

A KEY TO THE NEMERTEA FROM THE INTERTIDAL  
ZONE OF THE COAST OF CALIFORNIA

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## California Nemerteans

The nemerteans are a colorful, abundant and frustrating group of worms. External appendages and hard parts are almost entirely lacking, and the age and confusion of existing literature makes species identification thoroughly intimidating. Ribbon worms, however, are abundant in nearly every benthic environment. The vast majority are predators of a highly selective nature. Of those examined, most feed by choice on a single family, genus, or species of amphipod or polychaete. The identification of nemerteans in biological surveys would add another dimension to the food webs we are trying to puzzle out. The key included here is aimed in that direction.

The key is limited to nemertea of the intertidal zones, and is designed for the non-specialist. With the notable exception of Haderlie, 1975, in Light's manual, previous keys have been taxonomically oriented, and relied heavily on sectioning of internal structure. That approach has not proved to be practical for survey work. The present key is morphologically oriented and relies mainly on external characters. Some points do require limited dissection. Included are all intertidal species previously reported from California waters, and several northern species which have been identified recently in samples from Southern California.

Fig. 1 shows the basic organization of a nemertean. They are acoelomate worms arranged around a highly developed proboscis. Most species have evolved an elaborate venom apparatus. In the hoplonemerteans, this includes a stylet on the proboscis, mounted on a rounded basis. There are usually pouches of replacement stylets. There is also a nervous system organized into brain lobes and nerve cords, and a simple, closed circulatory system. The digestive

and reproductive systems show a high degree of metamerism.

Fig. 2 shows externally visible characters used in the key. Proboscis structure, i.e. stylet characteristics, has been avoided where possible. The first structure of importance is the mouth. It is either a separate structure located behind the brain, or it is subterminal, sharing a common external opening with the proboscis. The proboscis pore is subterminal in all species.

The proboscis is a muscular, highly enervated organ resting inside a proboscis sheath, which lies in a rhynchocoelom. It is everted by hydrostatic pressure in the rhynchocoelom and is not connected to the digestive system.

A variety of sensory organs are associated with head structures. Olfactory pits, cephalic glands, and cephalic furrows are generally difficult to see without sectioning. The only organs used in the key, then, are the "cephalic grooves" of the Lineidae, and the lateral sense organs of the Tubulanidae. Both are believed to be chemoreceptors.

The ocelli are very important. In some cases, they can be seen clearly through body tissues. In others, dissection is necessary. The simplest method is to make a transverse cut through the head, as shown in fig. 3. The number, arrangement and size of the ocelli are usually easily seen from this cut.

A more curious structure is the caudal cirrus. It is found only in spp. of *Micrura*, *Cerebratulus* and *Zygeupolia*. Its function is not apparent, particularly since it is so easily broken off and lost. For the same reason, it is of limited use in a key.

The taxonomic divisions of the nemertea are mainly based on the structure of the body walls. However, that structure is not very useful here, since

sectioning has been avoided at all costs. The following is a list of species included in the key in their taxonomic groupings.

Class Anopla

Order Paleonemertea

Family Tubulanidae

- Tubulanus albocinctus (Coe), 1904
- Tubulanus capistratus (Coe), 1901
- Tubulanus cingulatus (Coe), 1904
- Tubulanus frenatus (Coe), 1904
- Tubulanus pellucidus (Coe), 1895
- Tubulanus polymorphus Renier, 1804
- Tubulanus sexlineatus (Griffin), 1898
- Carinomella lactea Coe, 1905

Family Carinomidae

- Carinoma mutabilis Griffin, 1898

Family Cephalothricidae

- Procephalothrix major (Coe), 1930
- Procephalothrix spiralis (Coe), 1930

Order Heteronemertea

Family Baseodiscidae

- Baseodiscus punnetti (Coe), 1904

Family Lineidae

- Zygeupolia rubens (Coe), 1895
- Euborlasia nigrocincta (Coe), 1940
- Lineus bilineatus (Renier), 1804
- Lineus flavescens Coe, 1904
- Lineus pictifrons Coe, 1904
- Lineus ruber (Muller), 1771
- Lineus rubescens Coe, 1904
- Lineus torquatus Coe, 1901
- Lineus vegetus Coe, 1931
- Micrura alaskensis Coe, 1901
- Micrura nigrirostris Coe, 1904
- Micrura olivaris Coe, 1905
- Micrura pardalis Coe, 1905
- Micrura verrilli Coe, 1901
- Micrura wilsoni (Coe), 1904
- Cerebratulus albifrons Coe, 1901
- Cerebratulus californiensis Coe, 1905
- Cerebratulus lineolatus Coe, 1905
- Cerebratulus marginatus Renier, 1804
- Cerebratulus montgomeryi Coe, 1901

Class Enopla

Order Hoplonemertea

Family Ototyphlonemertidae

Ototyphlonemertes spiralis Coe, 1940

Family Emplectonematidae

Carcinonemertes epialti Coe, 1902

Emplectonema burgeri Coe, 1901

Emplectonema gracile (Johnson), 1837

Paranemertes californica Coe, 1904

Paranemertes peregrina Coe, 1901

Paranemertes sp. A

Nemertopsis gracilis Coe, 1904

Dichonemertes hartmanae Coe, 1938

EMERTES NEMERTIDS 1 worm/day  
14-35% of *Platyneveis* pop./yr in  
intertideal

Family Prosorhochmidae

Prosorhochmus albidus (Coe), 1905

Oerstedtia dorsalis (Abilgaard), 1806

Family Amphiporidae

Zygonemertes albida Coe, 1901

Zygonemertes virescens (Verrill), 1879

Amphiporus angulatus (Fabricius), 1774

Amphiporus bimaculatus Coe, 1901

Amphiporus californicus Coe, 1905

Amphiporus cruentatus Verrill, 1879

Amphiporus flavescens Coe, 1905

Amphiporus formidabilis Griffin, 1898

Amphiporus imparispinosus Griffin, 1898

Amphiporus punctatulus Coe, 1905

Amphiporus rubellus Coe, 1905

Family Tetrastemmatidae

Tetrastemma bilineatum Coe, 1904

Tetrastemma candidum (Muller), 1774

Tetrastemma nigrifrons Coe, 1904

Tetrastemma quadrilineatum Coe, 1904

Tetrastemma reticulatum Coe, 1904

Tetrastemma sexlineatum Coe, 1940

Tetrastemma signifer Coe, 1904

Order Bdellonemertea

Family Malacobdellidae

Malacobdella grossa (Muller), 1776

Malacobdella minuta Coe, 1945

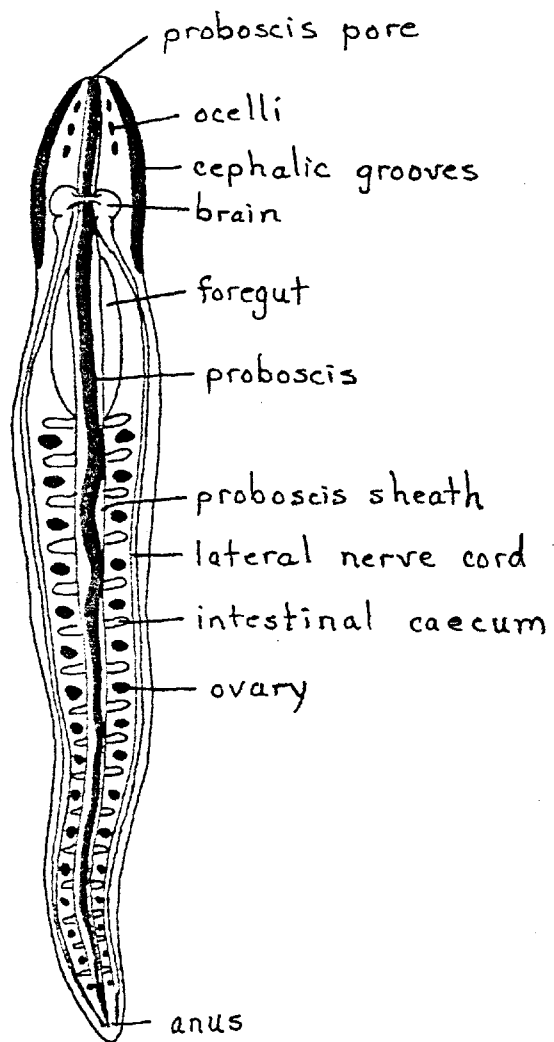


Figure 1. Internal Anatomy

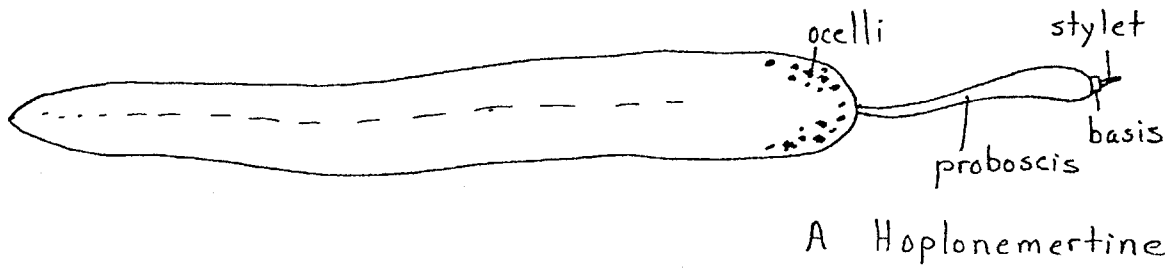
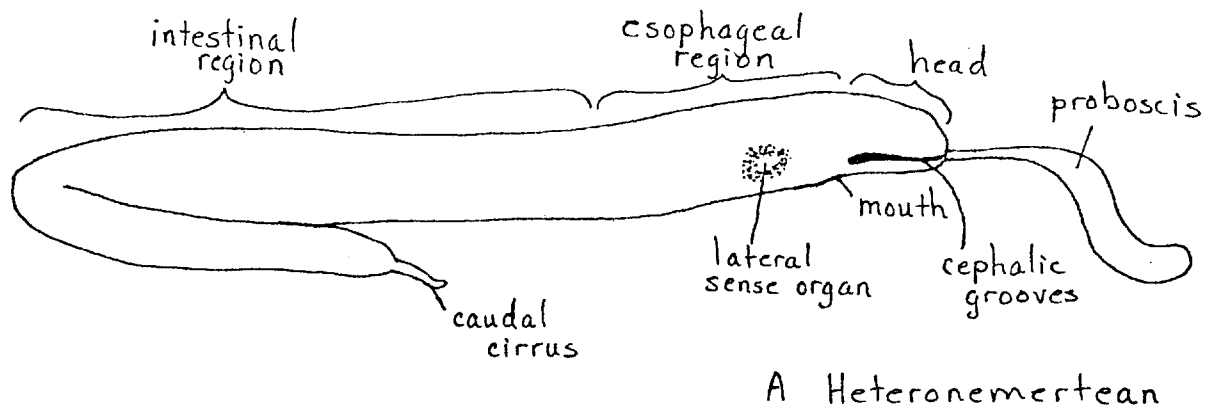


Figure 2. External Characters

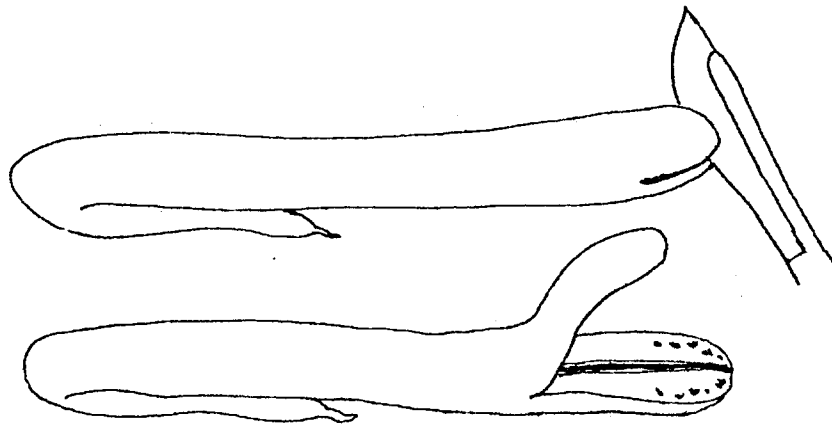






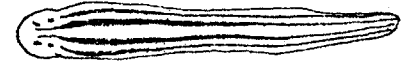
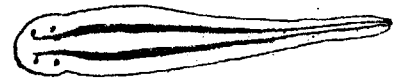
Figure 3. Dissection of Ocelli



A Key to Nemertea from the Intertidal  
Zone of the Coast of California

- |    |    |  |   |  |
|----|----|--|---|--|
| 1. | a. | Mouth posterior to brain; mouth and proboscis pore separate.....   |    | Anopla.....31                                  |
|    | b. | Mouth subterminal; mouth and proboscis share common opening.....   |    | Enopla.....2                                   |
| 2. | a. | Proboscis unarmed; sucking disc is present at posterior end of body.....                                 |   | Bdellonemertea...3                             |
|    | b. | Proboscis armed; without any posterior appendage.....  |   | Hoplonemertea....4                             |
| 3. | a. | Ovaries form a single irregular row on each side of the body; body size 5-8mm when mature.....           |   | <u>Malacobdella minuta</u>                     |
|    | b. | Ovaries diffusely scattered through intestinal region; body size 20-50mm.....                            |   | <u>Malacobdella grossa</u>                     |
| 4. | a. | Statocysts present on cerebral ganglia; ocelli absent; body minute.....                                  |   | <u>Ototyphlonemertes spiralis</u> <sup>1</sup> |
|    | b. | Statocysts absent; ocelli usually present; not interstitial.....   |   | 5  |
| 5. | a. | Parasitic on crabs; proboscis rudimentary, lacking accessory stylet pouches.....                         |   | <u>Carcinonemertes epialti</u> <sup>2</sup>    |
|    | b. | Free-living; proboscis well-developed with 2 or more accessory stylet pouches.....                       |   | 6  |
| 6. | a. | Body color of two tones, dorsal color sharply contrasting with pale ventral color.....                   |   | 7  |
|    | b. | Body color relatively uniform, or with pattern of stripes, spots, reticulation or cephalic markings..... |   | 9  |
| 7. | a. | Body short, straight, stubby; color purple dorsally, cream ventrally.....                                |  | <u>Paranemertes peregrina</u>                  |
|    | b. | Body long, slender, often forming tangled masses; body brown or green dorsally, white ventrally.....     |  | <u>Emplectonema spp.</u> ...8                  |

8. a. Dorsally green; ventrally cream, white  
or pale yellow-green.....Emplectonema gracile
- b. Dorsally velvet-brown; ventrally  
cream or buff.....Emplectonema burgeri
9. a. Body marked with distinct longi-  
tudinal stripes.....10
- b. Body not striped, or stripes ac-  
companied by other markings.....13
10. a. Dorsal surface with 2 dark stripes  
on a pale ground color.....11
- b. Dorsal surface with 4 or 6 dark  
stripes.....12
11. a. Stripes fade out posteriorly; ocelli  
not visible without dissection;  
intestinal region often rosy or  
purplish.....Nemertopsis gracilis
- b. Stripes distinct throughout body  
length; 4 large ocelli visible, form-  
ing a rectangle on dorsal surface of  
the head; intestinal region of same  
color as rest of body.....Tetrastemma bilineatum
12. a. Dorsal surface with 4 stripes: 2  
dorsal and 2 lateral.....Tetrastemma quadrilineatum
- b. Dorsal surface with 6 stripes: 2  
mid-dorsal, 2 dorso-lateral and 2  
ventro-lateral.....Tetrastemma sexlineatum
13. a. Dorsal surface reticulated, with  
brown rectangular markings and  
stripes on a cream or buff ground  
color.....Tetrastemma reticulatum
- b. Dorsal surface striped or spotted  
or uniform.....14
14. a. Head white or cream, sharply con-  
trasting with body color; and  
bearing a dark cephalic marking;  
body color striped or uniform.....15



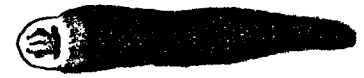
- b. Head of same color as body; without cephalic markings; body spotted or uniform.....16

NOTE THREE CHOICES

15. a. Body reddish-brown; head white or cream with 2 triangular dark spots on dorsal surface.....Amphiporus bimaculatus



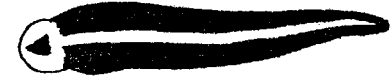
- b. Body reddish-brown; head white with a dark wreathlike marking on the dorsal surface.....Tetrastemma singifer



- c. Body color varies; head white with a single dark spot on dorsal surface.....



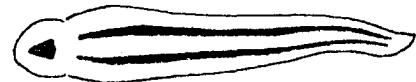
variety purpureum



variety bilineatum



variety pallidum



variety A

Tetrastemma nigrifrons

16. a. Body with pattern of conspicuous spots.....17

- b. Body color uniform.....18

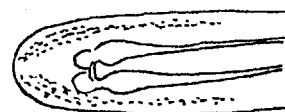
17. a. Brown mottling on dorsal surface only, may condense into irregular lines; 2 pair of large ocelli.....Oerstedtia dorsalis



- b. Brown mottling extends over ventral surface, though less thickly; ocelli small, numerous.....Amphiporus punctatulus



18. a. Ocelli form an irregular row along lateral nerve cords, extending well behind brain; large, sickle-shaped rhabdites present in epithelium.....Zygonemertes spp..19



- b. Ocelli anterior to brain; rhabdites, if present, are small, rod-shaped.....20
- 19. a. Body white or yellow.....Zygonemertes albida<sup>3</sup>
- b. Body green, often with purplish caste.....Zygonemertes virescens<sup>3</sup>

STEPS 20-30; Ocelli must be examined. This is best accomplished by dissection, or by staining and clearing of specimens. For the latter, be sure to note body color carefully.

NOTE 3 CHOICES

- 20. a. With 2 ocelli at anterior tip of head.....21
- b. With 4 ocelli forming a rectangle on head.....22
- c. With more than 4 ocelli.....23

- 21. a. Body filiform; color white; intestinal region deep green; prefers sandy habitats.....



.....Paranemertes californica<sup>4</sup>

- b. Body short, stubby; color white; intestinal region deep green; prefers muddy habitats.....



.....Paranemertes sp. A<sup>5</sup>

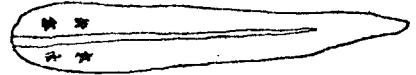
NOTE THREE CHOICES

- 22. a. Proboscis sheath limited to anterior 1/3 of body; ocelli minute; body yellowish.....



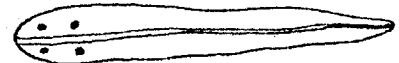
.....Dichonemertes hartmanae

- b. Proboscis sheath extends to posterior 1/3 of body; ocelli large, irregular, with rootlike processes of pigment extending on all sides; body opaque white.....



.....Prosorhochmus albidus

- c. Proboscis sheath extends to posterior end of body; ocelli large, spherical; body gray-green.....



.....Tetrastemma candidum

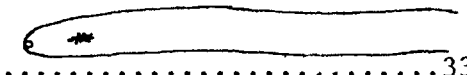

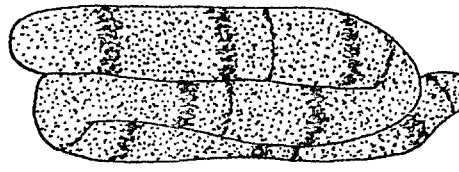


- 23. a. Ocelli small, in 4 clusters of 2-3, one on each side of proboscis and anterior to each brain lobe; body white, intestinal region green.....



.....Paranemertes californica<sup>4</sup>

- b. Ocelli vary, 14 or more present in clusters, or 10-20 present in rows; body white, yellow, red or brown; intestinal region green only if body is red.....Amhiporus spp<sup>6</sup>...24
24. a. Ocelli form a single row of 5-10 on each side of head, the anteriormost being largest; body yellow.....Amhiporus cruentatus
- b. Ocelli form irregular clusters; body white, yellow, red or brown.....25
25. a. Body white or pale yellow.....26
- b. Body red or brown.....28
26. a. Ocelli number 60-250, depending on size of the worm; body whitish.....Amhiporus formidabilis
- b. Ocelli number 50 or less; body white or yellow.....27
27. a. Ocelli number 30-50; proboscis with 3 pouches of accessory stylets; body opaque white; epithelium with rod-shaped, yellowish rhabdites.....Amhiporus imparispinosus
- b. Ocelli number 14-50; proboscis with 2 pouches of accessory stylets; body yellowish; epithelium without rhabdites.....Amhiporus flavescens
28. a. Body red; ocelli number 8-40.....29
- b. Body brown; ocelli number 40-70.....30
29. a. Ocelli number 20-40; 6-10 larger ocelli form 2 groups on each side of head.....Amhiporus rubellus<sup>7</sup>
- b. Ocelli number 8-16; ocelli form irregular clusters on each side of head.....Amhiporus californicus
30. a. Body color dark reddish or purplish brown; head with an angular whitish spot on each side, and sometimes a whitish V-shaped marking; ocelli number 40-70; apr. 20 in an elongated cluster on each anterior margin and 8-15 in each whitish spot.....Amhiporus angulatus



- b. Body color brown, due to minute dots thickly scattered on flesh ground color; ocelli number apr. 50, forming an irregular cluster on each side of head.....Amhiporus fulvus
- 31. a. Mouth immediately posterior to brain..........33
- b. Mouth far behind brain.....Procephalothrix spp.....32
- 32. a. Body contracts in snarled tangle; species prefers hard sand or clay fully exposed to surf.....Procephalothrix major<sup>9</sup>
- b. Body contracts in spiral coil; species prefers protected sites under stones or in mud.....Procephalothrix spiralis<sup>9</sup>
- 33. a. With distinct longitudinal cephalic grooves..........43
- b. Without cephalic grooves.....34
- 34. a. Body remarkably thick and massive; Head white, speckled; Body color of 2 varieties: a) buff speckled with brown, and with narrow dark rings; and b) purplish-brown speckled with white, and with narrow dark rings..........Euborlasia nigrocincta
- b. Body filiform or ribbon-like; body not spotted.....35
- 35. a. Head with white terminal border, and single dark spot on dorsal surface of head; body deep red..........Baseodiscus punnetti
- b. Head without white terminal border; cephalic spot absent or more than one present; body white, brown or red.....36
- 36. a. Body with rings and/or stripes<sup>10</sup>.....37
- b. Body without distinct markings.....42
- 37. a. Body with 1, occasionally 2 dark rings near head..........38
- b. Body with several rings.....39

NOTE THREE CHOICES

38. a. Body red; sometimes rather mottled; band is black or brown; size: to 2m; lateral sense organs often conspicuous.....Tubulanus polymorphus<sup>11</sup>

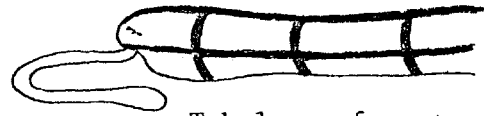
b. Body white; band is brick red; size: 10-25mm; lateral sense organs conspicuous.....Tubulanus pellucidus<sup>11</sup>



c. Body white or translucent; band is brown, faint; size: 50-100mm; lateral sense organs inconspicuous.....Carinomella lactea<sup>11</sup>

Very common in soft Bottom

39. a. Body yellow, rosy or greenish, with black markings: 3 longitudinal stripes and a series of narrow rings.....



Tubulanus frenatus

b. Body red or brown with white markings.....40

40. a. Body red with white rings, and without stripes.....Tubulanus albocinctus

b. Body brown with white rings and stripes.....41

NOTE THREE CHOICES

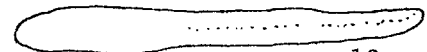
41. a. With 3 white stripes: 1 mediodorsal, and 2 lateral.....Tubulanus capistratus



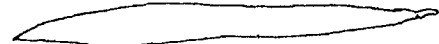
b. With 4 white stripes: 2 dorsal and 2 lateral.....Tubulanus cingulatus

c. With 5 or 6 white stripes: 1 medio-dorsal, 2 dorso-lateral, 2 ventro-lateral, and 1 medioventral which may be indistinct.....Tubulanus sexlineatus

42. a. Body white or yellowish; head rounded; caudal cirrus absent.....Carinoma mutabilis<sup>12</sup>



b. Body red or rosy; head long and pointed; caudal cirrus present (easily lost).....Zygeupolia rubens<sup>12</sup>



MUST BE OBSERVED TO SEPARATE THESE genera

43. a. Body yellow, nearly covered with brown spots, sometimes elongated and arranged in irregular lines or rectangles; caudal cirrus present.....Micrura pardalis



b. Body not spotted; caudal cirrus present or absent.....44

44. a. Body dark, with single white band across dorsal surface of head.....45



b. Body without markings, or markings otherwise.....46

45. a. Body deep red; white band located just behind tip of head; tip with a small dark spot.....Micrura nigrirostris



b. Body reddish-brown or purple; white band connects posterior ends of cephalic grooves; tip without a dark spot.....Lineus torquatus



46. a. Tip of head white, sharply separate from body color.....47

b. Tip of head not strikingly different from body color.....52

47. a. Body with series of narrow rings of contrasting color.....48

b. Body without rings.....49

NOTE THREE CHOICES

48. a. Body deep-brown, chestnut or slaty with narrow yellow rings and 7-15 inconspicuous yellow stripes, of which the mid-dorsal is most defined, connecting diamond-shaped areas on rings.....Lineus pictifrons<sup>13</sup>



b. Body brown or black, with narrow whitish bands throughout body.....Micrura wilsoni<sup>14</sup>

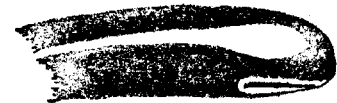


c. Ventrally white; dorsally red, deep orange or vermillion with narrow white rings throughout body.....Micrura verrilli





49. a. Tip of head white, extending to apr. 3/4 length of cephalic grooves; body dark brown or reddish-brown.....Cerebratulus albifrons
- b. Tip of head white, extending to 1/4 or less length of cephalic grooves; black, red or brown.....49
50. a. Body black or brown; slender, rounded throughout.....Micrura wilsoni<sup>14</sup>
- b. Body deep red; flattened posteriorly or ribbon-like.....51
51. a. Body slender, rounded anteriorly, somewhat flattened posteriorly; caudal cirrus absent; size = 10-15mm.....Lineus rubescens
- b. Body long and ribbon-like, with thin lateral margins; caudal cirrus present; size: to 2m.....Cerebratulus montgomeryi
52. a. Body with striking longitudinal markings.....53
- b. Body without distinct longitudinal markings.....54
53. a. Body dark brown with mediodorsal stripe of white or yellow, widening on head to form broad whitish marking.....Lineus bilineatus
- b. Body pale grey, with numerous fine, irregular, interrupted dark brown longitudinal lines.....Cerebratulus lineolatus
54. a. Body filiform; caudal cirrus absent.....Lineus spp.....55
- b. Body thick, becoming flattened or ribbonlike posteriorly; caudal cirrus present.....57
55. a. Body yellow, orange or buff; with 3-7 irregular ocelli, of which the anterior-most are largest.....Lineus flavescens
- b. Body brownish-green, brown or reddish-brown; with a row of 4-8 ocelli on each side of head.....56



56. a. Body contracts in spiral coil in preservation; with 20 or more fine inconspicuous lighter rings.....Lineus vegetus<sup>15</sup>
- b. Body contracts by shortening and thickening in preservation; without rings.....Lineus ruber<sup>15</sup>
57. a. Body with sharp, thin margins; ribbon-like; cephalic grooves deep, extending more than 1/2 distance from surface of head to brain.....Cerebratulus spp.<sup>16</sup>.58
- b. Body with rounded margins; cephalic grooves shallow, extending less than 1/2 distance from surface of head to brain.....Micrura spp.<sup>16</sup>.....59
58. a. With white or strikingly pale lateral margins; size = 50-100cm.....Cerebratulus marginatus<sup>17</sup>
- b. With pale lateral margins; size = 10-15cm.....Cerebratulus californiensis<sup>17</sup>
59. a. Body salmon, grey, flesh or light brown; ocelli absent.....Micrura alaskensis<sup>18</sup>
- b. Body olive-brown, ocher or buff; 6-12 or more small ocelli form an irregular row on each side of head.....Micrura olivaris<sup>18</sup>

## FOOTNOTES

1. Otocyphlonemertes spiralis is the only species of the Otocyphlonemertidae reported from the Pacific Coast. The original description (Coe, 1940) is inadequate, and no further work on the group has been done. Work on Brazilian Otocyphlonemertidae (Correa, 1948) indicates that more than one species is usually present in a given area.
2. Carcinonemertes epialti is the only species of this family reported from the Pacific Coast. Other areas, i.e. the Atlantic Ocean, have yielded new genera and new species when closely examined. It is very probable, then, that other Carcinonemertidae are present on the Pacific Coast.
3. Zygonemertes albida, Z. thalassina and Z. virescens appear to have intergrading characters. Z. albida, in particular, is probably a juvenile form of Z. virescens, which is white when young.
4. The original description of Paranemertes californica (Coe, 1904) states that two ocelli are present at the anterior tip of the head, occasionally fragmented into granules. Coe's revision, 1940, states that four clusters of two or three ocelli are present, one on each side of the proboscis and one anterior to each brain lobe. Coe, 1944, also described a Gulf of Mexico species which has two ocelli at the anterior tip of the head. A complete redescription of P. californica and, possibly, a revision of the genus is necessary to clear up the confusion.
5. Paranemertes sp. A refers to at least one, and possibly two or three, undescribed species present on the continental shelf in Southern California. It is characterized by the presence of two ocelli, and by certain peculiarities of the stylet and basis. The species appears to be quite separate from P. californica. Assoc with *pseudopolydora* in King Harbor only
6. The species of Amphiporus are very difficult to separate, as body color is not entirely reliable, and all other characters overlap tremendously. The group appears to be in a state of radiating speciation, and is probably best left as Amphiporus spp. by the non-specialist. The Amphiporus assemblage is unique to the Pacific Coast.
7. I.D. confirmation for Amphiporus rubellus may be obtained by sectioning of the esophageal region. Beneath the esophagus proper, and the stomach, ending blindly posteriorly, there is a highly developed esophageal caecum. The peculiarity exists only in A. bimaculatus and A. rubellus on the coast of California.
8. In mature females of Amphiporus californicus, the olive green color of the ova shows through the body walls of the intestinal region in a very conspicuous fashion.

(FOOTNOTES CONTINUED)

9. Coe, 1940 moved Procephalothrix major and P. spiralis from the genus Cephalothrix to the genus Procephalothrix without giving any justification for the change. The new combinations are accepted conditionally here.
10. This couplet presumes that specimens have been fixed in formalin. In the family Tubulanidae, glandular cells in the epithelium change color on exposure to formalin, producing a characteristic "preservation ring". This preservation artefact is necessary to separate species of Tubulanus and Carinomella from species of Carinoma and Zygeupolia without sectioning.
11. These three species are difficult to separate reliably. Tubulanus polymorphus' red color frequently fades to dirty yellow when preserved. The best approach is to look at a lot of specimens. T. pellucidus is relatively uniform in appearance, and can be separated accurately with practice. Carinomella lactea can be separated from all Tubulanus spp by sectioning of the intestinal region. In Carinomella, the lateral nerve cords are imbedded in the longitudinal muscles posteriorly. In Tubulanus, the lateral nerve cords are external to the circular muscles throughout the body.
12. These two species are placed in different orders. Carinoma mutabilis (Paleonemertea) may be separated from Zygeupolia rubens (Heteronemertea) by sectioning of the esophageal region. In this region, Carinoma spp. have 3 muscular layers: an outer circular, a middle longitudinal, and an inner circular layer. Zygeupolia spp have 2 layers only: an outer circular and an inner longitudinal layer.
13. The markings of Lineus pictifrons vary considerably according to its state of contraction and/or preservation. The "diamonds" connecting transverse and longitudinal markings are characteristic, unique, reliable, and visible even when all other markings are obscured.
14. The white rings of Micrura wilsoni often fade with preservation.
15. These species are difficult to separate. Lineus vegetus characteristically reproduces by fragmentation and regeneration. Lineus ruber characteristically reproduces sexually. L. vegetus generally prefers sites among growths and under stones in exposed surf zones. L. ruber prefers protected muddy sites under stones. Gontcharoff, 1951, has described an L. ruber complex of 4 species from French waters. One of these species, L. viridis, was synonymized with L. ruber by Coe, 1940; but may be identical to L. vegetus. Another, L. sanguineus, has not been reported from California waters, but may have gone unrecognized, thus far.
16. The genera Lineus, Micrura, and Cerebratulus are not adequately separated by definition. Cantell, 1975, has examined the problem, and concluded that Lineus is probably an artificial group containing several genera. He also

(FOOTNOTES CONTINUED)

states that adequate definition and separation of the three genera is not possible at this time, due to lack of sufficient anatomical investigation. The most that can be said at this point is that most species of Cerebratulus have neurochord cells in the brain and nerve cords, while most species of Micrura do not.

17. There is some doubt that both of these species are valid. The only consistent point of distinction appears to be relative size, not a reliable basis in naming species. Redescription of both species is indicated in order to determine whether Cerebratulus californiensis is valid or a juvenile and synonym of C. marginatus.
18. These two species are closely similar and some characters intergrade. The Micrura olivaris I have seen are distinctly greenish, and ocelli are fairly obvious. However, to be certain, it is best to check for ocelli by simple dissection.

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