

Ctenophora

(Plates 72–76)

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The ctenophores, or comb jellies, are transparent animals belonging to a small and entirely marine phylum of about 100–150 species, many (perhaps 50) of which are still undescribed. Although ctenophores are like medusae in being more or less transparent carnivores that often use tentacles to capture their prey, these similarities reflect a convergence in life styles rather than close evolutionary ties. Ctenophores are biradially symmetrical (discussion in Hyman 1940: 665), and nearly all West Coast species except *Pleurobrachia bachei* and some look-alikes are bioluminescent (Haddock and Case 1995). All ctenophores have a distinctive, complex, ciliated statocyst organ at the aboral pole that is used for orientation.

Ctenophores are so-named in recognition of the eight rows of ciliary comb plates, or ctenes, used for locomotion. All ctenophores bear these comb plates at some point in their life cycle, although some species can also move by flapping or waving other structures (the lobes and/or auricles). Most ctenophores use paired tentacles to capture prey, and these tentacles usually carry colloblasts—special, very sticky adhesive cells. Some ctenophore species capture prey on large mucous-laden, muscular surfaces known as lobes with the assistance of greatly reduced tentacles within the lobes. *Beroe*, lacking both lobes and tentacles, swallow their gelatinous prey whole.

The most commonly seen West Coast ctenophore is *Pleurobrachia bachei*, which is often cast up on beaches looking like a clear, watery marble and called a sea gooseberry or cat's eye. Most other species of ctenophores are not so robust and have little to no recognizable form out of water. Because no ctenophores are strictly intertidal invertebrates (although some may be found, on occasion, stranded in pools at low tide), we have taken some liberties in selecting the species to be keyed out here. The common coastal species and those species often encountered by blue-water divers offshore are included, as well as a small number of distinctive and robust deeper species likely to be recovered in midwater trawls not far from the coast.

Benthic ctenophores, known as platyctenes, account for nearly one-third of the known species. The body is highly flattened and modified, so they creep on a “foot” and can look much like flatworms, often living epizoically on other organisms such as sponges or seaweed (although their planktonic

larvae are ciliated like other ctenophores). Although found in many locations worldwide, platyctenid ctenophores occur in warm water and are unlikely to be found within the geographic range of this book. The platyctene *Vallicula multififormis* was present briefly in shallow water in San Diego in 1997, being perhaps a short-lived introduction from the Caribbean.

Preservation of ctenophores is a difficult and frustration-filled endeavor. Some species, including *Pleurobrachia bachei* and some *Beroe*, preserve well, at least some of the time, in a weak ($\leq 5\%$) formalin solution. Some species that leave only bits of debris in the bottle when preserved this way can be better preserved using glutaraldehyde instead of formaldehyde, and storage in a refrigerator after preservation seems to help maintain some specimens. Many fragile ctenophores, however, are simply unpreservable, in which case video, a good set of photographs, and drawings will have to suffice. For further techniques, see the introductory section here on preservation by Williams and Van Syoc.

Families used in the species list are from Cairns et al. (2002). However, a molecular phylogeny (Podar et al. 2001) supports the assertion that the phylum needs to be reorganized (Harbison 1985).

Glossary

(Plate 72)

ABORAL the end opposite the mouth, bearing a ciliated sense organ known as the “statocyst.”

AURICLES four slender gelatinous appendages or processes at the base of the lobes and near the mouth (of a lobate ctenophore), with a ciliated edge; these may be short or long, straight or coiled, and may beat in such a way as to help move water past the lobes.

COMB PLATES transverse rows of thousands of fused macrocilia, shaped roughly like a flat paint brush and comprising subunits that are stacked together to form comb rows (also known as “ctenes”); the effector organs of swimming in a ctenophore (see Tamm 1973).

COMB ROWS eight longitudinal rows or costae of comb plates (ctenes), tightly spaced and overlying the meridional canals, which beat in metachronal waves that pass from the aboral end

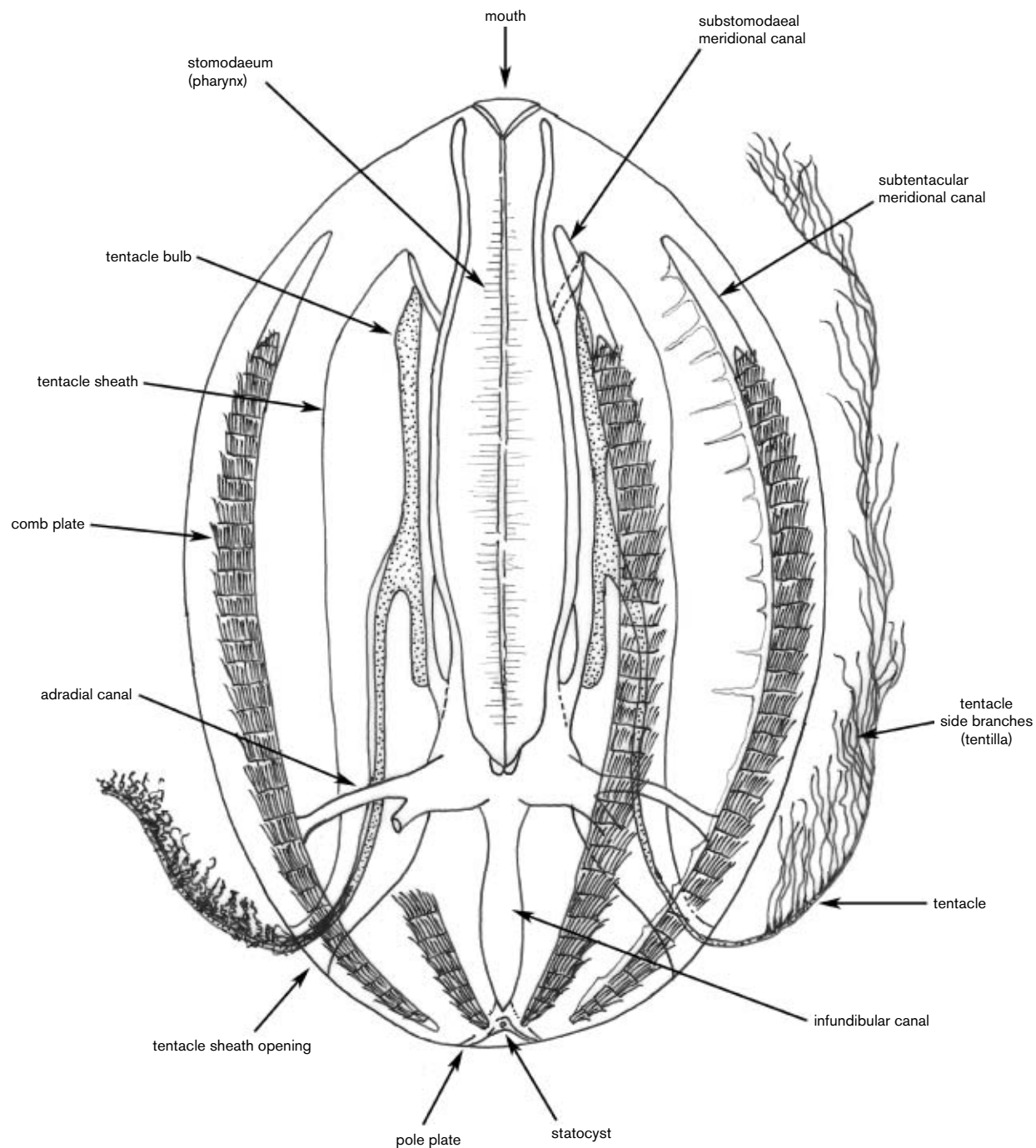


PLATE 72 *Hormiphora* sp., example of a ctenophore with labeled features (undescribed species, redrawn from Stanford, 1931, pp. 32 and 33, figs. 3 and 4).

toward the mouth, and thereby move the animal through the water by ciliary action.

CTENES see "comb plates."

DIVERTICULA (singular diverticulum) side branches or out-pocketings emerging from any of the canals; if these meet and join, it is said that they "anastomose."

GASTRIC CAVITY see "stomodaeum."

INFUNDIBULAR CANAL broad, often funnel-shaped, canal running between the base of the stomodaeum and the aboral pole (also known as the "aboral canal").

LOBES a pair of thin, muscular, cuplike oral extensions of the body; they may be as large or larger than the body itself, on both sides of the mouth.

MEDUSIFORM shaped like a jellyfish (a medusa).

MERIDIONAL CANALS usually eight, but in a few species only four, circulatory canals that run under the comb rows, which are connected by smaller internal canals running through the jelly to the stomodaeum.

MOUTH opening into the stomodaeum at the oral end.

ORAL the end of a ctenophore bearing the mouth.

PARAGASTRIC CANALS pair of canals originating at the base of the stomodaeum, running upward along each flattened surface of the stomodaeum toward the mouth (also known as the pharyngeal canals).

STATOCYST ciliated orientation organ at the aboral pole, which may be flush with the surface or sunken to some extent, and which is connected to the eight comb rows by ciliated grooves (also known as the aboral sense organ).

STOMODAEUM the gastric cavity that opens from the mouth; it is highly expandable (also known as the pharynx).

SUBSTOMODAEAL CANALS the four meridional canals closest to the plane of the stomodaeum.

SUBTENTACULAR CANALS the four meridional canals that lie on either side of the openings of the tentacle sheaths, closest to the plane that runs longitudinally through the two tentacle bulbs.

TENTACLE elongate, highly extensile, (paired) filamentous, feeding appendage, emerging from a swollen tentacle bulb at its base, often with side branches (also known as "tentilla") that are finer than the main, lateral tentacular filament. Tentacles are equipped with thousands of microscopic adhesive structures called colloblasts, with which they capture prey. The tentacles are often fragile and may be partially or entirely broken off during collection.

TENTACLE SIDE BRANCHES fine side filaments on the tentacles of many (but not all) tentaculate species, which may be closely spaced or set rather far apart (also known as "tentilla").

TENTACLE BULBS the (two) swellings at the base of the tentacles, often very elongate, up to half of the body length in some species, from which the tentacular filaments emerge; attached to the inner wall of the tentacle sheaths.

TENTACLE SHEATHS the (two) tubelike, or funnel-shaped, openings from the base of the tentacle filaments at their juncture with the tentacle bulbs, through which the tentacles emerge to the outside.

TENTILLA (singular tentillum) see "tentacle side branches."

VESTIBULE large preoral cavity inside the "mouth" of *Dryodora*, which may hold prey but is separate from the much smaller stomodaeum beneath it.

Key to Ctenophora

1. Body like a sac, mouth opens wide, gastric cavity occupies nearly entire interior; without tentacles or lobes (see plate 76) Order Beroida 23
 - Body otherwise and usually with some sort of tentacles 2
2. Body long and flat, like an airplane wing, with fine tentacles along the entire leading edge that sweep back over the body surface Order Cestida 22
 - Body not like an airplane wing 3
3. Body medusiform, open like a shower cap, with eight short comb rows on the upper surface and two small branched tentacles hanging into the open cavity (Order Thalassocalycida) (plate 75G, 75H) *Thalassocalyce* sp.
 - Body not like a shower cap. 4
4. Body solid, basically rounded at both ends, with a pair of tentacles arising in sheaths on opposite sides of the body; without oral lobes (see plate 72, 73, 76) Order Cydippida 5
 - Body with a pair of muscular, bowl-like lobes at the oral end; usually with small, inconspicuous tentacles between the lobes (see plates 74, 75) Order Lobata 16
5. Tentacles with side branches (tentilla), exiting body closer to the aboral pole or near the midpoint of the body; mouth typically small, often slightly pointed 6
 - Tentacles without side branches, exiting body closer to the oral pole or near the midpoint of the body; mouth very plastic and able to open very wide like a *Beroe* 13
6. Tentacle bulbs short; tentacle sheaths exit near the midpoint of the body 12
 - Tentacle bulbs short or long; tentacle sheaths exit toward the aboral pole 7
7. Body transparent, firm, and unpigmented; rounded like a clear gooseberry or grape 8
 - Body not as above 9
8. Tentacle bulbs short, with tentacle sheaths angling out at nearly 45°; stomodaeum less than half the body length; to about 15 mm diameter (plate 73B). *Pleurobrachia bachei*
 - Tentacle bulbs one-quarter to one half body length; tentacle sheaths parallel the stomodaeum for some distance; stomodaeum greater than one half body length 9
9. Body with tentacle bulbs very close to walls of stomodaeum; transparent and mostly unpigmented; with side branches that extend out when the tentacle is relaxed, forming an ordered, comblike pattern rather than a disorganized mass of fine filaments 10
 - Body with tentacle bulbs parallel to, but somewhat removed from, the walls of the stomodaeum; tentacles either nearly colorless and with a small number of side branches that are kept tightly coiled most of the time, or tentacles deeply colored with many disorganized, fine side branches 11
10. Body to 30 mm in length, moderately compressed, somewhat tapered at the aboral end; narrowing toward the mouth on small specimens, but becoming distinctly wider at the oral end on large ones; comb rows extend from very near the aboral pole to four-fifths body length or more; meridional canals about as long as comb rows and without diverticula; not luminescent (plate 73A) *Hormiphora californensis*
 - Body to 35 mm in length, nearly circular in cross-section, somewhat flattened at the aboral end and narrowing toward the mouth; comb rows extend from very near the aboral pole to at least three-quarters body length; meridional canals extend beyond comb rows and branch inward toward the center of the body; luminescent characteristics not known (plate 72) *Hormiphora* sp. (undescribed)
11. Body to 20 mm in length, tentacles unpigmented or with a little red, with few side branches that are held coiled up except when actively capturing prey; body transparent, sometimes with gelatinous extensions protruding below the statocyst; fast and maneuverable swimmer (plate 73C) *Euplokamis dunlapae*
 - Body to 20 mm in length, tentacles noticeably pink, red, or purplish, with fine and very numerous side branches that extend out to form a diaphanous cloud of filaments; body somewhat opaque, without gelatinous extensions at the aboral pole; not particularly fast swimming (plate 73D) undescribed mertensiid
12. Body to several centimeters long, circular in cross-section; with highly mobile and extensible mouth and with voluminous stomodaeum; young stages can flatten out onto salp body surface to look like a parasite (plate 73E) *Lampea* spp.

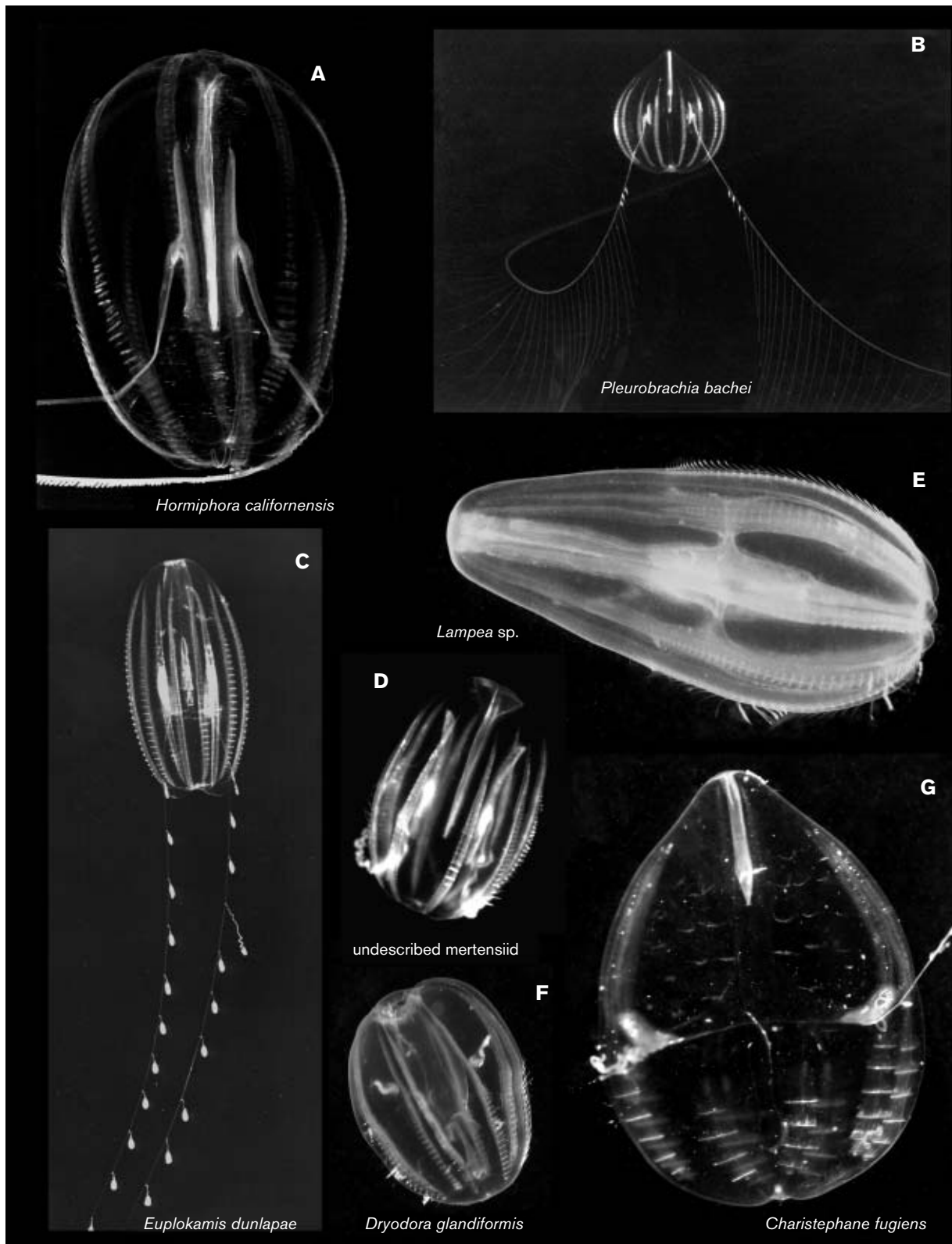


PLATE 73 A, *Hormiphora californensis*; B, *Pleurobrachia bachei*; C, *Euplokamis dunlapae*; D, undescribed mertensiid; E, *Lampea* sp.; F, *Dryodora glandiformis*; G, *Charistephane fugiens* (photographs A-B, D-G by Steven H. D. Haddock; photograph C by Claudia E. Mills).

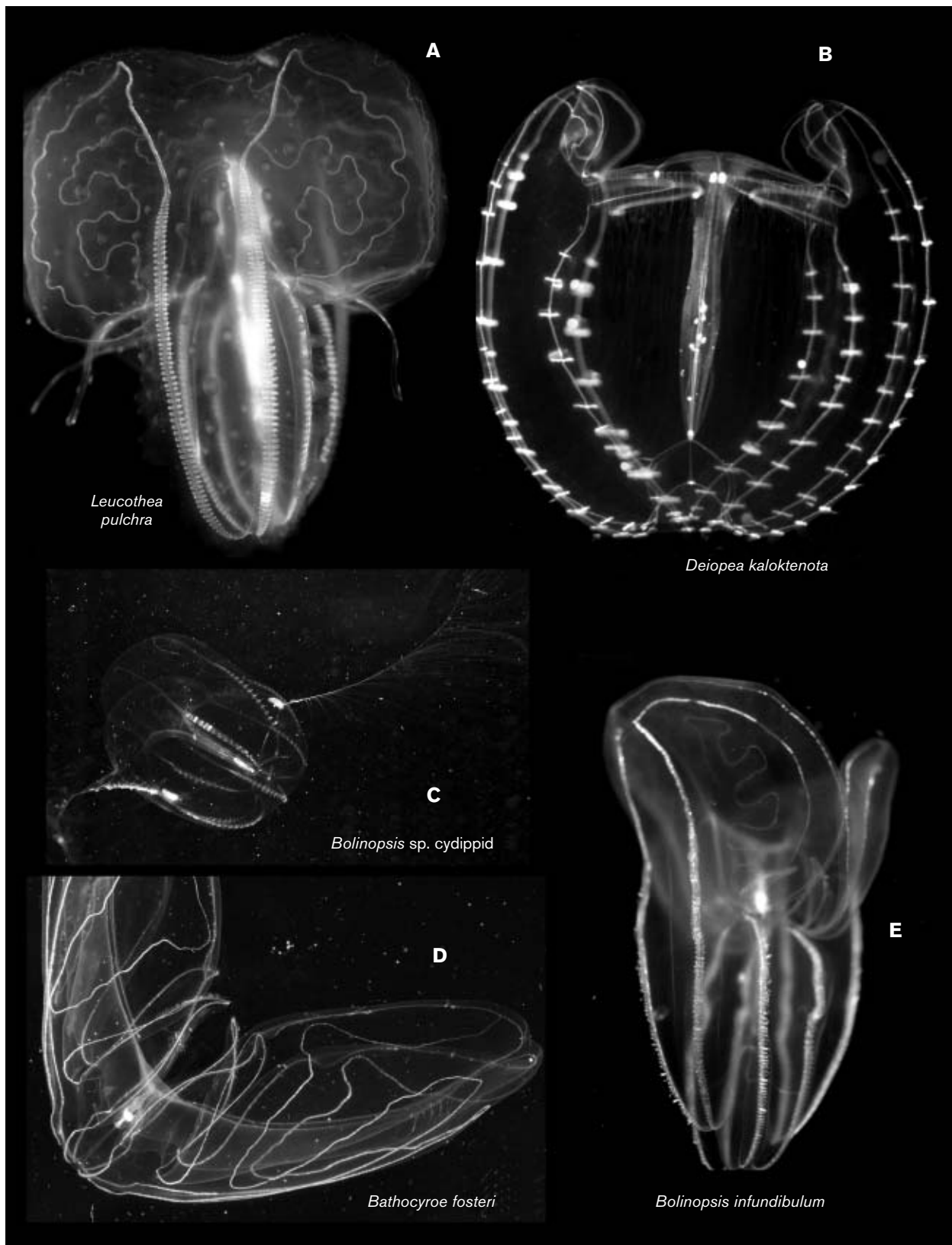


PLATE 74 A, *Leucothea pulchra*; B, *Deiopea kaloktenota*; C, cydippid larva of *Bolinopsis infundibulum*; D, *Bathocyroe fosteri*; E, *Bolinopsis infundibulum*. (all photographs A-E by Steven H. D. Haddock).

- Body to 20 mm tall, highly flattened in cross-section; tentacle sheaths short, angled, and near outer body wall; comb rows limited to aboral end of body, but subtentacular meridional canals extending three-quarters of the way to the oral end; highly transparent and unpigmented, or with light tan tentacles; deep water (plate 73G).
Charistephane fugiens
- 13. Tentacle bulbs small, round, and very near the surface, with sheaths so short that the tentacles are unable to withdraw completely inside; stomodaeum deep inside a large "vestibule" at the oral end of the animal; body transparent, without a greenish tint; a boreal species seen only rarely as far south as California (plate 73F)
Dryodora glandiformis
- Tentacle bulbs very long, typically more than one half the body length and with long, orally exiting tentacle sheaths; stomodaeum extends all the way to oral end of animal (this feature is true of nearly all ctenophores except *Dryodora*, above); body usually with a slight greenish tint. 14
- 14. Meridional canals unequal in length, maximum are three-quarters of body length; comb rows one half to three-fifths of body length; without stomodeal canals; body ellipsoid in cross-section, usually transparent, though may have a greenish cast 15
- Meridional canals all equal in length and nearly as long as the body; comb rows less than one half body length; with stomodeal canals; body nearly circular in cross-section; usually <10 mm long, with long tentacle sheaths exiting the body near the mouth; without distinctive orange pigment spots, but usually slightly opaque body may have red pigment diffusely distributed along canals (plate 76G) *Haeckelia beehleri*
- 15. Very small, usually <3 mm, with rounded oral end; with long tentacle sheaths exiting about one-quarter of the body length below the mouth; with large orange-red pigment spots on the canals around the base of the stomodaeum and tentacles, and with small red spots along the comb rows (plate 76J) *Haeckelia bimaculata*
- Small, usually under 7 mm long, with pointed oral end; with long tentacle sheaths exiting the body near the mouth; with two pairs of orange-red pigment spots—on the tentacle bases and about two-thirds to three-quarters down the tentacle sheaths (plate 76H, 76I)
Haeckelia rubra
- 16. Body with two rounded, lobe-like extensions used to catch prey and with four elongate, ciliated auricles that help move water across the lobes. 17
- Body with two rounded, lobe-like extensions used to catch prey, but without auricles; body to 20 cm, rounded with very large lobes, colorless but not very transparent, comb rows end on stubby protrusions near mouth, in the place of auricles (usually in deep water) (plate 75A).
 undescribed "giant lobate"
- 17. Body surface smooth, mostly colorless; lobes either as large as the rest of the body or considerably smaller; with static auricles. 18
- Body surface covered with brownish orange papillae; with very large lobes that can extend perpendicularly as much as a full body length; with long slender auricles that beat rhythmically (plate 74A). *Leucothea pulchra*
- 18. Lobes usually shorter than stomodaeum, not capable of flap/swimming (see choice below) 19
- With large, muscular lobes that are used for feeding but can also be clapped together for escape swimming in a movement reminiscent of the swimmer's "frog kick" 21
- 19. Body oblong and rounded at both ends, not highly flattened; may have rows of dark spots on the lobes in line with the canals, which in larger specimens may coalesce into dark pigmented lines; total length to 15 cm (this is the common Pacific coast lobate) (plate 74E)
Bolinopsis infundibulum
- Body highly flattened (rare coastal visitors from deep water) 20
- 20. Body rounded to oval in outline, highly flattened; with a pair of relatively small oral lobes; with only a few ctenes, spaced far apart on each comb row; total length not exceeding 5 cm; rare (plate 74B) *Deiopea kaloktenota*
- Body semi-circular to V-shaped, highly flattened; unpigmented, with a pair of large oral lobes; total length to 30 cm; rare (plate 75F) *Kiyohimea* spp.
- 21. Body flattened and reduced; may have a pair of diffuse dark spots on the inner surface of each lobe; gut colorless; near-surface species (plate 75B) *Ocyropsis maculata*
- Body rounded, much shorter than lobes; with small, dark-red stomodaeum; deep water species (plate 74D)
Bathocyroe fosteri
- 22. Length to 1.5 m, but usually <80 cm, the set of canals that run out the midline of the body originate near the base of the stomodaeum, rapidly curving up to the midline; gonads continuous; escapes by graceful rapid undulating of the body (plate 75D) *Cestum veneris*
- Usually <20 cm long, the set of canals that run out the midline of the body originate near the center of the stomodaeum, without curves; gonads visible as dashed white line; escape swimming very rapid wriggling (plate 75C, 75E) *Velamen parallelum*
- 23. Body highly flattened 24
- Body cylindrical to moderately compressed 25
- 24. Body to 15 cm, shaped like a compressed cone, with pointed aboral end and broad oral end with very large mouth; comb rows all the same length and extend three-quarters to five-sixths of body length; with highly branched meridional canals forming a network whose branches anastomose (merge) with one another; usually tinged rose pink, with darker red along the comb rows (plate 76A) *Beroe forskalii*
- Body to about 6 cm, soft and flaccid, with aboral end round to slightly tapered and oral end very broad with nearly semicircular mouth; comb rows of two lengths, extending about one half and two-thirds to three-quarters body length; meridional canals with many branches that all bend toward the mouth and do not merge with one another; overall color white or pale pink, with a diffuse orange or red spot or pair of stripes on either side of the body overlying the stomodaeum (plate 76E, 76F)
Beroe mitrata
- 25. Body slender and elongate, rarely longer than 3 cm and usually much less; meridional canals with very few branches, and those present extending inward toward the stomodaeum rather than in the plane of the body surface (plate 76D). *Beroe gracilis*
- Body substantial and thick-walled, typically reaching several centimeters in length, meridional canals branched and running in the plane of the body surface, but few if any of the branches merge. 26

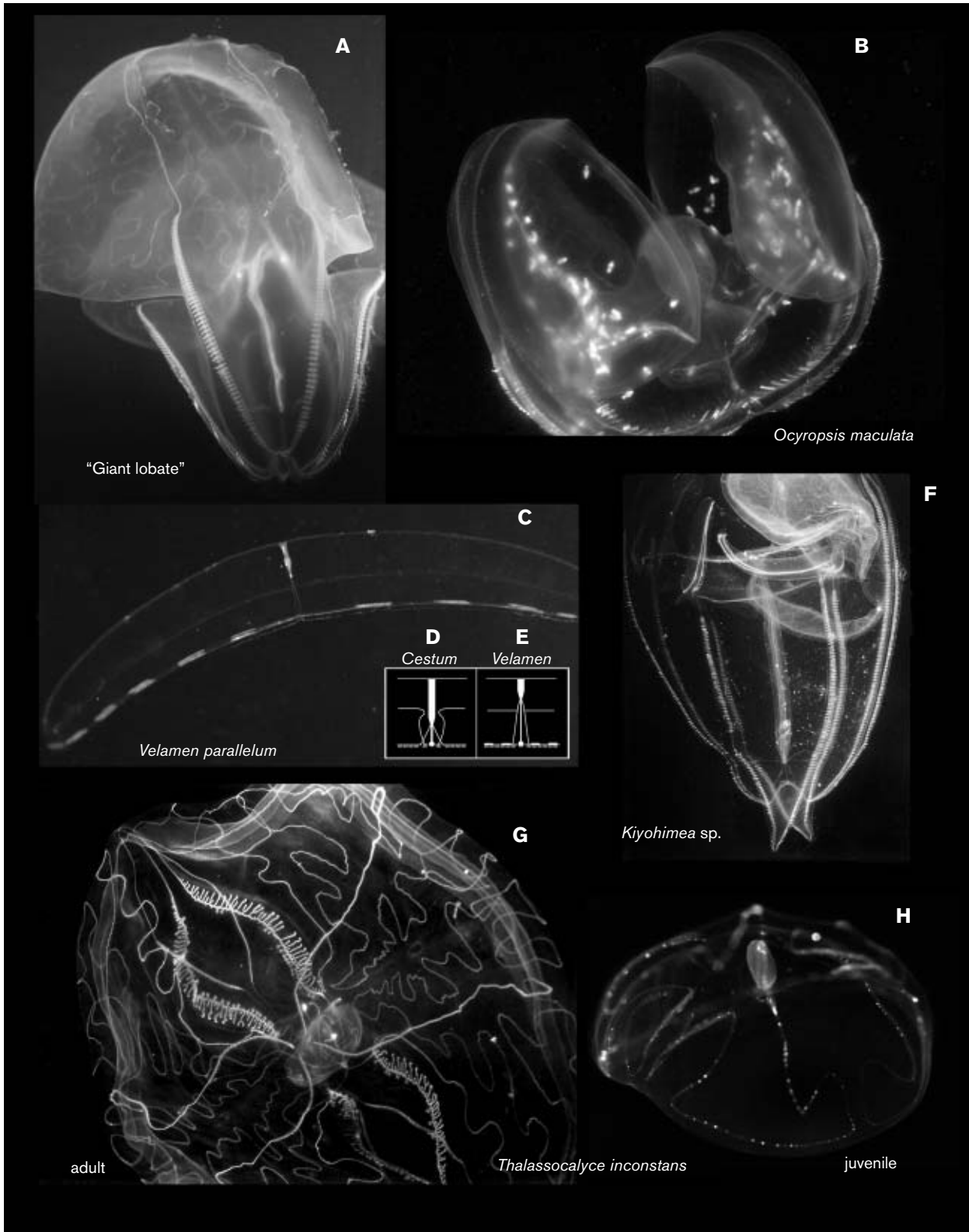


PLATE 75 A, Undescribed "giant lobate"; B, *Ocyropsis maculata* (white spots are symbiotic amphipods); C, *Velamen parallelum*; D, *Cestum veneris*; E, *Velamen parallelum*; F, *Kiyohimea* sp.; G, adult *Thalassocalyce inconstans*; H, juvenile *Thalassocalyce inconstans* (photographs A, B, C, E, G, H by Steven H. D. Haddock).

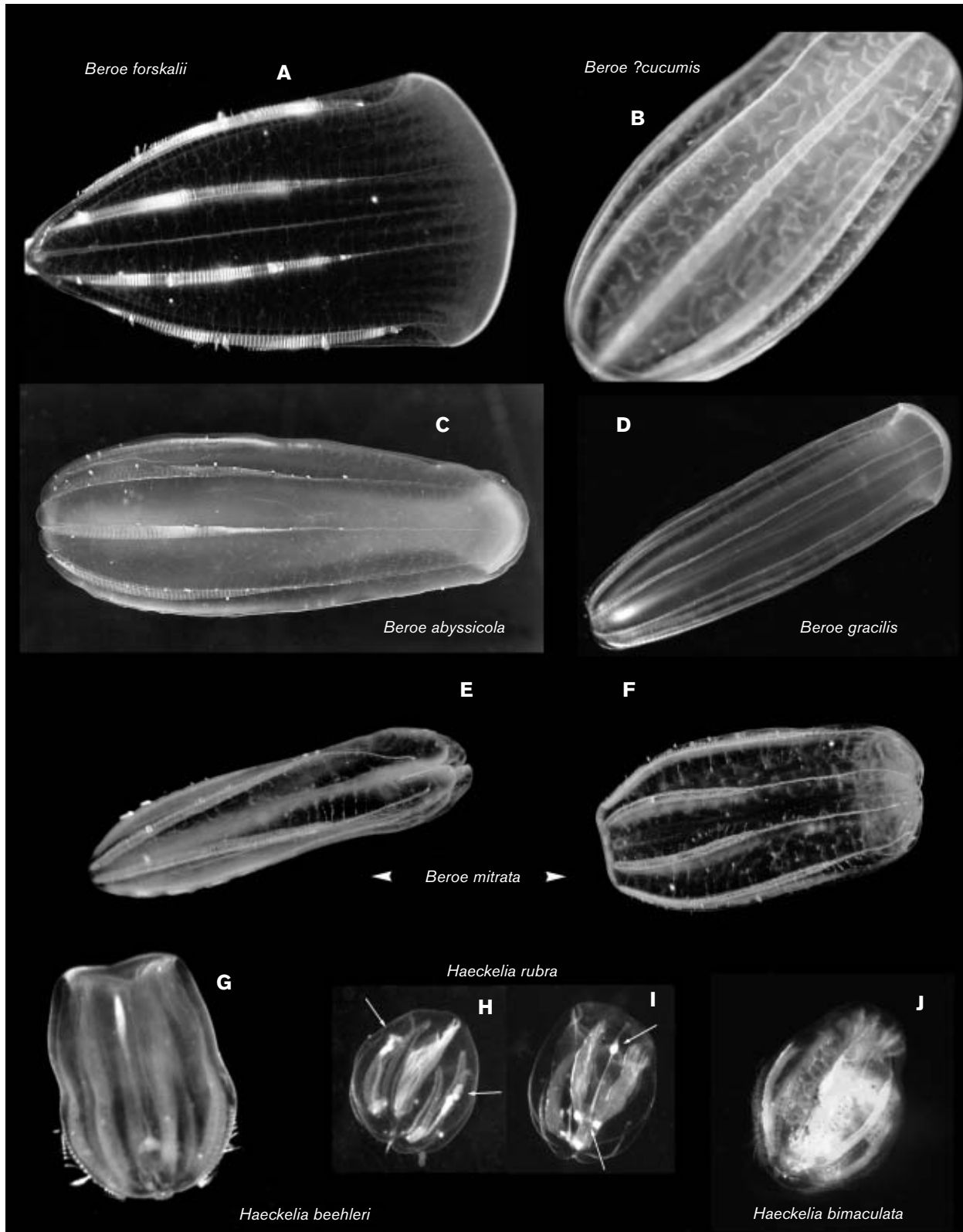


PLATE 76 A, *Beroe forskalii*; B, *Beroe ?cucumis*; C, *Beroe abyssicola*; D, *Beroe gracilis*; E and F, *Beroe mitrata*; G, *Haeckelia beehleri*; H and I, *Haeckelia rubra* (arrows indicate distinctive spots of red-orange pigment); J, *Haeckelia bimaculata* (photographs A, B, D, G, H, I, J by Steven H. D. Haddock; photographs C, E, F by Claudia E. Mills).

26. Body to 10 cm, usually much less, comb rows of two lengths, extending about one half and two-thirds the distance from aboral pole towards the mouth; transparent and colorless or with golden tan and/or orange-pink pigment on outer surface or along stomodaeum; paragastric canals unbranched; found near the surface, as well as to about 500 m (common) (plate 76B). *Beroe ?cucumis*
 — Body to 7 cm, comb rows of equal lengths, extending one half to two-thirds the distance from aboral pole towards the mouth; body somewhat opaque and usually with intense red, purple or nearly black color lining the stomodaeum; paragastric canals branched—with diverticula; deep water (plate 76D) *Beroe abyssicola*

List of Species

Order Cydippida

DRYODORIDAE

Dryodora glandiformis (Mertens, 1833). A boreal species known from both northern and southern oceans; found near Friday Harbor most years in the late winter and spring and rarely seen off central California; usually <1 cm long in our waters, but two or three times that size in the Arctic. Feeds, perhaps exclusively, on appendicularians. Color photograph in Wrobel and Mills 1998 and 2003, p. 63.

EUPLOKAMIDIDAE

Euplokamis dunlapae Mills, 1987. This species (to 2 cm long) is well-known from fjords in Washington and British Columbia. An unidentified *Euplokamis*, which may prove to be *E. dunlapae*, has been seen occasionally on video in Monterey Bay. See Mills 1987, Can. J. Zool. 65: 2661–2668 (description, behavior, larvae, depth distribution in British Columbian fjords); Mackie, Mills, and Singla 1988, Zoomorphology 107: 319–337 (prey capture and morphology of prehensile side branches on tentacles); Mackie, Mills, and Singla 1992, Biol. Bull. 182: 248–256 (giant axons and escape swimming). Color photograph in Wrobel and Mills 1998 and 2003, p. 62.

HAECKELIIDAE

Haeckelia beehleri (Mayer, 1912). Usually <1 cm, occasionally seen near the surface by divers, sometimes together with *H. bimaculata* and/or *H. rubra*. Body wall has a distinct green tint. Color photograph in Wrobel and Mills 1998 and 2003, p. 59.

Haeckelia bimaculata Carré and Carré, 1989. A tiny (<3 mm long) species, sometimes seen near the surface by very observant divers. See Carré and Carré 1989, Comptes Rendus de l'Académie des Sciences, Paris, 308 (série III): 321–327. Like *H. rubra*, this species uses cnidocysts from narcomedusan prey in its tentacles instead of colloblasts. Color photograph in Wrobel and Mills 1998 and 2003, p. 59.

Haeckelia rubra (Kölliker, 1853) (= *Euchlora rubra*). Usually <1 cm and has cnidocysts instead of colloblasts on its tentacles; the cnidocysts are obtained from narcomedusan prey, much in the way some nudibranchs obtain them from hydroids or sea anemones. See Mills and Miller 1984, Mar. Biol. 78: 215–221 (feeding behavior); Carré and Carré 1980, Cah. Biol. Mar. 21:

221–226 (cnidocysts and feeding); Carré, Carré, and Mills 1989, Tissue and Cell 21: 723–734 (cnidocysts in *H. rubra* and narcomedusan prey). Color photograph in Wrobel and Mills 1998 and 2003, p. 59.

LAMPEIDAE

Lampea panzerina (Chun, 1879). A rare visitor to central and southern California. Several species of *Lampea* could be found in our region, all reaching several centimeters in length. All feed, perhaps exclusively, on salps, to which they may attach and flatten out, looking like parasites, as they feed; large *Lampea* can ingest whole salp chains. Color photograph in Wrobel and Mills 1998 and 2003, p. 60.

MERTENSIIDAE

Charistephane fugiens Chun, 1879. The refractive index of this highly flattened species is so similar to that of water that it is easily missed among other animals in midwater trawl samples; up to about 2 cm in length. Front and side-view photographs in Wrobel and Mills 1998 and 2003, p. 62.

Undescribed mertensiid. A cydippid to about 2 cm in length, with pink tentacles having high numbers of side branches (tentilla) that look like a fuzzy cloud when extended underwater, is collected occasionally at least from central California and the Puget Sound/Strait of Georgia region. This may be the species erroneously called "*Mertensia ovum*" in the previous edition; *M. ovum* is an Atlantic boreal and arctic species not known from the Pacific (alternately, Torrey [1904] mistakenly labeled his drawing of *Hormiphora californensis* (see below) as *M. ovum*, which may be the origin of this name in the California fauna in previous editions of this book). Color photograph in Wrobel and Mills 1998 and 2003, p. 63.

PLEUROBRACHIIDAE

Hormiphora californensis (Torrey, 1904). The original description, as *Euplokamis californensis*, is incomplete, and the figure accompanying it is unfortunately mislabeled as "*Mertensia ovum*"; occurs at least off San Diego and Santa Barbara and in Friday Harbor with *Pleurobrachia bachei* and may be substantially larger—to about 3 cm long—but most casual observers will not notice this second species as different. Color photograph in Wrobel and Mills 1998 and 2003, p. 60.

Hormiphora sp. (undescribed). This approximately 3-cm-long Monterey Bay species was treated in the unpublished master's thesis of Stanford (1931) under the *nomen nudum* *Hormiphora coeca*. It is possible that it is the same as *H. californensis*, but the branched or diverticulate meridional canals described by Stanford appear to differentiate the two species. *Hormiphora* spp. on our coast are rarely recognized by the casual observer to be different from *Pleurobrachia bachei*.

Pleurobrachia bachei A. Agassiz, 1860. Probably the most common ctenophore in northeast Pacific coastal waters, to about 1.5 cm long, frequently occurring in great numbers and sometimes left by outgoing tides on the beaches, looking like glassy marbles. See Hirota 1974, Fish. Bull. 72: 295–335 (natural history); Tamm and Moss 1985, J. Exp. Biol. 114: 443–461 (spin feeding in the related *P. pileus*). Color photograph in Wrobel and Mills 1998 and 2003, p. 62.

Order Platyctenida

COELOPLANIDAE

**Vallicula multiformis* Rankin, 1956. This small warm-water benthic ctenophore, apparently native to the Caribbean, was seen briefly in shallow water in San Diego late in the El Niño summer of 1997, but disappeared when the water cooled down to normal temperatures (Constance Gramlich and George Matsumoto, personal communication). It can occur on a variety of substrates including algae, eelgrass, rock, and floats. It has also been collected in Hawaii on floats.

Order Thalassocalycida

THALASSOCALYCIDAE

Thalassocalyce sp. Probably *T. inconstans* Madin and Harbison, 1978, described from the Sargasso Sea and Northwest Atlantic slope water, which can reach at least 15 cm in diameter, but specimens seen near shore in our waters are usually much smaller juveniles (plate 75H). As it has become evident that this fragile species is not so uncommon, one wonders if more than one species of *Thalassocalyce* exist under a single name; specific differences have not yet been established. See Madin and Harbison 1978, Bull. Mar. Sci. 28: 680–687. Color photograph in Wrobel and Mills 1998 and 2003, p. 63.

Order Lobata

BATHOCYROIDAE

Bathocyroe fosteri Madin and Harbison, 1978. This not-uncommon species, reaching 4 cm across the lobes, was described from the northwest Atlantic, and it is possible that more than one species of *Bathocyroe* exists under this single name; it is common in deep water off California and easily distinguished by its flap-swimming (but see also *Ocyropsis*). See Madin and Harbison 1978, Bull. Mar. Sci. 58: 559–564. Color photograph in Wrobel and Mills 1998 and 2003, p. 64.

BOLINOPSISIDAE

Bolinopsis infundibulum (O. F. Müller, 1776). This common arctic and boreal lobate species occurs from the Bering Sea to California, from the surface to about 400 m, reaching lengths of up to 15 cm, but near-shore specimens along our coast are usually much smaller. (*Bolinopsis* off central Mexico are apparently *B. vitrea* [L. Agassiz, 1860], a subtropical species). Feeding behavior described by Matsumoto and Harbison (1993). Color photograph in Wrobel and Mills 1998 and 2003, p. 64.

EURHAMPHAEIDAE

Deiopea kaloktenota Chun, 1879. Known from several sites worldwide, this distinctive smaller lobate (to 4.5 cm) may be a younger (and usually shallower) stage of *Kiyohimea*, the only other known ctenophore with widely spaced ctenes, but the morphology of young stages of *Kiyohimea* is not yet known. Color photograph in Wrobel and Mills 1998 and 2003, p. 65.

**Eurhamphaea vexilligera* Gegenbauer, 1856. A warm water species to several centimeters in length that, in some years, is encountered in the southern end of our area. This distinctive lobate has a pair of long filamentous “tails” trailing from the aboral end and releases luminescent ink from sacs near the comb rows when disturbed. Feeding behavior described by Matsumoto and Harbison (1993).

Kiyohimea aurita Komai and Tokioka, 1940. Described from a specimen found near the Seto Marine Biological Laboratory in Japan that had found its way inshore and was possibly damaged, having tentacle bulbs but no tentacles; body semicircular at the aboral end. Entire, undamaged specimens of this extremely fragile species are rarely collected, but may reach 30 cm or more in length.

Kiyohimea usagi Matsumoto and Robison, 1992. A large, very fragile, deep water species described from Monterey Bay, differentiated from *K. aurita* by having tentacles and being more V-shaped. See Matsumoto and Robison 1992, Bull. Mar. Sci. 51: 19–29; color photograph in Wrobel and Mills 1998 and 2003, p. 65. The two species of *Kiyohimea* could very likely be the same, in which case the name *K. aurita* has precedence.

LEUCOTHEIDAE

Leucothea pulchra Matsumoto, 1988. Described from Monterey Bay and near Catalina Island, this species, which may be 25 cm or more in length, is similar to the more cosmopolitan *L. multicornis* (Quoy and Gaimard, 1824). See Hamner, Strand, Matsumoto, and Hamner 1987, Limnol. Oceanogr. 32: 645–652 (foraging behavior); Matsumoto 1988, J. Plankton Res. 10: 301–311 (description and feeding); Matsumoto and Hamner 1988, Mar. Biol. 97: 551–558 (swimming and feeding behavior). Color photograph in Wrobel and Mills 1998 and 2003, p. 65.

OCYROPSIDAE

Ocyropsis maculata (Rang, 1828). This flap-swimming, surface-dwelling species to several centimeters long is occasionally seen off Catalina Island and other southern California sites, where its occurrence probably best corresponds with strong El Niños, including that of 1997. The species name recalls the pair of large, dark, diffuse spots on the lobes—other species of *Ocyropsis* do not have these spots. Feeding behavior described by Matsumoto and Harbison (1993). Although most ctenophores are hermaphrodites, this genus usually has separate sexes (see Harbison and Miller 1986, Mar. Biol. 90: 413–424). Color photograph in Wrobel and Mills 1998 and 2003, p. 66.

FAMILY UNKNOWN

Undescribed “giant lobate.” Distinctive species only seen as an adult in deep water. Its younger stages have not been described, but should be readily distinguished by the lack of auricles.

Order Cestida

CESTIDAE

Cestum veneris Lesueur, 1813. Venus’ girdle. Uncommon from central California south; cosmopolitan in warmer waters where

* = Not in key.

it may reach over 1 m in length. Feeding behavior described by Matsumoto and Harbison (1993). Color photograph in Wrobel and Mills 1998 and 2003, p. 66.

Velamen parallelum (Fol, 1869). This very fast (often described as “darting”), small (to 20 cm) “Venus’ girdle” occurs fairly often from central California south. Feeding behavior described by Matsumoto and Harbison (1993). Color photograph in Wrobel and Mills 1998 and 2003, p. 67.

Order Beroida

BEROIDAE

Feeding behavior described by Matsumoto and Harbison (1993). Diversity of oral macrocilia and possible concomitant diet differences are described by Tamm and Tamm (1993).

Beroe abyssicola Mortensen, 1927. A usually deep water species reaching several centimeters in length, but sometimes also found at the surface, distinguished by its darkly pigmented gut; Vancouver Island to central California. See Arai 1988, Contrib. Nat. Sci. Roy. British Columbia Mus. 9: 1–7 (redescription); Mills and McLean 1991, Dis. Aquat. Org. 10: 211–216 (parasitic dinoflagellates on comb rows). Color photograph in Wrobel and Mills 1998 and 2003, p. 67.

Beroe ?cucumis Fabricius, 1780. A several-centimeter-long surface species in central California that may also be taken as deep as several hundred meters off southern California; corresponds fairly well to the description of *B. cucumis*, a bipolar arctic species, but it has not been demonstrated that the California specimens are really the same as those known from the Arctic. Color photograph in Wrobel and Mills 1998 and 2003, p. 68.

Beroe forskalii Milne Edwards, 1841. Probably an oceanic species, but seen fairly often along the California coast, where it reaches several cm in length. See Tamm and Tamm 1991, Biol. Bull. 181: 463–473 (how *Beroe* keeps its mouth shut using epithelial adhesion while swimming in a forward direction). Color photograph in Wrobel and Mills 1998 and 2003, p. 68.

Beroe gracilis Künne, 1939. A small species, often <1 cm long, described from near Helgoland in the northeast Atlantic, seen occasionally in swarms off central California and also collected individually in Friday Harbor. Probably more widely distributed, but not often specifically identified. Color photograph in Wrobel and Mills 1998 and 2003, p. 68.

Beroe mitrata (Moser, 1907). An infrequent visitor, to several centimeters cm in length. This highly mobile ctenophore (which can turn itself inside out), known also from Japan and the Mediterranean, may be an oceanic resident that sometimes is transported inshore. Color photograph in Wrobel and Mills 1998 and 2003, p. 69.

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