

## Nemertea

(Plates 86–90)

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Nemerteans, or ribbon worms (previously known as Rhynchocoela and Nemertini) are soft-bodied, unsegmented worms. About 1,150 nemertean species are recognized (Gibson 1995); 119 benthic forms are reported from U.S. Pacific waters (Crandall and Norenburg 2001) and approximately 50 species are known from intertidal areas of central and northern California and Oregon.

Most nemerteans are free-living benthic marine worms. About 100 species are members of deep-sea pelagic communities, a few species live in damp conditions on land (e.g., *Geonemertes*), a few inhabit fresh water (e.g., *Prostoma*), several live in the mantle cavity of clams (e.g., *Malacobdella*), and a variety of decapod crustacean species host species of the genus *Carcinonemertes*. The primary diagnostic features of nemerteans are the proboscis, usually a long, eversible tubular structure, and the fluid-filled rhynchocoel chamber within which the proboscis resides (dorsal to the digestive tract). Development is via a juvenile-like pelagic (planuliform) larva or benthic encapsulated development, typical of palaeo- and hoplonemerteans, or via a planktonic pilidium larva, typical of heteronemerteans (Norenburg and Stricker 2001).

The traditional higher classification of nemerteans is in flux. Cladistic and molecular studies are likely to significantly modify the classification. The proboscis is unarmed in members of the class Anopla, comprising the orders Palaeonemertea and Heteronemertea, whereas in the order Hoplonemertea (class Enopla), the proboscis is three-chambered and armed with one or many stylets (plate 90A). However, there is strong support for considering Heteronemertea and Hoplonemertea to be sister-groupings (Thollesson and Norenburg 2003). The relationships within Palaeonemertea and to the previous two groupings are still unclear. Therefore, we keep the name Palaeonemertea here and abandon the names Anopla and Enopla. The traditional order Bdellonemertea has been dropped, as its only genus, *Malacobdella*, clearly belongs within the Hoplonemertea Monostilifera (Thollesson and Norenburg 2003).

The proboscis typically is used in food capture; in a few species, it is also used for locomotion, including escape responses (particularly in the terrestrial and some of the supralittoral species). Most nemerteans are predators on polychaetes, various crustaceans or insects, or clams; some include opportunistic necrophagy and detritivory. The proboscis secretes

sticky and, in many species, toxic substances that serve to trap, hold, and paralyze the prey. Upon contact with a prey organism, the proboscis is rapidly everted and coiled around the prey, which is swallowed whole; often the mouth is capable of distending several times more than the diameter of the worm itself. Alternatively, the prey is stabbed by the stylet, making a wound through which toxins are delivered; the prey is swallowed whole or digestive enzymes are secreted into the stylet wound and the prey is consumed in suctorial fashion.

Identification of most nemertean species is difficult and time-consuming, usually requiring study of internal anatomy by means of light microscopy on serial sections. Specimens must be thoroughly relaxed (narcotized) prior to fixation. Nemertean species differ widely in their response to various relaxing agents. We have found the most success with magnesium chloride, MgCl<sub>2</sub> made isotonic to seawater (approximately 7.5% weight to volume in drinking water). Either the specimen is dropped directly into a 1:1 mixture of 7.5% MgCl<sub>2</sub> and seawater, or the 7.5% MgCl<sub>2</sub> is added slowly to seawater surrounding the specimen until a 1:1 mixture is achieved. If that fails, we often get good results by using either a 0.15–0.2% emulsion of propylene phenoxetol in seawater (or add 2% emulsion drop-wise to seawater surrounding specimen) or tricaine methanesulfonate (MS-222) crystals added gradually to seawater surrounding the specimen. Relaxed specimens are fixed in buffered 10% formalin (or 10% formalin-seawater) for 24 hours, followed by Bouin or Bouin-Hollande for about 24 hours. After fixation, they are transferred incrementally to 70% ethyl alcohol over a 24-hour period, followed by several changes of 70% ethyl alcohol over a period of days or weeks. The stylet armature of hoplonemerteans contains calcium and will be destroyed or deformed if the specimen is left in fixative too long.

Field identification is reliable for those species having unique color patterns or other unique external features. Some hoplonemertean species can be identified by characteristics of the proboscis armature, such as basis shape, sculpturing of the stylet, or number of accessory stylet sacs. These characteristics are best observed from living specimens. If the animal is sufficiently small and transparent, the proboscis armature can be viewed by compressing the whole animal between a microscope slide and coverslip. For large or opaque hoplonemerteans, it is best to remove the proboscis prior to fixing the specimen, as follows: once the specimen is completely relaxed, cut the animal transversely about two head-lengths from the snout. Pull

the proboscis from the cut end of the posterior body part, at least past the bulbous middle chamber, and cut the proboscis from the animal (the proboscis is attached posteriorly in the rhynchocoel by a highly extensible retractor muscle). The proboscis can then be placed in seawater on a microscope slide, with the middle chamber compressed under a coverslip. After observation, the proboscis should be preserved along with the specimen from which it came.

Monographs by Coe (1901, 1904, 1905, 1940) are the most comprehensive taxonomic references for benthic nemerteans of the Pacific coast. Coe (1943), covering U.S. Atlantic species, is useful for West Coast species also having Atlantic distribution. Gibson (1995) is a nomenclatural review of nemertean genera and species. A web site for nemertean research, <http://nemertes.si.edu>, has available a comprehensive bibliography, searchable by taxon and author, a nomenclator with valid binomens and synonyms, a list of contact information for specialists, digital identification keys, and a comprehensive checklist of U.S. Pacific coast nemerteans (Crandall and Norenburg 2001).

## Acknowledgments

We thank Eugene C. Haderlie for information in previous editions of this Manual, thereby making this update less arduous. This material is based upon work supported by the National Science Foundation under Grant No. DEB 9712463.

## Glossary

**ACCESSORY STYLET SACS** or **POUCHES** sacs lateral to the central stylet(s) and basis in the proboscis bulb region of armed proboscis (hoplonemerteans) containing accessory stylets. Plate 90A.

**BASIS** the structure to which the central stylet(s) in the proboscis of hoplonemerteans is (are) attached. Plate 90A.

**CAUDAL CIRRUS** small, taillike appendage at the posterior end of some heteronemertean species (plate 87A, 87C, 87E); may be lost during collecting.

**CEPHALIC FURROWS** pair of lateral, shallow ciliated grooves anterior to or near front of cerebral ganglia and posterior ciliated grooves running obliquely or transversely across the dorsal and ventral surfaces of the head, meeting mid-dorsally and usually mid-ventrally, typically over or in back of the cerebral ganglia. Plates 89A, 89E, 89J, 90H, 90R.

**CEPHALIC LOBE** front end of body that appears to be the head, but usually the brain is behind this. Plate 89E, 90R, 90AA.

**CEPHALIC SLITS** deep longitudinal slits or furrows along the anterior-lateral margin in most heteronemerteans, except Baseodiscidae (plate 88E, 88H).

**CEREBRAL ORGAN, CEREBRAL SENSORY ORGAN** a pair of ciliated canals or pits and a surrounding mass of nervous and glandular tissue, closely associated with the brain; fused to the posterior of the ganglia in Heteronemertea; connected by a nerve in Hoplonemertea, usually in front of, but may be in back of or next to, cerebral ganglia; organs not present in some species. Externally, cerebral organs usually open to the outside at the posterior of the cephalic slits of Heteronemertea, as lateral or sub-lateral pores in the anterior dorso-ventral furrows of Hoplonemertea, or as simple pores on the lateral body surface of Palaeonemertea. When mentioned in the key, look for tiny, circular, lateral holes near the brain.

**LATERAL SENSE ORGAN** a pair of lateral pits found in a few Palaeonemertea species. Each appears as a small circle well

behind the brain on the lateral margin of the body (spot in fifth white band.) Plate 86D.

**PROBOSCIS ARMATURE** the basis, central stylet(s), and accessory stylets and sacs found at the anterior portion of the bulb region of the proboscis in hoplonemerteans. Plate 90A.

**PROBOSCIS CHAMBERS** in hoplonemerteans, the proboscis is divided into a long anterior chamber with tall epithelium usually forming distinct papillae, a muscular central chamber or bulb region, and a posterior chamber, often shorter than the anterior chamber and lined with secretory epithelium (plate 90A). A duct passing from the posterior chamber through the bulb region to the base of the central stylet allows posterior chamber secretions (presumably toxins) to bathe the central stylet, thus creating a "poisoned dagger" for use in immobilizing prey.

**PROBOSCIS PORE, RHYNCHOSTOME** opening through which the proboscis everts, usually at the anterior tip of the body (anteriorly located openings in plate 86B, 86C).

**RHYNCHOCOEL** the fluid-filled chamber in which the proboscis lies.

**RHYNCHODAEUM** apical or subapical invagination of the body wall through which the proboscis is everted; also serving as the mouth in Monostilifera species.

**STATOCYST** structure found in *Ototyphlonemertes*: consists of a cell-lined vesicle (transparent sphere) embedded in the dorsal surface of each ventral ganglion of the brain, just behind the dorsal ganglion. The vesicle contains a statolith consisting either of two to eight easily counted spherical granules (oligogranular, plate 90GG), or it is a spherical aggregation of usually 12 or more such granules (polygranular, plate 90FF); easily seen with low-power microscopy of live worm slightly flattened under coverslip.

**STYLET** a single tiny, needlelike (monostiliferans) or multiple tacklike (polystiliferans) barbs anchored to the basis in the proboscis of hoplonemerteans (plate 90A, many figures, plates 89 and 90).

## Classification

**PALAEONEMERTEA** Nemerteans with unarmed proboscis and proboscis not differentiated into regions. Mouth below or behind the brain. Typically slender, very soft-bodied and extensile, and not very flattened. Most (all species here) lack ocelli (often present in larvae) and cephalic furrows or slits. If a specimen does not fit any of the more easily differentiated orders, it is probably in this order. Mouth may or may not be conspicuous (plate 86B, 86C); far behind brain in *Procephalothrix* (plate 86G).

**HETERONEMERTEA** Nemerteans with unarmed proboscis not differentiated into regions. Mouth below or behind the brain and usually conspicuous (plate 88D). Head commonly with cephalic slits (plates 88E, 88H), except for *Baseodiscus* and *Zygeupolia* (among species here). A caudal cirrus (plate 87A, 87C, 87E), if present, is a useful identifying characteristic for *Cerebratulus*, *Micrura*, and *Zygeupolia*.

**HOPLONEMERTEA** Nemerteans with a more or less three-chambered proboscis, usually armed with stylet(s) (plate 90A). Mouth in front of the brain and, in most hoplonemerteans, combined with the rhynchodaeum, leaving only one visible opening at the anterior end of the body (all species here), called the proboscis pore (often inconspicuous, making the animal appear to have no openings on the head). Head usually with pair of anterior, dorso-ventral cephalic furrows (sites of cerebral sensory organ pores); commonly with posterior, annular cephalic furrow, V-shaped dorsally and ventrally (plates 89A, 89E, 89J, 90H, 90R). One suborder, Monostilifera, is characterized as having a single

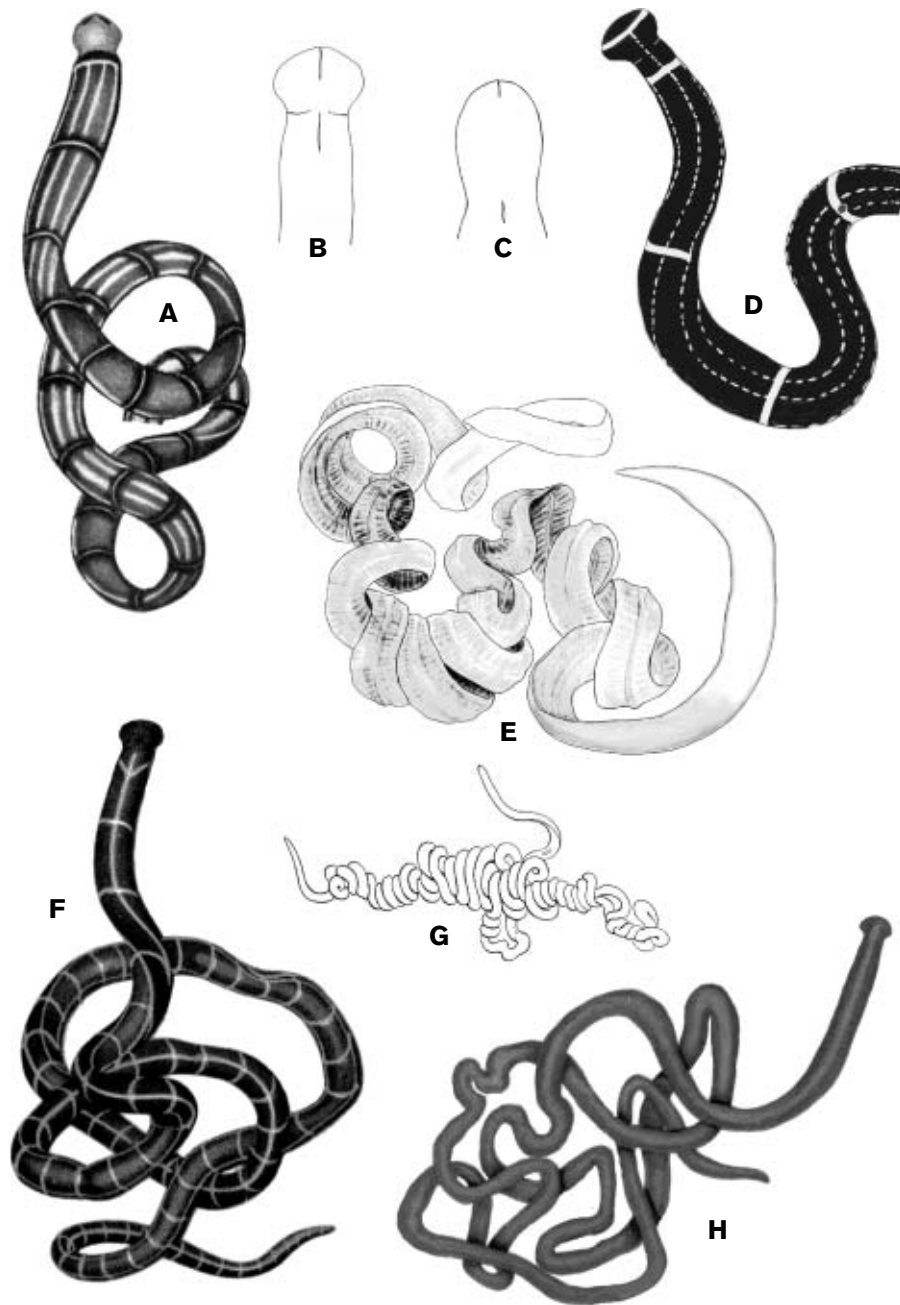


PLATE 86 A, *Tubulanus cingulatus*; B, *Tubulanus*, head, ventral view with anteriorly located proboscis pore and posteriorly located mouth; C, *Carinoma mutabilis*, head, ventral view, with anteriorly located proboscis pore and posteriorly located mouth; D, *Tubulanus sexlineatus*, lateral sensory organ appears as a dark spot in the fifth transverse white band; E, *Carinoma mutabilis*; F, *Tubulanus capistratus*; G, *Procephalothrix spiralis*; H, *Tubulanus polymorphus* (A, after Coe 1904; B-E, originals; F and H, after Coe 1901; G, after Coe 1940).

central stylet. However, the genus *Malacobdella*, consisting of commensals in the mantle cavity of clams, is highly modified and lacks armature (Thollessen and Norenburg 2003). Malacobdellans have a posterior sucker and the general appearance of a leech (plate 90B). The suborder Polystilifera, with a padlike basis studded with many minute stylets (mouth and rhynchostome externally separate), is not known from intertidal habitats of California or Oregon.

**Key to Nemertea**

- 1. Mouth distinctly ventral, under or behind brain . . . . . 2
  - Mouth and proboscis share pore near tip of snout . . . . . 32
- 2. Caudal cirrus present, but may be lost . . . . . 3
  - Caudal cirrus not present or unknown . . . . . 11
- 3. Cephalic lobe with longitudinal lateral slits (usually conspicuous) . . . . . 4
  - Without longitudinal cephalic slits, pointed head, no ocelli, intestinal region flattened; body whitish to pale rosy color, translucent in intestinal region; to 8 cm long (plate 87C) . . . . . *Zygeupolia rubens*
- 4. Cephalic lobe wide, often flaring wider than body posteriorly (lanceolate), flattening toward snout; snout relatively pointed; cephalic slits deep; usually no ocelli (inconspicuous, inside cephalic slits, if present); anterior body region cylindrical, strongly muscular (plate 88D). . . . . 5
  - Cephalic lobe narrow, not flared (not lanceolate) . . . . . 9
- 5. Intestinal region moderately to highly flattened (ribbon-like), adapted for swimming, not strongly contractile, usually with thin lateral margins (an ambiguous character); mouth usually large, may be elongate . . . . . *Cerebratulus* 6

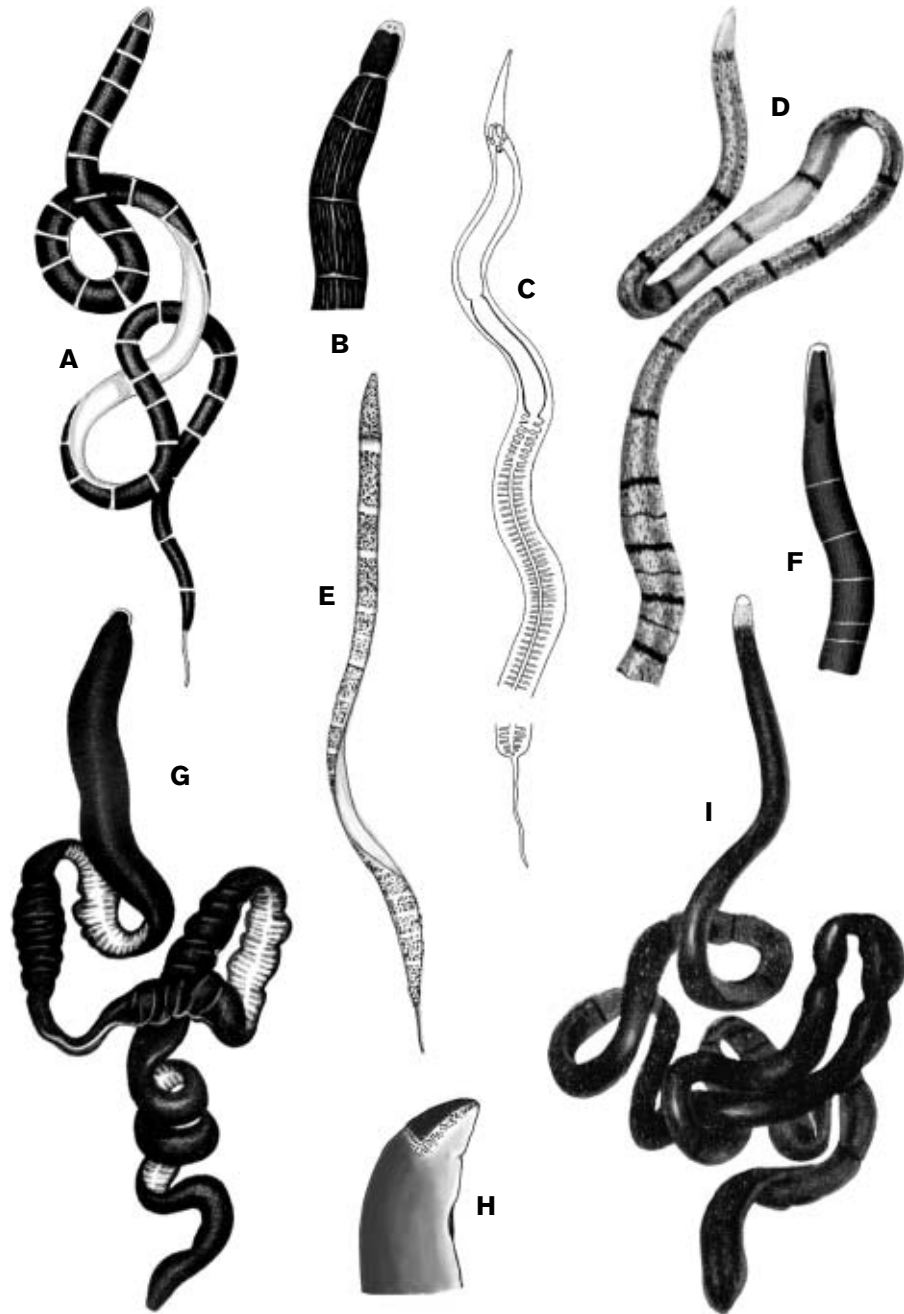


PLATE 87 A, *Micrura verrilli*; B, *Lineus pictifrons*; C, *Zygeupolia rubens*; D, *Euborlasia nigrocincta* var. 1; E, *Micrura coei*; F, *Micrura wilsoni*; G, *Baseodiscus punnetti*; H, *Baseodiscus punnetti*, head, lateral view; I, *Euborlasia nigrocincta* var. 2 (A, after Coe 1901; B, F, after Coe 1905; C, after Coe 1943; D-E, I, after Coe 1940, G-H, after Coe 1904).

- Intestinal region not highly flattened, without thin lateral margins; color ranging from translucent whitish to rosy, with brain showing through as reddish, and intestinal diverticula as salmon to brownish; without white bands or circles; cephalic lobe can be distinctly wider than body, with a pointed snout (cerebratulidlike); intestinal region flattened, but narrow; very long caudal cirrus; no ocelli; to 60 cm long (plate 88E, 88F) . . . . . *Micrura alaskensis*
- 6. Snout with discrete region of white; body with different color. . . . . 7
- Cephalic lobe without discrete white coloration. . . . . 8
- 7. Tip of snout with short but conspicuous white region; body blood-red dorsum and ventrum; to 2 m long (plate 88A, 88B) . . . . . *Cerebratulus montgomeryi*
- Similar to plate 88A, 88B *Cerebratulus montgomeryi*, but cephalic lobe white for slightly less than length of cephalic slits; body dorsally and ventrally brown, brownish purple, or blackish; to 30 cm or more . . . . . *Cerebratulus albifrons*
- 8. Body slaty brown to grayish or olive, paler ventrally, often with paler to whitish lateral margins; relatively sturdy; very deep cephalic slits; to 1 m long (plate 88C, 88D) . . . . . *Cerebratulus marginatus*
- Similar to plate 88C, 88D *Cerebratulus marginatus*, but body yellowish to pale rosy salmon, cephalic lobe paler; reddish brain and lateral nerve cords obvious; short caudal cirrus; very fragile; to 15 cm long . . . . . *Cerebratulus californiensis*
- 9. Conspicuous narrow white bands, or rings, with entire margins, encircling body at intervals . . . . . 10
- Without discrete white bands or circles (transverse "bands," if present, do not have discrete margins); body

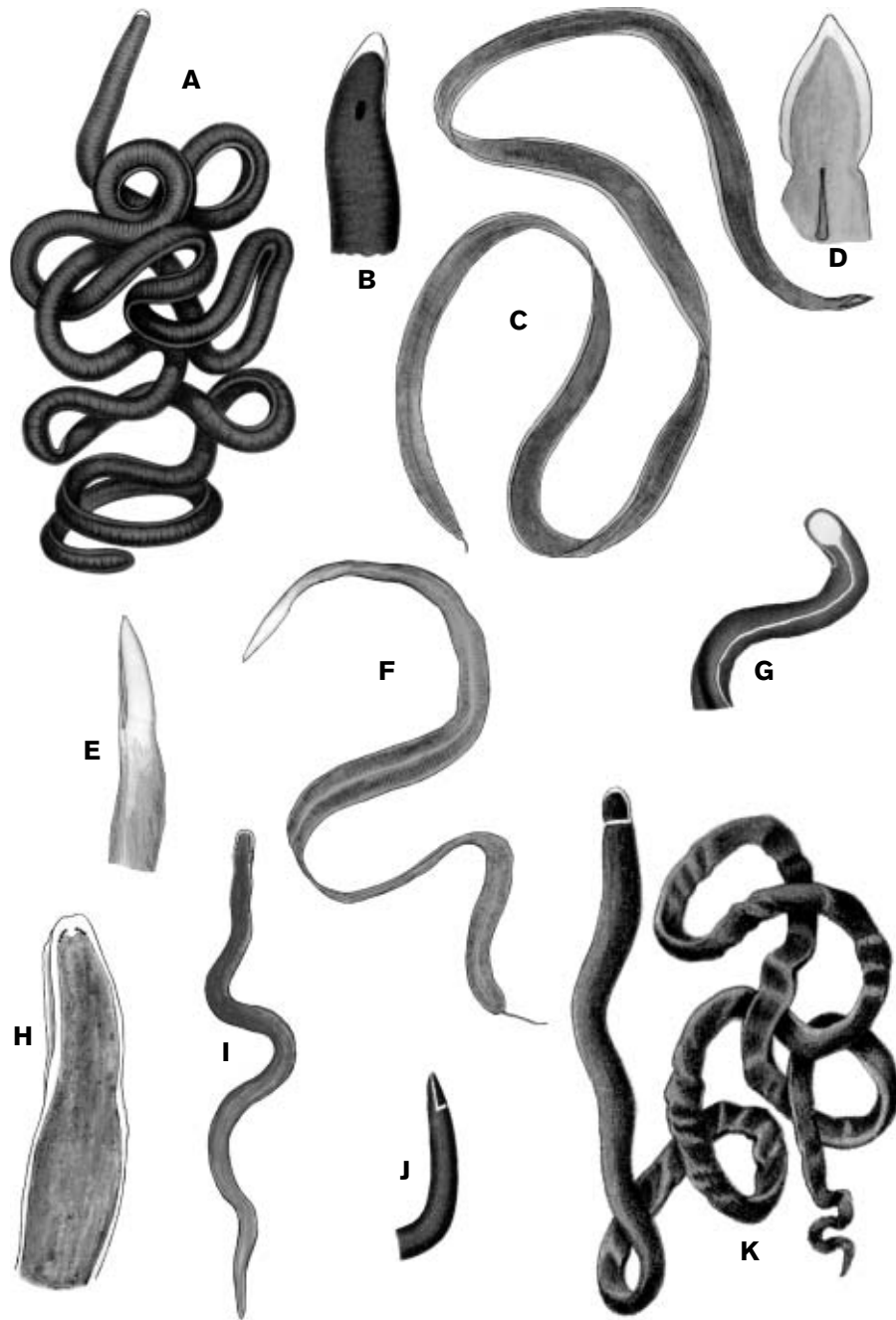
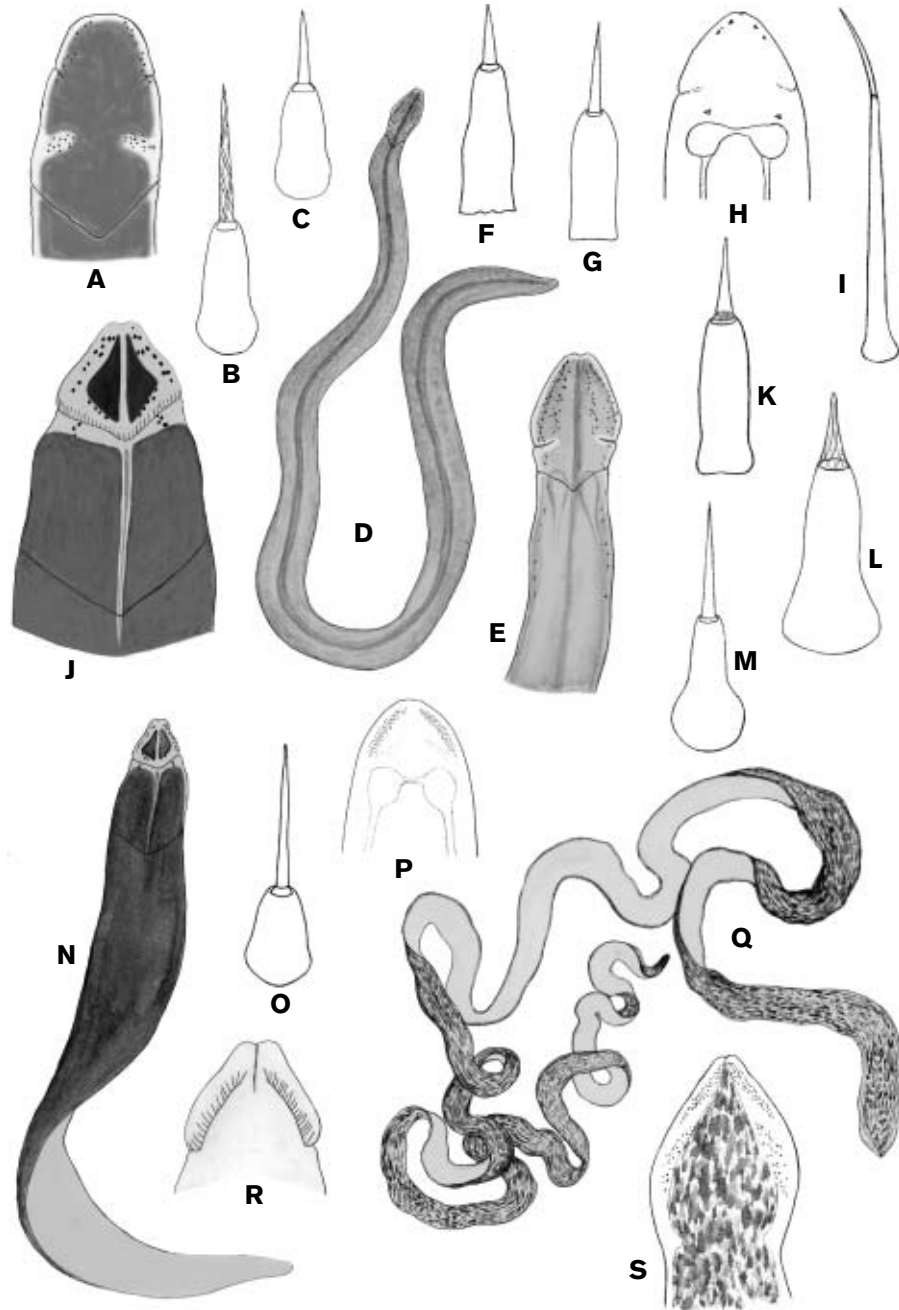


PLATE 88 A, *Cerebratulus montgomeryi*; B, *Cerebratulus montgomeryi*, head, ventral view; C, *Cerebratulus marginatus*; D, *Cerebratulus marginatus*, head, ventral view; E, *Micrura alaskensis* head, lateral view; F, *Micrura alaskensis*; G, *Lineus bilineatus*; H, *Lineus rubescens*, head, dorsal view; I, *Lineus ruber*; J, *Lineus torquatus*, head, lateral view; K, *Lineus torquatus* (A-B, J-K, after Coe 1901; C-F, H-I, originals; G, after Coe 1905).

- with pale yellowish ground color, dorsally with dense covering of variously sized dark brown to blackish pigment spots, sometimes coalescing into irregular longitudinal stripes that may be separated by transverse unpigmented regions; body cylindrical with strongly flattened ventrum; ocelli present, row of 10-18 inconspicuous ocelli along dorsal and ventral margin of each cephalic furrow; build and live in mucoid tubes; up to 3 cm long (plate 87E) . . . . . *Micrura coei*
- Not as above; see *Micrura alaskensis* . . . . . back to 5
10. Dorsal half of cephalic lobe clear bright orange, lateral and ventral surfaces white, dorsum with very broad, dark purple medial band transected at intervals by a fine white line, giving the appearance of a series of sharply demarcated rectangles running the length of the body; to 50 cm long (plate 87A) . . . . . *Micrura verrilli*
- White margin at tip and along cephalic slits; remainder of body with range of brownish hue, paler ventrally; to 15 cm long (plate 87F) . . . . . *Micrura wilsoni*
11. Cephalic lobe with longitudinal lateral slits (e.g., plate 88E, 88H) . . . . . 12
- Without longitudinal cephalic slits . . . . . 22
12. Body conspicuously divided into cylindrical foregut region and flattened intestinal region . . . . . back to 5
- Body not conspicuously divided into cylindrical foregut and flattened intestinal regions . . . . . 13
13. Body with discrete pigment patterning . . . . . 14
- Body without discrete pigment patterning . . . . . 20
14. Body with one or more obvious white or distinctly pigmented transverse bands or circles with discrete margins . . . . . 15
- Without transverse bands having discrete margins . . . . . 18

PLATE 89 A, *Paranemertes peregri*  
 na, head, dorsal view; B, *Paranemertes*  
*peregri*, spiral stylet; C, *Paranemertes*  
*peregri*, smooth stylet; D, *Zygonemertes*  
*virescens*; E, *Zygonemertes*  
*virescens*, anterior end, dorsal view;  
 F, *Zygonemertes virescens*, central  
 stylet; G, *Zygonemertes albida*, central  
 stylet; H, *Paranemertes californica*,  
 head, dorsal view; I, *Emplectonema*  
*gracile*, central stylet; J, *Amphiporus*  
*bimaculatus*, head, dorsal view; K,  
*Paranemertes californica*, central stylet;  
 L, *Emplectonema buergeri*, spiral stylet  
 (with six accessory stylet sacs, from  
 Puget Sound); M, *Emplectonema buergeri*,  
 smooth stylet (with two accessory  
 stylet sacs, from Alaska); N, *Am-*  
*phiporus bimaculatus*; O, *Amphiporus*  
*bimaculatus*, central stylet; P, *Emplec-*  
*tonema buergeri*, head, dorsal view,  
 Alaska; Q, *Emplectonema buergeri*,  
 Puget Sound; R, *Amphiporus bimacula-*  
*tus*, head, ventral view; S, *Emplec-*  
*tonema buergeri*, head, dorsal view  
 (Puget Sound) (A-E, J, L, N-O, Q-S,  
 originals; G, I, P, after Coe 1901; H, K,  
 after Coe 1940; M, after Coe 1905).



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| <p>15. Transverse bands or rings at intervals along body. . . . 16<br/>             — Single dorsal, transverse, white band connecting posterior ends of white cephalic slits; tip of snout white; remainder of body dark reddish to purplish brown; paler or reddish ventrum; no ocelli; to 40 cm long (plate 88J, 88K) . . . . .<br/>             . . . . . <i>Lineus torquatus</i></p> <p>16. Transverse bands or rings paler than ground color . . . . 17<br/>             — Transverse bands darker than ground color; purplish brown to blackish rings; one variety, with purplish brown dorsum and ventrum with white head speckled with fine red, orange or brown dots; other variety with paler, rosy color with elongated reddish or purplish dots; to 70 cm long, 12 mm wide (plate 87D, 87I) . . . . .<br/>             . . . . . <i>Euborlasia nigrocincta</i></p> <p>17. Whitish transverse bands or rings (see also key item 10; plate 87A) . . . . . <i>Micrura verrilli</i></p> | <p>Or plate 87F. . . . . <i>Micrura wilsoni</i></p> <p>— Yellow transverse bands, seven to 15 very fine longitudinal lines of yellow on dorsal surface; body soft and flabby, with longitudinal creases; no ocelli (but may have two surface pigment spots near cephalic tip); to 15 cm long (plate 87B). . . . . <i>Lineus pictifrons</i></p> <p>18. With discrete white or pale yellow dorsomedial stripe; body dark brown; to 20 cm long (plate 88G) . . . . .<br/>             . . . . . <i>Lineus bilineatus</i></p> <p>— With other form of patterning. . . . . 19</p> <p>19. Dorsal surface with dense covering of brownish to blackish, variously sized pigment spots, which may coalesce to form irregular longitudinal lines organized into elongate blocks by transverse bands of ground color (plate 87E) . . . . . <i>Micrura coei</i></p> <p>— Front end of cephalic lobe white, ventral and dorsal,</p> |
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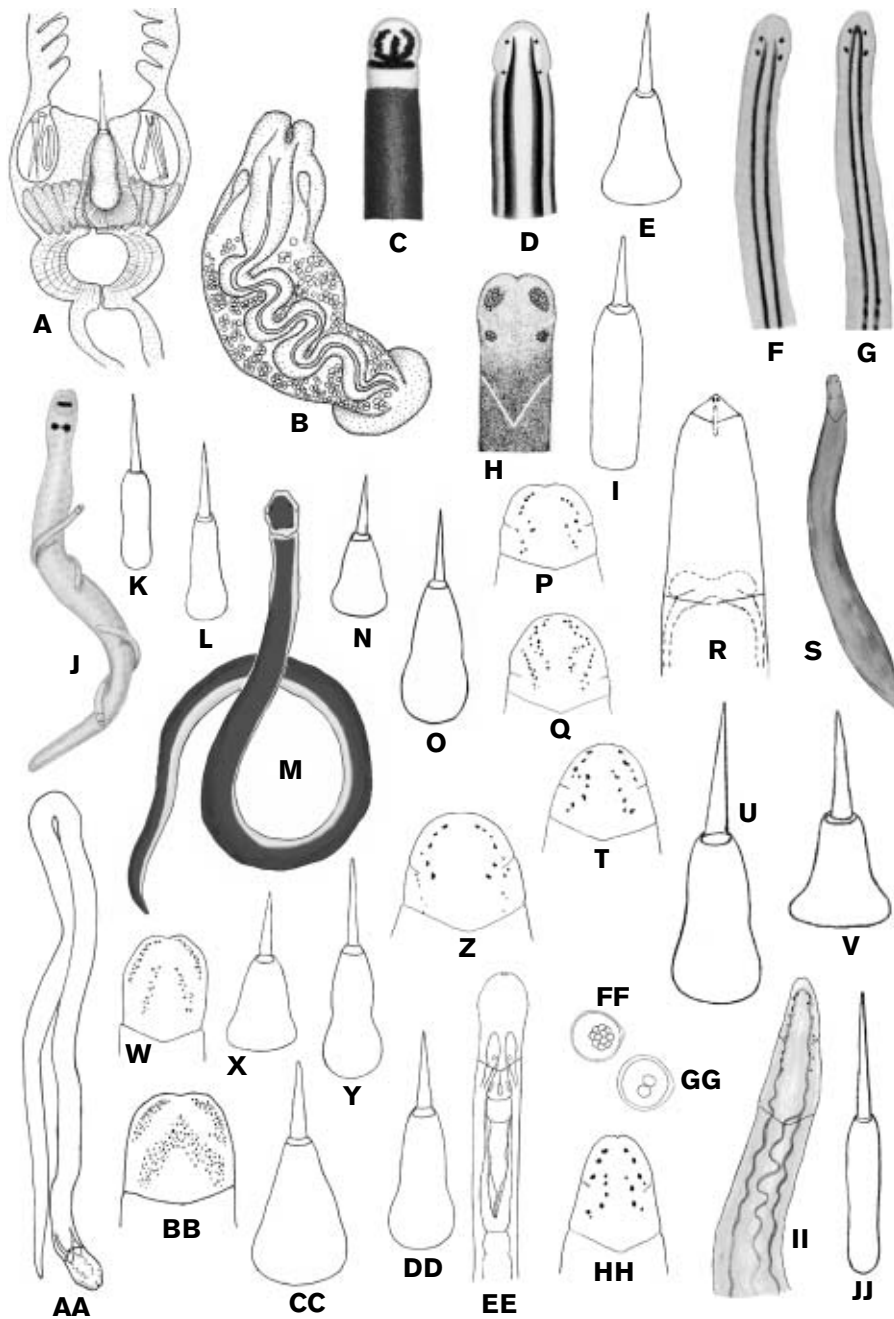


PLATE 90 A, diagram of hoplone-  
merterean proboscis showing central  
stylet on basis and accessory stylets  
and sacs in middle chamber, plus  
posterior end of anterior chamber  
and anterior end of posterior cham-  
ber; B, *Malacobdella* sp.; C, *Tetra-  
stemma signifer*, head, dorsal view;  
D, *Tetrestemma quadrilineatum*,  
head, dorsal view; E, *Tetrestemma  
quadrilineatum*, central stylet; F, *Nem-  
ertopsis gracilis*; G, *Nemertopsis gra-  
cilis* var. *bullocki*; H, *Pantionemertes  
californiensis*, head, dorsal view; I,  
*Pantionemertes californiensis*, cen-  
tral stylet; J, *Tetrestemma albidum*,  
brooding female with young; K, L,  
*Tetrestemma albidum*, central stylets;  
M, *Tetrestemma nigrifrons*; N, O,  
*Tetrestemma nigrifrons*, central  
stylets; P, Q, *Amphiporus flavescens*,  
eye arrangements; R, *Poseidone-  
mertes collaris*, head, dorsal view; S,  
*Oerstedtia dorsalis*; T, *Amphiporus  
flavescens*, eye arrangement; U, V,  
*Amphiporus flavescens*, central  
stylets; W, *Amphiporus impar-  
ispinosus*, eye arrangement; X, Y,  
*Amphiporus imparispinosus*, central  
stylets; Z, *Amphiporus imparispinosus*,  
eye arrangement; AA, *Amphiporus  
imparispinosus*; BB, *Amphiporus for-  
midabilis*, eye arrangement; CC,  
DD, *Amphiporus formidabilis*, central  
stylets; EE, *Ototyphlonemertes ameri-  
cana*; FF, *Ototyphlonemertes ameri-  
cana*, polygranular statocyst; GG,  
*Ototyphlonemertes* sp. oligogranular  
statocyst; HH, *Amphiporus impar-  
ispinosus*, eye arrangement; II, *Am-  
phiporus cruentatus*, head, dorsal  
view; JJ, *Amphiporus cruentatus*, cen-  
tral stylet. (A-B, M-O, S, W-Y,  
AA-DD, II, originals; C-E, K-L, P-Q,  
T-V, Z, HH, JJ, after Coe 1905; F-G,  
J, after Coe 1940; H-I, after Gibson,  
Moore, and Crandall, 1982, *J. Zool.*  
Lond. 196: 463-474; R, after Roe  
and Wickham 1984, *Proc. Biol. Soc.*  
Wash. 97: 60-70).

- sharply delineated from pink to rosy body; four to eight ocelli near tip of snout; to 15 mm long (plate 88H) . . . . . *Lineus rubescens*
20. Single row of easily observed ocelli present along each cephalic slit . . . . . *Micrura alaskensis*  
— Without ocelli (see key item 5; plate 88E, 88F) . . . . . *Lineus ruber*
21. Body contracts by shortening and thickening; cephalic lobe coloration reddish to reddish brown, remainder of body reddish to very dark brown; 1-10 cm (plate 88I) . . . . . *Lineus ruber*  
— Similar to *Lineus ruber* (plate 88I), but body contracts by coiling when sufficiently irritated; body olive green, brown to reddish, with hair-thin circles of lighter color giving animals a segmented appearance; two to eight ocelli; to 15 cm long . . . . . *Ramphogordius sanguineus*
22. Mouth far back of brain, body mostly cylindrical . . . . . 23  
— Mouth under or just behind brain . . . . . 24
23. Body yellowish to yellowish green with rosy head; weak tendency to contract into corkscrew shape (most reliable external means to distinguish individuals smaller than 15 cm from *P. spiralis*); to 1 m long . . . . . *Procephalothrix major*  
— Body and head mostly whitish; strong tendency to contract into corkscrew shape; to 15 cm long (plate 86G) . . . . . *Procephalothrix spiralis*
24. Ocelli absent . . . . . 25  
— Ocelli present, numerous (40-60 per side); snout with dark brown or blackish dorsal pigment shield with white anterior and lateral margins, white ventral surface; body paler brownish to red dorsum, grading to paler grayish ventrum; short, shallow, oblique (dorso-ventral) cephalic furrows to

- sides of brain region mark openings to cerebral organs; to 60 cm long, 10 mm wide (plate 87G, 87H) . . . . . *Baseodiscus punnetti*
25. Cephalic lobe usually broadly rounded, often exceeding width of body, pointed only when burrowing. . . . . 26
- Cephalic lobe narrower than body, relatively sharply pointed; intestinal region flattened; mouth close behind brain; caudal cirrus present; to 8 cm long (plate 87C) . . . . . *Zygeupolia rubens*
26. Lateral sense organs (see plate 86D) present, usually at least twice as far from snout as brain . . . . . 27
- Lateral sense organs lacking; no cerebral sensory organs; whitish anteriorly to translucent with brownish intestine posteriorly; intestinal region flattened; to 20 cm long (plate 86C, 86E) . . . . . *Carinoma mutabilis*
27. Cerebral sensory organs (therefore, external pores) present; worms often form parchmentlike tubes . . . . . 28
- Cerebral sensory organs (and external pores) absent; cephalic lobe and body white, more translucent in intestinal region; to 10 cm long (see "Annotated Species List") . . . . . *Carinomella lactea*
28. Body of more or less homogenous color, no distinct patterning. . . . . 29
- Body brown, with white, distinct longitudinal and transverse linear markings; numerous transverse rings. . . . . 30
29. Body white to translucent; to 25 mm long (see "Annotated Species List") . . . . . *Tubulanus pellucidus*
- Body deep orange to reddish orange; to 3 m long (plate 86H) . . . . . *Tubulanus polymorphus*
30. With four to six longitudinal lines. . . . . 31
- With three longitudinal lines, one dorsomedial and one each just below lateral margin of body; to 1 m long (plate 86F) . . . . . *Tubulanus capistratus*
31. With four longitudinal lines, one each along lateral margin of body, remaining two dividing dorsum into three equal parts; to 15 cm long (plate 86A) . . . . . *Tubulanus cingulatus*
- With five or six longitudinal lines, one is median dorsal, pair narrowly spaced lines along each lateral margin of body; the sixth, if present, marks ventral midline; to 1.5 m long (plate 86D) . . . . . *Tubulanus sexlineatus*
32. Commensal with crustaceans or clams; no cerebral sense organs . . . . . 33
- Not commensal with crustaceans or clams . . . . . 37
33. At base of legs or among appendages of abdomen of crabs; very short proboscis, without accessory stylet sacs; basis about 2.5–3 times length of central stylet; two ocelli . . . . . 34
- In mantle cavity of clams; posterior sucker, proboscis without stylet, no ocelli (plate 90B) . . . . . *Malacobdella* 35
34. On *Pugettia producta*, *Hemigrapsus oregonensis*, *H. nudus*, *Pachygrapsus crassipes*, *Cancer* spp. except *C. magister*; possibly other brachyuran crabs (see "Annotated Species List" if on nonbrachyuran host); to 6 mm long. . . . . *Carcinonemertes epialti*
- On *Cancer magister*; to 6 mm long . . . . . *Carcinonemertes errans*
35. In *Macoma secta* or *M. nasuta*; 11–12 gut undulations in mature specimen; to 20 mm long . . . . . *Malacobdella macomae*
- Other bivalve host. . . . . 36
36. In *Siliqua patula*; 15–16 gut undulations in mature specimen, to 42 mm long . . . . . *Malacobdella siliquae*
- In other bivalves (e.g., *Tresus nuttallii*, *Tresus capax*; see "Annotated Species List") . . . . . *Malacobdella grossa*?
37. Statocysts absent . . . . . 39
- With a pair of cerebral statocysts, no eyes (except larva), stylet smooth or fluted; in moderately coarse, well-sorted sand . . . . . *Ototyphlonemertes* 38
38. Each statolith comprising about 16 granules, stylet with helical fluting, no cerebral sensory organs, proboscis barely reaching past cerebral ganglia; to 10 mm long (plate 90EE, 90FF) . . . . . *Ototyphlonemertes americana*
- Each statolith comprising eight granules or fewer, stylet smooth (plate 90GG) . . . . . *Ototyphlonemertes* sp.
39. More than two ocelli . . . . . 40
- With one pair ocelli, conspicuous near tip of snout; snout often retracted into cephalic lobe to level of anterior cephalic grooves, thereby forming a collar at that point (plate 90R) . . . . . *Poseidonemertes collaris*
40. With four distinct ocelli, two anterior and two posterior . . . . . 41
- More than four ocelli . . . . . 47
41. With distinct color patterning . . . . . 42
- Without distinct color patterning . . . . . 45
42. With longitudinal brown stripes . . . . . 43
- Without longitudinal brown stripes. . . . . 44
43. With one pair median stripes; body ground color whitish to pale brown; filiform; ocelli large; up to 15 cm long (var. *bullocki* has a small dark rectangle, a little longer than wide, that unites the anterior ends of the longitudinal stripes); (see plate 90F, 90G for both varieties). . . . . *Nemertopsis gracilis*
- With four stripes, two medial and one along each margin; body ground color whitish; moderately flattened; up to 12 mm long (plate 90D, 90E) . . . . . *Tetrastemma quadrilineatum*
44. Head white with sharply demarcated dorsal wreath of brown pigment; body reddish brown; red blood corpuscles; up to 25 mm (plate 90C) . . . . . *Tetrastemma signifer*
- Head white with variously shaped dorsal shield of deep brown pigment; head with pair of clearly incised furrows on each side of cephalic lobe; body coloration variable, ranging from purplish to brown, sometimes with continuous or broken white dorsomedial line, or reddish with brown flecks or pale brownish dorsomedial band; paler ventrum, often with white longitudinal median band; red blood corpuscles; to 70 mm long (plate 90M–90O) . . . . . *Tetrastemma nigrifrons*
45. Body not white . . . . . 46
- Body and cephalic lobe white to very pale salmon; body somewhat flattened; brain yellowish; ocelli with diffuse corona of pigment; cerebral organs large, reaching next to brain; rhynchocoel to posterior third of body; stylet basis very slender; oviparous or viviparous; to 15 mm long (plate 90J–90L) . . . . . *Tetrastemma albidum*
46. Color varies from uniform yellowish to pale salmon to brown; often with darker dorsal mottling, which may include aggregations into transverse rings; ocelli may be difficult to see; body cylindrical; to 15 mm long (plate 90S) . . . . . *Oerstedtia dorsalis*
- Color predominately greenish or yellowish-green, although immature specimens may be grayish or whitish; body relatively flattened (rather than cylindrical as in (plate 90S) *Oerstedtia dorsalis*; small ocelli, to 35 mm long . . . . . *Tetrastemma candidum*
47. Ocelli not extending behind cerebral ganglia, but may be dorsal to or above them . . . . . 49
- Ocelli extend behind cerebral ganglia, along foregut and lateral nerve cords; stylet basis approximately one-and-a-half



- to two times length of stylet, with sharply truncated or concave posterior margin; numerous sickle-shaped bodies in epidermis visible with microscopic examination of compressed individuals . . . . . 48
48. Body pale green to dark bluish green; back end of stylet basis of mature individuals with lobed or serrated appearance; to 20 mm long (plate 89D, 89E, 89F) . . . . .  
. . . . . *Zygonemertes virescens*
- Body whitish; back end of stylet basis not lobed; to 25 mm long (plate 89G) . . . . . *Zygonemertes albida*
49. Stylets with helical fluting or striation at base . . . . . 50
- Stylets smooth (but see *Emplectonema buergeri*) . . . . . 52
50. Stylets with helical fluting . . . . . 51
- Stylets with striation at base, basis about twice length of stylet; two, four, or six pouches of accessory stylets, rhynchocoel fluid is red; body rosy to pinkish anteriorly, more gray or pale salmon posteriorly; intestine often green; four clusters of two to three small ocelli each, one pair flanking proboscis opening and one cluster in front of each brain lobe; up to 45 cm long (plate 89H, 89K) . . . . .  
. . . . . *Paranemertes californica*
51. Brown or purplish brown dorsum, paler ventrum; with unpigmented mask on dorsolateral surface of cephalic lobe over each of the two posterior groups of ocelli; each group with five to 12 ocelli; two pouches of accessory stylets; up to 25 cm long (plate 89A, 89B) . . . . .  
. . . . . *Paranemertes peregrina*
- Body color fleshy cream to orange-tan throughout; red brain visible; 18–35 ocelli, loosely arranged in four somewhat linear groups along margin of cephalic lobe and extending inward in front of brain; to 11 cm long; central stylet like that of *Paranemertes peregrina* (plate 89B) . . . . .  
. . . . . *Paranemertes sanjuanensis*
52. Rhynchocoel less than half of body length . . . . . 53
- Rhynchocoel more than half of body length . . . . . 54
53. Dorsal surface green with whitish, yellowish, or very pale green ventrum; stylets long and slender, and conspicuously curved; basis slender, two to three times length of stylet; up to 50 cm long (plate 89I) . . . . .  
. . . . . *Emplectonema gracile*
- Dorsal surface brown, often with reddish brown or purple mottling and streaking, with pale yellowish to beige ventrum; width 2-3 times dorso-ventral thickness; stylet short, back end of basis strongly swollen; up to 1 m long (plate 89M, 89P; spiral stylet and 6 accessory sacs in Puget Sound, plate 89L, 89Q, 89S) . . . . . *Emplectonema buergeri*
54. Blood vessels not red . . . . . 55
- Blood vessels conspicuous, with red corpuscles; five to 10 ocelli in single row on each side of cephalic lobe; slender stylet basis; rhynchocoel to posterior end of body; up to 25 mm long (plate 90II, 90JJ) . . . . . *Amphiporus cruentatus*
55. Body whitish, may be tinged with pink . . . . . 56
- Body not white or pinkish . . . . . 57
56. Proboscis with two or three pouches of accessory stylets; brain pale pink to brownish; four groups of ocelli with up to 15 ocelli each, depending on size of individual; up to 50 mm long (plate 90W–90AA, 90HH) . . . . .  
. . . . . *Amphiporus imparispinosus*
- Proboscis with 6-12 pouches of accessory stylets; brain rosy to red; 4 groups of ocelli with up to 50 ocelli each, depending on size of individual; up to 30 cm (plate 90BB–90DD) . . . . . *Amphiporus formidabilis*
57. Without pair of distinct, dark pigment patches in front of brain on dorsal surface of cephalic lobe . . . . . 58
- Head whitish with two large angular or oval patches of very dark brownish pigment; dorsum of body red, reddish brown, or brownish orange; ventrum rosy, orange, or beige; four clusters with six to 15 relatively large ocelli each and two posterior clusters with 2–5 ocelli each immediately behind the anterior cephalic grooves; stylet about twice length of basis; two or four pouches of accessory stylets; body with flattened dorsum and ventrum, widest at foregut region; swims actively if irritated; up to 15 cm long (plate 89J, 89N, 89O, 89R) . . . . .  
. . . . . *Amphiporus bimaculatus*
58. Dorsum yellow, but may be whitish; cerebral ganglia yellowish; up to 20 mm long (plate 90P, 90Q, 90T–90V) . . . . . *Amphiporus flavescens*
- Dorsum dark grayish-green to bluish-green, darker in dorsal midline, shading to lighter greenish-tan laterally; head and ventrum light cream to tan; anterior two groups of ocelli larger and closer to surface than posterior two groups; eye number increases with size, anterior with about five to 100 and posterior with about three to 50 per group; length 20–450 mm (plate 90H, 90I) . . . . .  
. . . . . "*Pantionemertes*" *californiensis*

### List of Species

Only West Coast geographic distributions are listed unless broader distribution indicates potential taxonomic problems. Most information is from Coe 1901, 1904, 1905, 1940; Gibson 1995; plus McDermott and Roe 1985, Amer. Zool. 25: 113–125 (feeding) unless otherwise indicated. Identity of some species that were originally described from elsewhere (commonly Europe) are speculative, as no specific comparative work has been done. Our confidence in such identifications varies with the degree to which the known morphological attributes (e.g., color, pattern, armature structure) are unique or diagnostic among all known nemerteans. The type locality is given when the general distribution is reported to extend beyond the Pacific coast of North America. Detailed type information for many of Coe's species can be found in Hochberg and Luniansky (1998, Hydrobiol. 365: 291–300, taxonomy). Some Washington state distribution information is based on Stricker (1996). Distributions for California with Crandall as citation are personal communications in 1999 by F. B. Crandall (National Museum of Natural History). Species noted by an asterisk are not recorded in published literature as occurring or are of uncommon occurrence intertidally along the central or northern California or Oregon coasts. They are listed here for completeness but are not included in the key.

### Palaeonemertea

*Carinomella lactea* Coe, 1905. Central to southern California (type region); also Atlantic Florida. In intertidal sand. Superficially similar to *Carinoma mutabilis* and *Tubulanus pellucidus*, but with lateral sense organs, without cerebral sensory organs. For figures, see Coe (1905, figs. 46, 47, 50, 51).

*Carinoma mutabilis* Griffin, 1898. British Columbia (type region) to Mexico. In intertidal and subtidal sediments. Superficially similar to *Carinomella lactea* and *Tubulanus pellucidus*, but without either lateral or cerebral sensory organs.

*Procephalothrix major* (Coe, 1930) (= *Cephalothrix major*). Central California to Mexico. In sediments under rocks fully exposed to surf. Large individuals reach a meter in length, width

only 2–5 mm. Similar to *Procephalothrix spiralis* (plate 86G), but body usually twisted or knotted, not spirally coiled. *P. major* and *P. spiralis* are morphologically distinguished internally by differences in their nephridia (Coe 1930, Biol. Bull. 58: 203–216). For figure, see Coe (1940, fig. 29).

*Procephalothrix spiralis* (Coe, 1930) (= *Cephalothrix spiralis*). Alaska to southern California; also northwest Atlantic coast (type region). In mud under intertidal and subtidal rocks. Recognized by spiral coiling of body when contracted.

*Tubulanus capistratus* (Coe, 1901) (= *Carinella capistrata*). Alaska (type region) and Puget Sound to Monterey, California. Intertidal; in delicate parchment tubes among algae and other surface cover or under rocks.

*Tubulanus cingulatus* (Coe, 1904) (= *Carinella cingulata*). Bolinas (Crandall) to San Diego. Intertidal and subtidal; on soft sediments.

*Tubulanus pellucidus* (Coe, 1895) (= *Carinella pellucida*). San Francisco Bay (Crandall) to San Diego; also Atlantic coast (type region). Intertidal; in delicate parchment tubes under rocks or among algae and other surface cover. Superficially similar to *Carinomella lactea* and *Carinoma mutabilis* (plate 86E) but typically much smaller; has both lateral and cerebral sensory organs. For figures, see Coe (1895, Trans. Conn. Acad. Arts Sci. 9: 515–522).

*Tubulanus polymorphus* Renier, 1804 (= *Carinella polymorpha*, *C. rubra*, *C. speciosa*). Aleutian Islands to Monterey, California; also northern Europe, Mediterranean (type region). Intertidal and subtidal; under rocks or among mussels and other surface cover in or adjacent to muddy substrata. Easily recognized by its uniform red-orange color and large size, to 3 m. Body soft and distensible; Roe once held a specimen about 2 m above the substratum, and part of its body still formed a pile on the ground.

*Tubulanus sexlineatus* (Griffin, 1898) (= *Carinella dinema*, *C. sexlineata*). Alaska to southern California. Intertidal and subtidal; in tubes among algae and other surface cover on rocks and pilings. Can reach 1.5 m in length.

## Heteronemertea

*Baseodiscus punnetti* (Coe, 1904) (= *Taeniosoma punnetti*). Monterey Bay, California to Mexico. Intertidal and subtidal; among algae and other surface cover on rocks.

*Cerebratulus*. Cerebratulids are typically large and not strongly contractile in length, often relatively flattened with thin lateral edges throughout the intestinal region; burrowing forms tend to fragment more readily than most other nemerteans; often swim when kept in container of clean seawater. Species without distinctive external markings are difficult to distinguish from each other.

*Cerebratulus albifrons* Coe, 1901. Alaska to San Diego. Intertidal and subtidal; in mud or under rocks; subtidal off central and southern California. Length 30 cm or more. Similar to *Cerebratulus montgomeryi* (plate 88A, 88B), but cephalic lobe white for greater distance posteriorly. For figures, see Coe (1901, plate 4, figs. 3, 4).

*Cerebratulus californiensis* Coe, 1905. Washington to Mexico. Intertidal and subtidal burrower in soft sediments. Relatively small, about 10–15 cm length, readily fragments, no distinctive markings. Similar to *Cerebratulus marginatus* (plate 88C, 88D), but with different colors. For figures, see Coe (1940, plate 24, figs. 7–10). We have found a form resembling *C. californiensis* in Elkhorn Slough, but with inconspicuous ocelli in the cephalic slits.

\**Cerebratulus herculeus* Coe, 1901 (= *Cerebratulus latus*). Bering Sea, Alaska (type region), Puget Sound, and southward to southern California (subtidal). Intertidal and subtidal burrower in mud. Enormous in size, often more than 2 m long and 25 mm wide, but capable of graceful swimming and active burrowing. Dark brown to reddish brown, duller ventrally. For figure, see Coe (1904, plate 1, fig. 5).

\**Cerebratulus longiceps* Coe, 1901. Alaska; dredged at Tomales Bay by Corrêa (1964). Lowest intertidal to subtidal. Length to 30 cm, width to 6 mm. Dorsum dark brownish-black or purplish, paler ventrally; much paler on tip of head and borders of cephalic slits; body and head much flattened, head long and pointed anteriorly. For figures, see Coe (1904, plate 5, figs. 4–7).

*Cerebratulus marginatus* Renier, 1804. Alaska to San Diego; also Japan, western North Atlantic south to Cape Cod, Arctic coasts, Europe south to Madeira, and Mediterranean Sea (type region). Intertidal and subtidal burrower in mud. Length to 1 m.

*Cerebratulus montgomeryi* Coe, 1901. Alaska to Monterey Bay. Intertidal and subtidal; under stones and in mud.

\**Cerebratulus occidentalis* Coe, 1901. Alaska, British Columbia, and Puget Sound; also San Francisco Bay (Corrêa 1964). Lower intertidal mudflats to predominantly subtidal. Reaches 15–30-plus cm. Dorsum chestnut brown to reddish brown anteriorly, light chocolate brown in intestinal region; brownish flesh color to light chocolate ventrally, with ventromedial ochre stripe; flattened posteriorly. For figure, see Coe (1904, plate 6, fig. 3).

*Euborlasia nigrocincta* Coe, 1940. California to Chile. Intertidal and subtidal under rocks and in hard clay in both exposed areas and protected bays. Length to 70 cm. Two intergrading color varieties, with many deviations, including inconspicuousness of dark transverse bands, especially in younger individuals.

*Lineus bilineatus* (Renier, 1804) (= *Cerebratulus bilineatus*, *Lineus albolineatus*, *L. bilineata*, *L. bilineatus*). Alaska to San Diego; also coasts of Europe, Mediterranean (type region), Black Sea, Madeira, South Africa. Intertidal and subtidal; under and among algae and other surface cover on rocks, often in kelp holdfasts. Feeds on polychaetes.

\**Lineus flavescens* Coe, 1904. Southern California to Gulf of California, with a disjunct northern record in Bodega Harbor (Crandall). Intertidal and subtidal on pilings and rocks, among algae and other surface cover. Ranging from 8–120 mm in length. Pale yellow to deep ochre, sometimes with shadings of orange or green; slender; head narrower than body and often rather pointed and emarginate anteriorly; several small irregular ocelli on each side of tip of head. For figures, see Coe (1904, plate 17, figs. 3, 4).

*Lineus pictifrons* Coe, 1904. Washington to Mexico. Under and among algae and other surface cover on rocks and piers exposed to surf, in kelp holdfasts, and in bay and harbor mud.

*Lineus ruber* (Müller, 1774) (see Gibson, 1995 for full synonymy). Alaska to Monterey (but see note below); also Circumpolar, Siberia, North Atlantic coasts of Europe (type region), Greenland to southern New England, Mediterranean and Black Seas, Madeira to South Africa. Mid-intertidal, under rocks on rocky shores. Deposits mucoid egg cocoon; larvae engage in sibling cannibalism; tens of crawl-away juveniles emerge from cocoon (Riser 1974, in Giese and Pearse, Reproduction of Marine Invertebrates, Vol. 1, Academic Press, pp. 359–389; reproduction). Feeds on polychaetes, oligochaetes, crustaceans, littorines, dissolved organics. Junior synonym and accepted as color variety of *Lineus viridis* for many years; reports could refer to either (e.g., Corrêa 1964). Neither senior author has seen *Lineus ruber*

\* = Not in key.

or *Lineus viridis* (both well known to Norenburg) during many years of collecting along coasts of central California, Puget Sound, and Alaska. Both species have high likelihood of appearing as invasive species (J. T. Carlton reports possible specimens of *L. ruber* in the highly invaded brackish lagoon Lake Merritt, Oakland, in San Francisco Bay). Likely to be confused with reddish variety of *Ramphogordius sanguineus* (= *Lineus vegetus*). Former contracts linearly, latter contracts into spiral form.

*Lineus rubescens* Coe, 1904. San Francisco Bay (Crandall) to San Diego. Intertidal and subtidal; under or among algae and other surface cover, on rocks and pilings, or under rocks.

*Lineus torquatus* Coe, 1901. Alaska to San Francisco Bay; also Japan, Kurile Islands, Russia. Intertidal; under rocks and in mud.

\**Lineus viridis* (Müller, 1774) (see Gibson, 1995, for complete synonymy). Included here only for comparative purposes. Not recorded in Coe 1940 as occurring anywhere on the West Coast. Coe 1901-1905 listed a West Coast occurrence at Annette Island, Alaska, also East Coast of North America, most European coasts, Mediterranean. *Lineus ruber* was considered a junior synonym and color variety of *L. viridis* for many years (with *L. viridis* being more green). See comments above for *L. ruber*. Likely to be confused with greenish variety of *Ramphogordius sanguineus* (= *Lineus vegetus*). Former contracts linearly, latter contracts into spiral form. Also resembles *L. ruber*, but coloration is olive green to dark greenish brown; head may have reddish hue, especially around cerebral ganglia. May occur in mid- to low-intertidal muddy habitats, under rocks or among mussels and other surface cover. Deposits eggs in mucoid cocoon from which approximately 100 or more small crawl-away juveniles emerge.

*Micrura alaskensis* Coe, 1901 (= *Micrura griffini*). Alaska to Mexico (type region); also Japan. Intertidal; in crevices, under rocks in soft sediments, and in sandy tidal flats.

*Micrura coei* (Coe, 1905) (= *Micrura pardalis sensu* Coe, 1905, renamed by Gibson, 1995). Monterey Bay to Mexico. Intertidal; in tide pools exposed to surf, on piers, on and under rocks, in mucous tubes.

\**Micrura olivaris* Coe, 1905. Bodega Head (Crandall) and Monterey Bay. Uncommon, in rock crevices in low intertidal. Pale olive-brown, buff, or grayish ochre, deeper olive in intestinal region, paler median dorsal stripe in esophageal region; six to 12 small black ocelli in irregular row on each side of head. No figure known.

*Micrura verrilli* Coe, 1901 (= *Lineus striatus*). Alaska to Monterey Bay. Intertidal; among roots of eelgrass, in kelp holdfasts, on rocks and in tide pools, and under rocks in sandy mud.

*Micrura wilsoni* (Coe, 1904) (= *Lineus wilsoni*). California to Mexico. Intertidal and subtidal; under rocks, in kelp holdfasts, on sandy mud, on piers.

*Ramphogordius sanguineus* (Rathke, 1799) (= *Lineus vegetus*, *Myioisophagos sanguineus*). California to Washington State; also cosmopolitan, especially in northern hemisphere (type region, northeast Atlantic coast). Intertidal, especially above mid-intertidal, to high marsh tide pools. Among algae and other surface cover, on rocks exposed to surf, also under rocks on sand and mud; common. Includes several previously described North Atlantic species (Riser 1994, Proc. Biol. Soc. Wash. 107: 548-556; Riser 1998, Hydrobiol. 365: 149-156, taxonomy, morphology). Frequently occurs in clusters, and color resembles either *Lineus viridis* or *Lineus ruber* (plate 88I), but becomes much more slender when fully stretched and coils spirally rather than contracting linearly when disturbed. Generally reproduces by fragmentation (fissipary). Feeds on dead shrimp, minced clams, etc., in laboratory conditions and also on polychaetes, oligochaetes. For figure, see Coe (1940, fig. 13, as *Lineus vegetus*).

*Zygeupolia rubens* (Coe, 1895) (= *Valencinia rubens*, *Zygeupolia littoralis*). Monterey Bay to Mexico; also Atlantic coast (type region). Intertidal; soft sediments of bays and harbors.

## Hoploneurtea

\**Amphiporus angulatus* (Müller, 1774). Alaska south to Point Conception, rare south of Puget Sound; also circumpolar, including Greenland (type region), western North Atlantic coast to Cape Cod and western North Pacific coast to Japan. In sandy and cobble situations, especially beneath stones; intertidal and subtidal. Dark or reddish brown or purplish dorsally, with paler margins and a conspicuous, whitish, angular patch on each side of head, continuous with color of ventral body surface. Body large, up to 20 cm, stout; when disturbed, can become greatly thickened anteriorly (Coe 1905). Gibson and Crandall (1989, Zool. Scripta 18: 453-470) declared *Amphiporus angulatus sensu* Müller (1774) as *nomen dubium*, while accepting *A. angulatus sensu* Coe (1901) from Alaska. On the basis of external appearance the latter is indistinguishable from *A. angulatus sensu* Verrill (1892) from New England and eastern Baffin Island (Norenburg pers. obs.), therefore probably also from Greenland, the type locale. For figures, see Coe (1901, fig. 10; plate 6, fig. 4; plate 7, fig. 2; plate 11, fig. 2; plate 13, fig. 3).

*Amphiporus bimaculatus* Coe, 1901 (= *Nipponnemertes bimaculatus*, *Collarenemertes bimaculatus*). Alaska to Mexico (type region). Intertidal; on and in rock crevices and pilings, among algae and other surface cover, also under rocks. Subtidal on kelp holdfasts. Specimens from the Sea of Japan called *A. bimaculatus* by Coe are not this species (Crandall pers. comm.). Not *Amphiporus* (Gibson and Crandall 1989, Zool. Scr. 18: 453-470). Often swims when placed in container of clean seawater.

*Amphiporus cruentatus* Verrill, 1879 (= *Amphiporus leptacanthus* Coe, 1995). Washington to San Diego. Intertidal and subtidal; among algae and other surface cover on rocks and pilings, common in kelp holdfasts.

*Amphiporus flavescens* Coe, 1905. Monterey Bay to Mexico. Intertidal and subtidal; under rocks and among algae and other surface cover on rocks and pilings. Quite variable in color intensity, number and arrangement of ocelli, and stylet armature.

*Amphiporus formidabilis* Griffin, 1898 (= *Amphiporus exilis*). Aleutian Islands, Alaska to Puget Sound (type region), south to Monterey Bay; also Japan (Corrêa 1964). Intertidal; among algae and other surface cover on rocks and pilings, under and in rock crevices, often exposed to surf. Often exposed on foggy days. Feeds on amphipods, isopods, and chelipeds of *Petrolisthes* sp. Difficult to distinguish externally from *A. imparispinosus*.

*Amphiporus imparispinosus* Griffin, 1898. (= *Amphiporus similis*, *A. leuciodus*). Alaska to Puget Sound (type region), south to Mexico; also Siberia. Upper intertidal to subtidal; under rocks and among algae/coralline algae on rocks and pilings, at exposed and quiet-water sites; common but patchy. Feeds on amphipods. Compare to *A. formidabilis*, above. *A. similis* was designated a separate species by Coe (1905) based on specimens having two versus three accessory stylet sacs; designated as *A. imparispinosus* var. *similis* in Coe (1940).

\**"Amphiporus" rubellus* Coe, 1905. Southern California (type region), may occur farther north. Intertidal to (more commonly) subtidal; among surface cover on wharf pilings and low intertidal rocks. Not an *Amphiporus* (Gibson and Crandall 1989, Zool. Scr. 18: 453-470, taxonomy). Salmon yellowish to pale

\* = Not in key.

orange or pale red dorsally, paler and usually grayish ventrally; large pigment cup ocelli in two groups as an irregular anterior row of six to 12 and a posterior cluster of six to eight on each side. For figures, see Coe (1905, plate 1, figs. 11, 12).

\**Amphiporus similis* Coe, 1905. Central California (type region). On pilings in Monterey, among coralline algae at Pacific Grove. Coe (1940, 1943) and others have synonymized this form with *Amphiporus imparispinosus* Griffin, 1898 (Gibson and Crandall 1989, Zool. Scripta 18: 453–470, taxonomy) retained it as a separate *species inquirenda*. Externally, *A. similis* is reported as having two pairs of cephalic grooves, whereas *A. imparispinosus* has a single pair (Crandall). For figures, see Coe (1905, plate 16, figs. 93, 94; plate 22, figs. 152, 153).

*Carcinonemertes epialti* Coe, 1902. Pacific coast North America. Intertidal and subtidal, at bases of legs and abdomen of several crab species, including *Pugettia producta*, *Hemigrapsus oregonensis*, *H. mudus*, *Pachygrapsus crassipes*, *Cancer* spp. except *C. magister*; possibly other brachyuran crabs. Common, but patchy by host and region. Feeds on developing crab embryos (Roe 1984, Biol. Bull. 167: 426–436; feeding, reproduction). May be a species complex (Wickham and Kuris 1988, Hydrobiologia 156: 23–30; taxonomy). Small size and great transparency make juveniles useful for classroom study. Spiny lobster, *Panulirus interruptus*, harbors *C. wickhami* in southern California (Shields and Kuris 1989, Fishery Bull. U.S. 88: 279–287; taxonomy, morphology).

*Carcinonemertes errans* Wickham, 1978. Washington (type region), also Alaska to Monterey Bay. Intertidal and subtidal, at bases of legs and abdomen of host, *Cancer magister*; common but patchy. Feeds on developing crab embryos. Migrates from old skeleton to new at time of host molting (Wickham et al. 1984, Biol. Bull. 167: 331–338; biology).

*Emplectonema buergeri* Coe, 1901 (= *Emplectonema violaceum* Griffin, 1898; not *E. violaceum* Bürger, 1896). Alaska (type region) to Monterey Bay. Intertidal and subtidal; under rocks, among mussels and other surface cover on rocks. Length to 1 m, width of 5 mm. Puget Sound forms with spiral-grooved stylets (Maslakova, Norenburg, pers. obs.), otherwise resemble description of Alaska forms with smooth stylets (Coe 1901, 1905); morphology of California forms (Coe 1940) not known. If differences verified, the forms are likely different species.

*Emplectonema gracile* (Johnston, 1837) (= *Nemertes gracilis*, plus large list of synonyms for forms not from the western U.S. coast). Alaska to Mexico, also northern Europe (type region) to Mediterranean. Intertidal and subtidal; among mussels and other surface cover on rocks and pilings, both exposed to surf and in muddy situations where barnacles occur; common but patchy; several individuals often together in tangled masses. Feeds on acorn barnacles. Proboscis basis much elongated and stylets curved.

*Malacobdella grossa* (Müller, 1776) (see Gibson 1995 for full synonymy). Puget Sound to California, also widespread along North Atlantic eastern (type region) and western coasts, and western Pacific coasts. Prior to Kozloff (1991, Can. J. Zool. 69: 1612–1618; taxonomy), all U.S. Pacific coast occurrences of *Malacobdella*, except for *M. minuta*, were designated *M. grossa*. Those from three hosts have been reassigned to new species (see below). The identity of *M. grossa* reported from *Tresus nuttallii* and *T. capax*, from Humboldt Bay north (Haderlie in Morris, Abbott and Haderlie, eds. 1980, *Intertidal Invertebrates of California*, pp. 84–90; general biology) needs to be investigated. Malacobdellids are plankton feeders.

*Malacobdella macomae* Kozloff, 1991. Oregon and central California. Commensal in clams *Macoma secta* and *M. nasuta*. For figure, see Kozloff (1991, Can. J. Zool. 69: 1612–1618, figs. 10–11).

\**Malacobdella minuta* Coe, 1945. Single specimen found in *Yoldia cooperi* off Point Loma, California. Distribution of host suggests possible occurrence north as far as San Francisco. Distinguished from other species by small size at maturity (5–8 mm), intestine with seven to eight undulations, gonads in single row.

*Malacobdella siliquae* Kozloff, 1991. Washington and Oregon. Occurs in the razor clam *Siliqua patula*. For figure, see Kozloff (1991, Can. J. Zool. 69: 1612–1618, figs. 1–2).

*Nemertopsis gracilis* Coe, 1904 (= *Nemertes gracilis* var. *bullocki*). Washington to Mexico. Intertidal and subtidal; among algae and other surface cover on rocks and pilings exposed to surf, also in rocky cracks and under rocks in muddy situations, usually in low intertidal, although Roe found specimens associated with the high-intertidal "*Pantionemertes*" *californiensis* at Elkhorn Slough; common. Feeds on the clam *Lasaea adansonii*. Original description for *N. gracilis* (plate 90F) differs from *N. gracilis* var. *bullocki* (plate 90G) only in color pattern. Specimens in China externally identical to those in California, except for minor color differences, designated a new species, *N. bullocki* (Sun 1998, Chin. J. Oceanol. Limnol. 16: 271–279, morphology, taxonomy).

*Oerstedtia dorsalis* (Abildgaard, 1806) (= *Tetrastemma dorsalis*, *T. dorsale*, *Oerstedtia dorsale*). Washington to Mexico, also both sides of Atlantic from northern Europe (type region) to Madeira and Nova Scotia to south of New England. Low intertidal and subtidal; among algae and other surface cover on rocks and pilings. This species originally described from Europe, where its epidermal coloring and pigmentation can range from a uniform brown to patterned speckling (Envall and Sundberg 1993, J. Zool. Lond. 230: 293–318). Similar to *Tetrastemma candidum*, but more cylindrical in cross-section, and head more bullet-shaped.

*Ototyphlonemertes* species are very likely to be encountered in the interstitial space of relatively well-sorted, intertidal or subtidal coarse sediments or shell-hash. Specimens can be collected by any of the "wash and decant" techniques (Norenburg 1988, in Higgins and Thiel, *Introduction to the Study of Meiofauna*, Smiths. Inst. Press, pp 287–292; biology); littoral forms often can be persuaded to migrate out of the sediment by simulating low tide—by placing sediment at upper end of a slanted white tray and then dripping seawater over the sediment (Corrêa 1949, Commun. zool. Mus. Hist. nat. Montev. 3: 1–9). Multiple allopatric and sympatric putative species have been found in regions with appropriate habitats that have been well sampled (Norenburg 1988, Hydrobiol. 156: 87–92; taxonomy). The Pacific coast has not been well sampled; known species are *Ototyphlonemertes spiralis* Coe, 1940, intertidal from coarse sand near San Diego; *O. americana* Gerner, 1969 (Helgoländer wiss. Meeresunters. 19: 68–110; taxonomy) from San Juan Island, Puget Sound. Forms that key out to either of the known species have a reasonable probability of not being those species (see Envall and Norenburg 2001, Hydrobiol. 456: 145–163; taxonomy). Two species, one with a smooth stylet and one with a spirally fluted stylet, occur at Half Moon Bay and at San Gregorio Beach (Norenburg pers. obs.); only the second appears to be a described species (see below).

*Ototyphlonemertes americana* Gerner, 1969. Puget Sound. Several individuals resembling *O. americana* were found mid- to low-tide range at Half Moon Bay and San Gregorio Beach just south of San Francisco (new record).

"*Pantionemertes*" *californiensis* Gibson, Moore, and Crandall, 1982. Washington to Huntington Beach, southern California (Crandall). High intertidal and supralittoral; under logs and stones

\* = Not in key.

that have been in place a long time, often covered with *Zostera* wrack. Length to 450 mm (Gibson, Moore, and Crandall 1982, J. Zool. London 196: 463–474; distribution, size, taxonomy, morphology). Not *Pantinnemertes* (Norenburg, Crandall pers. obs.; S. Maslakova, 2005, Ph.D. dissertation, George Washington University, Washington, D.C.). Feeds primarily on amphipod *Traskorchestia traskiana*. Most spawn in June–July; spawning can be induced by submerging ripe individuals in seawater for a few minutes, or by exposing submerged individuals to drying conditions (Roe 1993, Hydrobiologia 266: 29–44; feeding, reproduction).

*Paranemertes californica* Coe, 1904. Monterey Bay to Mexico. Intertidal; burrower in soft sediments in bays and harbors.

*Paranemertes peregrina* Coe, 1901. Alaska (type region) to Mexico. Intertidal; under rocks and among algae and other surface cover on rocks on wave-impacted shores. Also buried in soft sediments, or crawling on soft sediments when sediments are exposed at low tide; common. Feeds on polychaetes, especially nereids, at low tide (Roe 1976, Biol. Bull. 150: 80–106; feeding, ecology). Coe (1905) attributed two morphotypes to this species. One from California north to Juneau, Alaska, has stylets with spiral fluting, resulting in a braided appearance (plate 89B); with two accessory stylet sacs; dorsal color is purplish brown, tending more toward brown than purple. The second morphotype, described by Coe (1901) from Alaska, has stylets without spiral fluting (plate 89C), often has four accessory stylet sacs, and the body color is more purple than brown.

*Paranemertes sanjuanensis* Stricker, 1982. False Bay, San Juan Island. Intertidal; crawls on soft sediments at low tide. Beige colored. Stylets with helical fluting, giving stylets a braided appearance similar to that of *P. peregrina* (plate 89B). Roe has seen a few specimens at Bodega Harbor tentatively identified as *P. sanjuanensis* based on similar appearance and spirally fluted stylets. For figures, see Stricker (1982, Zool. Scripta 11: 107–115; taxonomy, morphology).

*Poseidonemertes collaris* Roe and Wickham, 1984. Bodega Harbor. Intertidal; rapid burrowers in surface sediments, especially sandy muds with moderate amounts of green algae present. When contracting, does not coil or twist, often retracts head to level of anterior grooves, forming a collar. (Roe and Wickham 1984, Proc. Biol. Soc. Wash. 97: 60–70; taxonomy, morphology).

*Tetrastemma albidum* Coe, 1905 (= *Prosorhochmus albidus*). Monterey Bay to Mexico. Intertidal; among algae and other surface cover on rocks and pilings exposed to surf. Not a *Prosorhochmus* (Norenburg, Maslakova pers. obs.). May be live-bearing (Coe 1940).

*Tetrastemma candidum* (Müller, 1774) (= *Fasciola candida*). Alaska to Mexico, also northeast Atlantic coasts (type region) to Mediterranean, South Africa, and Labrador to south of New England. Intertidal and subtidal; among algae and other surface cover on rocks and piers, and buried in soft sediments. Nondescript; may be a species complex. Compare to *Oerstedtia dorsalis*. Will feed on *Artemia* nauplii in laboratory.

*Tetrastemma nigrifrons* Coe, 1904. Central California (type region), Washington to Costa Rica; also Sea of Japan. Intertidal and subtidal; among algae and other surface cover on rocks and piers; common. Highly variable in both pigmentation and color pattern, four common patterns in geographic range of this manual.

*Tetrastemma quadrilineatum* Coe, 1904. Monterey Bay to Mexico. Intertidal; among algae and other surface cover on rocks and pilings, also in tide pools.

\**Tetrastemma reticulatum* Coe, 1904. Common at San Diego and San Pedro; may occur north to Monterey Bay (Crandall). Specimens small, only 8–15 mm long and very slender. White with rectangular and longitudinal chocolate brown to light or

reddish brown blocks covering much of dorsum. On pilings and among rocks in lowest intertidal. For figures, see Coe (1904, plate 14, figs. 7, 8; plate 20, figs. 7–9; 1905, plate 2, figs. 16, 17).

*Tetrastemma signifer* Coe, 1904. Monterey Bay to San Diego. Intertidal and subtidal; among algae and other surface cover on rocks and pilings, and in subtidal kelp holdfasts.

*Zygonemertes albida* Coe, 1901. British Columbia to Puget Sound, also Monterey Bay (new record). Intertidal and subtidal; among algae and other surface cover on rocks and pilings. Resembles pale, juvenile individuals of *Z. virescens* (see below). Positive identification is only possible with a sexually mature specimen. Sexually mature *Z. albida* remain whitish. Basis without posterior notching.

\**Zygonemertes thalassina* Coe, 1901. Alaska (type region), south to Point Reyes (Crandall). Among algae and surface cover on rocks and among shell hash, low-water and deeper. Uniform pale green, the color of pea soup; basis concave or serrated posteriorly, about three times as long as wide, stubby central stylet, four to five accessory stylets per pouch. For figures, see Coe (1901, fig. 5, plate 2, fig. 5; plate 7, fig. 1; plate 13, fig. 2).

*Zygonemertes virescens* (Verrill, 1879) (= *Amphiporus virescens*). British Columbia to Mexico; also Atlantic (type region) and Gulf Coasts. Intertidal and subtidal; under rocks, among algae and other surface cover on rocks and pilings, and on soft sediments at low tide. Variable in color (juveniles whitish to pale yellow or green, adults pale to dark hues of green), in number of ocelli (increasing with body size to 100 or more) and in relative sizes of basis and central stylet (basis usually with posterior notching or ruffling, length approximately four times diameter and one and a half to two times length of stylet; two to three accessory stylets per pouch). See above for comparison with *Z. albida*.

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\* = Not in key.