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Pleopis polyphemoides (Leuckart, 1859) (=*Podon polyphemoides*). Number of exopodite setae on thoracopods I–3, II–3, III–3, IV–2; Monterey Bay and North American West Coast (Baker 1938, Proc. Cal. Acad. Sci. 23: 311–365).

Pleopis schmackeri (Poppe, 1889). Number of exopodite setae on thoracopods I–4, II–4, III–4, IV–2; not yet known from the North American West Coast (T. Onbé, personal communication).

Podon intermedius Liljeborg, 1853. Number of exopodite setae on thoracopods I–2, II–1, III–1, IV–2; also not yet known from the North American West Coast (T. Onbé, personal communication).

Podon leuckarti Sars, 1862. Number of exopodite setae on thoracopods I–1, II–1, III–1, IV–2; Northern Bering Sea, Chukchi Sea, Bering Strait (Onbé et al. 1996, Proc. NIPR Symp. Polar Biol. 9: 141–152).

Pseudevadne tergestina Claus, 1877. Number of exopodite setae on thoracopods I–2, II–3, III–3, VI–1; Monterey Bay and North American West Coast (Baker 1938, Proc. Cal. Acad. Sci. 23: 311–365, as *Evadne tergestina*). See Uye and Onbé 1993, Bull. Plankton Soc. Japan 40: 67–69 (feeding).

Notostraca

Notostracans (plate 182C) range in size from about 2 cm–10 cm. They have an elongate body covered dorsally at the anterior end of the animal by a broad shieldlike carapace giving them a tadpolelike appearance. The head is incorporated into the anterior portion of the carapace. Their compound eyes are internalized and located on top of the head. Such positioning goes along with the generally bottom–dwelling nature of these crustaceans. The exoskeleton of the thorax and abdomen appears segmented; however, these "segments" are best referred to as "body-rings" because they do not always accurately reflect underlying segmentation (Linder 1952). The first 11 leg-bearing body rings make up the thorax, with the genital openings on the eleventh. The abdomen includes both an anterior leg-bearing section and a posterior legless section. There is variation within each species in the number of body rings in the abdomen and in the numbers of body rings having and not having legs. Also, the number of legs per body ring in the abdomen is variable. The abdomen ends in a telson from which extends a pair of long, thin, cylindrical, and multiarticulate caudal rami. This telson identifies membership in the genus *Triops,* one of the two genera in the order Notostraca. An elongate platelike process extends from the dorsal edge of the telson between the caudal rami in members of the other genus, *Lepidurus*.

Notostracans are omnivores that readily capture and eat fairy shrimps, small fishes, and other small animals. Notostracan reproduction includes obligate sexual, mixed sexual and female self-fertilization, and unisexual modes. Both North American species of *Triops, T. longicaudatus* Leconte, 1846, and *T. newberryi* (Packard, 1871), represent complexes of bisexual and unisexual populations (Sassaman et al. 1997).

Tadpole shrimps live in ephemeral inland waters ranging from fresh to alkaline or even brackish. Temporary rain-pools at the San Francisco National Wildlife Refuge and surrounding areas on San Francisco Bay are home to *Lepidurus packardi* Simon, 1886. *Lepidurus packardi* is protected under the U.S. Endangered Species Act and cannot be collected without a federal permit. It is the only notostracan so protected.

Identification of notostracans to species is often a difficult process that ends in an uncertain conclusion. Use the key in Linder (1959) and then consult Lynch (1966), Lynch (1972), Saunders (1980), and King and Hanner (1998) if you are working with a species of *Lepidurus,* or Sassaman et al. (1997) if you have a species of *Triops*.

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Ostracoda

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(Plates 184–196)

The Ostracoda are a large and important class of small bivalved crustaceans. Because of their microscopic size (0.20 mm–2 mm, rarely to 32 mm), they are not conspicuous animals, but they are abundant and diverse in most aquatic ecosystems if sampled correctly. There are probably at least 25,000 extant species, of which roughly 12,000 have been described (3,000 freshwater, 9,500 marine). Ostracoda have the best fossil record of any arthropod group: the carapace is usually well impregnated with calcite (calcium carbonate), so dead and molted carapaces accumulate abundantly as fossils in both modern sediments and ancient sedimentary rocks.

Ostracodes are found worldwide in the ocean from intertidal to abyssal and hadal depths (7,000 m), in coastal estuaries and marshes, in most fresh waters, and in a few terrestrial habitats. In tropical coral reef ecosystems and in deep-sea faunas, the careful collector may expect to find several hundred species, whereas high-latitude and stressed environments (e.g., coastal marshes, salt lakes, and ephemeral ponds) may yield only a few species. Diversity in the littoral zone varies with the habitat but may be surprisingly high; 58 species of interstitial and meiofaunal ostracodes were collected from intertidal sandy beaches of Anglesey, North Wales; 40 podocopid species from intertidal habitats of the Kurile Islands; and 20 species in a single sample of intertidal mussels near Seto, Japan (see "References").

In seasonally freshwater rock pools in the high intertidal to supratidal zone and in the freshwater lens above the halocline of anchialine (cavern and fracture) systems, certain freshwater (some salt-tolerant) species of Cyprididae may thrive; such populations are usually parthenogenetic and are probably dispersed by wind or birds. On foggy and rainy shores, the collector can inspect water-holding plants, such as mosses and bromeliads, and leaf litter for rare semiterrestrial ostracodes.

Although ostracodes are sometimes abundant, they are poorly known from the California and Oregon intertidal, which hosts more species than are reported here. The faunas of coastal estuaries, deltas, and lagoons of the accretionary coasts of North America (especially of the southern Atlantic and Gulf of Mexico) have been more intensively studied than those of erosional coasts, such as the rocky shores of central and northern California and Oregon. Users of this manual who collect from algae, mussel, and oyster beds; rocky tide pools; pocket beaches; seagrass; silty sand; and other appropriate habitats should expect to discover many additional unreported, and even some undescribed, species and more than a few taxonomic tangles.

This section lists the ostracode species known from the littoral and immediate sublittoral (to a depth of a few meters) within the geographic range of this handbook (from Pt. Conception through central and northern California and Oregon). The list of 32 Podocopa and 10 Myodocopa includes those species reported in previous literature that are considered valid, as well as new records for this region (specimens identified by the authors). Generic assignments have been updated for many species, and some species are left in open nomenclature because they are new or not yet firmly identified.

Of the 10 myodocopid ostracodes known from our region, three are also found both north and south of our region, three south only, one is a probable European introduction, and three have not yet been reported beyond our boundaries. Some of the seven additional myodocopids that have been reported from other localities on the West Coast may yet be found within our region, particularly two reported both north and south of our region (see the "List of Species").

Because of the cold California Current, the intertidal podocopid ostracodes are closely related to those of British Columbia, Alaska, the Aleutian Islands, the Kurile Islands, and northern Japan. Alaskan faunas are poorly known. Probably most of the 32 species described from Vancouver Island range south into California. The intertidal faunas of rocky shores at these latitudes are dominated by phytal dwellers, especially species of Cytheridae, Hemicytheridae, Leptocytheridae, Loxoconchidae, Microcytheridae, Paradoxostomatidae and Xestoleberididae. Because of their small size and fragility and difficulties of identification, several of these families are greatly under-represented in the California literature, although doubtless they are abundant on California shores (see "References").

By contrast, the littoral and sublittoral faunas of southern California (south of Pt. Conception) include many podocopids in common with coastal Mexico and Central America. A greater research effort off southern California has yielded a more diverse ostracode fauna (littoral and sublittoral) with many podocopid species in common with coastal Mexico and Central America. Many of these warmer water species are also well represented in late Cenozoic fossil assemblages of California.

Most ostracodes are benthic, crawling over or burrowing beneath the sediment surface, through the interstices of shelly sands and gravels, over rocks and plants, or through microalgae. Some are demersal plankton, swimming for short distances usually just above the sea floor to feed or mate (often at night). Fewer are planktonic in the open ocean. Ostracodes include detritivores, scavengers, herbivores, suspension-feeders, predators, commensals (of crustaceans, polychaetes, sponges, and echinoderms) and a single fish parasite. In turn, some are parasitized by even more minute copepods, isopods, nematodes, and ciliates.

Ostracodes are important food for fish and benthic invertebrates. Their carapace remains are consistently included in inventories of gut contents of fish, although not necessarily as dominant or selected components of the diet. The biotic interactions of most ostracodes with other invertebrates and fish are not well documented, and collectors are urged to watch for evidence of such relationships.

Some myodocopid and unrelated halocyprid ostracodes produce bioluminescence to deter predators. The luciferin and luciferase are exuded from glands in the upper lip (some Cypridinidae) or from epidermal glands around the margin of the carapace (some planktonic Halocyprididae). *Porichthys notatus,* the California midshipman fish, has been shown to be bioluminescent only in the southern part of its range where it can feed on the bioluminescent California myodocopid *Vargula tsujii*. Otherwise nonbioluminescent midshipman fish from Puget Sound were able to bioluminesce after being fed bioluminescent ostracodes. Additionally, a speciose Caribbean group of myodocopids has males capable of performing spectacular species-specific bioluminescent mating displays somewhat similar to those of fireflies.

General Morphology

Ostracodes can withdraw all limbs inside the enveloping bivalved **CARAPACE**, the margins of which may lock to form a tight seal. (There are reports of ostracode survival after passage through the guts of fish. A few may survive hours or even days of emersion, which has facilitated geographic dispersal to isolated coastal lagoons and terrestrial waters by hitchhiking on migratory waterfowl.) Ostracode valves are closed by **CENTRAL ADDUCTOR MUSCLES** connecting the inner dermis of each valve through the enclosed limb-bearing part of the body. The valves are either nudged apart by appendages or opened hydraulically, as there is no complementary set of opening muscles, nor is there any functional equivalent to the bivalve mollusk ligament. The ostracode carapace varies from smooth to highly ornamented but never has the series of fine concentric "growth lines" (indicating previous molts) present on the bivalved carapaces of Conchostraca. It is perforated by numerous, minute **NORMAL PORE CANALS** with chemosensory and tactile sensilla, which communicate with nerve cells in the underlying epidermis. Ecophenotypic variability of carapace structure is common in podocopid species populations of the coastal zone, especially in certain families of ornamented Cytheroidea, in response to fluctuations of salinity, substrate, organic carbon, and other poorly understood environmental parameters.

The exoskeleton of the soft body consists of a somewhat rigid head capsule (with labrum [upper lip] and **MOUTH**) and a flexible cuticular integument over the posterior region. The endoskeleton is a loose array of internal chitinous **SCLERITES**. The demarcation between the cephalon and thorax is indistinct, and there is argument about whether it has segmental or functional significance. The abdomen is either missing or not differentiated from the thorax; the posterior body (**TRUNK**) of most ostracodes appears under light microscopy to be unsegmented. In a few taxa, external transverse folds fringed with spines or small setae (most visible with scanning electron micrography [SEM]), and sometimes an internal chitinous framework, probably indicate vestigial trunk segmentation. Vestiges of as many as 10 or perhaps 11 segments (plus a telson) occur in the Platycopida (and fewer in the podocopid *Saipanetta*). In the Myodocopa, obvious dorsal trunk segmentation is found in a few Cladocopina (up to four segments) and a few Thaumatocypridoidea (probably more).

There are five to seven paired limbs (six to eight if copulatory limbs included), all more or less different in structure and function, and their homologies with other Crustacea are difficult to trace. Ostracoda never have six or more serially repeated pairs of trunk limbs, as in the superficially similar barnacle "cypris" larvae or in Conchostraca. The male and female external genitalia are thought, at least in some cases (particularly Myodocopa), to be a modified last (usually eighth) pair of limbs. Certain perhaps sensory structures have also been interpreted as the remnants of limbs. The body terminates in a pair of caudal **FURCAE**, which in Myodocopa is posterior to the anus but in Podocopa is anterior to the anus.

Ostracodes have no larval stage and no metamorphosis but hatch from the egg as a juvenile with at least three functional limbs and the enveloping bivalved carapace (less calcified than adult). Juveniles resemble reduced adults. During a fixed series (usually five to eight) of molts, they grow larger and acquire additional limbs; limbs also become more complex, more setose, and, in some cases, change function. Carapace details and primary and secondary sexual characteristics may begin to take shape in late instars but are not fully developed until the adult (terminal) instar. Because molting requires abandonment of the calcified part of the carapace cuticle, the hinge structures and marginal details are fully generated only during the final molt of Podocopa. Fossil assemblages in modern and ancient sediments include numerous molted valves and carapaces in addition to adult specimens. Juveniles are difficult to identify, so collectors should strive to recover large populations with complete growth series and adults of both sexes.

Sexes are separate, and fertilization is internal. Parthenogenesis is common in some freshwater lineages but has not been conclusively verified in marine dwellers. Many ingenious adaptations have evolved to enable copulation in spite of the enveloping carapace. Sexual dimorphism occurs in the internal soft anatomy (testes, ovaries, and associated receptacles, reservoirs and pumps), external genitalia (especially complex in males), appendages (with sensory, clasping and egg-cleaning modifications), **DOMICILIUM** (in brooders), and external size, shape and ornament of the carapace (sometimes very dimorphic). The details of sexual dimorphism are essential for identification at all taxonomic levels. One sex is sometimes easier to identify than the other.

Identification of Ostracoda has been difficult for nonspecialists. Dissection and examination must be performed under a light microscope. Few keys exist, and none should be relied upon as substitutes for consulting the primary taxonomic literature of many countries and languages. Secondary faunal compilations exist for a few other regions, but there are none for marine ostracodes of North America (except papers on Myodocopida of Western North Atlantic).

Considerable information about ostracode specialists and their research can be found on the Web site of the International Research Group on Ostracoda (www.uh.edu/~rmaddock/IRGO/cypris.html; http://userpage.fu-ber/in.de/~palaeont/irgo/ostracoda.html), with links to other sites, such as Cypris, the International Ostracoda Newsletter and Cohen's tabular key (illustrated). A Web search on "Ostracoda" will turn up numerous other sites, many beautifully illustrated. Southern California fauna are listed at www.scamit.org/taxonomic_tools.htm.

How to Collect and Prepare Ostracodes for Identification

Look for ostracodes in most intertidal habitats—even freshwater pools in the highest zone. Use the same collecting equipment and methods that you would use for other tiny crustaceans. Collect samples of algae, pitted rocks, oysters, or mussels into buckets or stout plastic bags and then extract the hidden tiny animals. Examine these samples directly under a dissecting microscope and remove the ostracodes with fine forceps (the flexible ones are good) or an eyedropper (for swimming ones).

For stubbornly hidden ostracodes, a wash may help. Try adding some fresh water or a little alcohol to the seawater and shaking or soaking the algae (etc.) until more animals emerge. You can wash and strain the sample water through a fine-meshed net or screen (holes not more than 0.5 mm for myodocopids, as small as 0.02 mm for the tiniest interstitial podocopids) and flush the inverted contents with a squirt bottle into a small dish for observation. Live ones often play possum at first but are fun to watch when they open their valves and move around after a few minutes. Picking and observing lively ostracodes from a sorting dish may be easier if you slow them down by adding a little anesthetic such as $MgCl_2$ (50% 0.36M) for a few minutes; revive them by returning them to plain seawater.

To hunt for ostracodes in bottom sediment and seagrass, drag a fine-meshed net (or homemade hand dredge) along the surface of the bottom, not digging in more than just a few centimeters. Cohen's favorite dredge is one that Todd Oakley made by attaching pantyhose to a frame. Flush seawater through the net (small running seawater hoses work) to remove fine sediment before flushing net contents into a sorting dish and picking ostracodes from the coarser sediment (stirring the sediment and quickly decanting mainly liquid may produce many but not all of the ostracodes). Some myodocopids are attracted to traps baited with a little fish or a light stick and anchored overnight. Some male myodocopids are attracted to a bright light suspended from a dark dock, and they then can be scooped up with nets. Preserve and store your labeled ostracode samples in 70% EtOH until you are ready to identify them. Take field notes.

Start the identification process by examining a sample under a dissecting microscope and sorting the ostracodes into groups of similar ones. Gently transfer an ostracode into a little glycerol in a labeled depression slide (use alcohol instead if you are preparing for SEM or molecular studies) and examine it under a microscope. Fine flexible forceps, an eyedropper (don't use much liquid), mouth pipette, brush, needles, or tiny wire loop (using a fine probe in your other hand as a pusher) are useful. Examine the ostracode under a compound microscope and perhaps sketch it (camera lucida helpful). Use a coverslip for higher powers. With the slide under the dissecting microscope, remove one or both carapace valves. Hold the ostracode in place with one tool (try the tiny wire loop) while you slide a sharp tool (fine dissecting needle or single edged razor blade) between the valve and the body to sever the central adductor muscle. Pry the valve off the body and cut the weak dorsal body connection to the valves. Examine the specimen again under the compound microscope. You may be able to identify the subclass or order of ostracode at this point.

If you are unfamiliar with ostracodes, sketch the limb positions and shapes before removing limbs (with fine needles) under the dissecting microscope. Cohen uses insect minuten pins glued inside the tip of narrow wooden sticks or fine pipette tips. Retain the valves and body in the glycerin slide, but with a needle move each limb to a permanent slide; cover both slides with a coverslip. Cohen makes permanent slides with polyvinyl lactophenol (this is very poisonous, so use care). When the limb slide is fully dry, the limbs can be examined and drawn under high power with the compound microscope.

The valves of myodocopans will weaken only somewhat over time in glycerin. Both valves and dissected limbs can also be stored in a vial of alcohol stoppered with cotton and placed in a larger vial that also contains a permanently inked label. Cotton stoppered vials should be stored in a larger and well-sealed jar of alcohol, perhaps with labeled vials of similar ostracodes. However, the valves of podocopans will decalcify in alcohol and glycerin. For storage, they should be dried on paper micropaleontological slides. SEM reveals many important minute characters (particularly of the carapace and copulatory limbs) not otherwise visible (see "References"). Additional voucher specimens (preserved in alcohol) of species used for SEM, molecular and ecological studies should always be retained and deposited in a museum collection as verification of your identifications.

Classification of Living Ostracoda

Early classifications of living Ostracoda were based mostly on soft anatomy, whereas classifications of fossils were based on carapace features. Older classifications are obsolete, and none of the newer syntheses is universally regarded as authoritative. Since the mid-twentieth century, in an effort to reconcile the discrepancies, some paleontologists began to study living faunas, and the advent of SEM revolutionized the description of carapace and appendage structure. Myodocopa and Podocopa differ noticeably from each other (see tabular key below), and some molecular analyses suggest that they may actually not form a monophyletic clade. The classification of Podocopa remains more uneven than that of Myodocopa.

Glossary

This list contains abbreviations used in the plates and gives illustrative examples from among the plates.

Terms used herein (and in many other ostracode publications) are defined (some with figure references).

1ST ANTENNA, ANTENNULA, A1 1st (cephalic) pair of limbs. Plates 184, 190A, 191D, 191E.

2ND ANTENNA, ANTENNA, A2 2nd (cephalic) pair of limbs. Plates 184, 191B, 191D, 191E.

3RD (CEPHALIC) LIMB see "mandible (md)." Plate 184.

4TH LIMB (1ST MAXILLA, MAXILLULA, 4) 4th (cephalic) limb, labeled "maxilla" in many papers; use care in reading literature descriptions. Plates 184, 192D, 193F.

5TH LIMB (2ND MAXILLA, 5) 5th limb, labeled "maxilla" in many papers; controversially considered to be and labeled "1st trunk leg," "1st thoracic limb," or "maxilliped" by some podocopid specialists; use care in reading literature descriptions. Plates 184, 191D, 191E, 192F.

6TH LIMB (6) 6th limb (and 1st trunk/thoracic limb); controversially considered to be and labeled "2nd trunk leg" by some podocopid specialists; use care in reading descriptions. Plates 184, 191D, 191E, 192G.

7TH LIMB (7) 7th limb (and 2nd trunk/thoracic limb); controversially considered to be and labeled "3rd trunk limb" by some podocopid specialists; use care in reading descriptions. Plates 184, 191D, 191E, 192H.

8TH LIMB (8) see "copulatory limb (CP)."

ADDUCTOR MUSCLE SCAR PATTERN (AMS) rather central pattern of scars (raised or depressed) indicating where central adductor muscles attach to valves; not always clearly visible. Plates 189A–189G, 189I, 189J, 190K, 190L.

ARTICLE see "podomere."

BASIS distal part of divided protopod (separated from coxa by suture). Plates 185C, 188A–188D.

BELLONCI ORGAN (BO) organ projecting from forehead or naupliar (medial) eye of most Myodocopa. Plates 184B, 185B.

BRANCHIAL PLATE (VIBRATORY PLATE, BP) flat setose epipod, (at least in Myodocopa) used to circulate water through the domicilium. Plates 184C, 184D, 192D.

BROOD POUCH an expanded region of the female domicilium, usually posterior, for protecting developing eggs and instars.

BRUSH-SHAPED ORGANS small pair of lobes bearing numerous fine setae; found between the fifth limbs in males of most Cytherocopina and some Cypridocopina; might represent vestigial appendages. Plates 190F, 194D.

CALCIFIED INNER LAMELLA (CIL) calcified part of the inner (medial) lamella of valve margin. Plate 189F.

CARAPACE lateral outfolds of dorsal epithelium and cuticle, bivalved and enveloping the entire body. Plates 184D, 187, 195, 196.

CAUDAL PROCESS (KEEL, K) posterior extension of carapace. Plates 184A, 186G, 186H.

COPULATORY LIMBS (CP) male limbs modified for copulation, at least in most Myodocopa, usually the 8th limb pair (see also "hemipenes"). Plate 184A.

COXA proximal part of divided protopod (separated from "basis" by suture; see "protopod"). Plates 185C, 188A–188D.

DOMICILIUM the volume between the two valves of the carapace and occupied by the soft body and limbs.

ENDITE medial extension (tooth, lobe, masticatory process) of protopod, generally used in feeding (see also "masticatory process"). Plate 188A.

ENDOPOD/ENDOPODITE (EN) in distally biramous crustacean limb, the medial ramus. Plates 184C, 184D, 185C, 190B.

EPIPOD (EP) extension (usually setose flat lobe) of lateral protopod; in ostracodes (at least in Myodocopa) it often forms a branchial plate used to circulate water. Plate 184A, 184B.

EXOPOD/EXOPODITE (EX) in distally biramous crustacean limb, the lateral ramus. Plates 184, 185C, 190B.

FREE MARGIN the perimeter of the valves (exclusive of the hinge region) where valves are in contact.

FURCA(E) (F) terminal (may be ventral in position) body extensions. Plates 184, 185D, 185H, 186F, 188E, 191E.

FUSED ZONE see "zone of concrescence."

HEMIPENES (HP) podocopan term for paired male copulatory appendages. Plates 184C, 191D, 193H.

HINGE (H) complementary interlocking articulatory structures on inner dorsal margin of valves. Basic types mentioned in key:

- **ADONT** single element hinge, bar on one valve fits into groove of other valve
- **MERODONT** three-element hinge, with anterior and posterior teeth (or sockets) separated by median bar (or groove)
- **LOPHODONT** a merodont hinge in which all elements are smooth
- **PENTODONT** a five element hinge, in which the anterior and posterior region of the median element are differentiated, either crenulate or smooth (family Pectocytheridae only)
- **HOLOMERODONT** a merodont hinge in which all elements are crenulate and negative on one valve, positive on the other
- **ANTIMERODONT** a merodont hinge in which the median element is reversed (negative or positive) from the terminal elements
- **ENTOMODONT** a four-element hinge, with the anterior region of the median bar or groove differentiated, usually with all elements crenulate
- **GONGYLODONT** a crenulate hinge with a systematic increase in size of teeth and decrease in size of sockets from anterior to posterior in the right valve, left valve complementary (family Loxoconchidae only)
- **AMPHIDONT** a modified entomodont hinge in which the four elements are well differentiated (families Hemicytheridae, Trachyleberididae)
- **HOLAMPHIDONT** an amphidont hinge in which all elements are smooth
- **HEMIAMPHIDONT** an amphidont hinge in which the posterior element is crenulate and the others are smooth
- **SCHIZODONT** entomodont hinge in which the anterior and anteromedian elements are bifid, and the posterior element is bifid or crenulate (Family Schizocytheridae only). Plate 191F.

INCISUR (INCISURE, ROSTRAL INCISUR, I) an anterior indentation (ranging from slight to deep and even slitlike) of the valves of the carapace; it acts like an oar-lock for the rowing antennae of many swimming Myodocopa. Plates 184A, 186G.

INNER LAMELLA inner layer of epidermis and cuticle of the dorsal body fold forming the valve, entirely uncalcified or calcified only around the free margin.

INNER MARGIN (IM) the inner or proximal edge of the calcified inner carapace lamella, forming an abrupt line or shelf in dead or fossil valves of Podocopida. Plates 189A, 189H, 190L.

KEEL (K) posterior extension of carapace (also called "caudal process"). Plates 184A, 184B, 185A, 186G, 186H.

LATERAL EYE (LE) paired compound eyes of most Myodocopida. Plates 184A, 184B, 185A, 185F.

LINE OF CONCRESCENCE (LC) the proximal edge of the zone of concrescence. Plates 189I, 190L.

MANDIBLE third limb (third head limb). Plates 184A–184D, 192E, 193G.

MAXILLULA, "MAXILLA" see "4th and 5th limbs."

MASTICATORY PROCESS see "endite."

NAUPLIAR EYE (MEDIAL EYE, NE) single medial anterior eye, normally composed of three eye cups, has reflecting tapetal layer. Plates 184, 185B.

NORMAL PORE CANALS (NPC) numerous perforations through valve with chemosensory and tactile sensilla, which communicate with nerve cells in the underlying epidermis; may be simple (open) or covered with sieve plates. Plate 189I.

OUTER LAMELLA the outer layer of epidermis and cuticle of the dorsal body fold forming the valve; may be calcified or uncalcified.

PALP term used for a podocopan armlike jointed portion (endopod or exopod plus basis) of limb, either directed forward and used for food manipulation, or directed backward and used for clasping.

PODOMERE (ARTICLE) segment of jointed crustacean limb separated from other segments by articulated joint or inflexible suture.

PROTOPOD (PROTOPODITE, PRO) basal podomere(s) of crustacean limb (plate 184B), often divided into two (sometimes three) segments: the coxa attaching the limb to the body and the more distal basis. Plate 188A, 188B.

RADIAL PORE CANALS (RPC) modified normal pores located at free margins of valves, housing nerve filaments that lead from tactile sensilla to nerve cells in the underlying epidermis. Plate 189H.

ROSTRUM anterior projection of valves of many myodocopans, overhangs incisur. Plates 184A, 184B, 186E, 186G.

SCLERITE internal chitinous struts supporting body and limbs. Plate 188C.

SEM scanning electron micrography. Plates 195, 196.

SPINNERET GLAND (SG) gland (connected to 2nd antenna) secreting adhesive thread. Plates 184D, 190B, 191D.

VALVE right or left half of bivalved ostracode carapace (sometimes erroneously referred to as "shell").

VESTIBULE (VESTIBULUM, V) in Podocopa, a marginal cavity between the outer valve lamella and calcified part of the inner valve lamella, extending from the line of concrescence to the inner margin, housing epidermal, glandular, and sometimes reproductive tissues. Plates 189I, 190L.

VIBRATORY PLATE (BRANCHIAL PLATE, BP) flat plate (with marginal setae) located proximally and laterally on limb (an epipod in Myodocopa, but podocopan homologies uncertain); used to circulate water. Plates 184C, 184D,192D.

"WALKING LEGS" posterior limbs that are long, slender, jointed, directed ventrally, and used for locomotion. Plates 184C, 184D, 191D, 191E.

ZENKER'S ORGAN (Z) muscular sperm pump (ejaculatory pump) located dorsally within male body (Cypridocopina) or interlamellar cavity (Sigilliocopina).

ZONE OF CONCRESCENCE (FUSED ZONE, ZC) a clear marginal band extending from the free margin to the line of concrescence, formed by a flangelike outgrowth of the outer lamella and traversed by radial pore canals.

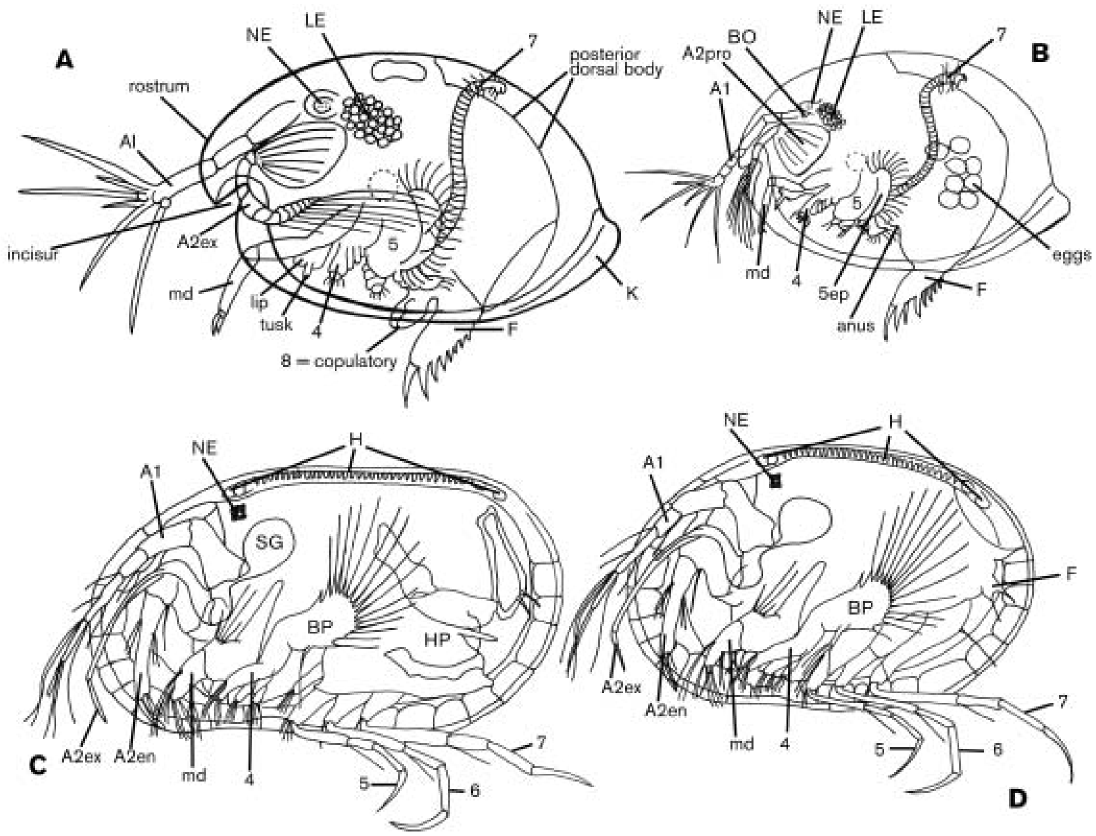

PLATE 184 Ostracoda, diagrammatic comparison of Myodocopa and Podocopa. Myodocopida (Cypridinidae) after Morin 1986: A, male; B, female; Podocopida (Cytheroidea), after Athersuch, et al. 1989: C, male; D, female (redrawn by Ginny Allen).

Key to the Ostracoda

TABULAR KEYS TO MYODOCOPA

ANNE C. COHEN

The three tabular keys on the following pages cover all Myodocopa from subclass to the family level (along with just the subclass Podocopa). A dichotomous key by Rosalie Maddocks further identifies Podocopa from orders to families (along with just the subclass Myodocopa). Because of the chance of encountering unreported species, taxonomic literature should be consulted if identification is attempted beyond the family level.

Key to Podocopa (and Subclass only of Myodocopa)

ROSALIE F. MADDOCKS

1. Carapace elongate oblong to almost circular; with or without rostrum and incisur; valves usually not overlapping; 2nd antenna with large muscular protopod; long exopod with nine podomeres (rarely less) with long setae (often used for swimming); smaller (often much smaller) endopod with one to three podomeres, usually conspicuously dimorphic in adults; large lamellar furcae posterior to anus; with or without lateral eyes and Bellonci organ (plates 184A, 184B, 185–188) . . . . Subclass Myodocopa
— Carapace ovoid, inflated-subtriangular, oblong elongate, or compressed; no rostrum or incisur; valves overlap around free margin; 2nd antenna geniculate, pediform; with very small exopod with no more than two podomeres; much larger propulsive endopod with up to four podomeres; variable furca anterior to anus; no lateral eyes or Bellonci organ (plates 184C, 184D, 189–196) . . . . . . Subclass Podocopa 2
2. Carapace size, shape diverse; left (sometimes right) valve usually overlaps right valve. Adductor muscle scar pattern varied (but includes rows) (plates 189A, 190K, 191D); seven pairs of limbs (including at least one walking leg) (plates 184C, 184D, 191D, 191E) plus large male hemipenes (plates 184C, 191D, 192I, 193H, 194H); 2nd antennal exopod greatly reduced (plates 184C, 184D, 190B); 4th limb (and usually mandible) without lateral setal comb (plates 184C, 184D, 192D, 192E), furcae mostly reduced (plates 184C, 184D, 191E), posterior body only rarely transversely ridged (plates 184C, 184D, 189–196) . . . . Order Podocopida 3
— Carapace oblong, laterally compressed, right valve overlapping left all around; adductor muscle scar pattern biserial; six pairs of limbs (no walking legs) plus male large hemipenes; 2nd antenna with large setose exopod (two podomeres); 4th limb (and mandible) with setal combs; furcae large, lamellar, with stout claws; posterior body transversely ridged; marine, not intertidal . . . . Order Platycopida

Key to the Suborders of Podocopida

3. Carapace ovoid to elongate, usually smooth (or punctate); adductor muscle scars an aggregate or rosette of numerous scars; calcified inner lamella narrow 4
— Carapace form and ornament diverse; adductor muscle scars varied, but distinctive arrangements of a smaller number of discrete scars (see descriptions further in key); calcified inner lamella relatively broad (plate 189F) 5
4. Carapace elongate-ovoid, symmetrical; right valve overlaps left; anterior end narrower, posterior inflated as brood chamber; adductor muscle scar pattern of six to 12 in compact rosette; hinge adont; mandibular palp with lateral setal comb; posterior body smooth; furcae generally absent; males rare; freshwater to slightly oligohaline; global . . . . Suborder Darwinulocopina
— Carapace inflated-ovoid, asymmetrical; left valve strongly overlapping right; adductor muscle scar pattern an aggregate of 20–35 scars; hinge merodont; mandible without setal comb; posterior body transversely ridged; large lamellar furca with fairly stout claws; males with spirally muscularized Zenker's organs; marine, always rare, circumtropical in reef habitats, probably cryptic and interstitial . . . . Suborder Sigilliocopina
5. Carapace diverse, usually smooth (or slightly punctate) (plate 195A, 195B); hinge usually adont (otherwise macrocypridid described in couplet 7a); adductor muscle scar pattern of five to nine discrete scars in a distinctive arrangement (plate 189); 5th limb endopod a small walking leg, or reduced in females and modified as a recurved clasper in males; 7th limb recurved over posterior body, modified distally for cleaning; some males with brush-shaped organ; testes and ovaries sometimes extend into interlamellar cavity of valves; Zenker's organs in dorsal region of male body; many marine and most freshwater ostracodes, some parthenogenetic (plates 189, 195A, 195B) . . . . Suborder Cypridocopina 7
— Carapace shape varied, often ornate, with complex hinges and marginal details; adductor muscle scar pattern of four to nine discrete scars in distinctive arrangement (see next couplets); 5th, 6th, and 7th limbs are walking legs (plates 184C, 184D, 191D, 191E); paired brush-shaped organ in males (plate 190F); testes and ovaries not extending into interlamellar cavity of valves; no Zenker's organs (plates 184C, 184D, 190–194, 195C–195J, 196). 6
6. Carapace with characteristic bairdioid shape (plate 195H), smooth or punctate; left valve overlaps right; adductor muscle scar pattern of three pairs of scars in anterior vertical column plus posterior pair of scars; 2nd antennal exopod a minute scale with up to three small setae; furcae small, rodlike with small setae; one to two balls of sediment usually visible in dorsal region of midgut; marine, global, especially diverse in reef habitats but represented in most subtidal faunas from all depths and sediment types . . . . Suborder Bairdiocopina
— Carapace extremely varied; left valve usually slightly overlaps right; adductor muscle scar pattern typically a vertical row of four (rarely, five) small scars (rarely some of the scars divided) (plates 190K, 190L, 191A, 191D–191F, 192J, 193J, 193K, 194I–194K); hinge adont, merodont, amphidont, schizodont (plate 191F), or other specialized condition; sexual dimorphism may be conspicuous; 2nd antennal exopod modified as a hollow spinning seta connected to spinneret gland (plates 184D, 190B, 191D); furcae reduced to two tiny setae (plate 191E); gut contents not usually identifiable; marine and nonmarine; global, extremely abundant and diverse in all aquatic habitats, accounting for more than 90% of all living Ostracoda, especially dominant in brackish water, intertidal and shallow sublittoral faunas (plates 184C, 184D, 190–194, 195C–195G, 195I, 195J, 196) . . . . Suborder Cytherocopina 9

Key to the Superfamilies of Cypridocopina

7. Carapace elongate; right valve overlaps left; hinge sinuous, consisting of five elements, terminal elements crenulated; adductor muscle scar pattern a compact circular spot with three discrete upper scars and a lower group of indistinct scars; female 5th limb jointed; 6th limb with one long and two shorter terminal claws; testes and ovaries do not enter interlamellar valve cavity; Zenker's organ with numerous chitinous spikes not arranged in rosettes. One to two balls of sediment visible in hindgut. Global, marine benthos, represented in all sublittoral and deeper habitats but usually uncommon . . . . Superfamily Macrocypridoidea
— Carapace shape and overlap variable; hinge adont; adductor muscle scar pattern of five to six discrete scars (anterior column of three scars and slightly lower posterior column of two to three scars); female 5th limb unjointed, 6th limb with one terminal claw; ovaries and testes or vas deferens partly housed within interlamellar valve cavity; Zenker's organ without chitinous spikes or with spikes arranged in rosettes; gut contents unrecognizable 8
8. Carapace shape and overlap varied; usually smooth; adductor muscle scar pattern of five scars in two columns; mandible with weak simple teeth; 7th limb with three short terminal setae, none recurved, no pincer; Zenker's organ without chitinous spikes; global, marine; swimming, crawling and burrowing; represented in all sublittoral and deeper habitats. . . . . Superfamily Pontocypridoidea
— Carapace varied, usually smooth (but not always; e.g., plate 195A, 195B); left valve usually slightly overlaps right; adductor muscle scar pattern (plate 189) of one cap (dorsal) scar plus about five scars in two columns; mandible with strong trifid teeth; 7th limb with long recurved pectinate seta and one to two short or long terminal setae or modified as pincer; Zenker's organ with chitinous spikes usually grouped in rosettes; global, highly diverse; marine, brackish and freshwater, found in all aquatic habitats, dominant in terrestrial waters; also well represented in littoral and shallow-sublittoral habitats of tropical regions, coastal lagoons, and estuaries, and in anchialine cave faunas (plates 189, 195A, 195B) . . . . Superfamily Cypridoidea, Family Cyprididae 9

Key to the Families of Cytheroidea Known to Be Present in the California and Oregon Littoral

This key is valid only for the species included in the species list of this section.

9. Carapace smooth or very faintly pitted (plates 190K, 190L, 192J, 193J, 193K, 194J, 194K). 10
— Carapace conspicuously (except *Acuminocythere,* plate 196C) pitted, ridged, or otherwise ornamented (plates 195C–195G, 195I, 195J, 196) 14

TABLE 2

Tabular Key to Myodocopa (and Subclass only of Podocopa)

Character	Subclass Podocopa	Subclass Myodocopa	Order Myodocopida	Order Halocyprida
Carapace (valve)				
Adult length (approximate)	0.1 mm–8 mm	0.1 mm–32 mm	Most 1 mm–3 (but up to 32) mm	0.1 mm–3 mm
Shape (lateral outline) (plates 184–187, 189–196)	Ovoid, inflated-subtriangular, oblong or elongate, **not circular**	Elongate oblong to almost circular	Elongate-ovoid or ovoid, few rather circular	Varied, elongate sub-quadrate to almost circular
Anterior rostrum (plates 184–187)	**Without** (projection in some Cypridoidea)	**With or without**	Most	Many, but not most
Anterior incisur (notch) (plates 184, 190–194)	**Without**	**With or without**	Most with (usually not above midheight), but not obvious on more circular valves	With (often above mid-height) or without (more circular valves)
Ventral margin	Straight, sinuous (partly concave) or slightly convex	Usually convex, some straight, none concave		
Posterior keel (projecting caudal process) (plates 184–186)	n.g.	Yes or no	Present in many	None, except some with posterodorsal corner-shaped process or spine
Anterior inner valve surface	n.g.	Setose or not	**With at least 1 seta**	Without setae
Body (plate 184)				
Medial eye	With or without	With or without	Present in most	Absent
lateral eye	**Absent**	**Present or absent**	**Present in most**	**Absent**
Bellonci organ	Absent	Usually present	Usually present	Usually present
Bifurcate?		Bifurcate or not	Not bifurcate	Many bifurcate
Posterodorsal body	Few with some segmentation	Few with some segmentation	Body smooth; some with gills or pouches	A few with some segmentation; no gills or pouches
Furca (plates 184, 185D, 185H, 186F, 188E, 191E)				
Furcal position	**Anterior to anus**	**Posterior to anus**		
Furcal shape	Varied, most not plate-like with claws, (no strongly sclerotized plates)	**Always strongly sclerotized flat plate with claws**		
No. of Limbs (including male copulatory limb)	7–8 (plus rudimentary brush organ in many)	6–8	8	6–8
2nd Antenna				
Best developed ramus	**Endopod (plates 191D, 191E, 192B**	**Exopod (plate 184)**		
Number of endopod articles	**3–4**	**1–3**	1–3	2–3
Male endopod	No clasper, but some dimorphic	Most with clasper	Many with clasper (usually reflexed)	Many with hooklike clasper
Number of exopod articles	**1–2 (or seta only)**	**9 (rarely less)**	9 (rarely less)	9

TABLE 2 (continued)

Character	Subclass Podocopa	Subclass Myodocopa	Order Myodocopida	Order Halocyprida
Mandible (plates 185C, 188A–188D, 190G, 192E, 193G, 194B)				
Sexual dimorphism	n.g.	Some	Dimorphic in Sarsielloidea	Apparently none
Proximal setose branchial plate	Many Podocopida	None		
Lateral setose comb	Platycopida only	None		
Proximal endite (on coxa)	n.g.	Usually present, varied	**Usually present and lobelike**	**Present as a cusped tooth**
Basis endite	n.g.	Present in some, varied	1 family with lobe, none with large tooth	**Many with cusped tooth**
Endopod: 1st article setal position	n.g.	V and/or D setae	V setae only	D (and sometimes V) setae
Exopod	n.g.	Present in some = lobe distally inserted on basis with endopod	Present in most (1 article) or absent	Present (1 article) or absent
4th Limb (plates 184, 190D, 190E, 192D, 193E)				
Sexual dimorphism	n.g.	Present in some	Reduced only in Sarsielloidea males	Apparently none
Proximal setose branchial plate	Present in Podocopida, absent in Platycopida	Absent (?except in Cylindroleberididae)	Possibly = bare proximal lobe in Cylindroleberididae	Absent
Lateral setose comb	Platycopida only	Present in some	Cylindroleberididae only	Probably absent
Exopod	n.g.	Many	Usually present = 1 article	Present (1–2 articles) or not
Endopod	Podocopida jointed	Jointed	2 articles	2–3 articles
5th Limb (plates 184, 190H, 191D, 191E, 192F, 193C, 194E)				
Sexual dimorphism	Often, some males with hooklike clasper	Some	Limb reduced in male Sarsielloidea; Cyclasteropinae males with process	Rare
Proximal setose branchial plate	Well-developed to absent	Present = epipod		
Limb shape	Leglike or reduced	Varied	**Compact feeding limb**	Leglike
With setose comb	No	Some	Cylindroleberididae only	No
Teeth or short claws	n.g.	Present or absent	Many with strong nonterminal teeth or claws	Some with terminal claw (only)
Endopod	Present	Present	Rami unclear	Present and jointed
Exopod	Absent	present in few	Rami unclear	Polycopina only
6th Limb (plates 184, 190I, 191D, 191E, 193D, 194F)				
Limb present	Present	Present or absent	Present	Present or absent
Sexual dimorphism	Platycopida	Some	None or slight	Some (*Conchoecia*)
Proximal setose branchial plate	Well-developed to absent	Present in some = epipod	**Absent**	**Present in some = epipod**
Limb shape	Leglike or reduced	Varied	**Short, flat, poorly jointed**	Leglike or absent

(*continued*)

TABLE 2 (continued)

Character	Subclass Podocopa	Subclass Myodocopa	Order Myodocopida	Order Halocyprida
Endopod	Present	Present	Rami unclear	Present
Exopod	Absent	Present in a few	Rami unclear	Present in some (1 article)
7th Limb (plates 190J, 191D, 191E, 192H, 193E, 194G)				
Limb present	Present or absent	Present or absent	Usually present	Present or absent
Sexual dimorphism	n.g.	Some	Limb reduced or absent in some males	None
Proximal setose branchial plate	Reduced if present	Absent		
Limb size	n.g.	Varied	**Usually long**	**Reduced or absent**
Limb shape	Leglike, absent, or a jointed (but not annulated) cleaning limb	Not leglike	**Long wormlike annulated cleaning limb**	**Lobe with few setae or limb absent**
Copulatory (8th) Limb or Hemipenis (plates 184, 191D, 192I, 193H, 194H)				
Paired or single	Paired	Paired or single	Paired	**Single**
Branches	n.g.	Branched in many	3 lobes	Single or 2 branches

NOTE: Bold = major character difference; D = dorsal; V = ventral; n.g. = character not given for Podocopa.

10. Adductor muscle scar pattern of five scars in vertical row (plate 190K, 190L); 1st antenna (plate 190A) with eight podomeres; basal podomere of 5th limb (plate 190H) has small branchial plate with setae (plate 190) . . . . Bythocytheridae
— Adductor muscle scar of four scars in vertical row (plates 191A, 191D, 191E, 192J, 193J, 193K, 194I–194K); 1st antenna with no more than six podomeres (plate 192A); basal podomere of 5th limb without branchial plate (plate 193C) 11
11. In lateral view, anterior end of carapace more narrowly rounded than posterior end (plates 191A, 191D, 191E, 193J, 193K, 194I, 194J) 12
— In lateral view, anterior end of carapace usually more broadly rounded than posterior end (plates 192J, 194K) 13
12. Carapace fragile, elongate, laterally compressed (plates 191A, 191D, 191E, 193J, 193K); inconspicuous sexual dimorphism; hinge lophodont; rather oval frontal scar (plate 191A); normal pore canals inconspicuous, funnel-type; no eye scar; mouth region (plate 193I) extended as cone with sucking disk; mandibles and 4th limbs greatly reduced and transformed to hypodermic-like apparatus (plates 191A, 191D, 191E, 193) . . . . Paradoxostomatidae
— Carapace strongly calcified, inflated, egg-shaped and ventrally flattened; conspicuous sexual dimorphism; hinge merodont; frontal scar V-, J-, or W-shaped; normal pore canals conspicuous, sieve-type; eye scar present behind eye spot; mouth region and mouth parts normal (plate 194I, 194J) . . . . Xestoleberididae
13. In lateral view, anterior carapace margin broadly rounded, posterior margin slightly more narrowly rounded, not caudate; ventral margin sinuate; exterior smooth; deep vestibules; hinge lophodont (plate 194K) . . . . Cytheromatidae
— In lateral view, anterior carapace margin obliquely rounded, posterior margin angulate to caudate; ventral margin nearly straight; exterior ribbed and pitted, with subtle ventrolateral alar thickenings, vestibules shallow or absent; hinge merodont (plate 192J) . . . . Cytheruridae
14. Carapace subrhomboidal to subhexagonal in lateral outline; with lightly pitted ornament (plates 191B, 191C, 196B) 15
— Carapace subovate or subquadrate in lateral outline; with lightly to heavily pitted to reticulate ornament (plates 191F, 195C–195G, 195I, 195J, 196A, 196C–196J) 16
15. Carapace subrhomboidal in lateral outline, with caudal process located above midheight; hinge gongylodont; normal pore canals simple (plate 196B). . . . . Loxoconchidae
— Carapace subhexagonal in lateral outline, with more or less distinct posterior angle at about midheight; lightly pitted ornament with faint radial ridges; hinge antimerodont; sieve-type and simple normal pore canals (plate 191B, 191C) . . . . Cytheridae
16. Hinge amphidont 17
— Hinge merodont or pentodont 18
17. Carapace elongate-oblong in lateral view, with concave posterodorsal element and slightly angulate posteroventral region; hinge hemiamphidont to holamphidont; adductor muscle scar pattern with upper one to two scars divided, plus two to three frontal scars; anterior radial pore canals very numerous; internal chitinous supports (sclerites) present in knee joints of walking legs (plates 195C–195G, 196E–196J) . . . . Hemicytheridae

TABLE 3
Tabular Key to Suborders and Superfamiliies of Order Halocyprida

Character	Suborder Polycopina Family Polycopidae	Suborder Halocypridina	Family Thaumatocyprididae	Family Halocyprididae
Carapace (valve)				
Adult size (length)	0.1 mm–1.1 mm	0.4 mm–3.2 mm	0.4 mm–2.5 mm	0.75 mm–3.3 mm
Shape (outline)	Ovoid or almost circular	Elongate-ovate to ovate, few rather circular	Almost circular	Usually somewhat subquadrate to oblong, less often rather ovate (*Deeveya*)
Rostrum	Rare (only *Pontopolycope*)	Present in many	Present in none	Usually conspicuous
Incisur	**Present in none** (except overhang in *Pontopolycope*)	**Present in many**	**Absent, but anteroventral margin straight or slightly concave and delimited by anterior and anteroventral processes**	**Usually conspicuous (often above mid-height)** (slight in *Deeveya*)
Dorsal margin	Convex	Convex or straight	Convex or straight	Usually rather straight, sometimes convex
Posterodorsal margin	Without keel	Without keel	With or without long spinelike process	Often with spine or corner-shaped glandular process
Body				
Bellonci organ	Usually bifurcate and Formed as two setae	Bifurcate or not, not formed as setae	Not bifurcate; sometimes absent	Bifurcate or not, often sexually dimorphic; sometimes absent
Posterodorsal body	Few with some segmentation	Few with some segmentation	Some with traces of segmentation	Smooth
Furca	**With short triangular process between at least longest claws**	**No triangular processes** (few with a minute blunt peg) **between claws**	**Anterior and ventral edges forming right angle, claws on anterior margin longer and articulated at base, claws on ventral margin unarticulated**	**All claws articulated at base** (Deeveyinae with minute glandular peg between two claws)
No. of Limbs (including male copulatory limb)	6	8	8	8
1st Antenna				
No. of articles	3–5 (inferred 8)	3–8	7–8	3–8
Bend in limb	None	Vanes	Between first and second article	Distal (*Deeveya* also bent between first and second)
Distal filament pad	Absent	Present in some	Absent	Euconchoecinae only

(*continued*)

TABLE 3 (continued)

Character	Suborder Polycopina Family Polycopidae	Suborder Halocypridina	Family Thaumatocyprididae	Family Halocyprididae
Mandible				
Coxal endite	Cusped tooth	Cusped tooth		
Basis endite	**No tooth**	**Cusped tooth**		
Exopod	Present (one article)	Absent		
Endopod—number of articles	Two articles	Jointed (number of articles unclear)		
Fourth Limb				
Exopod	Present (one to two articles)	Absent		
Endopod	Two to three articles	Two articles		
Fifth Limb				
Endopod—number of articles	One article	Jointed (number of articles unclear)		
Exopod	One article	None		
Sixth Limb: presence				
	Absent	**Present**		
Endopod	NA	Jointed		
Exopod	NA	Present in few (one article), usually absent	Present (one article—except *Danielopolina*)	Present only in Deeveyinae (one article)
Seventh Limb: presence				
	Absent	Reduced (or absent), with one to three setae	Unjointed	One to two articles
Male Copulatory Limb				
Branched or not	Two parts	One to two parts	Two parts	One to two parts

NOTE: Key differences are indicated in boldface.

— Carapace (plates 191F, 196C, 196D) elongate-ovate to subtriangular in lateral view, without concave or angulate elements; hinge schizodont (plate 191F); adductor muscle scar pattern with no divided scars (plate 191F); few anterior radial pore canals; knee joints of walking legs without internal supports . . . . Schizocytheridae

18. Carapace elongate-subquadrate in lateral view; coarsely pitted to reticulate; simple frontal scar; few radial pore canals; deep vestibules; hinge pentodont; egg care not known; male 6th and 7th limbs symmetrical (plate 196A) . . . . Pectocytheridae

— Carapace elongate-oval in lateral view; surface smooth to weakly pitted; frontal scar V- to J-shaped; numerous radial pore canals; vestibules shallow or absent; females brood young in domicilium; male right and left 6th and 7th limbs asymmetrical (plate 195I, 195J) . . . . Cytherideidae

List of Species

MYODOCOPA

ANNE C. COHEN

Myodocopa are mostly subtidal and few have yet been collected intertidally within the geographic range of this book; most listed below have been reported slightly subtidal near shore. AC = Anne C. Cohen; RFM = Rosalie F. Maddocks; DP = Dawn Peterson; identified specimens of many of the following species are in the California Academy of Sciences (San Francisco).

MYODOCOPIDA

To identify juvenile instars see Kornicker and Harrison-Nelson 1999, Smithsonian Cont. Zool. 602: 1–55 (see pp. 32–36) and

TABLE 4

Tabular Key to Families of the Order Myodocopida

Character	Subfamily Cypridinidoidea Cypridinidae	Subfamily Cylindroleberoidea Cylindroleberididae	Subfamily Sarsielloidea Philomedidae	Rutidermatidae	Sarsiellidae
Carapace (valves]					
Outline round (except for keel)	None (plates 184A, 184B, 185A)	None (plates 185E–G; 187A)	None (plate 186A, 186B, 186D, 186E)	None (plate 187B, 187C)	**Female and juvenile Sarsiellinae round or round except for keel (plate 187G, 187H)**
Incisur (anterior slot or indentation)	Deep (1 exception) (plate 184A, 184B)	Shallow (plate 187A) to deep (plate 185E) or **slitlike (Cylin droleberidinae) (plate 185F, 185G)**	Minute to deep (plate 186A, 186B, 186D, 186E) (*Pleoschisma* = none)	Shallow (plate 187B, 187C)	Minute (plate 186H) to shallow (plate 186G)
Smooth at low magnification?	Usually	Cylindroleberidinae, Cyclasteropinae	Some	None completely smooth	None completely smooth
Ornamented with nodes, ridges, etc.	Few	Asteropteroninae only	Many	Most	All
Posterior vertical row of external hairs	None except male *Codonocera*	All males (except Asteropteroninae)	None	None	None
Male more elongate?	Some	Some	Yes	Yes	Yes
Body					
Bellonci organ	Short or long	Usually long	Long	Long	Long
Upper lip with valvular nozzles?	**Present in all (many nozzles) (plate 185B)**	Absent	**Present (few nozzles) or absent**	Absent	Absent
Posterodorsal body	Most smooth (plate 184A, 184B); some males with row of large lobes	**Usually 7–8 (some fewer) dorsal over-lapping flat leaf-like gills**	Smooth	Smooth	Smooth
Furca					
lst claw with basal suture	Yes (plates 184A, 184B, 185D)	Yes (plate 185H)	Yes (plate 186F)	Yes	**No (plate 188E)**
Other claws without basal suture	Sometimes	No	No	No	Sometimes
1st Antenna					
3rd and 4th articles	Separated by suture	Usually separated by complete suture	Separated by suture	Sometimes fused	Fused
Male 5th article	Not reduced	Usually little reduction	Wedged ventrally between 4th and 6th	Wedged ventrally between 4th and 6th	Wedged ventrally between 4th and 6th
Male seta of 5th article with bush of long filaments?	No or slight (some with bushes on setae of terminal article)	Cyclasteropinae, most Cylindroleberididae and Asteropteroninae	Yes	Yes	Yes

(*continued*)

TABLE 4 (continued)

Character	Subfamily Cypridinidoidea Cypridinidae	Subfamily Cylindroleberoidea Cylindroleberididae	Subfamily Sarsielloidea Philomedidae	Rutidermatidae	Sarsiellidae
Males with terminal filaments with suckers?	**Yes**	No	No	No	No
7th article with clawlike a-seta	None	All Cylindroleberidinae, most Cyclasteropinae, some Asteropteroninae	None	None	None
2nd Antenna					
Protopod with seta?	With minute distal seta	Most with minute distal seta	No seta	No seta	No seta
Male endopod a clasper?	Not in most, but in some	Always	Always	Always	In most
Mandible					
Coxal endite shape	Spiny lobe, rarely absent	**Long, scythe-shaped branched, spiny**	Spiny lobe, some long, reduced in male	Spiny lobe (plate 188A), reduced in male (plate 188B)	Absent or small spiny lobe, reduced in male
Basis endite	Absent	**Lobe with setae**	Absent	Absent	Absent
Exopod	Short, 2 setae	Short, 2 setae	Short, 2 setae	Absent or reduced, 0–?2 setae	Absent or reduced, 0–1 setae
Endopodial claws form	**Terminal group (plate 185C)**	**Terminal group**	**Terminal group (plate 186C)**	**Pincer in females and juveniles (except Metaschismatinae)**	**3-pronged rake in female and juvenile Sarsiellinae (plate 188C)**
Endopodial claws—number and position	**All terminal:** (2-) 3 relatively short & **all on 3rd article (plate 185C)**	**All terminal:** (1-) 3 relatively long & **all on 3rd article**	**All terminal:** females & juveniles with (2-) 3 relatively long claws (plate 186C); males with 1–3 claws and all on 3rd article	**Not all terminal in females & juveniles: claws form pincers (plate 188A)** (except *Metaschisma*), **with 1 (-2) claw on 2nd article and 1 claw on 3rd; males with 1 terminal claw (plate 188B)**	**Not all terminal in females & juveniles: usually with 1 (Dantyinae 0–3) claw on each of 3 endopodial articles (plate 188C)**; males with 1–3 terminal claws only (or plus weaker proximal claws) (plate 188D)
4th Limb (plate 184A, 184B)					
Reduced and weak in males?	No	No	**Yes**	**Yes**	**Yes**
With setal comb	No	**Yes, on protopod**	No	No	No
With basal epipod?	No	Bare lobe ?= epipod	No	No	No
Endopod—claws on 2nd article (terminal)	At least 2 claws, several setae, many pectinate	**Reduced; no claws**	Females and juveniles with 2 claws and various setae	Females and juveniles with at least 2 claws, several/few setae; *Metaschisma* with 3	**Females and juveniles with terminal row of 5 stout claws** (3–5 triangular) and 1 subterminal long thin seta on each side of claw row

(*continued*)

TABLE 4 (continued)

Character	Subfamily Cypridinidoidea Cypridinidae	Subfamily Cylindroleberoidea Cylindroleberididae	Subfamily Sarsielloidea Philomedidae	Rutidermatidae	Sarsiellidae
5th Limb (plate 184A, 184B)					
Reduced, weak in males?	No	No	Yes	Yes	Yes
With setal comb	No	**Yes**	No	No	No
With teeth or claws	**Row of claws (usually 6) + short peg on 1st exopodial article**	No teeth or claws	**1 big squarish or elongate tooth on 2nd article, smaller teeth on 1st article**	**1 big squarish tooth on 2nd article, smaller teeth on 1st article**	**Sarsiellinae none; Dantyinae with big squarish tooth on 2nd article, small tooth on 1st article**
6th Limb (plate 184A, 184B)					
With well developed endites?	4	All reduced	4	4	1–4
7th Limb (plate 184A, 184B)					
Reduced in males?	No	No	In a few	No	Usually
Terminus	Peg or tooth opposite comb	Opposing combs	Peg(s) opposite comb	Peg(s) or comb opposite comb	Small opposing combs
Male 8th Limb (plate 184A)					
Copulatory limb	Big, complex, 3 lobes (1 jointed) with internal sclerites	Small in most males, 3 lobes, unjointed, no sclerites	Short to elongate, 3 lobes, some/all with sclerites	Small elongate with 3 lobes	Small elongate with 3 lobes, with distal sclerotized hook

NOTE: Key differences are indicated in boldface.

Kornicker 1992, Smithsoman Cont. Zool. 531: 1–243. For information on seven Northwestern American coastal species beyond range of this book, see Juday 1907, Univ. Calif. Publ. Zool. 3: 135–156; Lie, 1968, Fiskedirektoratets Skrifter, serie HavUnders¢kelser, Bergen 14: 229–556 (identifications unverified, specimens not extant); Lie and Evans 1973, Marine Biol. 21: 122–126 (identifications unverified, specimens not extant); Poulsen 1965, Dana Report 65: 1–484; Kornicker and Myers 1981, Smithsonian Cont. Zool. 334: 1–35; Chess and Hobson 1997, NOAA Tech. Memorandum NMFS-SWFSC-243, U.S. Dept. Com.; and website of SCAMIT (South. Calif. Assoc. Mar. Invert. Taxonomists): http://www.scamit.org/taxonomic_tools. htm or http://www. scamit.org/index.htm) (plates 184A, 184B, 185–188).

CYPRIDINIDAE

For summary and phylogenetic analysis see Cohen, A. C. and J. Morin 2003. Sexual morphology, reproduction and bioluminescence in Ostracoda. In Bridging the Gap: Trends in the Ostracode Biological and Geological Sciences. L. E. Park and A. J. Smith, eds. The Paleontological Society Papers 9. New Haven: Yale University Press.

Vargula tsujii Kornicker and Baker 1977, Proc. Biol. Soc. Washington 90: 218–231 (=*Vargula americana* [Müller, 1890] of Hobson and Chess 1976, Fisheries Bull. 74: 567–598). Benthic in sand, planktonic, 3 m–931 m, Baja California to south of Monterey Bay, not reported further north. Planktonic occurrence probably only as nocturnal demersal plankton: see Hammer 1981, Mar. Biol. 62: 275–280; Hobson and Chess 1976 (also fish predation); Chess and Hobson 1997, NOAA Tech. Memorandum NMFSSWFSC-243, U.S. Dept. Com. (also fish predation); Stepien and Brusca 1985, Mar. Ecol. Prog. Ser. 25: 91–105 (also fish predation). Bioluminescence in midshipman fish is related to predation on *V. tsujii*: see Thompson, Nafpaktitis, and Tsuji 1988, Mar. Biol. 98: 7–13; 1988, Comp. Biochem. Physiol. A, 89: 203–210; Thompson and Tsuji 1989, Mar. Biol. 102: 161–165; Thompson et al. 1998, J. Exp. Biol. 137: 39–52. For more on bioluminescence see Huvard 1990, Acta Zoologica 71: 217–223; 1993, Comp. Biochem. Physiol. A, 104: 333–338, J. Morph. 218: 181–193 (plate 185A–185D).

CYLINDROLEBERIDIDAE

For keys see Kornicker 1981, Smithsonian Cont. Zool. 319: 1–548 (subfamilies of Cylindroleberididae, genera of Cylasteropinae, Asteropteroninae; also general morphology of Myodocopida); Kornicker 1986, Smithsonian Cont. Zool. 425: 1–139 (some genera of Cylindroleberidinae). To identify juvenile instars see Kornicker 1992, Smithsonian Cont. Zool. 531: 1–243.

ASTEROPTERONINAE

Asteropella slatteryi Kornicker, 1981. Benthic in sand mixed with silt and clay in harbor (often in kelp bed) at Half Moon Bay; Moss Landing, Monterey Bay and Pilar Point Harbor, Half Moon Bay; 1.8 m–37 m. See Kornicker and Harrison-Nelson 1997, Smithsonian Cont. Zool. 593: 1–53 (description, distribution, ecology); Chess and Hobson 1997, NOAA Tech. Memorandum NMFS-SWFSC-243 (Catalina Is., benthic in sediment by day, nocturnal plankton, fish predation) (plate 187A).

CYCLASTEROPINAE

Leuroleberis sharpei Kornicker, 1981 (=*Cylindroleberis lobianci* Müller, 1894 of Sharpe 1908, Proc. U.S. Nat. Mus. 35: 399-430 [not =*C. lobianci* Müller]; =*Cycloleberis lobiancoi* of Hobson and Chess, 1976). Depth 2 m–146 m, planktonic (probably only as demersal plankton at night) and benthic from Gulf of California to Monterey Bay, possibly to Alaska; in Monterey Bay off Sunset Beach, Kaiser Trestle, Watsonville outfall, and Pajaro River, and also off South Jetty and northwest of harbor entrance at Moss Landing. For fish predation, benthic and planktonic habitats at Catalina Id., see Hobson and Chess 1976, Fish. Bull. 74: 567–598; Chess and Hobson 1997, NOAA Tech. Memorandum NMFS-SWFSC-243 (plate 185E).

CYLINDROLEBERIDINAE

Postasterope barnesi (Baker, 1978) (=*Parasterope barnesi* Baker 1978, Crustaceana 35: 139–141; =*Parasterope* sp. of Tuel et al. 1976, Biol. Survey Pillar Point Harbor, El Granada, Calif., Rep. Mar. Ecol. Inst., Redwood City, CA). Benthic in sand, 1.8 m–210 m; San Diego to Point Conception; Pillar Point Harbor, Half Moon Bay; also males collected at night in subtidal benthic light trap on silty sea grass near Spud Pt. Marina Bodega Harbor, CAS, AC. See Kornicker and Harrison-Nelson, 1997, Smithsonian Cont. Zool. 593: 1–53 (description, distribution, ecology) (plate 185F–185H)

PHILOMEDIDAE

For keys, see Kornicker 1981, Smithsonian Cont. Zool. 332: 1–16 (most genera of Philomedinae); Kornicker 1989, Smithsonian Cont. Zool. 467: 1–134 (genera of Pseudophilomedinae).

Euphilomedes carcharodonta (Smith 1952) (=*Philomedes carcharodonta* Smith 1952, J. Fish. Res. Board Canada 9: 16–41; ="myodocopid" in Tomales Bay, of Kornicker 1977, in Aspects Ecol. Zoogeog. Recent Fossil Ostracoda: 159–173 [pers. comm. Kornicker]). Benthic in 5 m–180 m from La Jolla to Ganges Harbor, British Columbia, including Monterey Bay, Half Moon Bay, Tomales Bay, and Bodega Bay. See Kornicker and Harrison-Nelson 1997, Smithsonian Cont. Zool. 593: 1–53 (description, distribution, ecology); Poulsen 1962, Dana Report 57 (description); Baker 1974, Texas J, Science 25: 131–132 (abundant on S. Calif. shelf); Oliver et al. 1980, Fish. Bull. 78: 437–454 (physical ecology, Monterey Bay) (plate 186A–186C).

Euphilomedes longiseta (Juday, 1907) (=*Philomedes longiseta* Juday 1907, Univ. Calif. Publ. Zool. 3: 135–156; =*P. longiseta*, of Lucas, 1952, Contr. Can. Biol. Fish., Stud. Biol. Stat. Canada, n.s. 6: 398–416). Surface plankton tows off San Diego (Juday, 1907); benthic sand, 6 m –9 m off Monterey Bay (Oliver et al. 1980, Fish. Bull. 78: 437–454); 20 m–90 m, near Vancouver Island (Lucas, 1952).

Euphilomedes morini Kornicker and Harrison-Nelson, 1997 (=*Philomedes longiseta* of Tuel et al. 1976, Biol. Survey Pillar Point Harbor). Benthic in 1.8 m on sand, Pillar Point Harbor, Half Moon Bay. See Kornicker and Harrison-Nelson 1997, Smithsonian Cont. Zool. 593: 1–53 (description, distribution, ecology) (plate 186D–186F).

Zeugophilomedes oblonga (Juday, 1907) (=*Euphilomedes oblonga*, of Oliver et al. 1980, Fishery Bull. 78: 437–454). Surface plankton off San Diego Bay and San Pedro (Juday 1907, Univ. Calif. Publ. Zool. 3: 135–156); benthic, 9 m–14 m, subtidal high energy beach, Monterey Bay (Oliver et al. 1980); see Kornicker and Harrison-Nelson 1997, Smithsonian Cont. Zool. 593: 1–53.

RUTIDERMATIDAE

For bibliography giving synonymy, distribution, biology for all Rutidermatidae as of 1986, see Cohen and Kornicker 1986, Smithsonian Cont. Zool. 449: 1–11. For keys see Kornicker and Myers 1981, Smithsonian Cont. Zool. 334: 1–35 (S. Calif.); Kornicker 1983, Smithsonian Cont. Zool. 371: 1–86 (part of Rutidermatidae); Kornicker 1992, Smithsonian Cont. Zool. 531: 1–243 (juvenile instars of *Rutiderma*). For subfamily Metaschismatinae see Kornicker 1994, Smithsonian Cont. Zool. 553: 1–200.

Rutiderma apex Kornicker and Nelson, 1997 (=*Rutiderma* sp. of Tuel et al. 1976, Biol. Survey Pillar Point Harbor, El Granada CA, Rep. Marine Ecol. Inst.). Benthic on sand, sandy silt, and silty clay, 1.8 m–11 m, Pillar Point Harbor, Half Moon Bay, Tomales Bay, and Dark Gulch, Mendocino County; also benthic on silty sea grass near Spud Pt. Marina, Bodega Harbor (males scooped from bottom, depth <1 m, and at night in subtidal benthic light trap) CAS, AC. See Kornicker and Harrison-Nelson 1997, Smithsonian Cont. Zool. 593: 1–53 (description, distribution, ecology) (plates 187B, 187C, 188A, 188B).

SARSIELLIDAE

For keys to subfamilies of Sarsiellidae, genera of Sarsiellinae, see Kornicker 1986, Smithsonian Cont. Zool. 415: 1–217; Kornicker 1991, Smithsonian Cont. Zool. 505: 1–140. Kornicker, L. S. and F. E. Caraion. For key to genera of subfamily Dantyinae see Kornicker and Caraion 1980, Smithsonian Cont. Zool. 309: 1–27.

SARSIELLINAE

Eusarsiella zostericola (Cushman, 1906) (=*Sarsiella zostericola* Cushman, 1906; =*Sarsiella tricostata* Jones, 1958). Benthic at <1 m–3 m, off Pt. Richmond, San Francisco Bay; shallow shores of Atlantic bays from Maine to Chesapeake Bay; also coastal lagoons of Texas, and near Essex, England. The species was introduced to San Francisco Bay, the Gulf of Mexico, and England with oysters (*Crassostrea virginica*) transplanted from the Atlantic coast. See Kornicker and Wise 1962, Crustaceana

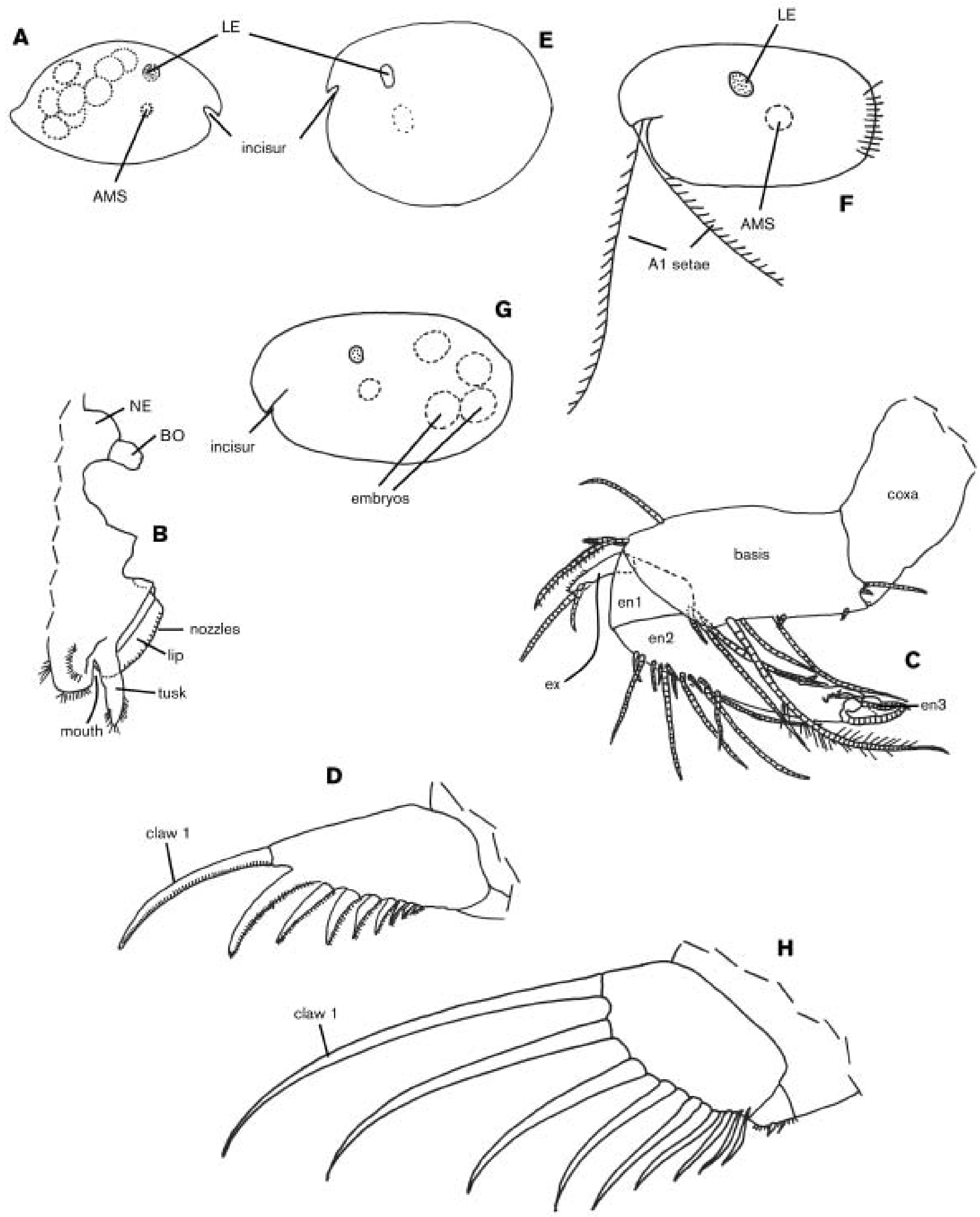

PLATE 185 Myodocopida, Cypridinidae and Cylindroleberididae; Cypridinidae: *Vargula tsujii*, after Kornicker and Baker, 1977: A, female showing deep anterior incisur, interior brooded embryos; B, anterior of body showing Bellonci organ attached to naupliar eye, upper lip (with nozzles and tusk); C, male mandible (medial view; coxal endite not shown, but showing relative shortness of terminal claws); D, left male furca showing 2nd claw without basal suture, other claws with sutures; Cylindroleberididae: E. *Leuroleberis sharpei* after Kornicker, 1981: female, showing circular shape and deep anterior incisur; *Postasterope barnesi* after Kornicker and Harrison-Nelson 1997: F, male, showing deep slitlike anterior incisur, long male setae of 1st antennae, male posterior hair row on valve; G, female, showing slitlike incisur, interior embryos; H, left furca showing all claws with basal suture (all but E, redrawn by Ginny Allen; E by A. Cohen).

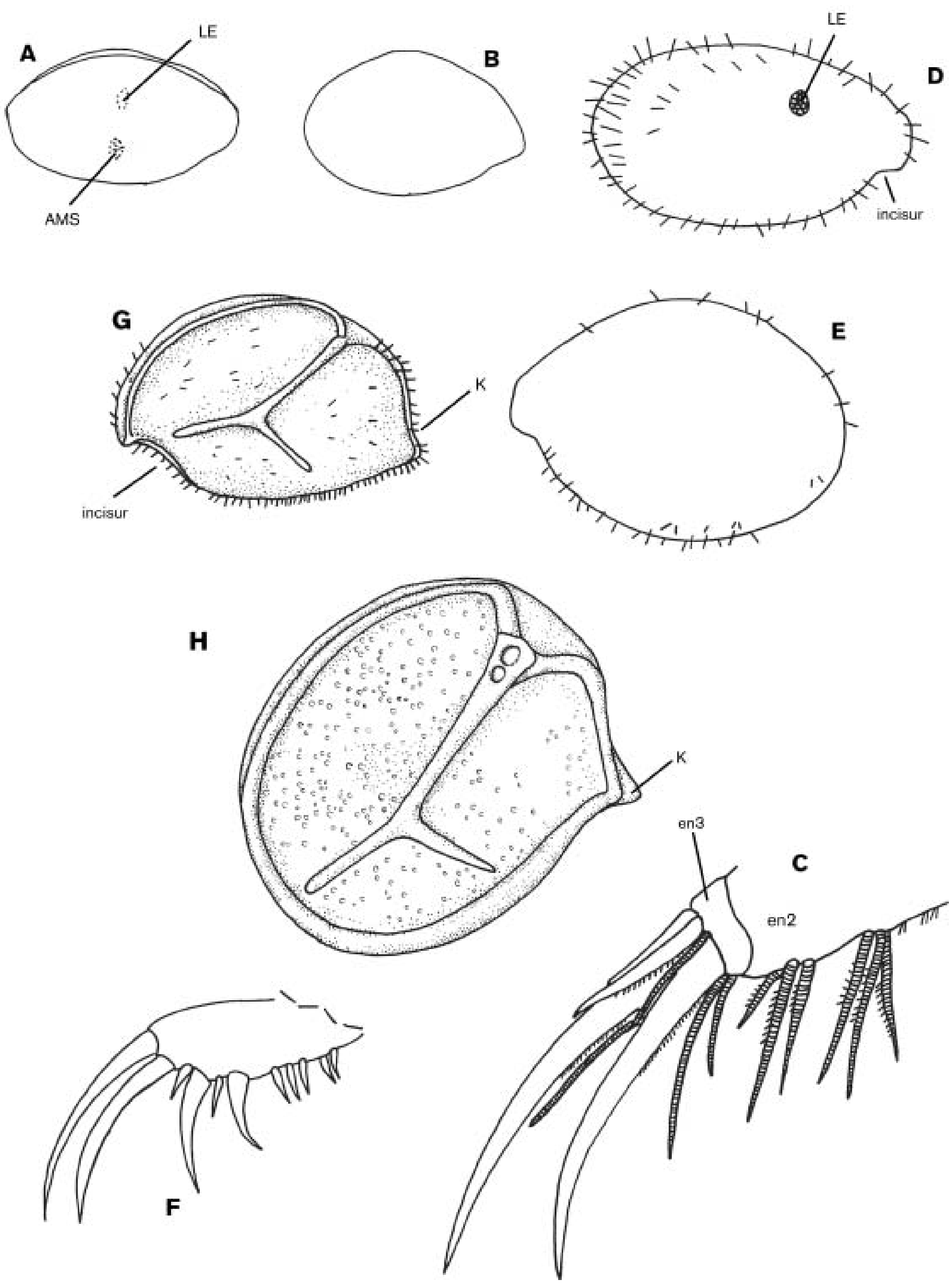

PLATE 186 Myodocopida, Philomedidae, Sarsiellidae; Philomedidae: *Euphilomedes carcharodonta*, after Poulsen 1962: A, male (more elongate valve, larger more visible lateral eye than female); B, female; C, female mandible tip, showing long terminal claws; *Euphilomedes morini,* after Kornicker and Harrison-Nelson, 1997: D, male; E, female; F, male left furca; Sarsiellidae: *Eusarsiella zostericola*, after Kornicker 1967, anterior of valves to left: G, male (with overhanging anterior rostrum); H, female (with mostly circular shape, no rostrum) (all redrawn by Ginny Allen).

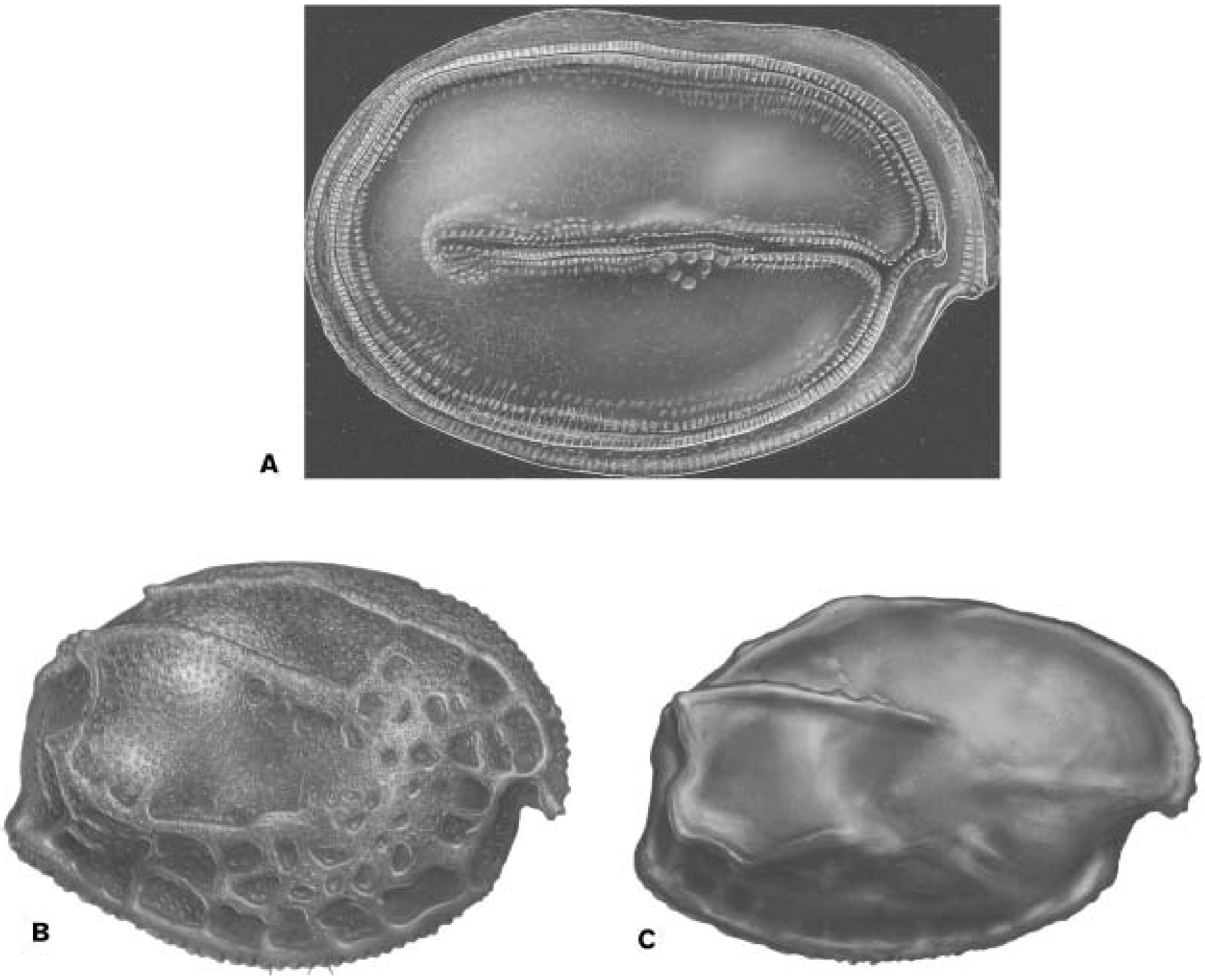

PLATE 187 Myodocopida, Cylindroleberididae and Rutidermatidae, showing ornate valves. Cylindroleberididae: A, *Asteropella slatteryi* female, from Kornicker, 1981, showing shallow incisur; Rutidermatidae: *Rutiderma apex,* from Kornicker and Harrison-Nelson, 1997: B, female; C, male (more elongate and less ornate than female) (drawn by Carolyn Gast, loaned by Smithsonian Institution).

4: 59–74 (description); Kornicker 1975, Bull. Amer. Paleont. 65: 129–139 (spread with oysters); Kornicker and Harrison-Nelson 1997, Smithsonian Cont. Zool. 593: 1–53 (distribution, and references therein); Bamber 1987, J. Micropaleo. 6: 57–62 (life history in Great Britain) (plates 186G, 186H, 188C–188E).

PODOCOPA

ROSALIE F. MADDOCKS AND DAWN PETERSON

PODOCOPIDA

BAIRDIOCOPINA

BAIRDIIDAE

Neonesidea sp. In sand dredged from shore, Whaler's Cove, Point Lobos (plate 195H).

CYPRIDOCOPINA

CYPRIDIDAE

Cypridopsis vidua (O. F. Müller, 1786). Females and juveniles in high intertidal/supratidal tide pools with freshwater influx, Bodega Bay, RFM. This parthenogenetic species is abundant worldwide in permanent and temporary fresh waters. See Sars 1925, An Account Crustacea Norway (Ostracoda) 9: 1–277; Tressler, 1959, in Fresh-water Biology, Ward, Whipple and Edmonson, eds.: 657–734); Delorme 1970, Can. J. Zool. 48: 253–266) (plate 189C–189E).

Herpetocypris reptans (Baird, 1835). Females in high intertidal/supratidal tide pools with freshwater influx, Bodega Bay, RFM. Parthenogenetic, common in fresh waters of Europe and North America. See above references (plate 189F–189H).

Heterocypris salina (Brady, 1868) (=*Cyprinotus salinus*). Empty valves in roots of eelgrass in brackish water inlet, depth <10 cm, Richardson Bay, Marin County, CA, DP. Females and juveniles in high intertidal/supratidal pools with freshwater influx, Bodega Bay, RFM. This parthenogenetic, halophile, somewhat variable species is very widely reported in brackish waters of Europe, Russia, the Caspian Sea and North America. See above references and Delorme 1970, Can. J. Zool. 48: 153–168; Swain (1999, Fossil Nonmarine Ostracoda U.S.). See also Ganning 1967, Helgoländer wiss. Meeresunters. 15: 27–40 (ecology of rockpool populations of Scandinavia) (plate 189A, 189B, 189I–189L).

PLATE 188 Myodocopida, Rutidermatidae and Sarsiellidae; Rutidermatidae: *Rutiderma apex,* after Kornicker and Harrison-Nelson, 1997: A, female mandible (showing terminal pincer-claws), medial view; B, male mandible (no pincer), medial view; Sarsiellidae: *Eusarsiella zostericola*: C, female mandible (showing one long ventral claw on each endopodial podomere forming rake), medial view; D, male mandible (long claw only on terminal podomere), medial view; E, male right furca showing 1st (longest) claw without basal suture, other claws with sutures (C, D, after Kornicker 1967; E, after Kornicker and Wise 1962; redrawn by Ginny Allen).

Sarscypridopsis aculeata (Costa, 1847) (=*Cypridopsis aculeata*). Empty valves in roots of eelgrass in brackish water inlet, depth <10 cm, Richardson Bay, Marin County, DP. It has been widely reported from Europe, Iceland, the Americas, central Asia and Africa. See above references and Delorme 1970, Can. J. Zool. 48: 253–266; Forester and Brouwers 1985, J. Paleont. 59: 344–369 (plate 195A, 195B).

CYTHEROCOPINA

BYTHOCYTHERIDAE

Sclerochilus sp. On intertidal mud and fine sand flat near Sandpiper Restaurant, northeast Bodega Harbor, RFM (plate 190A–190L).

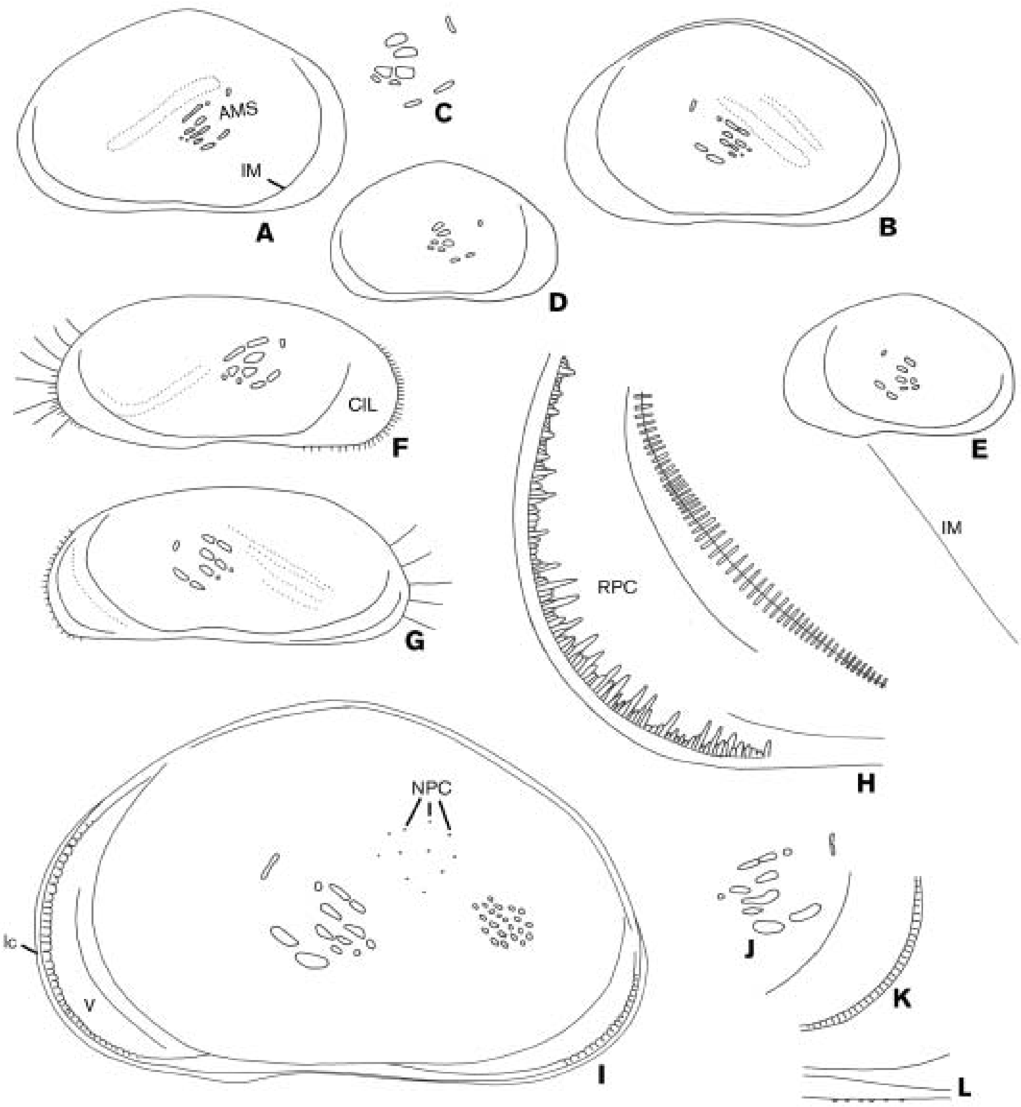

PLATE 189 Podocopida: Freshwater Cyprididae: *Heterocypris salina* (Brady, 1868), female specimen RFM 3413F (A, B, I–L): A, B, exteriors of right and left valves with traces of ovaries, X60; I, exterior of left valve, normal pore canals and granular micro-ornament indicated as dots and ovals, X105; J, muscle scar pattern of right valve, X105; K, anterior margin of right valve with radial pore canals, X105; L, anteroventral margin of right valve with minute tuberculae, X175; *Cypridopsis vidua* (O. F. Müller, 1786), female specimen RFM 3411F (C–E): C, muscle scar pattern of right valve, X105; D, E, exteriors of right and left valve, X60; *Herpetocypris reptans* (Baird, 1835), female specimen RFM 3412F (F–H): F, G, exteriors of right and left valves, X35; H, anterior margin of left valve with flange, radial pore canals, outer list, striate inner list, and inner margin, X175 (drawn by R. Maddocks).

CYTHERIDAE

Cythere alveolivalva Smith, 1952 (=*Cythere uncifalcata* Smith, 1952; *Cythere* sp. A of Valentine, 1976). This species is common in coastal regions of the northern Kurile Islands, Kamchatka Peninsula, and Alaska to California; also fossil (Pleistocene and Holocene) in Oregon and California (Tsukagoshi and Ikeya 1987) (plate 191B, 191C).

Cythere valentinei Tsukagoshi and Ikeya, 1987 (=*Cythere* sp. B of Valentine, 1976; *Cythere* cf. *C. lutea* and *Cythere alveolivalva* (part) of Swain 1969, in Neale (ed.), Taxon. Morph. Ecol. Rec. Ostracoda; *Cythere lutea* of Swain and Gilby 1974, Micropaleo. 20: 257–352). On intertidal mud and fine sand flat in Bodega Harbor, RFM. Valentine (1976) reported range in offshore waters as Point Reyes to southern Vancouver Island; also fossil (Pleistocene of Cape Blanco, Oregon).

Cythere sp. of Tsukagoshi and Ikeya, 1987 (=*Cythere alveolivalva* (part) of Swain 1969, in Neale (ed.), Taxon., Morph. Ecol. Rec. Ostracoda, and Swain and Gilby 1974, Micropaleo. 20: 257–352; *Cythere* sp. aff. *C. lutea* of Swain and Gilby 1974; *Cythere maia* of Valentine, 1976). Tide pool at Point Piedras Blancas, CA. Valentine (1976) reported range in offshore waters as Baja California to Point Piedras Blancas, CA; also fossil (Pliocene-Pleistocene).

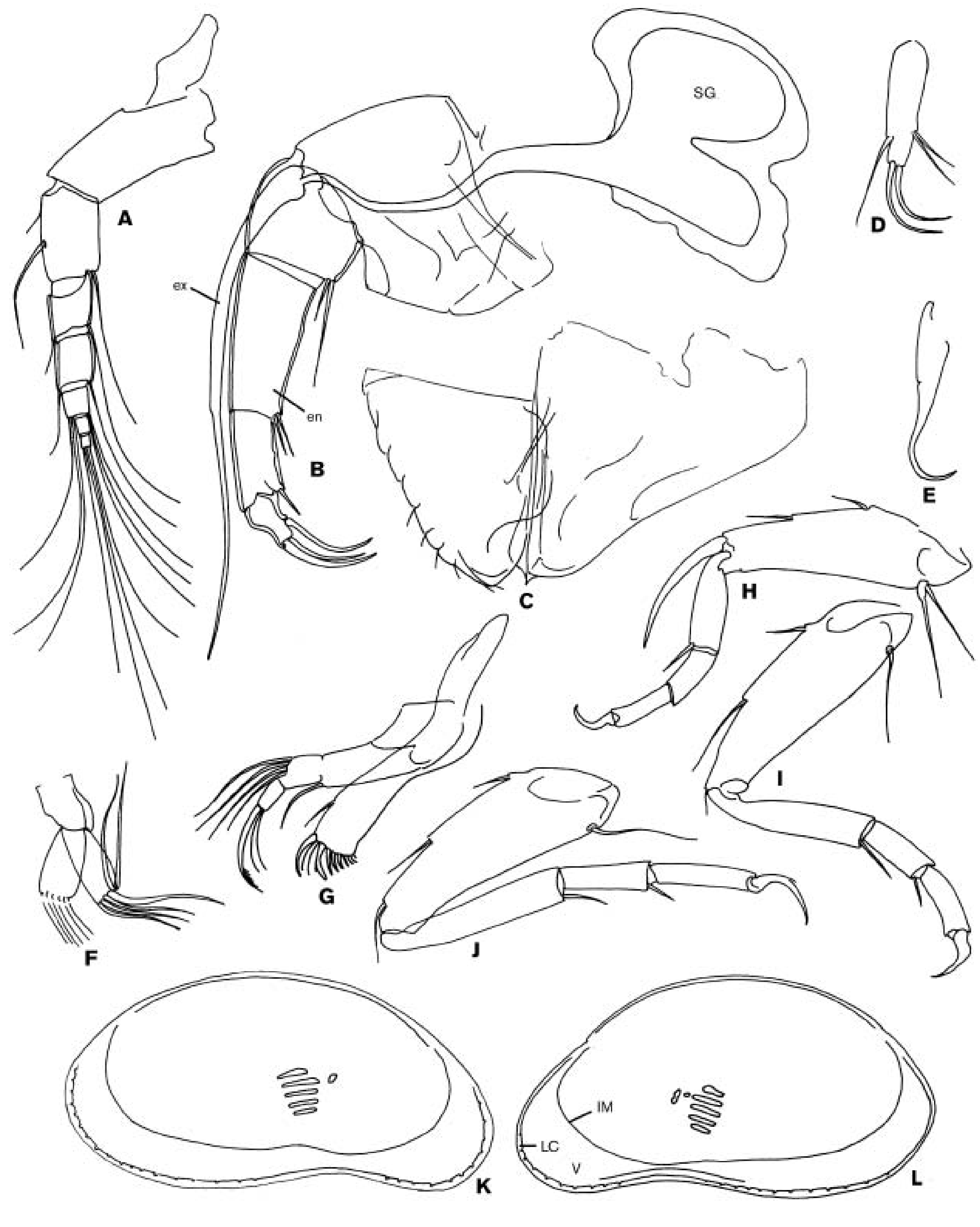

PLATE 190 Podocopida: Bythocytheridae: *Sclerochilus* sp.: female specimen RFM 3408F (A–E, G–L): A, first antenna; B, second antenna with spinnaret gland; C, mouth region with forehead, upper and lower lip; D, E, palp and masticatory process of maxillula (fourth limb); G, mandible; H–J, fifth, sixth and seventh limbs; all X430; K, L, exteriors of right and left valves, X120; F, male specimen RFM 3403M, brush-shaped organ, X430 (drawn by R. Maddocks).

CYTHERIDEIDAE

Cyprideis beaconensis (LeRoy, 1943). Shallow water among algae bloom, salt marsh, Skaggs Island Naval Station, Sonoma Co., CA, DP; Lake Merritt, Oakland; widely distributed in estuaries and marshes along the Pacific coast from southern Chile to British Columbia, also Midway and Oahu Islands in the North Pacific; probably dispersed on migratory waterfowl (Sandberg 1964, Stockholm Contribs. Geology 7: 1–178; Sandberg and Plusquellec 1974, Geoscience and Man 6: 1–26) (plate 195I, 195J).

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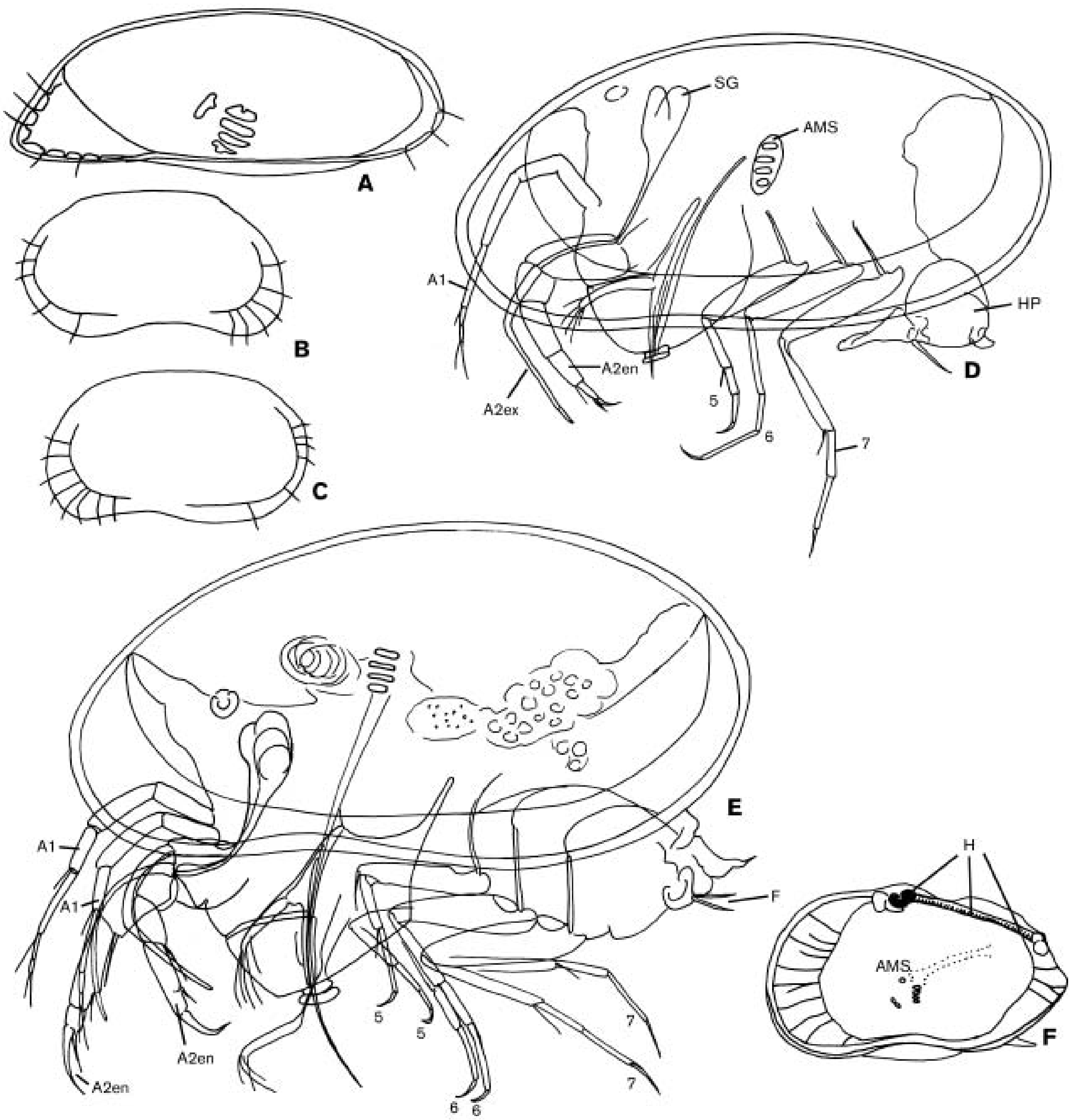

PLATE 191 Podocopida: Cytheridae, Paradoxostomatidae, Schizocytheridae. Paradoxostomatidae: A, *Acetabulostoma californica,* exterior of male left valve, X80, after Watling, 1972. Cytheridae: B, C,, *Cythere alveolivalva* Smith, 1952, exteriors of male right and left valves, X35, after Smith, 1952; Paradoxostomatidae: *Paradoxostoma striungulum* Smith, 1952 (D, E): D, entire male specimen RFM 3400M, as seen from left side in transmitted light; E, entire female specimen RFM 3401F, as seen from left side in transmitted light; with postmortem extrusion of body from carapace; all X175; Schizocytheridae: F, *Spinileberis hyalina*, interior of right valve, X65, redrawn from Watling 1970 (drawn by R. Maddocks).

CYTHEROMATIDAE

Paracytheroma similis Skogsberg, 1950 (Calif. Acad. Sci., Proc. 26: 483–505). On sand and rocks, 15 m in Monterey Bay, near Pacific Grove (plate 194K).

CYTHERURIDAE

Howeina sp. aff. *H. camptocytheroidea* Hanai, 1957. On intertidal mud and fine sand flat in Bodega Harbor, RFM (plate 192A–192J).

HEMICYTHERIDAE

Ambostracon glaucum (Skogsberg, 1928) (=*Cythereis glaucum* Skogsberg 1928, Calif. Acad. Sci., Occ. Pap. 15: 1–143). On holdfasts of algae in Carmel Bay; also on calcareous algae in tide pool just outside Hopkins Marine Station, Pacific Grove; Swain and Gilby (1974) reported it from 12 m in Bodega Bay; from 23 m in Morro Bay, and from 11 m–26 m in Coos Bay (Micropaleo. 20: 257–352). Valentine (1976) gave the range in offshore waters as Baja California to Pt. Piedras Blancas (Micropaleo. 20: 257–352) (plate 195C, 195D).

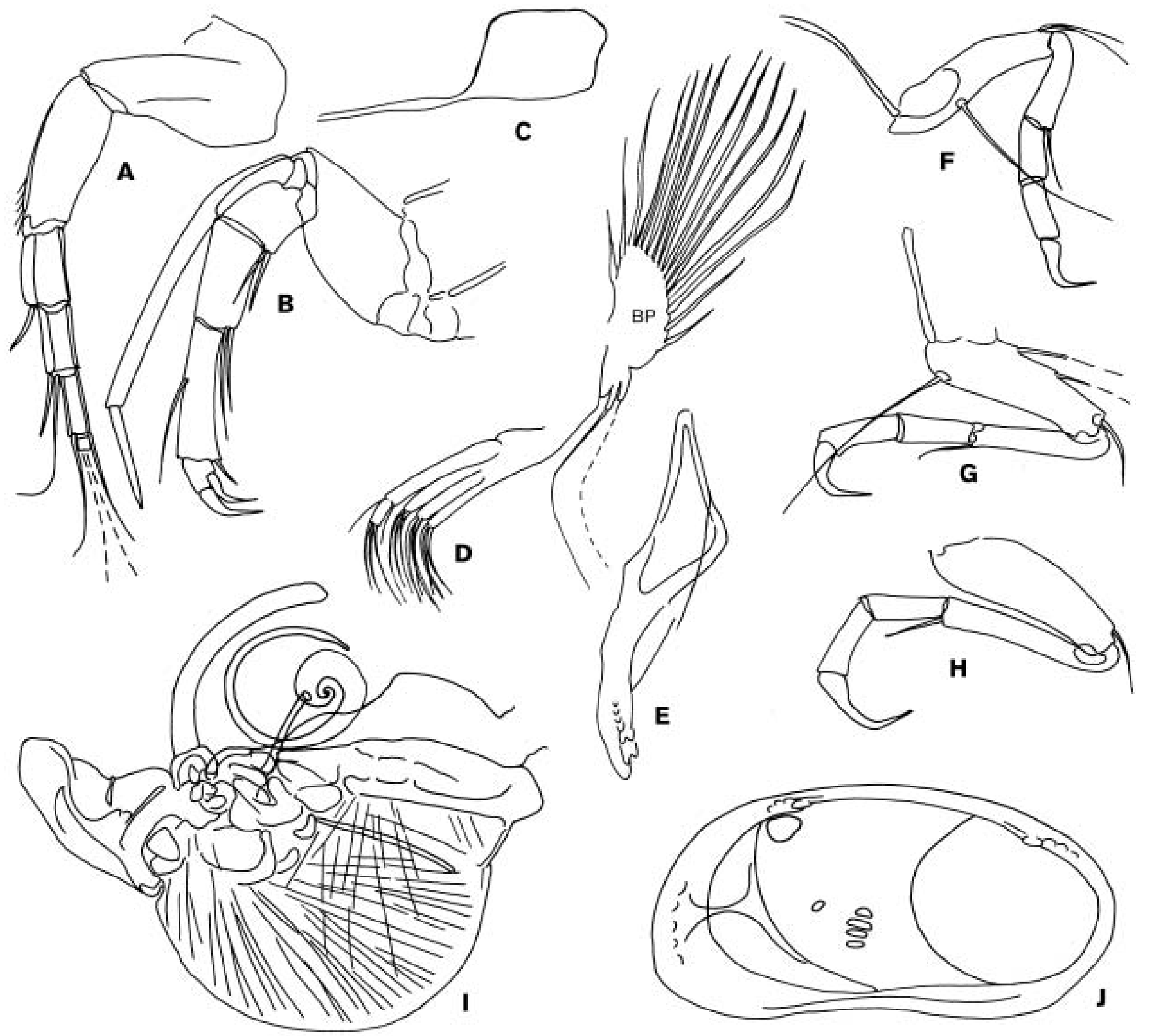

PLATE 192 Podocopida: Cytheruridae: *Howeina* sp. aff. *H. camptocytheroidea* Hanai, 1957, male specimen RFM 3403M: A, first antenna; B, second antenna; C, spinnaret gland; D, maxillula (fourth limb); E, mandible; F–H, fifth, sixth, and seventh limbs; I, hemipenis, all X430; J, exterior of left valve, X175 (drawn by R. Maddocks).

Aurila laeviculoidea Swain and Gilby, 1974. In sand in 10 m off Crescent City.

Aurila lincolnensis (LeRoy, 1943). Among shore rocks at Rockaway Beach, San Mateo Co., DP; also on intertidal mud and fine sand flats in Bodega Harbor; Swain and Gilby (1974) reported it from sand in 12 m in Bodega Bay, RFM, and in 10 m off Crescent City (Micropaleo. 20: 257–352). The species is widely reported off southern California and Mexico. Valentine (1976) gave the range in offshore waters as Baja California to Cape Flattery (plate 196E, 196F).

Aurila montereyensis (Skogsberg, 1928) (=*Cythereis montereyensis*, Skogsberg, 1928). On calcareous algae, among roots of eelgrass, and on holdfasts of *Macrocystis* in 2 m, in tide pools at Carmel Bay; Bodega Harbor, in fairly dense seagrass, silt with fine sand, RFM. Valentine (1976) gave the latitudinal range in offshore waters as north of Pt. Conception to near Cape Alava, Washington (plate 195G).

Aurila sp. aff. *A. corniculata* (Okubo, 1980). McNears Beach, San Francisco Bay, *A. corniculata* is reported from coastal waters of Japan, Korea, and the South Kurile Islands (Schornikov and Tsareva 1995, Mitt. Hamburg. Zoolog. Mus. Inst. 92: 237–253) (plate 196I, 196J).

Aurila sp. of Swain and Gilby, 1974 (Micropaleo. 20: 257–352). In sand in 10 m in Bodega Bay. It is likely that additional species of *Aurila* and related genera occur in the intertidal zone within the range of this manual (see Valentine 1976).

Radimella aurita (Skogsberg, 1928) (=*Cythereis aurita* Skogsberg 1928, Calif. Acad. Sci., Occ. Pap. 15: 1–143). On calcareous algae in tide pool and on holdfasts of *Macrocystis*, outside Hopkins Marine Station on Monterey Bay, near Pacific Grove; also on kelp near shore and on eelgrass in Carmel Bay. Valentine (1976) reported the range in offshore waters as Baja California to north of Santa Cruz); also fossil (plate 195E, 195F).

Radimella? pacifica (Skogsberg, 1928) (=*Cythereis pacifica* Skogsberg 1928, Calif. Acad. Sci., Occ. Pap. 15: 1–143). On calcareous algae in tide pool and on holdfasts of *Macrocystis* in 2

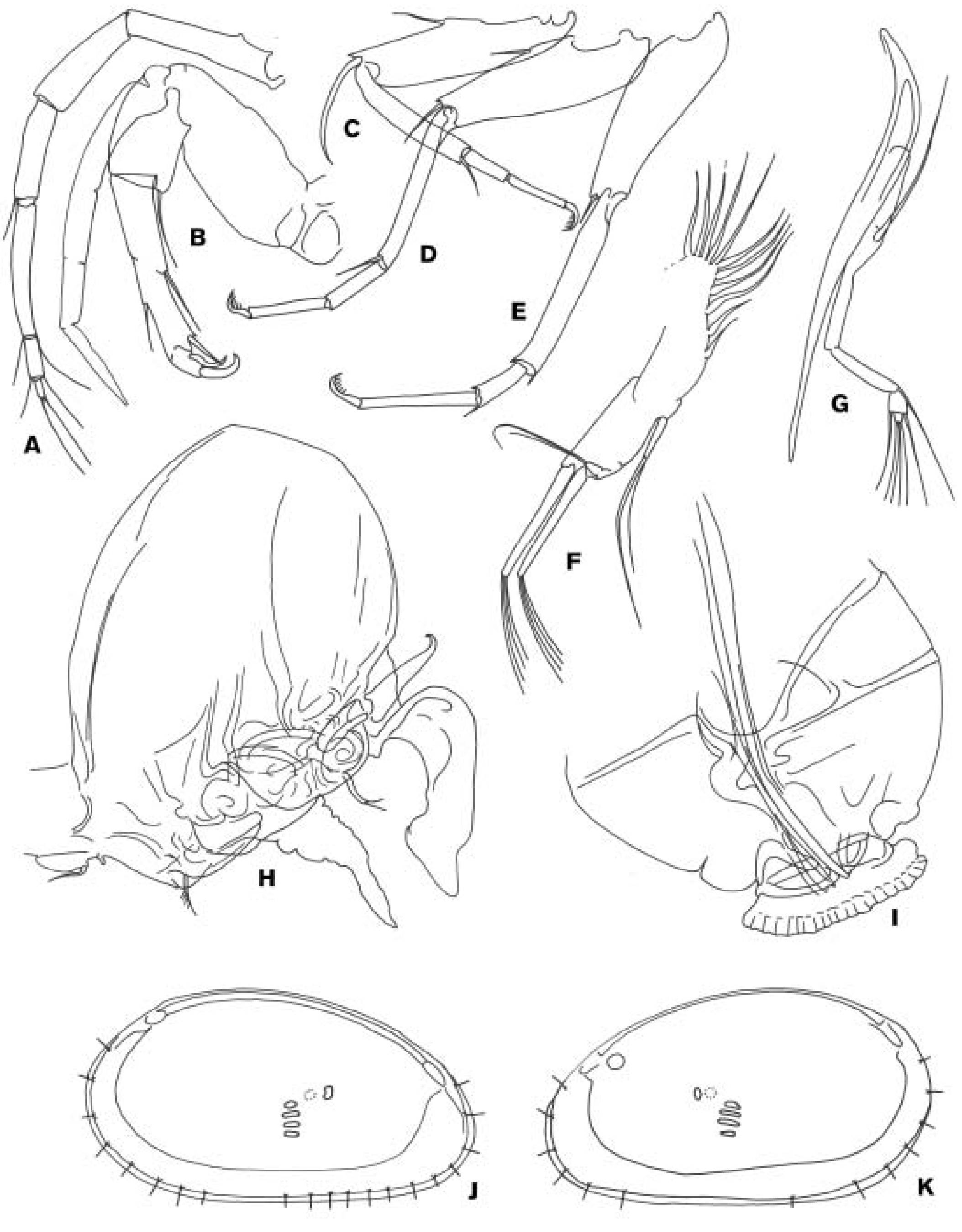

PLATE 193 Podocopida: Paradoxostomatidae: *Paradoxostoma* sp., male specimen RFM 3407M: A, first antenna; B, second antenna; C–E, fifth, sixth, and seventh limbs; F, maxillula (fourth limb); G, mandible; H, hemipenis; I, mouth region with forehead, upper lip, oral sucking disk, and mandible within esophagus; all X430; J, K, exteriors of right and left valves, X175 (drawn by R. Maddocks).

m, outside Hopkins Marine Station near Pacific Grove; also on kelp near shore and on eelgrass in Carmel Bay. Valentine (1976) reported the range in offshore waters as Baja California to south of Cape Vizcaino; also fossil.

Robustaurila jollaensis (LeRoy, 1943) (=*Aurila jollaensis*, of Swain and Gilby 1974, Micropaleo. 20: 257–352). Bodega Bay in 12 m and off Crescent City in 10 m. Valentine (1976) reported the range in offshore waters as Baja California to Cape Flattery; also fossil (plate 196G, 196H).

LOXOCONCHIDAE

Cytheromorpha sp. Empty valves in brackish water on medium-grained sand and rocks, in less than 1 m, McNears Beach, Marin Co.; in brackish water on muddy sand, 10 cm, Richardson Bay, Marin Co.; in brackish water on mudflat among floating algae, in 5 cm, Bolinas Bay, Bodega Bay, DP.

Loxoconcha lenticulata LeRoy, 1943. Empty valves in brackish water on medium-grained sand and rocks, <1 m, McNears

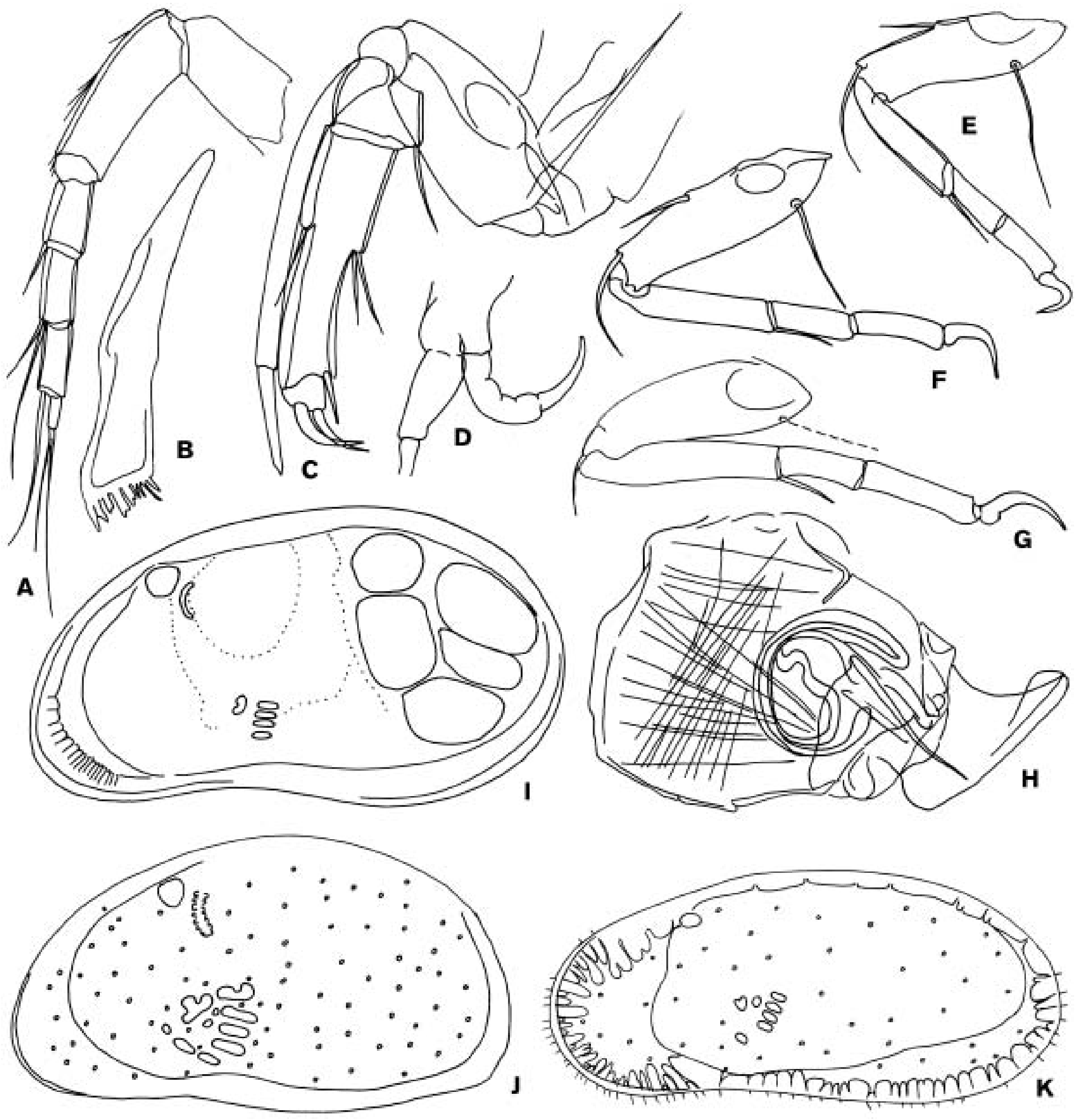

PLATE 194 Podocopida: Cytheromatidae and Xestoleberididae. Xestoleberididae: A–I, *Xestoleberis* sp., male specimen RFM 3402M (A–H); A, first antenna; B, mandibular base; C, antenna; D, brush-shaped appendage; E–G, fifth, sixth, and seventh limbs; H, hemipenis; all X430; I, left exterior of female specimen RFM 3410F, with developing eggs in domiciliary brood pouch, pigmentation and patch pattern indicated by dots, X175; J, *Xestoleberis hopkinsi* male left valve exterior, X120; Cytheromatidae: K, *Paracytheroma similis* male left valve exterior, X100 (J, redrawn from Skogsberg, 1950, pl. 29, fig. 1; K, redrawn from Skogsberg, 1950; drawn by R. Maddocks).

Beach, Marin Co., DP. Valentine (1976) reported the range in offshore waters as northernmost Baja California to Pt. Conception; also fossil (plate 196B).

PARADOXOSTOMATIDAE

Acetabulostoma californica Watling l972 (Proc. Biol. Soc. Washington 85: 481–488). Low intertidal on exposed side of Tomales Point, Marin Co., in the zone of the red alga *Corallina gracilis*. Most species of *Acetabulostoma* are parasitic on gammarid amphipods, but the host (if any) of *A. californica* is unknown (plate 191A).

Paradoxostoma striungulum Smith, 1952. Empty valves in brackish water on medium-grained sand and rocks, less than 1 m, McNears Beach, Marin Co., DP; living on intertidal fouled eelgrass (*Zostera marina*) blades in the South Slough National Estuarine Research Reserve, Coos Bay (J. T. Carlton, collector), CAS, RFM. Described from Departure Bay, British Colombia, on *Obelia* near water surface (Smith 1952, J. Fish. Res. Board Canada 9: 16–41) (plate 191D, 191E).

Paradoxostoma sp. One male living on mud and fine sand flat exposed at low tide, Bodega Harbor, RFM. It is likely that additional species of *Paradoxostoma* and related genera occur within the range of this book (plate 193A–193K).

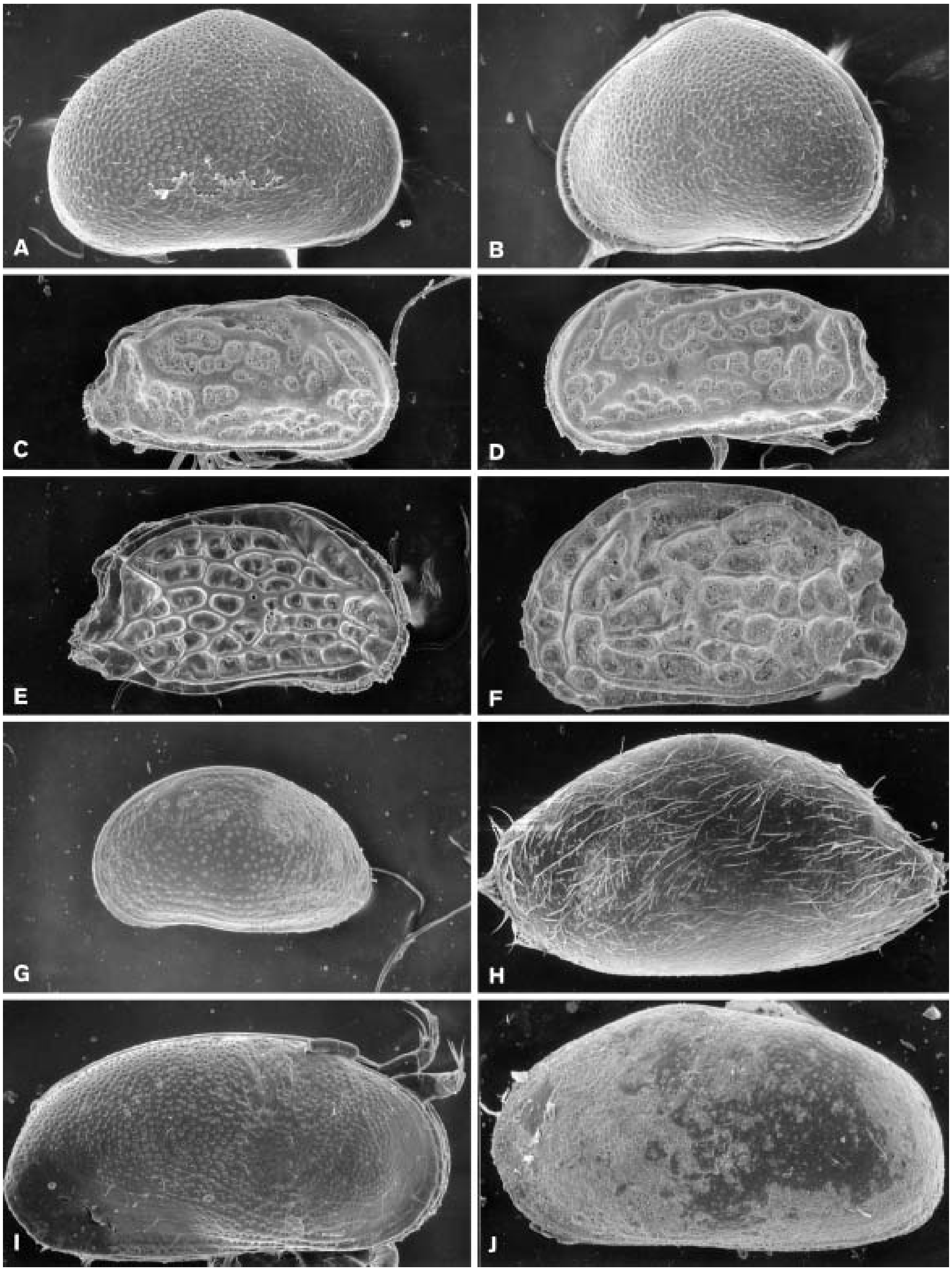

PLATE 195 Podocopida: Bairdiidae, Cyprididae, Cytherideidae, Hemicytheridae. A, B, Cyprididae: *Sarscypridopsis aculeata* (Costa, 1847), CAS 121631, right and left exteriors of female carapaces, X67; Hemicytheridae: *Ambostracon glaucum* (Skogsberg, 1928), CAS 121629 (C, D): C, right exterior of female; D, left exterior of male, X67; E, F, *Radimella aurita* (Skogsberg, 1928), CAS 121627: E, exterior of male (?) right valve; F, exterior of female (?) left valve; both X67; G, *Aurila montereyensis* (Skogsberg, 1928), CAS 121622, exterior of female (?) left valve, X67; Bairdiidae: H, *Neonesidea* sp., CAS 120522, left exterior of carapace, X67; Cytherideidae: I, J: *Cyprideis beaconensis* (LeRoy, 1943), CAS 121619: I, right exterior of male carapace; J, left exterior of female carapace with heavy coating of microbial slime; both X67 (SEMs by D. Peterson).

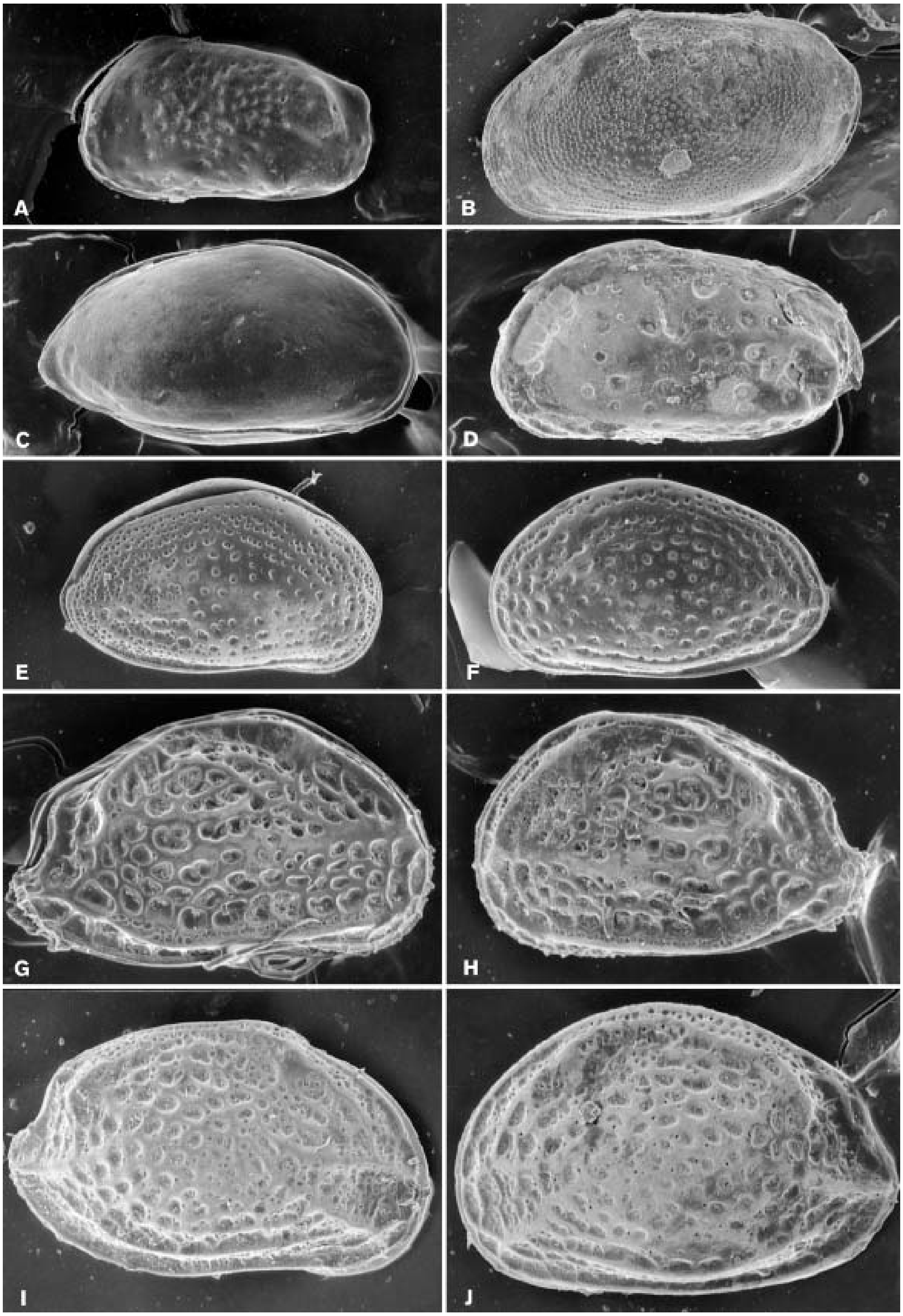

PLATE 196 Podocopida: Hemicytheridae, Loxoconchidae, Pectocytheridae, Schizocytheridae. Pectocytheridae: A, *Pectocythere parkerae* Swain and Gilby, 1974, CAS 121626, exterior of left valve, X100; Loxoconchidae: B, *Loxoconcha lenticulata* (LeRoy, 1943), UMPC 12220, exterior of male left valve, X100; Schizocytheridae: C, *Acuminocythere crescentensis* Swain and Gilby, 1974, UMPC 12096, right exterior of female carapace, X100; D, *Acuminocythere* sp. of Swain and Gilby, 1974, UMPC 12080, exterior of left valve, X100; Hemicytheridae: E, F, *Aurila lincolnensis* (LeRoy, 1943), CAS 121620, right and left exteriors of carapaces, X100; G, H, *Robustaurila jollaensis* (LeRoy, 1943), CAS 1212630, right and left exteriors of carapaces, X100; I, J, *Aurila* aff. *A. corniculata* (Okubo, 1980), CAS 121628, exteriors of right and left valves, X100 (SEMs by D. Peterson).

PECTOCYTHERIDAE

Pectocythere parkerae Swain and Gilby, 1974 (=*Munseyella* sp. B of Valentine, 1976). On sand in 11 m–36 m in Bodega Bay, off Crescent City, and in Coos Bay. Valentine (1976) reported the range in offshore waters as San Diego to Cape Lookout, OR (plate 196A).

Pectocythere tomalensis Watling, 1970 (Crustaceana 19: 251–263). In 6 m on sandy bottom, White Gulch, Tomales Bay; also on sand in 12 m in Bodega Bay (Swain and Gilby 1974, Micropaleo. 20: 257–352); Valentine (1976) reported the range in offshore waters as Monterey Bay to Cape Flattery.

SCHIZOCYTHERIDAE

Acuminocythere crescentensis Swain and Gilby, 1974 (="*Paijenborchella*" sp. A of Valentine, 1976). Morro Bay and off Crescent City and Coos Bay in 10 m–26 m. Valentine (1976) reported the range in offshore waters as north of Point Conception to Cape Flattery (plate 196C).

Acuminocythere sp. of Swain and Gilby, 1974 (="*Paijenborchella*" sp. B of Valentine, 1976). Empty carapace in mud and fine sand, flat exposed at low tide, in Bodega Harbor, RFM. Valentine (1976) reported the range in offshore waters as Pt. Buchon to Little River, CA (plate 196D).

Spinileberis hyalina Watling, 1970. On bottom silt and clay, 2 m, in Tomales Bay. See Watling 1970, Crustaceana 19: 251–263 (plate 191F).

XESTOLEBERIDIDAE

Xestoleberis hopkinsi Skogsberg, 1950. On holdfasts of algae in rocky tide pool full of brown algae, just outside the Hopkins Marine Station, Monterey Bay (plate 194J).

Xestoleberis sp. On mud and fine sand flat exposed at low tide, Bodega Harbor, RFM. It is likely that additional species of *Xestoleberis* occur within our range (plate 194A–194I).

ACKNOWLEDGMENTS

We thank Todd Oakley, Jeff Spees, and James T. Carlton for assistance and for providing new collections of Ostracoda. We also thank Frederick M. Swain for the loan of specimens described by Swain and Gilby (1974) from the University of Minnesota Paleontological Collections; Louis Kornicker and Elizabeth Nelson for literature and information regarding myodocopans and for the loan of the half-tone figures (drawn by Carolyn Gast) in plate 187; Ginny Allen for redrawing many myodocopid figures; and the Bodega Marine Laboratory for providing lab space for Cohen and Oakley during collections and for other assistance.

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Copepoda

JEFFERY R. CORDELL

Free-Living Copepoda (Orders Calanoida, Cyclopoida, and Harpacticoida)

(Plates 197–206)

Copepods have been compared to insects, because, like their terrestrial counterparts, they have successfully occupied an astounding diversity of habitats and modes of life (see Huys and Boxshall 1991 for a summary of copepod habitats). In terms of their importance in marine food webs, the role of copepods cannot be overstated. By way of their conversion of detritus and phytoplankton into animal biomass, copepods often form the first link between primary and secondary consumers. Many commercially important fish, including herring, anchovies, and rockfish feed on planktonic copepods during some or all of their life history stages. Benthic and epibenthic harpacticoid copepods often dominate the diets of flatfish and several species of Pacific salmon during their early life histories.

Given their importance in nearshore and estuarine food webs, one would expect to find a number of ecological and taxonomic studies of copepods of coastal California and Oregon. However, this is not the case. Even though coastal and estuarine ecosystems have undergone and continue to undergo rapid changes and increasing stress due to land use, urbanization, and introduced species, there have been no long-term studies of plankton or meiobenthic dynamics in this region. Likewise, taxonomic compendia of copepods for the Pacific coast are few. Esterly (1905, 1906, 1911, 1924) reported on marine plankton of San Francisco Bay and the San Diego region, Dawson and Knatz (1980) published a list and keys of the planktonic copepods of San Pedro Bay, and Gardner and Szabo (1982) give keys and an annotated bibliography for pelagic marine copepods of British Columbia. Lang (1965) produced what remains one of the finest treatments of a local fauna for harpacticoid copepods from interstitial waters and tide pools near the Hopkins Marine Station in Pacific Grove and the now-gone Pacific Marine Station (formerly located in Dillon Beach). He described 98 species of harpacticoids, of which 81 were new.

Thus the taxonomy of the copepod faunas of many California nearshore habitats remains little-studied, including those from salt marshes, estuaries, seagrass beds, sandy beaches, mudflats, rocky shores, fouling communities, and the shallow subtidal. Many species remain undescribed, and an unknown number of introduced taxa remain undetected. Great care must be exercised in attempting identification of copepods from these habitats. Unfortunately, the primary taxonomic literature usually must be used to identify the most common intertidal copepods, the Harpacticoida, to genus or species levels. However, there are several publications that have keys to higher taxonomic levels. Huys et al. (1996) provide a key to world harpacticoid families, and Boxshall and Halsey's *An Introduction to Copepod Diversity* (2004) contains keys to families of marine planktonic, marine benthic, and fish parasite copepods, and to genera of many copepod families. The latter book is also an excellent starting point for anyone wanting to study copepod classification.

EXTERNAL STRUCTURE OF THREE ORDERS OF FREE-LIVING COPEPODA

Of the nine copepod orders currently recognized, three—Calanoida, Cyclopoida, and Harpacticoida—contain most of the free-living individuals likely to be found in nearshore habitats. A fourth order, the Poecilostomatoida, has been placed into the Cyclopoida (Boxshall and Halsey 2004).

Copepods have developed two basic body plans, gymnoplean and podoplean, which are defined by the position of the major body articulation between prosome and urosome (plate 197). In the gymnoplean plan (Order Calanoida), this articulation is behind the fifth pedigerous somite (plate 197A), and in the podoplean plan (Orders Cyclopoida and Harpacticoida), it is between the fourth and fifth pedigerous segments (plate 197B). The prosome consists of the cephalosome that bears the first six pairs of appendages together with three or four free prosomites, which are sometimes referred to as the metasome and bear four or five pairs of swimming legs (plate 197A, 197B). In most harpacticoids, the somite bearing the first pair of legs is also fused to the cephalosome and together they form the