 1999.

The Oniscidea (formerly "Oniscoidea") are the only group of crustaceans fully adapted to live on land. They are distinguished by: extreme reduction (to one to three articles) of the antennules; endopods of male pleopod 1 and/or 2 elongate, styliform, specialized as a copulatory apparatus; and, presence of a complex water-conducting system (Hoese 1981, 1982 a, b). In species best adapted to terrestrial life (e.g., Porcellionidae, Armadillidiidae, Armadillidae) the exopods of pleopods 1–2 or 1–5 bear respiratory structures, called pseudotracheae or "lungs." Terrestrial isopods possess general body morphologies correlated to their ecological strategies and behaviour, and can be grouped in three main categories (Schmalfuss 1984): the runners, with an elongate, slightly convex body and long pereopods; the clingers, with a flat broad body and short strong pereopods; and the rollers, with a highly convex body able to roll up into a ball (pillbugs).

With almost 4,000 described species, Oniscidea is the largest isopod suborder. They occur in any kind of terrestrial habitat, from littoral to high mountains, from forests to deserts. In our region, 22 species, in 10 families, occur in littoral biotopes, but only species of *Ligia, Tylos, Littorophiloscia*, the Detonidae, and the Alloniscidae are typical inhabitants of the eulittoral zone.

The key and species list include all the strictly littoral oniscid species, some of which have wide distributions or have been introduced to North America, and some of which occur on both coasts.

1. Uropods ventral, hidden by pleotelson and not visible in dorsal view of the animal (plate 248A) . . . . Tylidae *Tylos punctatus*
— Uropods terminal, clearly visible in dorsal view 2
2. Flagellum of antenna with more than 10 articles; eye with more than 50 ommatidia . . . . Ligiidae 3
— Flagellum of antenna with two to seven articles; eye with <30 ommatidia, or eyes absent 6
3. Pleotelson with posterolateral projections; uropod with insertion of exopod and endopod at the same level. . . . . *Ligia* 4

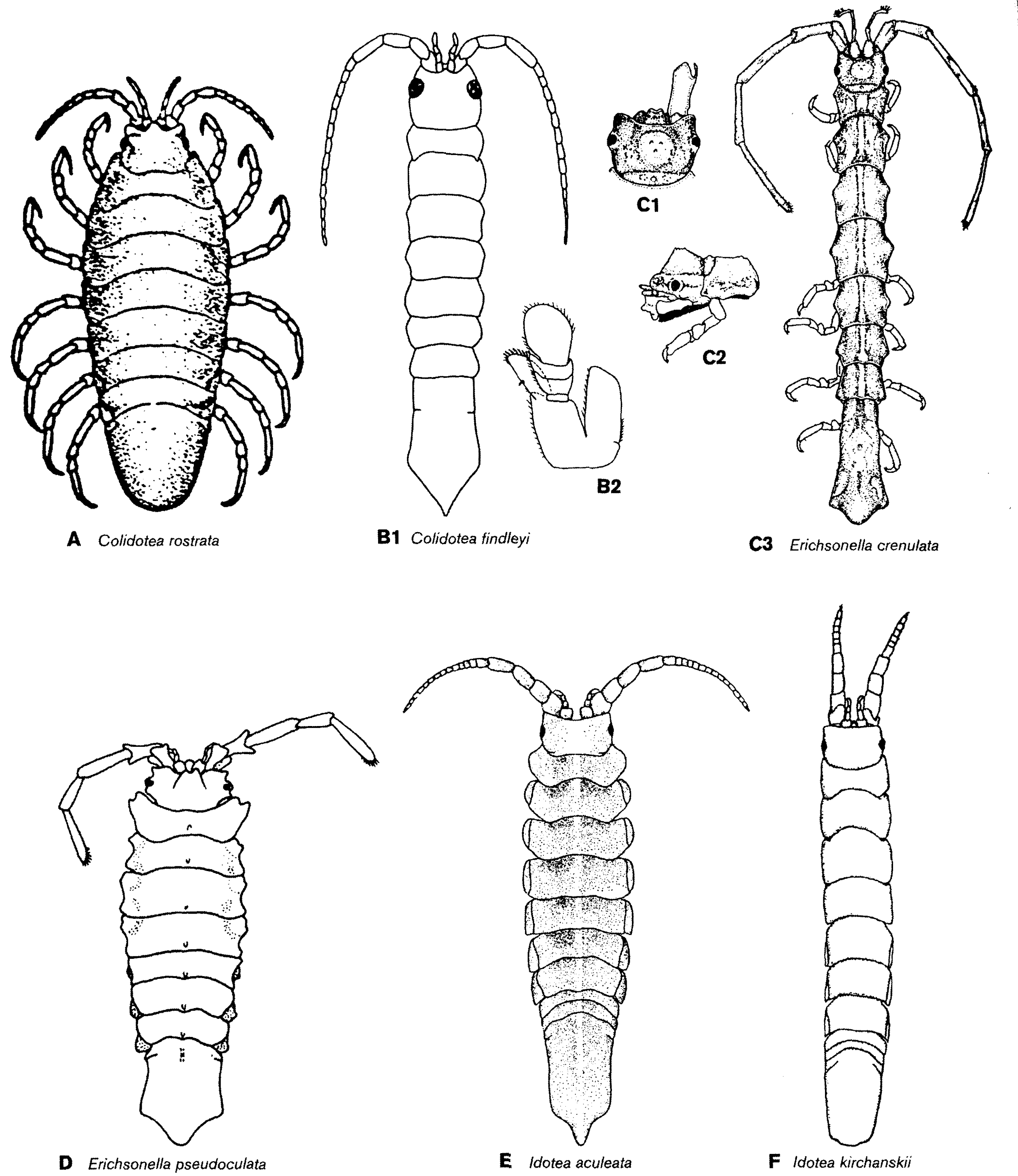

PLATE 245 Isopoda. Valvifera: A, *Colidotea rostrata*; B, *Colidotea findleyi*, B1, whole animal, B2, maxilliped; C, *Erichsonella crenulata*, C1, dorsal view of cephalon, C2, lateral view of cephalon, C3, whole animal; D, *Erichsonella pseudoculata*; E, *Idotea aculeata*; F, *Idotea kirchanskii* (after Benedict 1898; Stafford 1913; Menzies 1950a; Schultz 1969; Miller and Lee 1970; Brusca and Wallerstein 1977).

— Pleotelson without posterolateral projections; uropod with insertion of exopod distinctly proximal to that of endopod . . . . *Ligidium* 5

4. Distance between eyes equal to length of one eye; peduncle of uropod several times longer than broad (plate 248B). . . . . *Ligia occidentalis*

— Distance between eyes equal to twice length of one eye; peduncle of uropod about as broad as long (plate 248C) . . . . *Ligia pallasii*

5. Surface of body smooth and shiny; eye ovoid, far from posterior margin of cephalon; endopod of second male pleopod with rounded apex (plate 248D). . . . . *Ligidium gracile*

— Surface of body rough with sparse scales; eye subtriangular, almost reaching posterior margin of cephalon; endo-

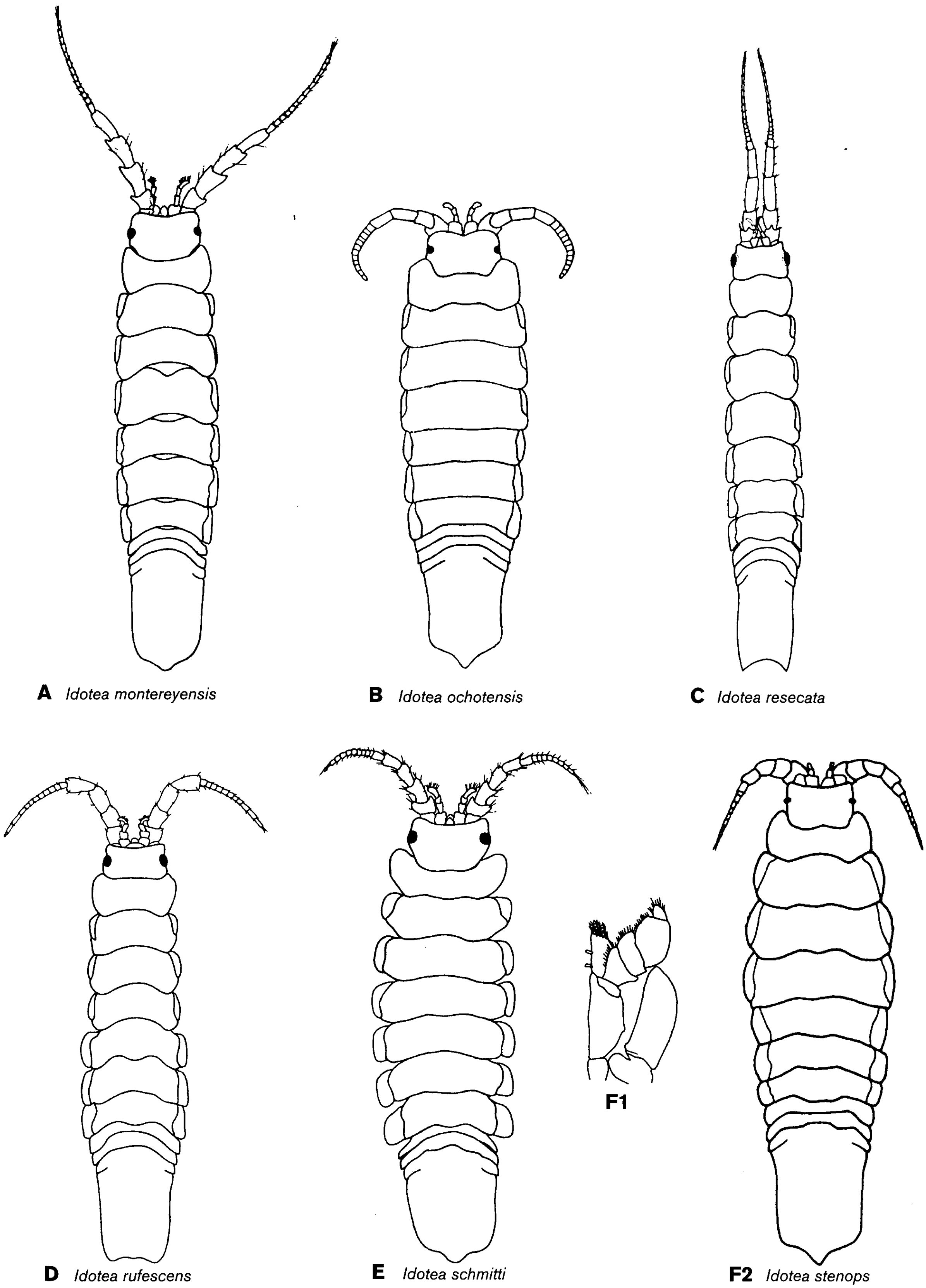

PLATE 246 Isopoda. Valvifera: A, *Idotea montereyensis*; B, *Idotea ochotensis*; C, *Idotea resecata*; D, *Idotea rufescens*; E, *Idotea schmitti*; F, *Idotea stenops*, F1, maxilliped, F2, whole animal (after Richardson 1905; Schultz 1969; Rafi and Laubitz 1990).

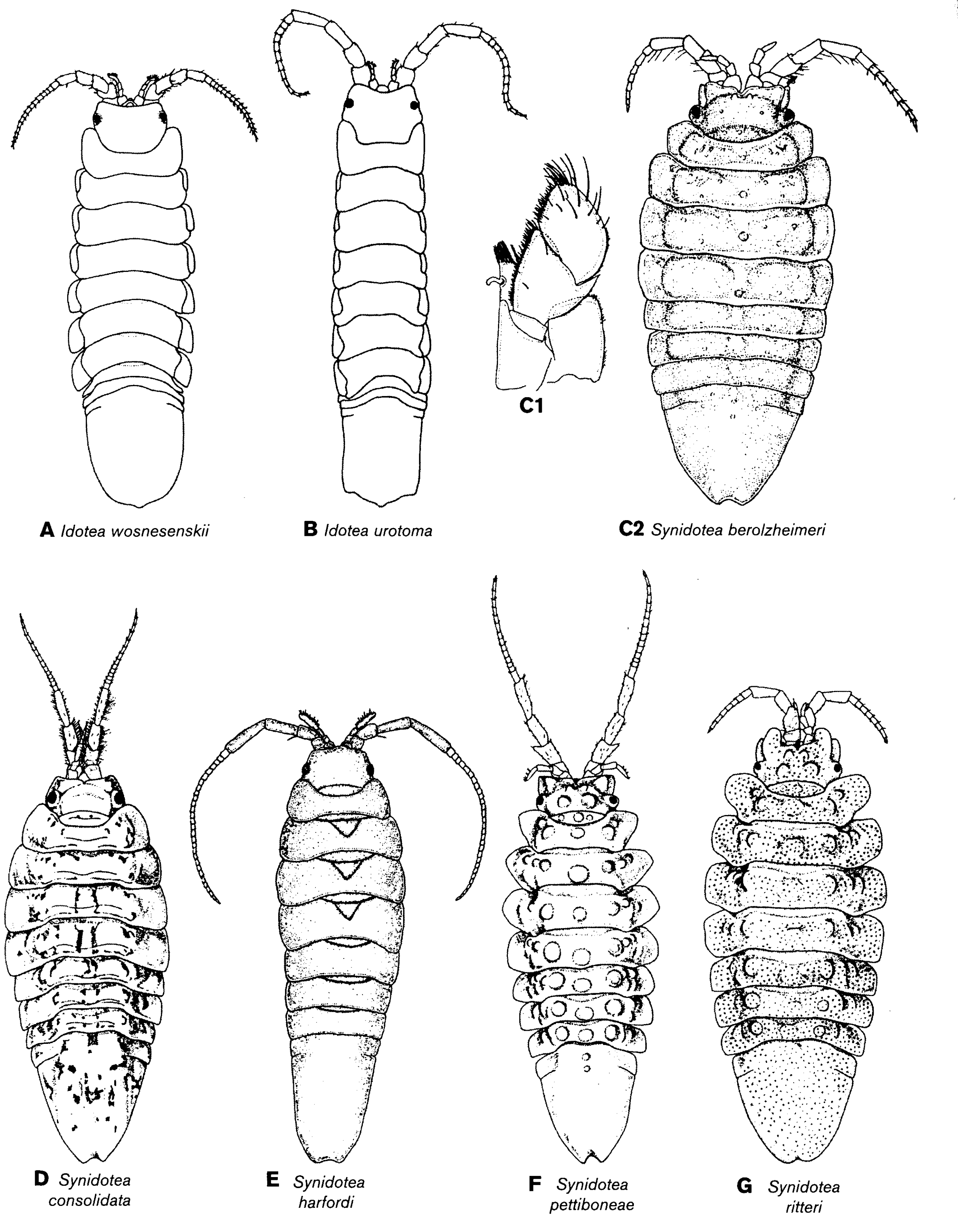

PLATE 247 Isopoda. Valvifera: A, *Idotea wosnesenskii*; B, *Idotea urotoma*; C, *Synidotea berolzheimeri*, C1, maxilliped, C2, whole animal; D, *Synidotea consolidata*; E, *Synidotea harfordi*; F, *Synidotea pettiboneae*; G, *Synidotea ritteri* (after Menzies and Miller 1972; Rafi and Laubitz 1990).

pod of second male pleopod with pointed apex (plate 248E) . . . . *Ligidium latum*

6. Flagellum of antenna tapering to a point, with articles distinguishable only in micropreparations. . . . . Trichoniscidae 7

— Flagellum of antenna with two to four clearly distinct articles. 8

7. Flagellum of antenna of three minute articles; eye consisting of a single black ommatidium (plate 249A). . . . . *Haplophthalmus danicus*

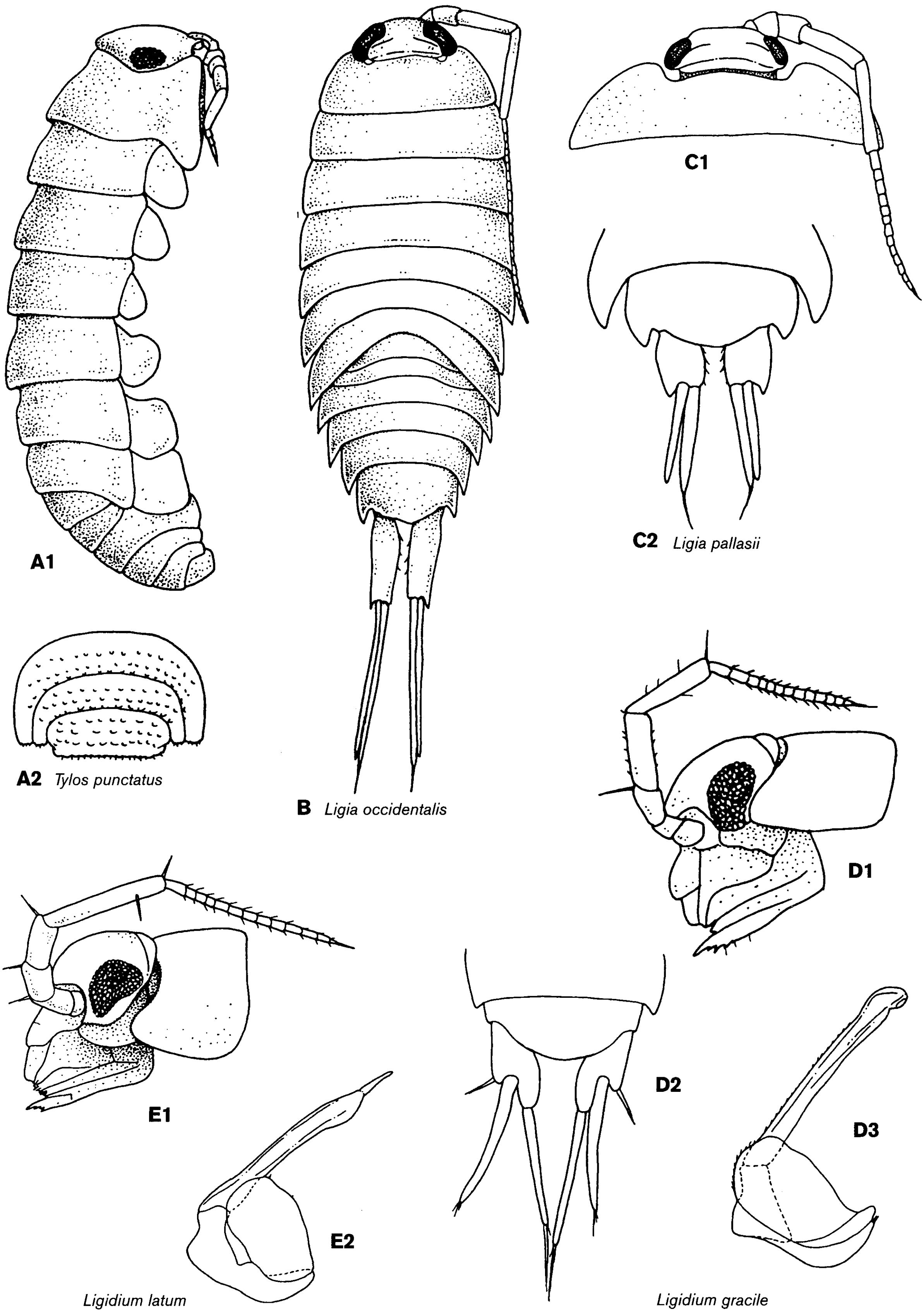

PLATE 248 Isopoda. Oniscidea: A, *Tylos punctatus*, A1, lateral view of whole animal, A2, fourth and fifth pleonite and pleotelson; B, *Ligia occidentalis*; C, *Ligia pallasii*, C1, cephalon and first pereonite, C2, fifth pleonite, pleotelson, and uropods; D, *Ligidium gracile*, D1, lateral view of cephalon and first pereonite, D2, fifth pleonite, pleotelson, and uropods, D3, second male pleopod; E, *Ligidium latum*, E1, lateral view of cephalon and first pereonite, E2, second male pleopod.

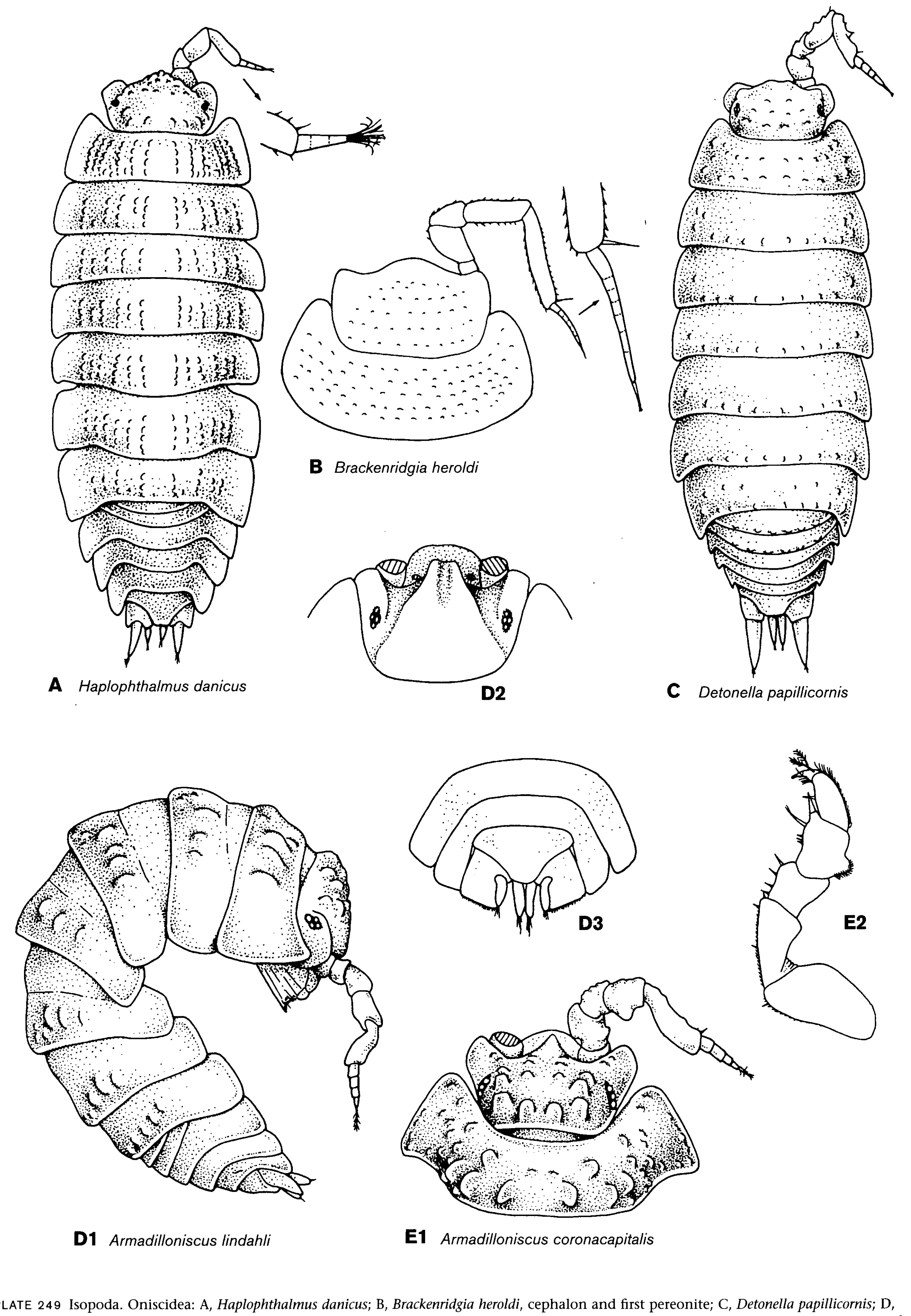

PLATE 249 Isopoda. Oniscidea: A, *Haplophthalmus danicus*; B, *Brackenridgia heroldi*, cephalon and first pereonite; C, *Detonella papillicornis*; D, *Armadilloniscus lindahli*, D1, lateral view of whole animal, D2, dorsal view of cephalon, D3, fourth and fifth pleonite, pleotelson, and uropods; E, *Armadilloniscus coronacapitalis*, E1, female cephalon and first pereonite, E2, male seventh pereopod.

— Flagellum of antenna of six or seven minute articles; eyes lacking (plate 249B) .... *Brackenridgia heroldi*
8. Flagellum of antenna with four articles .... Detonidae 9
— Flagellum of antenna with two or three articles 12
9. Uropods with peduncle subcylindrical, exopod inserted terminally and distinctly protruding from body outline (plate 249C)................... *Detonella papillicornis*
— Uropods with peduncle lamellar, exopod inserted on medial margin and not protruding from body outline........ 10
10. Body markedly convex and capable of rolling into a ball; cephalon with median lobe truncate (plate 249D) .... *Armadilloniscus lindahli*
— Body not markedly convex and incapable of rolling into a ball; cephalon with median lobe pointed 11
11. Penultimate article of peduncle of antenna with spurlike process on lateral margin; dorsal body surface of adult female covered with conspicuous tubercles; seventh male pereopod with a strong spine caudally directed and a rounded lobe on carpus (plate 249E) .... *Armadilloniscus coronacapitalis*
— Penultimate article of peduncle of antenna without spurlike process on lateral margin; dorsal body surface rough with low, rounded tubercles; seventh male pereopod without spine and lobe on carpus (plate 250A) .... *Armadilloniscus holmesi*
12. Flagellum of antenna with three articles 13
— Flagellum of antenna with two articles 15
13. Cephalon with cone-shaped lateral lobes protruding frontwards; pleon not abruptly narrower than pereon .... Alloniscidae *Alloniscus* 14
— Cephalon without cone-shaped lateral lobes; pleon abruptly narrower than pereon (plate 250D)........... .... Halophiloscidae *Littorophiloscia richardsonae*
14. Peduncle of uropod with posterolateral margin produced, rounded (plate 250C) .... *Alloniscus mirabilis*
— Peduncle of uropod with posterolateral margin not produced, oblique (plate 250B) .... *Alloniscus perconvexus*
15. Body moderately convex, unable to roll into a ball; uropod subcylindrical, distictly protruding backwards compared with pleotelson tip 16
— Body very convex, able to roll into a ball; uropod flattened, reaching pleotelson tip 21
16. Dorsal surface of body covered with fine but distinct scales; first article of flagellum of antenna distinctly shorter than second .... Platyarthridae 17
— Dorsal surface of body with no distinctly visible scales; first article of flagellum of antenna as long or longer than second .... Porcellionidae 18
17. Eyes with about 10 ommatidia; pleotelson tip reaching distal margin of uropodal peduncle (plate 250E).......... .... *Niambia capensis*
— Eyes lacking; pleotelson much shorter than uropodal peduncle (plate 250F) .... *Platyarthrus aiasensis*
18. Cephalon with a V-shaped suprantennal line; pereonite 1 with regularly convex posterior margin (plate 251A) .... *Porcellionides floria*
— Cephalon with no suprantennal line; pereonite 1 with posterior margin concave at sides .... *Porcellio* 19
19. Pleotelson with a rounded apex (plate 251B) .... *Porcellio dilatatus*
— Pleotelson with an acute apex 20
20. Dorsal surface of body granulated; posterior margin of first pereonite distinctly concave at sides (plate 251C) .... *Porcellio scaber*
— Dorsal surface of body smooth; posterior margin of first pereonite slightly concave at sides (plate 251D) .... *Porcellio laevis*
21. Cephalon with a triangular frontal scutellum; eyes with 20–25; posterolateral corner of first pereonite entire; uropod with large flattened exopod filling gap between pleotelson and fifth pleonite (plate 251E) .... Armadillidiidae *Armadillidium vulgare*
— Cephalon with no triangular frontal scutellum; eyes with four to eight ommatidia; posterolateral corner of first pereonite cleft; uropod with large flattened peduncle filling gap between pleotelson and fifth pleonite, exopod minute inserted dorsally (plate 251F)......................... .... Armadillidae *Venezillo microphthalmus*

List of Species

ANTHURIDEA

ANTHURIDAE

*Other anthurids may be present in our region; Ernest Iverson noted (1974) a small (2mm) bright orange anthurid in empty spirorbid tubes, with its telson and uropods modified to form an operculum to close the tube, in the Bodega Bay region.

Cyathura munda Menzies, 1951. Marin County and south; low intertidal to 132 m; common in kelp holdfasts (e.g., *Egregia* and *Laminaria*) and on surfgrass (*Phyllospadix*). See Wetzer and Brusca 1997.

Mesanthura occidentalis Menzies and Barnard, 1959. Point Conception and south; intertidal to 20 m on kelp and rocks.

PARANTHURIDAE

Califanthura squamosissima (Menzies, 1951). Dillon Beach and south; shallow subtidal to 142 m, muddy or sandy sediments and kelp beds; *Macrocystis* holdfasts.

Colanthura bruscai Poore, 1984. San Clemente and south; intertidal to 27 m.

**Paranthura algicola* Nunomura, 1978. A questionable species, not distinguishable by its description; possibly *P. elegans*. Reported by Nunomura (1978) from California, but no specific locality provided.

Paranthura elegans Menzies, 1951. Marin County and south; intertidal to 55 m on algal mats, mud bottoms, pier pilings, rocky low intertidal in holdfasts of *Laminaria* and *Macrocystis*, among coralline algae, and other habitats. See Wetzer and Brusca 1997.

**Paranthura japonica* Richardson, 1909. An introduced Asian species found in fouling communities in San Francisco Bay and in marinas in southern California (John Chapman, personal communication).

**Paranthura linearis* Boone, 1923. A *nomen nudum*. Reported by Boone from Laguna Beach.

ASELLOTA

ASELLIDAE

Asellus tomalensis Harford, 1877. Central California and north; shallow subtidal in fresh and brackish water.

* = Not in key.

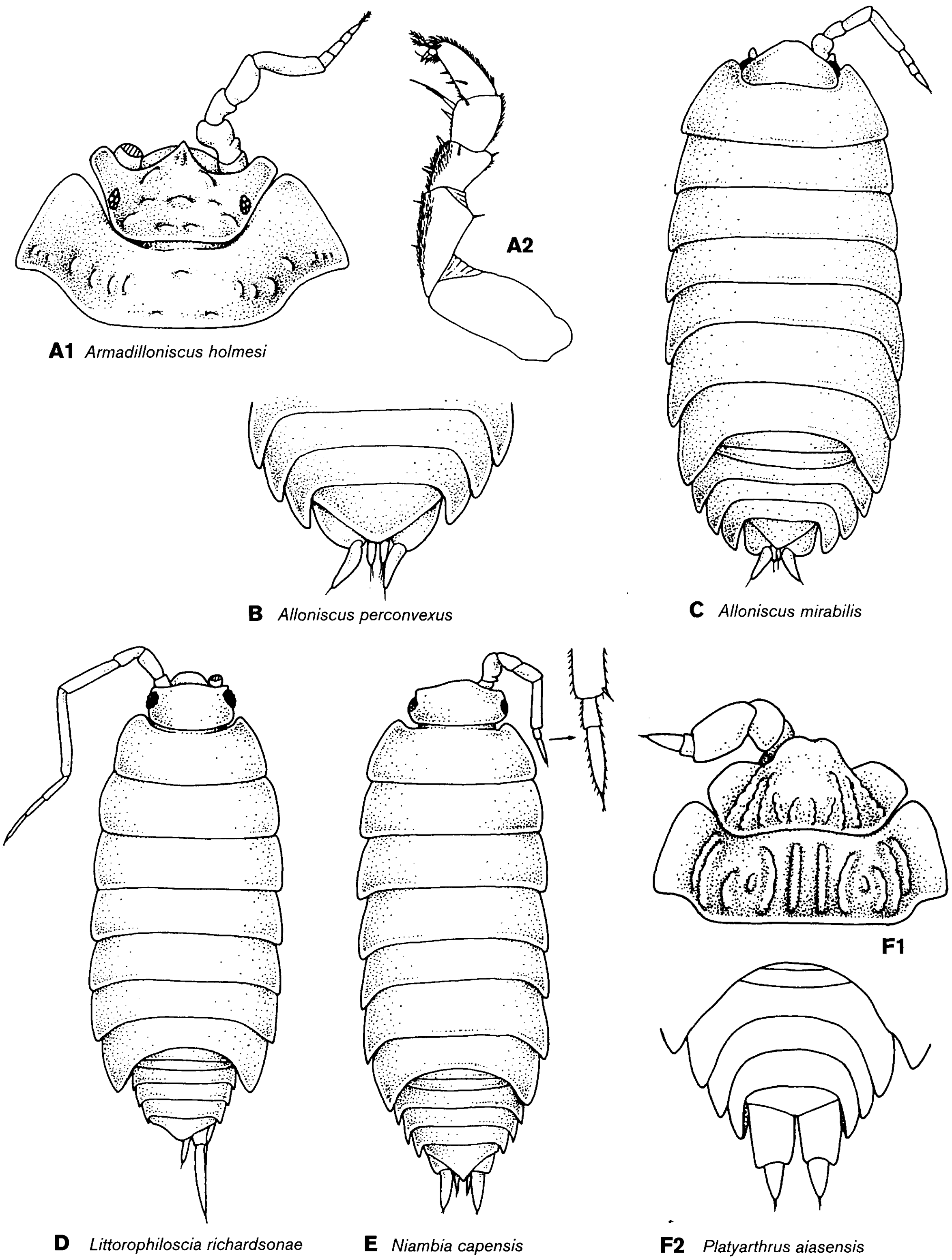

PLATE 250 Isopoda. Oniscidea: A, *Armadilloniscus holmesi*, A1, cephalon and first pereonite, A2, male seventh pereopod; B, *Alloniscus perconvexus*, third to fifth pleonite, pleotelson and uropods; C, *Alloniscus mirabilis*; D, *Littorophiloscia richardsonae*; E, *Niambia capensis*; F, *Platyarthrus aiasensis*, F1, cephalon and first pereonite, F2, pleon, pleotelson and uropods.

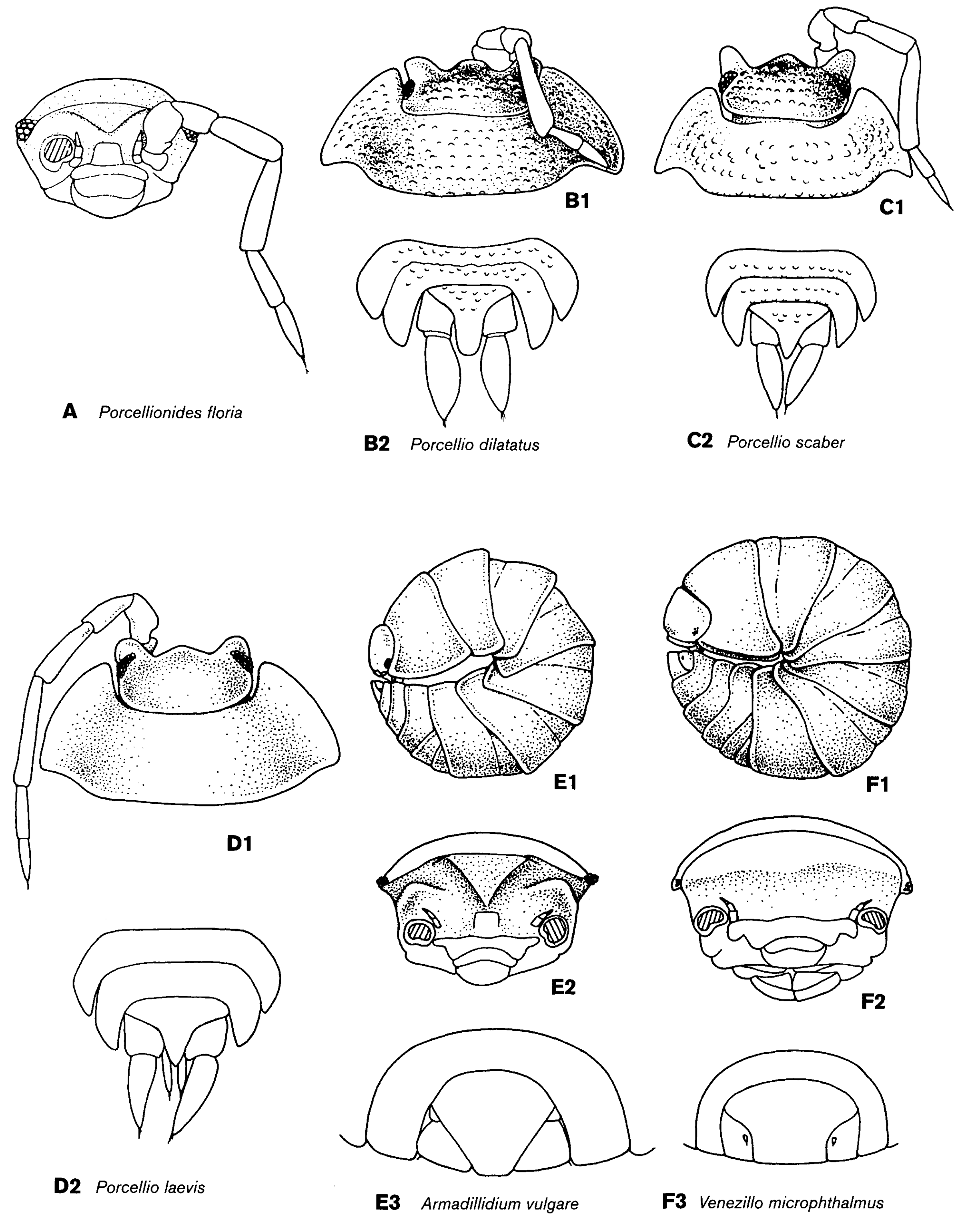

PLATE 251 Isopoda. Oniscidea: A, *Porcellionides floria*, frontal view of cephalon; B, *Porcellio dilatatus*, B1, cephalon and first pereonite, B2, fourth and fifth pleonite, pleotelson, and uropods; C, *Porcellio scaber*, C1, cephalon and first pereonite, C2, fourth and fifth pleonite, pleotelson, and uropods; D, *Porcellio laevis*, D1, cephalon and first pereonite, D2, fourth and fifth pleonite, pleotelson, and uropods; E, *Armadillidium vulgare*, E1, lateral view of whole animal, E2, frontal view of cephalon, E3, fifth pleonite, pleotelson, and uropods; F, *Venezillo microphthalmus*, F1, lateral view of whole animal, F2, frontal view of cephalon, F3, fifth pleonite, pleotelson, and uropods (F3 after Arcangeli 1932).

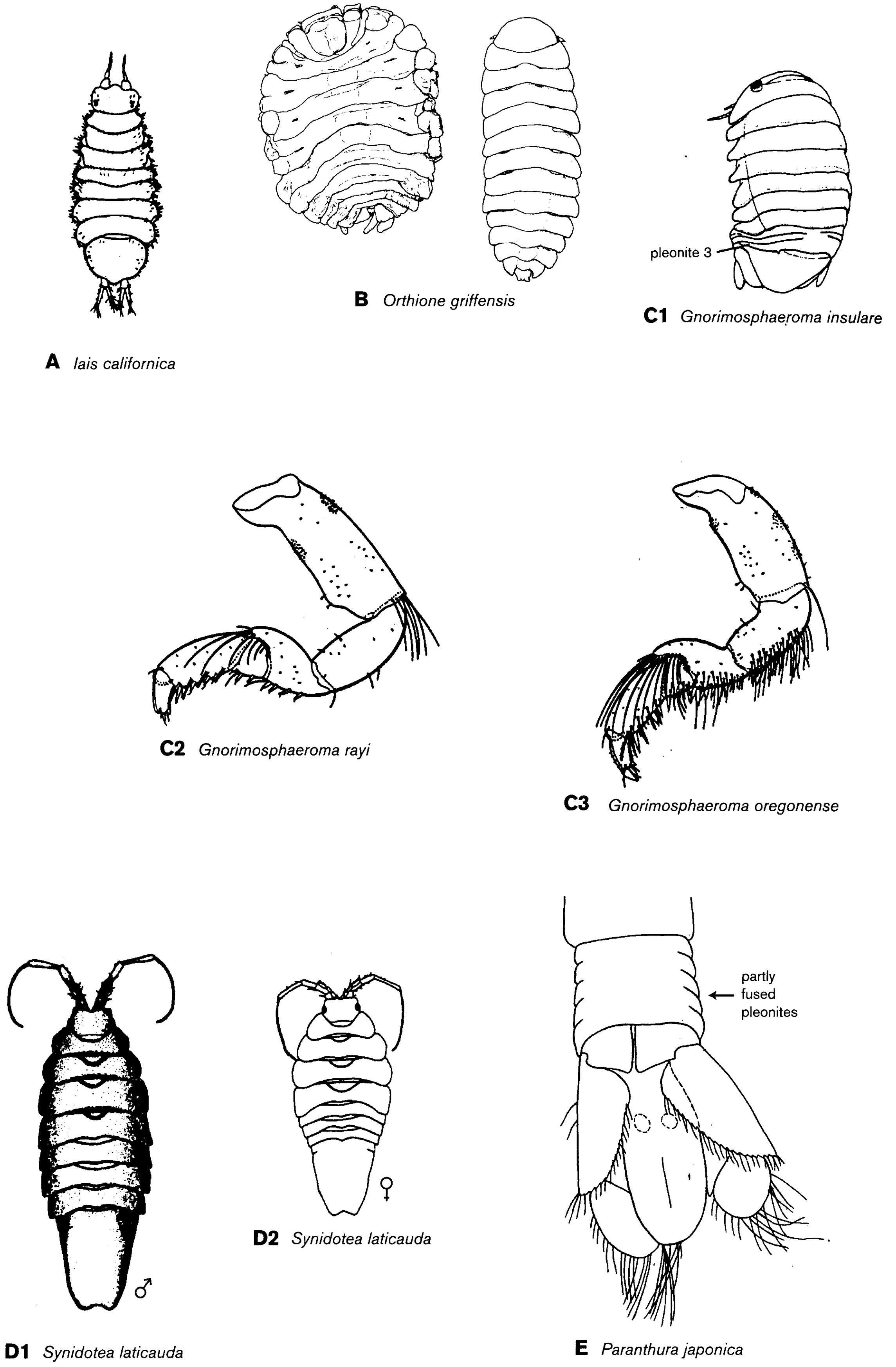

PLATE 252 Isopoda. A, *Iais californica*; B, *Orthione griffensis*; C1, *Gnorimosphaeroma insulare*, C2, *Gnorimosphaeroma rayi*, pereopod 1 (from Japan); C3, *Gnorimosphaeroma oregonense*, pereopod 1 (from American Pacific coast); D1, D2, *Synidotea laticauda*, male and female; E, *Paranthura japonica* (A, after Menzies and Barnard 1951; B, from Markham 2004; C1, after Menzies 1954; C2, C3, from Hoestlandt 1975; D, from Richardson 1909.

JANIRIDAE

See Wilson and Wägele 1994, Invert. Taxon. 8: 683–747 (review of family); Kussakin 1962, Trudy Zool. Inst. Akad. Nauk SSSR 30: 17–65 (in Russian; janirids of the seas of U.S.S.R.).

Caecianiropsis psammophila Menzies and Pettit, 1956. Tomales Bluff at Tomales Point (Marin County) and Asilomar (Monterey County); interstitial, buried in sand. See Menzies and Pettit 1956, Proc. U.S. Nat. Mus. 106 (3376): 441–446 (description).

Caecijaera horvathi Menzies, 1951. Hawaii and southern California; intertidal, living in burrows excavated in wood by the isopod *Limnoria*.

**Iais californica* (Richardson, 1904). Introduced from Australia or New Zealand with its host isopod *Sphaeroma quoianum*; in bays and estuaries. See Menzies and Barnard 1951, Bull. So. Calif. Acad. Sci. 50: 136–151; Rotramel, 1972.

Ianiropsis analoga Menzies, 1952. Marin County and north; intertidal under rocks or in *Laminaria* holdfasts. Hatch (1947) misidentified this species in Washington as the European *J. maculosa*; Carvacho's (1981) distribution for *Janira maculosa* (Washington State) is based on Hatch, and therefore incorrect.

Ianiropsis derjugini (Gurjanova, 1933) (=*Ianiropsis kincaidi derjugini*). Monterey County and north; intertidal under rocks covered by algae. See Miller 1968.

Ianiropsis epilittoralis Menzies, 1952. Marin County to San Luis Obispo County; on green filamentous algae in high intertidal (Iverson 1974).

Ianiropsis kincaidi (Richardson, 1904) (=*Ianiropsis pugettensis* Hatch, 1947). Monterey County and north; intertidal.

Ianiropsis minuta Menzies, 1952. Marin County; intertidal under rocks or sand.

Ianiropsis montereyensis Menzies, 1952. Marin to Monterey Counties; intertidal to shallow subtidal, under rocks or in *Macrocystis* holdfasts.

Ianiropsis tridens Menzies, 1952. San Juan Island to Monterey County; northern Chile; intertidal, on algae and occasionally found in sponges.

Janiralata davisi Menzies, 1951. Carmel Cove, Monterey County, low intertidal under rocks.

Janiralata occidentalis (Walker, 1898). Washington to Orange County; intertidal under rocks.

**Janiralata triangulata* (Richardson, 1899). Monterey Bay; shallow water.

JOEROPSIDIDAE

Joeropsis dubia dubia (Menzies, 1951) formerly *Jaeropsis*. Dillon Beach, Marin County and south; low intertidal to 100 m; on algal holdfasts, bryozoans, tunicates, hydroids, barnacles and under rocks. See Miller 1968.

Joeropsis dubia paucispinis (Menzies, 1951). Marin County; intertidal to 116 m. See Miller 1968.

**Joeropsis lobata* (Richardson, 1899). Monterey Bay; shallow water.

MUNNIDAE

See Kussakin, 1962, Trudy Zool. Inst. Akad. Nauk S.S.S.R. 30: 66–109 (in Russian; munnids of the seas of U.S.S.R.).

Munna chromatocephala Menzies, 1952. Central California and north; intertidal on red algae and among incrusting organisms on rocks.

Munna halei Menzies, 1952. Cape Arago (Oregon) to San Luis Obispo; intertidal under rocks, in *Macrocystis* holdfast, and among spines of the purple sea urchin *Strongylocentrotus purpuratus*. See Harty 1979, Bull. So. Calif. Acad. Sci., 78: 196–199 (occurrence and behavior on urchins at Cape Arago: when trapped under urchin's spines, the isopod remains still until the spines become erect and the isopod can crawl away; when held by the urchin's pedicellaria, the isopod is eventually freed and moves away apparently unharmed).

Munna stephenseni Gurjanova, 1933. Central California and north; intertidal to 18 m.

Uromunna ubiquita (Menzies, 1952) (=*Munna minuta* Hansen in Hatch, 1947). Intertidal to shallow subtidal; reported among colonies of the tube-building worm *Owenia* at La Jolla by Fager (1964, Science 143: 356–359).

PARAMUNNIDAE

**Munnogonium tillerae* (Menzies and Barnard, 1959) (=*Munnogonium waldronensis* George and Strömberg, 1968; =*Munnogonium erratum* [Schultz, 1964]). Central to southern California; 5 m–150 m; see Bowman and Schultz 1974, Proc. Biol. Soc. Wash. 87: 265–272 (redescription); Wilson 1997.

SANTIIDAE

Santia hirsuta (Menzies, 1951) (=*Antias hirsutus*). Tomales Bluff at Tomales Point, Marin County; intertidal in rock and sand between coralline and laminarian algal zones.

EPICARIDEA

BOPYRIDAE

**Aporobopyrus muguensis* Shiino, 1964. Bodega Bay (Milton Miller) and south; 10 m–12 m; in branchial chamber of porcelain crab *Pachycheles rudis*.

**Aporobopyrus oviformis* Shiino, 1934. Seto, Japan and Mugu Pier at Point Mugu; 10 m–12 m; in branchial chamber of porcelain crab *Pachycheles pubescens* in California.

**Argeia pugettensis* Dana, 1853 (=*Argeia pauperata* Stimpson, 1857; =*Argeia calmani* Bonnier, 1900; =*Argeia pingi* Yu, 1935). Branchial parasites on crangonid shrimps, 32 m–188 m. See Jay 1989, Amer. Midl. Nat., 121: 68–77 (parasitism on *Crangon franciscorum*).

**Asymmetrione ambodistorta* Markham, 1985. Southern California, 3 m infesting the hermit crab *Isocheles pilosus*. See Markham 1985, Bull. So. Calif. Acad. Sci. 84: 104–108 (description).

Bopyriscus calmani (Richardson, 1905) (=*Bopyrella macginitiei* Shiino, 1964). Southern and central California, intertidal to 9 m on branchial chamber of the snapping shrimp *Synalpheus lockingtoni* and *Alpheopsis equidactylus*. See Sassaman et al. 1984, Proc. Biol. Soc. Wash. 97: 645–654. (biology, taxonomy).

Ione cornuta Bate, 1864 (=*Ione brevicauda* Bonier, 1900). San Francisco and north; intertidal to shallow water in branchial chamber of ghost shrimps (on *C. longimana* in the eastern Pacific and *N. japonica* in the western Pacific).

**Munidion pleuroncodis* Markham, 1975. Central California and south; known to infest only the pelagic red galatheid *Pleuroncodes planipes*, which occurs in California only during warm

* = Not in key.

years when the host moves north from the tropical eastern Pacific. Offshore storms occasionally move *P. planipes* ashore where they are beached. See Markham 1975, Bull. Mar. Sci. 25: 422–441 (systematics); Wetzer and Brusca 1997.

**Orthione griffensis* Markham, 2004. Abundant on the mud shrimp *Upogebia pugettensis* in Oregon. See Markham 2004, Proc. Biol. Soc. Wash. 117: 186–198 (description).

Phyllodurus abdominalis Stimpson, 1857. Intertidal among pleopods of mud shrimp *Upogebia pugettensis* (female is posterior to first pair of large pleopods, small male roves; A. Kuris, observations). See Markham 1977, Proc. Biol. Soc. Wash. 90: 813–818 (systematics).

Schizobopyrina striata (Nierstrasz and Brender à Brandis, 1929). Shallow water on shrimps *Hippolyte californiensis* (in San Diego Bay) and on *Thor algicola* (in Gulf of California).

ENTONISCIDAE

Portunion conformis Muscatine, 1956. San Francisco to Marin County; intertidal. An endoparasitic castrator in the crabs *Hemigrapsus oregonensis* and *H. nudus*. See Muscatine 1956, J. Wash. Acad. Sci. 46: 122–126; Piltz, 1969, Bull. So. Calif. Acad. Sci. 68: 257–259; Kuris et al. 1980, Parasitology 80: 211–232 (host defensive mechanisms sometimes kill female *Portunion*); Shields and Kuris 1985, J. Invert. Path. 45: 122–124 (ectopic infections of host).

CABIROPIDAE (FORMERLY AS CABIROPSIDAE)

**Cabirops montereyensis* Sassaman, 1985. Monterey Bay. Shallow water on marsupium of the isopod *Aporobopyrus muguensis* (which in turn lives in the branchial cavity of the porcelain crab *Pachycheles*). See Sassaman 1988, Proc. Biol. Soc. Wash. 98: 778–789; 1992, Proc. Biol. Soc. Wash. 105: 575–584 (description of mature female and epicaridium larva).

*Undescribed cabiropid. An undescribed species occurs in the isopod *Tecticeps convexus* at Horseshoe Cove at Bodega Head (A. Kuris, unpublished observations).

HEMIONISCIDAE

Hemioniscus balani Buchholz, 1866. European species apparently introduced throughout the world; in eastern Pacific from Alaska (Coyle and Mueller 1981, Sarsia 66: 7–18) to Baja California. Parasitic in intertidal barnacles (see Blower and Roughgarden 1988, Oecologia 75: 512–515). This species has also been assigned to *Cryptothir*, *Cryptothiria*, and *Cryptoniscus*.

FLABELLIFERA

AEGIDAE

**Aega (Aega) lecontii* (Dana, 1854). Central and southern California. Offshore; taken from fish or from soft bottoms. See Brusca 1983, Allan Hancock Fdn. Monogr. Mar. Biol. no. 12, 39 pp. (systematics).

Rocinela signata Schiödte and Meinert, 1879 (=*Rocinela aries* Schiödte and Meinert, 1879).

Los Angeles to Ecuador; also in tropical western Atlantic; intertidal to 68 m; common, taken from fish or from soft bottoms. See Brusca and France, 1982, Zool. J. Linn. Soc. 106: 231–275 (systematics).

CIROLANIDAE

See Brusca and Ninos 1978, Proc. Biol. Soc. Wash. 91: 379–385; key to California species; Bruce and Jones 1981; Brusca et al. 1995.

Cirolana diminuta Menzies, 1962. Point Conception and south; intertidal to 50 m; easily confused with the tropical *C. parva*. *C. harfordi* var. *spongicola* Stafford, 1912, is probably this species. *C. diminuta* attack nearshore fishes in southern California, perhaps attacking fish initially injured by carnivorous ostracodes (Stepien and Brusca 1985, Mar. Ecol. Prog. Ser. 25: 91–105.

Cirolana harfordi (Lockington, 1877). Abundant in mussel beds on rocky shores, where they may occur in densities of thousands per square meter; intertidal to shallow subtidal. See Brusca 1966 (salinity and humidity tolerance); Johnson 1976, Mar. Biol. 36: 343–350 (biology, population dynamics); 1976, Mar. Biol. 36: 351–357 (population energetics). Abbott (1987) presents extensive sketches of external and internal anatomy based upon material from Pacific Grove (Monterey Bay).

Eurydice caudata Richardson, 1899 (=*E. branchuropus* Menzies and Barnard, 1959). San Diego and south; intertidal to 160 m.

Eurylana arcuata (Hale, 1925) (=*Cirolana arcuata*). Introduced to San Francisco Bay; occurs in New Zealand, Australia, and west coast of South America; intertidal to shallow subtidal. See Bowman et al. 1981, J. Crustacean Biol. 1: 545–557 (introduction).

Excirolana chiltoni (Richardson, 1905) (=*E. kincaidi* [Hatch, 1947]; =*E. vancouverensis* [Fee, 1926]; =*E. japonica* Richardson, 1912). Intertidal on sandy beaches. See Enright 1965, Science 147: 864–867; 1971, J. Comp. Physiol. 75: 332–346; 1972, J. Comp. Physiol. 77: 141–162; 1976, J. Comp. Physiol. 107: 13–37 (all, tidal rhythms); Klapow 1972, Biol. Bull. 143: 568–591 (molting and reproductive cycles); Iverson 1974.

Excirolana linguifrons (Richardson, 1899). Monterey Bay to southern California; intertidal on sandy beaches. See Connors et al. 1981, Auk 98: 49–64 (preyed upon by sanderlings, Bodega Bay area).

CORALLANIDAE

See Bruce et al. 1982.

Excorallana tricornis occidentalis Richardson, 1905. Southern California to Panama; intertidal to 138 m on rocks, sandy beaches, and in mangrove habitats. See Delaney 1993, Bull. So. Calif. Acad. Sci. 92: 64–69 (cuticle).

Excorallana truncata (Richardson, 1899) (=*E. kathyae* Menzies, 1962). Point Conception and south; intertidal to 183 m. See Delaney 1982, J. Crust. Biol. 2: 273–280; 1984, Bull. Mar. Sci. 34: 1–20 (systematics).

CYMOTHOIDAE

See Brusca 1981; Brusca and Gilligan 1983; Bruce 1986, 1990.

Ceratothoa gaudichaudii (H. Milne Edwards, 1840). Southern California (rare) to Cape Horn and around to southern Patagonia. Found on many species of pelagic fishes.

Elthusa californica (Schioedte and Meinert, 1884) (=*Livoneca californica*; misspelled as *Lironeca*). On dwarf surfperch (*Micrometrus minimus*), shiner surfperch (*Cymatogaster aggregata*),

* = Not in key.

surf smelt (*Hypomesus preitiosus*), topsmelt (*Atherinops affinis*), arrow goby (*Clevelandia ios*), and California killifish (*Fundulus parvipinnis*). See Waugh et al. 1989, Bull. So. Calif. Acad. Sci. 88: 33–39 (incidence of infestation on fish in Bodega Harbor).

Elthusa vulgaris (Stimpson, 1857) (=*Livoneca vulgaris*). In gill chambers of a wide variety of fishes. See Brusca, 1978, Occ. Paps. Allan Hancock Fdn. n. ser. 2: 1–19 (biology and systematics).

Enispa convexa (Richardson, 1905) (=*Livoneca convexa*). San Diego and south, but rare in California; a tropical species. Found in gill chambers of Pacific bumper (*Chloroscombrus orqueta*), pompanos (*Trachinotus rhodopus* or *T. paitensis*), and *Serranus* sp.

Mothocya rosea Bruce, 1986. San Diego and south; found in *Hyporhampus rosea* and *H. snyderi*.

Nerocila acuminata Schioedte and Meinert, 1881 (=*Nerocila californica* Schioedte and Meinert, 1881). Southern California and south; parasite of many fish species. See Brusca 1978, Crustaceana 34: 141–154 (biology).

LIMNORIIDAE

See Cookson 1991, Mem. Mus. Victoria 52: 137–262 (systematics, including treatments of *L. lignorum, L. tripunctata,* and *L. quadripunctata*); Menzies 1954, Bull. Mus. Comp. Zool. Harvard 112: 364–388 (reproduction); Menzies 1957, Bull. Mar. Sci. Gulf and Caribbean 7: 101–200 (systematics).

Limnoria algarum Menzies, 1957. Oregon to southern California, intertidal to 15 m. In holdfasts of *Macrocystis, Egregia, Laminaria, Postelsia, Nereocystis, Sargassum* and *Pelagophycus*.

Limnoria lignorum (Rathke, 1799). Temperate and boreal northern hemisphere distribution; south to Point Arena on the Pacific coast; intertidal to 20 m.; wood borer. See Cookson 1991, above.

Limnoria quadripunctata Holthuis, 1949. Widespread cool temperate distribution; central to southern California; intertidal to 30 m; wood borer. See Cookson 1991, above.

Limnoria tripunctata Menzies, 1951. Temperate and tropical locations around the world; on our coast from at least Oregon south; intertidal to 7 m; wood borer. See Menzies 1951, Bull. So. Calif. Acad. Sci. 50: 86–88; Cookson 1991 (above); Johnson and Menzies 1956, Biol. Bull. 110: 54–68 (migratory behavior); Beckman and Menzies 1960 Bio. Bull. 118: 9–16 (reproductive temperature and geographic range).

SEROLIDAE

Heteroserolis carinata (Lockington, 1877) (=*Serolis carinata*). Southern California and south; intertidal to 98 m. on soft bottoms. See Wetzer and Brusca 1997.

SPHAEROMATIDAE

See Harrison and Ellis 1991; Bruce 1993.

Ancinus granulatus Holmes and Gay, 1909 (=*A. seticomvus* Trask, 1970). Santa Barbara and south; intertidal to 10 m. *Ancinus* and *Bathycopea* are placed in the family Ancinidae by Bruce (1993) and some other workers. See Trask 1970, Bull. So. Calif. Acad. Sci. 69: 145–149.

**Clianella elegans* Boone, 1923. *Nomen dubium*. La Jolla and San Pedro.

Dynamene tuberculosa Richardson, 1899. Shallow water.

Dynamenella benedicti (Richardson, 1899). Monterey Bay; intertidal.

**Dynamenella conica* Boone, 1923. *Species inquirenda*. San Francisco to Monterey Bay; intertidal.

Dynamenella dilatata (Richardson, 1899). Monterey Bay; intertidal.

Dynamenella glabra (Richardson, 1899). Oregon to San Diego; intertidal.

Dynamenella sheareri (Hatch, 1947). Intertidal to shallow subtidal.

Exosphaeroma amplicauda (Stimpson, 1857). Interfidal under rocks and stones; see Rees 1975, Mar. Biol. 30: 21–25 (habitat; competition with *Gnorimosphaeroma oregonense*).

**Exosphaeroma aphrodita* Boone, 1923. *Nomen dubium*. La Jolla.

Exosphaeroma inornata Dow, 1958 (=*E. media* George and Strömberg, 1968). Northern California to Los Angeles; intertidal and shallow subtidal in holdfasts of kelp *Macrocystis*. See Dow 1958, Bull. So. Calif. Acad. Sci. 57: 93–97; Iverson 1974; Iverson 1978, J. Fish. Res. Bd. Can. 35: 1381–1384.

Exosphaeroma octoncum (Richardson, 1897). Monterey to Marin County; shallow water. See Iverson 1974.

Exosphaeroma rhomburum (Richardson, 1899). Monterey Bay; shallow water.

**Gnorimosphaeroma insulare* (Van Name, 1940) (=*G. oregonensis lutea* Menzies, 1954; =*G . lutea* Menzies, 1954). Fresh and brackish water, in shallow estuaries and lagoons, including Lake Merced on the San Francisco Peninsula. See Menzies 1954 (below); Eriksen 1968 Crustaceana 14: 1–12 (ecology); Riegel 1959, Biol. Bull. 116: 272–284 (osmoregulation) and 1959, Biol. Bull. 117: 154–162 (physiology, ecology, taxonomy); Hoestlandt 1973, Arch. Zool. Exper. Gen. 114: 349– 395, and 1977, Crustaceana 32: 35–54 (taxonomy); Iverson 1974.

Gnorimosphaeroma noblei Menzies 1954. Central California; high intertidal under rocks. See Menzies 1954, Amer. Mus. Novitates 1683, 24 pp. (review of *Gnorimosphaeroma* species); Iverson 1974.

Gnorimosphaeroma oregonense (Dana, 1853). Formerly spelled *G. oregonensis*. San Francisco Bay and north; intertidal to 24 m; brackish to salt water. See Menzies 1954 (above); Riegel 1959 Biol. Bull. 116: 272–284 (osmoregulation), and 1959, Biol. Bull. 117: 154–162 (physiology, ecology, taxonomy); Eriksen 1968, Crustaceana 14: 1–12 (ecology); Hoestlandt 1970, C.R. Acad. Sci. Hebd. Seances Acad. Sci. (D) 270: 2124–2125 (polychromatism); Rees 1975, Mar. Biol. 30: 21–25 (habitat; competition with *Exosphaeroma amplicauda*); Standing and Beatty 1978, Can. J. Zool. 56: 2004–2014 (humidity behavior and reception); Brook et al. 1994, Biol. Bull. 187: 99–111 (protogynous sex change); Zimmer et al. 2002 Mar. Biol. 140: 1207–1213 (cellulose digestion and phenol oxidation).

**Gnorimosphaeroma rayi* Hoestlandt, 1969. Japan, eastern Siberia, Hawaii, and Tomales Bay; shallow water; introduced with Japanese oysters planted in Tomales Bay. See Hoestlandt 1969, C.R. Acad. Sci. Paris 268: 325–327; Hoestlandt 1973 (cited above); Hoestlandt 1975, Publ. Seto Mar. Biol. Lab. 22: 31–46 (occurrence on Pacific coast).

Paracerceis cordata (Richardson, 1899). Intertidal to shallow subtidal, on pink coralline algae and kelp holdfasts (Lee and Miller 1980).

Paracerceis sculpta (Holmes, 1904). Southern California and south. Widely introduced around the world by shipping. Intertidal to shallow subtidal. Males with harems occurring in calcareous sponges. See Miller 1968; Shuster and Wade 1991, Nature 350: 606–610; Shuster 1989, Evolution 43: 1683–1698; Shuster 1992, Behavior 121: 231–258; Shuster and Sassaman

* = Not in key.

1997, Nature 388: 373–377 (all reproduction, genetics, in forms of this species); Shuster 1987, J. Crust. Biol. 7: 318–327 (three discrete male morphs); Shuster 1992, J. Exp. Mar. Biol. Ecol. 165: 75–89 (use of artificial sponges as breeding habit).

Paradella dianae (Menzies, 1962). Southern California to Bahía de San Quintín; intertidal to shallow subtidal. See Iverson 1974.

**Pseudosphaeroma campbellenis* Chilton, 1909. An introduced New Zealand species common in fouling communities in brackish water of Coos Bay (Oregon), San Francisco Bay, and other estuaries.

Sphaeroma quoianum H. Milne Edwards, 1840 (commonly spelled as *S. quoyanum,* an unnecessary correction of the original spelling; =*S. pentodon* Richardson, 1904). Intertidal to shallow subtidal in wood, mud and soft rock borer. Introduced to western North America in the late 1800s on ships from Australia (see Rotramel 1972; Carlton 1979; Carlton and Iverson 1981). See also Talley et al. 2001, Mar. Biol. 138: 561–573 (habitat utilization and alteration in California salt marshes).

Sphaeroma walkeri Stebbing, 1905. A western Pacific and Indian Ocean species introduced to southern California. See Carlton and Iverson 1981, J. Nat. Hist. 15: 31–48 (introduction to California).

**Tecticeps convexus* Richardson, 1899. Oregon to Point Conception. Intertidal to 9 m; common at times on the sandy beaches in the intertidal surf zone, as in Sonoma County, where they match in color the sediment of the beach they are on. *T. convexus* has an additional broad range of defensive mechanisms, including the ability to fold in half while protruding its sharp uropods, and, when disturbed, to emit a cucumberlike smell, all suggestive of predation pressure (J. T. Carlton). Placed in the family Tecticipididae by Iverson (1982), Bruce (1993), and other workers. See Iverson 1974.

GNATHIIDEA

GNATHIIDAE

See Cohen and Poore 1994.

Gnathia steveni Menzies, 1962. Redondo Beach to northwestern Baja California; intertidal.

MICROCERBERIDEA

MICROCERBERIDAE

Coxicerberus abbotti (Lang, 1960) (=*Microcerberus abbotti*), central California. Interstitial; intertidal. See Lang 1960, Arkiv for Zool. 13: 493–510 (description). Abbott (1987) presents a sketch of a specimen from the sandy beach in front of the Agassiz Laboratory at the Hopkins Marine Station in Pacific Grove.

VALVIFERA

ARCTURIDAE

Idarcturus hedgpethi Menzies, 1951. Tomales Bluff at Tomales Point, Marin County; collected by Joel Hedgpeth in low intertidal on hydroids.

* = Not in key.

CHAETILIIDAE

Mesidotea entomon (Linnaeus, 1767) (=*Saduria entomon*). Circumpolar, on our coast south to Pacific Grove. Intertidal in the northern part of its range, to 30 m in the south.

HOLOGNATHIDAE

See Poore 1990.

Cleantioides occidentalis (Richardson, 1899). Southern California and south; intertidal to 50 m. See Kensley and Kaufman 1978, Proc. Biol. Soc. Wash. 91: 658–665 (genus description); Brusca and Wallerstein 1979.

IDOTEIDAE

See Menzies 1950, Wasmann J. Biol. 8: 155–195 (*Idotea* of northern California); Brusca and Wallerstein 1977; Brusca and Wallerstein 1979, Proc. Biol. Soc. Wash. 92: 253–271 (both, idoteids of the Gulf of California); Brusca and Wallerstein 1979, Bull. Biol. Soc. Wash. 3: 67–105 (idoteid zoogeography); Wallerstein and Brusca 1982, J. Biogeogr. 9: 135–190 (fish predation and role in zoogeography and evolution); Brusca 1984, Trans. San Diego Soc. Nat. Hist. 20: 99–134 (phylogeny, evolution, biogeography of idoteids); Rafi and Laubitz 1970 Can. J. Zool. 68: 2649–2687 (idoteids of northeast Pacific); Poore and Lew Ton 1993, Invert. Taxon. 7: 197–278 (idoteids of Australia and New Zealand)).

Colidotea findleyi Brusca and Wallerstein, 1977. San Diego and south; intertidal to at least 1 m; common on the brown algae *Sargassum.* See Brusca and Wallerstein 1977; Brusca 1983, Trans. San Diego Soc. Nat. Hist. 20: 69–79 (evolution).

Colidotea rostrata (Benedict, 1898). Northern California (rare) and south; commensal of sea urchin *Strongylocentrotus.* See Brusca 1983 (above); Stebbins 1988 J. Crust. Biol. 8: 539–547 (natural history, behavior); 1988, J. Exp. Mar. Biol. Ecol. 124: 97–113 (urchins as refuge from fish predation); 1989, Mar. Biol. 101: 329–337 (population dynamics and reproductive biology in southern California); Delaney 1993, Bull. So. Calif. Acad. Sci. 92: 64–69 (cuticle).

Erichsonella crenulata Menzies, 1950. Southern California (Newport Bay); intertidal to shallow subtidal; on eelgrass *Zostera.*

Erichsonella pseudoculata Boone, 1923 (=*Ronalea pseudoculata*). Point Conception to the Mexican border. Intertidal to 18 m. See Menzies and Bowman 1956, Proc. U.S. Natl. Mus. 106: 339–343 (redescription).

Idotea aculeata (Stafford, 1913) (=*Pentidotea aculeata*). Intertidal on various habitats, including pink-colored individuals matching *Melobesia* encrusting on the surfgrass *Phyllospadix* (D. Carlton, Horseshoe Cove, Bodega Head).

Idotea fewkesi Richardson, 1905. Shallow water.

Idotea kirchanskii Miller and Lee, 1970. Oregon and south; bright green on the green surfgrass *Phyllospadix* and like *I. aculeata* also occasionally matching the pink epiphytic alga *Melobesia.* See Miller and Lee 1970, Proc. Biol. Soc. Wash. 82: 789–798 (description).

Idotea metallica Bosc, 1802. A rare tropical species occasionally occurring in southern California and Gulf of California during warm years; pelagic, attached to floating seaweed. Cosmotropical.

Idotea montereyensis (Maloney, 1933) (=*Pentidotea montereyensis*; =*Idotea gracillima* (Dana) of Richardson, 1905, and Schultz, 1969). Common on surfgrass *Phyllospadix.* See Lee 1966, Comp.

Biochem. Physiol. 18: 17–36; 1966, Ecology 47: 930–941; 1972, J. Exp. Mar. Biol. Ecol. 8: 201–215 (all, pigmentation, color change, ecology); Iverson 1974; Lee and Miller 1980.

Idotea ochotensis Brandt, 1851. Northern California and north; intertidal to 36 m.

Idotea resecata Stimpson, 1857. Intertidal; frequently found living in kelp (e.g., *Macrocystis, Egregia*) and eelgrass (*Zostera*). Consumes seeds of the surfgrass *Phyllospadix* (Holbrook et al. 2000, Mar. Biol. 136: 739–747); see also Menzies and Waidzunas 1948, Bio. Bull. 95: 107–113 (postembryonic growth); Miller 1968; Lee and Gilchrist 1972, J. Exp. Mar. Biol. Ecol. 10: 1–27 (coloration and ecology); Iverson 1974; Brusca and Wallerstein 1977 (description, range); Lee and Miller 1980; Alexander 1988, J. Exp. Biol. 138: 37–49; and Alexander and Chen 1990, J. Crustacean Biol. 10: 406–412 (both, swimming behavior); preyed upon in southern California kelp beds by the labrid fish *Oxyjulis californica;* when released from regulation by this fish, *I. resecata* "multiplies rapidly and destroys the kelp canopy" (Bernstein and Jung 1979, Eco. Mono. 49: 335–355). Abbott (1987) presents sketches of internal and external anatomy based upon material from *Macrocystis* kelp beds in Monterey Bay.

Idotea rufescens Fee, 1926. Intertidal to 82 m, on algae. Possibly a synonym of *I. resecata*. See Iverson 1974; Wetzer and Brusca 1997.

Idotea schmitti (Menzies, 1950). (=*Pentidotea schmitti; =Pentidotea whitei* Stimpson of Richardson, 1905). Intertidal to shallow subtidal. See Iverson 1974.

Idotea stenops Benedict, 1898. Intertidal to shallow subtidal. See Miller 1968; Iverson 1974; see Brusca and Wallerstein 1977 (description, range). Abbott (1987) presents sketches of internal and external anatomy based upon material from Point Pinos (Monterey Bay).

Idotea urotoma Stimpson, 1864 (=*Cleantis heathii* Richardson, 1899; =*Idotea rectilinea* Lockington, 1877). Intertidal to shallow subtidal; see Brusca and Wallerstein 1977 (description, range).

Idotea wosnesenskii Brandt, 1851 (=*Idotea hirtipes* Dana, 1853; =*Idotea oregonensis* Dana, 1853). San Francisco and north; one anomalous record from La Paz (Baja California). Intertidal to shallow subtidal. Named for the famous Russian naturalist Ilya G. Voznesenskii. See Brusca 1966 (salinity and humidity tolerance); Miller 1968; Brusca and Wallerstein 1977 (description, range); Alexander 1988, J. Exp. Biol. 138: 37–49; Alexander and Chen 1990, J. Crustacean Biol. 10: 406–412 (both, swimming behavior); Zimmer et al. 2002, Mar. Biol. 140: 1207–1213 (cellulose digestion; cannot oxidize dietary phenolics, despite feeding on seaweeds rich in phenols).

Synidotea berolzheimeri Menzies and Miller, 1972. Central California (San Luis Obispo to Sonoma Counties); intertidal, on hydroid *Aglaophenia*. See Menzies and Miller 1972, Smithsonian Contr. Zool. 102, 33 pp. for review of the genus *Synidotea*.

Synidotea consolidata (Stimpson, 1856) (=*Synidotea macginitiei* Maloney, 1933). Central California and north; intertidal to 20 m. This species has been confused in the literature with the very similar circumarctic *Synidotea bicuspida* (Owen 1839).

Synidotea harfordi Benedict, 1897. Oregon and south; introduced to Japan. Intertidal to shallow subtidal. See Brusca and Wallerstein (1979).

**Synidotea laticauda* Benedict, 1897. Abundant in fouling communities on floats and buoys in San Francisco Bay and also in Willapa Bay, Washington. Poore (1996, J. Crust. Biol. 16: 384–394) retained the name *S. laticauda,* while Chapman and Carlton (1991, J. Crust. Biol. 11: 386–400; 1994, J. Crust. Biol. 14: 700–714) indicate that this species is introduced and a synonym of the Japanese *Synidotea laevidorsalis* (Miers, 1881). See also Miller 1968.

Synidotea pettiboneae Hatch, 1947. Central California and north; intertidal on hydroids and bryozoans.

Synidotea ritteri Richardson, 1904. Alaska (Coyle and Mueller 1981, Sarsia 66: 7–18) to north of San Francisco; intertidal.

* = Not in key.

ONISCIDEA

See Miller (1938) and Brusca (1966) for aspects of biology and ecology of maritime isopods of the San Francisco Bay and Dillon Beach areas, respectively.

ARMADILLIDAE

Venezillo microphthalmus (Arcangeli, 1932). Southern and central California.

ARMADILLIDIIDAE

Armadillidium vulgare (Latreille, 1804). Cosmopolitan species of Mediterranean origin.

LIGIIDAE

Ligia occidentalis Dana, 1853. Oregon and south on rocky shores. See Armitage 1960, Crustaceana 1: 193–207 (chromatophores); Wilson 1970, Bio. Bull. 138: 96–108 (osmoregulation); Lee and Miller 1980.

Ligia pallasii Brandt, 1833. Santa Cruz and north; rocky shores on open coast. Principal food is encrusting diatoms, insect larvae, algae, and "occasional members of the same species" (Carefoot 1973, Mar. Biol. 18: 228–236). See also Wilson 1970, Bio. Bull. 138: 96–108 (osmoregulation); Carefoot 1973, Mar. Biol. 18: 302–311 (growth, reproduction, life cycle), and 1979, Crustaceana 36: 209–214 (habitat of young); Lee and Miller 1980; Zimmer et al. 2001, Mar. Biol. 138: 955–963 (possesses high numbers of microbial symbionts in hepatopancreatic caeca, which contribute to digestive processes); Zimmer et al. 2002, Mar. Biol. 140: 1207–1213 (cellulose digestion and phenol oxidation).

Ligidium gracile (Dana, 1856). Riparian.

Ligidium latum Jackson, 1923. San Francisco Bay area to Santa Barbara County; riparian.

PHILOSCIIDAE

Littorophiloscia richardsonae (Holmes and Gay, 1909). Littoral species common in marshes, along bays and estuaries. See Taiti and Ferrara 1986, J. Nat. Hist. 20: 1347–1380 (systematics).

PLATYARTHRIDAE

Niambia capensis (Dollfus, 1895) (=*Porcellio littorina* Miller, 1936). Introduced from southern Africa; supralittoral and riparian. See Miller 1936. Univ. Calif. Publ. Zool. 41: 165–172 (descriptions).

Platyarthrus aiasensis Legrand, 1953. Introduced; western Mediterranean/Atlantic; known in the United States from southern California and Texas. A myrmecophile (sharing the nests of ants).

PORCELLIONIDAE

Porcellio dilatatus Brandt, 1833 (=*Porcellio spinicornis occidentalis* Miller, 1936). Introduced from Europe. See Miller 1936, Univ. Calif. Publ. Zool. 41: 165–172 (descriptions).

Porcellio laevis Latreille, 1804. A cosmopolitan introduced species of Mediterranean origin. Synanthropic. See Miller 1936, Univ. Calif. Publ. Zool. 41: 165–172 (description).

Porcellio scaber Latreille, 1804 (=*Porcellio scaber americanus* Arcangeli, 1932). A cosmopolitan species of European origin. See Miller 1936, Univ. Calif. Publ. Zool. 41: 165–172 (descriptions).

Porcellionides floria Garthwaite and Sassaman, 1985. Southern and western United States and Baja California; very similar to the cosmopolitan synanthropic *Porcellionides pruinosus* (Brandt, 1833), which is present in the United States but does not seem to occur on the Pacific coast (Garthwaite and Sassaman 1985, J. Crust. Biol. 5: 539–555).

ALLONISCIDAE

See Menzies 1950, Proc. Calif. Acad. Sci. (4), 26: 467–481, on California *Armadilloniscus*; Schultz 1972, Proc. Biol. Soc. Wash. 84: 477–488 (systematics); Garthwaite et al. 1992.

Alloniscus mirabilis (Stuxberg, 1875) (=*Alloniscus cornutus* Budde-Lund, 1885). San Mateo County to Magdalena Bay; littoral halophilic species common on sandy beaches above high-tide line, where it borrows in sand under driftwood. See Schultz 1984, Crustaceana 47; 149–167 (systematics).

Alloniscus perconvexus Dana, 1856. A littoral halophilic species common on sandy beaches above high-tide line, where it borrows in sand under driftwood. See Lee and Miller 1980; Schultz 1984 (above).

DETONIDAE

Armadilloniscus coronacapitalis Menzies, 1950. Marin County to San Miguel and Anacapa Islands. A littoral halophilic species.

Armadilloniscus holmesi Arcangeli, 1933 (=*Actoniscus tuberculatus* Holmes and Gay, 1909, a preoccupied name). A littoral halophilic species found in marshes, bays, and estuaries under rocks and driftwood.

Armadilloniscus lindahli (Richardson, 1905). Marin County (Tomales Bay) and south; a littoral halophilic species. Schultz (1972, Proc. Biol. Soc. Wash. 84: 477–488) notes that this species is unique among West Coast *Armadilloniscus* in being capable of rolling into a ball like a pillbug.

Detonella papillicornis (Richardson, 1904). San Francisco Bay and north; a littoral halophilic species common under rocks above high tide line. See Garthwaite 1988, Bull. So. Calif. Acad. Sci. 87: 46–47 (occurrence in Bolinas Lagoon, California).

TRICHONISCIDAE

Brackenridgia heroldi (Arcangeli, 1932). Central and southern California.

Haplophthalmus danicus Budde-Lund, 1885. Cosmopolitan.

TYLIDAE

Tylos punctatus Holmes and Gay, 1909. Southern California and south; a littoral halophilic species restricted to sandy beaches where it burrows above the most recent high-tide line during the day and is active on surface at night (Hays 1977, Pac. Sci. 31: 165–186). See also Hamner et al. 1968, Anim. Behav. 16: 405–409 (orientation), and 1969, Ecology 50: 442–453 (behavior, life history); Schultz 1970, Crustaceana 19: 297–305 (systematics); Hayes 1974, Ecology 55: 838–847, and 1977, Pac. Sci. 31: 165–186 (ecology); Holanov and Hendrickson 1980, J. Exp. Mar. Biol. Ecol. 46: 81–88 (burrowing).

References

Abbott, D. P. 1987. Observing marine invertebrates. Drawings from the laboratory. G. H. Hilgard, ed. Stanford, CA: Stanford University Press, 380 pp.

Arcangeli, A. 1932. Isopodi terrestri raccolti dal Prof. Silvestri nel Nord-America. Boll. Lab. Zool. gen. agr. Portici 26: 121–141.

Bruce, N. L. 1986. Revision of the isopod crustacean genus *Mothocya* Costa, in Hope, 1851 (Cymothoidae: Flabellifera), parasitic on marine fishes. J. Nat. Hist. 20: 1089–1192.

Bruce, N. L. 1990. The genera *Catoessa*, *Elthusa*, *Enispa*, *Ichthyoxenus*, *Idusa*, *Livoneca* and *Norileca* n. gen. (Isopoda, Cymothoidae), crustacean parasites of marine fishes, with descriptions of eastern Australian species. Rec. Australian Mus. 42: 247–300.

Bruce, N. L. 1993. Two new genera of marine isopod crustaceans (Flabellifera: Sphaeromatidae) from southern Australia, with a reappraisal of the Sphaeromatidae. Invertebrate Taxon. 7: 151–171.

Bruce, N. L., and D. A. Jones. 1981. The systematics and ecology of some cirolanid isopods from southern Japan. J. Nat. Hist. 15: 67–85.

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

Brusca, G. J. 1966. Studies on the salinity and humidity tolerance of five species of isopods in a transition from marine to terrestrial life. Bull. So. Calif. Acad. Sci. 65: 146–154.

Brusca, R. C. 1980. Common intertidal invertebrates of the Gulf of California. 2nd ed. Tucson, AZ: Univ. Arizona Press.

Brusca, R. C. 1981. A monograph on the Isopoda Cymothoidae (Crustacea) of the Eastern Pacific. Zool. J. Linn. Soc. 73: 117–199.

Brusca, R. C. 1989. Provisional keys to the genera *Cirolana*, *Gnathia*, and *Limnoria* known from California waters. SCAMIT [Southern California Association of Marine Invertebrate Taxonomists] Newsletter 8: 17–21.

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

Brusca, R. C., and E. W. Iverson. 1985. A guide to the marine isopod Crustacea of Pacific Costa Rica. Rev. Biol. Trop. 33 (Suppl. 1): 1–77.

Brusca, R. C., E. Kimrey, and W. Moore. 2004. Invertebrates [of the Northern Gulf of California]. Pp. 35–107. In Seashore guide to the northern Gulf of California. R. C. Brusca, E. Kimrey, and W. Moore, eds. Tuscon, AZ: Arizona-Sonora Desert Museum.

Brusca, R. C., and M. Ninós. 1978. The status of *Cirolana californiensis* Schultz and *Cirolana deminuta* Menzies and George, with a key to the California species of *Cirolana* (Isopoda: Cirolanidae). Proc. Biol. Soc. Wash. 91: 379–385.

Brusca, R. C., and B. R. Wallerstein. 1977. The marine isopod Crustacea of the Gulf of California. I. Family Idoteidae. Amer. Mus. Novitates 2634: 1–17.

Brusca, R. C., and B. R. Wallerstein. 1979. The marine isopod crustaceans of the Gulf of California. II. Idoteidae. New genus, new species, new records, and comments on the morphology, taxonomy and evolution within the family. Proc. Biol. Soc. Wash. 92: 253–271.

Brusca, R. C., and G. D. F. Wilson. 1991. A phylogenetic analysis of the Isopoda with some classificatory recommendations. Mem. Queensland Mus. 31: 143–204.

Brusca, R. C., R. Wetzer, and S. France. 1995. Cirolanidae (Crustacea; Isopoda; Flabellifera) of the tropical eastern Pacific. Proc. San Diego Nat. Hist. Soc., No. 30, 96 pp.

Cadien, D., and R. C. Brusca. 1993. Anthuridean isopods (Crustacea) of California and the temperate northeast Pacific. SCAMIT [Southern

California Association of Marine Invertebrate Taxonomists] Newsletter 12: 1–26.

Carlton, J. T. 1979. Introduced invertebrates of San Francisco Bay. Pp. 427–444. In San Francisco Bay: the urbanized estuary. T. J. Conomos, ed. San Francisco: California Academy of Sciences.

Carvacho, A. 1981. Le genre *Janira* Leach, avec description d'une nouvelle espèce (Isopoda, Asellota). Crustaceana 41: 131–142.

Cohen, B. J., and G. C. B. Poore. 1994. Phylogeny and biogeography of the Gnathiidae (Crustacea: Isopoda) with description of new genera and species, most from southeastern Australia. Mem. Mus. Victoria 54: 271–397.

Garthwaite, R. 1992. Oniscidea (Isopoda) of the San Francisco Bay Area. Proc. Calif. Acad. Sci. 47: 303–328.

Garthwaite, R., F. G. Hochberg, and C. Sassaman. 1985. The occurrence and distribution of terrestrial isopods (Oniscoidea) on Santa Cruz Island with preliminary data for the other California islands. Bull. So. Calif. Acad. Sci. 84: 23–37.

Garthwaite, R., R. Lawson, and S. Taiti. 1992. Morphological and genetic relationships among four species of *Armadilloniscus* Uljanin, 1875 (Isopoda: Oniscidea: Scyphacidae). J. Nat. Hist. 26: 327–338.

Giard, A. 1887. Fragments biologiques. VII. Sur les Danalia, genre de Cryptonisciens parasites des Sacculines. Bull. Biol. Fr. Belgique (2) 18: 47–53.

Giard, A., and J. Bonnier. 1887. Contributions a l'etude des bopyriens. Trav. Inst. Zool. Lille Lab. Mar. Wimereux 5: 1–272.

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

Harrison, K., and J. P. Ellis. 1991. The genera of the Sphaeromatidae (Crustacea: Isopoda). A key and distributional list. Invert. Taxon. 5: 915–952.

Hatch, M. H. 1947. The Chelifera and Isopoda of Washington and adjacent regions. Univ. Wash. Publ. Biol. 10: 155–274.

Hoese, B. 1981. Morphologie und Funktion des Wasserleitungssystems der terrestrischen Isopoden (Crustacea, Isopoda, Oniscoidea). Zoomorphology 98: 135–167.

Hoese, B. 1982a. Der *Ligia*-Typ des Wasserleitungssystems bei den terrestrischen Isopoden und seine Entwicklung in der Familie Ligiidae (Crustacea, Isopoda, Oniscoidea). Zool. Jb. (Anat.) 108: 225–261.

Hoese, B. 1982b. Morphologie und Evolution der Lungen bei den terrestrischen Isopoden (Crustacea, Isopoda, Oniscoidea). Zool. Jb. (Anat.) 197: 396–422.

Holmes, S., and M. E. Gay. 1909. Four new species of isopods from the coast of California. Proc. U. S. Nat. Mus. 36: 375–379.

Iverson, E. W. 1974. Range extensions for some California marine isopod crustaceans. Bull. Soc. Calif. Acad. Sci. 73: 164–169.

Iverson, E. 1982. Revision of the isopod family Sphaeromatidae (Crustaccea: Isopoda: Flabellifera) I. Subfamily names with diagnoses and key. Journal of Crustacean Biology 2: 248–254.

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

Kensley, B., and R. C. Brusca (eds). 2001. Isopod systematics and evolution. Crustacean Issues 13, A. A. Balkema, Rotterdam, 365 pp.

Kensley, B., and M. Schotte. 1989. Guide to marine isopod crustaceans of the Caribbean. Washington, D.C.: Smithsonian Institution Press, 308 pp.

Kussakin, O. G. 1979. Marine and brackish isopods (Isopoda) of cold and temperate waters of the northern hemisphere. Volume 1. Suborder Flabellifera. (In Russian.) Opred. Faune S.S.S.R. Akad. Nauk 122: 1–470.

Kussakin, O. G. 1982. Marine and brackish isopods (Isopoda) of cold and temperate waters of the northern hemisphere. Volume 2. Suborder Anthuridea, Microcerberidea, Valvifera, Tyloidea. (In Russian.) Opred. Faune S.S.S.R. Akad. Nauk 131, 461 pp.

Kussakin, O. G. 1988. Marine and brackish isopods (Isopoda) of cold and temperate waters of the northern hemisphere. Volume 3. Suborder Asellota. Part 1. Families Janiridae, Santiidae, Dendrotionidae, Munnidae, Paramunnidae, Haplomunnidae, Mesosignidae, Haploniscidae, Mictosomatidae, Ischnomesidae. (In Russian.) Opred. Faune S.S.S.R. 152, 500 pp.

Lee, W. L., and M. A. Miller. 1980. Isopoda and Tanaidacea: the isopods and allies, pp. 536–558. In Intertidal invertebrates of California. R. H. Morris, D. P. Abbott, and E. C. Haderlie, eds. Stanford, CA: Stanford University Press, 690 pp.

Leistikow, A., and J. W. Wägele. 1999. Checklist of the terrestrial isopods of the new world (Crustacea, Isopoda, Oniscidea). Revta Bras. Zool. 16: 1–72.

Markham, J. C. 1974. Parasitic bopyrid isopods of the amphi-American genus *Stegophryxus* Thompson with the description of a new species from California. Bull. So. Calif. Acad. Sci. 73: 33–41.

Markham, J. C. 1977. Description of a new western Atlantic species of *Argeia* Dana with a proposed new subfamily for this and related genera (Crustacea: Isopoda: Bopyridae). Zoologische Mededelingen 52: 107–123.

Menzies, R. J. 1951. New marine isopods, chiefly from Northern California, with notes on related forms. Proc. U.S. Nat. Mus. 101: 105–156.

Menzies, R. J. 1952. Some marine asellote isopods from Northern California, with descriptions of nine new species. Proc. U.S. Nat. Mus. 102: 117–159.

Menzies, R. J. 1962. The marine isopod fauna of Bahía de San Quintin, Baja California, Mexico. Pac. Nat. 3: 337–348.

Menzies, R. J., and J. L. Barnard. 1959. Marine Isopoda on coastal shelf bottoms of Southern California: systematics and ecology. Pac. Nat. 1: 3–35.

Menzies, R. J., and D. Frankenberg. 1966. Handbook on the common marine isopod Crustacea of Georgia. Univ. Georgia Press, Athens, 93 pp.

Menzies, R. J., and P. W. Glynn. 1968. The common marine isopod Crustacea of Puerto Rico: a handbook for marine biologists. Stud. Fauna Curacao Other Caribb. Is. 27 (104): 1–133.

Miller, M. A. 1938. Comparative ecological studies of the terrestrial isopod Crustacea of the San Francisco Bay region. Univ. Calif. Publ. Zool. 43: 113–142.

Miller, M. A. 1968. Isopoda and Tanaidacea from buoys in coastal waters of the continental United States, Hawaii, and the Bahamas (Crustacea). Proc. U.S. Nat. Mus. 125: 1–53.

Monod, T. 1926. Les Gnathiidae. Essai monographique (morphologie, biologie, systematique). Mem. Soc. Sci. Nat. Maroc. 12: 1–667.

Mulaik, S., and D. Mulaik. 1942. New species and records of American terrestrial isopods. Bull. Univ. Utah 32: 1–23.

Negoescu, I., and J. W. Wägele. 1984. World list of the anthuridean isopods (Crustacea, Isopoda, Anthuridea). Trav. Mus. Hist. Nat. "GR Antipa" XXV: 99–146.

Perry, D. M., and R. C. Brusca. 1989. Effects of the root-boring isopod *Sphaeroma peruvianum* on red mangrove forests. Mar. Ecol. Prog. Ser. 57: 287–292.

Poore, G. C. B. 1984. *Colanthura, Califanthura, Cruranthura* and *Cruregens*, related genera of the Paranthuridae (Crustacea: Isopoda). J. Nat. Hist. 18: 697–715.

Poore, G. C. B. 1990. The Holognathidae (Crustacea: Isopoda: Valvifera) expanded and redefined on the basis of body-plan. Invert. Taxon. 4: 55–80.

Reinhard, E. G. 1956. Parasitological reviews. Parasitic castration of Crustacea. Exp. Parasit. 5: 79–107.

Richardson, H. R. 1899. Key to the isopods of the Pacific coast of North America, with descriptions of twenty-two new species. Proc. U.S. Nat. Mus. 21: 815–869.

Richardson, H. 1905. A monograph on the isopods of North America. Bull. U.S. Nat. Mus. 54: 727 pp.

Richardson, H. 1909. Isopods collected in the northwest Pacific by the U.S. Bureau of Fisheries Steamer "Albatross" in 1906. Proc. U.S. Nat. Mus. 37: 75–129.

Rotramel, G. 1972. *Iais californica* and *Sphaeroma quoyanum,* two symbiotic isopods introduced to California (Isopoda, Janiridae and Sphaeromatidae). Crustaceana, Suppl. 3: 193–197.

Schmalfuss, H. 1984. Eco-morphological strategies in terrestrial isopods. Symp. zool. Soc. Lond. 53: 49–63.

Schultz, G. A. 1966. Marine isopods of the submarine canyons of the southern California shelf. Allan Hancock Pac. Exp. 27: 1–56.

Schultz, G. A. 1969. How to know the marine isopod crustaceans. Dubuque: W. C. Brown, 359 pp.

Shiino, S. M. 1964. On three bopyrid isopods from California. Rept. Fac. Fish. Pref. Univ. Mie 5: 19–25.

Stafford, B. E. 1913. Studies in Laguna Beach Isopoda, IIB. J. Ent. Zool. 5: 182–188.

Stimpson, W. 1857. The Crustacea and Echinodermata of the Pacific shores of North America. Boston J. Nat. Hist. 6: 503–513.

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

Van Name, W. G. 1936. The American land and fresh-water isopod Crustacea. Bull. Amer. Mus. Nat. Hist. 71: 1–535 (and Supplements, 1940, 77: 109–142 and 1942, 80: 299–329).

Veillet, A. 1945. Recherches sur le parasitisme des crabes et des galathees par les Rhizocephales et les Epicarides. Ann. Inst. Oceanogr. Monaco, 22: 193–341.

Wägele, J. W., N. J. Voelz and J. Vaun McArthur. 1995. Older than the Atlantic Ocean: discovery of a fresh-water *Microcerberus* (Isopoda) in North America and erection of *Coxicerberus*, new genus. J. Crustacean Biol. 15: 733–745.

Wetzer, R., H. G. Kuck, P. Baez, R. C. Brusca, and L. M. Jurkevics. 1991. Catalog of the Isopod Crustacea type collection of the Natural History Museum of Los Angeles County. Nat. Hist. Mus. Los Angeles Co., Tech. Rpt. No. 3: 1–59.

Wetzer, R., and R. C. Brusca. 1997. The Order Isopoda. Descriptions of the Species of the Suborders Anthuridea, Epicaridea, Flabellifera, Gnathiidea and Valvifera, pp. 9–58. In: Taxonomic atlas of the benthic fauna of the Santa Maria Basin and Western Santa Barbara Channel. Vol. 11. The Crustacea, Part 2: *Isopoda, Cumacea* and *Tanaidacea*. J.A. Blake and P. H. Scott, eds. Santa Barbara: Santa Barbara Museum Natural History.

Wetzer, R., R. C. Brusca, and G. D. F. Wilson. 1997. The Order Isopoda. Introduction to the Marine Isopoda, pp. 1–8. In: Taxonomic atlas of the benthic fauna of the Santa Maria Basin and Western Santa Barbara Channel. Vol. 11. The Crustacea, Part 2: *Isopoda, Cumacea* and *Tanaidacea*. J. A. Blake and P. H. Scott, eds. Santa Barbara: Santa Barbara Museum of Natural History.

Wilson, G. D. F. 1994. A phylogenetic analysis of the isopod family Janiridae (Crustacea). Invert. Taxon. 8: 749–766.

Wilson, G. D. F. 1997. The suborder Asellota, pp. 59–120. In: Taxonomic atlas of the benthic fauna of the Santa Maria Basin and Western santa barbara channel. Vol. 11. The Crustacea, Part 2: *Isopoda, Cumacea* and *Tanaidacea*. J. A. Blake and P. H. Scott, eds. Santa Barbara: Santa Barbara Museum Natural History.

Wilson, G. D. F. and J. =W Wägele. 1994. A systematic review of the family Janiridae (Isopoda, Asellota). Invertebrate Toxonomy 8. 683–747.

Tanaidacea

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(Plate 253)

Tanaids are small, mostly marine creatures that look like tiny lobsters with elongate bodies a few millimeters in length and conspicuous claws that they hold in front of their heads. Some species are typically found on hydroids, bryozoans, coralline algae, barnacles, or other epibenthic organisms, and sometimes in fouling communities on floats or pilings, while other species occur on mud. Most live either in tunnels or in mucous tubes cemented together from particles of detritus, where they often appear with their head and claws poking out. Some members of the family *Pagurapseudidae* live coiled inside tiny snail shells with their claws protruding, like minute hermit crabs.

The tanaid body is subcylindrical or flattened dorsoventrally and is divided into three sections (plate 253A): a **CEPHALOTHORAX** (a small carapace consisting of the cephalon fused with the first two thoracic segments), which typically bears a pair of compound eyes, two pairs of antennae, mouth parts (including paired mandibles, first and second maxillae, and maxillipeds), and a pair of clawed appendages (**CHELIPEDS**); a **PEREON** consisting of six segments or **PEREONITES** (thoracic segments 3–8), each of which bears a pair of legs (**PEREOPODS**); and a short abdomen or **PLEON**, with two to three free segments (**PLEONITES**), plus a terminal **PLEOTELSON** (the telson fused with the 6th pleonite). The pleon usually bears a series of up to five pairs of flattened, two-branched **PLEOPODS** and a pair of caudal appendages called **UROPODS**. Tanaids differ from isopods in having six rather than seven pereonites, at least one jointed uropod branch, and (with few exceptions) a pair of pincers or true chelae on the chelipeds, where these are simple or subchelate in isopods.

The young are brooded in the female's brood pouch (**MARSUPIUM**), and emerge as epibenthic juveniles called **MANCAS**. The marsupium is formed on the underside of the pereon from thin plates (**OÖSTEGITES**) that project from the basal segments of one or more pairs of legs. The sexes are often dissimilar, and in some species different types of males may develop either from mancas or secondarily from females. Males of highly dimorphic species can generally be distinguished from females by their more strongly developed chelipeds, often bearing large and sometimes grotesque chelae; longer first antennae with more flagellar segments, which bear sensory setae (**AESTHETASCS**); larger eyes; and in some genera, fused or vestigial mouth parts.

Lang (1956) divided the tanaids into two suborders, the Monokonophora with a single, small genital cone (the penial process at the end of the sperm duct) between the last pair of legs, and the Dikonophora with two. Sieg (1980) proposed an arrangement with three suborders, the Apseudomorpha (corresponding to the Monokonophora), the Tanaidomorpha, and the Neotanaidomorpha (together corresponding to the Dikonophora), which is followed here. Only the Apseudomorpha and Tanaidomorpha are represented by species in this key.

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Key to Tanaidacea

1. First antenna with two-branched flagellum (plate 253B2); pleopods sometimes lacking; mandible with three-articled palp (plate 253H1); marsupium in females formed by four pairs of oostegites; not tube dwellers .... Apseudomorpha 2
— First antenna with unbranched flagellum; mandible without palp (plate 253H2); pleopods always present; marsupium in females formed by one or four pairs of oostegite; tube dwellers .... Tanaidomorpha 3
2. Five pleonites plus pleotelson; pleon coiled or asymmetrical; pereopods cylindrical; first pereopod more than twice the length of pereopods 2–5; lives in tiny snail shells .... *Pagurotanais* sp.
— Two free pleonites (pleonites 3–5 fused with pleotelson) plus a sharply triangular pleotelson with three dorsal swellings, each bearing a few spines; pleon straight and symmetrical; pereopods somewhat flattened and stout; first pereopod little longer than pereopods 2–5 (plate 253B) .... *Synapseudes intumescens*
3. Five pleonites plus pleotelson; five pairs of pleopods; four pairs of oostegites; uropods two-branched, though the outer branch may be inconspicuous; usually found on mud (plate 253A, 253G) .... *Leptochelia* sp.
— Three to five pleonites plus pleotelson; three pairs of pleopods (one may be rudimentary); one pair of oostegites modified into ovisacs on the fifth pair of pereopods; uropods unbranched; usually found on hard substrates.. Tanaidae 4
4. Three pleonites plus pleotelson; two functional pairs and one rudimentary pair of pleopods (plate 253C) .... *Pancolus californiensis*